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An Index to PGE-Ni-Cr Deposits and Occurrences in Selected Mineral-Occurrence Databases

By J. Douglas Causey, John P. Galloway, and Michael L. Zientek

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Introduction

Databases of mineral deposits and occurrences are essential to conducting assessments of undiscovered mineral resources (Singer, 1993). In the USGS's (U.S. Geological Survey) global assessment of undiscovered resources of copper, potash, and the platinum-group elements (PGE), only a few mineral deposit types will be evaluated. For example, only porphyry-copper and sediment-hosted copper deposits will be considered for the copper assessment. To support the global assessment, the USGS prepared comprehensive compilations of the occurrences of these two deposit types in order to develop grade and tonnage models and delineate permissive areas for undiscovered deposits of those types (Singer and others, 2002; Singer and others, 2005; Singer and others, 2008; and Cox and others, 2003).

This publication identifies previously published databases and database records that describe PGE, nickel, and chromium deposits and occurrences. Nickel and chromium were included in this overview because of the close association of PGE with nickel and chromium mineralization. Users of this database will need to refer to the original databases for detailed information about the deposits and occurrences. This information will be used to develop a current and comprehensive global database of PGE deposits and occurrences.

Acknowledgments

Several people provided assistance in preparing this report. Ken Assmus scanned and used optical-character recognition software to create digital versions of reports only available in hard copy. David Sinclair and Lesley Chorlton graciously provided us copies of the PGE-Ni-Cr database developed for the Geological Survey of Canada World Minerals Geoscience Database Project (1998-2003). Mark Mihalasky helped us understand how to create KML files. Warren J. Nokleberg and Robert J. Miller provided digital files they derived from the Aerogeologica metallogenic map of the former Soviet Union. Technical reviews of this report were provided by Lorre Moyer and Dan Mosier.

Data Sources

We compiled mineral databases for large regions of the globe and extracted site data containing PGE elements, nickel, or chromium from 55 published databases and 1 unpublished USGS database from 46 publications cited in the bibliography and referenced in our database.

The data were stored in a variety of formats, including Oracle, ESRI ArcInfo coverage and shapefile, dBASE, Access, FileMaker, and Excel. Data were imported into an Access 2000 database and selected information compiled in a new table.

This compilation includes fields for: the name of the deposit or occurrence; information about its location; the commodities present; the type of record; a reference to the database; and the record number in the published database. In some cases, no pertinent information was available for one or more of these fields. Fifteen records did not have latitude and longitude, and 946 did not have a name.

The information is stored in two tables in the database—one table contains the name, location, commodities, record number, and record type (Ni_Cr_PGE); the other table contains the references (References). Table 1 summarizes the fields and their definitions in the Ni_Cr_PGE table, and table 2 summarizes the fields in the associated References table.

Table 1. Database fields and definitions for Ni_Cr_PGE table.

Field name	Data type	Field size	Field definition
Site_ID	Number	Long Integer	Unique number for each record
Name	Text	150	Name of the site as reported in the source database
WGS84_Lat	Number	Double	Latitude (in decimal degrees), WGS 84 datum
WGS84_Lon	Number	Double	Longitude (in decimal degrees), WGS 84 datum
Commod_gp	Text	125	List of commodities, in order presented in source database
Src_Rec_No	Text	50	Unique record number used in source database
Record_tp	Text	100	Description of what the record represents
Country	Text	50	Country where site is located
State	Text	50	State or province where site is located
Ref_no	Number	Long Integer	Number of reference in Reference table

Table 2. Database fields and definitions for References table.

Field name	Data type	Field size	Field definition
Ref_no	Number	Long Integer	Unique number for each record
Reference	Memo	NA	Reference in U.S. Geological Survey bibliographic style
Ref_st_frm	Text	255	Reference short form—Author, date abbreviated reference

We normalized commodity information in the databases in order to extract the records of sites that contain PGE, nickel, or chromium. This involved converting the names of each elemental commodity to a standardized form of their chemical symbol (for example, CHROMIUM, chromium, or CR were converted to Cr), and the list of commodities was then concatenated into a comma-separated string. The original commodity order was not changed. If there was some indication that a commodity

or commodities were of secondary importance, they were set off with a semicolon. Otherwise, the meaning of the commodity order is unknown.

We did not attempt to eliminate duplicate records for a deposit or occurrence nor attempt to reconcile discrepancies in names or locations. However, we did correct the latitude and longitude values that were reversed in three of the databases (latitude values in longitude field and longitude values in latitude field). Most of the databases identified the country. However, for about 1,700 records that did not specify a country, a name was obtained using ArcGIS and a global country-boundary GIS database.

Values in the field describing the type of record (Record_tp) were from the original datasets, and may be in languages other than English. We corrected some minor typographical errors.

From 56 databases, we extracted 17,969 records for this database. Users are encouraged to refer to the original published databases for detailed information about each record.

Data Format and Presentation

The result of the compilation is presented in five formats: a Microsoft Access 2000 database, an ESRI format shapefile, an Arc Reader file, a delimited ASCII text file, and a Google Earth format KML file.

The Access database can be used by Access version 2000 and above, as well as by other software that reads Access 2000 database format. The database only contains two tables—a table of basic information about each site record and a table of references.

The shapefile (ESRI format) is made from the Ni_Cr_PGE table. For those databases that did not specify the datum of the latitude and longitude, the WGS 84 datum is assumed. For those whose datum is specified and it is not WGS 84, the locations are converted to WGS 84 using the ArcGIS v. 9.2 projection tool. The GDA 94 datum uses the WGS 84 ellipsoid, and the NAD 83 datum has essentially the same latitude/longitude, so those values were not modified either. Data in the Feature Attribute table can be joined to the References table in the Access database using the Ref_no field. This table was not converted to DBF format because the field with the complete reference is a memo field and data would be truncated.

The Arc Reader file (Ni_Cr_PGE_Index Report.pmf) provides a view of the data in a GIS-like view and the individual points can be queried. The view is the same as shown in figure 1. The file can be read by Arc Reader, a free program that runs on several operating systems. The program and system requirements can be found at http://www.esri.com/software/arcgis/arcreader/download.html.

There are two ASCII text files, one containing the information from the Access Ni_Cr_PGE table and one created from the Reference table. These files were exported from the Access database using the pipe (|) symbol as a field delimiter. The first line contains the field names.

A KML file was generated from ArcMap v. 9.3 using the Export to KML toolbar. All fields in the Access Ni_Cr_PGE table are included in the KML. This file can be used by Google Earth to show locations of the sites on the Earth's surface. No accuracy is implied. The sites may have been mis-located in the original database, and no corrections were done.

Discussion

The 17,969 records in 126 countries or territories are shown in fig. 1. The distribution, by country, is listed in table 3. The bulk of the sites are in the United States, followed by Canada, Australia, and Russia. This distribution is more a function of the database developers, who were located in the respective countries, than a real indication of the true distribution of deposits. Also, duplication of records is common, with some sites possibly being listed at least 5 times because many of the databases overlap in their area of coverage and some sites are repeated even within a single database. There was no attempt to remove duplicates, because this database is designed primarily as a pointer to other databases.

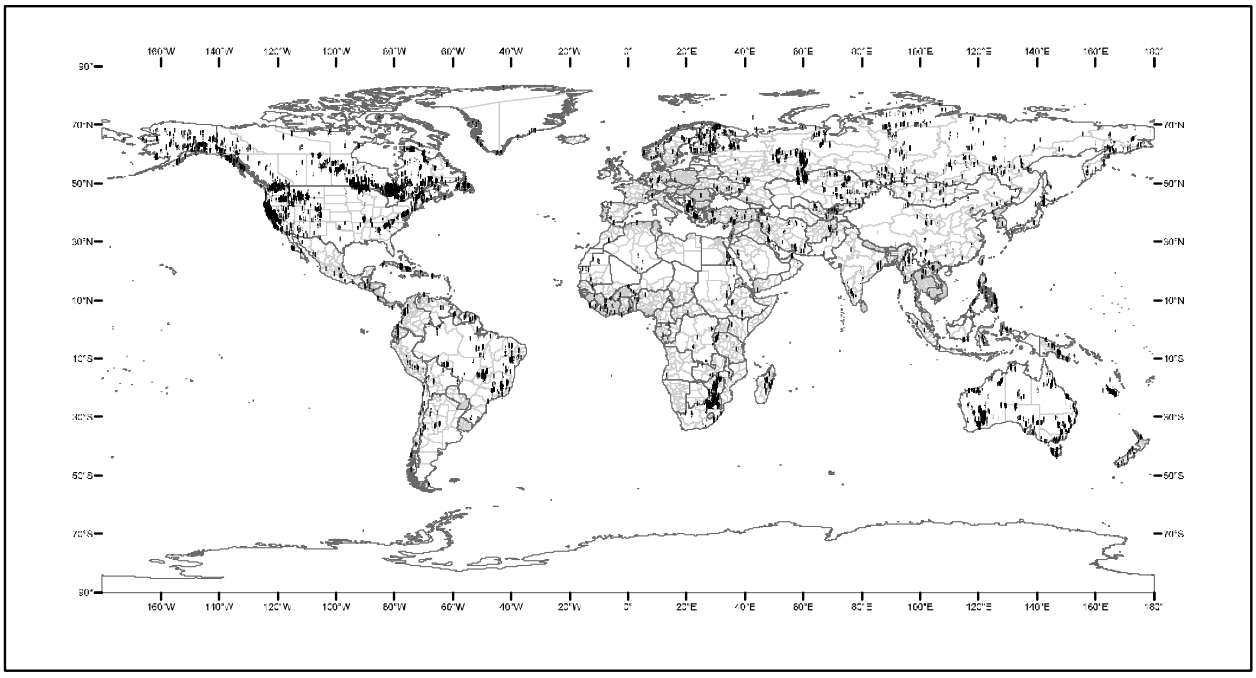

Figure 1. Location of sites (black dots) in Ni_Cr_PGE_Index.mdb.

Table 3. Distribution of records by country.

Country	Number of Records
Afghanistan	20
Albania	42
Algeria	16
Angola	3
Argentina	53
Armenia	8
Australia	2,091
Azerbaijan	1
Belgium	1
Benin	13
Bolivia	29
Bosnia and Herzegovina	2
Botswana	24
Brazil	549
Bulgaria	2
Burkina Faso	12
Burundi	19
Cambodia	2
Cameroon	2
Canada	3,634
Central African Republic	1
Chad	3
Chile	47
China	105
Colombia	43

Country	Number of Records
Costa Rica	11
Côte d'Ivoire	33
Cuba	205
Cyprus	4
Czech Republic	3
Democratic Republic of the Congo	16
Denmark	67
Dominican Republic	12
Ecuador	29
Egypt	31
Eritrea	2
Ethiopia	19
Finland	196
France	7
French Guiana	11
Gabon	1
Georgia	2
Germany	26
Ghana	8
Greece	29
Guatemala	28
Guinea	4
Guyana	7
Haiti	1
Honduras	2
Hungary	1

Country	Number of Records
India	138
Indonesia	53
Iran	54
Iraq	5
Italy	9
Jamaica	1
Japan	76
Kazakhstan	396
Kenya	9
Kyrgyzstan	12
Laos	12
Liberia	4
Macedonia	7
Madagascar	83
Malawi	2
Malaysia	7
Mali	1
Mauritania	25
Mexico	69
Mongolia	52
Morocco	18
Mozambique	3
Myanmar	49
Namibia	1
New Zealand	47
Niger	6

Country	Number of Records
Nigeria	1
North Korea	2
Norway	52
Oman	8
Pakistan	6
Panama	4
Papua New Guinea	74
Peru	31
Philippines	133
Poland	2
Portugal	1
Puerto Rico	2
Republic of the Congo	3
Romania	2
Russia	1,604
Saudi Arabia	9
Senegal	1
Serbia	32
Sierra Leone	17
Slovenia	1
Solomon Islands	2
Somalia	3
South Africa	493
South Korea	5
Spain	25
Sudan	19

Country	Number of Records
Suriname	11
Swaziland	4
Sweden	39
Syria	1
Taiwan	3
Tajikistan	2
Tanzania	18
Territory of New Caledonia and Dependencies	101
Thailand	10
Togo	5
Turkey	75
Uganda	5
Ukraine	80
United Arab Emirates	9
United Kingdom	7
United States	6,248
Uzbekistan	27
Venezuela	15
Vietnam	13
West Bank	2
Yemen	3
Zambia	7
Zimbabwe	136
Total Records	17,969

Some observations or interpretations may be possible from the limited information in this database. However, the user should consider some important points in any interpretation based only on the data in this database. The order in which commodities are listed in a database is not a reliable

indicator of their relative amount or importance (table 4). Also, the list of commodities may not be a true or complete listing of what is present at a site (tables 5, 6).

Table 4. Example of two records for a site in which the commodity order was switched in the data source.

Site_ID	Name	WGS84_Lat	WGS84_Lon	Commod_gp
206217	APEX	49.4108417	-93.6158	Ni, Cu
208262	APEX	49.410556	-93.6325	Cu, Ni

Table 5. Example of two records for a site that do not have an identical list of commodities. 5b. Example of five records for a site that demonstrate differences in name and commodity.

Site_ID	Name	WGS84_Lat	WGS84_Lon	Commod_gp
207311	Alotta	47.4500008	-79.2333298	Ni, Cu, PGE, Co
12081482	Alotta	47.4680233	-79.2542965	Cu, Ni; Co, Ag

Table 6. Example of five records for a site that demonstrate differences in name and commodity.

Site_ID	Name	WGS84_Lat	WGS84_Lon	Commod_gp
207771	Amandelbult	-24.7833	27.2833	PGE
180350	Amandelbult	-24.76667	27.33333	PGE; Pt, Ni, Cu
8574	Amandelbult	-24.774	27.335	Pt, Ni, Cu, Cr
12160189	Amandelbult Mine	-24.7817	27.28333	PGE, Ni, Cu
86539	Amandelbult-Northam	-24.8	27.25	PGE, Cr

While we recognize that there are caveats on applying any interpretation to specific records, it is still possible to extract some generalizations from this compilation. For example, because of limited information in many of the source databases, no information was extracted about the source rock. Given the caveats listed, we made some inferences based on the commodity suites. About 29 percent of the records (5,194) list chromium as the only commodity (fig. 2). We infer that most of these represent chromite or chromitite bodies hosted in magmatic, mafic/ultramafic intrusions. Another 1,623 records list nickel as the only commodity (fig. 3), and 905 have PGE, platinum, palladium, or some combination of these as the only commodity(ies) (fig. 4). These may also represent magmatic, mafic/ultramafic intrusions.

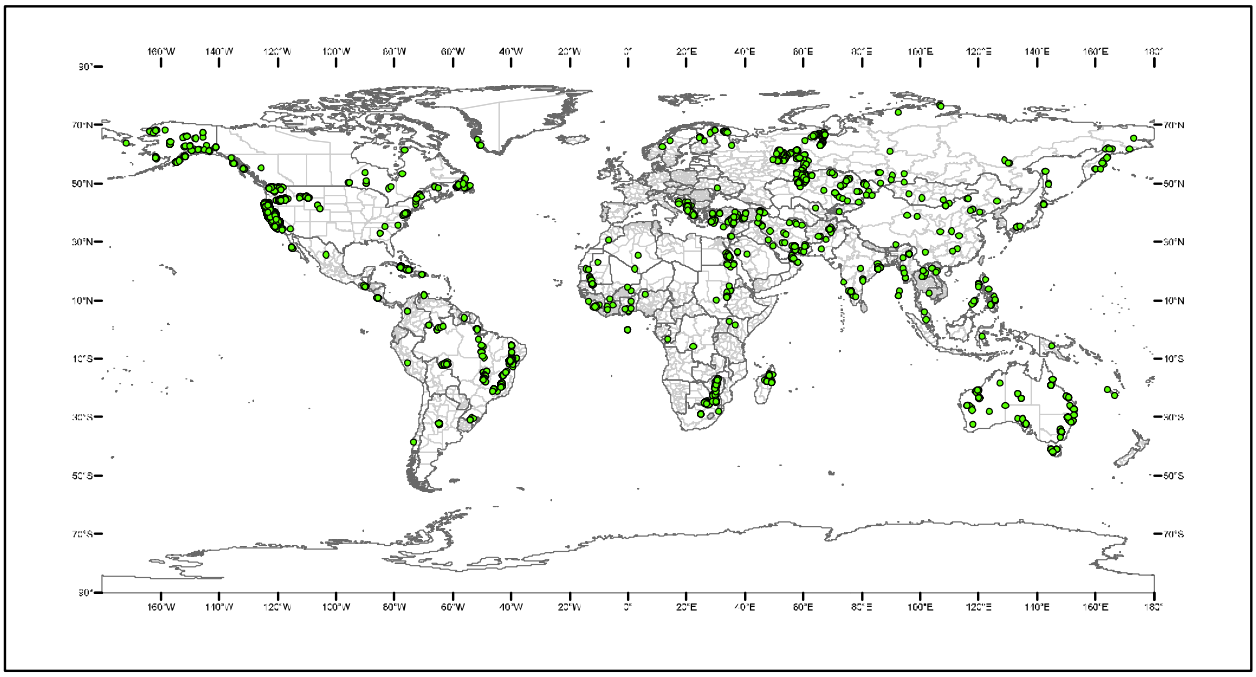

Figure 2. Locations of 5,194 site records (blue dots) that list only chromium as the commodity present.

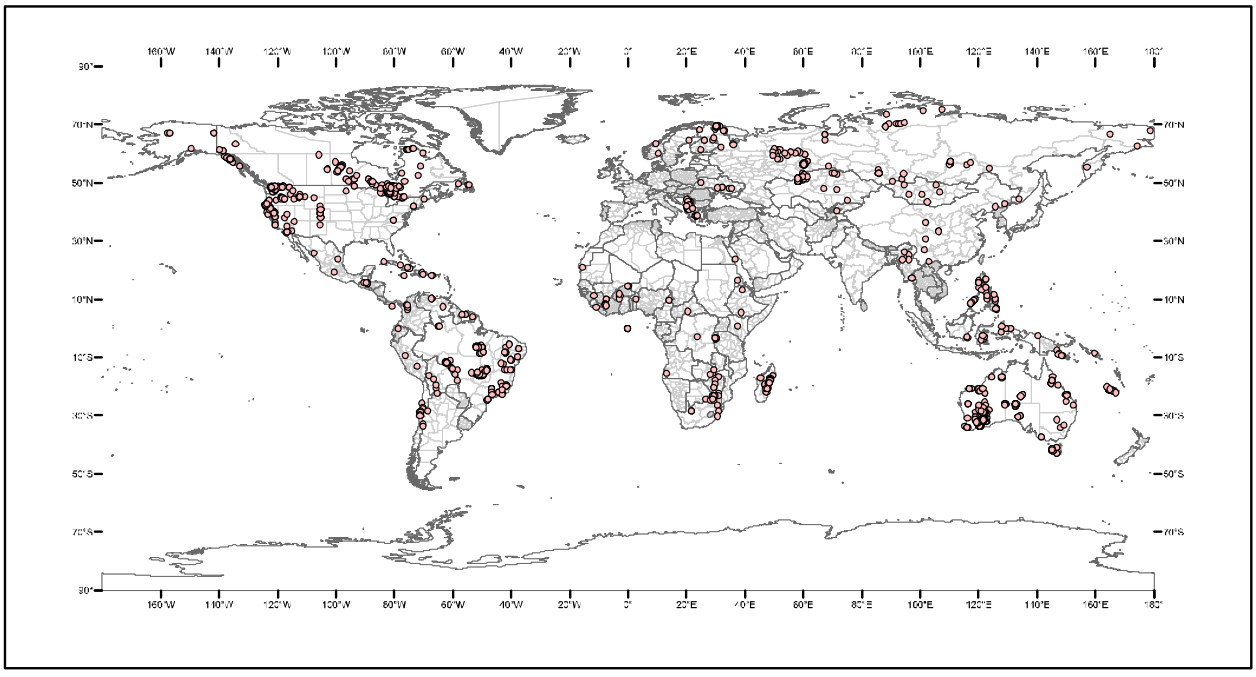

Figure 3. Locations of 1,623 site records (red dots) that list only nickel as the commodity present.

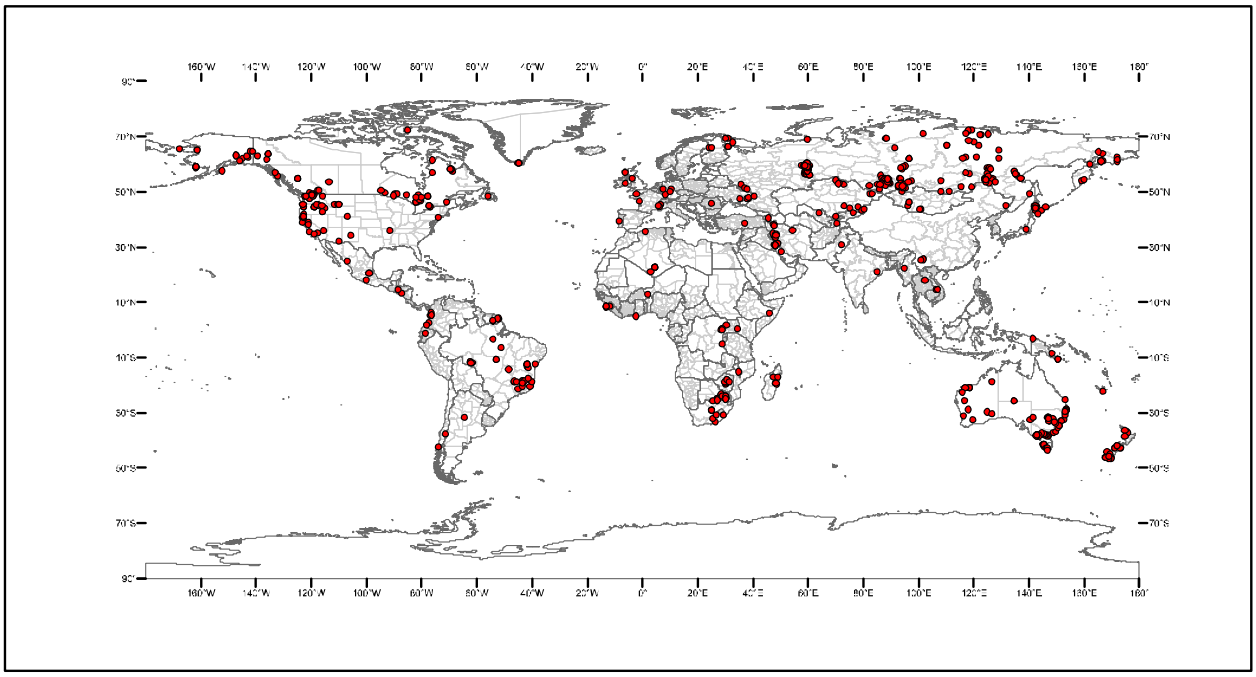

Figure 4. Locations of 905 site records (red dots) that list only contain only platinum, palladium, and/or PGE as the commodities present.

Examination of a few databases that do contain source-rock information indicates that these assumptions are generally true, but not always. For example some of the chromium-only records are for placer deposits. Records of sites that have nickel as the only commodity also include weathered products of mafic/ultramafic rocks—laterites.

Other possible interpretations from commodities or commodity assemblages are that gold + platinum indicates a placer deposit (513 records). Deposits containing silica, gemstone, phosphate, borate, limestone, feldspar, petroleum, barite, base metals, tungsten, or uranium probably do not have a magmatic, mafic/ultramafic host rock. A small percentage of the records are in this category.

In general, a record that contains Ni±Cr±PGE±Co(±Cu) most commonly indicates a magmatic, mafic- or ultramafic-intrusion source. A record that only lists gold + platinum may indicate a placer deposit, and a record that contains one or more nonmetallic commodities probably does not describe a magmatically hosted deposit.

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