Introduction

In exploration, knowledge and data are your two greatest assets. Geoscientists depend on data to provide direction on where to explore and drill. Investors, analysts and partners use data to assess the value and integrity of an exploration company’s results. Having the right technology can help to improve exploration productivity, as well as long term results in exploration programs. Taking an integrated approach towards your exploration technology can yield the greatest benefit, providing a solid data foundation for resource development as well as active exploration projects.

In this paper we look at how the integration of Metech’s acQuire software with Oasis montaj, Geosoft’s industry-standard spatial data environment enables exploration professionals to solve the problem of storing and accessing quality technical data.

The paper addresses how these technologies together with Geosoft’s Target mapping and Chimera geochemical analysis applications can provide all the required functionality for effective exploration data management, quality control, analysis, integration, reporting and presentation. Together, acQuire and Oasis montaj provide easy access to quality assured data that can be processed and analyzed within one integrated spatial data environment.

Integrated solution for exploration data

Summary

The integration of Metech’s acQuire software with Oasis montaj, Geosoft’s industry-standard spatial data environment, enables professionals in the exploration and mining industries to solve the problem of storing and accessing quality technical data.

Industry

Mineral Exploration

Solution

Easy access to quality assured data that can be processed and analyzed within one integrated spatial data environment

Products Used

- Pocket acQuire Digital Field Data Collection
- acQuire Data Management System
- Target Surface and Drillhole Mapping
- Chimera Exploration Geochemistry

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Overview

Comprehensive and easy-to-use software is essential for the management of ever increasing amounts of high volume exploration data, thereby enabling fast decision-making.

In this paper, we will introduce Metech’s acQuire data management system, which includes two components – the acQuire Data Model and the acQuire Software. The acQuire relational data model provides central storage for all the technical drillhole and geochemical data generated in an exploration or mining project. acQuire validates all imported data to ensure a high level of quality control. This paper will also provide an introduction to Geosoft’s Chimera™ geochemical data processing and analysis (DPA) application, and Target™ a comprehensive data processing and presentation solution for drillhole geology. The direct link to acQuire, Chimera and Target are integrated in the Oasis montaj environment in one simple package thus enabling knowledgeable and intelligent decision-making in a single package.

What is acQuire?

acQuire is an ‘out of the box’ data management system consisting of two components – the acQuire Data Model and the acQuire Software. acQuire provides a relational data model suitable for all drillhole and geochemical data, providing central storage for the technical data generated in both Exploration and Mining. acQuire also provides quality control of data and accessibility for reporting, providing a receptacle to data that is highly validated.

Integrity of data is paramount for any mining or exploration company, both from a technical and legal viewpoint. Historically, many organizations have had poor systems giving rise to inconsistencies, lost data and errors. Increasingly, both industry and government departments require higher levels of reporting standards. acQuire is designed to provide the optimal solution for storage and reporting of data.

Another significant objective of acQuire is to provide a means of optimizing data integration between all earth scientists. Traditionally, the Geochemist may have a different location for storing information that is directly related to work being done in another system by the Exploration Geologists. This leads to data duplication and poor version control, which ultimately leads to poor decision-making. In addition to integrating data use between departments and professionals, acQuire is designed to assist with external organization and software systems. For instance, acQuire provides a location to store information about laboratory batch information that assists with the integration with laboratories.

acQuire provides;

• Manual and automated data entry
• Automatic drillhole and sample generation tools
• Automated laboratory data importing
• Proven QAQC management systems
• Validation – system, company and user defined
• Customizable fields, views and workspaces
• User defined data entry objects
• Direct access to data clients

In this paper we will introduce the various functions that are available within acQuire, outlining the procedures undertaken when collecting data in the field, loading it into acQuire and extracting the relevant information via queries and exporting when required.
What is the acQuire Data Model?

The acQuire Data Model (ADM) is a designed structure that can be implemented in relational database systems such as: MSSQL Server, Oracle and MSAccess 2000 (MSDE).

Vast resources have been invested by the acQuire team in research and development of a database structure that can be used on every exploration and mine site in the world regardless of the commodity. This was achieved by identifying three major object types:

• Drillhole/Blasthole Object
• Point Sample Object
• Sample Batch Object

It was therefore possible to construct a data model that accommodates the persistent nature of these objects and also provides a commodity independent solution. At the same time, tools are provided for site-specific customization by the client data manager if required.

Our structured model is a supportable product, yet was still designed to incorporate site-specific needs. The ADM gives the acQuire Manager room to establish additional fields, validation and more.

What this means to you

Instead of “reinventing the wheel”, we provide a solution that incorporates all permutations for both exploration and production data. The ADM and its associated software system are being continually developed so as new subsystems evolve, your company receives the benefits.

The ADM had the following features:

• Company defined validation may be imposed whenever data is entered into the database.
• Re-logged data, as well as original data, can be saved in the same table should the geologist re-log a drillhole.
• Re-assay and re-split data can be stored at different intervals.
• Field and laboratory duplicate samples are stored.
• Field and laboratory standard samples are stored.
• Detection limits and analytical methods of elements can be tracked.
• Site-specific look-up tables can be established.

Pocket acQuire

In the past, data was collected from the field via whatever means were made available. In most instances, this was done on paper logsheets, which made the entry of data into a database to be time consuming. Generally, the person loading data into the database is not necessarily the same person who had collected the data, so any errors with the data collected cannot be immediately resolved. Also, it is difficult to maintain validation rules established on the company database to the data that is collected in the field.

Metech has been considering this problem for some time and is in the process of releasing a new product to assist in accurate data collection; Pocket acQuire. Pocket acQuire is designed to vertically integrate the data collection and management process. Pocket acQuire provides a digital field data collection solution where geologic lookups and validation rules can be transferred from the company database with ease. This means that when the field geologist is collecting data in the field, all the validation rules that exist on the company database also exist on the logging device.
Pocket acQuire has been designed for the CE operating system and can be used on a variety of mobile devices. Pocket acQuire works on a variety of mobile computing solutions and the interface screen is resolution independent. The interface is user configurable and non-prescriptive, validation data is sent to the device from the company database. The data collected on the device can then be imported into the company database already validated, minimizing data collection errors.

The database administrator is able to customize the logging sheets that the person in the field uses on a day-to-day basis. These log sheets, plus all relevant validation information is downloaded onto the logging device at the commencement of data collection. The geologist, or sampler, can then use the logging device, selecting from pick lists for the relevant codes whilst collecting data in the field. This data can then be uploaded directly to the company database by synchronization between the data logger and the acQuire database.

Validation

Validation within acQuire resides within the database. This means that any data entered into the database, either by acQuire or by other means, will be validated prior to the data being loaded. Company standards are always maintained. There are two types of validation;
- Defined by acQuire. For example, all azimuths entered must be between 0° and 360°.
- Defined by the manager. For example, the specific company codes used to define lithology. Manager defined validation can be added at any time. If keyed-in or imported data is not listed in the user defined validation, it is reported as an error and not entered into the database.

Customization

There are numerous functions and wizards available to acQuire users to assist in customizing both their database and the actual appearance of their workspace and acQuire objects.

acQuire allows the user to customize the database to incorporate more site-specific information, enabling them to create new fields that are not found in the acQuire Data Model. The user can also determine which fields to display for individual views. acQuire enables the user to define new view, plus the order in which the fields are to be displayed.

The diagram above displays how a user can create a new form definition, in this case for a Geology view. This form definition is then used...
to create a new form in the acQuire workspace, which displays the fields selected, with any associated validation. This form can then be filtered to display specific record sets.

Not only can the actual fields and the views be customized within acQuire, the actual workspace can also be modified to make it user specific. Individual objects may also have control sheets created, which provide a graphical interface to the end-user. The user only need to populate the required parameter fields for the objects to either load or query data.

Shortcut bars can also be created for the “infrequent” user, or someone who only uses a small number of acQuire objects on a day-to-day basis. Shortcut bars contain icons which are shortcuts to objects and functions within acQuire and to external files. Multiple shortcut bars can be created for the various tasks used regular basis.

The above diagram displays the a shortcut bar created for an exploration database, with the various icons pointing to different acQuire objects, functions and external files. The actual acQuire object displayed is for importing data, where a control sheet has been created to provide an interface for the user.

**Import Objects**

Data can also be loaded into acQuire via acQuire Import objects. These are used to import data from a source file, via a set of instructions or an Expression into the database. An import object can consist of one or many sheets. Each sheet has its own set of import instructions and can have its own source file. Sheets can be active or inactive and be set to either insert, update or merge mode. The first sheet can be a Control Sheet, this sheet is the users interface with the actual import sheets, and variables are selected and passed to the consecutive sheets. The import process can be previewed and executed from the Control Sheet.

The acQuire import objects support numerous source file formats including; CSV, SIF, TXT (tab, fixed width and space delimited) files, ODBC databases and ODBC database structures. Data can be loaded on a trial basis to check for
validity of data and any data rejected is written to a rejects file, which has the same format and data fields as the original source file. The expression field of the importer also gives the user the ability to manipulate the source data as it is imported into the database. Multiple source files can be loaded into multiple acQuire tables during the one process, saving time and reducing duplicate processing.

Data Entry Objects
Data Entry is used to generate data sets that have a regular pattern, for example, creating a set of grade control blastholes with associated sample numbers.

Each object can consist of many sheets. Each sheet is based on a form definition, so that each sheet has a particular set of fields that can be included to receive data. Data can be passed from sheet to sheet (for example, the Hole ID is generated on the first sheet and passed to the following sheets). Expressions, warnings and default values can be set to assist in the data generation. There are two modes in the life of a data entry object:

- Design Mode. This phase consists of two views – Grid and Form.
- Run Mode. This phase has two modes – Insert and Update.

acQuire Forms
Once data has been loaded into acQuire, it can be viewed via acQuire forms. It is a view of the contents of selected tables in the database. By creating forms, you can construct a set of views that let you work with the data in the most efficient way. A form has the look and feel of a spreadsheet and similar features – enter records, move, hide and freeze columns, and sort data. Forms can also be used for entering small amounts of data. Data can be exported from a form, either to file or to a view that is stored in the database and accessed by other data clients.

Generally, you will create a set of forms to present the data you need to work with regularly. By creating folders you can group these forms logically, such as by project or prospect. Individual acQuire forms are specific to a workspace and can be saved locally or in a network folder. Forms are based on form definitions which are defined by the database administrator. While form definitions control which fields (columns) will be visible, in the form itself, you control which records (rows) will be visible. This can be done by applying a filter to the form. Some form definitions are supplied with acQuire. If you need others, the database administrator can create them using acQuire Manager. The responsibility for creating new form definitions is left to the acQuire Manager.

Data Query – SQL Objects
The advantage of having a relational database management system, such as acQuire, is that queries can be made to effectively extract information from the database. acQuire assists in running queries on the database via the implementation of SQL objects. Like the import object, these objects can be customized, incorporating Control Sheets to provide an interface for the acQuire users. The user selects the required parameters, and these variables are passed into the SQL query. Once the query is execute, the results can be exported to a file or a permanent view can be created.
Data Client Views

Data Client Views are a permanent view of forms you want to display in a client application. For example, MS Excel, Minesight, or Oasis Montaj. Because they are based on forms, any field and record filtering should be completed before the view is created. In this way, you can ensure that only the data required for the external application is made available.

Each data client view is stored in the database. Client applications can then connect to the underlying database using ODBC and access the view. Exactly how you access a data client view from a client application depends on how the application implements queries to external databases. Generally, a straightforward process that involves selecting the database and then choosing the name of the data client view from a list of queries.

Data Client views provide a live link to clients. Any modifications to the data in acQuire or the database will be reflected in the client software if the view is refreshed in the client application. The link, however, is read only. Once the client has the data, any changes made to the data cannot be written back to the database.

Generally, you will create data client views for data that requires processing, analysis and display.

Exporters

Data can be exported through various functions within acQuire. Individual forms can be exported via the form export, with multiple file formats supported; CSV, TXT, tab delimited, width delimited, and various other proprietary formats. WYSIWYG exporting is also available, with record and columnar filtering; data can use the Cut/Paste options to replicate data into external software.

acQuire supplies the users with two exporter, one for Drillhole data and another for Geochemical/Point data. The Drillhole Exporter is used to extract all relevant drillhole data, including; collar, survey, analytical and lithologic records. This data can be filtered and transformed during the export.

As displayed in the Drillhole Exporter, the data can be exported to numerous formats. Currently supported by acQuire are; Datamine, Gemcom, Micromine, Minesight and Text output formats. Upon extraction, the data can also be manipulated, with coordinates transformed, drillholes desurveyed, and downhole intervals split by selected sample/geologic intervals. It is also possible to export the calculated X, Y and Z co-ordinates for analytical intervals down the drillhole.

There is also an exporter available for the geochemical data, which has a similar interface to that displayed for the drillhole exporter.

Both of these exporters can be incorporated into external packages. Geosoft uses this functionality to access acQuire databases from within their own application. This means that a user does not need to be inside acQuire to access the data, but can be in an associated software package, and still be able to accurately query and extract the relevant data from the database into their client software.

Data Import Directly from acQuire to Oasis montaj

Oasis montaj users can now import directly from acQuire databases. acQuire has been integrated into the Oasis montaj environment and provides fast and efficient access through the main toolbar.

The acQuire menu Import Acquire enables the user to access drillhole (Import Hole) or geochem (Import Point) data. These menu options access the same interface as the Drillhole and Point Export tools of acQuireDirect.
Once the acQuire data has been imported into a Geosoft database users then have access to the quality control, analysis, plotting, integration and reporting/presentation features available in the Chimera and Target applications.

The storage of important meta-information such as laboratory used, type of assay method, and detection limits is vital for comparing datasets over time. This information is stored within the Geosoft database to provide backup information for verification of the data. The data is displayed in a spreadsheet window that has the look and feel of an Excel™ spreadsheet for ease-of-use, with a powerful data processing engine behind it for time savings through performance.

Once imported, all element data are assigned as ‘ASSAY’ class, for use in the statistical tools.

### Quality Control

The use of standards and duplicates are mandatory in any geochemical survey, and serve as an essential part of your due diligence process – enabling you to confirm the validity of your data. In this example, we have included both standards and duplicates that must be extracted and verified before the data can be processed.

Chimera provides the tools to extract both standards and duplicates from your data and places the results in a new or historical (standards) database. Graphical tools are also available enabling the user to display the standards and duplicates results to verify results and ensure data quality.

Duplicates are plotted against each other in logarithmic or linear space depending on previously set parameters, the red lines indicate +/-10% tolerance.

The red horizontal lines on the Standards plot indicate tolerance; in this case, the limits are set at +/- two (2) standard deviations. Specified values can be previously set. Standard results can be compared over time, batch by batch; historical data is to the left of the dotted vertical line, new data is to the right.
Verification of data

As mentioned previously, the Chimera spreadsheet has the ease-of-use of an Excel spreadsheet, and provides similar tools for calculating statistics, sorting data, creating new columns, and writing mathematical formulae.

Histogram Tool

The Histogram tool provides a visual representation of the data distribution, enabling the user to switch between a logarithmic and linear distribution, and specify the thresholds for plotting geochemical data.

Scatter Plot Tool

The Scatter Plot tool enables users to plot one ASSAY channel against another ASSAY channel. The scatter tool is dynamically linked to the database and map enabling easy identification of outliers. The scatter tool also enables the selection of discreet populations (as shown on the figure below) and the plotting of these selected sample locations on a map.

Triplot Tool

The Triplot tool is similar to the Scatter tool but plots a ternary plot using three ASSAY channels. In this example, we are identifying coincident Cu, Pb and Zn anomalies.
Meaningful Map Production

The ability to quickly and easily produce meaningful maps is an important requirement of any exploration package, and it is vital that any graphical representation of geochemical data is accurate and professional. Along with the ability to grid data, Chimera provides a variety of methods for symbol plotting single and multi-element data.

The traditional way to display geochemical data is as symbol plots, overlaying other data types such as geophysics and geology. The Chimera system enables users to create colour symbol plots using statistical breaks, proportional size symbols, symbols based on two variables (e.g. Cu for size and Zn for colour), rose, pie and bar plots for up to 8 elements at individual location points.

Gridding data

If it is appropriate to grid your geochemical data, Chimera provides four different gridding methods; minimum curvature, kriging, tinning, and bi-directional line gridding. When gridding any geochemical data you must consider the distribution and density of your samples, and choose the correct gridding method, grid cell size and blanking distance accordingly.

Data Integration

A fundamental process in geochemical exploration is the integration of other available data, to assist in the identification of potential areas of interest, so that calculated and informative decisions can be made.

Cu was gridded using the minimum curvature method. The sample spacing was approximately one sample every kilometre; therefore, a cell size of 250m was used, with a blanking distance of 2000m.
Landsat imagery was added to interpreted geology. Imagery was clipped to the Broederstroom map area to create an integrated compilation of geochemistry, geology and imagery.

Subsetting data
In order to define targets it may be necessary to query the data and subset it into discrete populations. Chimera’s querying tools enable the user to subset data based on breaks such as lithology, map sheet number, sample type, or anomalous assay values.

Subsetted data based on geology, only samples collected within the granite have been selected. These samples can be further processed to look for subtle anomalies.

Drill Target Areas
Having identified potential targets, you will want to follow these up by drilling. Wholeplot enables geologists to set-up drill projects, manage results dynamically, produce presentation-quality section and plan maps, and interpret results for follow-up drilling and decision-making.

Wholeplot has a user-friendly import wizard that enables direct import from Excel™ files, Ascii files, and databases. The import file format is similar to other drillhole graphic packages:

- Collar file: hole ID, easting, northing, elevation, hole depth, dip, azimuth
- Survey file: hole ID, depth, dip, azimuth (Optional – to enable the import of down hole survey information)
- Data files for assay and geological data: hole ID, from, to value (we support both from-to and point data)

There is also a ‘hot link’ directly from Acquire. Assay data typically contains standards and duplicates that need to be extracted before the data can be processed. This can be done using Chimera as previously described.

Making your first plan or section should be a simple procedure. Target has a user-friendly interface, with intelligent defaults, enabling the quick creation of plans and sections. Geophysical, geochemical and lithological data can be displayed as bar charts, profiles, lithology logs, text or gridded. The map-making tools allow for integration of all available data to enable quick and calculated decisions. Printing of maps is a one-button operation. Below are examples of plans and sections created using Target.
Conclusion
We have illustrated how an integrated solution can be used to increase the value and ensure the integrity of geological, geochemical and geophysical data through better management, quality control, analysis, integration and reporting/presentation. This gives explorationists a solution that is cost effective (licensing, support, training) without compromising data specific functionality and performance.

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Datasets Used
The dataset used in the acQuire example is part of the 1Day tutorial database, which is included with the acQuire installation.

Recognition is given to the Council of Geosciences in South Africa for providing some of the data used in this example. It is part of their regional geochemical dataset, which is available for purchase by mining companies. The 1:50000 map includes multi-element geochemical data, processed geophysical grids, a Landsat image and regional geology in both raster and vector formats.