*A*

*Project Report*

*On*

# *LITHOLOGIC AND STRATIGRAPHIC ANALYSIS OF BOREHOLE DATA USING ROCKWARE SOFTWARE*

*CARRIED OUT AT*

*NATIONAL INSTITUTE OF HYDROLOGY (ROORKEE)*

*MASTER OF SCIENCE*

*IN*

*GEOLOGY*


*SUBMITTED BY*

*VIJAY PRASAD*

*DEPARTMENT OF GEOLOGY*

*GOVT.P.G.COLLEGE RISHIKESH*

*DEHRADUN (UTTARAKHAND)*

CONTENT

## CANDIDATE'S DECLARATION

I, hereby, certify that the Summer Training entitled "**Lithologic and Statigraphic Analysis of Boreholes Data Using Rockware Software".**

This work, during the period of **1st June 2016** to **August 2016**, is a record of my own work under the supervision of **Dr. Sudhir Kumar, Scientist 'G'**, Hydrology Investigation Division, National Institute of Hydrology (NIH), Roorkee (Uttarakhand).

The matter embodied in this Summer Training has not been submitted for the award of any other degree or diploma.

(Vijay Prasad)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

8/8/16

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Above all I am indebted to my parents, Brothers and sister, who always support me and provide me with the best facilities available in their command to carry out this work.

I gratefully acknowledge their efforts in making me complete the work in the present form.

VIJAY PRASAD

## ABSTRACT

Ground Water is required for all living beings, without water life is not possible. It is the first requirement of life. Earth is covered by 75% of water and 25% of land surface, but fresh water is only 1%.But the source of fresh water is continuously depleting. Contamination of ground water is also big problem. There are different types of sources which are responsible for the ground water pollution. It is polluted by solid waste, fertilizers used in crops etc.

Water contains many natural occurring substances. Many factors affect water quality like bicarbonates, sulphates, sodium, chlorides, calcium, magnesium, and potassium. Substances present in the air affect rainfall. Dust, volcanic gases, and natural gases in the air, such as carbon dioxide, oxygen, and nitrogen, are all dissolved or entrapped in rain.

When other substances such as sulphur dioxide, toxic chemicals, or lead are in the air, they are also collected in the rain as it falls to the ground. In opposite cleaning of water have many methods. Water is clean by naturally and artificially.

Water is purified in large part by the routine actions of living organisms. Energy from sunlight drives the process of photosynthesis in aquatic plants, which produces oxygen to break down some of the organic material such as plant and animal waste.

This decomposition produces the carbon dioxide, nutrients and other substances needed by plants and animals living in the water.

The purification cycle continues when these plants and animals die and the bacteria decompose them, providing new generations of organisms with nourishment.

# CHAPTER 1

## INTRODUCTION

India is blessed with a rich and vast diversity of natural resources, water being one of them.

Water is nature's most wonderful, abundant and useful compound. There are many essential elements for the existence of living beings; water is rated to be of the greatest importance. Without food, humans can survive for a number of days, but without water one cannot survive for more than a day.

Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries.

Groundwater is an important source of water supply throughout the world. Groundwater occurs almost everywhere beneath the earth surface not in a single widespread aquifer but in thousands of local aquifer systems and compartments that have similar characters. Knowledge of the occurrence, replenishment, and recovery of groundwater has special significance in arid and semi-arid regions due to discrepancy in monsoonal rainfall, insufficient surface waters and over drafting of groundwater resources.

The ground water quality is still important to the community, therefore it is important to ensure its quality is high at all time so that the consumer health is not compromised. Groundwater resources are affected in principle by three major activities. First of these activities is excessive use of fertilizers and pesticides in agricultural areas. The second one is untreated/partially treated wastewater to the environment. Finally, excessive pumping and improper management of aquifers result. The activity of solid waste disposal in open un-engineered landfill is the one of the factor that cause the ground water pollution due to lack of pollution control interventions such as water proof layer, leachate treatment pond, monitoring wells etc. (Mohamad et al., 2007).

Groundwater pollution also occurs due to clandestine disposal of toxic wastes, especially from industrial sites, or undetected leakage from pipes, waste storage containers, or underground tanks. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its restoration to actual condition requires prolonged time and decontamination is not possible by just stopping the ingress of pollutants from the source. Contamination of

groundwater by domestic, industrial effluents and agricultural activity is a serious problem faced by developing countries. The industrial waste water, sewage sludge and solid waste materials are currently being discharged into the environment indiscriminately. These materials enter subsurface aquifers resulting in the pollution of irrigation and drinking water (Girija et al., 2007). High rates of mortality and morbidity due to water borne diseases are well known in India. Access to safe drinking water remains an urgent necessity, as 30% of urban and 90% of rural households still depend completely on untreated surface or groundwater (Palanisamy et al. 2007).

The quality of water is defined in terms of its physical, chemical and biological parameters. Its development and management plays a vital role in agriculture production, poverty reduction, environmental sustenance and sustainable economic development. In some areas of the world, people face serious drinking water shortage because of the ground water contamination. Assessing risk involves identifying the hazard associated with a particular occurrence, action, or circumstance and determining the probability of that hazard occurring. Hence, evaluation of groundwater quantity and quality is important for the development of further civilization and to establish database for planning future water resources development strategies. The quality of water may depend on geology of particular area and also vary with depth of water table and seasonal changes and is governed by the extent and composition of the dissolved salts depending upon source of the salt and soil, subsurface environment.

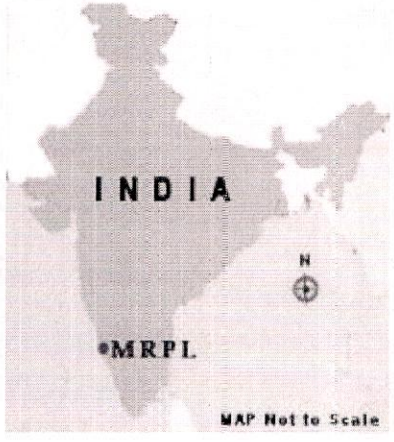
Monitoring of ground water regime is an effort to obtain information on ground water levels and chemical quality through representative sampling. In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dumping results in pollution of groundwater and health problems. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. As per the latest estimate of Central Pollution Control Board, about 29,000 million liter/day of wastewater generated from class-I cities and class-II towns out of which about 45% is generated from 35 metro-cities alone (Mangukiya et.al, 2012).

**STUDY AREA-**

**1.1 INTRODUCTION:** "Mangalore" officially is known as "Mangalore". It is the chief port city of the Indian state of Karnataka. It is known as Kudla in Tulu, Mangalore in Kannada, Kodial in Konkani, Maikala in Beary. It is located about 352 km. (220 mi) west of the state capital, Bangalore between the Arabian Sea and the Western Ghat mountain ranges. It is the administrative headquarters of the Dakshina Kannada (formerly South Canara) district in south western Karnataka.

**1.2** MRPL, a schedule 'A' CPSE and a subsidiary of ONGC is a State of Art Grass root Refinery located in a beautiful hilly terrain, north of Mangalore city, in Dakshin Kannada region.

The Refinery has got a versatile design with high flexibility to process Crudes of various API and with high degree of Automation.




MRPL has high standards in refining and environment protection matched by its commitments to society.

MRPL has also developed a Green Belt around the entire Refinery with plant species specially selected to blend with the local flora

MRPL has a design capacity to process 15 million metric tons per annum and have 2 Hydrocrackers producing Premium Diesel (High Cetane). It also has 2 CCRs producing Unleaded Petrol of High Octane.

**1.2 LOCATION:**

Mangalore is located at 12.87°N 74.88°E in the Dakshina Kannada district of Karnataka. It has an average elevation of 22 metres (72 ft) above mean sea level. It is the administrative headquarters of the Dakshina Kannada district, the largest urban coastal centre of Karnataka, and the fourth largest city in terms of population in the state. Mangalore is situated on the west coast of India, and is bounded by the Arabian

Sea to its west and the Western Ghats to its east. Mangalore city, as a municipal entity, spans an area of 184.45 $km^2$ (71.22 sq mi). Mangalore experiences moderate to gusty winds during day time and gentle winds at night. The topography of the city is plain up to 30 km (18.64 mi) inside the coast and changes to undulating hilly terrain sharply towards the east in Western Ghats. There are four hilly regions with natural valleys within the city. The geology of the city is characterized by hard lateritic hilly tracts and sandy soil along the seashore. The Geological Survey of India has identified Mangalore as a moderately earthquake-prone urban centre and categorized the city in the Seismic III Zone.

Mangalore Refinery and Petrochemicals Limited (MRPL), is an oil refinery at Mangalore and is a subsidiary of ONGC, set up in 1988. The refinery is located at Katipalla, north from Centre of Mangalore city.

The refinery was established after displacing five villages of Bala, Kalavar, Kuthetoor, Katipalla, and Adyapadi.

MRPL is situated in 442 Acres of land in the Mangalore Special Economic Zone (MSEZ), and is fully integrated with MRPL. At 100% operational load, the complex shall produce 914 KTPA Para-xylene and 283 KTPA Benzene.

The all-weather Mangalore Port is only 14 km from OMPL plant and is connected by dedicated pipeline, enabling hassle free export & import of products and feed stocks.

## REVIEW OF LITRATURE

Mangalore Refinery and Petrochemicals Limited (MRPL), is an oil refinery at Mangalore.

The refinery has a versatile design with high flexibility to process crudes of various API gravity and with high degree of automation.MRPL has a design capacity to process 15 million metric tones per annum and is the only refinery in India to have two hydrocrackers producing premium diesel (high cetane).It also has a Polypropylene unit with a capacity of 4,40,000 MT/annum.

It is also the only refinery in India to have two CCRs producing unleaded petrol of high octane. Currently, the refinery is processing about 14.65 million tones of crude per year and had a turnover of US$ 9 billion during last year.

MRPL, which was a joint sector company, become a PSU subsequent on acquisition of its majority shares by ONGC. As on 1 April 2007, 71.62% shares are held by ONGC, 16.95% shares are held by HPCL, and remaining shares are with public and financial institutions. MRPL has also been declared as Miniratna, a mini jewel, by Government of India in 2007.

Before acquisition by ONGC in March 2003, MRPL was a joint venture oil refinery promoted by M/s Petroleum Corporation Limited (HPCL), a public sector company and M/s IRIL & associates (AV Birla Group). MRPL was set up in 1988 with the initial processing capacity of 3.0 million metric tones per annum that was later expanded to the present capacity of 15 million metric tones per annum.

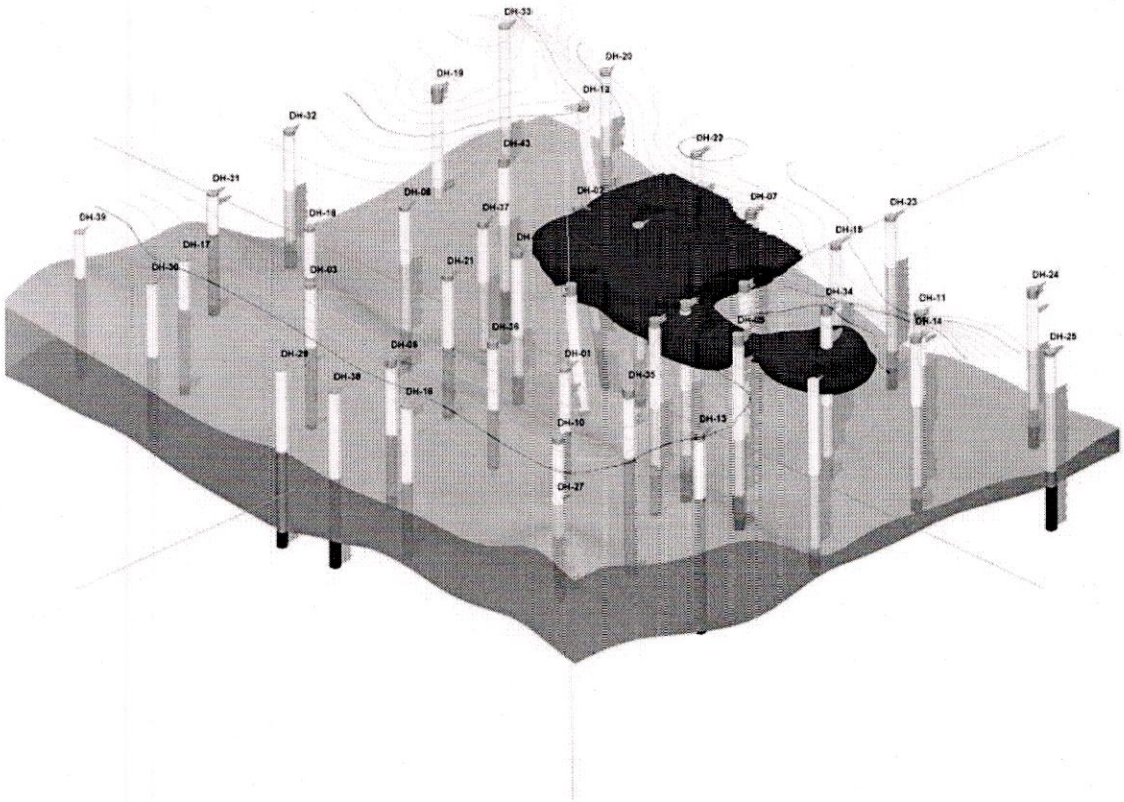
The refinery was conceived to maximise middle distillates, with capability to process light to heavy and sour to sweet crudes with 24 to 46 API gravity. On 28 March 2003, ONGC acquired the total shareholding of A.V. Birla Group and further infused equity capital of Rs.6 billion thus making MRPL a majority-held subsidiary of ONGC. The lenders also agreed to the debt restructuring package (DRP) proposed by ONGC, which included, *inter alia*, conversion up to Rs36554884 core of their loans into equity. Subsequently, ONGC has acquired equity allotted to the lenders pursuant to DRP raising ONGC's holding in MRPL to 71.62 percent.

# CHAPTER 3

## SOFTWARE USED AND METHOD APPLIED

### 3.1 ROCKWARE15 SOFTWARE:

RockWorks15



## 3.2 INTRODUCTION OF SOFTWARE:

Rockworks are an integrated software package for geological data management, analysis, and visualization.

Rockworks specializes in visualization of subsurface data as logs, cross sections, fence diagrams, solid models, structural and isopach maps in both 2D and dynamic 3D windows.

The borehole data manager is used for easy entry of well data: geophysical / geotechnical / geochemical measurements, observed lithologies, stratigraphic contacts, water levels, fractures, down hole well surveys, all in linked database tables. From this data you can create point, contour, plan-view, and lithology/stratigraphy surface (geology) maps; logs; cross sections; and profiles.

In addition there's an assortment of 3D diagrams: logs, surfaces, fence diagrams, and solid models.
Rockworks also contains a "flat" spreadsheet-style data window for use with the program's

**Rockworks Utilities**:

Basic gridding and contouring, solid modeling, volumetric, hydrology and hydrochemistry tools (drawdown & flow diagrams, Piper and Stiff diagrams), 2D and 3D feature analysis (rose and stereo net diagrams, lineation maps and densities), statistical computations and diagrams (histograms, scatter plots, ternary plots), survey mapping, coordinate conversions, and more.
The Rockworks Utilities portion of the program can be purchased separately.

**There are three graphic display windows in Rockworks**:

**RockPlot2D:**

Displays 2-dimensional, "flat" images such as maps, logs, and cross sections. It offers save, export, and printing tools, as well as on-screen editing, drawing, digitizing and measurement tools.

**RockPlot3D:**

It is an interactive graphic display window that utilizes OpenGL for easy visualization of 3D images such as logs, fence diagrams, solid models, and 3D surfaces. It provides interactive rotation, panning, zooming, and layering of different images. Adjust lighting, filter solids, adjust colors, and append images easily and quickly. View volumes instantly on the screen.

**Report Works:**

It's used to lay out pages for display and print.
Insert Rock Plot graphics (maps, cross sections, logs, diagrams, etc.) and raster images, Draw scale bars and shapes; add text and legends, and more. Print and export tools take your Rockworks images to presentation stage quickly and easily.

**3.3 System Requirements:**

The minimum system requirements for Rockworks may vary, depending on the type of data you will be processing and the types of diagrams you will be creating and viewing.

In general, the more RAM, the faster the processor, the newer the operating system, the better.

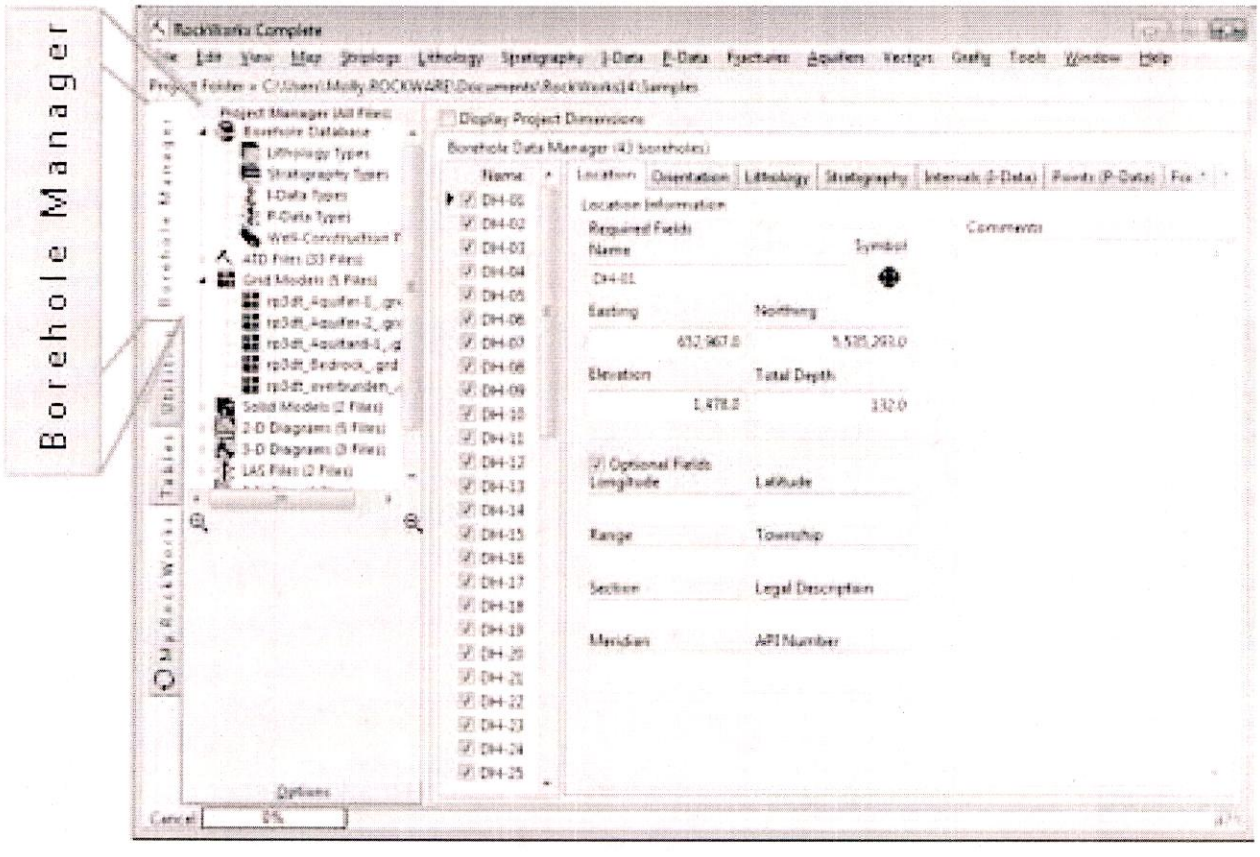
Here is our minimum recommended system setup for use of Rockworks:
Windows2000, NT, XP, Vista, or Windows 7.
(Windows98 & Windows ME is not supported.)
1 GB + of RAM
1.4 GHz or faster CPU.
Plenty of free disk space.
Display set to GREATER than 800 x 600 pixels

### 3.4 USE OF SOFTWARE:

Here are some important landmarks within Rockworks:

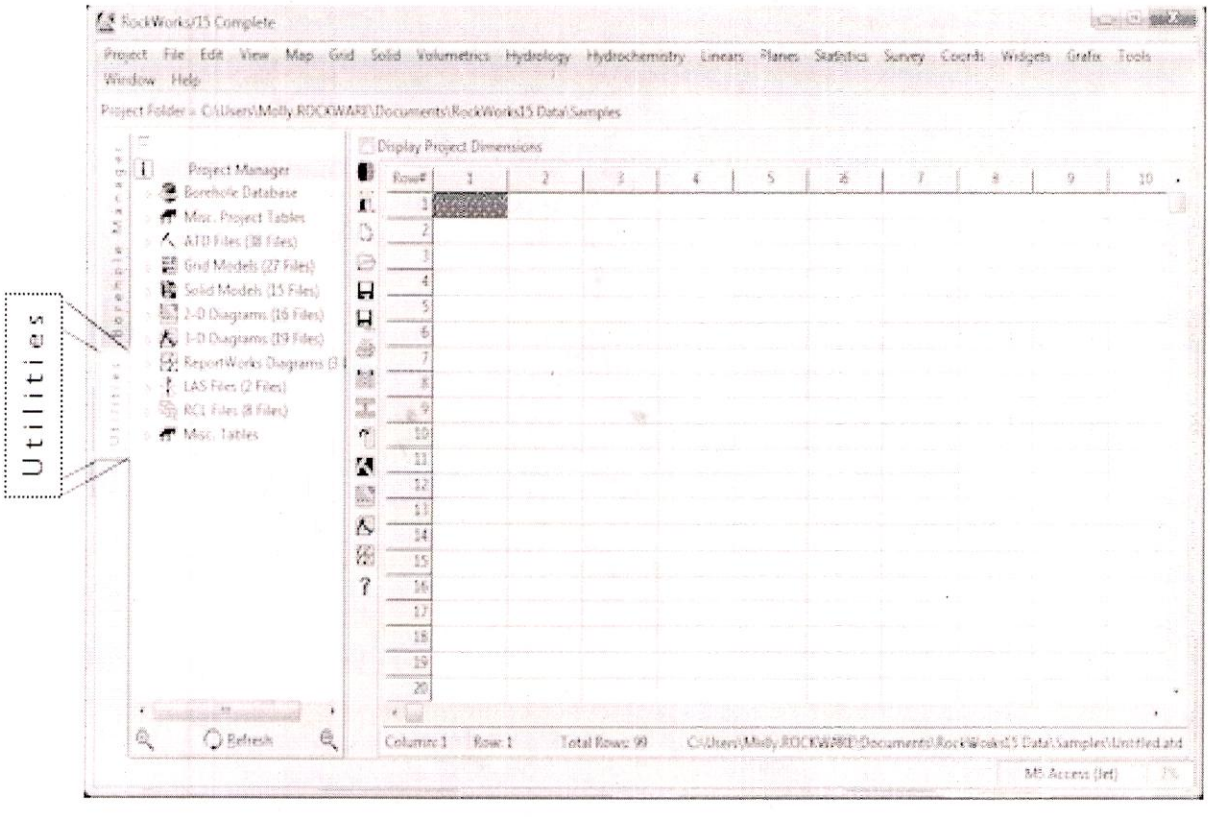
**The Borehole Manager:**

This is the data window and suite of menus for entering and working with borehole data. Here is where you do most of the sub-surface modeling and visualization in Rockworks: 2D and 3D logs, cross sections, fence diagrams, solid models, stratigraphic models, structure maps, etc. Borehole data is stored in a database (Access MDB by default). You can access the Borehole Manager using its tab along the left edge of the program window.



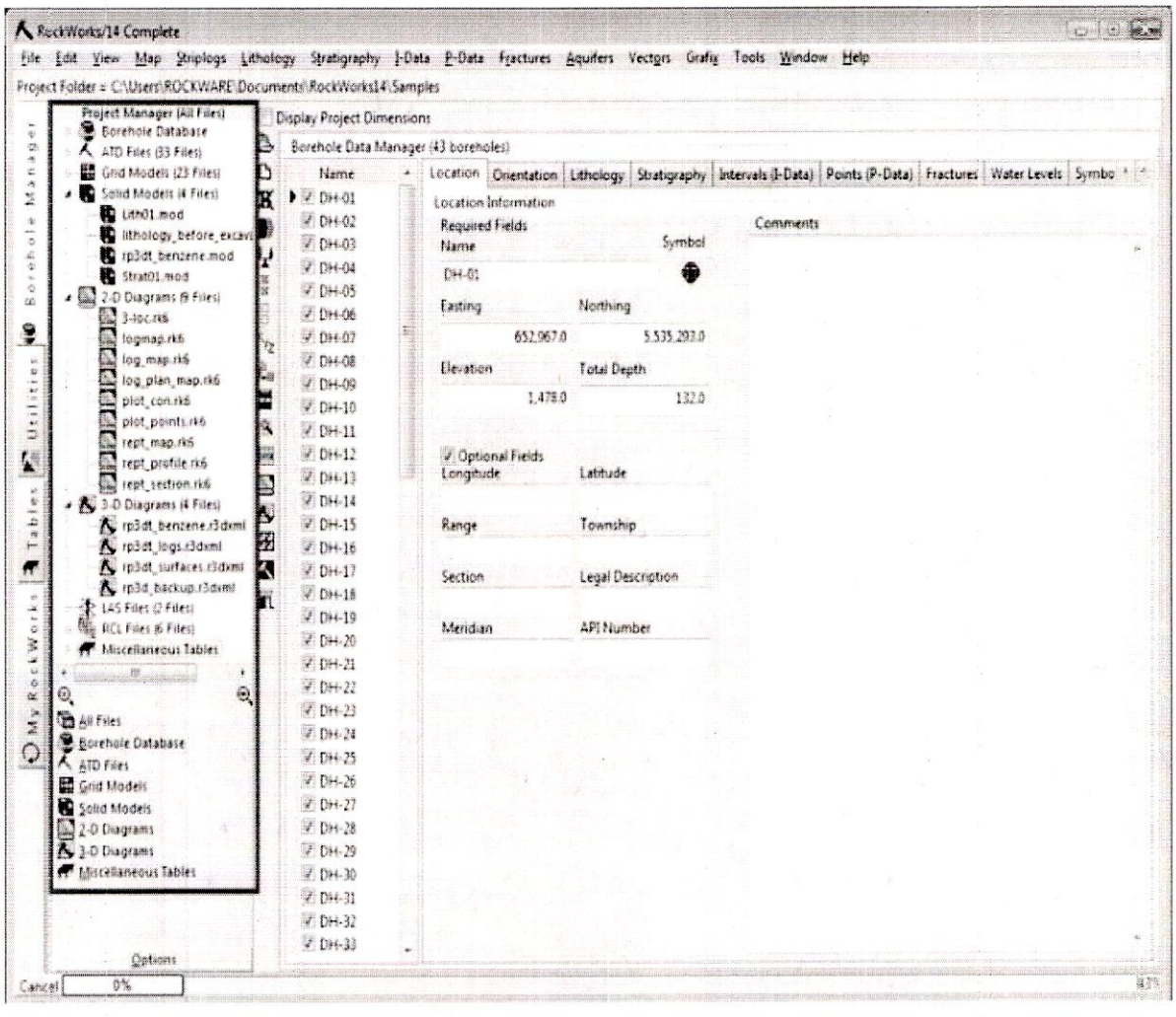
**The Rockworks Utilities:**

This is a simpler, row-and-column type of data window with its own suite of menus. Here we can create many different types of maps, charts, and diagrams.
Even if you are working primarily with borehole data, we will still use many of the tools in the Rockworks Utilities for analytical work (statistical analysis,Grid& solid model math/filtering tools, etc.).
We can access the Utilities window using its tab along the left edge of the program window.



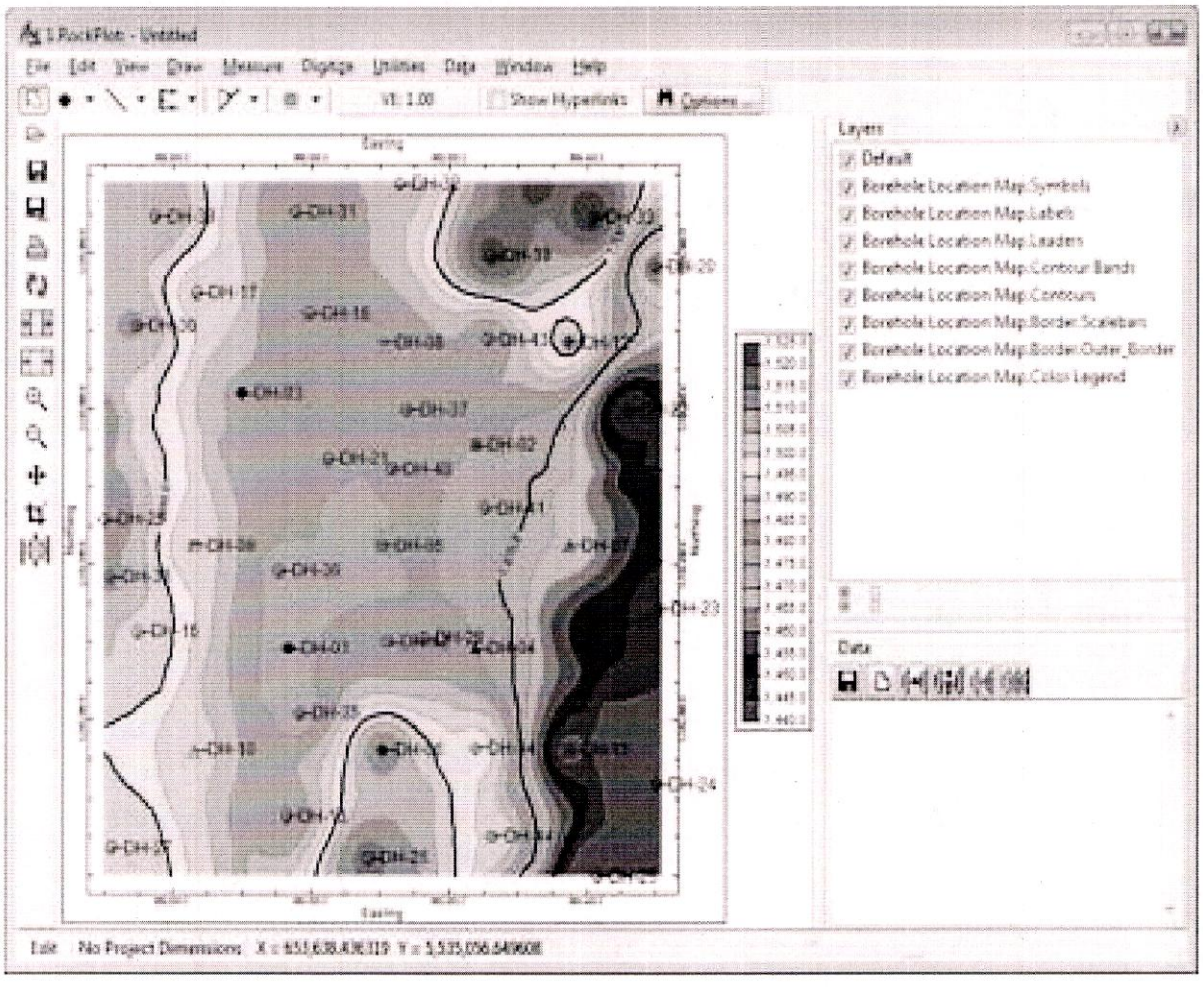

**Project Manager**:

This pane along the left edge of the program window, displaysRockworks files that reside in the current project folder, and tables in the project, Database, for quick and easy access: Hover over graphic files to see previews, double-clickon files to open them.




**RockPlot2D**:

This is the window in which 2D (flat) maps, logs, and diagrams are displayed.
This window is displayed automatically each time that a 2D graphic is generated.
This window can either be embedded in the program Options window, or displayed as a standalone window.
We can open a blank RockPlot2D window using the Window/ RockPlot2D menu option.
We can open saved RockPlot2D filesusing the Project Manager.




**RockPlot3D**:

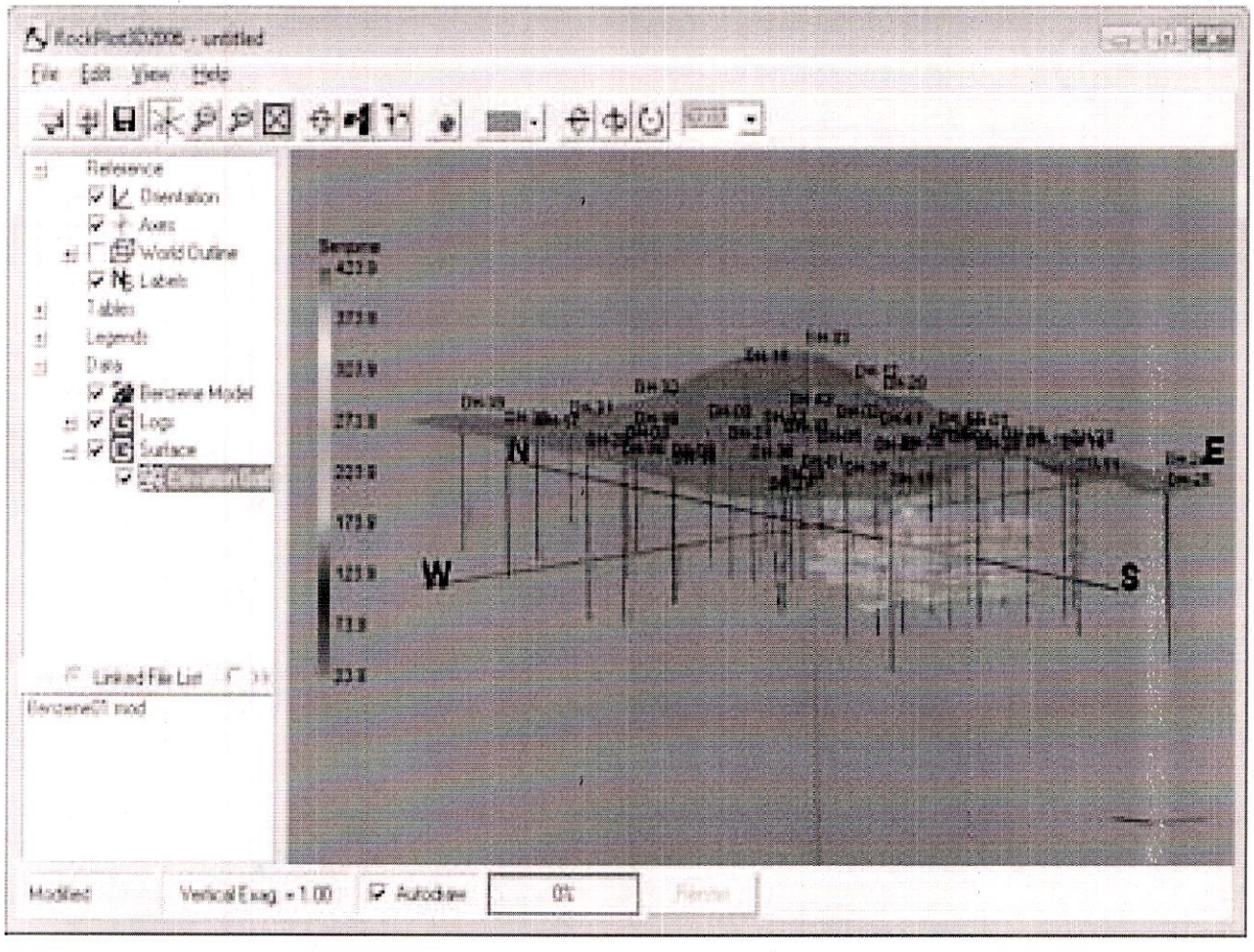
This is the interactive window in which 3D images are displayed (Surfaces, solids, 3D logs, fence diagrams, and more.).

This window is displayed automatically any time that a 3D graphic is generated.

This window can be embedded in the program Options windows or displayed as a stand-alone window .

We can open a blank RockPlot3D window using the Window / RockPlot3D menu option.

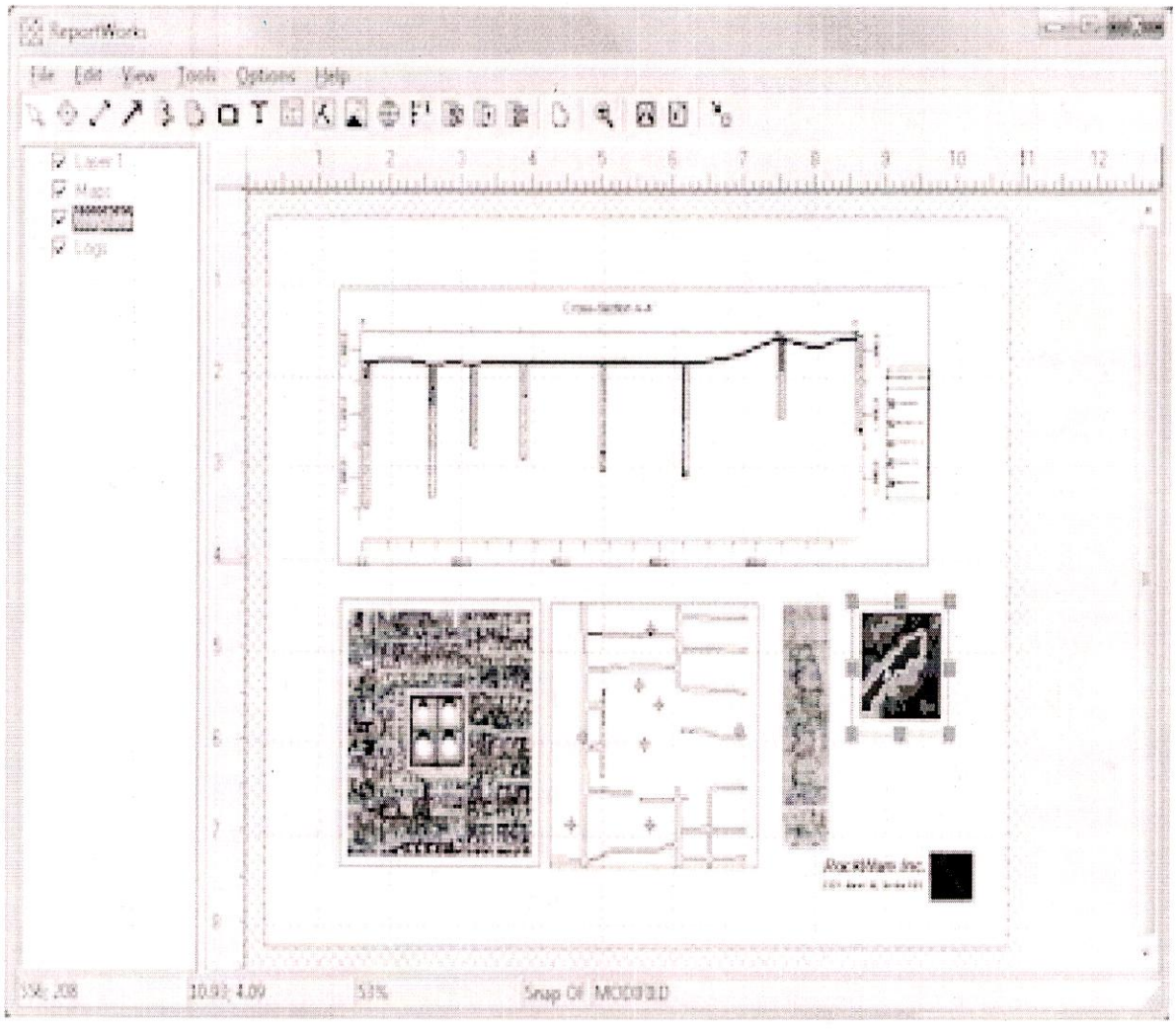
We can open saved RockPlot3D files using the Project Manager.




**Report Works**:

This is the page layout program for raster images, RockPlot2D Images, with legend, text, shape, scale bar annotations.

We can open a blank report Works window using the Window / Report Works menu option.
We can open saved Report Works files using the Project Manager.




**Getting Started in the Borehole Manager:**

Here are some reminders about how Rockworks works and things to remember when working with the Rockworks Borehole Manager.

**1. Create New Project:** When we're starting a new project, launch Rockworks and Create a new project using Project / New.

Borehole data for each project is stored in a Microsoft Access database or MDB file. Each project has its own database in its own project folder. Models and graphics are Stored in the project folder, too.

**Getting Started in the Borehole Manager:**

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**2. Enter Data:** Once the project is created, you can enter your data.
You can import your borehole data from Excel files, and other formats.
You can also hand-enter the borehole data. Use File / New Log to add a new Borehole record.

Use the Edit / Edit Data as Spreadsheet as a neat tool for spreadsheet-style editing Of a table, including copy/pasting, etc.

## Location Data:

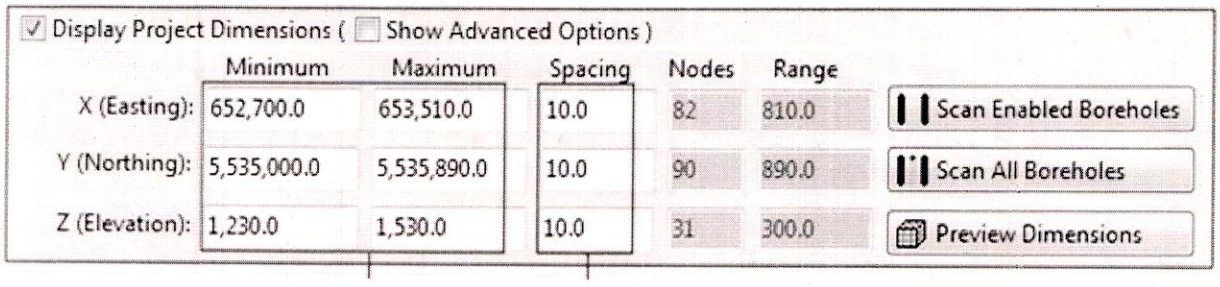
| LOCATION | EASTING | NORTHING | LATTITUDE | LONGITUDE | ELEVATION | TD |
|---|---|---|---|---|---|---|
| Mangalore S1 | 2,575.00 | 3,060.00 | 12.974318 | 74.841544 | 7.6 | 54 |
| Mangalore S2 | 2,675.00 | 3,060.00 | 12.974319 | 74.842466 | 5.49 | 50.7 |
| Mangalore S3 | 2,705.00 | 3,160.00 | 12.975223 | 74.842742 | 5.96 | 44 |
| Mangalore S4 | 2,970.00 | 3,725.00 | 12.980334 | 74.845182 | 5.96 | 49 |
| Mangalore S5 | 2,920.00 | 3,790.00 | 12.980921 | 74.844721 | 5.805 | 55 |
| Mangalore S6 | 3,290.00 | 3,740.00 | 12.980471 | 74.848133 | 7.08 | 53 |
| Mangalore S7 | 3,280.00 | 3,650.00 | 12.979657 | 74.848041 | 12.24 | 60.4 |
| Mangalore S8 | 3,275.00 | 3,505.00 | 12.978346 | 74.847996 | 12.25 | 76 |
| Mangalore S9 | 3,496.00 | 3,440.00 | 12.977759 | 74.850034 | 23.17 | 68 |
| Mangalore S10 | 3,420.00 | 3,427.50 | 12.977646 | 74.849333 | 26.6 | 58 |
| Mangalore S11 | 3,520.00 | 3,440.00 | 12.97776 | 74.850255 | 9.7 | 56 |
| Mangalore S12 | 3,750.00 | 3,410.00 | 12.977489 | 74.852376 | 8.54 | 76 |
| Mangalore S13 | 3,275.00 | 3,045.00 | 12.974186 | 74.847998 | 5.85 | 63.4 |
| Mangalore S14 | 3,986.00 | 3,145.00 | 12.975094 | 74.854554 | 11.56 | 43.5 |
| Mangalore S15 | 4,445.00 | 3,160.00 | 12.975232 | 74.858786 | 16.07 | 68.4 |
| Mangalore S16 | 3,835.00 | 3,914.50 | 12.982052 | 74.853157 | 57.13 | 61.1 |

## Lithology Data:

| borehole | depth1 | depth2 | LITHOLOGY |
|---|---|---|---|
| Mangalore S1 | 0 | 9.7 | Alluvium |
| Mangalore S1 | 9.7 | 54 | Granite |
| Mangalore S2 | 0 | 11.9 | Alluvium |
| Mangalore S2 | 11.9 | 50.7 | Granite |
| Mangalore S3 | 0 | 4.8 | Alluvium |
| Mangalore S3 | 4.8 | 44 | Granite |
| Mangalore S4 | 0 | 5 | Alluvium |
| Mangalore S4 | 5 | 49 | Granite |
| Mangalore S5 | 0 | 5.75 | Alluvium |
| Mangalore S5 | 5.75 | 55 | Granite |
| Mangalore S6 | 0 | 4.6 | Alluvium |
| Mangalore S6 | 4.6 | 53 | Granite |
| Mangalore S7 | 0 | 6.5 | Alluvium |
| Mangalore S7 | 6.5 | 60.4 | Granite |
| Mangalore S8 | 0 | 8 | Alluvium |
| Mangalore S8 | 8 | 76 | Granite |
| Mangalore S9 | 0 | 2 | Alluvium |
| Mangalore S9 | 2 | 68 | Granite |
| Mangalore S10 | 0 | 11.5 | Alluvium |
| Mangalore S10 | 11.5 | 58 | Granite |
| Mangalore S11 | 0 | 9 | Alluvium |
| Mangalore S11 | 9 | 56 | Granite |
| Mangalore S12 | 0 | 6.5 | Alluvium |
| Mangalore S12 | 6.5 | 76 | Granite |
| Mangalore S13 | 0 | 10.8 | Alluvium |
| Mangalore S13 | 10.8 | 63.4 | Granite |
| Mangalore S14 | 0 | 1.5 | Alluvium |
| Mangalore S14 | 1.5 | 43.5 | Granite |
| Mangalore S15 | 0 | 8.75 | Alluvium |
| Mangalore S15 | 8.75 | 68.4 | Granite |
| Mangalore S16 | 0 | 10.1 | Alluvium |
| Mangalore S16 | 10.1 | 61.1 | Granite |

## Stratigraphy Data:

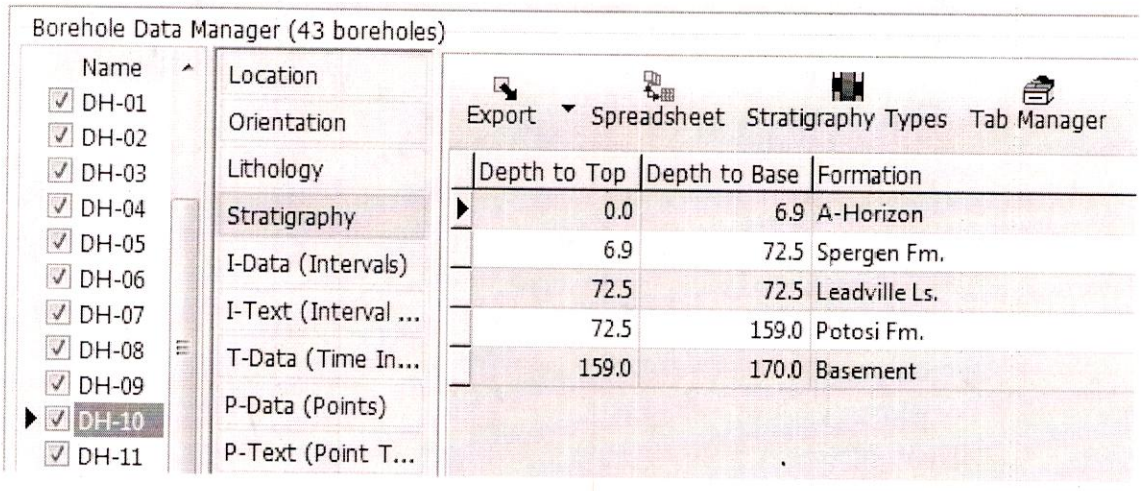
| borehole | depth1 | depth2 | STRATIGRAPHYY |
|---|---|---|---|
| Mangalore S1 | 0 | 9.7 | Alluvium |
| Mangalore S1 | 9.7 | 54 | Granite |
| Mangalore S2 | 0 | 11.9 | Alluvium |
| Mangalore S2 | 11.9 | 50.7 | Granite |
| Mangalore S3 | 0 | 4.8 | Alluvium |
| Mangalore S3 | 4.8 | 44 | Granite |
| Mangalore S4 | 0 | 5 | Alluvium |
| Mangalore S4 | 5 | 49 | Granite |
| Mangalore S5 | 0 | 5.75 | Alluvium |
| Mangalore S5 | 5.75 | 55 | Granite |
| Mangalore S6 | 0 | 4.6 | Alluvium |
| Mangalore S6 | 4.6 | 53 | Granite |
| Mangalore S7 | 0 | 6.5 | Alluvium |
| Mangalore S7 | 6.5 | 60.4 | Granite |
| Mangalore S8 | 0 | 8 | Alluvium |
| Mangalore S8 | 8 | 76 | Granite |
| Mangalore S9 | 0 | 2 | Alluvium |
| Mangalore S9 | 2 | 68 | Granite |
| Mangalore S10 | 0 | 11.5 | Alluvium |
| Mangalore S10 | 11.5 | 58 | Granite |
| Mangalore S11 | 0 | 9 | Alluvium |
| Mangalore S11 | 9 | 56 | Granite |
| Mangalore S12 | 0 | 6.5 | Alluvium |
| Mangalore S12 | 6.5 | 76 | Granite |
| Mangalore S13 | 0 | 10.8 | Alluvium |
| Mangalore S13 | 10.8 | 63.4 | Granite |
| Mangalore S14 | 0 | 1.5 | Alluvium |
| Mangalore S14 | 1.5 | 43.5 | Granite |
| Mangalore S15 | 0 | 8.75 | Alluvium |
| Mangalore S15 | 8.75 | 68.4 | Granite |
| Mangalore S16 | 0 | 10.1 | Alluvium |
| Mangalore S16 | 10.1 | 61.1 | Granite |




**4. Types Tables:**

Remember that lithology materials, stratigraphy formations, and well construction materials link to respective "Types" tables that we create.
The formations in the Stratigraphy Types Table must be listed in order from the ground downward for proper modeling to take place.
Rockwork uses the background colors you've selected for the materials when displaying 3D logs, and 3D surfaces and solids.

**STRATIGRAPHY TABLE:**



**DATA ADDED AS SPREADSHEET:**

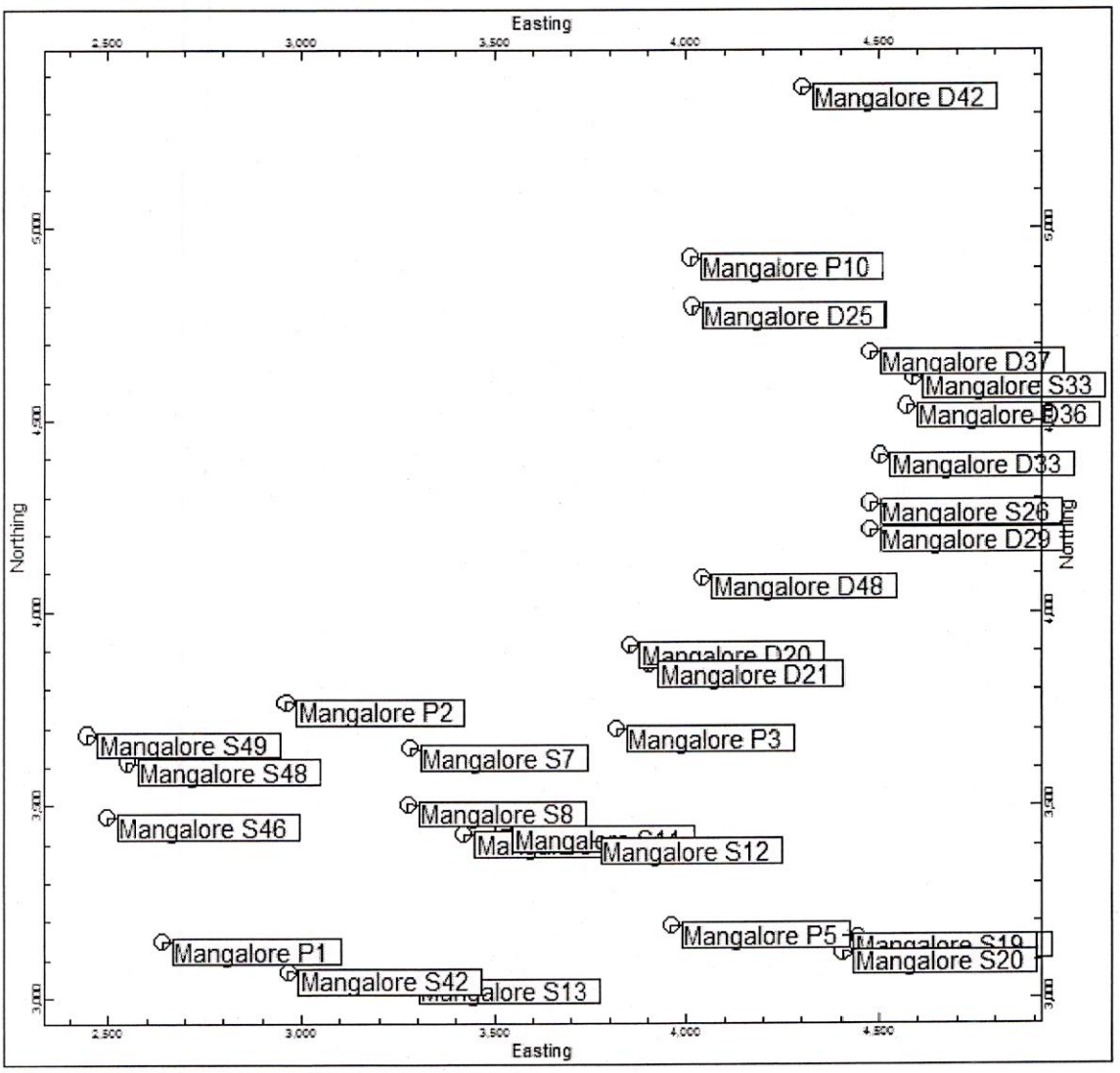
| Borehole Name | Enabled | Easting | Northing | Elevation | Total Depth | Longitude | Latitude | Township | Symbol |
|---|---|---|---|---|---|---|---|---|---|
| Mangalore D10 | FALSE | 3,420.00 | 3,460.00 | 28.786 | 28.5 | 74.84933 | 12.97794 | 483,660.00 | 14/0 |
| Mangalore D20 | TRUE | 3,851.00 | 3,914.50 | 59.03 | 50.6 | 74.85331 | 12.98205 | 484,091.00 | 14/0 |
| Mangalore D21 | TRUE | 3,901.00 | 3,865.50 | 60.13 | 70.5 | 74.85377 | 12.98161 | 484,141.00 | 14/0 |
| Mangalore D23 | FALSE | 4,470.00 | 5,225.00 | 72.256 | 20 | 74.85901 | 12.99391 | 484,710.00 | 14/0 |
| Mangalore D24 | FALSE | 4,295.00 | 5,079.50 | 78.33 | 20 | 74.85739 | 12.99259 | 484,535.00 | 14/0 |
| Mangalore D25 | TRUE | 4,015.00 | 4,800.00 | 58.5 | 50.2 | 74.85481 | 12.99006 | 484,255.00 | 14/0 |
| Mangalore D27 | FALSE | 4,205.00 | 5,020.00 | 78.184 | 20 | 74.85656 | 12.99205 | 484,445.00 | 14/0 |
| Mangalore D28 | FALSE | 4,690.00 | 4,055.00 | 68.07 | 20 | 74.86104 | 12.98333 | 484,930.00 | 14/0 |
| Mangalore D29 | TRUE | 4,475.00 | 4,215.00 | 68.03 | 65 | 74.85906 | 12.98477 | 484,715.00 | 14/0 |
| Mangalore D30 | FALSE | 4,500.00 | 4,225.00 | 67.635 | 60.6 | 74.85929 | 12.98486 | 484,740.00 | 14/0 |
| Mangalore D31 | FALSE | 4,640.00 | 4,260.00 | 67.52 | 20 | 74.86058 | 12.98518 | 484,880.00 | 14/0 |
| Mangalore D32 | FALSE | 4,700.00 | 4,260.00 | 70 | 77.4 | 74.86113 | 12.98518 | 484,940.00 | 14/0 |
| Mangalore D33 | TRUE | 4,500.00 | 4,410.00 | 73.96 | 65 | 74.85929 | 12.98654 | 484,740.00 | 14/0 |
| Mangalore D35 | FALSE | 4,500.00 | 4,540.00 | 74.08 | 20.45 | 74.85929 | 12.98771 | 484,740.00 | 14/0 |
| Mangalore D36 | TRUE | 4,570.00 | 4,540.00 | 74.14 | 65.4 | 74.85993 | 12.98771 | 484,810.00 | 14/0 |
| Mangalore D37 | TRUE | 4,475.00 | 4,680.00 | 73.973 | 70.3 | 74.85906 | 12.98898 | 484,715.00 | 14/0 |
| Mangalore D38 | FALSE | 4,555.00 | 4,660.00 | 74.039 | 70 | 74.85979 | 12.9888 | 484,795.00 | 14/0 |
| Mangalore D39 | FALSE | 4,565.00 | 4,900.00 | 78.25 | 20 | 74.85988 | 12.99097 | 484,805.00 | 14/0 |
| Mangalore D41 | FALSE | 4,480.00 | 5,200.00 | 72.126 | 20 | 74.8591 | 12.99368 | 484,720.00 | 14/0 |
| Mangalore D42 | TRUE | 4,300.00 | 5,370.00 | 69.721 | 63 | 74.85744 | 12.99522 | 484,540.00 | 14/0 |
| Mangalore D43 | FALSE | 4,820.00 | 4,190.00 | 57.13 | 55 | 74.86224 | 12.98455 | 485,060.00 | 14/0 |
| Mangalore D44 | FALSE | 4,820.00 | 4,270.00 | 68.23 | 65 | 74.86224 | 12.98527 | 485,060.00 | 14/0 |

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 RESULTS:

### 4.1.1 BOREHOLE LOCATIONS:

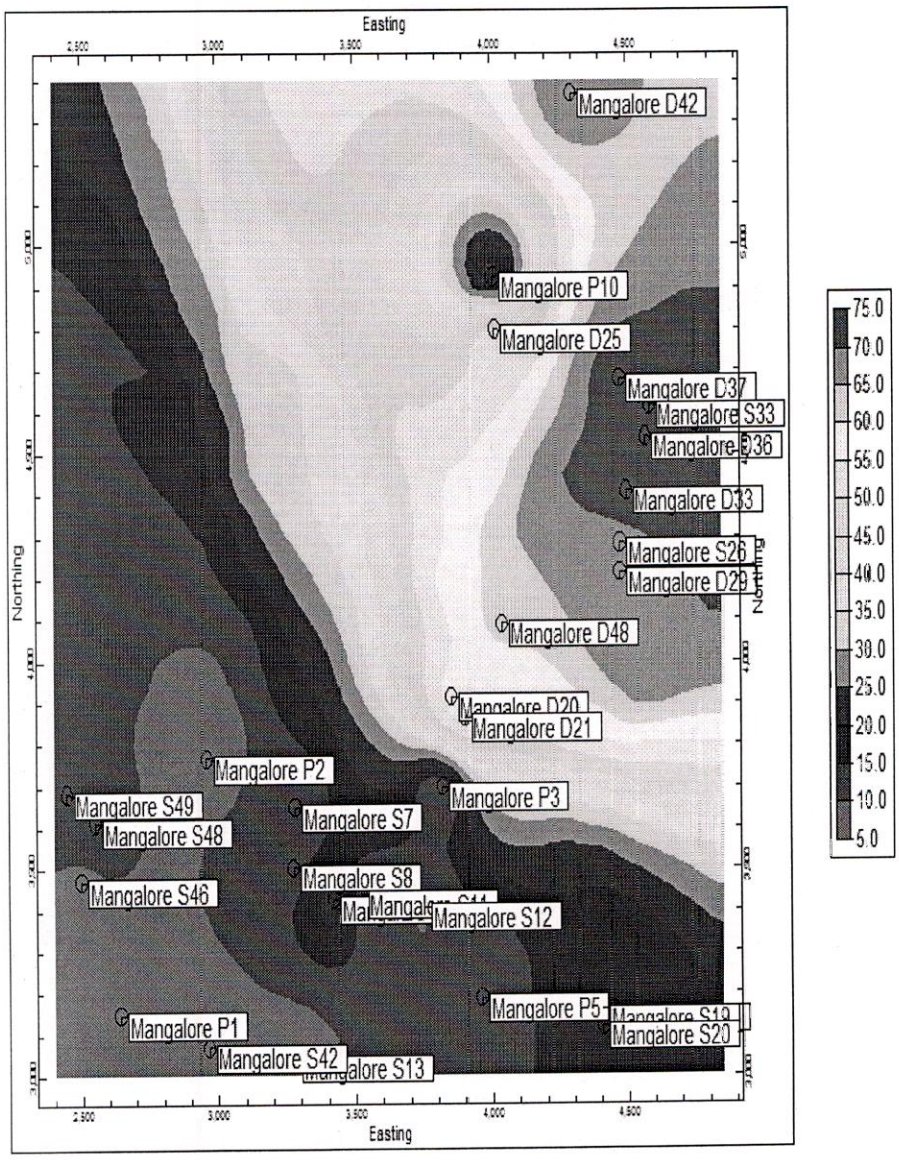


**BOREHOLE LOCATION:**

Borehole location can be shown in two different views:

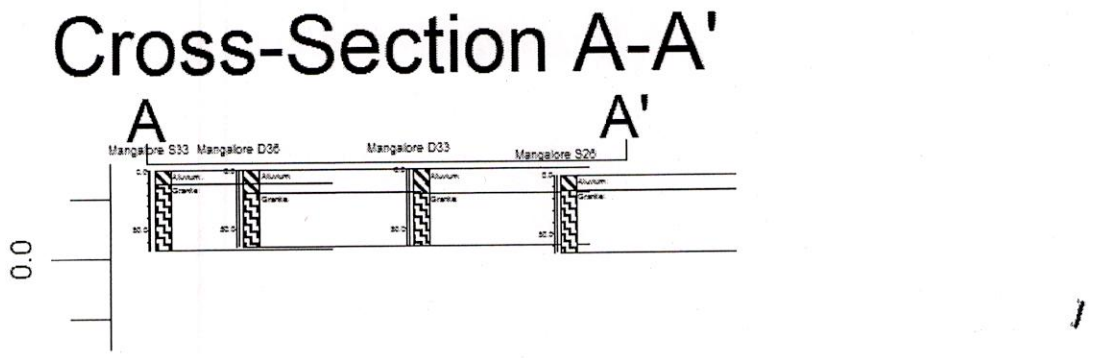
As shown in fig. Borehole locations can be created. These locations are of boreholes entered in rock ware data.

**CONTOUR BASED BOREHOLE LOCATION MAP:**




A contour based map of boreholes can also be created using rock ware software. This fig shows the boreholes formation .

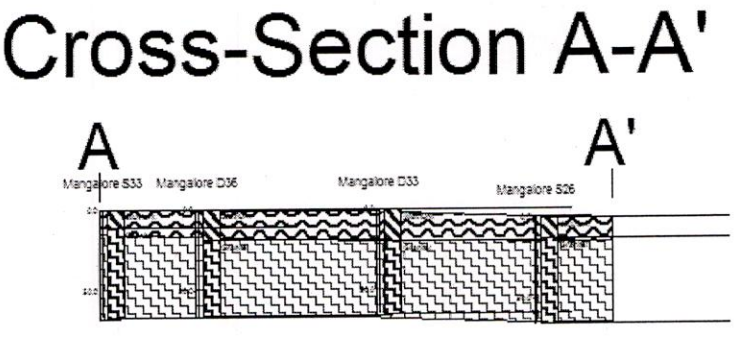
## 4.1.2 LITHOLOGIC SECTION:




In rockworks software, lithologic sections are created. Above given diagram shows lithologic section of different boreholes.

This section shows the formation of boreholes like of which soil they are made. Fig shows alluvium and granite which forms the lithology of boreholes.

### 4.1.3 STRATIGRAPHY SECTION:

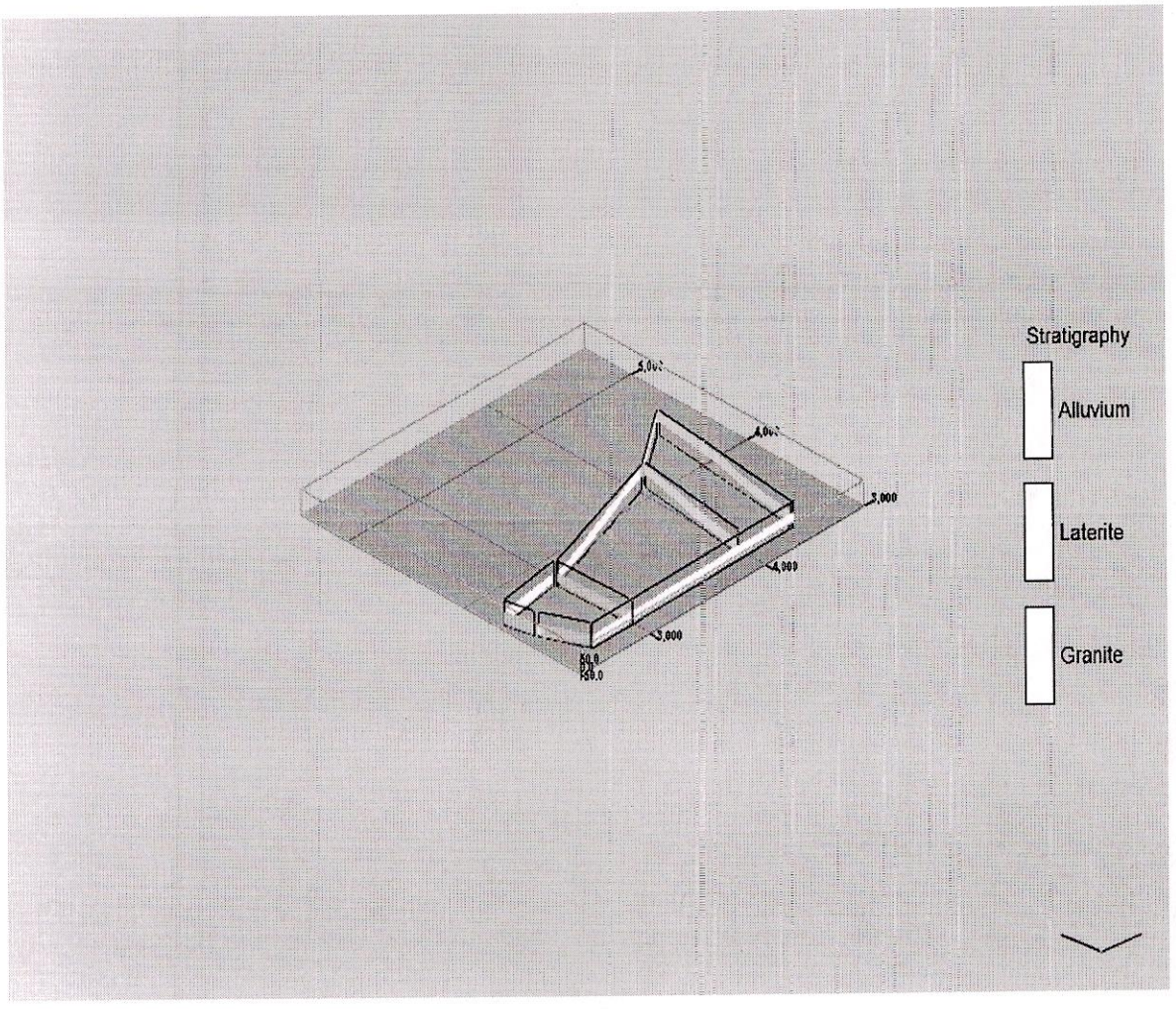



Stratigraphic section shows the stratigraphy of the boreholes.

Above given diagram shows the stratigraphy of boreholes.

This section shows alluvium and granite formation.

### 4.1.4 STRATIGRAPHY FENCE DIAGRAM:



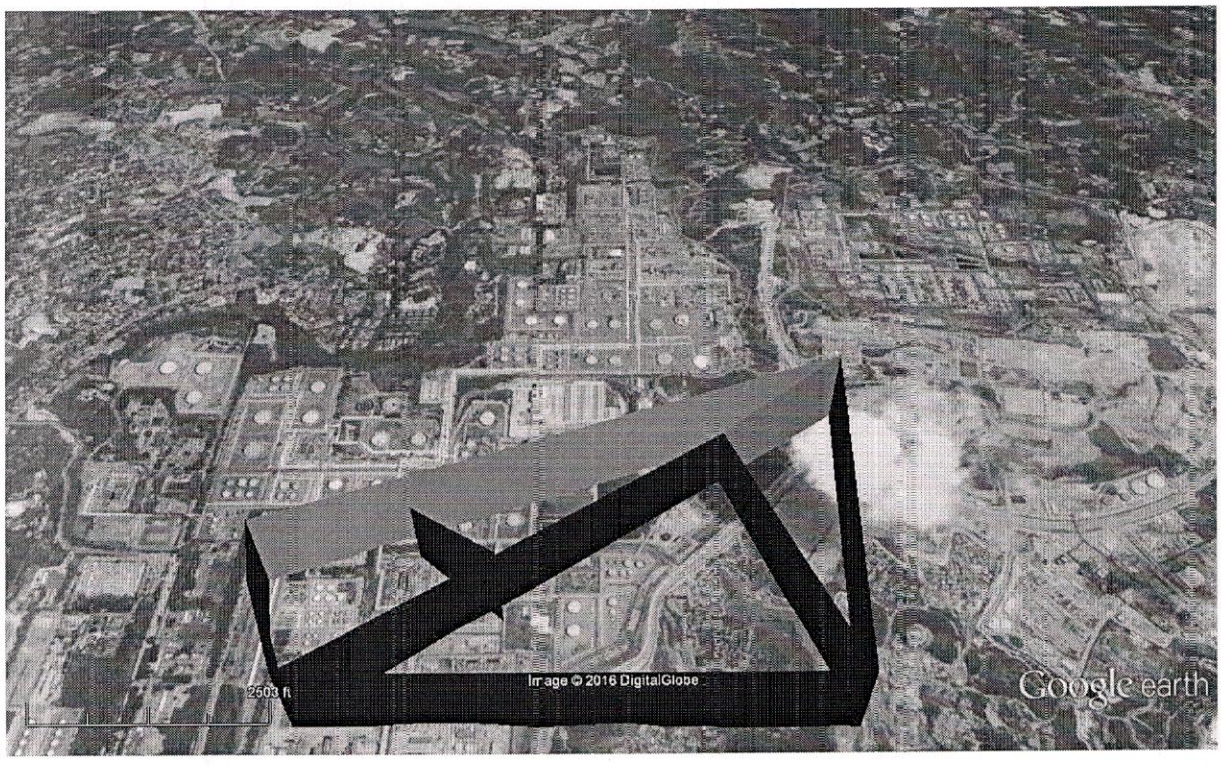

**FENCE DIAGRAMS:**

Fence diagrams made are of two different types

Fence diagram is created in stratigraphic section.

This diagram shows the location of different boreholes with a connected branch of themselves.

**FENCE DIAGRAM USING GOOGLE EARTH:**




Fence diagram using goggle earth can be plotted as shown in above given figure.

This diagram is different in sense from the simple fence diagram.

The difference is that it shown on goggle map and shows the location of boreholes which are selected for the location purpose on goggle map.

## 4.2 DISCUSSION:

As we know rockware 15 is used for creating profiles, sections (lithologic and stratigraphic), and fence diagrams are also created using goggle earth.

Borehole data entered is processed and worked out for creating section maps. Data used is processed and diagrams of desired formations are mapped.

These diagrams are used for understanding lithology of that place where boreholes were made.

As is known that lithologic sections and profiles can be created, these sections are also seen by cutting across the section of different boreholes.

Stratigraphy sections, profiles, fence diagrams are also useful in understanding the stratigraphy of the area, boreholes created over that place. Fence diagrams are made using goggle earth in rockware.

Rockware is thus useful in showing stratigraphy of the area, boreholes, and their fence diagrams using goggle earth. Which makes the work easy to understand and workable.

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2. Software Review, Rockworks 2006, Clint Carney, Nebraska Public Power District and Colorado School of Mines, Southwest Hydrology March/April 2007.http://www.swhydro.arizona.edu/archive/V6_N2/dept-softwarereview.pdf

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2. Tunisia)"http://www.academia.edu/2415396/GISbased_subsurface_databases_and_3D_geological_modeling_as_a_tool_for_the_set_up_of_hydrogeological_framework_Nabeul_Hammamet_coastal_aquifer_case_study_Northeast_Tunisia_ accessed on March 3, 2015.