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WORLD FE OXIDE +/- CU_AU_U (IOCG) DEPOSIT DATABASE

S. S. Gandhi

FOREWORD: About this database by L.B. Chorlton

This data set depicts the global distribution of a broad class of metallic mineral deposits characterized by substantial enrichment of iron oxide (> 20%), which is interpreted by scientists to be related to regional magmatic activity and hydrothermal alteration. While many of these deposits have traditionally been mined for iron ore, economically important auxiliary metals may include copper, gold, uranium, and rare earth elements. World class mined deposits of this type include the Olympic Dam (Australia), Candelaria (Chile), Kirunavaara (Sweden), Bayan Obo (China), and Magnitogorsk (Russia - Southern Ural Mountains).

Compilation of the Fe oxide +/- Cu-Au-U (IOCG) deposit database was commissioned under the World Mineral Geoscience Database Project (WMGDP: 1998-2004) under the joint sponsorship of the Geological Survey of Canada and exploration industry sponsors [1]. Industry sponsors requested a compilation of this poorly understand class of deposits in 2000, and most data were compiled between January, 2001 and March, 2004. Minor updates have been applied periodically following the WMGDP when the inevitable flaws such as missing locations were noticed, or updates were required for other programs such as Consolidating Canada's Geoscience Knowledge and Geomapping for Energy and Minerals.

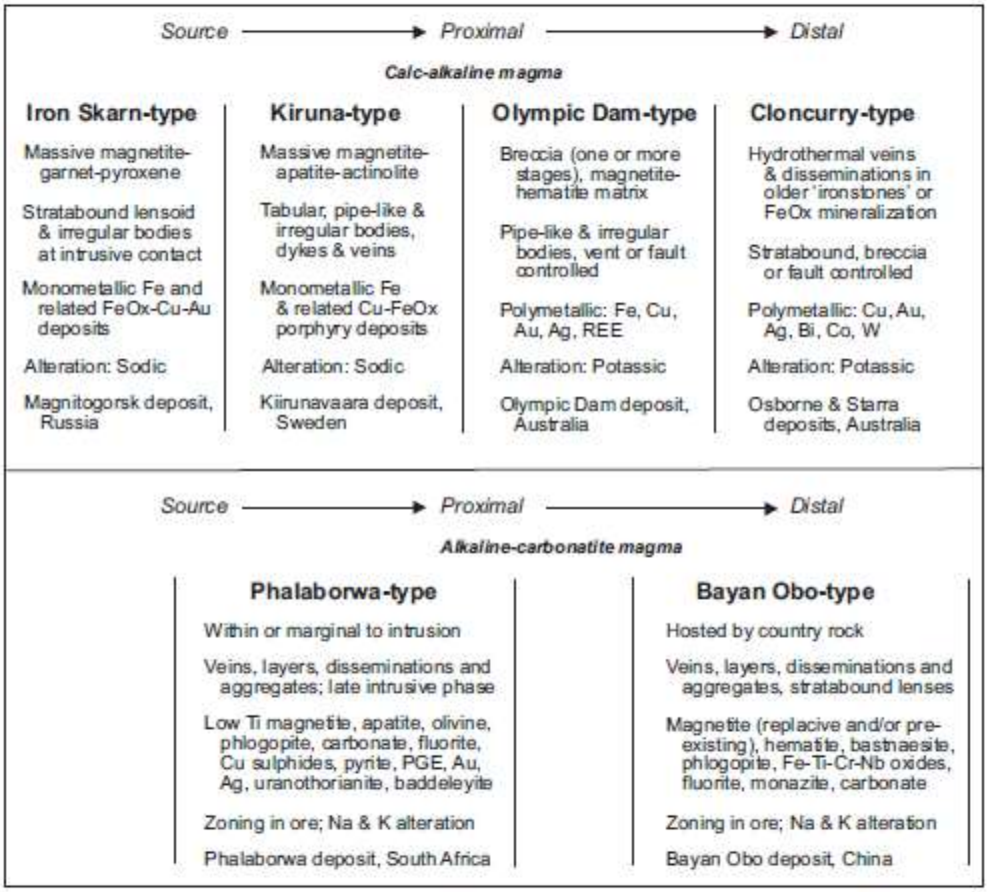
The Fe oxide +/- Cu-Au-U (IOCG) and related deposits included in this database include a broad spectrum of related deposit variants characterized by not only exceptional concentrations of the iron oxides magnetite and/or hematite, but widely distributed zones of multiphase brecciation and veining, and regional scale, multistage alteration systems which include iron oxide, sodic- calcic and potassic alteration (Corriveau, 2007; Corriveau et al., 2010; Corriveau and Mumin, 2010). In reality, there is an even broader continuum between the well-studied porphyry deposits, related epithermal deposits, and IOCG deposits. The compiler debated about what should be included in the database, but finally decided to include those deposits with > 20% iron oxide and an apparent association with regional magmatic events, though not necessarily immediately proximal to the related magmatic rocks. Therefore, iron-rich skarns and alkaline-intrusion associated deposits which met the > 20% iron oxide criteria were included, but stratigraphic iron formations were omitted. How to classify the range of deposits was also a difficult question because of their complex, multi-phase nature, but at the time of compilation the author decided to apply a very simple classification based on resemblance to six end member type examples, four related to calc-alkaline magmatic events and two related to alkaline magmas (Figure 1).

These regionally extensive, complex mineralizing systems have been the subject of intense research over the last two decades. Substantial review papers and special volumes, among them Hitzman et al. (1992), Porter (2000), Porter (2002), Williams et al. (2005), Corriveau (2007), and Corriveau and Mumin (2010), should be consulted for geoscientific context to complement this database.

When the author arrived at the Geological Survey of Canada in 1977, the similarities of magma-associated iron oxide-rich (magnetite-apatite) mineralization systems in the Northwest Territories and the Yukon to the well-known mineralizing systems of the Kiruna mining district, Sweden, and Olympic Dam, Australia, had been recognized (Badham, 1978; Hildebrand, 1986, Bell, 1986), but their regional extent and diversity of alteration and structure which is associated with them was not yet understood. Field visits to the Great Bear magmatic zone and East Arm of Great Slave Lake, Northwest Territories, led the author to examine some known uranium and nearby prospects from the Fe oxide+/-Cu-Au-U perspective (Gandhi and Lentz, 1990; Gandhi, 1994; Gandhi and Bell, 1996). This ignited his interest in these deposit types globally, leading to contract work for private industry around the deposits in the southern Great Bear magmatic zone after leaving the survey in 1997 and participation in related field trips and conference sessions from which the compilation greatly benefited.

At the time the majority of this database was compiled, it was difficult to obtain exact locations for every deposit, or to establish exactly what mineralization zone or piece of infrastructure was located by the data source. Many geographic coordinates were rounded to the nearest minute. Locations are therefore approximate for the most part, although recently it has been possible to use Google earth to accurately locate some very large open pits. It must also be emphasized that resource figures in this database are not current and do not comply with current standards for resource reporting [2]. They should be classified as historical resources and the original data source cited if they are re-reported. None fit the current definition of economic reserve.

Figure 1: Simple classification of magmatic-hydrothermal iron oxide deposits and related Cu-Au deposits, showing conceptual proximal to distal relationships to related magmatism (after Gandhi, 2004, from Corriveau, 2007).



These databases will never be complete nor will their existing contents be up-to-date unless resources are available for ongoing maintenance. Mineral exploration, geological mapping and academic study will continue to reveal new facts, and resource and production figures will require periodic revision. However, a compilation of nearly two thirds of all known deposits constitutes the majority of the effort necessary to make a useful global scale database, and it is hoped that this database becomes a useful framework on which to build. The relational nature of the database makes it easy to attach, classify, record and reference many types of ages, ore mineralogy, or stratigraphic and structural details for a given deposit, for example.

The first version of this database appeared on Natural Resources Canada's Geoscience Data Repository web portal: World and Canadian Minerals Deposits in 2007, and was updated in 2008. Geospatial excerpts from the database were made downloadable, and both these files and Fe oxide-Cu-Au points when added to the map portal window were hot-linked to full database reports on an NRCan server. The only access NRCan is now planning to provide for World and Canadian deposit databases is through Web Map Services (WMS). The WMS have been used by external web map portals which display points with no attribute data as components of geospatial "mashups". The aim of this Open File is to make the full database and its supporting database management utilities available, and to provide simple attributed derivative ESRI® Shape and Google Earth™ files, as well as folders of deposit and deposit group reports accompanied by index.html files that serve as Tables of Contents.

The database schema (Chorlton et al, 2007) used for this database was developed for the WMGDP, and used to bring pre-existing but diversely structured mineral deposit and occurrence databases into a uniform structure for which the same database management tools could be used. The web-style **Documentation** folder, modified from Laramée (2004), contains a thorough description of the WMGDP schema and supporting data management interfaces in the folder **GlobalDBSystem321**, and can be read using an Internet browser by clicking on the file **default.htm**. During the

WMGDP, compilers (deposit specialists) and company sponsors suggested topics to be included in the schema. They also provided helpful feedback for the functionality of the data management interfaces. This resulted in incremental updates between releases to company sponsors. World and Canadian lode gold databases (Gosselin and Dubé, 2005a, b) were released in schema 3.19, the version used for the final release 3.6 to company sponsors in 2004. The schema, now at version 3.21, release 3.7, is a major update of version 3.19, with the addition of extra tables required for compilations under the Northern Resource Development and Northern Mineral Resource Development programs.

The GlobalDB System schema (diagram page 7) includes sets of tables that can be used to describe six entities (things): **deposits/occurrences**, **deposit groups**, **mines**, **production figures**, **resource figures**, and **references**. The deposits and deposit groups modules describe locations, deposit type and subtype, names, country and province, commodities, geological ages, host rocks, related igneous rocks, mineralization styles, coincident features, radiometric dates, tectonic settings, shape and dimensions, NTS areas, qualified comments, links to other databases, geophysical /geochemical signature, sample data, and compilation stage and progress. The service tables: entities, tabledoc, links, columndoc, tabpages, and lookup explicitly define the entities, tables, links between tables, fields, interface tab pages, and lookup tables, to completely define the schema. Two additional service tables: dbversion and unitcvsn, provide the title, version and authors of the current database, and conversion factors (to metric) for the production and resource figures, respectively. The service tables, described above, should be consulted before transferring this data across database management programs and platforms, or rebuilding the data management applications when the application interfaces supplied with this Open File can no longer be used because of changes to the Windows® operating system.

Standalone custom Windows® application interfaces, developed by Robert M. Laramée[3], enable a user with a 32 bit computer equipped with the Windows operating system to browse, filter, and obtain output from this database. These interfaces are included in this Open File in the folder **GlobalDBSystem321**. All applications require an ADO connection file, or Microsoft® data link, to each database for which they are to be used, and should for convenience be created in the folder that houses the application interfaces[4]. The GlobalDBSystem321 folder and files can be saved anywhere and no installation is required. Instructions for creating the mandatory Microsoft data link file are included under "**Defining database aliases**" in the **Documentation\default.htm** and in the standalone file **HowtoADO.rtf**.

GShellBrowser allows a user to browse the database record by record, and offers the same tab page view of the data offered by the original data entry interface, GShellADO, known in short form as **GShell**. The latter only works under the Windows® XP and earlier Windows operating systems, and has been included in this package for users who still have a Windows XP computer (disconnected from the Internet because Microsoft no longer supports it by supplying Security updates), or have an XP emulator installed. GQueryADO, known as **GQuery** for short, provides a user the means to filter the occurrences based on attribute values, to build a template for a custom spreadsheet and export this spreadsheet or a default summary spreadsheet, and to create folders of occurrence reports for the full set or subsets of the deposits in the database. Both GShellBrowser and GQuery work under Windows 7 on a 32 bit computer once the pre-requisite ADO connection file has been created.

There are three additional programs in GlobalDBSystem321: **GQ_ADO_XtraTables**, **Documenter**, and **GBDSTools**. The program GQ_ADO_XtraTables builds or rebuilds summary tables for the use of GQuery, which improved performance over an older method of creating these summary tables on the fly. The program Documenter allows users to examine each table and field of each category of table (Data, Junction, Lookup, and Service depending on their roles), which complements the more general web page style documentation. Finally, GDBSTools provides a database manager with utilities that can check the internal integrity of the database, time stamp a new release and export SQL data scripts of the contents of the connected database. These SQL scripts can be used to populate a new database created with GlobalDBSchema321.sql in one of many SQL-enabled relational database management systems available today[5].

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FOOTNOTES

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[2]DISCLAIMER – RESOURCE/RESERVES DATA

Her Majesty the Queen in Right of Canada, represented by the Minister of Natural Resources (NRCan), does not warrant or guarantee the accuracy, completeness or fitness for any purpose of Reserve and Resource information (Data) contained in this database, including whether the Data is compliant with any securities regulations or standards, and NRCan does not assume any liability with respect to any damage or loss incurred as a result of the use made of the Data.

Resource and reserve figures are historical in nature. The Data source provided with each set of figures should be cited if the Data are re-reported.

[3] DISCLAIMER – APPLICATIONS AND DATABASE

The Geological Survey of Canada (GSC) has endeavored to develop and produce this product with a minimum of errors. GSC does not, however, warrant that the product is error free nor will GSC or its Minister and officials accept liability for any loss of profits or revenue, or any other form of loss or damage relating to the use of this product.

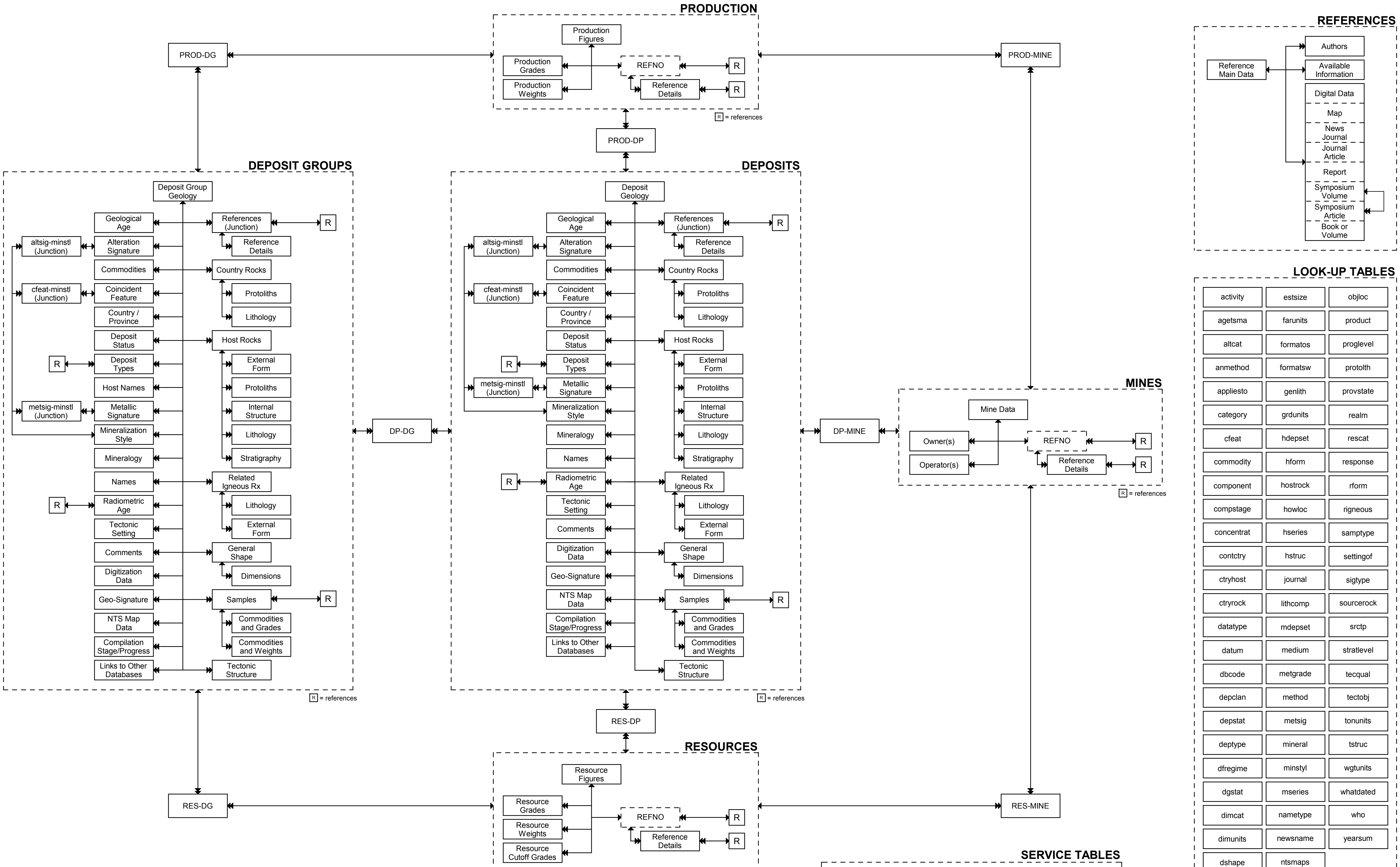
[4] CAUTION: UTILITIES MAY NOT WORK ON SOME WINDOWS COMPUTERS

While the WMGDP and successive projects have been successfully using Global DBSystem since the year 2000, there are now imitations due to the evolution of the Windows operating system and the introduction of 64 bit computers. In order to use GShellBrowser.exe, GQueryADO.exe, GQ_ADO_XtraTables.exe, Documenter.exe, and GDBSTools.exe, you must first create a data link file to allow connection between the program and the database (see “Defining database aliases” under Documentation). It is known that these instructions will not work on Windows 64 bit computers, and the interfaces will not work on computers with operating systems other than Windows®. At present, the data entry and browsing program GShellADO (GShell) will not work under Windows Operating Systems greater than XP, but is included here for anyone who might have an older operating system on a computer disconnected from the Internet or who has an XP emulator.

5 LOADING A WMGDP DATABASE USING SQL SCRIPTS

SQL scripts are provided here for anyone with an SQL-enabled database management system (DBMS) and the technical skill to modify the scripts according to the requirements of their software. We have loaded the data onto InterBase and PostgreSQL for the use of applications that emulate GQuery for the Internet and the contents of folders for loading the schema reflect our own processes. There are subtle differences in the scripts for loading the database schema among DBMSs, and some tweaks applied to the schemas supplied in this publication were specific to the Query applications. The scripts for inserting the data into the empty database schema are standard, and only one insert script is supplied per database.

A note of caution: it would be tempting to try to import the SQL contents of all of the mineral deposit databases in this Open File series (e.g. 7686, 7688, 7708, 7764, 7773, 7775 and so on) into one big database. This will not work because the entities of each separate database are indexed independently from each other, and were compiled on disconnected computers by compilers in many different places. In addition, the metadata file dbversion records different compilers and titles for each database. Thus, without substantial and careful re-indexing primary keys will clash between the different databases.



GlobalDB System Database Schema
Upgrade Level 21 -- 2005/03/02
by Robert M. Laramée, G.S.C.