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GENERATING CORE ADVANTAGE FROM GEOSCIENTIFIC DATA:

Data to Decision to Drill Hole

Tim Dobush and Carmela Burns

www.geosoft.com

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Abstract

Successful exploration programs rely on decision makers making effective use of data and information to develop their exploration programs into resource development projects and eventually a viable mine. Companies spend millions of dollars on the acquisition of geophysical, geochemical and geological data to support their discovery projects. Maximizing the return on investment from geoscientific data means rapidly and reliably converting high volumes of diverse data into knowledge that supports effective decision-making. Geoscientific data, together with the right technology to transform data into knowledge, can raise the productivity and success rates of exploration companies through improvements in target delineation, increased efficiency and cost effectiveness, and loss avoidance.

Introduction

The future is knowledge. For all organizations, knowledge is the key to boosting profits and reducing costs. The generation and exploitation of knowledge plays an ever-increasing part of creating wealth 4.

Knowledge resides in us, the individuals within an organization and we base our knowledge on the on-going assimilation of information, education and experiences. For the organization, the end result comes down to the effective and organized application of knowledge to make better and quicker decisions.

It's quite clear to see where the educational and experiential components come from, but where do we get our information?

Information is based on data. The key is "Knowledge from Data™" and the ability of organizations to maximize the value of the information within their data to enhance knowledge and make quicker and more effective decisions.

Then for most resource-based organizations, the main assets available to their exploration group to generate wealth are 1) their earth science professionals (geologists, exploration managers, consultants) whom we term "Knowledge Experts" and, 2) the data collected and/or acquired for their exploration programmes or projects at hand.

An organization's exploration success will be based on its ability to maximize the performance of their Knowledge Experts by utilizing the potential information contained within their geoscientific data to build on their current understandings and experiences.

So why hasn't this been effective to-date?

Although there has been a focus on the creation of data/information, little focus has been given on the relationship (utilization) of this data/information to the tasks of the Knowledge Expert and management. This has lead to a frustration with the expectation or value of the data/information. Before beginning to collect and utilize data, one must clearly define what the expected outcome is and from the outcome, the knowledge expert can then determine what are the decision-making activities required to achieve the outcome. We define decision-making activities as those that utilize the data in order to make a decision.

The end result is having knowledge that is both of quality and productive.

Knowledge Experts

In review, knowledge resides within the Knowledge Experts and their degree of knowledge is based on the on-going assimilation of information, education and experiences.

We can look at earth science professionals as Knowledge Experts, each possessing some specialized knowledge that can be utilized to solving the organization's tasks at hand. In the past, the term "specialized" has been delegated to those within an

organization that possess a certain qualification (i.e., geochemist) or skill set. The term "generalist" has been perceived to mean someone with a broad but limited knowledge in any specific field or category.

In re-looking at this perception, we can say that over time, the application of our knowledge to the required tasks will result in us becoming even more specialized. Although this may require us to broaden our tasks or roles, say in example of a field geologist to collect both geophysical readings and geochemical samples, in essence, we can consider a generalist as someone with multiple specialties.

Even with multiple specialties, a Knowledge Expert generally doesn't have all the knowledge required to solve the task at hand. Therefore, they need the organization to convert their specialized knowledge into performance.[1] To accomplish this and to be truly productive, Knowledge Experts are required to work in teams understanding that the contribution they bring to the team and the makeup of the teams will vary from one project to another. An organization's ROI and more importantly, an organization's competitive advantage will come from how well their teams work.

Increasingly, the focus of Exploration Managers or Project Geologists needs to be on understanding the value each of their Knowledge Experts brings to the teams; deciding on what Knowledge Experts will comprise the teams; and managing (organizing) these teams to maximize their productivity. The success of an exploration programme will be strongly influenced on bringing together the right mix of Knowledge Experts and understanding that this mix will vary from one project to another. In essence, the role of management is to make knowledge productive.[2]

Data

Data is defined as the original measurements collected/sampled directly or indirectly by an organization. Spatial data is data associated with a geographic location. In the context of this paper, we will refer to data meaning spatial data. Information is defined as any result/transformation made to the data based on some process, human or otherwise (i.e., gridding).

For any exploration project, data can play an important role in providing the basis of filling in the missing components of the Knowledge Expert's hypothesis on the geology and/or potential mineralization. Ideally, the optimal benefit from collecting and utilizing data would be on projects where the current knowledge or understanding is poor (i.e., new countries).

As information derived from data can play an integral part in the decision making process, it can be considered as the essential building block to a decision similar to a cell being the essential building block to all living matter around us.

At the nucleus of this cell is the value (measurement) and associated with it is metadata, supplementary data/information that provides the Knowledge Expert with

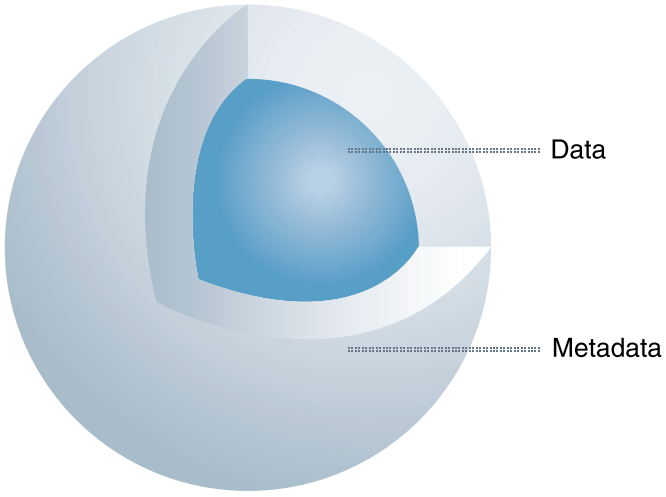

Figure 1:

"confidence" in the integrity of the data value. Both the data value and metadata are valuable and essential.

From a business aspect:

- Data can be considered a leveraged asset, part of the shareholder value of an organization that can be utilized to enhance the value of a property.
- Data can be a strategic differentiator, giving its Knowledge Experts the ability to enhance their project generation and exploration capabilities.
- Data provides the basis for project generation in areas of limited knowledge.

For the exploration industry, there is no shortage of available data or the ability to collect new data. The available data and its associated metadata includes drillholes, core logs, lithologies, airborne and ground geophysical data, multi-element geochemistry, satellite images, PC images (bitmaps, etc.), and AutoCAD images.

In today's world, data is exponentially growing in both volume and complexity with most single data sets in the order of 100's MB with combined data sets reaching into the 100's of GB. With this exponential in data comes a corresponding increase in distribution of digital data sets via the Internet from both government and private sources. For example, as of 1989, over $30 billion of exploration data was held in Australia alone. [3]

The data explosion is driven, in part, by new instrumentation capable of acquiring High Volume Data (HVD) and the computing hardware and associated software technologies capable of manipulating HVD. In conjunction with this explosion of data is a growing acceptance of multi-disciplinary data sets and integrated interpretations to address complex earth science problems.

Role of Software Technologies

Given the significant investments made in the acquisition of data, the assumption would be that the data is exploited to the maximum extent possible.

The reality is that, in many cases, only a fraction of the available data is utilized. Why?

Although we can list numerous reasons for us to not fully utilize data (i.e., the software is too hard to use or I have no time), these reasons tend to be more of a "facade" based around a basic misunderstanding of the role of software technologies.

Essentially, the role of software is to help the Knowledge Expert to unlock or transform the maximum potential of information contained within the data to supplement his or hers knowledge of the task at hand.

In addition, software technologies can play a role in:

- Conveying one's specialized knowledge so as to be understood by their team and the organization as a whole.
- To bring together (share) information and hypotheses, queries (interpretations) from each of the individual Knowledge Experts and to test/perfect these assumptions.
- Enhancing the interaction with the information while minimizing the unnecessary handling/manipulation of the data.

An organization should not undermine the importance of having the right software technologies to extract the relevant information from the data to add to the Knowledge Expert's understanding of the task at hand.

The software technologies chosen should reflect the needs of the organization and how each of the Knowledge Experts interact with each other within the organization. The needs of the organization are reflected in their goals (mandate) and how they carry out their exploration programmes.

At no time should software technologies be selected based solely on the capabilities of the software or the isolated preferences of the Knowledge Experts. The choice of software technologies is the decision of the organization as without proper care,

the improper transformation of data to information can lead to misdirected assumptions.

Productivity is the key, however, the Knowledge Expert needs to recognize the importance in owing their data, being responsible for the information derived from that data and how that information is utilized within the organization.

In the end, the software technologies we choose should enable us to answer the following questions:

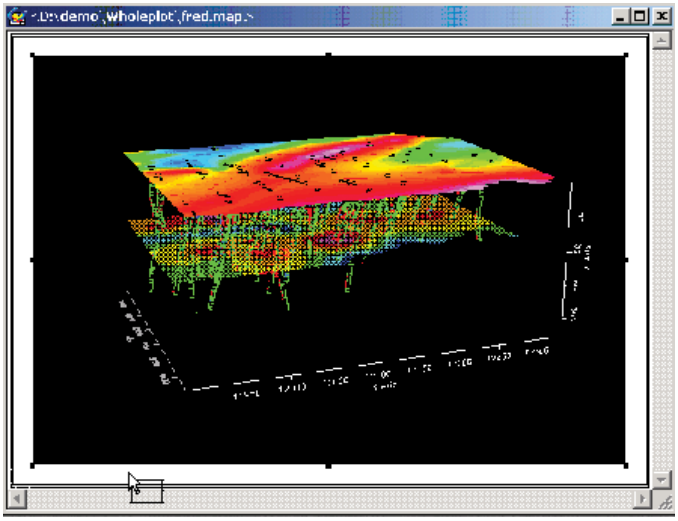

Figure 2:
Presentation maps can be conveyed as a way for the Knowledge Expert to make their assumptions understood by others. 3D technologies have a particular value in this realm.

- Do we have all the information to make a decision?
- Does our information correlate with our knowledge of the problem?
- Do we need to verify it with our original data?

Relationship between Data and Knowledge

Software technologies play a fundamental role in providing the connectivity between the data and the Knowledge Expert. Before looking at the different software technologies and how they provide this connectivity, we will first look at how data relates to the decision-making process within an organization.

We refer to the Earth Science Data Stream model (Figure 3) provides a rational framework for understanding the problem-solving process and the relationship of data, information and knowledge throughout this process 6.

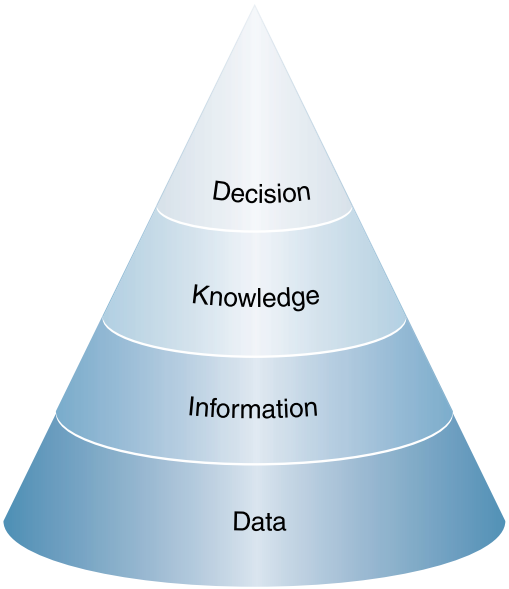

Figure 3:

As shown here, the model uses a pyramid to express the relationship between the original measurements, data, information, knowledge and the decision components.

There are some factors that characterize the pyramid shape of the model and the levels of organization within the model:

- The data level is the most abundant and varied component in the system meaning that from high volume multi-disciplinary data we should get a focused decision.
- Data must go through one or more transformations to become information.
- Data transformations are focusing processes – in which value is increased through manipulating large volumes of data into information, knowledge and finally, decisions.
- Where data is needed to supplement knowledge gaps, decisions are ultimately based on data – when we break, forget or consciously choose to ignore this connection (linkages), we expose ourselves to negatively influencing the decision-making process.

To exploit the fullest potential of information from data requires data to go through three steps for incorporation in the knowledge pool being:

- Data Management
- Data Processing and Analysis
- Information Management

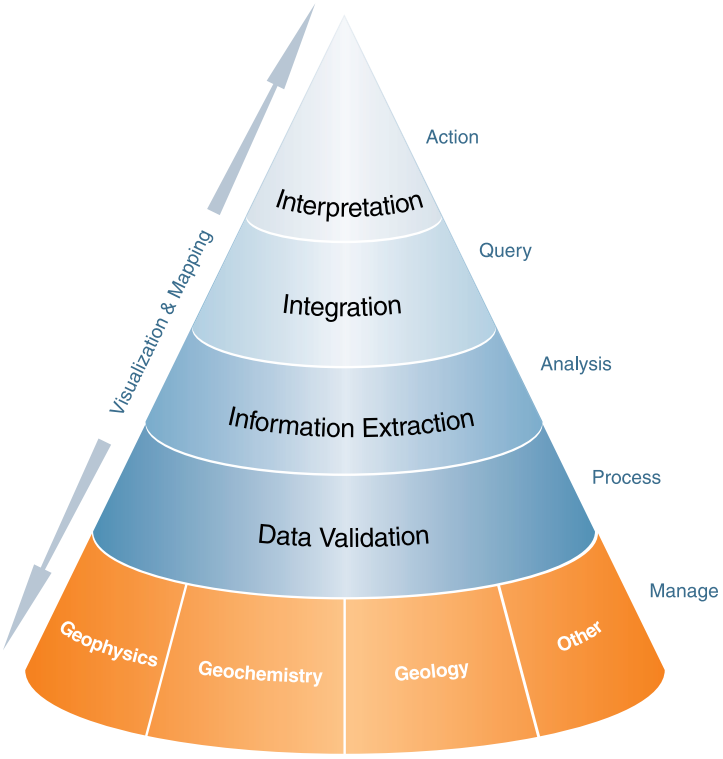

Figure 4:
The knowledge expert needs access to the complete process flow whether it is from the raw observations or "mining' down from the decision. Supplementary data/ information (metadata) provides the Knowledge Expert with "confidence" in the outcome of his/ her decision.

Enveloping these is the need to access data and information at any stage of the process. Accessing includes the ability to locate, examine and retrieve the data/ information.

The software technologies can and will generate anomalies or derive interpretations that can add to the uncertainty and its important that the Knowledge Expert can access, at any time, the original data, processes to derive the information and related information (metadata) to help to differentiate between true and false results.

To be effective to the Knowledge Expert, the software systems described need

to be “Experiential” in design meaning that the Knowledge Expert needs continuous exposure to the data and information so as to increase the understanding of the data and ultimately, to gain knowledge about the specific problem at hand.

“Experiential” systems should provide:

- The ability to quickly and easily produce meaningful maps is an important requirement of any software solution. Maps function as a means of assisting the Knowledge Experts in interpreting and visualizing information
- The ability to script or log the tasks performed on the data or information provides both for a level of quality assurance (i.e., what was done to this data) and the ability to repeat the tasks on a related set of data or information.
- Processing speed. As data is reduced from raw field measurements to final information, the database and programming structures must be efficient – especially considering the volume of data involved and the read-process-write sequence through processing is repeated many tens or hundreds of times.
- Visual feedback to the Knowledge Expert so that the results of processing, analysis and querying steps can be seen and evaluated.

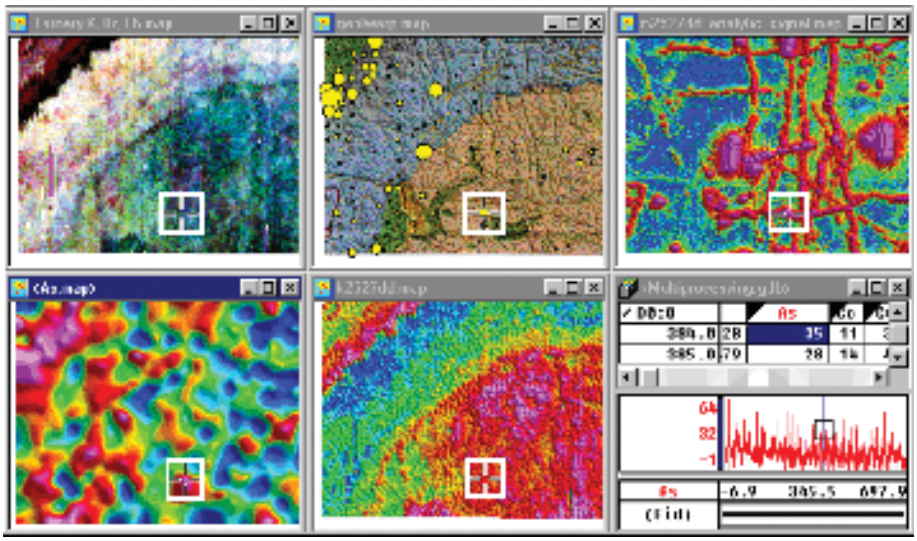

Figure 5:
Dynamic data links are graphical connections that link what a Knowledge Expert sees on a map to the same location on other displayed maps and to the original data in spreadsheet and profile views. This enables the user to accurately identify similar areas of interest and reference it back to the original data so as to retain data context (i.e. contact with the data and the processes that have been applied to the data).

Data Management

The extraction of potential information from data is more achievable if the data is organized to allow for the further processing, analysis and compilation

The main goal of data management is provide the Knowledge Expert with data that has integrity, quality and accessibility

The business value data management brings is:

- Loss avoidance
- Time savings (large percentages of time spent looking for data or long processing and analysis periods)
- Knowledge Expert productivity (faster and more projects are processed each year)

There needs to be a focus on data validation and controls to provide assurances of both its accuracy and relevance to the intended use.

Data Processing and Analysis (DPA)

We define Data Processing and Analysis (DPA) as the ability to process, transform, and analyze data into information.

DPA systems are therefore designed to work with the original data and through various processes and analyses, transform the data into information.

- DPA processes include geological noise reduction (convolution and non-linear filtering), math expressions, frequency domain filtering, gridding, advanced grid manipulation and other functions for enhancing the quality of the data.
- DPA analysis includes histograms, correlation coefficients, scatterplots, principal component, classifications and modeling.

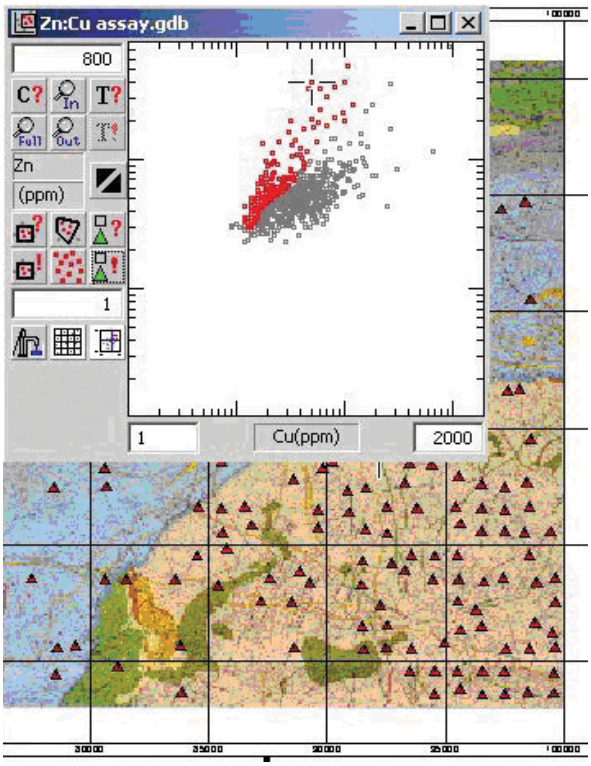

Figure 6:
Scatter plot tool displaying Cu and Zn as elements of interest, and a scanned geological map of the region displaying the selected sample locations.

Information Management (GIS)

We define Information Management as the ability to assemble, maintain, publish, query, and analyze information according to their geographical location.

GIS systems are therefore designed to work with information and to have the ability to spatially relate various types (layers) of information in order to test a Knowledge Expert's hypotheses.

- A main advantage of the GIS approach is that the user can determine complex relationships between all of the stored information (i.e., electronic light table)
- GIS provides the ability to extract different sets of information (themes/features) from a map

Data Access

For many Knowledge Experts, the "Data Experience" of sharing and distributing large volume data continues to be an inefficient and time-consuming process. "Data experience" is defined as the process through which Knowledge Experts find relevant data (usually via an Intranet or Internet), evaluate its usefulness, and retrieve the information and data.

Internet and Intranet data-sharing protocols can improve this "Data Experience" by streamlining the process of responding to data requests and 'self-serving' data/ information to any of the software technologies without the need to worry about data projection, windowing, security, file formats and server loading.

In order for a data-sharing protocol to solve the problem of distributing large volume data, it must be able to:

- Share geospatial data among many people connected to the same network
- Make geospatial data discoverable on the Web, either on the Internet, or through an Intranet portal
- Explore the data (find out more about the data) before downloading the data
- Exploit the data (download and start using the data) in the context of their area of interest
- Provide spatially aware data in any projected coordinate system or file format while storing the data in its "native format"
- Move data securely and efficiently

Relationship Between the Knowledge Expert, Data, the Organization and Software Technologies

It is the organization that provides the visions to combine Knowledge Experts with the data and to align the organization to effectively use the software technologies

The organization needs to provide the processes, which the software technologies must support, that are focused on outcomes, and provide the strategies for making knowledgeable decisions based on data.

By maximizing the useful information from data, the process itself fosters both the level and dissemination of knowledge regardless of whether the project was successful or not (a discovery or not a discovery)

If the Knowledge Expert is considered the most valuable asset to an organization, then it's important that the organization maximizing the return from this asset. If knowledge is that contribution, than software technologies can be looked upon as an investment tool that the Knowledge Expert utilizes to enhance their knowledge from the data. The question an organization then needs to ask when investing in software technologies is "How does this software technology improve on my assets?"

If we are of the belief that the Knowledge Expert continuously increases their knowledge and therefore value to the organization, then we can say that software technologies can be looked upon as an investment and its value is dependant on how well the Knowledge Expert can "link" the data to the successful outcome of the exploration project.

Conclusions

Knowledge is the most valuable asset in any organization.

The challenge of the organization is maximize the productivity of its Knowledge Experts and capitalize on the opportunities brought forward.

Software technologies play a fundamental role in providing the connectivity

between the data and the Knowledge Expert. The value of the software is based on this "level of connectivity".

Making use of software technologies to advance our knowledge, organize it, manage it, disseminate it and extract the value from it is likely to prove an increasing important source of competitive advantage for companies in the mining industry and an increasingly important attribute for Knowledge Experts working for them 5

Too many times, software technologies are looked and measured upon as a capital investment driven by economic factors like lowest price while it should be looked upon more as an investment in making the Knowledge Expert more effective to the organization.

Better decision-making and better discovery success rates will come from maximizing an organization's knowledge resources. With this is the need for an effective and integrated data and information toolkit to allow the Knowledge Expert to enhance their understanding and in turn make better decisions.

In the end, the reality must be that no software can replace the expertise of the Knowledge Expert. Software technologies remain tools that ease the job at hand, and helping us develop and improve our knowledge base.

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Geosoft Inc.
Queens Quay Terminal
207 Queens Quay West
Suite 810, PO Box 131
Toronto, ON Canada M5J 1A7
Tel: +1 (416) 369-0111
Toll-free: 1-800-363-MAPS
Fax: +1 (416) 369-9599
info@geosoft.com

International Offices:
Geosoft Africa Ltd.
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www.geosoft.com