Ministry of Education of the Republic of Belarus
Belarusian State University
Faculty of Geography and Geoinformatics
Department of Regional Geology

СОГЛАСОВАНО
Заведующий кафедрой
___________ О.В. Лукашёв
«17» июня 2024 г.

СОГЛАСОВАНО
Декан факультета
________ Е.Г. Кольмакова
«26» июня 2024 г.

GIS in Mineral Resource Management

Electronic educational and methodological complex
for specialty: 7-06 0532 01«Geography», 1-31 80 02 «Geography»
profile: Remote Sensing and
Spatial Analysis in Geoinformation Systems
In Two parts
Part 1

Registration No. 2.4.2-24/524

Compiler:
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Reviewed and approved at a meeting of the Scientific and Methodological Council of BSU
19.09.2024, Protocol No. 2.

Minsk 2024

UDC 528.88.04:55(075.8-054.6)+91:004(075.8-054.6)
G 49

Approved at a meeting of the Scientific and Methodological Council of BSU
Protocol No. 2 of 19.09.2024

The decision on deposit was made by:
Council of the Faculty of Geography and Geoinformatics
Protocol No. 11 of 26.06.2024

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GIS in Mineral Resource Management : electronic educational and methodological complex for specialty 7-06 0532 01 «Geography», 1-31 80 02 «Geography», profile: Remote Sensing and Spatial Analysis in Geoinformation Systems. In two parts. Part 1 / BSU, Faculty of Geography and Geoinformatics, Department of Regional Geology ; compiler Zui V. I. – Minsk : BSU, 2024. – 308 p. : il., tab. – Bibliogr.: p. 305–308.

The electronic educational and methodological complex (EEMC) is intended for undergraduates studying in the specialty 7-06 0532 01 “Geography” and it could be useful as well for the specialty 1-31 80 02 “Geography”. The content of the EEMC involves increasing the efficiency of managing the educational process and independent work of undergraduates in mastering the academic discipline “GIS in Mineral Resource Management” through the introduction of innovative educational technologies into the educational process, ensuring high-quality training of highly qualified geographers.

ОГЛАВЛЕНИЕ

EXPLANATORY NOTE

The electronic educational and methodological complex (EEMC) “GIS in Mineral Resource Management” is designed to implement the requirements of educational programs, educational standards and training in the specialty 7-06 0532 01 “Geography”. It could be useful also for the specialty 1-31 80 02 “Geography”. Its presence provides the stability of the quality of the educational process and is a methodological basis for ensuring effective independent work of undergraduates. The total course consists 126 hours, which includes 52 classroom hours; lectures – 8 hours, laboratory classes – 12 hours, curricular control of managed independent work – 32 hours, tests at the end of the course with an exam – 3 hours.

The EEMC for the discipline “GIS in Mineral Resource Management” was created at the scientific-methodological and software-technical levels corresponding to modern information and communication technologies and is designed to ensure the implementation of educational goals and objectives at all stages of the educational process in this discipline.

Its purpose is to implement requirements of the educational standard and curriculum, ensuring the continuity and completeness of the learning process, systematization and control of knowledge in the discipline “GIS in Mineral Resource Management”.

The goal of the EEMC is to increase the efficiency of managing the educational process and the independent work of undergraduates in mastering the academic discipline “GIS in Mineral Resource Management” by introducing innovative educational technologies into the educational process, ensuring high-quality training of highly qualified specialists.

Scope of application is for distance learning, conducting classes on the subject “GIS in Mineral Resource Management”, during independent preparation for classroom lessons, current and final control of knowledge in sections of the discipline, orientation in performing controlled independent work.

The functionality of the EEMC are the means of orientation in the content of the discipline “GIS in Mineral Resource Management” and the order of studying educational material, mastering theoretical and practical material, preparing for knowledge control. All EEMC material is structured into sections in such a way that a master’s student can master knowledge on the specified subject independently. EEMC on “GIS in Mineral Resource Management” includes 4 main sections: theoretical, practical, knowledge control and auxiliary ones.

The theoretical section of the EEMC contains lecture notes for the theoretical study of the academic discipline, based on lecture notes for the course “GIS in Mineral Resource Management” [electronic resource] / BSU, the Electronic Library of BSU.

The knowledge control section of the EEMC contains materials for knowledge control and certification, which make it possible to determine the compliance of the results of students' educational activities with the requirements of the educational standard and educational program documentation for the specialty. This section includes options for test tasks, questions for the exam, a list of tasks and measures for controlled independent work.

The auxiliary section of the EEMC contains training programs on “GIS in Mineral Resource Management”, a list of information and analytical materials [electronic resource] / BSU Electronic Library.

The EEMC on “GIS in Mineral Resource Management” is intended for teachers, students, and graduate students, undergraduates studying geological and geographical sciences.

The EEMC "GIS in Mineral Resource Management" reveals the methodological foundations for organizing geological exploration for minerals, obtaining source materials and their theoretical processing.

The subject “GIS in Mineral Resource Management” reveals research methods and the general theory of the occurrence of geological and geodynamic processes in the study area. The methodological foundations of regional geology and geodynamics, applied and fundamental problems of the placement and use of mineral resources are considered.

1. THEORETICAL SECTION

LECTURE NOTES

1.1. Introduction

Geological exploration of various types of mineral raw materials requiressufficient knowledge about the geological evolution of regions, the causes and features of geological processes in the bowels of the Earth in all its shells in the context of the development of our planet over time, the conditions for the formation of various minerals, as well as methods for their development, enrichment of the mined ore and, ultimately, extraction of a useful component from it. This science actually studies both random and systemic geological processes and their manifestations.

Minerals provide the material used to make most of the things of industrial-based society, for instance, roads, cars, computers, fertilizers, etc. Demand for minerals is increasing worldwide as the population increases and the consumption demands of individual people. The mining of Earth's natural resources is, therefore accelerating, and it has accompanying environmental consequences. The development of industrial production steadily requires the expansion of the mineral resource base in all regions of the world.

1.2. Mineral Resources: Definition, Types, Use and Exploitation

Types of mineral resources. A mineral is a pure inorganic substance that occurs naturally in the Earth's crust. All of the Earth's crust, except the rather small proportion of it that contains organic material, is made up of minerals; they originate in the process of geologic evolution and transformations of rocks, fig. 1.1. Main types of them are igneous, sedimentary and metamorphic rocks. Some minerals consist of a single element such as gold, silver, diamond (carbon), and sulphur.

More than two-thousand minerals have been identified and most of these contain inorganic compounds formed by various combinations of the eight elements (O, Si, Al, Fe, Ca, Na, K, and Mg) that make up 98.5% of the Earth's crust. The industry depends on about 80 of the known minerals. Sometimes hydrocarbons and water ice also are considered as minerals.

A mineral deposit is a concentration of naturally occurring solid, liquid, or gaseous material, in or on the Earth's crust in such form and amount that its extraction and its conversion into useful materials or items are profitable now or may be so in the future. Mineral resources are non-renewable and include metals (e.g. iron, copper, and aluminum), and non-metals (e.g. salt, gypsum, clay, sand, phosphates).

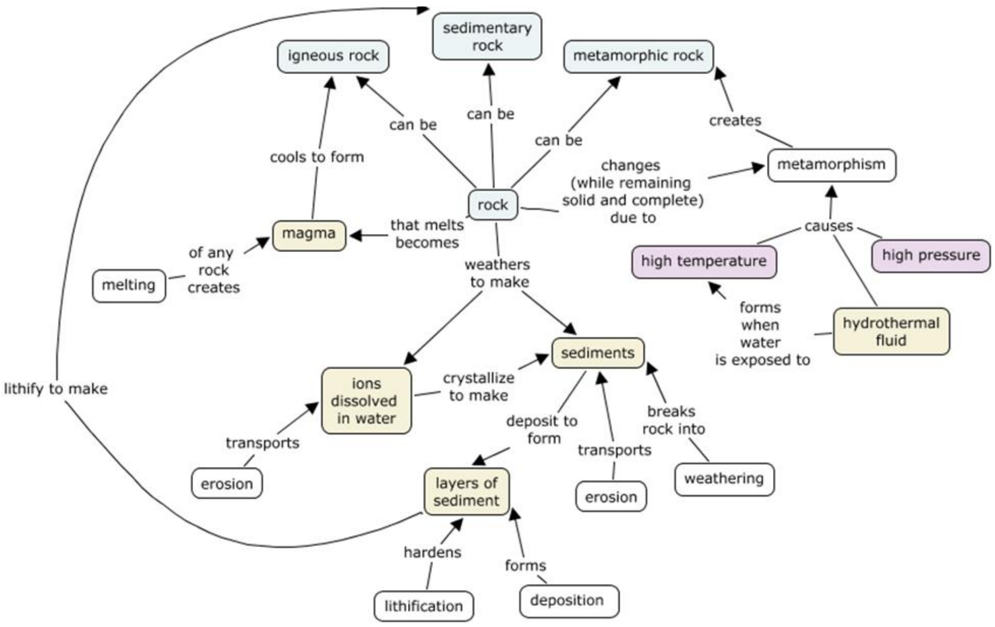


Figure 1.1 Rocks and the Rock Cycle [1].

Minerals are valuable natural resources being finite and non-renewable. They constitute the vital raw materials for many basic industries and are a major resource for development. Management of mineral resources has, therefore, to be closely integrated with the overall strategy of development; and exploitation of minerals to be guided by long-term national goals and perspectives. Main types of minerals shown in fig. 1.2.

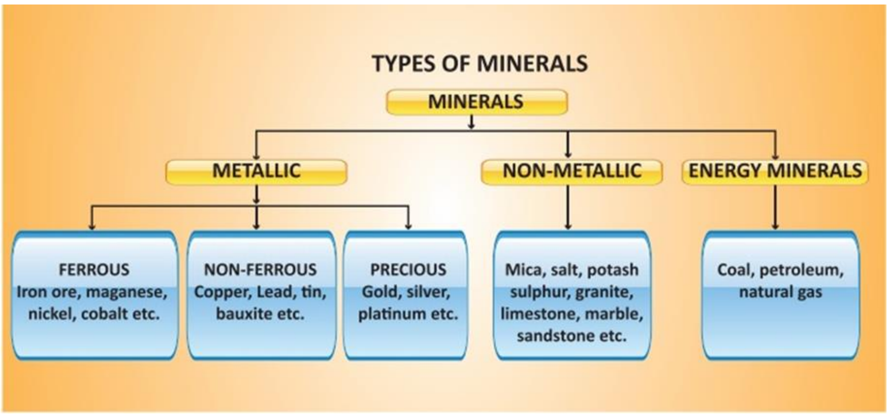


Figure 1.2 types of minerals [2]

There are three main groups of minerals: metallic, non-metallic and energy ones. In turn, metallic minerals are divided into ferrous (iron ores, manganese, nickel, cobalt, etc.), non-ferrous (copper, lead, tin, bauxite, etc.), precious (gold, silver, platinum, etc.). Mica, salt, potash, Sulphur, granite, limestone, marble, sandstone, etc. comprise the nonmetallic group. Coal, petroleum, natural gas belong to energy minerals. Some minerals, like gold and diamond, are rare and precious, while others, like quartz, are more ordinary.

Minerals grouped also by their chemical composition. Silicates, oxides, sulfates, sulfides, carbonates, native elements, and halides are all major mineral groups. Many minerals play important role for industry. An example of principal industrial minerals and their mining sites shown in fig. 1.3 for England, the UK.

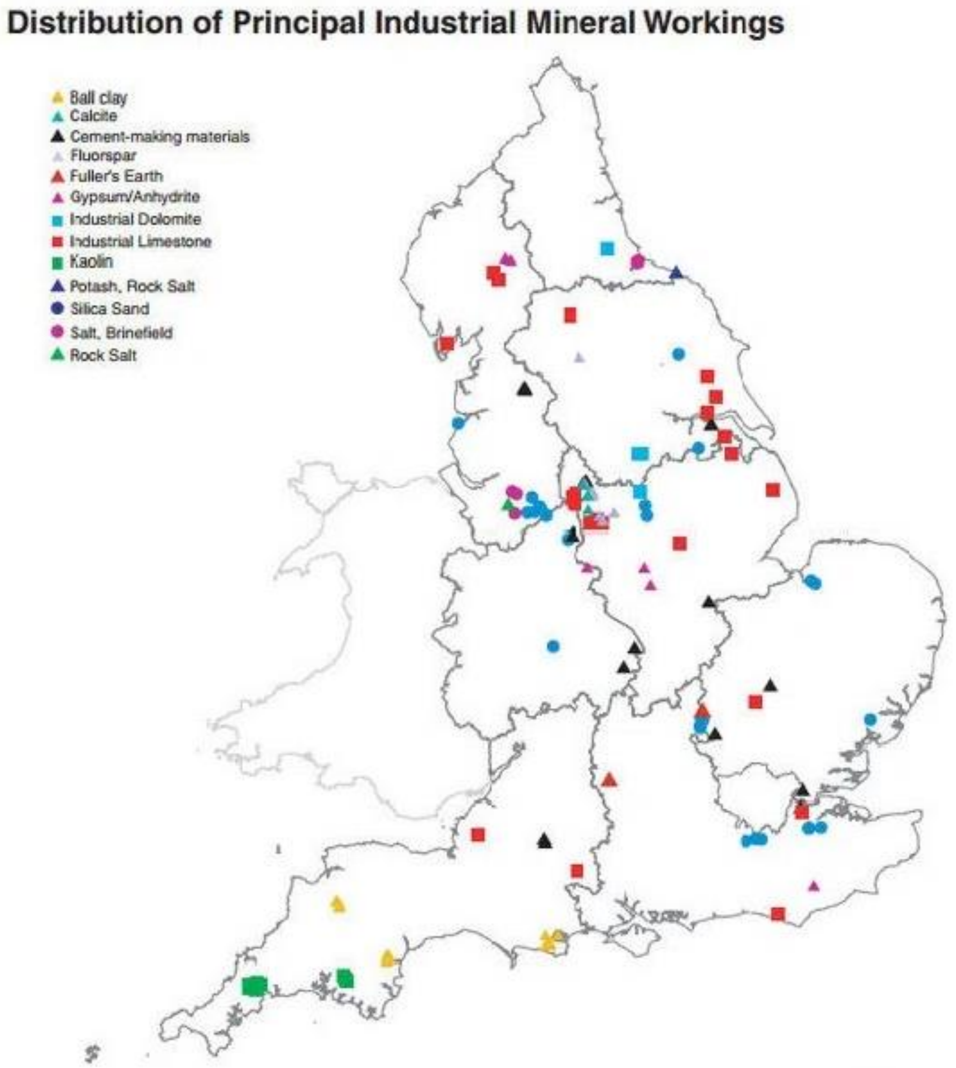


Figure 1.3. A map of England, showing the mining sites for some mineral resources [3]

(A) Fuel Minerals:

Coal, oil and natural gas are the basic fossil fuels.

(i) Coal:

The calorific value of coal varies with percentage of carbon present in it. Coal depending upon variation in percentage carbon, is divided into three categories (bituminous / anthracite type is the most abundant form present in a coal):

(ii) Crude Oil (Petroleum):

The petroleum on fractional distillation and further processing provides us numerous products and by-products after heating the crude oil to about 400°C. One million tons of crude oil on fractional distillation provides about 0.8 million tons of petroleum products. The percentage composition varies with the quality of crude oil or it could be varied up to a certain limit depending upon the requirement or demand.

The petroleum products used in industries including power generation, domestic use and for miscellaneous purposes. The consumption of petroleum products has been increasing consistently and is bound to increase at rapid pace in near future in view of rapid growth of these vital sectors.

(iii) Natural Gas:

The proven reserve for natural gas on April 1993 works out to be approx. 700 billion cubic meter (BCM). As regard to production Vis a Vis utilization aspect in earlier years, more than half of gas coming out of the wells remained unutilized. However, in recent years, we have achieved a utilization rate of 80–90 %.

(B) Metallic and Non-metallic Minerals:

1. Metallic mineral resources are resources of minerals that contain metal in raw form, their appearances have metallic shine and they can be melted to obtain new products. They also contain metals in their chemical composition; the only way you can extract them is through mining. Some examples of metallic mineral resources include Gold, Silver, Copper, Tin, Iron, Lead, Zinc, Nickel, Chromium, and Aluminum.

Silver – it is a light precious substance used for making jewelry, cell phone covers, fine silverware, coins, as well as photographic and X-ray films. Because of its versatility, availability, affordability, and appeal it is used for different things and it is very bright, durable, and easy to work with. Silver also is substantially cheaper than platinum or gold.

Platinum – Platinum is the most precious and durable of all metals used in the jewelry industry; it is very pure and it is rarer, denser, and stronger than gold or silver. Because of its purity, it does not tarnish or fade after much use, and it is extremely durable. Platinum has a deeper and more luminescent white hue than either white gold or silver. Platinum is the traditional metal for heirloom-quality jewelry. It is a natural partner for a fine white diamond.

Gold – gold, fig. 1.4 is a rare, valuable, and durable precious metal with a versatile use; gold is relatively heavy and made into a wide range of intricate jewelry designs. Apart from the jewelry, gold also used in dentistry, medicine, electronic chips, coins, and applications for the aerospace industry. Gold has high corrosion resistance and will not tarnish from everyday use. This makes it ideal for jewelry.

Gold commonly alloyed with other metals to increase its strength and durability, as well as to alter its hue.

Figure 1.4. Gold-bearing quartz vein from California [4]

Gold is available in various degrees of purity. Yellow gold is seen most often, but white gold (gold mixed with palladium, nickel, and silver) is also popular in some parts of the world, especially for bridal jewelry. Gold found sometimes in the form of nuggets of various shapes and sizes, fig. 1.5.

Figure 1.5. Gold crystal [5]

The lightest metal is lithium, fig. 1.6. Nowadays, it is widely used in electrical energy storage devices, for example in mobile phone batteries, electric cars and other types of vehicles (electric bicycles, buses, trolleys), in rocketry and other products.

Figure 1.6. Lithium [6]

Lead – it is a bluish-white soft malleable ductile plastic, or inelastic heavy metallic element found mostly in combination, and it is used especially in X-ray and gamma radiation shielding, pipes, cable sheaths, batteries, solder, and shields against radioactivity, weights, and ammunition.

Tin – a soft silvery-white, ductile and malleable metal. It is obtained mainly from the mineral cassiterite, which contains tin dioxide, SnO, tin is used in containers, as a protective coating, in tinfoil, and in soft solders and alloys.

Copper – Copper is a soft shiny and malleable metal used as in alloys (bronze and brass), it is the 29th element on the periodic table. This metal is resistant to corrosion when it exposed to air and water and it used to make coins, brass instruments, pipes, and fungicides, it is also a good conductor of electricity and for electrical wiring in our homes.

Aluminum – this is a silvery-white lightweight metal with a malleable and durable property. Aluminum is the third most abundant mineral in the Earth's crust and it used in smartphones, tablets, laptops, and a flat-screen TV. However, because of its strength and weight ratio, Aluminum is used in a huge variety of products including pots, pans, basins, cans, foils, kitchen utensils, window frames, and airplane parts.

2. Nonmetallic mineral resources are minerals that do not contain extractable metals in their chemical composition; they contain nonmetallic shine or luster in their appearance. Nonmetallic resources are things like stone, sand, gravel, clay, gypsum, halite and Uranium. They can be reprocessed through grinding, mixing, cutting, shaping for intermediate use, fig. 1.7.

Figure 1.7. The rust color of hematite (left) and the rust-yellow color of limonite (a variety of goethite, right) have long used for pigments [7].

Gypsum – this is a soft white or grey mineral consisting of hydrated calcium sulfate. It occurs chiefly in sedimentary deposits; it used for making cement, plaster of Paris, fertilizer, wallboard, and glass.

Gravel – gravel is one of the most accessible natural deposits classified by particle size range; it includes size classes from granule- to boulder-sized fragments that are gotten from river channels, river flood plains, and glacial deposits. People use gravel for various constructions and most often use for making construction materials such as concrete blocks, bricks, pipes, mixing with asphalt, and as construction fill.

Sand – this is the most accessible natural resource found in the beach, roadside, water channels, rivers, and streams, it is mostly quartz, formed by weathering of igneous rocks like granite, it comes in various sizes of grain. Sand has varieties of uses. It used in sandbags: for construction or to line the floors of arenas and other surfaces, for playgrounds, etc.

3. Fuel mineral resources are the basic mineral resources in the world, some examples of these include fossil fuels such as coal, crude oil (petroleum), and natural gas; they are often referred to as fossil fuels and are formed from hydrocarbon. When fossil fuels burned, they particularly give rise to a great source of heat energy. The proper use of fossil fuels has enabled large-scale industrial development and largely supplanted water-driven mills, as well as the combustion of wood or peat used to produce heat.

Crude oil popularly known as petroleum is a liquid found within the Earth comprised of hydrocarbons, organic compounds, and small amounts of others. It represents a mixture of naturally occurring hydrocarbons that are refined into heating oil, diesel, gasoline, jet fuel, and kerosene. Crude oil commonly extracted by drilling into sedimentary rocks in the exact position where the oil is found.

Coal – coal, fig. 1.8, is a sedimentary/metamorphic rock produced in swamps where there is a large-scale accumulation of organic matter from plants. As plants die, they decay and accumulate to become peat. Compaction of the peat due to burial drives off volatile components like water and methane, eventually producing a lump of black-color organic-rich coal called lignite. Further compaction and heating results in more carbon-rich coal called bituminous coal. When the rock metamorphosed, a lump of high-grade coal called anthracite produced. However, if temperatures and pressures become extremely high, all of the carbon changes to graphite. Graphite will burn only at high temperatures and is therefore not useful as an energy source. Anthracite coal produces the most energy when burned, with less energy produced by bituminous coal and lignite.

Figure 1.8 Excavating coal

Peatlands occur in every climatic zone and the total area globally is around 4.23 million km^2, which corresponds 2.83 % of the Earth's land surface, fig. 1.9.

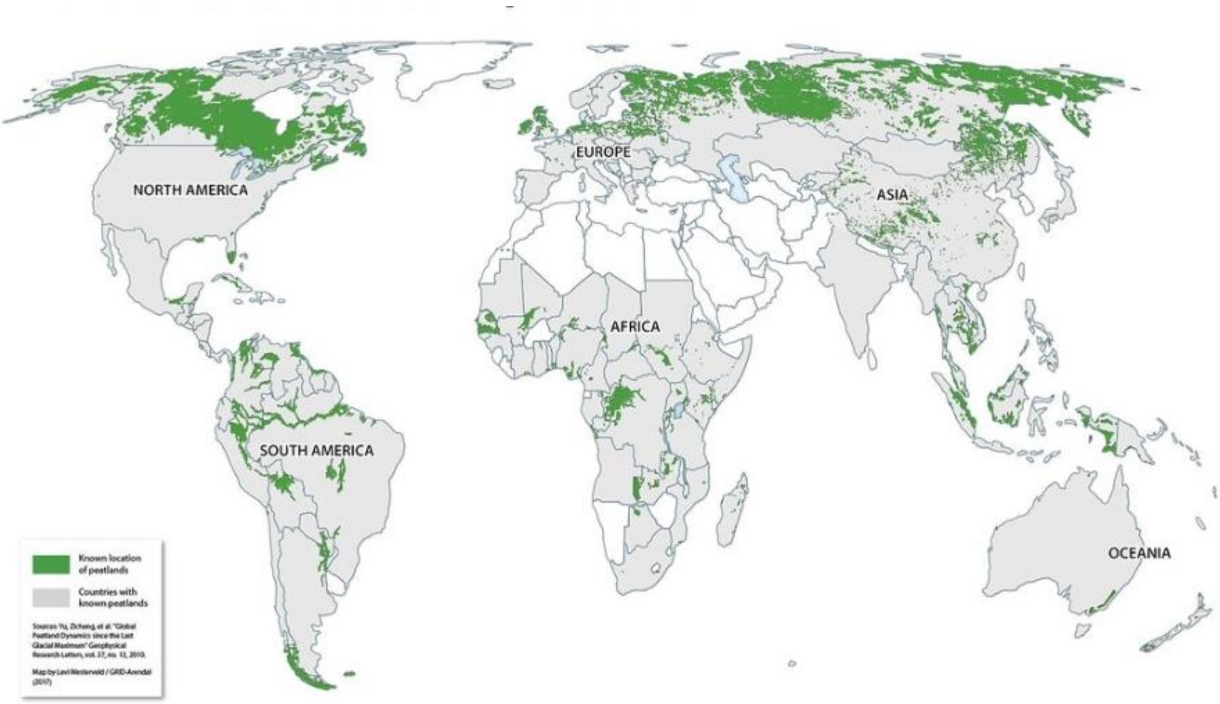


Figure 1.9. – Global distribution of peatlands [8].

Natural gas – natural gas is derived from marine plants and animals; that is by a combination of sedimentary processes, which trap and bury plant and animal remains, and then metamorphic processes, which heat and change the plant and animal remains into deposits of oil and gas.

Mineral resources exploration. Mineral resources usually mined once the deposit has been discovered in the ground or in the sea; this process is usually done by different methods most times using the opencast quarrying or underground mining method or by pumping. The mining process depends on the type of mineral discovered. For instance, salt is usually extracted by pumping; in this case, the salt is dissolved in water and pumped from underground just like in the case of oil and gas.

After these minerals have been extracted from the ground, they are processed and purified to a form of useful material in which we use on a daily basis. The mining process usually involves removing any unwanted impurities and further processing to increase the concentration of the economic mineral. Metallic minerals usually smelted or refined to produce metal close to the mine, or the concentrate transported to another site for further processing.

Oil and gas are also further refined before use. Finally, once a mineral deposit found it has to be extracted from the ground to access the valuable minerals it contains.

Use and Exploitation. The use of minerals varies greatly between countries. The greatest use of minerals occurs in developed countries. Like other natural resources, mineral deposits unevenly distributed on the Earth. Some countries are rich in mineral deposits and other countries have no deposits. The use of the mineral depends on its properties. For example, aluminum is light but strong and durable. It used for aircraft, shipping and car industries. The primary methods used to extract minerals from the ground are:

- Underground mining.
- Surface (open pit) mining.
- Placer mining.

The location and shape of the deposit, strength of the rock, ore grade, mining costs, and current market price of the commodity are some of the determining factors for selecting which mining method to use.

Resources are characterized as renewable or nonrenewable ones. Recovery of mineral resources has been with us for a long time. Early Paleolithic man found flint for arrowheads and clay for pottery before developing codes for warfare. In addition, this was done without geologists for exploration, mining engineers for recovery or chemists for extraction techniques. Tin and copper mines were necessary for a Bronze Age; gold, silver, and gemstones adorned the wealthy of early civilizations; and iron mining introduced a new age of man.

Human wealth comes from agriculture, manufacturing, and mineral resources. Our complex modern society is built around the exploitation and use of mineral resources. Since the future of humanity depends on mineral resources, these resources have limits; our known supply of minerals will be used up early in the third millennium of our calendar.

Furthermore, modern agriculture and the ability to feed an overpopulated world is dependent on mineral resources to construct the machines that till the soil, enrich it with mineral fertilizers, and to transport the products.

We are now reaching limits of reserves for many minerals. As the industrialized nations of the world continue the rapid depletion of energy and mineral resources, and resource-rich less-developed nations become increasingly aware of the value of their raw materials, resource driven conflicts will increase.

Higher-grade metallic ores found in veins deep under the Earth's surface can be profitably mined using underground methods, which tend to be more expensive. Large tabular-shaped ore bodies or ore bodies lying more than 1,000 feet (300 m) below the surface are generally mined underground as well. The rock is drilled and blasted, then moved to the surface by truck, belt conveyor, or elevator. Once at the surface, the material is sent to a mill to separate the ore from the waste rock.

Lower grade metal ores found closer to the surface can be profitably mined using surface mining methods, which generally cost less than underground methods. Many industrial minerals are also mined this way, as these ores are usually low in value and were deposited at or near the Earth's surface. In a surface mine, hard rock must be drilled and blasted, although some minerals are soft enough to mine without blasting.

Placer mining is used to recover valuable minerals from sediments in present-day river channels, beach sands, or ancient stream deposits. More than half of the world's titanium comes from placer mining of beach dunes and sands. In placer operations, the mined material is washed and sluiced to concentrate the heavier minerals [9].

Different types of mineral resources require using of different methodological techniques for conducting geological exploration, as well as different methods for their development and obtaining the final mineral. For example, excavators and large trucks are necessary to extract coal after stripping operations in quarries. In contrast, seismic surveys are required to identify potential traps for hydrocarbon accumulations, and deep wells are required to extract such minerals. Special dredges usually used to extract gold from placers in alluvial deposits of river valleys, etc.

In each specific case, a lot of specialized software has been developed for computer processing and analysis of the received data. For instance, for oil exploration and recovery they are "Petrel", "FieldPro" and others". However, along with this, other geographic information systems (GIS software) are widely used in the practice of prospecting and exploration of mineral resource deposits for mapping, statistical data processing, constructing maps, profiles and sections, assessing recoverable mineral reserves, etc.

This course is focused on the use of GIS software as applied to the practice of prospecting and exploration of mineral resources.

This guide is based on processing the latest data on practical and theoretical components of research methods, general and specific issues of an application of the GIS software (a spatial system that creates, manages, analyzes, and maps all types of data) for the sphere of mineral resources, their geological exploration, mapping resource deposits, methods of their development and relater tasks.

1.3. Structure and content of the "GIS in Mineral Resource Management"

The course "GIS in Mineral Resource Management" consists of sections covering the following issues:

1. Mineral Resources: Definition, Types, Use and Exploitation
2. Main GIS software used for development and analysis in Mineral Resource Management
3. Generic Mapping Tools (GMT) Introduction and Definitions
4. QGIS Introduction and Definitions
5. Golden Surfer
6. Oasis montaj
7. Laboratory tests based on GMT
8. Laboratory tests based on QGIS

1.4. Main GIS software used for development and analysis in Mineral Resource Management

Currently, geographic information systems (GIS) are increasingly used in solving scientific and practical problems in various fields of geology and nature management, environmental protection, forestry, agriculture and water management, etc.

There are several program packages frequently used in practice: ArcGIS, QGIS, Oasis Montaj, Maplnfo, Adobe Illustrator, Generic Mapping Tools (GMT), Surfer, Corel Draw, Grapher, etc. The packages GMT and QGIS are freely available in Internet. They are the fast-growing open source geographic information systems and released under terms of the GNU General Public License (GPL). It means that they are free to download and freely adaptable. Several times a year new releases of them become available. Some of them can be installed under several platforms. GMT is available free for installation under Windows, macOS, Linux, FreeBSD, and Cygwin (a Unix-formatted operating system). The Cygwin can coexist with Windows. For instance, the GMT 6.5.0 (latest release) version is freely available; it can be installed under several releases of Windows on a personal computer or laptop. You can download and install it on your computer, which is suitable for students. Other software products are commercial ones.

1.5. Generic Mapping Tools (GMT) Introduction and Definitions

The Generic Mapping Tools software package (GMT) is a set of about 60 console tools (utilities/modules) designed to process geological, geographical and other source data and to create high-quality graphic illustrations from simple *x–y* plots to artificially illuminated relief maps and 3D images of surface models, as well as animations. GMT outputs result in classic script recording as PostScript (PS) or Encapsulated PostScript (EPS) files, and starting from GMT-6 it provides plots in pdf format (new script recording). GMT allows PostScript files to convert on fly to bmp, eps, jpg, pdf, png, ppm, svg, tiff by the *psconvert* utility, and the Postscript file can be converted to *.cdr using CorelDraw. The GMT has no the graphic interface, unlike, for example, QGIS.

GMT is a powerful, full-featured GIS widely used in the scientific field. The software package contains also data on the coastlines of continents, major rivers, lakes, canals, state borders. GMT allows you to create professional-quality graphics, including animations.

Despite its impressive range of data processing capabilities, the main goal of GMT is to reduce the time when preparing high-quality illustrations for reports, projects, publications in journals, or slides when creating presentations. GMT allows you to create professional-quality maps and graphics with a resolution of 300, 720 or more dpi (dots per inch).

Modules of the GMT package designed for processing and displaying two-dimensional and three-dimensional information, rasterization, filtering, as well as animated video files and other image processing algorithms for rendering various map projections [10].

Initially, GMT was written for UNIX, either UNIX-compatible systems with a BSD (Berkeley Development Systems) kernel, UNIX, FreeBSD, OpenBSD, etc. – UNIX-compatible systems, or systems that emulate UNIX, for example – Linux, Cygwin. Later it was also translated for DOS and Windows, where batch-processing files (bat-files) are used instead of shell scripts under UNIX. We will consider scripts written in the form of bat-files in the manual; the structure of command lines is somewhat different from that in shell scripts. Nevertheless scripts written for Bash shell could be executed using the Git Bash (for instance Git-2.46.0-64-bit release) compatible with Windows.

As it was mentioned, the main difference between GMT and most other GIS (ArcGIS, QGIS, Oasis Montaj, etc.) is a lack of the graphical interface, which at first glance may seem like an inconvenience. However, with a large amount of data to process and a large number of maps obtained at the output, this is rather an advantage. You can write a script (program code) that will extract the required portion of data, process and arrange it in the form of a map or other graphics.

The GMT draws maps or graphs sequentially, calling the necessary utilities, each of which adds its own portion of data to the output file. For this reason, it is customary to format the sequence of utility calls in a shell script under UNIX, or as a bat-file under MS-DOS and Windows, by slightly editing which you can redraw the map or draw a new one. A batch file (file with the *bat* extension) defines the calls to GMT utilities (for instance edited with the standard WordPad program from the Windows package).

Installing GMT-6 under Windows. GMT can be downloaded from Internet and installed under 32- or 64-bit Windows (for instance, https://www.generic-mapping-tools.org/download or https://github.com/GenericMappingTools/gmt/releases), or GMT FTP mirrors. Depending on the bitness of your Windows, download the compressed file (Windows installer), for instance gmt-6.4.0-win32.exe (123 MB) or gmt-6.4.0-win64.exe (170 MB) release and run it. It is also useful to download the checksum file gmt-6.4.0-checksums.txt.

The package contains basic installation (GMT_basic_install.exe), which includes medium resolution data for the coastline of oceans, seas, lakes; also – high resolution data (GSHHS_highfull_install.exe); documentation. The latest is GSHHG 2.3.7: the global self-consistent, hierarchical, high-resolution geography database. By default, the program is installed in the C:\programs\GMT6 folder, no additional settings are required. The command line utilities are located in C:\programs\GMT6\bin folder. Other key directories are listed in Table 1.1.

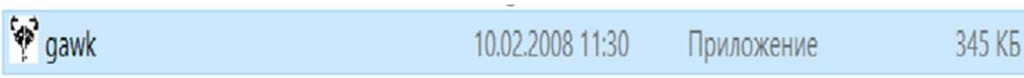
Paths to key folders available in the Windows registry; and when calling utilities from a batch file, you do not need to specify the full path in your scripts.

Table 1.1.

Key Windows installation directories of GMT (C:\programs\GMT\...)

Subdirectory	Explanations
\bin	Command line utilities
share\doc\gmt\html	Documentation in HTML format. Recommended for initial review.
share\doc\gmt\examples	Over 50 examples and 15 animations for working with GMT. Each of examples contains a batch file and the data needed to work. When the batch file is running, a graphic image is generated in the form of a PostScript file (with *.ps, or *.pdf extension). Scripts in examples to produce animations are also available for the bash shell.

At the same time, it is useful to install the relatively simple *gawk* programming language. It is freely available from http://ftp.gnu.org/gnu/gawk (the latest release is gawk-5, but you may use, no matter, either one for 32 or 64 bit), because, for example, in a number of tests supplied with the GMT package, in some cases, separate commands and options of this programming language are used. The *gawk.exe* file can be manually added to the C:\programs\GMT6\bin directory.



GhostScript and GSView. GMT uses PostScript fonts and the output is generated in the classic way as PostScript files. A popular utility of this kind are free GhostScript fonts, the desired version can be downloaded from Internet (https://github.com/ArtifexSoftware/ghostpdl-downloads/releases) or (https://ghostscript.com/releases/gsdnld.html). You need also a PostScript file viewer to open PostScript images. Therefore, two programs have to be installed on your computer: the GhostScript interpreter for *.ps files and the graphical shell for viewing them GSView (http://www.ghostgum.com.au/software/gsview.htm). No settings are necessary after installation. Ps files can also be opened e.g. with Adobe Photoshop or CorelDraw, but GsView works much faster. When working with GMT-6 releases the GsView is not obligatory to install.

GSView and Ghostscript are freely available from the Internet at a number of sites both for 32 and 64 bit Windows releases, fig. 1.10.

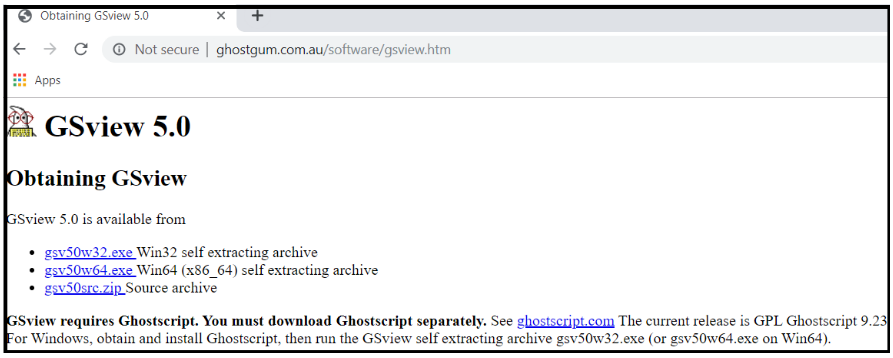


Figure 1.10 – Downloading GSview

The installation process will download fonts (for example, gs909w32). This completes the installation.

1.5.1. Simple examples of planning graphics using GMT

There are two forms of scripting for GMT subroutines – the "classic" and the "modern" mode (using the *begin* ... *end* modules). The classic mode was used in releases GMT1 – GMT4, with output graphic files created in PostScript format (*.ps). It also works under later versions 5 and 6 of GMT. The script in the "modern" mode has more compact form (e.g. no need to show at each line of the script the output file for results, no need repeating options -O, -K, -P, -R, -J, -B and some others). The graphic file is presented by default in *.pdf format. Prefixes 'ps' in line commands of the "modern" mode are omitted, for example, instead of '*pstext*' and '*pscoast*' (classic mode), we use '*text*' and '*coast*', instead of '*psxy*' and '*psxyz*' are used '*plot*' and '*plot3d*', instead of '*psscale*' – '*colorbar*'. Several other modules added (*figure*, *subplot*, *inset*, *movie*, *events*, *region*, etc.). We will consider the possibilities of GMT below on examples of creating various graphic files, both using the traditional and the modern modes of scripting derived from documentation supplied with GMT.

Example 1. Linear projection – square root plot. The conversion of Cartesian coordinates to GMT has three varieties: linear coordinates, logarithmic Log10 coordinate, and power coordinates.

Transformations turn the input coordinates (x, y) into positions (x', y') in the plot. Separate transformations are available for the x and y-axes (and the z-axis in the 3D plots). Below we will use the expression $u' = f(u)$, where u will be either x or y (or z for three-dimensional graphs). The coefficients in $f(u)$ depend on the desired plot size (or scale), the selected area (x, y), and the nature of f itself.

In Cartesian coordinates, the projection is specified in inches (i) or centimeters (c) (-Jx) or the length of the axes (-JX). If the scale or the length of the y-axis differs from that of the x-axis (which is common), then separating two scales (or lengths) with a slash ("/") is used, e.g. -Jx0.1i/0.5i or -JX8i/5i. Note that each option in the commands must be preceded by a hyphen "-" starting from the third line. Then our batch file of the function y = √ x can be created by any text editor, such as WordPad. Our bat file looks like:

```
gmt math -T0/100/1 T SQRT = sqrt.d
gmt math -T0/100/10 T SQRT = sqrt.d10
gmt plot -R0/100/0/10 -JX5i/2.5i -Bag -BWSne+gsnow -Wthick,blue,- -
P -K sqrt.d > GMT_sqrt.ps
```

Let's this file be GMT_sqrt.bat and save it using "File" → "Save as" → "Other formats" (Fig 1.11) → "MS-DOS text document", select the folder where you want to save this file and click "Save" (Fig 1.12).

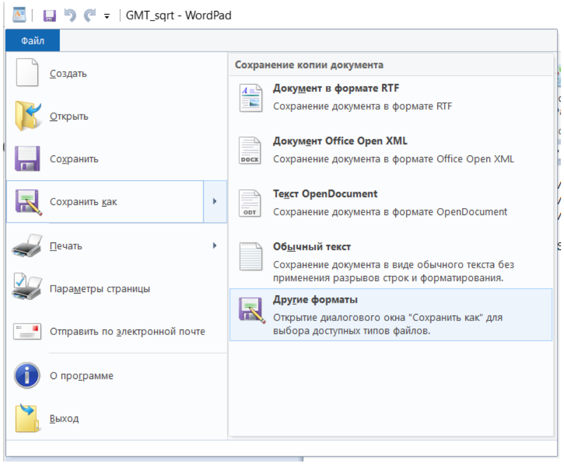


Figure 1.11 – Saving the file GMT_sqrt.bat (step 1)

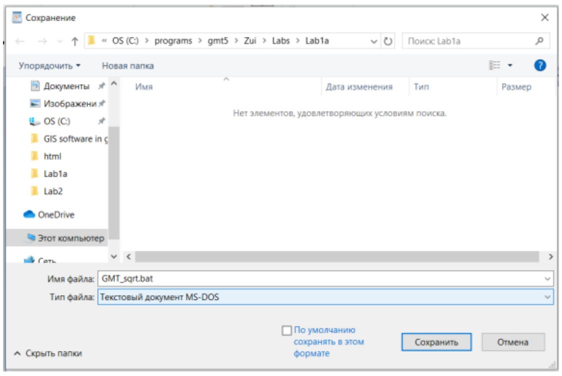


Figure 1.12 – Saving the prepared file GMT_sqrt.bat (step 2)

For a modern mode the ‘*psxy*’ must be replaced with the ‘*plot*’. No need to type the output file (“> GMT_sqrt.ps” or “>> GMT_sqrt.ps” at the end of command lines as well as the -R, -J, -O, -K options). The script is simplified:

```
gmt begin sqrt
     gmt math -T0/100/1 T SQRT = sqrt.d
     gmt math -T0/100/10 T SQRT = sqrt.d10
     gmt plot -R0/100/0/10 -JX5i/2.5i -Bag -BWSne+gsnow \ -
Wthick,blue,- sqrt.d
     gmt plot sqrt.d -Wthinner,-
     gmt plot -St0.1i -N -Gred -Wfaint sqrt.d10
gmt end show
```

The *end* command ends the current mode of operation, finishes processing the drawing(s) and places them into the current directory. The *show* module displays the constructed *sqrt* graph in *.pdf format (you can also choose or add, e.g. *.png format).

The first line *gmt math* -T0/100/1 T SQRT = sqrt.d calculates the square root value for *x* from 0 to 100 through one (0, 1, 2, 3…100) and writes the resulting root values to the sqrt.d file (column are *x* and *y* respectively) up to *x* = 100, it looks like:

```
0     0
1     1
2     1.41421356237
3     1.73205080757
4     2
5     2.2360679775
6     2.44948974278
7     2.64575131106
8     2.82842712475
9     3
. . . . . . . . . .
```

The next command *gmt math* -T0/100/10 T SQRT = sqrt.d10 calculates the square root values for *x* from 0 to 100 through 10 and writes the resulting root value to the sqrt.d10 file, it looks like:

```
0     0
10    3.16227766017
20    4.472135955
30    5.47722557505
40    6.32455532034
50    7.07106781187
60    7.74596669241
70    8.36660026534
80    8.94427191
90    9.48683298051
100   10
```

The *gmt plot* -R0/100/0/10 -JX5i/2.5i -Bag -BWSne+gsnow -Wthick,blue,- sqrt.d draws a blue line bold dashed curve line on the chart (option -Wthick,blue) of functions y = √x in the frame (-R0/100/0/10) for the *x* from 0 to 100 through 10; for the *y* – from 0 to 10). Option -JX5i/2.5i selects 5-inch axis lengths (i) for *x* and 2.5-inch for *y*. This data will be added to the resulting sqrt.pdf file. The -Bag option applies annotations for axes and a graticule.

Similarly the 4th and 5th command lines. For instance, *gmt plot* -St0.1i -N -Gred -Wfaint sqrt.d10 sqrt.d will add 0.1 inch triangles to the output (-St0.1i) in red (-Gred) every *x* = 10 and place them on the curve drawn by command 3.

Having opened the created file sqrt.ps, for example, using the GsView, we will see the following gmt plot (fig 1.13):

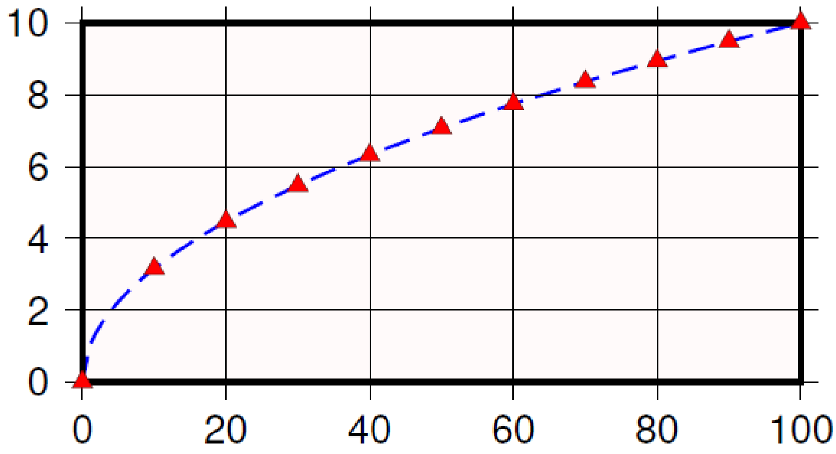


Figure 1.13 – Graph of the function y = √x

Optionally, you can modify the command parameters, e.g., color (yellow; green; violet; orange; pink; grey, etc., draw a solid blue line curve (-Wthick,blue) or a dash-dotted one (-Wthick,blue,-.). You can change the size of triangles, for instance to 0.3" (-St0.3i). You can set their size in cm (c) as well.

Example 2. Linear projection – log plot ($\log_{10}$). Consider plotting a square root in logarithmic Cartesian coordinates (-Jx), where *x* is in the logarithmic scale and *y* remains in the normal scale. To do this, you need creating a GMT_log.bat file (traditional mode) with the script:

```
REM "Classic" mode of the script
gmt psxy -R1/100/0/10 -Jx1.5il/0.15i -Bx2g3 -Bya2f1g2 -
BWSne+gbisque -Wthick,blue,- -P -K sqrt.d > GMT_log.ps
gmt psxy -R -J -Ss0.1i -N -Gred -W -O -h sqrt.d10 >> GMT_log.ps
```

Save the GMT_log.bat file like earlier (File → Save as → Other formats → MS-DOS text document). The sqrt.d and sqrt.d10 files were already created when plotting the square root above. The resulting graph is GMT_log.ps file.

In the first command: the -Bx2g3 and -Bya2f1g2 options mean that the *x*-axis and *y*-axis are digitized separately. Adding a flag (*a*) is given to indicate the annotation and location of the main lines (default), when (*f*) to indicate additional (small) dash, and (*g*) for gridlines.

-BWSne means: -B – create a map frame with: 'WS' – drawing the western (W) and southern ('S') axes with their digitization; 'ne' – drawing the north (n) and east (e) axes without digitizing. +gbisque means to add a background (+g) with a rose-yellow color (bisque). -Wthick,blue,- means to use pen (-W) thick, color blue, draw dashed line ('-' after 'blue'). You can also draw a dash-dotted line ('**-.**'), or a solid one (remove '**-.**'). In the second command: the option -Ss0.1i; (-S) means add characters, it will be 0.1 inch square (s0.1i).

The (-N) option means to turn off clipping of repeated characters, or characters outside the map frame (in this case, you can omit it). The (-Gred) option means to paint (-G) the squares in red. The (-O) option means to overlay the result of this command on an existing plot (GMT_log.ps).

Run the GMT_log.bat file and obtain a graph of the function $y = \sqrt{x}$ in semilogarithmic coordinates. Having opened the created GMT_ log.ps file using the GsView program, we will see the following (fig 1.14):

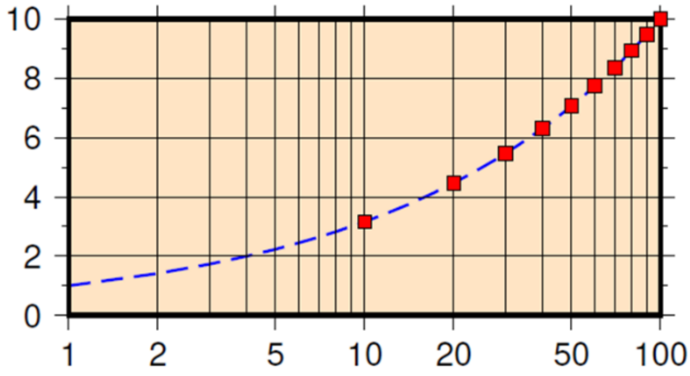


Figure 1.14 – The function y = √x in semi-logarithmic Cartesian coordinates

Example 3 Linear projection – power graph. Similarly, one can plot the function y = √x in the power scale of the projection $u' = au^b + c$, which allows to see the power-law relationship, for example, $x^p - y^q$. The p and q can be any values, we choose p = 0.5 and q = 1, this means that we display it in the $x - y^{0.5}$ axes. Create the GMT_pow.bat file:

```
REM "Classic" mode of the script
gmt psxy -R0/100/0/10 -Jx0.3ip0.5/0.15i -Bxa1p -Bya2f1 -
BWSne+givory -Wthick -P -K sqrt.d > GMT_pow.ps
gmt psxy -R -J -Sc0.075i -Ggreen -W -O sqrt.d10 >> GMT_pow.ps
```

In the first line options: -Bxa1p and -Bya2f1 mean that *x* and *y-axes* are digitized separately with the (+givory) background (ivory is the color of teeth). The used option (-Jx0.3ip0.5/0.15i) means Cartesian coordinates (-Jx) with different *x* (0.3ip0.5) and *y* (0.15i) inch scales are selected. Could be used inches (i), centimeters (c), or points (p). In the second command: (-Sc0.075i), the **(-S)** option means to draw in 0.75-inch circle **(**c0.075i). It must be painted in green color (-Ggreen). The remaining parameters were already discussed above. You can draw stars (-Sa0.1i), diamonds (-Sd0.1i), pentagons (-Sn0.1i), or crosses [multiplication symbol] '×' (-Sx0.1i), etc.

After we run the GMT_pow.bat script, the graph of the function $y = \sqrt{x}$ in power Cartesian coordinates will be created. Having opened it with the GsView program, we will see the following (fig. 1.15):

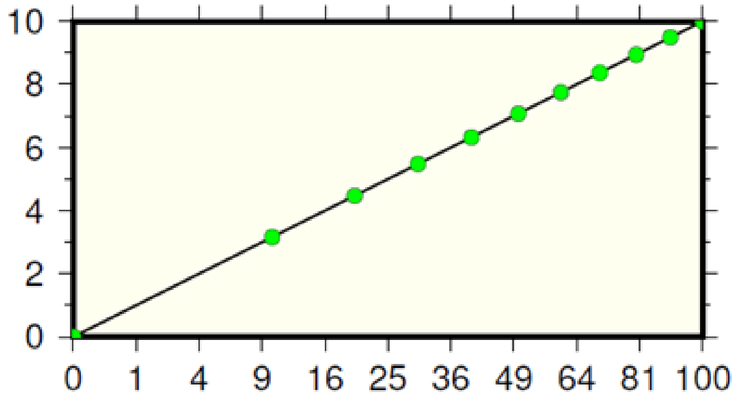


Figure 1.15 – Plot of the function $y = \sqrt{x}$ in the $x - y^{0.5}$ axes.

1.5.2. Main utilities and options of GMT

The GMT software package includes a number of utilities (table 1.2).

Table 1.2 – Main Utilities of the GMT Software Package

B	I	S	GR	Mapping
blockmean	isogmt	sample1d	grd2cpt	basemap
blockmedian	info	select	grd2kml	clip
blockmode	K	set	grd2xyz	coast
C	kml2gmt	simplify	grdblend	colorbar
connect	L	spatial	grdclip	contour
convert	logo	spectrum1d	grdconvert	grdimage
D	M	sph2grd	grdcut	grdcontour
defaults	makecpt	sphdistance	grdedit	grdvector
F	mapproject	sphinterpolate	grdfft	grdview
filter1d	math	sphtriangulate	grdfill	histogram
fitcircle	movie	splitxyz	grdfilter	image
G	N	surface	grdgradient	legend
get	nearneighbor	T	grdhisteq	mask
gmt.conf	P	trend1d	grdinfo	plot
gmt	postscriptlight	trend2d	grdlandmask	plot3d
2kml	project	triangulate	grdmask	rose
gmt5syntax	psconvert	V	grdmath	solar
gmtcolors	R	vector	grdpaste	ternary
gmt_shell_functions.sh	regress	W	grdproject	text
gmtswitch		which	grdsample	wig wiggle
		X	grdtrack	
		xyz xyz2grd	grdtrend	
			grdvolume	
			gre greenspline	

Each utility has certain functions, see details in the GMT-6 documentation: C:\programs\GMT6\share\doc\html.

1.5.3. Standardized command line options

Each utility has options, preceded by a hyphen (e.g. -R, -J, -O, -K, etc., that modify / supplement / expand the command executed, Table 1.3.

Table 1.3 – General options (classic script view)

Standardized command line options	Purpose
-B*information*	Map/Graph Frame and Axes Opts
-J*parameters*	Setting the Map/Graph Projection
-K	Adding to PS file follows below
-O	Overlay it on a chart
-P	Portrait orientation of the picture
-R*west/east/south/north*[*/zmin/zmax*][+**r**][+**u***unit*]	Setting the desired region
-U[*label*][+**c**][+**j***just*][+**o***dx/dy*]	Time stamp on the chart
-V[*verbosity*]	Run in detailed information mode
-X[**a**|**c**|**f**|**r**]*xshift*	The beginning of the graph by x
-Y[**a**|**c**|**f**|**r**]*yshift*	The beginning of the graph by y
-a[*col*=]*name*[,*...*]	Spatial Data with Columns
-bi*record*[+**b**|**l**]	Binary input selection
-bo*record*[+**b**|**l**]	Binary output selection
-d[**i**|**o**]*nodata*[+**c***col*]	Use NaN to columns with no data
-e[~]*"pattern"* | **-e**[~]/*regexp*/[**i**]	Filter for writing data that matches a given pattern
-f[**i**|**o**]*colinfo*	Set contents of input/output cols
-gx|**y**|**z**|**d**|**X**|**Y**|**D***gap*[**u**][+**a**][+**c***col*][+**n**|**p**]	Segment data by gap (space) detection
-h[**i**|**o**][*n*][+**c**][+**d**][+**m***segheader*][+**r***remark*][+**t***title*]	ASCII tables have header entries
-i*cols*[+**l**][+**d***divide*][+**s***scale*|**d**|**k**][+**o***offset*][,*...*][,**t**[*word*]]	Selecting input columns
-je|**f**|**g**	Spherical Distance Calculation Method
-n[**b**|**c**|**l**|**n**][+**a**][+**b***BC*][+**c**][+**t***threshold*]	Set the grid interpolation method
-o*cols*[,…][,**t**[*word*]]	Selecting output columns
-p[**x**|**y**|**z**]*azim*[*/elev*[*/zlevel*]][+**w***lon0/lat0*[*/z0*]][+**v***x0/y0*]	3D Perspective View Control
-q[**i**|**o**][~]*rows*[+**c***col*][+**a**|**f**|**s**]	Selecting input and output rows
-r[**g**|**p**]	Mesh registration job
-s[*cols*][+**a**|**r**]	Managing processing of NaN records
-t*transparency*	Setting layer transparency
-wy|**a**|**w**|**d**|**h**|**m**|**s**|**c***period*[*/phase*][+**c***col*]	Transform selected coordinate into repeating cycles
-x[[-]*n*]	Set the number of cores in multi-threaded modules
-:[**i**|**o**]	Expected input y/x not x/y

Most of options use a number of same arguments: region/range-related (-R) data changes, map or graph projection (-J), and so on. The options in the table above, listed in order of importance, as being used often, have same meaning in all programs. Their functionality and description of individual options described in the GMT documentation (see C:\programs\GMT6\share\doc\html).

1.6. GMT projections

More than 30 map projections and coordinate transformations available in GMT shown in Fig 1.16.

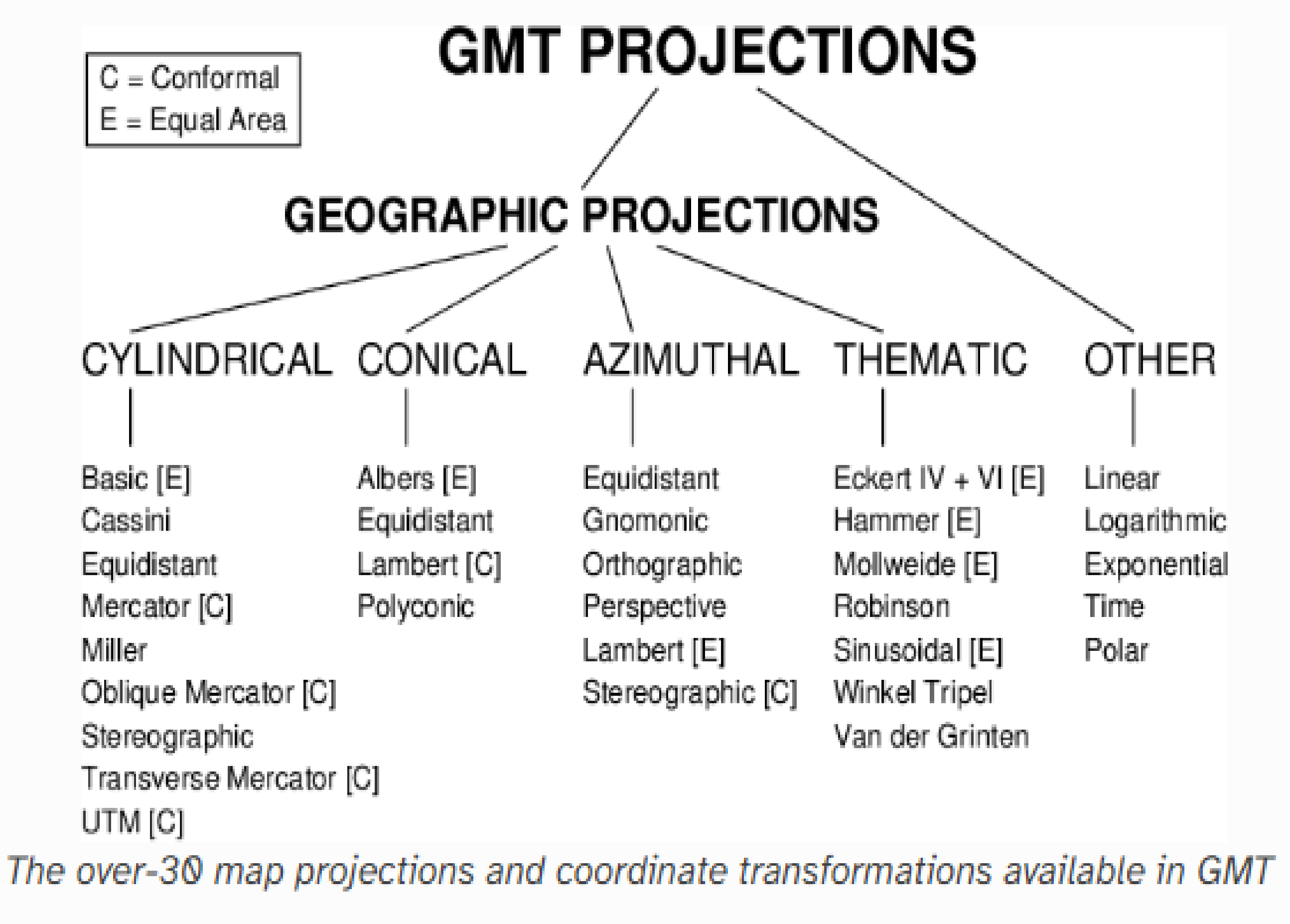


Figure 1.16 – Projections supported in GMT

GMT-6 offers 31 different map projections, specified with the -J option. The GMT software package supports using of two options: (a) GMT style syntax and (b) PROJ style syntax (the second one is not discussed below), they are available in the documentation C:\programs\GMT6\share\doc\html\tutorial\). The codes for the GMT styles (for instance selecting projections of constructed maps like Cylindrical Mercator, Azimuthal equal-area Lambert, Orthographic Azimuth and others are shown in Table 1.4 along with the corresponding parameters.

Table 1.4 – Projections supported in GMT

Projection	GMT code	Parameters
Azimuthal equal-area Lambert	**-Ja**|**A**	lon_0/lat_0[/*horizon*]/*scale*|*width*
Albersa conical equal area	**-Jb**|**B**	$lon_0/lat_0/lat_1/lat_2$/*scale*|*width*
Cylindrical Cassini	**-Jc**|**C**	lon_0/lat_0/*scale*|*width*
Stereographic cylindrical	**-Jcyl_stere**|**Cyc_stere**	[lon_0[/lat_0]/]*scale*|*width*
Equidistant conical	**-Jd**|**D**	$lon_0/lat_0/lat_1/lat_2$/*scale*|*width*
Azimuthal Equidistant	**-Je**|**E**	lon_0/lat_0[/*horizon*]/*scale*|*width*
Azimuthal gnomonic	**-Jf**|**F**	lon_0/lat_0[/*horizon*]/*scale*|*width*
Orthographic azimuth	**-Jg**|**G**	lon_0/lat_0[/*horizon*]/*scale*|*width*
Common perspective	**-Jg**|**G**	lon_0/lat_0/*alt*/*azim*/*tilt*/*twist*/*W*/*H*/*scale*|*width*
Equal Area Hummer	**-Jh**|**H**	lon_0/*scale*|*width*
Equal area sinusoidal	**-Ji**|**I**	lon_0/*scale*|*width*
Cylindrical Miller	**-Jj**|**J**	lon_0/*scale*|*width*
Equal area Eckert IV	**-Jkf**|**Kf**	lon_0/*scale*|*width*
Equal area Eckert VI	**-Jks**|**Ks**	lon_0/*scale*|*width*
Conical conformal Lambert	**-Jl**|**L**	$lon_0/lat_0/lat_1/lat_2$/*scale*|*width*
Cylindrical Mercator	**-Jm**|**M**	[lon_0[/lat_0/]]*scale*|*width*
Robinson	**-Jn**|**N**	[lon_0/]*scale*|*width*
Oblique Mercator 1 original and azumuthal	**-Jo**|**O**[**a**|**A**]	lon_0/lat_0/*azim*/*scale*|*width* [**+v**]
Oblique Mercator, 2: two dots	**-Jo**|**O**[**b**|**B**]	$lon_0/lat_0/lon_1/lat_1$/*scale*|*width*[**+v**]
Oblique Mercator 3: original and polar	**-Jo**|**O**[**c**|**C**]	$lon_0/lat_0/lon_p/lat_p$/*scale*|*width*[**+v**]
Polar [azimuth] (θ,r) (or cylindrical)	**-Jp**|**P**	*scale*|*width*[**+a**][**+f**[**e**|**p**|*radius*]][**+k***kind*][**+r***offset*][**+t***origin*][**+z**[**p**|*radius*]]
Polyconic (American)	**-Jpoly**|**Poly**	[lon_0[/lat_0/]]*scale*|*width*
Equidistant cylindrical	**-Jq**|**Q**	[lon_0[/lat_0/]]*scale*|*width*
Winkel Triple	**-Jr**|**R**	[lon_0/]*scale*|*width*
General stereographic	**-Js**|**S**	lon_0/lat_0[/*horizon*]/*scale*|*width*
Transverse Mercator	**-Jt**|**T**	[lon_0[/lat_0/]]*scale*|*width*
Universal Transverse Mercator (UTM)	**-Ju**|**U**	*zone*/*scale*|*width*
Van der Grinten	**-Jv**|**V**	[lon_0/]*scale*|*width*
Mollweide	**-Jw**|**W**	[lon_0/]*scale*|*width*
Linear, logarithmic, exponential and time	**-Jx**|**X**	*xscale*|*width*[**l**|**p***power*|**T**|**t**][/*yscale*|*height*[**l**|**p***power*|**T**|**t**]][**d**]
Cylindrical equal area	**-Jy**|**Y**	lon_0/lat_0/*scale*|*width*

There are a number of modules included into the GMT core. They are listed below.

GMT core modules

batch	gmtlogo	grdcontour	grdmix	project	pstext
blockmean	gmtmath	grdconvert	grdpaste	psbasemap	pswiggle
blockmedian	gmtregress	grdcut	grdproject	psclip	psxy
blockmode	gmtselect	grdedit	grdsample	pscoast	psxyz
dimfilter	gmtset	grdfft	grdselect	pscontour	sample1d
docs	gmtsimplify	grdfill	grdtrack	psconvert	spectrum1d
filter1d	gmtspatial	grdfilter	grdtrend	psevents	sph2grd
fitcircle	gmtsplit	grdgradient	grdvector	pshistogram	sphdistance
gmt2kml	gmtvector	grdhisteq	grdview	psimage	sphinterpolate
gmtbinstats	gmtwhich	grdimage	grdvolume	pslegend	sphtriangulate
gmtconnect	grd2cpt	grdinfo	greenspline	psmask	surface
gmtconvert	grd2kml	grdinterpolate	kml2gmt	psrose	trend1d
gmtdefaults	grd2xyz	grdlandmask	makecpt	psscale	trend2d
grdgdal	grdblend	grdmask	mapproject	pssolar	triangulate
gmtget	grdclip	grdmath	nearneighbor	psternary	xyz2grd
nfo					

Additional modules

earthtide	mgd77magref	grdgravmag3d	pscoupe	grdspotter	x2sys_datalist
gpsgridder	mgd77manage	grdredpol	psmeca	hotspotter	x2sys_get
psvelo	mgd77path	grdseamount	pspolar	originater	x2sys_init
gshhg	mgd77sniffer	talwani2d	pssac	polespotter	x2sys_list
img2grd	mgd77track	talwani3d	backtracker	rotconverter	x2sys_merge
mgd77convert	gmtflexure	pssegy	gmtpmodeler	rotsmoother	x2sys_put
mgd77header	gmtgravmag3d	pssegyz	grdpmodeler	x2sys_binlist	x2sys_report
mgd77info	gravfft	segy2grd	grdrotater	x2sys_cross	x2sys_solve
mgd77list	grdflexure				

The utilities/modules listed above are for the "classic" GMT kernel, additional kernel modules, and their usage. These modules are fully compatible with GMT 4 and 5 as well. All modules are requested via a call from the GMT package.

1.7. QGIS Introduction and Definitions

QGIS is one of the fastest growing open source geographic information systems. QGIS is released under the terms of the GNU General Public License (GPL). It means that it is free to download and freely adaptable. Several times a year new releases of QGIS become available.

This tutorial provides the information on the QGIS software package and instructions for performing basic operations in QGIS. Developers periodically upload to their server new versions with enlarged capabilities. The latest basic release (as for January 2024) is QGIS 3.36 (e.g., its setup file for QGIS-OSGeo4W-3.36.3 has 1.2 GBytes). We'll consider (in Part 2) it capabilities using one of its simpler releases QGIS 3.34 Prizren as an example. Its distribution is available free at the URL: http://www.qgis.org/ru/site/forusers/download.html. (file QGIS-OSGeo4W-3.34.6.msi -Setup-x86 which is only 1 240 260 MBytes) or from any nearest site, e.g. https://qgis.org/ru/site/forusers/download.html. It is less sophisticated and provides the familiarization with main elements of the QGIS interface when working with shape files, loading vector data into the project, visualization and study of spatial data in the QGIS. The installation runs smoothly and no additional alignments are necessary.

Laboratory works [11] aimed at studying the interface and basic capabilities of the QGIS [12], performing georeferencing of raster images, creating and editing vector objects and their attributes, building surfaces, conducting vector and raster GIS analysis, and creating map layouts using GIS tools will be considered in the practical section below.

1.7.1. Main characteristics of QGIS

QGIS uses spatial data to compile maps. Each piece of data will also contain non-spatial data known as attribute data. Attribute data is generally defined as additional information about a spatial feature, for example, a government building. The actual location of the government building is the spatial data. The attribute data includes the building name, the number of floors in the building, the government departments that use the building, when it was built, etc. QGIS includes a number of layers having different information, fig. 1.17.

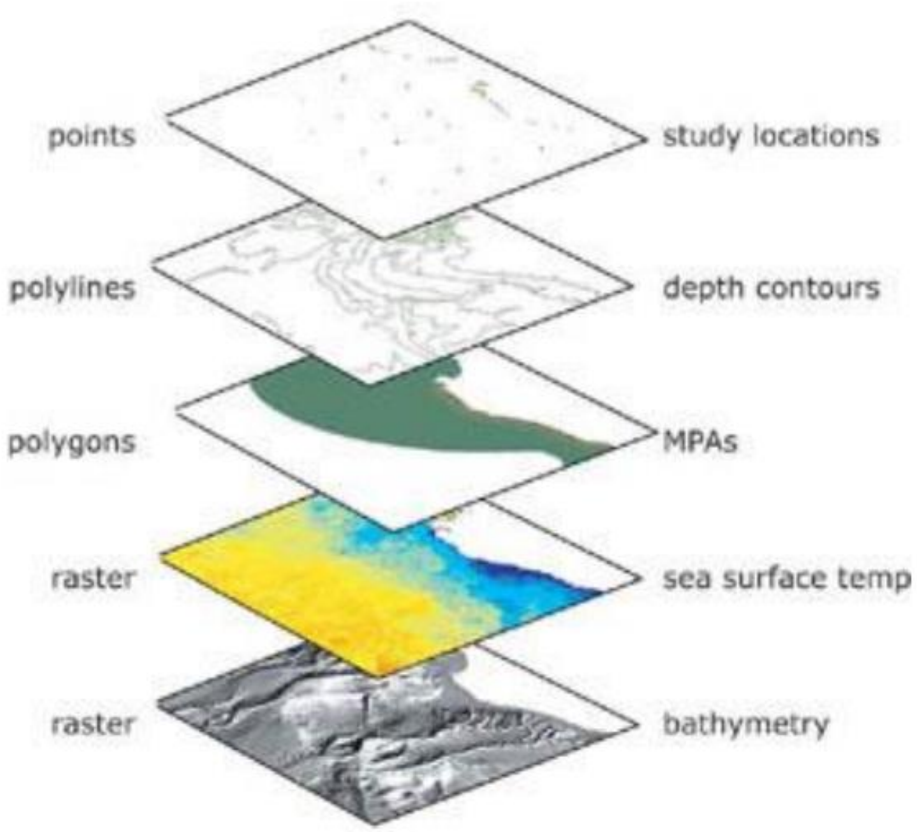


Figure 1.17 – Different layers of the same area [13]

A Vector layer. A representation of the world using points, lines, and polygons. Vector layers are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets, fig. 1.18.

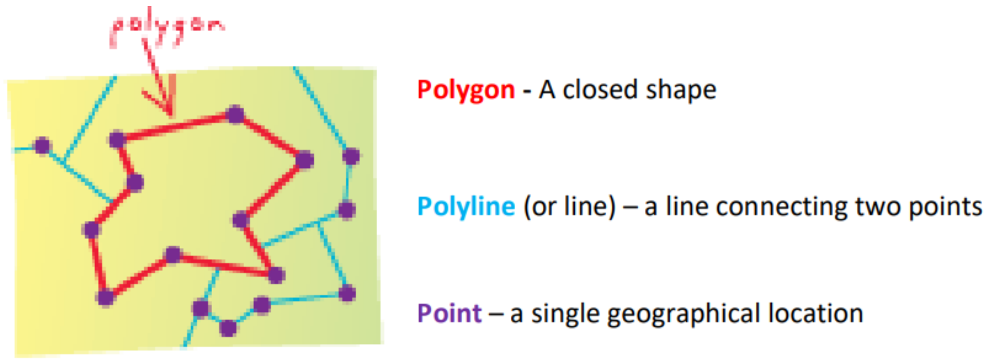


Figure 1.18 – Points, lines and polygons [13]

Raster layers. A spatial data layer that is in the form of an image with pixels. The image is made up of equally sized pixels (or cells) arranged in rows and columns. Each pixel contains an attribute value and location coordinates. Groups of cells that share the same value represent the same type of geographic feature. See 2 examples figs. 1.19 and 1.20:

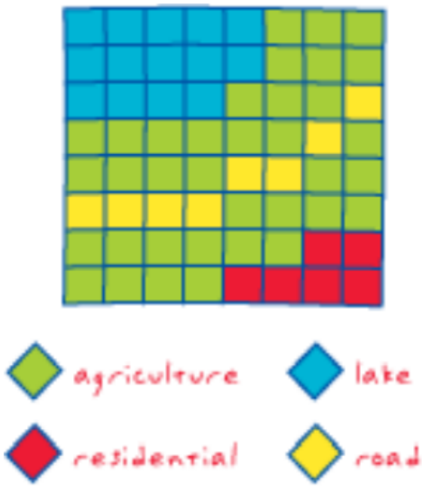


Figure 1.19 A raster grid [13]

Figure 1.20. Areal image (raster), Port Vila, Vanuatu [13]

Main terminology used [13]:

Attribute. An information about a spatial feature. For example, attributes about a school may include the name, level of education, and number of students.

Coordinate system. A coordinate system is a reference system used to represent the locations of geographic features, imagery, and observations such as GPS locations within a common geographic framework.

Scale. A level of resolution or zoom. The relationship between the size of the map and the corresponding size of the real world.

Shape file (*.shp). A type of vector data storage format for storing the location, shape, and attributes of geographic features. Each shapefile relates to a specific feature class i.e. the Roads shape file only contains information on roads.

Symbology. Conventions or rules that define how geographic features are represented by symbols on a map.

Query. In GIS, a request to select features or records from an attributes table based on user-selected criteria to display only those features or records that meet the criteria.

Quantum GIS project started in 2002. Now QGIS is free and open source Geographic Information System (GIS) application that allows users to create spatial datasets, manage, analyze and display them on a map or another plot. It comes with the right to download, run, copy, alter, and redistribute the software. It is multi-platform and can run in Windows, OSX, UNIX and UNIX-compatible operational systems, such as Linux, Cygwin and others. It is extendable, many of its functionalities are provided by plugins and scripts.

It permits:

• Adding Vector and Raster layers
• Adding tabular information as a Delimited text Layer
• Symbolizing vector data
• Symbolizing raster data
• Installing plugins
• Querying data
• Joining tables
• Introduction to the Processing toolbox
• Map Layouts

The QGIS interface shown in Figure 1.21

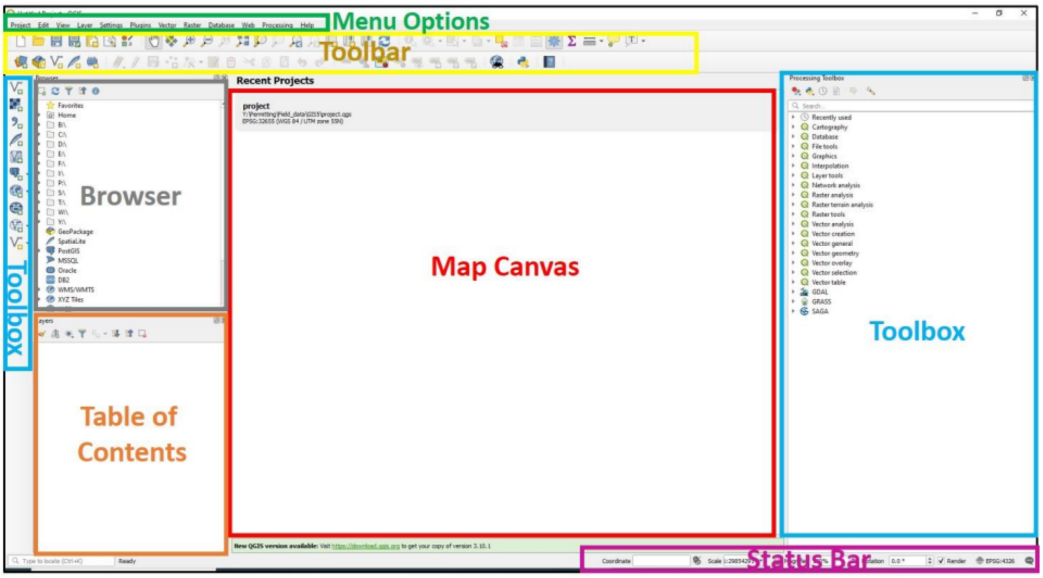


Figure 1.21. – The QGIS interface [13]

Some panels could be rearranged to better suite you need. For example, the QGIS interface for the release 2.18 could look like this, fig. 1.22:

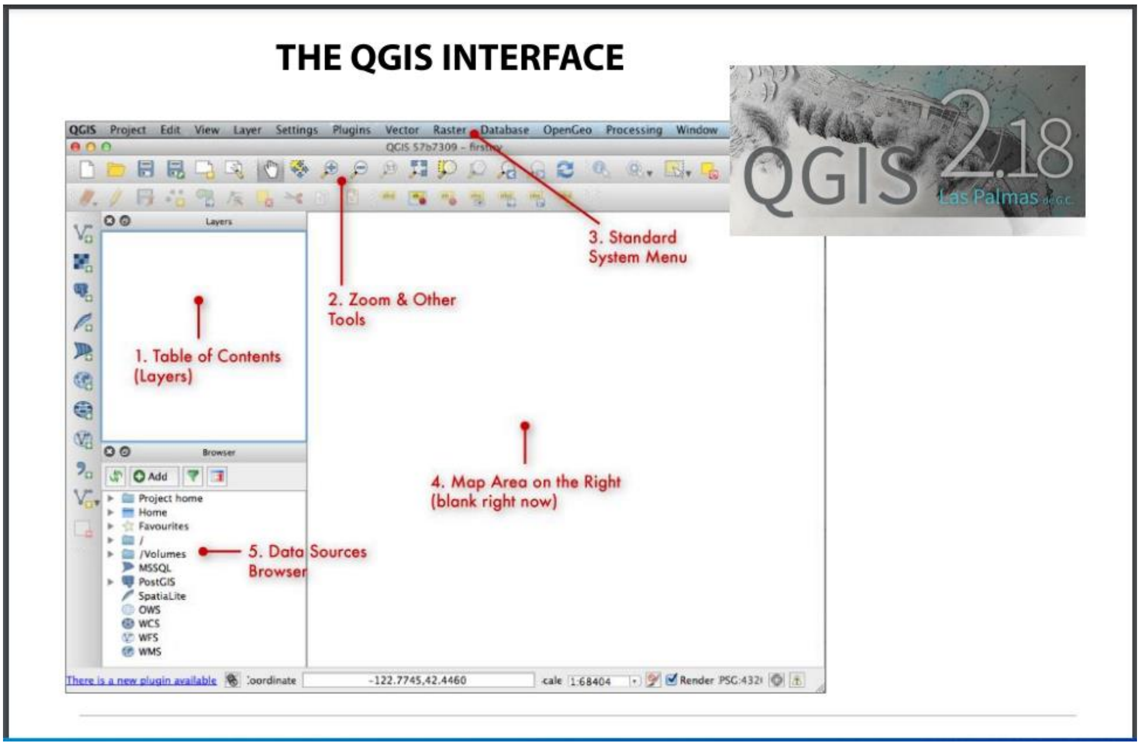


Figure 1.22 – The QGIS interface [12]

Typically the QGIS work area has seven parts;

- Menu Options
- Toolbar
- Map Canvas
- Browser
- Table of Contents
- Tool Box
- Status Bar

Menu Options, fig. 1.23

Figure 1.23 Menu Options [13]

The Menu Options bar provides access to various QGIS features using a standard hierarchical menu (drop down menu). Most menu options have a corresponding tool in the Toolbar and Tool Box; however, the menus are not organized exactly like the toolbars and may contain additional tools.

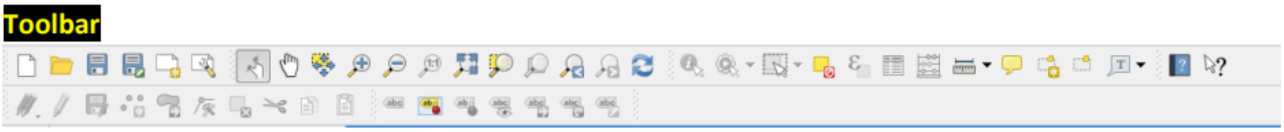


Figure 1.24 – Toolbar

The ***Toolbar***, fig. 1.24, provides an access to most of the functions found in the menu options bar, plus additional tools for interacting with the map canvas. Each Toolbar item has pop-up help available. Hold your mouse over an item and a short description of the tool's purpose will be displayed.

Below is a view of the Managing Layers Toolbar, Fig. 1.25.

Figure 1.25 Managing Layers Toolbar [13]

The Managing Layers Toolbar contains frequently used tools relating to GIS layers. The two symbols circled in red represent the 'add vector layer' tool and the 'add raster layer' tool, which will be most commonly used to bring data into the QGIS document.

Parts of the Toolbar can be moved around according to your needs. Additionally, parts of the Toolbar can be switched on/off. Hold the mouse over a blank spot on the Toolbar and click the right mouse button to see the context menu, which allows you to turn on/off tools.

If you have accidentally hidden all your Toolbars, you can get them back by choosing Menu Options – View – Toolbars

Map Canvas. The Map Canvas is the main part of QGIS – this is where the maps are displayed. The map displayed in the window will depend on the vector and raster layers you have chosen to load. The Map Canvas can be panned, shifting the focus of the display to another part of the map. The map can also be zoomed in and out. Various other operations can be performed on the map using the Toolbar. The Map Canvas and the Table of Contents are tightly bound to each other – the maps in Map Canvas reflect changes you make in the Table of Contents area.

Zooming the Map with the Mouse Wheel. You can use the mouse wheel to zoom in and out on the map. Place the mouse cursor inside the map area and roll the wheel forward (away from you) to zoom in and backwards (towards you) to zoom out. The zoom is centered on the mouse cursor position.

Table of Contents. The Table of Contents area lists all the layers in your map project. Click on a check box to turn a layer on or off. Double click on a layer in the legend to customize its appearance and set other properties (e.g. appearance of symbols, labels). A layer can be selected and dragged up or down in the Table of Contents to change the Z-ordering, which means that layers listed nearer the top of the Table of Contents are drawn over layers, listed lower down in the Table of Contents.

Tool Box, fig. 1.26.

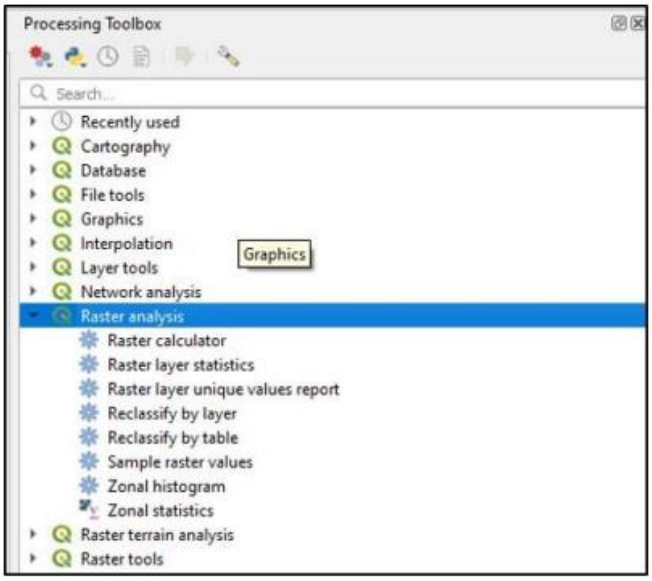


Figure 1.26 – Processing Toolbox [13]

The Processing Toolbox, which contains geoprocessing tools, used for creation and analysis of both vector and raster data. As mentioned before, some of these tools will also be available in the Menu Options as well.

Status Bar. The Status Bar shows you the current position of the mouse pointer in map 

coordinates (expressed as decimal degrees or meters) as well as the map scale and coordinate system. As you move the mouse pointer across the map view, the coordinates will change. As you zoom in and out of the map, the scale will change.

Adding Vector Datasets in QGIS. To start working with a map, we need load source data. Vector data is arguably the most common kind of GIS data. It describes geographic data in terms of points, which may be connected into lines and polygons. Every object in a vector dataset is called a ***feature***, and is associated with data that describes that feature. The raster data are also used when constructing QGIS maps.

QGIS can support a number of different vector data formats. These include ESRI Shape files and MapInfo TAB files, all of which can be used in QGIS in their current formats. We will mostly be using ESRI Shape files in QGIS tests below.

Map projections

Geographic Coordinate Systems [11]

• Defines locations on spherical model of the Earth

Projected Coordinate System

• Defines locations on flat model of the earth, Fig. 1.27

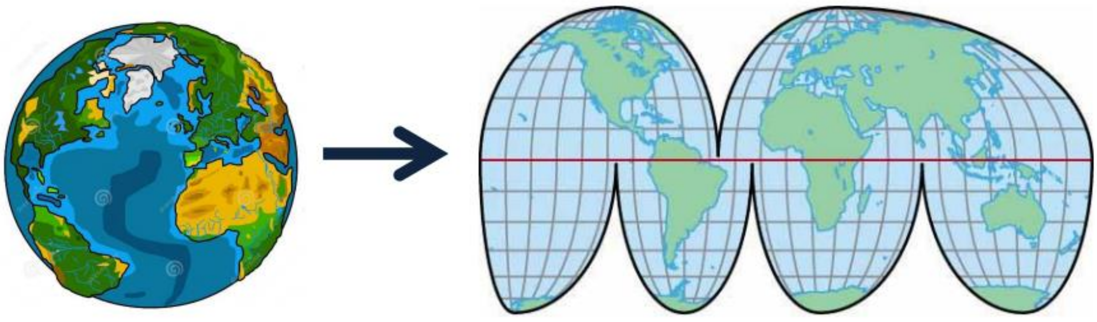


Figure 1.27 – Geographic and projected coordinate systems in QGIS [12]

Projected Coordinate System is shown below and can be easily changed, figs. 1.28 – 1.30 [12].

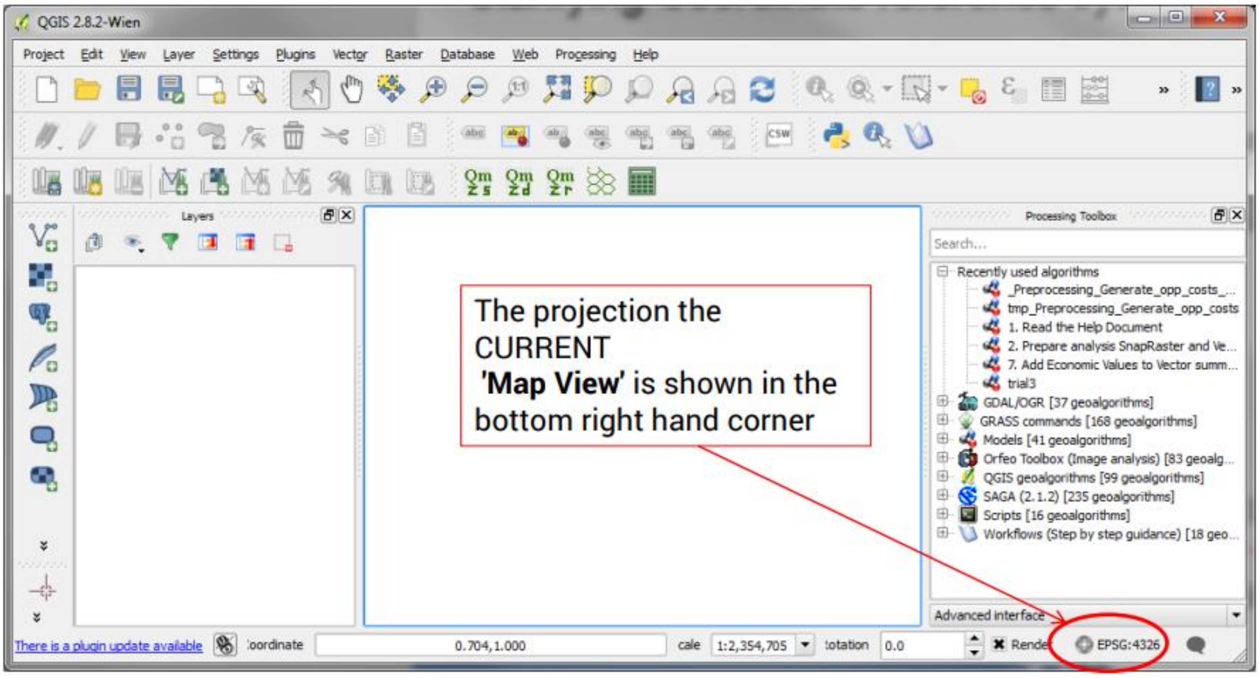


Figure 1.28. – Changing the projection of the QGIS Map View (step 1)

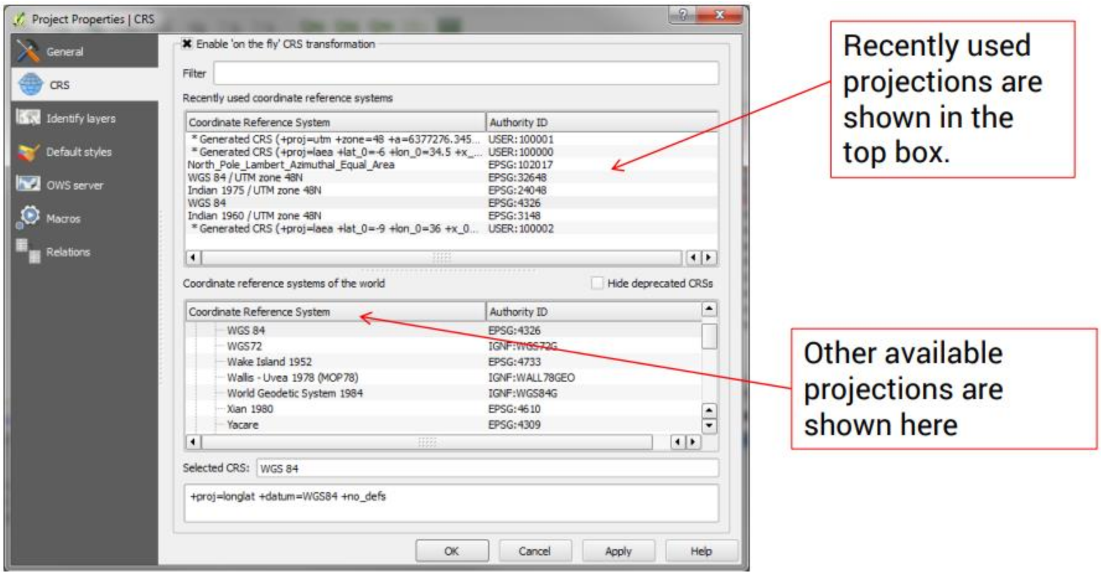


Figure 1.29. – Changing the projection of the QGIS Map View (step 2)

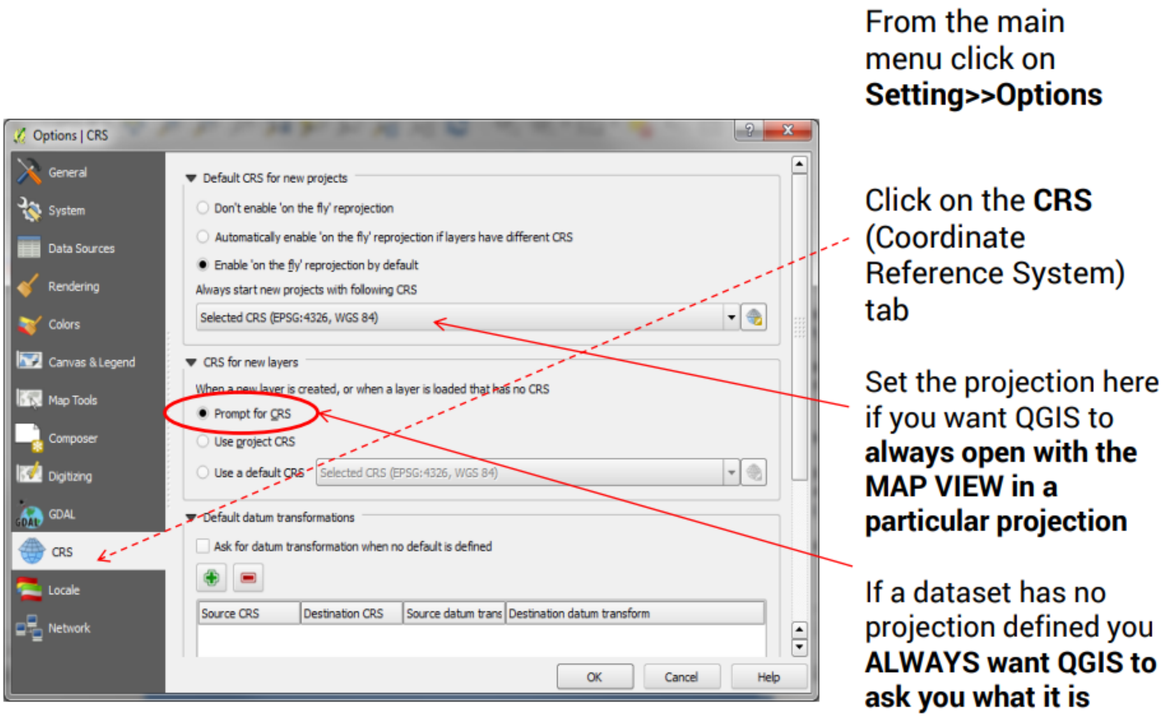


Figure 1.30. – Changing the projection of the QGIS Map View (step 3)

1.7.2. Comparison between QGIS and ArcGIS

QGIS *is free. Open-source, source codes are open for everyone to modify to particular needs. Huge support on forums like stack exchange. Many supported data formats thanks to GDAL/OGR library. High functionality for vector and raster operations through plugins. Easy integration with other open source software such as GRASS or SAGA.*

ArcGIS *Commercial – Not freely available.*
License is restricted.
Source codes not available for users.
Huge support on ESRI forums.
More restricted data formats, preference for ESRI created data formats such as shape files and grids.
Higher functionality, especially spatial analysis, and more reliable results than QGIS for some of them.
Designed as a single, stand-alone platform.

1.8. Brief introduction to ArcGIS

1.8.1. General information

The ArcGIS [14] is a powerful software and usually is delivered to students as a separate course, therefore very scarce information is given below on this software package and we do not plan laboratory tests for this section.

Maps provide a powerful mean to define and standardize how people use and interact with their geographic/geologic datasets. Interactive maps provide the main user interface for most GIS applications. Modern ArcGIS software aimed to perform numerous tasks, including advanced data compilation, cartography, analysis, query, and field data collection.

GIS users pan and zoom interactive maps, where map layers apply symbols based on a set of attributes and perform query and analysis of operations through the map layers. Parcels can be filled with colors based on their zoning types, or the size of point symbols for oil or gas wells can be specified based for instance on their production levels. GIS user can point to a geographic object in an interactive map to get information about the object. ArcGIS users can edit data and feature representations through interactive maps.

Geographic datasets can represent raw measurements (for example, satellite imagery), information interpreted and compiled by analysts (for example, roads, buildings, and soil types), or information derived from other data sources using analysis and modeling algorithms.

The GIS includes a rich set of tools to work with and process geographic information. This collection of tools is used to operate on the GIS information objects, such as the datasets, attribute fields, and cartographic elements for printed maps. Together, these comprehensive tools and the data objects on which they operate form the basis of a rich geoprocessing framework [15].

Geoprocessing is used to model how data flows from one structure to another to perform many common GIS tasks – for example, to import data from numerous formats, integrate that data into the GIS, and perform a number of standard-quality validation checks against the imported data, as well as perform powerful analysis and modeling. The ability to automate and repeat such work flows is a key capability in a GIS. It is widely applied in numerous GIS applications and scenarios.

One method used to build geoprocessing work flows is to execute a number of tools in a specific sequence, fig. 1.31. Users can compose such processes graphically using the ModelBuilder™ application in ArcGIS, and they can compose scripts using modern scripting tools, such as Python, VBScript, and JavaScript.

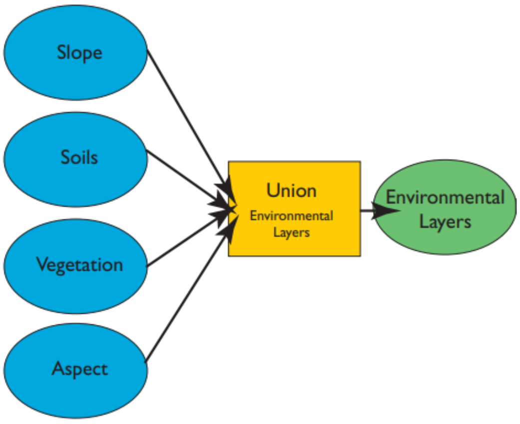


Figure 1.31. – ArcGIS includes a set of tools and data types that can be assembled into processes in a geoprocessing framework [15].

Geoprocessing is the key framework for modeling and analysis. Some common modeling applications shown in fig. 1.32:

• Models for suitability and capability, prediction, and assessment of alternative scenarios

• Integration of external models

• Model sharing

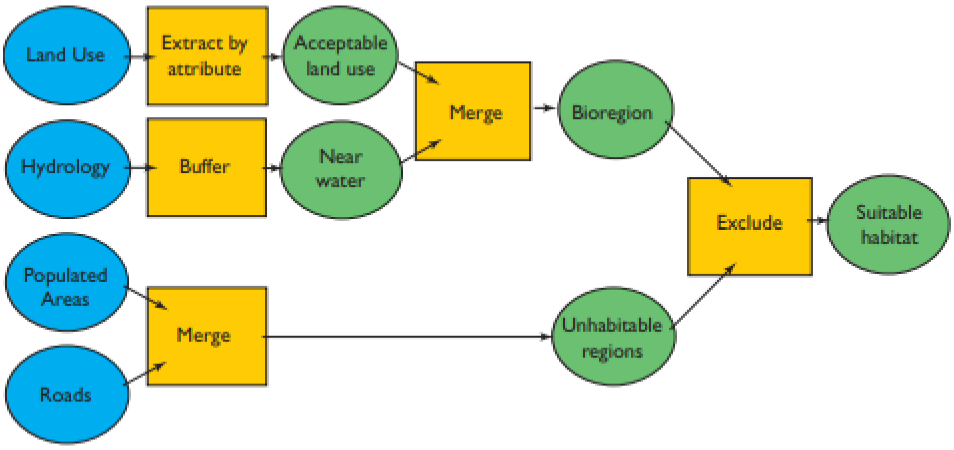


Figure 1.32. – Models can be shared within an organization [15]

Advanced geoprocessing tools are used to derive multiscale cartographic representations. GIS information management shares many of same concepts and characteristics with standard information technology (IT) architectures and can work well in centralized, enterprise computing environments. For example, GIS datasets can be managed in relational databases, just like other enterprise information. Advanced application logic is used to operate on the data stored in the DBMS. Like other transactional enterprise information, GIS systems are used to manage permanent change and updates in geographic databases.

ArcGIS provides a scalable framework for implementing GIS for a single user or many users on desktops, in servers, over the Web, and in the field. ArcGIS is an integrated collection of GIS software products for building a complete GIS, fig. 1.33. It consists of a number of frameworks for deploying GIS:

• ArcGIS Desktop — An integrated suite of professional GIS applications

• ArcGIS Engine — Embeddable developer components for building custom GIS applications

• Server GIS — ArcSDE®, ArcIMS®, and ArcGIS Server • Mobile GIS— ArcPad® as well as ArcGIS Desktop and ArcGIS Engine for Tablet PC computing.

Figure 1.33. – ArcObjects – The developer building blocks for ArcGIS [15]

1.8.2. ArcGIS Desktop

Most students work with the ArcGIS Desktop. Desktop GIS is the primary seat from which GIS professionals compile, author, and use geographic information and knowledge. GIS professionals use a standard desktop as a productivity tool for authoring, sharing, managing, and publishing geographic knowledge.

Most GIS professionals know that the value of imagery goes way beyond a backdrop for GIS layers. The information contained in most maps and GIS layers is derived from imagery to create or revise maps and GIS layers. Actionable information can be derived from imagery, fig. 1.34. Detecting, identifying, and mapping change for a wide variety of applications is a primary function of many organizations

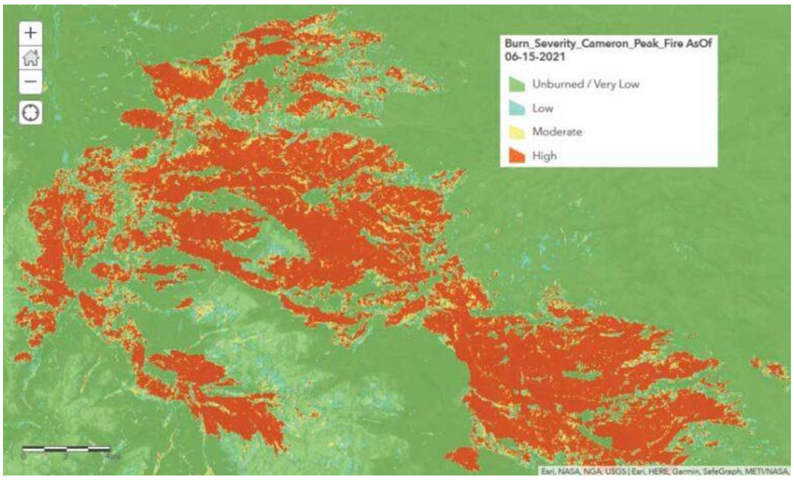


Figure 1.34. – Map of Cameron Peak Fire in Colorado of 2020 [14]

This map shows the burn severity of the 2020 Cameron Peak Fire in Colorado. Burn severity maps are crucial for determining slope stability, public safety response, mitigation measures, and water quality.

ArcGIS Desktop is an integrated suite of advanced GIS applications [15]. It includes a suite of integrated applications: ArcCatalog, ArcMap, ArcGlobe, ArcToolbox, and ModelBuilder. Using these applications and interfaces, users can perform any GIS task, from simple to advanced, including mapping, geographic analysis, data editing and compilation, data management, visualization, and geoprocessing. ArcGIS Desktop is scalable and can address the needs of many types of users. It is available at three functional levels, figs. 1.35 and 1.36:

1. ArcView focuses on comprehensive data use, mapping, and analysis.
2. ArcEditor adds advanced geographic editing and data creation.
3. ArcInfo is a complete, professional GIS desktop containing comprehensive GIS functionality, including rich geoprocessing tools.

Users have a possibility to develop extensions and custom tools using standard Windows programming interfaces (Visual Basic® (VB), .NET, and Visual C++®).

ArcGIS Desktop contains complete GIS capabilities and support for the following:
Mapping and 3D visualization
Raster and vector editing
Geoprocessing
Geographic data management in a comprehensive information model and framework • Datasets • Topology, integrity rules, and rich GIS behavior • Maps and globes • Geoprocessing tools, models, and work flows • Metadata, catalog, and database management
Data interoperability (to work with unlimited files, formats, and data sizes)
Maintaining and sharing data updates and work flows in a transaction model
GIS interoperability standards such as Open Geospatial Consortium (OGC) and International Organization for Standardization (ISO)
Web services • Map publishing • Data publishing and delivery • Editing • Geoprocessing

Figure 1.35. – Functional levels of ArcGIS Desktop [15]

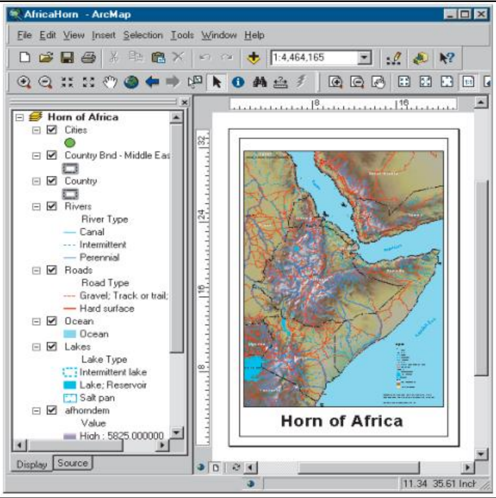
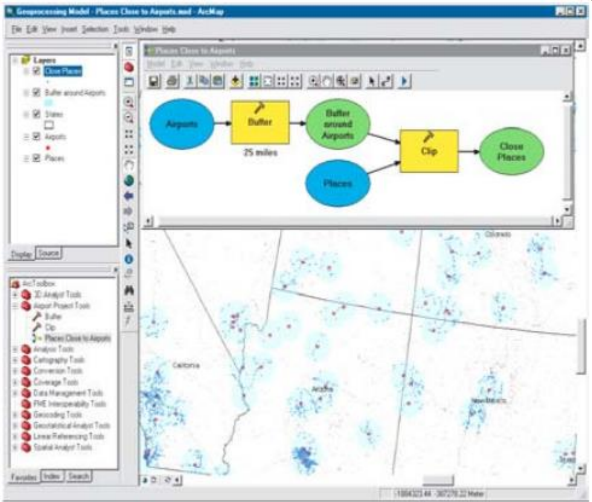
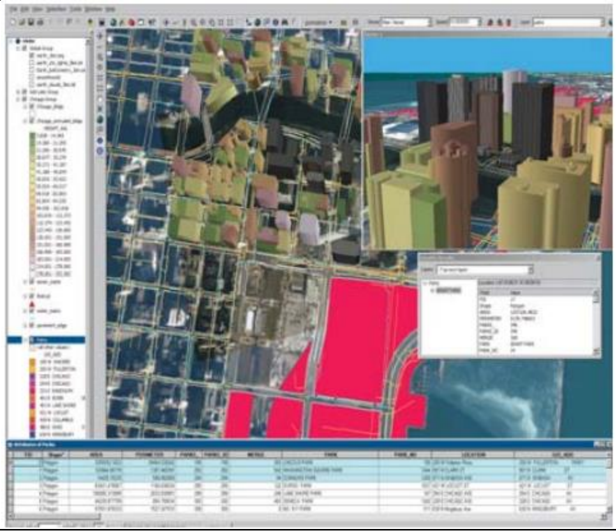
	
ArcCatalog is the application for managing spatial datasets and data models as well as for recording, viewing, and managing metadata.	ArcMap is used for all mapping and editing tasks as well as map-based analysis.
	
ArcToolbox and ModelBuilder are used for geoprocessing and spatial analysis.	ArcGlobe, an application provides an interactive global view to work with geographic data.

Figure 1.36 – A suite of integrated applications of ArcGIS Desktop [15]

ArcMap. ArcMap is the central application in ArcGIS Desktop for all map-based tasks including cartography, map analysis, and editing, figs 1.37 and 1.38. ArcMap is a comprehensive map authoring application for ArcGIS Desktop.

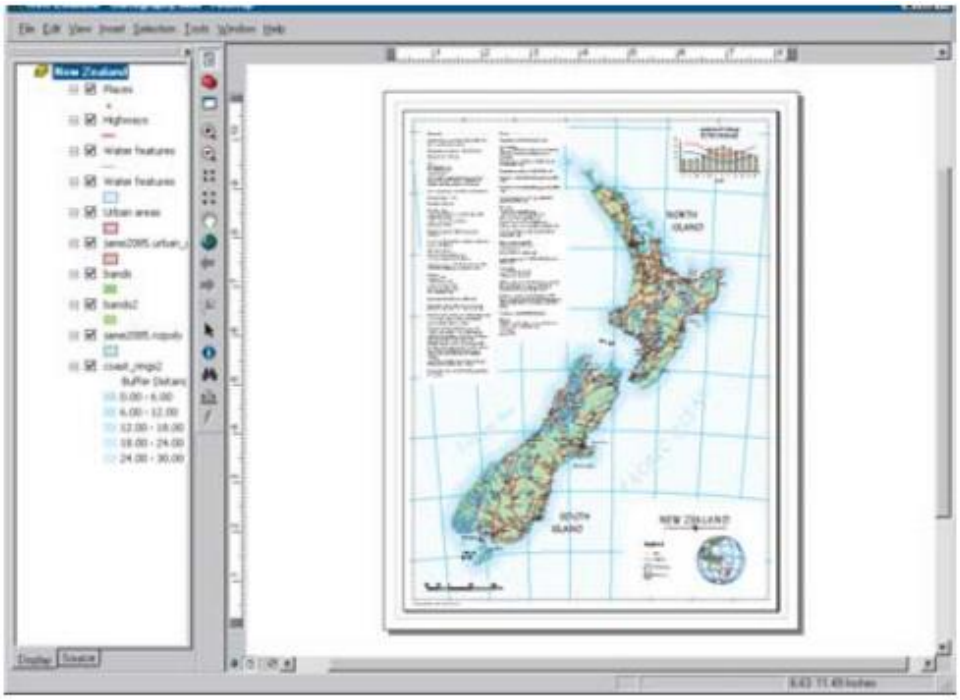


Figure 1.37 – Design and create publication-quality maps [15]

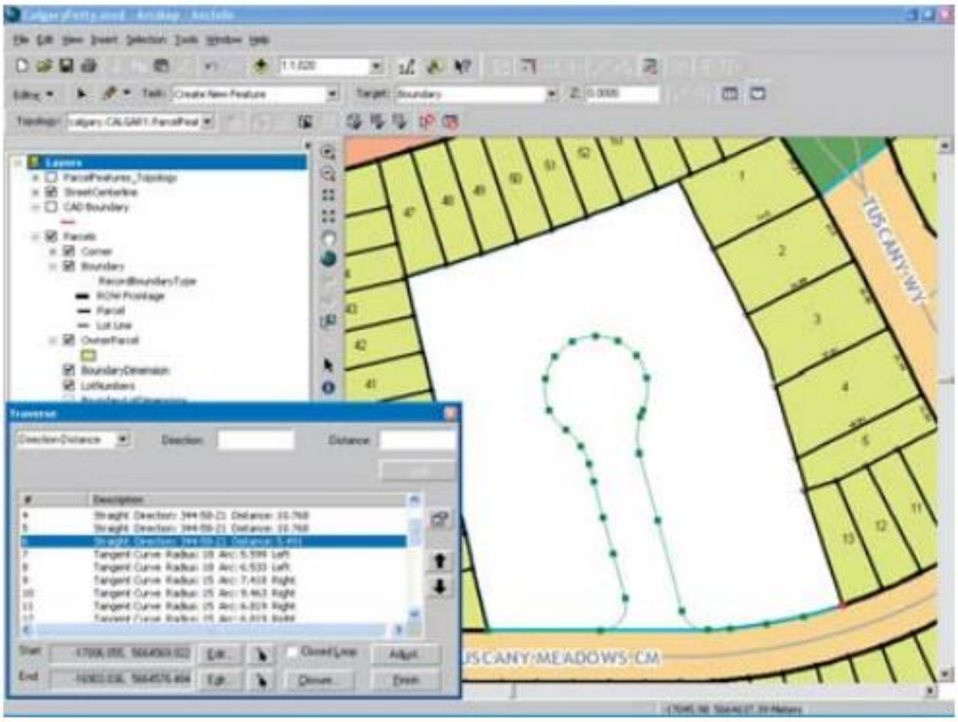


Figure 1.38 – Compile and edit data [15]

ArcMap offers two types of map views: a geographic data view and a page layout view [15]. In the geographic data view, users work with geographic layers to symbolize, analyze, and compile GIS datasets. A table of contents interface helps organize and control the drawing properties of the GIS data layers in the data frame. The data view is a window into any GIS dataset for a given area, fig. 1.39

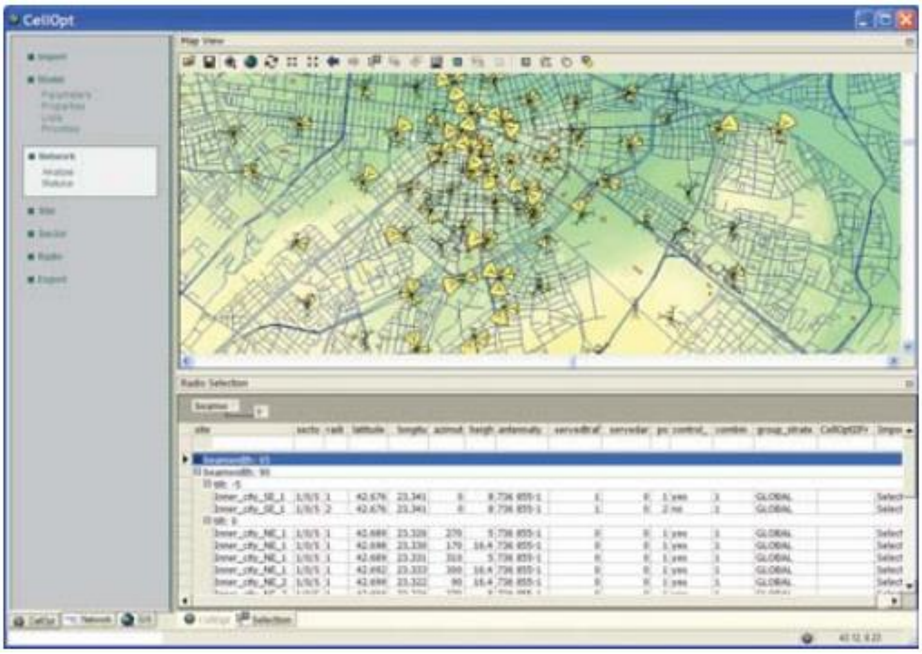


Figure 1.39 – Author and share maps with ArcReader, ArcGIS Engine, ArcIMS, and ArcGIS Server [15]

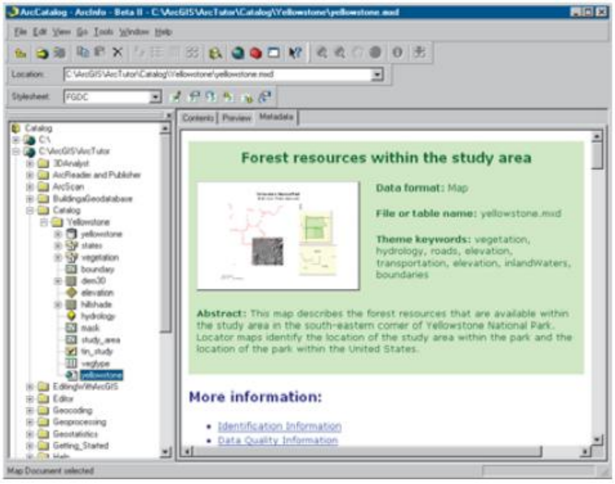
In the layout view, users work with map pages that contain geographic data views as well as other map elements, such as scalebars, legends, North arrows, and reference maps, fig. 1.40. ArcMap is used to compose maps on pages for printing and publishing.

Figure 1.40 – Perform modeling and analysis [15]

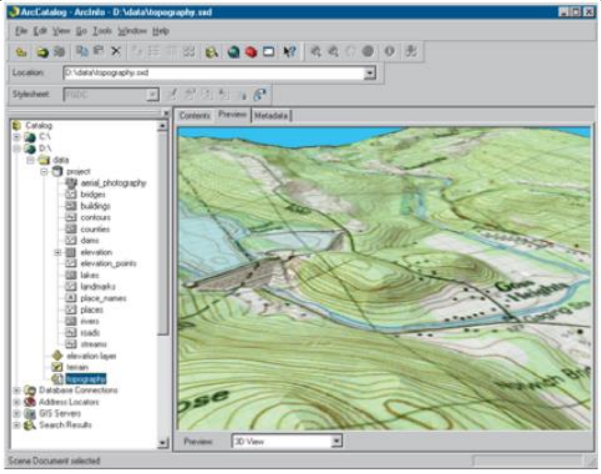
ArcCatalog. The ArcCatalog, fig. 1.41, application helps users organize and manage all geographic information, such as maps, globes, datasets, models, metadata, and services. It includes tools to:

• Browse and find geographic information.

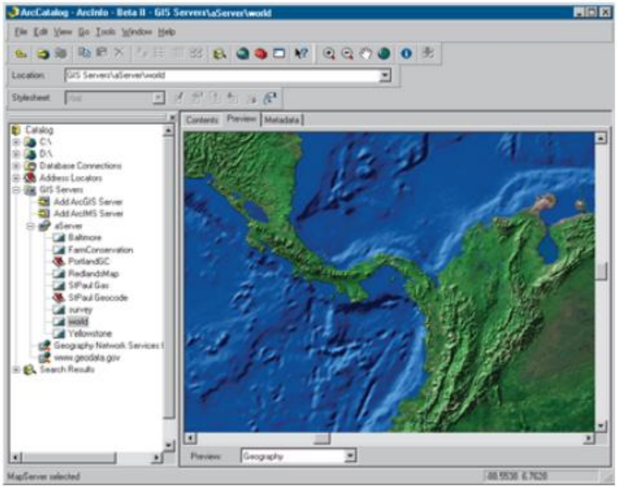
• Record, view, and manage metadata.
• Define, export, and import geodatabase data models.



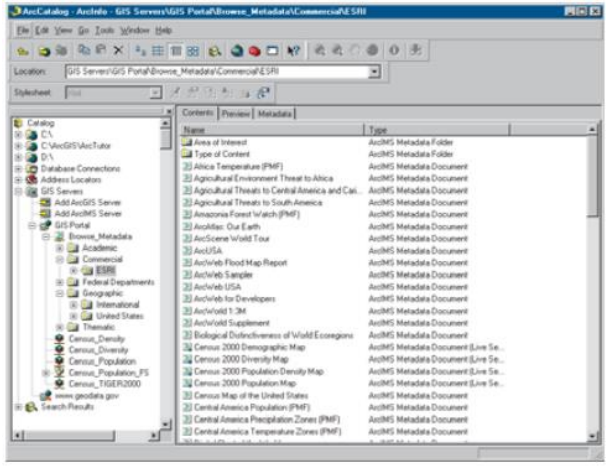
Metadata in ArcCatalog



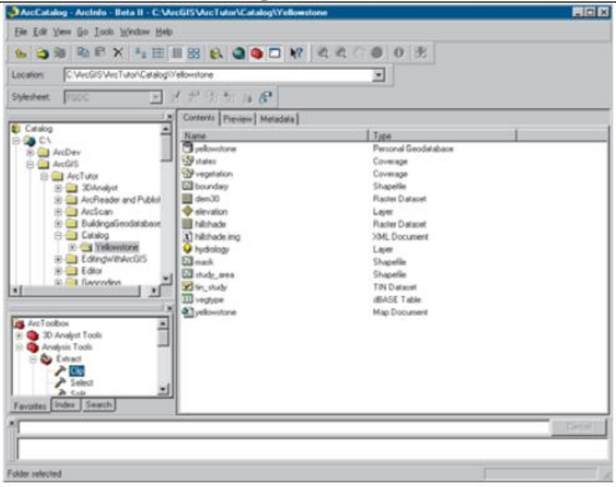
Previewing a 3D scene in ArcCatalog



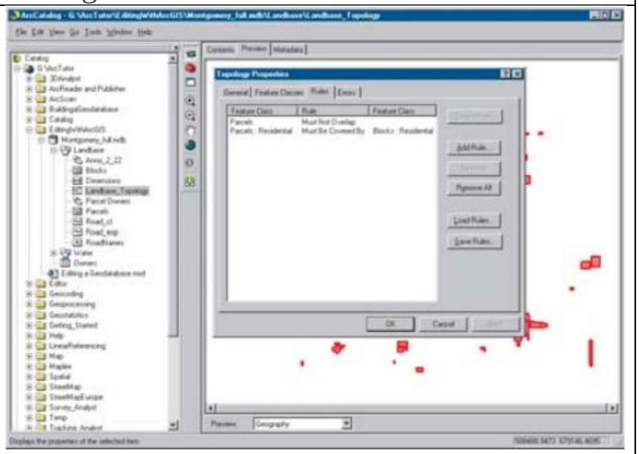
Previewing a map produced with ArcGIS Server in ArcCatalog



Organizing, editing, and managing a metadata catalog in an ArcIMS metadata server



Geoprocessing in ArcCatalog



Defining a geodatabase schema

Figure 1.41 – Functions of the ArcCatalog [15]

***Geoprocessing with ArcToolbox and ModelBuilder*.** ArcGIS Desktop provides a geoprocessing framework of tools that can be run in several different ways, including through dialog boxes in ArcToolbox, as inputs to models in ModelBuilder, as commands in the command line, and as functions in scripts. This framework facilitates the creation, use, documentation, and sharing of geoprocessing models. The two main parts of the geoprocessing framework include ArcToolbox, an organized collection of geoprocessing tools, and ModelBuilder, a visual modeling language for building geoprocessing work flows and scripts.

ArcToolbox. ArcToolbox contains a comprehensive collection of geoprocessing functions, including tools, fig. 1.42, for:

• Data management
• Data conversion
• Coverage processing
• Vector analysis
• Geocoding
• Linear referencing
• Cartography
• Statistical analysis

ArcToolbox is embedded in ArcCatalog and ArcMap and is available in ArcView, ArcEditor, and ArcInfo [15].

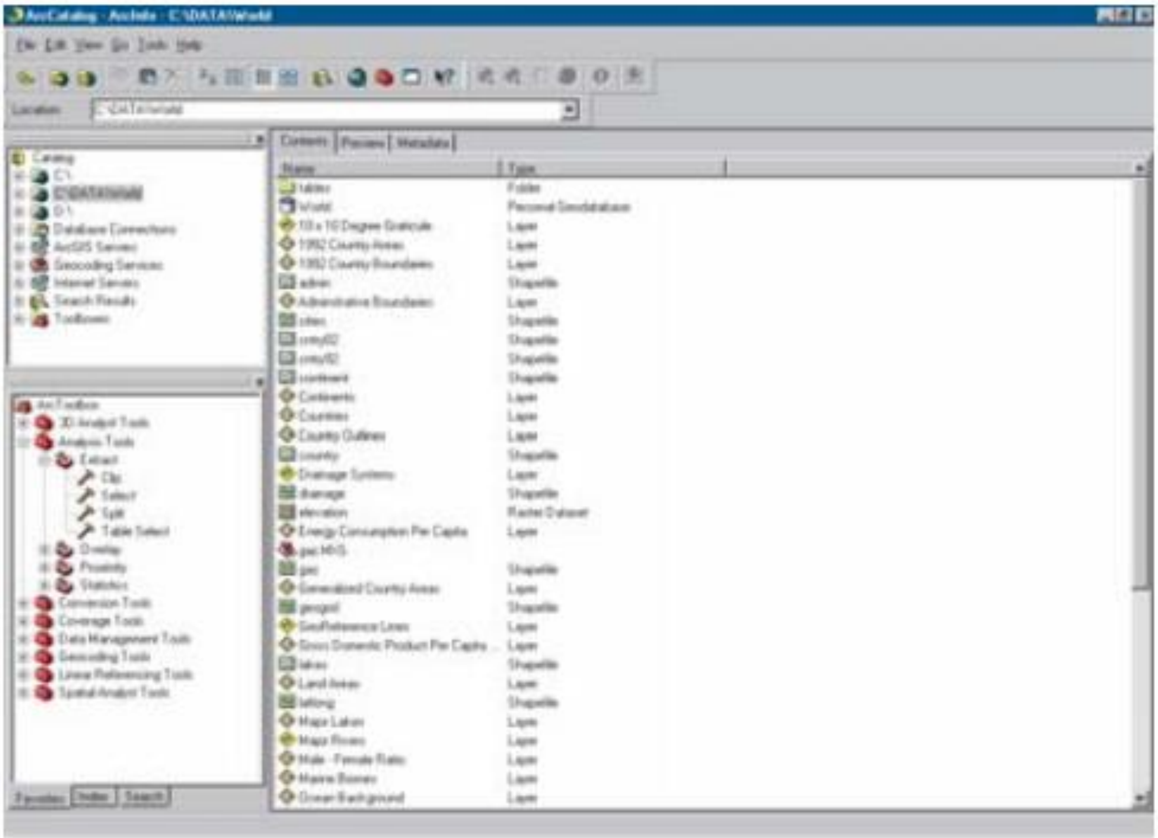


Figure 1.42 – ArcToolbox is available in all ArcGIS Desktop applications such as ArcCatalog [15]

Each product level includes additional geoprocessing tools:

• ArcView supports a core set of simple data loading and translation tools as well as fundamental analysis tools.

• ArcEditor adds a number of tools for geodatabase creation, loading, and schema management.

• ArcInfo provides a comprehensive set of tools for vector analysis, data conversion, data loading, and coverage geoprocessing

Although geoprocessing is accessible in ArcView and ArcEditor, ArcInfo is the primary geoprocessing seat in a GIS organization because it contains comprehensive geoprocessing tools for performing significant GIS analysis. At least one ArcInfo seat is needed to build GIS data and perform analysis.

Additional geoprocessing toolsets come with many of the ArcGIS extensions, such as ArcGIS Spatial Analyst, which includes up to 200 raster modeling tools, and ArcGIS 3D Analyst, which includes many triangulated irregular network (TIN) and terrain analysis tools. ArcGIS Network Analyst includes a number of transportation and network tools. ArcGIS Geostatistical Analyst adds kriging and surface interpolation tools [15].

ModelBuilder. The ModelBuilder interface provides a graphical modeling framework for designing and implementing geoprocessing models that can include tools, scripts, and data. Models are data flow diagrams that string together a series of tools and data to create advanced procedures and work flows, fig. 1.43.

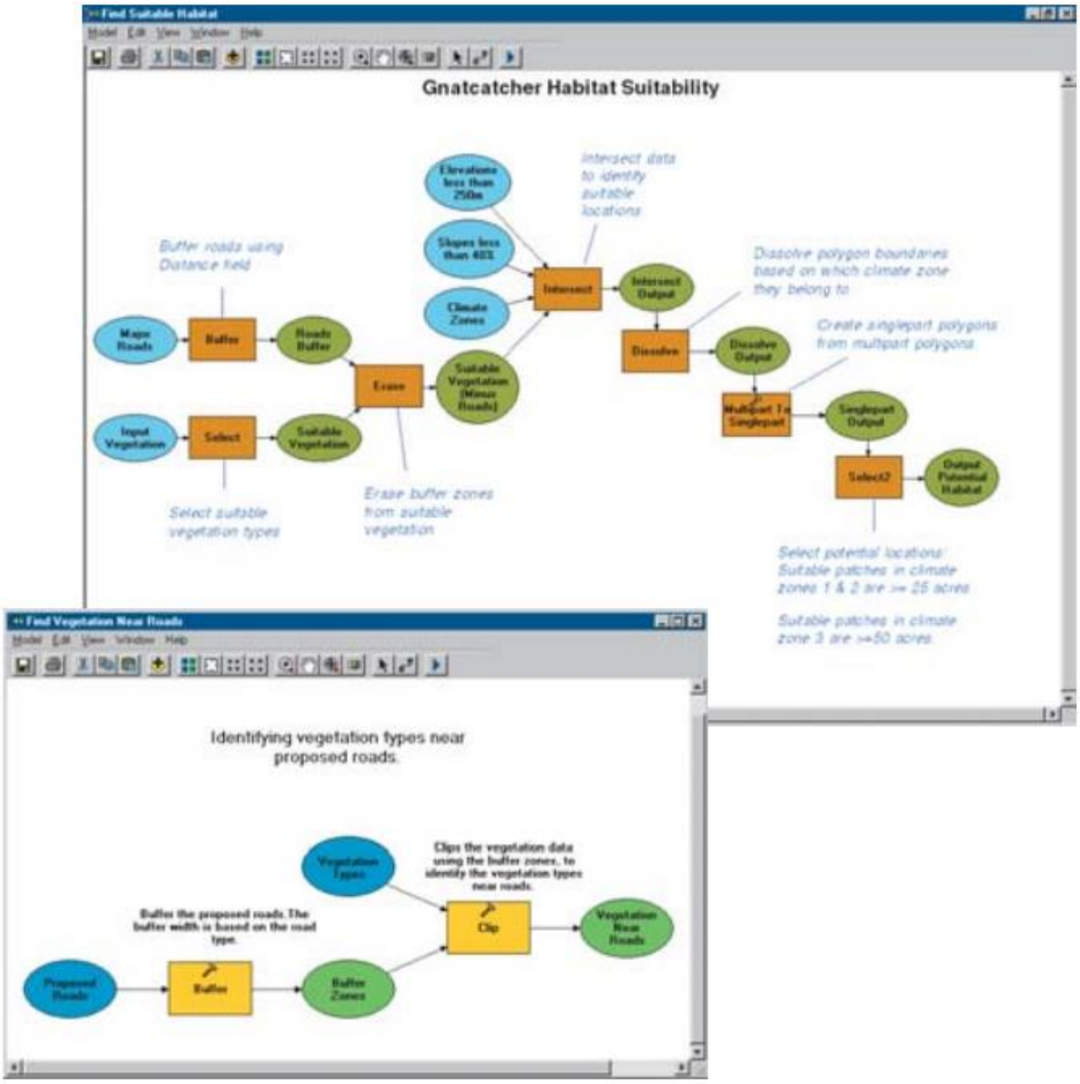


Figure 1.43 – ModelBuilder provides an interactive mechanism for building and executing complex GIS procedures [15]

ArcGlobe. ArcGlobe, part of the ArcGIS 3D Analyst extension, provides continuous, multiresolution, interactive viewing of geographic information. Like ArcMap, ArcGlobe works with GIS data layers, displaying information in a geodatabase and in all supported GIS data formats. ArcGlobe has a dynamic 3D view of geographic information. We do not consider it in more details.

1.8.3. What are ArcView, ArcEditor, and ArcInfo?

ArcGIS Desktop is the information authoring and usage tool for GIS professionals. It can be purchased as three separate software products, each providing a higher level of functionality.

• ArcView provides comprehensive mapping, data use, and analysis tools along with simple editing and geoprocessing.

• ArcEditor includes advanced editing capabilities for shapefiles and geodatabases in addition to the full functionality of ArcView.

• ArcInfo is the full-function, flagship ArcGIS Desktop product. It extends the functionality of both ArcView and ArcEditor with advanced geoprocessing. It also includes the legacy applications for ArcInfo Workstation (ArcPlot™, ArcEdit™, ARC Macro Language [AML™], and so on).

Because ArcView, ArcEditor, and ArcInfo all share a common architecture, users working with any of these GIS desktops can share their work with other users. Maps, data, symbology, map layers, custom tools and interfaces, reports, metadata, and so on, can be accessed interchangeably in all three products. Users benefit from using a single architecture, minimizing the need to learn and deploy several different architectures.

In addition, maps, data, and metadata created with ArcGIS Desktop can be shared with many users through the use of free ArcReader™ seats, custom ArcGIS Engine applications, and advanced GIS Web services using ArcIMS and ArcGIS Server.

The capabilities of all three levels can be further extended using a series of optional add-on software extensions such as ArcGIS Spatial Analyst and ArcGIS Network Analyst, fig. 1.44.

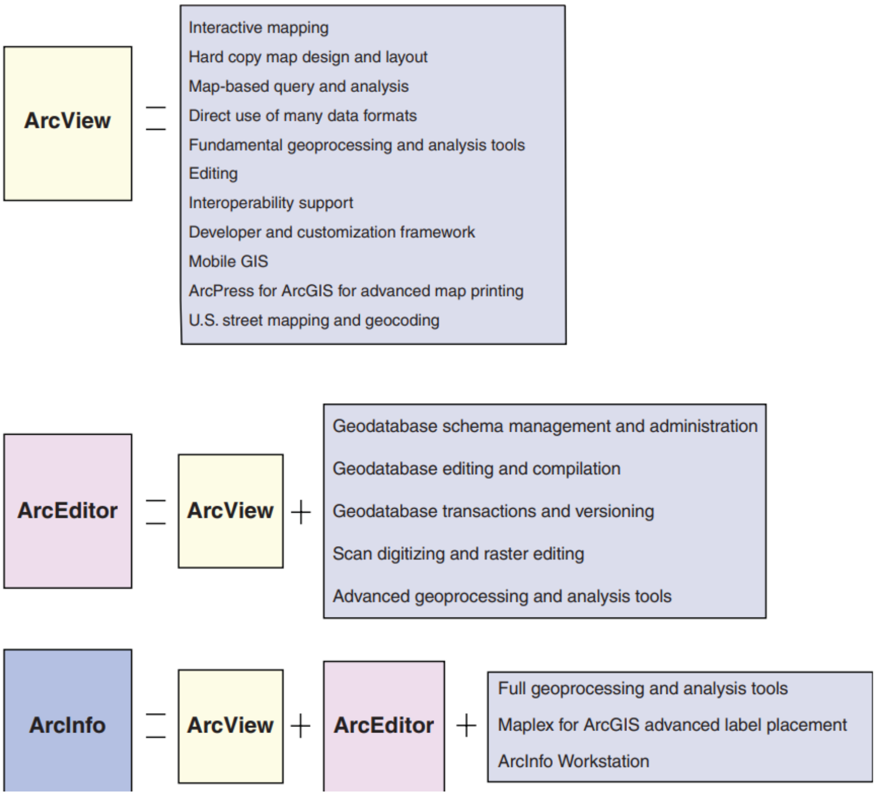


Figure 1.44 – Summary of capabilities of ArcView, ArcEditor and ArcInfo [15]

Capabilities of ArcView. ArcView is the first of the three functional product levels of ArcGIS Desktop. ArcView is a suite of applications, fig. 1.45:

ArcMap, ArcCatalog, ArcToolbox, and ModelBuilder. ArcView is a powerful GIS toolkit for data use, mapping, reporting, and map-based analysis. ArcView offers many exciting data use capabilities including advanced map symbology and editing tools, metadata management, and on-the-fly projection.

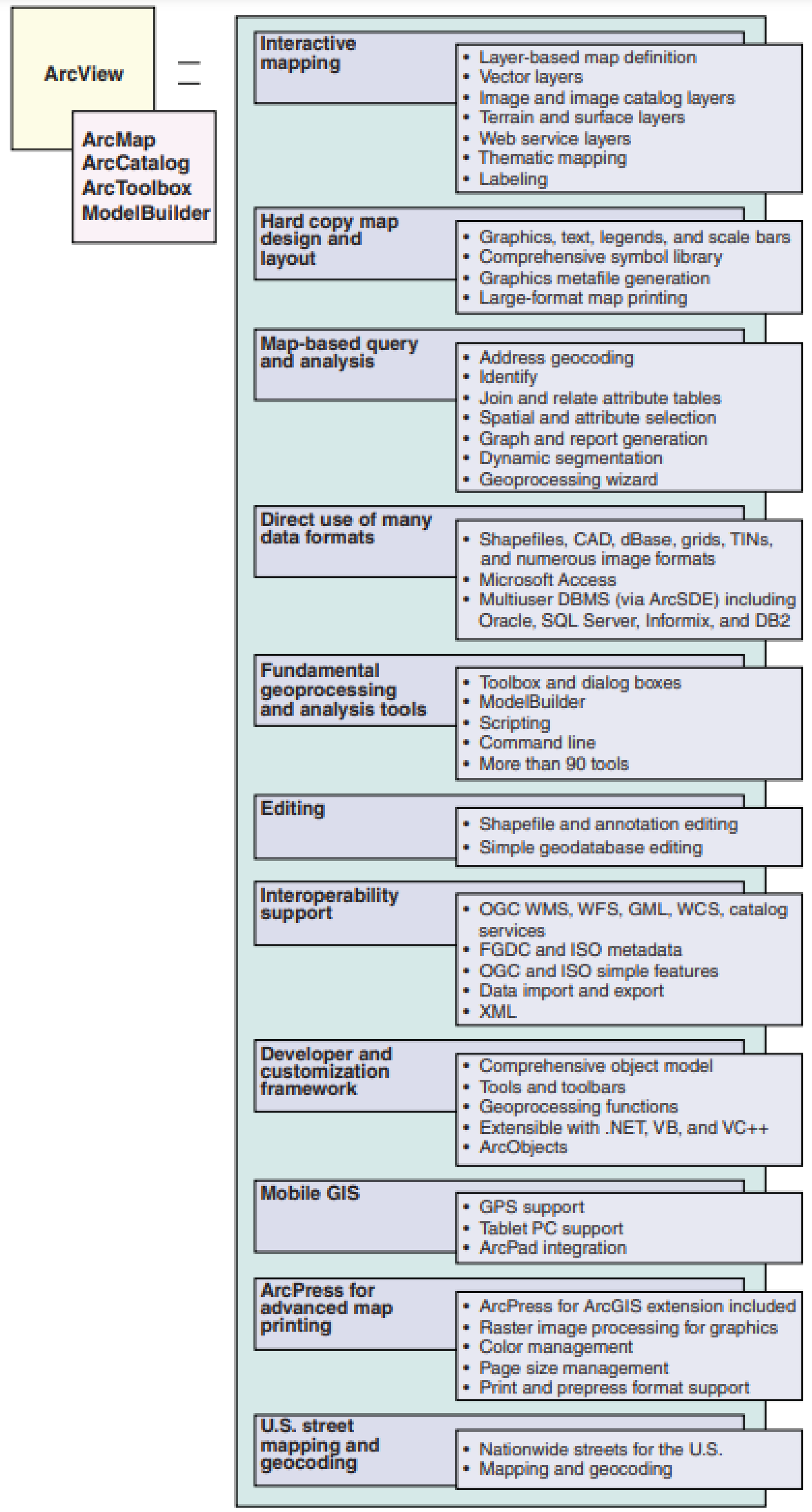


Figure 1.45 – Some of the key capabilities in ArcView [15]

Capabilities of ArcEditor. ArcEditor is a GIS data automation and compilation workstation for the construction and maintenance of geodatabases, shape files, and other geographic information. ArcEditor, along with ArcInfo, enables GIS users to fully exploit the rich information model, behaviors, and transaction support of the geodatabase. ArcEditor [15] offers the same functionality as ArcView but ads advanced editing tools, Fig. 1.46.

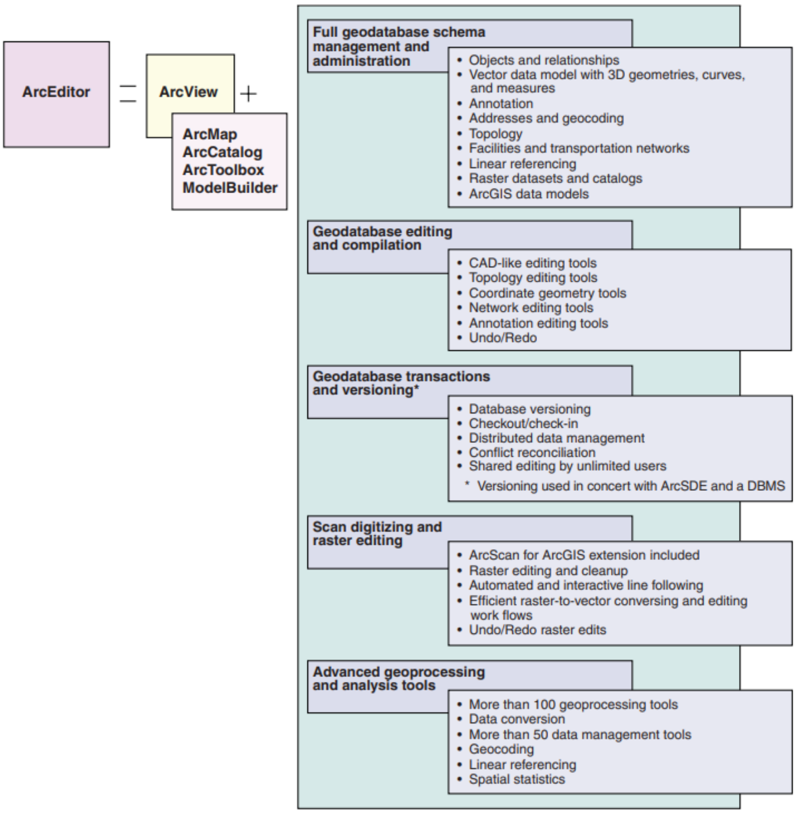


Figure 1.46 – A list of some of the key capabilities of ArcEditor [15]

ArcEditor provides all the capabilities of ArcView, as well as the ability to create geodatabase behaviors, such as topology, domains, and geometric networks. ArcEditor includes tools that support metadata creation, geographic data exploration and analysis, and mapping, and it includes the ArcScan™ for ArcGIS extension.

ArcEditor also includes comprehensive geoprocessing tools for automating data management workflows and performing analysis.

Implementing a DBMS and accessing it via ArcSDE facilitates multiuser geodatabase editing and maintenance with complete version management in ArcEditor. This includes advanced tools for version management – for example, version-merging tools to identify and resolve conflicts, perform disconnected editing, and conduct history management.

Capabilities of ArcInfo. ArcInfo is the flagship ArcGIS Desktop product. It is the most functionally rich client in ArcGIS Desktop. The high end ArcInfo product provides all the capabilities of ArcView and ArcEditor. In addition, it includes a comprehensive collection of tools in ArcToolbox to support advanced geoprocessing and polygon processing. ArcInfo provides all the capabilities of ArcView and ArcEditor as well as additional geoprocessing functionality. The ArcInfo version of ArcToolbox is important for sites that build and create spatial databases and for advanced analysis.

The classic workstation applications and capabilities contained in ArcInfo Workstation, such as Arc, ArcPlot, and ArcEdit, are included as well [15]. By adding advanced geoprocessing, ArcInfo is a complete system for GIS data creation, update, and query, mapping, and analysis, fig. 1.47.

ArcInfo also includes the Maplex for ArcGIS extension.

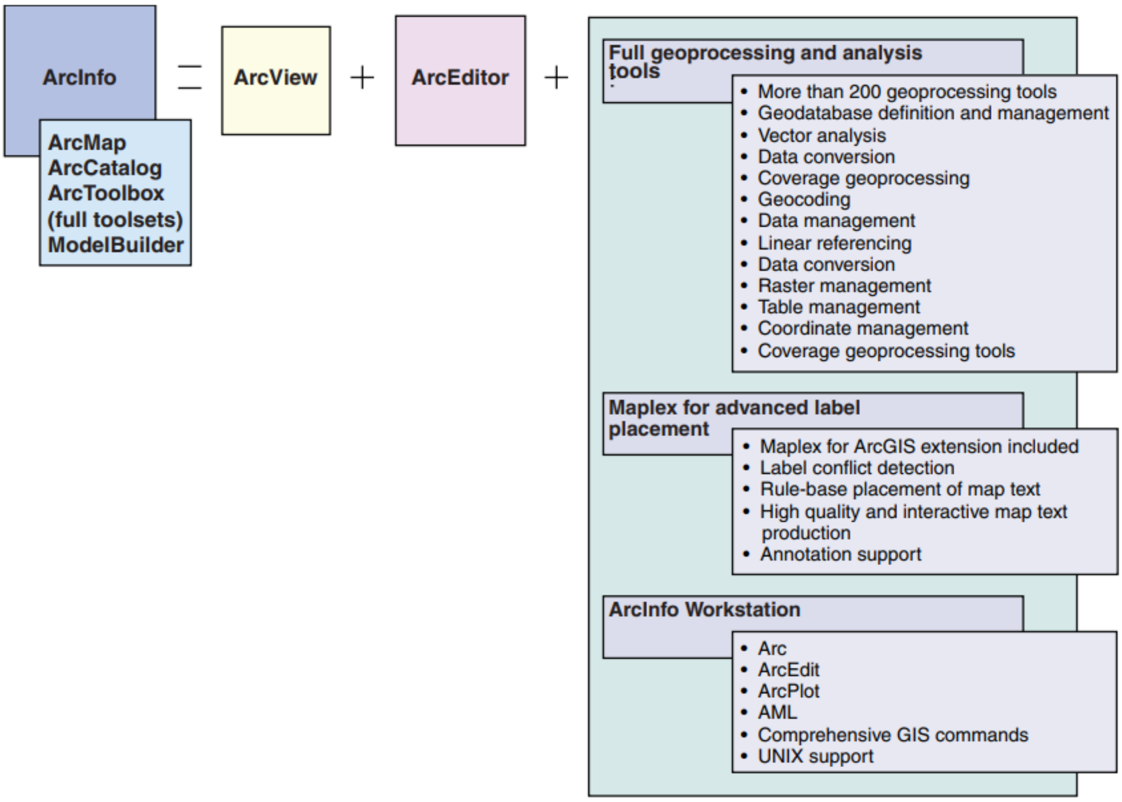


Figure 1.47 – Some of the key ArcInfo capabilities [15]

1.8.4. Optional extensions for ArcGIS Desktop.

Many optional extensions are available for ArcGIS Desktop, fig. 1.48. Extensions allow users to perform tasks such as raster geoprocessing and three-dimensional analysis. ArcView, ArcEditor, and ArcInfo can use all extensions.

The ArcScan for ArcGIS extension is included free of charge with ArcEditor and ArcInfo, and the Maplex for ArcGIS extension is also included with ArcInfo.

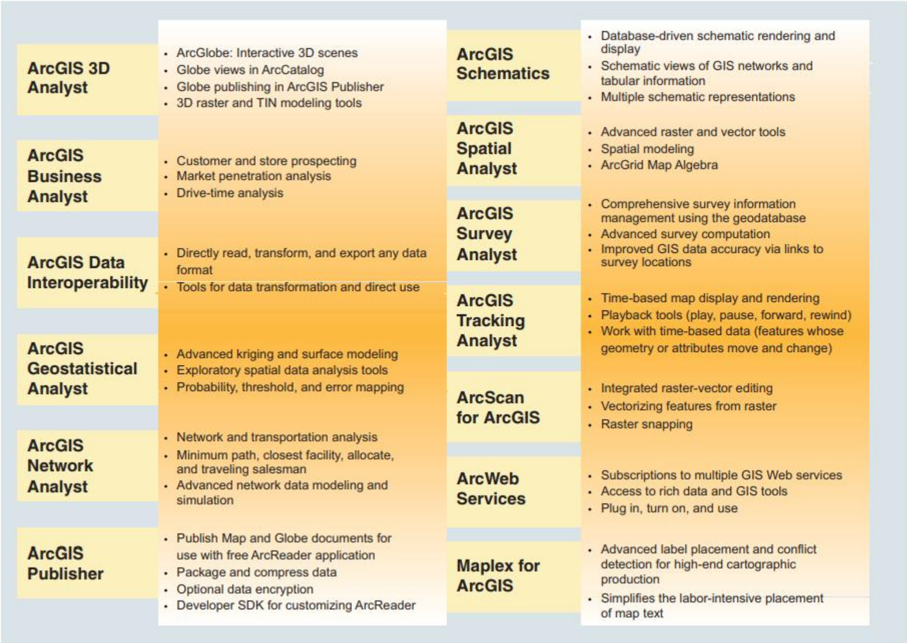


Figure 1.48 – Some of optional extensions available for ArcGIS Desktop [15]

ArcGIS 3D Analyst. ArcGIS 3D Analyst [15] enables effective visualization and analysis of surface data. With ArcGIS 3D Analyst, users can view a surface from multiple viewpoints, query a surface, determine what is visible from a chosen location on a surface, and create a realistic perspective image by draping raster and vector data over a surface. The core of the ArcGIS 3D Analyst extension is the ArcGlobe application. ArcGlobe provides the interface for viewing multiple layers of GIS data and for creating and analyzing surfaces.

ArcGIS 3D Analyst also provides advanced GIS tools for three-dimensional modeling such as cut/fill, line of sight, and terrain modeling, figs. 1.49 and 1.50.

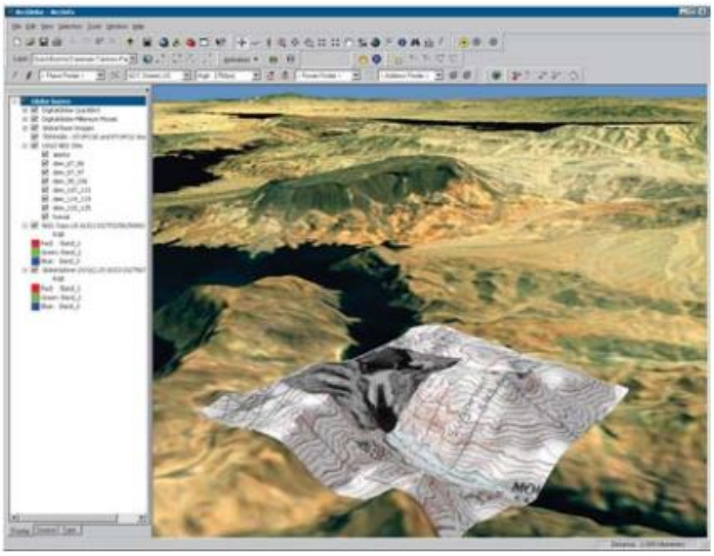


Figure 1.49 – ArcGIS 3D Analyst includes three-dimensional visualization and terrain modeling capabilities [15]

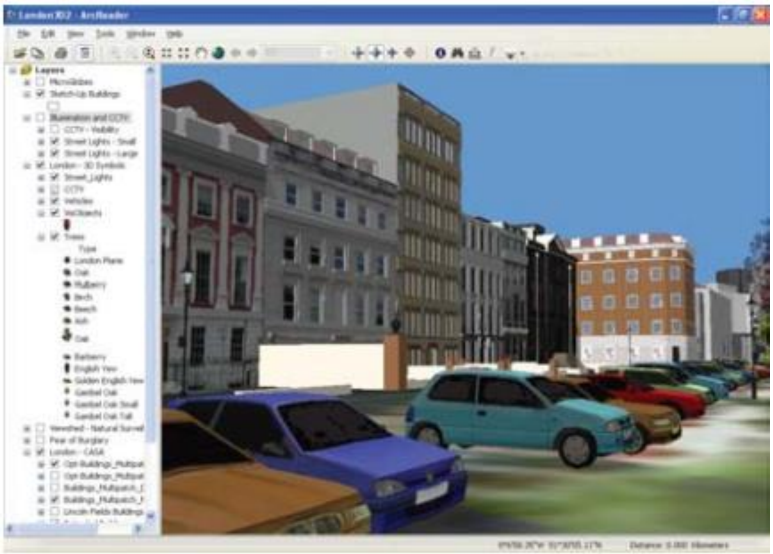


Figure 1.50 – ArcGIS 3D Analyst offers animation tools and functionality [15]

ArcGIS Geostatistical Analyst. ArcGIS Geostatistical Analyst provides statistical tools for analyzing and mapping continuous data and for surface generation. Exploratory spatial data analysis tools provide different insights about the data: its distribution, global and local outliers, global trends, level of spatial autocorrelation, and variation among multiple datasets, fig. 1.51.

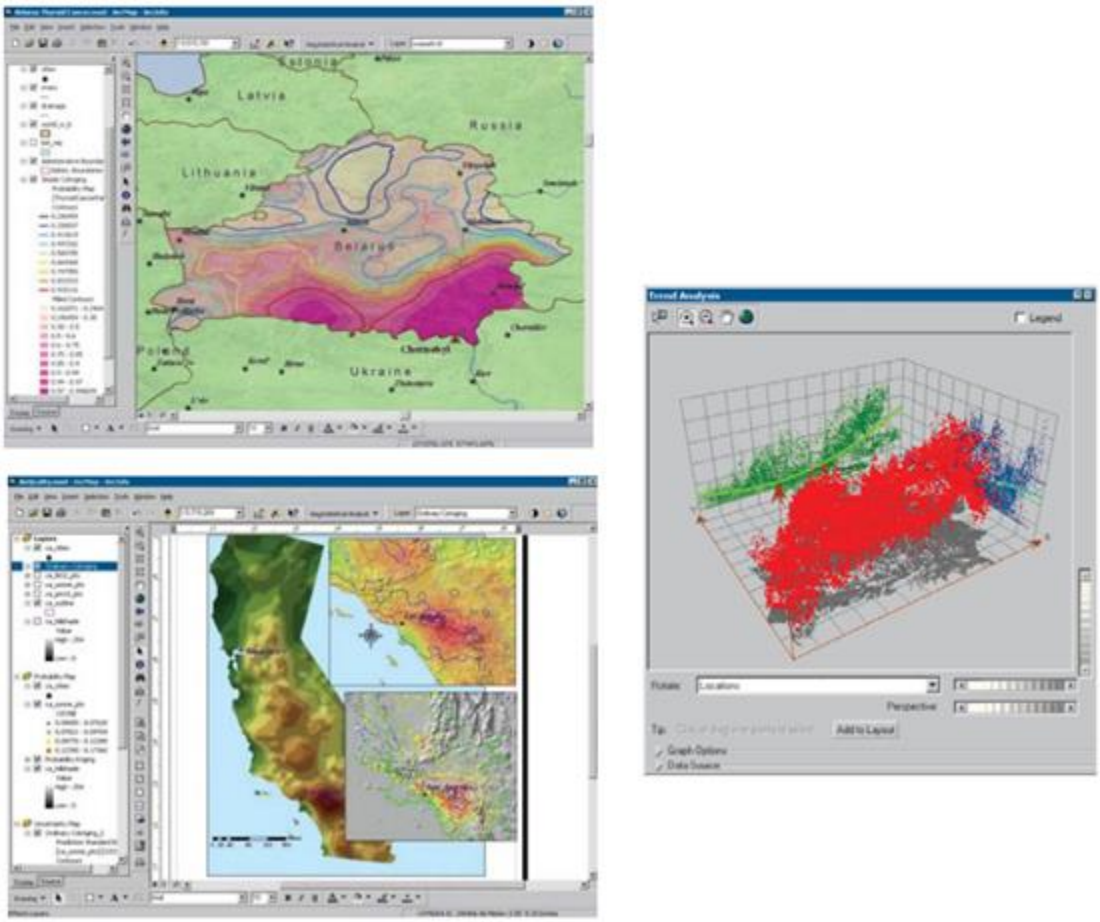


Figure 1.51 – Some possibilities of ArcGIS Geostatistical Analyst [15]

ArcGIS Spatial Analyst. ArcGIS Spatial Analyst provides a broad range of powerful raster modeling and analysis features, fig. 1.52, that allow users to create, query, map, and analyze cell-based raster data. ArcGIS Spatial Analyst also allows integrated raster-vector analysis. With ArcGIS Spatial Analyst, users can derive information about their data, identify spatial relationships, find suitable locations, and calculate the accumulated cost of traveling from one point to another.

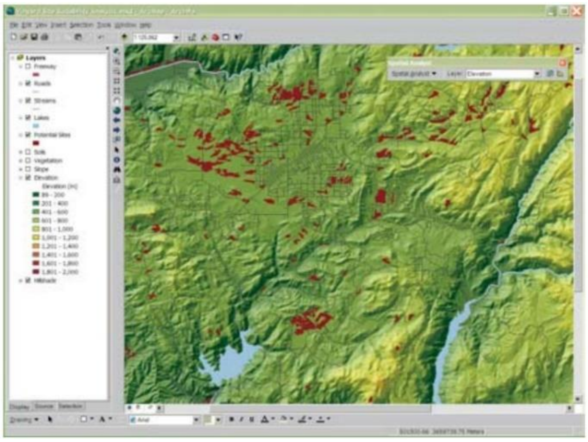


Figure 1.52 – Site suitability analysis [15]

ArcGIS Spatial Analyst provides a key toolbox when used with the geoprocessing framework in ArcGIS Desktop, fig. 1.53.

Figure 1.53 – Slope analysis using ArcGIS Spatial Analyst and ModelBuilder [15]

ArcGIS Publisher and ArcReader. ArcGIS Publisher is an extension used to publish data, maps, and globes authored using ArcGIS Desktop. ArcGIS Publisher enables the creation of a published map file (PMF) format for any ArcMap document as well as for any Globe document authored using the ArcGIS 3D Analyst extension.

PMFs are used in the free ArcReader application and allow users to share their ArcMap documents with other users. The PMF format can also be used to deploy maps over the Web through ArcIMS and ArcGIS Server [15].

Adding ArcGIS Publisher to ArcGIS Desktop allows users to open up access to their spatial information to many other users. With ArcMap and ArcGlobe, users can author interactive maps and globes, publish them with ArcGIS Publisher, and share them via ArcReader, ArcGIS Server, and ArcIMS ArcMap Server, figs. 1.54 – 1.56.

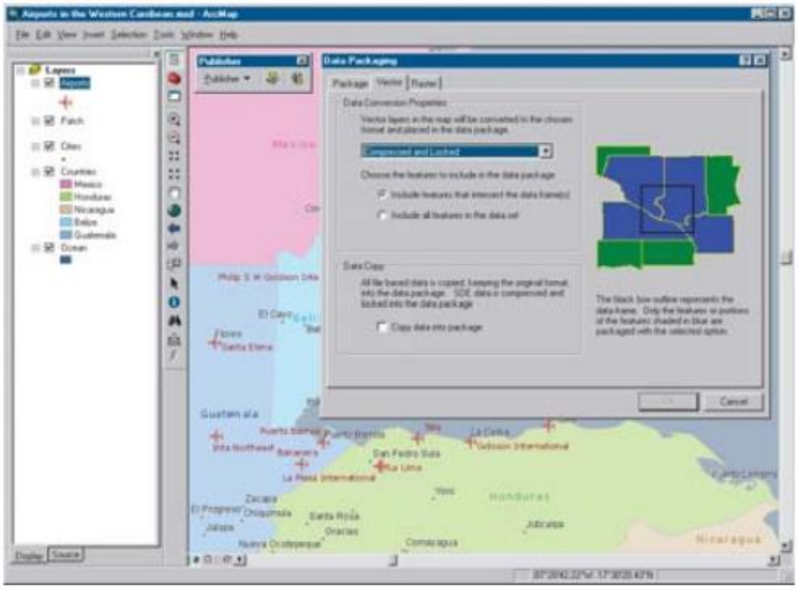


Figure 1.54 – Build PMFs in ArcMap with the ArcGIS Publisher extension [15]

Figure 1.55 – Deliver PMFs freely to any number of users

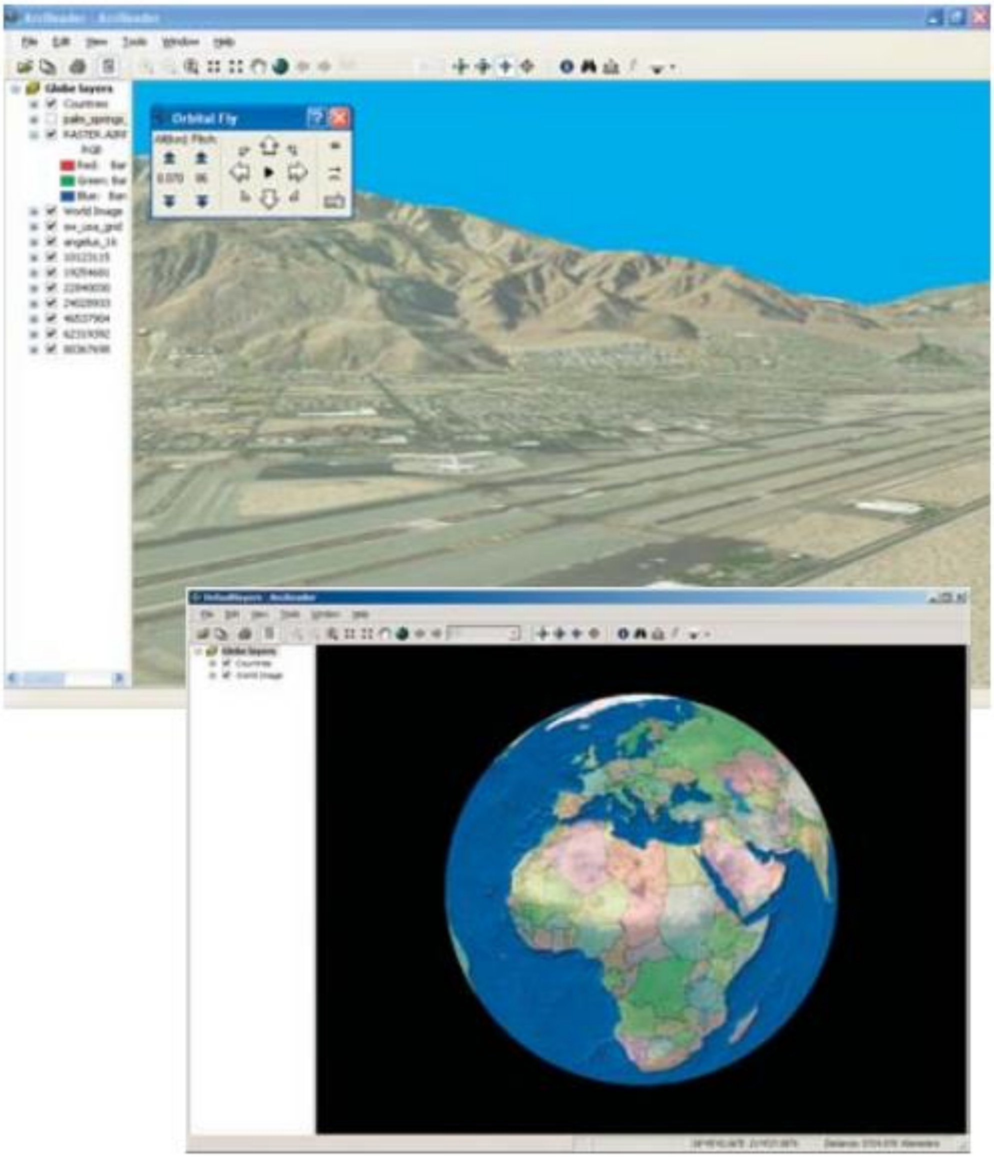


Figure 1.56 – Globe viewing in ArcReader [15]

1.9. Oasis montaj

1.9.1. General information

The information described below derived from the Oasis montaj Help and package documentation. **Oasis montaj** is a commercial, rapidly evolving software project and the major release from Geosoft, which is compatible to some extent with data produced by ArcGIS, QGIS, MapInfo. Therefore, we consider it in more details. It is a “light-weight” comparably to ArcGIS. **Oasis montaj** is available in two versions – a free ***Viewer*** and a licensed ***Mapping and Processing System*** [16].

The **Oasis montaj *Viewer*** is a free software product that enables you to view Geosoft data (databases, profiles, grids, voxels, maps), ArcGIS MXD files *(Note: The installation of ArcMap or ArcEngine is required to view MXD files in Oasis montaj*), and a variety of common image and data exchange formats. Specifically, this version provides you with the following capabilities:

***Software and Hardware Requirements*.** To run **Oasis montaj,** you require the following software and hardware:

Operating System. XP or newer required (2000, 95, 98, ME, NT not supported), Vista Business Edition under compatibility testing.

CPU. No requirement on a specific CPU type. An Intel Celeron processor is not recommended.

RAM. 2 GB recommended; 512 MB required.

Graphics. 256MB 3D (DirectX and OpenGL) Accelerated graphics card recommended.

Printer/Plotter. Any Windows supported color printer. Hewlett Packard large-format ink-jet plotters are recommended.

Illustration. Oasis montaj MUST be installed by a user with Local Administration rights on the machine.

Instalation Disk Space. 1 GB or more of free space on the *Program Files* drive is required for the installation process.

Data Disk Space. Data disk space depends on the volume of project data to be processed and the printer driver you are using, however 100 GB is recommended. This is largely based on your business and data requirements.

Internet. To use the Internet capabilities in Oasis montaj, you need to install Internet Explorer 5.0 or later. This does not mean that you have to have Internet Explorer as your default browser; Oasis montaj just uses the Internet connection technology supplied in IE5

1.9.2. Installing Oasis montaj Viewer

The Oasis montaj Viewer can be installed from a CD-ROM or downloaded from the web and installed as an *.exe file.

Install the Oasis montaj Viewer from CD ROM. Please note that your installation procedure will vary slightly depending on the operating system you are using.

Install from the Web. The **Oasis montaj *Viewer*** can be downloaded from the Geosoft website at (www.geosoft.eom/downloads/index.asp#free).

When installing **Oasis montaj** users **must** be logged on as **Administrator**.

1. Download the Oasis montaj Viewer (*.exe) file from the Geosoft website (www.geosoft.com downloads index.aspfffree).

2. Run the self-extracting file (Oasis montaj Viewer.zip), the InstallShield Wizard Setup dialog is displayed and tells you that the system is preparing the installation.

3. When ready, the program displays the Geosoft Oasis Montaj Viewer - InstallShield Wizard Welcome screen. To continue, follow the directions on the screens that appear.

4. When the "Installation Completed" dialog is displayed, you can check the boxes provided to launch **Oasis Montaj *Viewer*** or view the release notes.

5. Click the [Finish] button to complete the installation process.

Authorizing Your Internet Communication Settings. The Authorize Internet Communication dialog box enables you to authorize what communication takes place between your Oasis montaj system and the Geosoft Internet Server. The Internet Trust Relationship dialog box enables you to select the default setting for authorizing all future communication with the server.

All communication with the Geosoft Server is encrypted for your privacy and security. Authorize Internet Communication Dialog.

This dialog box is displayed when Oasis montaj tries to communicate with an internet server. For example, when you try to download data from the Geosoft DAP server and your authorization is set to Verify (the default setting).

• Click the [Authorize] button to authorize the communication and connect to the server.

• Click [Deny] to cancel the communication. The server will not be accessed.

• Click [Security] to view the Internet Trust Relationship dialog box and change your default authorization setting (see below).

Internet Trust Relationship Dialog. This dialog box enables you to set the type of access you want when communicating with an internet or external server to download data.

You can select from three levels of access that will define how the Geosoft Server will communicate with your computer:

Trusted. This setting will automatically authorize all communication with the server. This means that you will not be prompted to verify every time you connect with the Geosoft server. All communication with the server saved in a log tile on your local computer so that you can check to see what information was sent and received.

Verify. This setting will ask you to verify all communication with the server before proceeding with a download. This means that whenever you access the server, the server will show you what is being downloaded and ask you to authorize it.

Click the [**Accept**] button to give permission and download the file(s) or click the [**Deny**] button if you do not want to download the file(s).

All communication with the server saved in a log file on your local computer so that you can check to see what information was sent and received. This is the default setting.

Restricted. This setting will not authorize any communication with the server. This means that you do not want any communication with the server to take place. With this setting, you will not be able to download any data from the server.

Tip: You can modify your Internet Trust Settings at any time by clicking the *Global Settings/Internet menu* item from the GX menu.

Setting High-Resolution Graphics. In order to view colors in your maps and grids correctly, you may have to change your video card settings.

1. Click right mouse button on desktop screen.
2. On the *Properties* menu, click *Settings*.
3. Set the *Color Palette* to Medium Color 16-bit or Highest Color 32-bit.

Configuring Oasis montaj Settings. Before you begin working with **Oasis montaj**, you may want to configure your other default settings. The *General Settings* can be accessed from the *GX/Global Settings* menu option. For information on the different settings available in **Oasis montaj**, see the **SETTINGS GX** help topic in the online help system.

1.9.3. Tutorial 1: Getting Ready to Work

In this tutorial, you will be guided through the steps you need to know to start working with your new software. At this point, you should have already installed **Oasis montaj**. You should begin by starting **Oasis montaj**.

To Start Using Oasis montaj:

1. On the Start menu bar click *Programs* and then click *Geosoft* and then click *Oasis montaj Viewer | Oasis montaj Viewer*, fig. 1.57, or

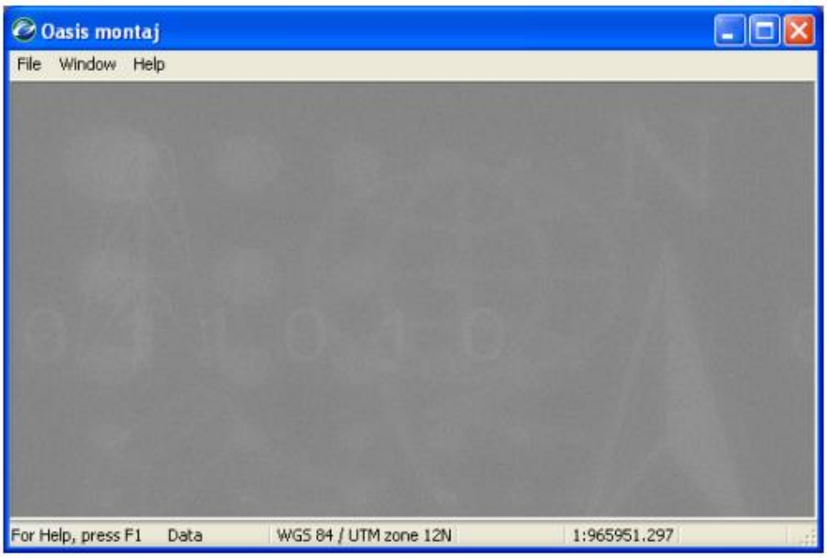


Figure 1.57. – Oasis montaj interface window

2. Double click on the **Oasis montaj Viewer** icon in Windows Explorer or File manager or the icon located on your desktop screen: **Welcome to the Oasis montaj Environment.**

When you run **Oasis montaj**, the system opens the **Oasis montaj** interface window.

System Files. As you work with the system, you will become familiar with a variety of standard Files used for specific functions. The following list provides a short summary of the more important Files.

Oasis montaj System Files	**System File Extensions**
• Geosoft Database File	*.GDB
• Map File, including Plots and Grids	*.MAP
• Geosoft (grid File	*.GRD
• Geosoft Voxel Files	*.GEOSOFT_VOXEL
• Geosoft Metadata files	*.XML
• Colour Information for Grids Images	*.AGG
• *ArcGIS MXD file	*.MXD
• Geosoft executable	*.GX
• Geosoft Script File	*.GS
• Oasis Menu, Oasis Sub-Menu	*.OMN, *.SMN
• Geosoft Project File	*.GPF
• Geosoft Projection Information File (for maps)	*.GI
• Geosoft Map file (used in the Maplnfo software to distinguish a Geosoft map file from a Maplnfo (*.map) file	*.GM

To access ArcGIS MXD files in **Oasis montaj requires ArcMap or ArcEngine to be installed on your computer.*

Creating a Working Directory. The system enables you to access Files anywhere but it is a good strategy to carefully organize your data (project information and Files) before carrying out any processing.

To start, please create a working directory e.g. D:\Tutorial. A general rule to follow in working with Geosoft applications is to avoid working in the directory where **Oasis montaj** was installed. We will follow this rule by keeping all the working data Files in D:\Tutorial.

Before you Begin. This tutorial uses sample data (casaber.gdb, casaber.grd, casaber.grd.gi, Oasis montaj.map, oasismontaj.map.gm, and xyz_format.xyz) which is available on the Geosoft website http: www.geosoft.com pinfo oasismontaj/free montajviewer.asp. Before you begin the tutorial, download and copy the data Files to your working directory D:\Tutorial.

Creating a Project. To work **Oasis montaj** requires an open Project. The **Oasis montaj** "Project" encompasses every item in your working project: data files (databases, maps, and grids), tools used (including 3D tool and the Project Explorer), the project setup including the menus you have displayed and whether you are working on a map or profile and the state in which you left it the last time you used it.

The project also controls your working directory. Projects are saved as (*.gpf) files. If you open an existing project from a directory), the system assumes that all your project files are located in the same directory. To streamline your work, as well as keep it organized, you may wish to make sure that your project file is in the same directory as the other files you want to use. It is recommended that each project you work on have its own project (*.gpf) file.

The *Project Explorer* tool enables you to browse as well as open any project item. The Project Explorer has two windows, the *Data* window that includes all data files included in the project and the *Tools* window that organizes and maintains the project tools. To access the Tools window, click the Tools bar on the bottom of the Project Explorer. To return to the Data window, click the Data bar on the top the Project Explorer.

To Create a Project:

1. Start **Oasis montaj**.

2. On the *File* menu, select *Project* and then select New. The *New Project* dialog is displayed, fig. 1.58 (all figures are used from the Oasis montaj documentation).

Note: Oasis montaj assumes that your data is in the directory containing this project

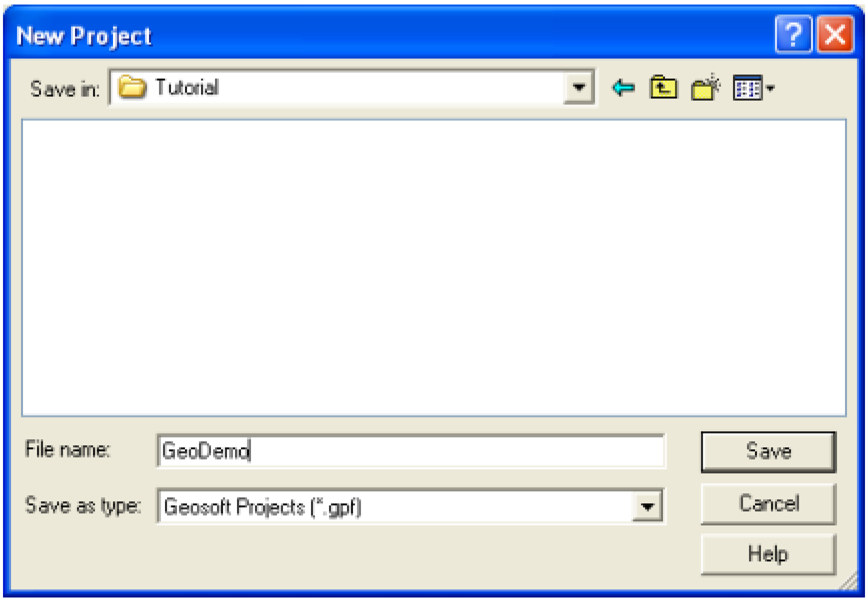


Figure 1.58 – Oasis montaj panel for a new project

3. Specify a name and directory for the project. For example, name the project **GeoDemo** and specify the working directory as **D:\Tutorial.**

4. Click the [**Save**] button. The system saves the project and indicates it is open by adding menus to the menu bar, adding buttons to the *Database Tools*, *Map Layout*, *Map Tools* and *Standard* short-cut tool bars and by displaying the *Project Explorer* window. These are visual clues indicating that you are ready to start working with the system, fig. 1.59.

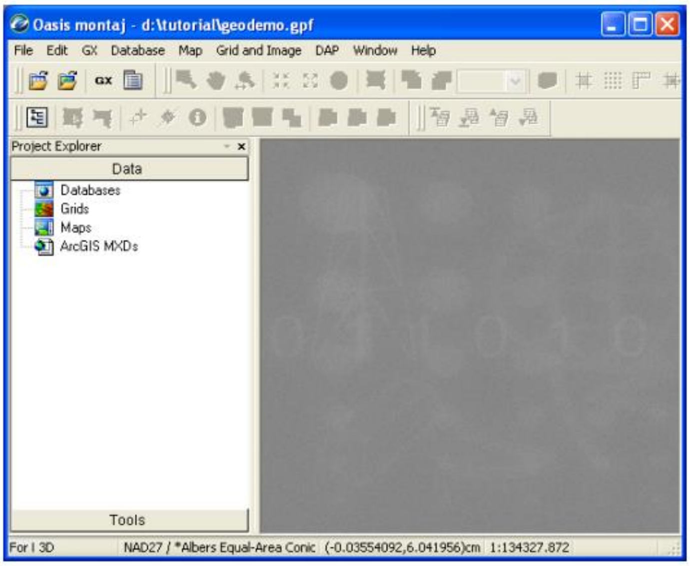


Figure 1.59. – Oasis montaj Project Explorer window

5. To close a project, on the *File* menu, select *Project|Close*.

1.9.4. Changing Default Settings

The program will work correctly with all of the standard default settings; however, these may be changed to reflect your personal requirements or those of your computer, fig. 1.60. The default settings are the selections made for many of the programs where there is no user input and are designed to yield logical results.

You may overwrite some of these intelligent defaults in normal use but this should not create any problems since the defaults are only intended to get you started with the system and should change as your knowledge of the system increases.

On the GX menu, select Global Settings | General. The Default Oasis montaj settings dialog is displayed. Select the desired choices from the available selections. You need not change any selections at this time. Once you are more familiar with Geosoft, you may come back to alter the settings.

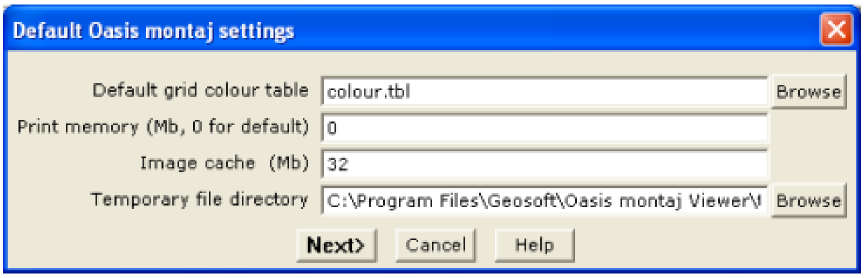


Figure 1.60. – Oasis montaj Default settings

The following list summarizes the default **Oasis montaj** *Viewer* settings:

Default grid color table. Select the default color table to use for displaying grids.

Select memory megabytes. Select the amount of RAM you would like the Geosoft print driver to use when printing. This only effect prints configurations that use the Geosoft drivers. Enter 0 to use the default, which is 33% of the total physical RAM available on the system.

The Geosoft print driver will slice each print job into bands of this size. The more RAM you use for printing, the faster printing will be. If you specify too much RAM, it is possible to significantly diminish the performance of other tasks on the computer. This amount should normally not exceed 50% of the installed RAM on your system, although we will allow the value to be up to 75% of the available RAM.

The Windows driver does not use this setting. If you use the Windows print driver, the printing process will use virtual memory up to the size required by the print. This can be up to 600 MB for A0 (E) size plots. We recommend that you use the Geosoft drivers when working with large plotters.

Image Cache. Select the amount of virtual RAM you would like to reserve for the image cache. As images are displayed in Oasis montaj, an efficient access version of the image will be stored in the cache if there is room. The cache copy of the image greatly improves the performance of rendering the image when zoom/pan/redraw operations are performed. If there is insufficient room in the cache, the image will always be rendered from the DAT interface, which is slower.

We recommend that you should set the image cache size to about 4 times the largest images that you routinely work with. Note that the image cache will be created in the GEOTEMP directory, and there must be sufficient room to hold the cache plus other Geosoft temporary files. The image cache should not be more than 50% of the available room in GEOTEMP.

Temporary file directory. This directory is used by **Oasis montaj** to store temporary files. Depending on the application, the requirements for storage in this directory can be VERY large (from 10 megabytes to gigabytes). We recommend setting this parameter to a very FAST drive. This will improve performance of all large data operations (magmap, gridding, etc).

Oasis montaj cannot start if this drive is invalid or if it is set to a drive, in which it cannot create files (CD ROM). Please ensure that the directory is always valid.

Note that in previous versions of **Oasis montaj** the GEOTEMP environment variable determined where this directory was stored. This variable is no longer used and the setting is controlled through the Windows registry.

Working with Data. To use **Oasis montaj** effectively, you will need to understand a bit about databases, spreadsheets, profiles and maps. The "window" to the database in **Oasis montaj** is a specialized earth science spreadsheet that appears automatically when you open a database. This spreadsheet provides access to a wide range of data management and profile viewing capabilities. Maps have special properties that you will learn about later.

The purpose here is to provide you with an overview of how to use this data management system effectively.

1.9.5. Oasis montaj Databases

One of the fundamental technologies in **Oasis montaj** is its unique database architecture. This is designed to let you display many kinds of data formats (ASCII and binary) in high-performance **Oasis montaj** databases.

Oasis montaj provides the ability to add compression to a database. You can choose to compress for speed, size or use no compression at all. The type of compression you use depends on which type better suites your needs. It is recommend that you use speed, as it provides the fastest access to your data with a good compression rate.

Opening a Database. Geosoft databases store and organize your survey data. Databases are displayed and organized in the Spreadsheet Window of the **Oasis montaj**.

To Open a Database.

1. On the *Database* menu, select *Open database*. The *Open Database* dialog is displayed, fig. 1.61.

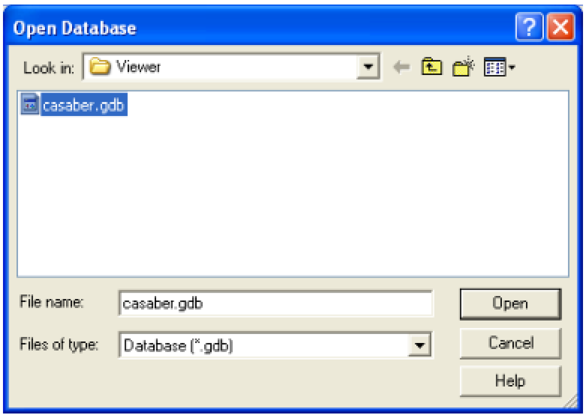


Figure 1.61. – Oasis montaj, Open Database panel

2. Select the tutorial database (**casaber.gdb**) and click [**Open**]. The *casaber.gdb* is displayed in your project, fig. 1.62.

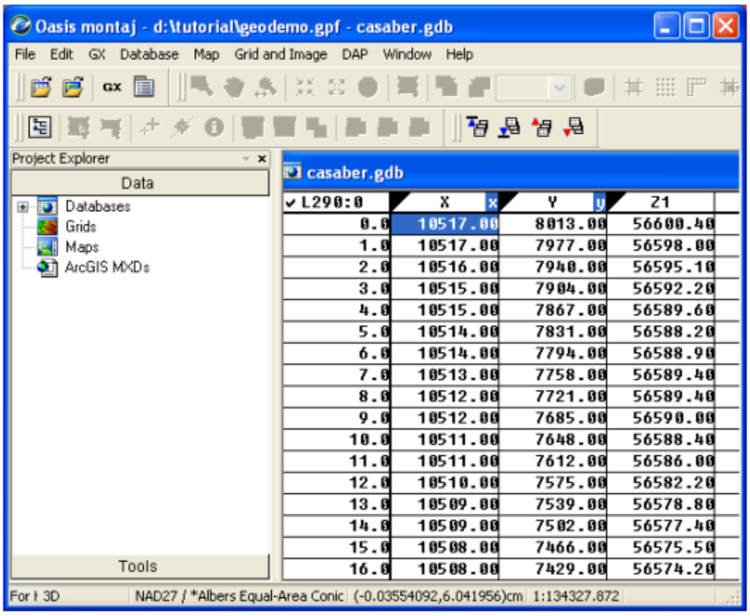


Figure 1.62. – Oasis montaj, spreadsheet of casaber.gdb

Adding Compression to your Database:

1. On the Database menu, select *Save database as*. The corresponding dialog is displayed, fig. 1.63.

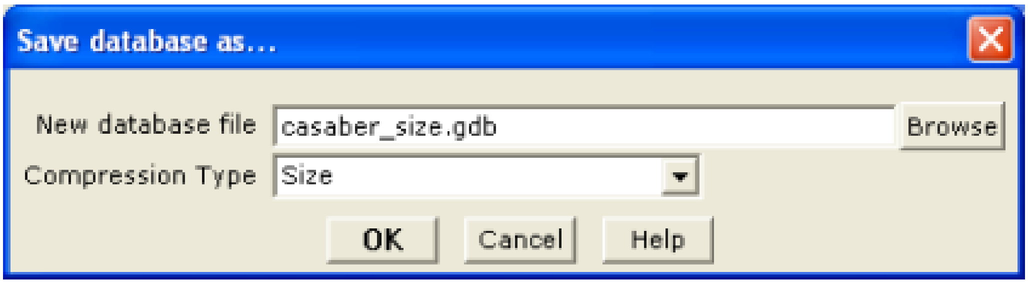


Figure 1.63. – Oasis montaj, Save Database dialog

2. Specify a new database name as (casaber_size.gdb) and then from the *Compression Type* dropdown list, select (**Size**). Click the [**OK**] button to continue.

3. The new compressed database (**casaber_size.gdb**) is displayed in your project.

Displaying Data Files in an Oasis montaj Database. There are a number of options for displaying Geosoft and third party formatted data files in an **Oasis montaj** database. Here you will display a standard Geosoft XYZ file. For more information about the Geosofi XYZ format and other file formats that can be displayed in an **Oasis montaj** database see (*Displaying Data Formats*).

Displaying an XYZ Format File in a Database:

1. On the Database menu, select Import, and then select Geosoft XYZ. The *Open a Geosoft XYZ file into a new database* dialog is displayed, fig. 1.64.

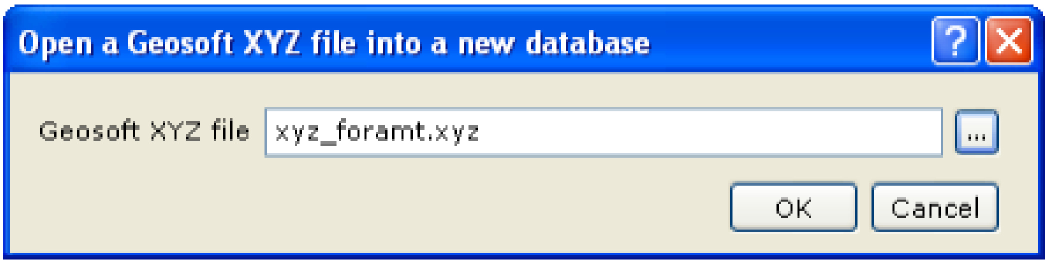


Figure 1.64. – Open a Geosoft XYZ file panel

2. Using the Browse () button locate the *Geosoft XYZ file* (xyz_format.xyz) in your project directory.

The Browse () button allows you to browse and select files from anywhere on your computer or network drives.

3. Click the [OK] button. The system displays the *Specify Maximum Database Sizes* dialog, fig. 1.65.

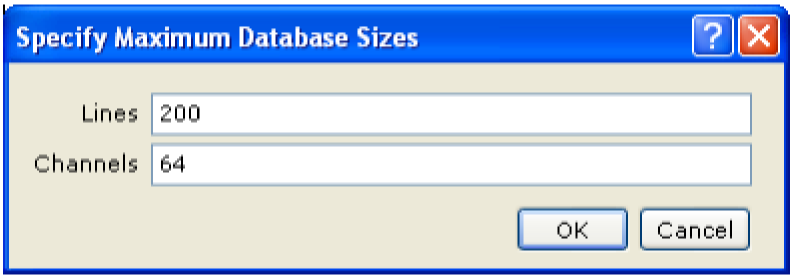


Figure 1.65. – Specify Maximum Database Sizes panel

4. This dialog enables you to specify the maximum size of the database in which the file will be displayed. You can accept the intelligent defaults and click the [**OK**] button. The file will be displayed in a Geosoft database with the same name as the XYZ file, but with a (*.gdb) extension (**xyz_format.gdb**), fig. 1.66.

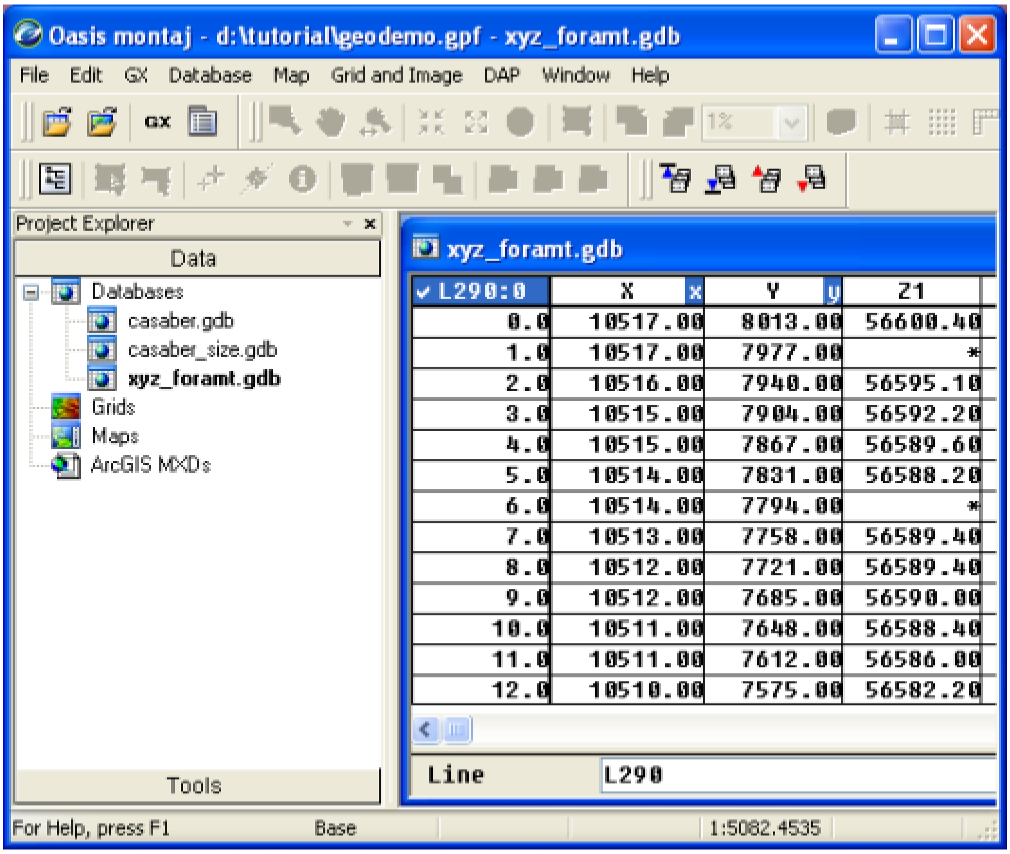


Figure 1.66. – Spreadsheet of the xyz_format.gdb window

Note: The default placeholder for missing or blank data (i.e. dummy value) in an XYZ file is (*).

Displaying/Hiding Channels (Columns) in the Spreadsheet. Unlike traditional spreadsheets, the **Oasis montaj** Spreadsheet windows provide a ***view*** of your database instead of the actual data in the database. This design enables you to customize the spreadsheet to display data to your specifications.

To Hide a Channel (Column) – Select (highlight) the channel header cell you want to hide, for example (**Z1**). Press the [**space bar**] key on the keyboard or using the mouse right-click and from the popup menu select *Hide Column*. The channel/column will be hidden from the Spreadsheet view.

*Note***:** The database (*.gdb) file still contains all the data. The spreadsheet is only used to provide a view of selected channels.

To Display a Channel:

1. Move to the top of the first empty channel header, fig. 1.67, and using the mouse, right-click and from the popup menu, select *List*.

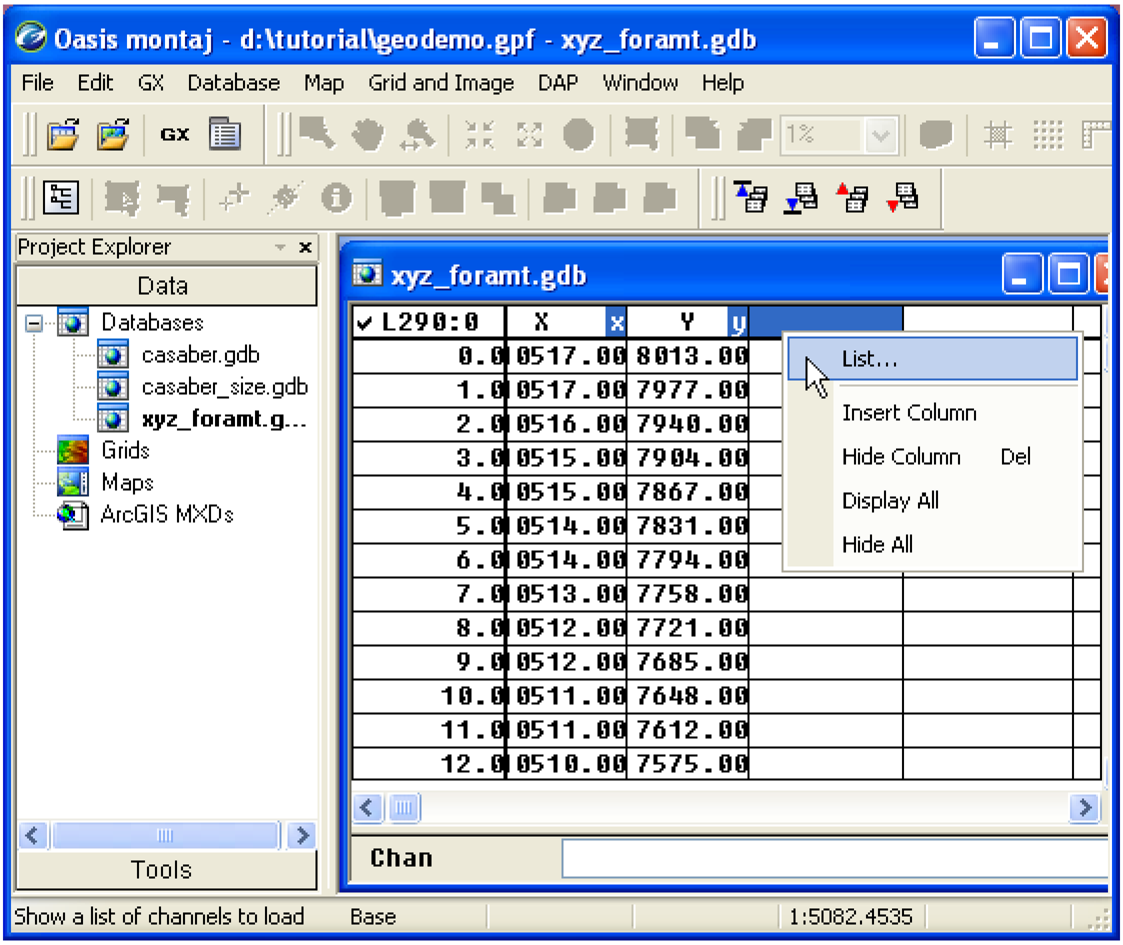


Figure 1.67. – Spreadsheet columns window

2. A box will appear beneath the empty channel header listing all the available channels that are not currently being viewed in the Spreadsheet window.

3. Select **Z1** and click the [**OK**] button, to display the channel in the Spreadsheet.

If you know the name of the data channel already, you can simply position the cursor on a specific Channel Header Cell, type the name and press the [**Enter**] key.

Note: The symbol (*) in a channel cell indicates that the data are too wide for the spreadsheet column. To change the width of a column, place the cursor on the dividing line between the column headers. The cursor changes to a double arrow. Holding the left mouse button, drag the line to the right to increase the column width. Release the mouse button when done.

After you open a Spreadsheet and display one or more channels, you can display and save the channel statistics. In this example, we will display the Statistics for the Z1 channel.

To Calculate Basic Statistics on a Channel:

1. Click three times on the channel header cell labelled **Z1** to select (highlight) the channel for all of the lines in the database. The selected data is the data the system will calculate the statistics on.

2. Using the mouse right-click and select Statistics from the popup menu, fig. 1.68.

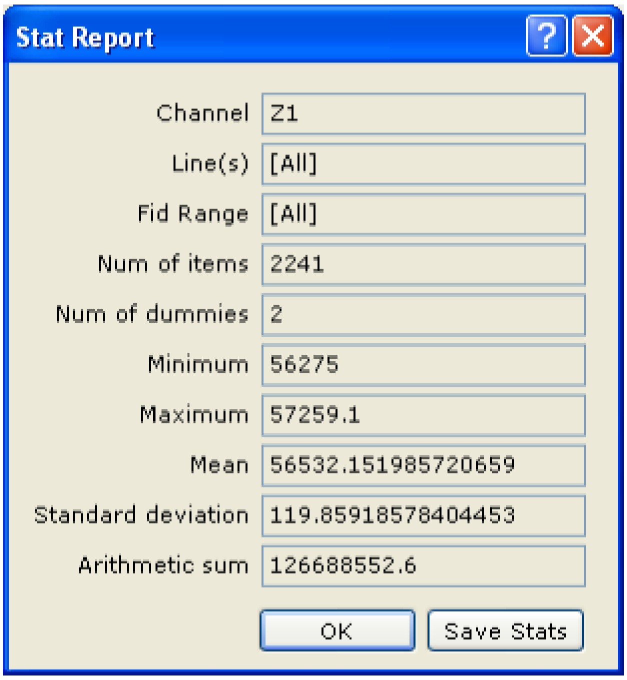


Figure 1.68. – Statistics window

3. You can save a copy of the statistical report by clicking the [**Save Stats**] button. The *Save Stats* dialog is displayed, fig. 1.69.

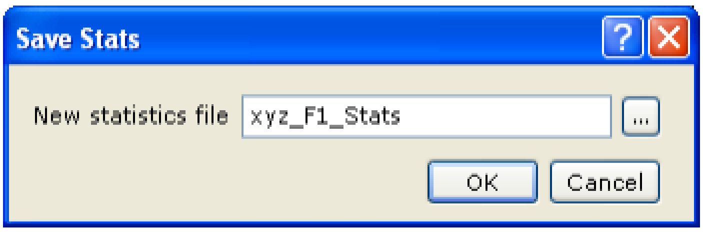


Figure 1.69. – Statistics save window

4. In the New statistics file box, specify a file name (**xyz_Fl_Stats.txt**). Click the [**OK**] button to save the file to your project directory. Then, click the [**OK**] button to close the *Stat Report* dialog box.

The following list summarizes how to obtain results on specific parts of your database:

Click once on the channel header cell to highlight the header cell. No statistics can be calculated.

Click twice (double click) on the channel header cell to highlight the data in the current line (group). Statistics are calculated for that specific line of the database.

Click three times on the channel header cell to highlight the data in all of the selected lines (groups) in the database.	Channel statistics are calculated for all of the selected lines in the database

Displaying Profiles in the Spreadsheet. After you open a Spreadsheet and display one or more channels, you have the option of displaying them as a graphical profile line. You can display profiles for one or more channels in your database. The profile appears in the profile windows directly below the corresponding database. You can have up to five windows displayed, with a maximum of 32 channels displayed in each window. Profile windows are linked dynamically to their corresponding database. When you select a value or range of values in either the database or profile window respectively, they are also highlighted in the other window.

To Display a Profile:

1. Select (highlight) the channel header cell labelled **Z1** and then using the mouse right-click and from the popup menu, select *Show Profile*.

2. The system displays a profile of the data channel in the *Profile Window* below the spreadsheet, fig.1.70.

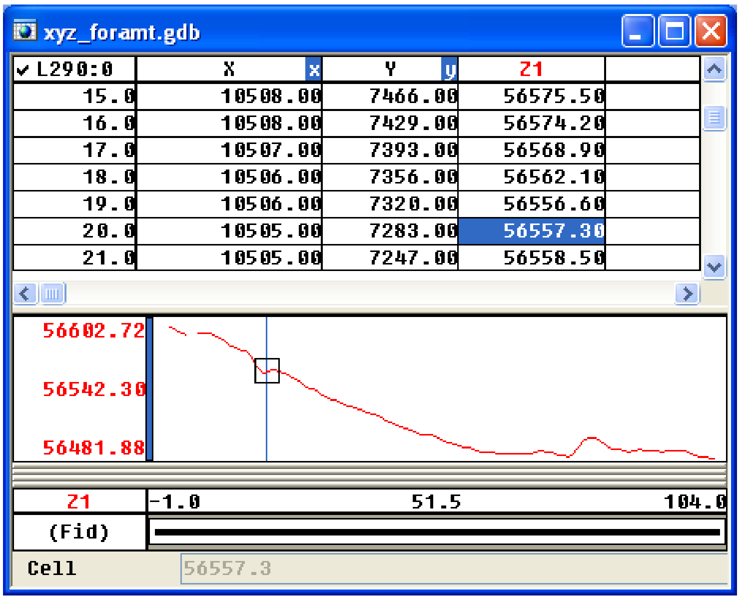


Figure 1.70. – Displaying a profile window

Note: To see where the Z1 values are located on the profile line simply click on a value in the **Mag** channel and the system will show a box indicating the corresponding area on the profile.

3. We recommend you experiment with the various "Profile" options accessed via the *Profile* popup menu, including *Profile Options*, *X* and *Y Axis Options*, *Horizontal* and *Vertical Rescaling, Zooming, and Profile Plotting*.

Profile menu – The ***Profile*** *menu is accessed by right-clicking while holding your cursor over the Profile window*, fig. 1.71.

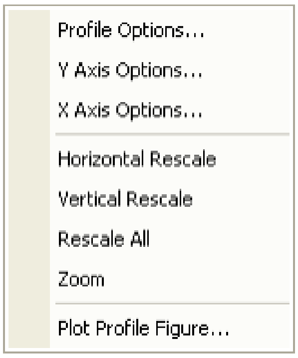


Figure 1.71. – Profile menu window

***To Display a Different Profile*:**

1. Move the cursor to the *Line Header Cell* in the top left corner of the spreadsheet. The currently displayed line in the worksheet is **L290:0**, fig. 1.72.

2. Click right mouse button on this cell and select the *List* option from the popup menu. A list of the line numbers is displayed. You can think of each line number as a worksheet in the spreadsheet window. When you view a new line number a new worksheet is opened in the spreadsheet window with corresponding line number information.

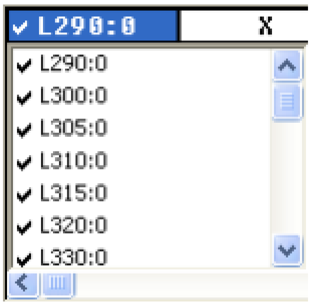


Figure 1.72. – Line option selecting

3. Click on **L350:0** from the list and display a profile for this line. The profile for **L350:0** is shown below, fig. 1.73:

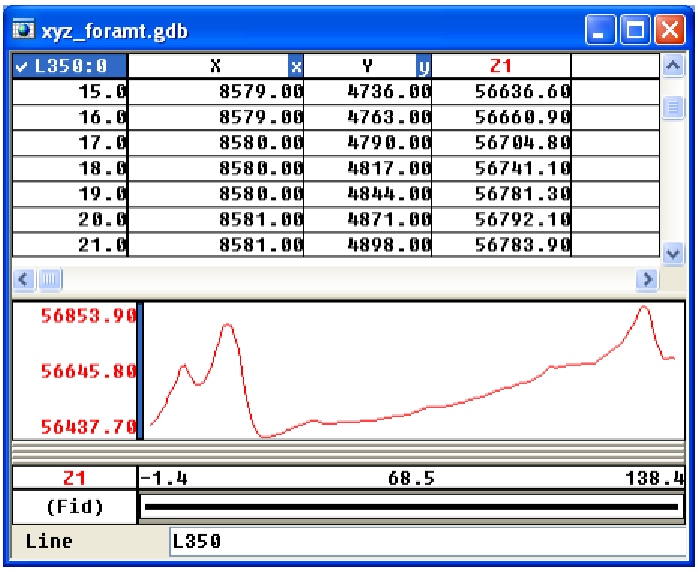


Figure 1.73. – Profile for the line 350:0

Note: When the Line Number Cell is highlighted, you can use the [**Page Up**] and [**Page Down**] keys from your keyboard to scroll through lines. You can also use the *Database Tool Bar* to scroll through the lines. The figure below shows what each of these buttons do.

1.9.6. Database Tool Bar

Display First Line/Group. Click this **Display Previous Line/Group**. Click button to show the data and profiles the data and profiles for the starting line in your database previous line in your database, fig. 1.74.

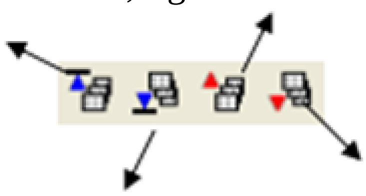


Figure 1.74. – Database tool bar

Display Last Line/Group. Click this button to show the data and profiles for the final line in your database.

Display Next Line/Group. Click this button to show the data and profiles for the following line in your database

Y-Axis Options. The **Y-***Axis Options* menu item on the *Profile* popup menu enables you to set the Y-axis scale options for the profiles in the profile window.

To set the Y-Axis Options:

1. Using the mouse, right-click while holding your cursor over the *Profile* window and the *Profile* popup menu will be displayed.

2. From the *Profile* popup menu, select Y-Axis Options. The *Panel Options* dialog will be displayed.

To Display Profiles at the Same Scale:

1. To display two profiles at the same scale, select the *Scale to fit for each line* option and check the *Same scale for all profiles in panel* option box, fig. 1.75.

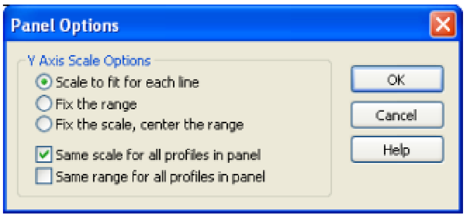


Figure 1.75. – Panel scale options

Table 1.5 Fitting scales

Scale to fit for each line	Adjusts the scale in the profile box to fit each line that is displayed
Fix the range	Uses the same range for all the profiles that are displayed.
Fix the scale, center the range	Fixes the ranges and displays the line in the center of the window.
Same scale for all profiles in panel	All profiles (including those from different channels) are set to the same scale
Same range for all profiles in panel	All profiles are centered individually on their own mid-data value

Plotting Profile Windows. Oasis montaj enables you to quickly plot your displayed profile windows as an **Oasis** montaj *Map* file. The map is named using the name of the current database and the profile line number.

1. On the *Profile* popup menu, select *Plot Profile Figure*. The *Create a profile figure* dialog is displayed, fig. 1.76.

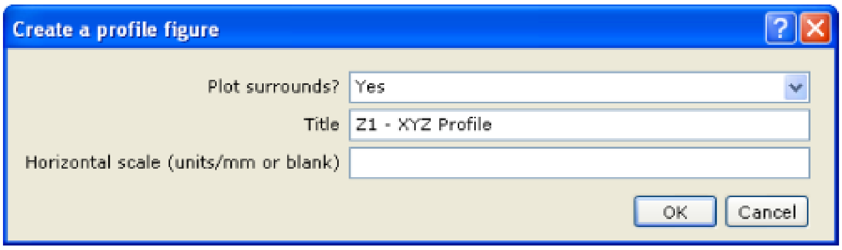


Figure 1.76. – Create a profile figure window

2. From the *Plot surrounds* dropdown list select **Yes**. Then specify a Title (**Z1 - XYZ Profile**) and optionally specify the *Horizontal scale (units/mm or blank*).

3. Click the [**OK**] button and the profile plot map (**xyz_format_L350.map**) is displayed in your project, fig. 1.77.

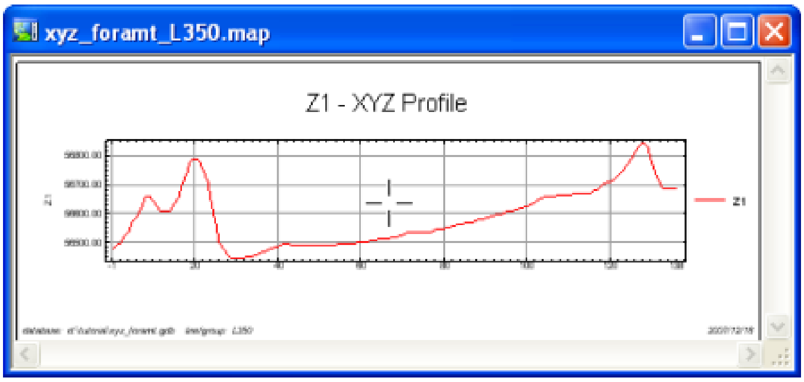


Figure 1.77. – XYZ profile window

1.9.7. Metadata

Metadata (data about data) is captured by **Oasis montaj** from the first time the data is touched. The metadata information, which is based on ISO 19115 standards, is stored inside the data (if supported) or as a companion XML file when you import or work with data in **Oasis montaj**. *Username*, *Date*, *Time* and any actions performed on the data will be maintained in the Metadata. When data is derived from other data, the Metadata is passed on and the lineage of what was done to the data is maintained in the *Lineage* section.

Viewing and Editing Metadata. Attributes (or metadata), information about data, can be simple or complex and the descriptive needs of different kinds of data are infinitely diverse. To allow for this and provide flexibility, Geosoft developed the *XML Metadata Viewer and Metadata Editor* to help you organize your metadata.

To View / Edit your Metadata:

1. From the *Project Explorer* window, you can select the data of interest, right-click and from the popup menu, select *Metadata*. The *Metadata Viewer* will be displayed or.

2. From the Database (or *Map, MXD, Grid and Image, 3D Tools*) menu(s), select *Metadata*. The *Database Metadata* dialog (or the appropriate data type dialog i.e. *Map Metadata, Grid Metadata*, etc.) will be displayed Database Metadata, fig. 1.78.

Figure 1.78. – Database metadata

3. Using the *Browse* button, locate the *Database file* and click the [**OK**] button (or *Map file*, *Grid file*, etc.). The *Metadata - file* name dialog is displayed, fig. 1.79.

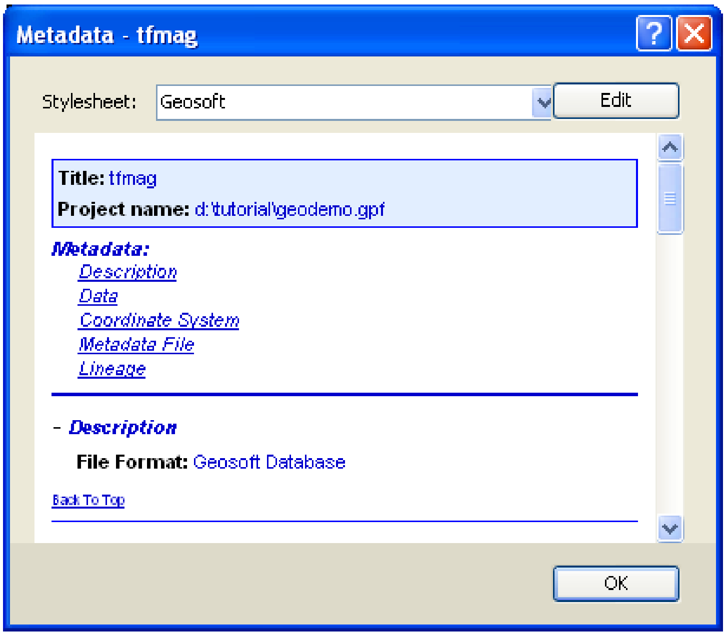


Figure 1.79. – Metadata panel

4. Use this dialog to *View* the Metadata associated with the selected database file. The *Stylesheet* dropdown list enables you to select from three style sheets (Geosoft, Geosoft ISO 19139 and XML).

5. To edit the Metadata, click the [**Edit**] button and the *Edit Metadata* dialog will be displayed, fig. 1.80.

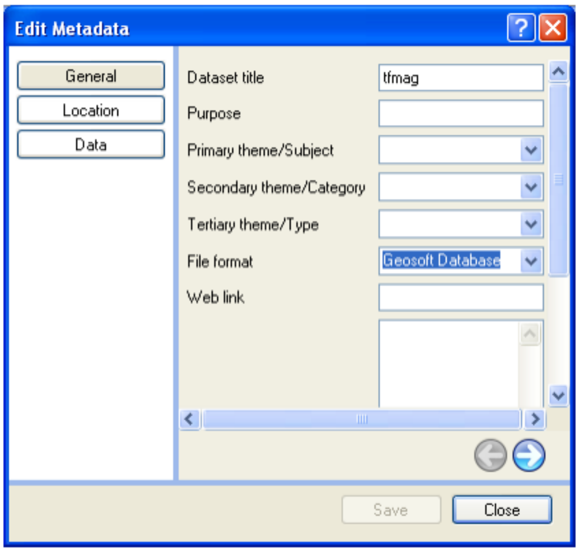


Figure 1.80. – Edit metadata window

6. You can use this dialog to edit the metadata associated with the selected database file. Selecting the [**General**], [**Location**] and [**Data**] buttons, enables you to access the different types of Metadata.

7. Click the [**Save**] button to save your edits and then click the [**Close**] button to close the *Edit Metadata* dialog and return you to the *Metadata Viewer*.

8. You can review your changes and then click the [**OK**] button to close the window.

Metadata Tool. The *Metadata Tool* is a context-oriented, interactive method for viewing and editing attributes assigned to Geosoft Global Settings, DAP Data, etc.

Note: Values displayed in a grey box cannot be edited. Values displayed in a white box may be edited.

***To View Metadata Tool*:**

1. On the *GX* menu, select *Global Settings* | *Advanced*. The advanced global settings will be displayed in the *Metadata Tool*, fig. 1.81.

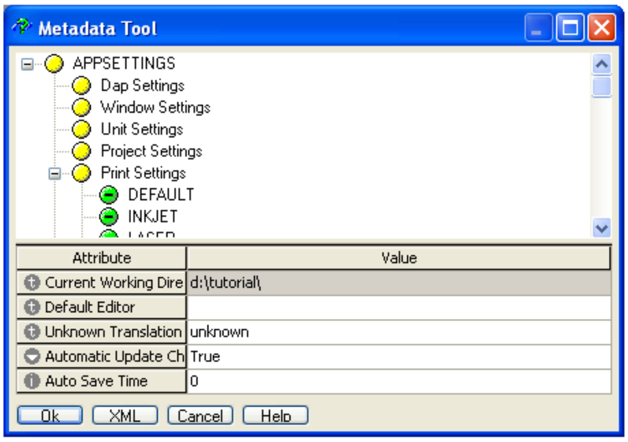


Figure 1.81. – Metadata Tool

2. The white letter in a grey circle to the left of the “Attribute” indicates the data value type; "i" for integers, "r" for real floating-point numbers, "t" for text, and "o" for data objects.

3. To close the dialog, click the [**Cancel**] button.

Drag-n-Drop. Oasis montaj includes the technology to drag data files directly from Windows Explorer and drop them into an **Oasis montaj** project for display. Data files that can be Drag-n-Dropped include, database files (*.GDB), grid files (*.GRD), map files (*.MAP) and *ArcGIS MXD files (* MXD).

Note: *The installation of Arc Map or Arc Engine is required to view MXD files in Oasis montaj. ArcEngine is included with the installation of **Oasis montaj 7.0** (licensed version).*

Also, any item in the *Project Explorer* may be dragged and dropped into the *Project* window for quick display.

The ability to drag XYZ files and drop them into an open database file (*.GDB) is also included in the *Oasis montaj Viewer*. Note that, only default parameters are used and XYZ files must be in the correct format and the database must be large enough to hold the dropped XYZ file.

1.9.8. Oasis montaj Maps

In **Oasis montaj**, a **Map** is more than a printed sheet of information. Maps are special items that serve a number of purposes in the system. The map window provides the basic mechanism for creating maps, displaying images, and linking to other maps and data. To work effectively with maps, you need to be familiar with the purposes of maps in the system as well as the role of **Views** and **Groups**.

Maps use *Views* to organize and display information. A *View* divides the information on a map into a Base view, (e.g. map surrounds, north arrows, and scale bars) which uses paper coordinates, and a Data view, (e.g. map coordinates, contours, and grids) which uses ground coordinates.

Maps use *Groups* to determine the order in which objects are displayed (rendered) on a map. *Groups* are layered on top of each other in a specific order determined by the *Map View/Group Manager Tool*.

Displaying a Map:

1. On the *Map* menu, select *Open map*. The Open Map dialog box is displayed.

2. Select the map file (**Oasismontaj.map**) and click [**Open**]. The map is opened in your project.

Adding Map Comments. Map Comments can be included with your map by using your default text editor. Map comments are saving in the map file (*.MAP).

1. On the *Map* menu, click *Edit Map Comments*.

2. The *Default Text Editor* (i.e. notepad) is displayed.

Note: If you have not specified your *Default Text Editor*, the *Select a default text editor* dialog is displayed. Using the [**Browse**] button, locate a text editor on your computer (notepad is recommended), and then click [**OK**].

3. Type your comments in the text window, then save the file and exit the text editor. The comments are saved in the map file (*.map file).

Displaying an ArcGIS MXD File. The installation of ArcMap or ArcEngine is required to view MXD files in **Oasis montaj**. ArcEngine is included with the installation of **Oasis montaj 7.0** (licensed version).

1. Select an *ArcGIS MXD file (*.mxd)* in Windows Explorer and drag-n-drop the file into your open project.

2. The *MXD file* will be opened and displayed in an *MXD Viewer*.

3. The MXD file appears exactly as it would in ArcGIS with no loss of data quality. Dynamic linking and cursor tracking are implemented between MXDs and Geosoft Maps.

Using the View/Group Manager Tool. You can use the *View/Group Manager* tool () to display and edit the *Views* and *Groups* in a map. This tool consists of a 'tree' structure that contains two main branches representing the *Base* view and the *Data* view. Under each view, a number of groups are listed according to their layer on the map.

Each group in a view shows an icon beside its name that identifies the group as either a map vector object () or an aggregate (). Views can either be normal *2D views* () or *3D views* (). The check boxes in the tree controls and indicates visibility of an item, Fig. 1.82.

To select single items in the tree, click on the item desired. Multiple selections of groups within a view can be achieved by holding the <Ctrl> key and clicking on the desired items. Changing the selection during group editing will end group editing without cancelling any current changes.

The effect of a double click on any item depends on the state of the map. If in shadow cursor mode the map will switch to either group or view selection mode and select the item that was clicked upon. If the map is already in either of these selection modes a double click has the same effect as hitting the 

button or using the activate shortcut key (default <Enter> key).

The group on the top layer (closest to the front) is listed first, followed by the next layer behind it, followed by the rest of the layers to the bottom layer at the end of the list. It is possible to control the render order in the tree by using the *Drag n Drop* technology. The *Drag n Drop* capability enables you to move map groups up and down within Views and to move Views relative to each other.

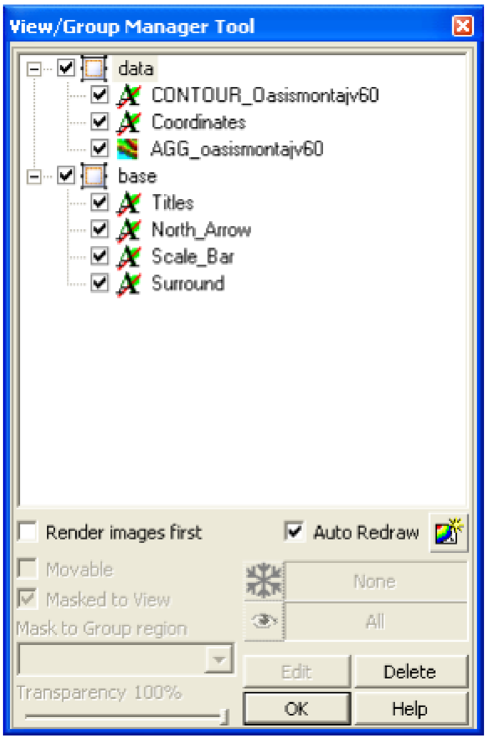


Figure 1.82. – Group Manager Tool

Rendering Options:

 Check the *Render images first* box to render (draw) the images groups first.

 Check the *Auto-Redraw* box to automatically redraw the map when a change is made to it.

 Click the *Redraw* button to redraw the map when changes are made to the groups in the View/Group Manager and the Auto-Redraw option is off.

The *View/Group Manager Tool* is a “modeless” dialog, which means it can remain open while you work on your map. It can be toggled on or off using the “M” hot key and can even be docked on the side of your screen or at the top with the toolbars.

Other Tool Options. The other Tool options include moving, masking, transparency settings, editing and deleting. All of the following properties require the licensed version of **Oasis montaj**.

 *Frozen Scale*. Click this button to freeze the scale of the currently selected map group, independent of the view scale of the map. For example, when zooming in the text size in a group will not grow but remain the same size on the screen.

 *Visible Scale*. Click this button to set a scale range in which the currently selected Group will be visible. For example, individual groups may be made visible only at specific scales. Then, while zooming, if the map scale is outside the range, the group is not drawn.

Moveable. Check the *Moveable* box to enable the movement of the selected group on the map using the cursor.

Masked to View. Check the *Masked to View* box to mask the selected view using the mask applied to the View (*Mapping|Masking|Apply mask to a view* - VIEWCLIP.GX).

This option enables you to apply a mask to selected groups within a View. Mask to Group region.

Mask to Group region. Using the *Mask to Group region* dropdown list, select the extended view mask applied to the View (*Mapping|Masking|Add|Replace group mask in view* - VIEWEXTCLIP.GX).

This option enables you to save the mask into the map and activate it on specific groups in the View.

Transparency. Check the *Transparency* box to enable the slider (Transparent – Opaque). Move the slider to the transparency level wanted for the selected group.

Edit. Click the button Edit to edit (or activate) the selected item.

Note: Double click on a group or view in a map or using the activate shortcut key (default Enter-Key) will also activate the edit mode for that item. The edit mode depends on the item; group edit mode for vector groups, image color tool for images and color symbols and 3D Viewer for 3D views.

Delete. Click the *Delete* Delete button to delete the selected View/Group.

Note: If you delete a group by mistake or make any other undesired changes, you can click the *Undo last map change* ( ) button on the Standard Toolbar or use the shortcut (Default Ctrl-Z) at any time to undo any changes and revert to the original map.

Using the Viewer Tool Bars. The following *Tool Bars* can be displayed in the **Oasis montaj *Viewer***. To *Show|Hide* tool bars, on the *Tools* tab of the *Project Explorer* select the tool bar of interest, right-click and select *Show|Hide* from the popup menu.

Standard Bar:

Open Database. Use this command to open a previously defined Oasis montaj database.

Open Map. Use this command to open an existing Geosoft map.

GX *Run GX*. Use this command to run a GX from the GX directory.

Load Menu. Use this command to load a menu to the menu bar.

Map Layout Bar:

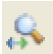
Zoom Box (Default Shortcut: B-Key). Click this button to activate the zoom box. Click on the map, then while holding down the left mouse button, move your cursor in the area of the map you want to zoom, click the left mouse button to select the area. Click the mouse button again to zoom to the area selected.

Note: Once the box has been defined, the cursor and the box are linked and by moving the cursor around the map, you can move the box to another location, and then click the left mouse button to zoom to the boxed area.

You can also access this command by clicking the right mouse button on a map and selecting *Zoom Box* from the popup menu.

 *Pan (Default Shortcut: P-Key or Spacebar)*. Click this button to move around in the currently selected map. Click the left mouse button and while holding the button down, move the hand cursor to pan around the current map area.

You can also access this command by clicking the right mouse button on a map and selecting *Pan* from the popup menu.

 *Interactive Zoom (Default Shortcut: Shift-Z)*. Click this button to activate the interactive zoom. Click on the area of the map you want to zoom (e.g. an anomalous location on a grid), then while holding down the left mouse button, move your cursor left to zoom out and right to zoom in on the selected area.

You can also access this command by clicking the right mouse button on a map and selecting *Interactive Zoom* from the popup menu.

 *Zoom Out (Default Shortcut: X-Key)*. Click this button to zoom out and shrink the displayed map features by 50%.

You can also access this command by clicking the right mouse button on a map and selecting Zoom Out from the popup menu.

 *Zoom In (Default Shortcut: Z-Key)*. Click this button to zoom in and increase the displayed map features by 50%.

You can also access this command by clicking the right mouse button on a map and selecting Zoom In from the popup menu.

 *Full Map (Default Shortcut: F-Key)*. Click this button to display the whole map area in the map window.

You can also access this command by clicking the right mouse button on a map and selecting *Full Map* from the popup menu.

 *Zoom to Selection (Default Shortcut: S-Key)*. Click this button to zoom to the selected map view or group.

You can also access this command by clicking the right mouse button on a map and selecting *Zoom to Selection* from the popup menu.

 *Last View (Default Shortcut: L-Key)*. Click this button to undo navigation changes that you have made recently. This command is useful for returning the view to any extents that was previously viewed after changing it by zooming and panning.

 Next View. Click this button to redo navigation changes that you have made recently.

 *Zoom Level Control*. This option enables the user to specify an estimation percentage of print size on screen (100%) or various other levels (for example, 400%, 200%, 100%, 75%, 50% and 25%). The control also supports custom levels by typing a percentage in the control and pressing the <Enter> key.

The zoom level reported here is somewhat related to the scale reported in the status bar. The scale shown in the status bar depends on the view-selected. For example, for a **50%** zoom reported or typed in the toolbar with a **1:500** scale data view with:

Base view Selected: Status bar shows **1:2.**

Data view Selected: Status bar shows **1:1000.**

 *Create Snapshot*. Click this button to create a snapshot (or bookmark) of the current map extents, based on the coordinate system and units of the current map view.

This option enables you easily return to a favorite location on your map. For more information on managing your snapshots, see the *Manage Snapshots* help topic.

 *Auto Snap to Grid*. Click this button to automatically *Snap to Grid* when working in your map. The snapping grid origin is at the lower left corner of a map or map template and the snapping distance can be controlled using the *Layout View Properties* button (licensed version only).

 *Toggle Snapping Grid*. Use this to toggle the visibility of the snapping grid. The Layout View Properties button, (licensed version only), controls the units and snapping grid size.

 *Toggle Ruler*. Use this to toggle the visibility of a ruler on the left and top sides of the view the snapping grid. The Layout View Properties button (licensed version only) controls the units displayed on the ruler.

 *Layout view properties*. Click this button to set the resolution, units and other properties for snapping and rulers. The default is 5mm.

The units set here controls the units that is used for layout of maps and map templates and affects coordinates and measurements displayed in the status bar for Base view operations (licensed version only).

 *Toggle Map View/Group Manager*. Click this button to open the *Map View/Group Manager* tool, which enables you to display and edit the *Views* and *Groups* in a map. This tool consists of a ‘tree’ structure that contains two main branches representing the *Base* view and the *Data* view (note that other Views such as 3D views and multiple Base and Date Views can also be included).

Under each view, a number of groups are listed according to their layer on the map. For instructions on how to use the manager, please refer to the ***Online Help***.

 *Map View Mode*. Click this button switches between Views; Data (ground coordinate). Base (map coordinate) and 3D views.

Map Group Mode. Click this button to select the different groups in a Map (including image aggregates, contours, surrounds, and other graphics layers). Once selected, you can move, cut, copy or edit the group.

Shadow Cursors. Click this button to enable desktop dynamic linking ( ). As you move the cursor around the map, the value for that same geographic location is highlighted or indicated in all linked databases, profiles and maps.

Note: When you open a map, the system automatically turns on a map link and activates the Shadow Cursor.

Shadow Cursor Data Linking Tool. Click this button to create a dynamic link between one or more maps and data (in Spreadsheet and Profile windows) to assist in locating and comparing data, profiles and maps.

If you have plotted flight lines on your map, you can use this button to link dynamically the map to the database and profiles.

When you move the Shadow cursor on the map, the database and profile views will update to show the corresponding data. If the corresponding data are in a different database line, then the spreadsheet window will automatically display this line. When you select a value in the database or a point on a profile, the Shadow cursor will update in the map view.

Geosoft Map Identify Tool. Click this button to display the "Geosoft Map Identify Tool" dialog.

Note: To enable the "Geosoft Map Identify Tool" button you must have a Geosoft map open and select in your current project and the map must include ArcGIS LYR information.

Auto-Redraw Maps. Click this button to toggle the *Auto-Redraw* option on/off. The Auto-Redraw option refreshes/redraws a map automatically after changes are made to it.

• When this option is **ON** any changes made to the map contents will cause the map to be refreshed/redrawn. This includes editing changes, group selection changes, or changing the rendering order of a group.

• If the Auto-Redraw is **OFF** the map is only refreshed on zoom, pan, or if the refresh button is pressed.

• A refresh button has also been added to the *Map View/Group Manager* dialog to support this feature. If the Auto-Redraw option is off, and you make changes to the groups in the Map View/Group Manager, click this button to refresh and show your changes on the map. This is useful for displaying your changes when moving groups in front or behind each other. By default, *Auto-Redraw Maps* is initially **ON**.

You can also access this command by clicking the right mouse button on a map and selecting *Redraw* from the popup menu.

 *Redraw (Default Shortcut: R-Key)*. Click this button to refresh/redraw a map in the Map window after making editing changes.

You can also access this command by clicking the right mouse button on a map and selecting *Redraw* from the popup menu.

 *Auto Recolor Grids*. Click this button to toggle the *Auto Recolor Grids* option on/off. The Auto Recolor Grids option recolors the displayed grid area as the grid extents change within a map window (e.g. when zooming or panning).

Note that, when turned on the grid values stay the same. However, as the viewed extents of the grid change; the grid color is recalculated and redrawn using the entire color palette over the current displayed grid area.

• When this option is **ON** any changes made to the extents of the viewed grid area will cause the grid to be recolored based on the grid values in the current viewed area, using the entire color palette.

• All displayed grids will be recolored when changes are made to the extents of the viewed area.

• When Auto Recolor Grids is **OFF** the grids return to their original colors.

The *Auto Recolor Grids* option is a temporary viewing tool. To save/share a recolored view of a grid you can *Create a Snapshot* or print the current map extents.

Note: If the *Auto Recolor Grid* mode is turned **ON** when you print, it will apply to the printed page. Either turn **OFF** the mode when printing or print out the selected area and it will apply the recoloring.

 *Change Extent on This Map Only*. Click this button to apply map commands to the currently selected map window only.

 *Change Extent on All Maps*. Click this button to apply map commands to all the open map windows the project.

 *Change Extent on Other Maps Only*. Click this button to apply map commands to all maps other than the currently selected map.

Displaying Grids and Images on a Map. In **Oasis montaj**, grids and images are always displayed on a map in the Map window. Several types of grids and images you can display are available. For a complete list of the grid and image formats that are supported in **Oasis montaj** see the online help topic ***Data Formats.***

In **Oasis montaj**, a ***Grid*** is a visual representation of a survey area interpolated from a series of survey points. For example, magnetic survey data is collected as a series of point values, which organized as a number of lines and arranged in a grid pattern.

When you create a grid, **Oasis montaj** takes these point values from the database and interpolates between them, creating a visual representation similar to a contour map. However, instead of simple contour lines, colors and shading are used to represent the magnetic differences across the grid.

There are two types of images in **Oasis montaj**, **Raster** and **Vector** images.

Raster Images. Raster images or bitmap graphics (.bmp, .tif, and .jpg) are created from a series of pixels to represent graphics. Each pixel in a bitmap image has a specific location and color value assigned to it.

Bitmap images are resolution dependent – that is, they represent a fixed number of pixels. As a result, they can appear jagged and lose detail if they are scaled on-screen or if they are printed at a higher resolution than they were created for.

Vector Images. Drawing programs such as AutoCAD create vector graphics (.dxf, .eps, .wmf), made of lines and curves defined by mathematical objects called vectors. Vectors describe graphics according to their geometric characteristics. The **Oasis montaj** CAD drawing tools (licensed version) enable you to draw vector lines and shapes.

A vector graphic is resolution-independent – that is, you can scale it to any size as well as printed on any output device at any resolution without losing its clarity. As a result, vector graphics are the best choice for type (especially small type) and bold graphics that must retain crisp lines when scaled to various sizes – for example, logos.

Because computer monitors represent images by displaying them on a grid, both vector and bitmap images are displayed as pixels on-screen.

Displaying a Grid on a Map.

1. On the *Grid and Image* menu, select *Display* and then click *Single Grid*. The *Place a grid on a map* dialog is displayed, fig. 1.83.

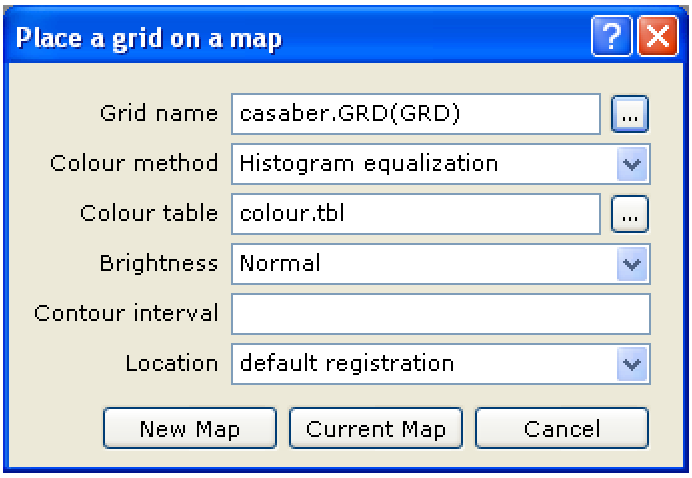


Figure 1.83. – Adding a grid on a map

2. Select the *Grid name* (**casaber.grd**), *Colour method*, *Colour table*, *Brightness*, *Contour interval*, and the *Location*. For more information on these parameters click the *Help* (?) button.

3. Click [**New Map**], the grid is displayed on a new map.

Note: To display a grid on a current map, click the [**Current map**] button.

***Displaying an Image on a Map*:**

1. On the *Grid and Image* menu, select *Display* and then select Image (*bmp, tiff, etc*.). The *Place an Image on a map* dialog is displayed.

2. Using the Browse ( ) button, display the *Image* dialog and select the image *File name* and *File type*.

3. Click [**Open**]. The *Place an image on a map* dialog is displayed again.

4. Select the image Location (*default registration or fit to an area*).

5. Click [**New Map**] the image is displayed on a new map.

Note: To display an image on a current map, click the [**Current Map**] button.

***Displaying a Geosoft Plot File*:**

1. On the *Map* menu, select *Import* then select *Geosoft PLT files*. The *Display a Geosoft PLT file* dialog is displayed.

2. Select the *Plot file* name. Click [**New Map**]. The Geosoft plot file is displayed on a new map.

Note: To display a Geosoft plot file on a current map, click the [**Current Map**] button.

***Displaying an AutoCAD DXF File*:**

1. On the *Map* menu, select *Import* then select *AutoCAD DXF files*. The *Display a DXF file on a map* dialog is displayed.

2. Select the *DXF file* name, the *Plot layers to*, the *Maximum number of pen styles*, and *Color*. For more information on these parameters, click the *Help* ( ) button.

3. Click [**OK**]. The DXF file is displayed on a map.

Auto Recolor Grids. Click the *Auto Recolor Grids* ( ) button to toggle the Auto Recolor Grids option on/off. This option recolors the displayed grid area as the grid extents change within a map window (e.g. when zooming or panning).

Note that, when turned **ON** the grid values stay the same. However, as the viewed extents of the grid change; the grid color is recalculated and redrawn using the entire color palette over the current displayed grid area.

• When this option is *ON* any changes made to the extents of the viewed grid area will cause the grid to be recolored based on the grid values in the current viewed area, using the entire color palette.

• All displayed grids will be recolored when changes are made to the extents of the viewed area.

• When Auto Recolor Grids is **OFF** the grids return to their original colors.

The *Auto Recolor Grids* option is a temporary viewing tool. To save/share a recolored view of a grid you can create a Snapshot or print the current map extents.

Note: If the *Auto Recolor Grid* mode is turned **ON** when you print, it will apply to the printed page. Either turn **OFF** the mode when printing or print out a selected area and it will apply the recoloring.

Create Snapshots. Use the *Create Snapshot* option to capture a snapshot (or bookmark) of the current map extents, based on the coordinate system and units of the current map view.

The Create Snapshot option was designed to help improve your workflow and ease of use, enabling you to quickly and easily capture and return to a favorite location on your map.

How to create a snapshot. The **Create Snapshot** option can be found on the **Map** menu, **Navigation Bar** ({bmct snapshot.bmp}) and various Map popup menus.

1. Zoom into an area of interest on your current map. Right-click and from the popup menu select *Create Snapshot*. The *Set Snapshot Name* dialog is displayed, fig. 1.84.

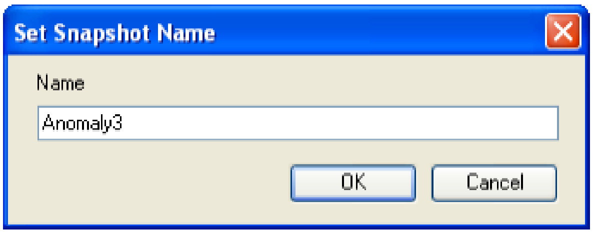


Figure 1.84. – Snapshot window

2. Specify a descriptive name for your snapshot and click the [OK] button. The snapshot will be saved with the current map.

How to view a snapshot. Snapshots can be quickly and easily viewed using the dynamic *Snapshot* menu item on the map popup menus.

1. Open and select a map that already includes associated Snapshots. Right-click, and from the popup menu select *Snapshots*. A dynamic sub-menu will be displayed listing all of the snapshots associated with the current map, fig. 1.85.

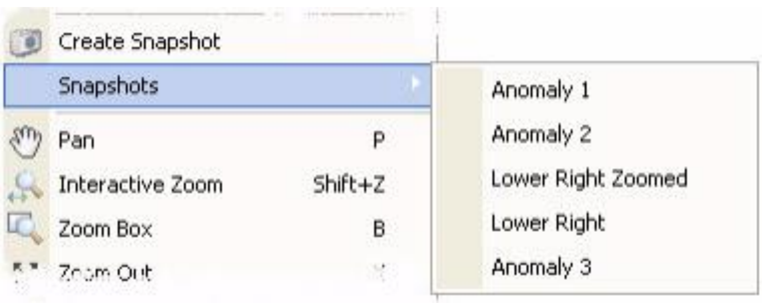


Figure 1.85. – Creating a snapshot

2. Select one of the previously created snapshots and your current map will be redrawn to the extents of the selected *Snapshot*.

Note: To manage your snapshots select the *Manage Snapshot* menu item on the *Map* menu.

Managing your snapshots. Use the *Manage Snapshots* dialog, fig. 1.86, found on the *Map* menu, to open, rename or delete your map snapshots.

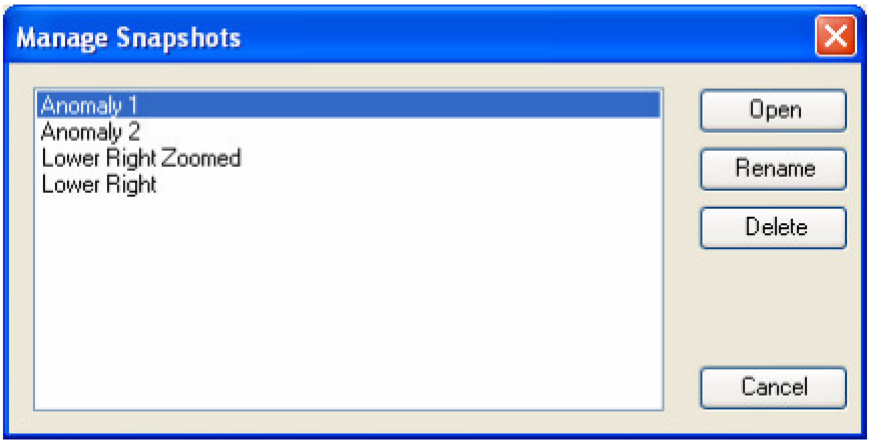


Figure 1.86. – Manage snapshots panel

Map snapshots (or bookmarks) are saved views of the map extents, based on the coordinate system and units of the map view. Map snapshots enable you to return to a favorite location on your map quickly and easily.

The snapshot option was designed to help improve your workflow and ease of use. For example, if you are working on a regional scale map and have a number of active project areas (or a number of anomalies in one project area) you can use this tool to quickly and easily zoom into your areas of interest.

DAP (Data Access Protocol). Oasis montaj includes a Geosoft DAP client which enables users to search and retrieve geoscientific datasets, imagery and other map data directly form a DAP server on a local network or on the Internet. There are two types of DAP clients, a thick client (a desktop software application) and a thin client (web browser).

Oasis montaj, Maplnfo and ArcGIS are thick DAP client software applications. Thick client applications enable you to download and save the actual data to your hard drive, so you can use the data in **Oasis montaj** or any other GIS or spatial data processing program.

Thin clients, like Geosoft’s DAP Data Explorer use a web browser to browse, view and extract data from a DAP server. Visit www.geodap.com/map/ and see how it works!

Geosoft’s DAP capability enables both licensed and free Viewer users to access global and corporate spatial servers – Geosoft DAP servers, NASA servers, USGS servers, and many WMS servers currently available.

DAP’s main features include:

• **Large Volume Data Transfer**: DAP technology handles the efficient transfer of very high-volume data, and its associated metadata, through a streaming technology.

• **Spatially Aware**: DAP is spatially aware, enabling user-specified spatial querying and retrieval.

• **Ready-to-use Data**: DAP provides localized data that matches your current Oasis montaj map window and projection information.

• Safe and Efficient Data Transfer: DAP data transfer technology provides direct DAP client/server communication enabling the transfer of compressed data that maintains original data integrity.

The *DAP* menu includes two options for finding data. **Find Data with Dapple** and **Find Data**.

Find Data with Dapple. Use the *DAP | Find Data with Dapple* option to search for data with *Dapple*. Dapple, Geosoft's global data explorer, enables you to browse, discover and display graphically rich data from global and corporate spatial servers – Geosoft DAP servers, NASA servers, USGS servers, and many WMS servers currently available.

The *Dapple* project is an open-source activity sponsored by Geosoft and derived from the NASA World Wind (fhttp://worldwind.arc.na.sa.gov/) open source project. *Dapple* represents our effort to make this powerful technology accessible and useful to professional earth scientists. Visit http://dapple.geosoft.com/derault.asp for more detailed information about *Dapple*.

Dapple includes a set of menus (*Tools*, *Servers*, *View*, *Settings*, and *Help*), an interactive Global Explorer window that displays the selected data layers, a Search window that enables you to define your 'Area of Interest' via Servers or the Web based on spatial extents and keywords, a Data Layers window that displays the selected data, an Overview Map window that displays your current spatial extents, and a Metadata window that displays the metadata for the currently selected Data Layer.

To access Dapple in Oasis montaj Viewer:

The ability to access data from global and corporate spatial servers (Geosoft DAP servers, NASA servers, USGS servers, and WMS servers) along with the Internet is a powerful and insightful way to work with spatial data. Dapple provides effective data browsing tools for locating geoscience data, satellite imagery, remote sensing data, geology maps, geophysical data, and many other data sets of interest to geoscientists.

1. On the *DAP* menu, select *Find Date with Dapple* and the *Dapple* dialog will be displayed, fig. 1.87.

Figure 1.87. – Dapple panel

2. To specify the spatial extents you can use the *Global Explorer* and *Navigation* tools, or in the *Overview map* window you can select an area (including the entire globe) or select a specific region using the dropdown list. You can further focus your *Search* criteria by entering "Keywords" in the text box (--- Enter keyword(s) ---) provided. To clear the search parameters, click the Clear search (×) button.

3. In the *Search* window, select the "Servers" tab and click the *Search* ( ) button. The *Available Servers* will be searched for any data that falls within your spatial extents and matches your keywords. (Note that, when you select the "Web" tab the Internet will be searched for data files that fall within your area of interest and match your keywords.).

The results are displayed on the "Servers" (or ’Web") tab and can be viewed in either 'Tree view' or 'List view'.

4. To download your search results, the selected dataset(s) must be added into the *Data Layers* window. To add datasets to the *Data Layers* window, select (highlight) a dataset from the "Servers" tree view (or select multiple datasets from the "Servers" list view). Right-click and from the popup menu, select *Add to Data Layers* and the selected data will be added to the *Data Layers* window (Note, that you can also use Drag-n-Drop to move the "Search" result datasets to the "Data Layers" window).

In the *Data Layers* window, select (highlight) the datasets to download. Then, on the Tools menu, select "Download Layers" and all selected data layers will begin the download process.

5. Once the download is initiated, the *Download Settings* dialog will be displayed. Use this tabbed dialog to set the "General" and "Individual" properties of the downloaded dataset(s). Click the [**Download**] button to complete the process and download the selected data to your current project directory.

Select *Help* on the main *Dapple* menu bar for more detailed information on the Dapple dialog.

Find DAP Data. Use the *Get DAP Data* dialog to search for data on one or more DAP data servers. This tool includes a set of menus, an interactive DAP browser window that displays the browser map of the active server, an ‘Area of Interest’ window that enables you to define your view area, and three tabbed dialog tools that control your data retrieval.

***To access the Get DAP Data dialog in Oasis montaj*:**

When data is downloaded from the DAP server, it will be windowed, resampled and reprojected to match the current client context within the limitations of the type of data you are dealing with.

Note that, you should have a map open and selected (with projection assigned to it) in your current project.

1. On the *DAP* menu, select *Find Data*. The *Authorize Internet Communication* dialog is displayed. Note: If your *Internet Trust Configuration* is set to "Trusted" this dialog will not appear.

2. Click the [**Authorize**] button. The system will query the DAP server to determine what data the DAP server has that matches the data view of your current map. When a match has been made the *Get DAP Data* dialog will be displayed, fig. 1.88.

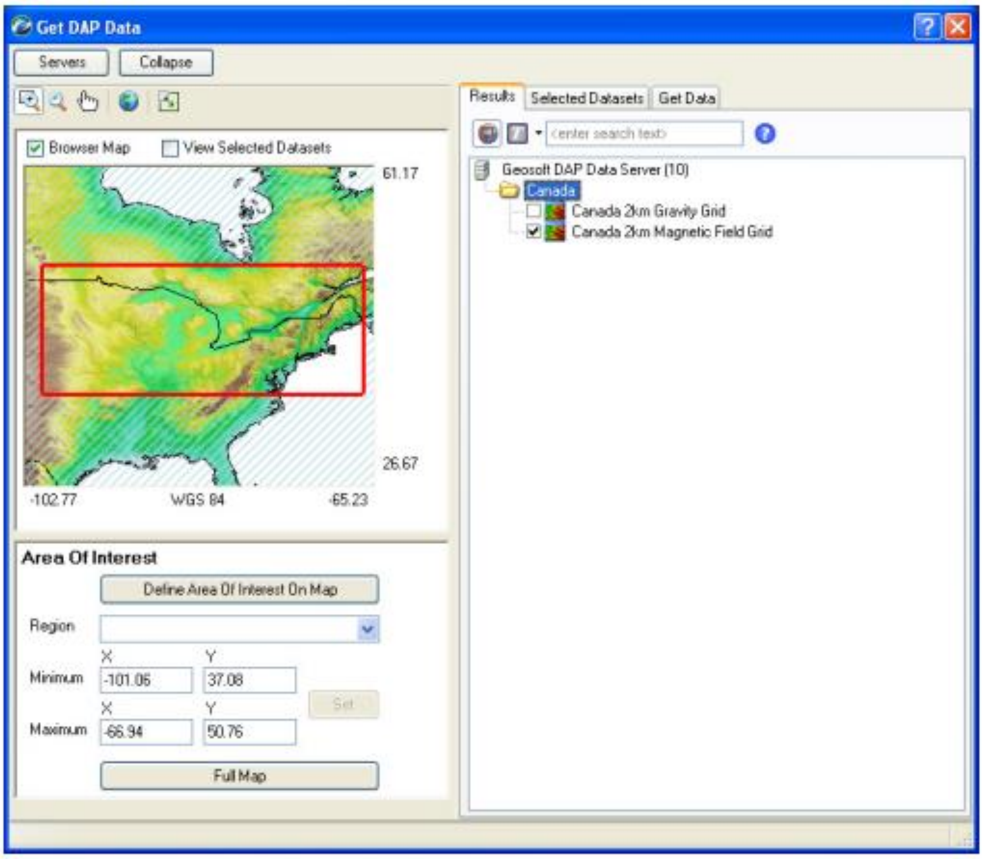


Figure 1.88. – Get DAP Data panel

3. The *Results* tab, on the right side of the dialog window, will display the data that is available for download. Note the number of data files available is specified beside the DAP Server name (e.g. **10** datasets are indicated above). Select (☑) the data you would like to download and display on your map.

4. Your *Results* can be filtered to only display items that intersect your *Area of Interest* (AOI) and/or contain *Text* that matches a *Text string*. These *DAP Filters* are provided on the top of the *Results* tab ( ). For more information on using the *DAP Data Filters*, click the *Help* ( ) button.

5. The *Selected* tab enables you to control the both the data to download and the visibility of the data on the current browser map by placing a check in the box on the left side of the list. You can also use this tab to control the rendering order of the displayed datasets using the upward and downward arrows.

Note: To view the selected data sets in the Browser Map check the View Selected Datasets check box (☑).

6. The *Get Data* tab enables you to specify your selected data options, such as *Filename*, *Resolution*, *Projection format* and *Display*. Once you are satisfied with the selected datasets and their download options, click the [**Get Data**] button to download and display the DAP data on your current map.

Note: There are a variety of DAP display technology features available. They include: re-project the grid to the projection of the current map view, re-project and resample the grid to a specified resolution, save the grid in the native projection format, display the grid as a simple color image, display the grid as a shaded color image, and download and save only, do not display the grid.

7. Once the download is complete click the *Exit* (☒) button to close the window. The gridded data will be displayed in your open map. For more information, click the *Help* (?) button on the *Get DAP Data* dialog, fig. 1.89.

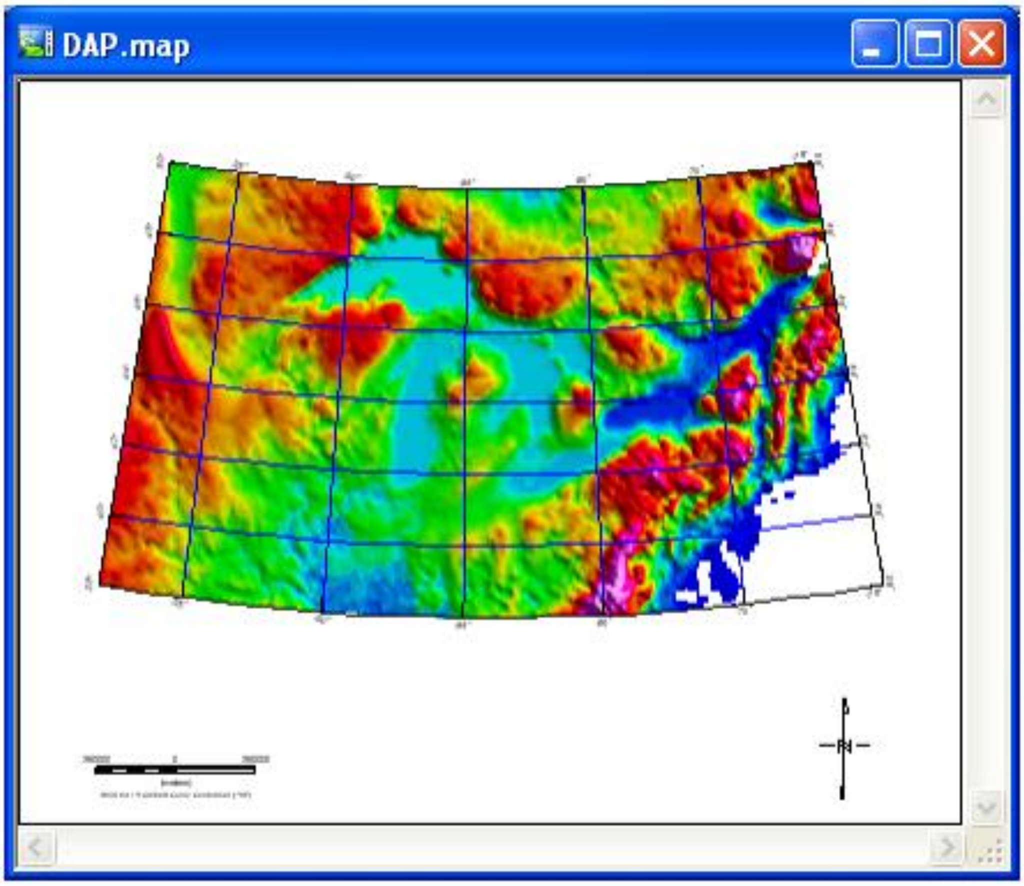


Figure 1.89. – Get DAP Data panel

Using the Metadata Tool. The *Metadata Browser* is a tool for viewing metadata associated with a DAP dataset.

Metadata is the information about data. Metadata can be simple or complex and the descriptive needs of different kinds of data are infinitely diverse. To allow for this and provide flexibility, Geosoft metadata is stored in a hierarchical data structure called a "meta". The Metadata browser will display the meta structure (also called a "schema") and the metadata information of a specific data source. Each branch of a metadata structure may contain a set of attributes with associated Values, and other branches.

Following is an example of the metadata that is stored for the “Canada Gravity 2k.grd” file on the DAP server, fig. 1.90:

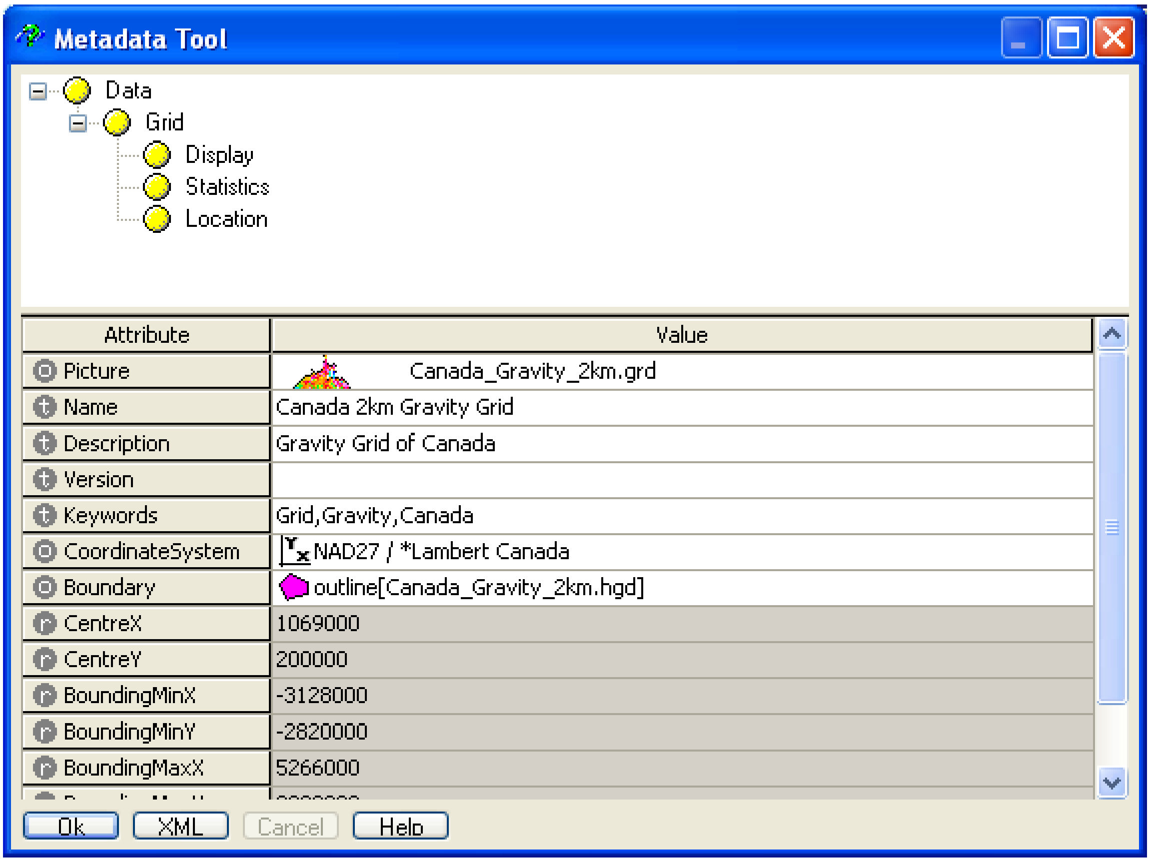


Figure 1.90. – Example from the Canada gravity field

To View Metadata in the Get DAP Data dialog:

1. Select (highlight) a dataset on the *Results*, *Selected Datasets* or the *Get Data* tabs in the *Get DAP Data* dialog, right-click and from the popup menu, select *View Meta*.

2. The *Metadata Tool* is displayed.

3D Tool. The **3D Tool** consists of a dialog with four tabs and an associated **3D Viewer**. Each tab enables you modify different aspects of the 3D View within the 3D Viewer.

The **3D Tool** enables you to modify the appearance of your 3D View in the **3D Viewer**. The 3D Tool is available in the *Tools* section of the ***Project Explorer*** and will appear whenever a 3D Viewer is open. If more than one 3D Viewer is open, the parameters of the 3D Tool will represent whichever Viewer currently has focus.

For more detailed information on the *3D Tool*, select (highlight) the *3D Tool*, and press the **F1** key, or use the *Search* tab in the **Oasis montaj** help system to locate the *3D Tool* help topic(s).

Note: To create an **Oasis montaj** 3D View, fig. 1.91, requires the **Oasis montaj *Mapping and Processing System*** (licensed version).

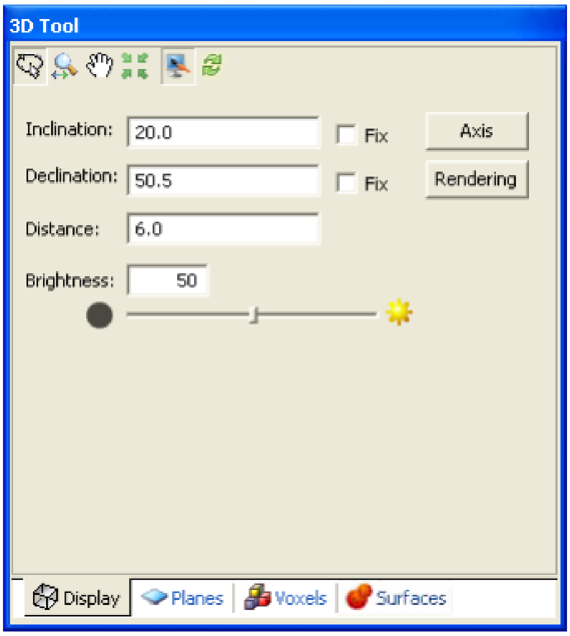


Figure 1.91. –3D Tool panel

3D Viewing Tools. The following interactive viewing buttons are provided along the top of all four of the **3D Tool** tabs:

Rotate Mode - enables you to rotate the displayed View 360 degrees in all directions. Note that, users that have a mouse wheel can zoom in and out while rotating the View, by turning the wheel.

Zoom Mode - enables you to zoom in and out of the displayed View. Note that you can also move the model closer and farther in any mode using the roller on your mouse.

Pan Mode - enables you to move the entire displayed View.

Centre Map in Window - resets the focus point of the view and the current 3D View is centered in the 3D Viewer (independent of the zoom).

Toggle Redraw On/Off - enables the auto-redraw to refresh redraw a map automatically after changes are made to it.

Force Redraw of 3D window - forces the refresh/redraw of the 3D View in the 3D Viewer.

Using the 3D Viewing Tools

To rotate (and spin) the 3D grid:

When you select the *Rotate* (and *Spin*) button the curser changes to the rotate mode, and enables you to rotate the displayed grid 360 degrees in all directions. Note that, users that have a mouse wheel can zoom in and out while rotating the View, by turning the wheel.

1. Select the Rotate button. The curser changes to rotate mode ( )

2. Left click, and while holding down on the mouse key move right to left or up and down. The grid will rotate in the direction in which you move the mouse.

3. You can also Spin the view by releasing the mouse button while you are rotating the View' and the View will continue to spin until you click inside the 3D Viewer window

Note: Moving the mouse from left to right turns the grid in an anti-clockwise direction, and moving right to left turns the image in a clockwise direction. If the model is "upside-down", the rotation will appear opposite to what you expect.

To zoom the 3D grid:

When you select the Zoom button the curser changes to the zoom mode, and enables you to zoom in and out of the displayed grid.

1. Select the *Zoom* button. The curser changes to zoom mode ( ).

2. Left click, and while holding down on the mouse key move to the right to zoom in and to the left to zoom out.

To use the pan tool:

When you select the *Pan* button the curser changes to the pan mode, and enables you to move the entire displayed grid.

1. Select the Pan button. The curser changes to pan mode ( ).

2. Left click, and while holding down on the mouse key move the grid right to left or up and down. The entire grid will move in the direction in which you move the mouse.

***To Centre the grid*:**

When you select the *Centre* button, the focus point of the grid is reset and the current displayed grid is centered in the 3D Surface Display Tool.

1. Select the Centre button. The displayed grid is centered.

***To toggle the redraw on and off*:**

When you select the *Toggle redraw On/Off* button the auto-redraw option refreshes/redraws a map automatically after changes are made to it.

1. Select the *Toggle redraw On/Off* ( ) button to enable the auto-redraw option.

2. When the *Toggle Redraw* is *On* any changes made to the map contents will cause the map to be refreshed/redrawn. This includes editing changes, group selection changes, or changing the rendering order of a group. When the *Toggle Redraw* is *Off* the map is only refreshed on rotate, zoom, pan, or if the refresh button is pressed. By default, the auto-redraw option is initially ON.

***To Force the Redraw of the 3D Window*:**

1. Select the Force redraw of 3D window ( ) button to refresh/redraw the 3D view in the 3D map window.

Display Tab. The Display tab enables you to modify the overall Display of the 3D View:

• Select the **3D Viewing Tools** (*Rotate*, *Zoom*, *Pan*, *Centre*, *Redraw*)
• Specify and fix the **inclination** of the View
• Specify and fix the **declination** of the View
• Specify the viewing **distance** from the central focal point of the View
• Modify the **brightness** level by moving the slider bar or specifying a %
• Click the [**Axis**] button to display the **Axis Options** dialog
• Click the [**Rendering**] button to display the **Rendering Options** dialog, fig. 1.92.

1.9.9. Using the 3D Display Tab

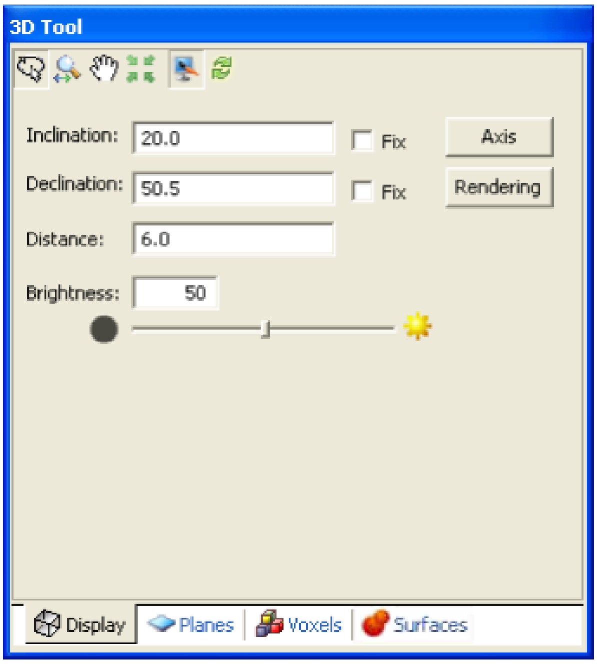


Figure 1.92 – 3D Tool window

***To specify and fix the inclination*:**

1. Click inside the *inclination* box and specify the inclination you want for the 3D grid.

2. Check the Fix box, and then click the OK button. The grid will be redrawn on your map with the new fixed inclination.

***To specify and fix the declination of the grid*:**

1. Click inside the *declination* box and specify the declination you want for the 3D grid.

2. Check the Fix box, and then click the OK button. The grid will be redrawn on your map with the new fixed inclination.

***To specify the distance of the grid*:**

The *distance* specifies the distance away from the center focal point relative to the longest displayed dimension. For example, a value of 5 will place the viewpoint 5 times the size of the grid away from the center of the grid.

1. Click inside the distance box and specify the distance you want for the 3D grid.

2. Click the OK button. The grid will be redrawn on your map with the new distance.

***To modify the brightness level of the grid*:**

When you select the *Brightness* bar, you can modify the brightness of the displayed grid.

1. Select the brightness bar.

2. Slide the bar to the left to increase the brightness level and to the right to decreases the brightness level of the displayed grid.

***To access the Axis Options dialog*:**

Select the [**Axis**] button to display the *Axis Options* dialog. This dialog can be used to add axis labels, axis, and a box to the 3D View.

1. Click the [**Axis**] button and the *Axis Options* dialog will be displayed.

2. Use this dialog to add Axis labels, change the background color and add an Axis and/or a box around the 3D View. For more information, see the Help topic ***Modify Axis Options (3D Tool).***

To access the Rendering Options dialog. Select the [**Rendering**] button to display the *Rendering Options* dialog. This dialog can be used to adjust the rendering resolution in the 3D tool. It is important to note that the controls on the *Rendering Options* dialog are system controls and changes made to this dialog will affect all 3D maps in your **Oasis montaj** system. The 3D Views rendering process makes heavy use of the available memory on your video card, and performance will be substantially reduced if your limits are exceeded.

1. Click the [**Rendering**] button and the Rendering Options dialog will be displayed.

2. Use this dialog to adjust the rendering resolution in the 3D tool. For more information on applying these options, see the Help topic ***Modify Rendering Options (3D Tool)***.

Planes Tab. The Planes tab enables you to modify the individual Planes within each 3D View:

• Select the **3D Viewing Tools** (Rotate, Zoom, Pan, Centre, Redraw), fig. 1.93.

• Select the **Plane** to modify.

• Click [**Delete**] to delete the current plane.

• Select the plane **Offset** in Z units relative to the plane coordinates.

• Specify the **Transparency** of the plane.

<u>*Relief Grid Options:*</u>

• Indicate the name of the **Relief** grid (if one is used for the selected plane).

• Specify the **Sample** resolution of the relief grid.

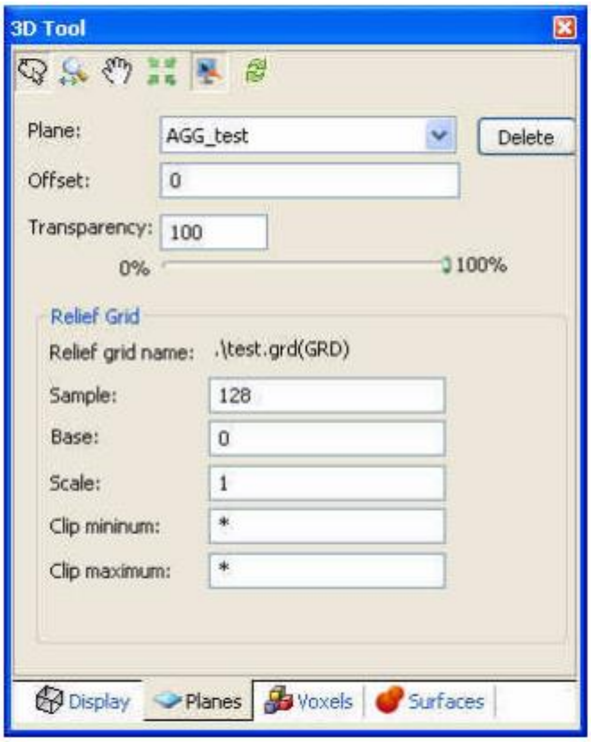


Figure 1.93. –3D Tool window

• Specify the **Base** value of the relief grid.
• Specify the vertical **Scale** of the relief grid.
• Specify a **minimum clipped** value for the relief grid.
• Specify a maximum **clipped value** for the relief grid.

Using the 3D Planes Tab.

***To Select the Plane to modify*:**

1. From the *Plane* dropdown menu select the plane to modify.

***To delete a Plane*:**

1. Using the *Plane* dropdown list, select the plane you want to delete and then click the [**Delete**] button. The *Delete View* dialog is displayed.

2. This dialog asks if you are sure, you want to delete the plane. Click the [Yes] button and the plane will be deleted from the current 3D View.

***To Select the Plane Offset in Z units*:**

1. In the *Offsets* box, specify the offset value in ground units. Press the [**Enter**] key. The plane will be redrawn in the 3D viewer with the new offset.

2. Move the *Trans*. Slider bar from left to right to increase the transparency.

Note: True transparency has been added and is automatically enabled with video cards that support it.

***To Specify the Relief Grid Sample Resolution*:**

1. In the *Sample* box, set a sampling resolution that is reasonable for the detail required in the relief surface. Higher sample resolutions provide more relief detail at the expense of performance. You can select a number up to 768 (your entry will be converted to an even multiple of 16). Press the [**Enter**] key. The relief grid will be redrawn in the 3D viewer with the new sample resolution.

***To Specify the Base value of the relief grid*:**

1. In the *Base* box, specify the base value of the relief grid. Press the [**Enter**] key. The relief grid will be redrawn in the 3D viewer with the new base value.

***To Specify the vertical Scale of the relief grid*:**

1. In the *Scale* box, specify the vertical scale of the relief grid. Press the [**Enter**] key. The relief grid will be redrawn in the 3D viewer with the new vertical scale.

***To Specify a minimum clipped value for the relief grid*:**

The *Clip minimum* enables you to specify the minimum Z value of your relief grid. Grid values below this will be clipped.

1. Click inside the *Clip min* box and specify the minimum value you want for the Z data of the relief grid. Press the [**Enter**] key. The relief grid will be redrawn in the 3D viewer with the new minimum Z value.

To Specify a maximum clipped value for the relief grid:

The *Clip maximum* enables you to specify the maximum Z value of your relief grid. Grid values above this will be clipped.

1. Click inside the *Clip max* box and specify the maximum value you want for the Z data of the relief grid. Press the [**Enter**] key. The relief grid will be redrawn in the 3D viewer with the new maximum Z value.

Use the 3D Voxel tab to modify the voxel display parameters in the 3D tool.

1.9.10. The Voxel tab

The Voxel tab, fig. 1.94, enables you to modify the Voxels display parameters in the 3D tool:

- Select the **3D Viewing Tools (**Rotate, Zoom, Pan, Centre, Redraw).
- Select the Voxel to modify from dropdown list.
- Select (check) **Box** to add a box around the Voxel.
- Select (check) **Mesh** to add a mesh to the Voxel.
- Click the [**Colour**] button to display the **Color Symbol Tool** dialog.

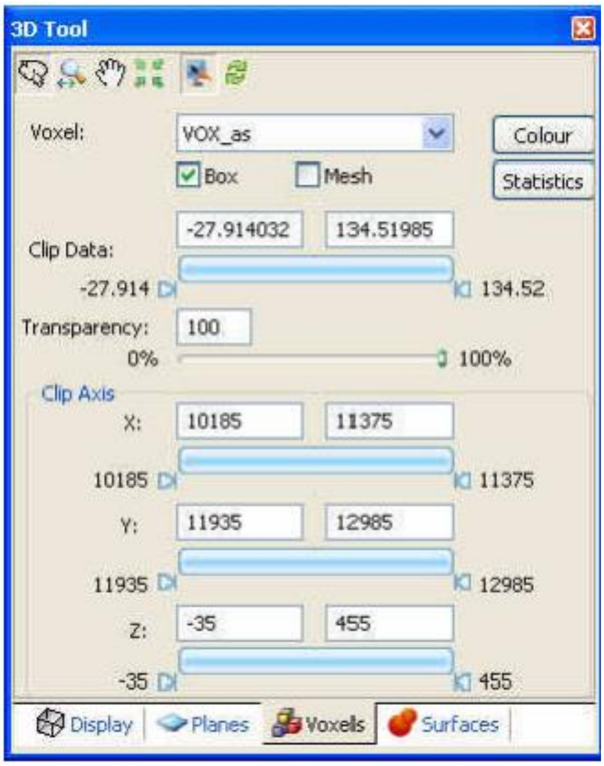


Figure 1.94. –3D Tool panel, voxels

- Click the [**Statistics**] button to display the **Voxel Statistics** dialog.
- **Clip Data -** depending on the voxel type, you will have the option to clip the Voxel data range using the slider bar or data boxes or select the [**Lithology Unit Selection**] button, fig. 1.95.
- Specify Transparency of the Voxel using slider bar or data box.
- Use **Clip Axis** to adjust the range of the Voxel Axis using the slider bars or by specifying the minimum and maximum **X**, **Y** and **Z** values.

Lithology Voxel

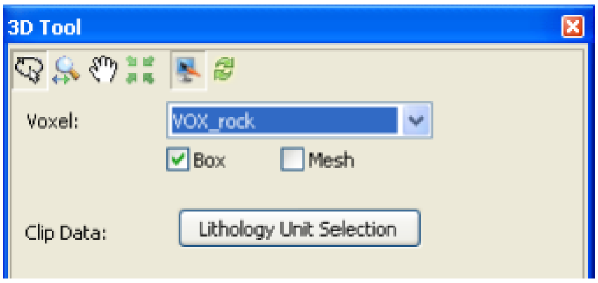


Figure 1.95. –3D Tool Lithology voxel

Using the 3D Voxel Tab

***To select a Voxel to modify*:**

1. From the *Voxel* dropdown list select the voxel to modify.

***To add/remove a box from around the voxel*:**

1. Select (check) the *Box* checkbox and a box will be added to the Voxel. Unchecking the *Box* checkbox removes the box.

2. This button works as a toggle you can toggle on or off the Voxel box.

***To Display Voxel Mesh*:**

1. Select (check) the *Mesh* checkbox and the Voxel will be displayed with mess lines. Uncheck the *Mesh* checkbox removes the mesh and displays the color shading grid.

2. This button works as a toggle you can toggle on or off the Voxel grid lines and/or color shading.

***To access the Color tool*:**

1. Click the [**Color**] button and the *Color Symbol Tool* will be displayed.

2. The *Color Symbol Tool* enables you to interactively edit/modify the color zoning of your zone colored symbols, store your custom color configurations in specialized color palette files (*.ITR, *.ZON, *.TBL and *.LUT) and apply the color palette files to any of your zone symbols. For more information, click the *Help* (?) button on the color Symbol Tool.

3. Click the [**OK**] button to close the *Color symbol tool* and return to the 3D Tool.

***To access the Voxel statistics*:**

1. Click the [**Statistics**] button and the *Voxel Statistics* dialog is displayed.

2. This dialog displays the *Voxel Name*, *Valid Data*, *Dummies, Volume, Minimum, Maximum, Mean Value and Standard Deviation*.

3. Click the 'X' on the top right corner to close the dialog and return to the 3D tool.

Voxel types. Depending on the voxel type, you will have the option to clip the Voxel data range using the slider bar or associated data boxes, or if it is a Lithology Voxel, you can select the [**Lithology Unit Selection**] button, which enables you to select the Lithology units to include/exclude from your Voxel.

***To Clip Data using the slider or data boxes*:**

The Clip Data can be modified interactively by moving the sliders on the *Clip Data* bar or by specifying a *Clip Data* range in the data boxes provided.

1. Click inside the *Clip Data* boxes, specify the minimum and maximum values and press the <*Enter*> key. The Voxel will be updated with the new clipped data range.

2. To interactively modify the *Clip Data*, use your cursor and move slider from either end of the slider bar (

).

3. Your Voxel data range will be updated interactively as you move the *Clip Data* slider bar.

***To Clip Data using the Lithology Unit Selection Dialog*:**

When working with a Lithology Voxel, the *Clip Data* option enables you to select/deselect the available Lithology units.

1. Select the [**Lithology Unit Selection**] button and the *Lithology Unit Selection* dialog will be displayed, fig. 1.96.

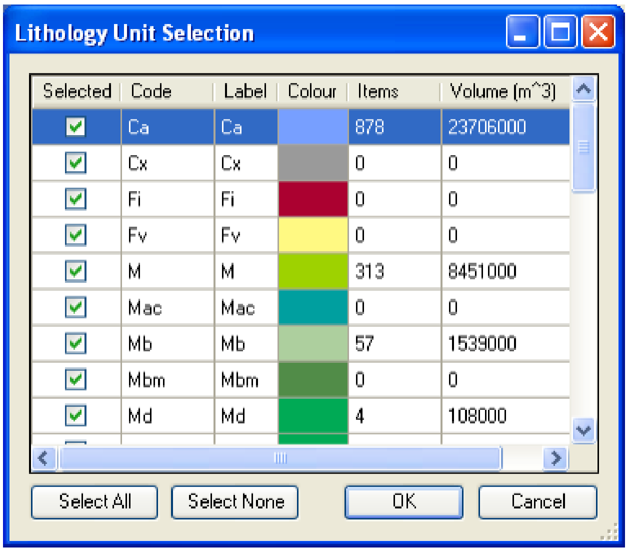


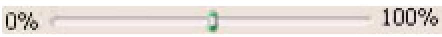
Figure 1.96. –3D Lithology Unit Selection

2. This dialog provides a [**Select All**] and [**Select None**] buttons or you can select (☑) or deselect (☐) each Lithology Unit individually by checking or unchecking the boxes in the *Selected* column.

***To specify the transparency of the Voxel*:**

The *Transparency* of the Voxel can be adjusted interactively by moving the slider on the *Transparency* bar or by specifying a value in the *Transparency* text box.

1. Click inside the *Transparency* box, specify the transparency percentage level and press the <*Enter*> key. The transparency of the Voxel will be updated.

2. To modify the transparency level interactively, using your cursor, move the slider on the *Transparency bar* 

increase the transparency, slide the bar to the left and to decrease the transparency slide the bar to the right.

***To Clip the X, Y and Z Axis data using the super or text boxes*:**

Using the *Clip Axis*, you can clip each of the 3D Axis (*X*, *Y* and *Z*) independently. The *Clip Axis* can be modified interactively by moving the individual sliders or by specifying *an Axis* range in the data boxes provided.

1. Click inside the *Clip Axis X (Y, Z)* boxes, specify the minimum and maximum values and press the <*Enter*> key. The Voxel will be updated with the new clipped Axis range.

2. To interactively modify the *Clip Axis X (Y, Z)*, use your cursor and move slider from either end of the slider bar (

). Your Voxel Axis range will be updated interactively as you move the *Clip Axis X (Y, Z)* slider bar.

3D Surfaces Tab:

Use the 3D Surfaces tab to modify the surface display parameters in the 3D tool, fig. 1.97. The  tab enables you to modify the Surfaces display parameters in the 3D tool:

- Select the **3D Viewing Tools** (Rotate, Zoom, Pan, Centre, and Redraw).
- Select the **Voxel** to modify from dropdown list.
- Select (check) **Box** to add a box around the Voxel.
- Select (check) **Mesh** to add a mesh to the Voxel.
- Click the [**Colour**] button to display the **Color Symbol Tool** dialog.
- Click the [**Statistics**] button to display the Voxel Statistics dialog.
- **Clip Data** range using the slider bar or data boxes.
- Specify **Transparency** of the Voxel using slider bar or data box.
- Use **Clip Axis** to adjust the range of the Voxel Axis using the slider bars or by specifying the minimum and maximum **X**, **Y** and **Z** values.

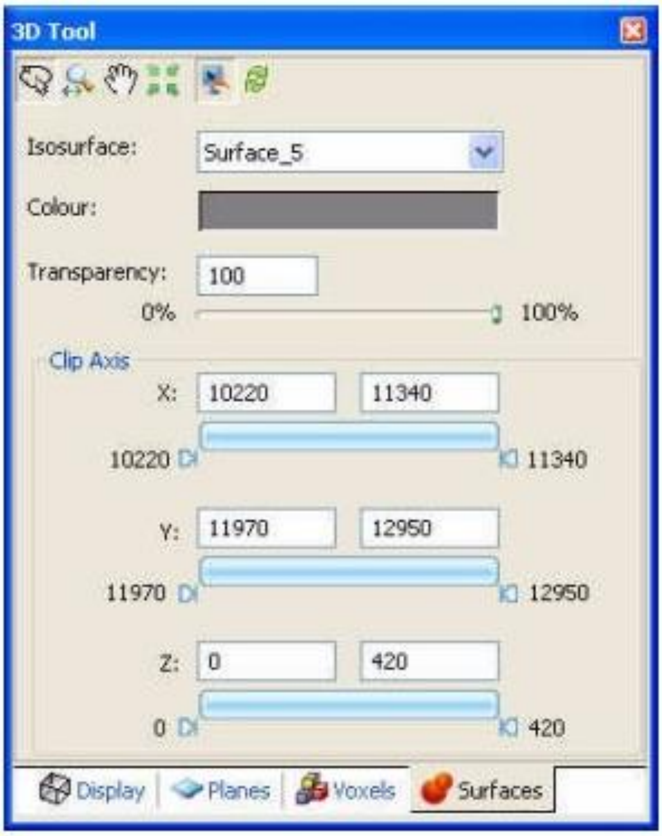


Figure 1.97. –3D Viewing Tools

Using the 3D Surfaces Tab

***To select an isosurface to modify*:**

1. From the *Isosurface* dropdown list, select the isosurface file from your current map.

***To access the Color tool*:**

The *Color* box enables you to specify the background color of the 3D View.

1. Click inside the Color box to display the Color tool dialog. Using this tool, you can select a color from the basic color table or by clicking the [**Define Custom Colors**] button, you can specify a custom color.
2. Click the [**OK**] button to apply the color to the selected isosurface.

***To specify the Transparency of the Isosurface*:**

The *Transparency* of the *Isosurface* can be adjusted interactively by moving the slider on the Transparency bar or by specifying a value in the *Transparency* text box.

1. Click inside the *Transparency* box, specify the transparency percentage level and press the <*Enter*> key. The transparency of the isosurface will be updated.

2. To modify the transparency level interactively, using your cursor, move the slider on the *Transparency* bar 

. To increase the transparency, slide the bar to the left, to decrease it slide the bar to the right.

***To Clip the X, Y and Z Axis data using the slider or text boxes*:**

Using the *Clip Axis*, you can clip each of the 3D Axis (X, У and Z) independently. The *Clip Axis* can be modified interactively by moving the individual sliders or by specifying *an Axis* range in the data boxes provided.

1. Click inside the Clip Axis X (Y, Z) boxes, specify the minimum and maximum values and press the <Enter> key. The Isosurface will be updated with the new clipped Axis range.

2. To interactively modify the *Clip Axis X (Y, Z)*, use your cursor and move slider from either end of the slider bar (

). Your Isosurface Axis range will be updated interactively as you move the Clip Axis X (Y, Z) slider bar.

Copying and/or Converting Grid Files

Oasis montaj enables you to copy and/or convert any supported grid format to any other supported grid format.

Copying and/or Converting Grid Files

1. On the *Grid and Image* menu, select *Utilities* | *Copy/convert*. The *Copy/convert grids* dialog is displayed, fig. 1.98.

2. Using the [**Browse**] button, select the *Input Grid File*, and specify the *Output Grid File*.

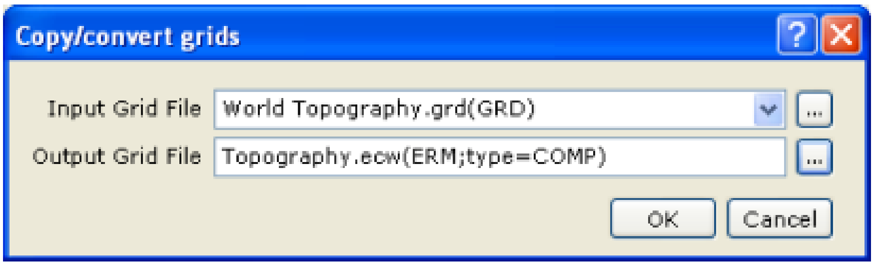


Figure 1.98. –Copying/converting grid files

3. Click the [**OK**] button. The grid is copied and/or converted as specified.

Note: For more information on copying and/or converting grid files, click the *Help* () button. For information on the supported grid formats, see the "Data Formats" help topic. (Hint: use the ***Search*** tab on the online Help system to locate topics of interest.)

Grid Properties

Basic grid property and statistics information can be quickly displayed in **Oasis montaj**. Displaying Grid Properties:

1. On the *Grid and Image* menu, select *Grid Properties*. The *Grid Properties* dialog is displayed, fig. 1.99.

2. Using the [**Browse**] button select the *Grid file* you want information on, for example, select the grid file (**casaber.grd**). Click the [**Open**] button on the *Grid File* dialog to return to the *Grid Properties* dialog.

3. Click the [**Next**] button to view the *Grid Properties* dialog.

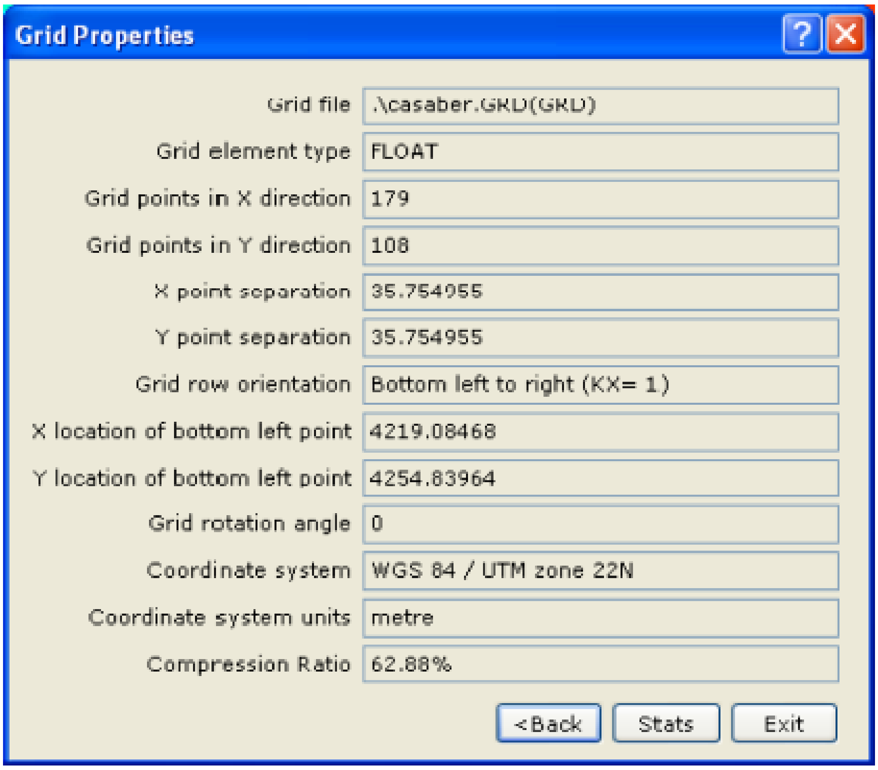


Figure 1.99. – Grid properties panel

4. Click the [**Stats**] button to view the *Grid Statistics* dialog, fig. 1.100.

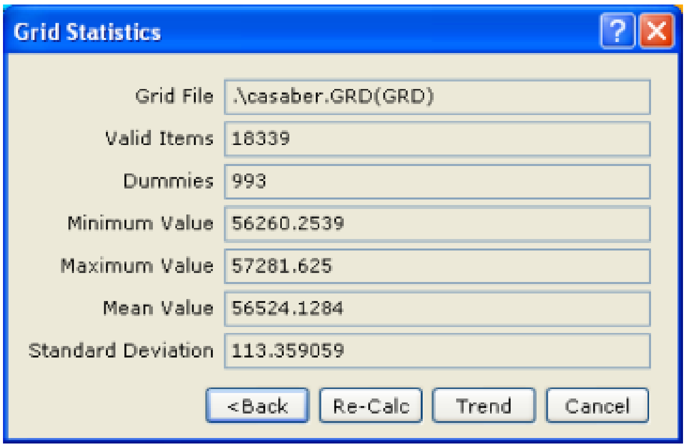


Figure 1.100. – Grid statistics panel

5. Click the [<**Back**] button to return to the *Grid Properties* dialog. For more information on the *Grid Properties* and the *Grid Statistics* click the *Help* (?) button. Click the [**Exit**] button to exit the *Grid Properties* dialogs.

Sending E-maps

E-maps, also called packed maps, enable you to pack all the files (grids, images, map objects) that are displayed on a map into a single file. This means that you do not have to worry about making sure all the files (such as *.GI or *.GRD files) associated with a map are included in the e-mail. When you open an e-map in **Oasis montaj**, all the information can be read in this format by all related functions, such as grid statistics.

1. Select (highlight) the map you want to send.

2. On the *Map* menu, click *Send map to*.

3. A new e-mail is composed in your default e-mail program with an attached e-map file.

Unpacking an E-map

If you receive an e-map and you would like to, for example, view the grid statistic of a displayed grid, you must first unpack the map and extract the grid file.

***To Unpack a Map*:**

1. Select (highlight) the **Oasis montaj.map**.

Note**:** The **Oasis montaj.map** file is a packed map that contains two files (**Oasis montajv60.grd**, and **Oasis montajv60.grd.gi**).

2. On the *Map* menu, click *Unpack map files*. The map is unpacked and the extracted associated grid files are placed in the current project directory.

1.9.11. Exporting and printing Data

Oasis montaj *Viewer* provides a variety of exporting capabilities including exporting databases and maps, fig. 1.101.

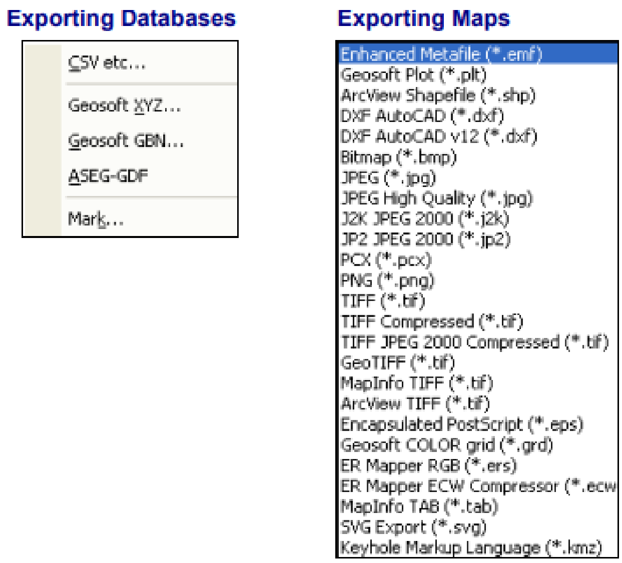


Figure 1.101 – Grid Exporting Databases and maps windows

Exporting Databases

Oasis montaj *Viewer* enables you to export **Oasis** databases in a variety of data formats. This tutorial will describe how to export to a Geosoft XYZ and CSV Data format file.

Export Geosoft XYZ Data Format

The directions below describe how to export a database as a Geosoft XYZ file.

1. Select the **Casaber.gdb** database in your current project.

2. On the *Database menu*, click *Export*, and then click *Geosoft XYZ*. The *Export XYZ data* dialog box is displayed, fig. 1.102.

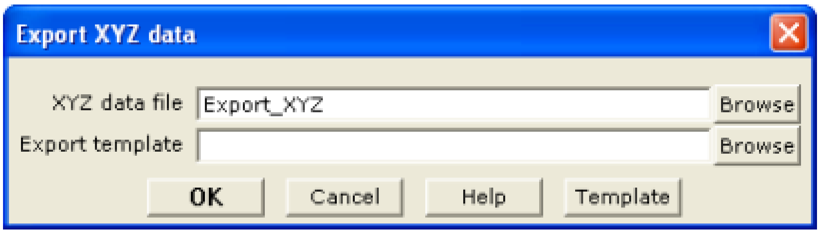


Figure 1.102 – Selecting XYZ file to export it

3. Specify the XYZ data file name (**Export XYZ**), and click the [**Template**] button. The *Export XYZ Template* wizard is displayed, fig. 1.103.

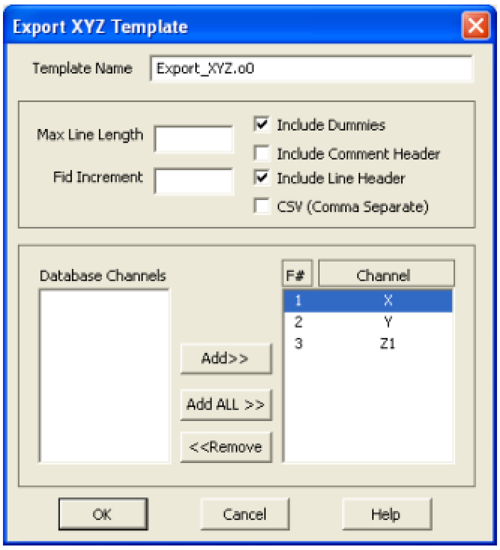


Figure 1.103 – Export XYZ file template

Note: The *Export XYZ Template* uses a wizard to determine which channels to export, the export parameter settings (maximum line length, fiducial increment), and to include (or not include) dummies, comment headers, line headers, and CSV formatting.

4. You can specify a *Template name* (**ExportXYZ.oO**) or use the default (default.oO) template.

5. Click [**OK**] to return to the *Export XYZ data* dialog, click [**OK**] to export the data as **Export_XYZ.xyz**.

Export CSV format

1. Select the **Casaber.gdb** database in your current project.

2. On the *Database menu*, click *Export*, then click *Other*. The *Export to Other format* dialog is displayed, fig. 1.104.

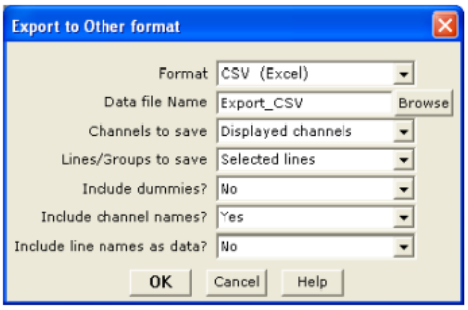


Figure 1.104 – Export to other formats

3. Specify the *Format* as **CSV** (Excel).

4. Provide the *Data file Name* (**Export_CSV**), and then specify the *Channels to save*, and the *Lines/Groups to save*. You can also specify to *Include dummies*, and to *Include channel names*.

5. Click the [**OK**] button. The system exports the data to the designated file.

Exporting Maps

Oasis montaj *Viewer* enables you to export **Oasis** maps to a variety of grid and image formats. This tutorial will describe how to export a map to a tiff file format.

***Exporting Map*:**

1. Select (highlight) the map you want to export (**Oasis montaj.map**).

2. On the *Map* menu, select *Export*. The *Export Map* dialog is in fig. 1.105.

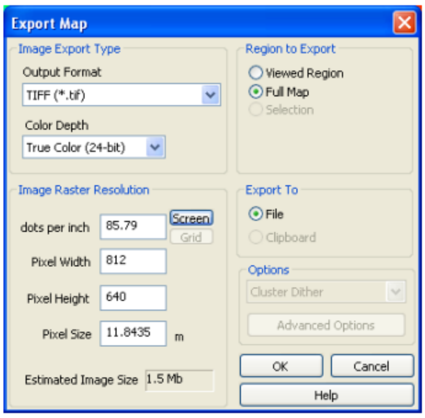


Figure 1.105 – Export map panel

3. In the *Image Type box,* choose the *Output Format* as (**TIFF (*.tif**)) and select the *Color Depth* (**True Color (24-bit)**).

4. Click the (**Full Map**) option In the *Region to Export* box.

5. In the *Image Resolution* box, change the *Pixel Size* to **35.75**.

Note: Pixel Size is the number of ground units each pixel in the image represents. In the example above, each pixel in the exported map represents **35.75** meters. You can set the pixel size to match the grid cell size *closely*. However, rounding error usually prevents the grid cell size from exactly equaling the pixel size.

6. Click **File** In the *Export to* box.

7. Click [**OK**] to export the **Oasis montaj.map** in the tiff format. The *Export file name* dialog is displayed.

8. Specify a file name for the tiff file and click [**Save**]. The tiff file is saved in your project directory.

Printing Maps in Oasis montaj

Oasis montaj, by default, uses your Windows system drivers to create printer or plotter output. When you start printing maps for the first time, you will most likely accept the defaults. Depending on your driver's performance however, you may want to add a new configuration that uses more advanced printing options.

Geosoft provides a special printer setup capability that starts an internal rasterizing engine that performs most of the print/plot processing and passes it to the driver for final output.

If you are not satisfied with your driver's performance, you can try selecting; Geosoft bands, Geosoft bands and dither, HP-RTL or the Postscript printing option. Refer to the on-line help system for a complete discussion on the pros and cons of the different printing modes.

Printer Setup

The *Printer Setup* dialog box enables you to specify the printer to use and the paper and orientation parameters.

You can plot the currently visible part of the map (i.e. enlarged or reduced map) or the entire map. When plotting, you also have the option of scaling the visible or entire plot to cover the entire plot area or to scale the entire plot to a specific range.

***Setting up the Printer*:**

1. On the *File* menu, click *Printer Setup*, the *Print Setup* dialog is displayed, fig. 1.106.

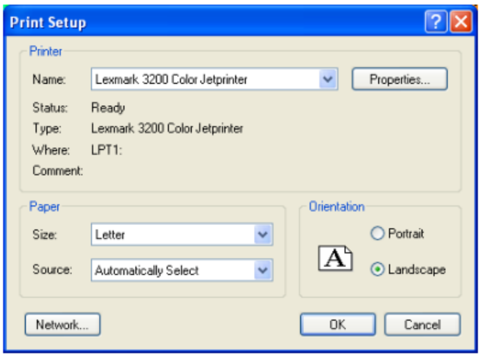


Figure 1.106 – Print Setup panel

2. Change the paper Orientation to **Landscape** and click [**OK**].

Note: For more information on printing setup parameters, click the *Help* (?) button on the *Print Setup* dialog box, or see the ***Printing*** topics in the **Oasis montaj** online help system.

Page Setup

The *Page Setup* dialog enables you to specify the paper settings (size, source, orientation and margins).

***Setting up the Page*:**

1. On the *File* menu, click *Page Setup*, the *Page Setup* dialog is displayed, fig. 1.107.

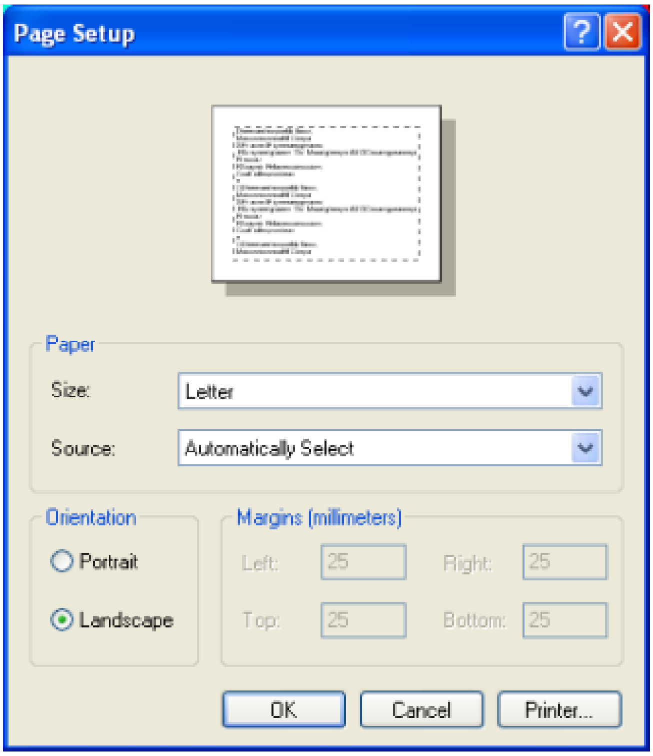


Figure 1.107 – Page Setup panel

2. Change the paper *Size*, *Source*, *Orientation* and *Margins* and click [**OK**].

Note: For more information on page setup parameters click the *Help* (?) button on the *Page Setup* dialog, or see the ***Printing*** topics in the **Oasis montaj** online help system.

Print a Map

1. Select (highlight) the map that you would like to print.

2. On the *File* menu, click *Print*. The system displays the *Print* dialog box, fig. 1.108.

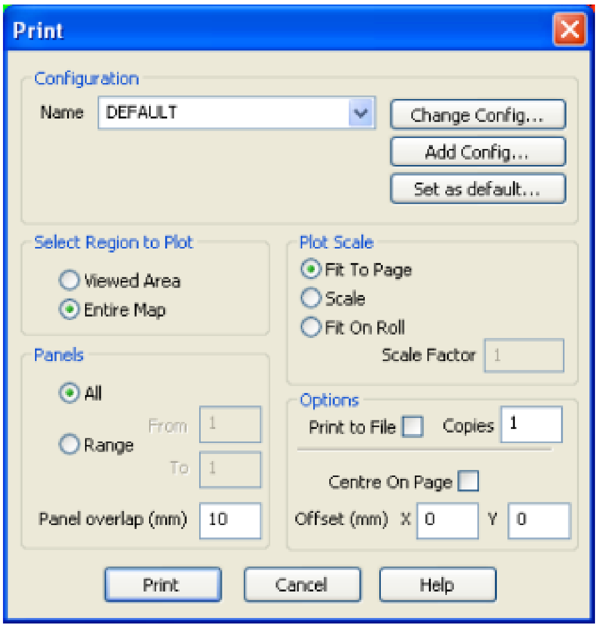


Figure 1.108 – Print Map Panel

3. In the *Select Region to Plot* box select **Entire Map** and in the *Plot Scale* box select **Fit To Page**.

Note: Map may not be plotted to scale. To maintain the map scale, select the **Use Scale Factor** option and specify a value, (**1 = 100%**). If you use this option, the map may require more than one page depending on the media to which you are printing or plotting.

4. In the *Panels* box, select **All**.

Note: *Panel overlap (mm).* If you are printing multiple panels, you can specify an overlap in mm. This helps you to match panels later.

5. In the *Options* box, select **1** copy.

6. Click the [**Print**] button to send the map or plot to the currently configured printer or plotter.

Note: For more information on print parameters and selecting them, click the *Help* (?) button on the *Print* dialog box, or see the ***Printing*** topics in the **Oasis montaj** online help system.

1.9.12. Geosoft Concepts

This section contains information about the components included in **Oasis montaj**™ and describes the concepts you will need to know to use the system. A quick overview of the concepts described in this section are available in the **Oasis montaj *Viewer*** help system [16] in the **About** directory called ***Tour for New Users***.

Oasis montaj is Geosoft's core software platform for working with large volume of spatial data. The core software platform consists of a free ***Viewer*** and a licensed ***Mapping and Processing System***. For more information on the **Oasis montaj *Mapping and Processing System*** visit www.geosoft.com/pinfo.oasis_montai.html.

Oasis montaj Viewer

The **Oasis montaj *Viewer*** is a free software product that enables you to view Geosoft databases, Geosoft Grids and a variety of common image and data exchange formats. Specifically, this version provides you with the following capabilities:

• Access Geosoft project data (databases, profiles, grids, voxels, maps, *ArcGIS MXD files), tools (3D Tool and Project Explorer) and Geosoft tool bars (Database Tools, Map Layout, Map Tools, and Standard).

• Evaluate data, information and interpretations by viewing and performing specific tasks using Geosoft databases, profiles, maps, and grids as well as Geosoft and third-party images (including Geosoft PLT, AutoCAD DXF, Maplnfo TAB, ArcView SHP, ArcGIS LYR, and Microstation DGN files).

• Verify data quality, analyses and interpretations by tracking processes applied to databases and maps.

• Perform selected processes made available through Geosoft menus or third-party GXs.

• Share results and knowledge by viewing and/or sending E-maps and 3D PDF files (see the Export To PDF 3D for more details) to team members and other professional contacts.

• Prepare reports by exporting to 3D PDF or using clipboard image copying capabilities.

To access ArcGIS MXD files* in **Oasis montaj requires *ArcMap or ArcEngine to be installed on your computer*.

The **Oasis montaj** environment provides direct access to data contained in Oasis databases through a spreadsheet window and an integrated profile display window. The Oasis database is a high-performance database that provides efficient storage and access for very large spatial data sets.

The ***Viewer*** provides visual data links that enable you to dynamically connect data in the spreadsheet, profile and map views. DAT technology (for accessing grids and images) enables the ***Viewer*** to display a variety of grid and image formats in **Oasis montaj**.

The **Oasis montaj** core platform provides the basic resources for all Geosoft Applications and Tools. Geosoft provides a variety of systems that address specific applications in exploration geophysics, drillhole geology, exploration geochemistry and other areas. These systems consist of menus and corresponding Geosoft executables (GXs) that run on the core platform.

What is Oasis montaj?

The concept of an integrated environment for earth science data emerged from over two decades of software development at Geosoft and is now implemented in the **Oasis montaj** software platform. Geosoft's vision reflects the fast pace of today's professional work environment and the significant changes in data processing over the past twenty years:

• An order of magnitude increases in data volumes.

• Increasing digital data availability and connectivity.

• Shift in processing from office to *in situ* (or field) environments.

• Replacement of proprietary software with commercial solutions

By design, Geosoft's **Oasis montaj *Viewer*** meets specific needs including:

• *Project Explorer Tool* enables users to browse as well as open any 'project' item.

• *Metadata Tool* provides a context-oriented, interactive way to view and edit attributes assigned to Geosoft data.

• *View/Group Manager Tool* enables users to manage and edit map View and/or Groups.

• File locations are displayed in a popup dialog when you mouse over an item in the *Project Explorer.*

• *Drag-n-Drop* display technology enables users to drag-n-drop Geosoft grids (.GRD), maps (.MAP), databases (.GDB), XYZ files (.XYZ) and *ArcGIS MXD files for quick viewing of data.

To access ArcGIS MXD files in* ***Oasis montaj* *requires ArcMap or Arc Engine to be installed on your computer.*

• *3D Mapping* enables users to view their data in 3-dimensions, providing a real-world view of their data.

• True transparency has been added and is automatically enabled, with video cards that support it.

• Geosoft's DAP (Data Access Protocol) technology enables users to access very large spatial datasets residing on an Internet Server (or locally on a Personal Computer).

• Connecting you to your data and information via dynamic linking – a unique technology for graphically connecting data, profiles and maps in a single desktop environment.

• Addressing high-volume data storage and access requirements for very large spatial data sets.

• Delivering focused solutions to specific Earth Science problems.

• Free **Oasis montaj *Viewer*** for Data and Information Sharing.

Viewer Capabilities

The **Oasis montaj *Viewer*** is a free software product for accessing and sharing data and images in native Geosoft and standard PC formats. The ***Viewer*** is available for download at www.geosoft.com. The Viewer can be freely distributed by anyone who wants to enable other geoscientists to share data and maps in a Geosoft environment. Some of the ***Viewer's*** capabilities are listed below.

Projects:

• Open and display projects and display/edit project comments.

• Browse and open any project item in the *Project Explorer*.

• Add or modify Metadata of all data items displayed in the *Project Explorer*.

• View project data "Properties".

Data and Profiles

• Open new databases imported from Geosoft GDB, Geosoft GBN, Geosoft XYZ and ASEG-GDF formats.

• Export databases as Geosoft GDB, Geosoft GBN, Geosoft XYZ, ASEG-GDF, CSV (Excel), ODDF (USGS), POST PC (USGS) and POST UNIX (USGS).

- Show and plot data profiles in up to five database profile windows.
- View data projected coordinate system information.
- View data statistics and historical processing logs.

• Dynamically link data between spreadsheet, profile window and maps.

Maps, Grids and Images

• Display a wide variety of grid and image files (for a detailed list see the ***Data Format*** Help topic).

• Import and display Geosoft PLT, AutoCAD DXF, MapInfo TAB, ArcView SHP and Microstation DGN files.

• Display *ArcGIS MXD files in an MXD Viewer (**Note that, the installation of ArcMap or Arc Engine is required to view MXD data in Oasis montaj*).

- Open and display maps, and display/edit map comments.
- Pan, zoom, and cursor-link map views.
- View map view projected coordinate system information.
- Copy and paste database data and maps to other Windows applications.
- Export maps to a variety of formats.
- Plot maps to Windows printers and large-format plotters.
- Send and receive E-Maps.

Online Help and Technical Support

• Full on-line help system with links to Geosoft Web Server.

• Access to Geosoft [**geonet**] support list and Geosoft Web Site resources.

Keeping you in touch with your data

An important design strategy in **Oasis montaj** was to keep you in touch with your data. In fact, the system is intended to connect you with your data and information in several unique ways:

• By providing an integrated environment that holds all of your project information.

• By enabling quick and easy access all your project data via the Project Explorer including; databases, grids, maps, tools and metadata information.

• By providing unique views of data (spreadsheet, profile and map).

• By connecting you to data and information in these views (through a specialized dynamic linking technology).

• By delivering a wide variety of algorithms and techniques.

• By "memorizing" the processing you apply to data and maps, by means of a proprietary process "maker" technology. This capability is especially useful for quickly testing and optimizing processing parameters. It also keeps a record of processing so that you can remember your settings if you stop working on your project and later return to it.

Geosoft's approach is intended to give you a means of keeping in close contact with your original and processed data and information – from start to finish, fig. 1.109. As you use the system, you will find your own ways to take advantage of these capabilities.

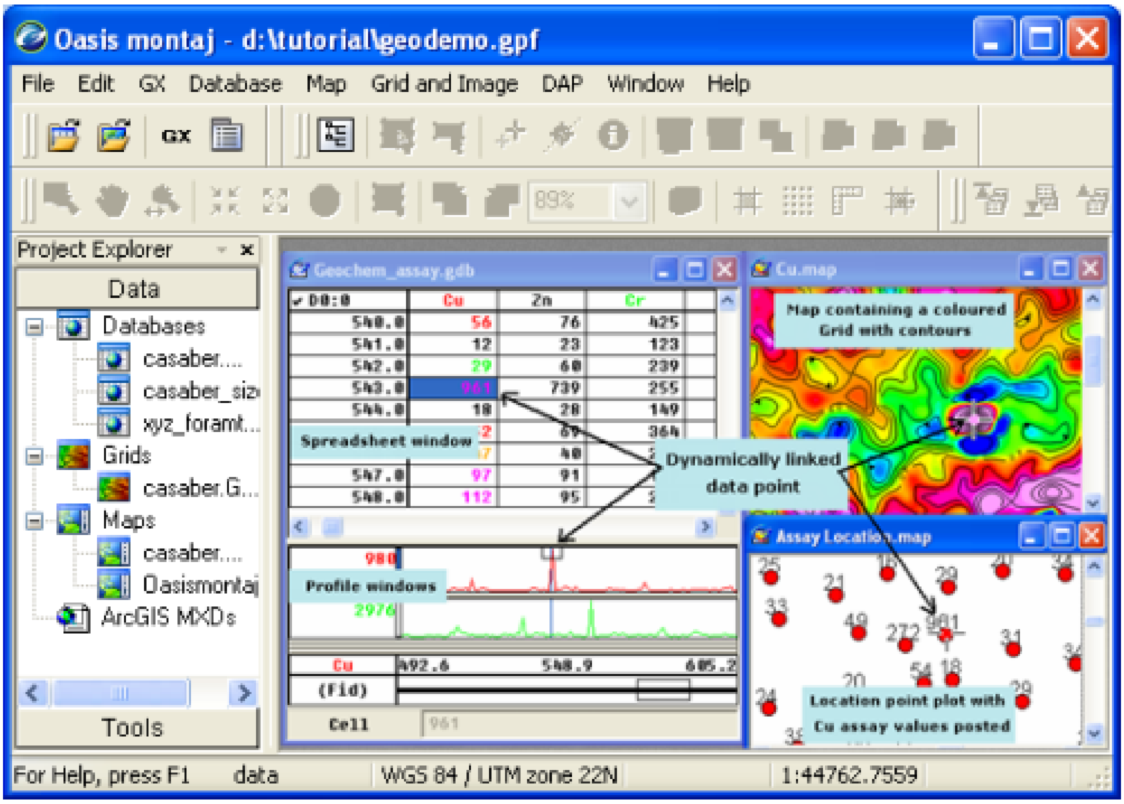


Figure 1.109 – Oasis montaj capabilities

Projects and the Project Explorer

To work in **Oasis montaj** you need requires an open Project. An **Oasis montaj** "Project" encompasses every item in your working project; from the data files (databases, maps, and grids), to the tools used (including auxiliary tools such as histograms, scatter plots etc. – licensed version only), to the project setup including the menus you have displayed and whether you are working on a map or profile and the state in which you left it the last time you used it.

The **Project Explorer** enables you to browse as well as open any project item. The project file (*.gpf) is used to keep track of all information related to a working project.

The Project Explorer has two windows, the Data window that includes all data files included in the project and the Tools window that organizes and maintains the project tools, fig. 1.110.

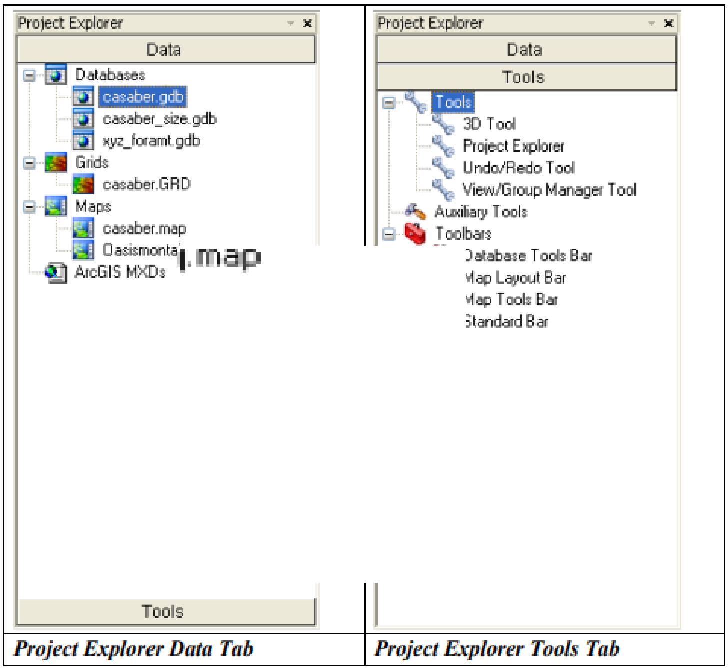


Figure 1.110 – Project Explorer

***Some of the capabilities of the Project Explorer are*:**

• Keeps track of all files and using the description and metadata tools enables you to keep track of project information. Note that, in previous versions, file information was maintained in the file system and the user had to keep track of what the files were.

• Explorer tools including; Tools, Toolbars and Auxiliary Tools (licensed version only).

Tools; 3D Tool, Metadata Tool, Project Explorer and Undo Redo Tool and the View/Group Manager Tool.

Toolbars; Database Tools Bar, Map Tools Bar, Navigation Bar and Standard Toolbar. Also available with the licensed version. Map Edit Tools Bar, Polygon Tools Bar and Script Bar.

Auxiliary Tools: Histogram, Scatter plot. Probability plot and Triplot (licensed version only).

• File locations displayed in popup dialog when you mouse over item in the Project Explorer.

• Enhanced metadata capabilities enable access to the Metadata of all items displayed in the Project Explorer.

• Recent Projects & recent Geosoft data files available under File menu.

Note: Grids appear in the Project Explorer under "Grids". Opening a grid opens a view of the grid in its own internal "map". A grid map view is just like a real map and can accept any graphics that a map can. It can also be saved as a map; in which case the map will appear in the "Map" section of the project explorer.

What you need to know about Project files

You require an open project to do any work in **Oasis montaj**. The project also controls your working directory. Projects are saved as (*.gpf) files. If you open an existing project from a directory, the system assumes that your files are located in the specified directory. To streamline your work, as well as keep it organized, you may want to make sure that your project is in the same directory as the other files you want to use.

It is recommend that each project you work on have its own project (*.gpf) file. If you use a number of applications or add-on tools in **Oasis montaj** that have different menus, you can use the project to display only the menus you require.

Open Workspace (.GWS) Files

Workspace files (*.gws) used in **Oasis montaj** prior to version 6.0 can be easily converted to Project files (*.gpf) simply by opening them in Oasis montaj 6.0 or greater.

On the *File menu*, select *Project|Open* and the *Open Project* dialog will be displayed. Using the *Files of Type* dropdown list, select *"Workspaces (*.gws)"* and when asked if you want to convert the old workspace into a new **Oasis montaj** project file, select [**Yes**]. The workspace file will be converted to a project file and all associated workspace information will be transferred to the new project file.

Metadata

Metadata (data about data) is captured by **Oasis montaj** from the first time the data is touched. The metadata information, which is based on ISO 19115 standards, is stored inside the data (if supported) or as a companion XML file. When you import or work with data in **Oasis montaj**. *Username*, *Date*, *Time* and any actions performed on the data will be maintained in the Metadata. When data is derived from other data, the Metadata is passed on and the lineage of what was done to the data is maintained in the *Lineage* section.

Viewing and Editing Metadata

Attributes (or metadata), information about data, can be simple or complex and the descriptive needs of different kinds of data are infinitely diverse. To allow for this and provide flexibility, Geosoft developed the XML *Metadata Viewer and Metadata Editor* to help you organize your metadata.

Even though each Geosoft data type (*Database, Grid, Map, ArcGIS MXD, Voxel*, etc.) exhibits many different attributes, using these tools are easy. The current selection drives what exists inside the tool, fig. 1.111.

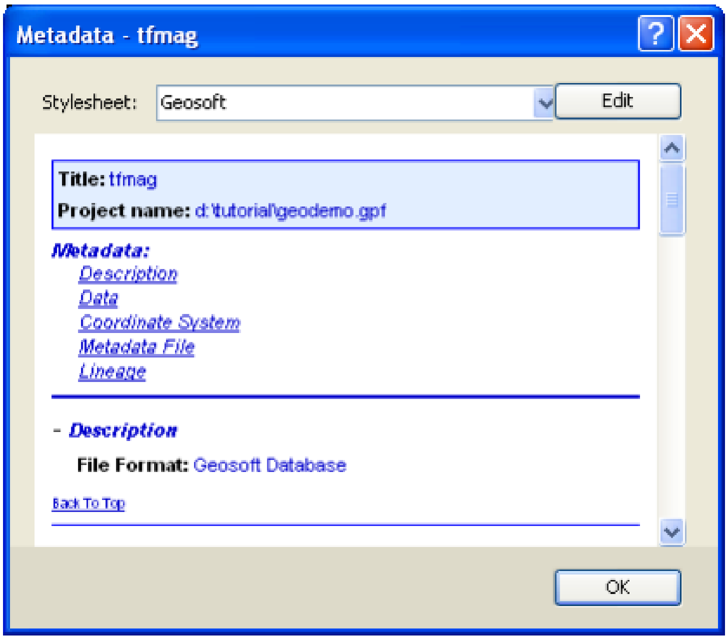


Figure 1.111 – Metadata Panel

Metadata Viewer

Databases and high-volume data processing

Many commercial and governmental groups currently use **Oasis montaj** for routine processing of high-volume datasets (tested up to 10 gigabytes) and also for relatively low volume processing in a variety of mapping and other applications. One key to the system's capabilities is the proprietary 3-dimensional database architecture, which enables the rapid processing and analysis of high-volume data. This object-oriented database structure stores data in a form that enables rapid access and efficient storage of your data.

Databases are displayed and organized in **Oasis Montaj** in the Spreadsheet Window, fig. 1.112. The spreadsheet window organizes and displays data differently than conventional (relational) spreadsheet and database programs. Conventional databases organize data as tables, records and fields, as shown below:

Hole_ID	From_Dep	To_Depth	Sample	Au	As
				ppm	ppm
DD001	0	1	15773561	0.05	13
DD001	1	2	15773562	0.04	11
DD001	2	3	15773563	0.03	19
DD001	2	3	15773564	0.04	19
*	*	*	*	*	*
DD003	98	99	15767021	0.4	-0.5
DD003	99	100	15767022	0.22	-0.5
DD004	0	5	15766457	0.04	-0.5

Figure 1.112 – Spreadsheet columns

Conventional databases organize data as tables, records and fields. This is effective for querying and searching type applications but limits it as a data processing engine because:

• Programs must read an entire record to access a single field.

• It is computationally intensive to change record structures.

• Data sampled at different intervals and starting points are difficult to store.

Oasis montaj is based on a proprietary 3-dimensional-file format architecture, fig. 1.113, which overcomes these limitations, as shown below:

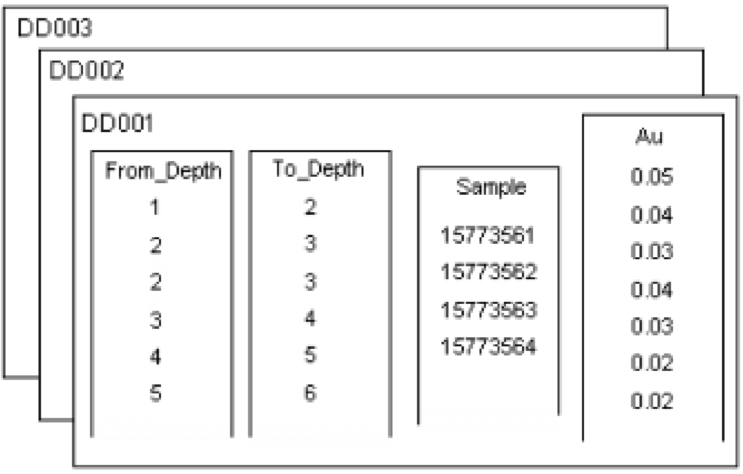


Figure 1.113 – 3-dimensional-file format architecture

Organized in lines (or groups), columns and elements, the database stores all data values of a particular type in individual columns or channels. This enables stand-alone processing of columns and eliminates the need to write results to interim storage areas and then re-write them after processing. The result is a significant increase in processing efficiency. This Geosoft file structure provides additional advantages including:

• Ability to process any number of lines/groups.

• Ability to handle lines/groups with unlimited columns.

• Ability to handle very large datasets.

In addition, since columns are stored separately, this file format is capable of storing and manipulating data with different end point and sample intervals.

Spreadsheets are the windows to your database

When you create or open a database, you see a spreadsheet. The Spreadsheet view is your “window” to the **Oasis montaj** database and it also provides you with flexibility in setting up your working environment. All data is stored securely in the underlying database – you simply decide which data you want to display in the spreadsheet and keep all other data in the background, hidden from view.

The spreadsheet is organized in rows, channels (columns) and lines (also called groups in other applications such as borehole plotting). Rows and columns work similar to standard spreadsheets in that you can edit and delete them as needed. The system also enables multiple “worksheets” in your database – depending on the type of data you are working with (line, random line or borehole); the worksheets have different names, fig. 1.114. To see what type of name is used, look at the Line Header Cell located at the top left corner of the spreadsheet. An “L” for example, indicates that you are working with line data.

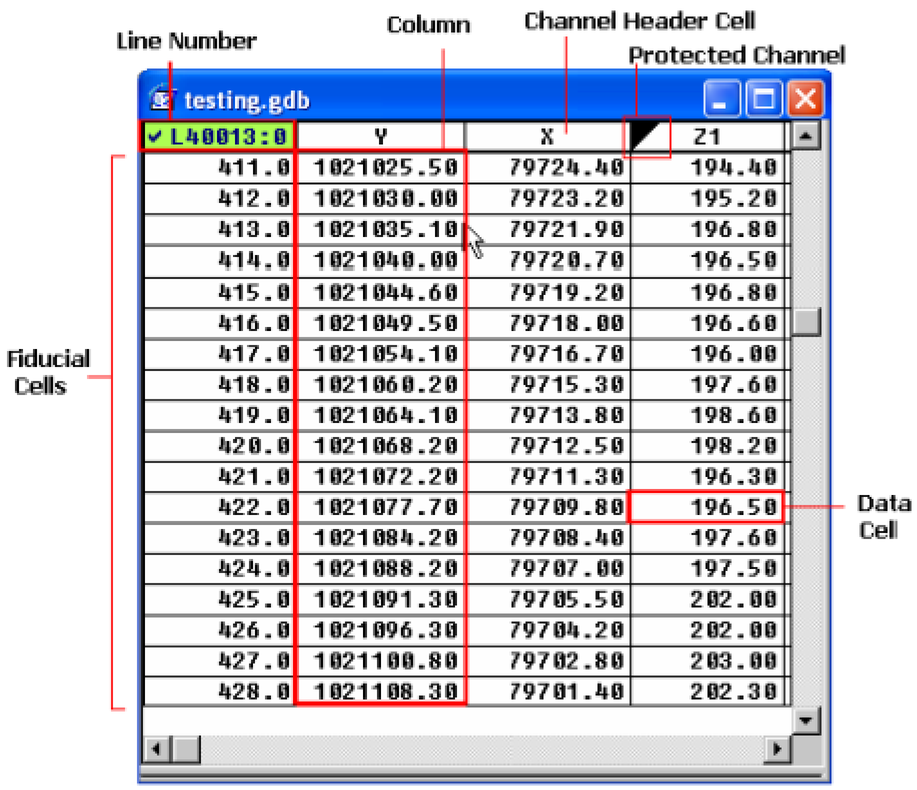


Figure 1.114 – Spreadsheet data format

General spreadsheet capabilities include:

- The ability to display data from your database through a spreadsheet window.
- Handling of any sample interval.
- Supports full editing and mathematical processing capabilities.
- The ability to process selected samples, selected channels and selected lines or groups.

How the Spreadsheet Displays Project Data

The spreadsheet does not display your actual data, but rather a view of the data. Depending on your type of project, the spreadsheet will display your data as either values or arrays, fig. 1.115.

For surveys where a single value is recorded at each station, for example an assay survey, each data cell will contain a single value.

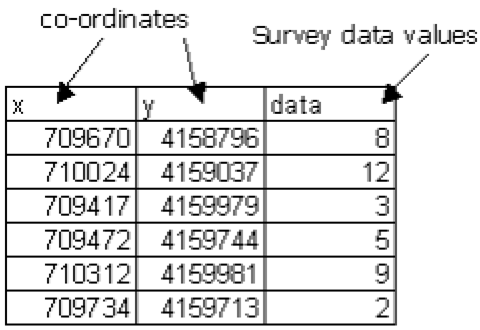


Figure 1.115 – Data Sample

For surveys where multiple readings were recorded at each station, for example an Induced Polarization survey, each data cell will contain multiple values, fig. 1.116.

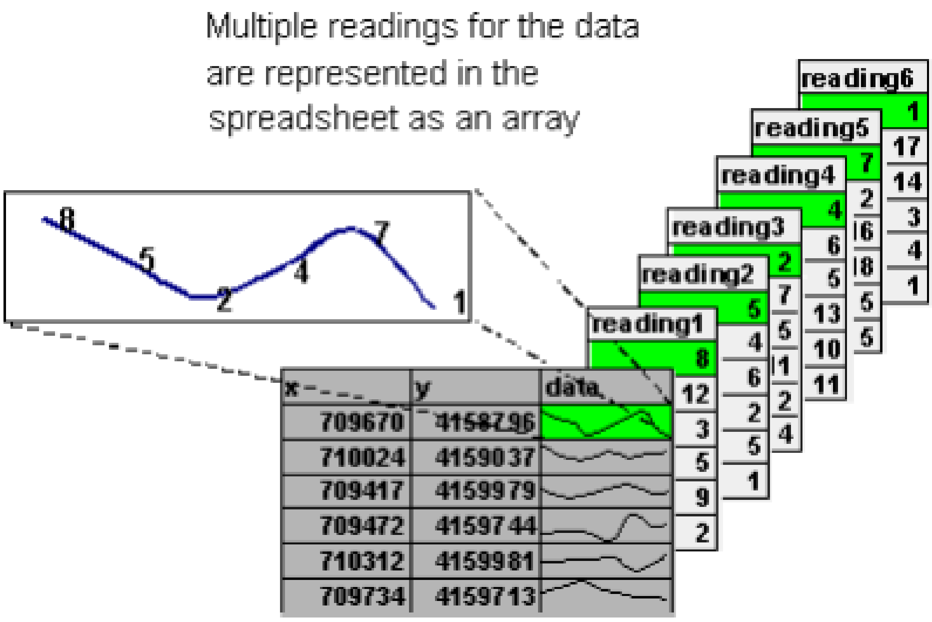


Figure 1.116 – Example an Induced Polarization survey data

The spreadsheet represents these values as a profile line in an array channel.

Profiles and viewing your data graphically

The Profile view is your "graphical window" to the **Oasis montaj** database. You can display profiles of one or more variables in your database simply by selecting the channel and selecting a simple menu item. The profile appears directly below its corresponding database in a profile window. You can have up to five "panes" with 32 variables in each pane.

A key point to note about profile windows is that they are linked dynamically to their corresponding database. When you select a value or range of values in the database or profile window respectively, they are also highlighted in the other window, fig. 1.117.

This capability keeps you in touch with your data and gives you an interactive means of accomplishing quality control or analysis tasks.

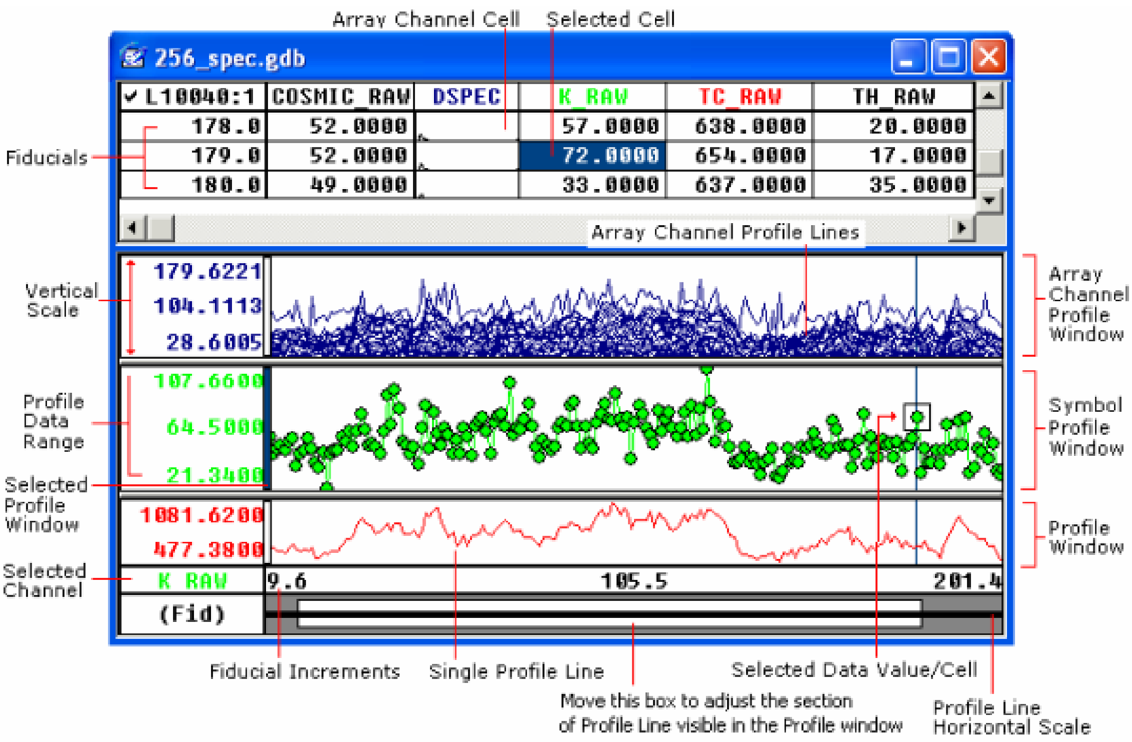


Figure 1.117 – An Example of profiles

Maps are more than printed sheets of information

Geosoft's mapping capabilities are the result of more than a decade of programming development, and the options for producing and editing maps – as well as the quality of output – reflect this level of experience. You can use the system to produce a variety of professional presentations quickly and easily, fig. 1.118.

However, you should also be aware that a map is more than a printed sheet of information in **Oasis montaj**; the Map view gives you an electronic area for analyzing, visualizing and editing your data and information.

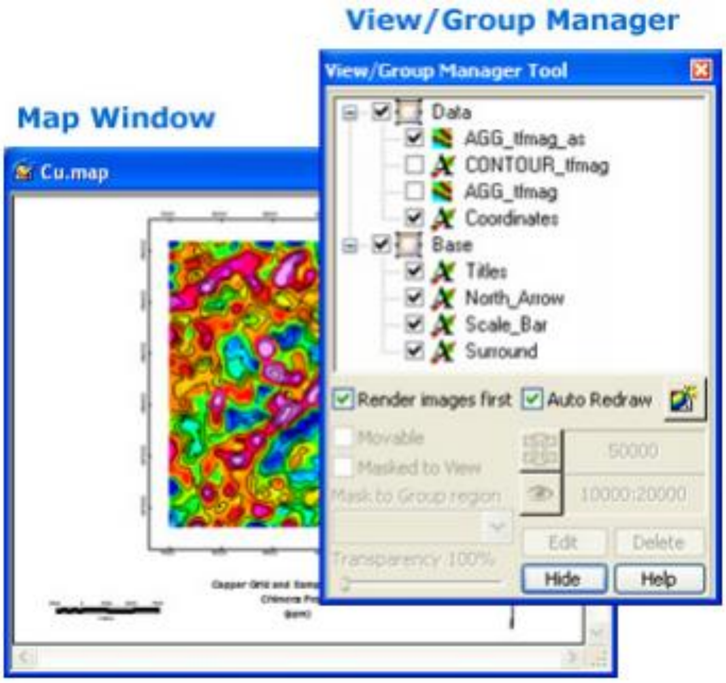


Figure 1.118 – An example of data representation

When you create a new map, the system opens up a new blank *Map Window*. After a *Map Window* is open, you can add a wide variety of data and base map-related information. **Oasis montaj** Maps use *Views* to organize and display information. A *View* divides the information on a map into a *Base* view, which uses paper coordinates, and a *Data* view, which uses ground coordinates. Map surrounds, north arrows, and scale bars are examples of map groups plotted in the *Base* view. Map coordinates, contours, and grids are examples of map groups that are plotted in the *Data* view.

Groups are a fundamental part of maps. **Oasis montaj** uses *Groups* to determine the order in which objects are displayed (rendered) on a map. Groups are layered on top of each other in a specific order determined by the *View/Group Manager Tool*. You can create, edit, move, hide, and mask groups. You can also move groups in front and behind each other. Any new object you add to a map, such as a polygon or line, is added to the current group, fig. 1.119.

True transparency has been added and is automatically enabled, with video cards that support it. For users who do not have video cards that support true transparency, ‘Light table’ display technology will be applied. Each group or layer in a map has individual transparency settings controlled from the *View/Group Manager Tool.* These transparency settings affect both 2D and 3D raster images and vector line work.

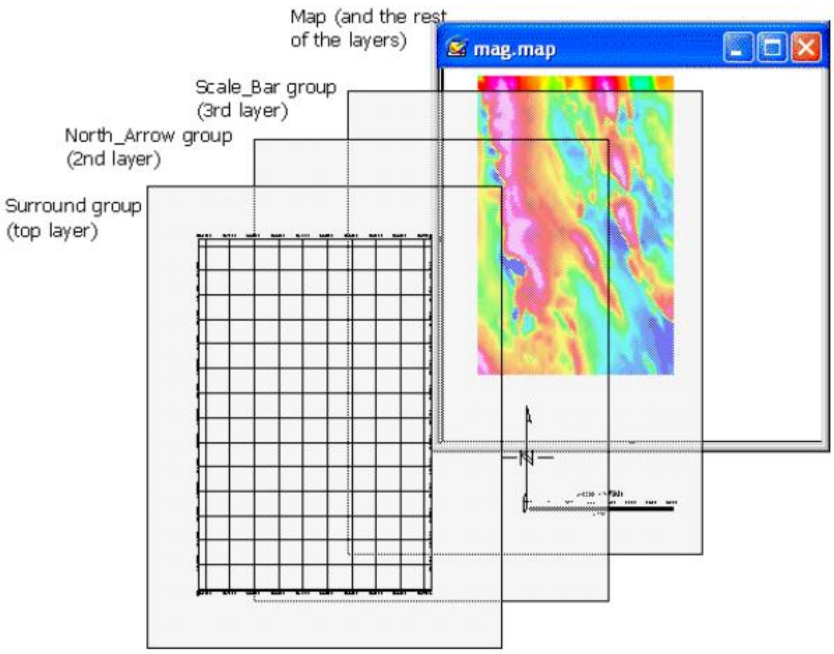


Figure 1.119 – Layers produce a resulting map

As you use the system, you will become familiar with the information that is stored in each type of *View* and how to manipulate them (for example, by turning off a map layer for plotting purposes). In addition, as shown in the next section, you will also learn to activate dynamic links between databases, profiles and maps so that you can perform advanced processing (selection of parameters) as well as interactive analysis and visualization.

ArcGIS MXD Files in Oasis montaj

ArcMap, the main application in the ArcGIS Desktop suite, is used for all mapping and editing tasks as well as for map-based query and analysis. An MXD map is the most common document type for users working with geographic information within ArcMap.

In **Oasis montaj** (licensed version) you can now open MXDs and view and manipulate them in a similar fashion as in ArcMap. This enables ArcGIS desktop users to share maps created in that environment with **Oasis montaj** users. Users can even drag layers to Geosoft maps or the montaj background to make new maps. It is also possible to use drag-n-drop to place a Geosofi group from the *View/Group Manager Tool* into an MXD map.

An MXD represents geographic information as a collection of layers and other elements in a map view. Common map elements include; the data frame containing map layers for a given extent, a scale bar, north arrow, title, descriptive text, and a symbol legend.

There are two primary display panels in an **Oasis montaj** MXD window; the data frame and the layout view. The data frame provides a geographic "window", or map frame, in which you can display and work with geographic information as a series of map layers. The layout view provides a page view where map elements (such as the data frame, a scale bar, and a map title) are arranged on a page, fig. 1.120.

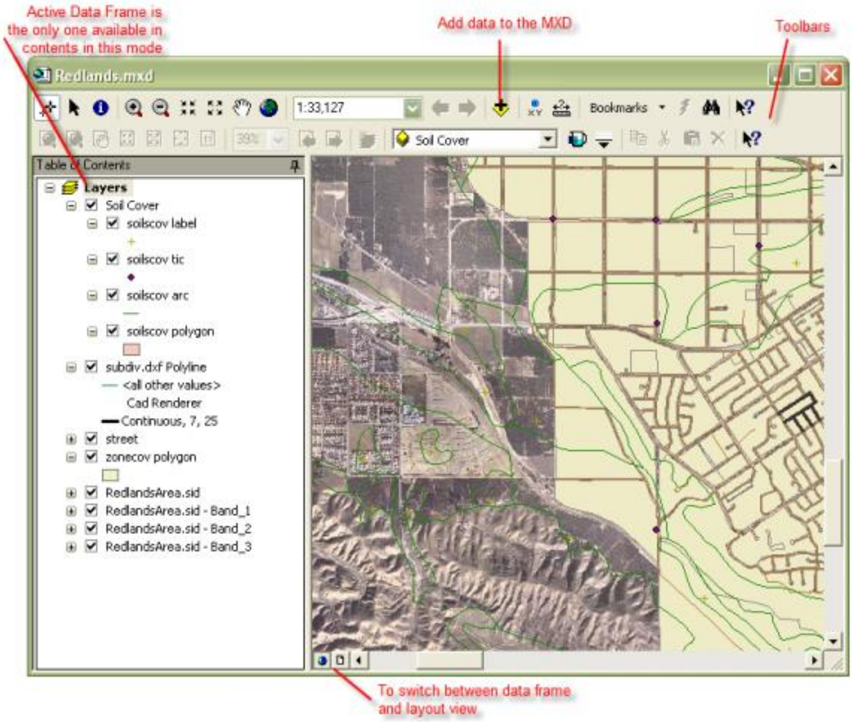


Figure 1.120 – An example of a page view for MXD files

When you save a MXD you have created in ArcMap or **Oasis montaj**, it uses the file extension (.MXD). MXD document files are managed in file system folders. You can work with an existing MXD in **Oasis montaj** by opening it from the ArcGIS MXD menu. This will open an MXD window, which enables you to switch between data frame and layout view mode. You can save the visible layers and certain layout elements to a new Geosoft map. It is also possible to create new MXDs in this menu at some predefined page sizes or to save a Geosoft map as an MXD.

You can also save a map layer definition as an ArcMap (.LYR) file and add it in an existing MXD window in the project using the toolbar or import it into a Geosoft map. One special feature that **Oasis montaj** adds in addition to the normal ArcMap tools is the dynamic linking using the *Shadow Cursor Tool*.

Note: **To access ArcGIS MXD files in* ***Oasis montaj*** *requires ArcMap or ArcEngine to be installed on your computer.*

Dynamically link data and information to knowledge

Dynamic links are a key part of Geosoft's strategy of helping professional is stay in close touch with their data – from import to processing to analysis. By definition, dynamic links are interactive graphical connections that you can activate between databases, profiles and any number of maps in your project. When you activate links and select any item or position in a database, profile or map, a cursor automatically connects the item or point in all items.

This capability gives you an important means of visualizing original or processed results in any view and seeing the corresponding representation in another view. The practical benefit is that you can quickly perform quality control, processing or analysis using all available data and information. Applying dynamic linking is also a highly efficient approach to building knowledge and making informed decisions, fig. 1.121.

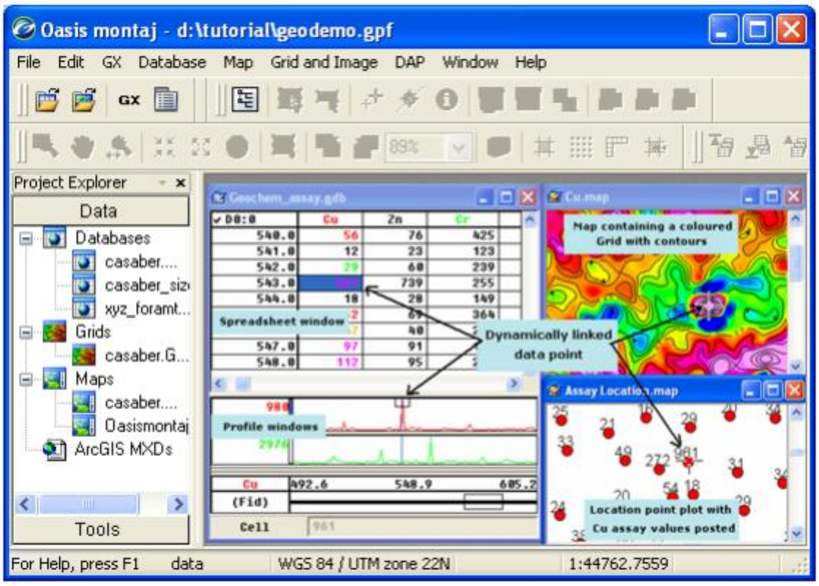


Figure 1.121 – Dynamically linked data

Geosoft Algorithms and Techniques

The Geosoft executable (GX) is the basic mechanism through which Geosoft provides the basic resources for all Geosoft Applications and Tools, fig. 1.122. GXs are programmed processes that are attached to the main menus in the system and to the special menus used in application suites. GXs run interactively in the graphical user interface but many GXs can also run in batch mode (using script commands).

Figure 1.122 – A snapshot of running of Geosoft GXs

All Geosoft GXs are signed. A Geosoft signed GX is a GX written and tested by Geosoft. It contains no viruses or code that can harm your system. As a user, you can trust that this GX works and is safe to use. Non-signed GXs will generate a report warning the user that there could be a problem with the GX or its contents and that Geosoft did not test or create this GX.

Individual users can create GXs using the GX Developer Toolkit. Geosoft's own developers also use this product to develop applications. The GX Developer is designed for users who consider themselves computer-oriented scientists (i.e. you do not have to be a computer scientist to use it effectively). If you encounter a non-Geosoft GX a report warning will be displayed notifying you that this is not a Geosoft signed GX.

Third party developers are also creating GXs and the product offers many opportunities for integrating other products into the system either via DLLs or by directly accessing Geosoft's database and function library.

The following dialog box shows a standard GX dialog box, fig. 1.123. Geosoft now supports Visual Basic programming so that users can create even more advanced dialogs boxes as required for their specific applications.

Figure 1.123 – Copying/converting grids

Process Maker technology links data processing

A dynamic process link is a built-in feature that remembers the processing parameters associated with a specific object such as a channel, grid or map and that enables you to quickly re-run the process using different settings.

A quick tool for reprocessing data, the process link is also useful for remembering processing settings. This latter capability is particularly effective if you are away from your project for any length of time and want to recall the settings you were using.

To access the maker popup menu is the maker associated with the object. Select this option and you will see the corresponding dialog box and settings. You can either change settings and re-process, or exit from the dialog as required, fig. 1.124.

Process Maker technology brings dynamic linking to data processing.

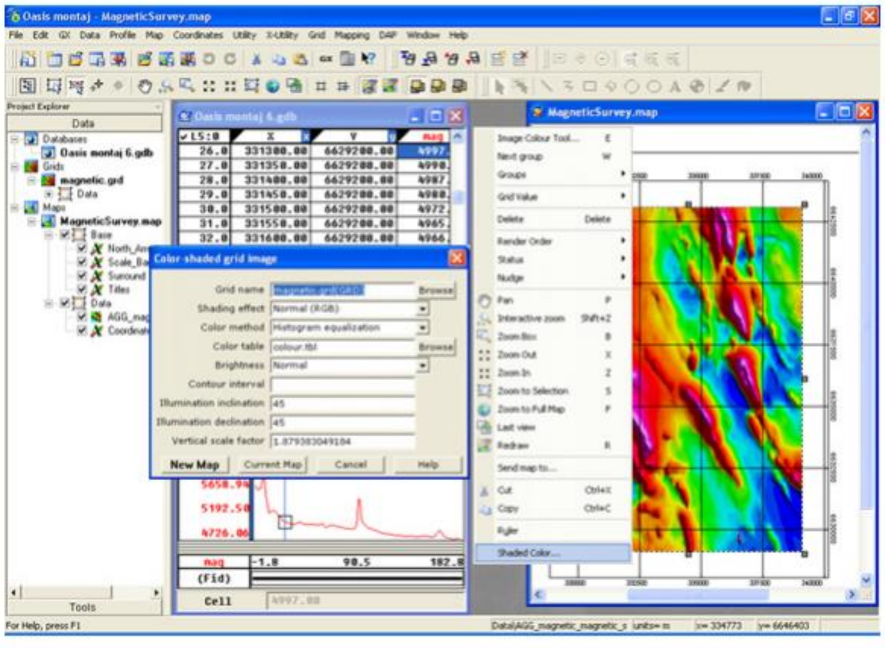


Figure 1.124 – A Magnetic Survey Map

Note: A Video Introduction to QGIS for beginners is available at: https://www.youtube.com/watch?v=-7v5qfJYWxA

1.10. Surfer

Sufer is a commercial software supported by the Golden Software Company; it has a number of periodically updated releases. A description below is given to introduce you to some of Surfer's features based mainly on the Surfer Release 8 [17]. It shows the basics of the **Surfer** and cannot cover all aspects of the program. We consider only briefly possibilities of the **Surfer** using a few test examples. Details are available at tutorials, accompanying the **Surfer's** release installed by you. It is in line to some general features with ArcGIS or QGIS, for instance, it can convert data from internal formats and save them as shape files widely used in both mentioned software packages. The description of the Surfer is considered in relation to some tests and the online tutorial.

Note about the User's Guide and Online Help. Various font styles are used throughout the **Surfer** ***User's Guide*** and online help. **Bold** text indicates menu commands, dialog names, and page names. *Italic* text indicates items within a dialog such as group box names, options, and field names. For example, the **Import File** dialog contains a Look in drop-down list. **Bold** and *Italic* text may occasionally be used for emphasis.

In addition, menu commands appear as **Map** | **Base Map**. This means, "click on the **Map** menu at the top of the plot window, then click on **Base Map** within the **Map** menu list". The first word is always the menu name, followed by the commands within the menu list.

Using the Tutorial with the Demo Version. If you are using the demo version of **Surfer**, you will not be able to complete some of steps due to disabled features. When this is a factor, it is noted in the text and you are directed to proceed to the next step that can be accomplished with the demo.

Understanding How to Use Surfer. The most common application of **Surfer** is to create a grid-based map from an XYZ data file. The **Grid** | **Data** command uses an XYZ data file to produce a grid file. The grid file is then used by most of the Map menu commands to produce maps. Post maps and base maps do not use grid files.

The flow chart illustrates the relationship between XYZ data files, grid files, contour maps, and wireframes, fig. 1.125.

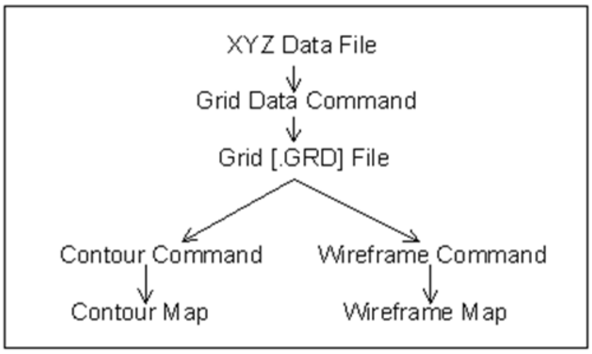


Figure 1.125 – A flowchart and a relationship XYZ data files – grid, files – maps

Creating an XYZ Data File. An XYZ data file is a file containing at least three columns of data values. The first two columns are the X and Y coordinates for the data points. The third column is the Z value assigned to the XY point. Although it is not required, entering the X coordinate in Column A, the Y coordinate in Column B, and the Z value in Column C is a good idea. **Surfer** looks for these coordinates in these columns by default, fig. 1.126.

	A	B	C
1	X Data	Y Data	Z Data
2	0.1	0	90
3	9	3	48
4	1.3	7	52
5	4.7	1	66
6	1.7	5.6	75
7	6	1	50
8	2.5	3.6	60

Figure 1.126 – A simple XYZ file shown in A, B and C columns

1.10.1. Introduction

Golden Software **Surfer** is a tool for surface modeling and analysis, landscape rendering, mesh generation, 3D map development and more. The program's powerful interpolation functions turn disparate data into superb surfaces of the highest quality. Surfer has a rich variety of generated maps: contours, vectors, raw data, shaded relief and others. Different maps can be overlaid on top of each other to identify dependencies in your data.

This Lesson is based on the Information Getting from the Help Menu of the **Surfer** Release 8.4 [17]. As it was mentioned, the **Surfer** soft was developed and supported during decades by the **Golden Software** Company (www.goldensoftware.com). The company GOLDEN SOFTWARE, LLC is located in USA, PO Box 281, Golden, CO 80402-0281 USA. Besides the **Surfer** package, this company also produced the widely known **Grapher**, **Strater**, and **Voxler** as software commercial products.

The Golden Software proposes besides, the full version, the trial fully functional version. On the website of the Golden Software Company, you can download both a fully functional (commercial) version of the product, as well as its trial version, which is free and valid for two weeks (https://www.goldensoftware.com/products/surfer/trial). Upon completing the form (your name, e-mail address, business activity, your field of interest, etc.), you will be provided a link to download the trial EXE file.

Surfer allows producing both two- and three-dimensional colorful maps and create a number of additional GIS analysis using them, figs 1.127 and 1.128.

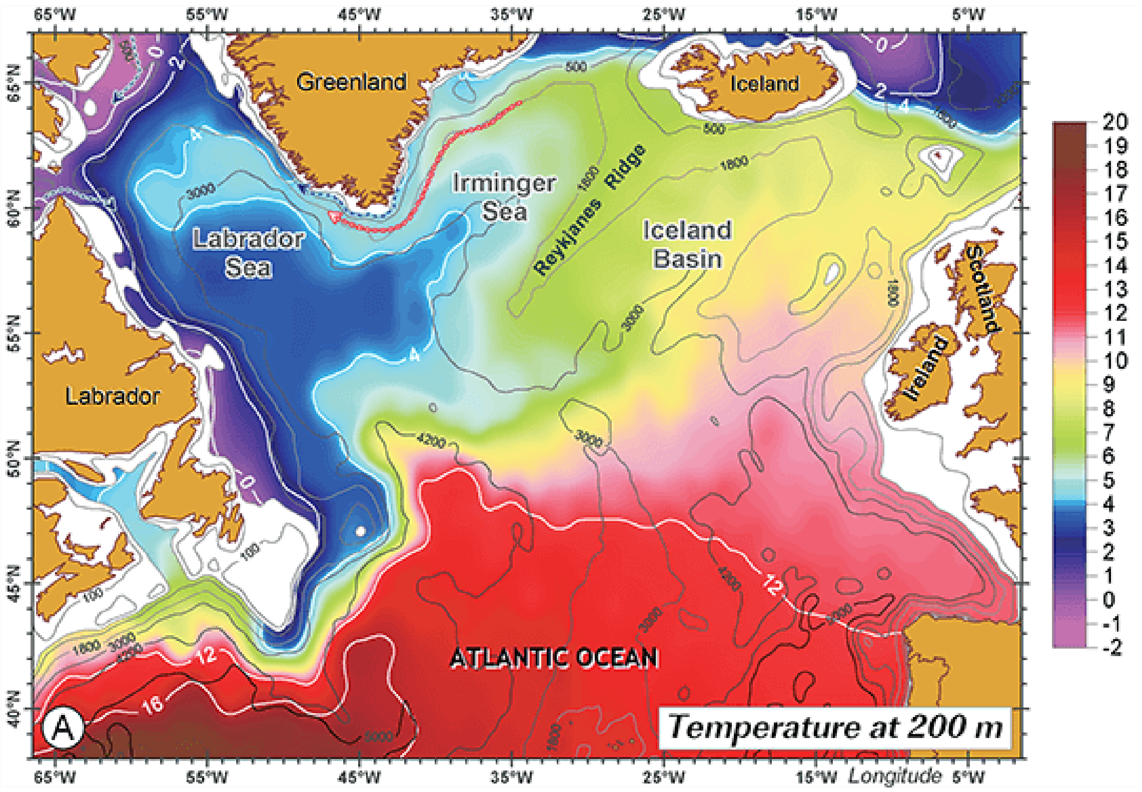


Figure 1. 127 – 2D Temperature distribution map superimposed on the bathymetry [18].

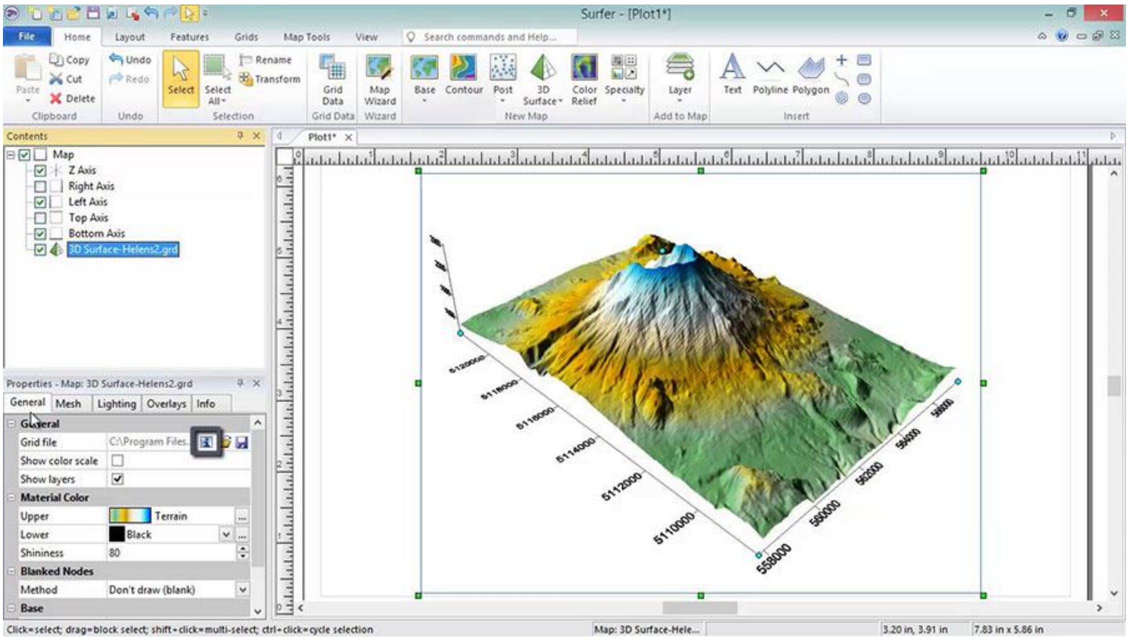


Figure 1. 128 – 3D map of the Helens volcano [https://nullprog.org/golden-software-surfer/]

Menu Commands, accessible after an installation the **Surfer**, give the detailed information on the function of software package**,** including the brief *Tutorial*, menu commands. The whole functionality of this software with its numerous possibilities (Surface 2D and 3D Maps (Contour Map, import a Base Map, **Post Map,** Image Map, Shaded Relief Map, **Vector Map,** Wireframe, 3D Surface), Gridding, Profiling, etc.) is provided. The Surfer is designed for Windows 98, Me, 2000, XP and later releases, including the Windows 10.

1.10.2. Online Tutorial

The tutorial is designed to introduce you to some of **Surfer's** features. We cannot cover all aspects of the program in a tutorial, so the tutorial teaches the basics of **Surfer**. After you have completed the tutorial, you should be able to begin creating your own grids and maps.

If you find you still have questions after you have completed the tutorial, you should consider reviewing the material in the User's Guide or accessing the rest of **Surfer's** extensive *online* help. Usually, the answers to your questions are found in these locations. However, if you find you still have questions, you can contacting the Golden Software's technical support.

Surfer Key Features

A wide range of very accurate and efficient data interpolation algorithms. The possibility of graphical representation of the surface as in the form of a contour map and in the form of a three-dimensional image with photographic accuracy.

Extensive customization options for realistic, expressive images, including light source location, relative tilt gradient, shading type and color, as well as the layout of different images on the same screen.

Unlimited design map. Implemented support for map projections: you can assign a coordinate system for each layer of the map, and then select from the list of coordinate systems necessary for display. This allows you to mix and match data and grid files from different coordinate systems, and gives you the freedom and time to create a map, fig. 1.129.

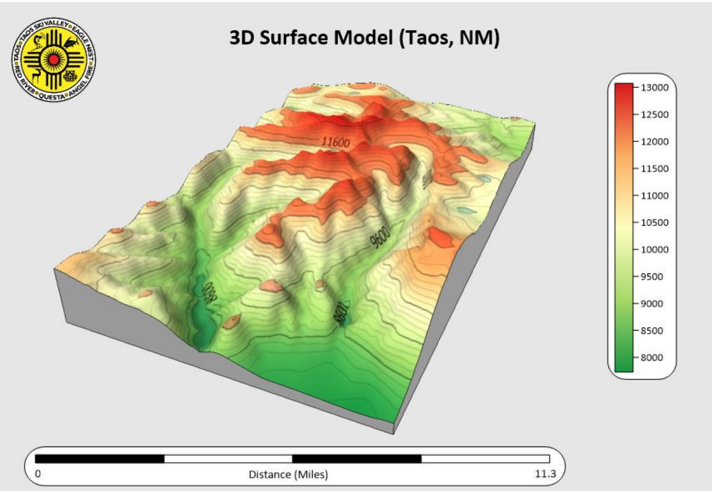


Figure 1. 129 – 3D Surface Model of Taos, New Mexico [19]

Installation on 64-bit version. Allows you to work with a large amount of information and graphic data without worrying about the lack of memory.

Instant display of changes made. The new functionality allows you to easily edit areas and instantly see the result of changes on the map thanks to the advanced settings of the program.

Drawing smooth curved lines. Added a new tool for smoothing curved lines, which allows you to draw smooth lines on the site.

Dynamic Digitization. The digitizing function allows you to know the values of certain points on the map based on the reports of the map grid and the X, Y, Z values.

Map overlay. The map overlay feature has been returned, allowing you to create several separate maps, and then select only the ones you need and combine them by overlaying each other.

Full data compatibility. Allows you to import and export to any known formats, including support for Access 2007 ACCDB and Google Earth (KML and KMZ).

Change the spectrum of colors on the map. With one click, you can quickly change the range of colors for the created map.

Specifying the data range for plotting. Ability to specify the range of data to plot when selecting the start and end lines from the data file.

Option to save calculations. The Surfer automatically saves the last ten calculation functions, so there is no need to re-enter the same functions.

Easy contour definition. A simple method allows you to quickly and easily define and change the main attributes of the path, such as large and small path lines, spacing, fill color, etc.

Extension of functions for editing mesh nodes. All displayed nodes can be edited during construction.

Export outlines to a 3D text file. The ability to obtain the necessary data from the contour map allows you to export contour lines to XYZ text data files.

Extension of the mathematical grid. Using the required number of files with a mathematical grid without restrictions.

Saving the grid and database from the map. Ability to extract file or grid data directly from the map.

Automatic creation of contour maps. By uploading a CLR file, you can create the desired color contour map for a specific scenario.

Saving coordinate system data for reuse. Surfer allows you to remember the design and save this information for future use.

New grid mosaic option. The new SUM overlay method allows you to add Z-values in areas where mesh overlay files exist.

Statistic parameters. A number of statistic parameters are widely used in the **Surfer**.

- **A set of auxiliary operations with surfaces**:
- calculating the volume between two surfaces;

- transition from one regular grid to another;
- surface transformation using mathematical operations with matrices;
- surface cutting (profile calculation);
- surface area calculation;
- surface smoothing using matrix or spline methods;
- file format conversion and a host of other features.
- **A set of image operations**:
- obtaining an image by overlaying several transparent and opaque graphic layers;
- import of finished images, including those obtained in other applications;
- using special drawing tools, as well as applying text information and formulas to create new and edit old images, fig. 1.130.

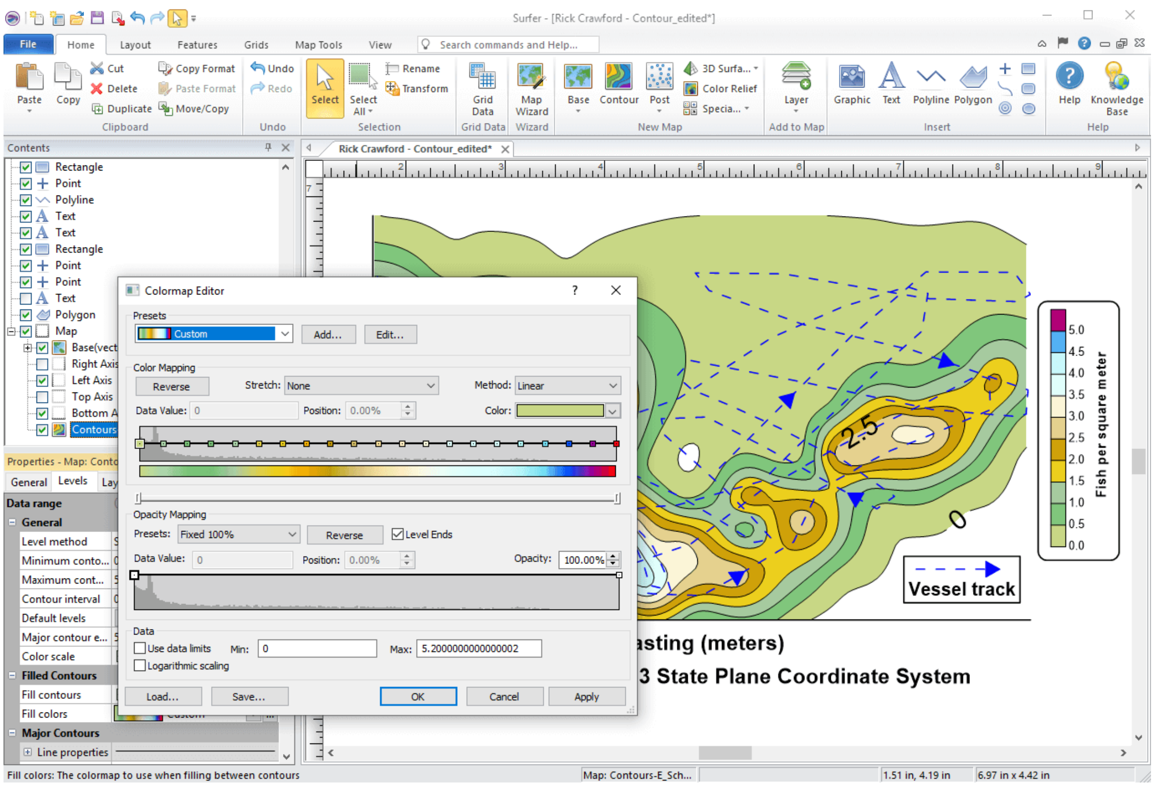


Figure 1. 130 – Map editing

The standard Help includes Tutorial Lessons (examples from the release 8.4)

Lesson 1 – Creating an XYZ Data File, it shows you how to import a data file and how to create a new data file.

Lesson 2 – Creating a Grid File shows you how to create a grid file, the basis for most map types in **Surfer**.

Lesson 3 – Creating a Contour Map shows you how to create a contour map and change the contour map properties.

Lesson 4 – Creating a Wireframe shows you how to create a wireframe and set the wireframe properties.

Lesson 5 – Posting Data Points and Working with Overlays shows you how to create a post map and overlay it with a contour map so that both maps share the same axes.

Lesson 6 – Introducing Surfaces shows you some of the features associated with the new surface maps.

Click the Next and Back links at the bottom of each topic to browse through the help topics. The lessons should be completed in order; however, they do not need to be completed at one time.

Surfer permits creating rather complicated like a plot with 2D combined with 3D maps, fig. 1.131, or shaded maps, fig. 1,132.

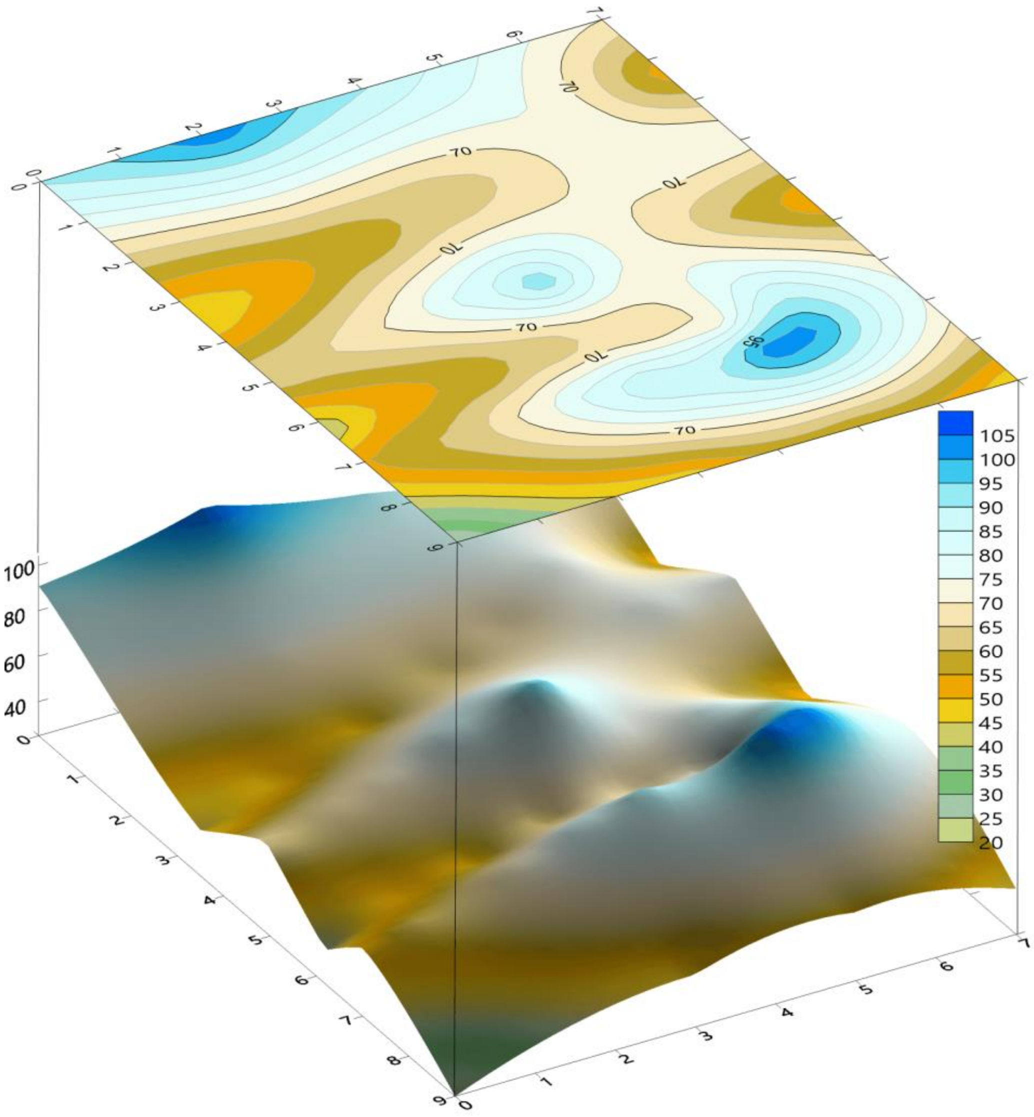


Figure 1. 131 – A plot with combining 2D and 3D maps [19]

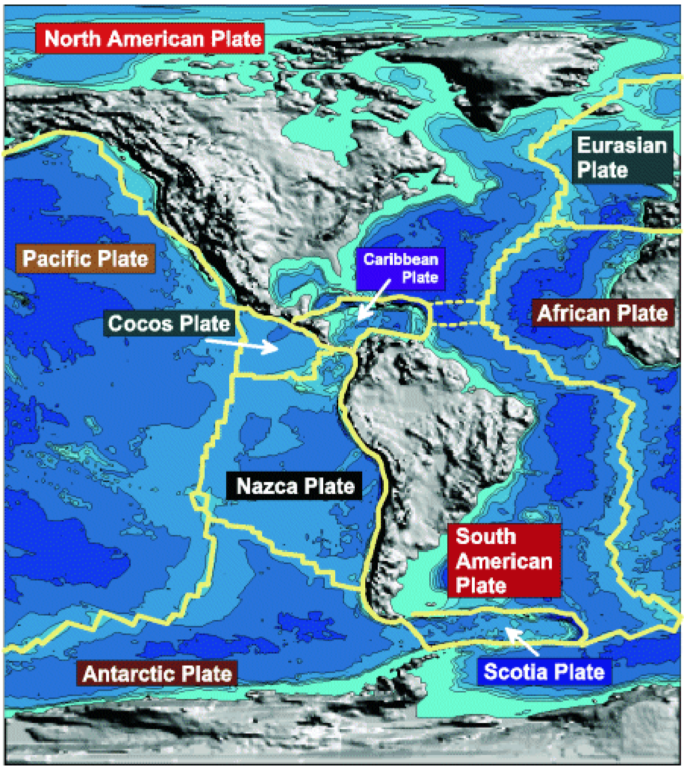


Figure 1.132 – Shaded Relief Map [20]

1.10.3. Surfer Test 2. Creating a Grid File

Grid files are required to produce a grid-based map. Grid-based maps include contour maps, image maps, shaded relief maps, 1-grid vector maps, 2-grid vector maps, wireframes, and surfaces. Grid files are created using the **Grid** | **Data** command. The **Data** command requires data in three columns, one column containing X data, one column containing Y data, and one column containing Z data. A sample XYZ data file (TUTORWS.DAT) supplied with **Surfer** permits to illustrate how to produce a grid file. After completing the tutorial, if you need to produce an XYZ data file of your data for your work.

To produce a grid file from TUTORWS.DAT:

1. If you have the worksheet window open, click on the **Window** menu and choose **Plot1**. Alternatively, you can create a new plot window with **File | New** (select *Plot Document* and then click OK).

2. Choose the **Grid** | **Data** command.

3. In the **Open** dialog, click the file TUTORWS.DAT (located in **Surfer's** SAMPLES folder). The name appears in the *File name* box below the list of data files.

4. Click *Open* and the **Grid Data** dialog is displayed. Alternatively, you can double-click the data file name to display the **Grid Data** dialog.

5. The **Grid Data** dialog allows you to control the gridding parameters. Take a moment to look over the various options in the dialog. Do not make changes at this time, as the default parameters create an acceptable grid file.

- The *Data Columns* group is used to specify the columns containing the X and Y coordinates, and the Z values in the data file.
- The *Grid Line Geometry* group is used to specify the XY grid limits, grid spacing, and number of grid lines (also referred to as rows and columns) in the grid file.
- The *Gridding Method* group is used to specify the interpolation method and interpolation options.
- The *Output Grid File* group is used to specify the path and file name for the grid file.
- The *Grid Report* option is used to specify whether to create a statistical report for the data.

6. Click **OK**. In the status bar at the bottom of the window, a display indicates the progress of the gridding procedure. By accepting the defaults, the grid file uses the same path and file name as the data file, but the grid file has a [.GRD] extension.

7. By default, a message appears after gridding the data. Click **OK** in the grid file has been created message box.

8. If Grid Report is checked, a report is displayed. You can minimize or close this report.

1.10.4. Surfer Test 3. Creating a Contour Map

The **Map | Contour Map** command creates a contour map based on a grid file.

To create a contour map of the TUTORWS.GRD file created in the previous lesson:

1. Choose the **Map** | **Contour Map | New Contour Map**, or click the  button.

2. The **Open Grid** dialog is displayed. The *grid file* you just created (TUTORWS.GRD) is automatically entered in the *File name* box. If the file does not appear in the *File name* box, select it from the file list.

3. Click the *Open* button to create a contour map.

4. The map is created using the default contour map properties.

5. If you want the contour map to fill the window, choose the **View | Fit to Window** command.

Opening Map Properties

After creating a map, you can change the map properties. There are several ways to open an object's properties. The most common method is to double-click on the object. Refer to **Properties** for alternative methods of opening properties.

Changing Contour Levels

After you create a *contour map*, you can easily modify any of the map features. For example, you might want to change the contour levels displayed on the map.

To change the contour levels of the map you just created:

1. Place the mouse pointer inside the limits of the contour map and double-click to display the *contour map properties* dialog.

2. In the contour map properties dialog, click the *Levels* page to display the contour levels and contour line properties for the map. In this example, the contour levels begin at Z = 20. Click on the scroll bar at the right to scroll to the bottom. You can see that the maximum contour level is Z = 105 for this map and that the contour interval is 5.

3. To change the contour range and interval, click the *Level* button and the **Contour Levels** dialog is displayed. This shows the *Minimum* and *Maximum* contour level for the map and the contour *Interval*.

4. Double-click in the *Interval* box and type the value 10. Click the OK button and the **Levels** page is updated to reflect the change.

5. Click OK in the contour map properties dialog and the map is redrawn with the new contour levels, fig. 1.133.

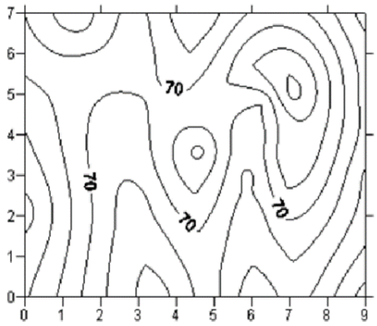


Figure 1.133 – Redrawn contour map with contour levels on 10-foot intervals

Changing Contour Line Properties

You can double-click any of the elements in the list on the *Levels* page to modify the individual element. For example, you can double-click an individual Z value in the list to change the Z value for that particular contour level. You can also double-click the line style for an individual level to modify the line properties for the selected level. This provides a way to emphasize individual contour levels on the map, fig. 1.134.

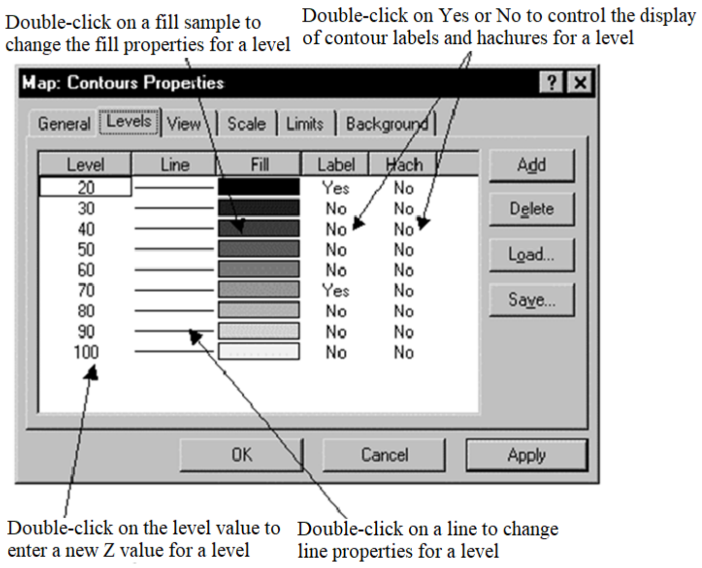


Figure 1.134 – Change Levels page to set specific parameters for the selected level

To change contour line properties:

1. Double-click the contour map to open the map properties.

2. On the **Levels** page, double-click the line sample for the contour level at Z = 70 to open the *Line Properties* dialog.

3. You can select the line color, style, or width for the selected line in the **Line Properties** dialog. In the *Width* box, click the up arrow, and change the width value to 0.030 in. (A width of 0.000 in is equivalent to one-pixel width.)

4. Click OK in the **Line Properties** dialog, and the **Levels** page is updated to reflect the change.

5. Click OK in the map properties dialog and the map is redrawn. The contour line at Z = 70 is drawn with a thicker line, fig. 1.135.

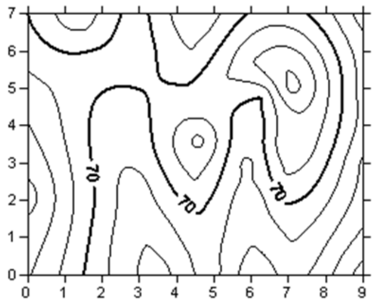


Figure 1.135 – The contour line at Z=70 appears bolder than other contour lines at the map after changing the line properties

Adding Color Fill between Contour Lines

Color fill can be assigned to individual levels in the same way as *line properties*. Alternatively, you can assign colors based on a gradational spectrum between two colors.

The **Levels** page in the contour map properties dialog shows a correspondence between a level (under the *Level* button) and a color (under the *Fill* button). The colors are used to fill in the space between the corresponding level and the next higher level. For example, if the contour levels are 20, 30, 40, ..., etc., then the color corresponding to level 20 is used to fill in the space between the level 20 contour and the level 30 contour.

To change color fill:

1. Double-click the contour map to open the contour map properties dialog.

2. Click the *Fill Contours* check box on the *General* page.

3. On the **Levels** page, click the *Fill* button to open the *Fill* dialog.

4. Click the *Foreground Color* button to open the *Color Spectrum* dialog. This dialog allows you to select colors to assign to specific Z values. Click on the left anchor point button above the spectrum, click on the color blue in the color palette, and then click OK. The *Foreground Color* button is now displayed as a graduation from blue to white in the **Fill** dialog.

5. Click OK and the fill colors on the **Levels** page are updated to reflect the change.

6. Click OK and the contour map is redrawn with color fill between the contours.

Add, Delete, and Move Contour Labels

Contour label locations can be changed on an individual basis. Labels can be added, deleted, or moved.

To add, delete, and move contour labels:

1. Right-click on the contour map and choose the **Edit Contour Labels** option. You can also edit labels of a selected contour map using the **Map | Contour Map | Edit Labels** command. The pointer changes to a black arrowhead ▶ to indicate that you are in edit mode.

2. To delete a label, click on the label and press the DELETE key on the keyboard. For example, click on a 70 label and then click the DELETE key on your keyboard.

3. To add a label, press and hold the CTRL key on the keyboard and click on the location on the contour line where you want the new label located. Add a 60-contour label to the lower left portion of the map.

4. To move a contour label, click on the label, hold down the left mouse button, and drag the label. Move the 70-contour label on the right portion of the map to the north, fig. 1.136.

5. To exit the **Edit Contour Labels** mode, press the ESC key.

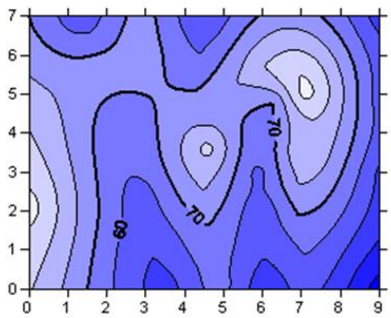


Figure 1.136 – Contour labels can be moved, added, or deleted

Modifying an Axis

Every contour map is created with four axes: the bottom, right, top, and left. You can control the display of each axis independently of the other axes on the map. In this example, we will change the contour spacing and add an axis label.

To modify an axis:

1. Move the pointer over one of the axis' tick labels on the bottom X axis and left-click the mouse. In the status bar at the bottom of the plot window, the words "Map: Bottom Axis" are displayed. This indicates that you have selected the bottom axis of the contour map. Additionally, hollow handles appear at each end of the axis, and solid green handles appear surrounding the entire map. This indicates that the axis is a "sub-object" of the entire map.

2. Double-click on the bottom axis to display the bottom axis properties dialog.

3. In the *Title* box on the **General** page, type "Bottom Axis" and then click the *Apply* button. This places a title on the selected axis.

4. If you cannot see the axis title, select View | Zoom | Selected. Notice that you do not have to close the properties dialog to select menu commands, toolbar buttons, or objects in the plot window.

5. Click on the *Scaling* page to display the axis scaling options. In the *Major Interval* box, type the value 1.5 and then click the *Apply* button. This changes the spacing between major ticks along the selected axis.

6. Click on the **General** page and then click the *Label Format* button. The Label Format dialog is displayed.

7. In the **Label Format** dialog, select the *Fixed* option in the *Type* group. Click on the down arrow on the *Decimal Digits* box and change the value to 1. This indicates that only one digit follows the decimal point for the axis tick labels.

8. Click **OK** to return to the axis properties dialog.

9. Click **OK** in the axis properties dialog and the map is redrawn. The axis tick spacing and labels are changed, and the axis title is placed below the map, fig. 1.137.

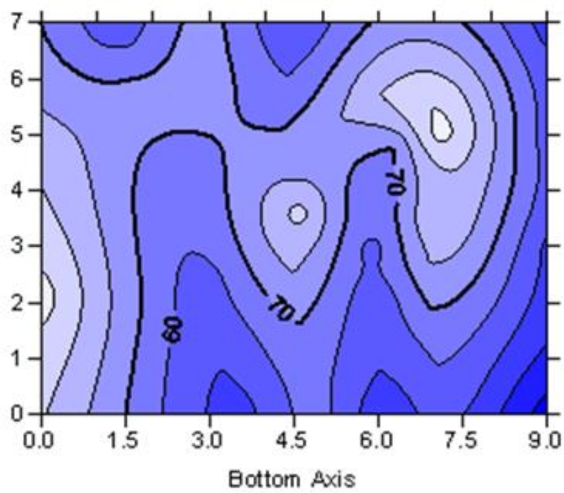


Figure 1.137 – You can use axis properties dialog to change the tick mark and axis title properties

Saving a Map

When you have completed the map or drawing in the plot window, you can save the map to a **Surfer** file [.SRF] containing all the information necessary to reproduce the map. When you save a map, all the scaling, formatting, and map properties are preserved in the file.

To save a map:

1. Choose the *File* | *Save* command, or click the button. The **Save As** dialog is displayed because the map has not been previously saved.

2. In the *File name* box, type TUTORWS.

3. Click *Save* and the file is saved to the current directory with an [.SRF] extension. The saved map remains open and the title bar changes to reflect the name change.

If you are using the demo version of **Surfer** *you will not be able to save the map*.

Exporting 3D Contours

When you have completed a contour map in the plot window, you can export the contour lines with associated Z values to an AutoCAD DXF file.

To export contour lines:

1. Select the map by clicking on the map in the plot window or by clicking on the word "Contours" in the *Object Manager*. If you do not see the Object Manager click *View | Object Manager* to open it, fig. 1.138.

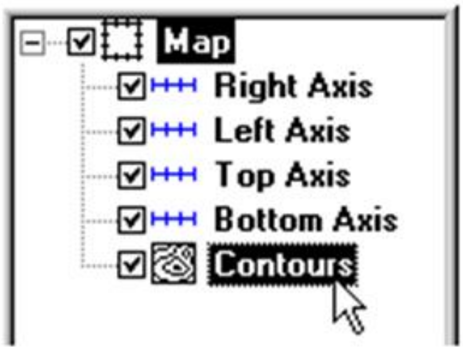


Figure 1.138 – You can select the map by clicking on it in the Object Manager (above) or by clicking the map in the plot window

2. Choose **Map | Contour Map | Export Contours**.
3. In the **Save As** dialog, type TUTORWS into the *File name* box.
4. Click *Save* and the file is exported to the current directory. This creates a file titled TUTORWS.DXF that can be opened in any program with an AutoCAD DXF import option.

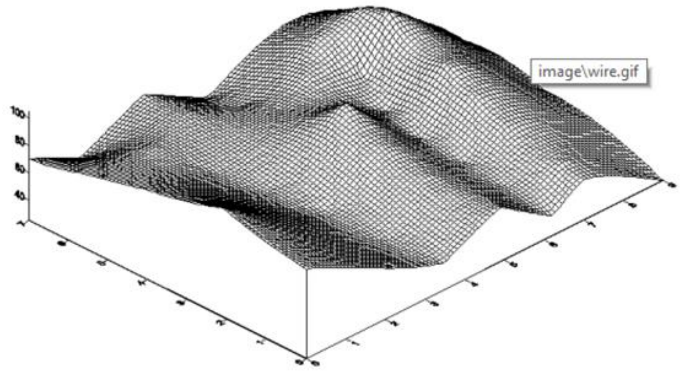
If you are using the demo version of **Surfer** you will not be able to export contours.

1.10.5. Surfer Test 4. Creating a Wireframe

Creating a New Wireframe

To create a new wireframe:

1. Select the **File | New** command, or click the button.
2. Select *Plot Document* in the **New** dialog and click OK. A new empty plot window is displayed.
3. Select the **Map** | **Wireframe** command or click the button.
4. Choose the grid file TUTORWS.GRD from the list of files in the **Open Grid** dialog, click *Open*, and the map is created, fig. 1.139. (TUTORWS.GRD, created in *Lesson 2 - Creating a Grid File,* is located in **Surfer's** SAMPLES folder.)



Figyre 1.139 – A wireframe map based on TUTORWS.GRD

Changing the Orientation of a Wireframe

Although this example uses a wireframe to illustrate rotation and tilt, you can perform this operation on most map types in **Surfer**.

To change rotation and tilt:

1. Click on the map once to select it.
2. Click the **Map** | **Trackball** command or click the button.
3. Click the left mouse button and hold it while moving the mouse to the left and right. This changes the rotation of the wireframe. The rotation is listed in the *status bar*.
4. Click the left mouse button and hold it while moving the mouse up and down. This changes the tilt of the map. The tilt is listed in the *status bar*.
5. Once you have rotated and tilted the map, click the ESC key on your keyboard to end trackball mode.

Changing the rotation, tilt, field of view, and projection can also be accomplished by double clicking the wireframe and using the options on the *View* page, fig. 1.140.

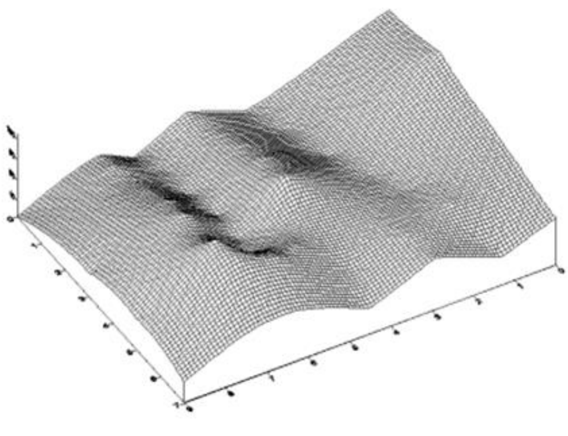


Figure 1.140 – This is the wireframe at a new rotation and tilt

Changing the Scaling of a Wireframe

You can change the scaling of wireframes and surfaces in three dimensions. In this example, the Z scaling is changed, and the wireframe becomes somewhat exaggerated in the Z dimension.

To change the Z scaling:

1. Double-click the wireframe to open the map properties.

2. Click the Scale page. You can set scaling by entering the number of map units per inch or by entering the length for the map in page coordinates.

3. In the *Length* box of the *Z Scale* group, change the value to 3 by scrolling to 3 or by highlighting the existing value and typing 3. The *Map units* value changes to reflect the change you made.

4. Click OK and the wireframe is redrawn exaggerated in the Z dimension, fig. 1.141.

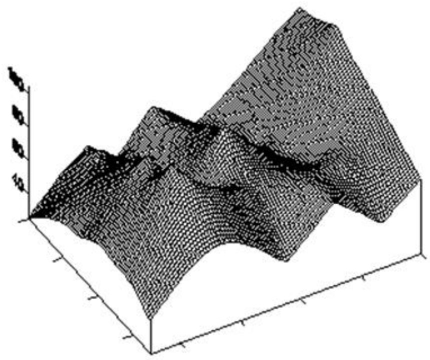


Figure 1.141 – The Z-scale on the wireframe map was changed to reflect the exaggeration in the Z-dimension

Adding Color Zones to a Wireframe

You can change the line colors of any wireframe by applying color zones. In this example, we will change color zones gradationally and individually.

To add a color zone to a wireframe:

1. Double-click on the wireframe, and the *wireframe properties* dialog is displayed.

2. Click on the *Color Zones* page.

3. Click on the *Line* button to display the **Line Spectrum** dialog.

4. Click on the *Minimum Line Properties* button to open the *Line Properties* dialog. From here, you can select the line color, style, or thickness.

5. Click on the *Color* button and select blue.

6. Click OK to return to the **Line Spectrum** dialog.

7. Click on the *Maximum Line Properties* button and change the line color to red using the steps above.

8. Click OK in the **Line Spectrum** dialog to return to the **Color Zones** page.

9. In the wireframe properties dialog, check the *Apply Zones to Lines of Constant* X and Y boxes by clicking in them.

10. Click *Apply* and the wireframe is displayed with gradational colors varying by the Z variable. (Leave the dialog open.)

To change the properties of an individual Z value:

1. On the *Color Zones* page, double-click the line sample for the contour level at Z = 70.

2. You can select the line color, style, or width for the selected line in the **Line Properties** dialog. In the *Width* box, click the up arrow and change the width value to 0.030 in.

3. Click OK in the **Line Properties** dialog and the **Color Zones** page is updated to reflect the change.

4. Click OK in the wireframe properties dialog and the map is redrawn. The color zone at Z = 70 is drawn with a thicker line, and is emphasized on the map. (If you need to zoom in on the map, click the button and then click on the map. Click the ESC key on your keyboard after you are finished zooming in), fig.1.142.

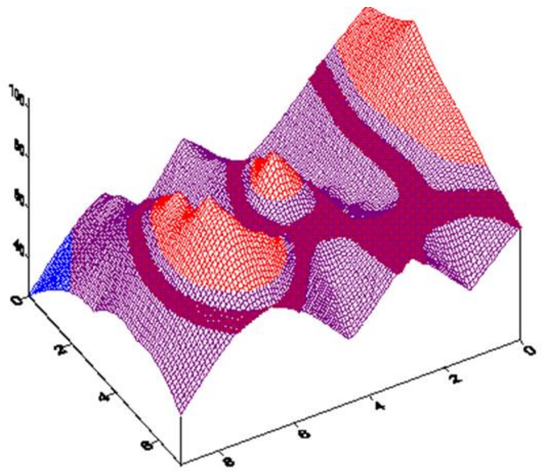


Figure 1.142 – The wireframe map is redrawn with Z=70 emphasized

1.10.6. Surfer Test 5. Creating Post Maps and Overlaying Maps

When a new post map is created, it is independent of any other maps in the current plot window. When the two maps are displayed, notice that two sets of axes are also displayed, one set for each map. When you use the *Map | Overlay Maps* command, the two maps are combined into a single map overlay with one set of axes.

To create a post map:

1. Choose *File | Open* to display the **Open** dialog. Choose TUTORIAL.SRF in the SAMPLES directory and then click the *Open* button. TUTORIAL.SRF opens and contains a contour map.

2. Select the *Map | Post Map | New Post Map* command or click the button.

3. Choose TUTORWS.DAT from the list of files in the **Open** dialog. (TUTORWS.DAT is located in **Surfer's** SAMPLES folder.)

4. Click *Open* and the post map is created using the default properties.

The contour map and post map are two separate maps on the page. If you look closely at the X axis, you will notice the two sets of axis tick labels for the two maps. Also, there are two map frames and axes sets listed in the *Object Manager*. We will line up the maps with the **Overlay** command after changing the post map properties.

Changing the Post Map Properties

To change the post map properties:

1. Open the *Object Manager* if it is not already open. The **Object Manager** is open if there is a check mark displayed next to the words **Object Manager** in the **View** menu. If there is no check mark, click on the command once.

2. Right click on the word "Post" in the **Object Manager**.

3. Select **Properties** from the context menu.

4. In the post map properties dialog **General** page, click the symbol button to open the *Symbol Properties* dialog.

5. Choose the filled circle symbol from the palette and click **OK**. The selected symbol appears in the symbol button.

6. Click the *Apply* button and the symbol appears at the posted data points on the map.

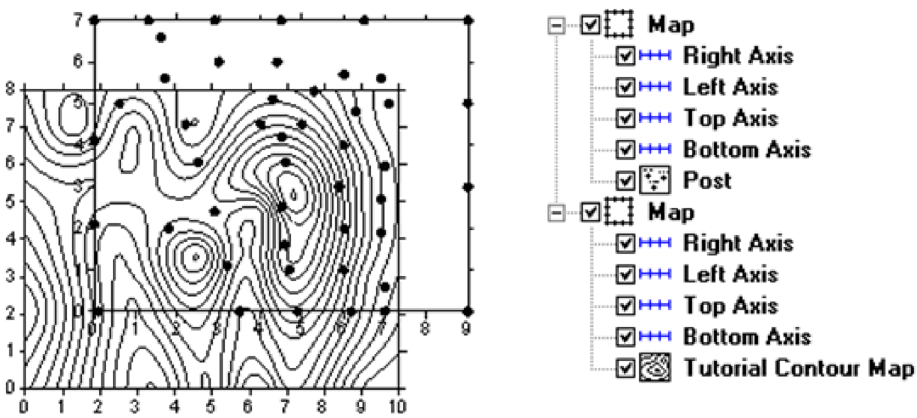
7. In the *Fixed Size* box (*Symbol Size* group), specify a size of 0.09 in.

8. Click OK and the post map is drawn with the new symbol size.

Overlaying Maps - Tutorial

To overlay maps:

1. To see the two separate maps, place the mouse pointer in the center of the maps and click. Press and hold the left mouse button and move the pointer slightly in any direction. Release the button and the two maps are offset, fig. 1.143.



Figue 1.143 – The two maps are offset to show that the contour map and a post map are separate maps. They also appear as two separate maps in the Object Manager as shown on the right

2. Click **Edit** | **Select All** to select both maps.

3. Choose the *Map* | *Overlay Maps* command to combine the two maps into a single composite map.

The contour and post maps are combined into a single composite map after using *Overlay*. Notice that the Object Manager displays one “Map” containing a post map, four axes and the contour map, fig. 1.144.

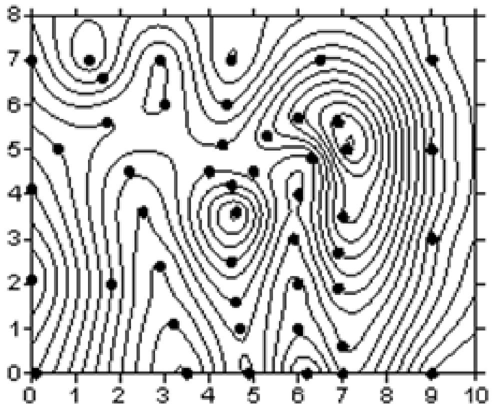


Figure 1.144 – A composite map

Selecting an Overlay and Assigning an Object ID

After creating a composite map, you can still modify the individual overlays in the map.

Selecting Maps

An individual overlay can be selected in the composite map by clicking on the overlay in the plot window or clicking on the overlay in the *Object Manager*.

The easiest way to select an overlay in a composite map is to click on the overlay name in the *Object Manager*. However, you can also select the overlay in the plot window with the mouse. Whenever two or more objects occupy the same position in the plot window, use the CTRL key and the left mouse button to select the desired object. The CTRL key allows you to cycle through the selection of overlapping objects. For example, if you want to select a text block behind a rectangle, hold down the CTRL key and click until the text is selected. You can use the status bar to help you to determine which object is selected. The status bar at the bottom of the **Surfer** window indicates the selected object. In the example below, the status bar reports that the post map is selected, fig. 1.145.

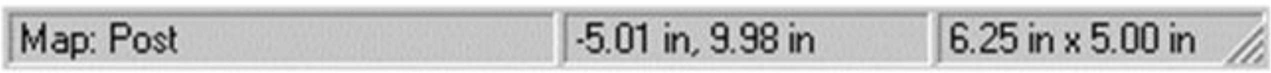


Figure 1.145 – The status bar

Renaming the Post Map

To select an overlay and assign an ID:

1. Make sure the **Object Manager** is open. If the **Object Manager** is not open, click **View | Object Manager**.

2. Click the overlay name in the **Object Manager**. In this case, click the word "Post." The status bar should now indicate "Map: Post", fig. 1.146.

Figure 1.146 – Click the word Post in the Object Manager to select the post map

3. Choose **Edit | Object ID**.

4. In the **Object ID** dialog, type the name "Tutorial Post Map" and click OK. The status bar, **Object Manager**, and properties dialog title reflect the name change.

If you double-click on Tutorial *Post Map* in the **Object Manager**, notice that the properties dialog title changes to **Map: Tutorial Post Map Properties**. When you rename an object in **Surfer 8**, the object's properties dialog reflects the name change making it easier for you to keep track of the object you are editing. For example, if you have eight post maps in the plot window, it is beneficial to change the post map names to something meaningful to save time when trying to edit them. This is especially important because the properties dialog can stay open when changing selections.

Adding Labels to the Post Map

You can add labels to the data points on post maps. The post map can be selected by a few different methods, though only the **Object Manager** method is discussed here.

To add labels:

1. Right-click on "Tutorial Post Map" in the **Object Manager** and choose **Properties**.

2. Click on the **Labels** page. In the *Worksheet Column for Labels* group, click the drop-down arrow and a list of columns in TUTORWS.DAT is displayed.

3. Select *Column C: Elevation* from the list.

4. Click the *Format* button to open the **Label Format** dialog.

5. Change the *Type* to *Fixed* and the *Decimal Digits* value to zero.

6. Click OK to return to the post map properties dialog.

7. Click OK and the overlay is redrawn with labels on each of the data points, fig. 1.147.

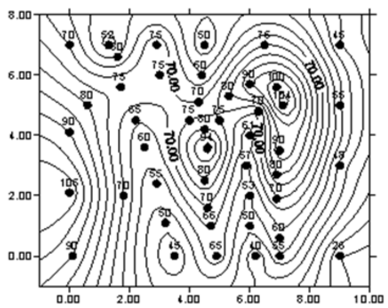


Figure 1.147 – You can add labels to post maps using post map properties dialog.

1.10.7. Surfer Test 6. Introducing Surfaces

To create a surface:

1. Select the **File** | **New** command, or click the button.

2. Select *Plot Document*, in the **New** dialog and click OK. A new empty plot window is displayed.

3. Select the **Map** | **Surface** command or click the button.

4. Choose the grid file TUTORWS.GRD from the list of files in the **Open Grid** dialog, click *Open*, and the surface is created using the default settings. (TUTORWS.GRD, created in *Lesson 2 – Creating a Grid File*, is located in **Surfer's** SAMPLES folder.)

Adding an Overlay

You can overlay *base*, *contour*, *post*, *image*, *shaded relief*, *1-grid vector maps*, and *2-grid vector maps* on surfaces. All overlays, except other surfaces, are converted into a type of bitmap known as a texture map. This texture map is then applied to the surface by stretching it and shrinking it as necessary. When these maps are overlaid, you have a choice on how to treat the texture map. You can use the colors from overlays only, from the surface only, or blend colors from the overlays and surface. For example, you could create a color-filled contour map, overlay the contour map and surface, and then use the colors from the contour map only.

When multiple surfaces of differing elevations are overlaid, the surfaces can intersect and overlap each other. If the surfaces are adjacent to each other in the X or Y direction, the surfaces are drawn side-by-side after using **Map** | **Overlay Maps**. In this example, we will overlay a plane with the surface you just created.

First, create the surface plane:

1. Select the **Map** | **Surface** command or click the button.

2. In the **Open Grid** dialog, open **Surfer's** SAMPLES folder and select TUTORPL.GRD.

3. Click *Open* and the surface is created using the default settings.

4. Right click on the upper 3D Surface in the *Object Manager*, choose **Object ID** and add the text TUTORPL.GRD to the end of the 3D Surface label to make it easier to distinguish the two surfaces in the **Object Manager** list.

Next, overlay the surfaces:

1. Click *Edit* | *Select All* to select both surfaces.

2. Click *Map* | *Overlay Maps* to overlay the surfaces, fig. 1.148.

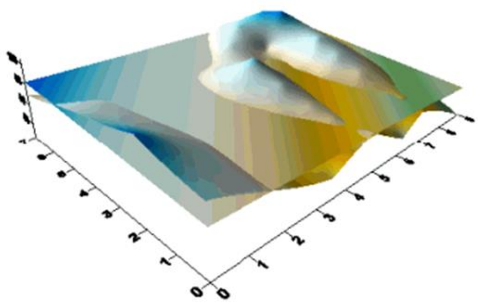


Figure 1.148 – You can overlay two or more surfaces. Depending on each surface's XYZ ranges, the surfaces may overlap or intersect each other

Adding a Mesh

Mesh lines can be applied to surfaces.

To add a mesh:

1. Double-click on the surface to open the *surface* properties.
2. Click the *Mesh* page.
3. Check the X and Y boxes.
4. Change the *Frequency* to 5 for the X and Y lines.
5. Click the OK or *Apply* button to add a mesh to the selected surface.

Notice that the mesh is applied to the selected surface within the composite map, not to both surfaces. With all map types, you can only change the map-specific properties of one map at a time. Properties that apply to all overlays in the composite map include *View*, *Scale*, *Limits*, and *Background*, fig. 1.149.

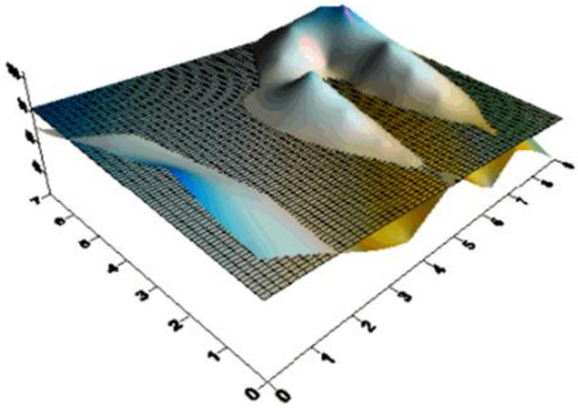


Figure 1.149 – The mesh is applied to the selected overlay in the composite map

Changing Colors

Changing color schemes on surfaces is similar to changing colors on other map types such as *image maps* or *contour maps*. The *Color Spectrum* dialog is used to load previously defined color schemes, and it is used to create your own color schemes.

Before experimenting with color, let us create a new surface map in a new plot window:

1. Click *File* | *New* or click the button.
2. In the **New** dialog, select *Plot Document* and then click OK.
3. Select the **Map** | **Surface** command or click the button.
4. In the **Open Grid** dialog, open **Surfer's** SAMPLES folder and select any grid file [.GRD]. HELENS2.GRD is a good choice for experimenting with color.
5. Click *Open* and the surface is created using the default settings.

To change the surface material color:

1. Double-click on the surface to open the surface properties.
2. There is a *Material Color* group on the *General* page. Click the *Upper* button.
3. Click the *Load* button in the **Color Spectrum** dialog.
4. The color schemes are stored in color spectrum files containing a [.CLR] extension. By default, **Surfer** opens in the SAMPLES folder, which contains many

predefined color spectrums. (Browse to the SAMPLES folder if it is not open.) Click on one of the [.CLR] files to select it and then click the *Open* button.

5. Notice that the colors and anchor node positions have changed in the **Color Spectrum** dialog. Click OK in the **Color Spectrum** dialog to return to the surface map properties dialog.

6. Click the *Apply* button in the surface map properties dialog to see your color changes. Drag the surface map properties off to the side if you cannot see the map.

You can continue to experiment with the colors by clicking the Upper button and loading other color spectrum files.

This is the end of the brief **Surfer** tutorial. If you still have questions, try looking for answers in the online help and user's guide. If you find you still have questions, you may contact Golden Software's *Technical support*.

You can see the corresponding video on using Surface at URL: https://www.youtube.com/watch?v=0UIODCmuO-k&list=PLyF2GV3kxX_8QQxvD6wmHooSUXBo3i-U8 or at

https://www.youtube.com/watch?app=desktop&v=6rLwv1I4KRU

1.11. STRATER

1.11.1. Introduction to Strater

The description and related information below is derived from the Help menu of the Strater 4 release.

Strater is a powerful well log, borehole, and cross section plotting software package, fig. 1.150. Strater creates 14 different log types: depth, line/symbol, crossplot, zone bar, bar, percentage, tadpole, post, classed post, complex text, graphic, lithology, well construction, and function logs. Each of the logs can be modified to suit your needs. **Strater** also creates maps to display the well locations and cross sections that interpolate between wells. **Strater** exports to a variety of formats, including a direct export to Golden Software's **Voxler** program.

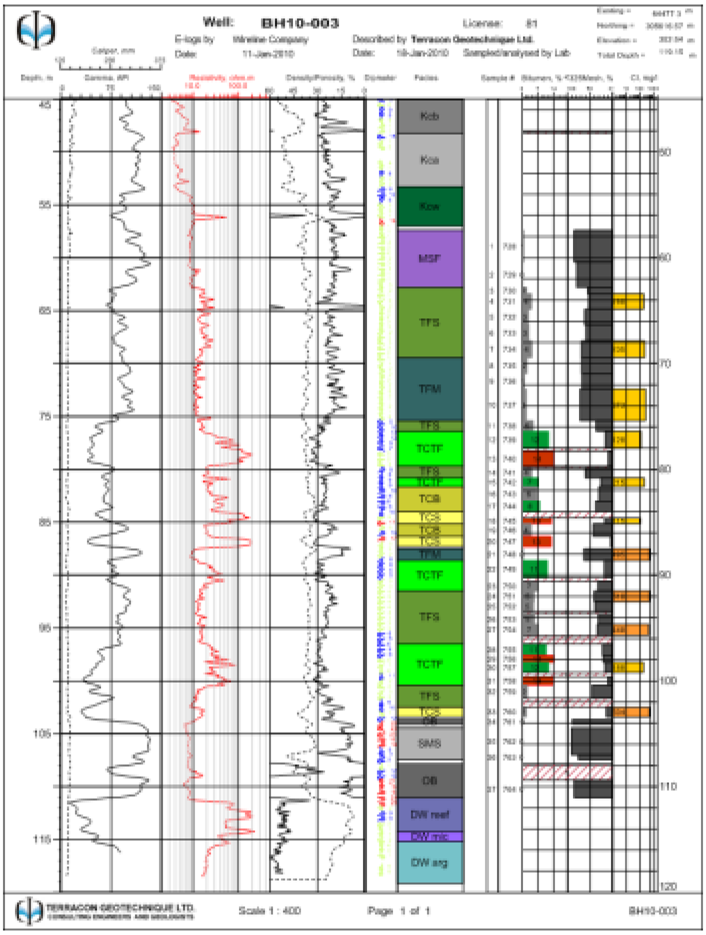


Figure 1.150 – Strater allows creating individual logs or cross sections connecting multiple logs

Data

Data can be imported from many sources, including ASCII text files, LAS files, and just about any database. Strater's internal data structure can contain multiple tables. Multiple boreholes can be stored in the data tables at one time.

Multiple Boreholes, Multiple Views

Strater can have multiple boreholes displayed in a single view, and create multiple borehole views in a single project. You can specify a different borehole for each log in a borehole view with a few mouse clicks.

Reuse

Once you design a borehole view, you can use the design repeatedly with other data. There are several features in Strater designed to save time with borehole graphic processing. After creating an initial design, you can take advantage of templates and schemes, which can be used in different projects with different data or in the same project multiple ways. Templates store the design elements of a project, including log items, header and footer items, data tables, and schemes.

Schemes contain detailed information of how the data relate to drawing properties. For example, a lithology log uses lithology schemes, which contain keywords, such as granite, clay, etc. Each of these keywords is assigned a fill pattern, contact line properties, line properties, and font properties. Schemes can be reused; therefore, you do not have to go through the process of assigning properties each time you create a log.

Strater Projects

A project file consists of all borehole views, data tables, and optional schemes, and is saved in a single .SDG file. When **Strater** first opens, you see a blank, unnamed project to which you can add all the components necessary to create the borehole design. Once the borehole design is complete, use *File* | *Save* to save it to an *.SDG project file.

Strater also provides batch printing and exporting. You can design a log and then print or export the log with multiple borehole data.

System Requirements

The minimum system requirements for Strater are:

- Microsoft Windows® XP SP2 or higher, Vista, 7, 8, or higher
- 1024 × 768 × 16-bit color minimum monitor resolution
- At least 100 MB of free hard disk space
- At least 512 MB RAM above the Windows requirement for simple data sets, 1 GB RAM recommended

Strater Demo Functionality

The Strater demo version is a fully functioning read-only demo. This means that most commands work exactly as the command works in the full program. Saving, exporting, printing, and copying are disabled in the demo version.

The demo has no further restrictions on use. Any data set or image can be used to create any project. All properties can be changed in the demo version. The demo does not have a “time-out period” so will not expire after a certain number of hours or days of use. The demo can be installed on any computer that meets the system requirements.

Strater User Interface

Strater contains four document window types, fig. 1.151: borehole view, map view, cross section, and table windows. Borehole views display various log types. Map views display post and base maps that can be used to identify where individual wells are located. Cross sections are created and edited in a cross-section view. The data is opened, edited, and transformed, and saved in the table windows.

Left-click anywhere on the image below to see detailed information about the various parts of the Strater window.

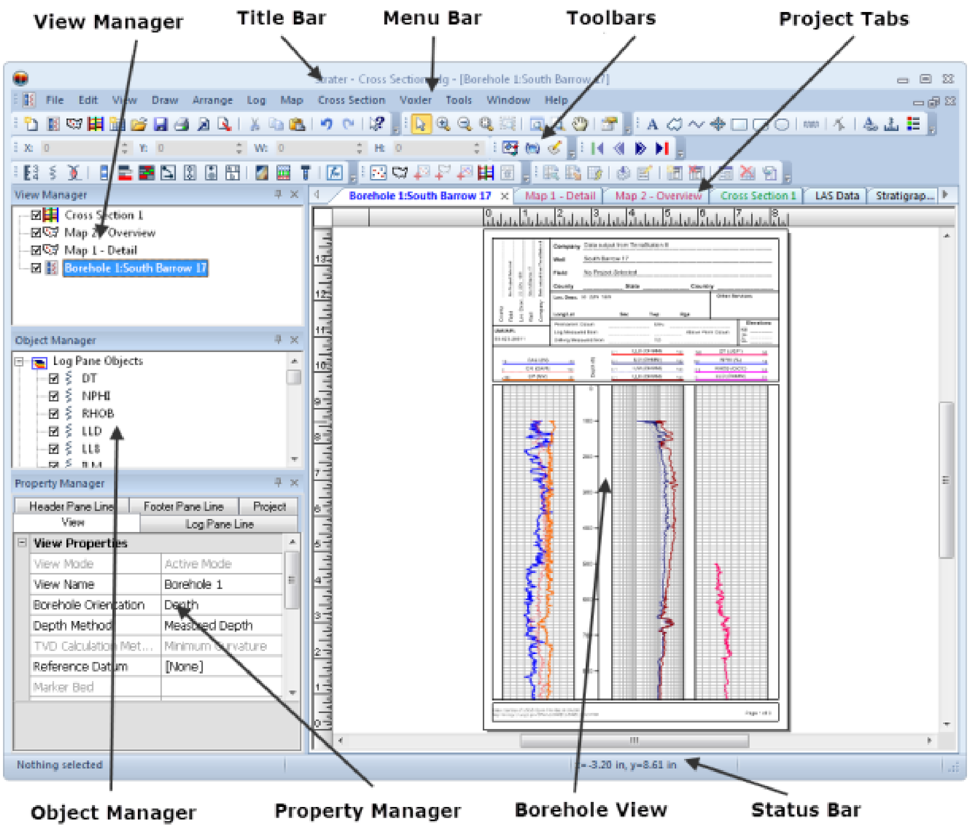


Figure 1.151 – This is the Strater borehole view with the View Manager, Object Manager, and Property Manager windows displayed on the left side.

Tabs displaying the view windows and tables are displayed above the horizontal ruler. Left-click anywhere in the image to see detailed information about each part of the Strater window.

Opening Windows

Clicking the *File* | *New* command opens a new project, or adds a new borehole view, map view, cross section view, or table to the existing project.

Strater Layout

The following table summarizes the function of the Strater layout components.

Table 1.6. The function of the Strater layout components

Title Bar	The title bar lists the program name plus the saved Strater .SDG file name. An asterisk (*) after the file name indicates the file has been modified since it was last saved.
Menus	The menu bar contains the commands used to run **Strater**.
Toolbars	The toolbars contain **Strater** tool buttons, which are shortcuts to menu commands. Move the cursor over each button to display a tool tip describing the command. Toolbars can be docked or floating. Toolbars can be customized with the *Tools* | *Customize* command.
View Manager	The **View Manager** displays a list of all of the borehole view, map view, and cross section windows open in the existing project.
Object Manager	The **Object Manager** contains a hierarchical list of the objects in a **Strater** borehole view, map view, or cross section window. These objects can be selected, added, arranged, edited, and renamed in the **Object Manager**. The **Object Manager** is initially docked on the left side above the **Property Manager** and below the **View Manager**. Changes made in the **Object Manager** are immediately reflected in the borehole view, map view, or cross section window. The **Object Manager** can be dragged and placed at any location on the screen.
Property Manager	The **Property Manager** allows you to edit any of the properties of the selected object. When no objects are selected in the borehole view or cross section, the general properties for the window are displayed.
Tabbed Documents	Multiple borehole views, map views, cross sections, and tables can be displayed as tabs. Click on the tab to display that window.
View window	The view window is the area where the selected borehole view, map view, cross section, or table is displayed.
Status Bar	The status bar displays information about the activity in **Strater**. The status bar is divided into five sections that contain information about the selected command or object, depth or XY position, size of the selected object, and the page number that is currently displayed.

View Window Types

There are four different view types available in a **Strater** workspace: `borehole views, map views, cross section views, and tables. There is no limit to the number of views that can be associated with a **Strater** project.

Borehole View

The primary graphical component to a **Strater** document is a borehole view. A borehole view represents a collection of logs and drawing objects used to display data graphically for one or more boreholes. A borehole view may be derived from a template file or it can be created from a default view window with the necessary log items defined to create the borehole. The borehole view displays the true data for the project once data are defined in the project file.

You are presented with an empty borehole view when you first start **Strater**.

Opening a New Borehole View

During a **Strater** session, new projects with an empty borehole view are created with the *File* | *New* | *Project* command. New borehole views in an existing project are created with the *File* | *New* | *Borehole View* command, clicking the button, or right clicking in the **View Manager** and selecting **New Borehole View**.

Opening an Existing Borehole View

Existing borehole views are opened by clicking the appropriate Borehole tab, clicking on the borehole name in the **View Manager**, or by selecting *Window* | [*Borehole name*]. By default, the first borehole view is named **Borehole 1** so this borehole view would be opened by choosing the **Window | Borehole 1** command. To open an existing project, use the *File* | *Open* command.

Map View

Map views graphically display wells on a map. Map views display any wells listed in the collars table. Wells can be removed individually to customize the appearance of the map view. Map views also can display base maps, such as field outlines or exported **Surfer** maps. Drawing objects and labels can be added to a map view. Map views can have maps from different projections and can convert the map into any supported projection.

Opening a New Map View

New map views are created in an existing project by clicking the *File* | *New* | *Map View* command, clicking the button, or right clicking in the View Manager and choosing New Map View.

Opening an Existing Map View

Existing map views are opened by clicking the appropriate **Map** tab, clicking the map view name in the **View Manager**, or by clicking **Window** | [**Map name**]. By default, the first map view is named **Map 1** so this map view would be opened by clicking the **Window** | **Map 1** command.

Cross Section View

Cross section views display multiple wells on a page. Each well can have a variety of curves, similar to a borehole view. Wells are connected to display layers, zones, or lithologies across the page, connecting information from the wells. Automatic connections between wells or manual connections between wells can be made. Well spacing and elevation hanging can be altered to give you the look you need to display your data. Deviated wells can be displayed as vertical or with the deviation displayed in the cross section. The cross section view also allows data to be exported to a data file for use in **Surfer** or exported to a **Voxler 3D** display to create fence diagrams. Drawing objects and labels can be added to a cross section view.

Opening a New Cross Section View

New cross section views are created in an existing project by clicking the File | New | Cross Section View command, clicking the button, or right-clicking in the

View Manager and choosing New Cross Section View to add a new blank cross section view to the existing project.

A new cross section window can also be created with the *Cross Section | Create Cross Section* command.

Opening an Existing Cross Section View

Existing cross section views are opened by clicking the appropriate **Cross Section** tab, clicking the cross-section view name in the **View Manager**, or by clicking **Window** | [**Cross Section name**]. By default, the first cross section view is named *Cross Section 1* so this cross-section view would be opened by clicking the *Window | Cross Section 1* command.

Data Table View

All data used to generate logs in a borehole view must be opened or imported into a **Strater** project. Data tabs represent these data tables. Collar tables, depth tables, interval tables, lithology tables, project settings tables, survey tables, text item tables, and well construction tables can be created in **Strater**. Each table type has a different function in **Strater**. Refer to the Table Types page for an in-depth discussion of the types.

Opening a New Table View

During a Strater session, new blank tables are created by clicking the *File | New | Table* command, clicking the  button, or by pressing CTRL+W on the keyboard.

Opening an Existing Table in a New View

To open existing data into the current project, click the *File | Open* command. If you want the worksheet to appear in a new data table, select the worksheet and click Open. Step through the opening process and a new data table is added.

To import existing data into the current project in an existing table, click on the table where you want the data to appear. Click *File | Import*. In the **Import Data** dialog, select the data file and click **Open**. Step through the importing process and the data is added to the current table.

Borehole View

A borehole view represents a collection of logs and drawing objects used to display data graphically for one or more boreholes. A borehole view may be derived from a template file or it can be created from a default view window with the necessary log items defined to create the borehole. The borehole view displays the true data for the project once data are defined in the project file.

You are presented with an empty borehole view when you first start **Strater**.

Opening a New Borehole View

During a **Strater** session, new projects with an empty borehole view are created with the *File | New | Project* command. New borehole views in an existing project are created with the *File | New | Borehole View* command. Alternatively, you can right-click in the *View Manager* and select *New Borehole View*.

Opening an Existing Borehole View

Existing borehole views are opened by clicking the appropriate **Borehole** tab, checking the box next to the borehole name in the **View Manager**, or by selecting *Window* |[*Borehole name*]. By default, the first borehole view is named **Borehole 1** so this borehole view would be opened by choosing the *Window* | *Borehole 1* command. To open an existing project, use the *File* | *Open* command.

Panes

There are three main components of a borehole view: the log pane, header pane, and footer pane. The panes are outlined when you open a blank borehole view. The upper rectangle is the header pane, the middle rectangle is the log pane, and the bottom rectangle is the footer pane. You can change the rectangle line properties in the *View Properties*. The size of the header, log, and footer panes is defined by clicking *File* | *Page Setup*.

The header and footer panes generally contain static, unlinked information. The header and footer items are used repeatedly with minimal changes when different borehole data are applied to the view. Two objects are exceptions to the static unlinked information "rule": linked text and some scale bars. Linked text data changes as new data is applied to the view. Horizontal scale bars can be associated with some log items, a cross section, or they can be created as a stand-alone, static object. When the scale bar is linked to a log or cross section, the scale bar changes as changes are made to the linked item.

The log pane contains all the graphical log items to display the borehole data. This pane is dependent on linked tables and columns to create the graphical view. The log pane is also dependent on depth and scaling values. These values determine the size of the pane rectangle and/or the number of pages. The log pane can also contain legends, text and linked text, drawn objects, and imported images, as well. The top rectangle is the header pane. The middle rectangle is the log pane, and the bottom rectangle is the footer pane, fig. 1.152.

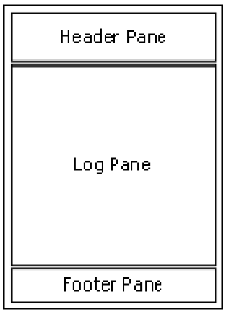
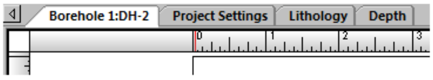


Figure 1.152 – Panes of Strater

Multiple Boreholes in the Borehole View

Strater permits multiple boreholes to appear in the same borehole view. You can define multiple boreholes with a single table, distinguished by a borehole ID, or you can create several tables that define different boreholes in each table. This allows you to quickly change the borehole graphics in the borehole view.

Appended to the borehole view name is the borehole ID associated with the data displayed in the view. In the following example, the Hole ID of this borehole view is DH-2: 

Click the borehole tab at the top of the Strater window to open a borehole view. If more than one borehole represented by the logs in a borehole view, the associated borehole view tab's name ends with -Multi- 

.

Types of Logs

Strater creates 14 different types of logs in the borehole view: Bar Log; Classed Post Log; Complex Text Log; Crossplot Log; Depth Log; Function Log; Graphic Log; Line/Symbol Log; Lithology Log; Percentage Log; Post Log; Tadpole Log; Well Construction Log; Zone Bar Log.

Adding Additional Information to the Borehole View

Scale bars, titles, linked text, drawing objects, legends, and images can be added to the borehole view at any location.

Creating a Log in the Borehole View

For detailed information, refer to the *Creating a Borehole* topic. In general, you can add a log to any borehole view by following these steps:

1. Click the *Log* | [*Object type*] command for the object you want to create. For instance, if you want to create a line/symbol log, click the *Log | Line/Symbol* command.

2. Click on the log pane where you want the log to be located.

3. In the dialog, select the data file to use. An existing table can be selected in the *Use Current Table* list.

4. If a new data file was selected, step through the importing process. The log will be displayed.

5. Any customizations can be made by selecting the log and making changes in the *Property Manager*.

Map View

Map views graphically display *wells* or *base map* files on a map. Map views display any wells listed in the *collars table* as a symbol on the map. Each well in the collars table is displayed as a separate symbol. Wells can display deviation as a line with a symbol at the end of the well or only show the collar location of the well. Wells can be edited as a group or individually. Individual wells can be unchecked in the **Object Manager** to customize the appearance of the map view. The map also contains a set of four *axes* that can be edited individually. Maps can add base layers, such as field outlines or exported **Surfer** maps, additional well layers, or *well selector lines*.

All map layers are positioned according to the map layer's *coordinate system*. Each layer can have a separate *source coordinate system*. All layers are re-projected into the ***Map** target coordinate system*.

Drawing objects and labels can be added to a map view, fig. 1.153**.**

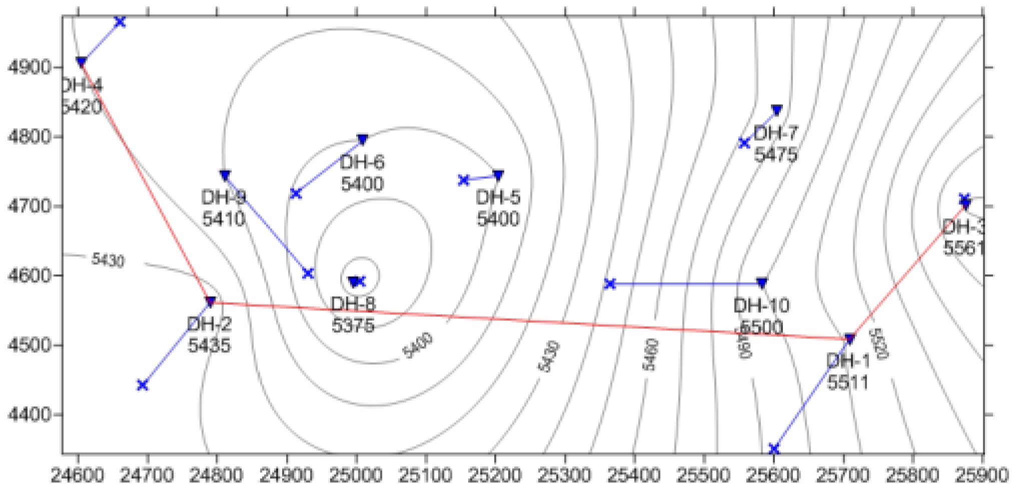


Figure 1.153 – Map view

Opening a New Map View

New map views in an existing project are created by clicking the **File** | **New** | **Map View** command, clicking the  button, pressing CTRL+M on the keyboard, or right-clicking in the *View Manager* and selecting *New Map View*. A new blank map view is created.

Opening an Existing Map View

Existing map views are opened by clicking the appropriate **Map** tab, checking the box next to the map view name in the **View Manager**, or by selecting **Window** | **[Map name]**. By default, the first map view is named **Map 1** so this map view would be opened by choosing the **Window** | **Map 1** command. To open an existing project, use the **File** | **Open** command.

Creating Map Layers

Create the first map layer with the *Map* | *Create Well Map* or *Map* | *Create Base Map* command.

If creating a well map and a single collars table already has been created, the map view automatically uses that Collars table. If no Collars table exists, you are prompted for the data file. A Collars table is automatically created. If multiple Collars table exist, you are prompted to select one table.

If an existing map has already been created and the well map or base map should be added to the existing map, click the *Map* | *Add Well Layer* or *Map* | *Add Base Layer* commands. If the **Create Well Map** or **Create Base Map** command is used and a blank map view is available, the map is created in that map view; otherwise, the map is created in a new map view.

Adding Additional Information to the Map View

Base maps, additional well maps, and well selector maps can be added to an existing map view. *Drawing objects* can also be added to a map layer.

Cross Section View

Cross section views display multiple wells on a page. Cross sections can be created from *zone bar*, *lithology*, or *line/symbol* log types. Other log types can be added to the display, similar to a borehole view, but these logs are not included in the automatic cross section connections.

Wells can be automatically connected to display *layers*, zones, or *lithologies* from a table view, connecting information from the wells across the page. The wells can also be displayed without connections or with manual connections, connecting the wells where you select.

Wells can be displayed vertically or with deviations calculated from *Inclination* (or *Dip*) and *Azimuth* columns from a table. Well spacing and elevation hanging can be *altered* to give you the look you need to display your data.

The cross section view, fig. 1.154 also allows data to be *exported* to a data file for use in **Surfer** or *exported* to a **Voxler** 3D display to create a fence diagram. Drawing objects, labels and other logs can be added to a cross section view.

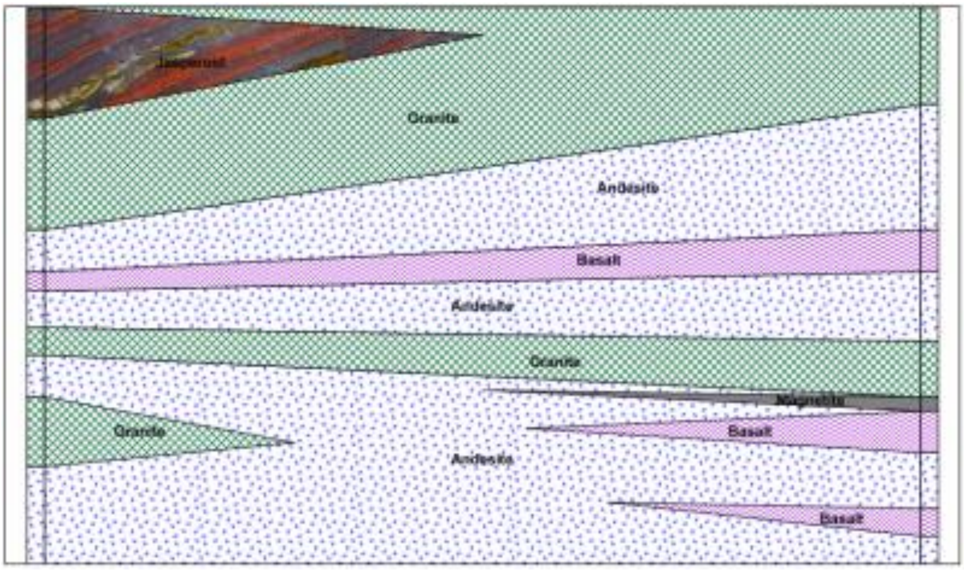


Figure 1.154 – A cross section view

Opening a New Cross Section View

Click the **File** | **New** | **Cross Section View** command, click the  button, or right-click in the *View Manager* and choose *New Cross Section View* to add a new blank cross section view to the existing project.

A new cross section view window can also be created with the *Cross Section | Create Cross Section* command.

Opening an Existing Cross Section View

Existing cross section views are opened by clicking the appropriate **Cross Section** tab, checking the box next to the cross-section view name in the **View Manager**, or by selecting **Window | [Cross Section name]**. By default, the first cross section view is named **Cross Section 1** so this cross-section view would be opened by choosing the **Window | Cross Section 1** command.

Adding Additional Information to the Cross-Section View

Drawing objects and *inserted map layers* can be added to a cross section view.

Menu Commands

The menu bar contents change, depending upon the current active window in **Strater**. Regardless of which view is currently active, clicking the image (, , , or) in the top left of the **Strater** window displays commands to restore, move, size, maximize, minimize, and close **Strater**. A *Next* option is also available that opens each tab in turn, from left to right.

Borehole View, Map View, and Cross Section View Commands

If a borehole view, cross section view, or map view is currently active, the following commands are available:

Table 1.7. Commands for borehole view, cross section view, or map view

File	Contains commands for opening, saving, exporting, and printing files
Edit	Contains clipboard commands and miscellaneous editing commands
View	Controls the display of toolbars, status bar, managers, resets window positions, and controls the zoom level of objects in the visible window
Draw	Provides tools to draw objects and text
Arrange	Contains commands to arrange objects on the page
Log	Provides commands to create each of the log types and to switch between active and design modes
Map	Provides commands add base maps, wells, and select wells for a cross section
Cross Section	Provides commands to create a cross section, connect, overlay, and adjoin logs in a cross section
Voxler	Provides a method to export objects directly to **Voxler**
Tools	Adjusts the program options and customization features
Window	Controls the display of the windows
Help	Provides access to help topics, tutorials, and links to locations on the Golden Software website

Table Commands

If a table is currently active, the following commands are available:

Table 1.8 Commands available for a currently active table

File	Contains commands for opening, saving, exporting, and printing files
Edit	Contains clipboard commands and miscellaneous editing commands
View	Controls the display of toolbars, status bar, managers, and resets window positions
Format	Set cell formats, column widths, row heights, and converts text to numbers or numbers to text
Data	Contains commands to sort, filter, and transform data, create true vertical depth (TVD) and export data
Table	Contains options to delete, rename, and convert tables, add or change hole IDs, create schemes, and update borehole names
Voxler	Provides a method to export objects directly to **Voxler**
Tools	Adjusts the program options and customization features
Window	Controls the display of the windows
Help	Provides access to help topics, tutorials, and links to locations on the Golden Software website

Keyboard Commands

You can use the keyboard to move the pointer within the borehole view, to select and move objects, and perform commands.

- The ARROW keys move the cursor within the borehole view.
- Pressing the SPACEBAR is equivalent to clicking the left mouse button.
- Double-pressing the SPACEBAR is the same as double-clicking the mouse.

Menu Access

Use the keyboard to access menu commands by holding down the ALT key and pressing an underlined letter in the menu bar. When the drop-down menu is displayed, you can access a command by pressing the underlined letter in the command.

Dialog Access

You can also use the keyboard to move around within a dialog. The TAB key moves between the options in the dialog. The SPACEBAR is used to simulate mouse clicks, allowing you to toggle check boxes or press buttons that provide you with access to other dialogs or close the current dialog. As you use the TAB key to move through the dialog, the options are highlighted as they become active. You can also use the underlined hotkeys by holding down the ALT key and typing the letter. This moves you immediately to the desired option. Note that not all of the dialogs have ALT key access.

GENERAL COMMANDS

These keyboard commands are used in both borehole views and data tables.

View and Menu Control

CTRL+F4	Close the view
ALT+F4	Close **Strater**
ALT+SPACE	Display the application control menu
ALT+HYPHEN	Display the view control menu
CTRL+F6	Next view or table
CTRL+SHIFT+F6	Previous view or table
CTRL+TAB	Switch between **Strater** views
ALT+ENTER	Move from the borehole view to an open **Property Manager**
ALT	Activate the menu bar
CTRL+ESC	Display the Windows start menu
ALT+TAB	Switch to the last active application

Help

F1	Open help
SHIFT+F1	Open context sensitive help on a highlighted command or open dialog
SHIFT+F10	Open the context-menu for the selected object(s)

File

CTRL+N	Open a new view
CTRL+O	Open a file into a new view
CTRL+S	Save a file
CTRL+P	Print the view
ALT+F4	Close **Strater**

Edit

CTRL+X or SHIFT+DEL	Cut the selected objects to the clipboard
CTRL+C or CTRL+INSERT	Copy the selected objects to the clipboard
CTRL+V or SHIFT+INSERT	Paste the clipboard contents into the view
CTRL+A	Select All (borehole view)
CTRL+SHIFT+A	Deselect All (borehole view)
CTRL+Y	Redo the previous undo command
CTRL+Z or ALT+BACKSPACE	Undo the last command
DEL	Delete the selected objects (clears cells in a data table)
F2	Rename Object (borehole view)

BOREHOLE VIEW

These keyboard commands are specific to the borehole view.

Edit

CTRL+A	Select all objects in the current borehole view
CTRL+SHIFT+A, F3	Deselect all
CTRL+I	Import an object
CTRL+E	Export an object
CTRL+F5	Update logs after tables change

View

PAGE DOWN	Scroll to the next page in a multi-page log
PAGE UP	Scroll to the previous page in a multi-page log
HOME	Scroll to the first page in a multi-page log
END	Scroll to the last page in a multi-page log
F5	Redraw the screen
CTRL++	Zoom in twice the scale at the center of the screen
CTRL+-	Zoom out twice the scale from the center of the screen
CTRL+R	Zoom on a selected rectangle
CTRL+L	Zoom in on selected objects so they fill the view
CTRL+T	Zoom by dragging the mouse, drag up to zoom in and drag down to zoom out
CTRL+G	Zoom to the extents of the page

Arrange

SHIFT+PGUP	Move to front
SHIFT+PGDN	Move to back
CTRL+PGUP	Move forward
CTRL+PGDN	Move backward

Log

F4	Toggle between active and design modes

Cross Section

CTRL+SHIFT+D	Connect logs with Layers

DATA TABLE COMMANDS

These keyboard commands are specific to working inside data tables.

DEL	Delete the contents of the selected cell, numeric cells are replaced with 0 (zero)
ARROW KEYS	Move to adjacent cell
ENTER	Preserve the typed contents in the cell
HOME	Go to the first column containing data
END	Go to the last column containing data
PAGE UP	Scroll the table up by the number of visible rows
PAGE DOWN	Scroll the table down by the number of visible rows
TAB	Move the active cell right one column
CTRL+HOME	Move the active cell to the top cell of the left most column
CTRL+END	Move the active cell to the bottom occupied row and right most column
CTRL+O	Sort the data
CTRL+U	Move the row containing the active cell up
CTRL+R	Insert Rows
CTRL+D	Delete
CTRL+F	Find

Three-Minute Tour

Several example files included with **Strater** so that you can quickly see some of **Strater's** capabilities. Only a few example files are discussed here, and these examples do not include all of **Strater's** many log types and features. The *Object Manager* is a good source of information as to what is included in each file.

Sample Strater Files

To see the sample Strater files:

1. Open **Strater**.

2. Click the *File | Open* command.

3. Click on an .SDG file located in the Samples folder. By default, the **Strater** Samples folder is located in C:\Program Files\Golden Software\Strater 4\Samples.

4. Click *Open* and the file opens.

The primary graphical component to a document is a *borehole view*. A borehole view is either based on a *template file,* or created from scratch by adding the necessary log, header and footer items. Boreholes views, map views, and cross section views display logs, well and base maps, and cross sections of the selected data when the tab is selected. When a *data table* tab is selected its data appears in the workspace.

Lith Secton-1 .sdg

The Lith Section-1.sdg sample file, fig. 1.155, contains a sample *lithology log* column. Age, formation, lithology type, and lithology description appear in the borehole view. Four data tables are included in the .SDG file and include the information being displayed in the borehole view.

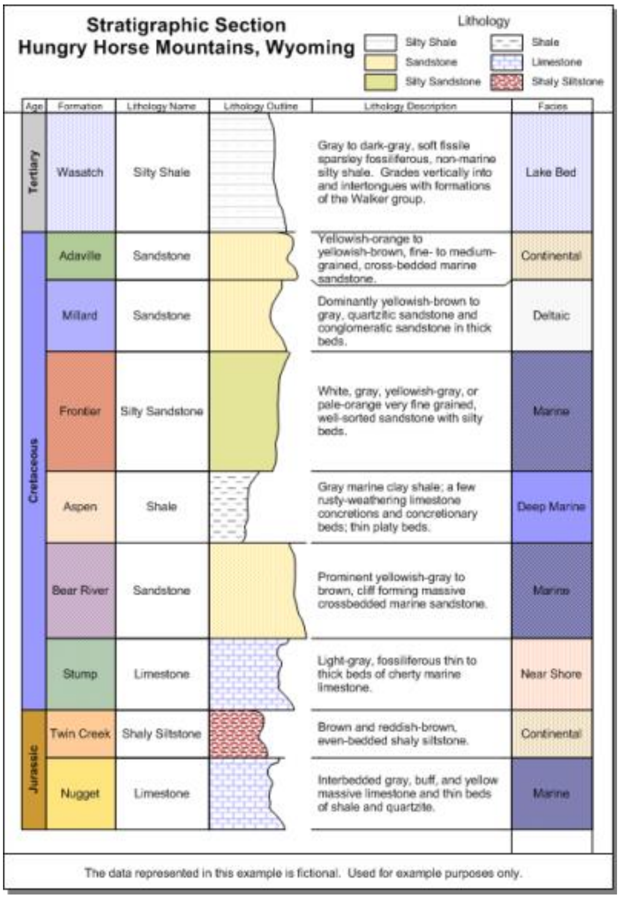


Figure 1.155 – A lithology log with stratigraphic section

Example Logs.sdg

The *Example Logs.sdg* sample file contains every type of log file that **Strater** can create. Click on a log and the *Property Manager* updates to show only that log's properties. Experiment with the properties for the logs to see how the log changes. Click on the map and cross section tabs to experiment with the properties for the map and cross section views, fig. 1.156.

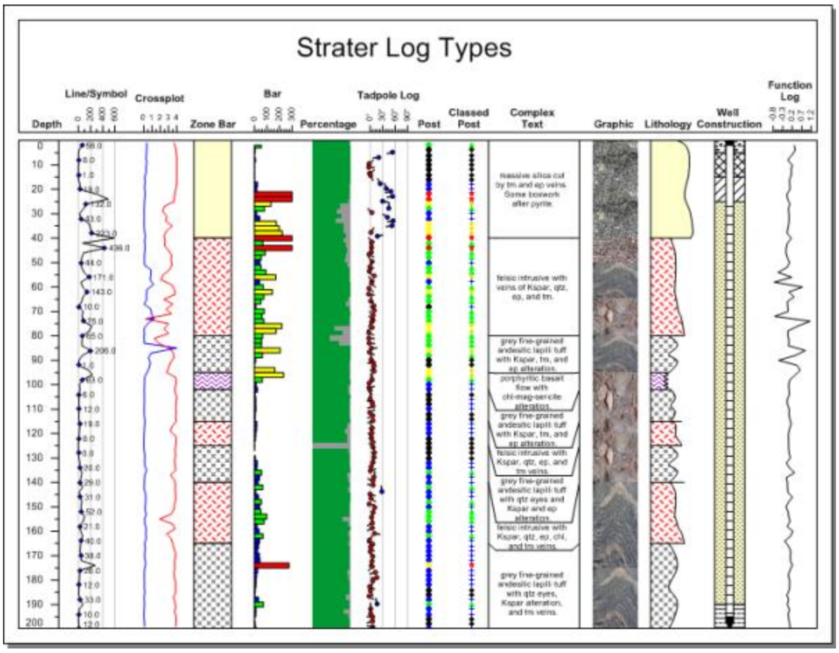


Figure 1.156 – Strater Log Types

The Example Logs.sdg file displays above an example of each log type in the same borehole view.

One purpose of the sample files is to discover the effects of changes made in the **Property Manager** – to experiment so that the functionality is closer to second nature and you do not need to search for the correct setting. Use these sample files, especially this file, to discover the breadth of options available. If you want to save any changes, we recommend keeping the original file and using the *File* | *Save As* command to save a copy of the file to a new name.

Using Strater

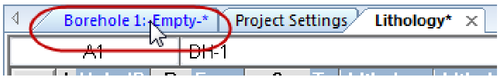
The general steps to progress from a data file to a borehole are as follows.

1. Open **Strater**.

2. Click the *File* | *Open* command or click the  button.

3. In the *Open* dialog, select the data file and click the *Open* button. For this example, the data should have *From* and *To* columns because of the type of log created. The sample *Tutorial 1.xls* file can be used with the Lithology sheet.

4. In the *Specify Worksheet Column Definitions* and *Specify Data Type and Column Positions* dialogs, set the column names and rows to import. The data opens into Strater and is displayed in a *table view*.

5. Click on the *Borehole 1* tab. 

6. Click the *Log* | *Depth* command to create a depth log.

7. Click on the screen in the location where you want the depth log to be displayed.

8. In the **Open** dialog, verify that *Use current table* is selected and click *Open*. The depth log is displayed. Verify that the table is selected, fig. 1.157.

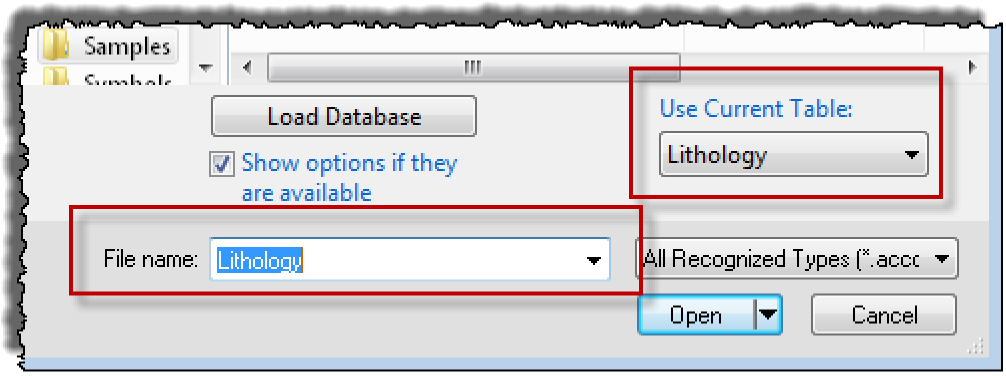


Figure 1.157 – Selecting a Lithology file

9. Click the *Log* | *Zone Bar* command to create a zone bar log.

10. Click on the screen where you want the zone bar log to be displayed.

11. In the **Open** dialog, verify that *Use current table* is selected and click Open. The zone bar log is displayed.

12. Click the *File* | *Save As* command. Enter a *File name* in the *Save As* dialog and click the Save button to save your **Strater** project.

To proceed from the borehole to a map view and cross section view, these steps are used.

1. Click the *File* | *New* | *Map View* command to create a new blank map window.

2. Click the *Map* | *Create Well Map* to display the wells on the map. Select and open a collars table, if prompted. The sample *Example Data.xls* file can be used with the *Collars* sheet.

3. Click on the Wells layer in the **Object Manager**.

4. Click the *Map* | *Add Well Selector* command.

5. Click on the wells in the order they should appear in a cross section.

6. Click the *File* | *New* | *Cross Section View* command to create a new blank cross section.

7. Click the *Cross Section* | *Create Cross Section* command to create the default cross section from the well selector.

View Manager

In **Strater** you can have multiple view window types in one project. This is useful in displaying multiple graphics for multiple wells, displaying different layouts for the same data, or displaying maps or cross sections. Click the *View* | *Managers* | *View Manager* command to display the **View Manager**. The **View Manager** contains a list of the various borehole views, cross section views, and map views. You can open or close views, add or delete views, and save or load template files in the **View Manager**.

The check box to the left of a view name indicates if that view is displayed or hidden. If a view is not visible either, check the box next to the view name or click the view name. Unchecking all view check boxes in the **View Manager** closes the entire project. When the last check box is unchecked, a window appears asking you to save any unsaved work in the project. The project then closes.

To display the view properties associated with any view in the **View Manager** menu, click on the view name. The view properties are listed in the **Property Manager**.

Right-click in the **View Manager** to see options available for adding or deleting views or for loading templates. The View Manager allows you to create new views, delete existing views, or save and load templates, fig. 1.158

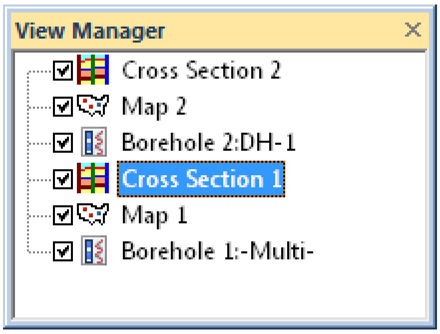


Figure 1.158 – View Manager

- *New Borehole View* creates a new blank borehole view in the current project.
- *New Map View* creates a new blank map view in the current project.
- *New Cross Section View* creates a new blank cross section view in the current project.
- *Delete* deletes the currently highlighted borehole view from the project. There is no *Undo* for this operation so use caution when deleting views.

- *Save Template of Current View* saves the current view window as a template *.TSF file.
- *Load Template* opens a template into a new borehole view.
- *View Properties* displays the currently selected view window's borehole, map, or cross section view properties in the *Property Manager*.

Object Manager

The **Object Manager** contains a list of all objects, separated into a list of each pane in the *borehole view* and *cross section view*. The objects can be selected, arranged, and edited in both the **Object Manager** and through the menu commands. Changes made in the **Object Manager** are reflected in the view window, and vice versa.

When an object is highlighted in the **Object Manager** it is also selected in the view window, indicated by a bounding box surrounding the object.

Opening and Closing the Object Manager

The *Object Manager* is opened and closed by clicking the *View | Managers | Object Manager* command. Alternatively, you can click ⊠ in the title bar of the **Object Manager** to close the window.

Panes

There are three groupings in the borehole view: Log Pane Objects, Header Pane Objects and Footer Pane Objects. There are three groupings in the cross section view: Cross Section Pane Objects, Header Pane Objects, and Footer Pane Objects. Each object is listed in the **Object Manager** according to its location in the view window. For example, if there is a rectangle in the footer, it is listed under the Footer Pane Objects section.

Use the ⊞ or ⊟ located to the left of the pane name to expand or collapse the list of pane objects.

Object Visibility

Each item in the list consists of an icon indicating the type of object, a text label for the object, and a check box that indicates if the object is visible, fig. 1.159. To change the visible status of an object, click the check box to the left of the object icon. Invisible objects do not appear in the view window and do not appear on printed or exported output.

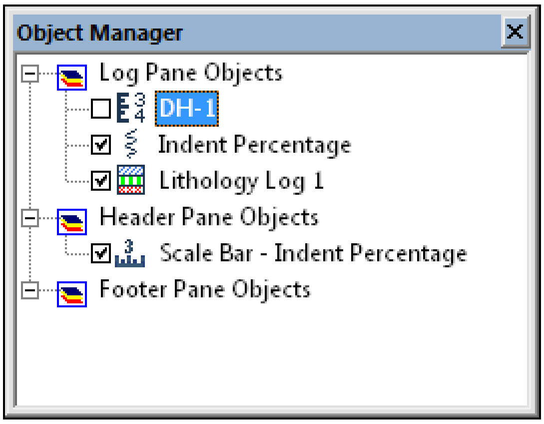


Figure 1.159 – Object Manager, checking a borehole

A check mark next to an object indicates that the object is visible. In this instance, the depth log associated with DH-1 is unchecked, so not visible.

Grouped and Ungrouped Objects

When two or more objects have been *grouped*, the objects appear under a special *Group* object, fig. 1.160. Grouped objects can be edited by clicking on the object in the group and editing in the **Property Manager** as normal. All grouped objects move together. *Ungroup* the grouped object to move individual objects outside the group.

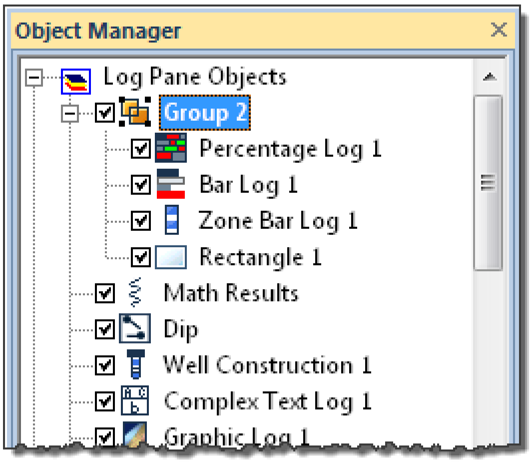


Figure 1.160 – Grouped objects appear under a special Group object in the Object Manager.

To *ungroup* the objects from the Object Manager, select the Group name, right-click and select *Ungroup*. The objects are no longer grouped.

Selecting Objects

To select an object, click the object name and the object name is highlighted, fig. 1.161. The selection handles in the graphical borehole view change to indicate the selected item.

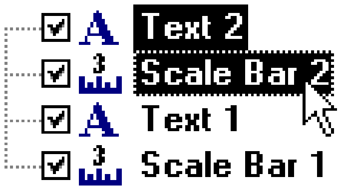


Figure 1.161 – Use the CTRL or SHIFT keys to select multiple objects in the Object Manager

To select multiple objects in a pane, hold down the CTRL key and click on each object. To select multiple contiguous objects, select the first object, and then hold down the SHIFT key and click on the last object.

If you select an object in the view window, its name is selected in the **Object Manager** as well. Note that multiple objects cannot be selected in multiple pane groups. For example, an object in the Footer Pane Object section and an object in the Log Pane Object section cannot be selected at the same time.

Opening Object Properties

To display the properties for an object, click the object name. The properties are displayed in the *Property Manager*.

Renaming Objects

To edit the text ID associated with an object in the **Object Manager**, select the object and click again on the selected item (two slow clicks). You must allow enough time between the two clicks so it is not interpreted as a double-click. Enter the new name into the box that appears. Alternatively, you can right-click on the object and select the *Rename Object* command or go to *Edit* | *Rename Object*.

Arranging Objects

To change the display order of the objects in a pane grouping with the mouse, select an object and drag it to a new position in the list. The pointer changes to a black arrow if the object can be moved to the pointer location or a black circle with a diagonal line ⃠ if the object cannot be moved to the indicated location. These actions are analogous to the *Arrange* | *Order Objects* commands, which include the *Move to Front, Move to Back, Move Forward, and Move Backward* options. These menu items are accessed through the borehole view Arrange menu or by right-clicking on an object in the **Object Manager**.

Deleting Objects

To delete an object, select the object and press the DELETE key on the keyboard. Some objects cannot be deleted.

Property Manager

The **Property Manager** allows you to edit the properties of an object. See the specific online help topic for the object you have selected for more information on the properties unique to that object.

Opening and Closing the Property Manager

The **Property Manager** is opened and closed with the **View** | **Property Manager** command. You can also click ☒ in the title bar of the **Property Manager** to close it.

Opening and Closing Sections

Click the appropriate tab to open pages in the tab view.

In both tab and horizontal views, individual sections can be expanded or collapsed. A ⊞ or ⊟ is located to the left of the name if the section can be expanded or collapsed. To expand the section, click ⊞, click the section name and press the plus key (+) on the numeric keypad, or press the right arrow key on your keyboard. To collapse a section, click ⊟, click the section name and press the minus key (-) on the numeric keypad, or press the left arrow key.

Display info area

To display an area with field hints right-click in the Property Manager, fig. 1.162, and select *Display info area*. When selected a hint area appears at the bottom of the Property Manager. When a field or label is selected a hint describing the function or type of data is displayed:

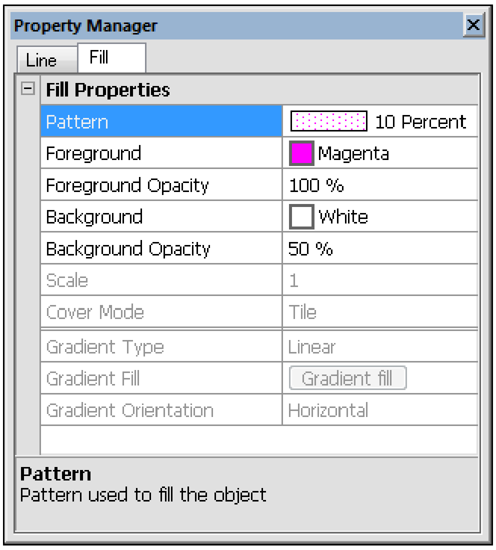


Figure 1.162 – Property Manager

Right-click and select *Display info area* to show hints about the currently highlighted field in the **Property Manager**.

To disable the info area, right-click in the **Property Manager** and deselect *Display info area*.

Keyboard Commands

When working with the **Property Manager** the up and down ARROW keys move up and down in the **Property Manager** list. The ENTER key activates the highlighted property. The right arrow key expands collapsed sections (i.e. *Fill Properties*) and the left arrow collapses the section.

Changing Properties

The **Property Manager** displays the properties for selected objects. For example, this selected well selector line has *Style*, *Color*, *Foreground Opacity*, *Width*, *Start Style*, *End Style*, and *Scale* properties, fig. 1.163.

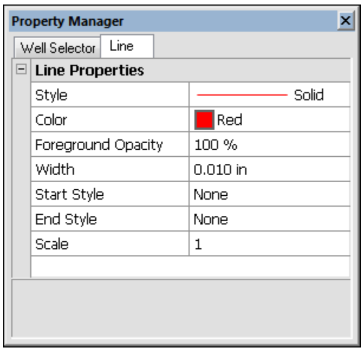


Figure 1.163 – Change any of properties for the object in the Property Manager.

To change a property, click the property's value and select a new property from the pop-up box, scroll to a new number using the buttons , or type new numbers or text. The method used to change a property depends on the property type. In the polyline example, changing the color requires clicking the current color box and selecting a new color from the *color palette*; changing the width requires typing a new number or scrolling to a new number. When you type the new number, press ENTER or click somewhere in the **Property Manager** to make the change permanent.

Occasionally, some properties are dependent on other selections. For example, in the fill properties there is a *Scale* option. This option is disabled (grayed out) unless you have selected an image fill type as the *Pattern* and *Cover Areas By* set to *Tile*.

Properties Tips

- If multiple objects are selected in the header or footer, only features common to all objects appear in the **Property Manager**.
- To change the default line, fill, symbol, or text properties for all borehole views and all sessions of **Strater**, use *Tools | Options*.

Changing the Window Layout

The windows, toolbars, managers, and menu bar display in a docked view by default; however, they can also be displayed as floating windows. The visibility, size, and position of each item may also be changed.

Visibility

Use the *View | Toolbars* commands to toggle the display of the toolbars. Alternatively, use the *Tools | Customize* command to open the **Customize** dialog. The **Toolbars** page of the **Customize** dialog displays all of the toolbars. A check mark indicates the toolbar is currently visible. Reset toolbars with the **Customize** dialog.

Use the *View | Managers* commands to toggle the display of the *Object Manager*, *Property Manager*, and *View Manager*. Alternatively, you can click the ☒ button in the title bar of the **Object Manager**, **Property Manager**, or **View Manager** to close the manager window. The **Property Manager** can also be opened by double-clicking on an object.

Auto-Hiding Managers

Click the button to auto-hide a docked manager. The manager slides to the side or bottom of the main Strater window and a tab appears with the window name, fig. 1.164.

Figure 1.164 –The Object Manager appears as a tab on the side of the window

Position the mouse pointer over the tab to view the manager. Move your mouse away from the manager and the manager "hides" again. You can also click inside the manager to anchor it at its current position. Click in another manager to release the anchor and hide the manager. Click the button to disable the auto-hide feature.

Size

Drag the sides of a floating plot window, table view, manager, toolbar, or menu bar to change its size. If a window or manager is docked, its upper and lower bounds are indicated by a or cursor. Move the cursor to change the size.

Position

To change the position of a docked manager, click the title bar and drag it to a new location. The entire manager appears in the location it will be displayed when the manager is floating. To dock the manager, use the docking mechanism. You can also double-click the manager's title bar to toggle between floating and docked modes. A tabbed manager view is also an option.

Docking Mechanism

Left-click the title bar of a manager and drag it to a new location while holding the left mouse button. The docking mechanism displays with arrow indicators as you move the manager, fig 1.165.

Figure 1.165 – The docking indicator can lock the Object Manager location

When the cursor touches one of the docking indicators in the docking mechanism, a blue rectangle shows the window docking position. Release the left mouse button to allow the manager to be docked in the specified location, fig. 1.166.

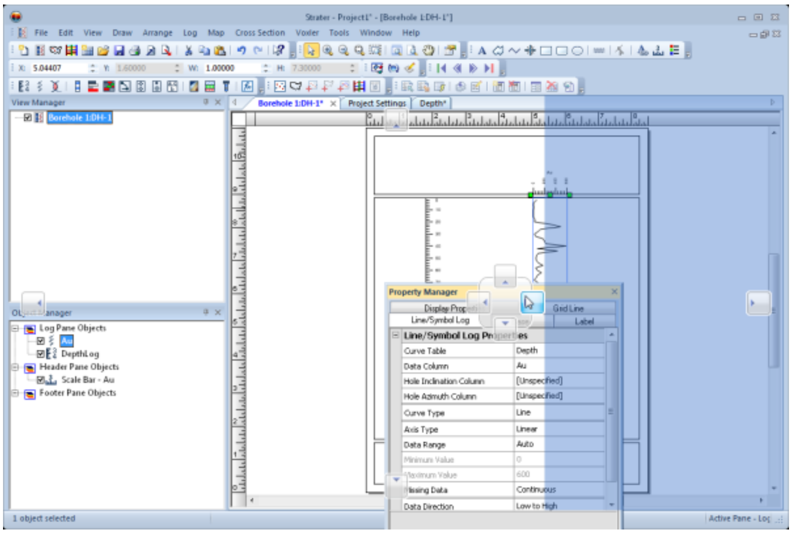


Figure 1.166 – This image displays the **Property Manager** being docked to the right side of the **Strater** window.

Tabbed Managers

To create tabbed managers:

1. Drag one manager on top of another window.

2. Hover over the center section of the docking mechanism. The blue area shows where the tabbed manager will display.

3. Release the mouse button.

To return to individual managers from the tabbed view:

1. Click on the manager's name on the tab.

2. Drag the tab to a new position. 

Floating Managers

The toolbars and menu bar can also be moved or displayed in floating windows.

To dock the toolbar or menu bar in a new location, click the "grip" bar along the toolbar or menu bar edge, hold the left mouse button, and then drag the toolbar or menu bar to a new location. Drag the toolbar or menu bar away from the window edge to display the toolbar as a floating window. Double-click the manager title bar to switch between floating and docked.

Restoring the Managers and Windows to Their Original Locations

If the windows or managers have moved or become invisible, or if they are in undesired locations, you can use the *View* | *Reset Windows* command to move them back to their original locations. You must restart **Strater** for the changes to take effect.

Tabbed Documents

Each tab represents a view window or a table. To select a tab to view, click the tab name. To close a tab, right-click and select Close or click the 'X' next to the tab name. The tab no longer is displayed. This does not delete the information on the tab; this action simply removes a tab from display. To display the tab again click the *Windows* | *Show All Tables* command or click on the view window name in the *View Manager*.

To delete the tab and all information contained in the view or table from a project, right-click on the tab and select *Delete*. Otherwise, click the *Table* | *Delete Table* command or right-click on the view name in the **View Manager** – select *Delete*.

Tab Colors

Each type of window displays the name of the window on the tab in a different color. Borehole views are displayed with blue text, map views are displayed with red text, cross section views are displayed with green text, and tables are displayed with black text. This can be changed from the *Tools* | *Options* dialog in the *Display* section.

Change Order of Tabs

You can change the order of tabs by clicking on the tab name. Hold down the left mouse button and drag the tab to the desired location in the tab array, fig. 1.167.

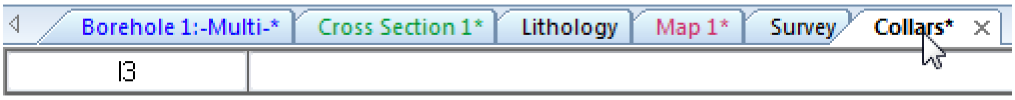


Figure 1.167 – Select the tab to move by clicking it and not releasing the mouse button, fig. 1.168.

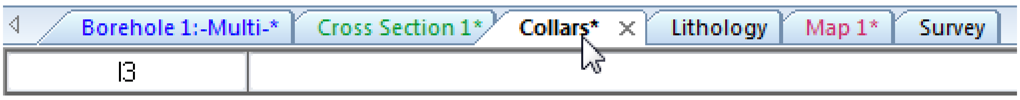


Figure 1.168 – Drag the tab to the desired location and release the mouse button.

1.11.2. Tutorial

1.11.2.1. Tutorial Introduction, main lessons

This tutorial is designed to introduce you to some of **Strater's** basic features. After you have completed the tutorial, you should be able to begin to use **Strater** with your own data, creating your own boreholes, maps, and cross sections. It is strongly encourage completion of the tutorial before proceeding with **Strater**. The lessons should be completed in order; however, they do not need to be completed in one session. The tutorial should take approximately one hour to complete.

The following is an overview of lessons included in the tutorial.

Lesson 1 – *Opening Data* shows how to open a data file in a table view.

Lesson 2 – *Creating Logs* shows how to create a Depth log, Line/Symbol log, and Zone Bar log.

Lesson 3 – *Changing Properties* shows how to edit the log properties.

Lesson 4 – *Creating and Editing Drawing Items* shows how to add text, linked text, and a legend to the borehole view.

Lesson 5 – *Changing Boreholes* shows how to change all of the logs to another borehole and how to change an individual log to a different borehole.

Lesson 6 – *Creating a Map View* shows how to import collar data into a table and create a map view with a well layer and a well selector line.

Lesson 7 – *Creating a Cross Section View* shows how to create and edit a cross section view.

Lesson 8 – *Saving Information* shows how to save the **Strater** project and how to create a template.

Advanced Tutorial Lessons

The advanced tutorial lessons are optional, but give additional information about working with legends, design mode, and LAS files.

Lesson 9 – *Editing Legends* shows how to edit many of the properties of the legend object.

Lesson 10 – *Design Mode and Activating Boreholes* shows how to create a log in design mode and activate the borehole with data after all of the logs are created.

Lesson 11 – *Creating Logs from LAS files* shows how to import LAS data and create logs from it.

Lesson 12 – *Creating a Cross Section from Line/Symbol Logs* shows how to create a cross section from line/symbol logs. It also steps through the process of creating manual layers and editing layers.

Lesson 13 – *Displaying Deviated Maps and Cross Sections* shows how to change the display of wells on maps and cross sections to display deviation paths.

A Note about the Documentation

Various font styles are used throughout the **Strater** quick start guide and online help. **Bold** text indicates menu commands, dialog names, and page names. *Italic* text indicates items within a dialog such as group box names, options, and field names. For example, the **Save As** dialog contains a *Save as type* drop-down list. Bold and italic text may occasionally be used for emphasis.

In addition, menu commands appear as **Edit** | **Undo**. This means, "click on the Edit menu at the top of the **Strater** window, then click **Undo** within the **Edit** menu list". The first word is always the menu name, followed by the commands within the menu list.

Topic Links

Each topic contains several links to other topics. Click the link for an in-depth discussion on the subject. Use the Back button in the help file to return to the tutorial topic.

Using the Tutorial with the Demo Version

If you are using the demo version of **Strater**, you will not be able to complete some of the steps due to disabled save, export, print, and copy features. The demo version is a fully functional read-only version of the program. When this is a factor, it is noted in the text and you are directed to proceed to the next step that can be accomplished with the demo.

Starting Strater

To begin a **Strater** session:

1. Navigate to the installation folder, which is C:\Program Files\Golden Software\Strater 4 by default.

2. Double-click on the Strater.exe application file.

3. A new empty project is created with an empty borehole view and an empty project settings table. If this is the first time that you have opened **Strater**, you will be prompted for your serial number. Your serial number is located on the CD cover, or in the email download instructions, depending on how you purchased **Strater**.

If **Strater** is already open, click the *File* | *New* | *Project* command or the button to open a new empty project before continuing with the tutorial

Lesson 1 - Opening Data

Data can be opened in **Strater** before any logs are created, while creating the logs, or after the logs have been created. In this section, the initial data is opened before any logs are created. If you prefer to create a log design first, use *design mode*. Design mode is discussed in *Lesson 10*.

To open an existing data file into a table:

1. Click the *File* | *Open* command or click the button.

2. In the *Open* dialog, navigate to the **Strater** Samples folder. By default, this is located in C:\Program Files\Golden Software\Strater 4\Samples. Click on the *Tutorial 1.xls* file and click *Open*.

3. In the *XLS Import Options* dialog, select the *Depth* sheet and click *OK*.

4. In the *Specify Worksheet Column Definitions* dialog, check the box next to *Specify Column Header Row*. This tells **Strater** that the column number specified contains text indicating the column name.

5. Click *Next*.

6. In the *Specify Data Type and Column Positions* dialog, set the *Data type* to *Depth* (*Single Depth*).

7. Set the *Hole ID* and *Depth* columns to the appropriate columns.

8. Click *Finish*.

The data is displayed in a table view named Depth. This table can now be used to create logs.

Lesson 2 - Creating Logs

The most common types of logs that are created are *depth logs* and *line/symbol logs*. Data are immediately associated with the log when creating log items in active mode, providing an immediate image representing the log. This section will use the previously opened data file to create a line/symbol and depth log. Another table will be opened to create a zone bar log.

To create the logs in the borehole view, click on the *Borehole 1* tab, fig 1.169.

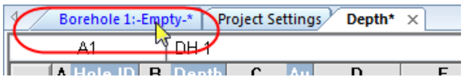


Figure 1.169 –Click on the Borehole 1 tab to switch to the borehole view, where logs are created.

Creating a Depth Log – Tutorial

Depth logs display the borehole's depth or elevation information. For deviated wells, the depth log can be adjusted so that the true vertical depth can be displayed.

To create a depth log:

1. Click the **Log** | **Depth** command or click the  button.

2. Click on the left side of the *log pane*, where you want the depth log to be located.

3. In the *Open* dialog, make sure that *Depth* is selected in the *Use Current Table* option and in the *File name* box, fig. 1.170.

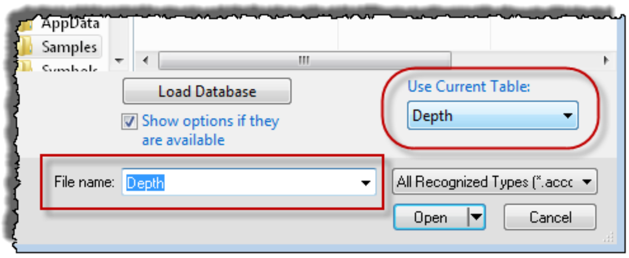


Figure 1.170 – Select the *Depth* table in the Use *Current Table* section and make sure it is selected in the *File name* box.

4. Click Open.

The depth log is created with the default properties, fig. 1.171.

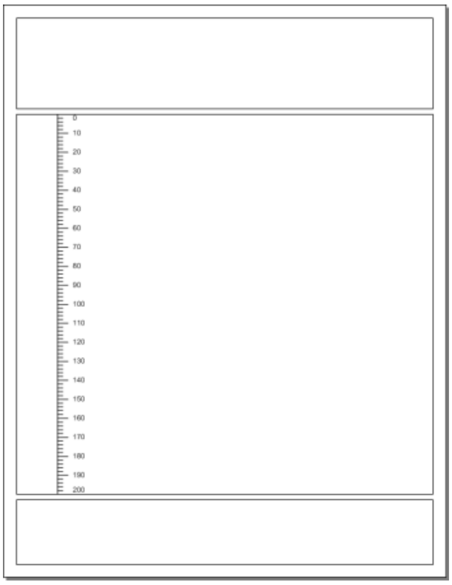


Figure 1.171 – The depth log is created where you clicked on the screen.

Creating a Line/Symbol Log – Tutorial

Line/symbol logs display table data connected with a line in depth order. Lines, symbols, or both line and symbols can be displayed.

To create a line/symbol log:

1. Click the *Log* | *Line/Symbol* command or click the  button.

2. Click in the *log pane* in the location you want the line/symbol log drawn. For this tutorial, click near the center of the log pane. You will position the log item more exactly later.

3. In the *Open* dialog, make sure that *Depth* is selected in the *Use Current Table* option and in the *File name* box, fig. 1.172.

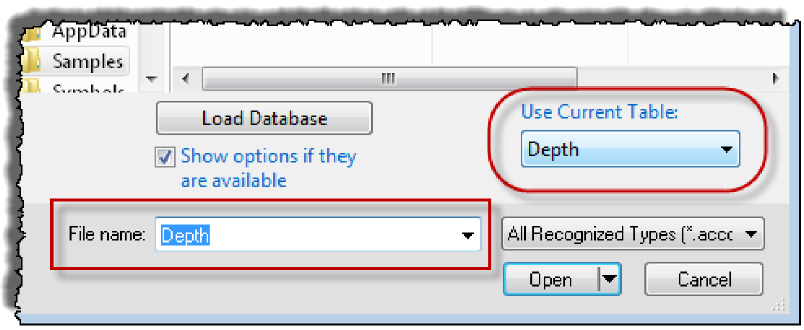


Figure 1.172 – Select the *Depth* table in the *Use Current Table* section and make sure it is selected in the *File name* box.

4. Click Open.

The line/symbol log is created with the default properties, fig. 1.173.

Note that a scale appears in the header pane. The default option for line/symbol logs is to always create a scale bar. The scale bar shows the range of values for the variable being displayed. If scale bars are not desired by default, click the *Tools | Options* command. Uncheck the box next to the *Auto Create Scale Bar* option in the General section.

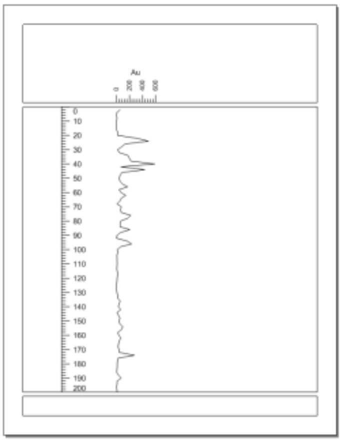


Figure 1.173 – The line/symbol log is created with the default properties

The borehole view should look similar to this, after adding the line/symbol log. Both the depth log and line/symbol log are shown, with the scale bar above the line/symbol log.

Creating a Zone Bar Log – Tutorial

Zone bar logs can display a variety of well log information, such as lithology or layer information. Zone bar logs include two columns of depth data, normally labeled as *From* and *To*. Because of this, each row contains data that represents conditions in a depth range.

To create a zone bar log:

1. Click the **Log | Zone Bar** command or click the  button.

2. Click in the *log pane* to the right of the line/symbol log.

3. In the **Open** dialog, select the *Tutorial 1.xls* file from the Samples folder and click *Open*.

4. In the *XLS Import Options* dialog, select the *Lithology* sheet and click *OK*.

5. In the *Specify Worksheet Column Definitions* dialog, check the box next to *Specify Column Header Row* option to set the contents of row 1 as the header row.

6. Click *Next*.

7. In the *Specify Data Type and Column Positions* dialog, verify that *Hole ID*, *From*, and *To* have the appropriate columns selected. The rest of the columns are not mapped to one of the remaining predefined columns but will be imported into the table.

8. Click Finish.

The zone bar log is created with the default properties. An interval table named *Lithology* is created with the data from the selected sheet, fig 1.174.

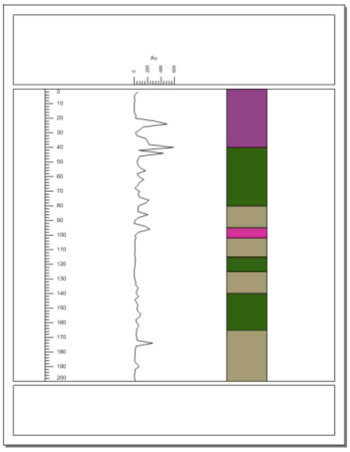


Figure 1.174 – The zone bar is added to the existing borehole view.

Lesson 3 - Changing Properties

The properties of an object are edited by clicking on the object and changing the properties in the *Property Manager*. The **Property Manager** is displayed by default on the lower left side of the **Strater** window. If the **Property Manager** is not visible, click the **View | Managers | Property Manager** command. A check mark appears next to **Property Manager** if it is visible.

When an object is selected, its properties are displayed in the **Property Manager**, fig. 1.175.

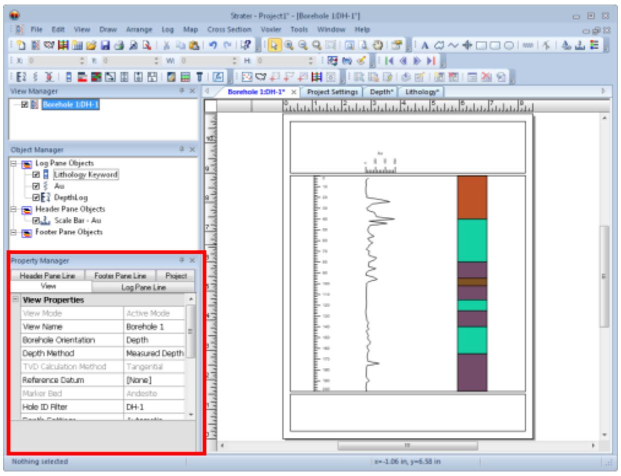


Figure 1.175 – The **Property Manager** is displayed in the lower left corner of the **Strater** window, by default

Editing Log Item Position and Size – Tutorial

The easiest way to position or size a log, is to click on the log in the *Object Manager* or in the log pane and drag it to a new location or size. However, items can be more accurately positioned with menu commands and toolbars.

To accurately position and size the line/symbol log:

1. Click on the line/symbol log in the **Object Manager** or log pane, fig. 1.176.

2. In the *Position/Size toolbar*, highlight the number next to *X*: and type in 2.0.

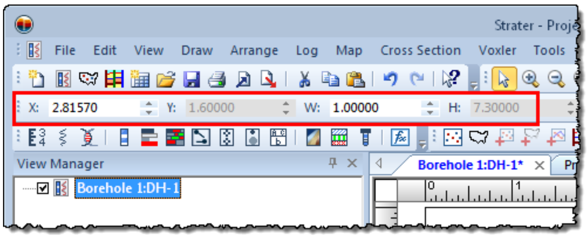


Figure 1.176 – Highlight the existing value in the X box and type the new location.

3. Press ENTER on the keyboard and the line/symbol log is moved in the borehole view so its left edge is two inches from the left edge of the paper.

4. Highlight the number next to *W*: and type 1.5.

5. Press ENTER on the keyboard and the line/symbol log is resized so that the log is one and a half inches wide.

6. Repeat the above steps with the zone bar log and depth log.

An alternate method would be to press the CTRL key on the keyboard and click on all of the log objects in the **Object Manager**. Then, click the **Arrange** | **Size Objects** | **Specify Width** command. Type in 1.5 and click *OK*. All of the selected objects are resized to 1.5 inches wide with a single command.

Spacing Objects

Log items can be positioned relative to one another with the *Arrange* menu commands.

To position the depth log relative to the line/symbol log:

1. The line/symbol log should be to the right of the depth log before completing the next section. If the line/symbol log is to the left of the depth log, click on the depth log. Hold down the left mouse button and drag the depth log to the left of the line/symbol log.

2. Select both the depth log and the line/symbol log. There are two ways to select multiple items in the log pane:

- Click on the first log in the borehole view window. Press the SHIFT key on the keyboard. While holding the SHIFT key down, click the second log in the borehole view window.
- In the Object Manager click the name of the first log. Press the CTRL key on the keyboard. While holding the CTRL key down, click the name of the second log.

3. When both logs are highlighted, click the **Arrange | Space Objects | Left to Right** command.

The line/symbol log remains in the fixed location. The depth log is moved so that the right edge of the depth log *bounding box* is at the same location as the left edge of the line/symbol log bounding box.

The **Arrange | Space Objects | Right to Left** command can be used when selecting the line/symbol log and the zone bar log to move the zone bar log to the immediate right of the line/symbol log, fig 1.177.

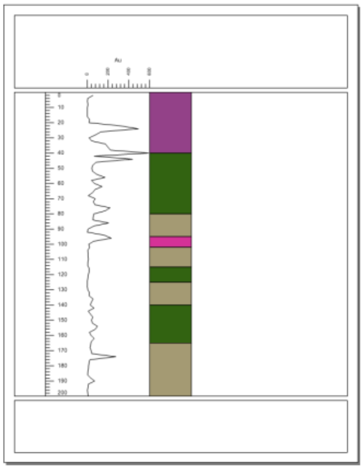


Figure 1.177 – The Space Objects commands remove the spaces between adjacent objects to maximize the space available in the view window.

Editing Line/Symbol Log Properties

Each object has unique *properties* that can be changed. Line/symbol logs can change the column that is being displayed, the scaling, the line, fill, and symbol properties, add labels, and add a background grid behind the line/symbol log.

To change the line/symbol plot properties:

1. Click on the line/symbol log either in the **Object Manager** or in the plot window to select it.

2. In the **Property Manager**, click on the **Display Properties** tab.

3. Click the ⊞ next to *Line Properties* to open the line properties section.

4. To increase the line thickness, highlight the value next to *Width* and type a new value, such as 0.04 inches.

5. Press ENTER on the keyboard to make the change.

6. To open the fill properties section, click the ⊞ next to *Log Fill Properties*.

7. To fill the curve to the left of the line with a blue color, make sure that the *Display Log Fill* option is set to *Left*.

8. Click the *Black* color next to *Foreground* and select *Blue* from the color list. The log is filled to the left with a blue color.

9. To open the symbol properties section, click the ⊞ next to *Symbol Properties*.

10. Highlight the zero next to *Symbol Frequency* and type 1.

11. Press ENTER on the keyboard to show a symbol at all points in the table.

12. Click on the *Label* tab to set label properties.

13. Change the *Show Label* to *Data* by clicking on the existing option and selecting *Data* from the list.

14. Click the ⊞ next to *Layout* to open the label layout section.

15. To reduce the number of labels, highlight the number next to *Frequency* and type 2.

16. Press ENTER on the keyboard and every other label is displayed.

17. Click the word *Center* next to Offset Types and select *User Defined* from the list.

18. Highlight the value next to *X Offset* and type 0.150 inches.

19. Press ENTER on the keyboard and the labels are moved to the right side of the symbols with an offset by 0.150 inches from the center of the symbol, fig. 1.178.

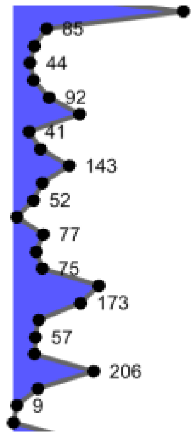


Figure 1.178 – The Display fill, symbols, and labels on the line/symbol log.

Editing Zone Bar Properties – Tutorial

Zone bar logs can change the column that is displayed, add labels, change line and fill properties, and add grid lines behind the log. Normally, the fill is controlled by a scheme, which is discussed in the next section.

To edit the zone bar log:

1. Click on the zone bar log in the *Object Manager* or in the log pane to select it.

2. Click on the *Label* tab in the *Property Manager*.

3. To display the name of the lithological layer in each zone on the zone bar, change the *Show Label* option to *Show Label With Fill*. The labels are added to the display, fig. 1.179.

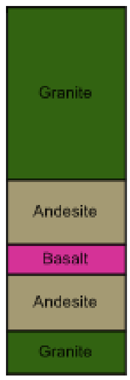


Figure 1.179 – The Display labels and colors in the zone bar log.

Editing Schemes – Tutorial

Schemes are an important part of **Strater**. Schemes provide a mechanism to define drawing properties, such as line, fill, symbol, and text properties, from a table value. Once a scheme is created, it can be used in many logs, cross sections, and other projects. This avoids the need to duplicate work.

Schemes are not used in all log types, but they are used in several, including the zone bar log. Schemes are required for lithology, percentage, and well construction logs. Schemes are optional for bar, classed post, post, and zone bar logs. Scheme properties can be edited from any view by clicking the *Draw | Scheme Editor* command or clicking the button.

A *zone bar log* uses a *keyword scheme* to relate data table information to interval block properties, such as fill color or fill pattern. When this log was created, **Strater** automatically created a basic, default scheme to fill the log with random colors. To edit the scheme connected with the zone bar log:

1. Click on the button to open the **Scheme Editor**.

2. On the left side of the **Scheme Editor**, click the next to *Lithology: Lithology Keyword*. The five scheme items are displayed below the scheme name, fig. 1.180.

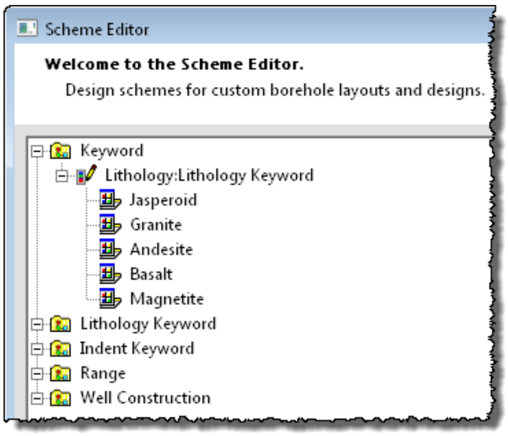


Figure 1.180 – Expand a scheme to view all scheme items. You can select each item to set its properties.

3. Click the *Jasperoid* item. The item properties are displayed on the right side of the **Scheme Editor**.

4. Set the *fill properties* to any desired pattern and color you wish. For instance, you may click next to *Pattern* and select the *BIF* image.

5. Select the *Granite* item on the left side of the dialog.

6. Set different fill properties. For instance, click next to *Foreground* and set the color to a dark green.

7. Click the solid fill next to *Pattern* and select a diagonal cross fill pattern.

8. Continue changing the properties for each of the remaining items until the fill properties for all five items have been changed.

9. Click *OK* and the **Scheme Editor** closes. The scheme properties are automatically applied to the zone bar log, fig. 1.181.

Figure 1.181 – Change the fill properties for each item in the scheme.

Note that the scheme item names are case-sensitive. If you were to change Granite to granite in one cell in the table, the scheme item properties would not be displayed for that interval.

Lesson 4 – **Creating and Editing Drawing Items**

The header and footer panes typically contain information about the company, borehole, etc. Most of this information is static; however, some of the information can change depending on data changes. You can create a variety of objects such as rectangles, lines, and text to display information anywhere in the view window.

This tutorial lesson creates a text object, creates multiple linked text objects, and aligns the text. A legend is also added to the view.

Creating Text – **Tutorial**

The **Draw | Text** command is used to create *text* anywhere in the view window.

To add text to the borehole view:

1. Click the **Draw** | **Text** command or click the  button.

2. Move the cursor into the borehole view. Click the left mouse button when the cursor is above the depth log in the header pane.

3. The *Text Editor* opens. Type *Depth* (*feet*).

4. Click *OK* and *Depth* (*feet*) appears in the location where the mouse was clicked.

5. Press ESC on the keyboard to end drawing mode.

6. Click on the text. A bounding box appears. You can click and drag the text to move the text to the desired location.

7. With the text selected, highlight the number next to the *Points* option in the *Font* section of the **Property Manager**.

8. Type a new size value and press ENTER on the keyboard to increase the size of the text.

Creating Linked Text – Tutorial

Linked text shows information that changes with the borehole being displayed, such as location information, depth, driller name, or page number. Linked text is derived from a table or borehole view property setting. So, when the data changes, the text automatically updates.

1. Click the *Draw | Linked Text* command or click the button.

2. Click to add linked text near the top left of the header section. The default linked text object, the *Hole ID*, appears.

3. Click a second time below the *DH-1* text. Another *DH-1* appears.

4. Press ESC on the keyboard to end drawing mode.

5. Click on the first *DH-1* text either in the *Object Manager* or in the header pane.

6. In the **Property Manager**, click on the **Label** tab.

7. Click the ⊞ next to *Format* to open the text format section.

8. Next to *Prefix*, type *Borehole ID*: with a space after the colon.

9. Press ENTER on the keyboard and the text appears to the left of the borehole ID number.

10. Click on the second *DH-1* text either in the **Object Manager** or in the header pane.

11. Click on the **Linked Text** tab in the **Property Manager**.

12. Click the *Hole ID* text next to the *Linked Text Type* option and select *Current Page* from the list. The page number is displayed.

13. Click on the **Label** tab.

14. Next to *Prefix*, type *Page*: with a space after the colon.

15. Press ENTER on the keyboard and the contents of the linked text box changes.

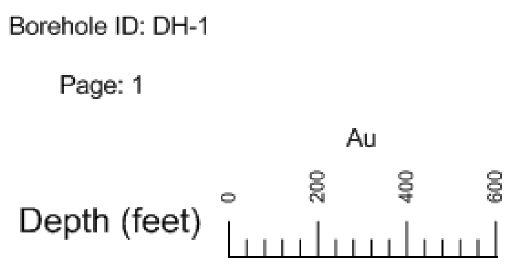


Figure 1.182 – Linked text example

Before the text is aligned, it may look something like this, fig. 1.182, with the text appearing at the locations where you clicked on the screen. It is often desirable to move the text to a specific location.

Aligning Text – **Tutorial**

There are several ways to position objects, including text boxes, in **Strater**.

- Click and drag objects to new locations.
- Click the *Arrange | Align Objects* command to automatically position objects relative to other objects.
- Click the *Arrange | Space Objects* command to control spacing between objects.
- Use the *Position/Size toolbar* to manually and precisely position objects.

To align the text and linked text:

1. Select the first linked text box by clicking on the Linked Text 1 object in the **Object Manager**.

2. Press and hold the CTRL key on the keyboard.

3. In the **Object Manager**, click on *Linked Text 2*.

4. Click the *Arrange | Align Objects | Left* command. The text blocks are now horizontally aligned along the left edge of the text.

5. Click on the *Text 1* object in the **Object Manager**.

6. Press and hold the CTRL key on the keyboard.

7. Click on the *Scale Bar – Au* object in the **Object Manager**.

8. Click the *Arrange | Align Objects | Middle* command. The depth text and the scale bar are now vertically aligned.

Align text to create a more organized layout for your borehole, fig. 1.183.

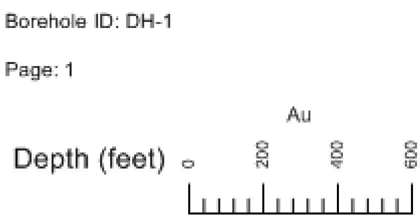


Figure 1.183 – Aligning text

Creating a Legend – **Tutorial**

Legends can be added to explain information contained in a log, such as the *zone bar log*. To add a *legend*:

1. Click on the zone bar log to select it.

2. Click the **Draw** | **Legend** command or click the  button.

3. Click on the borehole view where the legend should be located. The legend can appear in any of the panes. After clicking, the legend automatically appears.

4. Press the ESC key on the keyboard to end drawing mode.

The legend can be edited in the **Property Manager** to show fill properties, symbol properties, or both. The options can appear in multiple columns and with the text on the left or right side, fig. 1.184. Refer to the Advanced Tutorial *Editing Legends* lesson for additional information about formatting the legend.

Figure 1.184 – Legend items

Lesson 5 - Changing Boreholes

It is very easy to change boreholes in **Strater**. As mentioned earlier, the tables can contain data for more than one borehole and the project can reference more than one table.

Changing All Logs to a New Borehole

In our example, the *Lithology* and *Depth* tables both contain DH-1 and DH-2 in the *Hole ID* column. You can easily change the borehole from DH-1 data to DH-2 data. To change the borehole:

1. Click the **View** | **View Properties** command, click in the white space in the log pane, click the  button, or click on the Borehole 1: DH-1 view name in the View Manager.

2. Click *DH-1* next to *Hole ID Filter* and select *DH-2* from the list. The borehole log items and linked text change to reflect the DH-2 data.

Changing One Log to a New Borehole

To change only one log to a different borehole:

1. Click on the log that should be changed, such as the zone bar log.

2. In the **Property Manager**, click on the **Base** tab.

3. Click the well name next to Hole *ID Filter* and select the appropriate borehole name, such as *DH-1*. The zone bar log automatically updates to show the new borehole's data.

When changing only a single log, only the selected log changes to the new data. In this case, the depth log, line/symbol log, and linked text continue to show DH-2 data. Only the zone bar log shows the DH-1 data. The borehole view tab and the Hole ID Filter in the **Property Manager** show *-Multi-* to indicate that multiple logs are displayed in this borehole view.

Lesson 6 – Creating a Map View

A *map view* represents each of the wells in a *collars* table as a symbol on a map. Each well in the collars table is displayed as a separate symbol. Wells can be edited as a group or individually. The map also contains a set of four axes that can be edited individually. Maps can add base layers, additional well layers, or well selector lines.

Opening a New Map View

New map views in an existing project are created by clicking the *File* | *New* | *Map View* command or clicking the button.

Displaying the Well Locations – Tutorial

In the new map view, wells can be displayed based on information in the collars table. A collars table can be opened using the *File* | *Open* command or can be opened when creating the well map.

1. Click the *Map* | *Create Well Map* command or click the button.

2. In the **Open Collars File** dialog, select the *Example Data.xls* file and click *Open*.

3. In the *XLS Import Options* dialog, select the *Collars* table and click *OK*.

4. In the *Specify Worksheet Column Definitions* dialog, make sure that *Specify Column Header Row* is checked and click *Next*.

5. In the *Specify Data Type and Column Positions* dialog, set the *Hole ID, Starting Depth*, *Ending Depth*, *Elevation*, *Easting*, and *Northing* columns to the appropriate columns and click *Finish*. The two wells appear on the map.

The well map is displayed with the default properties. Because only two wells are visible, the wells are located at the extremes of the map limits, fig. 1.185.

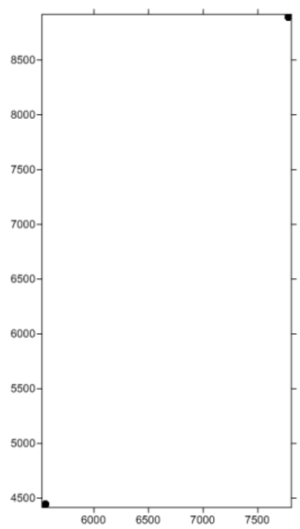


Figure 1.185 – Map with two boreholes

Changing the Well Properties - Tutorial

All of the well properties can be edited. To make changes to the well symbol and add well labels:

1. Click on the *Wells 1* map layer, fig. 1.186, in the **Object Manager**.

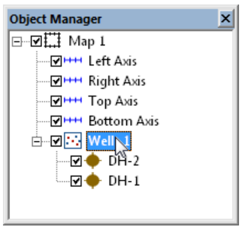


Figure 1.186 – Well 1 selecting

2. In the **Property Manager**, click on the **Label** tab.

3. Next to the *Label 1* option, click on [*None*] and select *Hole ID* from the list. By default, the name appears below the symbol.

4. Next to the *Label 2* option, click on [*None*] and select *Elevation* from the list. This displays the elevation of the well below the well name.

5. Currently, a scheme is used to display wells, but all symbols can be the same. Click on the **Wells** tab in the **Property Manager** not to use a scheme,.

6. Uncheck the box next to the *Use Keyword Scheme For Symbols* option.

7. Click on the **Symbol** tab.

8. Change the *Symbol* by clicking on the existing symbol and selecting the desired symbol from the list.

9. Change the *Fill Color* or *Line Color* of the symbol by clicking on the existing colors and selecting the desired color from the list.

The wells are changed to use a uniform symbol. Labels are also displayed below the wells, fig. 1.187.

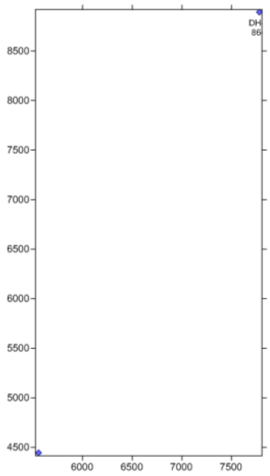


Figure 1.187 – Map with two boreholes

Changing the Map Properties – Tutorial

The map properties control the size of the map and the symbol, line, and font properties for all of the objects in the map. To change the limits and scale of the map:

1. Click on the *Map 1* object, fig. 1.188, in the **Object Manager**.

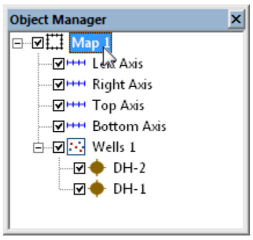


Figure 1.188 – Object Manager, selecting Map 1

2. In the **Property Manager**, click on the **Scale** tab.

3. To use different scales in the X and Y directions, uncheck the box next to Proportional XY Scaling.

4. Set the *Length* (*Page Units*) to 7 inches for both the *X Scale* and *Y Scale* by highlighting the existing value and typing 7.0.

5. Press ENTER on the keyboard to make the change. Creating a map that fits nicely within the page boundaries is important if you are going to insert the map view in a borehole view or cross section view because the entire map view page boundary is inserted.

6. Click on the **Limits** tab to set the size of the map.

7. Check the box next to *Use Data Limits* to have the limits controlled exactly by the objects in the map.

8. Click the *Fit All* button to expand the limits to include all of the text associated with the wells.

Reset the size and limits to show all of the information for both wells in the map, fig. 1.189.

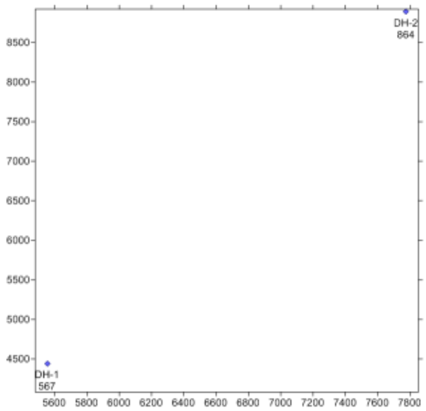


Figure 1.189 – Map in scale with two boreholes

Adding a Well Selector Line – Tutorial

A *well selector line* can be used to *create a cross section* or to show multiple wells connected on the map. Wells are selected in the order that they should appear in the cross section with the furthest left well in the cross section selected first on the map. To connect wells:

1. Click the *Wells 1* map layer.

2. Click the **Map** | **Add Well Selector** command, click the button, or right-click on the map and choose **Add** | **Well Selector**.

3. The cursor changes to . As the cursor approaches a well, the well name appears in a floating box. This makes selecting the right well easier. Click on the first well, *DH-1*, to select it.

4. Click on each additional well in the order that the logs will appear in the cross section. Click on *DH-2* next.

5. Press the ENTER key on the keyboard or double-click on the last well to end the current well selector line.

6. Press ESC on the keyboard to end selector mode.

The order of wells will be displayed in the cross section is shown in the **Object Manager** by the well order in the name for the well selector line. DH-1 appears first in the well selector name, so it will appear on the left side of the cross section. DH-2 appears last, so it will appear on the right side of the cross section. Had the wells been selected in the reverse order, DH-2 would be on the left side in the Object Manager name and in the cross section.

The cross section will have two wells: DH-1 on the left side of the cross section and DH-2 on the right side of the cross section, fig 1.190.

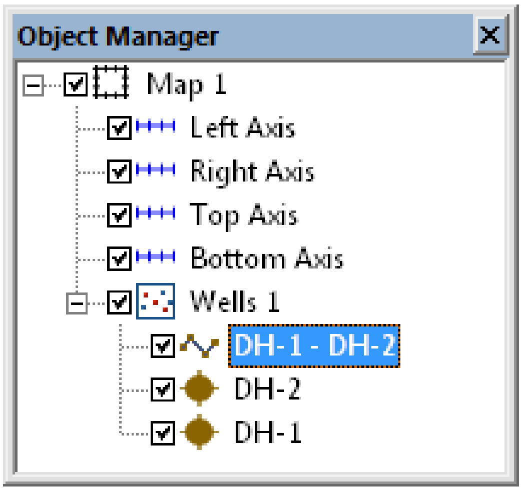


Figure 1.190 – Selecting wells DH-1 – DH-2

The wells are connected with a line. This line connects the wells that will be displayed in the cross section. The well selector line is added to the map, connecting the wells, fig. 1.191.

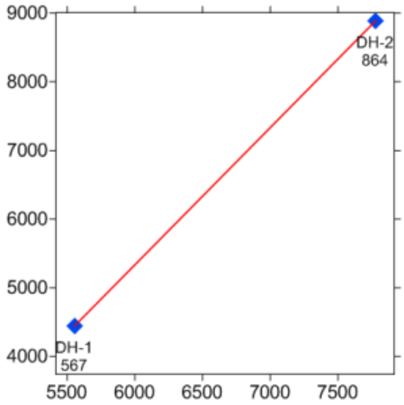


Figure 1.191 – Cross-section line position

Lesson 7 – Creating a Cross Section View

A *cross section* can be created displaying lithology and zone bar logs or displaying line/symbol logs. Wells can be connected with layers, representing lithologies or zones in the data. Layers can be edited or manually created.

Opening a New Cross Section View

New cross section views in an existing project are created by clicking the *File | New | Cross Section View* command or clicking the  button.

Displaying Wells in the Cross Section View – Tutorial

To add the wells to the cross section view:

1. Click the *Cross Section | Create Cross Section* command.

2. On the right side of the *Create Well Selector* dialog, select the order the wells should be displayed in the cross section. The *Wells* in selector should show DH-1 and then DH-2.

3. Click *OK*.

4. To create the cross section from lithology or zone bar logs, set the *Type of cross section logs to be created* to *Lithology/Zone bar log* in the *Import Or Select Data To Create Cross Section Logs* dialog.

5. Since the *Table* and *Data Column* are already defined for both logs, click *OK*.

The default cross section is created, displaying zone bar logs for both wells and connected lithologies. The default cross section is created from the wells in the order they were selected in Create Well Selector dialog, fig. 1.192.

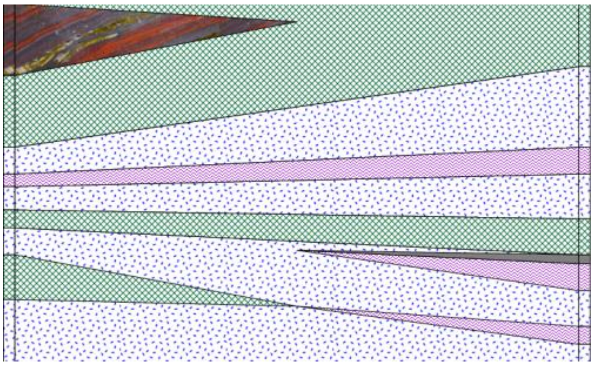


Figure 1.192 – Cross-section between DH-1 and DH-2 wells

Editing Cross Section Properties – Tutorial

Some properties control options for the entire cross section, such as layer labels, well headers, and distances between wells.

1. To add layer names, click on the *Layers* object in the **Object Manager**.

Click on the *Layers* object in the Object Manager, fig 1.193.

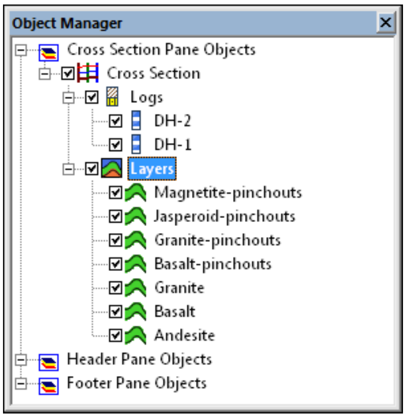


Figure 1.193 – Object Manager with Layers

2. In the **Property Manager**, click on the **Layers** tab.

3. Check the box next to *Show Layer Labels* and the layer names are automatically displayed.

4. To change the font properties for the layer labels, uncheck the *Use Scheme For Label Font* option.

5. Click on the **Label** tab in the **Property Manager**.

6. Click the ⊞ next to *Font* to open the font properties.

7. Highlight the value next to the *Points* option and type a new value to increase the size.

8. Press ENTER on the keyboard to make the change.

9. Check the box next to *Bold* to make the text darker.

10. To add well headers, click the **Cross Section | Add Well Headers** command. The well name and symbol are automatically added to the header section.

11. To display distances between wells, click the *Well Header 1* object in the **Object Manager**.

12. In the **Property Manager**, click on the **Distance** tab.

13. Check the box next to *Show Distance*. The distances are displayed between wells in map units.

The cross section can be updated to include labels for each layer and well header information, fig. 1.194.

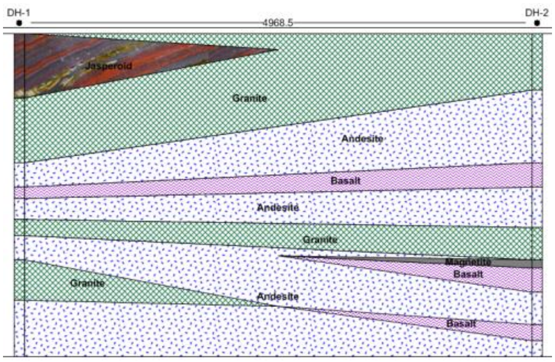


Figure 1.194 – Cross section with Labels and Distance

Inserting the Map View – Tutorial

The map view can be inserted into the cross section by clicking the *Draw | Insert Map View* command. After the map view appears, you can click on it and drag it to the desired location. To edit the inserted map view, edit the original map view. The inserted map automatically updates. The inserted map view can be added to any location in the cross-section view, as a reference to where the wells in the cross section are located, fig 1.195.

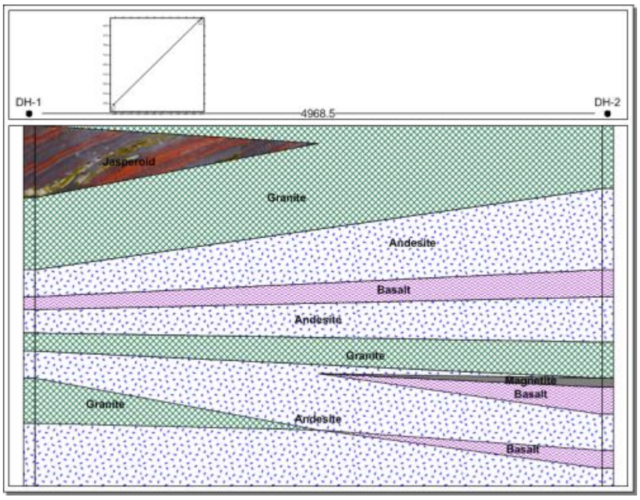


Figure 1.195 – Cross section with Map view

Reshaping the Cross -Section Connections – Tutorial

The layers connecting wells in the *cross section* can be individually *edited*. After selecting a layer in the cross section view window, click the **Draw | Reshape** command to enter *reshape* mode. All the nodes that make up the layer polygon are viewable. Although all of the reshape commands are applicable, a few key functions make reshaping cross section layers easier:

1. Click on a node to select it and move it to a new location.
2. Delete a node by selecting it and pressing DELETE on the keyboard.
3. Add a new node by pressing and holding the CTRL key on the keyboard when clicking.
4. If a node is shared (it affects more than one layer), you can separate it by holding the SHIFT key down and then moving the node. This may be useful when editing pinch out nodes, or when moving nodes that connect the layer to the log.
5. Press the ALT key to link a node to a node in another layer so that the nodes move together.

Currently, two pinch outs are shown connecting toward the bottom of the cross section. To separate these layers:

1. Click on the *Granite* pinch out on the left side of the cross section to select it.
2. Click the **Draw | Reshape** command.
3. Because the *Granite* and *Basalt* pinchouts share a common central node, you can separate the two pinch outs by using the SHIFT key. Hold the SHIFT key down on the keyboard and drag the right most node toward the left side of the cross section.
4. Click on the *Basalt* pinch out on the right side of the cross section.
5. Hold down the SHIFT key on the keyboard and drag the left most nodes toward the right side of the cross section. Holding down the SHIFT key separates the upper *Basalt* pinch out from the *Magnetite* pinch out.
6. Let's assume that we know that the basalt layer near the center of the cross section has a thick section in the middle. Click on the *Basalt layer* in the cross section view window to select it.
7. Hold down the CTRL key on the keyboard. Click several points above the *Basalt* area to create a curved area at the top of the layer.
8. Continuing to hold down the CTRL key on the keyboard, click several points below the *Basalt* area to create a curved area at the bottom of the layer.
9. Press ESC on the keyboard to end reshape mode when all edits have been made.

The final cross section displays all edits made to the pinch outs and the central Basalt layer, fig. 1.196.

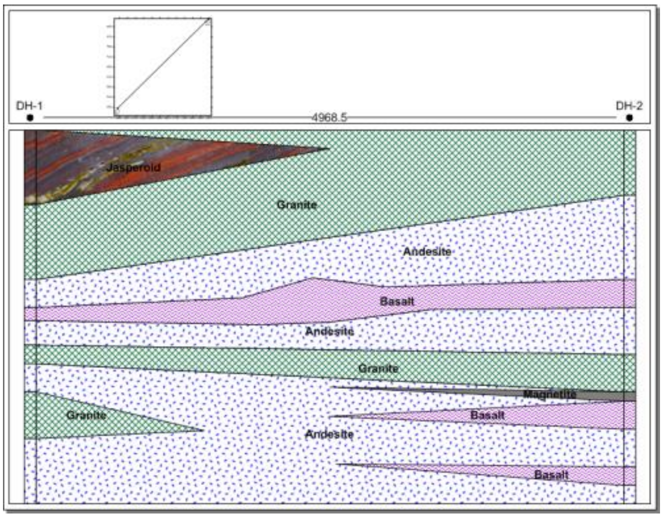


Figure 1.196 – Cross section after Reshape applied

Refer to the *Editing Individual Layers on a Cross Section* for additional layer editing information. Refer to *Lesson 12 – Creating a Cross Section from Line/Symbol Logs* for information on manually picking layer tops or other cross section editing methods.

Lesson 8 – **Saving Information - Tutorial**

When you have completed the project, you can *save* the file to a **Strater** file or a template file. **Strater** files save the schemes, data, and all view windows to the file. Templates can save a single borehole or cross section view window or the entire project, but without the actual data. If you are using the demo version, the save command is not available. To save the file:

1. Click the *File | Save As* command or click the button.

2. Set the *Save as type* to *Strater Files (*.sdg)* or to *Strater Template Files (*.tsf)*. Saving a template in this manner saves the entire project to the template.

3. Type a *File name*.

4. Click *Save* and the file is saved.

Here you have completed the simpler part of the **Strater** tutorial.

1.11.2.2. Advances Tutorials

Lesson 9 – **Editing Legends**

In *Lesson 4*, a legend was created. Many of the properties of the legend can be edited, including the text that is displayed, whether symbols or filled rectangles are displayed, and how many columns are displayed. Legends are for any log type that uses a *scheme*.

If you have completed lesson four and the borehole view is available, click on the *Borehole 1* tab. You can then continue to the next lesson.

If you do not have a borehole view available with a legend:

1. Create a new borehole view by clicking the *File | New | Borehole View* command or clicking the button.

2. Create a zone bar log by completing the steps on the *Creating a Zone Bar Log* tutorial page.

3. Edit the scheme associated with the zone bar log by completing the steps on the *Editing Schemes* tutorial page.

4. Add a legend by following the steps on the *Creating a Legend* tutorial page.

The default legend displays symbols and fill boxes. This can be changed to be more meaningful for the zone bar log. Now that a log and legend exist, we are ready to edit the legend properties, fig. 1.197.

Figure 1.197 – Legend symbols

Editing Legend Properties – Tutorial

To edit the legend, click once on the legend to select it in either the view window or the **Object Manager**. Once the legend is selected, all the properties of the legend are available in the **Property Manager**.

Changing Sample Layout

To change the sample layout:

1. Click on the **Legend** tab in the **Property Manager**.

2. The *Number of columns* contains the number of columns that should appear in the legend. Highlight the 1 and type 2. Press ENTER on the keyboard to make the change. Two separate columns appear.

3. The *Sample Options* describe what should appear for each sample. Click on *Both* and select *Rectangle* from the list. The symbols are removed and only the filled rectangles remain.

4. To remove the spaces between rows of the legend, uncheck the *Space Between samples* option.

The legend appears with two columns without spaces between rows, fig. 1.198.

Figure 1.198 – Legend symbols changed

Changing Title Options

To change the title of the legend:

1. To change the title, click on the **Title** tab in the **Property Manager**.
2. Expand the Text section by clicking the ⊞ next to *Text*.
3. Click the *Advanced* button next to *Advanced Properties*.
4. In the *Text Editor*, type the text that should appear, such as, fig. 1.199:

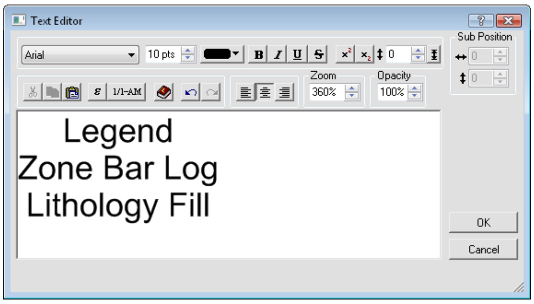


Figure 1.199 – Changing Legend Title.

Type the text in the Text Editor that should appear as the legend title.

5. Click *OK* in the **Text Editor** and the legend title appears.

6. To change the size of all of the text in the title, scroll down and open the *Font* section by clicking the ⊞ next to *Font*.

7. Highlight the 10 next to *Points* and type 20.

8. Press ENTER on the keyboard to make the change.

Changing Frame Options

To set the line and fill style for the area behind the samples and text:

1. Click on the **Legend** tab.

2. Next to *Frame Style*, click the word *None* and select *Rectangle or Rounded Rectangle* from the list. The *Rounded Rectangle* option rounds the corners of the rectangle.

3. Click on the **Frame Line** tab.

4. Increase the line thickness by highlighting the value next to *Width* and typing a new value.

5. Change the line color by clicking the color next to *Color* and selecting a different color from the list.

6. Click on the **Frame Background** tab.

7. To fill the area, click on the *None* next to *Pattern* and select the desired pattern from the list.

8. To change the frame background colors, click on the color next to *Foreground* or *Background* and select the desired color, fig. 1.200.

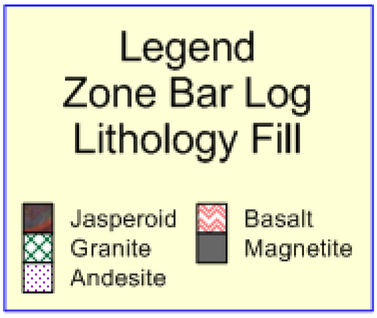


Figure 1.200 – Legend properties edited in the **Property Manager**

Lesson 10 – Design Mode and Activating Boreholes

This is an optional, advanced topic in **Strater** that shows how to work in design mode and then attach data to the design.

There are two "modes" in the borehole view and cross section view: *design mode* and *active mode*. Design mode is used to create placeholders for graphics without attaching them to data. Design mode is useful when designing complex logs and designing templates when you do not want to import any data. After loading a template and importing data, you can switch between design mode and active mode.

Before proceeding with this lesson, open a new **Strater** project by selecting **File** | **New** | **Project** or clicking the  button. If you are prompted to save the existing project, save it if desired.

Entering Design Mode – Tutorial

To enter design mode, click the **Log** | **Design Mode** command, click the  button, or press F4 on the keyboard. In the **Property Manager**, on the **View** tab, the *View Mode* should indicate *Design Mode*, fig. 1.201.

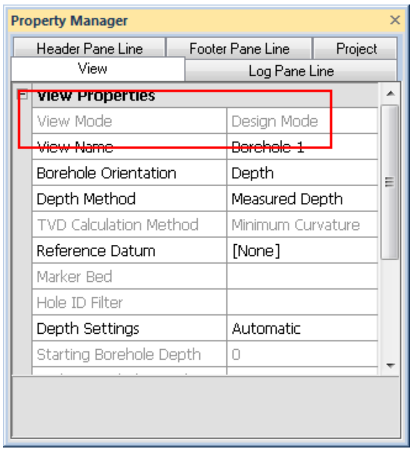


Figure 1.201 – The borehole View Properties indicate if you are in Design Mode or Active Mode.

Creating a Design – Tutorial

Design mode is useful when creating complex boreholes, creating templates, and when creating more complex log items like lithology or well construction logs. We will create only a single log item, a *lithology log*, for this lesson, fig. 1.202.

To add a lithology log in design mode:

1. Click the **Log** | **Lithology** command or click the  button.

2. Click in the log pane to position the lithology log. A lithology log place holder appears.

3. Notice that you are not prompted for data when creating log items in design mode.

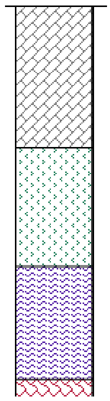


Figure 1.202 – The patterns in design mode are placeholders only.

Opening Data - Tutorial

Since you are not prompted for data in *design mode*, data needs to be added to the project. To open existing data files into new tables:

1. Click the **File** | **Open** command or the  button.

2. In the *Open* dialog, click on *Tutorial 1.xls* and click *Open*.

3. In the *XLS Import Options* dialog, select *Lithology* and click *OK*.

4. In the *Specify Worksheet Column Definitions* dialog, check the box next to *Specify Column Header Row* and click *Next*.

5. In the *Specify Data Type and Column Positions* dialog, select *Lithology* as the *Data type*.

6. Verify the columns are selected correctly and click *Finish*.

The data appears in a new table named *Lithology*. You can now attach the opened data to the design you previously created.

Attaching a Table to the Design – Tutorial

Once a table is opened, you can assign data to the lithology log in the borehole view. First, switch back to the borehole view by clicking the appropriate *Borehole* tab or by clicking the **Window | Borehole 1** command.

To assign data to the lithology log:

1. Click on the lithology log in either the view window or the **Object Manager**.

2. In the **Property Manager**, click on the **Lithology Log** tab.

3. The *Lithology Table* field is blank. Click in the blank box and select *Lithology* from the list. This is the table that was just opened.

4. Next to the *Lithology Keyword Column* option, click in the blank box and select *Lithology Keyword*.

5. Next to the *Indent Percentage Column* option, click on [*Unspecified*] and select Indent *Percentage*.

6. Next to the *Indent Keyword Column* option, click on [*Unspecified*] and select *Indent Keyword*.

7. Next to the *Indent Line Scale Column* option, click on [*Unspecified*] and select *Indent Line Scale*.

At this point, the log is ready to be activated.

Activating the Borehole – Tutorial

Once the lithology log properties are assigned, you can activate the borehole by selecting a borehole name. When a borehole name is selected, the data are linked to the borehole design. If there are multiple items in the borehole, each of the items must have tables and columns specified before activating the borehole.

To activate the borehole:

1. Click the **View | View Properties** command or click the  button.

2. In the **Property Manager**, click on the **View** tab.

3. Next to the *Hole ID Filter* option, click on the word -*Empty*- and select *DH-1* from the list.

4. Activate the borehole by clicking the **Log | Design Mode** command, clicking the  button, or pressing F4 on the keyboard.

The borehole is active, and the log displays empty fill patterns for each block. This is because fill patterns have not yet been set for the lithologies.

Creating a Lithology Scheme – Tutorial

This tutorial assumes you have completed the Editing Schemes lesson. You will now create a lithology scheme and link it to the lithology log you have created.

Creating the Scheme

To create a new lithology scheme:

1. Click the **Draw | Scheme Editor** command or click the button.

2. Click the button at the bottom of the dialog to create a new scheme. The *New Scheme* dialog opens.

3. In the **New Scheme** dialog, select the *Base Scheme on Column Data* option.

4. Select *Lithology* as the *Table Name*.

5. Select *Lithology Keyword* as the *Column Name*.

6. Enter the text *Lithology Fill* as the *Scheme Name*.

7. Select *Lithology Keyword* as the *Scheme Type*.

The New Scheme dialog lets you quickly create schemes based on a column, fig. 1. 203.

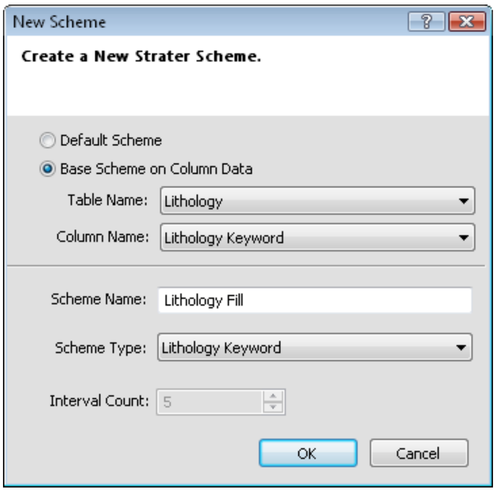


Figure 1.203 – The New Scheme panel

8. Click *OK*. The new scheme appears in the **Scheme Editor** under the *Lithology Keyword* section.

Editing the Scheme Properties

The new *Lithology Fill* scheme appears under the *Lithology Keyword* scheme types. Click the ⊞ next to *Lithology Fill* to open the list of the scheme item names. These scheme item names match the keywords in the table's *Lithology Keyword* column. You can click on each scheme item name and edit the properties for the item.

To edit the scheme item properties:

1. Click *Jasperoid* on the left side of the **Scheme Editor**.

2. The *Jasperoid* properties appear on the right side of the **Scheme Editor**.

3. Expand the *Fill Properties* section by clicking the ⊞ next to *Fill Properties* and set the fill pattern and colors for the *Jasperoid* scheme item.

4. Select *Granite* on the left side of the **Scheme Editor**. Set fill properties for the *Granite* scheme item.

5. Continue selecting fill properties for the rest of the scheme items, fig. 1.204, and click *OK*.

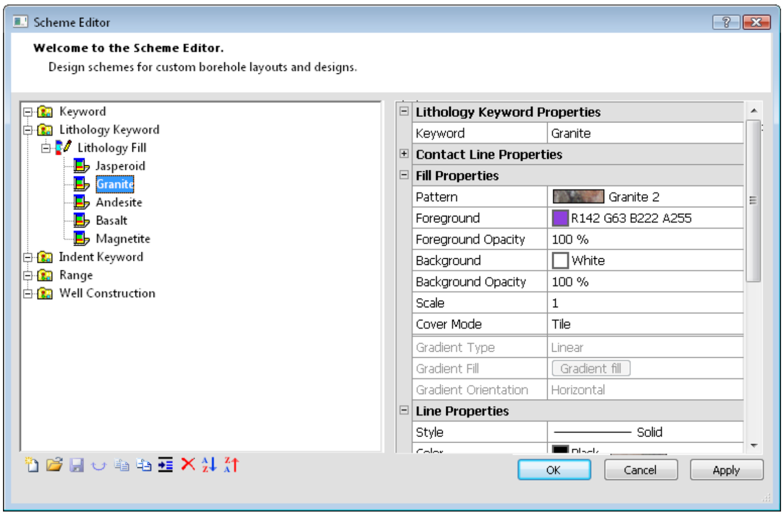


Figure 1.204 – The Scheme Editor Panel

Click the scheme item names on the left side of the **Scheme Editor** and then change the scheme item properties on the right side of the **Scheme Editor**.

Applying the Scheme

After creating the scheme, you can assign the lithology log to use the scheme in the **Property Manager**. To apply the scheme:

1. Click on the lithology log in the view window or **Object Manager**, if it is not already selected.

2. In the **Property Manager** select *Lithology Fill* as the *Lithology Scheme*.

Lesson 11 – Creating Logs From LAS Files – Tutorial

LAS Files contain curve information about a single well. To display a LAS curve in just a few steps:

1. Create a new project by clicking the *File | New | Project* command or the button.

2. Click the **Log | Line/Symbol** command or click the button.

3. Click in the log pane area where the line/symbol log should appear.

4. In the **Open** dialog, select the *SB16.LAS* file and click *Open*.

5. In the *LAS Import Options* dialog, set any necessary options and click *Import*.

The LAS data was opened into a new table and a line log was created using the first variable in the LAS file. You can change the variable the line log displays.

1. Click on the line/symbol log in the view window or **Object Manager**.

2. In the **Property Manager**, click on the **Line/Symbol Log** tab.

3. Click on the *DT* next to the *Data Column* option and select the desired column. The line/symbol log automatically updates to display the new data.

To create additional logs using the same LAS file:

1. Click the **Log | Line/Symbol** command or click the button.
2. Click in the log pane area where the line/symbol log should appear.
3. In the **Open** dialog, select the existing *SB16* table from the Use *Current Table* list and click *Open*. The new curve is created from the existing table.

Lesson 12 – Creating a Cross Section from Line/Symbol Logs – Tutorial

This is an optional, advanced topic in **Strater** that shows how to create cross sections from line/symbol logs and manually create the layers.

Opening a New Project

Before proceeding with this lesson, open a new **Strater** project by clicking the **File | New | Project** command or clicking the button. If you are prompted to save the existing project, save it if desired.

Downloading and Opening the Data – Tutorial

For this tutorial, let us use real world data, downloaded from the United States Geologic Survey (USGS). Some good sample data is available at *http://energy.cr.usgs.gov/OF00-200/WELLS/WELLIDX.HTM*. The location information displayed in the table has been copied to the **Strater** samples directory. This information will be used for the collars table.

Click on *Tunalik 1, Kugrua 1, Walakpa 2, and Walakpa 1* well names. After clicking on each well name, click the *LAS Format Log Data* link. On the new page, right-click on the *LAS File* name link to download the LAS data. Save all the LAS files to the same directory.

Opening the Data

Once the data is downloaded, open the location collars information into a new **Strater** table and open the LAS data into a single depth table. Use these steps:

Click the **File | Open** command.

Select the *LAS Collars.xlsx* file from the **Strater** Samples directory and click *Open*.

3. Select the *Collars* sheet and click *OK*.
4. In the *Specify Worksheet Column Definitions* dialog, check the box next to the *Specify Column Header Row* option and click *Next*.
5. In the *Specify Data Type and Column Positions* dialog,
   a. Set the *Data type* to *Collars*.
   b. Set the *Hole ID* to *Well Name*.
   c. Set the *Starting Depth* to *Datum, Kelly Bushing, ft*.

d. Set the *Ending Depth* to *Total Depth, ft*.

e. Set the *Elevation* to *Datum, sea level, ft*.

f. Set the *Easting* to *Longitude*.

g. Set the *Northing* to *Latitude*.

h. Click Finish.

6. Click the **File** | **New** | **Table** command.

7. Set the *Table Name* to *LAS Data* and the *Base Table Type* to *Depth Table* in the *Create New Table* dialog and click *Create*.

8. Click the **File** | **Import** command. In the *Import Data* dialog,

a. Browse to the directory where the LAS files have been saved.

b. Click on the first LAS file in the directory.

c. Hold down the SHIFT key on the keyboard and click on the last LAS file in the directory.

d. The *KG1.LAS, TU1.LAS, WA1.LAS*, and *WA2.LAS* files should be selected.

e. Click *Open*.

9. In the *LAS Import Options* dialog,

a. Check the box next to *Import Well Data* option.

b. Click the *Create Table* button.

c. Type *LAS Information* in the *Select Name* dialog and click *OK*.

d. Check the box next to the *Use same settings for subsequent LAS files* option.

e. Click *Next*.

10. In the *Import Data Into Current Table* dialog,

a. Click the *Create Columns from Source* button.

b. Click on *Depth* in the *Current Table Mapped Columns* list.

c. Select *M_DEPTH* in the *Import Source Data Columns* list.

d. Click the button and the *M_DEPTH* is mapped to the *Depth* column.

e. Click *Import* and the data is loaded into two tables, a *LAS Data* table and LAS *Information* table.

Creating the Cross Section – Tutorial

New cross section views in an existing project are created by clicking the *File* | *New* | *Cross Section View* command or clicking the button.

Creating the Cross Section

1. Click the *Cross Section* | *Create Cross Section* command.

2. In the *Create Well Selector* dialog, click the *Minimum* button to remove all but two wells from the list.

3. On the left side of the dialog,

a. Select the *Tunalik 1* well and click *Add*.

b. Select *Kugrua 1* and click *Add*.

c. Select *Walakpa 2* and click *Add*.

d. Select *Walakpa 1* and click *Add*.

4. On the right side of the dialog,

a. Select *Awuna 1* and click *Remove*.

b. Select *East Simpson 2* and click *Remove*.

c. The well order on the right side is the order the wells should be displayed in the cross section. The *Wells* in selector should show *Tunalik 1, Kugrua 1, Walakpa 2*, and *Walakpa 1*, in this order. If the wells are not in this order, click on the well name and drag the wells so that the order is the same as listed here.

5. Click *OK*.

6. Click *Yes* in the warning dialog.

7. In the *Import Or Select Data To Create Cross Section Logs* dialog:

a. To create the cross section from line/symbol logs, set the *Type of cross section logs to be created* to *Line/symbol log*.

b. Since the *Table* is set to *LAS Data*, the table is defined correctly.

c. Set the *Data Column* for each well to *SP*.

d. Click *OK* and the line logs are displayed for each well, fig. 1. 205.

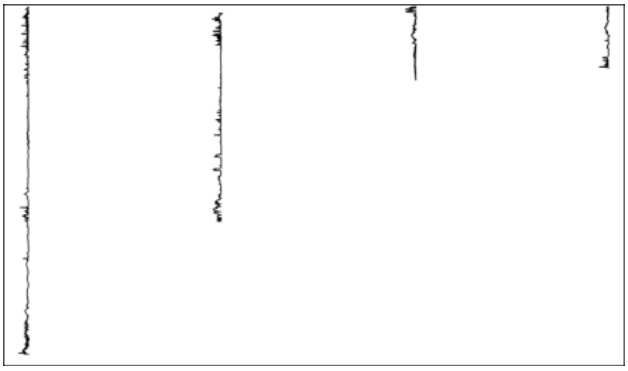


Figure 1.205 – Line logs are displayed for each well.

Importing and Filling Layers – **Tutorial**

To add the layers, you can either *click* on each log at the top or bottom of each layer or you can import a table of top or bottom values.

Adding the Layers

Since the USGS already determined the top values for several layers in each of these logs, we will import the layer tops.

1. Click on the *Cross-Section* object in the **Object Manager** to select it.

2. Click on the *Cross Section | Layer Marks | Import* command.

3. In the **Import Layer Marks** dialog, select the *LAS Collars.xlsx* file.

4. Select the *Tops* sheet and click *OK*.

5. In the **Specify Worksheet Column Definitions** dialog, check the *Specify Column Header Row* box and click *Next*.

6. In the **Specify Data Type and Column Positions** dialog,

a. Set the *Data type* to *Depth* (*Single Depth*).

b. Set the *Hole ID* to WELL NAME.

c. Set the *Depth* to DEPTH, feet.

d. Click *Finish*.

7. In the **Select Layer Mark Column** dialog, select ROCK UNIT as the *Column Name* and click *OK*.

8. Click *Yes* in the warning dialog and the layer lines are displayed, fig. 1.206.

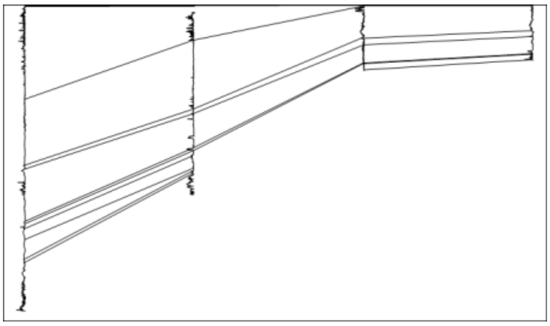


Figure 1.206 – The logs are connected with the layer marks from the Tops table

Filling the Layers

To fill the layers, a scheme will need to be created and the layer fill property will need to be activated.

1. Click the **Draw | Scheme Editor** command.

2. Click the button at the bottom of the *Scheme Editor* dialog.

3. In the *New Scheme* dialog,

a. Select *Base Scheme* on *Column Data*.

b. Set the *Table Name* to *Tops*.

c. Set the *Column Name* to ROCK UNIT.

d. Type a name for the scheme, such as *Cross Section Units*.

e. Click *OK*.

4. Click the next to the new scheme name.

5. Click on each scheme item and set the properties for that layer on the right side of the dialog.

6. Click *OK* to exit the *Scheme Editor*.

7. Click on the *Layers* object in the **Object Manager**.

8. In the **Property Manager**, click on the *Layers* tab.

9. Next to *Keyword Scheme*, click on the existing scheme name and select the *Cross-Section Units* scheme from the list.

10. Check the box next to *Fill between Layer Lines* to fill the layers with color.

11. Click *Yes* in the warning dialog and the layers are filled with the colors, as determined by the scheme, fig. 1.207.

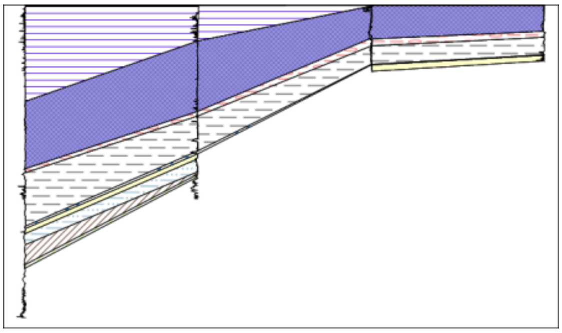


Figure 1.207 – The cross-section with filled layers

Lesson 13 – Displaying Deviated Boreholes in Maps and Cross Sections – Tutorial

Strater can create boreholes as vertical or as deviated. To display boreholes as deviated in both the map view and the cross section view, the deviation information is required. This data can be in a deviated survey table, a collars table, or in a depth or interval table.

Opening the Data

Before creating a map or cross section, we will open all the data tables first. There is an easy way to open multiple sheets from an Excel file in a **Strater** table. Therefore, we will use this method to open all the required sheets for this tutorial.

1. Click the *File | New | Project* command or click the  button to open a new blank project.

2. Click on the *Project Settings* tab to open a table view.

3. Click the *File | Open Multiple* command.

4. In the **Open Data** dialog, click on *Tutorial 3.xlsx* file and click *Open*.

5. In the *Multisheet Selection* dialog, leave all three sheets selected and click OK. Because the sheets are opened in the order listed, you will step through the next steps for each sheet.

6. For the *Collars* sheet:

a. In the *Specify Worksheet Column Definitions* dialog, make sure *Specify Column Header Row* is checked and set to 1. Click *Next*.

b. In the *Specify Data Type and Column Positions* dialog, make sure that the Data type is set to *Collars* and all of the columns are defined correctly. Click *Finish*.

7. For the *Survey* sheet:

a. In the **Specify Worksheet Column Definitions** dialog, make sure *Specify Column Header Row* is checked and set to 1. Click *Next*.

b. The Specify Data Type and Column Positions dialog, make sure that the Data type is set to Survey and all of the columns are defined correctly. Click Finish.

8. For the *Stratigraphy* sheet:

a. In the Specify Worksheet Column Definitions dialog, make sure Specify Column Header Row is checked and set to 1. Click *Next*.

b. In the Specify Data Type and Column Positions dialog, make sure that the Data type is set to *Lithology* and all of the columns are defined correctly. Click *Finish*.

Now all of the data tables are opened, the map and cross section can be created.

Creating Deviated Boreholes in a Map View – Tutorial

To create the deviated boreholes in the map view, a new map view must be created with the wells map layer. The properties of the wells layer are then edited to display the deviations from the survey table.

Creating the Map

1. Click the *File | New | Map View* command or click the  button to open a new *map view*.

2. Click the **Map | Create Well Map** command or click the  button to create a new *well map layer*.

The wells map is created with a point at each well location on the map, fig. 1.208.

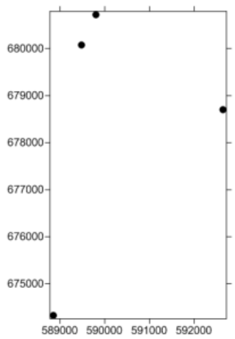


Figure 1.208 – The map is created with the well locations for each well in the collars table.

Displaying the Map with Deviated Wells

Once the map is created, the wells layer can be edited to show the deviations.

1. Click on the *Wells 1* layer in the *Object Manager* to select the well map layer.

2. In the *Property Manager*, click on the *Deviation Path* tab.

3. Check the box next to the *Show Deviation Path* option.

4. Click the *empty* box next to Deviation Table and select [*Survey Table*].

5. To show the well labels, click on the *Label* tab.

6. Click on the [*None*] option next to *Label 1* and select *Hole ID*. The borehole names are added to the map.

The wells map updates to show the deviation on the two center wells. The far right T-45 well's deviation path is outside the limits of the map. To update the limits,

1. Click on the *Map 1* object in the **Object Manager** to select the entire map.

2. Click on the *Limits* tab in the **Property Manager**.

3. Click the *Fit All* button next to the *Fit All* command. All of the wells and their deviations are displayed, fig. 1.209.

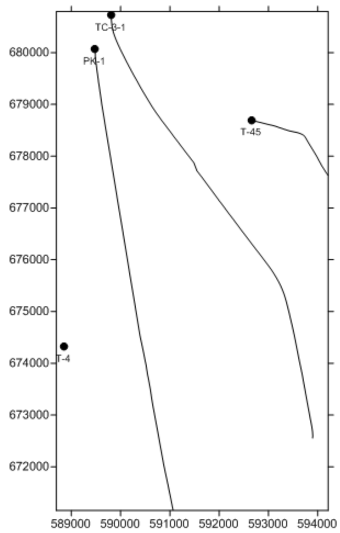


Figure 1.209 – Well locations and deviation paths displayed in the map view

Creating Deviated Boreholes in a Cross Section View – Tutorial

To create the deviated boreholes in the cross section view, a new cross section view must be created with the wells to be displayed. The properties of the cross section are then edited to display the deviations from the survey table.

Creating the Cross Section

1. Click the *File* | *New* | *Cross Section View* command or click the button to open a new *cross section view*.

2. Click the **Cross Section** | **Create Cross Section** command or click the button to create a new *cross-section*.

3. In the *Create Well Selector* dialog:

a. Click on the T-4 well in the *Wells in selector* list. Click and hold the left mouse button and drag the T-4 well to the top of the list.

b. Click on the T-45 well in the *Wells in select* list. Click and hold the left mouse button and drag the T-45 well to the bottom of the list.

c. Click *OK*.

4. In the *Import Or Select Data To Create Cross Section Logs* dialog, notice that *Lithology/Zone bar log* is selected and that each *Hole ID* has a *Table* and *Data Column* defined. Click *OK*.

5. To show the well labels, click the *Cross Section | Add Well Headers* command.

The cross section is created, showing a lithology log for each well and the connecting layers between wells, fig. 1.210.

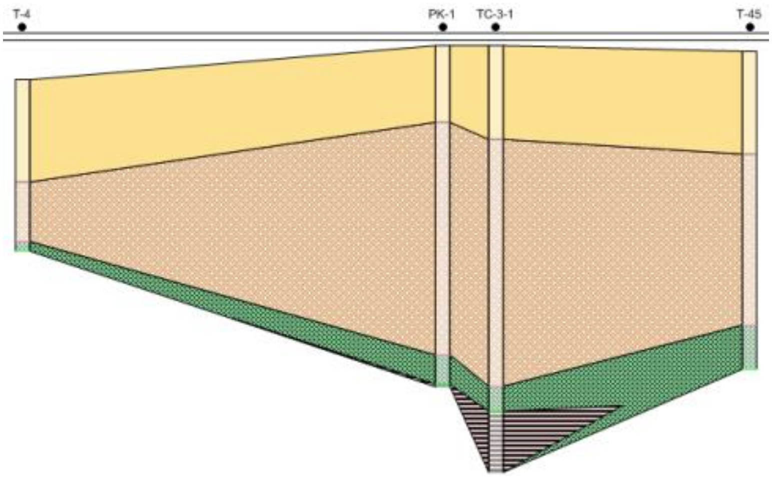


Figure 1.210 – The original cross-section is created with vertical wells

Displaying the Cross Section with Deviated Wells

To change the wells so that the deviation paths are displayed, the *Logs* layer, *Cross Section* object, and cross section *View* properties need to be edited.

- Click on the *Logs* item in the *Object Manager*.
- In the *Property Manager*, click on the *Logs* tab.
- Set the *Hole Inclination Column* to [*From survey table*]: *Survey*.
- Notice that the *Hole Azimuth Column* automatically changes to the survey table.
- Click on the *Cross-Section* object in the **Object Manager**.
- On the *Cross-Section* tab, check the box next to the *Display Logs As Deviated* option.
- If desired, click *Yes* in the dialog so that the *Depth Method* is automatically set to *True Vertical Depth*. Alternatively, click No and set the *Depth Method* manually.
  - Click the *View | View Properties* command.
  - Click on the **View** tab in the **Property Manager**.
  - Set the *Depth Method* to *True Vertical Depth*.

- If prompted to recreate the cross section, click *Yes* and the deviated wells are displayed in the cross section view.

The cross section is updated showing the deviations for the wells, fig. 1.211.

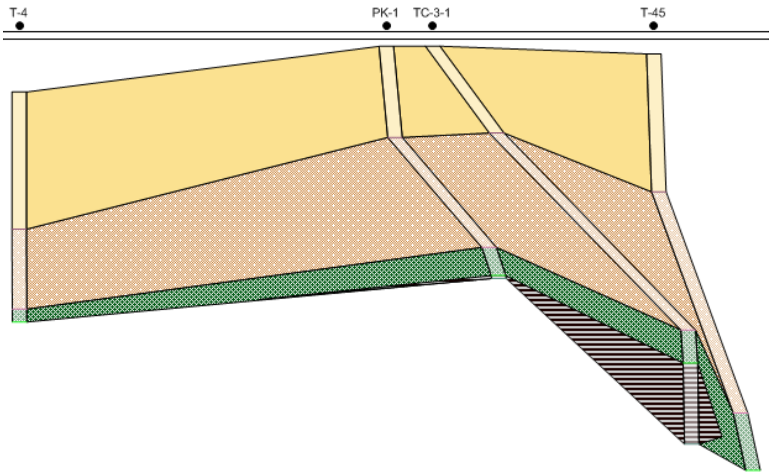


Figure 1.211 – The wells in the cross section are updated to show the deviations

1.11.3. Strater continued

Data Tables

Data, Schemes, and Log Properties

The data, scheme, and log, map, or cross section properties are all related in the process of creating a log in a *borehole view* or *cross section view*, creating a map *Wells* layer, or creating *layers* in a cross section. The data contains depth information (either single depth or from-to interval depth), borehole names, and the data to be displayed on the log. *Schemes* contain line, symbol, label, and fill property information that links the data to the log. When scheme information (keywords or numeric ranges) is found in the data, the logs in the borehole or cross section display properties of the scheme. The *Property Manager* determines which data table and column are used to create the log, the scheme to use (if any), and properties such as the log width. Each *log item* can use a different data table, column, scheme, and properties.

Project data, schemes, and log properties are all related in the process of creating a borehole log.

1. The data in each row is linked to a scheme item. This scheme links the Au (ppb) values from column C. In this case, the data in row 12 has a value of 492 and appears at a depth of 24. The data in row 12 falls within the range scheme item of 250 to 500. Note the fill is a solid light orange.

2. A bar log is created displaying the *Au (ppb)* data column. The *Au Concentration* scheme is selected.

The bar log is displayed. The *Au Concentration* scheme determines the appearance of the log. The color at the depth 24 is light orange, as indicated by the scheme, fig. 1.212.

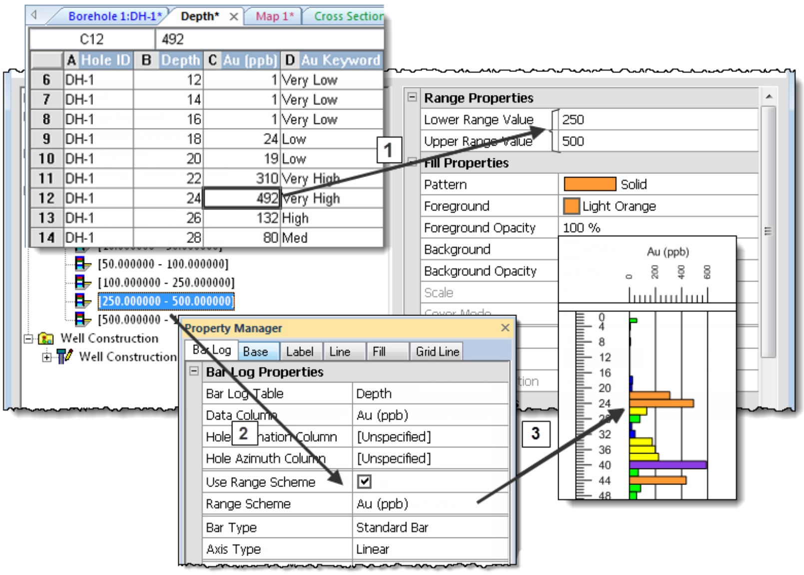


Figure 1.212 – The diagram shows the connection between a value in the table column, the scheme, and the log being displayed.

View Window Types

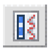
There are four different view types available in a **Strater** workspace: borehole views, map views, cross section views, and tables. A **Strater** project has no limit to the number of views that can be associated with it.

Borehole View

The primary graphical component to a **Strater** document is a *borehole* view. A borehole view represents a collection of logs and drawing objects used to display data graphically for one or more boreholes. A borehole view may be derived from a *template* file or it can be created from a default view window with the necessary *log* items defined to create the borehole. The borehole view displays the true data for the project once data are defined in the project file.

You are presented with an empty borehole view when you first start **Strater**.

Opening a New Borehole View

During a **Strater** session, new projects with an empty borehole view are created with the **File** | **New** | **Project** command. New borehole views in an existing project are created with the **File** | **New** | **Borehole View** command, clicking the  button, or right clicking in the **View Manager** and selecting *New Borehole View*.

Opening an Existing Borehole View

Existing borehole views are opened by clicking the appropriate **Borehole** tab, clicking on the borehole name in the **View Manager**, or by selecting **Window** | **[Borehole name]**. By default, the first borehole view is named **Borehole 1** so this borehole view would be opened by choosing the **Window** | **Borehole 1** command. To open an existing project, use the **File** | **Open** command.

Map View

Map views graphically display wells on a map. Map views display any wells listed in the *collars* table. Wells can be removed individually to customize the appearance of the map view. Map views also can display *base* maps, such as field outlines or exported **Surfer** maps. Drawing objects and labels can be added to a map view. Map views can have maps from different *projections* and can *convert* the map into any supported projection.

Opening a New Map View

New map views are created in an existing project by clicking the **File** | **New** | **Map View** command, clicking the  button, or right clicking in the *View Manager* and choosing *New Map View*.

Opening an Existing Map View

Existing map views are opened by clicking the appropriate **Map** tab, clicking the map view name in the **View Manager**, or by clicking **Window** | **[Map name]**. By default, the first map view is named **Map 1** so this map view would be opened by clicking the **Window** | **Map 1** command.

Cross Section View

Cross section views display multiple wells on a page. Each well can have a variety of curves, similar to a borehole view. Wells are connected to display layers, zones, or lithologies across the page, connecting information from the wells. Automatic connections between wells or manual connections between wells can be made. Well spacing and elevation hanging can be altered to give you the look you need to display your data. Deviated wells can be displayed as vertical or with the deviation displayed in the cross section. The cross section view also allows data to be exported to a data file for use in **Surfer** or exported to a **Voxler** 3D display to create fence diagrams. Drawing objects and labels can be added to a cross section view.

Opening a New Cross Section View

New cross section views are created in an existing project by clicking the **File** | **New** | **Cross Section View** command, clicking the  button, or right-clicking in the *View Manager* and choosing *New Cross Section View* to add a new blank cross section view to the existing project.

A new cross section window can also be created with the *Cross Section* | *Create Cross Section* command.

Opening an Existing Cross Section View

Existing cross section views are opened by clicking the appropriate **Cross Section** tab, clicking the cross section view name in the **View Manager**, or by clicking **Window** | **[Cross Section name]**. By default, the first cross section view is named

Cross Section 1 so this cross section view would be opened by clicking the **Window** | **Cross Section 1** command.

Data Table View

All *data* used to generate logs in a borehole view must be opened or imported into a **Strater** project. Data tabs represent these data tables. Collar tables, depth tables, interval tables, lithology tables, project settings tables, survey tables, text item tables, and well construction tables can be created in **Strater**. Each table type has a different function in **Strater**. Refer to the *Table Types* page for an in-depth discussion of the types.

Opening a New Table View

During a **Strater** session, new blank tables are created by clicking the **File** | **New** | **Table** command, clicking the  button, or by pressing CTRL+W on the keyboard.

Opening an Existing Table in a New View

To open existing data into the current project, click the *File* | *Open* command. If you want the worksheet to appear in a new data table, select the worksheet and click *Open*. Step through the opening process and a new data table is added.

To import existing data into the current project in an existing table, click on the table where you want the data to appear. Click **File** | **Import**. In the **Import Data** dialog, select the data file and click *Open*. Step through the importing process and the data is added to the current table.

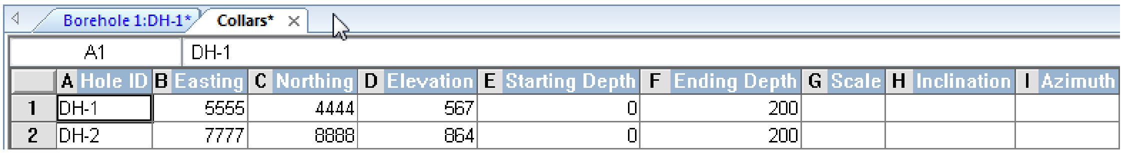
Table Types

Collars tables, depth tables, interval tables, lithology tables, project settings tables, survey tables, text item tables, and well construction tables can be created in **Strater**. Each table type has a different function in **Strater**. Each table has different default required columns. Although these columns are all created, not all of the columns need to have data stored in the column to create the logs.

Collars Table

Collars tables contain location information for each borehole. The default column definitions include *Hole ID, Easting, Northing, Elevation, Starting Depth, Ending Depth*, *Scale*, *Inclination* (or *Dip*), and *Azimuth*. The data in this table can be used for *linked text*, setting the *scaling* parameters for the borehole view, or specifying the elevation of the borehole collar for depth logs. The *Inclination* (or *Dip*) and *Azimuth* columns can be used to calculate *true vertical depth* for deviated borehole displays. The collars table is also used for placing borehole locations in a *map view* and for calculating *distances* in a *cross-section view*.

In a collars table each row contains the information for a separate borehole. All information for one borehole must be on a single line, fig. 1.213.



	A Hole ID	B Easting	C Northing	D Elevation	E Starting Depth	F Ending Depth	G Scale	H Inclination	I Azimuth
1	DH-1	5555	4444	567	0	200			
2	DH-2	7777	8888	864	0	200			

Figure 1.213 – The Table Format

Note that a project can have multiple collars tables, but each borehole should be listed in only a single collars table.

Column Definitions

Table 9. Column definitions

Hole ID	Contains the borehole ID, one borehole per line. Each borehole should only be listed in a single collars table.
Easting	Contains the X value, easting, longitude, or other horizontal location value of the borehole.
Northing	Contains the Y value, northing, latitude, or other vertical location value of the borehole.
Elevation	Contains the Z value or elevation of the borehole.
Starting Depth	Contains the starting Z value for the borehole in depth or elevation units. This is useful when using the *Print Multiple Logs* or *Export Multiple Logs* commands with different boreholes. If all boreholes have the same starting depth, select *[0]* from the list.
Ending Depth	Contains the ending Z value for the borehole in depth or elevation units. This is useful when using the *Print Multiple Logs* or *Export Multiple Logs* commands with different boreholes.
Scale	Contains the *Scaling Depth Per Inch* value. This is useful when using the *Print Multiple Logs* or *Export Multiple Logs* commands with different boreholes.
Inclination	The angle the borehole is oriented, in degrees. Inclination varies from 0 to 180. 0 indicates vertical pointing down, 90 indicates horizontal, and 180 indicates vertical pointing up. Negative and positive inclination values are treated the same. When recorded in a collars table, the azimuth and inclination apply to the entire borehole length.
Dip	*Dip* is an alternate method of calculating the angle the borehole is oriented. Dip is oriented in degrees and varies from -90 to 90. -90 indicates vertical pointing down, 0 indicates horizontal, and +90 indicates vertical pointing up
Azimuth	The compass orientation of the borehole. Azimuth is in degrees and varies from 0 (true vertical north) to 360. When recorded in a collars table, the azimuth and inclination (or dip) apply to the entire borehole length.

Depth Table

Depth tables are used for depth and variable information. The default column definitions include *Hole ID*, *Depth*, and additional parameter columns. The depth information is contained in one column. All variable information relates to that specific depth. Depth tables are used for *depth*, *line/symbol*, *cross plot*, *bar*, *percentage*, *tadpole*, *post*, *classed post*, and *function* logs. Depth tables include a single depth measurement and parameter values associated with that specific measurement, fig. 1.214.

Borehole 1:DH-1* | Depth*

D20

	A Hole ID	B Depth	C Parameter
1	DH-1	2	56
2	DH-1	4	6
3	DH-1	6	1
4	DH-1	8	8
5	DH-1	10	1
6	DH-1	12	1

Figure 1.214 – The Table Depth Format

Column Definitions

Hole ID	Contains the borehole ID associated with the depth.
Depth	Contains the depth or elevation of the recorded parameter.
Parameter(s)	One or more columns that contain information, such as contamination, chemical concentration, etc. The parameter value is recorded at the depth.

Interval Table

Interval tables are used to show a variable that occurs over a distance interval. There are two depth columns (From and To) in an interval table. The default column definitions are *Hole ID*, *From*, *To* and any additional parameter columns. The interval lengths can vary in the table. Interval tables are used for *depth*, *line/symbol*, *cross plot*, *zone bar*, *bar*, *percentage*, *tadpole*, *post*, *classed post*, *complex text*, *graphic*, *lithology*, *well construction*, and *function* logs. Interval tables measure variables within a defined interval depth based on *From* and *To* measurements, fig. 1.215.

Borehole 1:DH-1* | Interval*

D25 | 0.06

	A Hole ID	B From	C To	D Parameter 1	E Parameter 2
1	DH-1	0	2	0.36	0.005
2	DH-1	2	4	0.37	0.002
3	DH-1	4	6	0.33	0.001
4	DH-1	6	8	0.27	0
5	DH-1	8	10	0.37	0
6	DH-1	10	12	0.27	0

Figure 1.215 – The Table Interval Format

Column Definitions

Hole ID	Contains the borehole ID associated with the interval.
From	Contains the top depth or elevation of the recorded parameter.
To	Contains the bottom depth or elevation of the recorded parameter.
Parameter(s)	One or more columns that contain information, such as contamination, chemical concentration, etc. The parameter value is recorded across the interval.

Lithology Table

Lithology tables are a special type of interval table. These tables define the properties of *lithology logs* using keywords and *schemes*. The default column definitions include *Hole ID, From, To, Lithology Keyword, Lithology Description, Indent Percentage*, *Indent Keyword*, and *Indent Scale*. Although the primary purpose of a lithology table is to create a lithology log, the lithology table can also be used for depth, line/symbol, cross plot, zone bar, bar, percentage, tadpole, post, classed post, complex text, graphic, well construction, and function logs. Lithology tables use schemes extensively and describe lithographic features in detail, fig. 1.216.

Borehole 1:DH-1* | Lithology*

G10 Medium-Hard

	A Hole ID	B From	C To	D Lithology Keyword	E Lithology Description	F Indent Percentage	G Indent Keyword	H Indent Scale
1	DH-1	0	40	Jasperoid	massive silica cut by tm and	90	Hard	
2	DH-1	40	80	Granite	felsic intrusive with veins of K	75	Medium-Hard	
3	DH-1	80	95	Andesite	grey fine-grained andesitic la|	65	Medium-Soft	
4	DH-1	95	102	Basalt	porphyritic basalt flow with cl	45	Soft	
5	DH-1	102	115	Andesite	grey fine-grained andesitic la|	65	Medium-Soft	

Figure 1.216 – The Table Lithology Format

Column Definitions

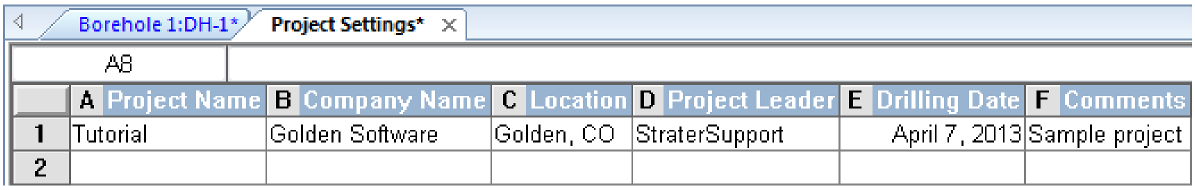
Table 10. Column definitions

Hole ID	Contains the borehole ID associated with the interval.
From	Contains the top depth or elevation of the recorded parameter.
To	Contains the bottom depth or elevation of the recorded parameter.
Lithology Keyword	Contains keywords to match the corresponding *lithology scheme* items. This is usually the rock name. This column is used to create fill patterns for the various interval blocks in the log.
Lithology Description	Contains full text descriptions, typically for the rock type, and can be used for *complex text* logs.
Indent Percentage	Contains the percentage of the interval block to display in the left-right direction. The normal range is zero to 100. None of the block is displayed with a zero percentage and 100 percent displays the whole block. The indent percentage can be used to display weathering resistance in a lithological unit.
Indent Keyword	Contains keywords for the *lithology keyword scheme* items. The indent keyword can be used to define the shape of the indent line.

Indent Scale	Controls the overall scaling width of the lithology indent line definition. The range is zero to 100. All values greater than 100 are set to 100 and all values less than zero are set to zero. A zero scale flattens the line and a 100 scale sets the width of the line to half the width of the lithology log. Therefore, if the lithology log is three inches wide, the range of the lithology line represents 1.5 inches. The indent scale should be used with the indent percentage.

Project Settings Table

The project settings table is a special type of text table and is automatically created when you open a new project. It is used to store project information, such as the project name, project location, project leader, and miscellaneous comments. The default column definitions are *Project Name*, *Company Name*, *Location*, *Project Leader*, *Drilling Date*, and *Comments*. The information stored in this table is for the whole project; it is not borehole specific. This table stores data that is often used in *linked text* objects. A single row in the project settings table includes all pertinent information for the entire project, fig. 1.217.



	A Project Name	B Company Name	C Location	D Project Leader	E Drilling Date	F Comments
1	Tutorial	Golden Software	Golden, CO	StraterSupport	April 7, 2013	Sample project
2						

Figure 1.217 – The Table Project Settings Format

Column Definitions

Project Name	Contains the name or description of the project.
Company Name	Contains the company name or identifying feature.
Location	Contains the location of the project.
Project Leader	Contains the name of the person or group leading the project.
Drilling Date	Contains the date that the project or borehole was started.
Comments	Contains any additional comments that should be recorded for the project.

Survey Table

Survey tables are a special type of depth table used to indicate the direction and azimuth of a directional borehole as it changes down the hole. The default column definitions include *Hole ID, Depth*, *Inclination*, and *Azimuth*. The survey table *Inclination* and *Azimuth* columns can be used for calculating the *true vertical depth* of boreholes. The survey table is used in conjunction with depth or interval tables for deviated boreholes. The survey table contains inclination (or dip) and azimuth information down the borehole, fig. 1.218.

	A Hole ID	B Depth	C Inclination	D Azimuth
1	DH-1	0	16.33	200.3
2	DH-1	5	15.24	175.3
3	DH-1	10	8.78	146.1
4	DH-1	15	3.91	158.7
5	DH-1	20	10.03	158.5
6	DH-1	25	19.18	178.2

Figure 1.218 – The Table Survey Format

Note that a project can have multiple survey tables, but each borehole should only be listed in a single survey table.

If deviated boreholes are defined, the inclination (or dip) and azimuth should both come from the same table. The order **Strater** looks for the inclination (or dip) and azimuth is first measured depth table, then in the survey table, then from a collars table. If inclination (or dip) and azimuth are not found in any location, the measured depth is used as the true vertical depth.

Table 11. **Column Definitions**

Hole ID	Contains the borehole ID, one borehole per line. Each borehole should only be listed in a single survey table.
Depth	Contains the depth or elevation for the recorded deviation.
Inclination	The angle the borehole is oriented in degrees. Inclination varies from 0 to 180. 0 indicates vertical pointing down, 90 indicates horizontal, and 180 indicates vertical pointing up. When recorded in a survey table, the azimuth and inclination apply from the depth to the next recorded depth.
Dip	*Dip* is an alternate method of calculating the angle the borehole is oriented. Dip is oriented in degrees and varies from -90 to 90. -90 indicates vertical pointing down, 0 indicates horizontal, and +90 indicates vertical pointing up
Azimuth	The compass orientation of the borehole's deviation. Azimuth is in degrees and varies from 0 (true vertical north) to 360. When recorded in a survey table, the azimuth and inclination (or dip) apply from the depth to the next recorded depth.

Text Item Table

Text tables are tables designed to store attributes for the particular borehole, fig. 1.219. The default column definitions include Hole ID and Depth. Other columns can be added, depending on the project. For example, drilling date, temperature, geologist, location, etc. can be stored in a text item table. Any type of data can be imported into this table. If there is a Hole ID defined in the table, the data can be used for *linked text*. The text item table is a good place to store miscellaneous information about the various boreholes.

Borehole 1:DH-1* | Text Item Table*

C13

	A Hole ID	B Depth	C Notes
1	DH-1	400	core sample
2	DH-2	150	drill bit replaced
3	DH-2	400	screen placement
4	DH-3	50	no samples

Figure 1.219 – The Table text item format

Column Definitions

Hole ID	Contains the borehole ID associated with the depth.
Depth	Contains the depth or elevation of the recorded text.
Text	One or more columns that contain information, such as contamination, chemical concentration, notes, etc. The parameter value is recorded at the depth.

Well Construction Table

Well construction tables are a special type of interval table used to define the geometry of specific items in a *well construction log*, such as casing and cap information. The default column definitions include *Hole ID*, *From*, *To*, *Outer Diameter*, *Inner Diameter*, *Offset*, and *Item information*. Well construction logs use keywords and *schemes* to define the properties for each item in the well construction table. You can have any number of well construction tables with different schemes within the project. Although the primary purpose of a well construction table is to create a well construction log, the well construction table can also be used to create *depth*, *line/symbol*, *crossplot*, *zone bar*, *bar*, *percentage*, *tadpole*, *post*, *classed post*, *complex text*, *graphic*, *lithology*, and function *logs*. Well construction tables include all information necessary to create well construction logs, fig. 1.220.

Borehole 1:DH-1* | Well Construction*

E14 | 0

	A Hole ID	B From	C To	D Outer Diameter	E Inner Diameter	F Offset	G Item
1	DH-1	0	5	8	0	0	Fill
2	DH-1	5	15	8	0	0	Cement
3	DH-1	15	25	8	0	0	Bentonite
4	DH-1	25	190	8	0	0	Sand
5	DH-1	190	200	8	0	0	Slough

Figure 1.220 – The Table Well Construction Format

Note

The order in which these items are listed in the table is the order they will be created. Therefore, solid items or items to be layered in the back must be added first in the borehole order.

Table 12. **Column Definitions**

Hole ID	Contains the borehole ID associated with the interval.
From	Contains the top depth or elevation of the recorded well construction item.
To	Contains the bottom depth or elevation of the recorded well construction item.
Outer Diameter	Contains the outside diameter of the item.
Inner Diameter	Contains the inside diameter of the item, used to create a cut-out section out of the middle of the items so that the center has no line or fill properties.
Offset	Contains the offset of the item within the well. Positive values move the item away from the center.
Item	Contains the keyword for the well construction scheme items. This is usually the name of the item (fill, cement, screen, etc).

Math Text and Linked Text

You can use math text to alter the appearance or add mathematical concepts or symbols to text entries in a data table. For example, if collar table data or lithology table data is actually displayed in a borehole view you can modify its appearance (or add symbols, etc.) using math text. See *Math Text Instructions* for detailed information.

Modifying Imported Data for use with Logs

Many users have data in external tables (such as .XLS) that they want to import into **Strater** to be used in logs. Use the following information to make this importing process as easy as possible.

Strater Data Table Requirements

Strater data tables have specific requirements for column names and types of data in columns, and each log type has required columns that must be present in order for **Strater** to even recognize the table as usable for a particular log type.

In some cases, **Strater** does not format the external data in a manner usable. However, the data importing process includes dialog boxes that allow you to modify and adjust the data being imported to conform to the data table requirements.

Using Data Tables Without Headers

Strater assumes that the first row is the default location for column header information. If an imported data table does not include this information, you can add it during the import process or edit the row number for the row containing the header. Column header labels are not required, but do make working with data easier. **Strater** can use data tables that do not have column header information

As an example, the following is a data table that does not include header column information, fig. 1.221:

log symbol data no headers.xls

	A	B	C
1	2	56	DH-1
2	4	6	DH-1
3	6	1	DH-1
4	8	8	DH-1
5	10	1	DH-1
6	12	1	DH-1
7	14	1	DH-1
8	16	1	DH-1
9	18	24	DH-1
10	20	19	DH-1
11	22	310	DH-1

Figure 1.221 – A modified table

There is usable data in this table, but because the columns are not labeled you can add the column headers during the import function:

1. Click the **Log** | **Line/Symbol** command or click the button.

2. Click inside the log pane to fix the position where a line/symbol log will be displayed.

3. The *Open* dialog is displayed. Navigate to the location of the file to open, click on the file name to select it, and click *Open*.

4. The *Specify Worksheet Column Definitions* dialog opens, fig. 1.222. Note the content of the *Column Name* field:

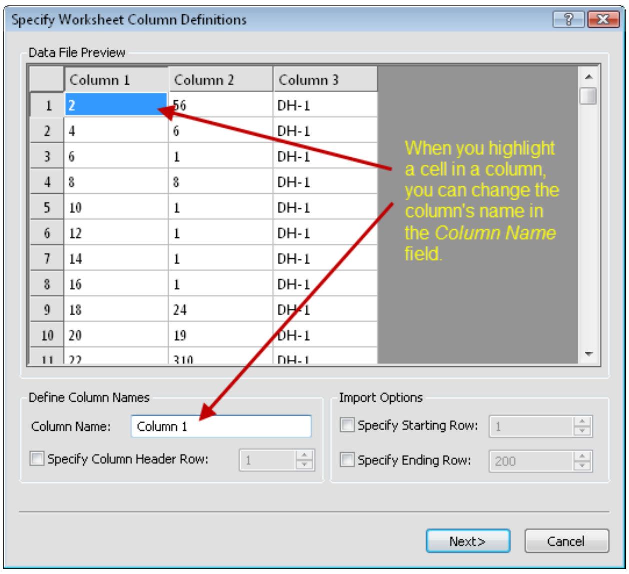


Figure 1.222 – The Specify Worksheet Column Definitions dialog allows you to name each column in an imported data table.

5. Enter a name for the first column in the *Column Name* field.

6. Click a cell in column 2, which changes contents of the *Column Name* field.

7. Enter the name for column 2 in the *Column Name* field.

8. Repeat this process for Column 3.

9. Do not click the *Specify Column Header Row* check box because the actual column header is not in a table row.

10. Click *Next*.

11. In the *Specify Data Type and Column Positions* dialog, link the data columns and click *Finish*. The data appears in the table, ready to use.

Associating Data Table Columns to Required Log Columns

Each log type has specific required columns of data that must appear in a specific location in the table. As an example, the Hole ID column is always in the first (far left) position in the **Strater** data tables.

You can specify which column of data in the data file corresponds to the required column in the data table. **Strater** will then change the location of the columns to match the position you specified during the import process. You can import from .XLS files even if the columns are not named or placed in accordance with **Strater** default values.

Let us use as an example an Excel spreadsheet data table, such as the one below, fig. 1.223:

log symbol data.xls

	A	B	C
1	drill depth	Au	Borehole Name
2	2	56	DH-1
3	4	6	DH-1
4	6	1	DH-1
5	8	8	DH-1
6	10	1	DH-1
7	12	1	DH-1
8	14	1	DH-1
9	16	1	DH-1
10	18	24	DH-1
11	20	19	DH-1

Figure 1.223 – The Excel sample table

All the required columns (Hole ID, Depth) are present for a line/symbol log, but they are named differently and not in the default order.

To import into **Strater** for a line/symbol log:

1. Click the **Log** | **Line/Symbol** command or click the button.

2. Click inside the log pane to fix the position where a line/symbol log will be displayed.

3. The *Open* dialog is displayed. Navigate to the location of the file to import, highlight the file and click Open.

4. The *Specify Worksheet Column Definitions* dialog opens. Click the *Specify Column Header Row* check box because the column header information (Drill Depth, Au, Borehole Name) is in row 1, which is the default row for header information.

5. Click *Next*. The *Specify Data Type and Column Positions* dialog opens:

6. Note that the contents of the *Hole ID* and *Depth* fields are incorrect. They display the column names associated with the default positions for these two required data columns. Because the columns of the imported .XLS file has these required columns in different locations, you must change these two fields.

7. Use the drop-down menus to select the appropriate columns for *Hole ID* and *Depth*: Change the required column definitions to match the column locations in the imported data table, fig. 1.224.

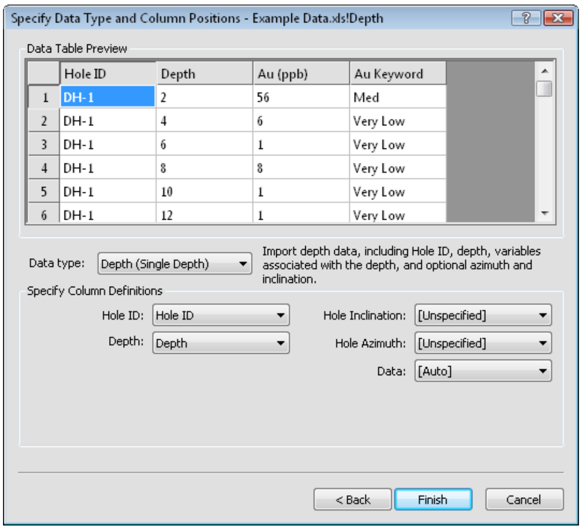


Figure 1.224 – The Example Excell Data.xls | Depth panel

7. Click *Finish*. The log is correctly displayed.

8. Click the **Sheet1** tab. Note that the names of the required columns have changed from their names in the imported .XLS file. In addition, their positions have changed, fig. 1.225:

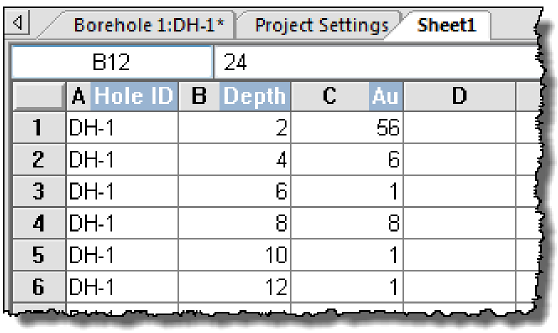


Figure 1.225 – The Project Settings Data changed

The required column names will always appear as the default names, even when the source data has different names for these columns.

By using this technique, you can adapt data files in **Strater** without having to go into the source data file location and make edits in the original file. As long as the required data is present in columns, you can make the necessary adjustments during the data importing process.

Creating Data

Data can be opened, imported into an existing project data table, entered into a new, blank table. **Strater** can read numerous file formats such as data files (including Excel spreadsheets and ASCII text files), databases, and LAS files. **Strater** can also link to virtually any database system installed on your computer using the Windows *Data Link Source* options.

Creating a Blank Table

During a **Strater** session, new blank tables are created by clicking the *File | New | Table* command, clicking the button, or pressing CTRL+W on the keyboard. The *Create New Table* dialog opens. Set any options for the table type, click *Create*, and a new blank table is created. You can enter data manually or import data into this table.

Importing Data

Strater allows you to import data from various data sources. You can maintain your data in other applications, such as a database, and import the tables you need into **Strater** to create boreholes. Any changes made to the data in the original application can be updated in **Strater** with the *File | Reload Data* or *File | Reload All* commands. Data imported into **Strater** can be edited and transformed. When changes are made to data in **Strater** the original data external to **Strater** is not changed.

Opening Data into a New Table

To open data into a new data table in the current project:

1. Click the *File | Open* command, click the button, or press CTRL+O on the keyboard.

2. In the **Open** dialog, select the file and click *Open*.

Set any options in the dialog:

a. If the file is an Excel file containing multiple worksheets, the **XLS** or **XLSX Import Options** dialog opens. Select the data sheet to open and click *OK*.

b. In the *Specify Worksheet Column Definitions* dialog enter the column definition information and click *Next*.

c. In the *Specify Data Type and Column Positions* dialog enter the definition information and click *Finish*.

4. The data is added to the project as a new data table tab.

Importing Data into an Existing Table

To add data to any existing data table:

1. Click the table tab that should have the new data.

2. Type data directly in the table view.

3. To import data from an existing file, click the *File | Import* command or click the  button.

4. In the *Import Data* dialog, select the data file and click *Open*.

5. Set any options in the dialog:

a. If the file is an Excel file containing multiple worksheets, the **XLS** or **XLSX Import Options** dialog opens. Select the data sheet to import and click *OK*.

b. In the *Specify Worksheet Column Definitions* dialog enter the column definition information and click *Next*.

c. In the *Specify Data Type and Column Positions* dialog enter the definition information and click *Finish*.

6. The data is added to the current data table.

Note About Importing Data Into an Existing Table

Data are imported into a current table when that data table is selected in the workspace. If you open data during a log item creation, the data are always opened into a new table.

Specify Worksheet Column Definitions

The **Specify Worksheet Column Definitions** dialog is used to select the column names and number of rows to import. Set the rows to import and the header row in the Specify Worksheet Column Definitions dialog, fig. 1.226.

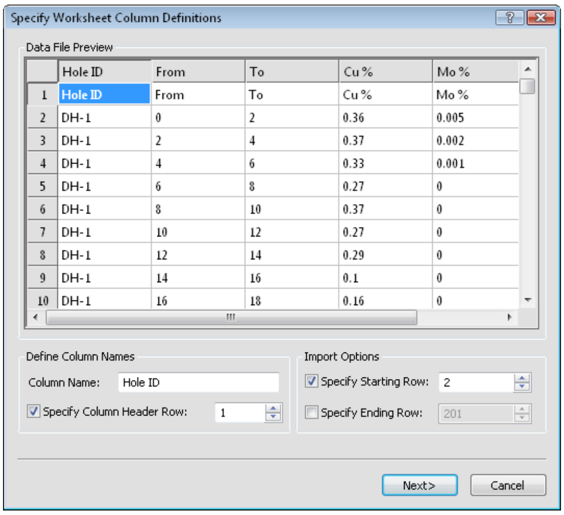


Figure 1.226 – Specify Worksheet Column Definitions panel

Data File Preview

The *Data File Preview* section displays the contents of the data being imported. The *Data File Preview* box is also used in manually defining column names.

Define Column Names

When importing data, you have the option of manually defining column names or using the column headers (if any) in a row. If the column names match the default **Strater** table column names, they are automatically matched in the next *Specify Data Type and Column Positions* dialog.

To manually define column names:

1. Click in a cell in the *Data File Preview* section.

2. Type the desired column name in the box next to the *Column Name* option.

3. Click in a cell in another column. Notice that the previously selected column has the new name listed.

4. Type the desired column name in the *Column Name* option.

5. Repeat until all of the columns are named.

To automatically define column names, check the box next to the *Specify Column Header Row* option. To change the row to use for the header names, highlight the existing row number and type the row number containing the header names. Alternatively, click the to increase or decrease the row.

Import Options

When importing data, you can import all rows or limit the rows to a specified range. By default, all rows are imported.

To limit the row range:

1. Check the box to the left of the Specify Starting Row option.

2. In the box to the right of *Specify Starting Row*, highlight the existing row number and type the row number that contains the first row to import. Alternatively, click the button to increase or decrease the starting row.

3. Check the box to the left of the *Specify Ending Row* option.

4. In the box to the right of *Specify Ending Row*, highlight the existing row number and type the row number that contains the last row to import. Alternatively, click the button to increase or decrease the ending row.

Specify Data Type and Column Positions

The **Specify Data Type and Column Position** dialog is used to define the table type and match the data to the table's required columns. Set the Data type and columns in the *Specify Data Type and Column Positions* dialog, fig. 1.227.

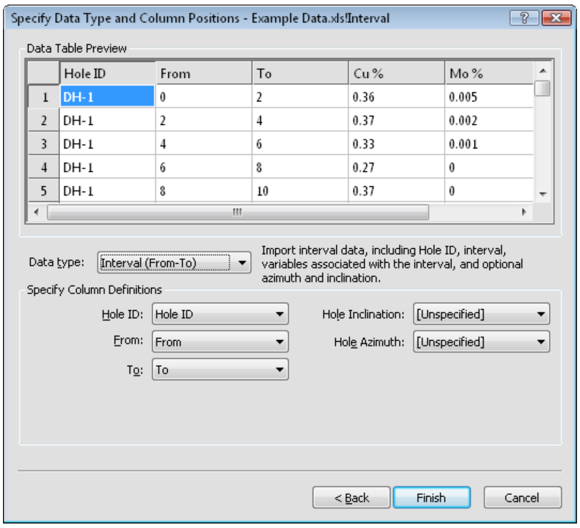


Figure 1.227 –Specify Data Type and Column Position

Data Table Preview

The *Data Table Preview* section displays the data contents.

Data Type

The data should fall into one of six *types of tables*: *Depth (Single Depth), Interval (From-To), Lithology, Well Construction, Collars, Survey*, or *Text (General)*. Select the desired table type. Notice that the *Specify Column Definitions* change based on the type of table selected. To set the type, click on the existing type and select the desired table type from the list. A description of the selected type appears to the right of the *Data type* list.

Specify Column Definitions

Once the data type is determined in the *Data type* section, the required data column for the data type are shown in the *Specify Column Definitions* section. Match the data to the columns for the table type. Each column definition can be set to any column in the file by clicking on the existing column name and selecting the desired column from the list. If a column should not be imported, select [*Unspecified*]. The column is created, but contains no data. If you are unsure, which column is appropriate for a required column definition you can select the [*Unspecified*] option and make the selection after the data appears in a table.

- *Depth (Single Depth)* tables have a single column containing depth information. You must assign a data column to the *Hole ID* and *Depth columns*. The Depth column information is required. The *Hole Inclination* (or *Hole Dip*) and *Hole Azimuth* columns can remain [*Unspecified*].
- *Interval (From-To)* tables have two columns containing depth information: *From* and *To*. You must assign data to the *Hole ID, From*, and *To* columns. The *From* and *To* columns are required. The *Hole Inclination* (or *Hole Dip*) and *Hole Azimuth* columns can remain [*Unspecified*].

- *Lithology* tables have two columns containing depth information: *From* and *To*. You must assign data to the *Hole ID, From, To,* and *Lithology Keyword* columns. The *Lithology Description, Hole Inclination* (or *Hole Dip*), *Hole Azimuth, Indent Percentage, Indent Keyword,* and *Indent Line Scale* columns can remain [*Unspecified*]. The columns are created, but can remain empty.
- *Well Construction* tables have two columns containing depth information: *From* and *To*. You must assign data to the *Hole ID, From, To, Offset, Well Item, Inner Diameter*, and *Outer Diameter* columns. The *Hole Inclination* (or *Hole Dip*) and *Hole Azimuth* columns can remain [*Unspecified*].
- *Collars* tables are informational tables that typically contain information about a borehole such as the location. You can assign data to the *Hole ID, Starting Depth, Ending Depth, Elevation, Hole Inclination* (or *Hole Dip*), *Hole Azimuth, Easting, Northing*, and *Scale* columns. The *Hole ID* is the only required column. All other columns can remain [*Unspecified*]. The *Starting Depth* can be set to [0] if all boreholes have the same starting depth and the starting depth is not listed in a column in the file.
- *Survey* tables are information tables that contain downhole directional information. You can assign data to the *Hole ID, Depth, Hole Inclination* (or *Hole Dip*), and *Hole Azimuth* columns. All four columns are required if you wish to use the *Survey* table for true vertical depth calculations.
- Text tables are general tables. You can assign to the *Hole ID* column. There are no required columns in this table.

All other data are imported into columns with the column title indicated in the *Specify Worksheet Column Definitions* or *Database Tables and Fields* dialogs.

Data Column

When a *line/symbol, zone bar, bar, post, classed post, complex text*, or *graphic* log is selected before the **Specify Data Type and Column Positions** dialog appears, an extra *Data* column is available. Click on the existing column name and select the desired column from the list. The log type is automatically created with the *Data Column* set to the selected column. If left to [*Auto*], the first column of data is displayed for the log.

LAS Import Options

Click the *File* | *Open* command or click the  button to open a new data file into a **Strater** project. In the *Open* dialog, select a LAS file and click *Open*. The **LAS Import Options** dialog is displayed.

To open multiple LAS data files at once, click the *File* | *Open Multiple* command in an existing table view window. To import multiple LAS data files into a single table view, click the *File* | *Import* command in the table view and select all of the files.

The **LAS Import Options** dialog is used to set the LAS-specific (Log ASCII Standard) importing options. Set options for importing the LAS file in the LAS Import Options dialog, fig. 1.228.

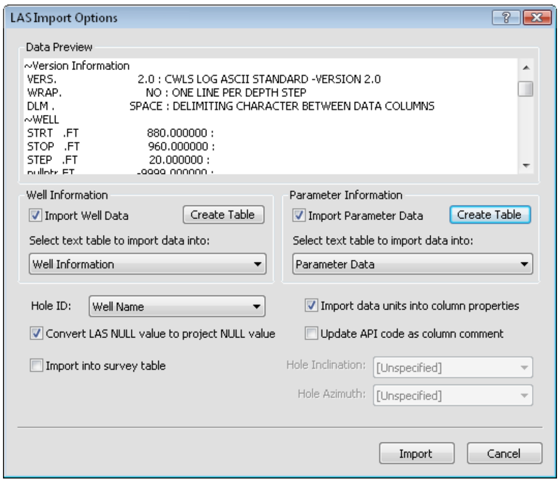


Figure 1.228 –LAS Import Options dialog

LAS Version

LAS versions 1.2, 2.x and 3.x can be imported into **Strater**. For more information on LAS files, refer to the *Canadian Well Logging Society* web page.

Data Preview

The *Data Preview* section displays the LAS file contents.

Well Information and Parameter Information

The *Well Information* and *Parameter Information* groups allow you to import various LAS file information from the LAS header into *text tables*. *Well Information* is everything under the ~WELL INFORMATION section in the LAS file and can be data such as *Start depth*, *Stop depth*, *Step*, *NULL Value*, *Location*, *Log Date*, and *Unique Well ID* information. *Parameter Information* is everything under the ~PARAMETER INFORMATION section in the LAS file and can be data such as *Depth Logger*, *Run Number*, *Depth Driller*, *Engineer's Name*, and *Logged by* information. Not all LAS files have parameter information. Not all LAS files contain information for all items.

Check the *Import Well Data* or *Import Parameter Data* boxes to import the information. If a LAS information table is already created, click on the table names and select the appropriate table from the list. Otherwise, click the [Create Table] button to create a new table. The resulting table contains all the columns of information available in the LAS file.

Hole ID

Click the box next to *Hole ID* to change the field that is used to name the well. Available options include *Well Name*, *API*, and *UWI*. Select the appropriate option to use that field name for the hole ID in **Strater**. If *API* or *UWI* selected and that field is empty or missing in the LAS file, a dialog appears prompting to provide a Hole ID.

Convert LAS NULL Value to Project NULL Value

The Convert *LAS NULL value to project NULL value* option is checked by default and is used if you prefer to use the null value you have defined in **Strater** instead of the null value defined in the LAS file. This option is checked by default, which means the LAS null values are automatically converted to the **Strater** null values. Uncheck this box if you do not want to use the **Strater** null values. You can also define a null value in **Strater** by clicking the *Tools | Options* command.

Import Into Survey Table

Check the box next to *Import into survey table* to import the directional information from the LAS file into a survey table. When checked, set the *Hole Inclination* and *Hole Azimuth* to the appropriate parameter by clicking on the existing option and selecting the appropriate parameter name from the list.

Import Data Units Into Column Properties

Check the box next to *Import data units into column properties* to have the units assigned for each parameter in the LAS file automatically added as the *column units* in the **Strater** table. This option is checked by default, importing the parameter information into the table. Uncheck the box to not import the data units. Note: the file may not contain unit types for all columns.

Update API Code As Column Comment

The *Update API code as column comment* option assigns the LAS file API comments into the *column description* box for each column in the **Strater** table. The *Column Description* can be used with *linked text*. Note: the file may not contain API codes for all columns.

Data Column

When a *line/symbol, zone bar, bar, post, classed post, complex text*, or *graphic* log is selected before the **LAS Import Options** dialog appears, an extra *Data Column* option is available. Click on the existing column name and select the desired column from the list. The log type is automatically created with the *Data Column* set to the selected column. If left to [*Auto*], the first column of data is displayed for the log.

Use Same Settings for Subsequent LAS Files

When the *File | Open Multiple* command is used to open multiple LAS files at once, check the box next to *Use same settings for subsequent LAS files* to use the same settings for all LAS files imported. If this box is not checked, the **Import Options** dialog appears once for each LAS file.

Import or Cancel

When all parameters for the LAS import are selected click *Import* to open, the LAS file in a new table view in the current project. To exit the dialog without importing data click *Cancel*.

Creating a Borehole

Boreholes are graphical displays of log-type data. Displaying boreholes requires a borehole design, data, and (for some log types) schemes. Boreholes are displayed in the log pane of a borehole view, and more than one borehole can be represented in a single borehole view. You can have multiple borehole views in each project file.

To create a new borehole view, click the *File | New | Borehole View*, click the button, right click in the *View Manager* and choose *New Borehole View*, or press CTRL+B on the keyboard.

In general terms, to make a graphical borehole in **Strater**, you must:

- Select a log type or open a template.
- Open, import, or create data.
- Edit the borehole properties to select data, apply *schemes*, and change other *properties*.

Modes

There are two "modes" in the borehole view - *design mode* and active mode. Design mode is used to create layouts and templates without attaching them to data. When the program is in active mode, the graphics are linked to data as they are being created.

Objects

Objects are any individual log type, shape, or text that appears in the borehole view. All objects in a borehole view are listed in the *Object Manager* where they are categorized by the borehole view pane in which they appear.

Visible boreholes in the borehole view can consist of multiple objects, including log type, legend, scale bar, a depth log, titles, text boxes, and rectangles to hold the text. Each instance of each of these items is a separate object, and are listed separately in the **Object Manager**.

Creating Logs

To create log objects:

1. For logs, click the **Log | [Object type]** command.

2. Click in the borehole view where you want the object to appear. Log items can be placed in the log pane only; move the cursor to the desired location. If an object cannot be placed in the position where the cursor is located, a ⊗ cursor appears.

3. If the borehole is in active mode, a prompt appears to select data when creating a log item. You can select new data in the **Open** dialog or select the existing data from the *Use Current Table* section. Click the *Open* button.

Creating Drawing Objects

To create drawing objects in the borehole view:

1. Click the **Draw** | [**Object type**] command.

2. Click on the screen where you want the object to be located. If an object cannot be placed in the position where the cursor is located, a ⊗ cursor appears.

If **Insert Map View** is selected and several map views exist in the project, select the desired map view and click *OK*.

Linking Data to the Object

When creating objects in design mode or after loading a template file, data are not associated with the objects. A borehole becomes "*live*" *or active* when data are applied.

1. Create objects in the borehole view.

2. Open, import, or create data.

3. To link all objects to a single borehole:

a. Click the **View** | **View Properties** command.

b. Click on the **View** tab in the **Property Manager**.

c. Next to *Hole ID Filter*, click on the existing option and select the desired borehole name from the list.

4. To link objects to different boreholes:

a. Click on the object in the borehole view or in the **Object Manager**.

b. Click on the **Base** tab in the **Property Manager**.

c. Next to the *Hole ID Filter* field, click on the existing option and select a borehole name from the list.

5. In the **Property Manager** edit the *properties* including data tables, data columns, and schemes.

6. Switch to active mode by clicking the *Log* | *Design Mode* command or click the button.

Many objects, such as drawing shapes and text boxes, are not associated with a specific borehole ID.

If all objects are properly linked to data and the borehole scaling values are correct, the placeholders in the borehole view change to display your data. If the data or borehole scaling values are not correct for the log, you may end up with a blank log. Check the data and *borehole view properties* in the event of a blank log.

Borehole View Properties

To view the general settings for a borehole view in the **Property Manager**:

Click the *View* | *View Properties* command, click *Edit* | *Deselect All*, click the button, click on the view name in the View Manager, right-click on the view name in the **View Manager** and choose *View Properties*, or click the mouse in any white space in the borehole view that is not part of a log or object.

The borehole view properties in the **Property Manager** contain the basic settings for the borehole view, including the view name, view data range, scaling, units, display mode, and the associated template name (if any). You can also define the line styles of the panes and define a project null value in the borehole view properties.

The borehole view properties consist of five tabs: **View**, **Log Pane Line**, **Header Pane Line**, **Footer Pane Line**, and **Project**.

View Properties

The **View** tab contains the borehole and depth options, fig. 1.229.

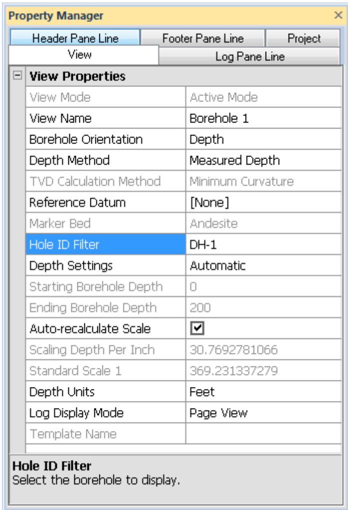


Figure 1.229 – Property Manager

View Mode

This is a read-only field that displays whether the current project is in design mode or active mode. Design mode is used to create graphics without attaching them to data. Design mode is useful when designing complex logs or when designing templates. When the program is in active mode, the graphics are linked to data as they are being created.

Toggle back and forth between design mode and active mode with the Log | Design Mode command or by clicking the  button.

View Name

The View Name is the label that appears in the borehole view tab to the left of the colon. **Strater** projects can contain multiple borehole views, such as monitoring well views and sampling well views. *View Name* is a way to separate the various views from one another and to identify clearly the view. The default name of the tab is *Borehole 1: X*, in which *X* is the current *Hole ID Filter* (described below). To change the view name, highlight the existing name and type the new desired name of the view in the *View Name* field.

Borehole Orientation

The *Borehole Orientation* tells **Strater** whether values in the depth column increase down or up. To change the orientation, click on the existing option and select the desired option from the list. Set the borehole orientation to Depth when the *Starting Borehole Depth* is less than the *Ending Borehole Depth*. Set the borehole orientation to Elevation when the Starting Borehole Depth is greater than the Ending Borehole Depth.

The borehole view orientation will automatically change to reflect the current *Starting Borehole Depth* and *Ending Borehole Depth*. For example, if the borehole orientation was originally set to *Elevation* and a user changed the start depth to be less than the end depth, the borehole orientation field automatically changes to *Depth*.

Depth Method

The *Depth Method* sets the display of the view to either *Measured Depth* or *True Vertical Depth*. The *Measured Depth* is the depth values from the tables. The *True Vertical Depth* is calculated from the depth values in the tables and the azimuth and inclination (or dip) values using the *TVD Calculation Method*. To change the *Depth Method*, click on the existing option and select the desired option from the list.

All logs except for depth logs are displayed using the specified depth method.

TVD Calculation Method

When the *Depth Method* is set to *True Vertical Depth*, the displayed depth value is calculated using the depth from the table and the azimuth and inclination (or dip). The *TVD Calculation Method* determines how the values are combined to get the true vertical depth. Available options are *Tangential, Average Tangential, Balanced Tangential*, *Radius of Curvature*, and *Minimum Curvature*. The default is *Minimum Curvature*, which provides a good estimate of the true vertical depth. To change the calculation method, click on the existing option and select the desired option from the list.

Reference Datum

The *Reference Datum* is the surface on the earth that defines the vertical reference for all wells in the borehole view. Changing the reference datum results in the logs in the borehole view being regenerated and "*hung*" on a different marker. The logs hang on an imaginary horizontal line that runs across the borehole view. The reference datum follows this horizontal line. To change the *Reference Datum*, click on the existing option and select the desired option from the list. Available options are [*None*], *Mean Sea Level*, and *Marker Bed*. Selecting [*None*] plots all logs at the starting depth. Elevations are not considered. *Mean Sea Level* places sea level (elevation = 0) on the horizontal line. All other locations vary based on depths and elevations from seal level. The wells in the borehole view will be placed at their respective elevations, as entered in the collars table. *Marker Bed* places the horizontal line at the top of the selected layer in the borehole view.

If you change the *Reference Datum* to either *Mean Sea Level* or *Marker Bed* and if the *Depth Settings* are set to *Collars Table* or *User Defined*, then the *Starting*

Borehole Depth and *Ending Borehole Depth* values will not be updated. This may result in parts of the borehole view being created off the visible page.

Marker Bed

When the *Reference Datum* is set to *Marker Bed*, the *Marker Bed* option becomes available. This is the level in the borehole view that defines how all logs are compared. The marker bed is the bed that is at the same vertical location across the borehole view and all logs.

Hole ID Filter

The *Hole ID Filter* displays the name of the Hole ID when every log pane item in the borehole view represents a single Hole ID. If there are more than one borehole represented in the logs and you have not selected an object in the log pane, the *Hole ID Filter* displays *-Multi-*. To change the Hole ID of all objects in the log pane, click the text next to *Hole ID Filter* and select the desired Hole ID from the list. When selected, all objects in the log pane will display information based on this selected Hole ID.

When the Hole IDs for all log items in the borehole view are changed to a single Hole ID the *Hole ID Filter* field automatically changes to reflect the revised single hole ID.

Depth Settings

The *Depth Settings* option controls the starting and ending borehole depths displayed in the borehole view. There are three options: *Automatic*, *Collars Table*, and *User Defined*. To change the *Depth Settings*, click on the existing option and select the desired option from the list.

- By default, the *Depth Settings* option is set to *Automatic*. When the *Depth Settings* option is *Automatic*, **Strater** scans the existing data tables to determine the starting and ending borehole depths that will fit all data.

When the *Depth Settings* option is set to *Automatic* and the *Depth Method* is set to *True Vertical Depth*, the inclination (or dip) field in the depth or interval table is used to calculate the overall true vertical depth. If the inclination (or dip) field is missing from the depth/interval table, then the inclination (or dip) field from the collars table is used. If the inclination (or dip) field is missing from the collars table, the inclination (or dip) value of 0 is used.

- When the *Depth Settings* option is set to *Collars Table*, the starting and ending borehole depths are retrieved from a collars table. You can also specify the scale of the borehole view in a collars table. Select a borehole in the *Hole ID Filter* list to update the *Automatic* and *Collars Table* selections.

When the *Depth Settings* option is set to *Collars Table* and the *Depth Method* is set to *True Vertical Depth*, the inclination (or dip) field in the collars table is used to apply the starting and ending depths. If the inclination (or dip) field in the collars table is missing, the inclination (or dip) value of 0 is used.

- When the *Depth Settings* option is set to *User Defined*, the *Starting Borehole Depth* and *Ending Borehole Depth* are available.

When the *Depth Settings* option is set to *User Defined* and the *Depth Method* is set to *True Vertical Depth*, the inclination (or dip) field in the depth or interval table is used to calculate the overall true vertical depth. If the inclination (or dip) field is missing from the depth/interval table, then the inclination (or dip) field from the collars table is used. If the inclination (or dip) field is missing from the collars table, the inclination (or dip) value of 0 is used.

Starting Borehole Depth

If the *Depth Settings* option is set to *User Defined*, you can specify the starting borehole depth. The *Starting Borehole Depth* is the depth to begin the data display. If the *Starting Borehole Depth* is greater than zero, the *Ending Borehole Depth* must be greater than the starting value. Likewise, if the *Starting Borehole Depth* is less than zero, the *Ending Borehole Depth* must be less than the starting value. If the *Starting Borehole Depth* is zero, the *Ending Borehole Depth* can be either negative or positive.

Ending Borehole Depth

If the *Depth Settings* option is set to *User Defined*, you can specify the borehole range. The *Starting Borehole Depth* is the depth to begin the data display and the *Ending Borehole Depth* is the ending depth for data display. If the *Starting Borehole Depth* is greater than zero, the *Ending Borehole Depth* must be greater than the starting value. Likewise, if the *Starting Borehole Depth* is less than zero, the *Ending Borehole Depth* must be less than the starting value. If the *Starting Borehole Depth* is zero, the *Ending Borehole Depth* can be either negative or positive.

Auto-recalculate Scale

Uncheck the box next to the *Auto-recalculate Scale* option if you want to adjust manually the *Scaling Depth per Centimeter/Inch* and the *Standard Scale 1* fields. Check the box next to *Auto-recalculate Scale* to not edit these fields. **Strater** will automatically calculate the scale of the log display so that all data fits on a single page. When these are set automatically by checking the *Auto-recalculate Scale* option, the entire borehole fits in a single page.

Scale Depth Per Inch/Centimeter

Use the *Scaling Depth Per Inch* (or *Centimeter*) to scale the borehole in units of measurement on the physical page. This value must be greater than zero. The page length limit is 2000 inches. To change the units between inches and centimeters use the general settings in the Options dialog.

Standard Scale 1

The *Standard Scale 1* displays the ratio between the scale depth per inch and the depth units you select. For example, if the *Scaling Depth Per Inch* is set at 2 and the depth units are *Feet* the standard scale automatically displays *24*, which is the number of inches per unit of depth (12 inches in a foot) multiplied by the scale depth per inch (2).

If you change the standard scale 1 number, the scale depth per inch automatically changes as well. For example, if you change the standard scale 1 number from 24 to 36 the scale depth per inch value changes to 3. If you change the depth unit to *meters* the standard scale value changes to 118.11, which is the number of inches in 3 meters.

Depth Units

Select the borehole unit type from the *Depth Units* list. The units selected here are the units of the data in the data table and are the base units for the depth log.

Log Display Mode

The *Log Display Mode* shows the current borehole in either *Page View* or *Full View*.

Page View separates the log into multiple pages with page breaks. The header and footer can be shown on each page, on only the first or last pages, or not at all by setting the display and size of the panes in the Page Setup dialog. If the *Log Display Mode* is set to *Page View* select *View* | *Page* or click the buttons to move among the pages.

The *Full View* shows the header and footer but expands the log pane to show the whole length of the log with no page breaks.

Template Name

The *Template Name* option shows the template name, if any, attached to this borehole view. This is a read-only field.

Log Pane Line / Header Pane Line / Footer Pane Line tabs

Use these tabs to adjust the line properties that surrounds each pane.

Project tab

This option allows you to store a null value with the **Strater** file *.SDG, and this value can be different from the null value set in *Tools* | *Options*. This *NULL Data Value* setting overrides the null value in **Tools | Options**.

Active Mode

An active or "live" borehole or cross section is a view window design that shows information in logs based on data in the data tables. All new boreholes created by clicking the *File* | *New* | *Project* command or clicking the button is automatically in active mode.

If you open an existing borehole or cross section view, and are unsure if it is active or design mode:

- Check the **Log** | **Design Mode** command or the toolbar button. If the button is depressed ( ) you are in design mode. To change to active mode, click this command or button again.

- Look in the **Property Manager** on the **View** tab and inspect the *View Mode* option. This is a read-only option; if this field displays Design Mode you can change to active mode by clicking .

Design Mode

There are two "modes" in the *borehole view* and *cross section view*: *design mode* and *active mode*. Active mode is the default mode when a blank borehole or cross section is created. When creating log items in active mode you are prompted for data to associate with each log.

If you prefer to design the borehole first and then associate data later, you can use design mode. This is a good option if you wish to create a borehole design, but do not have any actual data.

Opening Design Mode

You can enter design mode using one of these methods:

- Click the **Log | Design Mode** command.
- Press F4 on your keyboard to toggle between active mode and design mode.
- Click the button. While in design mode this button appears depressed: .

In addition, the *View Mode* in the *Borehole View Properties* and *Cross Section View Properties* indicates if you are in design mode or active mode.

Borehole View Design Mode Appearance

When designing a borehole view in design mode the screen shows generalized representations of the various log types. The logs displayed in design mode are fictitious and intended to give an impression of how the borehole view will look when actual data is attached, fig. 1.230.

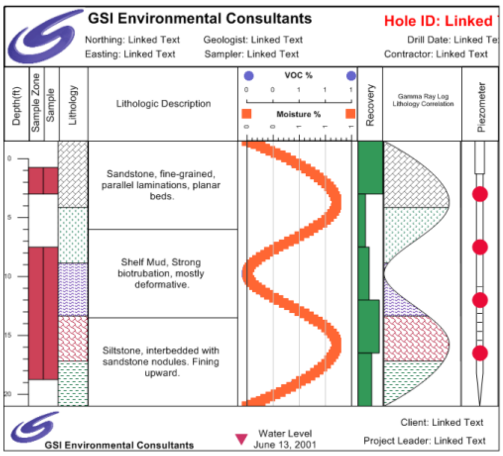


Figure 1.230 – Borehole column in design mode

This borehole view is displayed in design mode. The logs and linked text do not display actual data. Instead placeholders representing the logs and text appear.

Cross Section Design Mode Appearance

When designing a cross section view in design mode the screen shows generalized representations of the zone bar logs. The logs displayed in design mode are fictitious and intended to give an impression of how the cross-section view will look when actual data is attached. No layers are displayed between wells, fig. 1231.

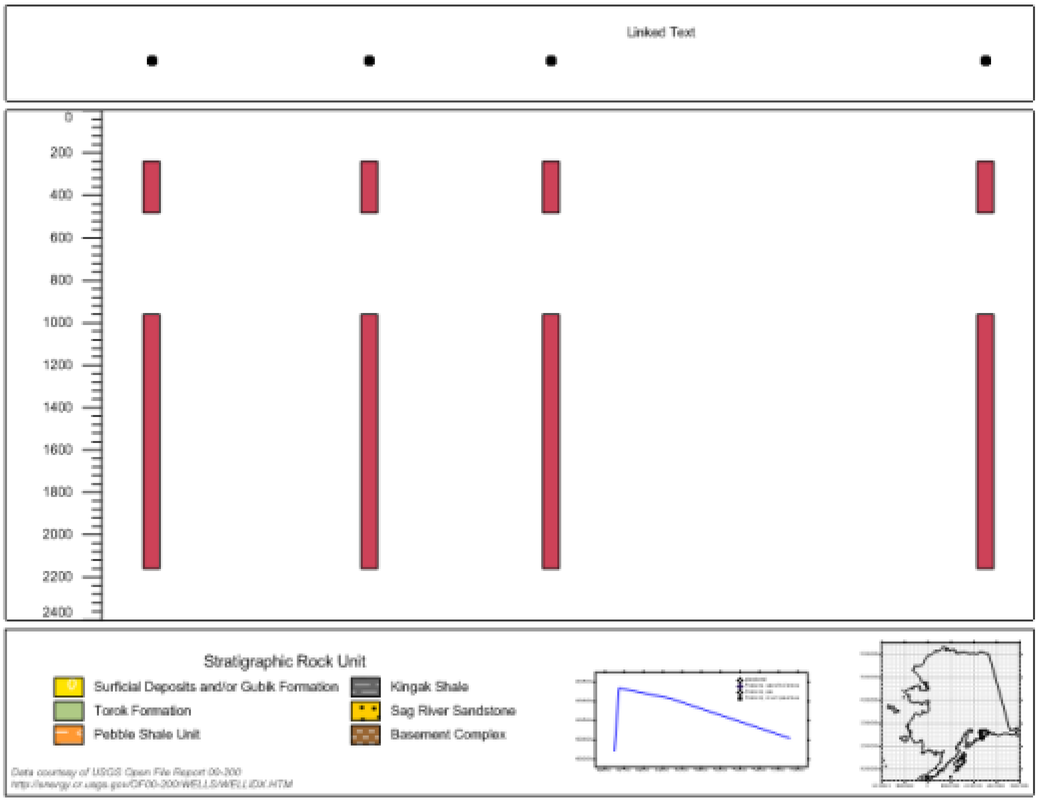


Figure 1.231 – Boreholes along a profile

True Vertical Depth

When boreholes are not completely vertical, the measured depth (MD) and true vertical depth (TVD) of the borehole are different. The measured depth is the total distance travelled along the borehole from the starting point (usually the collar) to the bottom of the borehole. The measured depth is used in combination with azimuth and inclination or dip information to calculate the true vertical depth, the actual depth below the starting point where a measured value should be displayed.

Inclination or dip and azimuth are indicators of how far off vertical a borehole is. When recorded in a collars table, the azimuth and inclination or dip apply to the entire borehole length. When recorded in a survey table, the azimuth and inclination or dip apply from the depth to the next recorded depth.

Inclination is the angle the borehole is oriented in degrees and varies from 0 to 180. Zero indicates vertical pointing down, 90 indicates horizontal, and 180 indicates vertical pointing up. Negative and positive inclination values are treated the same.

Dip is an alternate method of calculating the angle the borehole is oriented. Dip is oriented in degrees and varies from -90 to 90. -90 indicates vertical pointing down, 0 indicates horizontal, and +90 indicates vertical pointing up.

Azimuth is the compass orientation of the well's deviation, in degrees and varies from 0 (true vertical north) to 360. Azimuth values are measured relative to true north (not grid north in the local coordinate system).

In the borehole view properties or cross section view properties, when the *Depth Method* is set to *True Vertical Depth*, individual log depths are calculated using azimuth and inclination or dip values. They can be set from a depth, interval, survey, or collars table. There are three ways to enter the inclination or dip and azimuth data:

1. A single set of azimuth and inclination or dip data can be entered for each borehole in the collars table. The azimuth and inclination or dip data would apply to all points throughout the borehole.

2. A deviation survey could be imported for each borehole into a survey table. The deviation or survey data does not have to have the same sample interval as the wireline or depth/interval data.

3. Azimuth and inclination or dip data can be entered for each data point in the borehole directly in the depth or interval table as additional columns with the rest of the borehole data.

Once inclination or dip data is entered into a data table, the *Hole Inclination Column* or *Hole Dip Column* and *Hole Azimuth Column* need to be specified for each log in the borehole view or cross section view in the *Property Manager*. When the inclination or dip and azimuth data is entered in the table and the columns are specified for each log in the view window, the view window can be set to true vertical depth measurements. Click on the *View | View Properties* command or click the button. The view properties are listed in the **Property Manager**. Change the *Depth Method* from *Measured Depth* (the default) to *True Vertical Depth*. All the logs in the view will update with the selected depth method.

Depth logs are the only log types that have their own depth method selection, so you can set the depth scope of the depth log independently of the depth method for the view. This allows you to create one depth log showing measured depth and another showing true vertical depth side-by-side. To set the depth log to true vertical depth, click on the depth log in the **Object Manager** or view window to select it. In the **Property Manager**, set the *Depth Scope* to *Hole True Vertical Depth*.

Example True Vertical Depth

1. Click the *File | New | Project* command or click the button to open a new project.

2. Click on the *Project Settings* tab to enter the table view.

3. Open the data tables:

a. Click the *File | Open Multiple* command;

b. In the **Open Data** dialog, click on the **Example Data.xls** file in the Samples directory. By default, the Samples directory is located at C:\Program Files\Golden Software\Strater 4\Samples;

c. Click *Open*;

d. Select the *Deviation Survey* sheet;

e. Press and hold the CTRL key on the keyboard and select the *Depth* sheet;

f. Click *OK*.

g. For the Depth table:

a. In the *Specify Worksheet Column Definitions* dialog, make sure that the *Specify Column Header Row* is checked and set to 1. Click *Next*;

b. In the *Specify Data Type and Column Positions* dialog, make sure that the *Data type* to *Depth (Single Depth)* and that all of the columns are set correctly and click *Finish*.

h. For the Deviation Survey:

a. In the **Specify Worksheet Column Definitions** dialog, make sure that the *Specify Column Header Row* is checked and set to 1. Click *Next;*

b. In the **Specify Data Type and Column Positions** dialog, set the *Data type* to *Survey*. Make sure all of the columns are set correctly and click *Finish*.

4. Click on the *Borehole 1* tab or click **Window** | **Borehole 1** to return to the borehole view.

5. Create a line/symbol log by clicking the *Log | Line/Symbol* command or clicking the  button.

a. Click near the center of the log pane to position the line/symbol log;

b. In the **Open** dialog, select *Depth* in the *Use Current Table* list;

c. Make sure that *Depth* is listed in the *File name* option;

d. Click *Open*.

6. Set the line/symbol log to use true vertical depth measurements.

a. Click on the line/symbol log in the view window or in the *Object Manager* to select it;

b. In the **Property Manager**, click on the **Line/Symbol Log** tab;

c. Next to *Hole Inclination Column or Hole Dip Column*, click on [*Unspecified*] and select [*From survey table*]: *Deviation Survey*.

Notice that the *Hole Azimuth Column* automatically is set to [*From survey table*]: *Deviation Survey*. When using a survey table, the inclination or dip or dip and azimuth columns must come from the same table.

7. Create a depth log by clicking the *Log* | *Depth* command or clicking the button.

8. Click on the far-left side of the page in the log pane to position the first depth log.

9. Set the depth log to use measured depth.

a. With the depth log selected, in the **Property Manager**, click on the **Depth Log** tab;

b. Set the *Depth Scope* to *Hole Measured Depth* by clicking on the existing option and select *Hole Measured Depth* from the list;

c. Next to *Hole Inclination Column* or *Hole Dip Column*, click on [*Unspecified*] and select [*From survey table*]: *Deviation Survey*;

d. Notice that the *Hole Azimuth Column* automatically is set to [*From survey table*]: *Deviation Survey*. When using a survey table, the inclination or dip and azimuth columns must come from the same table.

10. Click the *Draw* | *Text* command or click the button.

a. Click above the depth log to position the text;

b. In the **Text Editor**, type *Measured Depth* and click *OK*, fig. 1.232;

c. Press ESC on the keyboard to end drawing mode.

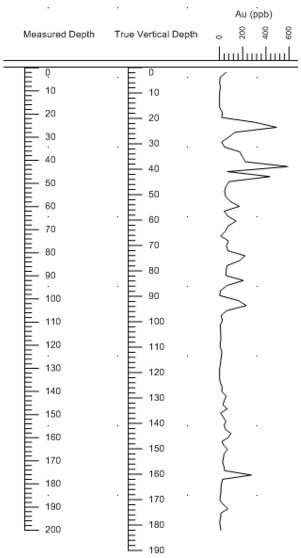


Figure 1.232 – Scale of Measured and True Vertical Depths

11. Create a depth log by clicking the *Log* | *Depth* command or clicking the button.

12. Click between the existing depth log and the line/symbol log to position the second depth log.

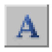
13. Set the depth log to use true vertical depth.

a. With the new depth log selected, in the **Property Manager**, click on the **Depth Log** tab;

b. Set the *Depth Scope* to *Hole True Vertical Depth* by clicking on the existing option and select *Hole True Vertical Depth* from the list;

c. Next to *Hole Inclination Column or Hole Dip Column*, click on [*Unspecified*] and select [*From survey table*]: *Deviation Survey*.

Notice that the *Hole Azimuth Column* automatically is set to [*From survey table*]: *Deviation Survey*. When using a survey table, the inclination or dip and azimuth columns must come from the same table.

14. Click the *Draw* | *Text* command or click the  button.

1. Click above the second depth log to position the text.
2. In the *Text Editor*, type *True Vertical Depth* and click *OK*.
3. Press ESC on the keyboard to end drawing mode.

15. Click the **View** | **View Properties** command or click the  button to display the borehole view properties.

16. Click on the *Measured Depth* option next to *Depth Method* and select *True Vertical Depth* from the list.

The view is displayed in true vertical depth. The first depth log shows measured depth and the second depth log shows true vertical depth. The log is also shown with true vertical depth.

Multiple Boreholes in One Borehole View

Strater allows users to place data from more than one borehole onto a single borehole view. The concept and functionality are easy – users simply import data for multiple wells, add logs and then associate the new log with the appropriate borehole data.

A **Strater** project can include multiple boreholes with many data attributes:

- You can import data from a single data file that has data from multiple boreholes into a project.
- You can import data from multiple source data files with each data file including one or more borehole.
- If importing data from multiple files, you also have the choice to import all the data together into one data table, or you can import each file into a separate data table.
- You can import a LAS file for one borehole into one data table, and import another LAS file for a different borehole into a different data table.
- You can easily change the borehole data source for a particular log to any borehole whose data is imported into the project.

For this example, we use the file *Mining Example-1.sdg*, which is found in the Samples folder in the installation folder for the **Strater** software. The default directory is C:\Program Files\Golden Software\Strater 4\Samples.

1. Click the **File** | **Open** command or click the  button.

2. In the *Open* dialog, select the *Mining Example-1.sdg* file and click *Open*.

3. Click on the *Interval* data tab.

4. Scroll down and note the contents of the *Hole ID* column. There are two different borehole Hole IDs in this one data table: DH-1 and DH-2. There is no limit to the number of separate boreholes, that can be part of a single data table.

5. Click the *Mining: DH-1* tab.

6. Click the **View** | **View Properties** command to view the borehole view properties in the **Property Manager**, fig. 1.233.

7. Notice the content of the *Hole ID Filter* field: DH-1, indicating that all logs in the view window are associated with the *DH-1 Hole* ID.

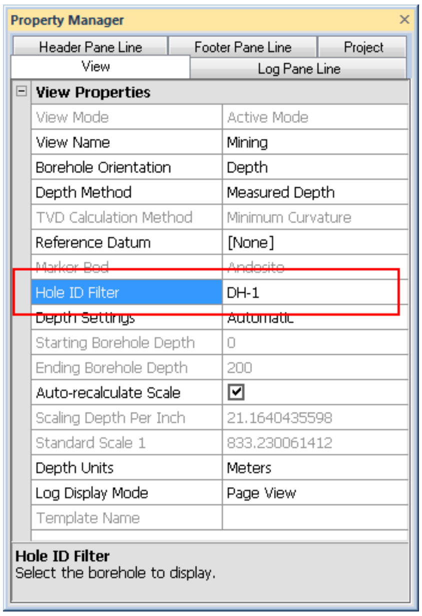


Figure 1.233 – The Hole ID Filter on the View tab

8. Let us change the borehole associated with one of the logs in the log pane from DH-1 to DH-2. Select the log Mo % in the view window or in the **Object Manager**.

9. In the **Property Manager**, click on the **Base** tab.

10. Click on the *DH-1* text next to the *Hole ID Filter* option. A list is displayed that contains all borehole IDs found in every data table currently imported in the project. Select *DH-2* from the list.

When you change the Hole ID Filter in the Property Manager the log changes from the original DH-1data (left) to DH-2 data (right), fig. 1.234.

11. Notice how the data in log *Mo* % has changed:

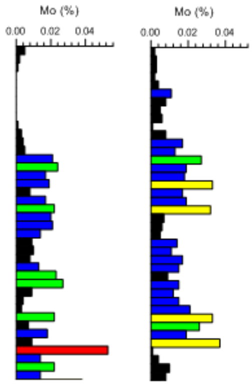


Figure 1.234 – The log changed from the original DH-1 (left) to DH-2 (right).

12. Click the **View | View Properties** command to view the borehole view properties in the **Property Manager**, fig. 1.235. The Hole ID Filter field shows which borehole is associated with the currently selected object in the log pane. If no object is selected, the -*Multi*- is displayed

13. Look in the *Hole ID Filter* field:

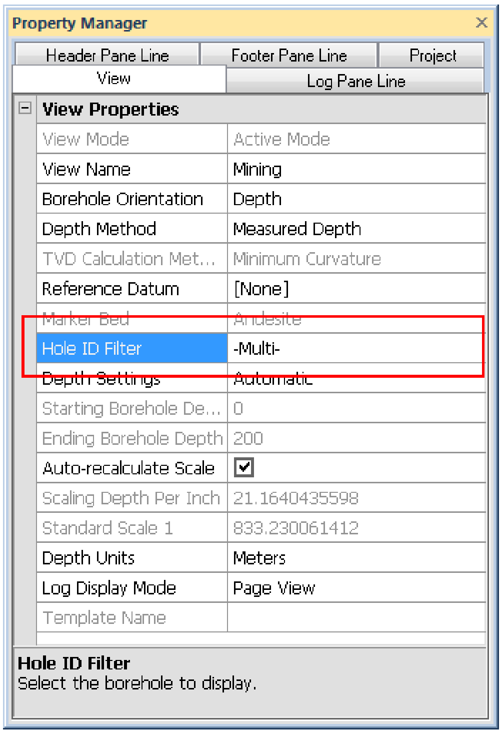


Figure 1.235 – Selecting Holes ID Filter

14. The -*Multi*- term indicates that there are multiple boreholes whose data is part of the logs in this borehole view, and that no single object in the log pane is currently selected. -*Multi*- is shown whenever there is data from more than one Hole ID in any log currently displayed in the log pane.

Adding a Log from a Different Borehole to an Existing Project

Adding a log with a different borehole ID is simple. **Strater** makes no distinction to adding data from any borehole. As an example, we will add data from a third borehole to this existing project.

1. This example uses the data file TUTORIAL 2.XLS, which is located in the Samples folder in the installation folder for **Strater** software. The default directory path is C:\Program Files\Golden Software\Strater 4\Sample.

2. Click the **Log** | **Zone Bar** command or click the  command to add a zone bar log to the view.

3. Place the cursor on the right side of the log pane and click the mouse button.

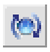
4. In the *Open* dialog, select the *Tutorial 2.xls* file and click *Open*.

5. In the *Specify Worksheet Column Definitions* dialog, notice in the *Data File Preview* section that the *Hole ID* of the data is *W17*. Click *Next*.

6. In the *Specify Data Type and Column Positions* dialog, make sure the columns are specified correctly and click *Finish*.

The new zone bar log uses the data from the specified data file, which contains only one well: *W17*. The new zone bar log uses the *W17* data.

Update Borehole Data

With a *borehole view* or *cross section view* active, click the **Edit** | **Update Borehole Data** command, click the  button, or press CTRL+F5 on the keyboard to force a redraw of the view window after changing the data. This is not normally necessary, as views normally update automatically.

Data, Schemes, and Log Properties

The data, scheme, and log, map, or cross section properties are all related in the process of creating a log in a *borehole view* or *cross section view*, creating a map *Wells* layer, or creating *layers* in a cross section. The data contains depth information (either single depth or from-to interval depth), borehole names, and the data to be displayed on the log. *Schemes* contain line, symbol, label, and fill property information that links the data to the log. When scheme information (keywords or numeric ranges) is found in the data, the logs in the borehole or cross section displays the properties of the scheme. The *Property Manager* determines which data table and column are used to create the log, the scheme to use (if any), and properties such as the log width. Each *log item* can use a different data table, column, scheme, and properties.

Project data, schemes, and log properties are all related in the process of creating a borehole log.

1. The data in each row is linked to a scheme item. This scheme links the *Au* (*ppb*) values from column C. In this case, the data in row 12 has a value of 492 and

appears at a depth of 24. The data in row 12 falls within the range scheme item of 250 to 500. Note the fill is a solid light orange.

2. A bar log is created displaying the *Au* (*ppb*) data column. The *Au Concentration* scheme is selected.

3. The bar log is displayed. The *Au Concentration* scheme determines the appearance of the log. The color at the depth 24 is light orange, as indicated by the scheme, fig. 1.236.

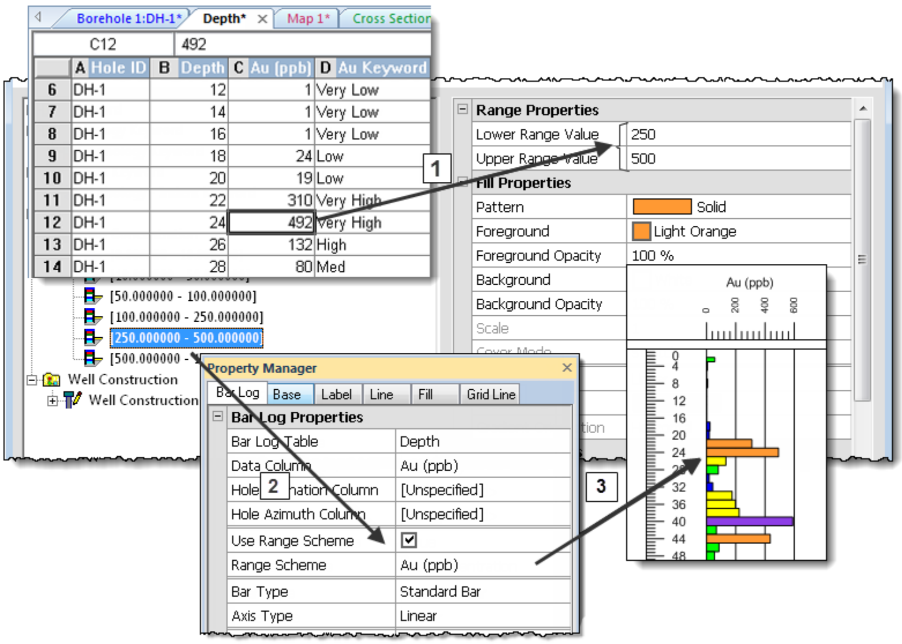


Figure 1.236 – This diagram shows the connection between a value in the table column, the scheme, and the log being displayed.

2. PRACTICAL SECTION

2.1. GMT examples of laboratory works

Examples for laboratory works are given below both in the “classic” (used in GMT4 and GMT5 releases) and in “modern” modes of scripting. The “modern” mode uses *begin ... end* modules, which makes the script more compact. Scripts of the majority of tests considered below are given in the “modern” mode, only a few of them were written in the “classic” version to also show their acceptance for GMT6 release.

Almost all GMT tools send Postscript code to standard output. We can simply redirect the standard output and write it to a file we need, or assign it to an existing one ("> *file*" or ">> *file*"). This achieves extraordinary flexibility – we draw one map by sequentially calling modules, each of them adds its own portion of data to the output file (frame, contour lines, routes, points, labels, scale bar, legend, etc.). For this reason, it is customary to write a sequence of utility calls working under Windows, in the form of an executable bat-file.

Example 2.1.1: Topo map of the Belarus – Baltic Region

We will start with rather easy example: a map as a simple graphical method for displaying information. Consider constructing a relief map. We create the executable file with the “modern” mode and save it in your work directory as BelBaltic_Relief.bat: There are a few command lines. The first command (*gmt begin*) starts the program and defines the output graphic file and its two formats pdf and jpg. Next four commands create the map, then next nine lines (*echo gmt pstext*) put town names in the map. The colorbar command draw color palette below the map. Finally, *gmt end show* finishes th map and opens it to view.

```
gmt begin BelBaltic_Relief pdf,jpg
     gmt makecpt -Cdem4 -T-5/500 > Reliefmap
     gmt grdcut @earth_relief_30s -R18/33/50/60 -Grelief.nc
     gmt grdimage relief.nc -JM4i -Ne0.1 -fg
     gmt pscoast -JM4i -B2g2 -Df -Lf31.0/48.5/8.0/400+lkm -Ia/blue -
Na/0.75,white -W0 -Slightblue
     echo 27.5667 53.9 Minsk | gmt pstext -F+f12p,Times-Italic+jLM
     echo 30.9754 52.4345 Gomel | gmt pstext -F+f12p,Times-Italic+jLM
     echo 21.0118 52.2298 Warszawa | gmt pstext -F+f12p,Times-
Italic+jLM
     echo 30.5238 50.4547 Kiev | gmt pstext -F+f12p,Times-Italic+jLM
     echo 23.9096 54.9027 Kaunas | gmt pstext -F+f12p,Times-Italic+jLM
     echo 24.10589 56.946 Riga | gmt pstext -F+f12p,Times-Italic+jLM
     echo 24.7535 59.437 Tallinn | gmt pstext -F+f12p,Times-Italic+jLM
     echo 28.3496 57.8136 Pskov | gmt pstext -F+f12p,Times-Italic+jLM
     echo 20.50 54.717 Kaliningrad | gmt pstext -F+f12p,Times-
Italic+jLM
     gmt colorbar -Dx1c/-1.55c+w5c/0.4c+h -CReliefmap.cpt -Bx100+l"Elev
(m)"
gmt end show
```

The constructed map looks like, fig. 2.1:

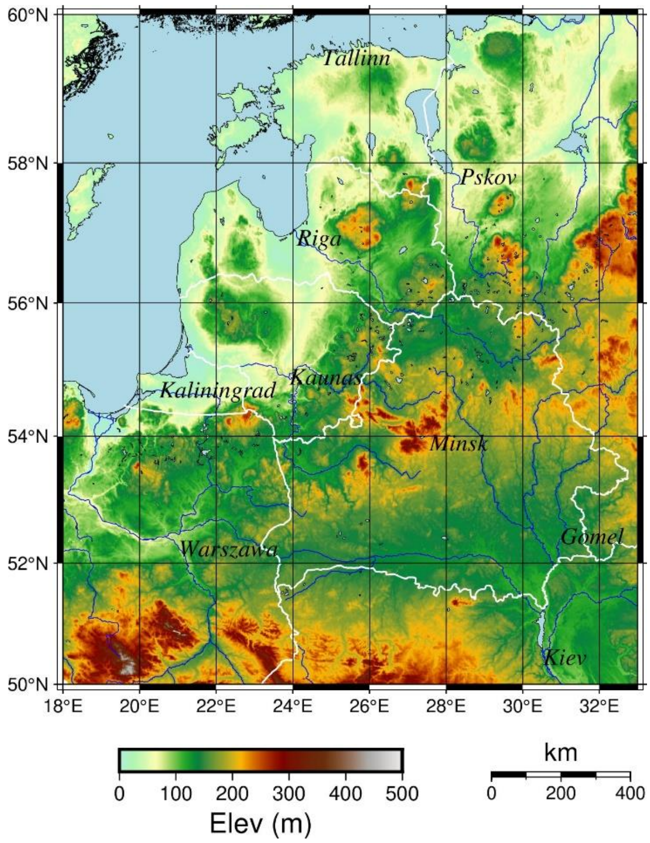


Figure 2.1 – Relief map for the Belarus-Baltic region

The program takes the input file earth_relief_30s from Internet.

Example 2.1.2: Earthquakes in the Sea of Japan region

Subroutine Japan_Quakes.bat text with the "modern" scripting mode:

```
REM Map of earthquakes near Japan
gmt begin Japan_Quakes
     gmt makecpt -Cred,green,blue -T0,70,300,10000
     gmt pscoast -R130/150/35/50 -JM6i -B5 -Na/1p,white -
Ia/0.25p,blue -Lf147/36/8.0/400+lkm -S151/190/255 -
W0.25p,royalblue -Ggray
     gmt plot @tut_quakes.ngdc -Wfaint -i4,3,5,6s0.1 -C -Scc
     echo 146.5 38 Pacific Ocean | gmt pstext -F+f20,Helvetica-
Bold,yellow=thin
     echo 134 40 Sea of Japan | gmt pstext -F+f20,Helvetica-
Bold,yellow=thin
     echo 132  46.5 China | gmt pstext -F+f20,Helvetica-
Bold,seashell=thin
     echo 132  49.5 Russia | gmt pstext -F+f20,Helvetica-
Bold,seashell=thin
     echo 132  42.0 N. Korea | gmt pstext -F+f20,Helvetica-
Bold,seashell=thin
     gmt legend -Dx0.75/1.5+w3.0 -F+pthick Depth_earthquakes.txt
gmt end show
```

The constructed map of earthquakes in the region looks like, fig. 2.2:

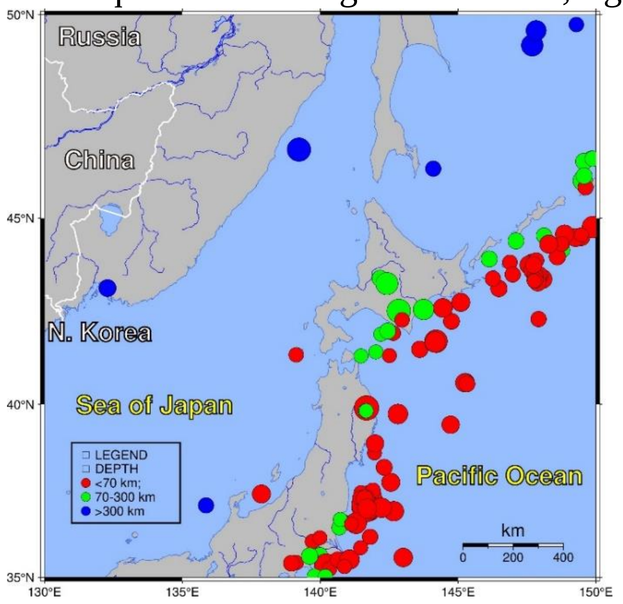


Figure 2.2 – Earthquakes in the Sea of Japan region

Create the Depth_earthquakes.txt file with the following text:

```
S 0.1i s 0.00i 151/190/255 0.15p 0.2i LEGEND
S 0.1i s 0.00i 151/190/255 0.15p 0.2i DEPTH
S 0.1i c 0.10i red 0.15p 0.2i <70 km;
S 0.1i c 0.10i green 0.15p 0.2i 70-300 km
S 0.1i c 0.10i blue 0.15p 0.2i >300 km
```

Required files: Depth_earthquakes.txt and tut_quakes.ngdc that the program downloads from Internet.

Example 2.1.3: The allocation of the Atlantic rift by earthquakes. The text of the subroutine in the “modern” version of the script entry:

```
REM Atlantic Rift (GMT EXAMPLE 07 Modified)
REM
REM Purpose:   Make a basemap with earthquakes and isochrons etc
REM GMT modules:    coast, legend, text, plot
REM
gmt begin AtlanticRift
     gmt coast -R-60/10/-10/20 -JM24c -Slightblue -
GP26+r300+ftan+bdarkbrown -Dl -Lfx21/9.75/2.0/1500+lkm -Wthinnest
-B10 --FORMAT_GEO_MAP=dddF
     gmt plot @fz_07.txt -Wthinner,-
     gmt plot @quakes_07.txt -h1 -Scc -i0,1,2+s0.025 -Gred -
Wthinnest
     gmt plot @isochron_07.txt -Wthin,blue
     gmt plot @ridge_07.txt -Wthicker,orange
     gmt legend legend.txt -Dx0.25/0.2/7/3.3+w3.0 -Vl -F+pthick
```

```
     echo -43 -5 SOUTH   >  tmp
     echo -43 -8 AMERICA >> tmp
     echo -7 11 AFRICA   >> tmp
     gmt text tmp -F+f30,Helvetica-Bold,white=thin
     del tmp
gmt end show
```

The earthquake map of the Mid-Atlantic Rift section looks like fig. 2.3:

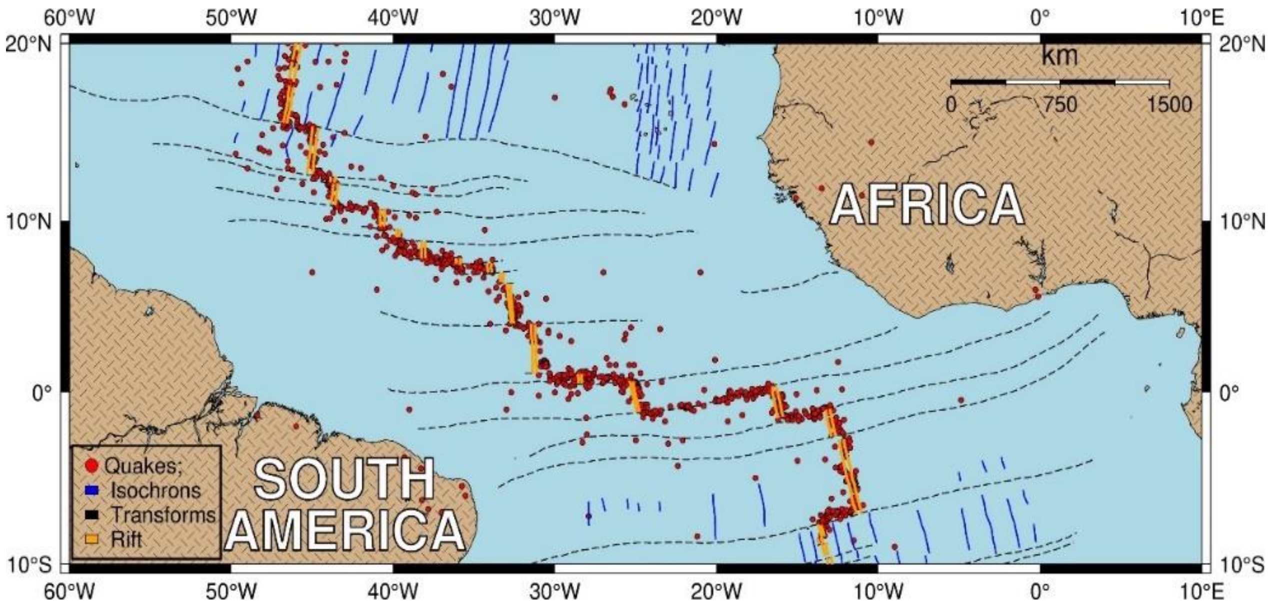


Figure 2.3 – Allocation of the Atlantic rift by earthquakes

Required files: quakes.xym (earthquakes); isochron.xy (isochrones); ridge.xy (rift) the program downloads from Internet; yeo need creating the legend.txt (legend layout).

The content of the legend.txt file in this case looks like this:

```
S 0.1i c 0.10i red 0.15p 0.2i Quakes;
S 0.1i r 0.1i blue 0.25p 0.25i Isochrons
S 0.1i r 0.1i black 0.25p 0.25i Transforms
S 0.1i r 0.1i orange 0.25p 0.25i Rift
```

Example 2.1.4: Fragment of a gravimetric map of the Australia-New Zealand region. The text of the subroutine (Example 27 from the GMT documentation) with the “modern” method:

```
REM       GMT EXAMPLE 27 (GMT documentation)
REM
REM Purpose:   Illustrates how to plot Mercator img grids
REM GMT modules:    makecpt, grdimage, grdinfo, coast, colorbar
REM
gmt begin ex27
```

```
     REM Gravity in tasman_grav.nc is in 0.1 mGal increments and
the grid
     REM is already in projected Mercator x/y units.
     REM Make a suitable cpt file for mGal
     gmt makecpt -T-120/120 -Crainbow
     REM Since this is a Mercator grid we use a linear projection
     gmt grdimage @tasman_grav.nc=ns+s0.1 -I+d -Jx0.6c
     REM Then use gmt coast to plot land; get original -R from grid
img remark
     REM and use Mercator gmt projection with same scale as above
on a spherical Earth
     gmt grdinfo @tasman_grav.nc -Ii > R.txt
     set /p R=<R.txt
     gmt coast %R% -Jm0.6c -B -BWSne -Gblack --
PROJ_ELLIPSOID=Sphere -Cwhite -Dh+ --FORMAT_GEO_MAP=dddF
     REM Put a color legend in top-left corner of the land mask
     gmt colorbar -DjTL+o1c+w5c/0.4c -Bx -By+lmGal -I -F+gwhite+p1p
gmt end show
```

The constructed map looks like, fig. 2.4:

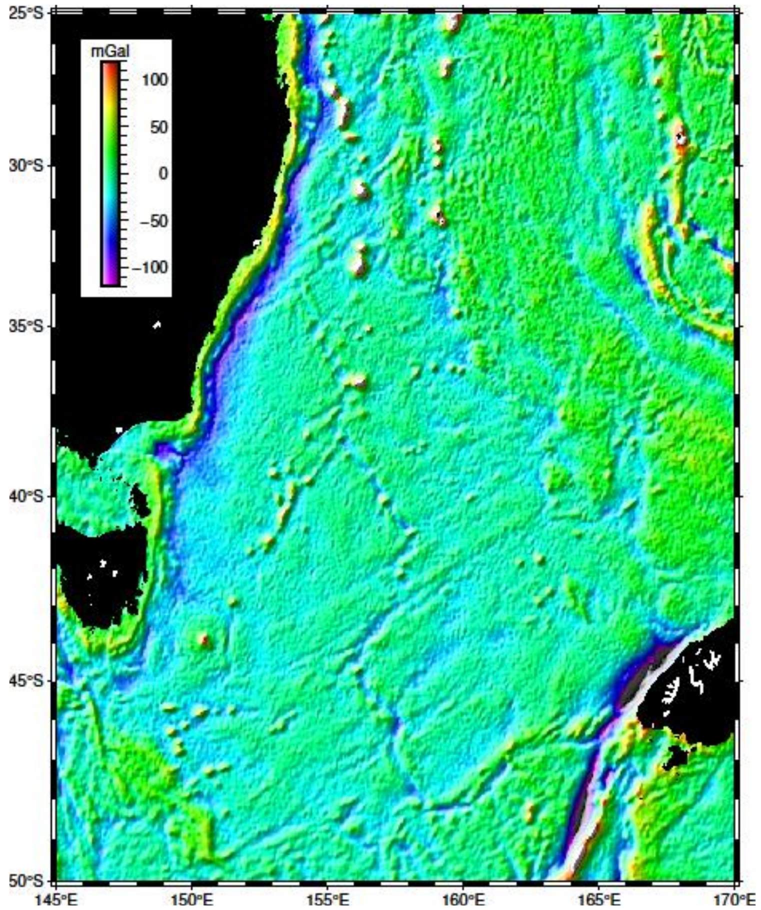


Figure 2.4 – Gravimetric map in between Australia and New Zealand

Required file tasman_grav.nc to run the program is downloaded from Internet.

Example 2.1.5: 3D Map of Black Sea Data Availability for Heat Flow.

Subroutine text with the "classic" method:

```
REM       GMT Black Sea Heat Flow Density 3D
REM Purpose:   Make 3-D bar graph on top of perspective map
set ps=BlackSeaHFD_3D.ps
gmt pscoast -R28d/42d/41d/47d/0/100 -JX25d/15d -JZ7.5 -
B1f1g1/1f1.0g0.5/20f10:"HFD,  mW / m @+2@+":wESNZ  -Dh -Ia/0/0/255
-Lfx2.5/-2.0/2.0/400+lkm -Na/2 -Sazure2 -Gwheat -Wfaint -A5000 -
p165/50 -K -Vl -X2.5 -Y2.5 > %ps%
gmt psxyz ArealHFD.txt -R -JX -JZ7.5 -So0.025ib1 -p165/50 -
Glightblue -Wfaint -O -K -P >> %ps%
echo {print $1, $2, $3} > tmp.txt
gawk -f tmp.txt CountriesBLS.txt | gmt pstext -R -JX -JZ -O  -p -
Gwhite@18 -F+f18p,Helvetica,firebrick=thinner+jRM >> %ps%

gmt psconvert -A -C-dINTERPOLATE -P -Tj BlackSeaHFD_3D.ps
del tmp.txt
```

The map looks like, fig. 2.5:

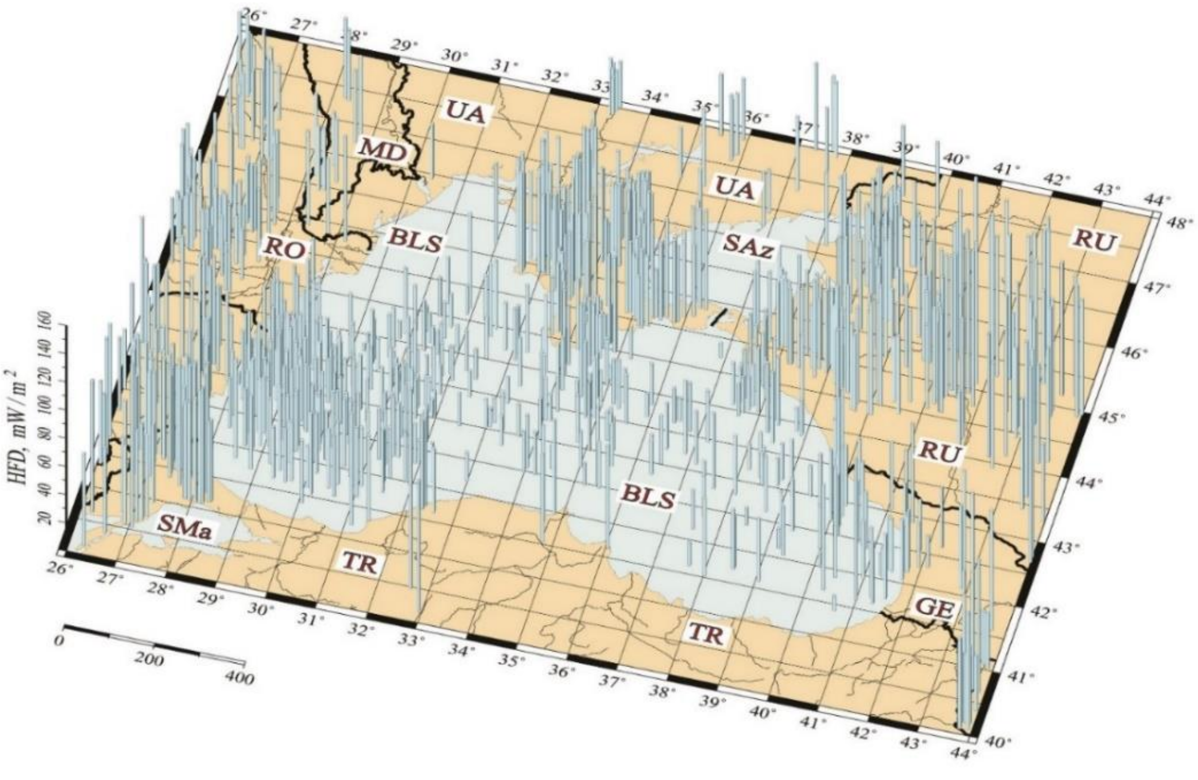


Figure 2.5 – 3D Map of Black Sea data availability for heat flow

The lengths of the vertical strips and their locations show the value of the heat flow in mW/m^2, the scale (km) is shown in the lower left corner of the map.

Required files: ArealHFD.txt: CountriesBLS.txt you can get from the teacher.

Example 2.1.6: Displaying oceanic earthquakes within 3000 km of Hobart and > 1000 km from the International Date Line.

Dased on the example 24 from GMT-6.3 documentation (the "modern" method):

```
REM       GMT EXAMPLE 24 (GMT documentation)
REM
REM Purpose:   Extract subsets of data based on geospatial criteria
REM Highlight oceanic earthquakes within 3000 km of Hobart and >
1000 km from dateline
gmt begin ex24
     echo 147:13 -42:48 6000 > point.txt
     echo ^> Our proxy for the dateline > dateline.txt
     echo 180  0 >> dateline.txt
     echo 180  -90 >> dateline.txt
     gmt info -I10 @oz_quakes_24.txt > R.txt
     set /p R=<R.txt
     gmt coast %R% -JM22c -Gtan -Sdarkblue -Wthin,white -Dl -A500 -
Ba20f10g10 -BWeSn
     gmt plot @oz_quakes_24.txt -Sc0.1c -Gred
     gmt select @oz_quakes_24.txt -Ldateline.txt+d1000k -Nk/s -
Cpoint.txt+d3000k -fg -Il | gmt plot -Sc0.1c -Ggreen
     gmt plot point.txt -SE- -Wfat,white
     gmt text point.txt -F+f14p,Helvetica-Bold,white+jLT+tHobart -
Dj7p
     gmt plot point.txt -Wfat,white -S+0.5c
     gmt plot dateline.txt -Wfat,white -A
     del point.txt dateline.txt
gmt end show
```

The constructed map looks like, fig. 2.6:

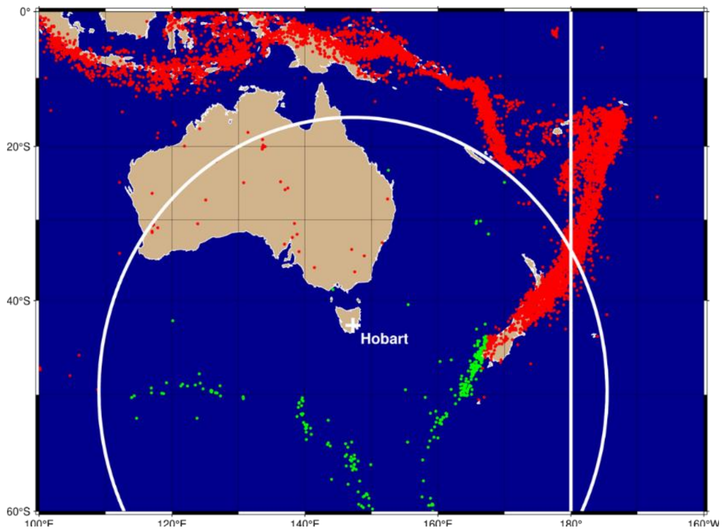


Figure 2.6 – Oceanic earthquakes within 3000 km of Hobart and > 1000 km from the International Date Line

Required file: oz_quakes_24.txt (downloaded from the Internet, (@ symbol)).

Example 2.1.7: Geological map of the vicinity of the Sabalan volcano. Subroutine text SabalanSprings.bat with the "modern" method:

```
REM Fragment of Geologic map at the Sabalan volcano, Iran
gmt begin SabalanSprings pdf,jpg
     gmt psbasemap -R48/48.1/38.15/38.3 -Jb48/48.1/38.15/38.3/1:150000 -
B0.05f0.05g0.0125 -Lfx2/-1/5/4+l"km" -Vl -X1.75 -Y4
     #gmt plot SpringsSabalan.txt -R48/48.1/38.15/38.3 -Sc0.2c -
Glightblue -Wthinnest,blue
     gmt plot RedTopLeftAreaSabalan.txt -Glightpink1 -Vl -
Wthinnest,black
     gmt plot ReddishUppermostSabalan.txt -Glightred -Vl -
Wthinnest,black -:
     gmt plot Reddish2ndSabalan.txt -Glightred -Vl -Wthinnest,black
     gmt plot YellowBelowAreaSabalan.txt -Glightgreen  -Vl -
Wthinnest,black -:
     gmt plot GreenishUpperSabalan.txt -Gwheat1 -Vl -Wthinnest,black -:
     gmt plot GreenishMiddleSabalan.txt -Glightgreen -Vl -
Wthinnest,black -:
     gmt plot LightBlueMiddleSabalan.txt -Glightyellow -Vl -
Wthinnest,black -:
     gmt plot VioletHorizSabalan.txt -Glightbrown -Vl -Wthinnest,black -
:
     gmt plot GreenLowerSabalan.txt -Glemonchiffon3 -Vl -Wthinnest,black
-:
     gmt plot GreyLowerSabalan.txt -Glightbrown -Vl -Wthinnest,black -:
     gmt plot BisquitLowestSabalan.txt -Glightbrown -Vl -Wthinnest,black
-:
     REM Faults
     gmt plot FauiltMeridional1.txt -Vl -Wthick,black -:
     gmt plot Fault2.wpt -Vl -Wthick,black -:
     gmt plot Fault3.wpt -Vl -Wthick,black -:
     gmt plot Fault4.wpt -Vl -Wthick,black -:
     gmt plot Fault5.wpt -Vl -Wthick,black -:
     gmt plot Fault6.wpt -Vl -Wthick,black -:
     gmt plot Fault7.wpt -Vl -Wthick,black -:
     gmt plot Fault8.wpt -Vl -Wthick,black -:
     gmt plot Fault9.wpt -Vl -Wthick,black -:
     gmt plot Fault10.wpt  -Vl -Wthick,black -:
     REM Settlements
     gmt psxy VillagesSabalan.txt -Sa0.4 -Vl -Wthin,brown
     Settlement names
     echo {print $1, $2, $3} > awk.txt
     gawk -f awk.txt   VillagesSabalan.txt | gmt pstext -D0.5i/0.4 -
F+f10p,Times-Italic,darkblue=thinnest+jRM
     echo 48.081026, 38.256546, Kord Kandi | gmt pstext -D0.35i/-0.4 -
F+f10p,Times-Italic,darkblue=thinnest+jRM
     gmt plot SpringsSabalan.txt -Sc0.2 -Gred -Vl -Wthin,blue
     REM Legend to the map
     gmt pslegend Sabalan_legend.txt -Dx6.75/3.5/7/3.3+w9.0 -Vl -X0.75 -
Y-0.7 -F+pthick
gmt end show
```

The constructed map looks like, fig. 2.7:

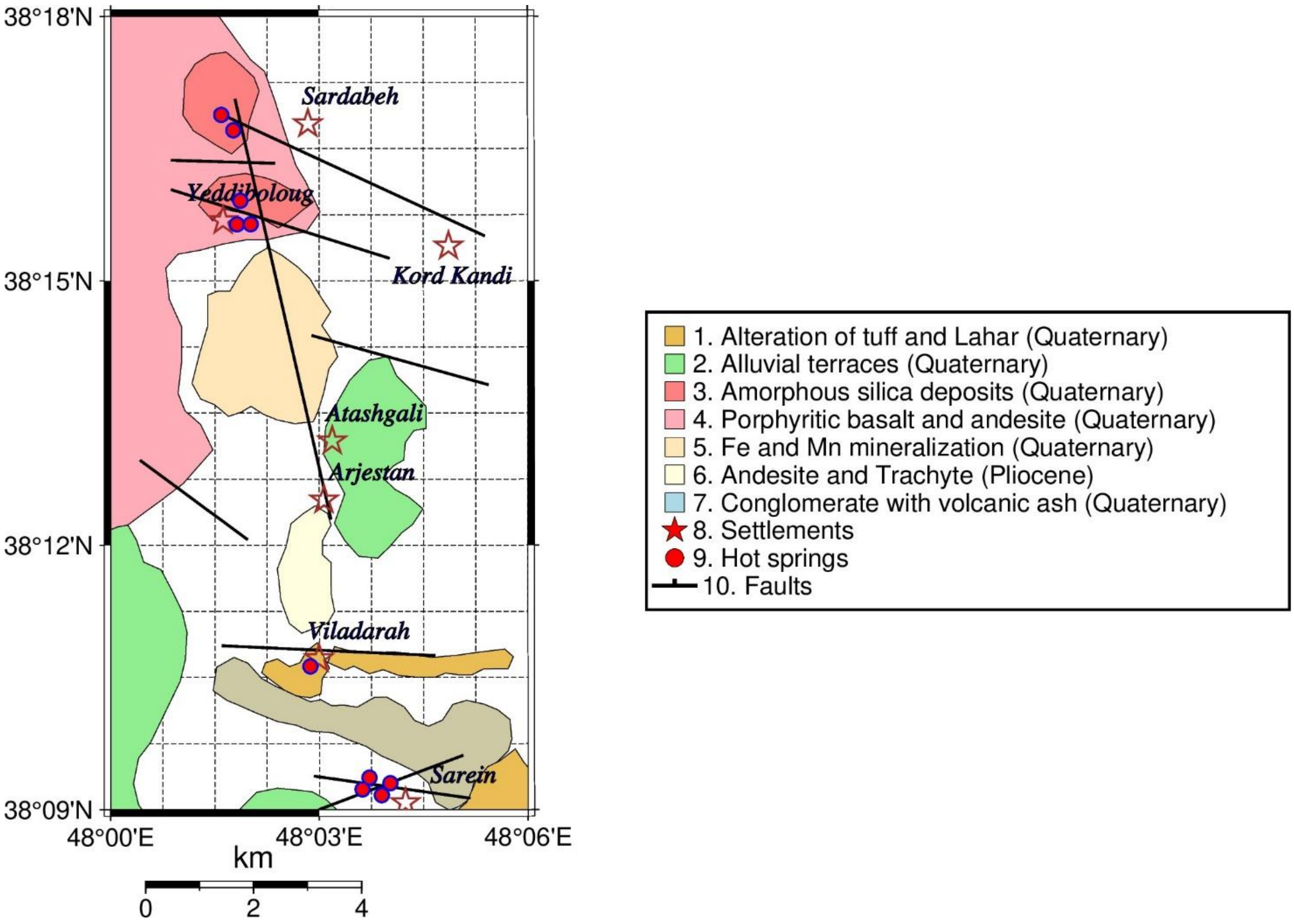


Figure 2.7 – Geological map of the vicinity of the Sabalan volcano

Required files you can get from the teacher: SpringsSabalan.txt; RedTopLeftAreaSabalan.txt; ReddishUppermostSabalan.txt; Reddish2ndSabalan.txt; YellowBelowAreaSabalan.txt; GreenishUpperSabalan.txt; GreenishMiddleSabalan.txt; LightBlueMiddleSabalan.txt; VioletHorizSabalan.txt; GreenLowerSabalan.txt; GreyLowerSabalan.txt; PinkLowestSabalan.txt; BisquitLowestSabalan.txt; Fault2.wpt – Fault10.wpt; FaultMeridional1.txt; VillagesSabalan.txt; SpringsSabalan.txt; Sabalan_legend.txt.

The Sabalan_legend script looks like:

```
S 0.1i s 0.15i lightbrown 0.15p 0.2i 1. Alteration of tuff and
Lahar (Quaternary)
S 0.1i s 0.15i lightgreen 0.15p 0.2i 2. Alluvial terraces
(Quaternary)
S 0.1i s 0.15i lightred 0.15p 0.2i 3. Amorphous silica deposits
(Quaternary)
S 0.1i s 0.15i lightpink1 0.15p 0.2i 4. Porphyritic basalt and
andesite (Quaternary)
S 0.1i s 0.15i wheat1 0.15p 0.2i 5. Fe and Mn mineralization
(Quaternary)
S 0.1i s 0.15i lightyellow 0.15p 0.2i 6. Andesite and Trachyte
(Pliocene)
```

```
S 0.1i s 0.15i lightblue 0.15p 0.2i 7. Conglomerate with volcanic
ash (Quaternary)
S 0.1i a 0.15i red 0.15p 0.2i 8. Settlements
S 0.1i c 0.10i red 0.15p 0.2i 9. Hot springs
S 0.1i f0.1i+l 0.25i red 1.5p 0.25i 10. Faults
```

Example 2.1.8: Heat flow and mud volcanoes in the Caspian Sea region. Subroutine text Caspian_HFD_MudV.bat with the “modern” mode:

```
REM       GMT Caspian Sea HFD Mud Volcanoes
REM Purpose: Make Heat Flow Density and Mud volcanoes Caspian
gmt begin Caspian_HFD-MudV pdf,jpg

     gmt psbasemap -R46.0/54.5/36.5/41.5 -Jb50.0/38/38/46/1:3250000
-B1f1 -Lfx17.5/-1.95/4.0/200+l"km" -Vl -X3 -Y2.6
     gmt blockmean Circum_CaspianHFD.txt -R46.0/54.5/36.5/41.5 -
I10m -Vl  > Circum_CaspianHFD_1.txt
     gmt surface Circum_CaspianHFD_1.txt  -
GCircum_CaspianHFD_1.surface -I1.5m -T0.35 -V
     gmt grdimage   Circum_CaspianHFD_1.surface -CHFD7e.cpt -Jb -Vl
     gmt coast -Jb -B -Dh -Ia/thick,blue -Na/2 -Vl -Wthickest,white
     echo {print $2, $1} > wawk.txt
     gawk -f wawk.txt CaspianF1.txt | gmt plot -B -Jb -Wthick
     gawk -f wawk.txt CaspianF2.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF3.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF4.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF5.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF6.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF7.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF8.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF9.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF10.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF11.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF12.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF13.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF14.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF15.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF16.txt | gmt psxy -B -Jb -Wthick
     gawk -f wawk.txt CaspianF17.txt | gmt psxy -B -Jb -Wthin
     gawk -f wawk.txt CaspianF18.txt | gmt psxy -B -Jb -Wthin

     REM Heat flow stations
     gmt plot Circum_CaspianHFD.txt  -Jb -Sc0.075i  -Gwhite -Wthick
     REM Mud volcanoes
     gawk -f wawk.txt Mud_volcanoes.txt | gmt plot -B -Jb -Si0.08i
-Gred -Wthin
     gmt grdcontour Circum_CaspianHFD_1.surface -C10 -A10 -Gd5c -S4
-T+d8p/2p -Wthin,royalblue
     echo 51.75 37.2 Caspian Sea | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
     echo 52.6 40.8 Caspian Sea | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
```

```
     echo 50.2 37. Iran | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
     echo 47.85 39.32 Iran | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
     echo 47.2 39.8 Azerbaijan | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
     echo 54.1 40.4 Turkmenistan | gmt pstext -Jb -Gwhite@18 -
F+f14p,Helvetica,firebrick=thinner+jRM
     gmt colorbar -Dx2c/-1.4c+w10c/0.4c+h -CHFD7e.cpt  -
Bx20+l"mW/m@+2@+"
     #gmt colorbar -DjCT+w2.75i/0.5c+o3.5/18.8c -CHFD7e.cpt -
Bxaf+l"mW/m@+2@+" -Jb -Vl
gmt end show

del awk.txt
del Circum_CaspianHFD_1.surface
del wawk.txt
```

The constructed map looks like, fig. 2.8:

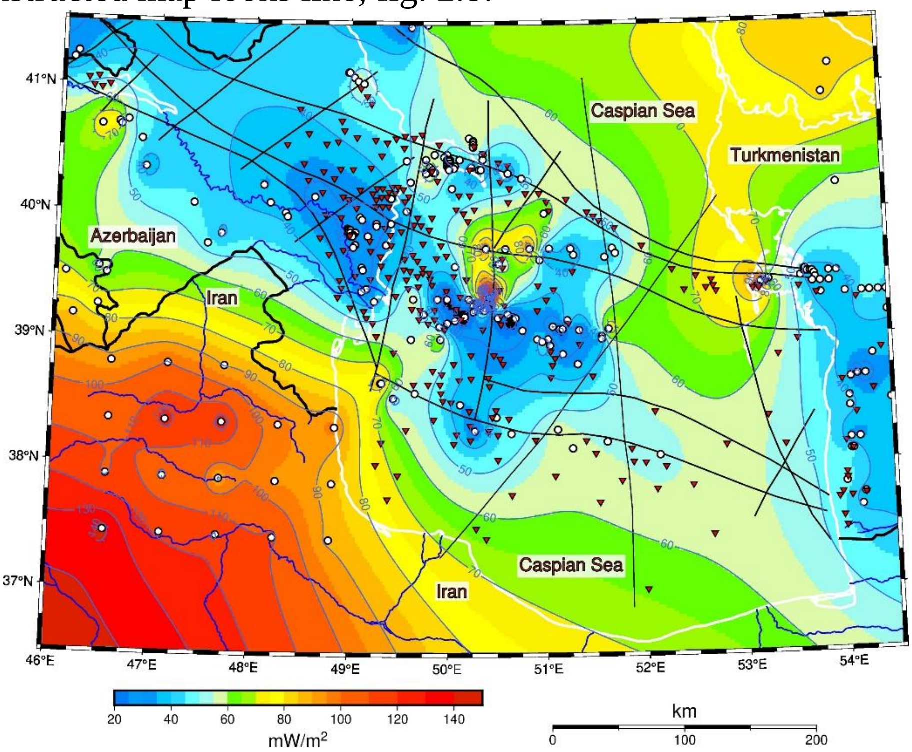


Figure 2.8 – Heat flow and mud volcanoes in the Caspian Sea region

Required files: Circum_CaspianHFD.txt; HFD7e.cpt; CaspianF1.txt – CaspianF18.txt; Mud_volcanoes.txt you can get from the teacher.

Example 2.1.9: Temperature distribution at the top of the upper salt in the Pripyat Trough

GMT can work with non-Latin fonts. This is an example using Cyrillic fonts (absent in standard GMT distribution). The “fonts” directory with Cyrillic PostScript fonts must be in the directory where the subroutine below is located (for example, UpperSaltRoofTemperature-en_2015.bat). The contents of the “fonts” directory in the case of using the freely available Cyrillic fonts LinBiolinum and LinLibertine (http://linuxlibertine.sf.net/) are as follows:

```
GPL.txt
LICENCE.txt
LinBiolinum_Bd-0.5.5.otf
LinBiolinum_It-0.5.1.otf
LinBiolinum_Kb-0.5.4.otf
LinBiolinum_Re-0.6.4.otf
LinBiolinum_Sl-0.4.9.otf
LinLibertine_Bd-4.1.5.otf
LinLibertine_BI-4.1.0.otf
LinLibertine_C-4.0.4.otf
LinLibertine_It-4.2.6.otf
LinLibertine_Re-4.7.5.otf
OFL.txt
README.txt
```

At the same time, Cyrillic text files with inscriptions must be typed in a computer in ISO-8859-5 encoding. You can use other commercial or publicly available PostScript fonts.

Subroutine text with the “classic” mode (UpperSaltRoofTemperature-ru_2015.bat file):

```
REM Temperature Distribution map at the top of the Upper Salt in the
Pripyat Trough, Belarus

set ps=UpperSaltRoofTemp-ru_2015.ps

REM common settings
gmt gmtset GRID_CROSS_SIZE 0
gmt gmtset ANNOT_FONT_SIZE_PRIMARY 12
gmt gmtset MAP_GRID_PEN_PRIMARY thinnest
REM Common additional settings
gmt gmtset PS_LINE_JOIN round
gmt gmtset PS_CHAR_ENCODING ISO-8859-5 FONT LinBiolinumO
gmt gmtset MAP_DEGREE_SYMBOL colon
gmt gmtset FORMAT_GEO_MAP +D ddd.mm.xxxF
gmt gmtset GS_FONTPATH=fonts

REM create file CUSTOM_font_info.d in current working directory
REM and add PostScript font names of Linux Biolinum and Libertine
echo LinBiolinumO 0.700 0 > CUSTOM_font_info.d
echo LinBiolinumOI 0.700 0 >> CUSTOM_font_info.d
echo LinBiolinumOB 0.700 0 >> CUSTOM_font_info.d
echo LinLibertineOB 0.700 0 >> CUSTOM_font_info.d
gmt psbasemap -R27.30/31.0/51.25/53 -Jb29.25/52/52/52.5/1:1500000 -
B0.5f0.25 -Lfx1/-1.5/2.0/60+lkm -V -P -K -X2.0 -Y4.0 > %ps%
gmt blockmean Upper_Salt_Temperature_2015.txt -R -I0.5m -V >
Upper_Salt_Temperature.gmt
gmt surface Upper_Salt_Temperature.gmt -
GUpper_Salt_Temperature.surface -I0.5m -R -T0.35 -V
```

```
grdimage Upper_Salt_Temperature.surface -CTempSalt.cpt -Jb -K -O -P -
R -V >> %ps%
gmt pscoast -Jb -R -B2f1g2 -Dh -Ia/1/0/0/255 -K -Na/2 -O -P -V -
Wthin,slightblue >> %ps%

REM Faults
gmt psxy npripyat.txt -Jb -R -B -K -O -P -Sf0.25/0.05R -V -
Wthick,black >> %ps%
gmt psxy spripyat.txt -Jb -R -B -K -O -P -Sf0.25/0.05R -V -
Wthick,blaack >> %ps%
gmt psxy NorthStep.txt -Jb -R -B -K -O -P -: -V -Wthick,black >> %ps%
gmt psxy m-zvystp.gmt -Jb -R -B -K -O -P -Sf0.25/0.05L -V -
Wthick,black >> %ps%
gmt psxy lyakhovi.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy divin.gmt    -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy ndniepr.gmt  -Jb -R -B -K -O -P -Sf0.25/0.05R -V -
Wthick,black >> %ps%
#gmt psxy sdniepr.gmt  -Jb -R -B -K -O -P -Sf0.25/0.05R -V -W1/0/0/0
>> %ps%
gmt psxy radul.gmt    -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy nzybkov.gmt  -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy surazh.gmt   -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Urechye_Okt.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Star_Vasilev.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Kalinkovichi.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Elsk.gmt     -Jb -R -B -K -O -P -V -W1thick,black >> %ps%
gmt psxy Khoiniki.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Bragin0.gmt  -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Bragin1.gmt  -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Pripyat.gmt  -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy pripyatS.gmt -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Bragin.gmt   -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy Loev.gmt     -Jb -R -B -K -O -P -V -Wthick,black >> %ps%
gmt psxy VA-05km.txt  -Jb -R -B -K -O -P -V -: -Wthicker,red >> %ps%
gmt psxy Upper_Salt_Contur.txt -Jb -R -B -K -O -P -V -: -
Wthickest,royalblue >> %ps%
gmt psxy Upper_Salt_Temperature_2015.txt -Jb  -R -B -K -O -P -Gblue -
Sc0.17 -V -Wthick,white >> %ps%
gmt grdcontour Upper_Salt_Temperature.surface -Jb -B -C5 -A5f10 -O -K
-Gd2i -S2 -T1.5i/0.5i >> %ps%
REM Clean Adjoining Regions to North, South and East of the Pripyat
Trough
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A PripNorthClean.txt >> %ps%
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A PripSouthClean.txt >> %ps%
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A PripEastClean.txt >> %ps%
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A M_Zhitk_Vyst_Clean.txt >>
%ps%
REM Restoring rivers & M_Zhitk._Vystup at cleaned areas
gmt pscoast -Jb -R -Dh -Ia/1/0/0/255 -K -Na/2 -O -P -V -
Wthin,slightblue >> %ps%
gmt psxy m-zvystp.gmt -Jb -R -B -K -O -P -Sf0.25/0.05L -V -
Wthick,black >> %ps%
REM Tectonic Units:
echo 30.35 52.75 A | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -
K >> %ps%
```

```
echo 30.92 52.63 B | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 30.22 51.55 C | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 30.52 51.35 D | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 29.4 51.44 E | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -K
>> %ps%
echo 27.78 52.30 F | pstext -R -Jb -F+f12p,Times-Italic-Bold+jLM -O -
K >> %ps%
REM North-pripyat Step
echo 30.25 52.85 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 30.6 52.7 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -K
>> %ps%
echo 30.75 52.57 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 27.5 52.55 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -K
>> %ps%
echo 27.35 51.8 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -K
>> %ps%
echo 27.35 51.97 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -
K >> %ps%
echo 30.3 51.5 ? | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -O -K
>> %ps%
REM Box for Legend
echo 27.3 51.4 > tmp
echo 29.25 51.4 >> tmp
echo 29.25 51.26 >> tmp
echo 27.3 51.26 >> tmp
echo 27.3 51.4 >> tmp
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A tmp >> %ps%
del tmp
echo 27.8 51.5 > tmp
echo 28.6 51.5 >> tmp
echo 28.6 51.4 >> tmp
echo 27.8 51.4 >> tmp
echo 27.8 51.5 >> tmp
gmt psxy -R -Jb -O -K -Gwhite -Wthinner -A tmp >> %ps%
del tmp
REM Legend, Super Regional Faults
echo 28.5 51.365 > tmp
echo 28.7 51.365 >> tmp
gmt psxy -R -Jb -O -K -Gwhite -L -Sf0.5/0.05R -Wthickest,black -A tmp
>> %ps%
del tmp
REM Legend, Regional Faults
echo 28.72 51.37 1; | gmt pstext -R -Jb -F+f11p,Times-Italic+jLM -O -
K >> %ps%
echo 28.85 51.37 > tmp
echo 29.05 51.37 >> tmp
psxy -R -Jb -O -K -Gwhite -L -Sf0.5/0.05R -Wthick,black -A tmp >>
%ps%
del tmp
```

```
echo 29.075 51.37 2; | gmt pstext -R -Jb -F+f11p,Times-Italic+jLM -O
-K >> %ps%
REM Legend, Isolines
echo 27.4 51.3 > tmp
echo 27.5 51.3 >> tmp
gmt psxy -R -Jb -O -K -Gwhite -L -Sf0.5/0.05R -Wthin,black -A tmp >>
%ps%
del tmp
echo 27.63 51.3 > tmp
echo 27.73 51.3 >> tmp
gmt psxy -R -Jb -O -K -Gwhite -L -Sf0.5/0.05R -Wthin,black -A tmp >>
%ps%
del tmp
echo 27.52 51.3 40 | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
echo 27.755 51.3 3; | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -
K >> %ps%
REM Legend, Boreholes
echo 27.9 51.3 | gmt psxy -Jb  -R -B -K -O -P -Gblue -Sc0.17 -V -
Wthick,white >> %ps%
echo 27.94 51.3 4; | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
REM Legend, Towns
echo 28.05 51.3 | gmt psxy -Jb  -R -B -K -O -P -Gred -Sg0.25 -V -
Wthick,white >> %ps%
echo 28.1 51.3 5; | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
REM Legend, Poor studied areas
echo 28.2 51.3 "?" | gmt pstext -R -Jb -F+f9p,Times-Bold+jLM -O -K >>
%ps%
echo 28.35 51.3 6; | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
REM Positive structures
echo 28.47 51.3 > tmp
echo 28.67 51.3 >> tmp
gmt psxy -Jb  -R -B -K -O -P -V -Wthicker,red tmp >> %ps%
echo 28.7 51.3 7; | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
del tmp
REM Legend Upper Salt limits
echo 28.8 51.3 > tmp
echo 29.0 51.3 >> tmp
gmt psxy -Jb  -R -B -K -O -P -V -Wthickest,royalblue tmp >> %ps%
echo 29.03 51.3 8 | gmt pstext -R -Jb -F+f10p,Times-Italic+jLM -O -K
>> %ps%
del tmp
REM Adding Towns symbols
gmt psxy Pripyat-towns-ru-ISO8859-5.txt -R -J -i0,1 -Sc0.15c -Gred -O
-K >> %ps%
REM Adding Pripyat towns names
gawk "BEGIN {FS=\",\"} $4 > 10 {print $1, $2, $3}" Pripyat-towns-ru-
ISO8859-5.txt | gmt pstext -R -J -F+f10p,LinBiolinumOI+jBL -Dj-
0.27i/0.1i -Gwhite -C5%% -Qu -TO -O -K >> %ps%
REM Countries
```

```
gawk "BEGIN {FS=\",\"} $1 > 20 {print $1, $2, $3}" Legend-text-
ru1UpSaltRoof-ISO8859-5.txt | gmt pstext -R -J -
F+f10p,LinBiolinumOB+jBL -Gwhite -C5%% -Qu -TO -O -K >> %ps%
REM Color scale
gmt psscale  -DjCT+w3.0i/0.35c+o4.5/14.5c -Ef+C -O -K -CTempSalt.cpt
-Baf -R -J -O -K -Vl >> %ps%
echo 30.0 51.3 @+o@+C | pstext -R -Jb -F+f14p,Times-Italic-Bold+jLM -
O  -Y-1.5 >> %ps%
gmt psconvert -A -C-dINTERPOLATE -P -Tj UpperSaltRoofTemp-ru_2015.ps
REM clean up
del .gmt*
del CUSTOM_font_info.d
del Bel100mT_2015.gmt
del Bel100mT_2015.surface
del PripT100m2015-ru.ps
del gmt.conf
```

The constructed map looks like, fig. 2.9:

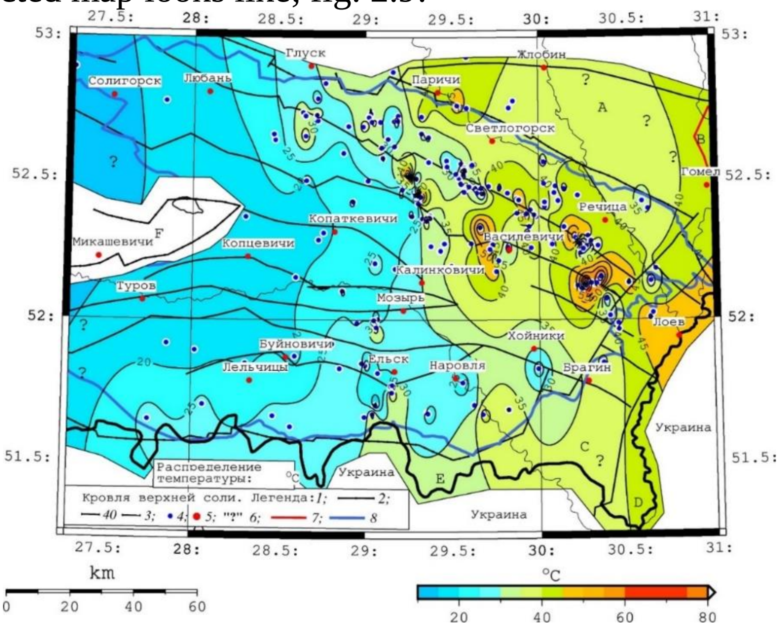


Figure 2.9 – Temperature distribution at the top of the upper salt in the Pripyat Trough

Note that in the ISO-8859-5 encoding, there is no degrees and minutes symbols, instead a colon is used here.

Required files: Upper_Salt_Temperature_2015.txt; TempSalt.cpt; npripyat.txt; spripyat.txt; NorthStep.txt; m-zvystp.gmt; lyakhovi.gmt; divin.gmt; ndniepr.gmt; sdniepr.gmt; radul.gmt; nzybkov.gmt; surazh.gmt; Urechye_Okt.gmt; Star_Vasilev.gmt; Kalinkovichi.gmt; Elsk.gmt; Khoiniki.gmt; Bragin0.gmt; Bragin1.gmt; Pripyat.gmt; pripyatS.gmt; Bragin.gmt; Loev.gmt; VA-05km.txt; Upper_Salt_Contur.txt; PripNorthClean.txt; PripSouthClean.txt; PripEastClean.txt; M_Zhitk_Vyst_Clean.txt; Legend-text-ru1UpSaltRoof-ISO8859-5.txt; Pripyat-towns-ru-ISO8859-5.txt. You can them them from the teacher.

Example 2.1.10: World seismicity map for one month

Subroutine text is written in the "modern" mode (file ex22.bat):

```
REM       GMT EXAMPLE 22 (GMT documentation)
REM
REM Purpose:   Automatic map of last month of world-wide seismicity
REM GMT modules:    set, coast, plot, legend
REM

gmt begin ex22
     gmt set FONT_ANNOT_PRIMARY 10p FONT_TITLE 18p FORMAT_GEO_MAP
ddd:mm:ssF
     REM Get the data (-s silently) from USGS using the curl
     REM Hardwired here to the month of October, 2017
     REM
SITE="https://earthquake.usgs.gov/fdsnws/event/1/query.csv"
     REM TIME="starttime=2017-09-01%2000:00:00&endtime=2017-10-
01%2000:00:00"
     REM MAG="minmagnitude=3"
     REM ORDER="orderby=magnitude"
     REM URL="${SITE}?${TIME}&${MAG}&${ORDER}"
     REM curl -s $URL > usgs_quakes_22.txt
     REM Count the number of events (to be used in title later. one
less due to header)
     gmt which @usgs_quakes_22.txt -G > file.txt
     set /p file=<file.txt
     gmt info %file% -h1 -Fi -o2 > n.txt
     set /p n=<n.txt
     REM Pull out the first and last timestamp to use in legend
title
     gmt info -h1 -f0T -i0 %file% -C --TIME_UNIT=d -I1 -o0 --
FORMAT_CLOCK_OUT=- > first.txt
     set /p first=<first.txt
     gmt info -h1 -f0T -i0 %file% -C --TIME_UNIT=d -I1 -o1 --
FORMAT_CLOCK_OUT=- > last.txt
     set /p last=<last.txt
     REM Assign a string that contains the current user @ the
current computer node.
     REM Note that two @@ is needed to print a single @ in gmt
text:
     set me=GMT guru @@ GMTbox
     REM Create standard seismicity color table
     gmt makecpt -Cred,green,blue -T0,100,300,10000 -N
     REM Start plotting. First lay down map, then plot quakes with
size = magnitude * 0.015":
     gmt coast -Rg -JK180/22c -B45g30 -B+t"World-wide earthquake
activity" -Gburlywood -Slightblue -A1000 -Y7c
     gmt plot -C -Sci -Wfaint -hi1 -i2,1,3,4+s0.015 %file%
     REM Create legend input file for NEIS quake plot
     echo H 16p,Helvetica-Bold %n% events during %first% to %last%
> neis.legend
     echo D 0 1p >> neis.legend
```

```
     echo N 3 >> neis.legend
     echo V 0 1p >> neis.legend
     echo S 0.25c c 0.25c red   0.25p 0.5c Shallow depth (0-100 km)
>> neis.legend
     echo S 0.25c c 0.25c green 0.25p 0.5c Intermediate depth (100-
300 km) >> neis.legend
     echo S 0.25c c 0.25c blue  0.25p 0.5c Very deep (^> 300 km) >>
neis.legend
     echo D 0 1p >> neis.legend
     echo V 0 1p >> neis.legend
     echo N 7 >> neis.legend
     echo V 0 1p >> neis.legend
     echo S 0.25c c 0.15c - 0.25p 0.75c M 3 >> neis.legend
     echo S 0.25c c 0.20c - 0.25p 0.75c M 4 >> neis.legend
     echo S 0.25c c 0.25c - 0.25p 0.75c M 5 >> neis.legend
     echo S 0.25c c 0.30c - 0.25p 0.75c M 6 >> neis.legend
     echo S 0.25c c 0.35c - 0.25p 0.75c M 7 >> neis.legend
     echo S 0.25c c 0.40c - 0.25p 0.75c M 8 >> neis.legend
     echo S 0.25c c 0.45c - 0.25p 0.75c M 9 >> neis.legend
     echo D 0 1p >> neis.legend
     echo V 0 1p >> neis.legend
     echo N 1 >> neis.legend
     REM Put together a reasonable legend text, and add logo and
user's name:
     echo G 0.25l >> neis.legend
     echo P >> neis.legend
     echo T USGS/NEIS most recent earthquakes for the last month.
The data were >> neis.legend
     echo T obtained automatically from the USGS Earthquake Hazards
Program page at >> neis.legend
     echo T @_https://earthquake.usgs.gov@_.  Interested users may
also receive email alerts >> neis.legend
     echo T from the USGS. >> neis.legend
     echo T This script could be called monthly to update the
latest information. >> neis.legend
     echo G 0.9c >> neis.legend
     echo # Add USGS logo >> neis.legend
     echo I @USGS.png 1i RT >> neis.legend
     echo G -0.75c >> neis.legend
     echo L 12p,Times-Italic LB %me% >> neis.legend
     REM OK, now we can actually run gmt legend.  We center the
legend below the map.
     REM Trial and error shows that 1.7i is a good legend height:
     gmt legend -DJBC+o0/1c+w18c/4.2c -F+p+glightyellow neis.legend

     del neis.legend usgs_quakes_22.txt
gmt end show
```

The constructed map looks like, fig. 2.10:

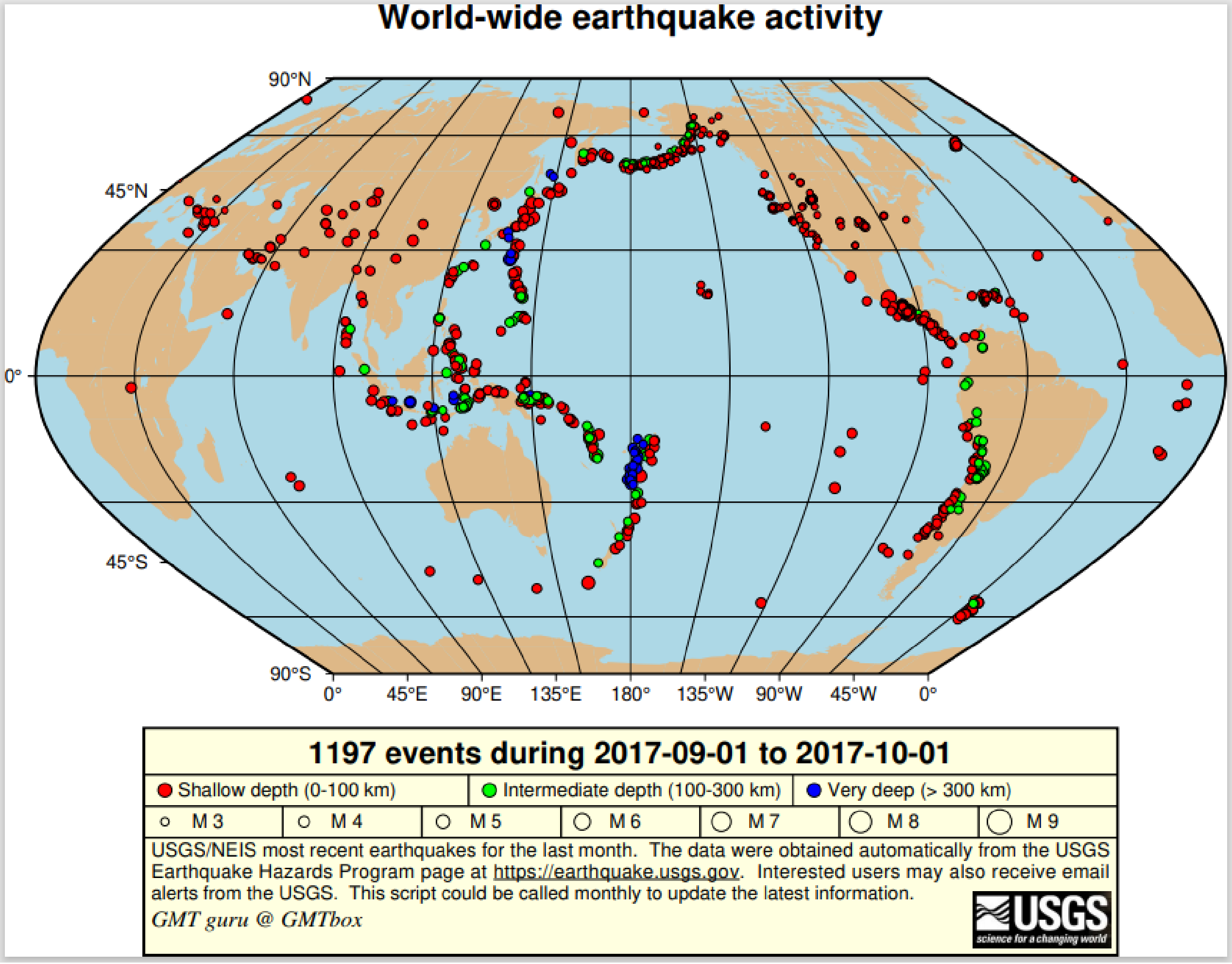


Figure 2.10 – World seismicity map for one month

The program downloads necessary data files with earthquakes from the GMT server via Internet.

Example 2.1.11: Antarctic map & topo maps

The map built in stereographic projection (-Js) according to the data on the site http://www.antarctica.ac.uk//bas_research/data/access/bedmap/download/bedelev.asc.gz illustrates Antarctica. It consists of two parts. The upper part shows the contours of Antarctica, its ice shelves and the adjacent part of the ocean. The lower part shows the relief of the continental floor (elevation above the ocean level) and bathymetric data on the adjacent part of the ocean floor. The legend is shown on each part separately:

An example of the text of the map script is given below in the “modern” version. It is borrowed (file ex42.bat) from the GMT documentation included in the installation version of the GMT 6.3.0 software package.

```
REM                GMT EXAMPLE 42 (GMT documentation)
REM
REM Purpose:       Illustrate Antarctica and stereographic
projection
REM GMT modules:  makecpt, grdimage, coast, legend, colorbar,
text, plot
REM

gmt begin ex42
     gmt set FONT_ANNOT_PRIMARY 12p FONT_LABEL 12p PROJ_ELLIPSOID
WGS-84 FORMAT_GEO_MAP dddF
     REM Data obtained via website and converted to netCDF thus:
     REM curl
http://www.antarctica.ac.uk//bas_research/data/access/bedmap/downl
oad/bedelev.asc.gz
     REM gunzip bedelev.asc.gz
     REM grdconvert bedelev.asc BEDMAP_elevation.nc=ns -V
     gmt makecpt -Cearth -T-7000/4000
     gmt grdimage @BEDMAP_elevation.nc -Jx1:60000000 -Q
     gmt coast -R-180/180/-90/-60 -Js0/-90/-71/1:60000000 -Bafg -Di
-W0.25p
     gmt colorbar -DJRM+w6.5c/0.5c+o1.5c/0+mc -F+p+i -
Bxa1000+lELEVATION -By+lm
     REM GSHHG
     gmt coast -Glightblue -Sroyalblue2 -X5c -Y12c
     gmt coast -Glightbrown -A+ag -Bafg

     echo H 18p,Times-Roman Legend > legend.txt
     echo D 0.25c 1p >> legend.txt
     echo S 0.4c s 0.5c blue       0.25p 0.75c Ocean >> legend.txt
     echo S 0.4c s 0.5c lightblue  0.25p 0.75c Ice front >>
legend.txt
     echo S 0.4c s 0.5c lightbrown 0.25p 0.75c Grounding line >>
legend.txt
     gmt legend legend.txt -DjLM+w4c+jRM+o1c/0 -F+p+i
     REM Fancy line
     echo 0    14        > lines.txt
     echo 6.5 14         >> lines.txt
     echo 13   11.5 >> lines.txt
     echo 19   11.5 >> lines.txt
     gmt plot lines.txt -R0/19/0/25 -Jx1c -B0 -W2p -X-6c -Y-13.5c
     echo 0 13 BEDMAP > tmp.txt
     echo 0 24 GSHHG >> tmp.txt
     gmt text tmp.txt -F+f18p+jBL -Dj8p/0
gmt end show
```

The constructed map looks like, fig. 2.11:

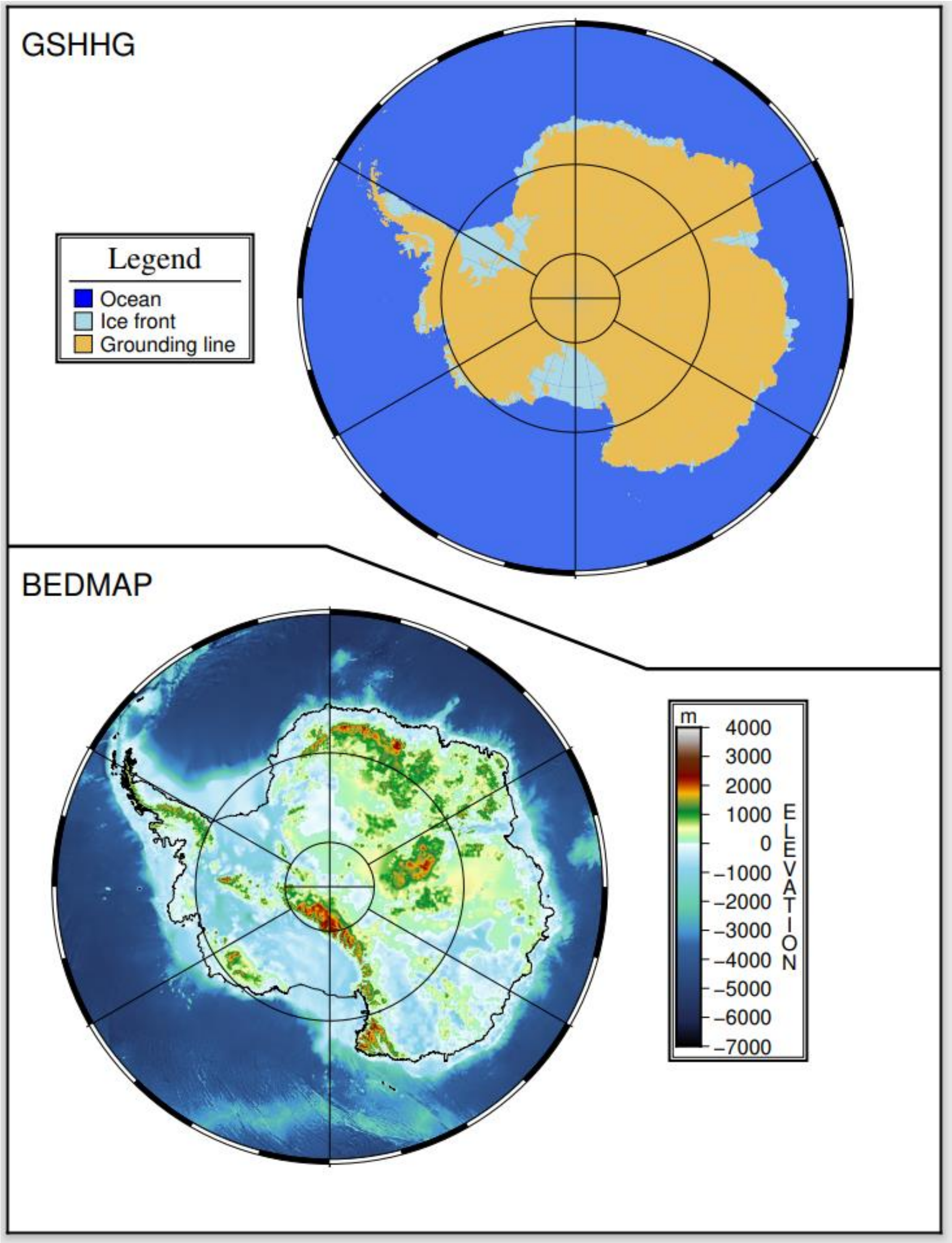


Figure 2.11 – Antarctic topo map

The Program takes necessary data files from Internet.

2.2. Creating animations

Computer animation (sequential slide show) uses prepared graphic files, as well as computer simulation of movement by changing and redrawing the shape of objects or displaying sequential images with motion phases, which were prepared in advance or generated during animation. The animation can be used in computer games, multimedia applications (for example, when delivering lectures), as well as to "revitalize" individual design elements, such as web pages.

Computer animation is a type of three-dimensional animation created using three-dimensional computer graphics. The term "computer animation" currently refers specifically to three-dimensional animation, while other terms are used for two-dimensional "hand-drawn" animation using a computer, for example, "Flash animation" and "GIF animation".

Reproduction of animation is a process of sequential change of individual patterns (frames) with a given frequency and perceived as a "moving" image. At the same time, it most often consists of hundreds or thousands of individual drawings / slides.

GMT allows you to create animations. At the same time, a lot of CPU time is spent on their creation (thousands of individual drawings). In this regard, the creation of animation requires the use of fast computers, usually with multi-core processors. Such computers in most cases work under UNIX or UNIX-compatible operating systems (Linux, FreeDSD, OpenBSD, Cygwin or others). Creating animation under Windows with GMT is possible, but is time consuming.

The GMT documentation (C:\programs\GMT6\share\examples\) contains a number of examples of scripts for creating animations written for UNIX-compatible operating systems in one of several UNIX shells, namely the *bash* shell (Bourne again shell) – in some sense, an analogue of DOS. The time for creating one animation on a 24-core MacPro 2013 computer takes from several minutes to several hours, depending on the complexity of the constructions. Due to the time consumption of creating animations, we do not provide several examples of them for the Windows operating system. However, in principle, some of scripts can be rewritten as bat-files to test them under Windows. Another way is using the bash shell scripts and run them under *Git-bash*. Git for Windows, for instance the latest Git-2.46.0-64-bit.exe, which is available to download free from Inernet (https://git-scm.com/download/win). It includes many commands used usually by bash under UNIX and UNIX-compatible operational systems. After installation, it generates the *git-bash.exe* file which permints to use the animation script (for example anim*_file.sh) under Windows. You can test one of scripts from a GMT6 package. If the GMT6 installed with default settings, you can find a few ready-to-run scripts in the folder C:\programs\GMT6\share\docs\examples\anim*\. You can try, for example the *anim01.sh*, (animated sinusoidal curve) to produce movie using the installed Git for Windows.

Example 2.12: Animation of sinusoidal curve

The ready script *anim01.sh* created for *bash* shell could be run under the *git-bash.exe*

```
#!/usr/bin/env bash
#               GMT ANIMATION 01
#
# Purpose:      Make simple MP4 of sine function
# GMT modules:  math, basemap, text, plot, movie
```

```
# Unix progs:   echo, convert, cat
#
# The finished movie is available in our YouTube channel as well:
# https://youtu.be/5m3gRhFFFLA
# 1. Create files needed in the loop
cat << 'EOF' > pre.sh
gmt math -T0/360/10 T SIND = sin_point.txt
gmt math -T0/360/1 T SIND = sin_curve.txt
gmt begin
     gmt basemap -R0/360/-1.2/1.6 -JX22c/11.5c -X1c -Y1c \
     -BWSne+glightskyblue -Bxa90g90f30+u@. -Bya0.5f0.1g1 --
FONT_ANNOT_PRIMARY=9p
gmt end
EOF
# 2. Set up the main frame script
cat << 'EOF' > main.sh
gmt begin
#    Plot smooth blue curve and dark red dots at all angle steps so
far
     last=$(gmt math -Q ${MOVIE_FRAME} 10 MUL =)
     gmt convert sin_curve.txt -qi0:${last} | gmt plot -W1p,blue -
R0/360/-1.2/1.6 -JX22c/11.5c -X1c -Y1c
     gmt convert sin_point.txt -qi0:${MOVIE_FRAME} | gmt plot -
Sc0.1i -Gdarkred
#    Plot bright red dot at current angle and annotate
     gmt plot -Sc0.1i -Gred <<< "${MOVIE_COL0} ${MOVIE_COL1}"
     printf "0 1.6 a = %3.3d" ${MOVIE_COL0} | gmt text -
F+f14p,Helvetica-Bold+jTL -N -Dj0.1i/0.05i
gmt end
EOF
# 3. Run the movie
gmt movie main.sh -Sbpre.sh -Chd -Tsin_point.txt -Vi -D5 -Zs -
Nanim01 -Fmp4
```

After processing is finished, it produces the *anim01.mp4* movie file. Please be patient when working with animations under Windows, as some of them supplied with the GMT6 documentation ready-to-use bash-scripts require up to few horurs to produce a movie file. You can view the created movie file with a corresponding mediaplayer, fig. 2.12.

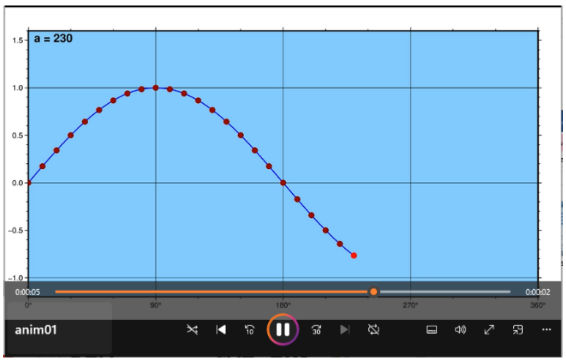


Figure 2.12 – Slide No. 230 produced by anim01.sh

2.3. Guided independent work

Example 2.13: Topography of the Hawaiian Islands. This program requires necessary data files: HI_geoid4.nc и HI_topo4.nc takes from Internet. They are also available from the teacher.
The program produces twodimensional and threedimensional maps, which demonstrate the relief features (both below and above the oceanic level) of the considered region based on the data liles mentioned above.

The text of the subroutine in the “modern” script form:

```
REM
REM Purpose:   3-D mesh plot of Hawaiian topography and geoid
REM       GMT EXAMPLE 04 from theGMT6 documentation
REM Purpose:   3-D mesh and color plot of Hawaiian topography and
geoid
REM
gmt begin
     gmt figure ex04
     gmt makecpt -C255,100 -T-10/10/10 -N
     gmt grdcontour @HI_geoid_04.nc -R195/210/18/25 -Jm1c -p60/30 -
C1 -A5+o -Gd10c
     gmt coast -p -B2 -BNEsw -Gblack -TdjBR+l
     gmt grdview @HI_topo_04.nc -R195/210/18/25/-6/4 -Jz0.8c -p -C
-N-6+glightgray -Qsm -B2 -Bz2+l"Topo (km)" -BneswZ+t"H@#awaiian@#
R@#idge@#" -Y5c --FONT_TITLE=50p,ZapfChancery-MediumItalic --
MAP_TITLE_OFFSET=-4c
     gmt figure ex04c
     gmt grdimage @HI_geoid_04.nc -I+a0+nt0.75 -R195/210/18/25 -
JM15c -p60/30 -C@geoid_04.cpt -X1.25i -Y1.25i
     gmt coast -p -B2 -BNEsw -Gblack
     gmt basemap -p -TdjBR+l --COLOR_BACKGROUND=red --FONT=red --
MAP_TICK_PEN_PRIMARY=thinner,red
     gmt colorbar -p240/30 -DJBC+o0/1c+w13c/0.75c+h -C@geoid_04.cpt
-I -Bx2+l"Geoid (m)"
     gmt grdview @HI_topo_04.nc -I+a0+nt0.75 -R195/210/18/25/-6/4 -
JZ8c -p60/30 -C@topo_04.cpt -N-6+glightgray -Qc100 -B2 -Bz2+l"Topo
(km)" -BneswZ+t"H@#awaiian@# R@#idge@#" -Y5c --
FONT_TITLE=50p,ZapfChancery-MediumItalic --MAP_TITLE_OFFSET=-4c
gmt end show
```

The constructed maps look like, fig 2.13:

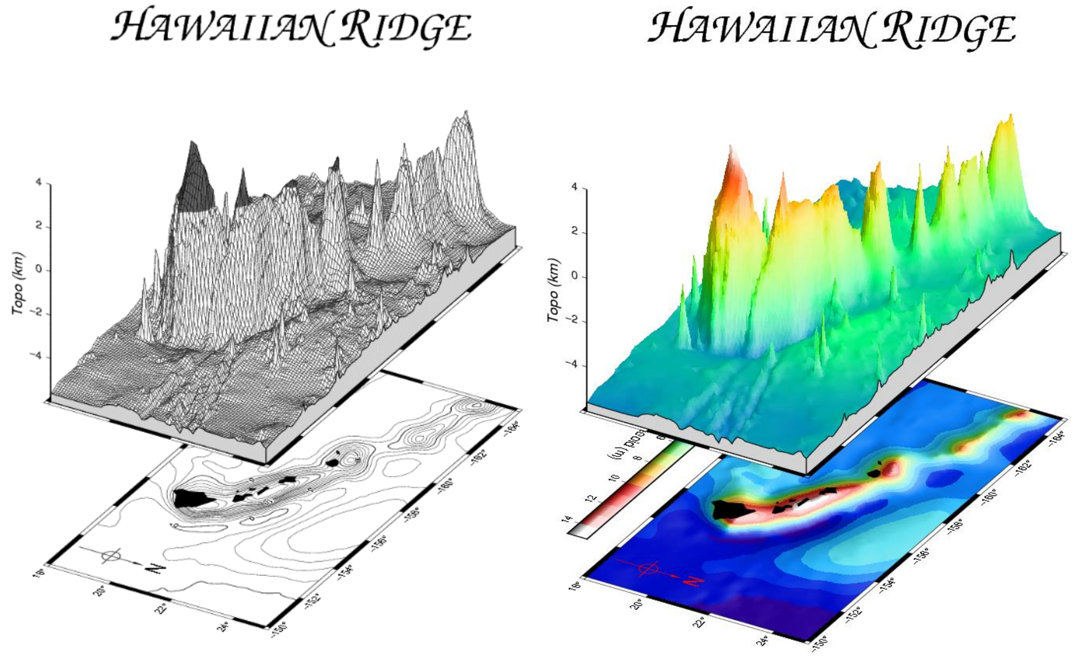


Figure 2.13 – Hawaiian Ridge 3D maps

Example 2.14: Schematic topographic map of the Far East. The text of the subroutine in the “modern” script form:

```
REM We construct the Far East Topography Map with earthquakes
REM
     gmt begin FarEastTopographyMap pdf,jpg
     gmt basemap -R127/142/42/49.8  -JM15c  -B2f1 -BWENS -Lfx3.5/-
1.5/4.0/400+lkm -Vl -X3 -Y2.6
     gmt grdcut @earth_relief_30s -R90/180/0/50 -I0.5m -Gh.grd
     gmt grdimage h.grd -R127/42/142/49.8r -JM15c -Cmount.cpt -
Ne0.1 -fg
     gmt coast -JM15c  -B2f1 -S151/190/255 -Df -Na/1p,white -
Ia/0.25p,blue -W0.25p,royalblue
     gmt plot Quakes_Far_East.txt -Sc0.1i -Gwhite -Wthinnest -:
      gmt colorbar -Dx8c/-1.55c+w6c/0.4c+h -Cmount.cpt  -
Bx500+l"Elev (m)"
     echo 133.2 48.75 Russia > tmp
     echo 133.2 47.4 China >> tmp
     echo 130.85 42.35 N. Korea >> tmp
     echo 140.0 43.75 Japan >> tmp
gmt pstext tmp -F+f20,Helvetica-Bold,white=thin

gmt end show

del tmp
```

The constructed map of the topography of the Far East region with a few earthquakes looks as follows, fig.2.14:

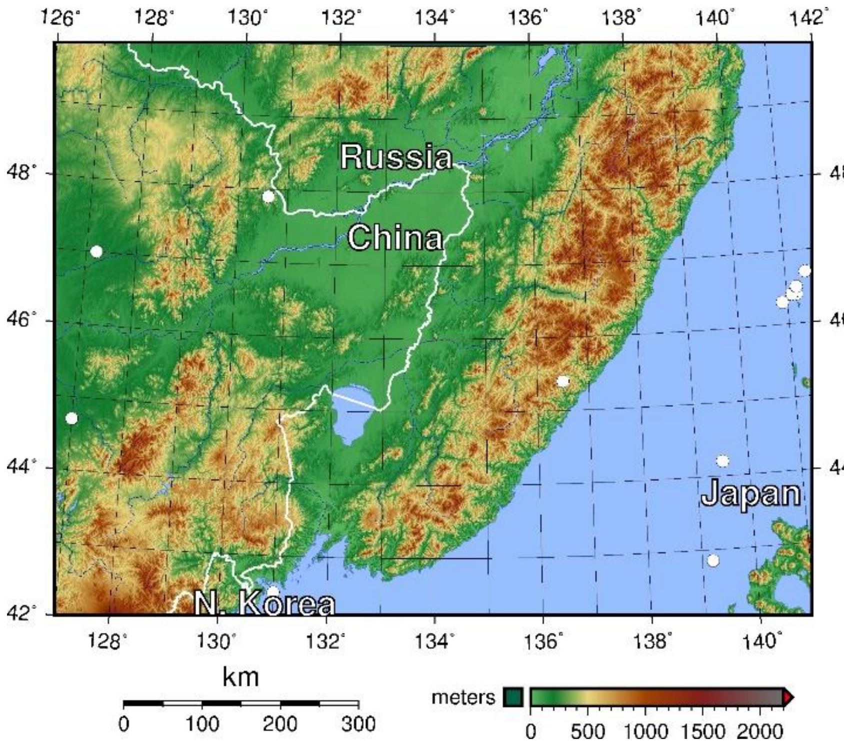


Figure 2.14 – Schematic topographic map of the Far East

The necessary grid files h.grd and hi.grd can be obtained from the teacher.

Example 2.15: Chukchi Peninsula and Alaska with the Bering Strait. The script of the subroutine in the “modern” form is:

```
REM Creating the Bering Strait area map
     gmt begin BeringSrait pdf,jpg
     gmt basemap -R-178/-164/63/68  -JM15c  -B2f1 -BWENS -Lfx3.5/-
1.5/4.0/400+lkm -Vl -X3 -Y2.6
     gmt grdcut @earth_relief_30s -R-178/-164/63/68 -Gh.grd
     gmt grdimage h.grd -R-178/-164/63/68 -JM15c -Cmount.cpt -Ne0.1
-fg -Vl
     gmt coast -JM15c  -B2f1 -S151/190/255 -Df -Na/1p,white -
Ia/0.25p,blue -W0.25p,royalblue -Vl
     gmt plot Points.txt -Sc0.26 -W1,black -Gwhite -Vl
     gmt text Settlements.txt -R-178/-164/63/68 -Dj0.25c/0.1c -
F+f12p,Helvetica,black+j+a
     #gmt text Settlements.txt -R-178/-164/63/68 -JM15c -F+cTL -
F+f18p,Helvetica,-=0.5p,red+cCM+tWELCOME  -B5 -pdf -Gyellow -
Wfaint -S -C+tO
     echo -168.8    66.0 Bering Strait > tmp
     echo -169.5    67.5 Chukchi     Sea >> tmp
     echo -168.0    64.0 Bering     Sea >> tmp
     gmt text tmp -Dj0.25c/0.1c -F+f14,Helvetica-Bold,yellow=thin
     gmt colorbar -Dx8c/-1.55c+w6c/0.4c+h -Cmount.cpt -Bx500+l"Elev
(m)"
gmt end show
del tmp
```

This program required the following files: the location of settlements (Points.txt); names of settlements (Settlements.txt), which can be obtained from the teacher.

The constructed map of the Chukotka Peninsula and Alaska with the Bering Strait separating them and the state border (white line) looks like:

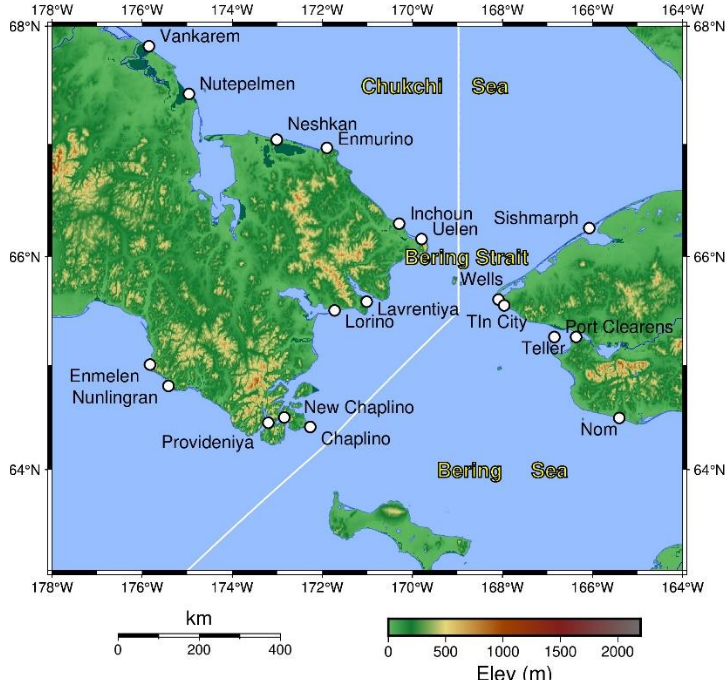


Figure 2.15 – Chukchi Peninsula and Alaska with the Bering Strait

Example 2.16: Drilling exploration of the Minsk region. The text of the subroutine in the “modern” form:

```
REM       Distribution of boreholes in the Minsk Region
REM
gmt begin MinskRegionBoreholes pdf,jpg
     gmt basemap -R25.9/29.75/52.25/55.2 -JM4i  -B1f1 -Lfx3.5/-
1.5/4.0/200 -Vl -X3 -Y2.6
     #gmt coast -JM4i -B1g1 -Df  -Ia/blue -Na/1p,white -W0 -
Slightblue
     gmt plot MinskOblBorder.txt -JM4i -Gwheat -B  -Vl -Wthin,black
     gmt makecpt -
Cwhite,yellow,green,lightblue,blue,pink,orange,red,firebrick -
T0,50,100,150,200,250,300,400,500,600
     gmt plot MinskBoreholesDepth.txt -Wfaint -Sc0.15 -C
     gmt coast -JM4i -B1g1 -Df  -Ia/blue -Na/1p,white -W0 -
Slightblue
     REM Legend to the map
     gmt legend -Dx11.0/0.0+w3.0 -F+pthick Depth_legend_New.txt

gmt end show
```

Required files: MinskOblBorder.txt, MinskBoreholesDepth.txt, Depth_legend.txt, the location of settlements (points.txt), the names of settlements (Settlements.txt) can be obtained from the teacher.

Drilling exploration of the Minsk region is depicted on a map with the main rivers; colored circles indicate depths of the wells. The constructed map looks like:

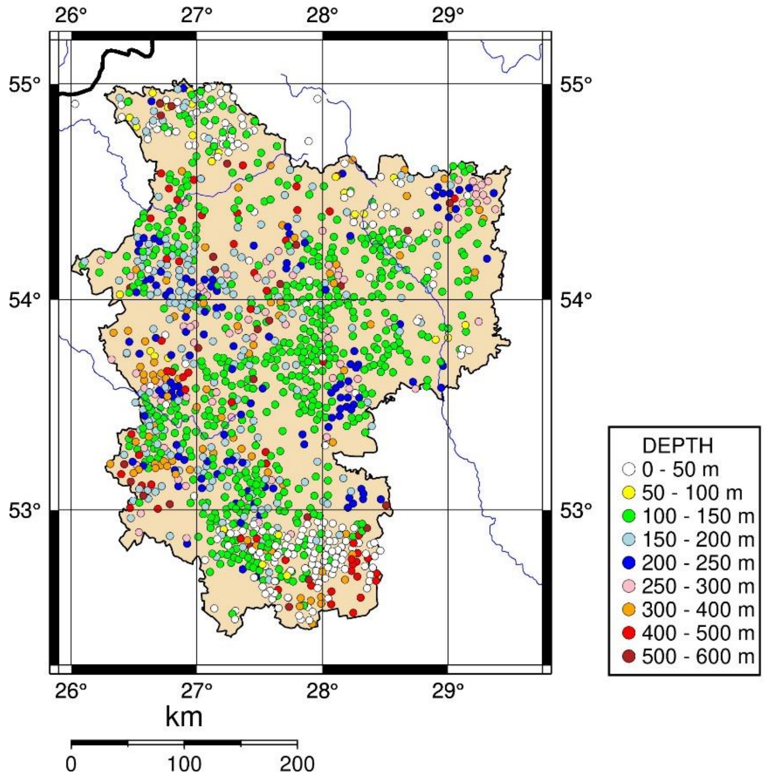


Figure 2.16 – Drilling exploration of the Minsk region

Example 2.17: Temperature distribution map at a depth of 100 m in the Orsha Depression. The text of the subroutine is in the "modern" form:

```
REM We conctruct the Orsha temperature distribution map at the
depth of 100 m
REM
     gmt begin Orsha100mT pdf,jpg
     gmt psbasemap -R27/33/53/56.5 -Jc30/54.5/1:2500000 -B1f1g1 -Vl
-X1.5 -Y3
     gmt pscoast -Jc -B -Dh -Ia/2/0/125/155 -Na/2 -Lfx4.0/-
1.4/4/150+lkm -Vl -W1
     gmt blockmean BelT100m_2021.txt -R27/33/53/56.5 -I0.2m -Vl >
Bel100mT.txt
     gmt surface Bel100mT.txt -GBel100mT.surface -I1.5m -T0.35 -Vl
     gmt grdimage Bel100mT.surface -CBelT100m.cpt -Jc -Vl
     gmt plot BAnorth.txt -Jc -Vl -Wthickest,orange -:
     gmt plot OrD-07km.txt -Jc -Vl -Wthickest,blue -:
     gmt plot TectonBelOD.txt -Jc -Vl -Wthickest,blue,-. -:
     gmt plot Polotsk2.txt -Jc -Vl -Wthick,black
     gmt plot MinskOblBorder.txt -Vl -Wthin,red
```

```
     gmt psxy Mogil_OblCor.txt -V -Wthin,red -:
     gmt plot VitebskOblSouth.txt -Vl -Wthin,red -:
     gmt plot npripyat.gmt -Jc -Sf0.25/0.05R -Vl -Wthickest,black
     gmt grdcontour Bel100mT.surface -Jc -C0.5 -A0.5+f10p -L5/15 -
Gd4c -S4 -T+d8p/2p  -Wthin,black
     gmt coast -Jc -Dh -Ia/1,blue -Na/2 -Vl -W,thicr,black
     gmt plot Bel100mT.txt -Jc -G200/0/0 -Sc0.12 -V -W,thick,red
     gmt plot BeltownsOrsha.txt -Jc -B -Glightred -Sa0.3 -V -
Wblack,thick
     echo 30.6 55.1 Vitebsk > tmp
     echo 30.35 54.1 Mogilev >> tmp
     echo 27.75 53.75 Minsk >> tmp
     echo 32.5 54.9 Smolensk >> tmp
     echo 31.35 54.83 Rudnya >> tmp
     echo 32.3 53.45 Khotimsk >> tmp
     echo 28.2 55.93 Asveya >> tmp
     echo 31.4 55.72 Velizh >> tmp
     echo 30.25 55.95 Nevel >> tmp
     echo 32.45 53.9 Roslavl >> tmp
     echo 32.45553.9 Roslavl >> tmp
     echo 30.4 54.6 Orsha >> tmp
     echo 27.6 54.95 Dokshitsy >> tmp
     echo 28.22 55.45 Disna >> tmp
     echo 28.5 54.15 Borisov >> tmp
     gmt text tmp -Jc -F+f9,Helvetica,black
     gmt colorbar -Dx8c/-1.4c+w8c/0.4c+h -CBelT100m.cpt -
Bx2+l"@+O@+C"
gmt end show
del tmp
```

The temperature distribution in the Orsha Depression at a depth of 100 m has the form, fig. 2.17:

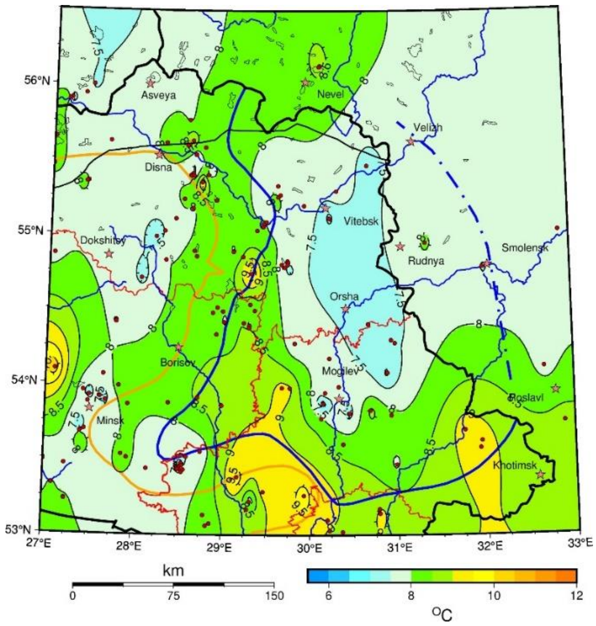


Figure 2.17 – Temperature distribution map at a depth of 100 m in the Orsha Depression

Necessary files for compiling a map: BelT100m_2021.txt, BelT100m.cpt, BAnorth.txt, OrD-07km.txt, TectonBelOD.txt, Polotsk2.txt, MinskOblBorder.txt, VitebskOblSouth.txt, Mogil_OblCor.txt, npripyat.gmt, BeltownsOrsha you can get from the teacher.

Example 2.18: Map of heat flow density in the Podlasie-Brest Depression. The text of the subroutine is in the "modern" form:

```
REM We construct the Heat Flow Density map for the Podlasie-Brest
Depression within Belarus
REM
set ps=BrestHFD.ps

gmt begin BrestHFD pdf,jpg
     gmt coast -R23.1/25.85/51.5/53.1 -Jb25/53.75/52.5/54/1:1200000 -
B1f1 -BNESW -Lfx3.5/-1.4/6/60k+lkm -W0.25p,royalblue -Dh -Ia/4,blue -
Ia/1,blue -Na/3 -Y2.5
     gmt surface BelHFD2015.txt -R23.1/25.85/51.5/53.1 -
GBrestHFD.surface -I1.0m -T0.35 -Vl
     gmt grdimage BrestHFD.surface -CHFD7bGro.cpt -Jb -Vl
     gmt grdcontour BrestHFD.surface -C5 -A5+f10p -Gd5c -L20/60 -S4 -
T+d8p/2p -Wthin,royalblue
     REM Cleaning the Poland and Ukrainian areas
     gmt psxy Brest100mTclean.txt -Jb -G255/255/255 -Vl -
W,thick,white
     gmt coast -R23.1/25.85/51.5/53.1 -Jb25/53.75/52.5/54/1:1200000 -
W0.25p,royalblue -Dh -Ia/1,blue -Na/3
     gmt plot BelHFD2015.txt -Jb -G200/0/0 -Sc0.2 -Vl -W,thick,red
     gmt plot svisloch.txt -Jb -Vl -Wthick,black
     gmt plot vysokoe.txt -Jb -Vl -Wthick,black
     gmt plot lyakhovi.txt -Jb -Vl -Wthick,black
     gmt plot sratno.txt -Jb -Vl -Wthick,black
     gmt plot divin.txt -Jb  -Vl -Wthick,black
     gmt psxy spripyat_Brest.txt -Jb -Vl -Wthick,black
     gmt psxy BA1Yu.txt -Jb -Vl -Wthickest,blue
     echo 23.6 52.8 Poland > tmp
     echo 23.3 51.8 Poland >> tmp
     echo 25.45 52.3 Belarus >> tmp
     echo 24.2 52.27 PBD >> tmp
     echo 25.35 52.53 PS >> tmp
     echo 24.75 53.035 BA >> tmp
     echo 25.5 51.65 Ukraine >> tmp
     echo 24.2 51.60 LRH >> tmp
     gmt text tmp -Jb -F+f12,Helvetica,white=thin
     gmt text Beltowns5Gro.txt -R23.1/25.85/51.5/53.1 -Dj0.25c/0.1c -
F+f12p,Helvetica,black+j+a
     gmt plot BrestPoints.txt -Jb -Sc0.25  -Groyalblue -Wblack -Vl
     gmt colorbar -Dx8c/-1.4c+w5c/0.4c+h -CHFD7bGro.cpt -
Bx20+l"mW/m@+2@+"
gmt end show
del tmp
```

The compiled map is shown below, fig. 2.18 (thick blue line is the eastern border of the Podlasie-Brest Depression within Belarus, black lines – faults):

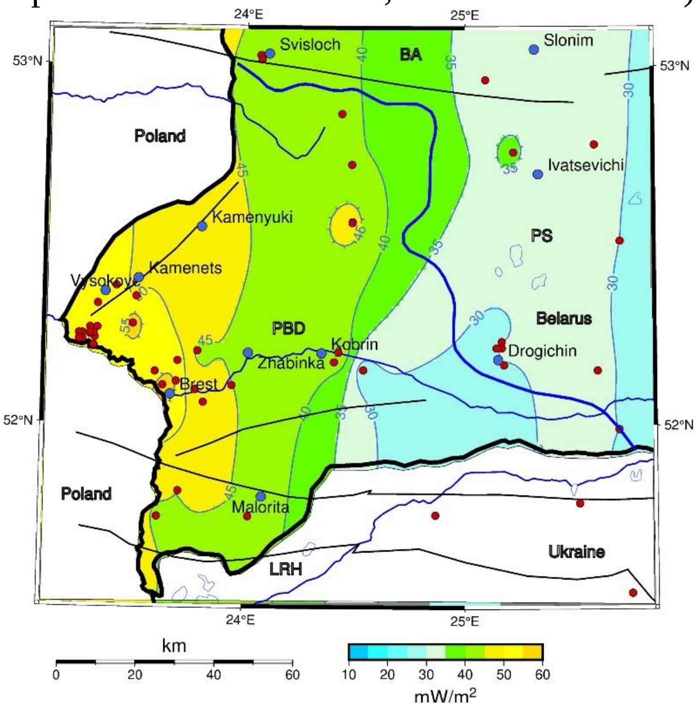


Figure 2.18 – Heat flow density Map in the eastern part of the Podlasie-Brest Depression

Necessary files to compile the map: BelHFD2015.txt, Berst100mTclean.txt, svisloch.txt, vysokoe.txt, lyakhovi.txt, sratno.txt, divin.txt, spripyat_Brest.txt, BA1Yu.txt, Beltowns5Gro.txt and BrestPoints.txt you can get from the teacher.

Example 2.19: Landform of the California Rocky Mountains

The map is constructed in the Mercator projection (–Jm) using California mountain topography (us.nc file). The resulting *California_mountains.ps* file is converted to *California_mountains.jpg*.

The text of the subroutine in the “modern” script form:

```
REM California mountain ridges
REM       GMT California mountains (based on GMT documentation)
REM
REM Purpose:   Illustrates how to plot mountain ridges of
California

gmt begin CaliforniaMountains
     REM Create cpt-file based on the GMT “rainbow” file
     gmt makecpt -Crainbow -T0/2000 > elevation
     gmt grdcut @earth_relief_30s -R-108/-103/35/40 -Grelief.nc
     REM Use mercator gmt projection with topo data (relief.nc
file)
     gmt grdimage relief.nc=ns+s0.5 -I+a45+nt1 -Jm1.0i -C
     REM Then use mercator gmt projection with same scale
```

```
     gmt coast -R-108/-103/35/40 -Jm1.0i -Ba1f0.5 -Lf-
107/34.5/6.0/200+lkm -Ia/blue -BWSNE --PROJ_ELLIPSOID=Sphere -
Cwhite -Dh+ --FORMAT_GEO_MAP=dddF
     REM Put a color legend below the plot
     gmt colorbar -Dx7c/-1.55c+w5c/0.4c+h -C -Bx400+l"Elevation, m"

gmt end show
del elevation
```

The required file: earth_relief_30s is downloaded from Internet, otherwise it is available from the teacher.
The constructed map looks like, fig. 2.19:

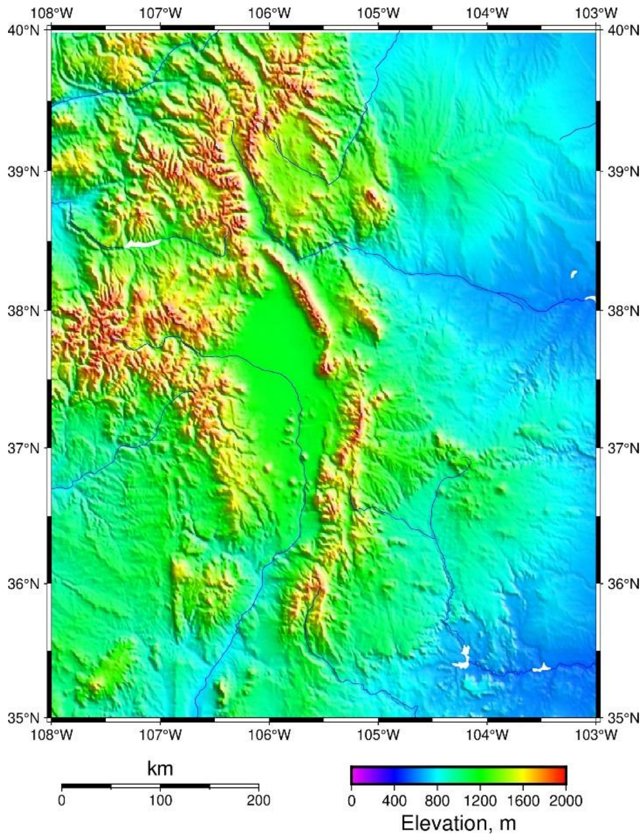


Figure 2.19 – Landform of the California Rocky Mountains

Example 2.20: Temperature distribution map for the neitral layer

The neitral layer is the depth at which the seasonal (winter - spring - summer - winter) annual amplitude of temperature fluctuations from heating the earth's surface by the Sun becomes small – below the sensitivity threshold of a borehole thermometer. The map is constructed in stereographic projection (–Js) and illustrates contours.

The script below is written in the “modern” version of GMT.

```
REM We construct the temperature distribution at the “Neitral
Layer” within Belarus
REM
gmt begin NeitralT pdf,jpg
     gmt basemap -R23/33/51/56.25 -Jb28/54/51/57/1:4000000 -B2f1
-BNESW -Lf26/50.5/6.0/200+lkm+lkm -Vl -X1.5 -Y3
     blockmean NeitrlT.txt -R23/33/51/56.25 -I1.5m -Vl >
NeitralT.txt
     gmt surface NeitralT.txt  -GNeitralT.surface -I1.5m -T0.5 -
Vl
     gmt grdimage NeitralT.surface -CBelT100m.cpt -Jb -Vl
     gmt coast -Jb -B -Dh -Ia/1/0/125/155,blue  -Na/2 -Vl -W0.5
     gmt grdcontour Neitralt.surface -C0.5 -A0.5+f10 -Gd1c -L5/12
-S2 -T+d8p/2p -Vl -Wthin,black
     gmt plot npripyat.txt -Jb -Sf0.25/0.05R -Vl -Wthickest,black
     gmt plot spripyat.txt -Jb -Sf0.25/0.05R -Vl -Wthickest,black
     gmt plot sratno.txt   -Jb -Wthin,black -Vl
     gmt plot svisloch.txt -Jb -Wthin,black -Vl
     gmt plot m-zvystp.txt -Jb -Sf0.25/0.05L -Vl -Wthickest,black
     gmt plot vilnius.txt  -Jb -Wthin,black -Vl
     gmt plot suvalki.txt  -Jb -Wthin,black -Vl
     gmt plot naliboki.txt -Jb -Wthin,black -Vl
     gmt plot oshmyany.txt -Jb -Wthin,black -Vl
     gmt plot lyakhovi.txt -Jb -Wthin,black -Vl
     gmt plot divin.txt    -Jb -Wthin,black -Vl
     gmt plot vysokoe.txt  -Jb -Wthin,black -Vl
     gmt plot ndniepr.txt  -Jb -Sf0.25/0.05R -Vl -Wthickest,black
     gmt plot sdniepr.txt  -Jb -Sf0.25/0.05R -Vl -Wthickest,black
     gmt plot radul.txt    -Jb -Wthin,black -Vl
     gmt plot nzybkov.txt  -Jb -Wthin,black -Vl
     gmt plot Orsha.txt    -Jb -Wthin,black -Vl
     gmt plot Smolensk.txt -Jb -Wthin,black -Vl
     gmt plot NorthStep.txt -Jb -Wthick,black -V -:
     gmt plot BA1Yu.txt    -Jb -Wthick,red -Vl -:
     gmt plot BAnorth.txt  -Jb -Wthick,red -Vl -:
     gmt plot BA4W.txt     -Jb -Wthick,red -Vl -:
     gmt plot BA5S.txt     -Jb -Wthick,red -Vl -:
     gmt plot VA-05km.txt  -Jb -Wthick,red -V -:
     gmt plot OD-07km.txt  -Jb -Wthick,blue -V -:
     gmt plot NeitrlT.txt  -Jb -B -Gyellow -Sc0.15 -Vl -
Wthin,black
     REM Box for Legend
     echo 31.75 56.25 > tmp
     echo 31.71 55.018 >> tmp
     echo 33.0 55.0 >> tmp
     echo 33.0 56.25 >> tmp
     gmt plot tmp -Jb -B -G240 -Vl -Wthick
     REM Legend, Super Regional Faults
     echo 32.0 56.0 > tmp
     echo 32.5 55.992 >> tmp
     gmt plot tmp -Jb -G0 -L -Sf0.2/0.05R -Wthickest,black
     del tmp
     echo 32.7 55.99 1 | gmt text -Jb -Vl
```

```
     REM Legend, Regional Faults
     echo 32.0 55.8 >tmp
     echo 32.27 55.798 >> tmp
     gmt plot tmp -Jb -G0 -Wthick,black
     del tmp
     echo 32.27 55.798 > tmp
     echo 32.20 55.72 >> tmp
     gmt plot tmp -Jb -G0 -Wthick,black
     del tmp
     echo 32.20 55.72 > tmp
     echo 32.5 55.718 >> tmp
     gmt plot tmp -Jb -G0 -Wthick,black
     del tmp
     echo 32.69 55.71 2 | gmt text -Jb -Vl
     del tmp
     REM Legend, Temperature Isolines
     echo 31.99 55.55 > tmp
     echo 32.15 55.545 >> tmp
     gmt plot tmp  -Jb -G0  -Wthick,black
     del tmp
     echo 32.27 55.56 10 | gmt text -Jb -Vl
     echo 32.42 55.545 > tmp
     echo 32.55 55.545 >> tmp
     gmt plot tmp -Jb -G0 -Wthick,black
     del tmp
     echo 32.67 55.56  3 | gmt text -Jb -Vl
     REM Legend, Borehole
     echo 32.25 55.35 | gmt plot -Jb -Gyellow -Vl -Sc0.15 -
Wthin,black
     echo 32.66 55.36  4 | gmt text -Jb -Vl
     del tmp
     REM Legend, Towns
     echo 32.25 55.15 | gmt plot -Jb -Gred -Vl -Sa0.25 -
Wthin,black
     echo 32.65 55.16  5 | gmt text -Jb -Vl
     gmt plot Beltowns3.txt -Jb -B -Gred -Sa0.25 -Vl -Wthin,black
     echo {print $1, $2, $3} > awk.txt
     gawk -f awk.txt Beltowns3.txt | gmt pstext -Jb -D0.5i/0.4 -
F+f10p,Times-Italic,darkblue=thinnest+jRM
     REM Countries
     echo 32.5 51.85 Russia > tmp
     echo 29.2 56.14 Russia >> tmp
     echo 26.5 56.12 Latvia >> tmp
     echo 25 55.7 Lithuania >> tmp
     echo 25.3 51.3 Ukraine >> tmp
     echo 31.25 51.3 Ukraine >> tmp
     echo 23.35 53.0 Poland >> tmp
     gmt text tmp -Jb -F+f12p,Times-Italic,royalblue=thinnest -Vl
     del tmp
     gmt colorbar -Dx10c/-1.4c+w5c/0.4c+h -CBelT100m.cpt -
Bx1+l@+O@+C"
gmt end show
```

Initial data (faults, temperature data for wells, their location, etc.) can be obtained from the teacher.

The constructed map looks like, fig. 2.20:

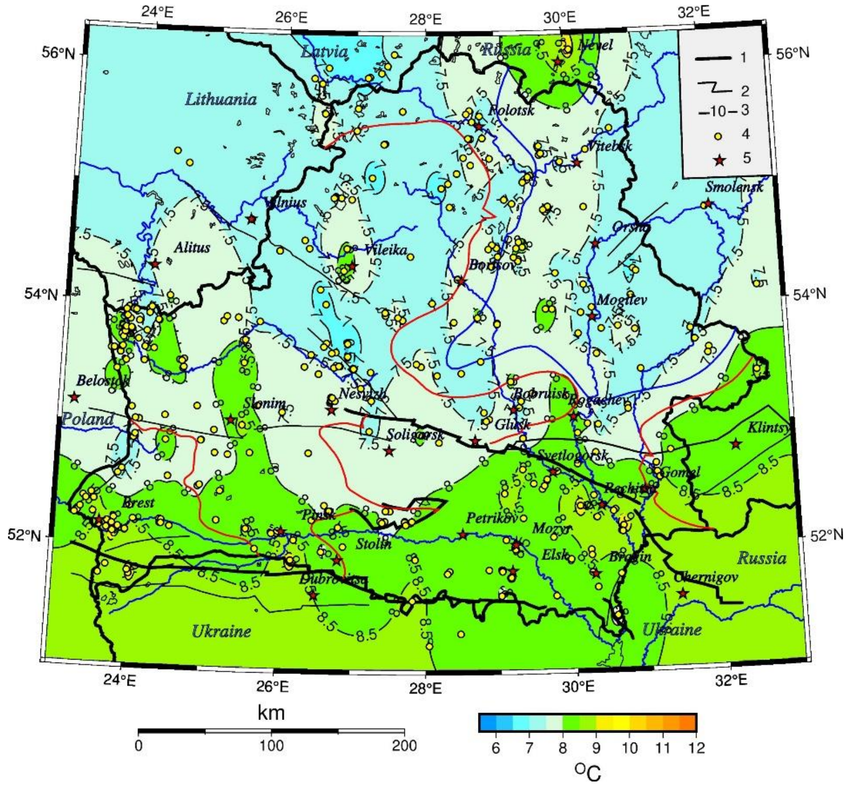


Figure 2.20 – Temperature distribution map for the neutral layer

Example 2.21: Thermograms of deep boreholes of the Orsha Depression

This figure illustrates the degree of reliability of recording thermograms of deep boreholes in the Orsha Depression. The thermograms of production logging indicate a deviation from the equilibrium temperature of the rock massifs (not kept enough nime before measurements).

The script below is written in the “classic” version of GMT.

```
REM We construct several thermograms of deep boreholes drilled
within the Orsha Depression
REM
set ps=OrshaDeep.ps
gmt psxy -R4/35/0/1700 -JX12/-12.5 -Bx2f1g1+l"Temperature, @+O@-
C" -By200f100g100+l"Depth, m"  -BWsNe+gsnow -Wthick,black -P -K -
X4.0 -Y1.5 Bogush1rev.ter  > %ps%
gmt psxy -R -JX -Bx -By -P -K -O  -Wthick,darkviolet
Orsha2oprev.tep  >> %ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,orange Orsha2o.ter
>> %ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,green Krapiven.tep
>> %ps%
```

```
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthin,black Krapiven.tep  >>
%ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,yellow Smolensk1.ter
>> %ps%
gmt psxy -R -JX -Bx -By -Sc0.05 -P -K -O -: -Wthick,black
Smolensk1.ter  >> %ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,blue Suraz1S2.ter  >>
%ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,blue,- Rudnya1.tep
>> %ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,black,- Suraz1S2.tep
>> %ps%
gmt psxy -R -JX -Bx -By -P -K -O -: -Wthick,red golozerx.txt  >>
%ps%
echo 16.5 1350 1 > tmp
echo 14.4 860 2 >> tmp
echo  16.7 960 3 >> tmp
echo 20.5 1250 4 >> tmp
echo 18.3 850 5 >> tmp
echo 23.5 1160 6 >> tmp
echo 26.3 1160 7 >> tmp
echo 12.3 50 9 >> tmp
echo 11.5 480 8 >> tmp
REM echo 10.2 310 11 >> tmp
gmt pstext -R -JX -O -F+f14,Helvetica,black=thin tmp >> %ps%
gmt psconvert -A  -C-dINTERPOLATE -P -Tj OrshaDeep.ps
```

Initial data (thermograms for boreholes) can be obtained from the teacher.
The constructed graph looks like, fig. 2.21:

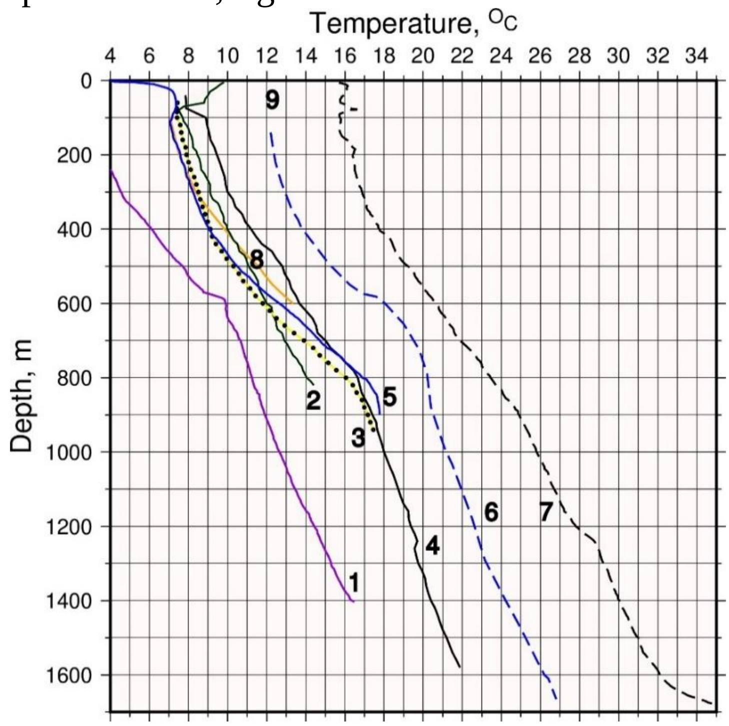


Figure 2.21 – Thermograms of deep boreholes of the Orsha Depression

Example 2.22: Relationship between age and thickness of oceanic crust

This figure illustrates the gradual thickening of the oceanic crust with its age and when newly produced crust moves away from the middle of the oceanic rift.

The script below is written in the "modern" version of GMT.

```
REM               GMT EXAMPLE 49 from the GMT6 documentation
REM
REM Purpose:      Illustrate data analysis using the seafloor
depth/age relationship
REM GMT modules:  blockmode, gmtmath, grdcontour, grdimage,
grdsample, makecpt,
REM       subplot, basemap, legend, colorbar, plot, xyz2grd
REM

gmt begin ex49
     REM Pull depth and age subsets from the global remote files
     gmt grdcut @earth_relief_02m -R30W/5E/30S/5S -
Gdepth_pixel.nc
     gmt grdcut @earth_age_02m -R30W/5E/30S/5S -Gage_pixel.nc
     REM Flip to positive depths in km
     gmt grdmath depth_pixel.nc NEG 1000 DIV = depth_pixel.nc
     REM Obtain depth, age pairs by dumping grids and pasting
results
     gmt grd2xyz age_pixel.nc -bof > age.bin
     gmt grd2xyz depth_pixel.nc -bof > depth.bin
     gmt convert -A age.bin depth.bin -bi3f -o2,5,5 -bo3f >
depth-age.bin
     REM Obtain modal depths every ~5 Myr
     gmt blockmode -R0/100/0/10 -I5/10 -r -E -Q depth-age.bin -
bi3f -o0,2,3 > modal.txt
     REM Create density grid of (age,depth) distribution
     gmt xyz2grd -R0/100/0/6.5 -I0.25/0.025 -r depth-age.bin -
bi3f -An -Gdensity.nc
     REM Make CPTs for ages and depths
     gmt makecpt -Chot -T0/100/10 -H > t.cpt
     gmt makecpt -Cabyss -T0/7 -H -I > z.cpt
     gmt subplot begin 2x1 -Fs15c/11.3c -Sc
     REM Image depth distribution, modal depths, and competing
predictions
     gmt grdimage density.nc -Q -Ct.cpt -JX15c/-11.3c -Bxaf+u"
Myr" -Byaf+u" km" -c
     REM Compute Parsons & Sclater [1977] depth-age curve (in km)
     REM depth(t) =   0.35 * sqrt(t) + 2.500, t < 70 Myr
     REM        =  6.4 - 3.2 exp (-t/62.8), t > 70 Myr
     gmt math -T0/100/0.1 T SQRT 0.35 MUL 2.5 ADD T 70 LE MUL 6.4
T 62.8 DIV NEG EXP 3.2 MUL SUB T 70 GT MUL ADD = ps.txt
     gmt plot ps.txt -W4p,green
     gmt plot ps.txt -W1p
     REM Compute Stein & Stein [1992] depth-age curve (in km)
     REM depth(t) =  0.365 * sqrt(t) + 2.6,  t < 20 Myr
```

```
     REM     = 5.651 - 2.473 * exp (-0.0278*t), t > 20 Myr
     gmt math -T0/100/0.1 T SQRT 0.365 MUL 2.6 ADD T 20 LE MUL
5.651 T -0.0278 MUL EXP 2.473 MUL SUB T 20 GT MUL ADD = ss.txt
     REM Plot curves and place the legend
     gmt plot ss.txt -W4p,white
     gmt plot ss.txt -W1p
     gmt plot -Ss0.4c -Gblue modal.txt -Ey+p1p,blue
     gmt plot -Ss0.1c -Gwhite modal.txt
     echo S 0.5c - 0.9c - 4p,green 1.2c Parsons & Sclater (1977)
> tmp.txt
     echo S 0.5c - 0.9c - 4p,white 1.2c Stein & Stein (1992) >>
tmp.txt
     echo S 0.5c s 0.4c blue - 1.2c Modal depth estimates >>
tmp.txt
     gmt legend -DjRT+w5.5c+o0.25c -F+p1p+gbeige+s tmp.txt
     echo S 0.5c - 0.9c - 1p 0.75c > tmp.txt
     echo S 0.5c - 0.9c - 1p 0.75c >> tmp.txt
     echo S 0.5c s 0.1c white - 0.75c >> tmp.txt
     gmt legend -DjRT+w5.5c+o0.25c tmp.txt
     REM Image depths with color-coded age contours
     gmt grdimage depth_pixel.nc -R30W/5E/30S/5S -JM? -Cz.cpt -c
     gmt plot -W1p @ridge_49.txt
     gmt grdcontour age_pixel.nc -A+f14p -Ct.cpt -Wa0.1p+c -
GL30W/22S/5E/13S
     gmt colorbar -Cz.cpt -DjTR+w4.7c/0.4c+h+r+o0.85c/0.35c -
Baf+u" km" -F+p1p+gbeige+s+c0p/10p/4p/4p
     gmt subplot end
     del age_pixel.nc depth_pixel.nc age.bin depth.bin depth-
age.bin density.nc modal.txt ps.txt ss.txt z.cpt t.cpt tmp.txt
gmt end show
```

The script takes the initial data from the Internet, otherwise you can get it from the teacher.

The constructed graph looks like, fig. 2.22:

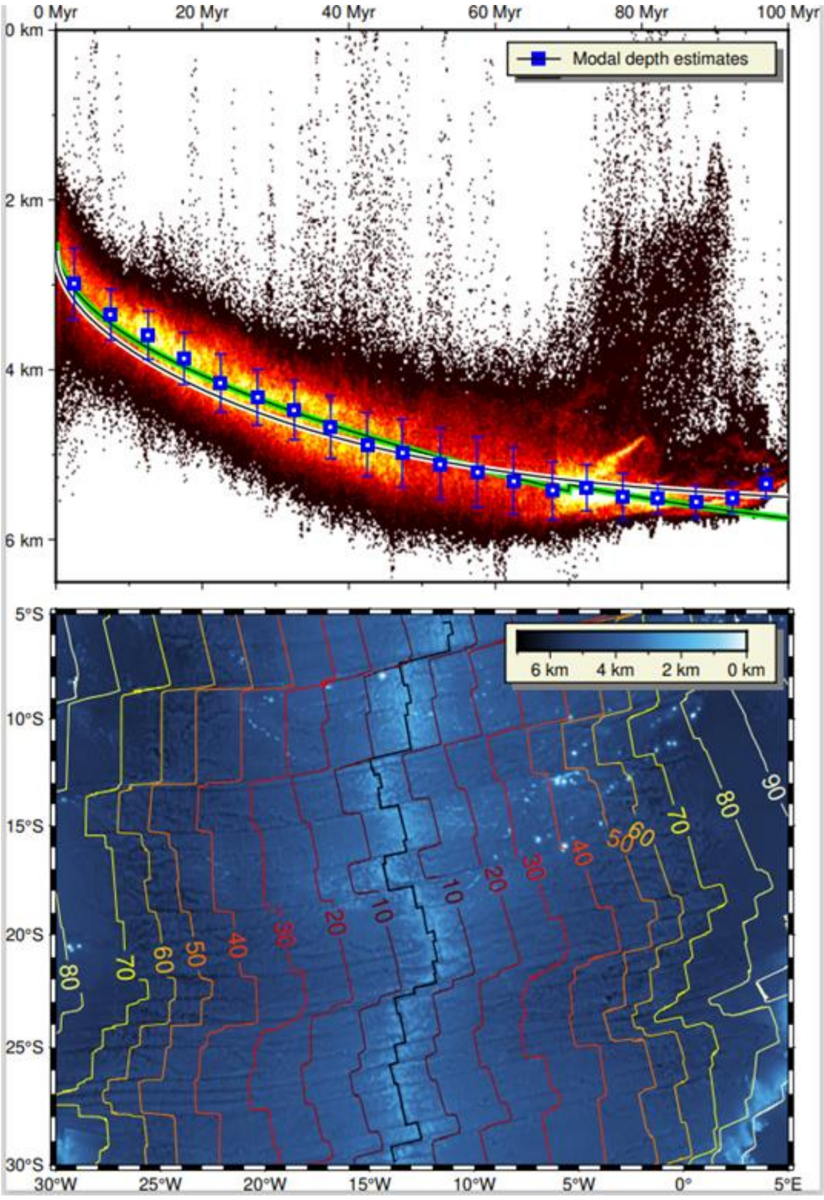


Figure 2.22 – Relationship between age and thickness of oceanic crust

3. KNOWLEDGE CONTROL SECTION

3.1. Questions for the discipline exam

(for parts 1 and 2)

1. The main software products discussed in the course "GIS in Mineral Resource Management".

2. Types of computer hardware and trends in their development. The processor, input and output devices, operational and long-term memory, printers, plotters in computers.

3. Problems solved with the use of computer processing tools. Give some examples.

4. Sources and types of data used for further processing in GIS: Earth remote sensing data, earthquake catalogs, geological maps, data on gravity and magnetic fields, well logs, relief, etc.

5. Using GMT for processing geological and geophysical data and constructing graphs, diagrams, maps.

6. Main options in GMT software package commands: -R, -J, -B, -O, -K, -G, -g, -I, REM. How to select coordinate systems and projections.

7. How to convert the Post Script output format of graphics in the GMT environment to other formats (jpg, tiff, png, pdf). Show an example of converting to other formats using one of labs completed by you as an example.

8. How to identify the boundaries of lithospheric plates, active faults in the oceans using computer graphics? Consider an example from your tests.

9. Which seaquakes are dangerous in terms of tsunamis? Give an example of the computer test for the Sea of Japan region.

10. Classic (traditional) and modern (modern) methods of writing scripts in GMT

11. The computer software package “QGIS”, its modular structure and interface features. Types of tests fulfilled by you using the QGIS.

12. Vector and raster data, their difference. Layers in QGIS. Raster model for representing spatial data in GIS. Advantages and disadvantages of the raster model.

13. Purpose of bases for storing and processing geological data.

14. Definition of GIS. Basic components and functionality of GIS.

15. GIS classifications. Composition capabilities of GIS software products.

16. Data sources necessary for constructing geological maps, profiles, sections.

17. Data sources for GIS: Satellite data, CAD data, geodetic technologies, databases.

18. Capabilities of the Surfer software and its use.

19. Using the Geostatistics software modules.

20. Purpose and capabilities of the QGIS software package.

21. Types of geological problems solved using the QGIS software package.

22. Construction of geological sections and profiles using GIS software.

23. General characteristics of the complex of GIS software products ArcGIS.

24. Overview of additional ArcGIS GIS capabilities.

25. Brief overview of geographic coordinate systems used in mapping.

26. Raster model for representing spatial data in GIS. Advantages and disadvantages of the raster model. The most common raster formats for representing spatial data in GIS.

27. Overview of the vector format and raster data - geodatabase.

28. Methods for classifying quantitative geodata in GIS. Georeferencing raster images.

29. Spatial statistics in GIS.

30. Processing of geological data in GIS.

3.2. Abstract topics

The independent work (abstract) includes 10 examples, they are test scripts written for the GMT software package (examples 2.12 – 2.21). Scripts for them are given above in the section 2, paragraphs 2.3 – Guided independent work.

1. Example 2.12: Topography of the Hawaiian Islands.

2. Example 2.13: Schematic topographic map of the Far East.

3. Example 2.14: Chukchi Peninsula and Alaska with the Bering Strait.

4. Example 2.15: Drilling exploration of the Minsk region.

5. Example 2.16: Temperature distribution map at a depth of 100 m in the Orsha Depression.

6. Example 2.17: Map of heat flow density in the Podlasie-Brest Depression.

7. Example 2.18: Landform of the California Rocky Mountains.

8. Example 2.19: Temperature distribution map for the neutral layer.

9. Example 2.20: Thermograms of deep boreholes of the Orsha Depression.

10. Example 2.21: Relationship between age and thickness of oceanic crust.

You can use also examples, described in the Sufer chapter to gain your practice for creating graphics under the Goldware Surfer program package.

3.3. Organization of independent work

The independent work is carried out on the basis of the Regulations on independent works of students (undergraduates, students), approved by the Minister of Education of the Republic of Belarus on April 6, 2015.

In the discipline studied, it is planned:

- Performing creative and research tasks;

- Work with published sources, including scientific articles;

- Study of topics and problems that are not covered in lectures;

- Scientific reports;

- Writing thematic reports and essays on problematic topics.

List of recommended diagnostic tools:

- Oral surveys – 25%;

- Interviews – 25%;

- Report on practical work – 25%; - laboratory tests – 25%.

Methodology for generating the final assessment. The final assessment is formed based on three documents:

1. Rules for certification (Resolution No. 53 of May 29, 2012);

2. Regulations on the BSU rating system;

3. Student assessment criteria (passed).

4. The final grade is formed from the rating assessment of the final control of current progress (40%) and the result of the answer at the test (60%).

List of recommended diagnostic tools and methodology for forming the final assessment. The form of the current certification in the discipline "GIS in mineral resource management" is provided by the curriculum for credit. The final assessment is based on three documents:

1. Rules for conducting certification of students, cadets, listeners when mastering the content of educational programs of higher education (Resolution of the Ministry of Education of the Republic of Belarus dated May 29, 2012 No. 53).

2. Regulations on the rating system for assessing students' knowledge in an academic discipline at BSU (Order of the Rector of BSU No. 189-OD dated March 31, 2020).

3. Criteria for assessing the results of educational activities of students in higher education institutions on a ten-point scale (Letter of the Ministry of Education of the Republic of Belarus dated May 28, 2013 No. 09-10/53-PO).

The assessment of the degree of mastery of theoretical material is checked through regular testing. To assess the degree of completion of laboratory work, undergraduates prepare a written report, which is checked by the teacher.

When forming the final grade, a rating assessment of the student's knowledge used, which makes it possible to trace and evaluate the dynamics of the process of achieving learning goals. The rating assessment involves the use of weighting coefficients for the current control of knowledge and the current certification of master's students in the discipline.

Approximate weighting coefficients that determine the contribution of forms (events) of current knowledge control to the assessment of current academic performance: electronic tests (arithmetic average of grades for all electronic tests) – 40%; – written reports on laboratory work (the arithmetic mean of marks for written reports on all laboratory works) – 60%. The final grade for the discipline is calculated based on the assessment of current performance and the answer to the test, taking into account their weighting 10 coefficients. The weight of the assessment for current performance is 40%, the assessment for the test is 60%.

4. AUXILIARY SECTION

Full-time education for students

4.1. Educational and methodological map for the academic discipline

(for parts 1 and 2)

Section number.	Title of section, topics, activities	Number of classroom hours					Independent work	Knowledge control form
		Lecture	Practical wor	Seminars	Laboratory	Other		
1	2	3	4	5	6	7	8	9
1	**Mineral resources. Introduction**							
1.1	General introduction to the subject	1						Oral survey, test
1.2	Mining technology and excavation of minerals	1						Oral survey, test
2	**Main kinds of software packages**							
2.1	ArcGIS / QGIS. General Introduction and functionality. Geographic space modeling. Representation models.	2			2	4		Oral survey, test
2.2	GMT, Oasis Montaj. General Introduction and functionality	2			2	8		Oral survey, test
2.3	Surfer. General Introduction and functionality	1				2		Oral survey

3	**Laboratory practice and tests**	2						
3.1	Laboratory models using QGIS software packages.					2	4	Report on the laboratory work
3.2	Laboratory models using GMT software package.					2	4	Report on the laboratory work
3.3	Laboratory models and Oasis Montaj Viewer software package						2	Report on the laboratory work
3.4	Laboratory tests using Surfer software package.					2	2	Report on the laboratory work
3.5	Laboratory tests using Strater software package					2		Testing

4.2. Recommended reading

(for parts 1 and 2)

Main

1. Rocks and the Rock Cycle.
URL: https://serc.carleton.edu/integrate/teaching_materials/mineral_resources/student_materials/unit1reading.html – Access date: 09.09.2024.

2. Types of minerals. URL: https://www.brainkart.com/article/Mineral-Resources_41102– Access date: 09.09.2024.

3. A map of England, showing the mining sites for some mineral resources. URL: https://www.studysmarter.co.uk/explanations/environmental-science/physical-environment/mineral-resources– Access date: 09.09.2024.

4. Gold-bearing quartz vein from California. URL: https://bio.libretexts.org/Courses/University_of_Pittsburgh/Environmental_Science_(Whittinghill)/06%3A_Geology/6.05%3A_Geologic_Resources/6.5.01%3A_Mineral_Resources– Access date: 09.09.2024.

5. Gold crystal. URL: https://geo.web.ru/druza/m-Au_0.htm– Access date: 09.09.2024.

6. Lithium. URL:
https://cyclowiki.org/wiki/%D0%9B%D0%B8%D1%82%D0%B8%D0%B9 – Access date: 09.09.2024.

7. The rust color of hematite (left) and the rust-yellow color of limonite (a variety of goethite, right) have long been used for pigments. URL: https://serc.carleton.edu/integrate/teaching_materials/mineral_resources/student_materials/unit1reading.html. – Access date: 09.09.2024.

8. Global distribution of peatlands. URL: https://www.grida.no/resources/12546– Access date: 09.09.2024.

9. How do we extract minerals. URL: https://www.usgs.gov/faqs/how-do-we-extract-minerals– Access date: 09.09.2024.

10. Zui, V.I. Introduction to GMT. Minsk: BSU. 2023. 51 p. https://elib.bsu.by/handle/123456789/298166 - Access date: 09.09.2024.

11. Zhukovskaya, N.V. Introduction to GIS on the basis QGIS [Введение в ГИС на основе QGIS]. Minsk: BSU. 2018. 132 p. (in Russ.). URL: https://elib.bsu.by/handle/123456789/196241?locale=en

12. Xavier de Lamo. Introduction to QGIS. URL: https://www.google.com/search?q=Xavier+de+Lamo.+Introduction+to+QGIS&rlz=1C1GCEA_enBY1003BY1003&oq=Xavier+de+Lamo.+Introduction+to+QGIS&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIKCAEQABiABBiiBDIKCAIQABiABBiiBNIBCTI5MDZqMGoxNagCALACAA&sourceid=chrome&ie=UTF-8 – Access date: 09.09.2024.

13. QGIS Fundamentals: Viewing Spatial Data & Producing a Map. https://samoa-data.sprep.org/resource/qgis-fundamentals-viewing-spatial-data-producing-map-workbook

14. ArcGIS URL: (https://www.esri.com/about/newsroom/arcuser/image_jl/).– Access date: 09.09.2024.

15. What is ArcGIS 9.1? URL: https://www.google.com/search?q=What_is_ArcGIS_Sep2005&rlz=1C1GCEA_enBY1003BY1003&oq=What_is_ArcGIS_Sep2005&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIKCAEQABiABBiiBDIKCAIQABiABBiiBDIKCAMQABiABBiiBDIKCAQQABiABBiiBDIKCAUQABiABBiiBNIBCTM2NzlqMGoxNagCALACAA&sourceid=chrome&ie=UTF-8 – Access date: 09.09.2024.

16. Oasis montaj Help and package documentation

17. Help Menu of the Surfer Release 8.4

18. Surfer. Explore the Depths of Your Data. URL: https://www.goldensoftware.com/products/surfer/features– Access date: 09.09.2024.

19. New 3D Customization Options in the Latest Surfer Release. URL: https://www.goldensoftware.com/new-surfer-3d-customization-options/– Access date: 09.09.2024.

20. Golden software Surfer. URL:– Access date: 09.09.2024. URL: https://www.youtube.com/watch?v=TmJC7vI87Hk

21. Shaded Relief Maps. URL: http://www.innovativegis.com/basis/Courses/GMcourse11/Syllabus/1stClass_reading/About%20Surfer/surfer.html – Access date: 09.09.2024.

List of additional literature

1. Bolstad, P. GIS fundamentals: a first text on geographic information systems. GIS fundamentals / P. Bolstad. – Acton, MA White Bear Lake, Minnesota: XanEdu, 2016.

2. Date, C.J. An introduction to database systems. 8th edition (international edition)/ C.J. Date. — Pearson/Addison Wesley, 2003.

3. Diego Berino. Mineral Resources from Exploration to Sustainability Assessment.

4. E-Book on Mineral Sector /

https://www.google.com/search?q=E-Book+on+Mineral+Sector&rlz=1C1GCEA_enBY1003BY1003&oq=E-Book+on+Mineral+Sector&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigAdIBCTI4OTdqMGoxNagCALACAA&sourceid=chrome&ie=UTF-8 – Access date: 09.09.2024.

5. Fischer, M.M. Geographic information systems, spatial data analysis and spatial modelling: an introduction / M.M. Fischer, H.J. Scholten, D. Unwin // Spatial analytical perspectives on GIS. – Routledge, 2019. – P. 3–20.

6. Fotheringham, S. Spatial analysis and GIS / S. Fotheringham, P. Rogerson. – CRC Press, 2013.

7. Getis, A. Spatial analysis and modeling in a GIS environment / A. Getis // A research agenda for geographic information science. – CRC Press, 2004. – P. 157–196.

8. Graser, Anfita. Learning QGIS / Anfita Graser. – Birmingham: Packt Publishing Ltd., 2016. – 190 p.

9. Lloyd, C. Spatial Data Analysis: An Introduction for GIS Users / C. Lloyd. – OUP Oxford, 2010. – 206 p.

10. Mastering QGIS / Kurt Menke [et al.]. – Birmingham: Packt Publishing Ltd., 2015. – 388 p.

https://www.academia.edu/41009797/Mineral_Resources_From_Exploration_to_Sustainability_Assessment.

11. ME551/GEO551 Introduction to geology of industrial minerals spring 2011. Basic concepts: Geology, mining, and processing of the industrial minerals. Virginia, 187p. URL: https://slideplayer.com/slide/5798628/ – Access date: 09.09.2024.

12. Mineral Resources. UEL: https://www.brainkart.com/article/Mineral-Resources_41102/. – Access date: 09.09.2024.

13. Mineral resources (ppt in colors). URL: https://www3.nd.edu/~cneal/planetearth/Chapt-15-Marshak.pdf

14. Nikos Mamoulis. Spatial Data Management: Synthesis Lectures on Data Management / N. Mamoulis. Morgan & Claypool Publishers, 2011.

15. Pimple, Eric. Programming ArcGIS 10.1 with Python Cookbook /Eric Pimple. – Birmingham: Packt Publishing Ltd., 2013. – 304 p.

16. Shekhar, S. Encyclopedia of GIS / S. Shekhar. – New York, NY: Springer Berlin Heidelberg, 2017.

17. Shellito, B.A. Introduction to Geospatial Technologies / B.A. Shellito. – New York: W. H. Freeman and Company, 2018.

18. Toms, S. ArcPy and ArcGIS – Geospatial Analysis with Python. – Birmingham: Packt Publishing Ltd., 2015. – 224 p.

19. Tripp, G.C. ArcGIS Pro 2.x Cookbook / G.C. Tripp, G.T. Corbin. – Birmingham – Mumbai: Packt Publishing, 2018.

20. Wise, S. GIS Fundamentals, Second Edition / S. Wise. – Boca Raton: CRC Press, 2014.

22. Yeung, G., Albert K. W. Spatial Database Systems: Design, Implementation and Project Management / Albert K. W. Yeung, G. Brent Hall. Springer, 2007.

23. Zandbergen, Paul A. Python Scripting for ArcGIS / Paul A. Zandbergen. – Red-lands, California: ESRI Press, 2013. – 353 p.

4.3. Electronic Resources

(for parts 1 and 2)

1. State enterprise "Belgeothenter" [electronic resource] (Государственное предприятие «Белгеоцентр» : http://www.belgeocentr.by/normativnaya-baza – Access date 21.04.2024.

2. BSU electronic library [electronic resource] (Электронная библиотека БГУ): https://elib.bsu.by/ – Access date 21.04.2024.

3. Zui, V.I. Introduction to GMT. Minsk: BSU. 2023. 51 p. https://217.21.43.28/handle/123456789/9122/browse?type=title&sort_by=1&order=ASC&rpp=20&etal=-1&null=&offset=5 – Access date: 09.09.2024.

4. Zhukovskaya, N.V. Introduction to GIS on the basis QGIS [Введение в ГИС на основе QGIS]. Minsk: BSU. 2018. 132 p. (in Russ.). URL: https://elib.bsu.by/handle/123456789/196241?locale=en – Access date: 09.09.2024.