A Vision for USGS Mineral Resource Data

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Introduction

One of the critical missions of the USGS is to provide information on mineral resources of the United States; data such as location, geologic characteristics, development status, past and current production and reserves and resources of mineral deposits. This data must meet the needs of a variety of users and uses including:

- Scientific research on mineral deposits by the USGS and others;
- USGS mineral resource and geoenvironmental assessments;
- Responding to congressional or other agency requests such as the recent report on Rare Earth Elements or for an and inventory of strategic and critical minerals;
- Federal and State land management agencies such as BLM and the Forest Service in minerals management, abandoned mines and other functions;
- Support for EPA to provide a scientific basis for regulations, bonding and reclamation planning; and finally
- mineral exploration.

A (perhaps "the"), core element of mineral resource information is a mineral deposit database. A mineral deposit database should have the following characteristics:

- It should be as complete as possible; i.e. contain records for all or nearly all mineral deposits and occurrences in the US.
- The data should be accurate especially with regard to locations.
- The database should be comprehensive in that it contains the data that users need.
- It should be structured in such a way that data can be delivered in formats and with the kinds of queries that users require.
- It should be GIS-based or be readily used in a GIS environment.
- It should be accessible via the Web both as a full or partial download as well as for use directly on the Web.
- It should be current, i.e. regularly maintained and updated once it has been compiled.

The existing USGS database – MRDS does not meet these requirements for reasons summarized by Schweitzer and Nicholson (2011) and Nutt (2011) at the July 2011 Mineral Resource Program (MRP) managers meeting in Denver. A new database and a new approach to data management are needed.

This note presents a preliminary vision of how USGS can move forward with the development of a new mineral resource database. The discussion covers the overall objectives and some important points regarding implementation - all based on the assumption that a new minerals database project will be started in FY12.

Project Objective.

The overall objective of the project will be to develop a modern comprehensive mineral deposit and occurrence database of the United States. The rest of the world can wait. In fact many countries, e.g. Canada (Chorlton and others, 2007), Australia (Esers and others, 2002) and the European Union (Serrano and others, 2010) have or are developing their own sophisticated minerals databases.

Project Implementation – General Aspects

a) Overall Project Structure

The minerals database project should proceed in three phases.

1) The first phase, taking place over a period of 2 to 3 years beginning in FY12, will consist of the development of the new database and the collection of the data to fill it.

2) The second phase, which is open ended and may start before the completion of Phase I, will consist of the maintenance and updating of the database.

3) The third phase, which will run concurrently with Phase II will consist of expanding the capabilities and utility of the database by adding new features and new types of data.

Each phase consists of very different activities which in turn will require different types of personnel and levels of expenditure. The greatest number of personnel and highest level of expenditure will be in Phase I. Only Phase I of the project is discussed in more detail below as much of the structure and details of Phases II and III and not currently known and will be developed during Phase I.

Project Philosophy

The underlying philosophy for the management of the minerals database project consists of nine elements.

1) Focus on quality content.

2) Move USGS mineral deposit data management into the Geoscience Information Network (GIN) (Allison and others, 2008a, 2008b, 2009).

3) Do not reinvent the wheel. Build upon the ideas of USGS Mineral Resources On-Line Data (http://mrdata.usgs.gov/) by studying other data management and

4) Increase productivity by working with other groups within USGS such as the National Minerals Information Center (NMIC), the Geoenvironmental Models Project and the Nonmetallic Industrial Mineral Resources of the US Project.

5) Make use of "in-house" expertise in the management of large data sets from other USGS divisions such as the National Water Information System (NWIS) and the expertise of the USGS librarians in the collection of data sources.

6) Make maximum of use of data collected by State Agencies including geological surveys and other state government departments, such as those responsible for land and environment.

7) Speed data capture and minimize entry errors through the use automated data capture and import procedures wherever possible.

8) Allocate personnel resources to insure that personnel are focused on tasks appropriate to their expertise and that data which requires a high level of expertise to acquire is compiled by qualified personnel.

9) Meet with potential data users (customers) to determine their needs and insure that the database can meet them.

Phase I Implementation – Some Details.

This will be a large and complex project; the project planning process has just started and can be considered preliminary at best. Based on the current understanding of the project it is envisioned that Phase I will consist of seven (7) tasks. These are described below.

The development of a project budget and the determination of personnel needs are at a very early stage and are not discussed here.

Task 1: Break with the Past.

Work on the existing MRDS database should cease on September 30, 2011. The database should be archived, posted on the MRDATA web site and made available for download.

A new name for the USGS Minerals database should be selected. Two possibilities that come to mind are "USGSMINDB" or "USMIN".

Task 2: Needs Assessment.

Meetings will be held with various users and customers of the minerals data including USGS personnel who are or have been assigned to Mineral Resource Assessments, the Geoenvironmental Models project, the Industrial Minerals project and NMIC. Additional meetings will be held with personnel from congressional and senate committees that have oversight on natural resource issues, other federal agencies such as BLM, BIA, EPA and the Forest Service as well as with selected state geological surveys and agencies. In addition to government agencies and personnel contacts will also be made with mineral industry groups to solicit their input.

The objective of the meetings will be to determine the kind of information and forms of information that these personnel and agencies require for their work.

Task 3: Output Determines Input.

What users want out of the database determines what we must put into it. The suggestions we receive from meeting with potential database customers will be used to determine what goes into the database and the kinds of queries necessary to produce the outputs needed by users.

An important example is the database of significant mineral deposits of the United States (Long and others, 1998). This database, prepared during the last Mineral Assessment of the United States and still under development, had to be compiled manually. We need to be able to query the new database and generate a report like Long's database.

Two other examples are the current compilation of maps showing which states have produced industrial minerals which is being carried out by Bill Langer and Anna Wilson, and the significant deposits and active mine map compilation exercise started in the fall of 2010 by Carma San Juan, Robert Callahan and myself.

A critical aspect of output is to insure that the database can provide data to users in a form that they want to use. USGS scientists consistently state that they want to be able to view data on a map on one screen and in a spreadsheet on another. This capability was built into the Canadian mineral deposit database (Chorlton and others, 2007) and needs to be part of the new USGS database.

Task 4: Data Acquisition and QA/QC Procedures.

We will need to develop standard procedures and rigorous metadata collection to document and enforce data quality. Among data attributes, to quote Greg Lee, "Location is king." We must insure the locations of the mineral deposits and occurrences are as accurate as possible given the source.

Since data acquisition will proceed before we have selected the final database structure it is important that we develop strict quality control and metadata procedures to be used by all personnel engaged in data acquisition.

Task 5. Data Acquisition.

The major focus of Year One (FY12) will be on data acquisition, including extracting what is useful from MRDS. The initial focus should be on the continental US; we will start with a single state, most likely Nevada as a prototype exercise.

a) Data Sources. Data should be sought from all available sources including but not limited to:

- USGS maps, reports and data such as the hundreds of detailed mineral resource compilations done on Wilderness Study Areas.
- Private industry data from NI 43-101 reports for Canadian companies (available from www.sedar.com), Annual Reports and Form 10-Ks for US companies (available from www.edgar.com or the SEC) and company Web sites.
- State agencies such as geologic surveys and land departments. For example the Colorado Division of Reclamation, Mining and Safety (http://mining.state.co.us/) publishes a GIS database with locations and other information on 5,558 permitted mines in the State of Colorado.

b) Acquisition Methodology. We should move as much as possible into the modern world and use technology to speed data acquisition and minimize errors. This can include:

- Extraction of locations and basic attributes for mine shafts, adits, prospect pits, and quarries from scanned USGS topographic quadrangle maps using modified optical character recognition software to "crawl" the maps. It may also be possible to use the same approach on scanned geological maps.
- Digitizing mines and prospects from USGS and State geologic maps that are already being incorporated into the National Geologic Map Database by Dave Soller (http://ngmdb.usgs.gov/ngmdb/ngm_catalog.ora.html).
- Acquiring geologic attributes such as host rock unit, lithology and age directly from geologic maps by digitizing or using image processing techniques.

c) The actual data acquisition work can be organized into teams based on the type of data being acquired. Broadly speaking a mineral deposit database contains three types of data:

1) location and basic attributes (such as name),

2) geologic data, and

3) production and resource data.

For environmental use we would need to add mine and mine waste information which would be a fourth data type. The acquisition of each type of data requires different skills. For example much of the location data can be acquired by GIS technicians.

d) Content

The database should contain mineral occurrences and deposits. Because these are related to mining the database will also contain mines. As noted by Chorlton and others (2007) this requires a database to accommodate many-to-many relationships since one mine may exploit more than one deposit and one deposit may be exploited by more than one mine.

1. Deposits and Occurrences. One philosophic issue is whether to focus only on well-studied or significant deposits or to include mineral occurrences as well. If USGS moves to a weights-of-evidence approach in mineral resource assessment then only the better studied deposits and prospects are needed.

   In my opinion however, the database should contain all mineral occurrences. A good example of the value of a mineral occurrence is a site in the northwest Brooks Range of Alaska where minor lead-zinc mineralization was reported by the USGS in 1970. In 1975, this occurrence was included in a data compilation for the US Bureau of Mines mineral resource evaluation for lands being considered for inclusion in the country's conservation system. Subsequent field work showed significant lead-zinc mineralization and the site is now the Red Dog Mine.

2. Mines and Prospect Pits. Similarly sites such as prospect pits, adits and mine shafts shown on topographic maps should also be included in the database. First from a mineral exploration standpoint, someone found something of interest there in the past and excavated an opening. Second such sites are of concern for safety and environmental reasons as possible abandoned mines. Even if no other data is available such features can be attributed with district information such as commodities.

   In a hearing on Abandoned Mine Lands by the House Natural Resource Committee on July 14, 2011 it was noted that there was no reliable data on the number of abandoned mines on Federal Lands (http://naturalresources.house.gov/Calendar/EventSingle.aspx?EventID=250281). A complete and accurate mineral deposit database would do much to meet this need.

   Another example is the "lead diggings" shown on geologic maps of the SW Wisconsin lead-zinc district (Brown and Whitlow, 1960). These sites are mineral occurrences that may have been exploited in the past but that may also be of concern for environmental protection and health reasons today.

3. Production Data. USGS has completed a number of compilations of grade and tonnage of mineral deposits but has no single public database of the best available mineral production data on a mine and deposit basis (NMIC data is reported state by state and data for individual mines is confidential). If this data is collected then projects such as updating or changing grade-tonnage models become much easier.

4. Reserve and Resource Data. In addition to production data it is important that reserve and resource data are also collected. Together production, resources and reserves equal the total endowment of a deposit which is the measure used in grade-tonnage models. Due to new securities reporting requirements this type of data is now more widely available.

e) Links to Data Sources

One critical task of the database is to refer users to additional information. A number of on-line databases; for example Wise Uranium (www.wiseuranium.org) include links to documents on the Sedar and SEC web sites.

The new USGS database must include references to data sources and links to the documents themselves would be a plus. However, linking to document sources poses problems as links easily become broken and difficult to keep current. We can include links to USGS reports and State Geologic Survey reports where the links are believed to be durable. For non-copyrighted private or other documents, such as NI 43-101 reports and company annual reports, we should establish a digital library on a USGS server and link to the documents there.

Task 6. Database System Selection and Development.

The current Oracle database platform should be evaluated to determine if we want to continue to use it. <u>However, it is not critical that we decide on the database platform or structure early in the project</u>. Various platforms and approaches to data management can be evaluated over the course of the first year. Data can be acquired and stored in simple table format and later imported into the final database.

We should review the efforts and approach of other geologic surveys in this arena so as not to waste money, time and energy reinventing the wheel. EarthResourceML (http://www.earthresourceml.org/) looks particularly interesting as it is an extension of GeoscienceML which is a part of the US Geoscience Information Network (USGIN). It has also been adopted for use in the ProMine Project in Europe, which aims at "developing a pan-European GIS-based database containing the known and predicted metalliferous and non-metalliferous resources which' together define the strategic reserves (including secondary resources) of the EU" (Vuollo and others, 2010).

EarthResourceML was developed by the Australian Chief Government Geologists Committee (CCGC) and is now under the governance of the Commission for

Geoscience Information (CGI), a commission of the International Union of Geological Sciences (IUGS). The data model is open-source and development reflects user input such as the additions requested by the ProMine Project (https://www.seegrid.csiro.au/wiki/Xmml/EarthResourceML).

Task 7. Design of Phase II and Scoping of Phase III.

The regular updating and maintenance of the content of the database must be the core element of the ongoing project. We need to develop and put into place the procedures for this during Phase I. This would include a means for users, both within and outside the USGS to transmit new or updated data to the project for inclusion in the database. Similarly we need to establish standards and procedures for review and publication of the data, e.g. database publication on an annual basis.

In the last National Academy of Sciences review of the USGS Minerals Program it was recommended that USGS move its mineral deposit database into three dimensions (National Research Council, 2004). They suggested including such data as mine plans, cross sections and drill hole data. This recommendation was not acted upon.

The development of procedures for the inclusion of polygons for mineral deposits and three dimensional data such as mine plans, cross sections and drill hole data will be important aspects of Phase III of the project.

Concluding Remarks

The above discussion, as with most "vision" statements is very general and short on some significant details in particular staffing and budget needs. Some of the details will be addressed over the coming month during the budget planning process. However many of the details of implementation; (i.e. how we are going to get this done) – will have be learned on-the-fly.

The important thing is for MRP and the USGS to commit to the project and to get started.

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