Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7776

World Volcanogenic Massive Sulphide (VMS) Deposit Database

J.M. Franklin, H.L. Gibson, I.R. Jonasson, and A.G. Galley

2015

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7776

World Volcanogenic Massive Sulphide (VMS) Deposit Database

J.M. Franklin[1], H.L. Gibson[2], I.R. Jonasson[3], and A.G. Galley[4]

[1] Franklin Geosciences, 24 Commanche Dr., Ottawa, Ontario, Canada
[2] Mineral Exploration Research Centre, Department of Earth Sciences, Laurentian University, Sudbury, Ontario, Canada
[3] Geological Survey of Canada (Ottawa), 601 Booth Street, Ottawa, Ontario, Canada
[4] Canadian Mining Innovation Council (CMIC), 1770 Courtwood Crescent, Suite 202, Ottawa, Ontario, Canada

2015

doi:10.4095/296569

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation

Franklin, J.M., Gibson, H.L., Jonasson, I.R., and Galley, A.G., 2015. World volcanogenic massive sulphide (VMS) deposit database; Geological Survey of Canada, Open File 7776, 1 .zip file. doi:10.4095/296569

WORLD VOLCANOGENIC MASSIVE SULPHIDE (VMS) DEPOSIT DATABASE

J.M. Franklin, H.L. Gibson, I.R. Jonasson, and A.G. Galley

FOREWORD: About this database by L.B. Chorlton

Volcanogenic massive sulphide (VMS) deposits are important sources of the base metals copper, zinc, and to a lesser extent lead, and many contain economic quantities of silver and gold. They are broadly defined as strata-bound accumulations of sulphide minerals that precipitated at or the sea floor in spatial and genetic association with contemporaneous volcanism (Franklin et al., 2005a). They may be hosted in either volcanic or sedimentary strata that form integral parts of the volcanic complex. The main orebodies commonly occur as mound-like to concordant tabular masses of sulphide minerals dominated by pyrite (Franklin, 1996). Less economically important zones of irregular veins, stockwork, and disseminated replacement ore proximal to the massive orebodies are called stringer zones.

VMS deposits have been well studied over the last four decades, and though there are inevitably differences of opinion, they are well understood relative to other deposit types (Franklin et al., 2005a). Reviews and summary articles, such as Franklin et al. (1981), Lydon (1984, 1988), Franklin (1996), Barrie and Hannington (1999), Galley et al. (2007), as well as Franklin et al. (2005a), complement this database and should be referred for more in-depth geoscientific context.

The compilation of this version of the VMS deposit database took place between 2004 and 2005 to support a review of volcanogenic massive sulphides: their classification, hydrothermal systems, key characteristics, and geodynamic controls Franklin at al., 2005a, b). Classifications were applied based on the general lithostratigraphic compositions of regional host sequences, elaborating on an approach based on deposit host rock types (Barrie and Hannington, 1999). Franklin et al. (2005a) broadened the definition of host sequences to mean the full lithostratigraphic packages between major regional breaks or discontinuities to more accurately reflect the depositional and geotectonic settings of the mineralization. The resulting five classes (subtypes in this database) are: 1-Bimodal mafic; 2-Mafic; 3-Pelitic mafic; 4-Bimodal felsic; and 5-Siliciclastic felsic. For deposits where extra details such as back arc settings or presence of ophiolite or iron formation were known, extra modifiers, or even additional secondary deposit types, were added. Approximate ages and metal contents were entered so the database could be analyzed for age distributions and mean metal contents by class.

Deposit locations and ages were extracted from Jenkins and Lydon (2002), Seltmann et al. (2003), compilations by Government of Canada scientists (e.g. Picklyk et al., 1978; Jakubek et al.,1989), and other fairly old sources (e.g. UNESCO, 1972; Singer, 1990). At the time the older sources for this database were compiled, it was difficult to obtain exact locations for every deposit or to establish what mineralization zone or piece of infrastructure a location refers to. It was common for geographic coordinates to be rounded to the nearest minute, and the coordinates from Franklin et al. (2005b) were rounded to two decimal places. Locations are therefore approximate.

It must also be emphasized that resource figures in this database are not current, and do not comply with current standards for resource reporting [1]. Geological resources approximating what was represented at one time as the total tonnage and average metallic grade for each deposit were entered for the sole purpose of calculating mean metal contents (Franklin et al., 2005a, Table 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.

These databases are never complete nor are they 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.

The first version of this database appeared in 2008 on Natural Resources Canada's Geoscience Data Repository web portal: World and Canadian Mineral Deposits. Geospatial excerpts from the database were made downloadable, and both these files and VMS points when added to the map portal window were hot-linked to full database reports on an NRCan server. This web access has since been removed because of the new rules of the Treasury Board of Canada Secretariat. The only access NRCan is now planning to provide for World and Canadian deposit databases is through Web Map Services (WMS). WMS, provided by the original portal but since removed, have been used by external web map portals which display raster 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 reports accompanied by an index.html file that serve as a Table of Contents.

The database schema (Chorlton et al, 2007) used for this database was developed for the World Minerals Geoscience Database Project (WMGDP: 1998-2004)[2], and used to bring pre-existing but diversely structured mineral deposit and occurrence databases into a uniform structure to take advantage the same database management tools. The web-style **Documentation** folder, modified from Laramée (2004), contains a thorough description of the WMGDP schema as well as the supporting data management interfaces found within the folder **GlobalDBSystem321**. It can be read using an Internet browser by clicking on the file **Documentation\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 (last page of this document) 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].

FOOTNOTES

[1]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.

[2]ACKNOWLEDGEMENTS

The World Minerals Geoscience Database Project (WMGDP) was carried out by the former Mineral Resources Division, Geological Survey of Canada (now Ore Systems, Central Canada Division, Geological Survey of Canada), with the support of the following industry sponsors: Anglo American plc, Barrick Gold Corporation, BHP Billiton Group, Cyprus Amax Minerals Company, Inco Ltd., Metal Mining Agency of Japan, North Ltd., Phelps Dodge Exploration Corporation, Placer Dome Exploration Inc., Randgold Resources Ltd., Rio Tinto Mining and Exploration Limited, Teck Cominco Limited and Western Mining Corporation. W. D. Sinclair managed this project on behalf of the Geological Survey of Canada, L. B. Chorlton coordinated schema, tool development, and compilation, and R. M. Laramée implemented the schema, developed the applications for GlobalDBSystem, and provided technical support to compilers.

Although volcanogenic massive sulphide deposits were not one of the deposit types prioritized by project sponsors, this database was imported into the WMGDB schema after the project from Franklin et al. (2005b) to round out the database collection. Franklin et al. (op.cit) acknowledge contributions from Seltmann et al., 2003 (Centre for Russian and Central Asian Mineral Studies (CERCAMS)) for the Ural and Altaid district, various International Geoscience Correlation Program (IGCP) projects, and Jenkins and Lydon (2002), as well as older compilations by the U.S. Geological Survey (e.g. Singer, 1990), the Geological Survey of Canada (e.g. Picklyk et al., 1978; Jakubek et al., 1989), and UNESCO (1972), as sources for locational data. All of the size and grade data came from publicly available literature sources. Elizabeth Hillary created the original data source table.

[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.

REFERENCES

Barrie, C.T., and Hannington, M.D., 1999. Classification of volcanic-associated massive sulfide deposits based on source composition; Reviews in Economic Geology, v.8, p. 1–11.

Chorlton, L.B., Laramée, R.M., Sinclair, W.D., and Hillary, E.M., 2007. Digital inventory of bedrock and mineral deposit geology; *in* Proceedings for a workshop on deposit modeling, mineral resource assessment, and their role in sustainable development; (ed.) Briskey, J.A. and Schulz, K.J., Proceedings of a workshop that followed the 31st International Geological Congress, Rio de Janeiro, Brazil, August 18–19, 2000, USGS Circular 1294, p. 101– 113.

Franklin, J.M., 1996. 6.3. Volcanic-associated massive sulphide base metals; *in* Geology of Canadian mineral deposit types; (ed.) Eckstrand, O.R., Sinclair, W.D., and Thorpe, R.I.; Geological Survey of Canada, Geology of Canada No. 8, p. 158–183.

Franklin, J.M., Gibson, H.L., Jonasson, I.R., and Galley, A.G., 2005a. Volcanogenic massive sulfide deposits; *in* Economic Geology 100th Anniversary Volume 1905 –2005; (ed.) Hedenquist, J.W., Thompson, J.F.H., Goldfarb, R.J., and Richards, J.P., Society of Economic Geologists, p. 523–560.

Franklin, J.M., Gibson, H.L., Jonasson, I.R., and Galley, A.G., 2005b. Supplement to volcanogenic massive sulfide deposits; *in* Economic Geology 100th Anniversary Volume 1905 –2005; (ed.) Hedenquist, J.W., Thompson, J.F.H., Goldfarb, R.J., and Richards, J.P., Society of Economic Geologists, Appendix Table A1.

Franklin, J.M., Sangster, D.F., and Lydon, J.W., 1981. Volcanic-associated massive sulfide deposits; *in* Economic Geology 75th Anniversary Volume 1905–1980 ; (ed.) Skinner, B.J., Society of Economic Geologists, p. 485–627.

Galley, A.G., Hannington, M.D., and Jonasson, I.R., 2007. Volcanogenic massive sulphide deposits; *in* Mineral deposits of Canada: a synthesis of major deposit types, district metallogeny, the evolution of geological provinces, and exploration methods; (ed.) Goodfellow, W.D., Geological Association of Canada, Mineral Deposits Division, Special Publication No. 5, p. 141–161.

Gosselin, P., and Dubé, B., 2005a. Gold deposits of the world: distribution, geological parameters and gold content; Geological Survey of Canada, Open File 4895, 271 p., 1 CD-ROM, doi:10.4095/220379.

Gosselin, P., and Dubé, B., 2005b. Gold deposits of Canada: distribution, geological parameters, and gold content; Geological Survey of Canada, Open File 4896, 105 p., 1 CD-ROM, doi:10.4095/220380.

Jakubek, S.S., Lepinis, Y.J., MacRobbie, D.C., and Sozanski, A.G., 1989. Canadian deposits not being mined in 1989; Energy Mines and Resources, Mineral Resource Bulletin MR 223, 400 p.

Jenkins, C. L., and Lydon, J. D. (Compilers), 2002, A mineral deposit data base structure and a data base of VMS and Sedex deposits, Geological Survey of Canada Open File 4165, 1 CD-ROM, doi:10.4095/213270.

Laramée, R.M., 2004. Global DB System, Release 3.6, World Minerals Geoscience Database Project; Geological Survey of Canada, archived sponsors' web site.

Lydon, J.W., 1984. Ore deposit models: Volcanogenic massive sulfide deposits. Part 1: a descriptive model; Geoscience Canada, v.11, p.195–202.

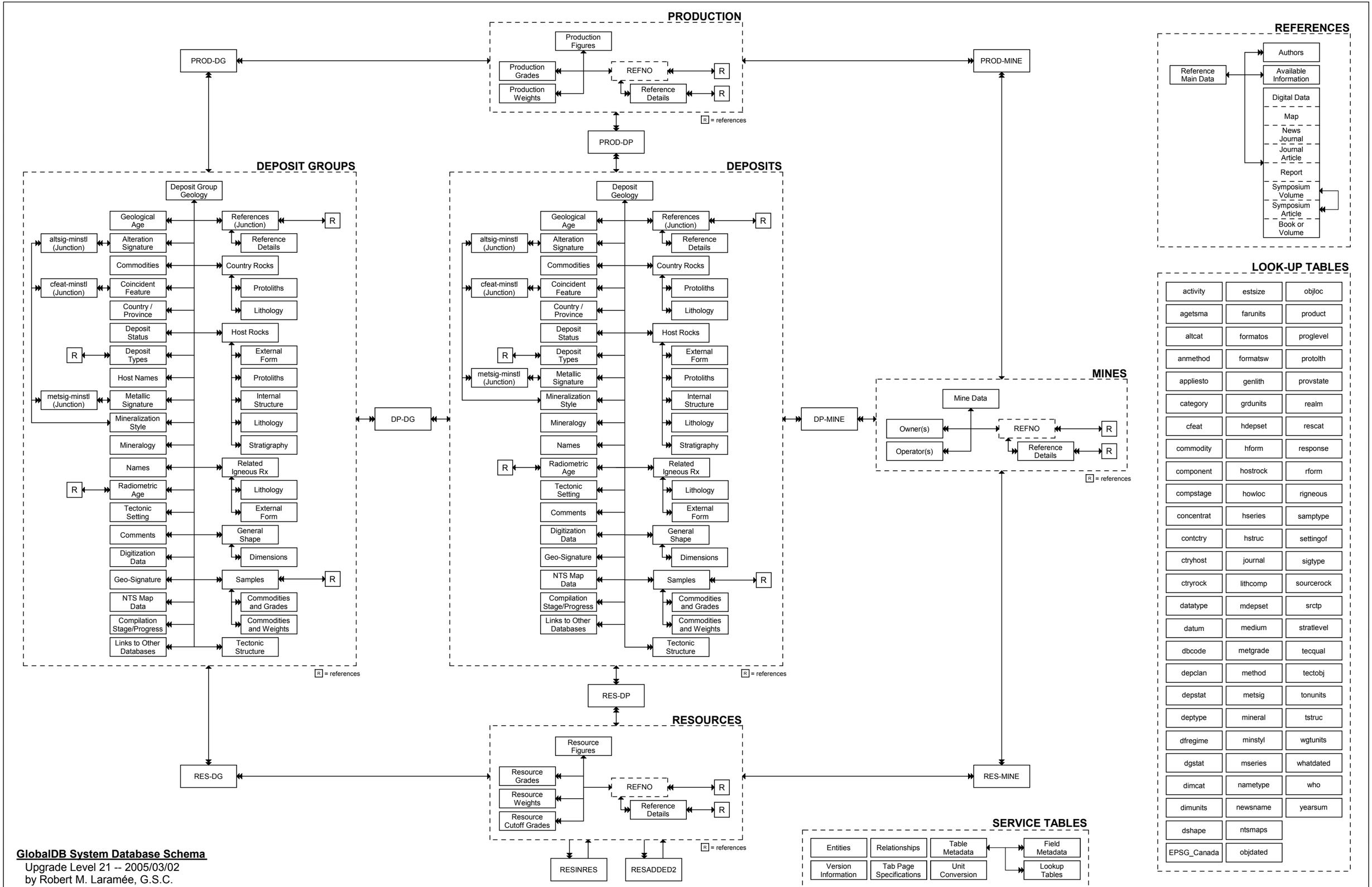
Lydon, J.W., 1988. Ore deposit models: Volcanogenic massive sulfide deposits. Part 2: Genetic models; Geoscience Canada, v.15, p.43–65.

Picklyk, D.D., Rose, D.G., and Laramée, R.M., 1978. Canadian Mineral Occurrence Index (CANMINDEX) of the Geological Survey of Canada; Geological Survey of Canada, Paper 78-8, 28 p.

Seltmann, R., Shatov, V., and Yakubchuk, A., 2003. Mineral deposits database and thematic maps of Central Asia; London, Center for Russian and Central Asian Mineral Studies (CERCAMS), Depoartment of Mineralogy, Natural History Museum (NHM), scale 1:5,000,000, ArcView™ 3.2 and MapInfo 6.0 (7.0) GIS packages.

Singer, D.A., 1990. Development of grade and tonnage models for different deposit types [abs.]; IAGOD Symposium in conjunction with International Conference on Mineral Deposit Modeling, 8th Program with Abstracts, p.A99–A100.

UNESCO, 1972. Metallogenic map of Europe and neighboring countries; Commission for the Geological Map of the World, sheets 1-9, scale 1:250,000,000.



GlobalDB System Database Schema

Upgrade Level 21 -- 2005/03/02

by Robert M. Laramée, G.S.C.