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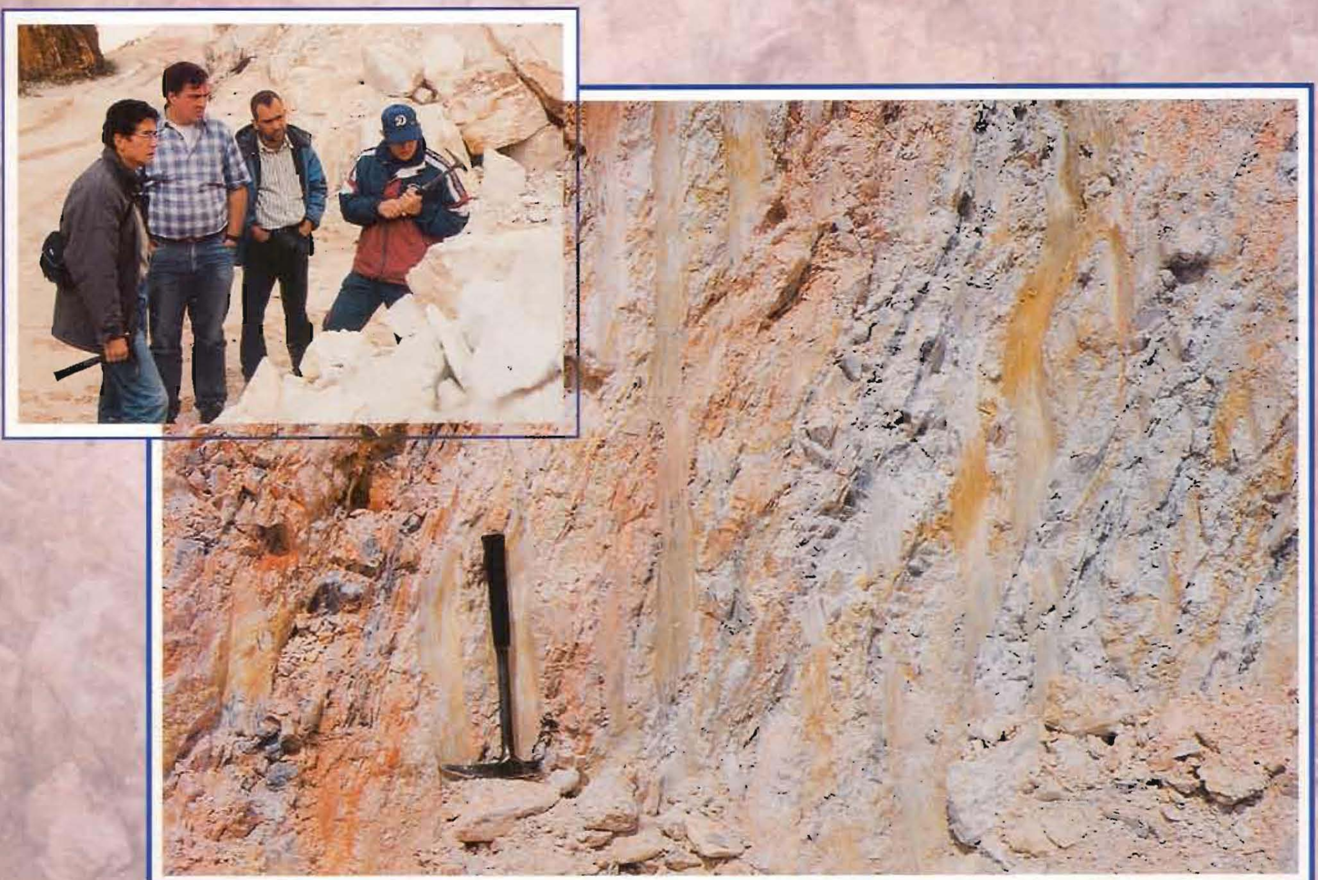

IGCP 443 INTRODUCTORY NEWSLETTER

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COVER: Talc with thin dolomitic intercalations. The colour varieties of talc are caused with Fe-oxides. The strip of talc deposits originated with metasomatism of Late Proterozoic dolomitic marbles of the Itaiacoca Group. The strip is located in regional shear zone of NE–SW course and towards NW and SE is bordered with Paleozoic granites. The tectonic setting is moreover penetrated with dykes of Cretaceous dolerites trending NW–SE. Talc deposits on photographs are situated 4 km to SE of the Socavão village, Paraná State, Brazil. They were visited during the IGCP 443 first field correlation in August 14–17, 2000. Photo: Z. Németh, 2000.

OBÁLKA: Mastenec s tenkými vložkami dolomitu. Jeho rozličné sfarbenie je výsledkom pôsobenia oxidov Fe. Pruh mastencových ložísk vznikol metasomatózou vrchnoproterozoického dolomitického mramoru zo skupiny Itaiacoca. Je v regionálnej strižnej zóne smeru SV–JZ a na SZ a JV hraničí s telesami paleozoického granitu. Celou stavbou navyše priečne prenikajú dajky kriedového doleritu smeru SZ–JV. Mastencové ložiská zachytené na fotografiách ležia 4 km na JV od dediny Socavão (štát Paraná, Brazília) a boli navštívené počas prvej terénnej korelácie projektu IGCP 443 v dňoch 14.–17. augusta 2000. Foto: Z. Németh, 2000

GeO vestník

Preface

The UNESCO/IUGS correlation programme IGCP 443 Magnesite and Talc – Geological and Environmental Correlations started in 2000 for 5 years' period. The proposers of the project were Dr. Martin Radvanec, Slovakia; Prof. Walter Prochaska, Austria; Prof. Antonio C. Gondim, Brazil and Prof. Basile Christaras, Greece. These scientists later became the leaders of the project as well as of individual thematic research groups; the leader of the environmental thematic group became Prof. Cai Keqin from China.

The main aim of ongoing correlation is upgrading of knowledge about magnesite and talc in four thematic groups: (1) Geology and structure of magnesite and talc deposits, (2) Geochemistry, petrology and mineralogy, (3) Methods of exploration, investigation of the raw materials and processing, as well as (4) Geoenvironmental models.

Presented Introductory Newsletter widens scientific message presented during both, the IGCP 443 Inaugural Meeting in Rio de Janeiro, Brazil, in August 9, 2000, and the first field correlation on talc deposits of the Paraná State, Brazil, August 14-17, 2000, prepared and led by Antonio Carlos Gondim, the IGCP 443 3rd project leader.

The intention of this Newsletter, being "an introductory one", is to reflect the-state-of-the-art about magnesite and talc in numerous, prevailingly leading worldwide producers of this raw material. Presented knowledge will serve as a basis for further correlated research. Despite the fundamental classification and genetic aspects of magnesite mineralization were already summarized in 1980s by German and Austrian geologists in the monograph Magnesite by Möller et al. (1989), our Newsletter maintains untouched original interpretations and classifications valid in individual countries. Further upgrading of magnesite and talc knowledge in widened thematic range will be the topic of following IGCP 443 correlations and annually will be summed up in Newsletters and final monograph Magnesite and talc.

December 2000

Martin Radvanec, Walter Prochaska and Zoltán Németh

IGCP 443 - MAGNESITE AND TALC - CORRELATION OF THEIR GEOLOGY, ORIGIN, METHODS OF EXPLORATION, DRESSING AND ENVIRONMENTAL IMPACTS

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IUGS UNESCO IGCP

IGCP 443

Magnesite and Talc

Geological and Environmental Correlations

IGCP 443 INTRODUCTORY NEWSLETTER

Edited by

Martin Radvanec
Walter Prochaska
and
Zoltán Németh

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Magnesite and talc in Brazil related to the world context

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IGCP 443

Abstract

The main reserves of magnesite in the world are located in China, North Korea, Russia, Brazil, Turkey, India, Slovak Republic, Greece, Spain and Austria. The world's main talc reserves are present in China, USA, Japan, Brazil and Korea Republic. The largest producers of magnesite are represented by China, Russia, Turkey, Brazil, Slovak Republic, North Korea, Austria, Greece, Spain, India, Australia and Canada. For talc production the pointed out countries are China, USA, Japan, Korea Republic, India and Brazil.

The magnesite deposits of Brazil are formed by sedimentation and orogenic metamorphism. In this country the talc deposit genesis is by metamorphic and hydrothermal processes. The exploration of magnesite and talc in Brazil considers lithostratigraphic, lithologic, structural and morphologic controls of the deposits. In Brazil, the use of talc is mainly in ceramics, followed by indutries of chemitry products, cosmetics, soaps, candles, feed and others. The magnesite and talc deposits in all Brazilian districts are exploited by open pit methods. This kind of exploitation causes environmental impacts mainly on soil and natural ecosystems, but degraded areas have usually been recuperated.

Key words: magnesite and talc, reserves, production, genesis, exploration, environmental impacts, Brazil and world

Introduction

Brazil has very important deposit districts of magnesite and talc. From the viewpoint of the world production, Brazil is the fourth country in reserves of magnesite and talc in the world.

The main reserves of magnesite are located in China, North Korea, Russia, Brazil, Turkey, India, Slovak Republic, Greece, Spain and Austria (Table 1). The world's main talc reserves are present in China, USA, Japan, Brazil and Korea Republic (Table 3).

At the rank of production, Brazil appears as the fourth country in magnesite and sixth in talc. The largest producers of magnesite are represented by China, Russia, Turkey, Brazil, Slovak Republic, North Korea, Austria, Greece, Spain, India, Australia and Canada (Table 2). For talc production the pointed out countries are China, USA, Japan, Korea Republic, India and Brazil (Table 4).

Magnesite in economic context

The main world magnesite and talc districts distribution is exhibited in Fig. 1. The world reserves of magnesite with division into individual countries are demonstrated in Table 1 and the production of natural magnesite by the supreme producers is in Table 2.

The last Mining Annual Review (1999) specified in its editorial about industrial minerals, that the past year had been grisly for world magnesia markets, and was characterized by oversupply, low prices and temporary closures. The price of magnesite in 1998 varied between US$ 165 and US$ 280 per tonne, depending of the purity.

In Brazil, the State of Bahia supplies 98 % of the magnesite production, being followed by Ceará State that produces 2 %. The main magnesite districts located on the map of Brazil, two in Bahia State and one in Ceará State, are present in Fig. 2. The annual production of natural magnesite in Brazil is 1,2 million of tonnes.

The magnesite use in Brazil is mainly in refractory industries with products for the iron and steel metallurgy.

Tab. 1
Magnesite reserves in the world

Countries	%	Magnesite reserves (10^3 t)
China	28.8	1,000,000
North Korea	21.6	750,000
Russia	21.0	730,000
Brazil	5.2	180,000
Turkey	4.6	160,000
India	1.3	45,000
Slovak Republic	0.8	30,000
Greece	0.8	30,000
Spain	0.8	30,000
Austria	0.6	20,000
Others	14.5	505,000
Total	100.0	3,480,000

Source: DNPM – Sumário Mineral (2000)

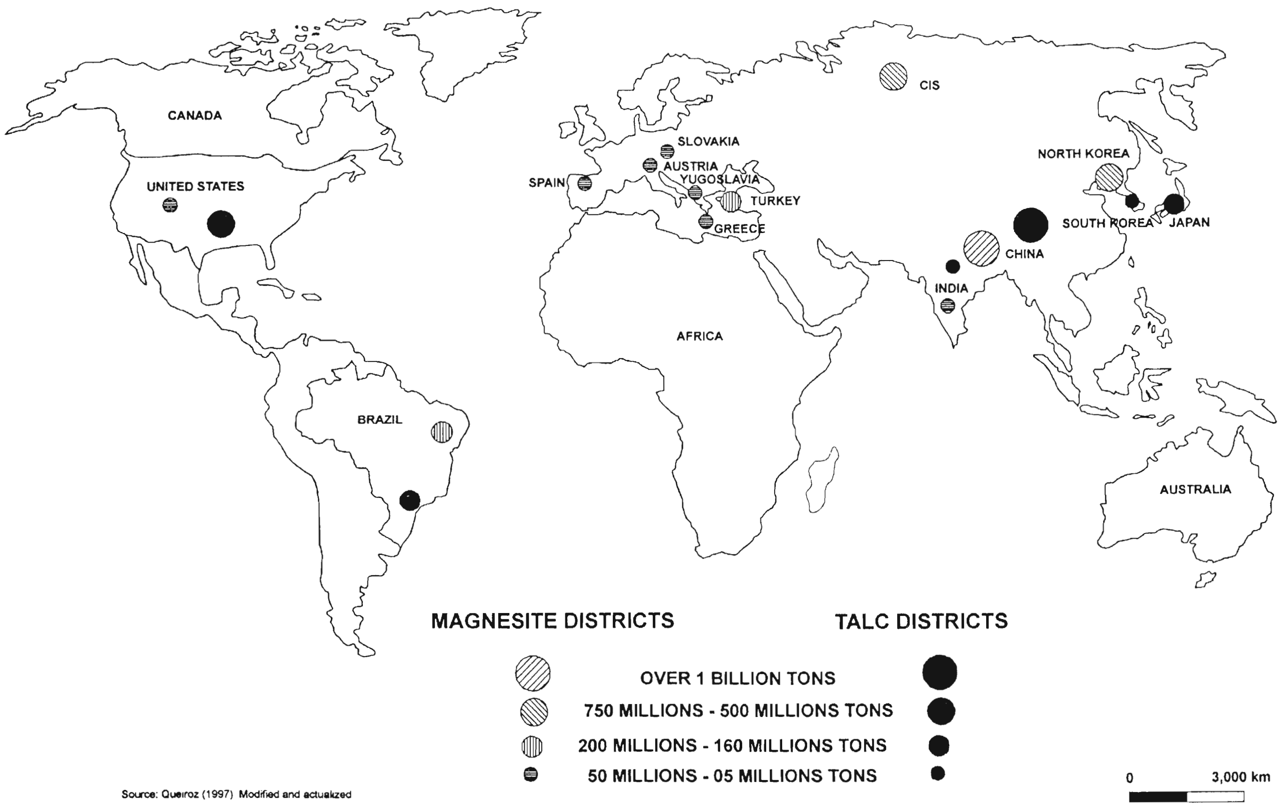

Fig. 1. Main magnesite and talc districts in the world.

Tab. 2
World production of natural magnesite

Countries	%	Production magnesite (10^3 t)
China	46.98	8.500
Russia	12.16	2,200
Turkey	7.74	1,400
Brazil	6.63	1,200
Slovak Republic	5.53	1,000
North Korea	4.42	800
Austria	3.59	650
Greece	3.59	650
Spain	2.76	500
India	2.06	372
Australia	1.98	359
Canada	1.10	200
Others	1.44	260
Total	100	18,091

Source: Mining Annual Review (1999)

Fig. 2. Magnesite districts in Brazil.

80 % of the Brazilian production is represented with dead-burned magnesite used in cement and glass industries. Additional, caustic magnesite products (20 %) are used in fertilizer, abrasive, animal feed and another chemical industries (Correia, 2000).

Geological setting of Brazilian magnesite districts

The magnesite reserves in Brazil reach 180 million of tonnes. The magnesite deposits are situated mainly in two districts in the Bahia State, presenting 85 % of the total Brazilian reserves and in the Ceará State, providing 15 % of reserves. As shown before, these states are the only producers of magnesite in Brazil.

The Bahia stratiform deposits of Brumado county, Serra das Eguas district, are hosted by the meta-volcanosedimentary sequence with dolomite marbles, calc-silicate rocks, quartzites, BIF (banded iron formation) and ortho-amphibolites. This sequence belongs to the Archean to Early Proterozoic greenstone belts in the São Francisco Craton (Queiroz, 1997). The genesis of ore deposits in Serra das Eguas district is complex. The magnesites are formed by sedimentation and orogenic metamorphism. Another magnesite-bearing district in Sento-Sé county is located in the north of the Bahia State. In this district the magnesite deposits are formed by Early Proterozoic orogenic metamorphism of dolostone. The host sequence is known as Castela unit (Oliveira, 1997). The magnesite districts of Bahia are accompanied with talc deposits. The origin of talc deposits is explained with metamorphism and related hydrothermal activity.

Magnesite deposits in the Ceará State of NE Brazil are located in the the Iguatu county of José de Alencar district. Deposits are associated with Late Proterozoic magnesite-dolomite marbles (Casaes, 1997) and belong to sedimentary types. Relating talc mineralization was formed during the metamorphic reworking by magnesite and silica reaction.

Talc

In the last ten years, the worldwide talc production has been maintained in the range of 9 and 8 million of tonnes.

The trend without growth has been attributed to the effect of global economy that also did not grow as well as to the Asian financial crisis. Yantang and Luping (2000) suggest that one of the causes of this situation is the use of substituting minerals for talc as an industrial filler mineral, such as calcite and kaolin in paper industry; wollastonite and nepheline syenite in pottery and porcelain industry; calcium carbonate, kaolin, mica and wollastonite in the paint and coating industries; bowlingite rock (which contains talc in its composition), chlorite and mica in the roofing industry.

Tab. 3
Talc reserves in the world

Countries	Talc reserves (10^3 t)
China	1,000,000
USA	544,000
Japan	200,000
Brazil	178,000
Korea Republic	18,000
India	9,000

Sources: DNPM, Sumário Mineral (2000), USGS, Mineral Commodity Summaries

The main world reserves of talc, distributed in individual countries, are demonstrated in Table 3. Brazil is the sixth producer of talc in the world being preceded by China, USA, Japan, Korea Republic and India. Table 4 presents an information about the talc production in the world. The whole production of talc in Brazil is 460,000 tons.

Tab. 4
Talc production in the world in 1999

Countries	%	Talc production (10^3 t)
China	28.0	2,300
USA	11.6	954
Japan	11.5	950
Korea Republic	10.1	830
India	6.7	550
Brazil	5.5	460
Others	26.5	2,170
Total	100.0	8,214

Sources: DNPM, Sumário Mineral (2000), USGS, Mineral Commodity Summaries, February 2000

Geological setting of Brazilian talc districts

The Brazilian reserves of talc plus pyrophyllite (178,000,000 tonnes) are mainly situated in the states: Minas Gerais (49 %), Bahia (30 %), Paraná (15 %) and São Paulo (4 %). There are also some reserves in Rio Grande do Sul, Goiás, Piauí and Ceará. The pyrophyllite reserves are almost exclusively in the Minas Gerais State, containing 99.96 % of the pyrophyllite reserves in Brazil. Nevertheless, the Paraná State is the talc production leader in Brazil, with 50 % of national production. This state is followed in talc production by Bahia (25 %), São Paulo (24 %) and Minas Gerais (1 %). The production of the raw material (talc + pyrophyllite) in Brazil is 460,000 tonnes, which means 300,000 tonnes of talc and 160,00 tonnes of pyrophyllite (Campos, 2000).

Fig. 3. Talc and pyrophyllite districts in Brazil.

Talc deposits in the Paraná State are situated in the region of Castro and Ponta Grossa counties. The host rocks are dolomite marbles in a metavolcanosedimentary sequence of the Itaiacoca Group of Late Proterozoic age. The mineralization has metamorphic and hydrothermal origin.

Talc deposits of the Bahia State are associated with magnesite mineralization in the Serra das Eguas and Sento-Sé districts. They are of Archean to Early Proterozoic ages. Their genesis was caused by metamorphic and hydrothermal processes.

Talc deposits in the Minas Gerais State are situated in the counties: Caranaíba, Caranda, Ouro Preto, Ouro Branco and Nova Lima. Inside the last mentioned county the biggest talc/pyrophyllite reserves in Brazil occur, being associated with serpentine bodies. They are mined because the serpentine is used in the steel industry (Lara Filho, 1997).

Talc deposits of Minas Gerais State originated mainly by hydrothermal alteration of ultrabasic igneous rocks. The pyrophyllite deposits of Minas Gerais State are associated to Archean metavolcanic rocks of basic and ultrabasic character. The genesis of these deposits is metamorphic-metasomatic. They are generally mined as soapstone.

Small talc districts are situated also in others states of Brazil (Fig. 3).

The talc in Brazil is used in ceramics (tiles, floors, artistic and electric wares), porcelain, refractors, papers, rubbers, fertilizers and agriculture defensives; veterinary products, cosmetics, soaps, candles, plastics, paints, food industries (rice, soya, oil, sweets, chewing gums), color pencil, soldering, explosives, sculptures and decoration pieces. The major talc consumers are ceramics (66 %), chemicals (8 %), cosmetics, soaps and candles (4 %), feed industry (3 %) and others (19 %).

Exploration, mining and environmental aspects of magnesite and talc districts in Brazil

The exploration of magnesite and talc in Brazil considers the several controls that are common in this type of deposits. At the Paraná talc district, for example, the exploration is guided by following controls (Gondim, 2000):

1. Lithostratigraphic control: Itaiacoca Group (Late Proterozoic).
2. Lithologic control: dolomite marbles.
3. Structural control: fault systems.
4. Morphologic control: vertical dolerite dykes and quartzites layers. These rocks are more weathering resistant than the host dolomite marbles. They protect the talc bodies against the erosion.

The deposits of magnesite and talc in all Brazilian districts are exploited by open pit methods.

The open pit mines cause environmental impacts on soil, but the recuperation of degraded areas is done. In order to dry extracted magnesite and talc, it is necessary to employ ovens. Gas or wood with continual reforestation are good choices as combustible for these ovens and it is possible to avoid the use of another kinds of natural vegetation which were commonly used in the past.

Acknowledgements. Our acknowledgement belongs to UNESCO and IUGS for the financial support of the IGCP 443 Magnesite and Talc.

We would like to express our thanks to the geologists Ricardo Bernardo Dias, Manoel Luis Camlofski, Luciano Cordeiro de Loyola and professor Luiz Eduardo Mantovani of Brazil for fruitful discussions during the field correlation on talc deposits in the Paraná State.

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References

Campos, L. E. G., 2000: Talc and pyrophylite. *In: Mineral Summary 2000, DNPM, Brasília, Brazil, 20, 103–104.*

Casaes, L., 1997: Depósitos de magnesita da região de José de Alencar, Ceará. *In: Schobbenhaus, C. Queiroz, E. T de & Coelho, C. E. S. (Eds.): Principais depósitos minerais do Brasil. Rochas e minerais industriais, Parte C, 4, 634.*

Correia, D. M. B., 2000: Magnesite. *In: Mineral summary 2000, DNPM, Brasília, Brazil, 20, 69–70.*

Gondim, A. C., 2000: First field correlation. Talc deposits of the Paraná State – Brazil. *IGCP – 443, Curitiba, Paraná, Brazil, 14.*

Lara Filho, J. de, 1997: Geologia do talco e pirofilita. *In. Schobbenhaus, C. Queiroz, E. T de & Coelho, C. E. S. (Eds.). Principais depósitos minerais do Brasil. Rochas e Minerais Industriais. Parte C, 4, 529–544.*

Mineral Commodity Summaries, 2000 In: Mineral Commodity Summaries, USGS, Reston, VA, USA, 198 p., www.usgs.gov

Mining Annual Review, 1999: Mining annual review 1999. London.

Oliveira, V de P., 1997: Depósito de Magnesita de Sento Sé, Bahia. *In. Schobbenhaus, C. Queiroz, E. T de & Coelho, C. E. S. (Eds.): Principais depósitos minerais do Brasil. Rochas e Minerais Industriais. Parte C, 4, 634.*

Queiroz, E. T de, 1997: Geologia da magnesita. *In: Schobbenhaus, C. Queiroz, E. T de & Coelho, C. E. S. (Eds.). Principais depósitos minerais do Brasil. Rochas e Minerais Industriais, Parte C, 4, 634.*

Sumário Mineral, 2000: Sumário mineral 2000. DNPM, Brasília, Brazil, 20, 120.

Yantang, Y & Luping, M., 2000: Substituting talc. The view from China. Industrial Minerals, February, 2000, p. 47–51.

Talc occurrences in the state of Bahia, Brazil: a short review

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IGCP 443

Abstract

125 occurrences of talc are reported in the State of Bahia, Brazil. They occur in four distinct geologic terranes which are primarily formed by the (I) Archean granulites, (II) migmatitic gneisses of Paleoproterozoic age, (III) chemical sediments hosted in Paleoproterozoic volcanosedimentary complexes, and (IV) Transamazonic and older granitic rocks, that are intruded in the previously cited terranes. Talc resulted from metasomatism of preexisting rocks by the action of metamorphism and hydrothermal processes. It is also suggested that, in the (IV) type terranes, where talc is in association with chemical sediments it may be derived from the original magnesian-rich silicate mineral by effect of the metamorphism.

Key words: talc, Precambrian deposits, State of Bahia, Brazil.

Introduction

In the last decade the Brazilian talc production has been lower than 300,000 tonnes per year. In 1996 it reached 297,669 tonnes (UMB/DNPM, 1997), from which the Bahia State participated with about 15 %.

In this paper the major geologic features of the talc deposits of the Bahia State are presented on the base of the main geologic characteristics of the host lithologies, the mineralogy of the talc occurrences, and the *talcification* processes. It is hoped that these data will shed some more light in the understanding of the genetic processes of these deposits.

Geologic framework

The occurrences of talc are distributed in four different kinds of geologic terranes which are termed (I) Archean granulitic basement, (II) Paleoproterozoic gneissic migmatitic basement (III) Paleoproterozoic meta-volcanosedimentary sequences, and (IV) Enclaves and "roof pendents" in Transamazonic and Archean granites (sensu latu).

Materials and methods

125 talc occurrences were cataloged by the author from 1979 to 1996. The works from SGM/CPM (1974), DNPM/MME (1979) and Sá (1982) were helpful to subsidize the geologic classification of the host lithologies.

The study of these occurrences has been performed taking into consideration the following records: (i) identification of the host geologic terrane, (ii) size and shape (the geometry) of the deposit, (iii) mineralogy and zonation, (iv) quality and use, and (v) genetic aspects.

The distribution of catalogued depositin in geographic quadrangles (Q) is demonstrated in Fig. 1. Each Q is limited by 1° geographic coordinates. The amount of deposits reported in each Q is indicated by the number within it. In Fig. 1 the boundaries of the Paleoproterozoic and Archean terranes are also delineated. The distribution of the metavolcano-sedimentary sequences is shown in Fig. 2.

Archean granulitic basement (GI)

It is defined within the Atlantic Belt by Barbosa (1995) for the high grade metamorphic rocks of the easternmost portion of the Sao Francisco Craton in the State of Bahia. It was less affected by the tectonothermal and magmatic events that took place in the craton during the Transamazonic cycle (2.6 to 1.8 Ga). Its Rb/Sr isochrons range from 2.2 to 3.1 Ga (Barbosa, 1995), and its lithologic complexity increases from the seashore to the interior of the country where it gradually changes into the gneissic migmatitic complex.

The talc occurrences in GI are restricted to a sole deposit in Q 39–40° W/11–12° S and two deposits in Q 40–41° W/13–14° S. It is of interest to enhance the fact that there are more than 40 occurrences of vermiculite in the GI terranes and that they were formed owing to the metasomatism of alkaline pegmatites. Most of vermiculite deposits, mainly those located northward of the Ipira-

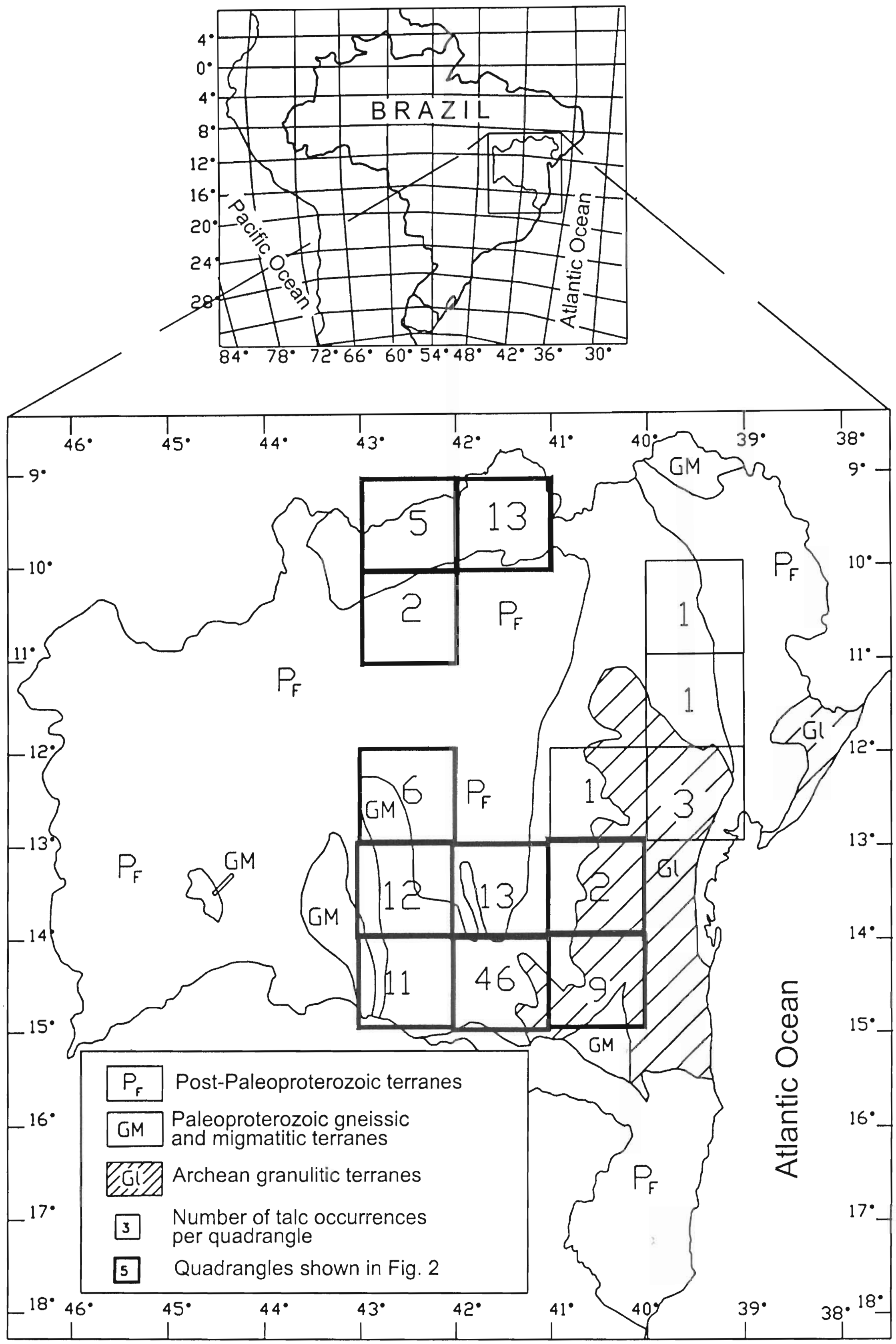

Fig. 1. Talc ocurrences in Bahia State, Brazil.

Gaviao-Ponto Novo belt, in the Q 39–40° W/11–12° S, are associated with apatite and, excepting the vermiculite occurrence placed at the neighbourhood of the town of Jequié, they are barren in talc.

Three deposits of talc, which are above quoted, are concordant small lens-like bodies up to 100 m in length and 10 m in width. The talc is laminar and in colour it varies from green to white. It is associated with chlorite and chrysotile and in the deposit which is located in the south-easternmost part of the Q 40–41° W/13–14° S (Jequié) with vermiculite.

Paleoproterozoic gneissic migmatitic basement (GM)

The gneissic migmatitic terranes are part of the Transamazonic mobile belts that were deeply affected by the tectonothermal and magmatic events that took place since the end of the Archean and were marked by intrusions of granites, syenites and adamellites and the development of *rifting* accompanied by peralkaline volcanism and deposition of chemical and subordinately clastic sediments. The rocks which are derived from these volcanic and sedimentary materials constitute the metavolcanosedimentary sequences that will be described next.

The occurrences of talc in the GM correspond to 60 % of the total of the reported talc deposits. They are lens-like bodies which are concordant to the structural trend of the host lithologies. In spite of they tend to be more elongated and thick than those described for the GI terranes, they rarely exceed to 200 m in length and 10 m in width. The talc from these deposits varies from laminar or schistose to massive. It may exhibit a variety of colour from white to several shades of green and grey.

Three categories of talc are recognized in the GM terranes. They correspond to those deposits which are the product of *talcification* of (i) small mafic-ultramafic bodies, being similar to that occurrences of the GI terranes, (ii) thin lenses of chemical sediments, originally banded facies of BIF, and (iii) as in (i) and (ii) but the deposits are at or nearby the contact with the granitic intrusions. The talc characterized in both (ii) and (iii) categories is associated with a complex mineralogy that includes tremolite-actinolite, chlorite, schorl, and quartz, and they can grade into, or be associated with the calc-silicate products of the intense metasomatism on carbonate-rich BIF facies.

Paleoproterozoic metavolcanosedimentary sequences

The most important occurrences of talc are those located in the Paleoproterozoic metavolcanosedimentary sequences (black areas in Fig. 2) that occur in the central belt of the do Sao Francisco Craton. Carvalho and Evangelista (1992) grouped these sequences into three areas (Fig. 2). The Area I comprises the Xique-Xique, Barreiro-Colomí, Casa Nova and Sobradinho metavolcanosedimentary sequences; the Area II contains the Boquira and Riacho de Santana metavulcanosedimentary sequences, and finally the Area III, that, from the east to the west borders comprises the Contendas-Mirante, Umburanas, Guajeru, Brumado, Ibitira, Cacule, Licinio de Almeida and Urandi sequences. The geology of these terranes was described by several authors (e. g. Carvalho, 2000; Carvalho and Albuquerque, 1996; Carvalho et al., 1982, Costa and Silva, 1980; Cunha et al., 1992; Marinho et al., 1979; Neves, 1980; Oliveira, 1981 and Souza, 1990). They are stratigraphically laying on and infolded into the gneissic migmatitic basement and basically they are made up by a complex association – the reason why they are also termed "Complex" – that includes acid to intermediate volcanic rocks of peralkaline character, derived schists and phyllites, chemical sediments and locally, pelitic and psammitic sediments. The chemical metasediments are described by Carvalho (1982, 1988, 1991), Carvalho et al. (1982, 1995), Machado (1983), Rocha (1985), Souza (1990) and Souza (1992) as facies of banded iron, iron-manganese, manganese and iron-poor limestone (iron--poor carbonate rich facies) formations. Thick layers of magnesite are interbedded in the later type of chemical formation. There is no stratigraphic control for the chemical sediments. In many places they have a gradual contact with the GM basement and in these places – in a similar way to that one observed for the deposits at the vicinities of the granitic (sensu latu) intrusions – it is frequent the association with calc-isilicate rocks and the presence of talcification. These metasomatic zones are easily reported in places where the metavolcanosedimentary rocks occur as "island" in the gneisses and migmatites or they constitute "roof pendants" in the intrusions.

The number of occurrences of talc deposits in these terranes indicates that they are second in position and that they rank first in terms of reserves and production. The following categories of talc deposits are considered here: (a) pockets of talc in the magnesitic and dolomitic horizons representing a common situation in the iron-poor carbonate-rich facies and where the talc presents a silky feeling, laminar and massive habits and grey colour, (b) *stratabound* veinlets of talc filling fractures in the lithotypes that stand up the chemical facies described in (a) – that is the iron-poor carbonate-rich facies; such talc is soft-massive and normally white, (c) conformable stratum or strata within the iron-poor carbonate-rich facies, where the talc exhibits a white colour and a homogeneous soft-massive habit, (d) at the contact zone between these limestones and the gneissic migmatitic basement. The talc has the same physical aspects and mineral association as those reported for the type (ii) described for the gneissic migmatitic terranes and, in both the situation, they may be in association with the calc-silicate hornfels, and finally (e) talc occurs at the contact zones between the volcanosedimentary sequences and the granitic intrusions or near these zones, where the talc exhibits whitish shades of colour, massive to porous habits and is the presence of calc-silicate rocks is common.

The most economically important talc deposits are those that occur in the Sento Sé (or Barreiro-Colomí) (Q 41–42° W/9–10° S) and in the Brumado (or Ibitira-Brumado) (Q 41–42° W/13–14° S) sequences. They are also of good quality and may be used as row material in

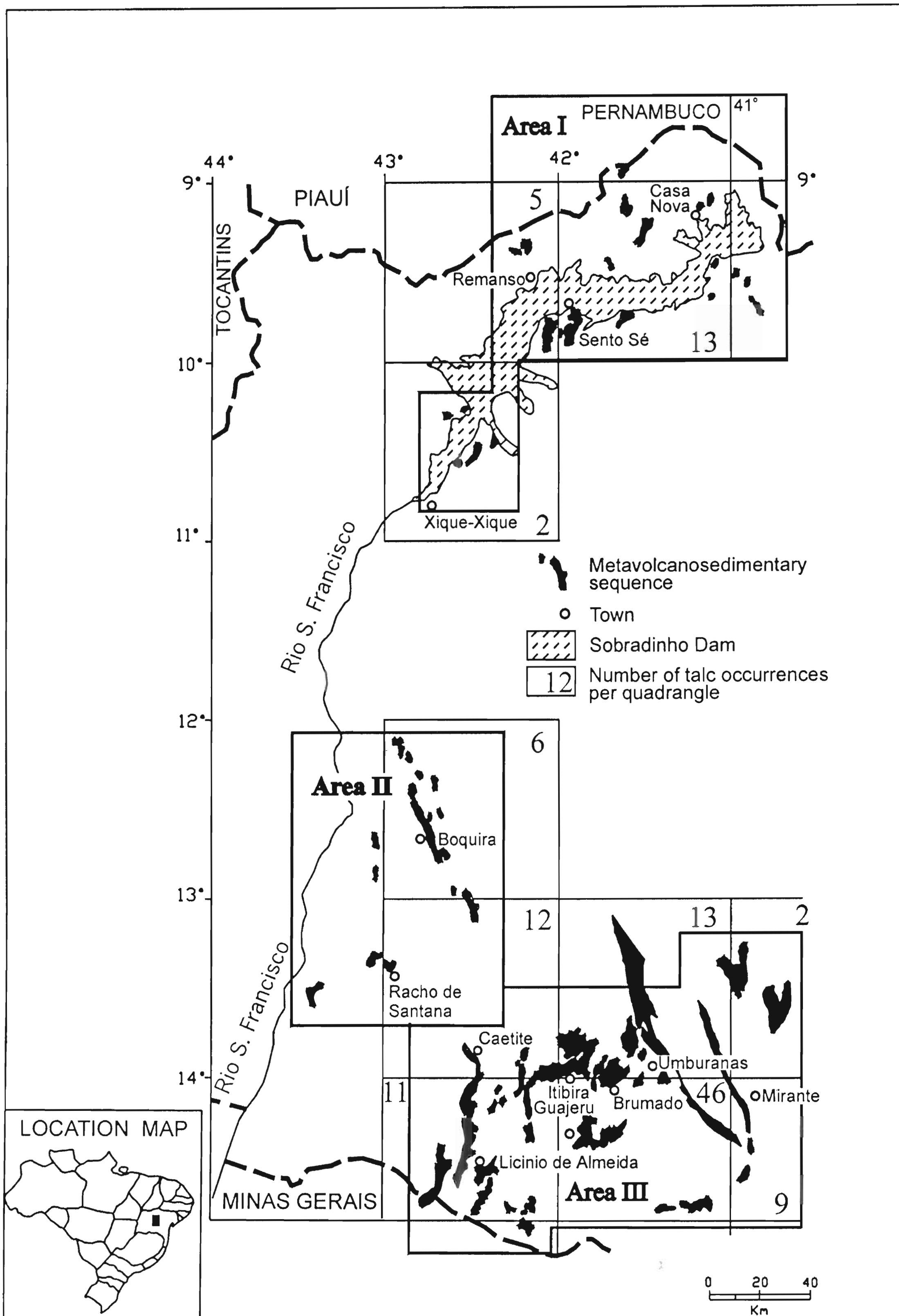

Fig. 2. Distribution of the Paleoproterozoic metavolcanosedimentary sequences.

many industries that adopt exigent requirements as it is the case of perfumery (cosmetics) and pharmacy. Their reserves have been estimated over 15 million tonnes. Only for the Brumado metavolcanosedimentary sequence that includes the famous Serra das Éguas deposits, the reserves have been calculated in more than 12 million tonnes. The more recent talc production in the State of Bahia basically comes from this region and it is about 45,000 tons per year. This amount represents only 15 % of the Brazilian annual production of talc (UNB/DNPM, 1998).

Enclaves and "roof pendants" in the Transamazonic and Archean granites (sensu latu)

Intrusive plutons and stocks of granites, syenites, monzonites, granodiorites and intermediate rocks such as monzosyenites and adamellites occur all over the Paleoproterozoic terranes of the São Francisco Craton in the State of Bahia. In size they outcrop in areas that may range from a few hundred square meters to more than 4,000 km^2, the last value being estimated for the Guanambi-Riacho de Santana Intrusive Complex.

From few known talc occurrences recorded in these terranes one is located in Q 41–42° W/14–15° S and three others in Q 40–41° W/14–15° S, being hosted in granodiorites. They constitute small deposits of few tens of meters long and less than 4 meters in width. The mineral association includes a wide variety of minerals other than talc such as variable amounts of magnesian amphiboles (tremolite-actinolite), chlorite, quartz and tourmaline (dravite and schorl). It must be pointed out the important role of the intrusive processes in the control of the *tálcification* when deposits occurred nearby mafic-ultramafic bodies of pyroxenite-gabbro-norite (e. g. Q 41–42° W/14–15° S) and serpentinite (e. g. Q 40–41° W/14–15° S) compositions. The talc derived from these mafic-ultramafic rocks is also associated with chlorite (penninite) and crocidolite.

Genetic discussion

The works carried out till present led to conclusion that the studied talc occurrences are the result of *talcification* that took place from one of the following mechanisms: (A) metasomatism of preexisting lithotypes, (B) simple metamorphic evolution of the magnesian silicate chemical sediments, either associated or not with carbonates, as well as evolution of magnesian carbonates like those that occur in the iron-poor carbonate-rich facies. Related to the (A) mechanism, the transformations occurred:

A.1. on the mafic-ultramafic bodies which are enclosed in the GI and GM complexes of the Archean/Paleoproterozoic basement;

A.2. on the chemical sedimentary facies of silicate and carbonate types of the BIF;

A.3. on the chemical sedimentary facies of iron-poor carbonate-rich type that occur stratigraphically associated to the BIF. This kind of limestones are typified by the presence of thick levels of dolomite and magnesite and they bear the most important deposits of talc which occur in the metavolcanosedimentary sequences of Sento Sé (also termed Barreiro-Colomi) and Brumado (also termed Ibitira-Brumado).

Metasomatism

The geological processes that led to metasomatism of the above specified lithotypes (mafic-ultramafic rocks and magnesian limestones) are related to:

A.1 – Action of CO_2-rich hydrothermal solutions,

A.2 and A.3 – Action of SiO_2-rich hydrothermal solutions.

The CO_2 of the hydrothermal solutions that acted on the magnesian silicates, at least for some deposits, could be derived from decay of preexisting carbonates by thermometamorphic processes that took place during the Transamazonian tectono-thermal and magmatic events. The formation of calc-silicate rocks in specific sites support this idea.

The silica necessary to explain the talcification of the magnesian carbonates was probable supplied by the intrusive processes. It was important also in the generation of the calc-silicate hornfels. Pockets, fracture-veins and veinlets wich are filled with talc in the chemical sedimentary facies of the metavolcanosedimentary sequences were formed by the action of siliceous hydrothermal solutions on magnesian carbonates, as it was illustrated by Carvalho and Albuquerque (1996).

Metamorphic evolution

The idea to explain the presence of seams and strata which are interbedded in the magnesite and dolomite-rich carbonate facies of the Sento Sé and Brumado metavolcanosedimentary sequences is based on the fact that *"in the sedimentary facies of BIF which are metamorphically set between the green schist to the lower limits of the amphibolite metamorphic facies, the minnesotaite is the mineral phase which results from the metamorphism of greenalite"*. By the fact that the later mineral is a product of the diagenesis of iron-magnesian silicate gels, and that the minnesotaite is an iron-rich variety of talc, it is probable that the stratiform talc which is found in the studied chemical carbonate facies may represent an equivalent metamorphic phase. The absence of minnesotaite, in the talc from the Bahia State is explained by the iron deficiency, the typical mark of the magnesite and dolomite-rich carbonates that occur associated to these metavolcanosedimentary sequences.

References

Barbosa, J. S. F., 1995: Mapa Geológico do Estado da Bahia. ao Milionésimo. SGM/UFBA. *Governo da Bahia, Salvador, Brazil.*

Carvalho, I. G., 1982. Geology of the Boquira District Bahia, Brazil IV Cong. *Latinoamericano de Geologia, Buenos Aires, Argentina. Actas 2, 221–228.*

Carvalho, I. G., 1988: Host rock geochemistry and its contribution to the genetic interpretation of the Boquira Deposits, Brazil. VII Cong. *Latinoamericano de Geologia, Belem, Brazil, Anais 1, 216–229.*

Carvalho, I. G., 1991: Formações ferríferas sedimentares do Estado da Bahia, Brasil. I Cong. Geoq. de Países de Língua Portuguesa. *Resumos Estendidos, São Paulo, Brazil, 1, 215–217.*

Carvalho, I. G., 2000: Chemical depositions associated with the metavolcanosedimentary sequences at the central portion of the São Francisco Craton in the state of Bahia, Brazil· a review. *Revista Brasileira de Geociencias 12 (in print).*

Carvalho, I. G. & M. A. G. de Albuquerque, 1996: Contribuição geoquímica ao estudo das deposições químicas dos complexos metavulcanossedimentares do Proterozóico Inferior no Estado da Bahia. *Geochimica Brasiliensis, 10, 379–400.*

Carvalho, I. G. & Evangelista, A. S., 1992: Contribuição ao conhecimento metalogenético dos complexos metavulcanossedimentares do Proterozóico Inferior da faixa central do cráton do São Francisco. I Simp. Regional. *Geologia Bahia-Sergipe, Anais 1, Salvador, Brazil, 135–138.*

Carvalho, I. G., Zantop, H. & Torquato, J. R. F., 1982: Geologic setting and genetic interpretation of the Boquira Pb-Zn deposits, Bahia State, Brazil. *Revista Brasileira de Geociências, 12, 414–425.*

Carvalho, I. G., Misi, A., Iyer, S. S. & Tassinari, C., 1995: The Boquira Lead-Zn Deposits, Brazil: a review based on new isotopic data. *IX Cong. Latinoamericano de Geologia. Resumos 1, 201* Texto Completo em disquete TEM 5-290 F1-F8. Caracas, Venezuela.

Costa, L. A. M. & Silva, W. G., 1980: Projeto Santo Onofre: mapeamento geológico, Relatório Final. *DNPM/CPRM, Rio de Janeiro, Brazil.*

CPM/SME, 1974: Projeto cadastramento de Ocorrências minerais do Estado da Bahia, Governo da Bahia, Salvador, Brazil, 2, 317

Cunha, J. C., Silveira, W. P. & Soares, J V., 1992: Reavaliação das seqüências metavulcanossedimentares da porção Central do Cráton do São Francisco na Bahia. 37 Cong. *Brasil. de Geologia. São Paulo, Brazil. Anais 2, 160–161*

DNPM/MME, 1979: Anuário Mineral Brasileiro. Brasília, Brazil. Ano 8, 325. Talco: 296–298.

Machado, R., 1983 Discussão e gênese do protomiminério de manganês de fácies óxido-carbonato denominado de Bandarito, Bahia. *Revista Brasileira de Geociências, 13, 99–122.*

Marinho, M. M., Soares, J. V., Silva, E. F. A., Lago, S. E., Oliveira, N. S. & Rangel, P A., 1979: Projeto Contendas-Mirante, Relatório Final. *CBPM/SME. Governo da Bahia, Salvador, Brazil.*

Neves, B. B., 1980: Evolução geocronológica do Pre-cambriano do Estado da Bahia. *Textos Básicos. Salvador, Bahia, Brazil. 3, 1–101*

Oliveira, J. E., 1981: Caracterização geoquímica da Seqüência Vulcanossedimentar Guajerú, Bahia. *Dissertação de mestrado, Inst. de Geoc./UFBA, Salvador, Brazil.*

Rocha, G M., 1985: Características das fácies ferrífera de Boquira. Dissertação de mestrado , Inst. de Geoc./UFBA, Salvador, Brazil.

Sá, J A. da S., 1982. Mapa metalogenético do Estado da Bahia. *CPM/SME, Governo da Bahia. Brazil.*

Souza, F. A., 1992: Contribuição ao estudo do intemperismo laterítico de duas regiões do semiárido baiano – Gentio do Ouro e Sento Sé. *Dissertação de Mestrado, Inst. de Geoc./UFBA, Salvador, Brazil.*

Souza, S. L., 1990: Projeto Caetité: Fase II. Relatório Final. *CBPM/SME, Governo da Bahia, Brazil.*

UNB/DNPM, 1998. Universo da Mineração Brasileira Miningsite: "http://www.miningsite.com.br".

Characterization of the Paraná talc deposits, Brazil

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Abstract

The Paraná State production of talc of estimated 180,000 tonnes/year represents 50 % of the talc production of Brazil. The 80–90 % of the raw material production is used in ceramic industry. The talc occurs in the Late Proterozoic Itaiacoca Group with variegated lithology. Deposits are located in dolomite marbles preferentially near the dolerite dykes and quartzite layers representing harder rocks and protecting the talc bodies against erosion. These morphological controls of talc deposits location represent an important guide to exploration. According to mineralogical constitution, touch, visual aspects and chemical results the talc of the Itaiacoca Group is regionally divided into five different subregions.

Key words: talc, production, qualitative characteristics, Itaiacoca Group, Paraná State

Introduction

In Brazil, Paraná State production of talc is estimated on 180,000 tonnes/year, which represent 50 % of the nationwide production (Campos, 1999). In the past, during the 1980s, the talc production was about 280,000 tonnes/year, and the bigger part (more than 65 %) of the production went to ceramic industries (Berg and Loyola, 1987; Loyola, 1987). Nowadays the production proportion for ceramic use is 80–90 %.

The talc deposits are located at the regions of Castro and Ponta Grossa municipalities. All deposits are mined by open pit methods.

Geological setting

The talc occurs in the Late Proterozoic Itaiacoca Group representing a geological structure 10 km wide and a little more than 100 km long with a NE regional trend. Low grade metamorphic rocks sequences underwent strong ductile as well as brittle deformation. The talc mineralizations are concordant with the regional trend of the sedimentary and metamorphic structures.

Sediments of Itaiacoca Group (dolomite marbles, quartzites, phyllites, acid and basic metavolcanic rocks) represent a variegated mixture of facies related to rifting on continental crust.

Two batholithic granite bodies, situated towards NW and SE of the talc deposit areas intruded to the metavolcanic-sedimentary sequence. These bodies are polydiapiric granites, mainly syntectonic, dated on 550 Ma (Gondim, 2000).

The region is penetrated by several Cretaceous vertical to subvertical dolerite dykes 5–30 m thick, trending NW–SE (Gondim, 2000).

The talc mineralization is pervasive in dolomite marbles. The deposits in the Itaiacoca district are hundred meters long (trending NE-SW), two hundred meters wide and one hundred meters deep (Gondim, l. c.), in Socavão district they are less than hundred meters long and 30 meters wide (Souza, 1988).

Types of mineralization

The genesis of the talc is connected with two kinds of mineralization processes: regional metamorphism and hydrothermalism. There are also reworked talc bodies, formed by erosion and colluvionar processes (Lima, 1993; Ribas, 1999; Gondim, 2000).

In Itaiacoca Group also retrograde metamorphism in dolomite marbles is supposed. The talc mineralization, in this hypothesis, was formed during the temperature decreases.

The bodies of talc always occur near the dolerite dykes and quartzite layers representing harder rocks than the dolomite marbles and protecting the talc bodies against erosion. These morphological controls of talc deposits location represent an important guide to exploration.

Chemical and physical characterization of the talc mineralization

The characterization of 55 samples of talc ore from the Itaiacoca Group has been made. The samples represent all kinds of the talc ore produced at the Paraná State.

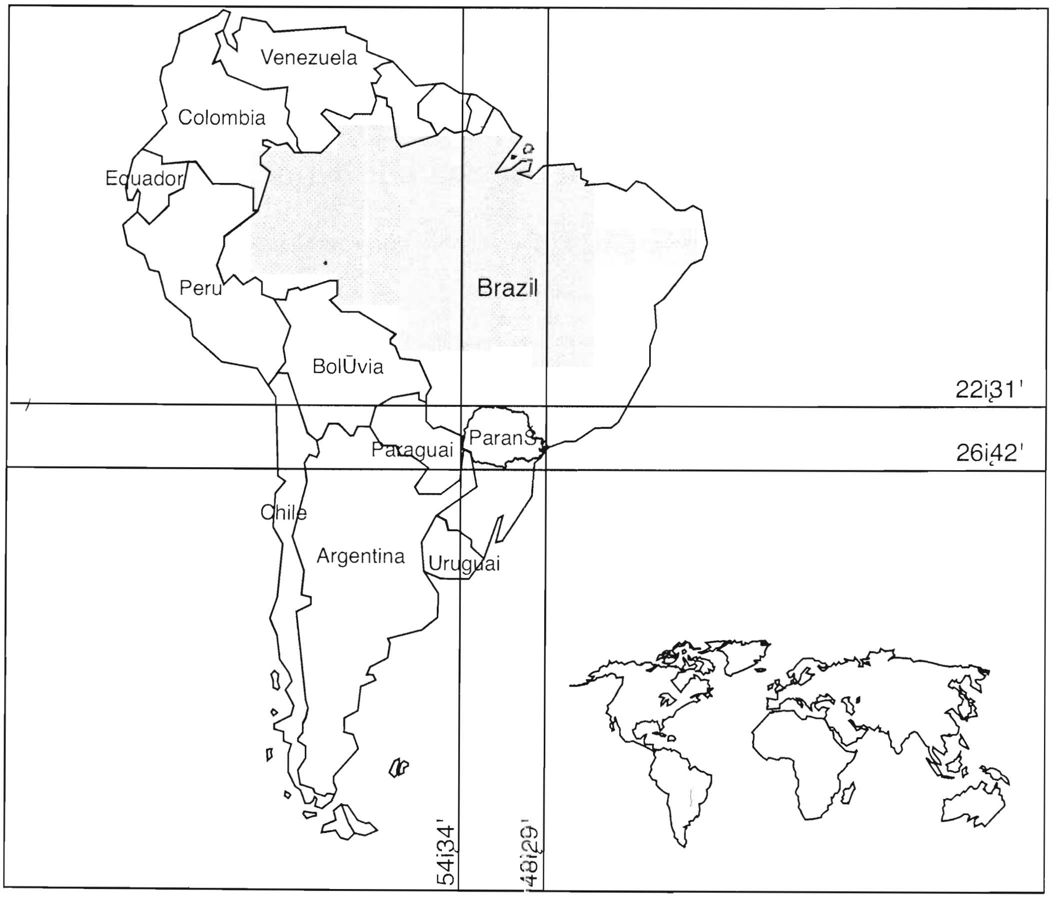

Fig. 1. The state of Paraná in South America.

Tab. 1
Results of the 55 samples

Sample colors	% of the samples	MgO	Fe_2O_3	Al_2O_3
yellow	5.5	24 to 31 %	0.4 to 2.2 %	0 to 2 %
white	21.8	21.8 to 32.1 %	0.2 to 4.1 %	0.1 to 10.6 %
light brown	3.6	25 to 30.3 %	1 to 4 %	2 to 3.7 %
light yellow	29.1	26.6 to 30.5 %	0.3 to 2.2 %	0.2 to 1.9 %
light green	5.5	24.7 to 29.9 %	1.6 to 1.9 %	4.7 to 6.1 %
light pink	34.5	16.1 to 31.5 %	0.1 to 3.1 %	0.1 to 8.9 %

The chemical results show a big difference in the several kinds of samples. From 55 samples, 22 have MgO higher than 29.5 %, and 10 of them higher than 31%.

The Al_2O_3 represents an impurity in the talc ore. Some samples contain more than 8 % of alumina. In these samples, it is accompanied together with 2–3 % Fe_2O_3 which means the presence of other clays minerals as impurities. With Al_2O_3 higher than 4 %, the samples overfired in 1450 °C ceramic tests.

The results of the Cation Exchange Capacity analyses show that the samples with results higher than 1 have also other minerals than talc. Some samples have results higher than 10, which means that the ore contains clay minerals as montmorillonite and chlorite in a significant percentage of mineral constitution.

The presence of clays minerals gives a better resistance in ceramics produced using these ores. An increase of temperature in ceramic tests for pure talc ores samples did not show significant changes and the color after firing remained white. The 67 % of the talc sample results fulfil requirements for use in white ceramic industry.

Table 1 demonstrates general results from 55 studied samples. It is possible to observe that the original color of the talc, does not mean a better purity.

According to mineralogical constitution, touch, visual aspects and chemical results Loyola (1987b) describes qualitative differences of the talc in various localities of the Itaiacoca Group and divides the area to five different subregions:

1. At the south of the region the important zones of pure talc are present.

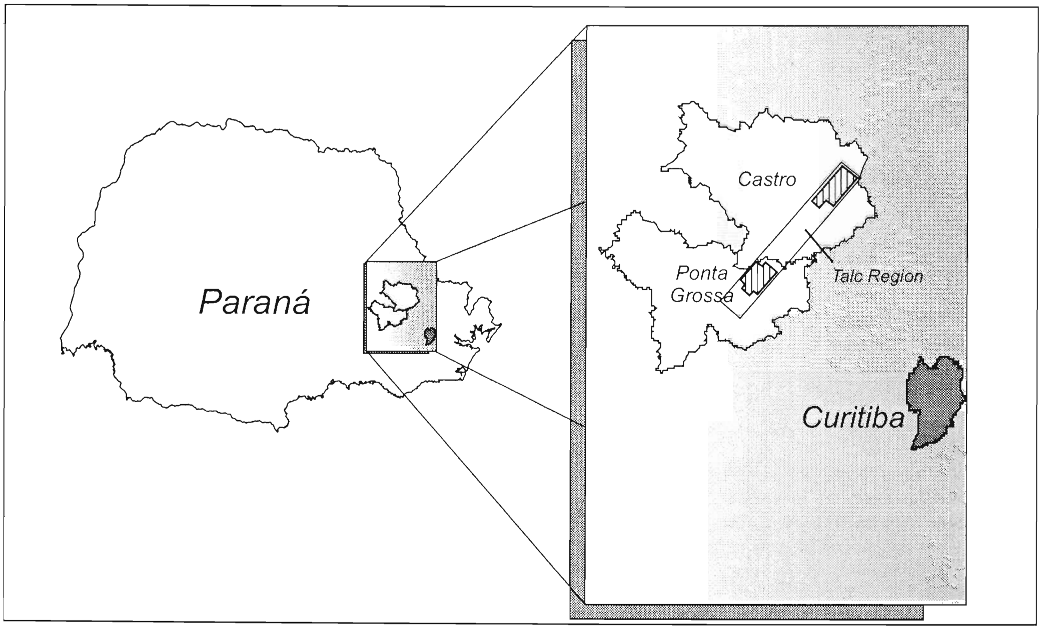

Fig. 2. Talc regions in Paraná State.

2. The southwestern zone is characterized with increased contents of chlorite and montmorillonite.

3. At the southeast tremolite and chlorite were found.

4. In the middle part of the region, the deposits are related to the metavolcanic rocks and regional faults, the talc ore is powdered and also serpentine was found.

5. In the north, the talc ore is chemically pure but powdered and without soapy aspect.

Further mineral impurities found in the several mines are quartz, serpentine, montmorillonite, chlorite, tremolite, muscovite, calcite and dolomite.

References

Berg, E. A. T & Loyola, L. C. de., 1987: Contribuicão ao estudo de talcos do estado do Paraná. *In: Congresso Brasileiro De Cerâmica (31 1987 Brasília) Anais São Paulo, ABC. 2, 783–819*

Campos, L. E. G., 2000 Talco e pirofilita *In: Sumario Mineral 2000 DNPM Brasília. 20, 103–104*

Gondim, A. C., 2000 Talc deposits of Parana State. *IGCP–443 First field correlation guidebook Curitiba, 14.*

Lima, R. E. de, 1993 Evolucão geologica dos depositos de talco da região de Itaiacoca e Abapã – Parana UNB, Brasília Dissertacão (Mestrado) – Instituto de Geociências, Universidade de Brasília

Loyola, L. C. de, 1987: Talco no Paraná: caracterizacão tecnológica. *MINEROPAR, Curitiba.*

Loyola, L. C. de, 1987: Relatório de desenvolvimento do projeto geologia e tecnologia do talco paranaense. Coordenacão da Producão Mineral, Curitiba.

Ribas, S. M., David, C. A. S., Brandão, W. & Valaski, Z. de F., 1999: Avaliacão metalogenética do distrito mineiro de talco no Estado do Paraná. *MINEROPAR, Curitiba, 1.*

Souza, P. E. C. e., 1988: Caracterizacão das minas de talco do Paraná – Paraná. *In: Encontro nacional do talco. Sindicato da Indústria de Extracão de Minerais Não Metálicos de Ponta Grossa, Anais, Ponta Grossa 4, 333–341*

Position of the Slovak magnesite on world markets

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Abstract

The reserve base in Slovak Republic is 3,400 million tonnes of magnesium raw material Identified world resources of magnesite are total some 12 billion tonnes, and there are also large resources of magnesium-bearing substitutes such as dolomite, brucite and olivine. Furthermore, magnesium compounds can be recovered economically from well and lake brines and from sea water The latter, which contains 0.13 % by weight of magnesium, is a major source of this raw material and its compounds.

The contribution summarizes the production possibities of the Slovak magnesite industry and its possibilities to survive in competition with the world production.

Key words: magnesite, marketing, market segmentation

Introduction

World production of the magnesite clinker, caustic magnesite and fused magnesite reaches 8,184 million tonnes per year (Kendall, 1998).

During the last 5 years world production has decreased aproximately about 20 %. This was evoked mainly by the decrease of specific needs of refractory products in basic branches of consumption, in steel and cement industry. Despite the increase of total world steel production, the reduced demand for refractory materials causes their lower production.

Position of Slovak magnesite on world markets

Slovak Republic belongs among the most important producers of the natural magnesite with 1,600 thousand tonnes of exploited raw magnesite being 11.4 % in the world exploitation. Slovak magnesite with its geological reserves of the raw magnesite – 734 million tonnes participates with 5 % on the world production of the magnesite clinker. Ratio of the clinker on the European market is 11 %. Table 1 shows basic statistical data of the magnesite industry related to 1. 1. 1999.

In 1998 the Slovak miners exploited 1,572.8 thousand tonnes of the boose and 877.8 thousand tonnes of concentrates were produced. Exploitation decreased in comparison with 1997 about 7.9 thousand tonnes, concentrate production increased about 10.3 thousand tonnes. In comparison with 1993 the exploitation of magnesite increased and was stabilized (Figs. 1 and 2).

Table 2 presents review of Slovak refractory material producers with regard to the magnesite clinker and bricks in 1998.

Tab. 1
Basic indexes about Slovak magnesite

	1997	1998
Number of deposits – total	12	9
– from this: expoited	3	4
Reserves – total (Tt - thousand tonnes)	1 145 428	1 143 343
– from this: balance researched (Z-1 Z-2) (Tt)	155 209	153 354
balance finding (Z-3) (Tt)	652 886	652 810
not balanced (Tt)	337 333	337 179
Exploitation (Tt)	1216	1252
Import (Tt) *	20,6	24,3
Export (Tt) *	249,1	236,7

* index from the tax tariff 2519

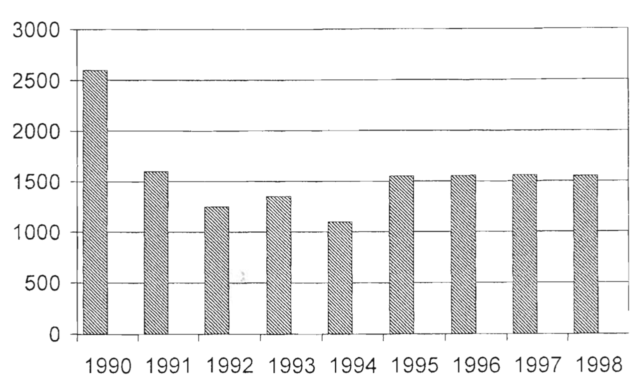

Fig. 1. Development of the magnesite exploitation (Tt).

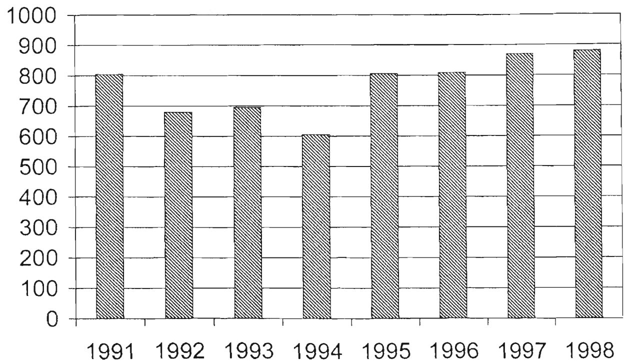

Fig. 2. Development of the magnesite concentrate production (Tt).

Tab. 2
Review of the Slovak producers of the magnesite clinker and bricks.

Company	Production of the magnesite clinker per year (tonnes)	Production of the basis building material per year (tonnes)	Privatization
SLOVMAG, Inc., Lubeník	120,000	90,000	1994
LOVINIT, Inc., Lovinobaňa		60,000	1996
Slovak Magnesite works JSC, (SMZ) Jelšava	300,000		1994
VSŽ KERAMIKA, Ltd., Košice		10 000	1992–1996
MAGNATEC Slovakia Inc., Hačava	(15,000–20,000) in bankruptcy		1995
DINAS, State Enterpr., Banská Belá		5,000	
KOMAG, Inc., Košice	(40,000) in bankruptcy		1996

Tab. 3
Review of the world market with magnesite clinker

Company	Type	Sign	MgO	CaO	SiO_2	Fe_2O_3	Al_2O_3	C:S	Crystal magnitude
Grade LCA1									
Premier Periclase	S	Premier LC	97.2	2.10	0.25	0.20	0.07	8.4	150
Quimica del Rey	B	RY-99-SAD	98.77	0.80	0.15	0.10	0.10	5.3	115–125
Qmag	N	Qmag Super	97.0	2.10	0.50	0.10	0.10	4.0	140
Grade A1									
Ube Chamical	S	Ube 98 HD	98.10	1.30	0.35	0.07	0.07	3.7	100
Dead Sea Periclase	B	CF	99.2	0.70	0.02	0.03	0.01	35.0	80
Biliton Refractories	B	Nedmag SD	98.5	0.69	0.13	0.48	0.06	5.3	90–110
Quimica del Rey	B	RY-99-AD	98.84	0.80	0.15	0.10	0.10	5.3	
Magnatech Hačava	N	Hamag DBP	99.5	0.15	0.04	0.12	0.017	3.7	
Qmag	N	QmagExtra	96.6	2.30	0.70	0.10	0.10	3.3	80
Grade B1									
Konya KronMagnezit	N	Sodur	97.0	1.5	0.77	0.50	0.50	2.0	90–100
Magnesita	N	M-40	96.3	2.9	0.80	0.50	0.08	3.6	160
Radex Group	N	Low Iron	96.0	1.8–	0.5–	0.30	0.15	2.0	
Grade B2									
Kumas	N	KM Special	96.0	2.0	1.25	0.40	0.10	1.6	
Liaoning	N	9730	97.3	1.2	0.80 0.8	0.6–	0.2–0.4	1.5	
Grade C1									
Liaoning	N	China 9210	92.5	2.00	2.80	0.90	1.40	0.4	
Liaoning	N	China 9010	90.0	2.50	4.50	1.50	1.70	0.5	
Liaoning	N	China 9510	95.0 3.0	1.26–	4–5 2.12	0.94– 0.70	1.54–1.9	0.3	
Steetly Magnesia	S	Britmag 323	90.7	3.10	2.25	3.10	0.70	1.4	
Steetly Magnesia	S	Britmag 222	93.1	2.30	2.20	1.50		1.1	
Grade iron magn.									
Komag	N	Flotmag	90.2	3.50	3.50	5.6	0.7	–	
Radex Group	N	Brick Grade	91.0 3.5	2.0– 0.6	0.4–	4–6	0.5	5.5	
Radex Group	N	High Lime	85.0 8.5	6.5–	1.0	5–8	1.0	6.5–8	
SMZ Jelšava	N	TS Normal	87.5	3.0	1.0	8.0	0.4	2.5–4	
SMZ Jelšava	N	TS Special	88.5	2.5	0.6	8.0	0.3	2	
SMZ Jelšava	N	TS Briket.	88.5	2.8	0.7	7.5	0.3	4	
Slovmag Lubeník	N	TS Štandard	89.0	3.0	2.0	9.0	0.35	1.5	
Slovmag Lubeník	N	TS Special	88.0	2.4	1.2	8.5	0.25	2.0	

Global view on the magnesite quality is also determining factor for realization on the market. All new deposits in the world have 92–98 % content of the MgO.

Table 3 indicates qualitative classification of Slovak magnesite clinker. The review demonstrates, that Slovak magnesite clinker is classified to the lowest quality class due to the 8–9 % content of the Fe_2O_3. Magnesite of supreme quality should have Fe_2O_3 content not exceeding 1 %. The content of Fe_2O_3 in combination with CaO being also present in Slovak natural magnesite, causes decisive decrease of the fireproof ability of the clinker and then also building materials, produced from such clinkers. Broad use have such products in production of cement building materials, magnesite and magnesite-chromium building materials, as well as for nonworking panels in electric furnaces. Magnesite of these qualitative parameters is elaborated also by recent world producers, such as Veitch-Radex-Didier firm, Refratechnik, Lovinit Lovinobaňa, ZM Ropczyce and PMO Krakow. Deposit exploited by Slovmag Lubeník belongs also to this group. Such building materials have been broadly used during the steel production in Siemens-Martin furnaces recently being compensated with electrical furnaces and convertors. Operating conditions of new equipments need glare-defiant materials with much higher content of MgO. The same trends are existing also in production of cement building materials, where clinkers with low iron content, for example periclase-spinelitical type, are preferently used.

Slovak magnesite industry is decisively orientated to the export of the production. The export of individual enterprises reaches 60–90 %. Recently the products are exported mainly to Czech Republic, Germany, Italy, France, China, India, Cuba, Canada, U.S.A, Iran, JAR, Austria, Slovenia and Ukraine. High export range increases requirements for the products to be competive concerning their quality and price. Slovak producers have difficult situation since young Slovak private firms must face to the strong multinational corporations - mainly from Austria and Germany.

Certified system of the quality management according ISO 9000 is unambiguous demand for facing to the hard competition. Slovmag Inc. Lubeník, Slovak Magnesite works JSC Jelšava, VSŽ Keramika, Ltd. Košice, Lovinit Inc. Lovinobaňa fulfil such demand.

Aproximately 70 % of the products of the magnesite industry are used for steel industry, 15 % for cement industry and 15 % for color metallurgy, for ferro-alloy and lime, for glass industry and for filling of the heat-accumulation furnaces. Systematical monitoring of the qualitative and quantitative trends in mentioned branches is a neccessary requirement for proper research and development orientation as well as successful business. Steel industry is main consumer of refractory materials, therefore it is the main target of the concentrated marketing investigation made by Slovak magnesite producers.

References

Clarke. G., 1992. Magnesia around the world. Industrial Minerals. April 1992.

Kendall. T., 1998: Dead burned magnesite. Industrial Minerals. February 1998.

Kendall. T., 1996: Refractory magnesia, hot topics reviewed. Industrial Minerals. September 1996.

Magnesite and talc mineralization in Slovakia

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Abstract

Magnesite and talc deposits and occurrences in Slovakia are located in Lower and Upper Paleozoic sequences of Gemericum and Veporicum, two of several tectonic megaunits of Western Carpathians building the territory of Slovakia. Description takes into account the geological background of mineralization, mineralogy, bulk chemistry and spatial constraints of mineralization into several main zones. According to the regional competence there are successively described the largest magnesite deposits of the western part of Gemericum - Dúbrava massif (Dúbrava, Miková, Jedľovec) and the eastern part of Gemericum – Košice deposit, in both cases together with numerous smaller occurrences. The talc deposits Dlhá dolina (located in Gemericum) and Mútnik (area of Veporicum) are characterized by their interconnection with magnesite mineralization. At the end of contribution the most significant occurrence of amorphous magnesite near village Hodkovce is briefly described.

Key words: geological setting of deposits, mineralogy, bulk chemistry, reserves, production, Gemericum, Veporicum

Introduction

Magnesite deposits (Fig. 1) are located in Carboniferous formations of so-called Magnesite Carboniferous Belt, and only small part of occurrences is in the Lower Paleozoic rock complexes.

Carboniferous magnesites are, according to the lithostratigraphic division of Lower Paleozoic complexes of Gemericum by Bajaník et al. (1983), situated in in the upper part of the Ochtiná Formation of Dobšiná Group, i. e. in the environment of black schists with intercalations of metabasalts and their pyroclastics. The age of formation is according to the trilobites and brachiopods designated to Namurian B-C (Bouček and Přibyl, 1960) and according to conodonts to Upper Viséan-Namurian A (Kozur et al., 1976). Faunae used for dating was found directly in magnesite bodies or in their nearest footwall. Rocks are metamorphosed in the greenschist facies.

Lower Paleozoic carbonatic bodies are located in the Betliar Formation (formation of black phyllites) - in the Holec Beds (according to lithostratigraphy by Grecula, 1982). Carbonates are only locally changed to magnesi-

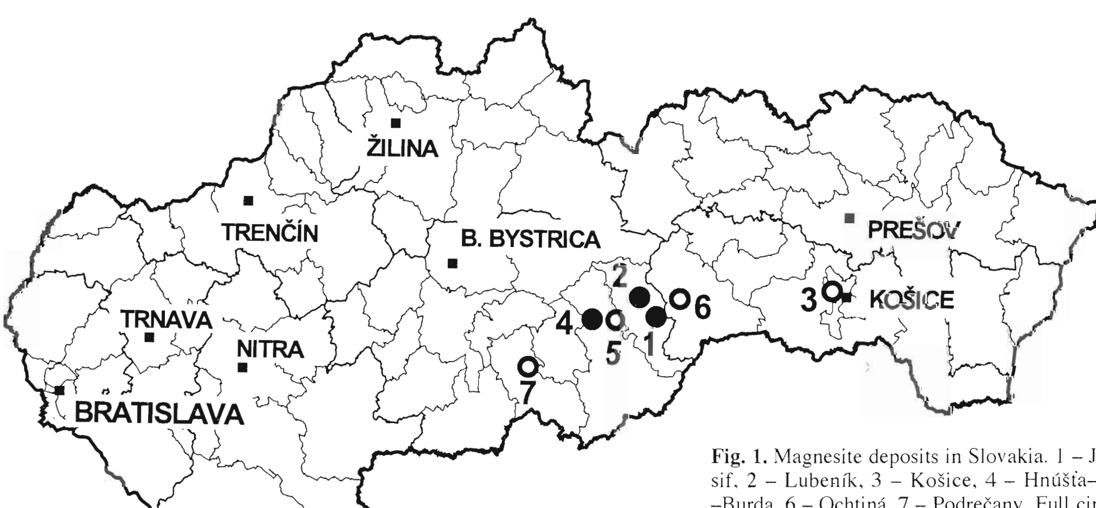


Fig. 1. Magnesite deposits in Slovakia. 1 – Jelšava–Dúbrava massif, 2 – Lubeník, 3 – Košice, 4 – Hnúšťa–Mútnik, 5 – Rovné–Burda, 6 – Ochtiná, 7 – Podrečany Full circle – exploited mineral deposit, empty circle – non-exploited mineral deposit.

tes. Siderite and ankerite with local presence of magnesite are more often. In deeper levels of Lower Paleozoic complexes magnesite was reached by drilling works (localities Vlachovo, Dlhá dolina, Mníšek nad Hnilcom). Some occurrences of magnesite (Veľká Šteť, Martin Šebök) have problematic allocation. They are understood to be either Carboniferous or Lower Paleozoic, developed in the Rakovec Group (Abonyi, 1971).

Small occurrences of amorphic magnesite were found near Hodkovce in the weathering crust of ultrabasic body (Zlocha, 1972).

Magnesite deposits of so-called Magnesite Carboniferous Belt are located in the northern zone of Gemericum. Its western part (Fig. 2) contains the deposits in the segment Podrečany – Ochtiná and eastern segment (Fig. 6) deposits near Košice town. In the westernmost part, in Cinobaňa and Ružiná - Tuhár belt (syncline) they are located in the area of Veporicum. The main magnesite belt starts near Podrečany and continues northeastward under the Neogene formation via villages Veľká Ves, Breznica, Selce, Poproč-Burda and Dúbrava massif toward Ochtiná village.

Mineralogy and bulk chemistry

The main mineral component of magnesite bodies is coarse-grained and light-coloured magnesite. Medium and fine-grained magnesite is less common, its colour is grey, yellow-grey and brownish. There are present also other minerals: dolomite, talc, quartz, calcite, chlorite, pyrite, ankerite, rutile, apatite, sericite, chalcopyrite, tetrahedrite and muscovite (Trdlička, 1959). Magnesite structure is massive, confining and on the edges of mineralized bodies banded. In oxidized zones magnesite changes to ochres. Exploited magnesite deposits have relatively constant quality with variations of MgO in the range 40.2–42.6 %, Fe_2O_3 3–4 %, CaO 1.5–4.8 %, SiO_2 0.7–2.5 %, MnO 0.1–0.4 %. The quality of fireproof products depends mainly on chemical composition of raw material. The content of isomorphic iron in magnesite facilitates the raw material caking and

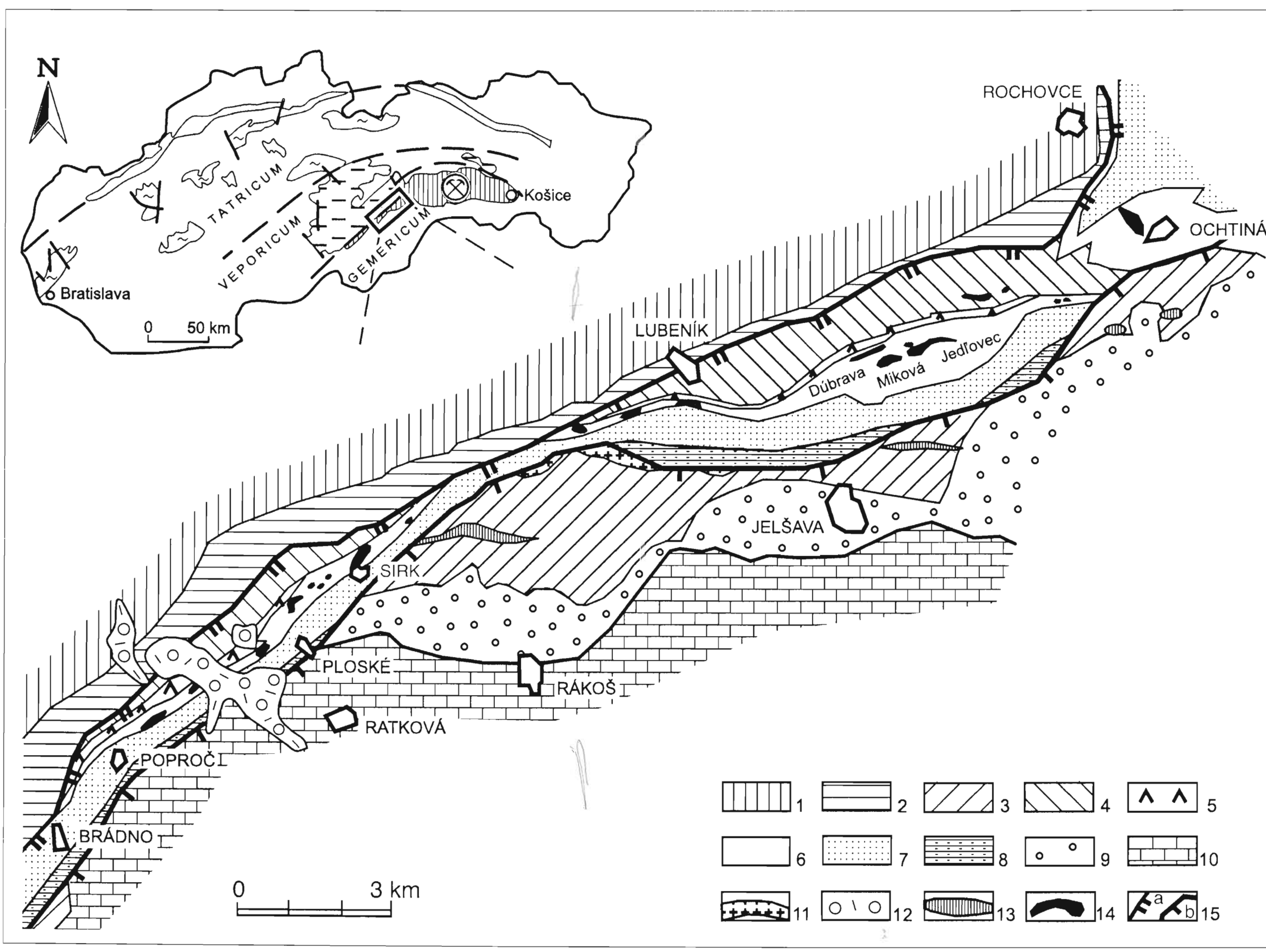


Fig. 2. Magnesite deposits between Brádno and Ochtiná – western part of Gemericum (modified after Abonyi and Abonyiová, 1981). 1 – Veporicum undivided, 2 – Permian cover of Veporicum, 3 – Gelnica Group, 4 – Rakovec Group, 3–4 – Lower Paleozoic of Gemericum, 5 – greenstones, 6 – basalt pyroclastics and black phyllites, magnesite-bearing horizon, 7 – graphitic phyllites, 8 – sericite-graphite phyllites with psammitic and psephitic intercalations, 5–8 – Carboniferous Ochtiná Group, 9 – Gočaltovo Group, 5–9 – Upper Paleozoic of Gemericum, 10 – nappe of Mesozoic carbonates and shales, 11 – Turčok and Železník granite, 12 – Tertiary andesitic agglomerates, 13 – ankerite deposits and occurrences, 14 – – magnesite deposits and occurrences, 15 – overthrusts: a – Lubeník–Margecany line, b – Hrádok–Železník line.

Tab. 1
Slovak Republic reserves and production – magnesite (Tréger and Baláž, 2000)

Year	1996	1997	1998	1999
Number of deposits (total)	12	9	10	10
– exploited	3	4	4	3
Total reserves [kt]	1,145,428	1,143,343	1,170,652	1,169,115
– economic proved and probable (Z-1 + Z-2)	155,209	153,354	161,501	160,231
– economic supposed (Z-3)	652,886	652,810	657,089	657,064
– potentially economic	337,333	337,179	352,062	351,820
Mining output [kt]	1,216	1,252	1,261	1,143
Concentrates production [kt]	825	864	878	918

increases quality of fireproof products for metallurgical industry. Harmful components are SiO_2 and CaO (so-called CS module - the ratio of $CaO:SiO_2$).

Magnesite deposits in Carboniferous formations

Carboniferous magnesite deposits represent the main part of magnesite resources in Slovakia and supply entire demands of Slovak industry. Deposits and occurrences transposed on Veporicum are processed in the factory in Lovinobaňa. Deposits and occurrences of the main mineralized belt between Brádno and Ochtiná villages (Fig. 2) supply factories Jelšava, Lubeník and Hačava, exploiting and processing magnesite. Deposits near Košice, Bankov-Banisko and Medvedia (Fig. 6) belong, according to the quantity of raw material, among the best magnesite deposits and were the base of raw material for Košice factory.

The deposits Ružiná, Cinobaňa and Podrečany in the Upper Carboniferous sequences are located as tectonic outliers on Veporicum. Recently proved overthrust of Upper Carboniferous rocks towards north and northwest from supposed course of Lubeník-Margecany line, the dividing line between Gemericum and Veporicum (Fig. 2), reaches 4–8 km distance. The deposit Ružiná is exhausted yet and deposit Cinobaňa is abandoned because of its small dimensions and low-quality of raw material.

Deposits and occurrences in the western part of Gemericum

The most productive part of Upper Carboniferous rock complexes with deposits of magnesite is in the segment between Brádno and Ochtiná villages (Fig. 2). This segment contains also biggest deposit Dúbrava massif, furthermore medium-sized deposits Sirk, Lubeník, Burda and Ochtiná and small deposits Ratkovská Suchá, Ploské, Ploské-Latinák and Amag. Biggest among further occurrences are Hlinka, Hrádok and Biela skala. Mineralized horizon geographically crosses Revúca highland in the NE–SW direction.

Surrounding rocks are formed by basal parts of Upper Carboniferous complexes. Lower horizon is lying on Lo-

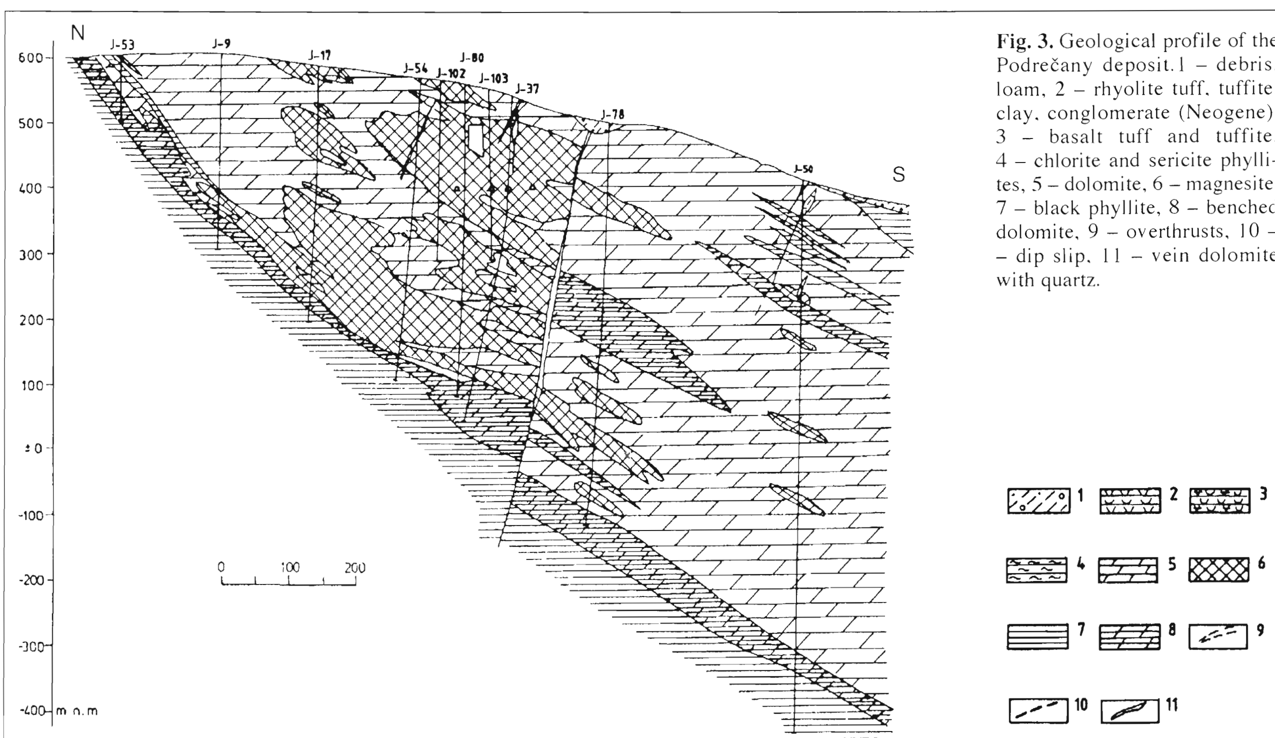


Fig. 3. Geological profile of the Podrečany deposit. 1 – debris, loam, 2 – rhyolite tuff, tuffite, clay, conglomerate (Neogene), 3 – basalt tuff and tuffite, 4 – chlorite and sericite phyllites, 5 – dolomite, 6 – magnesite, 7 – black phyllite, 8 – benched dolomite, 9 – overthrusts, 10 – – dip slip, 11 – vein dolomite with quartz.

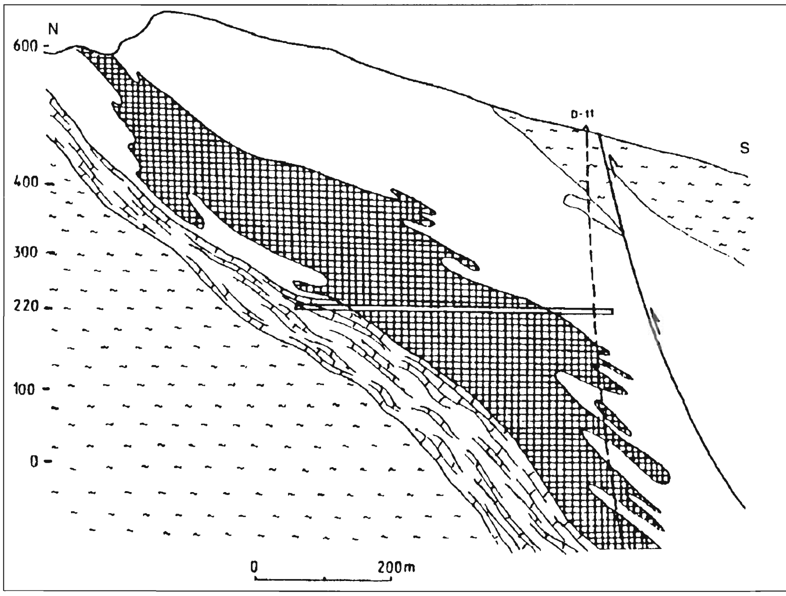


Fig. 4. Geological profile through the magnesite deposit Dúbrava massif (Čapo, 1992). 1 – magnesite, 2 – dolomite, 3 – bench dolomite, 4 – black schists (Carboniferous), 5 – overthrust, 6 – mining works, 7 – borehole.

wer Paleozoic rocks of Rakovec nappe with moderate angular unconformity 15°. In the segment from Brádno to Hrádok the Carboniferous greenstones represent the lowermost part of sequence.

Towards overlier greenstones continue via alternated intercalations of tuffs, tuffites and gray phyllites to black phyllites with small amount of psammitic material.

Carbonatic bodies forming recent deposits of magnesite and dolomite originally represented the bioherm limestones and mud as well as organodetritic limestones in peribioherm parts of sedimentary basin. They suffered orogenic metamorphism probable during closure either of Rakovec or Meliata-Hallstatt sedimentary basins, including subduction and exhumation. This process equilibrated and produced the mineral asemblage magnesite-calcite-dolomite.

Occurrences of cliff corals and faunae association display the biohermic biotop in the environment of shallow open sea. Faunae typical for coral bioherms – corals and lilies – was found from the bottom of bioherms (Bouček and Ulrich, 1931; Heritsch, 1934; Mišík, 1953). Bouček and Přibyl (1960) determined faunae of trilobites, mainly rugorose corals, shellers, mosses, ortocone nautiloideas and others. Viséan and Namurian A ages were determined on the basis of conodonts (Kozúr et al., 1976) from carbonatic rocks and underlying phyllites in the Ochtiná area. Into the underlying phyllites and carbonates the contribution of faunae remnants from older formations was also possible. This is indicated also by moderate angular unconformity between Early Paleozoic and Carboniferous volcano-sedimentary rocks.

Overliers of carbonates are represented with black phyllites locally with psammitic to psephitic intercalations, thick altogether 300–350 m.

Dúbrava massif (Dúbrava, Miková, Jedľovec)

Deposit is located 3.5 km towards NE of Jelšava on the main mountain ridge of Kohút – Hrádok hills with altitudes Dúbrava, Miková and Tatárska hoľa hills. These altitudes are also the apical parts of the deposit segments.

Mineralized body has in the Carboniferous Ochtiná Formation the same geological position as we have described in the introductory part of this chapter. Systematic survey of this deposit started in 1957.

Carbonatic body has the directional length 4,500 m, course NE-SW, dip 55–60° to SE and maximal thickness 600 m (Fig. 4).

Magnesite bodies in the western part of deposit (Dúbrava body) have average thicknesses 70–80 m. They are proved in the inclined length 1,500 m and assembled are in the lower part of carbonatic body. Several magnesite bodies in the middle (Miková) part reach thickness 100–180 m. Deposit is explored in the length 1,300 m. Eastern (Jedľovec) part of deposit consists from small magnesite bodies thick 5–50 m and on dip it is explored in one line reaching 1,300 m.

Magnesite in deposit has average content 42.53 % MgO and harmful components CaO 2.5 %, SiO_2 0.55 % and Fe_2O_3 4.15 %. According to CS module magnesite belongs to calcitic technological type.

Calculation in 1967 indicated above 500 millions kt of resources and after modification of conditional parameters in 1976 this sum was reduced to its three fifths. Resource excluded during the second calculation had higher Fe_2O_3 content causing the lower quality of fireproof products.

Ochtiná deposit

Deposit is located near the western border of Ochtiná village, 4 km to NW of Štítnik town (Figs. 2 and 5). Owing the suitable space characteristics it was exploited already at the end of 19th century. Mineralized body is elongated in NW–SE direction, having length app. 1,000 m and width 400 m. Its maximal thickness is 160 m. Magnesite has average MgO content 40.50 % and content of harmful admixtures SiO_2 2.85 % and Fe_2O_3 3.95 %.

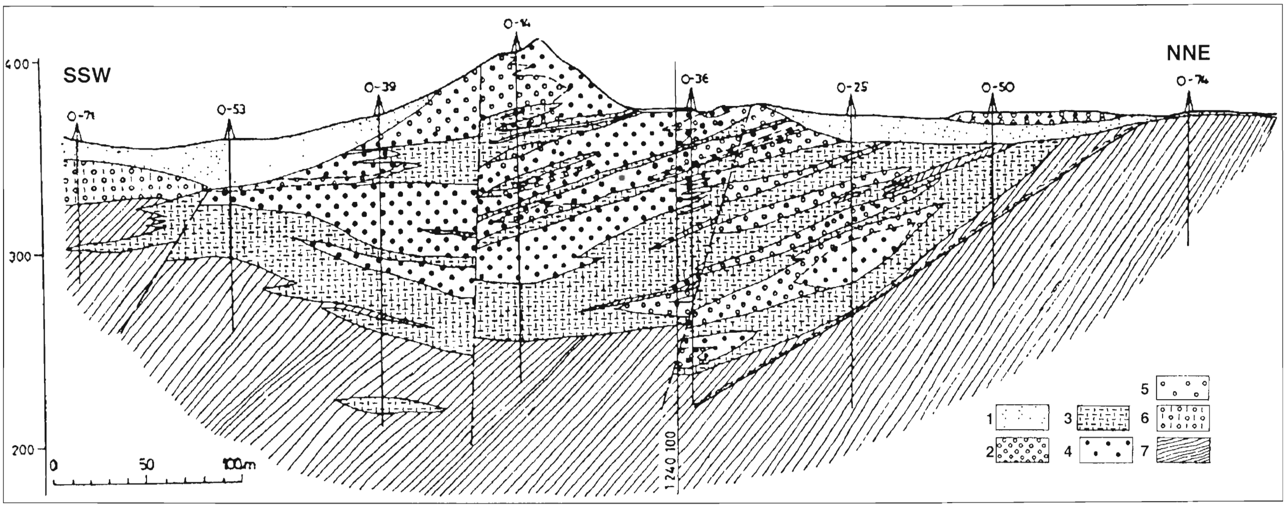


Fig. 5 Geological cross-section of the Ochtiná deposit (Abonyi, 1957). 1 – loam, debris, 2 – gravel, clay, sand, 3 – fine-crystalline dolomite, 4 – magnesite, 5 – magnesite with dolomite relicts (metasomatic), 6 – ochre, weathered magnesite, 7 – sericitic-graphitic phyllite.

According to CS module it is of quartzy type. According to the final account and conditions valid in 1957 the deposit contained 16,000 kt of raw material. Exploited it was till 1963.

Deposits in the eastern part of Gemericum

The easternmost Carboniferous magnesite deposit in Slovakia is located in the northwestern edge of Košice town (Fig. 6). It has the same geological position like deposits in the western part of Gemericum. The immediate footwall and hanging wall of deposit are represented with black phyllites and unequal content of psammitic component. There is also varying content of carbonatic admixture locally with dark graphitic-dolomitic limestone and dolomite transiting to pelitic sediments. Upper parts of bodies are formed with chlorite phyllites laterally intercalated with basalts. Upper Carboniferous rocks southward of deposit are covered by thick layer of clastic and volcanoclastic rocks of Neogene.

Košice deposit

Geological survey of deposit started by superficial drills immediately after its discovery around 1900. Exploitation by superficial quarry started in the Bankov part in 1908. Deposit consists from two separate bodies named Medvedia and Bankov–Banisko (Fig. 6). Medvedia body has coulisse-like shape and is inserted into footwall of Bankov–Banisko body. Mineralized bodies on surface have NW–SE strike and 40-70° dip to SW. Medvedia body has superficial length 600 m and thickness 200–280 m, verified lateral length is 1,000 m and inclined length 1,100–1,200 m.

The shape of Medvedia body (Figs. 7 and 8) is complicated by overthrust and normal faults trending W–E. In depth the course of bodies is changed from the direction NW–SE in northern part to N–S in middle one and to NNE–SSW in southern part.

Magnesite body Bankov–Banisko (Fig. 6) has directional length on surface 980 m, the total length 1,600–1,800 m and on inclination it is verified in the length 1,400 m. The body has very irregular shape. Besides the overthrust duplicating the deposit, there are numerous normal faults, shifting rock blocks. The maximal thickness of deposit is 280 m. Differing from other deposits, there is smaller ratio of diagenetic dolomite and more of-

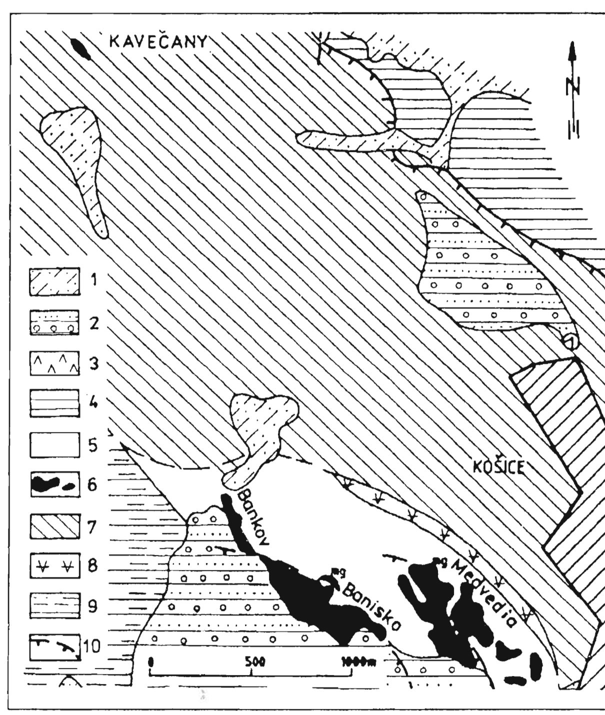


Fig. 6. Magnesite deposit near Košice (Varga, 1979). 1 – loam, debris (Quaternary), 2 – gravel, sand and clay, 3 – rhyolite tuff (2–3 – Neogene), 4 – dolomite (Triassic), 5 – shales and sandstones, 6 – magnesite and dolomite, 7 – chlorite-sericite phyllites, 8 – greenstones, 9 – chlorite phyllites with diabase intercalations (5–9 – Carboniferous), 10 – overthrust.

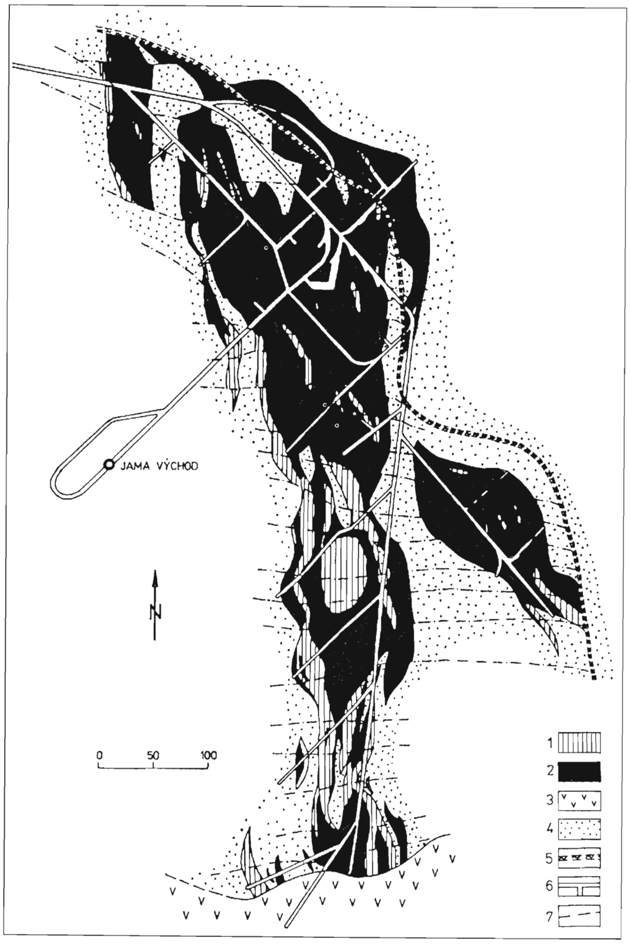


Fig. 7. Geological map of the 6th mining level of magnesite deposit Košice–Medvedia (according to Pauco et al., 1984). 1 – dolomite, limestone, dolomitic limestone, 2 – magnesite, 3 – rhyolite tuff and tuffite (Neogene), clay, gravel, sand, 4 – graphitic-sericitic phyllite (1, 2, 4 – Carboniferous), 5 – fault with mylonites, 6 – workings, 7 – faults.

ten occurrence of black phyllites inside the body. Mineralized bodies in peribioherm parts on lateral wedging have higher ratio of silicates and breccia, pseudobreccia and subparallel textures. Upper part of mineralized bodies is weathered. In these places originated the caverns filled with water of volumes from m^3 to 500 m^3 being the potential threat of flood of mine spaces. Mineralization of deposit consists of coarse, medium and fine-grained metasomatic magnesite, fine-grained diagenetic dolomite, coarse and medium-grained metasomatic dolomite, forming the aggregates with magnesite. In the underlying parts and near margins of body the limestone and dolomitic limestone are abundant.

The average chemical composition of magnesite in deposit is 42.76 % MgO, 1.75 % CaO, 1.95 % SiO_2, 3.21 % Fe_2O_3 and 0.96 % of Al_2O_3 (Abonyi and Abonyiová, 1981). The Košice magnesite bodies belong to the group containing the higher SiO_2 content in carbonates. Highest SiO_2 content (4.72 %) has been found in carbonates with 0–20 % MgO. The groups with 20–35 % and 35–40 % MgO have 2.87 and 2.75 % SiO_2. Lowermost SiO_2 content 1.95 % has magnesite with MgO above 40 %. If the Ochtiná deposit, where assumption of higher SiO_2 content results from the specific evolution of stratiform body, is not taking into account, the Košice deposit has the highest SiO_2 content. Increased content of Fe_2O_3 is in both bodies of Košice deposit and highest (7 %) was found in the Bankov body. Higher Fe_2O_3 content is usually present in upper parts of mineralized bodies. The Košice deposit of magnesite is the second biggest in Slovakia. Proved resources down to altitude -150 m are about 150,000 kt. Next sources of raw material are in both – lateral and depth continuations of deposit below 6th mining level (+50 to -1,000 m above sea level). There have been found around 476,000 kt of geological resources of C_2 category and 22,000 kt of prognostic resources.

Talc and magnesite in Lower Paleozoic rock complexes

Dlhá dolina talc and magnesite deposit

Steatitized carbonates are located approx. 215–760 m below surface in the termination of the Dlhá dolina valley (7 km north of Gemerská Poloma village; Fig. 10). Recent exploration proved mineralized lensoid carbonatic body long 3,000 m with maximal thickness 407.5 m, being elongated in direction E–W, resp. ESE–WNW (Kilík, 1994). The tectonic contact of talc and magnesite-bearing body with granite is represented with the shallow overthrust (max. to 20°).

The talc mineralization, relating to magnesite precursor, originated by hydrothermal metasomatism. Two types of talc occurrences are present in deposit:

a) intergranular talc – fine nests, clusters and veinlets in intergranular spaces of magnesite grains,

b) veiny type – talc veins and lenses thick to 4–8 m.

Talc of massive texture and light-green, grey and dark-grey colour has splendid quality and resources being comparable with the best deposits in the world.

The length of magnesite body, present in deposit in upper part of Lower Paleozoic formation of black schists and in places near granite, is 275 m. Its direction is NNE and dip 45° to S. Magnesite is coarse-grained, grey to white-grey, partly steatitized. Magnesite quality is 35.6–40.6 % MgO, 4-5 % Fe_2O_3, 3–9 % SiO_2 and 0.3–0.4 % CaO (Malachovský et al., 1991).

Deposits and occurrences of talc in the area Jelšava - Hnúšťa - Kokava

The talc deposits in the Veporic crystalline complexes (Fig. 11) are present prevailingly in the margins of magnesite deposits located in the intensively mylonitized shear zones. Talc deposits are located in the chloritic and chlorite-sericite schists. The transition of chlorite-sericite schists to garnet mica schists, or biotite gneisses and amphiboles has been found in some localities.

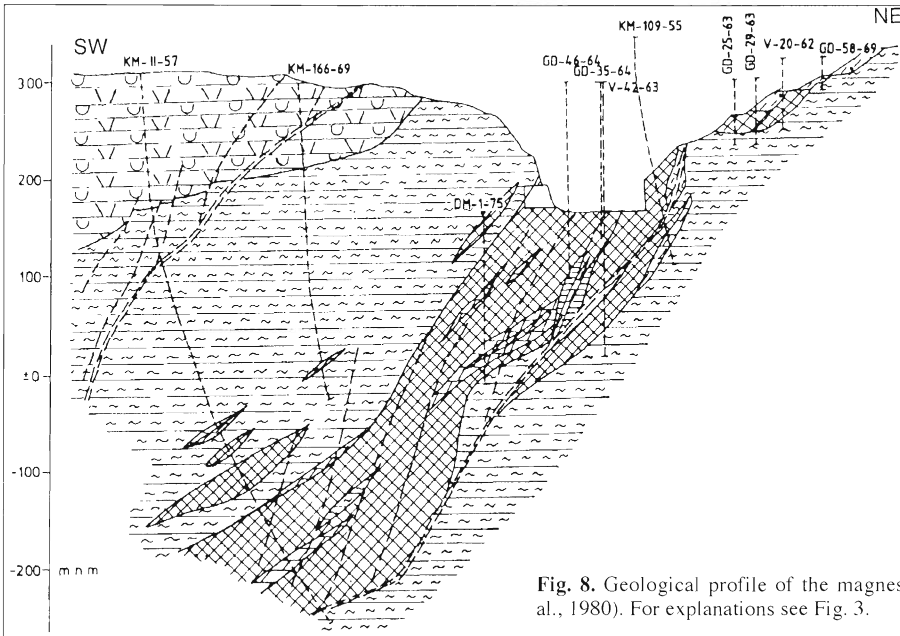


Fig. 8. Geological profile of the magnesite deposit Košice–Medvedia (Barkáč et al., 1980). For explanations see Fig. 3.

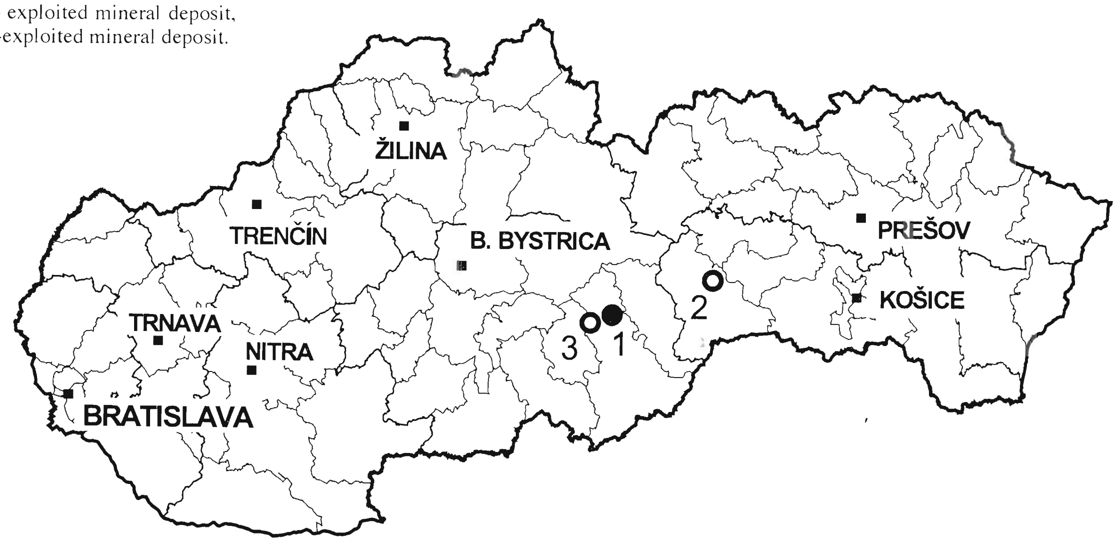
The Polom deposit is a part of the dolomitic body. The Hačava deposit is located in the tectonic zone without clear relations to carbonates, because these are not present in the deposit. It is probable, that the talc is genetically related to the small ultrabasic body, similarly as in the locality Muránska Dlhá Lúka.

Mútnik deposit

The deposit consists of the several magnesite-talc lenses and individual bodies of chlorite-talc shists (Figs. 11 and 12). The carbonatic lens in the lower part of deposit contains only irregular smaller attitudes of chlorite-talc schists. In its overlier there are three discontinual magnesite–talc lenses. These, so-called overlying lenses, are very irregular and very quickly fade out. Only the lens No. 3, thick above 20 m, has the more continual course. Mutual distance among individual lenses is 20–50 m. Their course is E–W with dip to E, but the dip of the whole sequence is 45° to S. The dip of the main lens near surface is nearly vertical. Lenses No. 2 and 4 are parallel with the main lens, while the lens No. 3 is steeper (in the eastern segment to 70°). The thickness of the main lens is in average 60 m, but the thickest reaches more than 100 m (Suchár et al., 1960).

The Mútnik deposit is located in the chlorite-sericite schists with intercalations of garnet mica schists and amphibolites. In the magnesite body, related to talc, there are developed also the dolomitic intercalations. Carbonatic body is strongly tectonized and is accompanied with

Fig. 9. Talc deposits in Slovakia. 1 – Hnúšťa, 2 – Gemerská Poloma, 3 – Kokava nad Rimavicou. Full circle – exploited mineral deposit, empty circle – non-exploited mineral deposit.



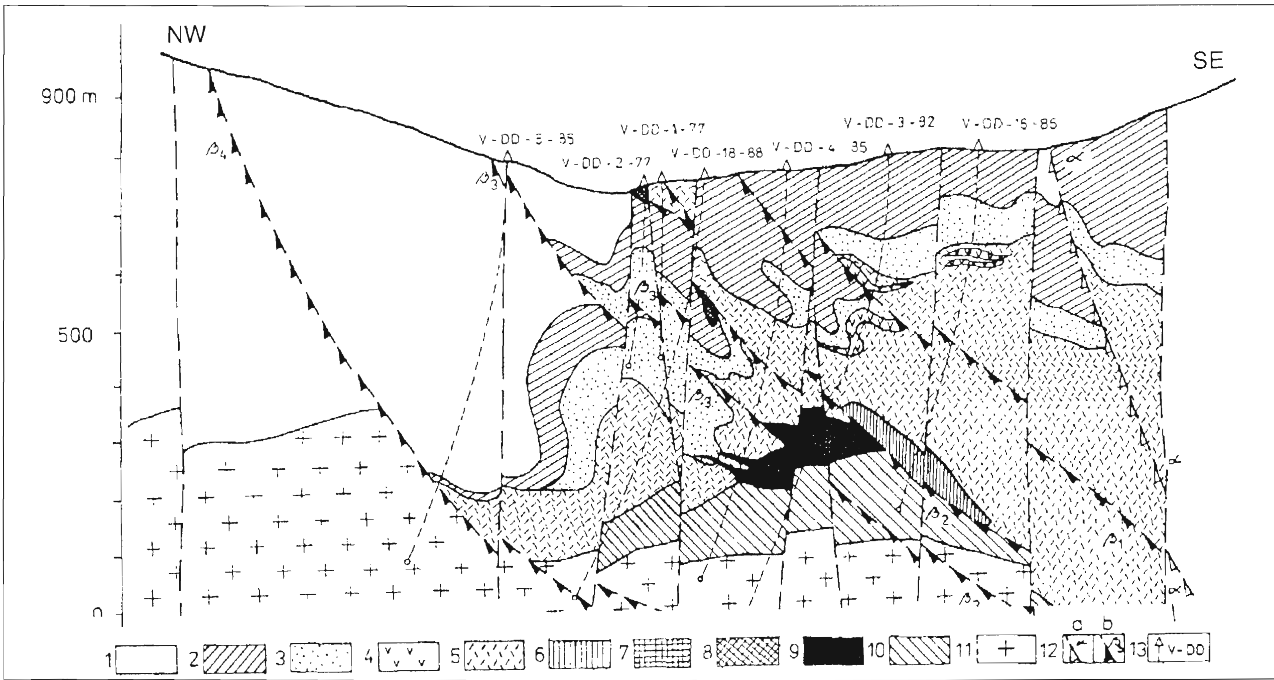


Fig. 10. Geological profile through the locality Gemerská Poloma with occurrences of magnesite and talc (Malachovský et al., 1991). 1 – metapsammites with phyllitic intercalations, 2 – rhyolite metapyroclastics, 3 – dacite and trachyte metapyroclastics, 4 – metabasalts, 5 – laminated phyllite, 6 – steatitized magnesite, dolomite, 7 – skarn, episkarn metasomatite in assemblage with metabasalt, 8 – greisen, 9 – intensively albitized granite and quartzy albitite, 10 – Li-F-granite with rare metals (Nb, Ta, Li, Rb), 11 – coarse-grained granite, granitized porphyry, 12a – – overfault (older), 12b – overfault (younger), 13 – drill.

strong mylonitization on the margins. The magnesite of the carbonatic body has, compared with the other talc deposits, the lower Fe_2O_3 content and distinctive is with the granular interpenetration of talc (min. 1%).

The degree of steatitization of magnesite decreases to the depth. The content of the main components: the scaled talc – SiO_2 61.82 %, Al_2O 0.54 %, FeO 0.9 %, MgO 30.63 %; the technical talc – SiO_2 44.65 %, TiO_2 0.69 %, Al_2O_3 11.7 %, FeO 3.15 %, MgO 29.15 %, CaO 0.83 %.

The talc is exploited nearly continually from 1933. In 1952–1960 the geological survey proved 14,705 kt of C_1 category and 7,216 kt of C_2 category of talc for the caustic production and 4,895 kt of C_1 and 2,701 kt of C_2 resourses of talc for the production of forsterite buiding materials (Suchár et al., 1960). The re-calculation of the talc resource in 1969, registered the resources of 381,9 kt of C_1 category and 379,2 kt of C_2 category (Lisý,1970). The Mútnik deposit by the amount of proved resource recently represents the biggest exploited deposit of talc in Slovakia.

Occurrences of amorphous magnesite in the weathered crust of ultrabasic rocks

The most significant occurrence of amorphous magnesite is located 500 m south of village Hodkovce. It is related to the weathered crust near north and northwest edges of ultrabasic body. The weathered crust only partly outcrops and is covered by 20–70 m thick layer of Neogene clay and sand. Amorphous magnesite is present in veinlets thick mostly 6–10 cm and rarely to 60 cm. The length of veinlets is some metres to tens of metres (maximal length 50 m). Thickness of weathered crust is around 50 m, max. to 100 m. Magnesite mineralization has areal spread appr. 1 km^2. Magnesite of best quality occurs in weathered dunites with MgO 44–46 %, CaO to 1 % and SiO_2 0.5–3 %. Besides magnesite also dolo-

Tab. 2
Slovak Republic reserves and production – talc (Tréger and Baláž, 2000)

Year	1996	1997	1998	1999
Number of deposits (total)	6	6	6	6
– exploited	1	1	1	1
Total reserves [kt]	242,378	242,369	242,364	242,359
–economic proved and probable (Z-1 + Z-2)	636	629	627	626
– economic supposed (Z-3)	93,139	93,137	93,134	93,134
– potentially economic	148,603	148,603	148,603	148,599
Mining output [kt]	9	7	4	1

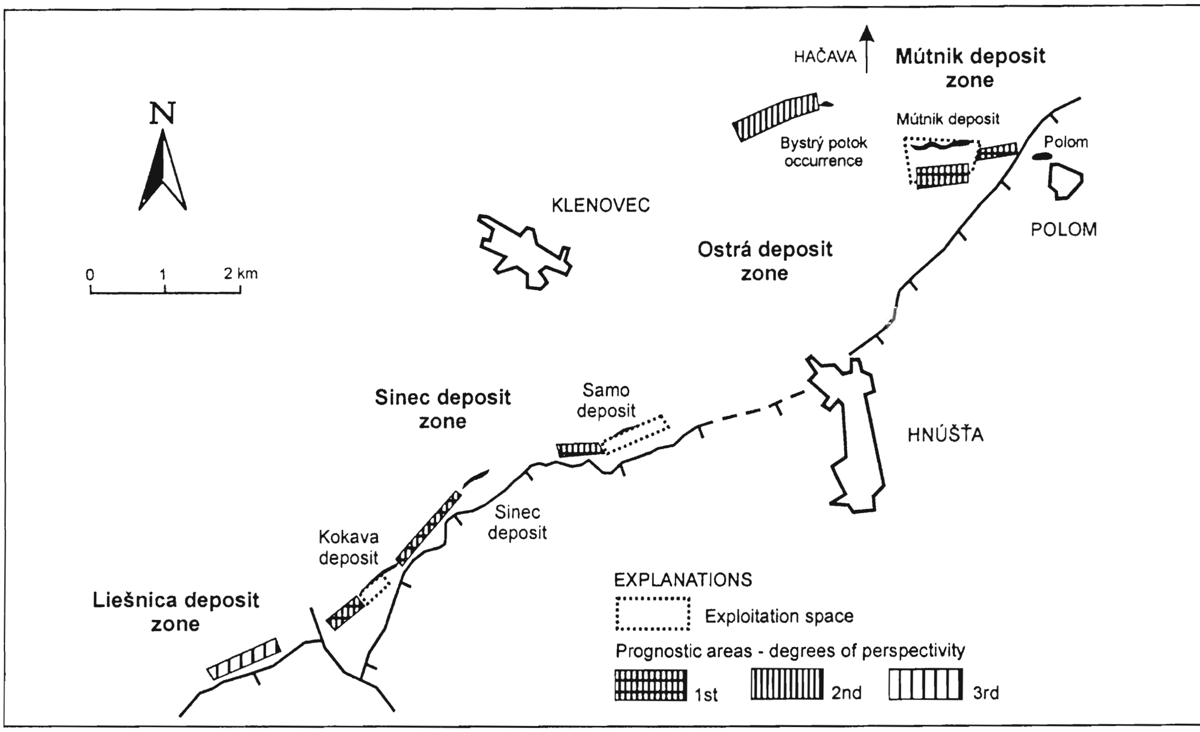


Fig. 11. Map of talc deposits in the Hnúšťa – Kokava area with prognostic talc planes (modified after Grecula et al., 1995).

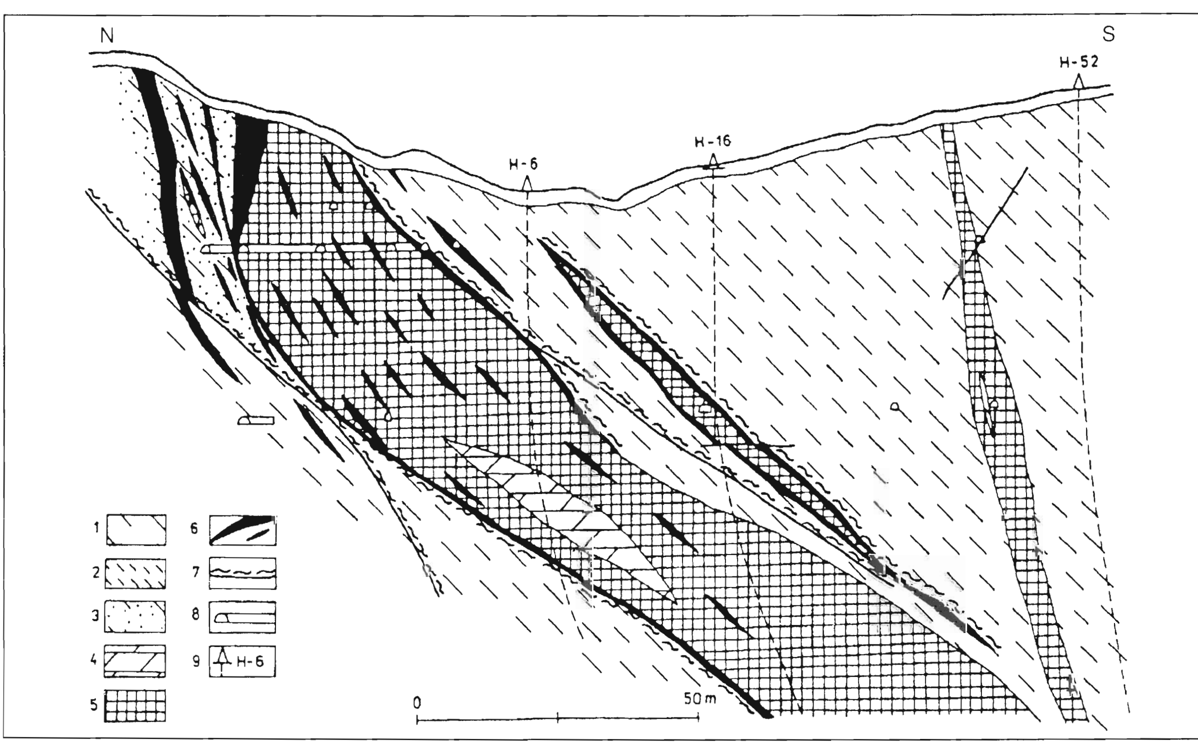


Fig. 12. Geological profile through the talc deposit Mútnik (Suchár et al., 1960). 1 – sericitic-chloritic schists, 2 – chloriticic schists, 3 – talc schists, 4 – dolomite, 5 – magnesite, 6 – talc, 7 – mylonitic zone, 8 – workings, 9 – drill.

mite, opal, chalcedony, quartz, aragonite and flakes of weathered serpentinite are present in veins.

References

Abonyi, A., 1971. Magnesite deposits of Slovakia. *Mineralia Slov., 3, 319-342. (in Slovak)*

Abonyi, A. & Abonyiová, M., 1981. Magnesite deposits of Slovakia. *Mineralia Slov. – Monograph, 1, Alfa, Bratislava, 98. (in Slovak)*

Bajaník, Š., Vozárová, A., Hnazel, V., Ivanička, J., Mello, J., Pristaš, J., Reichwalder, P., Snopko, L. & Vozár, J., 1983: Explanations to geological map of Slovak Ore Mts. – eastern part, 1 : 50 000. *GUDŠ, Bratislava, 1–233. (in Slovak with extended English resumé)*

Barkáč, Z. et al., 1980: Košice – ore forecast. Final report and calculation of reserves. *Manuscript. Archives of Geologica Survey of Slovak Republic. (in Slovak)*

Bouček, B. & Přibyl, A., 1960: Revision der Trilobiten aus dem slovakischen Oberkarbon. *Geol. Práce, Zpr., 50, 5–50.*

Bouček, B. & Ulrich, F., 1931 Presence of fossils in the magnesite zone of the Slovak Ore Mts. *Věst. St. geol. Úst. Čs. Republ., 7. (in Czech)*

Čapo, J. et al., 1992. Dúbrava massif Magnesite. Stadial report. *Manuscript. Archives of Geological Survey of Slovak Republic. (in Slovak)*

Dianiška, I., 1985: Lubeník – magnesite. Final report and calculation of reserves. Manuscript. *Archives of Geological Survey of Slovak Republic. (in Slovak)*

Grecula, P., 1982: Gemericum – segment of the Paleotethyan riftogenous basin. *Mineralia Slov. – Monograph, Alfa, Bratislava, 1–263. (in Slovak with extended English resumé)*

Grecula, P et al., 1995: Mineral deposits of the Slovak Ore Mountains. *Geocomplex, Bratislava, 1–829.*

Heritsch, F., 1934: Rugose Korallen aus dem Karbon der tschechoslovakischen Karpathen. *Věst. St. geol. Úst. Čs. Republ., 10, 138–154.*

Kilík, J., 1994: Gemerská Poloma – talc. Communication. Manuscript. *Archives of Geoenvex. (in Slovak)*

Kozur, H., Mock, R. & Mostler, H., 1976: Stratigraphische Neueinstufung der Karbonatgesteine der unteren Schichtenfolge von Ochtiná (Slovakei) in das oberste Vise Serpukhovian (Namur A). *Geol. Paläont. Mitt., Innsbruck, 6, 1, 1–29.*

Lisý, E., 1970: Talc deposits. In: Geologic and economic study of Spiš-Gemer Ore Mts. *Manuscript. Archives of Geological Survey of Slovak Republic. (in Slovak)*

Malachovský, P et al., 1991 Gemerská Poloma – Sn and rare elements. Final report and calculation of reserves. Manuscript. *Archives of Geological Survey of Slovak Republic. (in Slovak)*

Mišík, M., 1953: Geological setting of area between Jelšava and Štítnik towns. *Geol. Spor., Slov. Akad. Vied, 4, 557–588. (in Slovak)*

Pauco, M., Varga, I. & Hrinko, V., 1984: Košice-Medvedza. Final report and calculation of reserves. *Manuscript. Archives of Geological Survey of Slovak Republic. (in Slovak)*

Suchár, A. et al., 1960: Mútnik - magnesite. Final report and calculation of reserves. *Manuscript. Archives of Geological Survey of Slovak Republic. (in Slovak)*

Suchár, A., 1961: Burda – Poproč. Final report and calculation of reserves. Manuscript. *Archives of Geological Survey of Slovak Republic. (in Slovak)*

Suchár, A., 1974: Results of the talc exloration in surrounding of Kokava nad Rimavicou. *Mineralia Slov., 6, 1–16. (in Slovak with English resumé)*

Trdlička, Z., 1959: Contribution to mineralogy of Slovak magnesites. *Geol. Práce, Zoš., 56, 165–199. (in Slovak)*

Tréger, M. & Baláž, P., 2000: Raw material of Slovak Republic. Anniversary volume 2000 (conditions to 1999). *Ministry of Living Environment, Geological Survey of Slovak Republic, Spišská Nová Ves, 168–178.*

Zlocha, J., 1972. Hodkovce – magnesite. Final report. Manuscript. *Archives of Geological Survey of Slovak Republic. (in Slovak)*

Magnesite and talc deposits in Austria

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Abstract

Most of the magnesite mineralizations of the Eastern Alps occur in Paleozoic series of the Upper Austroalpine units with a remarkable spread in the ages of the single deposits. One exception is the Radenthein mine which is a tectonic wedge thrusted into the Austroalpine crystalline basement. According the special chemistry of inclusion fluids the metasomatic stocks of sparry magnesite were formed by evaporitic bittern brines during the Permoscythian in a very shallow hydrothermal environment where these fluids came into contact with underlying Paleozoic carbonates.

Generally the formation of talc deposits in the Eastern Alps can be attributed to the Alpine orogenic cycle. The Rabenwald talc mine was formed during the staking of the Austroalpine nappes in a magnesite-bearing thrust zone. The Lassing talc mine is situated in the Greywacke Zone and was formed by hydrothermal processes after the peak of the Eoalpine metamorphism.

Key words: magnesite, talc, genetic models, fluid investigation, shear zones, Eastern Alps

Introduction

Numerous magnesite and talc mineralizations of various sizes can be found in the Eastern Alps of Austria, some of them are of considerable economic importance. The minerogenetic map of Austria exhibits several locations of these mineralizations, many of them have been exploited in the past. The first industrial application of magnesite and talc products mainly for lining of the blast furnaces of the local steel plants was developed in Austria. Starting approximately in 1850, the world's first magnesite deposits being mined for refractory applications were those in the province of Styria. Simultaneously the scientific investigations of this type of deposits started and soon afterwards a general classification of magnesite deposits was given by Redlich in 1909.

Today Austria's well-developed magnesite and talc industry is of worldwide economic importance and to a large extent is still based on the Austrian mines. The mine production of these commodities is shown in Table 1.

Tab. 1
Magnesite and talc production in Austria

	Number of deposits	Mine production (tpa)
Magnesite	6	720,000
Talc	3	137,000

In the following an attempt is made to show the geologic position and the geodynamic prerequisites for the formation the carbonate hosted sparry magnesite and the talc mineralizations of the Eastern Alps. The arguments are mainly based on field observations, on the geochemistry of the mineralizations and on the investigations of the inclusion fluids that allow a characterization of the ore forming fluids.

Throughout the last decades the discussion about the genesis of these magnesite and talc mineralizations was very controversial and reflects the changing opinions about the genetic models of these mineralizations during the history of investigation.

Analogous mineralizations occur in Upper Carboniferous strata of the Gemeric units of Slovakia, which can directly be compared with the talc and magnesite deposits of the Greywacke Zone.

Genetic models proposed in the past

Magnesite

It is far beyond the scope of this chapter, even to list the enormous amount of papers, published on the Austrian magnesite mineralizations since the start of modern geoscientific investigation in approximately 1850. Therefore only the general trend in the genetic opinion is referred and discussed.

Opinions concerning the genesis of the Austroalpine sparry magnesite mineralizations are inconsistent and discussion about this topic has longstanding tradition. Different genetic models, including a synsedimentary origin or an Eoalpine metamorphic vein-type or metasomatic mineralization have been proposed in the past.

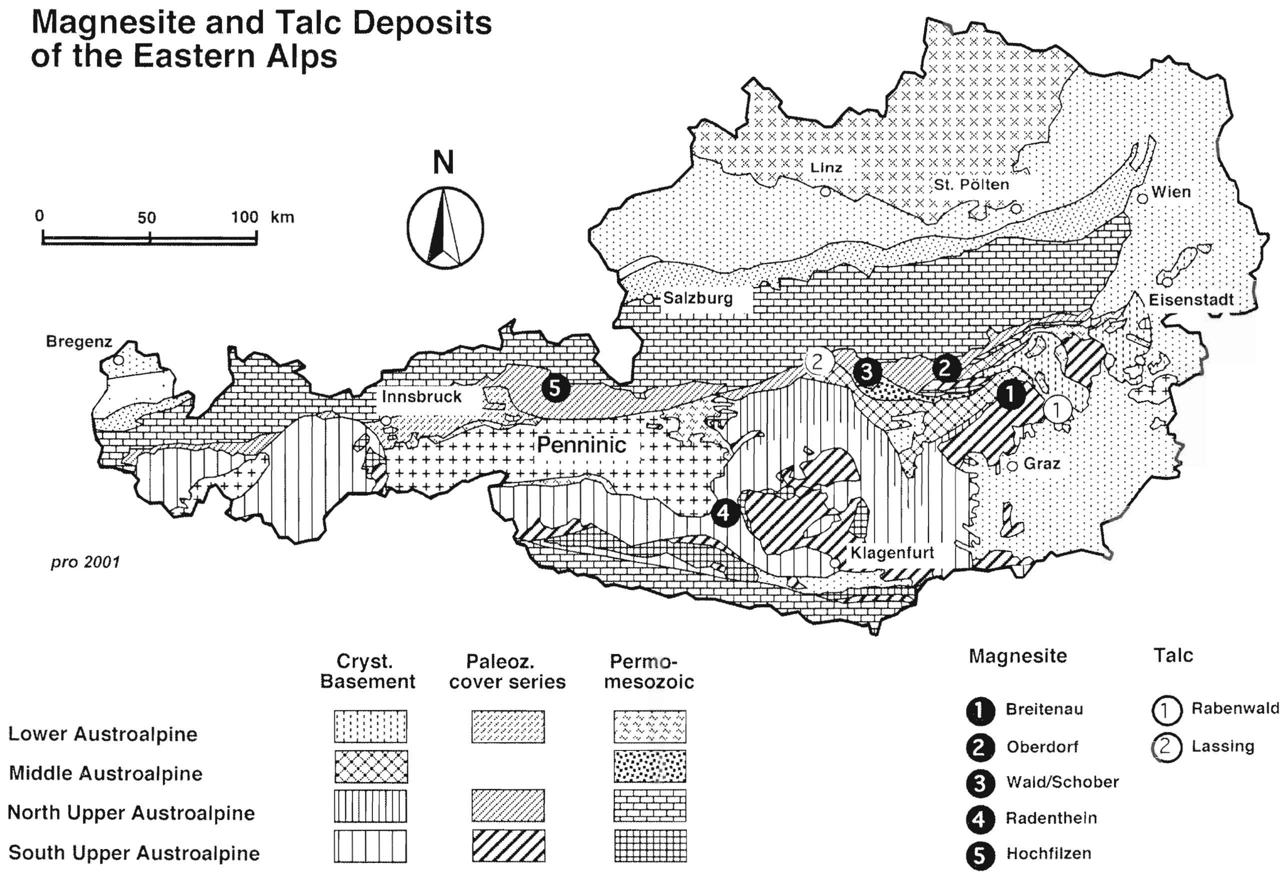

Fig. 1. Position of the magnesite and talc deposits of the Eastern Alps of Austria.

Accordingly there is no consensus about a genetic model and not even about the principal mechanisms for the magnesite mineralization. Starting soon after the discovery of the world's first magnesite deposits in the Eastern Alps after 1850 syngenetic models (e. g. Rumpf, 1873; Leitmeier, 1917) and epigenetic models (e. g. Koch, 1893; Vacek, 1886; Redlich, 1907) were published. Starting in the 1950-ies a general trend towards syngenetic and early diagenetic models can be observed (De Llarena, 1953; Leitmeier and Siegl, 1954). Niedermayr et al. (1989) argued for synsedimentary or early diagenetic genesis for magnesite mineralization in Permian series of the Eastern Alps and extended this model to the Alpine sparry magnesites.

Pohl and Siegl presented an extensive overview on the magnesite mineralizations of the Eastern Alps in 1986. Möller (1989) edited a monograph on magnesite summarizing the recent geochemical and mineralogical facts on the "magnesite problem".

Earlier workers (Redlich, 1907; Petrascheck, 1932; Rüger, 1939; Clar, 1954; Friedrich, 1969 etc.) already mentioned a consanguineous origin of the Alpine sparry magnesite mineralizations and the siderite deposits. In general they argued for hydrothermal fluids of different origin like magmatic or metamorphic fluids of Alpine (Tertiary) age. Nevertheless these concepts never gained general acceptance.

Talc

The concepts of the formation of the Austrian talc mineralizations were never discussed with similar enthusiasm. General opinion is that they were formed during the Early Alpine tectono-metamorphic event. In the case of the talc-bearing shear zones connected with ultramafic rocks the origin of Mg in the hydrothermal solutions is evident. The same goes for the carbonate-hosted talc mineralizations bound to dolomites and magnesites of the Upper Austroalpine Paleozoic units.

Geologic position of the magnesite and talc mineralizations in the Eastern Alps

Most of the magnesite mineralizations occur in the Greywacke Zone, which is the Paleozoic basement of the Mesozoic platform carbonates of the Upper Austroalpine nappe. Fundamental overviews on the geology and tectonostratigraphy of the Greywacke zone were given by Schönlaub (1982) and Neubauer et al. (1994). The rock series of the Greywacke Zone range from the Ordovician to the Carboniferous and comprise carbonates, metapelites and metamorphosed acid volcanics. The grade of metamorphism is generally of lower greenschist facies both in the Variscan and in the Eoalpine tectono-metamorphic event. The lower Veitsch nappe is affected only by the Alpine metamorphism.

Generally speaking, magnesite mineralizations tend to form irregular lenses and stocks whereas veins are very rare.

Talc mineralizations in Austria generally occur in two geologic environments:

1. Talc related to ultramafic rocks of the Penninic unit in the central parts of Austria.
2. Talc mineralization of the carbonate type: Upper Austroalpine carbonate series (dolomites, magnesites) were altered to talc-carbonate schists during the Eoalpine event.

Magnesite mineralizations

In the Eastern Greywacke Zone carbonate-hosted sparry magnesite mineralizations occur mainly in Lower Carboniferous strata of the Veitsch nappe. A set of lens-shaped magnesite bodies of various size can be found in a sequence of sericite schists, greywackes, conglomerates and metatuffs. Carbonate series hosting the magnesite bodies are of Upper Tournéan/Viséan age and exhibit shallow water, marine environment. In some cases the ore bodies are enveloped by mottled hydrothermal dolomite, but sometimes sharp contacts to the Carboniferous host rock limestones occur. The most prominent example is the abandoned Veitsch mine, which is the type locality of carbonate-hosted sparry magnesite deposits. An exception is the Breitenau mine, which is located in Paleozoic series of pelagic environment of probably Silurian to Lower Devonian age.

In the Western Greywacke Zone magnesite can be found in Upper Silurian to Middle Devonian series with a remarkable age-spread of the different deposits. The most frequent host rocks of magnesite mineralization in this area are dolomites of the Lower to Middle Devonian, but also black dolomites of Silurian age contain magnesite occurrences (e. g. Entachen Alm). Siegl (1964) reported hydrothermal magnesite mineralization of the Permian basal breccia of the Alpidic orogenic cycle.

The position of the highly metamorphosed Radenthein deposit is unclear. Some authors (Angel et al., 1953) consider it to be a tectonic wedge of Upper Austroalpine Paleozoic rocks thrust into the tectonically deeper "Altkristallin" during the Alpine tectonic event, while others (Tufar et al., 1989) regard it as an original member of the rock sequence. The general situation (magnesite wedges thrust into highly metamorphosed crystalline basement series) of the Rabenwald talc deposit is similar to the one of the Radenthein magnesite deposit.

Talc mineralizations

Generally the formation of talc deposits in the Eastern Alps can be attributed to the Alpine orogenic cycle. Pre-Alpine talc formation has evidently been destroyed by the younger tectono-metamorphic events.

Several talc deposits were mined in the Eastern Alps, many of them of ultramafic origin (especially in the Penninic units) which generally do not meet industrial requirements.

Another accumulation of talc deposits can be found in Carboniferous strata of the Greywacke Zone. These deposits only occur in the lowermost nappe of the Greywacke Zone of Carboniferous age. No Variscan metamorphism can be observed in this unit. Eoalpine greenschist metamorphism is widespread.

The most important deposit of this type is the Lassing talc mine where production ceased in July 1998 after a mine collapse. These carbonate-hosted talc mineralizations are typical vein type deposits and postdate the peak of the Early Alpine metamorphic event.

The Rabenwald talc mine also is of the "carbonate type" and is a big open pit mine. It is bound to a prominent shear zone in the Lower Austroalpine Unit at the eastern margin of the Eastern Alps.

A quartz-mica products (with similar industrial applications as talc products) called "leucophyllite" is produced in two mines and has similar end-uses as talc. Like talc these leucophyllites are also of hydrothermal origin. The mineralizations are bound to shear zones in metamorphic terraines. This material is produced in the deposits of Aspang (Lower Austroalpine) and Kleinfeistritz (Austroalpine Crystalline Complex east of the Tauern Window). Leucophyllites are the alteration products and the immediate host rocks of the talc mineralization of Rabenwald but are not being mined in this deposit.

Genetic models for the formation of magnesite and talc in the Eastern Alps

The genetic models presented in the following are mainly based on fluid investigations of these mineralizations. The chemical composition of paleofluids can be used as geochemical tracer to investigate the original signature and origin of different kinds of inclusion fluids. Analytical work on the chemistry of the inclusion fluids (F, Cl, Br, I, Na, K, Ca, etc.) can contribute substantially to the question of the origin of mineralizing fluids.

For recognizing original fluid characteristics, very conservative systems which are not buffered and changed by ambient mineral reactions in the alteration zones have to be considered. Thus Cl-Br- and to some extent I-systematics are more suitable to provide clues as to the identity of the highly saline fluids than other element ratios which may be changed by wall rock alterations. Evidently Cl-Br-ratios are very difficult to be modified by fluid/rock reactions thus providing a tracer for hydrothermal fluids at least as "robust" as hydrogene isotope composition.

Magnesite

First results of fluid investigations on magnesites and dolomites from the Eastern Alps show very high Br/Cl ratios of the inclusion fluids thus indicating highly evolved seawater to be the mineralizing fluid for the magnesite mineralization. The extent of fractionation and the de-

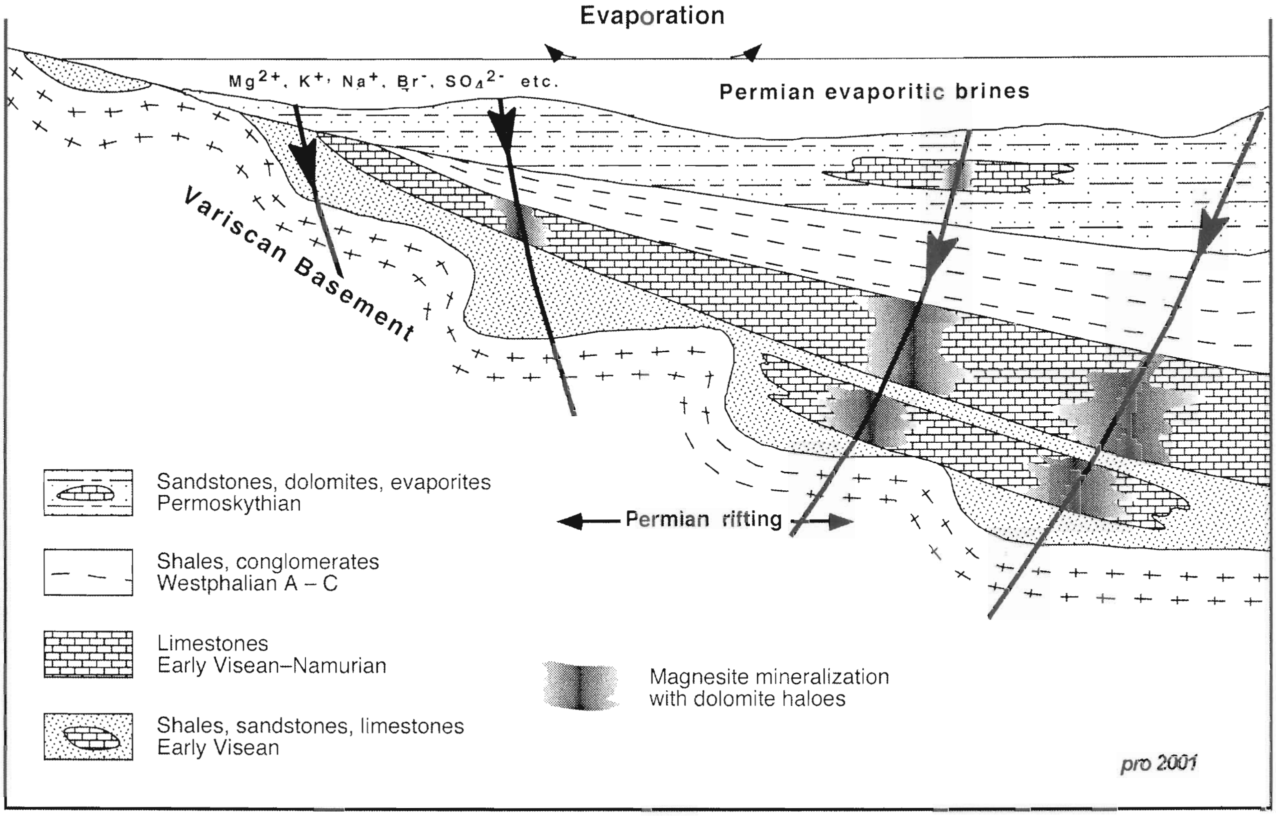

Fig. 2. Model for the formation of magnesite in Paleozoic strata of the Eastern Alps in the Permian.

velopment of an "evaporation trend" suggest evaporitic bittern brines to be the original fluid source.

Extensive studies on the evaporation path of seawater were done by McCafferey et al. (1987). Despite the similar ionic radii of chlorine (1.81 Å) and bromine (1.96 Å) the fractionation of these elements in evaporitic processes is quite different. In an initial stadium of evaporation Na, Cl and Br are concentrated in a hypersaline environment and their ratios do not change. At an evaporation index of > 10 halite is precipitated. Br has a very conservative behaviour and is not incorporated into the halite lattice. At an evaporation index of approx. 70 Mg salts start to precipitate and Br is still being enriched in the residual brines. In natural systems this process can lead to Cl/Br molar ratios as low as 90 (seawater: 655). At this stage K-salts are being precipitated.

The cation systematics changed from an original Na preponderance to Mg and K dominated systems.

During their downward flow into the brittle regime of the crust, these fluids can be incorporated into hydrothermal systems still exhibiting their original anion ratios.

The genetic model presented here is based on the following observations:

1. The mineralizing event is post-Variscan and pre-Eoalpine because of mineralized Variscan basal conglomerates on one hand and the termination of hydrothermal mineralizing features at Alpine nappe boundaries.
2. In general the magnesite as well as the siderite mineralizations are neither stratabound nor stratiform.
3. The high salinity of the fluids and especially the chemical composition of the fluids indicate that the mineralizing fluids were originally oxidized evaporitic, bittern brines with high Mg/Fe-ratios leading to magnesite formation in a very shallow environment. While percolating into deeper crustal levels, water-rock reactions lead to a reducing environment and to the leaching of Fe resulting in the formation of siderite deposits.
4. The immediate transition in the fluid composition between marine host rock carbonates and the mineralizations characterized by evaporitic fluids is not compatible with a simple marine-sedimentary model.
5. The structure of the mineralizations is hydrothermal-metasomatic. No indications of a synsedimentary concentration of Mg can be observed.

In Permian (to Lower Triassic) times evaporitic basins are ubiquitous in the Austroalpine realm. Deposition of thick series of evaporites is widespread in the Permoscythian strata of the Upper Austroalpine unit. High degrees of evaporation (evaporation index 20 to 90) produced residual "bitterns" with high salinities and high concentrations of Br, Mg, K, and SO_4 in the fluids. The peculiar fluid composition of the magnesites is in itself a strong argument for the Permomesozoic timing of the mineralization.

High heat flow in a rift environment (Schuster et al., 1999) induced hydrothermal convection systems where residual evaporitic brines percolated into the crust. According to the very high Mg/Fe-ratio of these fluids metasomatic stocks of sparry magnesite were formed in a very shallow hydrothermal environment where these fluids came into contact with underlying Paleozoic carbonates. Diagenetic reactions and host rock alterations changed these brines into acid and reducing fluids with the capacity of leaching Fe from the country rocks. Vein-type siderite-hematite-sulphide mineralizations were formed in the metapelitic and metavolcanic host rocks. Within the Devonian platform carbonates metasomatic siderite bodies were formed. Metasomatism and mimetic crystallization of the marine host rock carbonates often preserved primary sedimentary textures very well, which led earlier researchers to postulate syngenetic models.

However, the proposed hydrothermal-metasomatic model of Permoscythian evolved evaporitic brines as ore-forming fluids can explain all observed features of the magnesite mineralizations of the Greywacke zone regardless of their stratigraphic and tectonic position. This model is consistent with observations like the overall high salinity of the fluids, the uniform and special fluid chemistry and the Sr- and stable isotope contents which can neither be explained by sedimentary scenarios nor by Alpine remobilization models.

Talc

Because of their economic importance only the talc mineralizations of the carbonate type are discussed in the following. In the Eastern Alps of Austria the Lassing and the Rabenwald talc mineralizations are the most important examples.

Decisive criteria for the formation of Lassing-type talc deposits of the Greywacke Zone thus include:

1. The geological constraints of talc formation (dolomitic protolith, tectonism).
2. Hydrothermal transport and mobilization of various elements, especially Si.
3. Suitable P, T conditions of the fluids for the talc formation.

One of the most striking features of this type of talc deposits is the location in prominent thrust zones and faults transecting carbonate series of the Carboniferous Veitsch nappe of the Greywacke Zone.

Evidently talc formation in this deposit is due to the ingress of Si-bearing hydrothermal fluids reacting with the dolomitic component of the carbonate rocks. Talc formation took place according to the reaction:

$$3CaMg(CO_3)_2 + 4SiO_2(aqu.) + 6HCl \rightarrow$$
$$\rightarrow Mg_3Si_4O_{10}(OH)_2 + 3CaCl_2 + 2H_2CO_3 + 4CO_2$$

As a result of this hydrothermal reaction only newly formed talc and residual (but recrystallized) dolomite can be found in the talc-bearing area. Continuous availability of H_2O and removal of CO_2 from the system along fractures are basic requirements for talc formation of this type.

The Rabenwald deposit is related to a distinct thrust zone some tens of meters in thickness. A strongly altered rock (leucophyllite) typically envelopes the talc schists in this deposit. Metamorphism of the gneissic host rocks of the deposit is of Variscan age. Retrograde metamorphic overprinting during the Upper Cretaceous is ubiquitous. Leucophyllitization and talc formation are contemporaneous with this "Early Alpine metamorphism".

During the Alpidic orogeny and tectonism the Austroalpine units were overthrust upon each other resulting in the present tectonic sequence. Magnesites from the Upper Austroalpine Paleozoic units were thrusted into the underlying Lower Austroalpine gneisses.

Hydrothermal fluids produced during the syntectonic and metamorphic event mobilized Si from the adjacent host rocks during leucophyllitization. The magnesite in the thrust zone reacted with the Si component of the fluid. As a consequence quartz veins are absent in the magnesite, but frequent in the leucophyllite and in the gneisses. Mg was only locally transported in the fault and not necessarily supplied from deep-seated ultamafic sources.

According to a series of papers on the origin of these rocks (Prochaska, 1991; Prochaska et al., 1992) the Rabenwald talc formation is related to compressional stages and subsequent exhumation of the Alpine orogenic event. They had been formed by chemical alteration and hydrothermal activity related to deep seated shear zones during the staking of the Austroalpine nappes in the Cretaceous.

Temperature conditions during the formation of these structures were between 400 and 500 °C, determined by stable isotope equilibria between quartz, muscovite, chlorite and rutile (Prochaska, 1993). Heavy ∂D-values indicate the influence of seawater (or formation water similar to seawater) expelled from deeper tectonic units after stacking of the nappes in the Early Cretaceous. $^{87}Sr/^{86}Sr$-ratios are dominated by the gneissic host rocks and are generally in the range of ~ .720. K/Ar cooling ages of the micas of the phyllonites are identical with the regional cooling ages and Ar-Ar ages indicate a complete recrystallization and rejuvenation of the mineral assemblage in these Alpine shear zones.

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References

Angel. F., Awerzger. A., Kuschinsky. A. & Meixner. H., 1953: Die Magnesitlagerstätte Millstätter Alpe bei Radenthein. *Carinthia, 2. 143, 98–118.*

Clar. E., 1954: Über Parallel-, Schräg- und Kreuzbänderung in Spatlagerstätten. *TMPM, 4, 1–4, 55–64.*

De Llarena, J. G., 1953: Über die sedimentäre Entstehung des ostalpinen Magnesits "Typus Veitsch" *Montan-Zeitung, 69, 55–62.*

Friedrich, O. M., 1969: Beiträge über das Gefüge von Spatlagerstätten. IV Teil. *Radex-Rundschau, 3, 550–562.*

Koch, M., 1893: Mittheilung über einen Fundpunkt von Untercarbon-

Fauna in der Grauwackenzone der Nordalpen. *Z. Dtsch. geol. Gesell., 45, 294–298.*

Leitmeier, H., 1917: Einige Bemerkungen über die Entstehung von Magnesit- und Sideritlagerstätten. *Mitt. Geol. Gesell. (Wien), 9, 159–166.*

Leitmeier, H. & Siegl, W., 1954: Untersuchungen an Magnesiten am Nordrande der Grauwackenzone Salzburgs und ihre Bedeutung für die Entstehung der Spatmagnesite der Ostalpen. *BHM, 99, 11, 201–208 and 12, 221–235.*

McCaffrey, M. A., Lazar, B. & Holland, H. D., 1987: The evaporation path of seawater and coprecipitation of Br– and K+ with halite. *J. sed. Petrology, 57, 928–937*

Möller, P., 1989: Magnesite – Geology, Mineralogy, Geochemistry, Formation of Mg-Carbonates. *Monograph Series on Mineral Deposits, Berlin, 300.*

Neubauer, F., Handler, R., Hermann, S. & Paulus, G., 1994: Revised lithostratigraphy and structure of the Eastern Graywacke Zone (Eastern Alps). *Mitt. Österr. Geol. Gesell., 86, 61–74.*

Niedermayr, G., Beran, A. & Brandstätter, F., 1989: Diagenetic type magnesites in the Permo-Scythian rocks of the Eastern Alps, Austria. *Monograph Series on Mineral Deposits, 28, 35–60.*

Petrascheck, W., 1932: Die Magnesite und Siderite der Alpen – Vergleichende Länderstudien. *Sitz.-Ber. Akad. Wiss., math.-naturwiss. Kl. Abt. 1, 141, 195–242.*

Pohl, W. & Siegl, W., 1986: Sediment-hosted magnesite deposits. *In: K. H Wolf (Ed.): Handbook of stratabound and stratiform ore deposits, 14, 223–300.*

Prochaska, W., 1991. Beispiele für alpidisch-hydrothermale Lagerstättenbildung in den Ostalpen. Mitt. naturwiss. *Verh. Steiermark, 121, 129–148.*

Prochaska, W., Bechtel, A. & Klötzli, U., 1992: Phyllonite formation and alteration of gneisses in shear zones (Gleinalm-Kristallin, Eastern Alps). *Mineral. Petrology, 45, 195–216.*

Prochaska, W., 1993: Untersuchungen stabiler Isotope an alpidischen Ganglagerstätten in den Ostalpen. *BHM, 138, 138–144.*

Redlich, K. A., 1909: Die Typen der Magnesitlagerstätten. *Z. f. prakt. Geol., 17, 300–310.*

Rüger, L., 1939: Die Bodenschätze Großdeutschlands, Beck'sche Verlagsbuchhandlung, München, 360.

Rumpf, J., 1983: Über krystallisierte Magnesite und ihre Lagerstätten in den nordöstlichen Alpen. *Verh. Geol. R.-A. 1873, 312–315.*

Schönlaub, H. P., 1982: Die Grauwackenzone in den Eisenerzer Alpen (Österreich). *Jb. Geol. B.-A. 124, 361–423.*

Schuster, R., Scharbert, S. & Frank, W., 1999: Permo-Triassic Crustal Extension During Opening of the Neotethyan Ocean in the Austroalpine-South Alpine Realm. *EUG 10 J. Conf. Abs. 4, 297*

Siegl, W., 1964: Die Magnesite der Werfener Schichten im Raume Leogang bis Hochfilzen sowie bei Ellmau in Tirol *Radex-Rundschau, 178–191*

Tufar, W et al., 1989: Formation of magnesite in the Radenthein (Carinthia, Austria) type locality. *In: Möller (Ed.): Magnesite – geology, mineralogy, geochemistry, formation of Mg-carbonates, Monograph Series on Mineral Deposits 28, 135–171.*

Vacek, M., 1886: Über die geologischen Verhältnisse des Flusgebietes der unteren Mürz. *Verh. Geol. R.-A. 1886, 455–464.*

Mineralia Slovaca, 32 (2000), 549–550

Types of magnesite deposits in Yugoslavia

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Abstract

In Yugoslavia within the zone of ultrabasics of the Inner Dinarides the following major genetic types of magnesite are present: hydrothermal-sedimentary type within freshwater Miocene basins (Bela Stena type), infiltration type within ultrabasics as well as detrital magnesite type. Contribution summarizes magnesite deposits and occurrences of the country and associates them with individual genetic types.

Key words: magnesite, ultrabasics, genetic classifications

Introduction

Magnesite is one of the most important non-metallic raw-materials of Serbia. Ultramafic rock complexes and sediments of Neogene lake basins within which different types of magnesite deposits are located, have been explored during the second half of the 20th century. They are not only economically significant, as a raw material for the production of refractories, but also interesting from the scientific, genetic, viewpoint.

Genetic classification of magnesite deposits

According to Ilic (1983), genetic classification of magnesite deposits is following:

1. endogene (hydrothermal) deposits:
   a. metasomatic deposits of crystalline magnesite
   b. vein deposits of compact (cryptocrystalline) magnesite
2. transitory, hydrothermal–sedimentary deposits (Bela Stena type)
3. exogenetic (sedimentary) deposits
   a. salipherous
   b. infiltration
   c. detrital deposits.

In Yugoslavia, within the zone of ultrabasics of the Inner Dinarides, the following genetic types are defined:

1. hydrothermal–vein deposits within ultrabasics;
2. infiltration deposits within ultrabasics;
3. hydrothermal–sedimentary deposits within freshwater Miocene basins;
4. detrital magnesite deposits

Economic magnesite deposits are of hydrothermal–vein, hydrothermal–sedimentary and detrital types.

Hydrothermal–sedimentary type

Widely distributed in the ophiolitic zone of the Inner Dinarides, hydrothermal–sedimentary magnesites are present in the form of layers or lenses within sedimentary series of freshwater Miocene basins. Sometimes, they are located in Miocene series of the freshwater Neogene – Miopliocene basins. These basins are filled with clastic terrigenous sediments (conglomerate, breccia, sandstone, marl) and volcanogenic–sedimentary series (tuff, siliceous rocks, hydrothermal–sedimentary magnesites and dolomites; Ilic, 1988). According to the results of five-decades lasting field and laboratory exploration (as well as experimental work), it is known that this type of magnesite deposits is characteristic for the freshwater Miocene basins existing near to and/or over ultrabasic (peridotite – serpentinitic) rocks. During sedimentation, they were exposed to synchronous volcanic activity.

Deposits of hydrothermal–sedimentary magnesites in Serbia belong to the following areas (according to perspectivity of discovering deposits of economic interest; Lapcevic, 1988):

1. Sumadija area:
   a. Suvobor region
   b. Kosovo region
2. Kopaonik area:
   a. Ibar region
   b. Kosovo region
3. Zlatibor area:
   a. Zlatibor region
   b. Tara region
   c. Ozren region
4. Srem area:
   a. Fruska gora region.

In Tables 1 and 2, the following classification of magnesite deposits of the set type (as a subtype of the deposits of the infiltration type) according to regional and local structural geological factors is presented.

The largest is Bela Stena deposit in Ibar region (Kopaonik area), located at the cut of several main faults, along which the terrain was sinking several times in the time period between pre-lacustrine to post-lacustrine stage. Magnesite (in the form of bicarbonate) was transported by ascending carbonatic solutions from peridotite – serpentine rock to the lake and concentrated in the form of wide lens. As the Bela Stena deposit was made of the material of different origin (magmatic, metamorphic, even sedimentary), it was concluded that this is unique type of magnesite deposit (Ilic, 1983).

Tab. 1
Magnesite deposits of the set type according to regional structural geological factors (Lapcevic, 1988)

Mineral type of magnesite	Formation type of deposit	Tectonic position	Paleographic characteristics	Morphological type of deposit
Microcrystalline magnesite	Magnesite deposit in rocks of peridotite formations	Oceanic ultrabasic belts controlled by faults separating zones of different mobility	Land formations formed under suitable conditions during Cretaceous or Paleogene	Magnesites of the set type made in altered ultrabasics during forming the weathering crust. Mramor, Beli Kamen, Medvece, etc.

Tab. 2
Magnesite deposits of the set type according to local structural geological factors (Lapcevic, 1988)

Dimensions of the deposit	Adjacent alterations	Type of the ore body	Localities
- Large deposits (>5.000.000 m^2)	Zone of serpentinites – magnesited subzone, rarely zone of weathered serpentinites	Set type and irregular magnesite bodies. Rich deposits contain over 20 % of ore in the rock; medium rich: 10–20 %, and poor: 5–10 %.	Mramor, Glavica, Ridovi and Cosovac
- Medium deposits (1,000,000 – 5,000,000 m^2)			Miokovacki Beli Kamen, Busike, Parlog
- Small deposits (<1,000,000 m^2)			Deposits of no economic interest.

Detrital magnesite

Detrital magnesite deposits are a special genetic group of magnesite deposits. They are sedimentary formations, formed as a result of erosion activity onto the other types of magnesite deposits and redepositing within various environments (at the land, within rivers or lakes; Ilic, 1988).

According to the genetic classification (Ilic, 1983), there are the following types of the deposits:

1. lacustrine type
   a. subtype of basal clastics;
   b. subtype of intraformational clastics;
2. alluvial type
3. eluvial–deluvial type.

1. *Lacustrine type* is famous because of the widest distribution as well as economic importance in Serbia. It is divided into the two following subtypes:

a. *Subtype of basal clastics* is the dominant type of the lacustrine deposits. Within the Inner Dinarides, it is present in freshwater Miocene basins. The following deposits are known: Parlog (Cacansko–kraljevacki Neogene basin), Ljetovnik (Pranjanski Miocene basin), occurrences in villages Razani and Rosic and in Veliko Brdo hill (Razanski Miocene basin). For this type it is interesting that magnesite appears in basal series of freshwater to/over ultrabasic rocks containing higher concentrations of hydrothermal–vein magnesite body, presented by large veins and/or stockwerk (Ilic, 1988). So, near NW edge of Cacansko–kraljevacki Neogene basin, just to detritic deposit Parlog, a stockwork deposit Miokovacki Beli Kamen is located.

b. *Subtype of intraformational clastics* is presented by magnesite conglomerates and breccias, appearing in the parts of sedimentary complexes of Neogene basins overlying basal series. There is only one deposit of this type in Serbia – Janok locality (Cacansko–kraljevacki Neogene basin), 4 m thick magnesite conglomerate, interlayered within sand–marly Middle-to-Upper Miocene series. That deposit was formed as a result of abrasion and redeposition of hydrothermal–sedimentary deposit. Because of short lateral distribution of the magnesite layer, Janok locality is not of economic importance, but it directs to the presence of autochthonous hydrothermal–sedimentary magnesite deposit (Ilic, 1983).

2. *Alluvial type* is presented by magnesite fragments (originating from hydrothermal-vein deposits) within alluvial deposits of the majority of rivers in Serbia. The most important is the occurrence near village Badanj (Kopaonik Mt.). It is located in the alluvial deposit of the Radosicka reka river. Terrain is made of serpentinite peridotites, containing the vein magnesite body, but also magnesite fragments of different size. Small-size exploitation is possible, but there is no economic importance.

3. *Eluvial–deluvial type* is of insignificant space distribution and limited economic importance, but small-size exploitation is possible. The best explored locality in Serbia is occurrence of magnesite detritus in the area of vein deposit on Kukavica (Kopaonik Mt.).

Although not enough explored, detritic magnesite deposits in Serbia are interesting from the economic point of view, because of large reserves of magnesite (particularly in Razanski Miocene basin). The most important type for exploitation is lacustrine type (subtype of basal clastics), Ljetovnik deposit (Pranjanski Miocene basin) and Parlog deposit (Cacansko–kraljevacki Neogene basin). Alluvial and eluvial–deluvial types are of limited economic importance.

References

Gemaljevic, B., 1973: Exploratory works on sedimentary magnesite: Beli kamen – Ljetovnik – Brezak, Magnesite mine "Sumadija", Cacak, 60. (in Serbian)

Ilic, M., 1964: Genetic types of magnesite deposits in the zone of ultrabasites of Dinarides. Ph.D. thesis, Library of Faculty of Mining and Geology, Beograd, 262. (in Serbian)

Ilic, M., 1983: Results of recent exploration of detrital magnesite in Serbia (Yugoslavia). *Vesnik A, 41, Beograd, 41–74. (in Serbian)*

Ilic, M., 1988: Genetic types of magnesite deposits in the freshwater Miocene basins of Yugoslavia. *Annales Geologiques de la peninsule Balkanique, LI, Beograd, 556–565.*

Lapcevic, I., 1982: Magnesites of the set type near Razane in W Serbia. *Vesnik, XL, Beograd, 55–72. (in Serbian)*

Lapcevic, I., 1988: Magnesites of the set type in the ultrabasics of the Inner Dinarides. *Vesnik, 44, Beograd, 177–195.*

Vakanjac, B., Petrovic, B., Tomanec, R. & Starostin, V. I., 1983: On the genesis of vein magnesite deposits. *Bull. of Faculty of Mining and Geology, Beograd, 1–36.*

Zekic, M., 1977: Geological characteristics of vein magnesite deposits in ultramafics. *M.Sc. thesis, Library of Facultu of Mining and Geology, Beograd, 86. (in Serbian)*

Review of talc and magnesite deposits in Russia

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Abstract

The magnesite and talc deposits in Russia are grouped in three main areas: South Urals, East Siberia and Far East. Contribution characterizes individual deposits from the viewpoint of their resources, geological setting, genesis, mineralogy and processing. Some differences in genetical classifications of magnesite and talc deposits by various authors are mentioned. The magnesite deposit Satkinskoe (Satka) is treated in more details.

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Key words: location of deposits, geological and genetical relations, Satkinskoe (Satka) deposit

Magnesite

Resources. In Russia there are 13 explored deposits with proven resources. They are located in 4 magnesite-bearing provinces: South Urals (24 %); Udereiskaya, East Siberia (22 %); East-Sayanskaya (52 %); Malyi-Khinganskaya (2 %). The estimated total R.F. resources of 12–13 milliard tonnes is an approximation, based largely on geologic evidence. The probable resources are 2.8 milliard tonnes. At present time, Satkinskoe (Satka) deposit in South Urals is the only one, which is mined. Before 1992, 4–5 million tonnes were mined annually. The majority of known deposits is represented with crystalline magnesite type. The exception is Khalilovskoe deposit of amorphous magnesite (South Urals). It was mined before the Second World War, but recently it is closed. Magnesite in Russia is mined by open-pit methods. The possibility of underground mining is considered for Satkinskoe deposit because of the exhaustion of the high-quality crystalline magnesite resources.

Geology. Taken altogether, magnesite deposits of Russia can be divided into 3 formation types: (a) associated with ultrabasics, (b) with magnesian-carbonate complexes and (c) with evaporite salt complexes.

Magnesites connected with ultrabasics form veins, lenses and stockworks. The thickness of the bodies is 1–20 m; the length – 100–150 m. An amorphous magnesite is associated with keralite, nontronite, opal and hydrous ferric oxides. The world practice shows that refractories from amorphous magnesite have higher quality, then those from crystalline magnesites (Petrov, 1983).

Magnesite of carbonate complexes occurs in beds and lenses. The bodies are thick 10–200 m. Their length extend from 0.5 km to several tens km, sometimes up to 100 km and more. The main commercial mineral is crystalline magnesite. Additional minerals are talc, quartz, chlorite and dolomite.

Deposits of evaporite type are not treated here.

Genesis. There are several genetic classifications of magnesite deposits. The first group of investigators divides all magnesite deposits into 3 genetic types: hydrothermal-

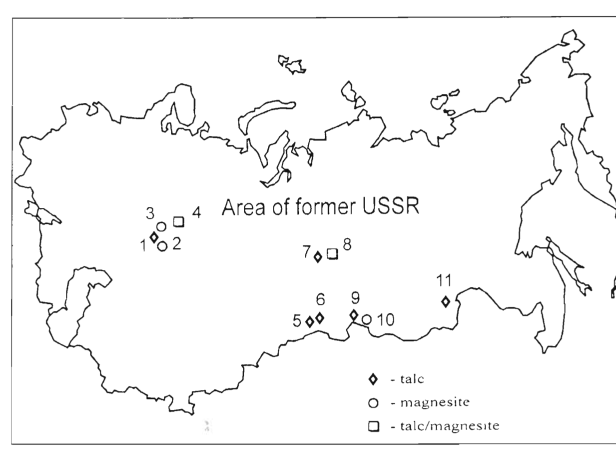

Fig. 1. Magnesite and talc deposits in the area of Ural, Siberia and Far East. Uralian deposits: 1 – Miasskaya group, 2 – Orsko-Khalilovskoe deposit of amorphous magnesite, 3 – Satkinskoe, 4 – Shabrovskoe. Siberian deposits: 5 – Svetli Klyuch, 6 – Alguiskoe, 7 – Kirgiteiskoe, 8 – Udereiskaya group of deposits, 9 – Onotskoe, 10 – Savinskoe. Far East: 11 – Birakanskoe.

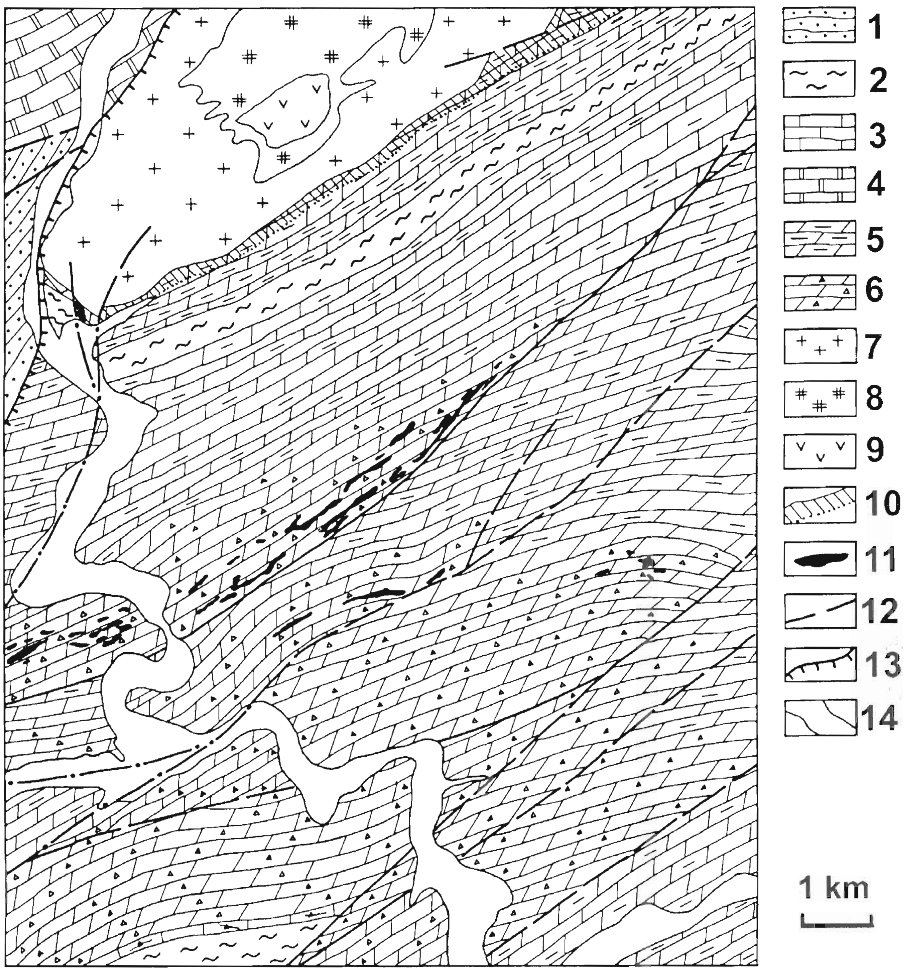

Fig. 2. Geological map of Satka magnesite deposit. 1 – arcose sandstones (Upper Riphean), 2 – black shales, 3 – limestones (Upper Riphean), 4 – calcareous marl (Upper Riphean), 5 – – clayey dolomites (Lower Riphean Satka Fm.), 6 – massive, brecciated and laminated dolomites (Karagay Member of Lower Riphean Satka Fm.), 7–9 – – Berdiaush rapakivi massif· 7 – granite rapakivi, 8 – syenite rapakivi, 9 – nepheline syenite, 10 – contact marble, 11 – magnesite bodies, 12 – faults, 13 – – Bakal-Satka regional thrust, 14 – alluvium.

-metasomatic (Satkinskoe, South Urals; Kirgiteiskoe, Udereiskaya province and others); sedimentary (deposits of Alpine mobile belt of Western Europe); infiltrative (lenses and veins of amorphous magnesite in weathering crust of ultrabasics; Krupenin, 1999; Timescov, 1983). The second group of authors also distinguishes 3 genetic types of magnesite deposits: sedimentary (Satkinskoe, Kirgiteiskoe and others), the deposits of weathering crust (Khalilovskoe and other deposits of Ural greenstone belt) and metamorphic (Shabrovskoe talc-magnesite deposit and others).

The basic disagreements between these scientific streams are connected with genetic position of Satkinskoe (Satka) deposit. The first group of scientists considers it to be hydrothermal, whereas, the second group assigns Satkinskoe deposit as primary sedimentary.

At last, there are scientists, which try to combine these points of view. For example, they divide all deposits into 3 main genetic types: unchanged sedimentary, crusts of weathering and metamorphic. Metamorphic deposits consist of 2 subtypes: metasedimentary and metaultrabasic. These scientists consider Satkinskoe deposit as a primary sedimentary one. The features of hydrothermal activity are connected with an operation of hot metamorphogenic solutions and have local distribution.

An original concept, concerning magnesite origin and connection between magnesite and talc deposits was proposed by P. P. Smolin at the end of 1980–1990. For example, it was reported, that there were two most important geochemical peculiarities of magnesite: chemical activity and refractoriness. Due to their refractoriness, Mg-silicates are formed by two ways: a) they are accumulated in the mantle as restite and then ascend to upper horizons of the Earth crust; b) magmas, enriched by magnesium, are formed as a result of partial melting of mantle rocks. These magmas ascend to upper horizons along faults and are flowed on the surface. After that, specific chemical activity is developed. Magnesian rocks are destroyed as a result of weathering and form sediments of magnesite and clastic rocks. Subsequently, crystalline magnesite and Mg-silicates, for example talc, are formed (Smolin, 1983).

Processing. The institute "VNIInerud" carries out the investigations, concerning the use of the waste products which were formed during the open pit mining on Shabrovskoe deposit. This investigation includes reagentless flotation, high-gradient magnetic separation and superfine milling. "Extra" grade was obtained as a result of the method. High-quality forsterite refractory materials were also obtained as a result of addition of 15 % periclase to serpentine.

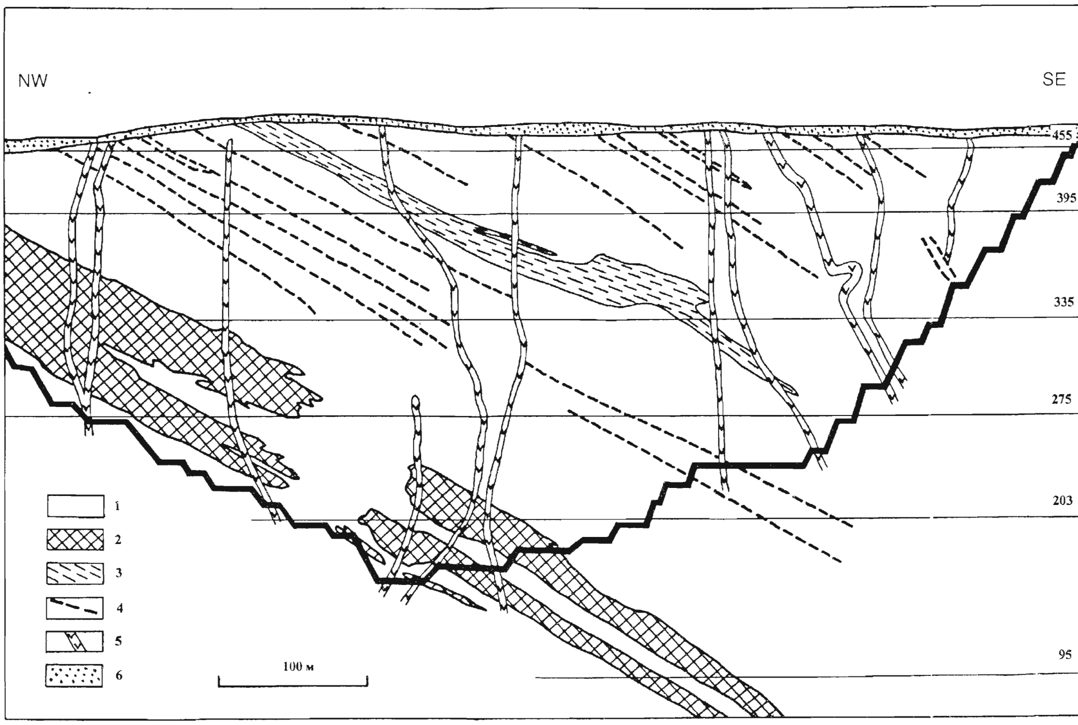

Fig. 3. Cross-section through Satka magnesite deposit located in the middle part of Karagay open pit. 1 – host dolomites. 2 – magnesite bodies. 3 – bed of clayey dolomites and slates. 4 – beds of black shales. 5 – diabase. 6 – overburden.

Satkinskoe (Satka) sparry magnesite deposit

Magnesite deposit Satkinskoe (Satka) is located in Tcheliabinsk region, Satka district, near the Satka city on western slope of Southern Urals.

Geologically the deposit is related to Central Urals uplift, nothern part of Bashkirian megaanticlinorium and Taratash anticlinorium, the western slope of Satka syncline. Country rocks are represented by laminated, partly massive or brecciated dolostones of Lower Riphean Satka Formation (thickness about 2,000 m). The Satka Fm. consists of five members. Fifth Karagay Member (thick about 750 m) is magnesite bearing. Satka Fm. is overlaid with upper Lower Riphean Ai Fm. (arcose sandstones, polymict conglomerates, beds of basalts with age 1,650 Ma (U-Pb, Krasnobaev et al., 1992) and underlied by Lower Riphean Bakal Fm. (interbedding slates and limestones with metasomatic siderite deposits; thickness of formation is about 1,450 m).

Metasomatic ore bodies are present in two levels in the lower part of Karagay Member in layered and brecciated dolostones. Ore bodies have sharp discordant lateral contacts with country dolomites. ^{87}Sr enriched Mg-brines have been derived from argillites or schists formations. Lower ^{18}O in magnesite compared with the host dolomite points to the influence of meteoric water. Magnesite formation below sedimentary discontinuities might be explained by the flow of Mg-rich groundwater through brecciated lithologies of the carbonate platforms to deeper parts of the basin during emerging periods of the carbonate platform. The Mg-brines might be traced back to weathering processes of the Archean greenstone belts of the East European Platform under humid climates.

The magnesite deposit consists from about 20 ore bodies, on two levels in lower part of Karagay Member of Satka Fm. Ore bodies are located in belt long ca. 8 km with NE strike and SE dip about 30 degrees. There are usually two main bodies with thickness 20–40 to 80 m, areally reaching some square kilometres. Magnesite has pinolitic structure (grain size about 1–5 cm) and relict of laminated or massive textures of dolostones. Sometimes magnesite has recrystallization structures of white beds and nests in gray ore.

Content of magnesite is about 95–99 %, additional minerals are dolomite, Mg-chlorite, talc and quarz. Parametres of individual kinds of magnesite used in the factory (Kombinat "Magnezit"): (1) SiO_2 – 0.9; CaO – 1.4; (2) SiO_2 – 1.1; CaO – 2.1; (3) SiO_2 – 2; CaO – 4. FeO is about 1 and MgO is about 45–47 %.

The Satkinskoe (Satka) deposit, belonging with reserves about 300 millon tonnes of magnesite among giant deposits. The deposit, being detaily explored, is mined with tree open pits and one underground mine called "Magnesitovaya" shaft.

Talc

Resources. In the Russian Federation, talc and talc stone are widely distributed in Urals and Siberia. The commercial resources are determined to 24 milliard tonnes for talcites and 130 milliard tonnes for dimension talc stone and approximate reserves are estimated as 26 and 320 milliard tonnes, correspondingly. In summary, there are known more than thirty occurrences of talc and dimension talc stone. The majority of talc resources is concentrated in West Siberia (~ 52 %). Notable talc resources are found in Urals and in East Siberia (15 % and 19 % from total, correspondingly). The mining of talc is no more than 350,000 tonnes annually. Recently Onotskoe and Shabrovskoe deposits are mined. The mining is mainly produced by open-pits and only small quantity of high-quality steatite is mined by underground way (Romanovich et al., 1999b).

Geology. The talc deposits in Russia are mainly connected with 2 types of rock associations: a) dolomite and dolomite-containing carbonaceous formations, b) ultrabasic formations. Special places take residual talc into crust of weathering and talc redeposited in karst cavities (Romanovich et al., 1999b; Smolin,1983; Smolin,1987; Tatarinov,1969; Timescov, 1983; Shevelev and Urasina, 1983).

In first case, the largest talc deposits are connected with Upper Proterozoic series of carbonate-silicate rocks. Talcites and talc-bearing rocks are located along contacts between dolomite or magnesite and silicate rocks. The contact between magnesite and serpentinite is characteristic for Kamchadal area, Onotskoe deposit. Talc occurs as fine dissemination, veins, veinlets and lenses. The length of talc bodies varies from 50 to 200 m. Total length of the zone is 500 m, thickness 40 m. Talc bodies of Kirgiteiskoe deposit are located along contact between dolomites and clay slates. The length of the largest lens is 550 m and thickness 20 m.

Shabrovskoe deposit is a classic example of talc bodies connected with ultrabasics. The talc-magnesite lens extends to 2 km. The thickness is 50–350 m. The smaller talc bodies are present in numerous ultrabasics of Middle and South Urals. As a rule, they are located on contact of serpentinite and serpentinous peridotites with aplite and albitite dykes. The length of bodies is 50–200 m, the thickness 5–20 m. The resources vary from 100 to 500 thousand tonnes. Some of these deposits were mined.

Talc of the weathering crust and redeposited talc are present in a few deposits only. The powder talc ores from Kirgiteiskoe deposit are of the greatest commercial importance. They have the highest brightness (Fe content is no more than 0.1–0.2 %).

Mineralogy. Smolin (1987) showed, that there was the whole family of talc minerals. All of them have one crystal-structure base with stoichiometry corresponding to the ideal talc $Mg_3(Si_4O_{10})(OH)_2$. There are following differences between individual varieties: a) besides Na, other cations are present, b) relation of cations in octahedron differs, too, c) there are variations in Si quantity, d) molecular water is present. The following varieties of talc are recognized: proper talc, Ni-Mg–talc, ferrotalc, Mn-ferrotalc. Besides, the following intercalation minerals are distinguished: talc-serpentine, talc-chlorite, talc-pyrophyllite (l. c.).

Talc and serpentine are highly plastic materials at high pressure and are favorable for the formation of lenses and bed-like bodies (Nasedkin and Markov, 2000).

Genesis. There are several genetic and commercial-genetic classifications of talc deposits. Correspondingly with the first classification, talc deposits are divided into 4 types: contact-reactional deposits associated with dolomite, contact-reactional deposits associated with ultrabasics, metamorphic and residual ones, associated with weathering crust (Krupenin, 1999; Timescov, 1983). Some of the authors combine 1 and 2 types (e. g. Tatarinov, 1969). Smolin (1983) recognized only 2 genetic types of talc deposits: regional metamorphic and residual of weathering crust. It is Smolin's opinion, that metasomatic contact-reactional processes operated during regional metamorphism in local areas (l. c.).

References

Ellmies, R., Voigtlander, G., Germann, K., Krupenin, M. T & Moeller, P., 1999: Origin of stratabound deposits of magnesite and siderite in Riphean carbonate rocks of the Bashkir maga-anticline, western Urals. *Geol. Rdsch., 87, 589–602.*

Krasnobaev, A., Bibikova, E. V., Ronkin, Y L. & Kozlov, V I., 1975: Geochronology of Ayskaya suites volcanites and isotopic age of lower boundary of Riphean. *Proceedings of Russian academy of sciences. Geological series, 6, 25–40.*

Krupenin, M. T., 1999: Condition of forming of siderite-bearing Backal Formation of Lower Riphean. *Urals Branch of RAS. Yekaterinburg, 256.*

Nasedkin, V V & Markov, V K., 2000: Some features of microdestruction evalution in rocks by high pressure. *In: V. N. Strachov (Ed.): Physical properties of rocks by high pressures. Institute of Physics of Earth. Moscow, 39–41*

Petrov, V P (Ed.), 1983: High–Mg raw materials. *Nauka, Moscow*

Romanovich, I. F., Smolin, P P., Khairulina, G. Z. & Shevelev, A. I., 1999a. Mineral raw materials. Magnesite, brucite. *Geoinformmark, Moscow, 34.*

Romanovich, I F., Saetgaleev, Ya. Kh. & Rakhmatullin, E. Kh., 1999b: Mineral raw materials. Talc and pyrophyllite. *Geoinformmark, Moscow, 37*

Shevelev, A. I. & Urasina, L. P., 1983: Commercial genetic types of magnesite deposits. *In: V P Petrov (Ed.): High–Mg raw materials. Nauka, Moscow, 82–91*

Smolin, P P., 1983: Mineragenetic history, problems of evolution of resources and rational application of magnesite, brucite and talc. *In V P Petrov (Ed.): High-Mg raw materials. Nauka, Moscow, 11–60.*

Smolin, P P., 1987: New data about talc mineralogy and commercial talc resources. *In: V P Petrov (Ed.): New non-metallic raw materials. Nauka , Moscow, 72–140.*

Tatarinov, P M. (Ed.), 1969: Non-metallic raw materials. *Nedra, Moscow, 470.*

Timeskov, V A., 1983 Scientific problems of forecast and prospecting of magnesite deposits. *Soviet geology, 3, 73–80.*

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Magnesian raw material of Ukraine

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Abstract

The most important magnesite and talc deposits of Ukraine, Pravdinskoy, Veseljanskoe, Radionovskoe and Sivach, are characterized with relation to their genesis and industrial use. Magnesite and talc mining in Ukraine has little interface with human society and the environmental threat from the pollution of the drainage system as well as the air by emissions is minimal The greatest and most evident environmental impact of magnesia exploitation has centered around seawater magnesia plants.

The prospecting, targeted to the primary haloes, is characterized with the presence of calcite and baryte and increased contents of Cl, As, Hg and Ba. More distant zones have increasing concentration of Cu, Zn and V

Talc accumulations are indicated by positive and negative haloes of the ferric group elements, as well as by increased concentrations of F, Cl, Hg and P In the vicinity of granite-porphyry occurring near ultrabasites the elements Ba, Pb, Zn, Zr and P are dispersed. Magnetic exploration and the emanation survey by the minimum radon concentration are efficient for identifying the most prospective sites for talc deposits. It is also advisable to explore the endogenic haloes of Cl, F, Hg, K, Na, Rb and Li, indicating talc mineralization.

Key words: genetical division of magnesite deposits, environmental considerations, prospecting methods

Introduction

Magnesite ($MgCO_3$) deposits and occurrences can be divided into crystalline and cryptocrystalline varieties as well as hydrothermal metasomatic and infiltration types.

The former are of primary commercial use. The deposits are composed of crystalline magnesite, having bedded on lens-like structures. Deposits of the first type belong to the medium-temperature ones that originated at moderate depths. Magnesite resulted from the hydrothermal impact on limestones exerted by magnesium-rich chlorides solutions.

Infiltration deposits represented by amorphous magnesite are localized among serpentines ultrabasites affected by hypergenesis in the zone of weathering. Magnesite accumulations form lens like deposits. The parameters and commercial value of such deposits are not high. Magnesite, when pure, contains 47.8 % MgO and 52.2 % CO_2. The pure mineral is sometimes, but rarely, found as transparent crystals resembling calcite. However, magnesite predominantly contains variable amounts of the carbonates, oxides, and silicates of iron, calcium manganese, and aluminum. Magnesite may be either crystalline or 'amorphous' (cryptocrystalline). Accessory siliceous minerals such as serpentine, quartz, or chalcedony are usually present. Calcium minerals are usually absent or in low concentrations in cryptocrystalline magnesite, in contrast to their almost invariable presence and higher concentrations in the crystalline variety. Magnesite dissociates upon heating to form magnesia (MgO) and carbon dioxide. When heated sufficiently, magnesia develops a crystal structure identified with that of the natural mineral periclase. The mineral periclase occurs only rarely in nature and not in any known, commercially workable deposits. Deposits of crystalline magnesite are usually found associated with dolomite.

Talc, $Mg_6SiO_{12}(OH)_4$, is a hydrous magnesium silicate. Its contact-metasomatic, hydrothermal, and metamorphic deposits are known. The former originate near the contact of dolomites and dolomitized limestones with granitoid and are divided into two subgroups: (a) those that originated with the introduction of CO_2, and (b) those, which were formed due to the introduction of SiO_2. The latter, associated with serpentinous ultrabasites, are grouped into the deposits formed: (a) due to the introduction of CO_2 and (b) owing to the introduction of SiO_2. Metamorphogenetic deposits of talcites and soapstones are associated with the introduction of MgO and CO_2 into schists and dolomites.

Preferrent use of magnesite

More than 90 % of a world mining of magnesite burns for reception fire-resistant magnesia in powder form and

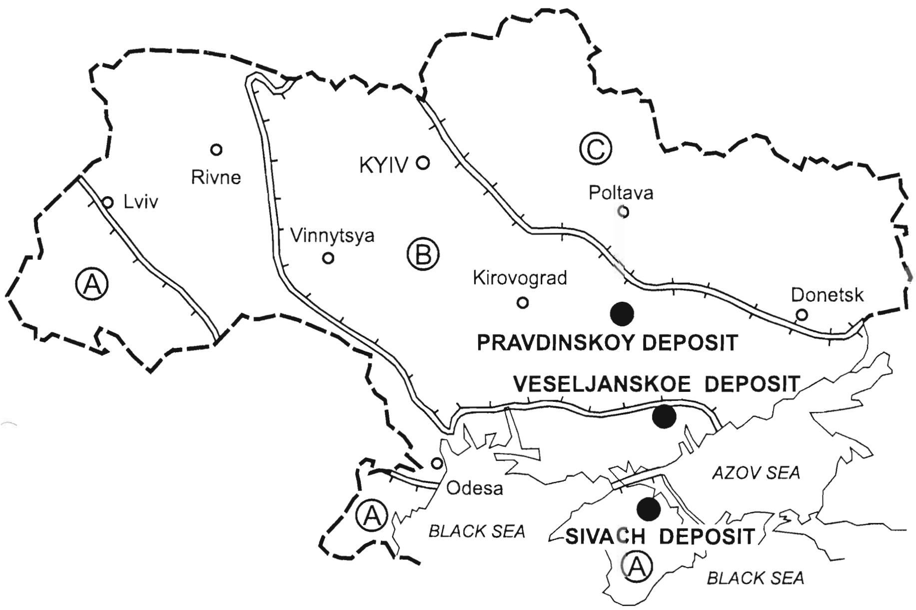

Fig. 1. Map showing the main geological groups of magnesian raw material of Ukraine. Magnesite and talc deposits of Ukraine: Pravdinskoy and Veseljanskoe. The brine provides Mg and Na salts, gypsum and other chemical components: Sivach deposit. A – Carpathian-Krymian province, B – Ukrainian Shield, C – Dneprovo-Doneck province.

moulded articles. These materials will be used self-maintained or in an intermixture with other refractoriness for interior lining of the basic fore hearth operators of furnaces and converters. Besides the magnesite will be used by production apart of resistant cement; for impregnation of wood building constructions, which eliminates their combustion and corruption; in a pharmaceutical industry.

Magnesite and talc deposits of Ukraine

Pravdinskoy deposit

The deposits of magnesite and talc located in metamorphic Precambrian formations are known in a series of regions of the Zaporozhye and Dnepropetrovsk areas. One of the most perspective radiant magnesium of raw material for metallurgy of Ukraine is the talc-magnesite. It is reconnoitrered and stands on balance a deposit Pravdinskoy of talc-magnesites. There are also other similar perspective objects. Field of talc-magnesite genetically conjugative with ultrabasites, ultramafic and mafic rocks by complexes of Ukrainian shield first of all by complexes Sursco-Belozers of a type. Deposits Pravdinskoe of talc-magnesite and carbonaceous-bearing serpentinites is located at village Gruchevka, the Krinichan regions in Dnepropetrovsk province. Deposit was reconnoitrered in 1964–1968 by trust "Dnepr-geology" and with new expanded prospecting in 1971–1972 by "South-Ukr-Geology". The reserves were authorized burring USSR in 1973 on a category $B+C_1$ – 105.1 million tones, from which 55 % belongs to talc-magnesite and 45 % to carbonaceous serpentinites. Prognostic resources up to depth 150 m contain about 300 million tones. Deposit is associated with Precambrian crystalline rocks and weathering crusts of Pliocene and Quarternary. The mineralized strata occur among steeply dipping (60–80° to SW). Precambrian crystalline rocks of tabular shape having NW course. Length of mineralized body along the strike is 800 m, width 150–350 m and thickness 100–180 m. The reserves are reconnoitrered to the depth 160–180 m and proved by individual wells in depths up to 350 m from the surface. In a central part of the field a strip of waste rocks divides a mineralized strata into two blocks – southwestern and northeastern. The thickness of a strip of waste rocks is 10–45 m and it increases depthward. Thickness of the productive strata in the southwestern block is 80–160 m and in northeastern – 110–360 m. The deposit has cover thick 6–35 m.

The laboratory and trial examinations have shown, that the talc-magnesite and carbonaceous-bearing serpentinites are applicable for production of high-quality fire-resistant brick-making forsterites. Talc-magnesite and magnesite serpentinites can be used also for flour as effective magnesium fertilizer for soil. The additive 20–25 % decomposed samples of magnesite concentrate (received during dressing of talc-magnesite) were converted into different solid forms and can be produced as milled raw material applicable for fabrication forsterites – valuable refractories. The talc-magnesite are complex ores, as contain except for talc (45–50 %) and magnesite increased amounts of nickel, cobalt and chrome. They are suitable for manufacturing of burnt talc-magnesite. At their flotation (the yield of magnesite is 40 % and talc 48 %). The talcous concentrates of the marks A and B would also be valuable raw material, widely applicable in different branches industry. The particular volumes of a talcous concentrate can be exported. From blocks of talc-magnesite it is pos-sible to receive also commercial a talcous-fired magnesite brick for lining of rotary furnaces. Talc-magnesite of middle decomposited samples can be used for insecticides (for protection of plants) and for production of glasses. Joint-stock company "Entrails" of city Dnepropetrovsk begins the opening of the Pravdinskoe deposit with exploitation of talc-magnesite and carbonaceous-bearing serpentinites.

Veseljanskoe deposit

In Orehovskoe area of the Zaporozhye field in 15 km distance to SW from railway station Fisaki the exploration by the Ukrainian geologic management in 1952–1955 detected deposit Veseljanskoe of talc-magnesite with reserves on a category C_1 – 132.3 million tonnes. This deposit was not affirmed. The steeply dipping (70–80°) talc-magnesite body occurs in depth 60 m. Mineralized bed thick 30–300 m prolongs along the strike of 5 km. The variegated surrounded lithology contains lenses and hardpans of serpentine. The deposit is covered with weathering crust thick 40–80 m, concerning the recent position of magnesite among raw materials. The deposit Veseljanskoe is perspective for detail exploration.

Radionovskoe deposit

The Ukrainian shield is promising area for discovering of new magnesium deposits of other types. In connection with those already used in production of magnesite powder with other materials, the forsterite refractories (i. e. refractories from Mg with low concentrations of Fe in olivine) prefer the application of natural forsterite. Similar raw material is delivered from Kareliya and Ural. In Western Sorokinskaya zone of the Priazovsky block in the area of rivers Berda and Obitochna the deposit Radionovskoe occurs. The high-magnesium-bearing ultrabasites were detected and can be used as natural raw material for forsterite refractories. The lithological and geochemical preliminary data indicate fulfilling of technical requirements on forsteriteous raw material. Prognostic resources of category P_2 in depth interval 200 m reach 250 million tonnes. The deposit Radionovskoe has an advantage of complex mining possibilities (titanium, apatite, nickel etc.). The dressing of basic and ultrabasic rocks associated with deposit (anorthosite, gabbro, serpentine, etc.) allows obtaining olivine, olivine-pyroxene and pyroxene concentrates as the high-quality magnesium raw material.

In Ukraine for production of refractories, processed using high temperature treatment of dunite, the raw material from Ural (Tagil) is imported in quantities about 100 kt. Among Precambrian ultrabasites of Ukrainian shield the relevant sources of Mg can be detected among superficial sources related to weathering crusts of ultramafic rocks. The relation to ultramafics is proved by lithological background of several Mg anomalies. The diagenetic type of magnesite, usually tied with evaporites, starts to play an important role in Ukraine. The Caledonian-Caledonian sedimentation magnesite is tied with weathering crusts in Pridneprovje region. Deposits of the epi-Variscan weathering crust are present in Dneprovo-Donesk area. New research in Ukraine, apart from recent valuable view on industrial minerals genesis in numerous countries of a world, has found a magnetic character of talc. This is caused by low concentration of Fe in talc. During weathering from talcous formations the harmful impurities were leached. Features that talcous magnesite exhibits in the Dnepropetrovsk area alongside with development of linear weathering crusts allow to recommend this region as primary for research on Fe-free talc with specialization on forecast of disintegration talc types of weathering crust.

In Ukraine the perspective fields of pyrophyllite, applied in manufacturing of ceramic materials, glazes, acid-resisting products and heat-resisting concretes are located in Ovruch regions of Zhitomir area (neighboring strata represent quartzite). The formation of pyrophyllite is related to greenschist facies of metamorphism. Recently there was found a new pyrophyllite field in Nagorjanskoe area.

Sivach deposit

The magnesium raw material basis of Ukraine will in the future require an import of some amounts of high-quality magnesium raw material preferment of brucite $Mg(OH)_2$ type. Brucite will be widely used not only for production of refractories, but also for fabrication of periclase and other magnesium products of supreme quality. Recently Russia, Turkey and China are the substantial suppliers of this raw material. The essential contribution to a solution of a problem of high-quality magnesium of raw material is of processing of magnesium salts from developing brine deposit Sivach. Use of Sivach brine enables to produce the high stability refractories with the MgO content 93–99 % (periclase type refractories), which one can be used in hyperthermal technologies. The Sivach brine provides Mg and Na salts, gypsum and other chemical components. Mg salts can be used also as the additive at fabrication of the relevant refractories. In world the share of ocean waters used in reception of magnesium yields is gradually increasing. In Ukraine the leaching of siliceous strata from the depths 1,700–3,000 m by wells, being realized in Dneprovo-Donezkoy cavity (the Chernigov and Poltava area), is recently non-commercial.

Environmental considerations

Magnesite mining extended in various regions, have little interface with urban society. Contestation as to land use is not a problem in Ukraine. The drainage of underground and open pit mines does not contribute significantly to pollution of streams because the drained area contains low amounts of soluble or oxidizable minerals. In the past calcining plants emitted substantial amounts of stack dust, but modern dust collectors and precipitators have removed most of these emissions and allowed the recovery of valuable products. The greatest and most evident environmental impact of magnesia operations has centered on seawater magnesia plants. Recent innovations leading to greater control of the characteristics of the effluents have decreased the amount of turbid effluents.

Prospecting for magnesite and talc

At the stage of prospecting it is recommended to investigate the primary haloes in order to identify blind and deep-seated magnesite bodies. According to universal zonality, the supra-ore zones are characterized by the development of calcite and baryte and by increased contents of chlorine, arsenic, mercury and barium, whereas the sub-ore zones are notable with increasing concentration of copper, zinc and vanadium.

Talc accumulations occur commonly in the periphery of ultrabasites. It should be borne in mind that they are indicated by positive and negative haloes of the ferric group elements, as well as by increased concentrations of F, Cl, Hg and P. Where dykes of granite-porphyry occur near ultrabasites, attention should be given to the dispersions in the contents of such elements as Ba, Pb, Zn, Zr and P. Magnetic exploration is carried out to identify the zones of contact of ultrabasites as the most prospective sites for detecting talc deposits. Talc bodies are distinctly localized with the help of the emanation survey by the minimum radon concentration. In the process of prospecting, it is advisable to explore the endogenic haloes of Cl, F, Hg, K, Na, Rb and Li, indicating talc mineralization. Special attention should be given to the coincidence of the haloes formed by the introduction or removal of elements that indicate the epicenters of productive bodies. It is rather efficient to combine geochemical methods with thermography which helps detect steaming haloes and water-abundant zones in rocks. A distinct and intensive endothermic peak at 965 °C is identified in talc formations from the thermal analysis data. Zonality is an important geochemical indicator. By determining zonality indices, studying the correlation of elements, and the data provided by the differential phase analysis for mercury, it is possible to predict talc mineralization at the present level of erosion or at a certain depth. Geological and geochemical methods being considered inefficient, mainly in base prospecting for talc deposits in direct field observations.

References

Komov, I. L., 1996. Mineralogical methods of prospecting for non-metallic minerals. *Mineral Resour. Ukraine. Vol. I., part 2, 4. 5. 10–25.*

Komov, I. L., 1996: Geochemical methods of prospecting for non-metallic deposits. *30th Intern. Geol. Congress, China. Abstracts, 3, 59.*

Komov, I. L., 1998: New progressive geochemical methods of prospecting for ore and non-metallic minerals. *Carpathian-Balkan Geological Association. XVI Congress. Vienna. Abstracts, 280.*

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Talc and magnesite deposits in China

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Abstract

The most important magnesite and talc deposits in China are located in Hecheng-Dashiqiao (Yingke) ore belt of northeastern China. They are developed in the upper part of Dashiqiao Formation of lower Liaohe Group of Middle Proterozoic age. The general geological setting, occurrence of magnesite and talc ore bodies as well as character of mineralization are characterized in this contribution. In the case of Fanjiayu talc deposit the polystadial formation of talc is suggested. The magnesite deposits in China have formed mainly via sedimentary process. The metamorphic hydrothermal and Mesozoic magmatic hydrothermal mineralization overprinted the synsedimentary mineralization to form the talc and a part of the magnesite deposits. In these cases, the origin of magnesium came from the original magnesite-bearing strata, whereas the SiO_2 may be derived from magmatic hydrothermal fluids.

Key words: magnesite and talc mineralization, Fanjiayu deposit, Proterozoic Liaohe Group, Hecheng-Dashiqiao (Yingke) ore belt

Introduction

China has abundant talc and magnesite mineral resources. The talc-magnesite deposits occur mainly in the magnesium carbonate formation, and the reserves of this type ores amount up to 99 % of all those in China (Institute of Mineral Deposits, CAGS, 1992).

Location of deposits

The talc-magnesite deposits of the magnesium carbonate formation are located mainly in Hecheng and Yingke county, Liaoning Province, northeastern China, forming the Hecheng-Dashiqiao (Yingke) ore belt (Fig. 1). The largest and famous deposits include Xiafangsheng, Jinjiabao, Huaziyu, Qinshanhuai, Shengshuishi and Fanjiayu. They are strictly controlled by the upper part of Dashiqiao Formation of lower Liaohe Group of Middle Proterozoic age (Zhang, 1984). The ore-bearing sequence in descending order is: thinly bedded dolomitic marble, sericite phyllite (>250 m); ore bodies including 3 ore beds: upper part of magnesite ore body, with siliceous dolomite and some phyllite containing fossils of algae (>400 m); middle part of thick magnesite ore body with interbedded dolomitic marble (>2000 m); lower part of magnesite ore body with laminated dolomitic marble phyllite (>350 m). Some deposits also occur in the Nantong county, Sichuan Province of southwestern China (Fig. 1).

Magnesite

The occurrence of the magnesite ore bed extends over 100 km and is 4 km wide. The magnesite ore body in the whole ore belt shows mainly bedded or bed-like shape and is concordant with host rock. The ore body has a typical length of 200–2,700 m and thickness of 30–300 m. The ore bodies are interbedded with metamorphosed sedimentary rocks and are in lateral transition to dolomitic marble.

The ore minerals include mainly magnesite and talc, with some tremolite, scapolite, clinochlore, quartz, siderite, ferromagnesite, breunnerite, pyrite, magnetite, hematite and limonite, etc. Crystalline magnesite is mainly white and pink, with some white-gray, gray, right-yellow and dark-green varieties. The mineral grain size varies from fine grained (<0.5 cm), medium grained (0.5–1.0 cm), to coarse grained (1–5 cm) and very coarse grained (>5 cm). The largest magnesite grains may reach up to 10–15 cm. The contents of MgO are inversely proportional to CaO and SiO_2.

The quality of magnesite is affected by talc-mineralization, and the concentration of a great amount of talc may form an independent industrial talc ore body.

Talc

Talc is often found as an associated mineral with magnesite in the Hecheng-Dashiqiao (Yingke) ore belt. The

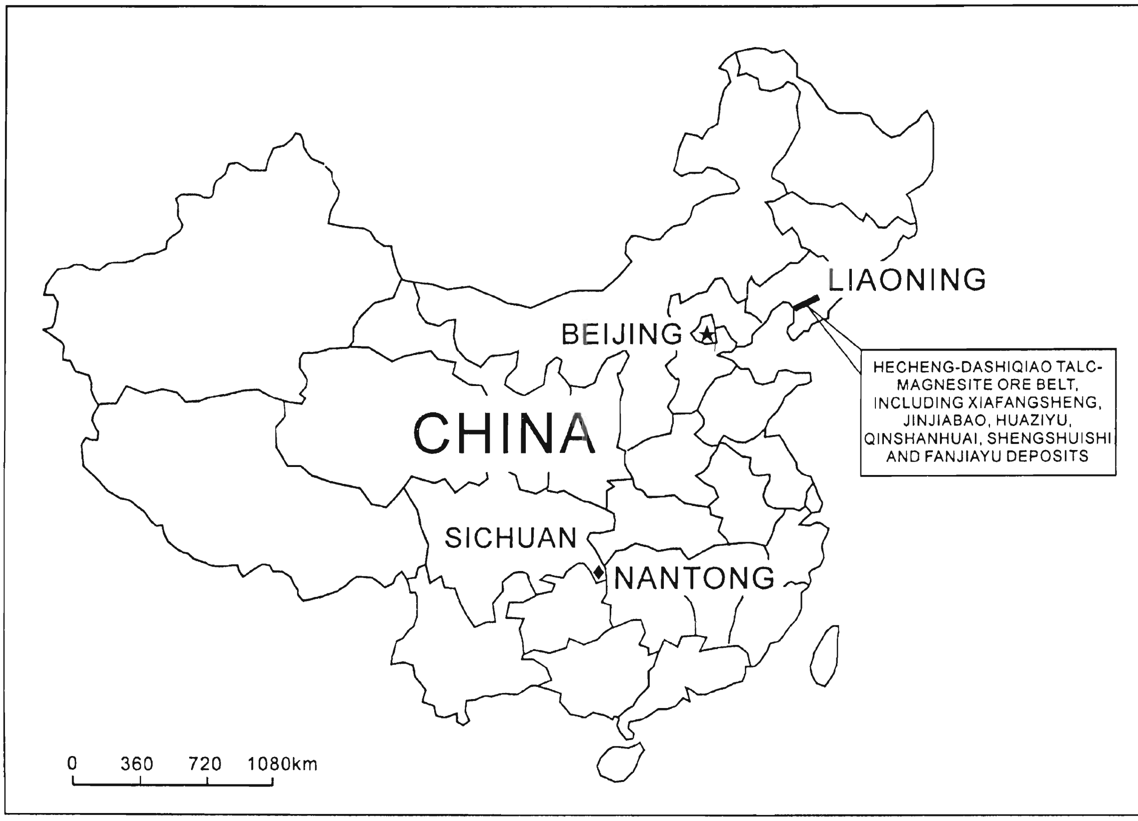

Fig. 1. Sketch map showing the distribution of the talc-magnesite deposits in China. Most of the deposits occur in Liaoning Province of northeastern China. Minority of deposits occurs in the Nantong area, Sichuan Province of southwestern China.

talc deposits are distributed strictly along the magnesite belt in this region. Based on its occurrence, talc deposit can be classified into vein, lenticular, lump and disseminated type.

Vein and lenticular talc can form independent talc deposits. Lump and disseminated talc has no industrial value and can only decrease the grade of a magnesite deposit.

At least three stages of talc origin can be recognized. The first stage is represented with scaly and columnar talc. They differ from others by their dark colors as well as high Ti and V contents. This type of talc is formed from the magnesite being replaced by regional metamorphic solutions with supply of SiO_2. The second stage is associated with magnesite formed by mechanical-chemical metamorphic re-emplacement. The talc formed in this stage is characterized by enrichment of carbon. The genesis is related to hydro-dynamic and metamorphic hydrothermal solutions, but the magnesium came from the magnesite deposit. The third stage is related to Mesozoic granitic hydrothermal solutions, such as talc deposit in Fanjiayu.

Fanjiayu talc deposit

The ore body of Fanjiayu talc deposit occurs within the magnesite ore body and is obviously controlled by tectonics. The alteration zone of the wall rock near the deposit is 1–2 m thick. In the ore body, the massive pink talc veins were observed cutting light brown massive talc and indicating polystadial formation of talc. In the ore body the breccia of Mesozoic magmatic dikes are found besides the breccia of magnesite. These features indicate that the talc deposit of Fanjiayu is probably of magmatic hydrothermal origin. The Mesozoic magmatic hydrothermal activity provided only SiO_2, and the magnesium obviously came from the magnesite bed. There would not be any talc deposits without the magnesite bed.

Conclusion

The magnesite deposits in China have formed mainly via sedimentary process. The metamorphic hydrothermal and Mesozoic magmatic hydrothermal mineralization overprinted the synsedimentary mineralization to form the talc and a part of the magnesite deposits. In these cases, the origin of magnesium still came from the original magnesite-bearing strata, whereas the SiO_2 may derive from magmatic hydrothermal fluids.

References

Zhang, Q., 1984: Geology and metallogeny of the Early Precambrian in China. *Jilin Peoples Publishing House, Changchun, China, 300–336 (in Chinese).*

Institute of Mineral Deposits, Chinese Academy of Geological Sciences (CAGS), 1992: Introductions for map of mineral resources in China. *Geological Publishing House, Beijing, China, p. 17–26 (in Chinese).*

Magnesite deposits in Australia

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Abstract

The main areas of magnesite resource in Australia are in South Australia and Queensland with smaller groups of deposits in Tasmania, Western Australia, Northern Territory and New South Wales. The magnesite industry in Australia is progressing rapidly and significant financial investments have been made in 1999–2000, especially in South Australia and Queensland. Total estimated Australian magnesite resources exceed 1.4 billion of tonnes.

Key words: areas of magnesite resource, trends of magnesite industry, Australia

Introduction

There are seven main areas of magnesite resource in Australia:

1. Batchelor (Northern Territory)
2. Murrin Murrin (Western Australia)
3. Bandalup (Western Australia)
4. Leigh Creek (South Australia)
5. Kunwarara (Queensland)
6. Arthur Lineament (Tasmania)
7. Thuddungra (New South Wales)

Work on these projects range from pilot stage through to final feasibility to trial magnesium production status. Very significant financial investment has been made in 1999–2000 on exploration, testing, process experimentation and plant production in South Australia and Queensland. Other proposed magnesium projects are based on fly-ash (Hazelwood in Victoria) and serpentinite tailings (Woodsreef, New South Wales). Total Australian production between 1940 and 1994 was 2.8 million tonnes from deposits in New South Wales, Queensland, South Australia and West Australia. However, current interest is focussed on the first six areas listed above and the anticipated construction of magnesium smelters close to the South Australian, Queensland and Tasmanian deposits. Total estimated Australian magnesite resources exceed 1.4 billion tonnes.

Main areas of magnesite resource

Batchelor, Northern Territory

Large magnesite deposits occur near Batchelor at the Celia (Huandot) and the Coomalie prospects within silicified carbonates of the Paleoproterozoic Celia Dolomite of the Pine Creek Inlier. The magnesite was probably primary and formed in an alkaline lake (Bone *in* Ahmad, 1998). The magnesite inferred resource is 20 million tonnes at 42 % MgO which at a projected production of 50,000 tonnes per annum will last 200 years.

Fig. 1. Map showing seven major areas of magnesite in Australia.

Murrin Murrin, Western Australia

There are many magnesite deposits in Western Australia but total production from six deposits between 1915 and 1984 was only 77,000 tonnes. Abeysinghe (1998) lists 12 past producing and significant deposits and another 58 minor occurrences. The Murrin Murrin deposit area is part of a much larger area associated with altered ultramafics in the Archean eastern goldfields region. The major area of magnesite at Murrin Murrin exceeds 250 million tonnes.

Bandalup, Western Australia

Another magnesite deposit occurs at Bandalup to the east of Esperance in the south of Western Australia (Abeysinghe, 1996; Hart, 2000). Magnesite derived from Archean ultramafics and mafics has been precipitated into the Upper Eocene Pallinup Siltstone in bands up to 7 m thick separated by sands. 17,000 tonnes of magnesite were mined from this deposit in 1984. Current indicated resources are 1.3 million tonnes.

Leigh Creek, South Australia

Magnesite has been produced from several deposits in South Australia. The Leigh Creek deposit is located about 580 km north of Adelaide. The deposit belt extends for 120 km north east of Leigh Creek and contains an estimated 516 million tonnes of nodular magnesite at 42 % MgO (SAMAG 1999, unpublished). The magnesite is interbedded with dolomite with a total thickness of 120 m and is within the Skillogalee Dolomite of the Burra Group which is <802 Ma and >750 Ma. The magnesite is primary and was deposited in a peritidal carbonate sequence in an intracratonic rift basin (Balperio, 1989).

Kunwarara, Queensland

Continuous production began in Queensland in 1978. The most important deposit is at Kunwarara, 50 km north of Rockhampton and consists of 500 million tonnes of shallowly buried, flat lying 10–15 m thick nodular, magnesite in a mudstone/sandstone matrix. Of this 20 million tonnes is high grade. This deposit is one of several in this region formed adjacent to ultramafic rocks in a fluvial environment by precipitation and secondary enrichment during the Cainozoic (Draper, 1998). In August 1999 the Australian Magnesium Corporation (AMC) poured its first test ingots of magnesium from Kunwarara magnesite (Brown, 1999).

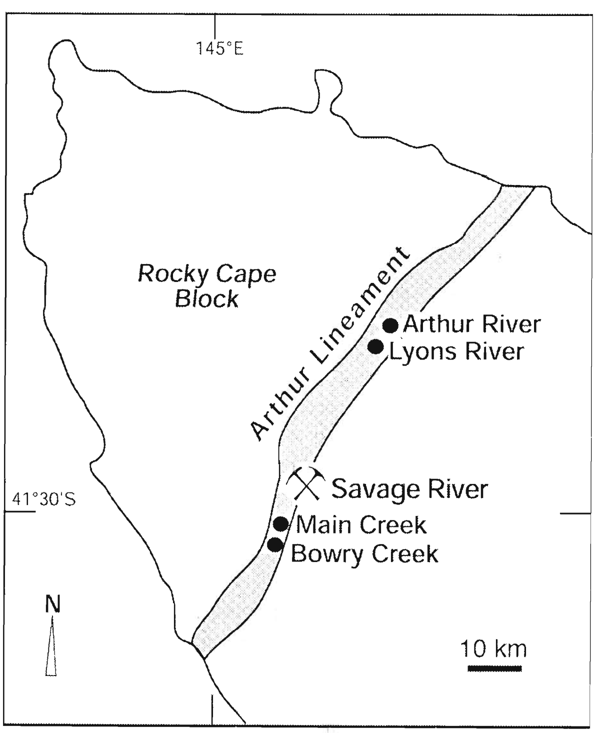

Fig. 2. Five major deposits of magnesite in NW Tasmania.

Arthur Lineament, Tasmania

Five major deposits of probably metasomatic magnesite occur within the Neoproterozoic (>777 Ma) phyllites and schists of the steeply dipping Bowry "Formation" of the Arthur Metamorphic Complex (Bottrill et al., 1998; Frost, 1982; Frost and Matzat, 1984).

- The Arthur River deposit contains an estimated 30 million tonnes at more than 42 % MgO.
- The Lyons River deposit contains an estimated 30 million tonnes at >40 % MgO.
- The Main Creek deposit contains an estimated 40 million tonnes at 44-45 % MgO.
- The Bowry Creek deposit contains an estimated 300,000 tonnes at 43 % MgO.
- The Savage River deposit occurs as vertically dipping lenses within a sequence of amphibolites associated within the actively mined Savage River Iron Ore deposit (Frost and Matzat, 1984).

Thuddungra (New South Wales)

The Thuddungra deposits, 35km NW of Young, consist of small irregular veins and pods of magnesite within the weathered zones of Silurian serpentinites. A reserve of 12.4 million tonnes is estimated. There are several other similar deposits in New South Wales and the region produced a million tonnes of magnesite up to 1975.

References

Abeysinghe, P. B., 1996: Talc, pyrophyllite and magnesite in Western Australia. *Miner. Resour. Bull., 16, 1–118.*

Ahmad, M., 1998: Geology and mineral deposits of the Pine Creek and McArthur Basin, Northern Territory. *Australian Geological Survey Organisation Journal of Australian Geology and Geophysics, 17 (3), 1–17*

Belperio, A. P., 1989: Palaeoenvironmental interpretation of the Late Proterozoic Skillogalee Dolomite in the Willouran Ranges, South Australia. *In. Jago, J. and Moore, P. (Eds.): The Evolution of a Late Precambrian-early Palaeozoic Rift Complex: the Adelaide Geosyncline. Geol. Soc. Austr Spec. Publ., 16, 85–104.*

Bottrill, R., Brown, A., Calver, C., Corbett, K., Green, G., McClenaghan, M., Pemberton, J., Seymour, D. & Taheri, J., 1998: A summary of the economic geology and mineral potential of Late Proterozoic and Palaeozoic provinces in Tasmania. *Australian Geological Survey Organisation Journal of Australian Geology and Geophysics, 17(3), 123–143.*

Brown, D. C., 1999: Australian Magnesium Corp Produces first metal. *Magnesium Monthly Review, 28(8), 6.*

Draper, J., 1998: An overview of post-Mesoproterozoic mineralisation in Queensland. *Australian Geological Survey Organisation Journal of Australian Geology and Geophysics, 17(3), 61–73.*

Frost, M., 1982: The magnesite deposit at Main Creek Savage River Tasmania. *Economic Geology, 77, 1901–1911.*

Frost, M., & Matzat, H., 1984: A further large magnesite deposit along the Savage River in NW Tasmania. *Economic Geology, 79, 404–408.*

Hart, R., 2000: Developing your project in Western Australia, 1–17. *In: Second Annual Magnesium Conference. March 2000 Sydney Australia.*

Magnesite and talc deposits of Pakistan

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Abstract

Article presents a review of the most important magnesite and talc deposits of Pakistan with their location on schematic map and short characterization. At the end of contribution the largest talc deposit Sherwan is described from the viewpoint of its tectonic setting and the mineralization.

Key words: magnesite, talc, deposits, Pakistan

IGCP 443

Magnesite

The magnesite deposits of Pakistan occur in two forms, one as veins in ophiolites and the other in dolomites.

The former deposits are much smaller as compared to the later deposits. Vein type magnesite is pure white, fine grained, massive, cryptocrystalline, and has a conchoidal fracture. Vein type magnesite deposits are common in ophiolitic harzburgite-dunite igneous complex of Zhob valley, Balochistan, Pakistan. An average chemical composition of a typical magnesite from such occurrences shows 45.38 % magnesia, 0.38 % silica, 1.72 % lime, 1.04 % iron oxide, and 51.15 % loss on ignition.

Magnesite deposits in dolomite occur in a number of places at northwest frontier of the Punjab province of Pakistan. Magnesite occurs in lenticular bodies in dolomite and dolomitic limestone with occasional remnants of unaltered dolomite and limestone, and appears to have been formed by hydrothermal replacement of the pre-existing calcareous rocks by descending meteoric waters with increased amount of Mg.

The average annual production of magnesite in Pakistan is about 5,700 tonnes.

Talc

The largest deposit occurs in dolomite and dolomitic limestone, and is believed to be the product of hydrothermal alteration of existing rocks. Sherwan deposit at Hazara is the largest deposit of this type. Small occurrences are reported in Jamrud, Kurram agency, and Landi Kotal, all in the northwestern part of the country. Small showings of talc in Zhob district of Balochistan occur in the form of veins in ultramafic rocks. Other occurrences of talc in Chalt (Gilgit) and Nauseri in Azad Kashmir are present in talcose schists.

Sherwan talc deposit

The Sherwan talc deposit, so far the largest in Pakistan is spread over an area 1.5 km wide and 15 km long, where most of the production comes from four mines, namely Bandi, Chelethar, Khandakhu and Panjkuian. The deposit occurs in a doubly-plunging syncline. Talc occurs in irregular, small bodies along bedding-plane shears in dolomite and also as veins along a set of steeply dipping fractures. Talc appears to have formed as a result of alteration of dolomite and dolomitic limestone. The principal impurity in talc is dolomite which is present in stringers and patches.

An average chemical composition of a typical talc sample shows silica 63.21 %; alumina 1.12 %, iron oxide 0.21 %, lime 0.45 %, magnesia 29.92 % and loss on ignition 4.62 %.

The average production of talc in Pakistan is about 40,500 tonnes.

References

Ahmad, Z., 1969: Directory of mineral deposits of Pakistan. *Geol. Surv. Pakistan.*

Ahmad, Z. & Siddiqui, R. A., 1993. Minerals and rocks for industry *Geol. Surv. Pakistan, II, III*

Anwar, M., 2000: Mineral Statistics of Pakistan. *Geol. Surv. Pakistan.*

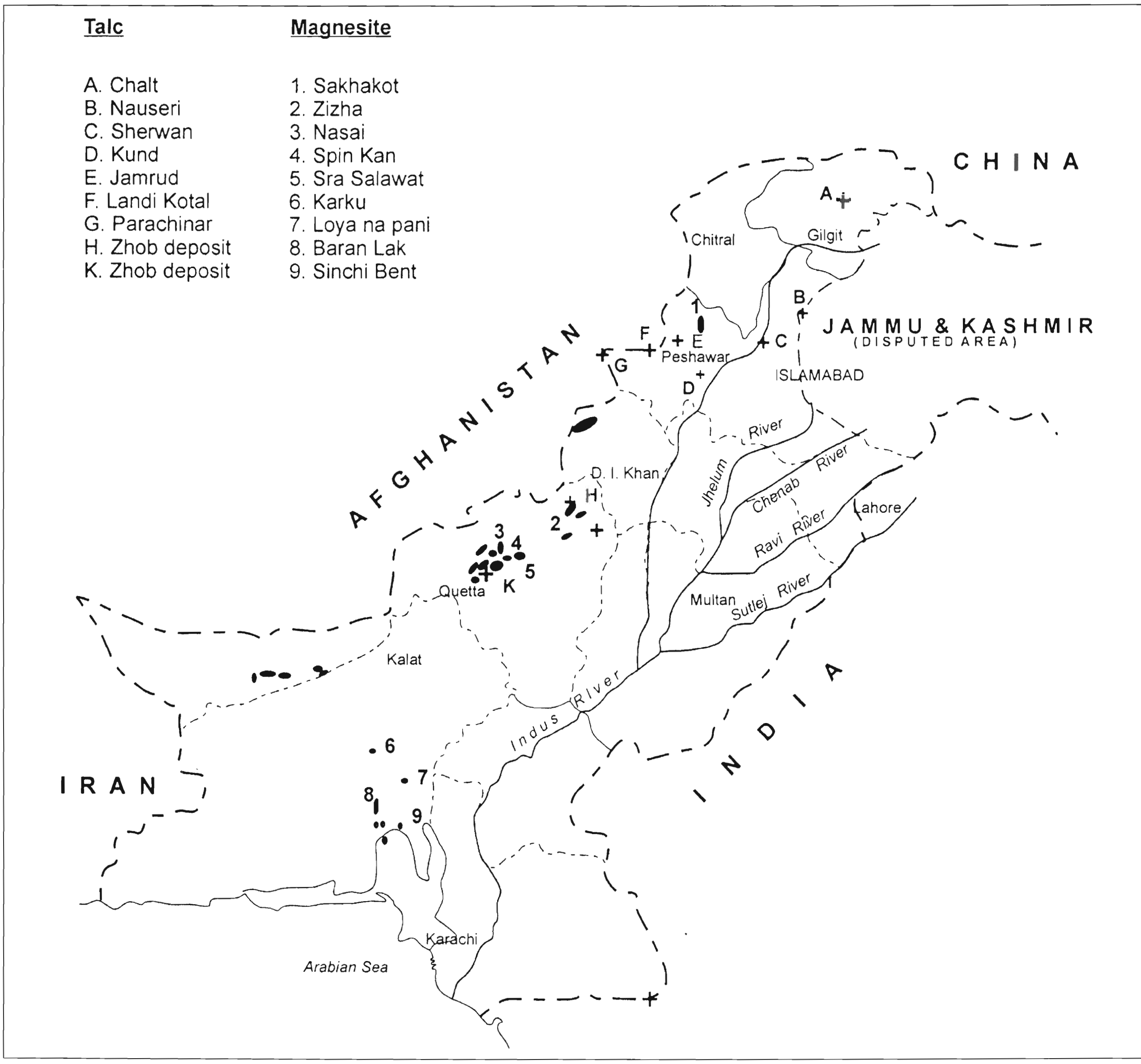

Fig. 1. Talc and magnesite deposits in Pakistan.

Mineralia Slovaca, 32 (2000), 565–566

Tectonic control of magnesite mineralization in Bhavani shear zone, South India

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Abstract

Vein type magnesite was found in peridotite lenses at the western termination of the Bhavani lineament forming a part of the Moyar-Bhavani shear zone. The major rock types of the zone, hornblende gneiss and quartz-biotite schist are mylonitized by ductile shearing. Structural analysis revealed two folding events accompanied by pervasive plastic deformation. The mineralized veins are not affected by these deformation events. Therefore magnesite mineralization, which was facilitated by fractures, is treated to be post-tectonic.

Key words: magnesite, tectonic control of mineralization, Bhavani shear zone, India

Location of magnesite occurrences

Magnesite occurs as veins in peridotite at the western termination of the Bhavani lineament in Kerala (Fig. 1). Bhavani lineament is a major crustal discontinuity, which in fact is a zone with a width of about 10 km. The zone, extending for about 300 km from Mukkali in Kerala in a NE direction has been considered as a fault or shear. The zone has been recently treated as a part of the major Moyar-Bhavani shear zone, which has significantly influenced the evolution of the South Indian granulite belt. The shear is also noted for acid to ultrabasic intrusives as well as mineralization of gold and scheelite besides magnesite.

Lithology

Hornblende gneiss and quartz-biotite schist are the major rock types. Hornblende gneiss is exposed in most of the area, while quartz-biotite schist is confined to the southern part. The gneiss is often banded and at places contains layers of hornblende-actinolite schist and talc-tremolite schist. Boudins and thin bands of amphibolite are also observed in the hornblende gneiss and quartz-biotite schist. Along the borders amphibolite is sometimes converted into hornblende-actinolite schist. The change from amphibolite to schist is through a thin zone of mylonite. Peridotite occurs as lenses in gneiss at a few locations. Intrusive granite is also noticed near the south-eastern part.

Character of mineralization

Magnesite mineralization is observed in the central and northern parts of the shear zone. The mineralization is

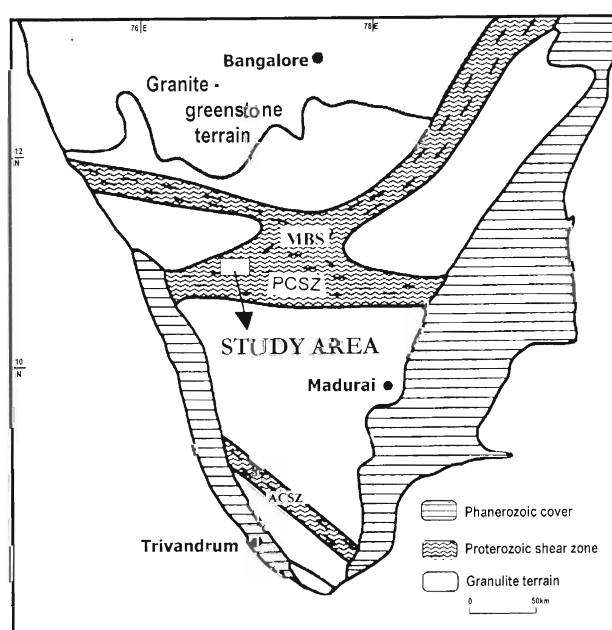

Fig. 1. Tectonic map of South India showing location of study area. MBS – Moyar Bhavani shear zone, PCSZ – Palghat Cauvery shear zone, ACSZ – Achankovil shear zone.

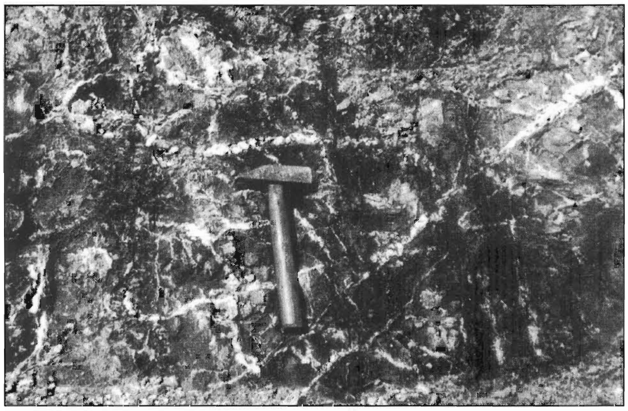

Fig. 2. Magnesite veins in peridotite (vertical section).

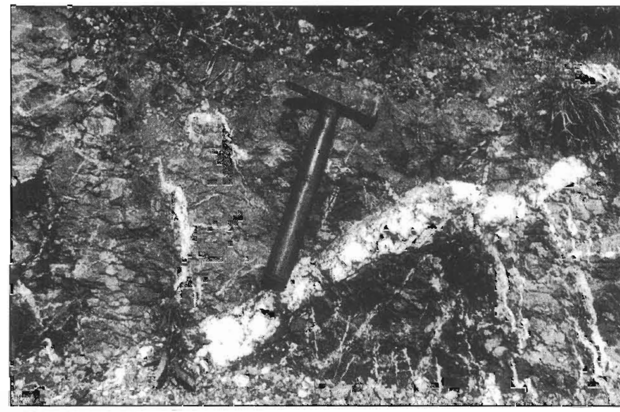

Fig. 3. Magnesite veins in peridotite (vertical section).

confined to an area of ca. 2 km^2 in each case. Magnesite veins occur in lenticular peridotite, composed mostly of olivine and subordinate clinopyroxene enclosed in hornblende gneiss and amphibolite. The highly weathered peridotite lenses, exposed over strike lengths of less than a kilometre, follow the ENE–WSW trend of the country rocks (Nair et al., 1979). Preliminary investigations have shown mineralization to extend to a maximum depth of about 50 m. It is not established whether the peridotite body itself extends beyond this depth. Magnesite veins with width varying from less than a centimetre to as much as 30 cm criss cross the host rock (Figs. 2 and 3). Where veins intersect, an increase in thickness is noticed. Thick veins have a strike extension of more than 2 m, while the thin ones are less than a metre in strike length. Strike of major veins (more than a metre in strike extension) shows strong preferred orientation with the majority extending between NW–SE and N–S, the mean direction being N30W–S30E. The dominant trend of joints (N25W–S25E) in peridotite and country rocks coincides with that of the veins suggesting a close affinity between magnesite veins and fractures in the rocks. Mineralizing solutions have particularly preferred the NW–SE trending regional fractures.

Tectono-metamorphic evolution

The rocks have undergone amphibolite facies metamorphism and polyphase deformation causing formation of three generations of folds (Nair et al., 1981). The early folds F_1 are asymmetrical and almost isoclinal and the associated penetrative foliation (S_1) after biotite and hornblende is axial planar. Younger asymmetrical F_2 folds deform S_1 foliation. The hinges of F_1 and F_2 are coaxial and trend E–W. Broad open F_3 folds trending N–S are the latest. Mylonite zones, 1–5 m wide and parallel to each other, carrying patches of hornblende-actinolite schist have developed at many places. Boudins and bands of amphibolite are observed in both hornblende gneiss and quartz-biotite schist. The gneiss is traversed by a series of parallel ductile shears. Streaked plates of biotite, crystals of hornblende, elongated polycrystalline aggregates of quartz and felspar and associated grain-size reduction define strong mylonitic foliation and lineation. Several other features characteristic of ductile shearing have also been observed.

Conclusion

Temporal relations of deformation, metamorphism and mineralization have been worked out based on structural analysis. The structures can be considered as developed during two deformational events, the first phase of the first event was synchronous with metamorphism and was responsible for the formation of F_1 and axial planar S_1, while the later phase produced F_2 folds. The second deformational event affected all the earlier structures. The mineralized veins are not affected by any of these folding events and hence the mineralization was post-tectonic. However, fractures have facilitated the localization of magnesite veins thus exerting a tectonic control on mineralization.

References

Nair, P. K. R., Mathai, T. & Prasannakumar, V., 1979: Structural control of magnesite mineralization at Attapadi, Palghat district, Kerala. *Current Science, 48, 861–862.*

Nair, P. K. R., Prasannakumar, V. & Mathai, T., 1981: Structure of the western termination of the Bhavani lineament. *J. Geol. Soc., India, 22, 285–291*

Talc deposits in the central western sector of Argentina

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Abstract

The talc deposits of the main productive districts, located in Mendoza, Córdoba, San Juan, Santiago del Estero and San Luis provinces, are briefly characterized from the viewpoint of their geology, lithology and tectonic setting. At the end of contribution the resources and total talc production of Argentina, discriminated by provinces and five years' periods, are summarized.

Key words: location of deposits, geological and tectonic setting, resources and use of talc

Introduction

Although there is not exploitation of talc deposits in Argentina at present, this mineral occurs in several districts within the central western region of the country. Morever, in some cases the talc production has been important, specially among the industrial types.

Location of main deposits

The main productive districts are located in Mendoza, Córdoba, San Juan, Santiago del Estero and San Luis provinces (Angelelli et al., 1980). Mendoza, for example, has remarkable deposits in Precordillera and Cordillera Frontal. Córdoba also has important amount of this mineral within the crystalline basement of Sierra de Olaen. The thirt place is occupied by San Juan province in Pie de Palo range, a very remarkable morphostructural unit located in the westernmost part of Sierras Pampeanas. Regarding to Santiago del Estero, part of Córdoba and San Luis, there are impure deposits which have been occasionally used as lime furnace rock cover.

Geological setting of talc deposits and genetic aspects

Talc deposits from Mendoza and San Juan have a strong structural control. It is represented with fractures or faults generally disposed within or close to the contact between serpentinite bodies with the host rock composed mainly of micaceous schists, in some cases garnet-bearing. They are disposed in short lenticular veins or small bodies from a few decimetres to more than 6 metres wide. The mineral shows a compact fine-grain texture, colour ranging from dirty grey to green in varieties of good quality and to pale green or white in another cases. The presence of impurities like antigorite, chlorite, actinolite and iron hydroxides is common. In contrast, the talc deposits in Córdoba are mainly composed of light to dark brown steatite which form 6 to 8 metres wide bodies within amphibolite strips. In some cases, the mineral occurs with vermiculite.

Talc deposits were formed by processes of hydrothermal alteration of serpentine and amphibolic schists along fractures or faults zones.

In Mendoza, the main productive province, talc deposits are located in two geological regions: Precordillera and Cordillera Frontal. During 1975 the production was obtained from 40 mines, 25 of them corresponding to Precordillera and the rest from Cordillera Frontal (Elizalde, 1950).

From the geological point of view, for talc deposits in Precordillera there are several studies for references: Keidel (1939), Cooperativa de Geólogos de Mendoza (1950), De Romer (1964), Cingolani (1970), and Varela (1972). On the other hand, the most important contributions to the knowledge of talc deposits in Cordillera Frontal were given by Zardini (1958) and Polanski (1972).

In Precordillera, talc deposts occur in serpentines, in the contact of these rocks with schists and within the schists but always close to the serpentine bodies where the rocks have suffered an intense tectonic reworking.

The area is built mainly with Paleozoic metamorphic and igneous rocks and Mesozoic sedimentary and volcanic rocks which are located over the older units in the Eastern part of Precordillera. Talc deposits have genetic relations with Paleozoic rocks. These are represented with sericitized phyllites, dark grey to green schists, limestones, eruptive units and serpentinites with a wide range of dimensions. Paleozoic metamorphic complex is mylonitized and deformed. It has a general orientation N–S with diversity of inclinations being a result of the dominant tectonic processes in Precordillera. Keidel (1939) refers that the talc deposits are as a rule following the tectonic lines where the solutions were emplaced and deposited.

Zardini (1960) and Cosentino (1968) define the talc deposits as tabular bodies within the serpentinite units. They are characterized by the presence of dominant antigorite and chrysotile. There are also calcite, chlorite, actinolite, and scarce sulphides like pyrite. Such bodies are separated or surrounded by external walls of dark calcite and internal disruptions composed by laminar to massive grey to green dolomite.

The concentrations of talc form veins or cloaks located in distance 200–300 metres between individual talc outcrops, which reach dimensions of 20–40 metres. However, the limits of the deposits are not well defined because the contacts with the host rock are transitional. In general, these deposits have thickness between 1–2 to 6 metres.

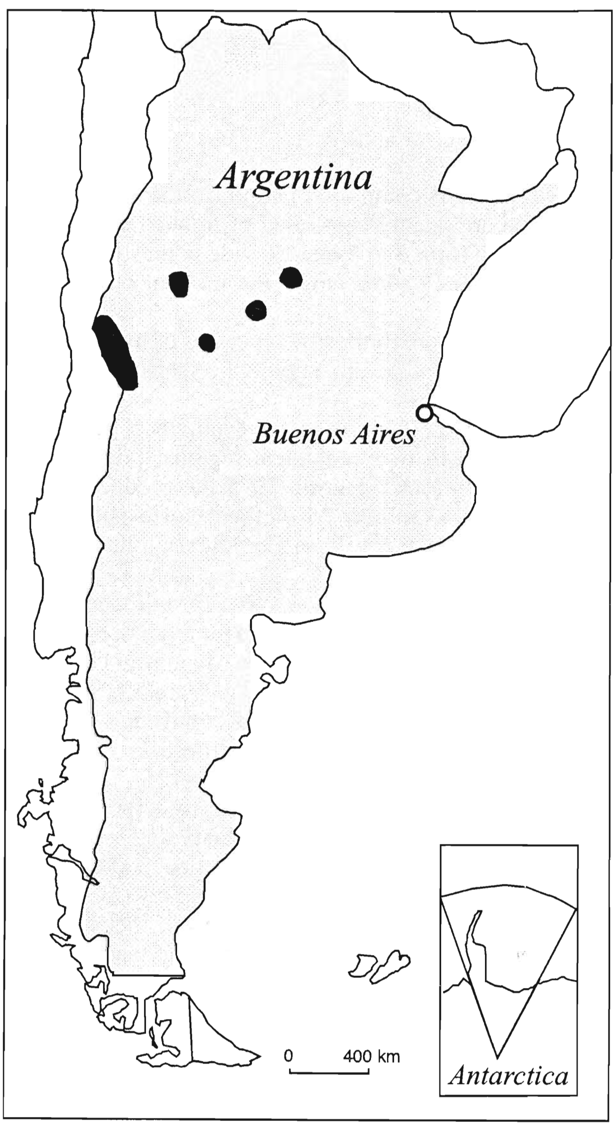

Fig. 1. Talc deposits in central western Argentina.

Resources and use of talc

The information about the talc resources in Argentina is very scarce. However, the geological conditions are favourable. Originally it was exploited from low depths. Regarding to the annual production, during 30 years the total amount of extracted talc was about 600,800 tonnes of talc.

Talc in Argentina has been used in the industry of rubber

Tab. 1
Total production of talc expressed in tonnes, discriminated by provinces and each five years (after Angelelli et al., 1980)

Mendoza		Córdoba	San Juan
1945–1949	6.892	645	.....
1950–1954	18.273	41	1.098
1955–1959	16.442	238	2.354
1960–1964	11.903	2.040	3.036
1965–1969	15.520	2.516	3.024
1970–1975	28.081	5.022	2.847

and paper, elaboration of paintings, as a supporting material of plaguecides and insecticides and in pharmaceutical and cosmetological production.

References

Angelelli, V., Schalamuk, I. & Fernández, R., 1980: Los yacimientos de minerales no metalíferos y rocas de aplicación de la región Centro-Cuyo. *Secretaría de Estado de Minería. Anales. Buenos Aires, 19, 261.*

Cingolani, C., 1970. Estudio geológico de la zona de la Cortadera y alrededores. Noreste de Uspallata, provincia de Mendoza. *Doctoral Thesis. Facultad de Ciencias Naturales y Museo. Universidad Nacional de La Plata. 283. Unpublished.*

Cooperativa de Geologos de Mendoza, 1950: Descripcion de la Hoja Geologica 23 c, Mendoza. *Dirección General de Industria y Minería. Buenos Aires. Unpublished.*

Cosentino, J. M., 1968. Contribucion al conocimiento geológico del cordón de Bonilla, Uspallata, provincia de Mendoza. *Asociación Geológica Argentina. Revista. Buenos Aires, 23, 21–31.*

De Romer, H. S., 1964. Sobre la geología de la zona "El Choique" entre el cordón de los Farellones y el cordon de Bonilla, quebrada de Santa Elena, Uspallata, Mendoza. *Asociación Geológica Arghentina. Revista. Buenos Aires, 19, 9–18.*

Elizalde, C. O., 1950. Inventario de los recursos mineros de la provincia de Mendoza. *Dirección General de Industria y Minería. Buenos Aires.*

Keidel, J., 1939: Las estructuras de corrimientos paleozoicos de la sierra de Uspallata. *PHYSIS. Buenos Aires, 14, 1–96.*

Polanski, J., 1972: Descripcion geológica de la Hoja 24 ab, Cerro Tupungato, provincia de Mendoza. *Servicio Nacional Minero Geológico. Boletín, Buenos Aires, 128.*

Varela, R., 1972: Estudio geotectónico del extremo sudoeste de la Precordillera de Mendoza. Doctoral Thesis. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. Unpublished.

Zardini, R. A., 1958: Serpentinitas del río Las Tunas, Cuchillo de Yalguaraz, Mendoza. *Asociación Geológica Argentina. Revista. Buenos Aires, 12, 67–86.*

Zardini, R. A., 1960: Serpentinitas de la mina "La Mendocina", Uspallata, Mendoza. *Asociación Geológica Argentina. Revista. Buenos Aires, 15, 43–51.*

Magnesite production – threat for living environment?

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Abstract

The article presents possible negative impacts of magnesite production on soil, vegetation and animals. The requirement for imission decrease is stressed. The application of filters, dust chambers, or electrostatical ways for catching magnesite will decrease imissions to demanded level of hygienic norm and simultaneously will allow to achieve positive economical results and ecological behaviour of the producer.

Key words: pollution of living environment by magnesite production, imissions, recovery

Introduction

All processes realized by magnesite firms, i. e. exploitation of magnesite, its elaboration, firing in rotary and shaft furnaces and production of magnesite building material, cause polluting of living environment. During a period of more than 30 year the imissions from the firms have became severe ecological negative factor.

Pollution of soil by magnesite dust

The main component of imission is represented with magnesite dust (approx. 1 mm in dimensions) with content of MgO 65–85 %, where MgO is in oxid form and carbonate form. According to the weight of particles and air conditions the dust is deposited in various distances from pollutants mainly on agricultural and forest sources.

Magnesite imissions are changed chemically and mineralogically by input to the soil. The content of magnesite in soil is increasing and agrochemical and pedological characteristics of contaminated soil are also changed.

Contaminated soil is alkalized, content of carbon is increasing and value of pH is increasing to 7–9 according to the contamination change. Contamination with magnesite compounds is highest in arable level of soil, depthward it is decreasing. The distribution of magnesite pollution in contaminated areas firstly has island shape, later an areal pollution appears as the last level of contamination. Soils in more rangy terrain increasingly suffer the water erosion.

Influence of imissions on vegetation

Forest economy is one of the most sensitive productional branches (qualitatively as well as quantitatively) towards impacts of air pollution. This is caused by biological character of the forest. It is bounded to the stable place, its position cannot be changed and therefore it cannot miss influence of magnesite imissions. Forests, dying in industrial areas, are the result of mentioned facts.

Mostly oaks, beeches and in higher altitudes spruces and pines are growing in endangered forests. The degradation of forests and especially dying of top branches of trees cause the soil lightening and growth of new gross vegetation similarly like on forest glades.

According to results from areal diagnosis of negative imission impacts with regard to the influence of external factors, mainly the configuration of terrain, three zones of forest threat were established:

A – Area of strong threat, that includes area without vegetation and area of dying vegetation. In the case of Slovak magnesite industry it is totaly 1,014 hectares.

B – Area of medium threat, characterized by long-term influence of low concentration of imission compounds (mainly SO_2). This type represents chronic type of damage, mainly damage of sensitive pine woods, and such damage can evoke severe devastation; totally 2,011 ha.

C – Area of weak threat (protected zone) characterized with low level of pollution; totally 3,617 ha.

Magnesite imissions impact to the substances cycle in forest ecosystem by following ways:

1. decisive changes of soil chemistry (pH value of water in surface area is 9.1–9.3 and HCl pH is 8.6–9.1).
2. Negative influence on both, the decomposion and mineralization of organic substances; limited effectiveness of microorganisms and effectiveness of biological soil activity.
3. The dust in assimilation organs damages photosynthesis, causes defoliation and decreases wood growth.
4. Magnesite imissions attack and limit the dynamics of physical, chemical and biological processes as well as

damage absorption complex of soil and nutrition of woods.

5. Magnesite imissions influence qualitative changes in ecosystem compounds, that means retreat of economically most important woods and their replacement by more sturder woods (e.g. birches, alders, etc.) as well as quantitative changes – mainly reduction of wood reserves, soil bonity deterioration, total wood health and resistance deterioration.

Town forests in areas of magnesite sources are abused by imissions. Main imission compound is MgO, that creates secondary minerals in contact with water and CO. After their falling down on soil and vegetation at high concentration mainly the hydromagnesite appears in contacts with trunk, branches and leaves.

In areas of high SO_2 concentration (acid rains) it is possible and proper to apply MgO for decreasing the acidity in soil. This positive feature has already been used in several areas.

Second imission compound is SO_2, that can create with water low-concentrated acids. Imission compounds in synergical activity negatively influence the wood by decreasing their solar income and assimilation intensity. Imissions evoke decomposition of chlorophyll. They change physical and chemical composition of soil, increase soil reaction and decrease its overall fertility.

Influence of imissions on animals

Following facts result from knowledge about high content of magnesite and other compounds of magnesite waste in living organisms:

– Surplus of Mg impacts mainly on juvenile animals, because these do not have developed, resp. stabilized physiological functions.

– Mg is accumulated in organs, bones and fur even in situation, when highest possible limit 12.5 $g.m^{-2}/30$ day is not overcome.

– Surplus of Mg has negative impact on nervous, renal and endocrinal systems, on the bones and on the gravidity of animals.

– Plan indexes for sheep and cattle stock-raising are not fulfilled due to area pollution by magnesite dust. On the contrary, pig raising is successful. Damages for cattles and sheeps consist of decreased weight, frequent diarrhoea and increased consumption of mineral substances.

Remedy for imission decrease consists from catching magnesite dust by fabric filtre, by dust chamber, by electrostatical or other way and consequent elaboration of catched dust to the clinker. By this way it is possible to decrease imissions in magnesite production to the demanded level of hygienic norm and simultaneously achieve positive economical results and ecological behaviour of the producer.

References

Novek, Z., 1996: Economical evaluation of ecology in mining and metallurgical organizations. *Proceedings from 5th science sympozium about ecology in chosen area Jelšava-Lubeník, Stredný Spiš, Hrádok. Slovak Republic, 146–155.*

Novek, Z. & Kameníková, K., 2000: Economical evaluation of the soil element in magnesite firm. *Acta Montanistica Slovaca, 5, 49–52.*

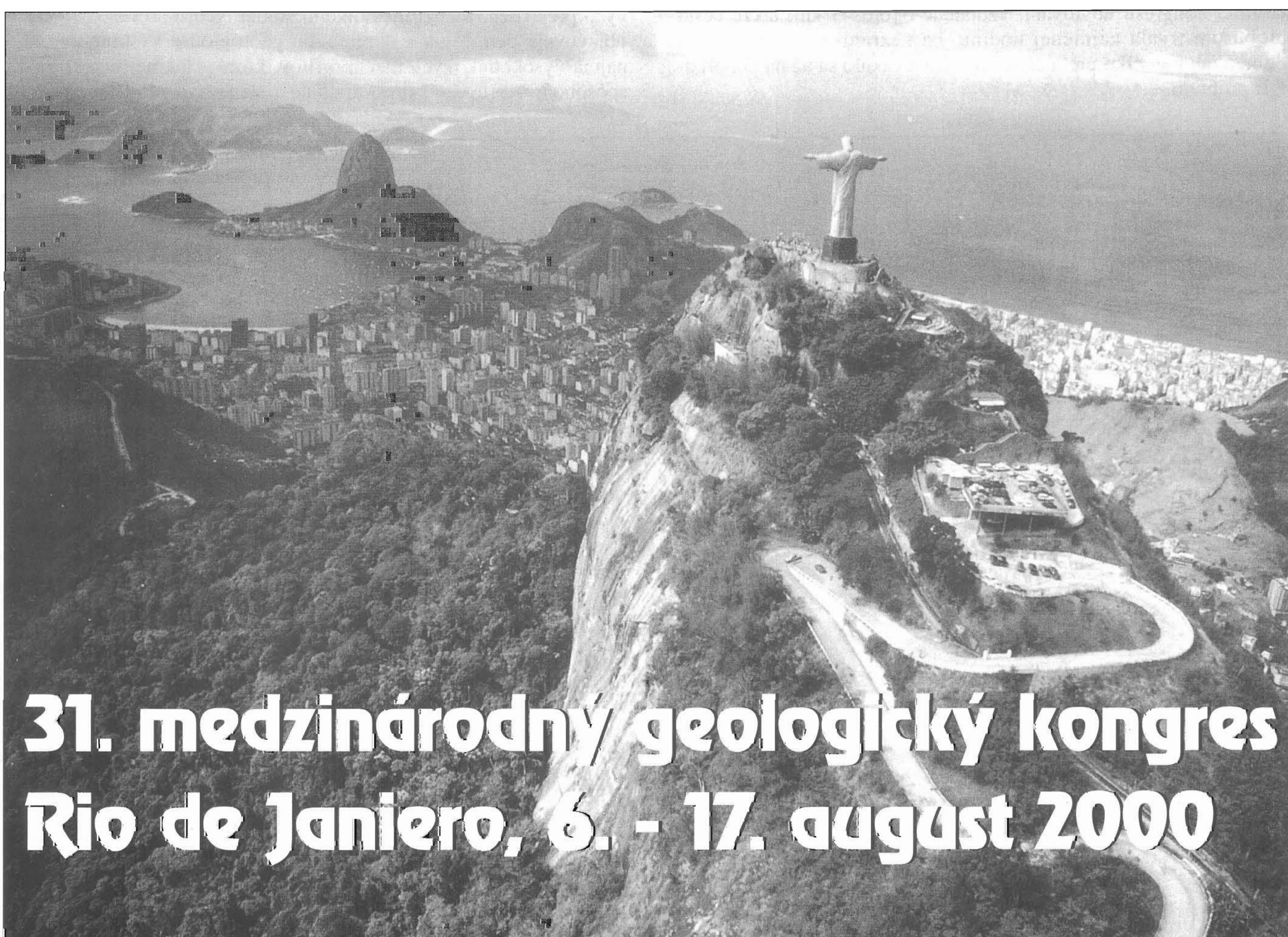
Novek, Z. & Jančišinová, A., 1999: Economical evaluation of a firm's water economy. *Acta Montanistica Slovaca, 4, 37–41.*

Geovestník

Informačný spravodajca pre geológiu, baníctvo, úpravníctvo a životné prostredie

Príloha časopisu Mineralia Slovaca, roč. 32, č. 6

Obsah



Medzinárodný geologický kongres (IGC) je plenárnym reprezentantom Medzinárodnej únie geologických vied (IUGS) a koná sa raz za štyri roky.

Riodejaneirský kongres v kongresovom centre otvoril viceprezident Brazílie Marco Mariel a minister baníctva a energetiky Rodolpho Tourinho. Téme obsiahnutej v hesle kongresu *Geológia a trvalo udržateľný rozvoj – poslanie pre tretie tisícročie* sa venovala najväčšia pozornosť, aj keď – ako zvyčajne pri takýchto príležitostiach – sa vo veľmi širokom zábere prezentovala geológia príslušného regiónu Južnej Ameriky.

Organizátori dostali 5750 abstraktov (abstrakty a ostatné materiály sú na kompaktných diskoch, čo je rozdiel oproti predchádzajúcim kongresom, z ktorých si účastníci odnášali aj 10 kg kongresových materiálov), čiže podstatne viac, ako bolo účastníkov kongresu (okolo 4000, z toho asi 3200 platiacich), ktorých presný počet nebol zverejnený.

Zo Slovenska sa na kongrese zúčastnili: J. Franzen, M. Kaličiak, M. Radvanec, Z. Németh, S. Rapant, P. Grecula, M. Hrašna, M. Kuhn a D. Hovorka.

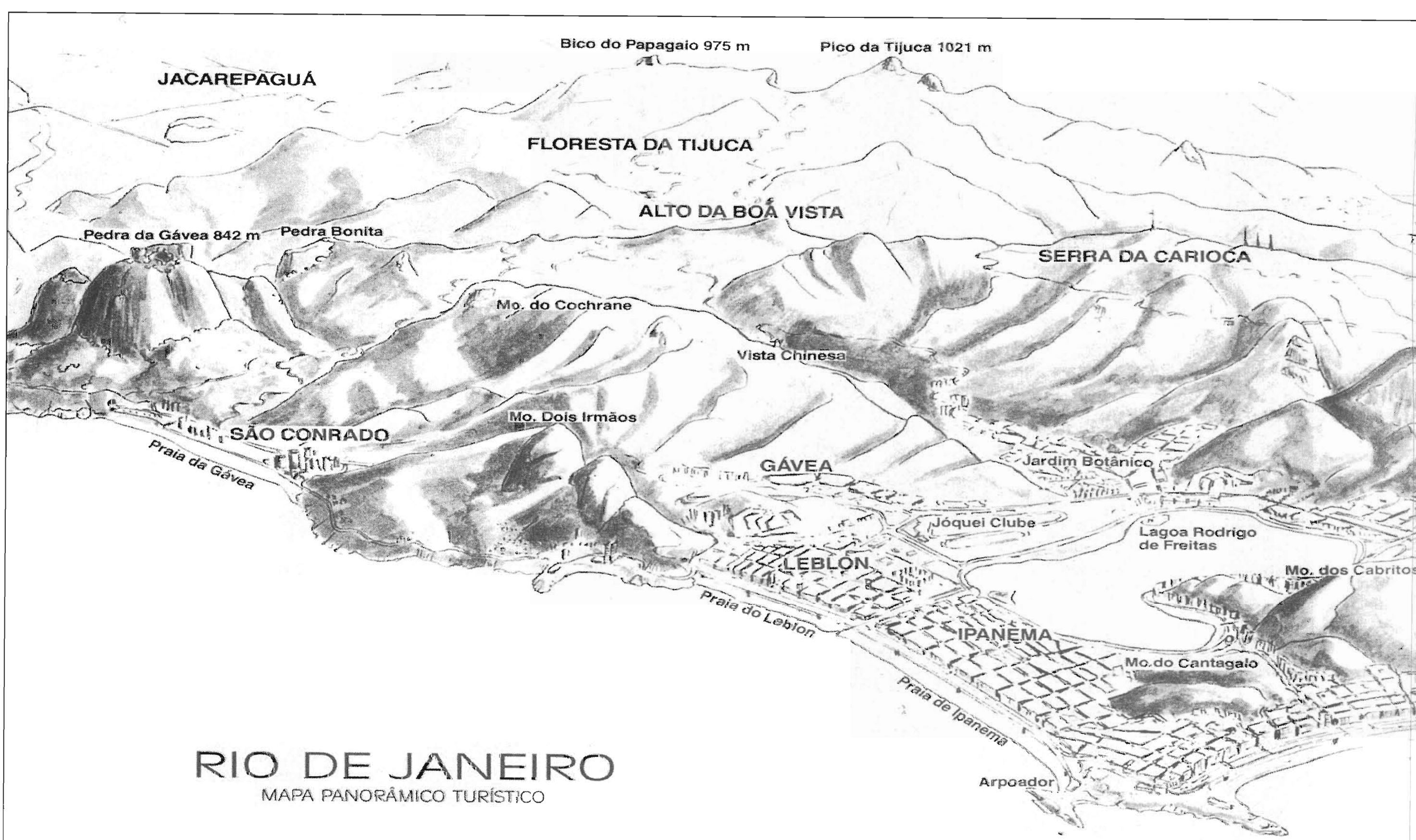
Prednášky a postery (tie prevažovali nad prednáškami) sa prezentovali približne v 150 sekciách. Žiaľ, absencia prihlásených (aj prítomných) prednášateľov bola veľmi častá, ba odpadli aj zasadnutia celých sekcií, o čom sa účastníci – poslucháči – neraz dozvedeli až v sále v očakávaní prednášateľa. Jednou z príčin azda bolo aj to, že kongresové centrum (Rio Centrum) je od hotelov, v ktorých boli účastníci kongresu ubytovaní, vzdialené okolo 45 km, takže cesta autobusom trvala najmenej hodinu, ba nezriedka aj vyše dvoch hodín, a tak niekoľko prednášok odpadlo a čakalo sa až na popoludňajší program.

Kongres mal aj iné organizačné nedostatky. Platí to aj o úvodnom a záverečnom ceremoniáli a o oficiálnych spoločenských akciách. Navyše bol pre účastníkov veľmi drahý, a tak sa všeobecne hodnotil – s pejoratívnym príznakom – ako dobrý obchod. Rovnako vyznelo aj záverečné hodnotenie predstaviteľov IUGS, čo pohotovo využila talianska delegácia pri získavaní hlasov na usporiadanie 32. kongresu vo Florencii (sľúbila podstatne nižšie vložné, prijateľné ceny za ubytovanie i nižšie poplatky za účasť na exkurziách).

Na výstave Geoexpo, ktorá býva súčasťou každého kongresu, sa predstavili najmä firmy a geologické organizácie z USA, z Európy hlavne Francúzsko, Taliansko, no aj Rakúsko a Rusko.

Organizátori aj reprezentanti IUGS chceli na riodejaneirskom kongrese predstaviť víziu tretieho tisícročia. Pravdepodobne v takomto duchu si do všetkých sekcií vyžiadali východiskové prednášky, ktoré sa popri súčasných poznatkoch v príslušnom geologickom odbore venovali problematike s výhľadom do najbližších desaťročí.

Na kongrese načrtnuté smery vývoja geológie nemôžeme v tomto príspevku opísať presnejšie. Nedali sa postihnúť ani fyzicky a navyše ako členovia oficiálnej delegácie Slovenska sme mali povinnosť zúčastniť sa na rade zasadnutí mimo odborných sekcií. Napriek tomu sme postrehli, že sa veľká pozornosť venovala odhaľovaniu príčin geologických procesov prebiehajúcich vo vrchnej časti plášťa a v spodnej časti zemskej kôry, ktoré v rozhodujúcej miere vplývajú na geologické fenomény vo vrchnej časti kôry v ich povrchových prejavoch. Medzi metodikami štúdia týchto procesov sa často objavovala petrológia s izotopovou geológiou a výskumom fluíd najmä vysokotlakových metamorfitov, ktoré – takmer detektívnym spôsobom – prinášajú prekvapujúce zistenia o vývoji orogénnych



(mobilných) zón. Na to nadväzujú nové metalogenetické koncepcie, ako aj dešifrovanie vývoja starých sedimentárnych bazénov, ich metamorfnej a deformačnej histórie. S tým súvisí aj štúdium látkových, fluidných a termálnych tokov v zemskej kôre, ako aj cyklickosť geologických procesov.

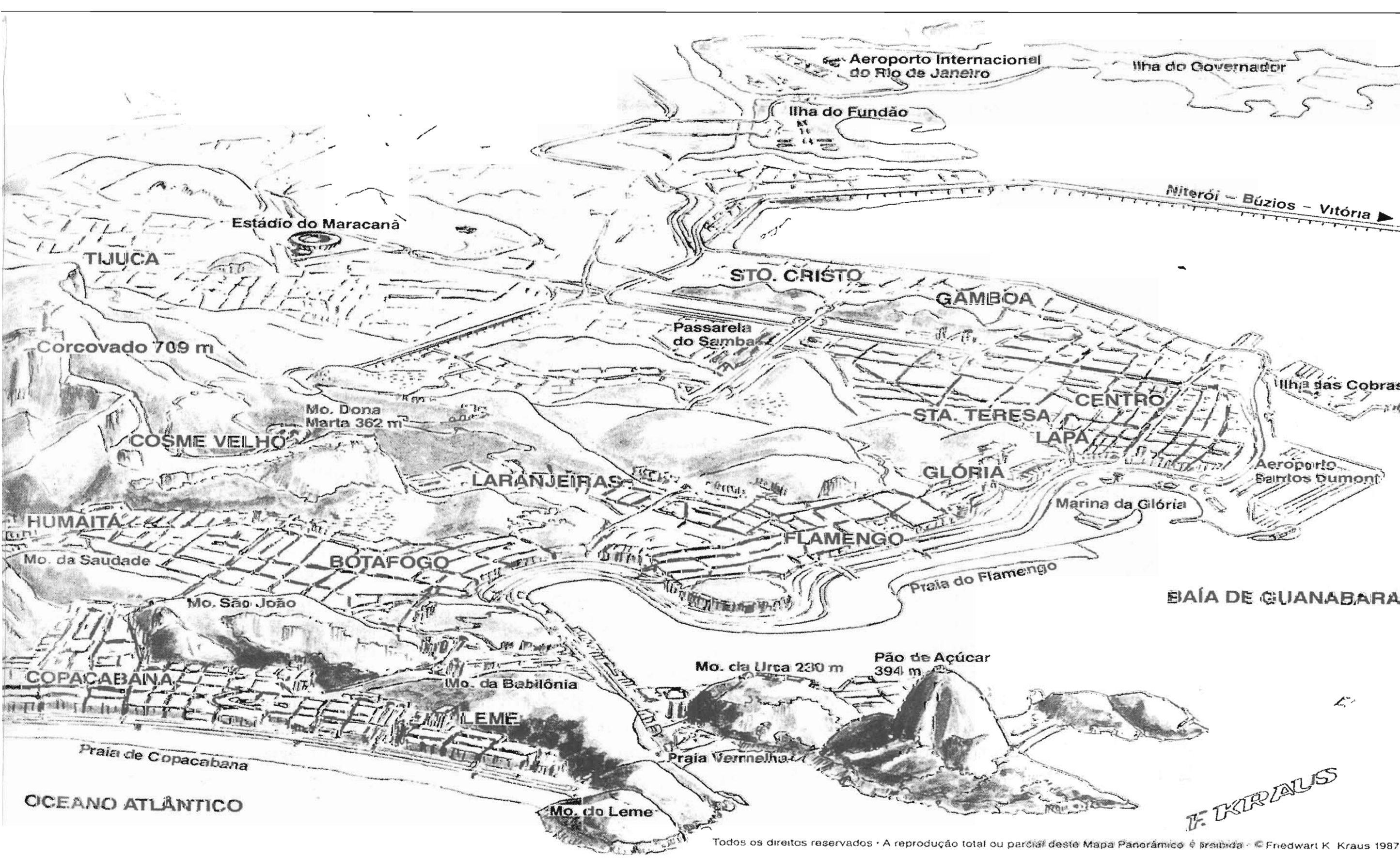
Hoci sa to nezdá, výskum hlbinných procesov je motivovaný chápaním a predikciou ich prejavov na povrchu Zeme a v jej pripovrchovej časti, teda prejavov ovplyvňujúcich život na Zemi. Naďalej trvá orientácia geologického výskumu na environmentálnu problematiku. Intenzívne sa začína zužitkúvať biogeochémia, geomedicína, urbanistická geológia, a najmä agrogeológia. Tá sa na zasadnutí riaditeľov geologických služieb sveta zaradila medzi ústredné disciplíny, ktoré budú skúmať geologickú činnosť už v najbližších rokoch. Dokumentovala sa užitočnosť spojenia geológie a biológie v Geologickej službe USA, čím sa geológia po útlme ťažby surovín opätovne stáva predmetom záujmu verejnosti a politikov.

Environmentálna geológia je stále v popredí, ale vyžadujú sa od nej aj prognózy, predpovede udalostí vplývajúcich na život človeka, a to nie iba v globálnom, lež aj v regionálnom meradle. S tým súvisí aj príprava podkladov technikou GIS a v jazyku zrozumiteľnom pre používateľov. Expanzia robiť geologické výstupy v geografickom informačnom systéme sa už začala a treba privítať, že aj na Slovensku. Tak sa aj naše poznatky a informácie budú postupne touto technikou sprístupňovať v internetovej sieti, na kompaktných diskoch a stále v menšom rozsahu na papieri.

Na rázcestí sú aj geologické mapy. Na osobitnom sympóziu sa diskutovalo hlavne o nasledujúcich otázkach, ktoré s nimi súvisia: Obíde revolučný vývoj informačných technológií tvorbu a vydávanie geologických máp? Budú mať klasické geologické mapy význam aj v nasledujúcom storočí? Priblížia nové technológie podstatne mapu používateľovi? Otázok bolo, prirodzene, veľa a náhľadov ešte viac. Isté je, že geologické mapy budú potrebné aj naďalej, budú sa dopĺňať o nové dáta a interpretácie, no zostanú najmä východiskom ďalších „všeobecne využiteľných" špeciálnych máp pre spoločnosť, krajinu, jednotlivca, podnikateľa, plánovača atď., atď.

Kongres akcentoval potrebu tvoriť atlasy máp regiónov či administratívnych celkov. Do popredia na ňom vystupovalo modelovanie geologických procesov v trojrozmerných a štvorrozmerných modeloch. Zdá sa, že v tom majú vedúce postavenie geofyzici, ktorí výskumom základných fyzikálnych vlastností Zeme v rozhodujúcej miere pomáhajú pri vysvetľovaní geologických procesov v hlbších častiach litosféry. Do novej etapy vstupuje aj diaľkový geologický prieskum vysoko nad povrchom Zeme. Prístroje s vysokou citlivosťou (hyperspektrá) a s mimoriadnou rozlišovacou schopnosťou – umiestnené vo vesmírnych staniciach – sa mnohorako využívajú pri hľadaní nerastných surovín, osobitne ropy. Vysoko sofistikované počítačové programy otvárajú novú éru výskumu vegetácie v súvislosti s geologickým podložím, ale aj v iných environmentálnych disciplínach.

Dosť dobre badať, že sa z útlmu spamätúva výskum, hľadanie aj ťažba nerastných surovín a že záujem o ne opäť rastie. Kým v rudách prežíva trend ťažiť veľké ložiská, v nerudách sú dôležitejšie skôr technologické a kvalitatívne parametre. Mimoriadny dôraz sa kladie na novú, netradičnú a ekonomicky rentabilnejšiu exploatáciu nerudných surovín, pričom má byť rozhodujúci ich technologický výskum. Podľa jedného z vedúcich predstaviteľov ložiskovej geológie prof. Briana Skinnera budú nasledujúce decéniá obdobím veľkého rastu využívania nerastných surovín. Predpokladá, že v naj-



bližších päťdesiatich rokoch vzrastie spotreba kovov päťnásobne, a to je podstatne viac, ako je ich súčasná ťažba. Recyklácia kovových materiálov na to nebude stačiť, a preto sa musia hľadať nové zdroje nerastných surovín, čo povedie k opätovnému rozmachu vyhľadávania a prieskumu surovín s využívaním moderných geologických poznatkov, geofyziky a satelitných snímok. Nové metodiky vyhľadávania sa už začínajú objavovať a ich nositeľmi majú byť najmä štátne geologické služby. Mineralogický informačný inštitút v Goldene (Colorado) napr. predpokladá na každého Američana počas jeho života nasledujúcu spotrebu: kameň, štrk a piesok 77 t, ropa 318 l, cement 31 kg, zemný plyn 168 000 m^3, Fe 19,3 kg, Pb 0,49 kg, Al 2,7 kg, Au 0,056 kg, Cu 0,872 kg, Zn 0,453 kg, ílové horniny 10,6 kg, fosfáty 12,6 kg, uhlie 267,3 kg, soľ 13,8 kg, ostatné kovy a suroviny 31,3 kg.

Na kongrese pracovali aj sekcie zaoberajúce sa geológiou planét a predstavili veľmi zaujímavé výsledky z kozmických sond, najmä zo štúdia paleoklímy alebo ukladania rádioaktívneho odpadu. Azda najpočetnejšie boli sekcie zaoberajúce sa ropou a zemným plynom, ktorých sa týkajú odbory od sedimentológie, štruktúrnej geológie, petrotektoniky, geofyziky až po technológiu ťažby. Prirodzene to vyplynulo aj z faktu, že ropná spoločnosť Petrobras v súčasnosti patrí medzi najprudšie sa rozvíjajúce spoločnosti tohto druhu na svete, čo veľmi názorne potvrdila aj jej účasť na výstave Geoexpo 2000.

Ako sme už spomenuli, zúčastnili sme sa ako delegáti na zasadnutí rady IUGS 11. a 14. augusta 2000. Z jej rokovania uvádzame:

• Správa prezidenta IUGS, ktorým bol dve funkčné obdobia Dr. Robin Brett z USA, predtým generálny tajomník IUGS, podčiarkla nezastupiteľnosť geovied v živote modernej spoločnosti aj nevyhnutnosť orientovať ich na riešenie naliehavých otázok globálneho rozsahu a významu. Širokú a neformálnu medzinárodnú kooperáciu geovedcov, a to najmä pri plnení programu IGCP/UNESCO v ostatných rokoch veľmi pozitívne zhodnotila aj Medzinárodná rada vedeckých únií (ICSU). Konštatovalo sa, že stratu prestíže geovied viac-menej vo všetkých krajinách sveta (znižovanie prostriedkov na geologický výskum a prieskum zo štátneho rozpočtu, pokles počtu geologických univerzitných katedier a ich pracovníkov a pod.) treba vyvážiť bohatou a všestrannou vedecko-popularizačnou činnosťou čo najväčšieho počtu geovedcov rozličných krajín.

• IUGS má 112 riadnych členských krajín a novými sa stali: Gambia, Mongolsko, Namíbia a Jemen.

• Za nového prezidenta IUGS bol väčšinou hlasov zvolený Dr. Ed de Mulder z Holandska, ktorý sa venuje stratigrafii, sedimentológii a morskej geológii. Veľkým a neskrývaným sklamaním bolo, že nový prezident nevystúpil s obligátnym inauguračným prejavom, lebo na zasadnutí rady chýbal. Vo funkcii tajomníka IUGS bol hlasovaním potvrdený prof. Attilio C. Boriani. Sídlom sekretariátu zostal Trodheim a IUGS vyjadrila vďaku vláde Nórska, ktorá hradí podstatnú časť nákladov na jeho chod. Za pokladníka namiesto Dr. Z. Johana zvolili Dr. W. Janoscheka z Rakúska. Rada v rámci úpravy vnútorného štatútu obmeny funkcionárov prijala nový systém cirkulácie podpredsedov a členov IUGS. Od roku 2000 je novým podpredsedom IUGS Dr. Tadaši Sato z Japonska a Dr. Peter Dobrowski z Kanady, novým členom rady Dr. H. K. Gupta z Indie a Dr. Jane Plant z Anglicka. Od roku 2002 sa členom rady stane Dr. Jean-Paul Cadet z Francúzska a Dr. Alberto Riccardi z Argentíny.

• Členský poplatok v IUGS je už desaťročia diferencovaný podľa počtu obyvateľov členskej krajiny a jej hrubého domáceho produktu. Slovenská republika od svojho prijatia za riadneho člena na kongrese v Pekingu roku 1996 patrí do 2. kategórie a jej členský príspevok je 800 USD ročne. Inflácia vo svete je veľmi nerovnomerná a v USA je z hospodársky silných krajín najnižšia. Vo vzťahu k USD sa prijala zásada, že sa od roku 2001 členský príspevok zvýši o 10 % a potom každý rok o 3 %, čo v prípade SR značí na rok 2001 zabezpečiť 880 USD.

• Zaujímavo, ba až dramaticky prebiehalo hlasovanie o mieste konania 32. kongresu roku 2004. Zápas o to sa začal už roku 1996 v Pekingu, kde vystúpil prof. Vai za Taliansko a Dr. Janoschek za Rakúsko. Kým v Pekingu bol emotívnejší a presvedčivejší zástupca Talianska, v Riu de Janeiro sa situácia podstatne zmenila. Dr. W. Janoschek predstavil Viedeň ako najvhodnejšie miesto konania kongresu obsahovo aj „umeleckým dojmom“ (my sme držali palce Viedni a tajne sme za ňu hlasovali), ale napriek tomu dosť presvedčivo zvíťazila Florencia. 32. medzinárodný geologický kongres bude vo Florencii v auguste 2004. Hlasovanie zrejme ovplyvnil najmä sľub talianskych organizátorov pripraviť lacný kongres s bezplatným ubytovaním (v kláštoroch a seminároch v okolí Florencie) pre stovky účastníkov. Pre nás je istou útechou, že člena našej delegácie D. Hovorku pozvali ako budúceho člena konzorcia (širšieho či dočasného organizačného výboru) na prípravu 32. kongresu. Slovensko má aj šancu – s Maďarskom, Poľskom a ČR – ponúknuť a po prípadnom prijatí aj usporiadať jednu z exkurzií v rámci florentského kongresu.

Súčasťou riodejaneirského kongresu bol aj rad exkurzií pred ním i po ňom, ako aj jednodňových až dvojdňových exkurzií v jeho priebehu. Pretože rovnako ako celý kongres aj exkurzie obstarávali cestovné kancelárie, vložné bolo vysoké. Toho by sme sa mali vyvarovať aj my pri organizácii väčších akcií.

Na kongrese bolo aj prvé zasadnutie projektu IGCP Magnezity a mastence, ktorým sa zaoberá nasledujúci príspevok.

Je prirodzené, že sa k výsledkom 31. medzinárodného geologického kongresu v Riu de Janeiro bude treba vrátiť a po preštudovaní či aspoň „prezretí“ bohatých materiálov premietnuť jeho najdôležitejšie výsledky aj do orientácie slovenskej geológie v nasledujúcom období.

D. Hovorka, P. Grecula

Niektoré údaje o Riu de Janeiro

1. januára 1502 zakotvili portugalskí moreplavci v zálive, ktorý sa vtedy volal Guanabara, a predpokladali, že našli deltu veľkej rieky. Pomenovali ju po portugalsky Rio de Janeiro (teda rieka Január).

Mesto založil 1. marca 1565 Estácio de Sá a na počesť portugalského kráľa Dona Sebastiaa ho pomenoval Sao Sebastiao do Rio de Janeiro.

Od roku 1763 do založenia súčasného hlavného mesta Brazília roku 1960 bolo Rio de Janeiro hlavným mestom Brazílie. O jeho rozvoj a výstavbu sa zaslúžil najmä Kubitshek a architekt Niemeyer a Costa. Po obsadení Portugalska Napoleonom roku 1808 sa kráľovským sídlom Portugalska stalo Rio de Janeiro. Sídlil v ňom princ Don Joao VI., ktorý bol roku 1815 korunovaný za kráľa Spojeného kráľovstva Brazílie a Portugalska. Toto obdobie bolo pre rozvoj brazílskeho národa veľmi významné.

Rio de Janeiro má vyše 6 miliónov obyvateľov (sami sa označujú ako Cariocas). Väčšinou sú európskeho, portugalského pôvodu, ale sú medzi nimi aj prisťahovalci z afrických krajín a brazílski Indiáni.

Rio má nádherné okolie. Leží medzi morom a horstvom budovaným predkambrickým kryštalinikom. Patrí medzi najkrajšie mestá na svete.

Projekt UNESCO a IUGS IGCP 443 po prvom roku plnenia

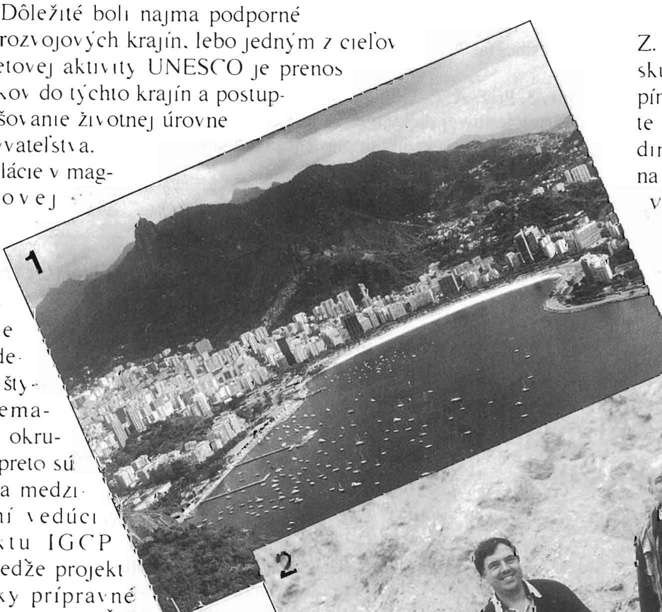
IUGS UNESCO IGCP

IGCP 443

Magnesite and Talc

Geological and Environmental Correlations

Medzinárodný geologický korelačný program IGCP 443 bol schválený na 28. zasadnutí vedeckej rady IGCP projektov v Paríži 31. januára až 3. februára 2000. Schváleniu predchádzala jeho trojročná príprava a získavanie písomnej podpory odborníkov z krajín s výskytom magnezitu a mastenca. Dôležité boli najma podporné listy z rozvojových krajín, lebo jedným z cieľov celosvetovej aktivity UNESCO je prenos poznatkov do týchto krajín a postupné zvyšovanie životnej úrovne ich obyvateľstva.



Korelácie v magnezitovej a mastencovej problematike sú rozdelené do štyroch tematických okruhov, a preto sú aj štyria medzinárodní vedúci projektu IGCP 443. Kedže projekt a všetky prípravné práce prebiehali v Štátnom geologickom ústave Dionýza Štúra, hlavným medzinárodným vedúcim sa stal Ing. M. Radvanec a koordinátorom Ing. Z. Németh, pracovníci tejto inštitúcie. Štyri tematické skupiny zahŕňajú predovšetkým geologickú tematiku, ale v záujme komplexnosti výskumu sa týkajú aj ložiskovej, prieskumnej, úpravníckej problematiky a ochrany životného prostredia. Sú to: 1. *Geologia a štruktúra ložísk magnezitu a mastenca* (vedúci prof. W. Prochaska, Rakúsko), 2. *Geochémia, petrológia a mineralógia* (vedúci Ing. M. Radvanec, Slovensko), 3. *Metódy geologického prieskumu, výskum technologických vlastností suroviny a úpravníctvo* (vedúci prof. A. C. Gondim, Brazília) a 4. *Geoenvironmentálne modely* (vedúci prof. B. Christaras, Grécko, od novembra 2000 prof. Gai Keqın, Čína).

Práca v rámci projektu IGCP 443 sa roku 2000 sústredila na zistenie stavu poznania problematiky magnezitu a mastenca v jednotlivých štátoch sveta. Tomu bolo podriadené aj pracovné stretnutie v Korutánsku (Rakúsko) 28.–31. mája 2000 zamerané na ťažobnú lokalitu Veitsch-Radex Radentheim a OMYA Gummern, podobné ako prvá terénna korelácia na mastencových ložiskách v štáte Paraná (Brazília) 14.–17. augusta 2000, ktorá prebiehala po celosvetovej inaugurácii projektu.

Inauguračné zasadanie bolo v rámci 31. medzinárodného geologického kongresu v Riu de Janeiro (Brazília) 9. augusta 2000. Prezentovala sa ňou filozofia projektu, jeho štruktúra, ako aj spôsoby riešenia vedúce k očakávaným výsledkom (M. Radvanec, Z. Németh). Konštituovanie tematických a národných pracovných skupín bolo spaté s vystúpením viacerých vedúcich národných skupín. Po úvodnom prehľade o súčasnom stave poznatkov o magnezite a mastenci vo svete a ich ekonomickom význame (A. C. Gondim) bola prednáška venovaná nasledujúcej terénnej korelácii na ložiskách mastenca v oblasti Curitiba – Ponta Grossa – Castro v štáte Paraná.

Pri terénnej korelácii boli navštívené ložiská v oblasti Castro (ležiace na JV od dediny Socavão) a na V od mesta Ponta Grossa (povrchová dobývka Sao José a Grande), ktorých regionálna geologická stavba je načrtnutá vo vysvetlivke k fotografiám na obálke tohto časopisu. Pri skúmaní genézy navštívených mastencových ložísk sa konštatovala úloha prínosu SiO_2 do hostiteľského dolomitického mramoru meteorickou vodou obohatenou zo susediaceho zvetrávajúceho granitu. Hlavná úloha sa pri metasomatóze hostiteľských hornín pripisovala telesám doleritu, ktoré priečne prenikajú pruhom telies mramoru. Mastencové ložiská vznikli práve na priesečníku doleritových dajok a pruhu mramorových telies.

Prekvapením bola veľmi jednoduchá úprava suroviny. Skladala sa zo sušenia selektívne vyťaženého mastenca na oceľových platniach, pod ktorými sa spaľovalo drevo vyťažené v okolí úpravne. Vďaka opätovnému zalesňovaniu a rýchlemu rastu sa použité dreviny (*Bracatinga* a *Scubrella mimosae*) mohli opäť spaľovať už po siedmich rokoch. Výsledkom terénnej korelácie bolo viac námetov na nový výskum brazílskej národnej skupiny IGCP 443, ako aj návrhy na zdokonalenie úpravy suroviny a na environmentálnu ochranu.

Na celosvetovom projekte IGCP 443 participujú nasledujúce krajiny (štáty so zvýšenou aktivitou sú označené hviezdičkou): *Argentína, *Austrália, *Brazília, Chile, *Čína, Fínsko, Grécko, *India, *Juhoslávia, Kanada, Kolumbia, Kórea, Kuba, Namíbia, Nemecko, *Pakistan, *Rakúsko, *Rusko, *Slovensko, Turecko, *Ukrajina a USA. V druhej polovici roka 2000 boli v týchto štátoch ročné zasadania spaté s etablovaním vedúcich národných skupín. Na zasadnutí čínskej národnej skupiny sa zúčastnil aj vedúci projektu Ing. M. Radvanec (Peking 4. november 2000).

Výsledkom ročnej sumarizácie poznatkov o magnezite a mastenci v participujúcich štátoch je *Newsletter*, ako aj nepublikovaný katalóg vyše 130 ložísk magnezitu a mastenca vo svete. Informácie o projekte IGCP 443 sú dostupné na dvoch internetových adresách: www.unesco.org/science/earthsciences/igcp/ a www.gssr.sk/igcp443.

V roku 2000 sa začalo organizovať celosvetové stretnutie účastníkov projektu IGCP 443, ktoré bude počas kongresu SGA/SEG v Krakove (Poľsko) 26.–29. augusta 2001. Nadviaže naň terénna korelácia na Slovensku (30. august – 3. september 2001) s návštevou magnezitového a mastencového ložiska Košice-Bankov, Jelšava, Gemerská Poloma a Mútnik. Informácie o týchto odborných akciách sú dostupné na http://galaxy.uci.agh.edu.pl/~sga.

Na záver vyjadrujeme presvedčenie, že činnosť v rámci projektu IGCP 443 v nasledujúcich rokoch povedie k naplneniu základného cieľa projektu, ktorým je príspevok k celosvetovej prosperite.

Zoltán Németh

Obr. 1. Rio de Janeiro, miesto konania inauguračného zasadania projektu IGCP 443. Pohľad na luxusnú štvrť Botafogo z Pão de Acucar. V pozadí vľavo na horizonte je známa socha na kopci Corcovado, neoficiálny symbol tohto mesta (foto autor).

Obr. 2. Časť účastníkov terénnej korelácie na mastencových ložiskách v štáte Parana. Zľava prof. A. C. Gondim, Brazília, hlavný organizátor terénnej korelácie, Ing. M. Radvanec, medzinárodný vedúci projektu, Dr. L. de Loyola zo štátnej prieskumnej inštitúcie Minerais do Parana S. A. Mineropar, prof. L. E. Mantovani, univerzita v Curitibe, a Dr. M. L. Camlofski z miestnej ťažobnej organizácie Progeo (foto autor).

Obr. 3. Prof. A. C. Gondim demonštruje bezprostredný kontakt šikmo sklonenej doleritovej dajky a dolomitického mramoru. Na rozhraní boli prejavy metasomatózy so vznikom mastenca (foto autor).

IGCP 443

IUGS
UNESCO
IGCP

Filozofia projektu

1. Rastúci záujem o magnezit a mastenec motivuje nový prieskum. Úspech pri nachádzaní ďalšej zásoby závisí od úrovne poznania geologických, petrologických a tektonických otázok genézy magnezitu a mastenca, ako aj od poznania princípov recentnej lokalizácie známych výskytov.

2. Nové významné ložiská sa najpravdepodobnejšie objavia v rozvojových krajinách a ich ťažba zvýši životnú úroveň tamojších obyvateľov.

3. Rast ťažobnej a úpravníckej aktivity môže mať nepriaznivý vplyv na životné prostredie najmä v rozvojových krajinách, a preto je nevyhnutné hľadať nové, veľmi efektívne spôsoby monitoringu v ohrozených oblastiach, ako aj účinné spôsoby environmentálnej ochrany.

Pracovný plán na roky 2000–2001

2000

Inauguračné zasadanie – Rio de Janeiro (Brazília)
9. 8. 2000
Terénna korelácia – Curitiba–Castro (Brazília)
14.–17. 8. 2000
Úvodný Newsletter

2001

Ročné zasadanie – kongres SGA-SEG, Krakov (Poľsko)
26.–29. 8. 2000
Terénna korelácia – Košice, Jelšava, Gemerská Poloma, Mútnik – Slovensko 30. 8. – 3. 9. 2001
Newsletter 1

2002

Ročné zasadanie a terénna korelácia – Čína
Transfer poznatkov do rozvojových krajín
Newsletter 2

2003

Ročné zasadanie a terénna korelácia – miesto konania sa upresní na kongrese SGA-SEG roku 2001
Newsletter 3

2004

Záverečné zasadnutie a terénna korelácia – Florencia (Taliansko)
Záverečná monografia Magnezit a mastenec

Očakávané výsledky projektu

a) V teoretických vedách

1. Projekt sa pokúsi dať odpoveď na doteraz nie úplne zodpovedané otázky genézy magnezitu a mastenca, ako aj distribúcie stopových a toxických prvkov v surovine a v sprievodných mineráloch a horninách.

2. Definícia pozície magnezitu a mastenca v zemskej kôre, definícia geologických procesov vedúcich k rozmiestneniu akumulácií magnezitu a mastenca, definícia zdroja Mg a ostatných sprievodných prvkov. Časť magnezitu sa generuje aj v súčasnosti, a preto možno teoretické poznatky dopĺňať aj výskumom recentných procesov.

b) V aplikovanej vede a v technologických procesoch

1. Štúdium zdroja hlavných a stopových, najmä toxických prvkov vo vzťahu ku genetickým typom magnezitu a k okolitým horninám s prihliadnutím na konkrétne geologické procesy. Správanie sledovaných prvkov pri nasledujúcich technologických procesoch.

2. Spôsob väzby hlavných, stopových a toxických prvkov, definícia procesov vedúcich k ich uvoľňovaniu a k poškodzovaniu životného prostredia pri prírodných procesoch, pri ťažbe a metalurgickom spracúvaní.

c) Pre rozvoj ľudskej spoločnosti

1. Sumarizácia využívania magnezitu a mastenca v modernej spoločnosti, spôsoby efektívnej produkcie výrobkov z nich, minimalizácia negatívnych vplyvov na životné prostredie pri ťažbe a úpravníckych postupoch.

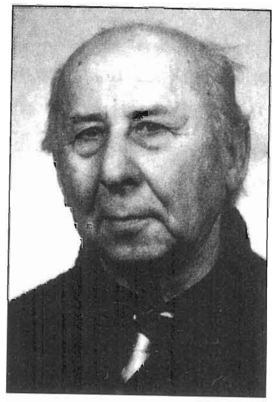
2. Hľadanie nového, netradičného využívania magnezitu a mastenca.

3. Nové geologické a genetické poznatky sa využijú pri hľadaní potenciálnych regiónov s výskytom magnezitu a mastenca najmä v rozvojových krajinách.

4. Analýza potrieb medzinárodného trhu a hľadanie technológií s optimálnym spoločenským úžitkom z celosvetovej produkcie magnezitu a mastenca.

Do 2 [illegible]

Za RNDr. Albertom Bartolomejom Leškom, DrSc.



25. apríla 2000 po krátkej ťažkej chorobe zomrel v Bratislave významný slovenský geológ RNDr. Albert Bartolomej Leško, DrSc., ktorý patril do prvej priekopníckej generácie vychovanej „Andrusovovou školou".

RNDr. A. B. Leško, DrSc., sa narodil 3. júna 1918 v maloroľníckej rodine v Čemernom, ktoré je dnes súčasťou Vranova nad Topľou. Základné vzdelanie získal v rodnej obci, gymnaziálne štúdiá absolvoval v Michalovciach v rokoch 1930–1934 a v Užhorode v rokoch 1934–1938. Po maturite vstúpil do gréckokatolíckeho seminára v Prešove a v rokoch 1938–1943 absolvoval štúdium teológie. Po absolutóriu z teológie sa nedal hneď vysvätiť, ale po dohode s biskupom Pavlom Gojdičom, OSBM, pokračoval v štúdiu na Prírodovedeckej fakulte Slovenskej univerzity v Bratislave. Štúdium prírodopisu a geografie v rokoch 1943–1948 skončil štátnou záverečnou skúškou. Roku 1950 vykonal rigorózne skúšky a získal doktorát prírodných vied (RNDr.). Vedeckú hodnosť kandidáta geologických vied (CSc.) získal roku 1962 a doktora vied (DrSc.) po obhajobe doktorskej dizertácie Geológia východoslovenského flyšu roku 1969.

Vedeckú činnosť začal A. B. Leško u akad. D. Andrusova už počas univerzitných štúdií roku 1947 v Geologickom ústave Prírodovedeckej fakulty SU v Bratislave, kde pôsobil do roku 1950. V čase politickej „očisty" na vysokých školách „dobrovoľne" prešiel do Štátneho geologického ústavu (dnešného Štátneho geologického ústavu Dionýza Štúra). Od začiatku svojej odbornej činnosti sa venoval výskumu jednej z málo prebádaných oblastí – východoslovenskému flyšu, ale pre zásadné hospodársko-spoločenské zmeny, nedostatok odborníkov a napokon aj z ideologických či kádrových príčin pôsobil v rozličných oblastiach geológie. Už roku 1951 bol „predisponovaný" na generálne riaditeľstvo Železorudných baní v Rožňave, kde sa stal hlavným geológom a viedol prieskum rudných ložísk v Gemeri, ale už koncom roku 1951 až do roku 1954 pracoval v Uhoľnom prieskume v Turčianskych Tepliciach, ktorý ho poveril výskumom neogénneho podložia východoslovenskej panvy. Roku 1955, keď sa začali tvoriť generálne mapy ČSR, A. B. Leška opäť pozvali do služieb GÚDŠ a tam pracoval do roku 1959. V rámci ústavu riešil otázky východoslovenského flyšu, najmä duklianskej jednotky a jej vzťah k magurskému príkrovu. Bol autorom a vedeckým redaktorom listu Snina generálnej mapy. Vo výskume sa neobmedzil iba na východoslovenský flyš, ale riešil aj problematiku vnútrokarpatského paleogénu, vzťah k bradlovému pásmu a geológiu Humenských vrchov.

Po politických previerkach roku 1958 musel A. B. Leško roku 1960 GÚDŠ opustiť a stal sa zamestnancom Keramických závodov v Košiciach, kde mal na starosti rozširovanie surovinovej základne. Neskôr prešiel do n. p. Geologický prieskum v Spišskej Novej Vsi a viedol práce späté s výstavbou vodného diela na Domaši, Ciroche, dolnom toku Váhu a inde. Pre jeho všestrannú činnosť vo výskume a v aplikovanej sfére, potrebu zabezpečiť podrobný geologický výskum ho na základe intervencie vedúceho paleogénneho oddelenia (O. Samuela) opäť prijali do GÚDŠ.

Po federalizácii ČSSR a vytvorení Slovenského geologického úradu, vrcholnej geologickej organizácie na Slovensku, si A. B. Leška na dva roky vyžiadala táto inštitúcia. Bol riaditeľom odboru pre geologickú perspektívu územia Slovenska a spolu s prvým predsedom SGÚ Ing. J. Slávikom, DrSc., sa zaslúžil o spracovanie zámerov na overovanie surovinovej základne Slovenska.

Po opätovnom návrate do GÚDŠ A. B. Leškovi zverili veľmi náročnú štátnu úlohu – výskum hlbinných štruktúr so zameraním na výskyt živíc.

O vedeckej erudícii RNDr. A. B. Leška, DrSc., svedčí aj veľký počet jeho odborných publikácií (vyše 100) uverejnených v domácich aj v zahraničných geologických časopisoch. Osobitnú pozornosť si zaslúži monografia Geológia východoslovenského flyšu (v spoluautorstve s O. Samuelom).

Popri vedeckej práci sa A. B. Leško aktívne zapájal aj do spoločensko-profesijného života. V rokoch 1966–1976 bol predsedom bratislavskej pobočky SGS a členom vedeckej rady GÚDŠ. Od založenia časopisu Mineralia Slovaca roku 1960 až do roku 1988 bol členom jeho redakčnej rady. V tom čase bol členom Slovenskej geologickej rady pri SGÚ a rozličných odborných komisií. Za výsledky vo výskume ho odmenili viacerými vyznamenaniami. Roku 1970 sa stal nositeľom Radu práce červenej hviezdy a bol aj zaslúžilým pracovníkom SGÚ. Jeho vedecký prínos ocenili aj zahraničné geologické spoločnosti v Taliansku a Poľsku. Ako prejav uznania ho za čestného člena prijala Poľská geologická spoločnosť (1979), Geologicko-mineralogická spoločnosť Talianska (1973) a stal sa aj čestným členom SGS (1985). Zúčastnil sa na viacerých medzinárodných geologických, geofyzikálnych a ropných konferenciách a kongresoch v zahraničí – v Budapešti (1970), Moskve (1972), Ľvove (1976), Paríži (1980) a v Montreale 1982.

Do dôchodku A. B. Leško odišiel roku 1982.

Z krátkej retrospektívy vidno, že sa A. B. Leško napriek mnohým príkoriam vypracoval na popredného odborníka, významom prekračujúceho česko-slovenské hranice. V jednom zo separátov, ktoré mi venoval, napísal „Nikdy sa nepoddaj. Je múdrejšie a lepšie vždy dúfať ako raz zúfať." To bolo zrejme jeho krédo nielen vo vede, ale aj v živote a v duchovnej sfére. Len tak si možno vysvetliť, že zostal svojmu zmysluplnému životu verný aj v období, keď mal tzv. vedecký svetonázor nahradiť nielen duchovný život, ale v istých filozofických smeroch aj zdravý rozum. Z dôverného poznania A. B. Leška viem, že ustavične v sebe nosil nové životné horizonty, horizonty návratu k plnej slobodnej duchovnej úcte k tomu, kto nám nielen dal, ale aj dáva zásadný zmysel života, a to napriek tomu, že sme sa ešte úplne nezbavili nánosu predchádzajúcich čias. Hoci sa mu táto túžba splnila až po odchode do dôchodku, aj v tomto veku na novom pôsobisku dokázal siať nové trvalé hodnoty v prospech jednotlivcov a spoločenstva.

RNDr. A. B. Leško, DrSc., diakonské svätenie prijal v Hlinnom počas Vianoc a kňazské 1. januára 1950 v biskupskej kaplnke v Prešove z rúk biskupa Pavla Petra Gojdiča, OSBM. Vysviacka už bola iba poloverejná, za účasti seminaristov a najbližších príbuzných. Biskup P. P. Gojdič novému kňazovi povedal „Choď do Bratislavy a tam pomáhaj!" V dôsledku tzv. prešovského soboru bola 25. apríla 1950 Gréckokatolícka cirkev v Československu zlikvidovaná, a tak otec Bartolomej nemohol oficiálne svoju kňazskú činnosť vykonávať. Jeho túžba sa splnila až po páde totalitného režimu v novembri 1989. V gréckokatolíckej eparchii začal pôsobiť už koncom roku 1989 a stal sa správcom farnosti Voľa. V Nacinej Vsi postavil nový chrám zasvätený sv. Konštantínovi-Cyrilovi a Metodovi. Prostriedky naň získal takmer sám vďaka kontaktom doma i v zahraničí. V Nacinej Vsi úspešne rozvíjal tradíciu našich vierozvestov a budoval zdravé obradové a národné povedomie. Je autorom aj niekoľkých desiatok náboženských a historicko-národnostne ladených článkov, z ktorých viaceré vyšli aj v zahraničí. 1. augusta 1999 odišiel na dôchodok do Bratislavy a tam ho 2. mája 2000 biskupský vikár Peter Sabol pochoval v Ružinovskom cintoríne.

Sú ľudia, pre ktorých netreba hľadať slová uznania, lebo najvyšším uznaním je ich statočná činorodá zmysluplná práca. Hodnotu života často meriame podľa rozličných kritérií, väčšinou iba relatívnych, ale poznáme aj osobnosti – a medzi také patril aj RNDr. A. B. Leško, DrSc., ktoré vytvorili hodnoty všade tam, kde pôsobili, lebo odovzdali svojej práci nielen um, ale aj srdce umocnené statočnou prácou a šľachetným duchom. Práve takéto hodnoty A. B. Leško rozdával geologickej vede aj pastorácii a vychádzal zo zásady, že nezainteresované myslenie je neplodné. Kreatívna a zanietená myseľ, opierajúca sa o radostný optimizmus, je historickým poslaním človeka, ktorý v tvorivom hľadaní ustavične obnovuje svoju podobu. A. B. Leško práve tým v každodennom živote vštepoval svojmu okoliu naozajstný zákon ducha statočného človeka so zmyslom pre chápanie a radostné prežívanie pocitu z dobre vykonanej práce.

RNDr. A. B. Leško, DrSc., svojou prácou oživoval zem, vdychoval do každého kameňa ducha, ktorému zasvätil svoje srdce, ktoré bude medzi nami žiť, aj keď ho dočasne prikryli hrudy zeme. To srdce, ktoré bolo po jeho rodine druhou najväčšou láskou, cez ktorú nachádzal najhlbší zmysel života.

Česť jeho pamiatke.

O. Samuel

Slovenská geologická spoločnosť aktivizuje odborné komisie

Kým v minulosti bola činnosť odborných komisií v gescii kolégia pre vedy o Zemi a vesmíre pri Predsedníctve SAV, v posledných rokoch ju vykonávajú vedecké spoločnosti pri SAV, medzi ktoré patrí aj SGS.

Na zasadnutí rozšíreného výboru SGS 30. novembra 2000 bola na programe aj problematika odborných skupín a komisií a všeobecne sa na ňom konštatovalo ochabnutie činnosti niektorých z nich. Príčin takéhoto stavu je viac a patrí medzi ne napr. aj zmena štruktúry členskej základne SGS, odchod početnej a zároveň aktívnej generácie do starobného dôchodku a pod.

Jednou z oblastí, v ktorej sa pociťuje veľmi naliehavá potreba aktivizovať činnosť, je slovenská terminológia a nomenklatúra všetkých geovedných odborov V diskusii na túto tému sa na zasadnutí výboru za plného súhlasu prítomných konštatovalo, že v čase, keď ustavične a nápadne rastie – priaznivý aj nepriaznivý – vplyv svetových jazykov (v ostatných decéniách najmä angličtiny) na slovenskú geovednú terminológiu, je tvorba tejto terminológie, no najmä písomnej podoby najrozličnejších internacionálnych termínov mimoriadne žiaduca. Geológovia z rozličných geovedných disciplín si uvedomujú, že sa stále viac vedeckých prác vysokej profesionálnej úrovne publikuje v angličtine, ale napriek tomu – či práve preto – je tvorba a kodifikácia terminológie v materinskom jazyku profesionálnou, ba i morálnou povinnosťou vedcov každej generácie.

Preto sa obraciame na členskú základňu SGS, na kolegyne a kolegov s pozitívnym vzťahom k spomenutej problematike, ktorí sú schopní a ochotní zúčastniť sa na tvorbe terminológie v rámci komisií SGS, aby sa prihlásili na adresu uvedenú na konci tejto poznámky. SGS plánuje ustanoviť nové terminologické komisie na svojom valnom zhromaždení na začiatku februára 2001

Kolegovia, čakáme Vašu priaznivú odpoveď

Z poverenia výboru SGS D. Hovorka
e-mail: mineralogia@fns.uniba.sk

Zasadnutie slovenskej geologickej rady

19. decembra 2000 zasadala SGR a prijala informáciu o návrhu projektov úloh, ktoré sa začínajú v roku 2001, ako aj o návrhu koncepcie rozvoja geológie na Slovensku do roku 2005. Materiály dostali členovia SGR na preštudovanie a pripomienkovanie tak, aby bolo možno na nasledujúcom zasadnutí rady prijať príslušné odporúčania. Návrh koncepcie ešte treba dať do súladu s materiálmi, ako je koncepcia surovinovej politiky Slovenska, koncepcia trvalo udržateľného rozvoja (je dostupná na www stránke Ministerstva životného prostredia SR a na internetovej stránke www.rec.sk) a pod. Na zasadnutí sa zhodnotilo aj plnenie predchádzajúcich uznesení a odporúčaní SGR a konštatovalo sa, že sa väčšina splnila a ostatné sa plnia priebežne. Do pozornosti geologickej obce sa odporučil materiál Aplikácia metodiky OSN na vybraných ložiskách SR (prístupný na www stránke MŽP SR).

V. Gajdoš

Významné životné jubileá členov Slovenskej geologickej spoločnosti v roku 2001

Päťdesiatroční jubilanti

RNDr. Anna Ďurišová
RNDr. Jozef Halmo
RNDr. Adrián Harničár
RNDr. Jozef Pagáč
RNDr. Anna Pospiechová

Šesťdesiatroční jubilanti

doc. RNDr. Ján Čurlík, CSc.
RNDr. Zoltán Hlavatý, CSc.
RNDr. Ján Mello, CSc.
doc. RNDr. Peter Reichwalder, CSc.
Ing. Roman Ravinger, CSc.

Šesťdesiatpäťroční jubilanti

RNDr. Zora Bondarenková
RNDr. Michal Čuchrač
P. g. Andrej Földes
RNDr. Rudolf Gabčo
RNDr. Pavol Grecula, DrSc.
Ing. Jozef Hudáček
doc. RNDr. Pavol Hvožďara, CSc.
Ing. Jiří Knésl
RNDr. Eduard Köhler, DrSc.
RNDr. Ivan Križáni
RNDr. Pavel Malík, CSc.
Emília Mašurová
RNDr. Zdenko Nejdl
Ing. Daniel Očenáš
prof. RNDr. Rudolf Ondrášik, DrSc.
RNDr. Tomáš Repka, CSc.
Ing. Jozef Slavkovský, CSc.
RNDr. Milan Šindler
Ing. Ján Tabak
RNDr. Imrich Varga
prof. RNDr. František Zábranský, CSc.

Sedemdesiatroční jubilanti

RNDr. Vladimír Bartek
doc. RNDr. Vavrinec Bohm, CSc.
RNDr. Milan Brodňan
Ing. Pavol Bujalka, CSc.
RNDr. Ing. Ján Burian, CSc.
doc. RNDr. Vincent Ďurovič, CSc.
RNDr. Ondrej Franko, DrSc.
RNDr. Otília Jendrejáková, CSc.
Ing. Eugen Kullman, DrSc.
RNDr. Anna Kullmanová
RNDr. Ján Michel
Emil Mikuláš
RNDr. Ondrej Samuel, DrSc.
doc. RNDr. Viliam Sitár, CSc.
RNDr. Laurenc Snopko, CSc.
RNDr. Ivan Šarík

Sedemdesiatpäťroční jubilanti

prof. Ing. Viliam Pašteka, DrSc.

V mene celej geologickej verejnosti všetkým jubilantom srdečne blahoželáme a do ďalších rokov želáme veľa tvorivých síl a dobré zdravie.

doc. RNDr. Peter Reichwalder, CSc.
predseda SGS

Plán odborných akcií Slovenskej geologickej spoločnosti na I. polrok 2001

V I. polroku 2001 usporiadajú pobočky Slovenskej geologickej spoločnosti a odborné skupiny tieto akcie:

Banskobystrická pobočka (predseda RNDr. M. Háber, CSc.)

Marec 2001
Prednáškové popoludnie:
J. Soták: Paradigma turbiditov pre 21. storočie.
L. Baková: Melanzové a olistostrómové útvary na Orave (štruktúrne profily Zaskalie a údaje z bazálnych kataklazitov
J. Kotulová: Štúdium organickej hmoty v Tichom potoku (Centrálnokarpatský paleogén, spodný miocén).

Apríl 2001
J. Michálek: Geológia a vybrané ložiská nerastných surovín západnej Austrálie.
Miesto: Geologický ústav SAV, Severná 5, Banská Bystrica, zasadačka.
Deň a hodina konania budú upresnené na plagáte.
Akcie zabezpečuje M. Háber.

Bratislavská pobočka (predseda RNDr. P. Uher, CSc.)

22. 2. 2001
Prednáškové popoludnie:
Naši geológovia na cestách (premietanie diapozitívov s geologickou tematikou z pracovných a poznávacích pobytov slovenských geológov): P. Uher: Pegmatity Kanadského štítu.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod. Zabezpečuje P Uher

22. 3. 2001
Seminár Aktuálne problémy kryštalinika Západných Karpát (jednotlivé prednášky budú upresnené neskôr).
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje P. Uher.
Záujemci o prednesenie príspevkov kontaktujte sa u P. Uhera.
(mobil: 0905 484 251; e mail: geoluher@savba.sk)

28. 4. 2001 (sobota)
Terénna exkurzia naprieč Malými Karpatmi medzi Sološnicou a Doľanmi (kryštalinikum, mladšie paleozoikum, mezozoikum, terciér). Zraz: Bratislava, autobus. stanica Mlynské Nivy, 8:00 hod. Zabezpečuje P. Uher.

Košická pobočka (predseda prof. Ing. Shah Wali Faryad, CSc.)

8. 2. 2001
Z. Németh, M. Putiš a P. Grecula: Petrotektonický výskum – cesta k hlbšiemu poznaniu tektonickej evolúcie gemerika.

8. 3. 2001
S. Jacko ml.: Balancovanie seizmických rezov – čo a ako?

29. 3. 2001
Prednáškové popoludnie – Vulkanizmus jz. časti Talianska
B. Žec: Vulkanologická expedícia Taliansko 2000.
M. Košúth, M. Zacharov, L. Hlaváčová a K. Vargová: Vulkanizmus Liparských ostrovov.
T. Petrasová, A. Lippaiová, J. Bóna a P. Jonáš: Vulkanzmus vulkánu Somma–Vezuv
B. Žec, M. Máté, K. Trebuňová a A. Tóthová: Vulkanizmus Etny.
Premietanie filmu: Vulkány jz. časti Talianska (skrátený záznam z expedície).

10. 5. 2001
J. Janočko: Čaká nás doba ľadová?

Geofyzikálna skupina (predseda doc. RNDr. J. Lanc, CSc.)

15. 3. 2001
Prednáškové popoludnie (spolu s Hydrogeologickou odbornou skupinou):
K. Vrana, I. Vojtaško a D. Žák: Nové poznatky z výsledkov úlohy Systém zisťovania a monitorovania škôd na životnom prostredí vznikajúcich banskou činnosťou.
Miesto: Štátny geologický ústav D. Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje J. Lanc.

Geochemicko-mineralogická skupina (predseda doc. RNDr. M. Chovan, CSc.)

15. 2. 2001
Prednáškové popoludnie:
Podrobnejšie informácie o mieste a znení prednášok budú upresnené na plagáte.
Zabezpečuje M. Chovan.

Hydrogeologická skupina (predseda RNDr. D. Marcin)

15. 3. 2001
Prednáškové popoludnie (spolu s Geofyzikálnou odbornou skupinou):
A. Remšík (ŠGÚDŠ, Bratislava): Hydrogeologické pomery Žiarskej kotliny.

24. 5. 2001
P. Malík a D. Bodiš, (ŠGÚDŠ, Bratislava): Hydrogeologické pomery Licinskej pahorkatiny (Gemer).

22. 11. 2001
J. Dzúrik a G. Vandrová, (Geospektrum, Bratislava, INGEO Žilina): Monitorovací systém minerálnych vôd.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Poznámka: Prípadné potrebné zmeny ohľadom termínov a náplní prednášok budú včas oznámené formou plagátov
Zabezpečuje D. Marcin.

Inžinierskogeologická skupina (predseda RNDr. Ľ. Iglárová)

1. 2. 2001
A. Matejček: Višňové – prognózy a skutočnosť pri realizácii výskumnej štôlne.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje Ľ. Iglárová.
R. Adamcová: Retardačné schopnosti minerálnych tesnení skládok odpadu.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje Ľ. Iglárová.

Paleontologická skupina (predseda RNDr. J. Michalík, DrSc.)

29. 3. 2001
Prednáškové popoludnie:
Výsledky práce novej generácie paleontológov
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.

26. 4. 2001
Jednodenný terénny seminár v Malých Karpatoch.
Podrobnosti k akcii budú uvedené na vývеske.
Zabezpečuje J. Michalík.

Skupina ropnej geológie (predseda RNDr. P. Ostrolucký, CSc.)

19. 4. 2001
Prednáškové popoludnie:
Aktuálne problémy výskumu a prieskumu uhľovodíkov.
Podrobnejšie informácie budú zverejnené na plagáte.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje P. Ostrolucký.

Sedimentologická skupina (predseda doc. RNDr. M. Kováč, CSc.)

1. 3. 2001
Prednáškové popoludnie:
Kolektív: Litostratigrafia vrchného miocénu: Panón – vek, fácie, cykly.
Podrobnejšie informácie budú zverejnené na plagáte.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Na prednáškovom popoludní sa uskutoční voľba nového predsedu odbornej skupiny
Zabezpečuje M. Kováč.

Skupina štruktúrnej geológie (predseda RNDr. F. Marko, CSc.)

8. 3. 2001
Prednáškové popoludnie:
Program a termín popoludnia k akcii bude upresnený na plagáte.
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje F. Marko.

Vulkanologická skupina (predseda RNDr. L. Šimon, PhD.)

5. 4. 2001
L. Šimon: Pseudokráteri na lávových prúdoch kvartérneho vulkánu Pútikov vŕšok (nové výsledky).
Miesto: Štátny geologický ústav Dionýza Štúra, Mlynská dolina 1, 817 04 Bratislava, zasadačka 3. poschodie, 13:30 hod.
Zabezpečuje L. Šimon.

Uhoľná odborná skupina Prievidza (predseda Ing. J. Fazekaš, CSc.)

Február – Apríl 2001
Prednáškové popoludnie:
Geologicko-banské podmienky pre budúce exploatačné obdobia na závodoch HBP, a. s. Prievidza.
Program, miesto a čas konania bude upresnený na pozvánkach, resp. plagáte.
Zabezpečuje J. Fazekaš.

Pozvánka na konferenciu

Štátny geologický ústav Dionýza Štúra
v Bratislave
Geomin, družstvo v Jihlave
Prírodovedecká fakulta UK v Bratislave
Slovenská asociácia ložiskových geológov
Geologický ústav SAV v Bratislave
Ministerstvo životného prostredia SR
Ministerstvo životného prostredia ČR

si Vás dovoľujú pozvať
na konferenciu

ŠLICHOVÁ PROSPEKCIA A AKCESORICKÉ MINERÁLY

spojenú s exkurziou

14. – 16. novembra 2001
v Banskom Studenci

1. cirkulár

Šlichová prospekcia má dôležitú úlohu najmä pri vyhľadávaní rudných nerastných surovín. Potvrdila sa jej efektívnosť, časová aj ekonomická nenáročnosť. Pri aplikácii nedeštrukčných metód hodnotenia je šlichová vzorka využiteľná na štúdium opakovane bez obmedzenia, čo umožňuje jej analýzu z rozličných pohľadov a rozmanitými metódami aj po väčšom časovom odstupe, a preto je veľmi cenným prameňom dát a informácií.

Výskum koncentrátov ťažkých minerálov sa využíva najmä v prospekcii širokého spektra nerastných surovín. Akcesorické minerály sú významným zdrojom informácií pri výskume petrogenézy magmatitov a metamorfitov. Podobne typomorfné vlastnosti minerálov možno aplikovať v sedimentológii.

Jedným zo sfér nového hodnotenia šlichovej vzorky je určovanie kvalitatívneho a kvantitatívneho zastúpenia antropogénnej zložky. Jej charakteristika a poznanie jej distribúcie významne dopĺňajú iné metódy hodnotenia stupňa znečistenia recentných riečnych sedimentov.

Pre bohaté možnosti využívania výsledkov pôvodnej šlichovej prospekcie predpokladáme rokovanie konferencie v nasledujúcich tematických okruhoch:

1. **Výsledky šlichovej prospekcie – súčasné možnosti interpretácie**
2. **Akcesorické a ťažké minerály – indikátory petrogenetických a sedimentologických procesov**
3. **Antropogénny materiál v recentných sedimentoch – indikátor znečistenia**

Konferenčné príspevky môžu mať formu prednášky alebo posteru. Prednášky a abstrakty posterov budú publikované v monotematickom čísle vedeckého periodika Mineralia Slovaca. Príspevky na zverejnenie treba pripraviť podľa požiadaviek a pokynov tohto časopisu.

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Ubytovanie:
chata Dinas, Banský Studenec
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Druhý cirkulár s upresnenými informáciami sa pre prihlásených bude distribuovať do 15. marca 2001.

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5. Zreteľne treba odlíšiť východiskové údaje od interpretácií.
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10. Grécke písmená použité v texte treba identifikovať na ľavom okraji slovom (napr. sigma).
11. Pri písaní starostlivo odlišujte pomlčku od spojovníka.
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Ilustrácie

1. Musia byť vysokej kvality. Majú dokumentovať a objasňovať text. Originál (pred zmenšením) môže mať rozmer najviac 340 x 210 mm. Maximálny rozmer ilustrácie vytlačený v časopise je 170 x 230 mm. Skladacie ilustrácie treba úplne vylúčiť.
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Tabuľky

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4. Vertikálne čiary v tabuľkách nepoužívať.
5. Tabuľky sa číslujú priebežne a uverejňujú sa v číselnom poradí.

Literatúra

1. V zozname literatúry sa v abecednom poriadku uvádza iba literatúra citovaná v danom článku. Citácia označená „v tlači" sa môže uviesť v zozname, len ak je z citovaného článku aspoň stĺpcová korektúra. Citácie s doplnkom „v prípade", „zadané do tlače" sú neplnohodnotné a nemajú sa používať ani v texte. Citácia „osobná informácia" sa cituje iba v texte (Zajac, os. informácia, 1988).
2. Používať nasledujúci spôsob uvádzania literatúry:
   Kniha
   Gazda, L. & Čech, M., 1988: Paleozoikum medzevského príkrovu. Alfa Bratislava, 155.
   Časopis
   Vrba, P., 1989: Strižné zóny v komplexoch metapelitov. Mineralia Slov., 21, 135 - 142.
   Zborník
   Návesný, D., 1987: Vysokodraselné ryolity. In: Romanov, V. (red.): Stratiformné ložiská gemerika. Špec. publ. Slov. geol. spol., Košice, 203 - 215.
   Manuskript
   Radvanský, F., Slivka, B., Viktor, J. & Srnka, T., 1985: Žilné ložiská jedľoveckého príkrovu gemerika. Záverečná správa z úlohy SGR-geofyzika. Manuskript—archív GP Spišská Nová Ves, 28.
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