ProMine pan-European Mineral Deposit database: a new dataset for assessing primary mineral resources in Europe

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Abstract

The ProMine Mineral Deposit database, that was collaboratively developed by 11 partners from 9 European countries within the framework of the ProMine project Work Package 1, is a new dataset that compiles homogeneous and thorough information on primary mineral resources in Europe. It contains 12,979 records, covering 34 European countries and described, using lexicon-guided fields, in terms of status, geographic position, deposit type, morphology, age, mineralogy, hydrothermal alteration, commodities, grades, former production, reserve and resource. As the main objective of the MD database is to help improving assessment of mineral resources in Europe, a first estimated endowment for 22 selected commodities, for class A (very large) to D (small) deposits, is presented. In addition, a homogeneous multi-layer information system covering the whole European territory and including mineral deposit, geological, structural and geophysical layers has been developed. This GIS is freely accessible through a dedicated web portal. It will allow, through the combination of data from the different thematic layers, and the study of their spatial relationships, to develop a predictive approach of EU mineral resources endowment.

Keywords: ProMine, Mineral resources, deposits, database, GIS, endowment, Europe

Introduction

ProMine is a European Union (EU) co-funded project, focused on theme 4 of the FP7, and more precisely on "Innovative concepts and processes for strategic mineral supply and for new high added value mineral-based products".The philosophy behind the project is to stimulate the extractive industry to deliver new products to manufacturing industry. The purpose of Work Packages (WP) 1 and 2 is to deliver interactive GIS tools to define new reserves of strategic minerals in the EU, that the extractive industries can quantify and exploit in the future, and which will be the source of raw materials for the manufacturing industries. The objective of WP1 is to develop a Pan-EU GIS data management and visualization system for natural and man-made mineral endowment and the realization of a Pan-EU predictive resource assessment. In order to reach this objective, WP1 produced a pan-European database of primary mineral resources (including new strategic and 'green' commodities such as Ga, Ge, In, Li, Nb, Ti, Ta, PGE and REE), the ProMine Mineral Deposit (MD) database. This database serves the development and feeding of a homogeneous multi-layer information system covering the whole European territory and including mineral deposit, geological, structural and geophysical layers (plus an anthropogenic concentrations layer that will be produced in 2012). The present

paper provides a brief overview of the ProMine MD database, its content, dissemination and forthcoming treatments for assessing mineral resources potential and predictability in Europe.

1. The ProMine MD Database

The MD database, developed with Microsoft Access, stores all the information related to mineral deposits in Europe. Each deposit is described through about 40 fields, distributed into 8 categories. Most fields that contain text values (*i.e.* non numerical) are lexicon guided, in order to improve efficiency of future data processing. Lexicons are either simple (simple list of values), dynamic (list to which new values can be added) or hierarchical (tree-like list with father/son relationships allowing to store information according to its level of accuracy). The 8 categories and main fields they contain are the following:

1 - General information :district[a], owner [b] (mining company), status[c,d], geographic coordinates[a] (WGS84), author [a] and date of creation [a], controller [a] and date of control [a], country[c,d], deposit name(s)[a,d], general comments[a], URL[a,d] and source[a,d] of deposit site, other database describing the site[a,d] and ID[a,d];
2 - Deposit information : Deposit type(s)[c,d], main morphology[d], secondary morphologies[c,d], azimuth [a], dip [a], length [a], width [a] and dow-dip extension [a] of orebody;
3 - Information on mineralization and host rocks : Stratigraphic age of mineralization [c] (upper and lower limit), absolute age of mineralization [a] with error [a], unit [e] and dating method [e], mineralogies of ore[a,c] and gangue[a,c], hydrothermal alteration(s)[a,c], stratigraphic age of host rock[c] (upper and lower limit), absolute age of host rock [a] with error [a], unit [e] and dating method [e], formation name(s)[a,d] and lithologies of host rock[c,d];
4 - Economic information : Exploitation type(s)[c,d], main commodity[e], and, per commodity [e] : ore type[c], former production [a] with average grade [a] and year(s) of production [a], reserve [a] with type [e], average grade [a], reference [b] and year of information [a], resource [a] with type [e], average grade [a], reference [b] and year of information [a];
5 - High-Tech Metals : Per commodity [e] characterization of high-tech metals hosts [a] (mineralogy, grade, abundance), link with the Anthropogenic Concentration (AC) database [b];
6 - Comments : General comments on geology [a] and economy [a];
7 - Iconography : Illustrations [a] (pictures, maps, diagrams, cross-sections, etc.);
8 - Bibliography : References for geological [b] and economic [b]informations.

([a]free text fields; [b]dynamic lexicon guided fields; [c] hierarchical lexicon guided fields; [d] multiple entry fields; [e] simple lexicon guided field)

2. Overview of the database content

Feeding of the ProMine MD database was done in 2010-2011 by the 11 partner institutes of the ProMineproject WP1, from 9 countries in Europe. The first version of the database, that was delivered on November 2011, contains 12,979 records (mines, deposits, occurrences or showings) and covers 34 European countries1 (Figure 1). The database will be maintained and updated up to the end of the ProMine project (spring 2013) and hopefully beyond.

[1]Albania, Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Montenegro, The Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Switzerland and United Kingdom

A main objective of the MD database is to help improvingassessment of mineral resources in Europe. Table 1 provides estimated endowment for 22 selected commodities, for class A to D deposits, extracted from the MD database. Because some fields, for some deposits in the database, may have been left blank for several reasons (*e.g.*, no information available, highly doubtful information or classified information which is not fit for publication) the present study does not pretend to be exhaustive. Figures given below should solely be considered as rough estimates or trends, and not as precise values. As economic information is not always available, and assuming that all encoding errors that could generate overestimations have been correctly eliminated, the calculated endowment figures provided herein are probably lower end estimations.

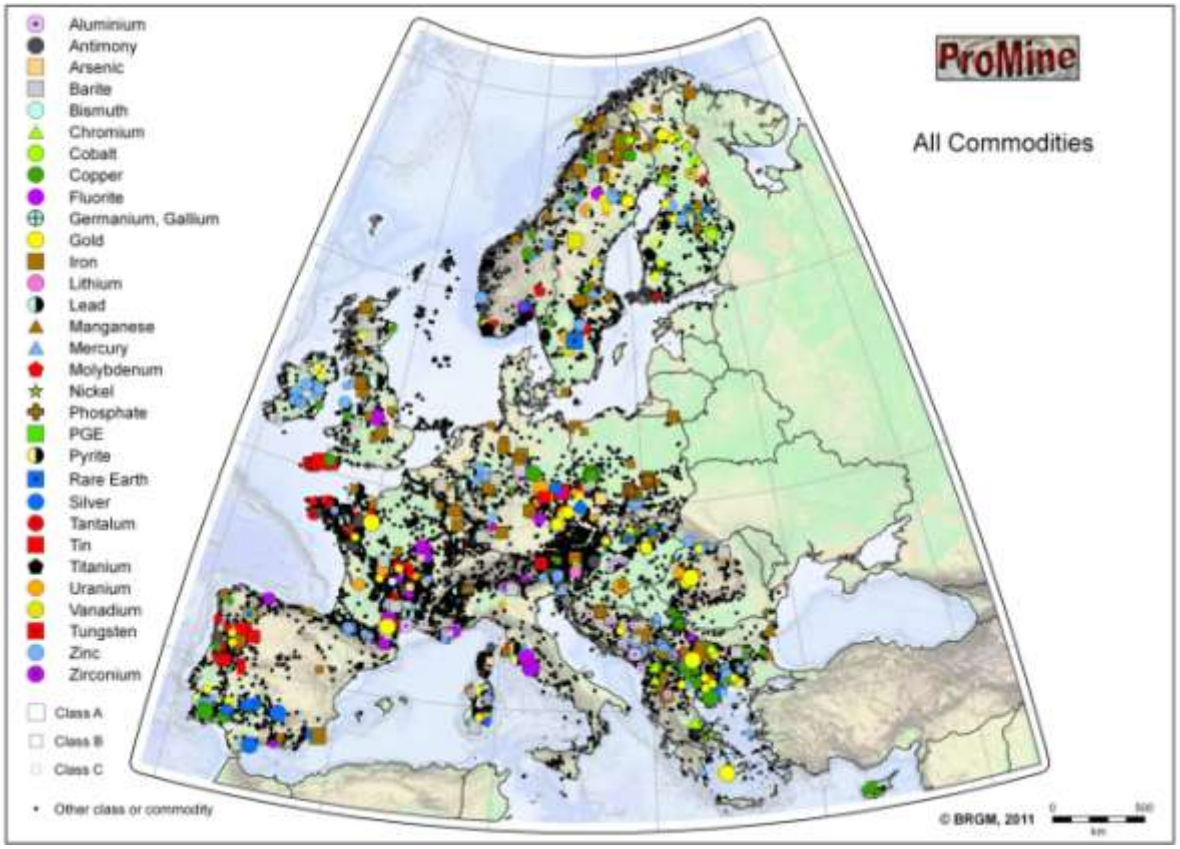

Figure 1 : Spatial distribution of records in the ProMine MD database.

3. Data dissemination and forthcoming processing

In order to display data and to allow access through the Internet, an interoperable architecture (compliant with ISO, OGC standards, and INSPIRE Directive) was developed, that was designed to include a Metadata Catalogue, MD (Mineral Deposit) and AC (Anthropogenic Concentration, under construction) PostGIS/Postgres databases, WMS (Web Map Service) and WFS (Web Feature Service, to be developed in 2012) for MD and AC data, Geology, Geophysics and Predictive (to be developed in 2012) map layers (Serrano *et al.*, 2010; Vuollo*et al.*, 2010). This architecture also includes a ProMine web portal. As a consequence, selected fields of the MD database are now accessible through its dedicated portal (http://ptrarc.gtk.fi/promine/default.html).

With an increasing awareness of the dependency of European countries on their mineral importations, the European Commission(2010, 2011) has produced a list of 14 raw materials that are critical at EU level (*i.e.* materials "which display a particularly high risk of supply shortage in the next 10 years and which are particularly important for the value chain"). This work on identifying critical raw materials also revealed the

need for better data and knowledge. A first outcome of the ProMine MD database was then to produce a map of these 14 critical materials and a preliminary assessment of their potential within the European Union.

Another outcome of the MD database, that will be available in 2012 on the ProMine web portal, is the implementation of "added-value" layers that include(1) maps of mineral potential over the whole European Union and (2) predictivity (or favourability) maps for selected commodities, using previously defined "commodities associations" (*i.e.*metallogenic types). Considering the size of the area to cover (the whole European Union), the large number of metallogenic types to consider and the complexity of the geological framework, such a huge task has never been completed before. It will be done at BRGM (French Geological Survey) according to a data processing procedure established collaboratively by all ProMine WP1 partners and using robust and well-tried methods, based on expert-guided data-driven approaches (*e.g.*, Billa *et al.*, 2004; Roy *et al.*, 2006; Cassard *et al.*, 2008), for maps calculation.

Commodity	Class A			Class B			Class C			Class D			∑ Tonnage (classes A to D)
	Lowerlimit of class (t)	No. of deposits	∑ Tonnage	Lowerlimit of class (t)	No. of deposits	∑ Tonnage	Lowerlimit of class (t)	No. of deposits	∑ Tonnage	Lowerlimit of class (t)	No. of deposits	∑ Tonnage	
Ag	10,000	5	185,444	2,500	17	72,934	500	44	42,103	100	94	21,581	322,062
Au	500	1	700.2	100	17	2,826.2	10	86	2,563.7	1	164	628.8	6,718.9
Pltd	1,000			100	1	523.6	10			1	2	5.7	529.3
Al	1E+09			1E+08	2	2.94E+08	1E+07	13	5.45E+08	1E+06	18	81,156,000	9.2E+08
Cu	1E+07	3	55,826,080	1E+06	26	65,278,601	100,000	68	21,181,016	10,000	219	7,591,200	1.5E+08
Pb	5E+06	1	8,190,000	500,000	32	45,165,357	50,000	155	25,626,393	5,000	189	3,709,888	82,691,637
PbZn	1E+07	1	33,000,000	1E+06	1	2,146,000	100,000	10	2,325,880	10,000	18	632,045	38,103,925
Sn	200,000	2	3,266,000	25,000	14	1,405,268	1000	22	112,764	100	18	6,554.6	4,790,587
Zn	1E+07	1	10,100,000	1E+06	30	73,405,761	100,000	132	36,599,762	10,000	218	8,637,582	1.29E+08
Co	500,000			50,000	3	504,400	2,000	34	342,744	200	52	35,811	882,955
Cr	2.5E+07	1	39,500,000	5E+06	5	46,530,000	1E+06	4	11,051,694	200,000	7	3,233,300	1E+08
Fe	1E+09	2	2.42E+09	1E+08	28	7.96E+09	1E+07	101	3.1E+09	1E+06	198	6.76E+08	1.42E+10
Mn	1E+08	1	1.16E+08	1E+07	1	10,750,000	1E+06	14	53,206,990	100,000	31	8,391,079	1.89E+08
Mo	500,000			100,000	5	843,148.6	5,000	11	223,339	1,000	9	23,117	1,089,605
Nb	1E+06			100,000	1	750,000	10,000	1	25,200	2,000	1	3,496	778,696
Ni	2E+06	3	9,115,000	500,000	4	2,823,900	20,000	36	3,699,562	2,000	61	489,138	16,127,601
V	2E+06	1	2,005,733	200,000	3	984,252.8	20,000	16	767,224.8	2,000	19	182,321.5	3,939,532
W	200,000			50,000	4	374,438	5,000	21	260,367	500	21	38,315	673,120
Brt	5E+06	4	49,362,400	1E+06	17	37,159,000	200,000	32	14,652,350	50,000	20	1,971,813	1.03E+08
Fl	5E+06	6	52,621,000	1E+06	10	20,061,620	200,000	21	9,722,000	50,000	29	3,330,705	85,735,325

Table 1 - Calculated endowments of classes A to D deposits for 22 commodities in Europe; Series 1(yellow): Precious metals; series 2 (green): Base metals (s.l.); series 3 (orange): Iron and ferro-alloy metals; series 4 (blue): Two non-metallic commodities frequently associated with metallic ones. Tonnages (endowment, i.e. resources + reserves + past production) are given in metric tons.

Conclusion

The ProMine MD database, presented herein, is a new outcome from the EU co-funded ProMine project and a crucial step toward better assessment of primaryresources in Europe that, in turn, will strengthen the extractive industry and help secure European supply in mineral resources, including critical and "green" commodities. It is a new homogeneous and thorough dataset, containing a considerable amount of information that will allow, in a near future, mineral resources potential and predictability assessment studiesthat were not possible so far.

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