



REPUBLIC OF SERBIA
MINISTRY OF MINING AND ENERGY

 **GEOINSTITUT**



*Mineral deposits and mining districts
of
Serbia
Compilation map and GIS databases*

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Abstract

Work for the map and GIS databases of the mineral deposits and mining districts of Serbia was carried out within the context of a French Government aid project for the Republic of Serbia's Ministry of Mining and Energy.

The Minerals map, compiled at 1:750,000 scale, shows the country's principal deposits for energy minerals, base and precious metallic minerals, and industrial minerals, and also the country's main mining districts. The data have been plotted on a topographic and simplified geology base using MapInfo software.

The mineral deposits and mining districts databases have been constructed under Microsoft Access, based on the model developed by BRGM for its scientific research projects.

The "Ore deposit" database contains 199 records that include:

- geographic location,
- geological data (typology, morphology, age and type of mineralization and host rock, mineralogical composition of the ore, gangue and hydrothermal alteration),
- economic data (mine status, type of development, former production, status of resources and reserves),
- data concerning environmental hazards likely to be generated by the deposit,
- bibliographic references.

The same information is also provided in catalogue form as an appendix to this report.

Twelve main mining districts are distinguished. The relevant information concerning these districts is stored in the "District" database and includes:

- a list of the deposits located within the district,
- the main primary and secondary ore minerals (commodities or substances) present, each annotated with an assessment of the contained metal weight so as to enable an evaluation of the district's economic importance,
- the dominant typology or characteristic(s) of the district,
- the age of the mineralization and host rocks,
- a synopsis of the geological and economic data,
- a comment on the potential environmental releases and damage associated with the relevant mining and mineral-processing industry,
- the main bibliographic references.

All this information is also provided in catalogue form as an appendix to this report.

The report introduces these documents and then reviews the country's mineral and mining potential through a series of figures compiled from thematic analyses of Serbia's best-represented mineral commodities.

Serbia's Kosovo-Metohija Pliocene Basin contains the largest exploitable reserves of lignite in Europe. Serbia is also known for its copper mining in the Timoc District and lead-zinc mines in the Kopaonik District —two districts that provide an important economic potential, but where the relaunching and development of the mining industry will require major changes and extensive investment. If one considers the examples of Greece and the Republic of Macedonia, then the Tertiary volcanic exposures of the Serbo-Macedonian Metallogenic Province should be highly favourable for the presence of precious metals. Moreover, in Serbia, this province appears to have been under-explored for gold, particularly with the availability of modern exploration tools and procedures suited to the country's geology and morphology. Among the many industrial minerals present in Serbia, particular attention should be paid to the significant resources in borate, magnesite and raw materials for the ceramics and glass industries (halloysite, wollastonite).

The documents, despite their imperfections, provide a basis for promoting and aiding in the restructuring and development of Serbia's mining sector. Combining mining with environmental data, they provide a "sustainable development" approach.

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PLATE

Mineral deposits and mining districts of Serbia. Compilation map at 1:750,000 scale

Appendices

App. 1 - Catalogue of the Mineral Deposits of Serbia.

App. 2 - Catalogue of the Main Mining Districts of Serbia.

CD-ROM containing: (i) the mineral deposits ("Ore deposit") and mining districts ("District") databases (under Access); (ii) the map compilation files in MapInfo 6.5 format; (iii) the map compilation files in ArcView 3.2 format; (iv) the various graphic documents in **'wmf'** format; (v) the text of this report.

Introduction

Serbia, located in the Balkans and at the heart of Europe, possesses significant mineral resources, particularly where lignite, copper, lead, zinc and industrial minerals are concerned.

Mining and the mining-metallurgical-mechanical complexes in this part of the world were, before the demise of communism, the keystone to the regional economy. The mining and metallurgical sector was at a peak prior to the break-up of the Federal Republic of Yugoslavia in the early 1990s, but declined rapidly due to the 1992 to 1995 embargo and finally became paralysed following the Kosovo conflict and the NATO bombing in 1999.

The Republic of Serbia's new government, following democratic elections in 2000, is fully aware that the rebirth and development of its industry and economy can only be achieved through capital investment, and thus of necessity through privatization. The government has to provide advantageous conditions in order to attract investment to the mining industry.

In the context of its "Fonds d'Etudes et d'Aide au Secteur Privé" (*Private sector study and aid funds*), the French government released the necessary funding and instructed BRGM to provide help to the Republic of Serbia's Ministry of Mining and Energy in relaunching the mining sector, which has a major role to play in the country's economy, and promoting it to private investors.

Two aspects have been approached in context of this cooperation project:

- support for modernizing the mining law,
- construction of a synoptic promotional map and GIS-type databases for the mineral deposits and mining districts of Serbia.

The first aspect was the subject of a specific study that is summarized in BRGM Report BRGM/RC-51453-FR "Institutional support to the Ministry of Mining and Energy of the Republic of Serbia for the improvement of the mining law" by N. Stolojan and M. Lansiaert, January 2002.

The present report concerns the second aspect. It introduces the Minerals map, GIS databases and catalogues concerning Serbia's mineral deposits and mining districts. It also provides an opportunity to review the country's mining potential and define priority zones for mineral exploration and development.

BRGM was aided in this work by various bodies involved in the geology and mining economy of Serbia, and in particular by the Faculty of Mines and Geology of the University of Belgrade and by GeoInstitut.

The project has also benefited from the knowledge acquired by BRGM in the context of its scientific research project entitled "GIS Central Europe", as well as from various expert assessment missions to the Balkans during the period 2000-2001, in partnership with the *Société Tec Ingénierie*, for a mining audit of the Trepca mining and metallurgical complex in Kosovo and for a reconnaissance visit to Bor in northeastern Serbia.

The mineral deposits map was compiled using MapInfo 6.5 software. So that it can be reproduced with other GIS software, we also created export files compatible with ArcView 3.2 software and a file in ***.wmf** format that can be accessed with PowerPoint..

The mineral deposits and mining districts databases have been constructed under Microsoft Access, based on the model developed by BRGM for its scientific research projects.

1. Introduction to the Minerals map of the Republic of Serbia

The Minerals map at 1:750,000 scale, produced using MapInfo 6.5 software, shows all the relevant deposits on a very simplified geologic base.

The raw materials extracted from the subsurface classically fall into the following categories:

- fossil fuels (coal *s.l.* and hydrocarbons) also known as "energy minerals",
- metallic minerals,
- industrial minerals,
- precious and semi-precious stones,
- construction materials,
- mineral waters and geothermal energy, relating to deep groundwaters and generally studied under "hydrogeology".

The priority for the Minerals map only concerns the first three groups, for which we have tried to be as exhaustive as possible. We have also plotted the location of a few semi-precious stone sites, as well as the main quarries worked for cement raw materials. However, no data has been plotted for mineral waters or geothermal energy.

1.1. PROJECTION SYSTEM AND TOPOGRAPHIC BASE

The details of the projection system used for the map are:

- Transverse Mercator,
- spheroid NAD 27, ellipsoid Clarke 1866,
- central meridian: 21°,
- reference latitude: 0°,
- scale factor: 1,
- false easting: 1000 km,
- false northing: 0 km.

The data shown on the topographic base have purposely been limited to national borders, the drainage pattern and the main road network. Other than mineral deposits, only the main towns are named.

1.2. GEOLOGICAL BACKGROUND

The geological base was deliberately simplified to show only the major lithostructural units, some of which have played a dominant role in the origin and distribution of the mineralization. Thus, we have emphasized (Fig. 1):

- The ultrabasic rock massifs characterizing Triassic-Jurassic ophiolitic paleo-rifts;
- The Upper Cretaceous volcanic and volcano-plutonic complexes that gave rise to the copper mineralization of the Carpatho-Balkan Metallogenic Province in northeastern Serbia;
- The Tertiary volcano-plutonic complexes that characterize the major Serbo-Macedonian Metallogenic Province, which crosses Serbia from the borders of Macedonia and Bulgaria in the south-southeast to the borders of Bosnia-and-Herzegovina and Croatia in the north-northwest;
- The intrusive granites, of which the oldest have been dated as Permo-Carboniferous and the youngest as Tertiary;
- The Quaternary sediments, mainly represented by the molasse of the Pannonic Basin in the Voivodine.

Finally we have graphically highlighted the main discontinuities (faults and thrusts), and particularly the groups of faults delimiting the Vardar Zone.

The geology is based on the Geological map of Yugoslavia at 1:500,000 scale (Federal Geological Institute, 1970). The changes and additions that have been made derive from the 1:200,000-scale Geological Map of Serbia (Milovanovic and Ciric, 1968) and from different map compilations found in a variety of publications.

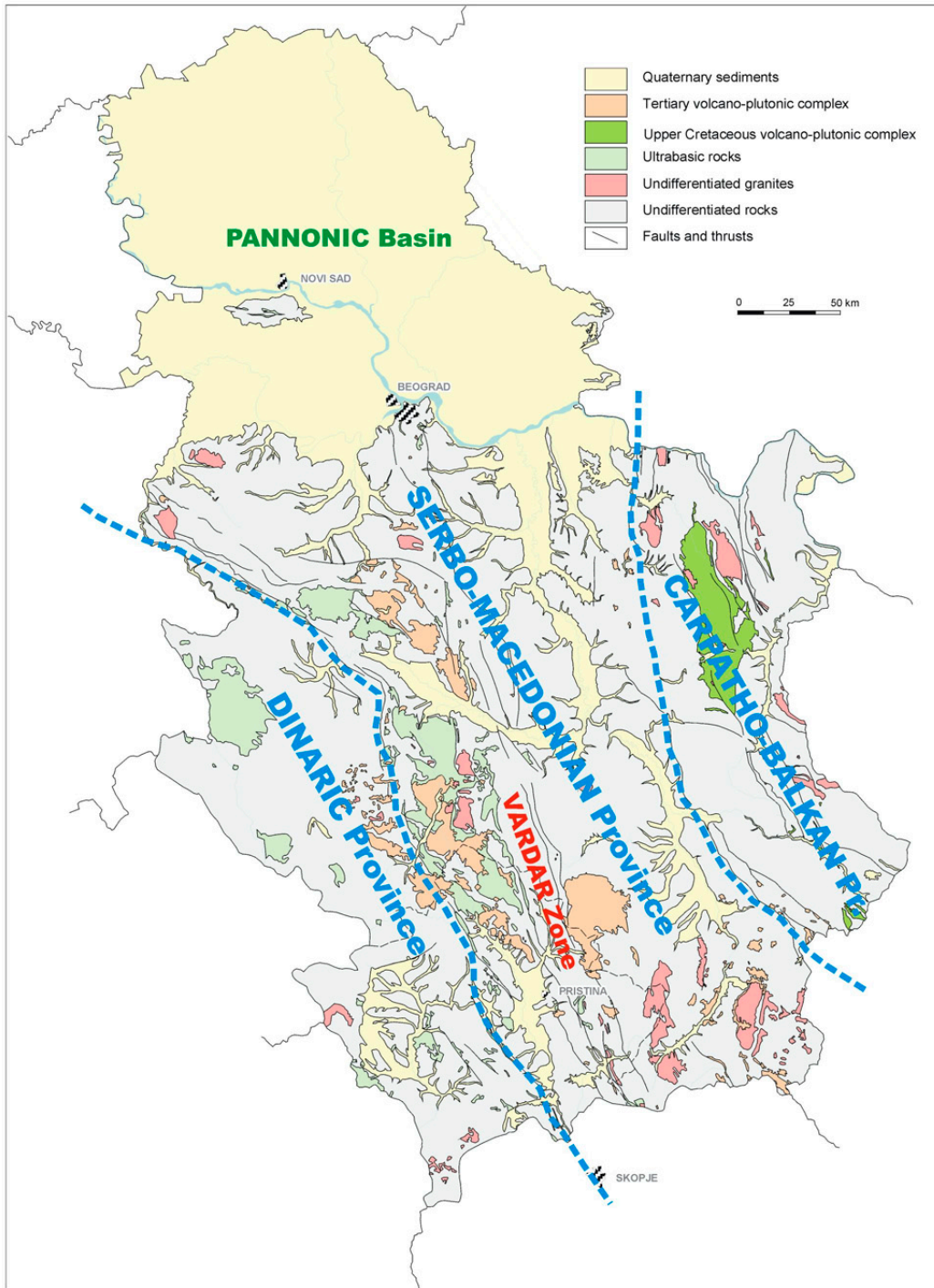


Fig. 1 – Simplified geological map of Serbia showing the main structural and metallogenic provinces.

1.3. MINERAL DEPOSITS

Although sometimes grouped by district, the major metallic-mineral and industrial-mineral mines and quarries are generally well localized and represented as such.

The **symbol shape** used for representing the deposit has allowed us to distinguish:

- fossil fuels, or energy minerals – represented by hexagons,
- metallic minerals – represented by circles coloured according to the dominant commodity(ies),
- industrial minerals – represented by squares coloured according to the dominant commodity(ies).

The **symbol size** and **size of the deposit name** reflect the economic importance of the concentrations. They are proportional to the deposit's cumulative metal weight (mined + reserves) where these figures are known or can be estimated. We restricted ourselves to defining only three classes:

- large size deposit,
- medium size deposit,
- small size deposit and occurrence.

This classification is dependent on the commodity(ies) present in the deposit, as shown by Table 1.

Commodity	Large size deposit	Medium size deposit	Small size deposit
Lignite	> 1,000,000 kt	1,000,000 - 5,000 kt	< 5,000 kt
Copper	> 1,000,000 t	1,000,000 - 10,000 t	< 10,000 t
Lead	> 100,000 t	100,000 – 1,000 t	< 1,000 t
Zinc	> 200,000 t	200,000 – 2,000 t	< 2,000 t
Nickel	> 200,000 t	200,000 – 2,000 t	< 2,000 t
Iron	> 100, 000 kt	100,000 – 1,000 kt	< 1,000 kt
Chromite	> 5,000,000 t	5,000,000 – 200,000 t	< 200,000 t
Magnesite	> 10,000,000 t	10,000,000 – 100,000 t	< 100,000 t
Kaolin	> 10,000,000 t	10,000,000 – 500,000 t	< 500,000 t
Gold	> 50 t	50 – 1 t	< 1 t
Silver	> 2,500 t	2,500 – 100 t	< 100 t

Table 1 – Deposit classification for the main commodities according to economic size.

1.4. MINING DISTRICTS

The deposits, and particularly the metalliferous deposits, can be grouped within districts characterized by similar geological and gitological (metallogenic) contexts, identical mineralogical associations, and a contained mineralization derived from commonly contemporaneous metallogenic processes.

The mining districts are represented by envelopes whose colour reflects the dominant commodity(ies). The retained name is usually that used in scientific articles dealing with the metalliferous deposits of Serbia.

1.5. SMELTERS

The map was completed by showing the five main smelters, i.e. the Bor copper smelter, the Zvecan lead smelter, the Kosovo Mitrovica zinc smelter, the Glogovac nickel smelter and the Zajaca tin smelter.



Fig. 2 – Introductory screen to the "Ore deposit" database.

Fig. 3 – "General information" data input screen for deposit location, status, mining company, etc.

2. Mineral deposits database and catalogue

The "Ore deposit" database has been constructed according to the model developed and used by BRGM for its GIS projects on the Andes, Africa and Central Europe. It is an Access database with five main input screens. The contained data for each deposit can be printed at any time in file (or status) format containing the essential information. Here we have printed the files and grouped them into a Catalogue of the Mineral Deposits of Serbia as Appendix 1 to this report.

2.1. THE DATABASE EXPLAINED THROUGH ITS DATA INPUT SCREENS

The "General information" data input screen (Fig. 3) is used for information concerning the identity and location of the deposit (coordinates, administrative province), the name of the mining company, the status of the deposit, references to other databases containing information on the deposit, etc. The "Comments" box allows relevant information to be included that is not requested by any of the database's screen input headings.

The input screen shown in Figure 4 is devoted entirely to the deposit geology. It requests information on the deposit's typology (metallogeny, geology) and morphology(ies), and also asks for data concerning both the mineralization (age, ore and gangue mineralogy, hydrothermal alteration) and the host rock (age, formation name[s], lithology[ies]).

Information concerning the type of exploitation (mining and processing) and the main commodity(ies) is given under the "Economy" data input screen shown in Figure 5. This screen is also used for entering past (former) production figures and the status of the reserves and resources along with a qualification of the degree of confidence (proven, probable, possible), etc. Due to the confidential character generally associated with data concerning production and reserves, it is generally impossible to provide more than the past production figures.

The environmental factors and main hazards likely to arise from the deposit are given in the "Environment" data input screen.

Note that the "Environmental signature" of a mineral deposit is defined as "the compositions, concentrations and availabilities of chemical elements in waters, soils, sediments and airborne particulate at a site". These chemical elements result from the natural weathering of exposed mineral deposits, as well as from mining, mineral processing and smelting activities. For example, the environmental signature of a mine site may include:

- its metal contents,
- the composition of the mine drainage water,
- the stream sediments and soils,
- the identification of readily soluble secondary salts associated with the mine waste.

Seeing that few data regarding these items were available for the present study, we have based the "environmental signature" of a mineral deposit mainly on geological factors that could have potential environmental effects, i.e.:

- ore and gangue mineralogy (e.g. acid-generating versus acid-consuming minerals),
- secondary mineralogy,
- wall-rock alteration and the alteration products,
- type (e.g. veins, massive, disseminated, etc.) and size of the ore deposit
- lithology of the host rock (e.g. existence of acid-consuming limestone).

Other factors such as climate, hydrology, topography and physiography, as well as mining and milling methods, also play a key role in influencing potential environmental effects, but have not been taken into account due to a lack of available data.

The literature references are given in the "Bibliography" data input screen shown by Figure 6. They are linked to a list of almost 150 published (thus non-confidential) articles, mainly in English or with an English abstract. A specific tab to the right of the reference accesses an additional screen giving details and key words of the article in question.

The bibliographic searches were done from the two databases:

- GeoRef, developed and maintained by the American Geological Institute,
- PASCAL, developed and maintained by the CNRS in France.

Other publications were provided by the Faculty of Mining and Geology of the University of Belgrade.

Fig. 4 – "Geology" data input screen.

Fig. 5 – "Economy" data input screen.

YUG-00141 Name Kolubara Identifier Name Commodity

General information Geology Economy Environment Bibliography

Geological bibliography

Authors	Jankes G., Cvetkovic D., and Glumicic T.	
Title	Determination of different forms of sulphur in Yugoslav soft brown coals.	
Authors	Cveticanin R.	
Title	Review of Yugoslav coal basins.	
* Authors		
Title		

Economic bibliography

Authors	Anonymous.	
Title	Jugoslavija za Rudarstvo.	
Authors	Anonymous	
Title	Electric Power Industry of Serbia - 1998	
Authors	Anonymous	
Title	Electric Power Industry of Serbia - 1999	
Authors	Dimitrijevic D.	
Title	Kolubarski ugljeni basen i njegovi resursi u pogledu dobijanja produkata vecje toplotne vrednosti Translated Title: Kolubara coal basin resources and their potential for production of higher calorific value products	
Authors	Mitrovic M.	
Title	Mogucnosti ciscenja lignita kolubara pre sagorevanja u termoelektrani Translated Title: Possibilities of purifying the Kolubara lignite before combustion in a thermal power plant	
* Authors		

Enr: 115 sur 199

[3]

Identifier 530.

Type Journal.

Author(s) Dimitrijevic D.

Title Kolubarski ugljeni basen i njegovi resursi u pogledu dobijanja produkata vecje toplotne vrednosti Translated

Date 1983

Source Geoloski Anali Balkanskoga Poluostrva, 46, p. 333-351.

Abstract coal; basins; resources; Yugoslavia; economic geology; economics; Europe; evaluation; Kolubara coal basin; organic residues; reserves; sedimentary rocks; Serbia; Southern Europe

Close/Exit

Fig. 6 – "Bibliography" data input screen and article details.

The Introductory screen to the "Ore deposit" database also contains other tabs giving access to database utilities, i.e.:

- "Queries", which can be variably complex like select a given commodity, status, geological type, etc., within the "Ore deposit" database,
- "Reports" for preparing and printing records contained in the database,
- "Import/Export" for exporting data in Excel format, or importing new data.

These possibilities are illustrated by Figures 7, 8 and 9.

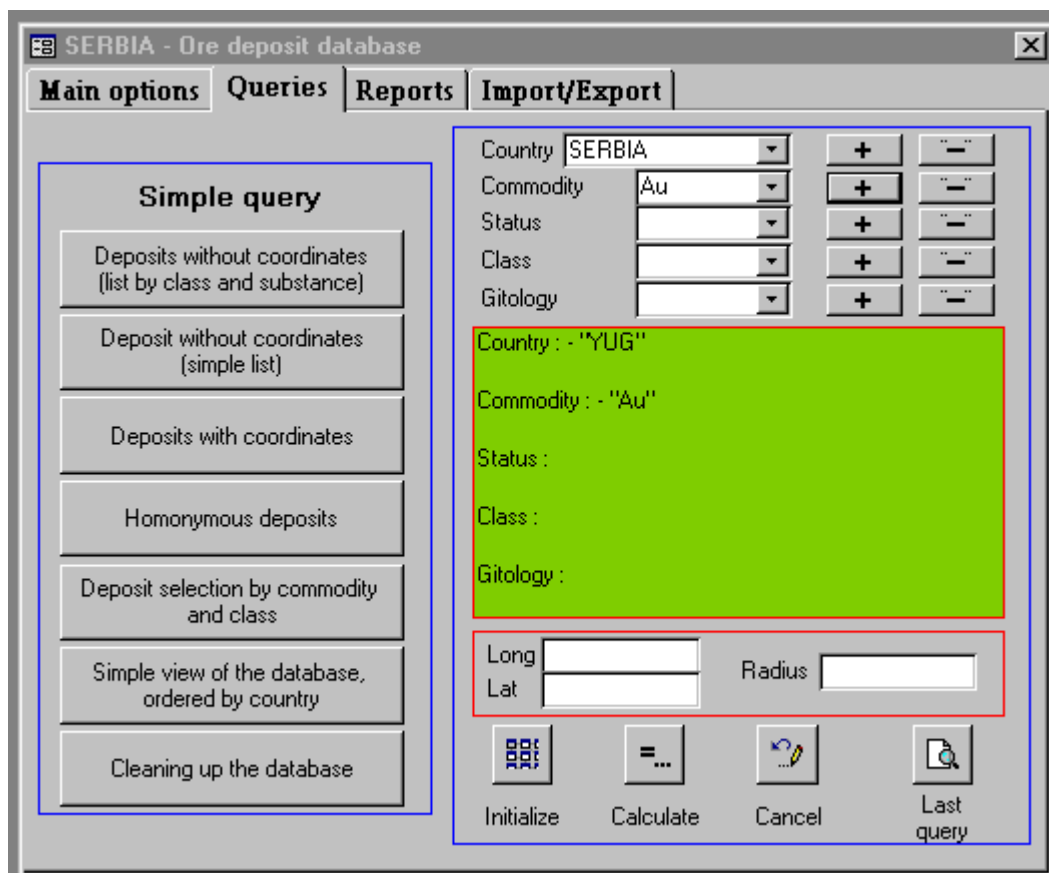


Fig. 7 - Types of query enabled by the "Ore deposit" database.

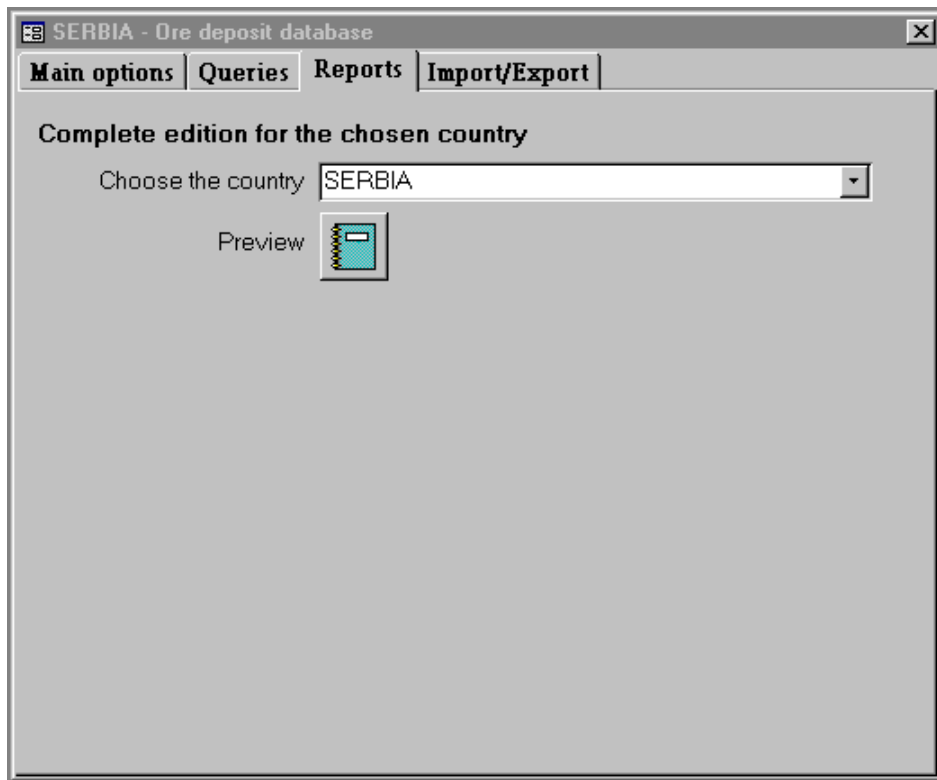


Fig. 8 – Utility for printing records.

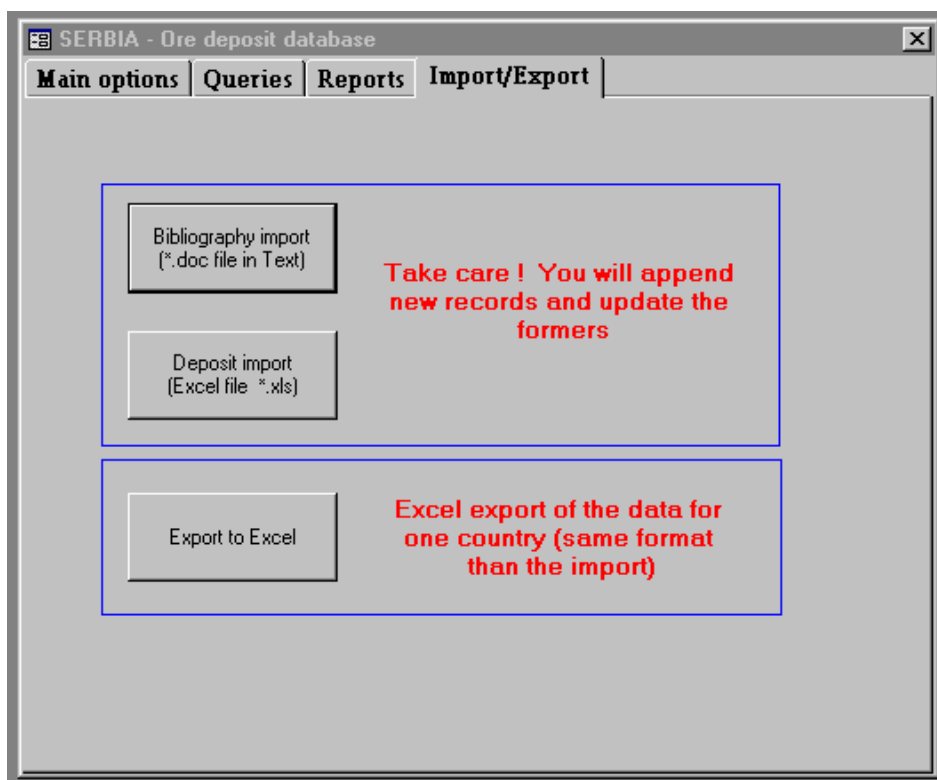


Fig. 9 – Utility for data import/export.

2.2. CATALOGUE OF THE MINERAL DEPOSITS OF SERBIA

Information relating to the recorded 199 deposits and occurrences in the database has been printed as information sheets to make up the catalogue given in Appendix 1.

The deposits in the catalogue are classified according to their identification number, which corresponds to the sequential input number. The catalogue also gives a table linking the deposit name(s) to the deposit identification number —the deposits in the table are in alphabetical order.

Each sheet gives a summary of the:

- General information, including the deposit name(s), identification number, commodities exploited along with their cumulative metal weight (mined + reserves + resources), current mining status (where known), name of the last mining company exploiting the deposit, longitude and latitude (in decimal degrees) and administrative province.
- Geological data, with type of deposit, its morphology(ies), the age and composition of its mineralization, and the age, type and local name of the host rock.
- Economic data, indicating the type of exploitation, the deposit commodity(ies) accompanied by the type of ore, the metal weight and the grade of the former production, reserves and resources.
- Comments on the environmental hazards likely to be generated by the deposit.
- "Free" comments for specific information or details not requested by any of the database's screen input headings.
- Bibliographic references, distinguishing between those that are geologically oriented and those that are economically oriented.
- The deposit reference number in other published databases.

3. Mining districts database and catalogue

Like the "Ore deposit" database, the "District" database has been constructed according to the model developed and used by BRGM for its GIS projects on the Andes, Africa and Central Europe. It is an Access database linked to the "Ore deposit" database. The contained data for each district can be printed at any time in file (or "status") form showing the essential information. Here we have printed the files and grouped them into a Catalogue of the Main Mining Districts of Serbia as Appendix 2 to this report.

3.1. PRESENTATION OF THE DATABASE

The "District" database has a similar form to the "Ore deposit" database (Fig. 10), except that data is entered via a single data input screen (Fig. 11).

The different information that can be input to the database through this screen includes:

- District name,
- List of deposits contained in the district,
- The main and secondary ore minerals or commodities (here termed "substances") present within the district. The link with the "Ore deposit" database gives an automatic update of the cumulative metal weight for each of the indicated commodities,
- The district's dominant typology or characteristic (here entered under "geology"),
- The age of the mineralization and host rock,
- A free "Comments" box for summarizing the geological and economic data,
- A comment related to potential environmental releases and damage linked to the mining and mineral-processing industry,
- The main bibliographic references.

3.2. CATALOGUE OF THE MAIN MINING DISTRICTS OF SERBIA

We have defined 12 main mining districts. The data concerning these districts are given in catalogue form in Appendix 2 where the districts are classified in alphabetical order. The name adopted for each district is that most commonly found in the literature.

Each District file summarizes the following information:

- the list of deposits included in the district,
- the main and secondary commodities, each accompanied by an estimation of the metal weight from which to ascertain the economic importance of the district,
- the dominant "geological" type in the district,
- the age of the mineralization,

- a relatively complete comment summarizing the district's geological, geological and economic factors; it may also define the district's present and potential mining interest where sufficient information is available,
- a comment concerning the likely hazards to be provoked by the mining and the mineral-processing and metallurgical plants within the district,
- a selection of published bibliographic references.

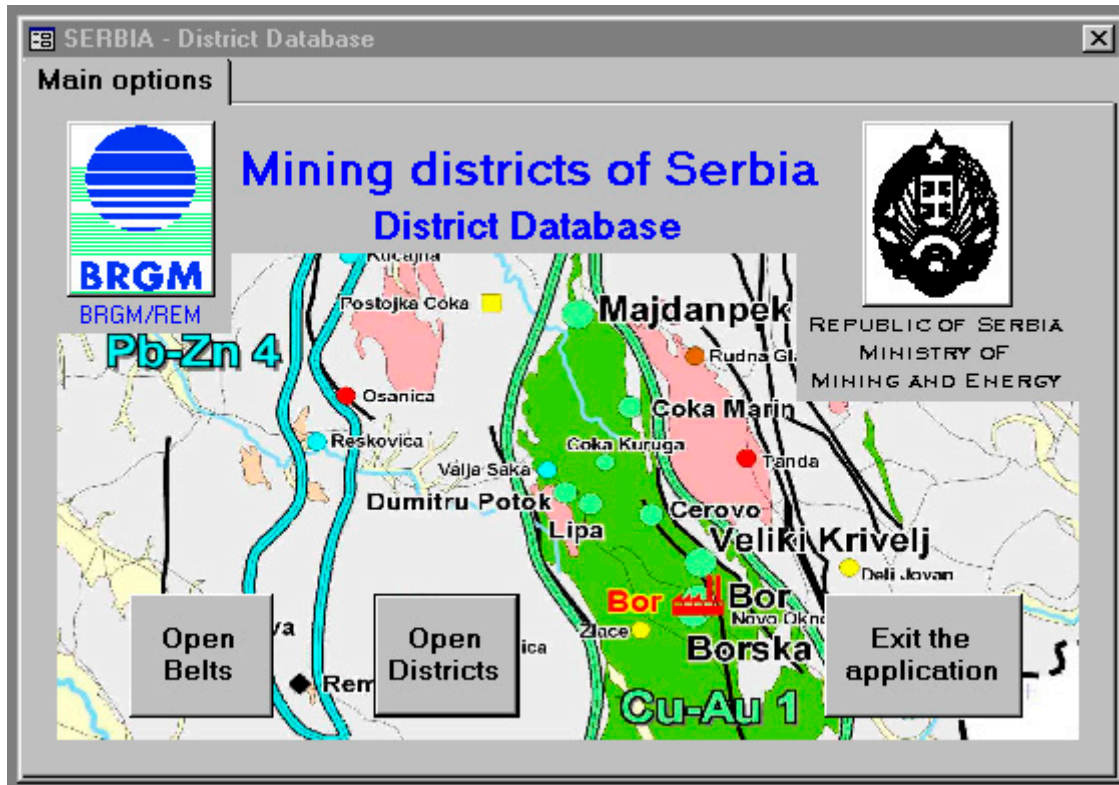


Fig. 10 – Introductory screen to the "District" database.

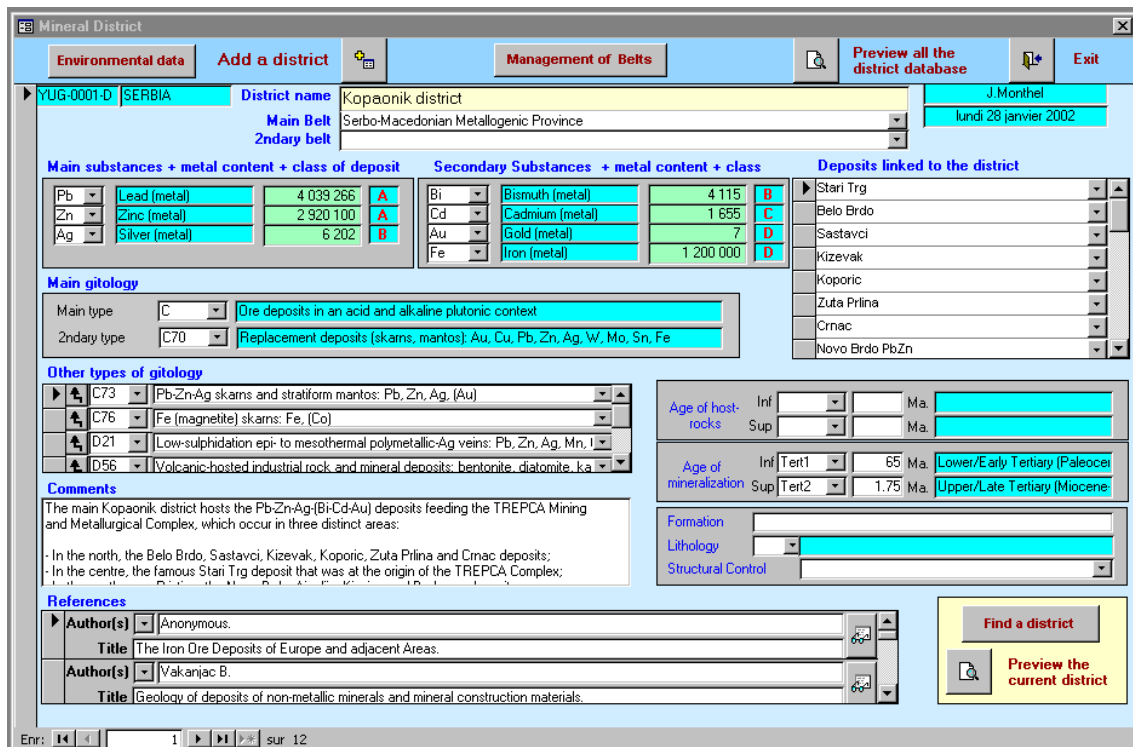


Fig. 11 – Input screen for the "District" database.