

Invest in Greece
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Mineral Resources

WHY INVEST IN THE MINERAL INDUSTRY IN GREECE

- **Stable and predictable economic and business environment, low inflation and falling interest rates, satisfactory and rapidly improving infrastructure, possibility to raise funds through listing at the Athens Stock Exchange (several companies of the sector have already done so).**
- **Dynamic and export oriented sector with positive development prospects and long tradition in Greece**
- **Consistently high product quality with an excellent reputation in the international markets**
- **High R&D level with access to European Union R&D funding**
- **Tradition in the mineral industry**
- **Well educated and experienced technical staff and highly skilled workforce**
- **High quality and large volume deposits, in some minerals, by international standards**
- **Competitive operating costs**
- **No export duties**
- **Generous investment incentives**

The Mineral Industry in Greece

The mining and extractive metallurgy sector has been traditionally one of the most important and dynamic segments of the Greek industry. The majority of mining companies are well organized, have a strong export orientation and achieve remarkable rates of development. The sector can be divided into three subsectors, namely,

- Metallic minerals
- Industrial minerals
- Marble

The metallic minerals subsector mainly involves a relatively small number of large, capital-intensive companies, that are, in some cases, vertically integrated, i.e. engaged in both mining and metallurgical processing. Typical examples are Aluminium de Grece (a producer of bauxite - through an affiliate company - as well as of alumina and aluminum) and Larco (mines laterite and operates the ferronickel plant at Larymna).

The companies dealing with industrial minerals and marble are generally smaller in size but are more numerous. Furthermore, unlike companies in the metallic minerals sector, they produce and commercialize a range of different products usually addressing a variety of applications. Examples are "Silver and Baryte Ores Mining Co" (bentonite, perlite but also bauxite), "Grecian Magnesite" (magnesite, magnesia, refractories) and "Dionyssos Marble" (white marble, carbonate fillers).

With respect to the ownership of the companies of the mining sector, the situation is as follows. There are:

- Greek private firms (majority of cases).

- Public companies (i.e. listed on the Athens Stock Exchange). Four companies have already listed (one active in metallic minerals, one active in industrial minerals and two marble producers) while many others have applied or plan to apply for listing.

- Companies (either public or private) majority-owned by international groups: a relatively small category but one which involves some well known mining/metallurgical firms such as Aluminium de Grece (Pechiney group) and TVX Hellas (TVX Gold Inc).

- State owned companies: Larco and Eleusis Bauxite Mining Co (Elbaumin). Larco is an integrated producer of

- ferronickel, the sole manufacturer of FeNi in the European Union.

Elbaumin is a relatively small producer of bauxite as well as of high-grade manganese.

In the early '90s, following the successful implementation of a wide privatisation programme, some mining companies passed on to the private sector. In particular, the companies that changed hands were:

- a) Hellenic Chemical Products and Fertilisers SA, the Kassandra/Stratoni mining branch, producer of mixed sulfide ore concentrates. The company belonged to the National Bank of Greece as well as to the Bodosakis Foundation. The new owner (since 1995) is the Canadian firm TVX Gold Inc and the company was renamed TVX Hellas.
- b) Mevior SA, and Elvior SA are producers of feldspar and quartz, majority-owned by Greek industrial development banks. The owner of a huntite/hydromagnesite mining and processing company acquired them both.

The mining and basic metallurgy sector in Greece covers a wide range of mineral commodities: various metallic ores, many industrial minerals and a broad spectrum of marble types, some of them unique by international standards. There are three types of mineral raw materials, namely lignite (fossil fuels in general), aggregates and clays that have not been included in this presentation due to the strongly local character of their markets.¹

The position of Greek mining companies in their business environment generally ranges from good to very good. Many companies enjoy an excellent reputation in the international markets while some of them are worldwide leaders in their fields. A few companies already have production and/or distribution subsidiaries out of Greece, both in and out of the European Union. Most mining companies have applied extensive restructuring programs over the last years aimed at enhancing their product range and controlling operating costs. Hence they have managed to substantially improve their competitiveness.

¹ The mining and basic metallurgy as defined above comprises the following minerals and mineral based products: metallic minerals, alumina/aluminum, nickel, industrial minerals (excluding clays) and marble.

Nowadays, the sector has a variety of competitive advantages such as

Sound technical know-how on both the mining and the processing level

Modern, flexible and cost effective facilities.

High and consistent product quality (a fair number of companies holds QA Certificates of the 9000 series)

Broad and well organized distribution networks.

Experienced personnel and high caliber managerial staff.

The turnover of the mineral industry in Greece is estimated to 1.4 billion USD (1.260.000.000 EURO), divided approximately on a 50%-50% basis between mining/processing and basic metallurgy (the latter comprises alumina/aluminum and nickel). Exports are some 530 million USD, representing almost 10% of the country's total exports.

The evolution of financial data for the years 1995-1998 of 8 mining/metallurgical companies and 9 marble firms, the largest and most representative of the two sectors is provided in the following table:

Remarks

1. Turnover has increased by some 25% over the period 1995 to 1998.
2. Equity has increased by 21% and total assets by 26% over the same period.
3. Net fixed assets have increased by 45%, a figure reflecting the continuous investments of the sector.
4. Equity to total assets remains in the 60 to 65% range, the liabilities of the companies of the mining sector are clearly below the average of Greek industrial firms.

The plans of the companies involved in the mineral industry in Greece vary according to their size, product range, type and ambitions of ownership etc. However, the sector's profile has started to change rapidly mainly through (a) mergers and acquisitions and (b) financing by listing at the Stock Exchange.

The target of the relatively big companies of the sector is to grow and become multinational. More particularly:

- a) To broaden their production base by establishing operations also out of Greece
- b) To increase their presence in the market, through participation in distribution channels, strategic alliances with end users of their products etc.
- c) To develop new markets both geographically and from an application point of view.

The strategy of the relatively smaller players ranges from growth based on their own resources to becoming part of bigger groups. Some profitable small companies have been already acquired by well known foreign firms that are trying to strengthen their position in their field.

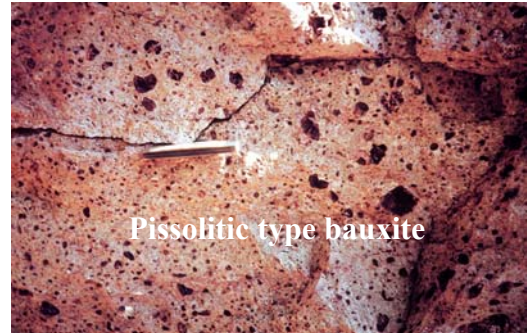
Change in basic financial magnitudes	Index of change			Value in million EURO
	1995/1996	1996/1997	1997/1998	1998
Turnover	0.98	118	108	515.9
Net Profit (before tax)	0.64	174	109	65.1
Equity	113	108	100	383.0
Total Assets	114	108	104	618.3
Net Fixed Assets	132	111	102	299.0
Profitability and liability ratios				
Net Profit to Turnover (%)	13.0	8.5	12.6	12.6
Equity to total Assets (%)	65.6	64.8	64.8	61.9

An example is the former Georgiades-Pavlidis huntite operation that was acquired by the UK based Microfine Minerals and was renamed to Microfine Hellas.

At the beginning of the 21st century, the perspectives of the Greek mineral industry appear to be positive. Most privatizations have proven to be successful, the restructuring of the sector has up to now yielded good results and the stock market offers access to financing for the development projects. Still, most companies of the mining sector need to establish (or broaden their) strategic alliances with international firms with technical and/or commercial know-how in their field. There is no doubt that the mineral industry in Greece has important strengths. However, it is also clear that it has to identify and exploit the trends and opportunities of the international business environment if it wishes to remain competitive and further improve its position and perspectives.

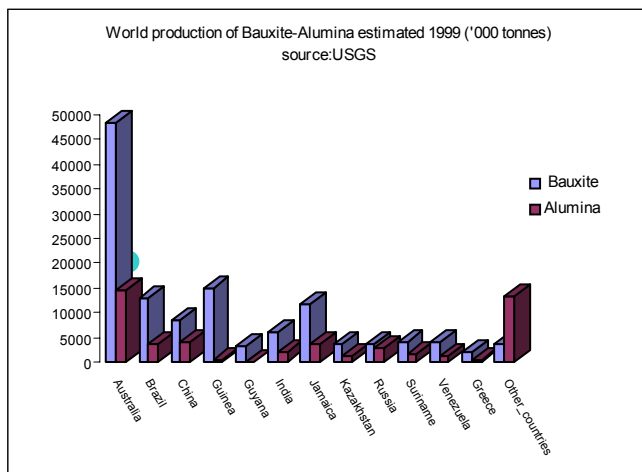
BAUXITE ALUMINA

ALUMINUM



Bauxite is a naturally impure mixture of aluminum hydroxide minerals plus various mixtures of silica, iron oxide, titania, aluminosilicates and other impurities in trace amounts. The principal aluminum hydroxide

70% of the total bauxite mined in 1999. Greece holds the 12th position in the relevant world classification. World production of primary aluminum metal was 22,1 million tonnes, in 1998. The main aluminum metal producing countries were U.S.A., Russia, Canada, China, Australia and Brazil.



minerals found in varying proportions within bauxite are gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), and the polymorphs boehmite and diaspore ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$). Of all bauxite mined, approximately 85% is converted to alumina (Al_2O_3), which in turn is used as a raw material for the production of aluminum metal by electrolytic reduction. It is estimated that 10% of the total bauxite production goes to non-metal uses and the remaining 5% is used in non metallurgical applications.

Aluminum metal has a low density, high electrical and thermal conductivity, corrosion resistance and good malleability.

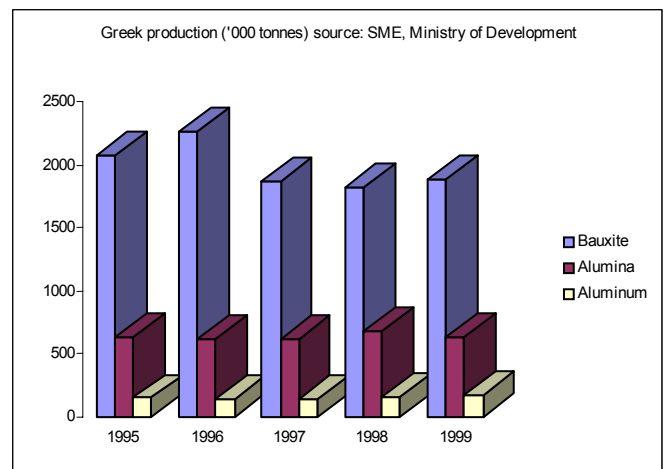
The principal industrial end-uses for non-metallurgical grade bauxite are in the manufacture of refractories and abrasives followed by applications in the cement industry. In addition, aluminum chemicals, the steel industry and glass-making also consume significant quantities of bauxite.

WORLD PRODUCTION -RESERVES

In 1999, world bauxite production was 127 million tonnes. Australia, Guinea, Brazil, and Jamaica accounted for about

GREEK BAUXITE

Greece is the largest bauxite producing country in



the E.U., with an annual production of 1.882.500 tonnes in 1999. The annual production of alumina, in 1999, was 632.500 tonnes and of aluminum 170.300 tonnes. Bauxite exports in 1999 reached 668.000 tonnes with a value of 19.075.568,6 EURO. Alumina exports in 1999 reached 335.700 tonnes, with a value of 52.531.181,2 EURO, and of aluminum 71.100 tonnes with a value of 109.464.416,7 EURO.

During 2000 bauxite production was estimated to be 1.987.000 tonnes (5,6 % increase compared to 1999 production), while exports increased reaching 900.000 tonnes.

The major Greek bauxite deposits are located and developed within the Parnassos-Ghiona geotectonic zone (Parnassos, Ghiona, Elikonas and Oeti mountain region).

Significant ore deposits and occurrences exist in the Kalidromo mountain region, the Domokos area, Euboea, Skopelos Island, Chalkidiki and in other regions.

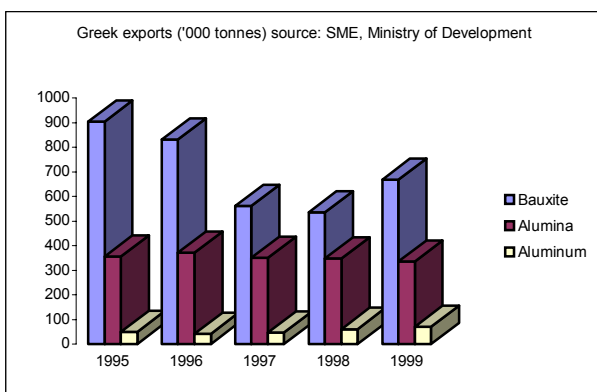
The proven reserves in the Parnassos – Ghiona zone exceed 100 million tonnes, whereas potential reserves are estimated to be several hundred million tonnes.

In the Parnassos - Ghiona zone, which is the main bauxitic province, five bauxitic horizons are developed covering stratigraphically the period from Upper Triassic to Lower Cretaceous. Today, only two bauxitic horizons are mined economically: (i) the middle horizon of the Upper Jurassic to Lower Cretaceous period mainly of boehmitic composition and (ii) the upper bauxitic horizon of the Middle to Upper Cretaceous period, being characterised by the increased presence of diaspor, resulting in increased hardness and abrasiveness.

The main bauxite producing companies are:

Delphi-Distomon S.A., which is a subsidiary of the domestic alumina and aluminum metal producer (Aluminium de Grece S.A.). In 1998 the company produced around 860.000 tonnes of bauxite ore from mines at Itea and Distomon areas. All the output is fed to the alumina-aluminum plant.

Bauxites Parnasse Mining Co S.A. merged with **Silver and Baryte Ores Mining Co S.A.** to form the largest mining group in Greece. The bauxite operations are mainly in the Itea area, Parnassos mountain. A part (almost 55%) of its bauxite concentrate production is shipped to the alumina – aluminium plant, whereas the remainder is exported for special uses in the cement and steel industries. Silver and Baryte is active in Euboea, Helicon

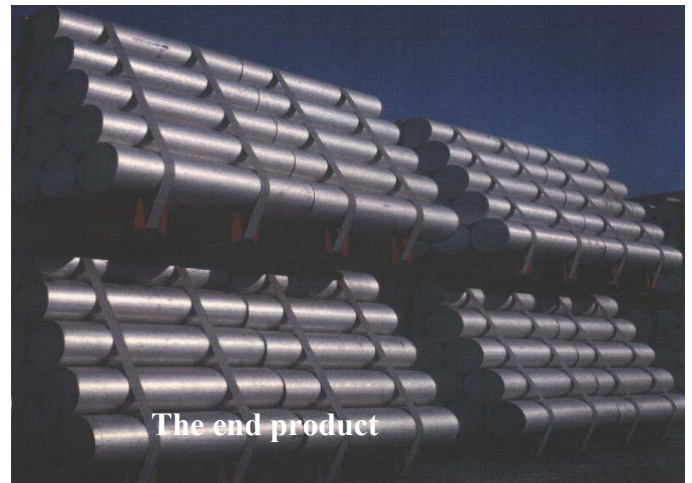


and the Parnassos mountains. The total production in 1998 was around 860.000 tonnes .

The other Greek producer **Elefsis Bauxite Mines S.A. (Elbaumin S.A.)** was formerly a member of the Skalistiris Group, but is now a state-run enterprise. In 1998 the company produced 120.000 tonnes from their mines at Ghiona and Oeti mountains.

Aluminium de Grece S.A. was founded in 1960, as a subsidiary of **Pechiney**, the well known French group, to

treat significant Greek bauxite deposits. The metallurgical plant is situated in Aghios Nikolaos, Boeotia Prefecture, treating 1,5 million tonnes of bauxite per annum for the production of around 700.000 tonnes of alumina and 160.000 tonnes of aluminum metal.



PERSPECTIVES

Greek bauxite production has followed a declining trend in the nineties, mainly due to the collapse of the economies of the CIS countries, traditionally a big market for Greek bauxite. However, the year 2000 was a positive one for the Greek Bauxite sales, a steady year for the international market, and finally a year for the adjustment of the alumina and aluminum prices in the international market. Russia and other countries of the former Soviet Union seem to recover after the political and economic crisis that started during the summer of 1998. The exports of Greek bauxite to those countries, for the first time after several years, exceeded 400.000 tonnes (72.000 tonnes in 1999) whereas for the year 2001 a further increase is expected.

As for Aluminium de Grece S.A., the 2000 was a very productive year. The refinery and the smelter operated at full capacity. The Company announced that it will continue its investment project of 70 million US\$. As for the year 2001 the perspectives are foreseen as very promising.

It should be noted that, Greek bauxite has certain important comparative advantages. Namely the high quality of the ore, the important reserves, the existence of an alumina-aluminum plant that consumes most of the domestic production and the suitability of Greek bauxite for specialty applications i.e. cement, steel etc. It is worth noting that the companies in the bauxite sector have applied programmes aiming at controlling the operating costs and increasing their ore reserve base.

During the '80's the development of a second alumina plant was studied and evaluated. The project owner was the Greek Industrial Development bank (HIDB) a state controlled organization. The project has been shelved and HIDB is seeking private investors for its implementation. The existing bauxite reserves in Greece are fully capable of supporting the operation of a second alumina facility.

NICKEL



Processing plant at
Larymna area

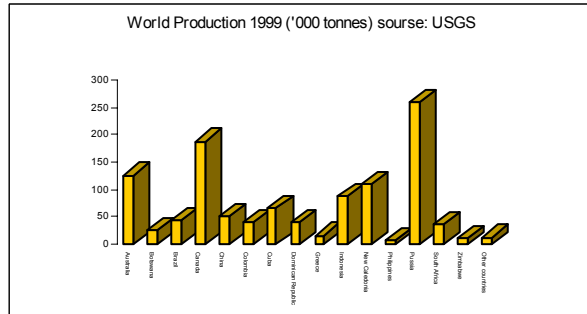
GREEK NI-ORE DEPOSITS

The main Ferro-Ni bearing laterite deposits of Greece can be classified as follows: (a) in situ Ni-laterite deposits, such as the Tsouka in Lokris, Profitis Ilias in Vermion and Kastoria in northern Greece (b) transported Ni-laterite deposits, such as the Nissi and Kopais in Lokris, Euboea island and Metallion in Vermion and (c) bauxitic laterite deposits, such as the Nissi in Lokris.

The potential of Ferro-Nickel ore reserves in Greece is currently estimated to be in the range of 100 million tonnes, grading 1-1,4 % Ni.

Greece is a major laterite and ferronickel producer in the European Union and the sole nickel producer in the EU utilising domestic ores. Nickel run-of-mine production in Greece amounted in 1999 to 1.639.411 tonnes of Ferro-Ni bearing laterite, while nickel output was as high as 13.462 tonnes and nickel exports were 13.546 tonnes (value: 80.704.328,7 EURO) in the form of Fe-Ni, to the stainless steel European industries.

For the year 2000 production is estimated to be 2.198.376 tonnes of Ferro-Ni bearing laterite and 17.126 tonnes of nickel output.



chemical industries.

WORLD PRODUCTION

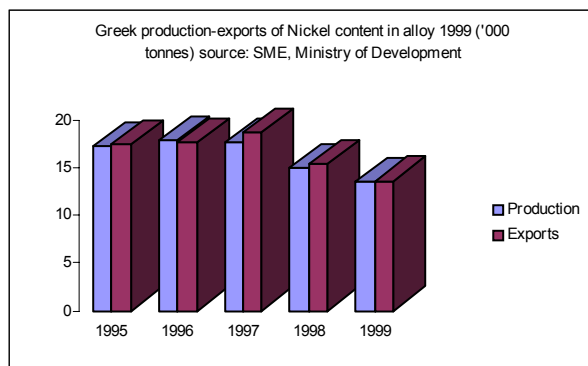
World mine production of nickel in 1999 reached 1,1 million tonnes, extracted from laterite and sulphide ores (60% lateritic ore deposits and 40% sulphides).

Two thirds of the world production comes from the ex-Soviet Union, Canada, Australia and New Caledonia.

Greek production is in the hands of **Hellenic Mining and Metallurgical Co of Larymna**, better known as **Larco**, one of the country's largest metallurgical complexes. At present, Larco is a state owned company and some well known industrial concerns (both international and domestic) have expressed their interest in taking over its management and eventually buying out the majority of its shares.

The mining operations are based at Psachna (in north central Euboea), Aghios Ioannis (Lokris area) and Kastoria and the metallurgical facility is located in Larymna. In recent years the company has been active in Albania attempting to develop the Bitincka deposit in SE Albania. Larco's production level corresponds to some 2-3% of the world total nickel output and is exported to various destinations in Western Europe.

PERSPECTIVES



Nickel prices in the beginning of 1999 were at the lowest point of the last 15 years but recovered drastically in the second half of 1999. The increase in the Ni price continued during 2000, and as a result the average price was 40% higher compared to the 1999 price. As a result, LARCO maximized its production level, which in 2000 reached 17.000 tonnes and realized good profits. The market situation remained good also in 2001 and LARCO started to implement an ambitious investment programme aiming at modernizing and optimizing the operation of the Larymna metallurgical facility (including energy conservation and environmental protection actions). The programme's budget is 2.3 million EURO and it is partly funded by the EU, in the frame of the Energy Operational Programme.

As regards the domestic nickel ore reserves, there exist extensive ophiolite complexes in Greece that have not been adequately explored. Existing geological information indicates that there is a strong possibility for these areas to contain large Ferro-Ni ore bodies.

Lead-Zinc



Lead (Pb) is a very soft bluish-white metal, that has a low melting point of (327°C). It is highly malleable, ductile and a poor conductor of electricity. It is obtained mainly from galena and recovered through a roasting and refining process. Much of the lead in use today is also obtained through recycling.

Zinc (Zn) is a bluish-gray metal. Zinc's most remarkable quality is its natural capacity to protect other metals. It is mainly produced from the mineral sphalerite.

These metals usually co-exist in nature comprising the metallic components of the base metal sulphide deposits, which show a wide distribution worldwide.

WORLD PRODUCTION

As for Pb, Australia is the largest producer, with some 23% of the world total, followed by, China, USA, Peru and Canada. World production reached in 1999 3 million tonnes of lead in concentrates. Worldwide proven reserves of lead are estimated to 64 million tonnes.

The largest producers of zinc concentrate are China, Australia, Canada, Peru and USA. World production for zinc in 1999 was 8,04 million tonnes of metal in concentrates. Total world reserves amount to about 190 million tonnes of contained zinc.

GREEK DEPOSITS

The most important Pb-Zn sulphide deposits in Greece are those of Olympias, Madem Lakkos and Mavres Petres, being located in Chalkidiki peninsula, 90 km east of Thessaloniki.

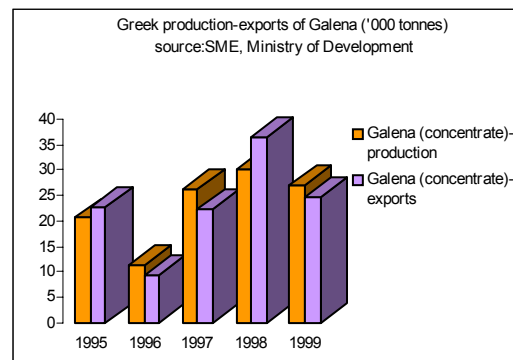
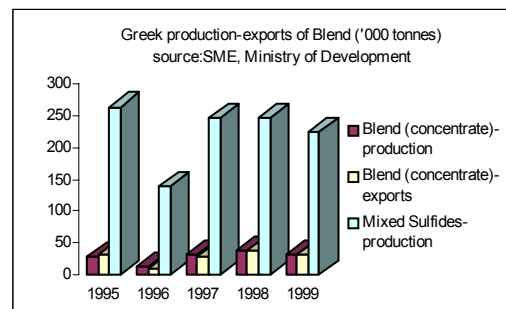
The Madem Lakkos deposit has been continuously under exploitation since the 50's. The Olympias deposit was discovered in 1969 and exploitation started in 1976. The operation of the Olympias mine was temporarily suspended in 1994, to work out a plan that would also include the recovery of gold contained in the waste stockpiles.

The Madem Lakkos massive sulphide replacement type orebody extends 600 m

along strike, 2000 m down dip and averages 20 m in thickness. The present ore reserves at Madem Lakkos and Mavres Petres are limited, since all Pb-Zn mine production during the last five years came from these deposits. In 1999, the Stratoni mill treated 224.114 tonnes of ore averaging 8,8% Zn, 9,8% Pb and 200 gr/t Ag, from the Madem Lakkos and Mavres Petres mines, to produce 26.460 tonnes lead-silver concentrate and 32.370 tonnes zinc concentrate.

As for the year 2000 unofficial information report a production from the Madem Lakkos and Mavres Petres mines, of 187.601 tonnes of ore, and 21.320 tonnes lead-silver concentrate and 31.695 tonnes zinc concentrate

The Olympias ore body is a stratabound massive sulphide deposit, with an inclined thickness of 10 m, 200-400 m along strike and over 1000 m down dip. The Olympias reserves and resources, including a pyrite stockpile and tailings, are estimated to be 16 million tonnes



averaging 7,8 gr/t Au, 114 gr/t Ag, 3,9% Pb and 5,2% Zn.

In the Polykastron-Skra area, N. Greece a mixed sulphide ore has been located. The reserves are estimated to 2.500.000 tonnes grading 3,85% Zn, 3,03% Pb, 15gr/t Ag and 0,23% Cu.

Also, in the area of Molaoi, SE Peloponnese, there exists a stratiform Zn-Ag-Pb mineralization of Kuroko style. The ore reserves are estimated to be in the order of 3.800.000 tonnes grading 8,27% Zn, 1,76% Pb and 55 gr/t Ag.

Finally the Kirki Pb-Zn deposit, near Alexandroupolis, has been intensively mined in the past. Nowadays mining is only periodic. It should be noted that the Kirki area is of high exploration priority for precious metals due to the favourable geologic and metallogenetic conditions present. In the neighbouring areas of Konos and Perama-Petrota epithermal type gold deposits have been recently located.

PERSPECTIVES

The perspectives of the mining activities are directly related to the potential operation of the metallurgical plant for gold, planned for construction in the Olympias area. Only in this case, will the exploitation of the Pb-Zn sulphide deposits be viable.

The prospecting for the location of new Pb-Zn deposits in Greece is not considered as a first priority target. However, Chalkidiki peninsula is still considered as a favourable exploration target, due to the presence of precious metals (Au,Ag) in the mineral paragenesis of the base metal sulphide mineralization. Other areas of research interest include the Drama area and Rhodope massif, where manganese and base metal sulphide deposits of replacement-type are located.

MANGANESE



Manganese is the twelfth most abundant element in the earth's crust and occurs as various minerals.

The most important commercial manganese mineral is pyrolusite (MnO_2) with 63% Mn content, followed by psilomelane ($\text{Ba,Mn Mn}_8\text{O}_{16}(\text{OH})_4$), occurring in colloidal form, with 45-60% Mn and rhodochrosite (MnCO_3) with 47% Mn content.

Based on their main uses manganese ores are classified in three broad categories: metallurgical manganese, manganese for dry-cell batteries and chemical type manganese.

WORLD PRODUCTION – CONSUMPTION

In the world market, manganese is mainly sold as ore, iron alloys, metal, chemical Mn etc. In 1999 World mine production of manganese reached 7 million tonnes of recoverable metal. Leading countries in manganese production include South Africa, China, Gabon, Australia, Ukraine, Brazil, and India. Leading producer countries, of manganese ferroalloys, are Brazil, China, France, Japan, Norway, South Africa and Ukraine.

GREEK DEPOSITS

In several areas of Drama prefecture in northern Greece (Tartana-Karpouslouk, Sikidia, Finterna, Farassino, «25th Drama km», Mavro Xylo, Kouri etc), pyrolusitic type manganese deposits (MnO_2) are hosted within the Falakron mountain of the West Rhodope massif.

The Drama manganese deposit is under exploitation since 1950 by **Eleusis Bauxite Mines Co. (ELBAUMIN)**, presently controlled by the state.

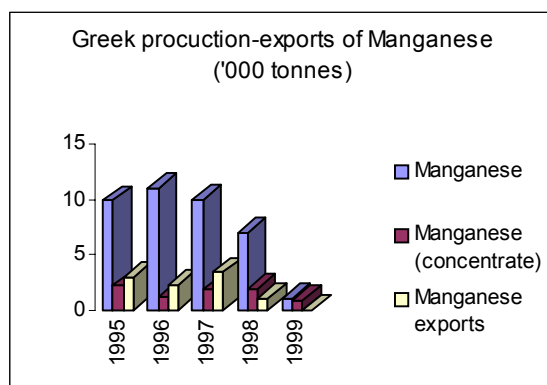
ELBAUMIN is the only producer of pyrolusitic type manganese ore in the European Union. Up to

date, 2 million tonnes of ore have been mined and 400.000 tonnes of concentrate have been produced. The annual concentrate production from the company's pilot plant located at a site near the 25th km of the Drama-Nevrokopi national road is at present around 1.000 tonnes sold at prices in the 300 USD/tonne range. The pyrolusitic manganese of the area is among the best worldwide in quality due to its superior electrochemical behavior. It exhibits high activity and high potential (560-630 mV) and therefore is an excellent material for the manufacture of dry-cell batteries. The natural pyrolusite (MnO_2) concentrate is known in the international market as SCALMA 72 and SCALMA 74, with a MnO_2 content of 72% and 74% respectively. During the year 2000 activities were directed towards the processing of intermediate products and the production of only SCALMA 74.

Also, in the NE Chalkidiki peninsula (Piavitsa, Varvara sites) manganese ores of replacement type are located. At the Piavitsa site, along 2,5 km, open pit quarrying operations took place during the '80s for the mining of manganese ore. The potential reserves are estimated to 10,5 million tonnes grading 34% in Mn. At Varvara, in the west wedge of the Stratoni-Varvara thrust-fault, IGME discovered a stratiform manganese ore deposit, whose potential reserves are estimated to 1,5 million tonnes, with an average grade of 29,35% in Mn and 1,5 gr/t of Au. The Chalkidiki manganese ores are also suitable for the manufacture of dry-cell batteries.

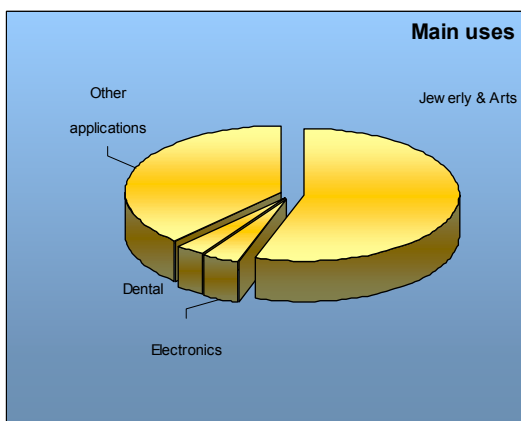
PERSPECTIVES

The outstanding quality of the Greek manganese deposits (Drama prefecture), that are suitable for special applications such as battery manufacture, the existence of reserves not currently exploited (state mine of Aghia Varvara, Chalkidiki), as well as the strong possibility of locating new reserves (Drama and Chalkidiki Prefectures) make up a favorable environment for potential investments both for exploration and for commercial exploitation.





Gold predominates over all other metals in the esteem of the human race. It has certainly been the most sought after metal, at least since the first recorded mining adventure by Jason and his Ar-



gonauts who sailed in the ship Argo to search for the Golden Fleece, the sheepskin in which the inhabitants of Colchis caught gold dust, too fine to be recovered otherwise.

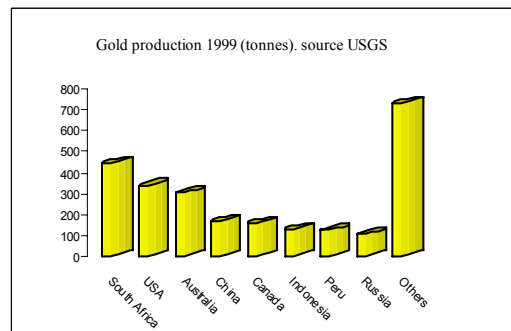
Since prehistoric times, intense mining activity has been recorded in the ancient Greek territory, especially in what is today Central - Eastern Macedonia. Gold is obtained from a variety of minerals, but most of it is found in native form.

The significant gold deposit types of Greece from the economic point of view, are: the epithermal style, the Cu-Au porphyry type, gold mineralization in fractures and shear zones in metamorphic formations and gold as a byproduct of polymetallic massive sulphides of replacement type. Placer gold deposits in Greece are of lesser economic significance.

WORLD PRODUCTION

The most important gold producing countries of the world include South Africa, USA, Australia,

China, Canada, Indonesia, Peru and Russia. South Africa, USA and Australia and together these accounted for 43,4% of the total world gold production in 1999.



GREEK DEPOSITS

Gold in interesting concentrations is located in the replacement style massive Zn-Pb-Au-Ag sulphide deposit of Olympias and in the porphyry Cu-Au deposit of Skouries in Chalkidiki prefecture.

These two deposits contain 209 tonnes of gold and 1260 tonnes of silver. Olympias underground ore reserves are estimated to be 9,1 million tonnes averaging 8,7 gr/t of gold, 138,3 gr/t of silver, 4,7% Pb and 5,9% Zn. However, additional resources are estimated at 4,6 million tonnes with 7,4 gr/t of gold, 131,1 gr/t of silver, 4,6% Pb and 7,0% Zn. In addition, the stockpile of the pyrite-arsenopyrite concentrate that has been produced over the last years at the Olympias mine is estimated to be 285.000 tonnes grading 22,9 gr/t Au and 24,5 gr/t Ag. Ag 2,4 million tonnes of tailings, averaging 3,4 gr/t of gold should be added to the existing stockpile reserves. Another important deposit is the Skouries porphyry ore deposit whose reserves are estimated to 129,5 million tonnes grading 0,89 gr/t Au and 0,56% Cu. The gold content is 115 tonnes. However, the owner company claims additional resources of 76,5 million tonnes grading 0,66 gr/t Au and 0,52% Cu. It should be noted that geologists from both the University of Athens and IGME have reported the presence of palladium at 2,5 gr/t in the chalcopyrite concentrate, thus improving the economic potential of the ore.

At Vina, Zepko, Papades and Stratoniki, which are located between the Olympias and Straton (Madem Lakkos) deposits in N.E Chalkidiki Peninsula, a new vein-type, gold-bearing sulphide mineralization has been discovered. Gold and silver concentrations up to 51,2 gr/t (lowest value) and 3500 gr/t (highest value) respectively were recorded in the outcropping mineralization.

The first epithermal gold deposit (St. Demetrios), in Greece has been discovered by IGME in the area of Konos, near Sapes of Rhodope prefecture. Gold is found on the surface in silica caps and in the argillic-sericitic zone where it is associated mainly with quartz and baryte veins. The reserves are estimated to 3.100.000 tonnes with a grade of 3.5 gr/t, being equivalent to 11 tonnes of gold. Gold occurs in the form of native gold (2-20 µm), gold tellurides and more commonly is associated with enargite and tetrahedrite (gold-fieldite). A new exploration campaign carried out by the company **Thrace Minerals S.A.**, that has acquired the mining rights, has led to the location of a new deposit in the Viper area, adjacent to the St. Demetrios deposit, at a depth of 150 – 200 m comprising 900.000 tonnes of mineral grading 21gr/t. The deposits contain 19 tonnes gold in total.

Additionally, in Perama area (10 km south of Konos) a new epithermal gold deposit was located by **Thracian Gold Mining S.A.** Gold is associated either with oxides, together with quartz, argillic minerals and hematite as submicroscopic grains (usually 3 – 6µm) or included in pyrite and gold-silver tellurides. The reserves, according to the company's estimations, are 11 million tonnes grading 3,7 gr/t of gold, being equivalent to 41 tonnes.

Another epithermal gold deposit has been discovered in western Milos island, at the Prophitis Ilias area. The gold mineralization extends from surface down to a depth of 300m, whilst further down sulphide mineralization is developed. **Midas S.A.** holds the mining rights and has estimated the reserves at 5 million tonnes grading 4,4 gr/t of gold, equivalent to 22 tonnes of gold.

Exploration works carried out by IGME and various private mining companies, located new occurrences of epithermal type gold deposits with favourable perspectives in the islands of Lesvos, Limnos and Samos as well as the Pefka area N.E of Alexandroupolis .

PERSPECTIVES

Mineral exploration for gold is quite 'popular' nowadays in Greece and both domestic and for-

eign mining companies have expressed their interest in this particular sector.

An investment in the Olympias and Skouries mines of \$ 300 million, could secure an annual gold production of 6,5 tonnes and 6 tonnes respectively. In that case, Greece will be the first gold-producing country within the European Union.

The possibilities of discovering new gold deposits in Greece are favourable. Based on the existing geologic and metallogenetic data, the location of new epithermal style gold deposits in Evros and Rhodope prefectures, as well as in the Aegean island complex is predicted in the near future. Also, exploration projects are expected to begin for the location of porphyry style Au-Cu deposits within the belt extended from Greece's northern border with FYROM to the southern Chalkidiki peninsula.

COPPER



COPPER belongs to the group of base metals. Copper minerals are classified as follows: natural, sulphides, oxides and mixed.

WORLD PRODUCTION

Copper is mined in about 50 countries, of which the top two, (i.e. Chile and the USA) account for about 46% and the top ten for 80% of the world total production. World mine production in 1999 was 12,6 million tonnes of recoverable copper. Copper is among the most recycled metals via scrap processing.

GREEK DEPOSITS

The more significant, from the techno-economic point of view, types of copper deposit in Greece are copper porphyry deposits and volcanosedimentary massive sulphides related to submarine mafic effusive rocks (Cyprus type).

The most important copper deposit of Greece is Skouries, located 20 km SW of the Olympias mine in the eastern Chalkidiki peninsula. The Skouries ore deposit is part of a wider metallogenetic zone within the Serbomacedonian massif, trending NW - SE (20 km wide and of 150 Km long). In the NW part of the zone Kroussia Mts. are located, SE of the FYROM-Greek border and N-NE of the Kilikis town. These mountains include porphyry intrusions with small copper deposits, such as those of Vathi, Pontokerasia, and Gerakario, whereas porphyry of greater mining interest are those of Skouries, Fissoka, Tsikara and Dilofo, which are located in the southeastern part of this zone.

Skouries is a gold-bearing porphyry copper ore deposit and it mainly consists of chalcopryite and bornite. Gold occurs as native metal throughout the deposit, principally as

inclusions in the sulphide zone (chalcopryite) and often as free grains in the oxidation zone. Palladium appears to have an affinity to copper minerals.

Following an exploration campaign in the region, it appears that the ore reserves amount to 129,5 million tonnes averaging 0,56% Cu and 0,89 gr/t Au, thus containing 115 tonnes of gold. These reserves are sufficient for a 20-year mine life. The geological reserves are 206 million tonnes of ore averaging 0,54% Cu and 0,80 gr/t Au, at a 0,40 gr/t Au cut-off grade. The average palladium content in the chalcopryite concentrate reaches 2,5 ppm.

The porphyry style mineralization at Vathi area in Kroussia mts, north of Kilikis, seems to be the most important exploration target for gold-bearing porphyry copper systems in the Kroussia region. Drill core samples (0- 163m) at Vathi area averaged 0,41% Cu and 0,84 ppm Au.

Another significant copper ore deposit type in Greece is the Cyprus type. The most important Cu deposits of this type are the Ermioni deposits that had been exploited for a long period and up to the late '70s, the mineral occurrences in Orthrys mts (Limogardi area), and those of Perivoli area in Pindos Mnt.

PERSPECTIVES

The metallogenetic district of Southern Chalkidiki is considered as a first priority exploration target for the location of Cu-Au porphyry style deposits. The features of the Skouries ore deposit may undoubtedly serve as an "exploration tool" to locate mineral deposits of similar type in favourable geologic environments. The metallogenetic district of the Kroussia Mountains is of minor interest, with the exception of the Vathi area of Kilikis prefecture.

On the other hand, Mt Orthrys (Limogardi area in particular) is a target for locating Cyprus type sulphide mineralization.

BENTONITE



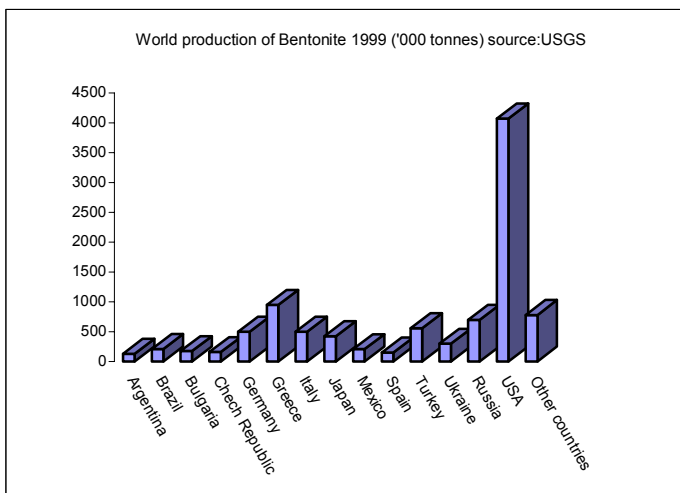
BENTONITE is a clay consisting essentially of smectite minerals (montmorillonite group). Bentonite is commonly divided into three types: the high swelling or sodium (Na-bentonite), the low swelling or calcium (Ca-bentonite), and the moderate swelling or intermediate.

PROPERTIES - USES

In water, Na bentonite disperses well and swells to increase viscosity, gel strength, suspending power and thixotropy.

Bentonite is mainly used as a mud constituent for oil - and water - drilling, as a bonding material in the pelletizing of iron ore in steel industry and as a bonding material for sand grains in iron and steel foundries. It is also used as a sealant in diaphragm walls, as an additive in foundation, in the construction of waste disposal landfills, and as pet litter material.

WORLD PRODUCTION



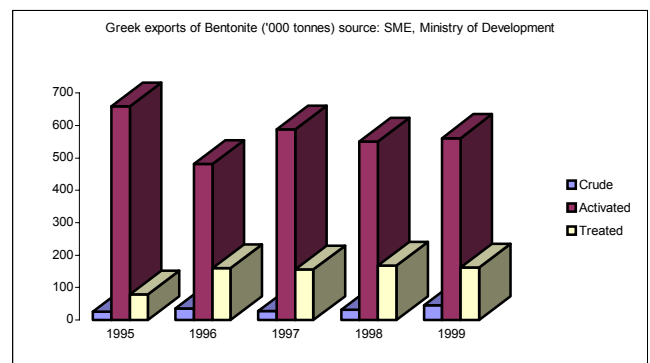
World annual production of bentonite is estimated to be

around 10 million tonnes. The USA, is the largest producer (40% of the world total production), followed by Greece, Russia (ex U.S.S.R.), Turkey, Germany, Italy, and other countries.

GREEK BENTONITE

Greece's production comes almost entirely from the island of Milos. Exploration works have been also carried out in the neighbouring island of Kimolos.

Extensive bentonite deposits of Lower Pleistocene age are present in the eastern part of Milos and include the deposits of Aspro Horio, Tsantili, Zoulias, Ankeria, Koufi, Ano Komia, Kato Komia, Rema, Garyfalakena, Mavrogianis, Agrilides.



The Miloan bentonite is predominantly Ca, Mg rich (>80%). In order to acquire the desired physical and chemical properties, the Miloan bentonites are «activated» by being treated with soda ash in a special plant situated in the north east part of the island (Voudia area).

Potential reserves on Milos amount to tens of millions of tonnes. In 1999, production was 1.049.657 tonnes of crude bentonite, 592.291 tonnes of activated bentonite, and 186.713 tonnes of processed bentonite. Whereas exports were 561.500 tonnes of activated bentonite (value: 29.640,5 EURO), 164.682 tonnes of processed bentonite (value: 7.336,8 EURO), and 45.166 tonnes of crude bentonite (value: 710.198,1 EURO).

During 2000 bentonite production was estimated at 900.000 tonnes.

There are two major bentonite producers: **Silver and Baryte Ores Mining Co. S.A.** and **Mykobor Mining Co. S.A.** (taken over by Silver and Baryte Ores Mining Co., a couple of years ago). The two companies together produce more than 80% of the total bentonite output. In addition there is a number of smaller operations on the island, such as **G. Roussos Bros, I. Mavrogiannis, P. Xidous, N. Bouras, I. Tsironis, and Sud Chemie Co.**

Over 95% of the total sales of the sector are directed towards the international markets. The European market absorbs the bulk of the bentonite sales (80%), N. America holds the second place, while smaller quantities are delivered to S. America and Eastern Mediterranean.

Exported bentonite is mainly used in iron ore pelletizing (36%), in foundries (33%), in civil engineering and environmental applications (21%), in drilling (6%) and as pet litter material (4%).

PERSPECTIVES

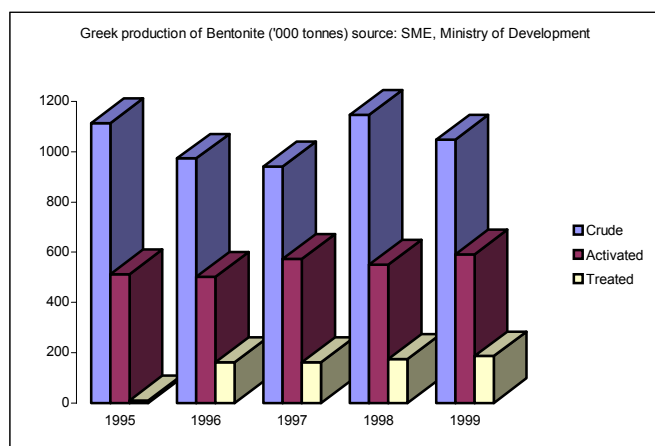
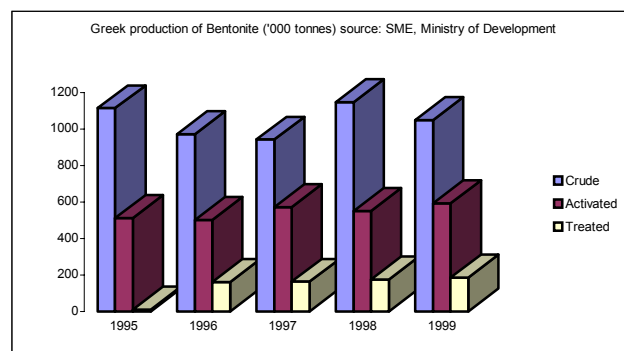
During the last few years the global demand in volume terms has grown at a rate of about 3%, per year.

2000 was a dynamic year concerning bentonite consumption in foundries and its use in iron ore pelletizing, due to the high demand for automobiles in the USA and Europe, the intense mobility observed worldwide in the steel industry; being expressed via mergers, buy-outs and take-overs, as well as due to the economy upturn in Asia and elsewhere.

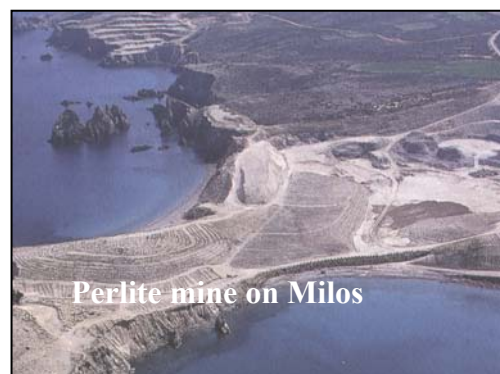
Bentonite consumption for civil engineering and environmental applications shows a significant increase over the last few years, in view of the growing social awareness for environmental protection and rehabilitation. Forecasts for 2001 indicate a continuing increase in the bentonite market, especially in the construction sector, due to the increases anticipated in the relevant activities in connection with the big public works being currently in progress in Greece.

During 2000, Silver and Baryte Ores Mining Co. S.A. have proceeded substantially to their vertical integration aiming at the markets of final bentonite products, as well as to products of high added value.

It is foreseen that in the years to come the mineral exploration activities in Greece will be intensified in order to secure additional high quality bentonite reserves. This is valid not only for Milos, but also for other areas of Greece, such as Kimolos island, Lesbos island and Thrace, where the possibilities to discover new deposits, are favorable. This assessment is based on results obtained by I.G.M.E.



PERLITE



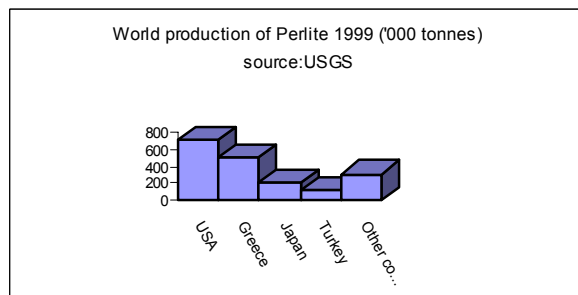
Perlite is distinguished from other natural volcanic glasses by its silicic or rhyolitic composition, due to the presence of 2 to 5 %wt total chemical water held within the glass structure and often by the presence of pearly luster and onion-skin-like perlite fractures.

When heated rapidly to over 870 °C perlite can expand to as much as 20 times its original volume, changing from a rock to a lightweight frothy material.

The expansion properties of perlite make it useful for a wide range of applications, including building materials, horticulture, filter aids etc.

WORLD PRODUCTION – CONSUMPTION

The world processed perlite market was estimated to be 1,9 million tonnes in 1999 and it was growing at an annual average of 13% by volume over the last five years. Major producers continue to be USA, Greece, Japan, and Turkey. Also, China has now an important perlite output. The principal end uses are: construction products 71%, horticultural aggregates 10%, filter aids 9%, fillers 7% and other applications 3%.



GREEK PERLITE

Greece is the main exporter and the second largest perlite producer in the world.

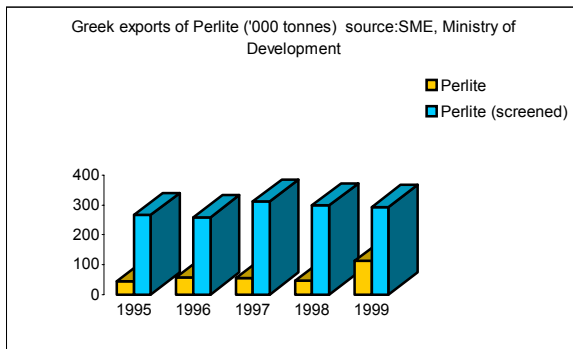
In 1999 production output was 777.898 tonnes of crude perlite and 435.441 tonnes of screened perlite. Exports amounted to 293.251 tonnes of screened material with a value of 10.271.460 EURO and 112.826 tonnes of crude material with a value of 3.228.173,1EURO.

Commercially, the most important perlite deposits occur on the island of Milos (Provatas, Trachylas and Tsigrado areas), in the Aegean Sea. Furthermore, perlite occurrences are found on the islands of Kimolos (Xaplovouni), Kos (Zini, Thymiano, Lathra, Aghios Mamas), Lesbos (Tsichada area, Petsofas), Yali (Eastern part of the island, where mining operations will start in the near future) as well as in the mainland. Exploitation in Milos is carried out by open-pit quarries. Total reserves of perlite are estimated to be very large.

The most important uses of expanded perlite in Greece are: (i) as a component in the production of building materials (plaster, mortars etc.), (ii) in horticultural applications as a growing medium in gardening and as soil conditioner in lawns, and (iii) in cryogenic applications.

At present the by far biggest company active in the field is **Silver and Baryte Ores Mining Co**, since they have acquired (1998) **Otavi Mines Hellas S.A.** Today **Silver and Baryte Co**, operates perlite mines at Thachylas, Provatas and Tsigrado areas on Milos island, producing around 500.000 tpa, most of which (96%) is exported. A smaller operator is the company **N. Bouras Co.**, producing only 30.000 tpa of crude perlite. A relatively new company **Aegean Perlite S.A.**, has just recently made its first sales of perlite from Yali island.

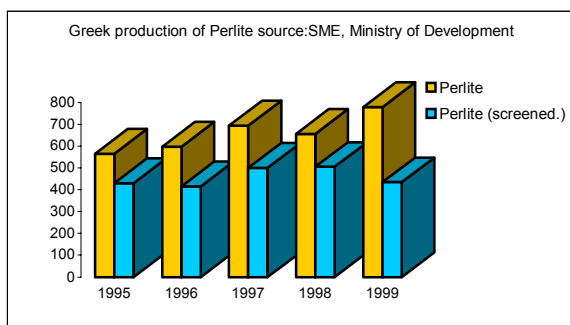
Silver and Baryte Ores Mining Co, carries out the perlite expansion at the Ritsona plant (**Perlomin SA**) which supplies the domestic market and serves as an applied R & D center where the performance of various ore types and grades are tested and expanded perlite products are developed. Besides, **Perlomin**, the following companies,



operate perlite expansion plants: **Perlite Hellas SA**, **Monotika Macedonia SA**, and **Monostyr SA**, with a total production of about 130.000 m³/y.

PERSPECTIVES

World perlite consumption is estimated to increase at a 2% average annual rate in the coming years. The use of perlite in building and construction exhibited an annual growth of approximately 7% over recent years as a result of increased demand for insulating boards and ceiling tiles. Also the use of perlite in agriculture recently showed an increase of 5%. Sales of Greek perlite showed an upward trend during the last few



years. It is foreseen that in 2001 sales of perlite for construction use (especially in the USA) and for use as a washing stone for jeans will increase.

To meet the increased demand, Silver Baryte Ores Mining Co is constructing a new plant in Milos with a capacity of 80.000 tpa.

In the meantime, exploration projects are in progress for the development of the perlite deposits of the country, whereas specialized industrial research projects aim at the formulation and optimisation of new building materials based on perlite products.

MAGNESITE

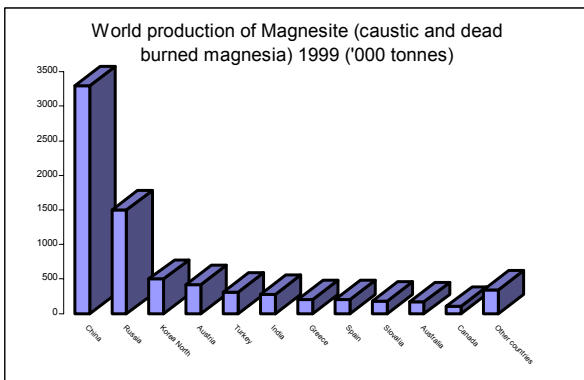


Magnesite (MgCO_3), magnesium end-member of an isomorphous series of Mg, Ca, Fe, Mn etc. carbonates, is a high MgO (magnesia) content mineral.

From crude magnesite, two commercial product lines of magnesia are derived. Caustic magnesia, produced by calcination at temperatures generally between 900-1100 °C and dead-burned magnesia, which is sintered at higher temperatures (1700-1900 °C).

WORLD PRODUCTION - USES

World production of natural magnesite was of the order of 3 million tonnes in 1999. World production of caustic calcined magnesia and dead-burned magnesia was 8 million tonnes. The principal producing countries in descending order are China, Russia, North Korea, Austria, Brazil, Turkey, India and Greece. The most important end use of dead-burned magnesia



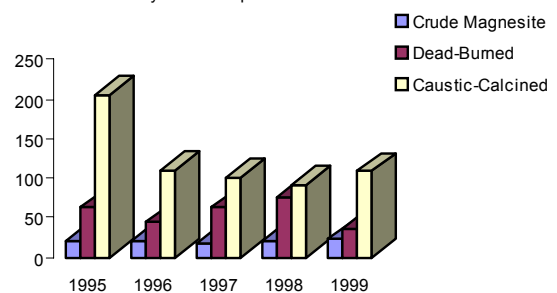
is refractory products (bricks and masses) for steel mills, cement and glass plants etc. Other applications include welding fluxes, extraction of magnesium metal and various small volume, specialised applications. Caustic magnesia has a variety of end-uses ranging from electrofused magnesia and construction applications to agricultural, chemical, pharmaceutical and environmental uses.

GREEK DEPOSITS

The largest magnesite deposits mainly occur within a discontinuous ophiolite belt in the western part of the Chalkidiki peninsula (Gerakini, Ormilina, Kastri) and in Euboea island (Gerorema, Paraskevorema, Kakavos, Troupi).

The magnesite reserves are estimated at tens of million tonnes for Chalkidiki and 8 million tonnes for Euboea. Greece's magnesite industry is internationally recognized for the first class quality of end-products. Total Greek production in 1999 was 495.194 tonnes of crude magnesite, 39.965 tonnes of dead burned magnesia and 117.817 tonnes of caustic magnesia. Exports to various destinations abroad were on the order of 22.000 tonnes of crude magnesite with a value of 930.300,8 EURO, 35.587 tonnes of caustic magnesia with a value

Greek exports of **Magnesite** ('000 tonnes) source:SME, Ministry of Development



of 6.162.876 EURO and 108.991 tonnes of dead - burned magnesia, with a value of 13.206.162,9 EURO.

During the year 2000 production of dead-burned magnesia was estimated at 32.000 tonnes and of caustic magnesia at 115.000 tonnes.

Today, one magnesite mining company is active in Greece:

Grecian Magnesite S.A., which ranks among the top magnesia producers and exporters in the western world, is the biggest exporter in the E.U. The company's major deposits, along with its works, are located in Gerakini area of the Chalkidiki peninsula. The total production capacity for calcined products is close to 200.000 tpa,

whereas 97% of the output is exported. The company produces and commercialises raw magnesite, caustic magnesia, dead - burned magnesia and basic monolithic refractories and holds an ISO 9001 quality assurance certificate for all its operations. Furthermore, it has recently applied for listing at the Athens Stock Exchange.

Viomagn S.A., which succeeded Fimisco when the latter was privatized (1995), was active until 1999 (the year during which it stopped its operation) operating mines and works on the Euboea island. The company mainly focussed on refractory raw materials (dead-burned magnesia) and products (bricks and masses).

PERSPECTIVES

The business environment in the magnesite sector is and will probably remain competitive.

The current position of the Greek magnesite industry allows for a positive outlook. Specifically, during 2000 Greek Magnesia export activity was intensive in all market uses. For 2001 it is foreseen that the above tendency will continue and the market perspectives remain positive.

The strategy of the Greek magnesite industry has focussed on enhanced product quality and shift of the product mix towards higher added-value grades. Furthermore, special emphasis has been placed on the development of new markets and applications as well as on R & D in view of developing improved and more competitive products.

For the coming years, large investment programmes are planned for the improvement of the existing installations and for lowering operating costs. In the frame of its investment policy Grecian Magnesite S.A., will proceed to the construction of two additional production lines and to new investment abroad. The plans also include sizeable business development, geographical diversification of the production base and strategic alliances at both the production and the distribution level.

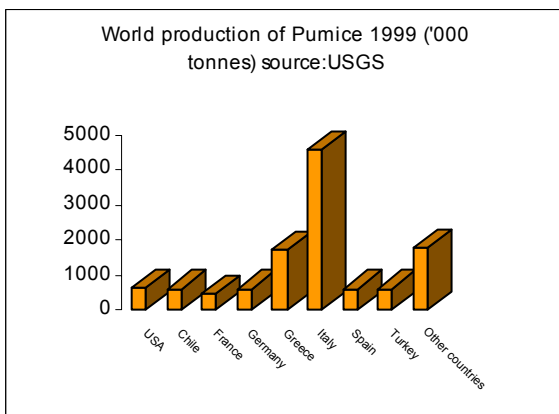
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PUMICE



Pumice quarry at Yali isl.

Pumice and volcanic cinder are **pyroclastic** rocks characterized by a cellular structure. Pumice has high porosity, low density and provides good thermal and sound insulation. Being a natural and environment-friendly material it is used in many areas of construction and industry. More specifically, in



construction it is used for the production of lightweight blocks, concrete, prefabricated elements, insulating coatings and for floor insulation and filling purposes. Its industrial applications include stone-wash jeans, hand soaps, cosmetic skin removals etc.

GREEK PUMICE

Greece is one of the worlds' largest producers and exporters of pumice. Several islands in the Cyclades and Dodecanese, that are part of the recent volcanic arc of the Aegean sea, host pumice occurrences and deposits. Today mining activity is restricted only to the Yali island (between Kos and Nisyros Islands) in Dodecanese.

In the southwest part of Yali, three distinguished pumice-bearing horizons are developed. They consist of pyroclastic tuffs and ash of high purity with an average thickness of 160 m and estimated geological reserves of the order of 120 million m³.

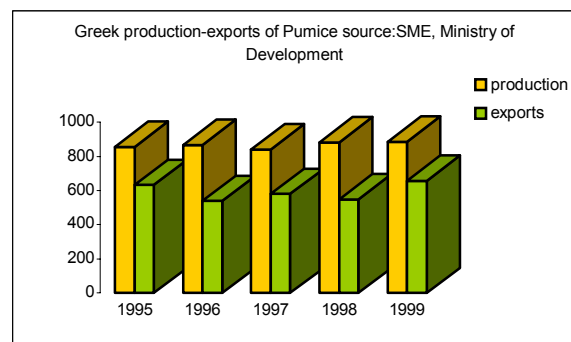
Lava Mining and Quarrying Co SA, a subsidiary of Heracles General Cement Co Ltd, is the only pumice producer in Greece operating a quarry on Yali island. Quarrying of this deposit is performed without the use of explosives. Production in 1999 was approximately

886.000 tonnes out of which 24% is consumed by the domestic market and the remaining 76% is exported throughout the world (mainly USA and EU). The mined material is crushed and sized in situ. Four different main pumice grades are produced according to their granulometry: special Besser (0-5mm), Besser (0-8mm), Rice (5-8mm) and German (8-16mm). During the year 2000 pumice production was estimated at 854.000 tonnes.

PERSPECTIVES

The market of pumice is closely linked to the construction activity. Despite strong international competition, Greek pumice holds a leading position in the world market. Furthermore, attempts are made to develop new markets, in the field of geotechnical and agricultural applications.

An increase in sales of pumice for construction purposes, especially in the USA is expected for year



2001. An increase is also expected in the use of pumice in the production of stone-washed jeans.

GYPSUM-ANHYDRITE



Gypsum, the dehydrated form of calcium sulfate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and anhydrite, the anhydrous form (CaSO_4), are frequently found in close association, and it is seldom that a calcium sulfate deposit will consist exclusively of one mineral or the other.

PROPERTIES - USES

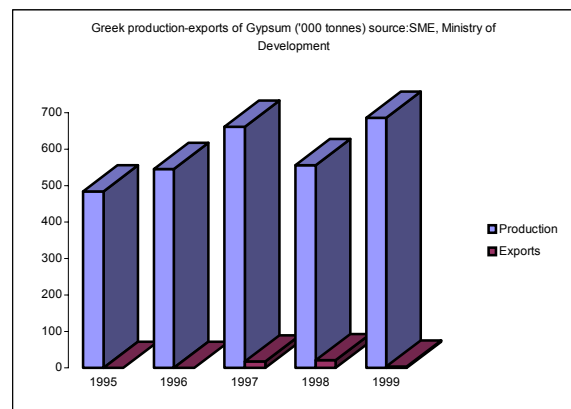
When calcined, gypsum loses 75% of its water of crystallisation and forms the hemihydrate $\text{CaSO}_4 \cdot 1/2 \text{H}_2\text{O}$, also called 'plaster of Paris'. When water is added, the product can be spread, cast or moulded prior to setting to a rock hard and fire-resistant material.

WORD PRODUCTION-USES

Gypsum deposits are extremely widespread and more than 90 countries produce gypsum. World production in 1999 is estimated to 107 million tonnes of crude ore. The main producing countries in descending order are USA, Iran, Canada, China, Spain, Mexico, Japan and Thailand. Industrialised nations use gypsum mainly for wallboard products. In developing countries, however, most gypsum is used in cement plants.

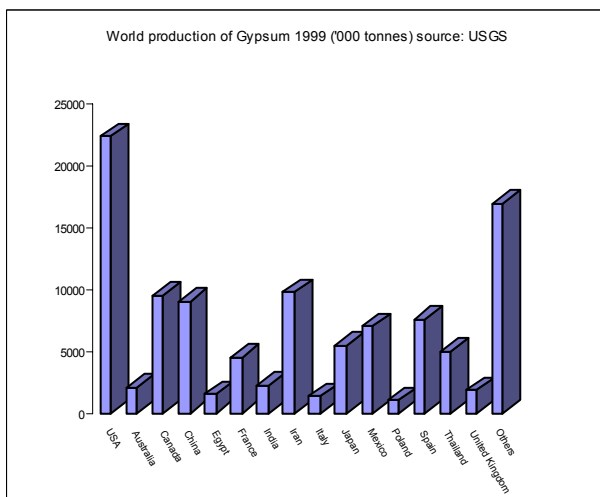
GREEK GYPSUM

Greece is an important gypsum producer with an annual output in the range of 700.000 - 850.000 tonnes of crude ore. During 2000 gypsum production was estimated at 720.000 tonnes. Gypsum exports in 2000



reached 43.000 tonnes.

In western Greece and in Crete several large gypsum-anhydrite deposits have been located, with total reserves of the order of several billion tonnes.



In Aetolia / Akarnania County the Katouna deposit, grading 88-93% in pure gypsum with some anhydrite residues is located and its reserves exceed 100 million tonnes. The deposit is mined by **Knauf Gypsopoia SAIC**, subsidiary of the German Knauf Co, with an annual production of gypsum in the range of 150.000 tonnes. The company has established a modern facility at Stanos, Amphiloikia area, for producing wallboard, plasters, plaster of Paris, mortar and a variety of gypsum types.

In addition, at both the northern and southern sides of Skopos Mt, Zakynthos island, several gypsum deposits have been located. They contain high quality white gypsum, with an average grade of 90-95% and proven reserves of around 8.000.000 tonnes. They are

currently being exploited by **Viogyps Karvelis Co**, producing 20.000 tpa.

Also, in Igoumenitsa area (Thesprotia Prefecture), the Vryssela gypsum deposit is located but remains unexploited up to now, although a relevant study by IGME has proven it to be of satisfactory quality and quantity features. Geological reserves are estimated at 200 million tonnes.

In Crete, the most important gypsum deposit is the Altsi, located in eastern Crete and being under exploitation nowadays. It consists of anhydrite, which is the main mineral of the deposit, and secondary gypsum. The reserves are estimated to exceed 50 million tonnes.

In Crete three companies are active in the production of anhydrite-gypsum with total output on the order of 700.000 tonnes, covering the needs of the cement industry.

Lava Mining and Quarrying Co SA, a member of the Heracles Cement group, produces around 250.000 tpa of anhydrite and gypsum.

Interbeton Co., affiliate of *Titan Cement Co S.A.*, produces 275.000 tpa, and **Zervakis SA**, produces 185.000 tpa, of mainly gypsum and some anhydrite.

Also, small quantities of gypsum are quarried from the Ormos Stomiou deposit in western Crete. The material is used for building and artistic purposes.

Furthermore, it must be mentioned that in southern Crete some alabaster deposits are located. All their small production is consumed in the local traditional handicraft market, i.e. alabaster artifacts.

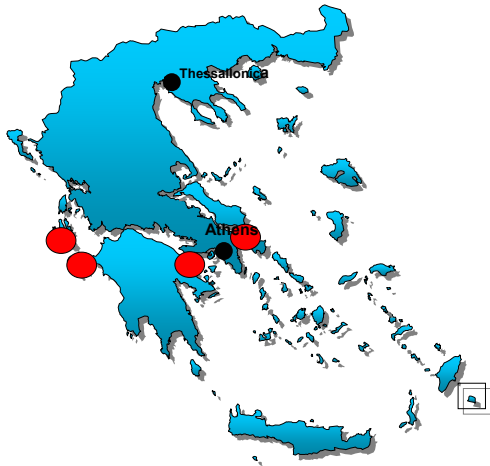
PERSPECTIVES

Greece hosts large and high quality gypsum and anhydrite deposits, in locations accessible for quarrying. Besides its extensive use in the cement industry, gypsum may be also used in the building sector (manufacture of wallboard) as well as for the production of innovative high quality materials in combination with other industrial minerals such as perlite, vermiculite or zeolite that are abundant in the country.

Therefore, gypsum may be considered as an investment target of low risk. A very interesting deposit that can support the operation of an integrated gypsum plant is the Vryssela, at Thesprotia prefecture. It is located near the Igoumenitsa port and its geographical position is favourable for supplying the emerging markets of the Balkan countries.

Another source of gypsum is exhaust gas, from which artificial gypsum can be produced via desulphurization. This artificial product is believed to be a substitute for naturally occurring gypsum in the future.

WHITE CARBONATES



The White carbonates include calcium carbonate, dolomite and huntite that are found in abundance in Greece. These minerals are extensively used for filler and extender applications. It is worth mentioning that nowadays, in Europe, the most popular minerals for fillers and extenders are ground calcium carbonate (GCC), kaolin, talc and precipitated calcium carbonate (PCC).

Natural Calcium Carbonate

Calcium carbonate (CaCO_3) is derived from a variety of sources, mainly limestone, chalk or marble. At present, CaCO_3 is the most cost effective filler material.

In Greece, the raw materials used for carbonate filler production are: pure white friable microcrystalline limestone, dolomitic and calcitic marbles.

The Greek carbonate filler industry consists mainly of 6 companies, producing fine-grained carbonate fillers. Among them, the most important are the following three:

I.Kalafatis - Ionian Kalk SA. situated in Minies, (Argostoli area on Kephallonia island).

The raw material is very pure microcrystalline limestone, containing more than 99,6% CaCO_3 , with SiO_2 : 0,02%, Fe_2O_3 : 0,01%, Al_2O_3 :0,07%. The company produces around 130.000 tpa of finely ground calcium carbonate products.

About 65% of the output is exported, the remainder being consumed by the domestic market.

Petrochem K. Zafranias S.A., with offices in Athens, and a plant at Corinth. Their mines are located on Zakynthos island as well as in Corinth and Kavala, producing CaCO_3 raw materials. Microcrystalline white

Huntite mine on Lefkara area, Kozani Prefecture



limestone from Zakynthos, calcitic and dolomitic marble chips from Corinth, Kavala and Thassos, as well as imported talc constitute the raw materials used. The company produces around 45.000 tpa of finely ground calcium carbonate and dolomite products.

Dionyssos Pentelikon Commercial S.A. & Industrial Marble Co produces around 40.000 tpa of ground calcium carbonate (GCC) products in their milling unit at Dionyssos, near Athens. The main raw material is derived from the wastes of Dionyssos quarries and from Zakynthos island. The calcitic marble of Dionyssos consists of 97% calcite, 0,5% silicates, 0,5% sericite and 0,5% chlorite. The second raw material is a microcrystalline, very soft limestone from the company's deposit in Zakynthos.

Dolomite

Dolomite is a sedimentary rock composed mostly of the mineral dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$).

In Greece, dolomite carbonate rocks are very



common. However, the Greek production of dolomite is relatively small. Two companies

are currently active in quarrying and processing of dolomite. **I. Kanapitsas & Co**, in Achladi area, Phthiotis prefecture for sand blasting, glassmaking, for filler in the paint

industry etc. and, **Farmakis – Houhounis Co.**, who exploit the dolomite deposit of Stefani area, Boetia prefecture. Their dolomite has been primarily used in the paper industry, while its potential to be used as a sand blasting material in shipyards is currently being investigated.

In 1999 the dolomite production was 30.000 tonnes.

Until recently, another quarry of friable dolomite was active in Kozani area. Also considerable friable dolomite deposits, which at present remain unexploited, have been located by IGME in Lihada area (Southern Euboea), in Thesprotiko and in other areas.

Huntite

Magnesium or hydrous magnesium carbonates occur as thick horizons in the Neogene basin of the Kozani – Aiani – Servia area in western Macedonia. The main minerals of the ore are huntite $\text{CaMg}_3(\text{CO}_3)_4$, hydromagnesite $\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 4\text{H}_2\text{O}$ and in smaller amounts dolomite, aragonite, calcite, clay minerals, silica (opal) and feldspars. The main application of huntite/hydromagnesite is as a flame retardant filler in plastics.

Two companies, namely **White Minerals S.A.** and **Microfine Hellas S.A. Co.** exploit two huntite quarries located in Lefkara area, Kozani prefecture. **White Minerals S.A.** produces a huntite/hydromagnesite mixture, with a 60/40 ratio. According to the company the reserves are estimated to be of the order of 300.000 tonnes. The product is used in polymers as active ultrafine filler (90%-2 μ) with high whiteness (96%), exhibiting good flame retardant properties. It is also used as an extender substituting TiO_2 in paint manufacturing and in other uses as reinforcement filler due to the nature of its flakes, having aspect ratios up to 1:40. **Microfine Hellas S.A.**, a subsidiary of the U.K. based Microfine Minerals Ltd, produces huntite and their processing plant is located at Giannitsa Province, N-W of Thessaloniki. The company's final product is used in the same applications as described above.

In 1999 the total huntite production was 17.750 tonnes. The huntite exports in 1999 reached 12.000 tonnes, with a 1.517.241,4 EURO value.

PERSPECTIVES

Of all the fillers, ground calcium carbonate (GCC) is the one which has exhibited the

strongest growth, with an average of 7% per annum over the last two decades.

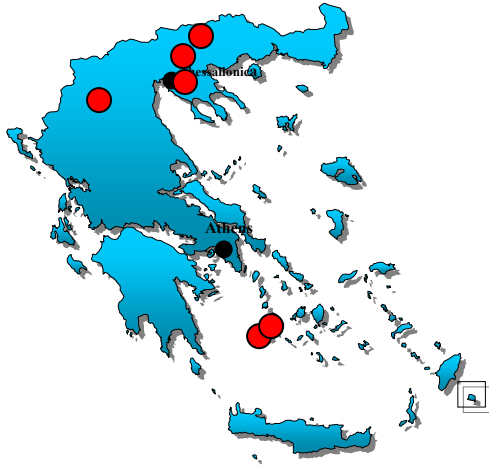
The forecast for the coming years is that GCC market will grow at an average of 2 to 3% per year.

In Greece, there is a substantial interest to invest in the GCC sector, due to the existence of vast amounts of high quality carbonates.

As regards huntite / hydromagnesite, the market is, for the time being, relatively small but the price levels are quite high supporting the profitability of the two Greek operations.

OTHER MINERALS

FELDSPAR-KAOLIN-POZZOLANIC EARTH-SILICA



FELDSPAR

Feldspar is the earth's most abundant mineral group. Feldspars are aluminum silicate minerals and are widely used mainly in the glass and ceramic industries. They are also used as a functional filler and extender in the paint, plastic and rubber industry.

The main producing countries of feldspar are: Italy, Turkey, USA, Thailand, France, Germany, Spain and the Republic of Korea.

Glass containers are a major end use of feldspar, including flint (clear), green, and amber glass.

Sodium feldspars are produced in Greece by **MEVIOR S.A. Co**, who operates a processing plant in Assiros, Thessaloniki prefecture. The feldspars come from pegmatite vein deposits in the prefectures of Thessaloniki and Kilkis.

Two qualities of feldspars are produced: Quality A (0-6mm) assaying Na_2O min 10%, Fe_2O_3 max 0,1% and K_2O about 1% and Quality B assaying Na_2O min 8%, Fe_2O_3 max 0,3% and as less K_2O as possible. Quality A is used for the production of sanitary utensils and high quality tiles without glazing, whilst Quality B is used for the production of coloured tiles with glazing.

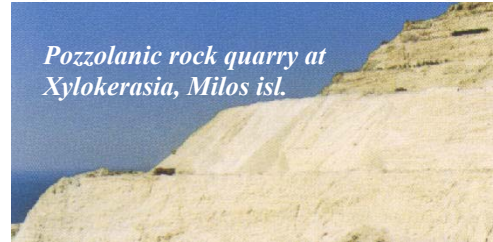
The production level is of the order of 70.500 tpa. 65% of which is exported to Italy while the remaining covers the local consumption, and mainly the needs of **Filkeram Johnson Tiles Industry**.

KAOLIN

The term Kaolin, is used, in a commercial sense, for near – white clay deposits which are dominantly comprised of the mineral kaolinite.

Leading countries for kaolin production include USA, Colombia, Uzbekistan, Czech Republic, and the Republic of Korea. Kaolin is used as a pigment, filler, coater, ceramic raw material, pharmaceutical, e.t.c.

The production of kaolin in Greece is coming from the island of Milos and from the Lefkoghia area, Drama County, N. Greece. Kaolinite occurrences have been also located in the Stypsi, Messotopos, and Agra areas of Lesbos island but no mining takes place there at



Pozzolanic rock quarry at Xylokerasia, Milos isl.

present. The total annual production of Greek kaolin is currently approx. 56.000 tonnes.

The kaolin deposits of Milos (areas of Chalakas-Ralaki and Lagada) contain as main minerals: kaolinite and fine-grained halloysite associated with quartz, cristobalite, alunite, baryte, feldspars, halite and Fe-oxides. Two companies are involved in the kaolin mining on Milos. “**Silver and Baryte Ores Mining Co**”, holding the 75% of the total output of the island, and “**ELME S.A**”, a subsidiary of the Titan Cement Company. The largest part of the production is consumed in its crude form by the domestic cement industry, whereas a small part is used in the manufacture of white cement, and as filler in the paper, plastics and rubber industries.

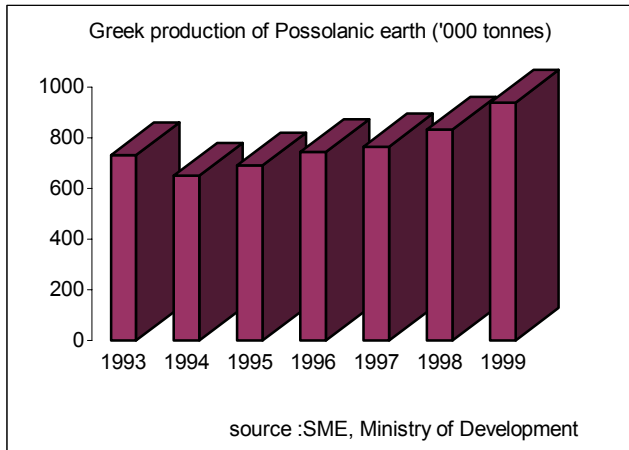
As for the Lefkoghia kaolin deposit, the dominant clay minerals are kaolinite, illite and mixed layers of illite/smectite. The non - clay minerals include quartz and feldspars. In general, the kaolin content is low. There are two active quarries in the area, operated by the “**Lefkoghia S.A**” company, subsidiary of **Filkeram Johnson S.A**. The quarried material, after classification, is mixed with ball clay, and is consumed by the mother company for production of ceramic tiles.

POZZOLANIC EARTHS

Pozzolanic earths are natural or artificial materials of silicic or argillo-silicic composition. In powder form, pozzolanic earths react chemically with $\text{Ca}(\text{OH})_2$ to form a stable component of **hydraulic character**.

Pozzolanes, due to their properties, are used as additives in the pozzolanic cement (up to 20%) and in concrete, to improve quality (improvement of cement setting conditions) and to reduce the cost of the product.

The center of pozzolana quarrying works is the Xylokerasia area, on the S-W part of the Milos island. The Milos deposit consists of white to dark grey acidic tuffs, generally with an abundance of fine-grained glass-pumice matrix. The reserves are estimated at 200 million tonnes.



Lava Mining and Quarrying Co, a subsidiary of **Heracles General Cement Co** and **ELMME S.A.** a subsidiary of **Titan Cement Co** are the two mining companies active in Xylokerasia area of Milos. Bulldozers perform the quarrying aided by limited use of explosives. The mined material is conveyed to the crushing plant for preparing the final product. Both the above companies produce about 900.000 tonnes of Milos pozzolanic earth..

Volcanic tuffs with pozzolanic properties have also been located in other parts of Greece, such as the nearby island of Kimolos and in Pella area (central Macedonia), where about 40.000 tpa of pozzolanic earth is produced by **Kyvos SA** being totally consumed by the Titan Cement Co.

QUARTZ

Silica, being formed by the chemical reaction between silicon and oxygen, may occur either as a crystalline or as a non crystalline (amorphous silica) compound. The domestic silica production currently comes from **ELVIOR S.A.** in northern Greece and from **Lava Mining and Quarrying Co. S.A.** in Milos island.

ELVIOR S.A. exploits veins of milky crystalline quartz in various areas in Thessaloniki prefecture, M. Panagia in Chalkidiki prefecture, Kastri and Agyia in Larissa prefecture. The mined material is treated in a crushing, washing and sieving (classification) plant to obtain a size fraction of 0-6 mm. Consecutively, this material is ground at the nearby iron-free ball mill facility of **MEVIOR S.A.**, an associated company, to produce the following size fractions: 0,1-0,3 mm, 0,3-1,2 mm, 0,4-2,4 mm and -325 mesh. A high whiteness product is obtained, being used not only in traditional applications such as industrial floor, special cements, tiles adhesives etc. but also in the production of 'artificial granite' mainly consisting of quartz grains and fine material (-325 mesh). Furthermore in a state of the art attrition unit, large quantities (i.e. 200.000 tpa) of wastes coming from previous exploitation activities and containing 70-80% of quartz material are treated and cleaned.

Lava Mining & Quarrying Co exploits microcrystalline quartz from Kastriani area (12 km SE

of Adamas, the port town of Milos island). The properties, which render this product commercially prominent, are high SiO_2 content and whiteness. Two grades of silica sand are produced: SSL10 (white coloured) and SSL20 (pink-coloured), their main difference being the SiO_2 and Fe_2O_3 content. Microcrystalline quartz of Milos is delivered in various grain sizes: 0-1, 0-3, 0-5, 0-10, 0-20 and 0-100 mm. The silicate product finds many uses in glass making, in pottery, in construction applications, as filling material in the paint industry, as foundry sand, in refractories and in the cement industry.

Finally, **IGME** has located an occurrence of 1,2 million tonnes of fine – grained feldspar-quartz sand in Argos Orestikon area, Kozani and Kastoria prefectures. The SiO_2 content of the natural material is 87-92 %, while the Fe_2O_3 content is 0,36 – 0,8%. After pilot scale beneficiation quartz sand is obtained assaying $\text{SiO}_2=94-96\%$ and $\text{Fe}_2\text{O}_3=0,04-0,08\%$. This product is suitable for glass making and ceramics.

In 1999, total production of mined material was 126.000 tonnes.

"NEW GENERATION" INDUSTRIAL MINERALS

ZEOLITE-OLIVINITE-VERMICULITE-GARNET-WOLLASTONITE



Exploration campaigns, carried out by IGME and several mining companies, have shown the existence of exploitable deposits of zeolite, olivinite, garnet, wollastonite, vermiculite. These minerals may be used in various industrial and environmental applications.

ZEOLITE

Zeolites are hydrated aluminosilicates of alkalis and alkaline earths with the following empirical chemical formula: $M_{2/n}O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$.

Because of their structure and chemistry, zeolites are characterised by attractive physical and chemical properties including: ion exchange capacity, adsorption and related molecular sieve properties, dehydration/rehydration potential, and catalytic properties. The above properties form the basis for most of the commercial uses of natural zeolites in industrial, agricultural and environmental applications. In addition physical properties such as light colour, specific gravity etc. render zeolites suitable for use in construction, paper industry etc.

World production of natural zeolite was estimated to be 3-4 million tonnes in 1999. Out of this, China is thought to have accounted for 2,5 million tonnes. Other major producers are Cuba, Germany, Japan and South Korea.

Sedimentary zeolite deposits in Greece were reported for the first time in 1981, on the island of Santorini. Mineral exploration work carried out mainly by IGME, has located several zeolite deposits (zeolitic volcanic tuffs) mainly in Thrace as well as in some Aegean

islands (Polyaegos, Kimolos, Samos). In Thrace, there exist several zeolite deposits (Petrota, Pentalofos, Metaxades, Lefkimi, Feres, Skaloma).

Since 1996, **Silver and Baryte Ores Mining Co SA** has initiated the exploitation of the Pentalofos, Thrace, zeolite deposit using open pit mining methods. The ore is extracted without using explosives and it is processed in the company's plant at Ritsona. Zeolite ore sales for 1998 have reached 4700 tonnes, mainly addressing the French, German, Dutch, English and Greek markets, principally for animal feed and to a lesser extent for aquarium filters.

OLIVINE – DUNITE

Olivine refers to a group of orthosilicate minerals in an isomorphous series, with magnesium-rich forsterite (Mg_2SiO_4) as one end-member and iron-rich fayalite (Fe_2SiO_4) as the other. Its use as a slag conditioner, foundry sand, and as a raw material in the manufacture of refractories and olivine-fluxed pellets make it strongly connected to the iron and steel industry. Furthermore, it is an excellent medium for the neutralization of industrial acid wastes, and as a sand blasting abrasive. Other uses for olivine/dunite include abrasives, asphalt fillers, construction aggregates, water filtration etc. Commercial olivine and dunite deposits are found mainly in Norway, Japan, Spain, India, Italy, USA, Sweden, Austria, Pakistan and Mexico.

In Greece, in areas whose ophiolitic rocks are extensively developed, there exist significant olivine deposits, mainly in the Kozani prefecture (Vourinos area) and in Chalkidiki (Vavdos) area. Olivine is the main mineral (olivinite) of the dunite-harzburgite rocks that are very common in the above areas. Laboratory and mineral processing tests have shown that the Greek olivinities are in principle, suitable for the manufacture of refractories, foundry sand, neutralization of acid wastes and sand blasting.

VERMICULITE

Vermiculite is the mineralogical name generally applying to a group of hydrated, trioctahedral ferromagnesian aluminous platy or micaeous silicate minerals. Within the internal structure of vermiculite there exist water molecules, which when rapidly heated to high tem-

peratures, cause the vermiculite to increase in volume. This process produces a lightweight material, which finds use in various construction products as an excellent thermal insulator, in agriculture, horticulture and other applications.

South Africa is the leading country worldwide in vermiculite production. Other vermiculite producing countries include Australia, Brazil, China, Egypt, India, Kenya, Russia, Japan and Zimbabwe.

Significant vermiculite concentrations were located by IGME along the tectonized contacts of the serpentinite bodies of the Vertiskos Unit in the Serbomacedonian zone with the hosting two-mica gneisses. Vermiculite forms zones varying in thickness from a few centimeters to 5 meters, of single mineralogical composition or in association with tremolite and talc.

GARNET

Garnet is one of the world's most commonly occurring natural abrasive minerals. Garnet is a family of complex silicate minerals having similar physical properties and crystallizing in the cubic system.

World production of garnet is of the order of 100.000 tpa, with USA as the dominant producer followed by Australia and India.

In Greece, garnets are mainly located in Xanthi Prefecture, Serifos island and some other areas (Drama prefecture, Chalkidiki). In the Kimmeria area, Xanthi prefecture, garnet-bearing skarn (garnetite) of andraditic ($\text{Ca}_3\text{Fe}_2\text{Si}_3\text{O}_{12}$) composition is developed. The resources of garnetite are estimated at about 1.000.000 tonnes. Also, in Serifos island, garnet is developed in the skarn zone and it is mainly of andraditic composition. The geologic reserves are estimated to be in the order of 2,5 to 3 million tonnes, grading 40-50% garnet in the areas of Aghia Marina, Western Aghia Marina, Psari, Tsilipaki, etc. Laboratory and mineral processing tests carried out in the frame of an E.U. funded project revealed that the Xanthi garnet is suitable for sand blasting uses, exhibiting high cleaning speed. Also, tests on the Serifos garnet, carried out in U.S.A, have shown that the material is suitable to be used as a smoothing medium for wood surfaces, leather or ceramic products. Finally, due to its quality characteristics, it may be used as filter for liquid purification.

WOLLASTONITE

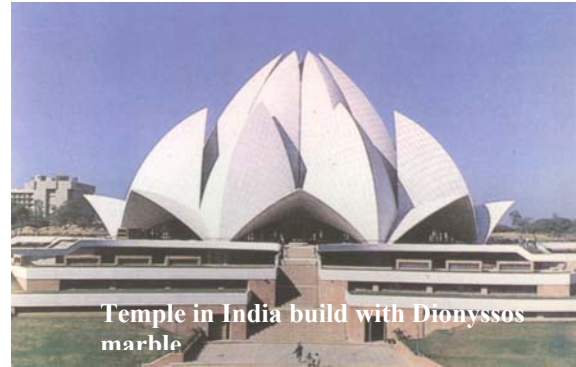
Wollastonite is a calcium meta-silicate mineral with the chemical formula CaSiO_3 . Although it is a unique mineral, wollastonite has a relatively short history in industrial use. It is the only naturally occurring, non-metallic, white

acicular mineral. Its acicularity is the main reason for its gradually increasing use since the late 1970s and the 1980s as reinforcing filler and as a substitute for short fibre asbestos and milled fibre-glass. The USA is the largest producer of wollastonite, followed by China, India, Finland, Kazakhstan, Uzbekistan and other countries.

In Greece, significant wollastonite occurrences have been located in the areas of Kimmeria, Xanthi prefecture, and Panorama, Drama prefecture. These wollastonite occurrences are not currently exploited.

In Panorama area, the geologic reserves of the wollastonite bearing skarn are estimated at 700.000 tonnes, grading more than 50% in wollastonite. The Wollastonite of Panorama, Drama prefecture, with a low aspect ratio (i.e.5:1) is possibly suitable for filler in ceramics and in some metallurgical uses. Recently it has been tested successfully as a partial substitute for asbestos in the asbestos-cement industry. In the Xanthi area, wollastonite occurs in Kimmeria and Kalamou sites. The Kimmeria wollastonite deposit mining rights are held by **MEVIOR S.A.**

MARBLE

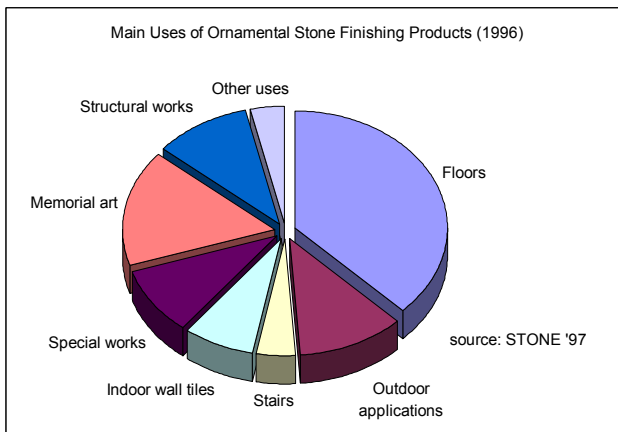


Temple in India build with Dionysos marble

MARBLE

The commercial use of the term "marble"-*"marmaro"* in Greek - does not only involve metamorphic limestone deposits but also any ornamental stone that can be cut to

Marble producing countries in decreasing order, are: Italy, China, Spain, India, Greece, Brazil and Portugal. According to data from 1996, the main uses of dimension stone end-products include floorings, outdoor applications, staircases, indoor wall tiles, special applications, decorative and memorial art constructions etc.



standard dimensions, can be polished to a mirror surface and finally can be used for decorative purposes. Currently, although it is still very common to characterise dimension stones by their traditional names - some of them given in antiquity-, an effort is made to refer to them by their petrological names and place of origin.

GREEK MARBLE

The Ancient Greeks were the first among many civilisations to notice the unique properties of this remarkable stone that lasts for so long, remains so beautiful and can be shaped to their needs so easily.

Marble quarrying in Greece has hardly ever stopped since it started many centuries ago. The first monuments of Greek sculpture appeared as early as 630 BC. The peak of the Greek classical period is represented by such outstanding structures as the Athens Acropolis with its Parthenon and its Erechthion, the Aphrodite of Milos, the Hermes of Praxitelis etc.

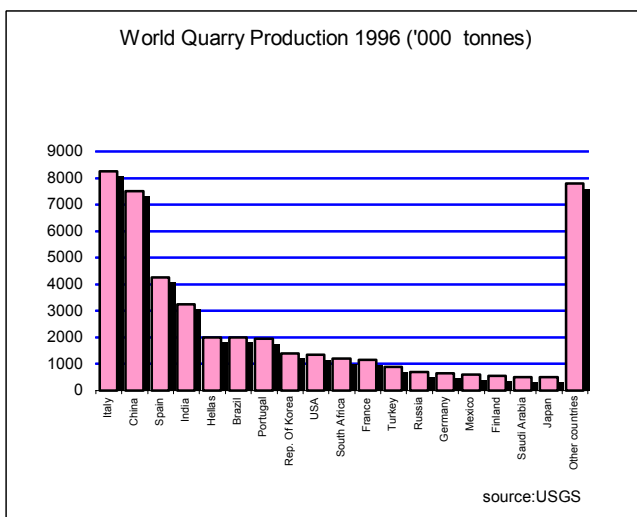
The geological history of Greece has led to the creation of extended deposits of ornamental stones. Today, in Greece the following types of dimension stones are produced:

Metamorphic rocks: Calcitic marble, dolomitic marble, cipollins and ophicalcites, schists, gneiss.

Sedimentary rocks: Limestone, travertine, breccia, onyxes and alabaster.

WORLD PRODUCTION – CONSUMPTION – USES

During 1996, world quarry production of raw ornamental stones reached 46,5 million tonnes. The main



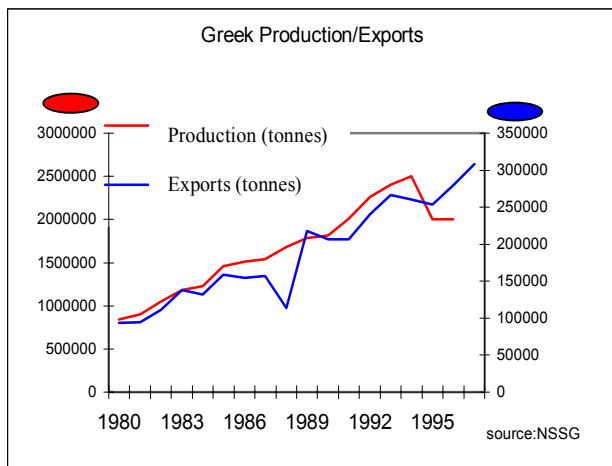
The history of the modern Greek marble industry started in the 1960's, when building activities and standards of living were rising sharply. Quarrying companies are scattered in all regions of Greece, since there are marble deposits in almost the whole country. The number of enterprises engaged in the marble sector is estimated to be about 4.000 and includes small, medium-sized and several big units that rank among



the best industrial units in Europe. The number of employees reaches 60.000 persons, many of them are highly specialised in the field of quarrying, processing and marble applications.

Marble quarry production has impressively increased in the last few years. In 1966, quarry production of marble blocks was 141.000 tonnes, while in 1998, annual production was estimated to be around 2.500.000 tonnes, representing 6,8% of total world production.

The excellent quality of the Greek marble and the high capacity of the Greek marble industrial sector, being able



to readily fulfill the demand of the foreign markets, have



resulted to a significant increase the volume of exports in recent years. Thus, starting in 1971 from exports of 36.000 tonnes with a value of 181.952 EURO, Greek dimension stone exports have, in recent years, exceeded 260.000 tonnes with an average yearly value of over 88 million EURO. Greek marble products are exported either as slabs and tiles of standard dimensions or as special products, artwork items etc. Moreover, small quantities of blocks and rough slabs are also exported. The various Greek marble types and products are exported all over the world, from Western Europe to the U.S.A., China and the Arabic countries.

The significant marble quarrying, cutting and processing centres of Greece are presented below.

DRAMA, KAVALA -THASSOS REGIONS (EASTERN MACEDONIA)

This region is the most important marble quarrying centre of the country with modern units of primary production and processing and total marble block production exceeding 1,3 million tpa derived from 115 active quarries. It should be pointed out that 80% of the total Greek marble exports come from this region.

The main products in the area are the Thassos snow-white dolomitic marble, the whitish dolomitic marble of Volakas and the Kavala semi-white calcitic marble.

KOZANI, VERIA REGIONS (WESTERN MACEDONIA)

From this area, white, white - whitish and coloured marble of superior quality is quarried at Koumaria (Veria), and Tranovaltos -Zoodohos Pighi (Kozani).

The marble of Veria is considered to be one of the most famous «pure» marbles of Greece, known since the ancient times.

The white - whitish marble of Tranovaltos, Kozani, started to be quarried due to its beauty and the excellent mechanical characteristics. Today more than 30 quarries operate in this area with an estimated total production of 105.000 tpa.



IOANNINA REGION (EPIRUS)

In the Klimatia-Karitsa area, of Ioannina Prefecture, a characteristic “beige” limestone is quarried. In the past, it was the most popular dimension stone in the domestic market due to its nice colour and low price. The quarry production is about 60.000 tpa. A great number of cutting/processing plants operated by small to medium size enterprises exists in this area.

LARISSA - VOLOS REGION (THESSALY)

The Larissa and Volos area offers a great variety of white, whitish, pink, and coloured marbles. Also in this area, schistogneisses are quarried under the commercial name “Schist-slabs of Pelion”. The marble of Tissaion mountain, in the south end of the Magnesia peninsula, is of great economic value. Intensive exploitation of this marble took place during the ancient times.

Volos area has become an important center of intensive quarrying activity and the total production of marble blocks exceeds 95.000 tpa.

LEVADIA-DOMVRENA (STEREA HELLAS)

The area of Levadia-Domvrena offers a great variety of pink-white, whitish, black and coloured marbles. This area includes the whitish dolomite marbles of Helicon mt., the blackish limestone of the Levadia area, and the limestone of Domvrena in Boeotia Prefecture. Also, in Ritsona area the pink-purple limestone is quarried. The Levadia and Helicon are also important centres of intensive quarrying activity with a total annual production of marble blocks exceeding 60.000 tpa.



ATTICA REGION

In the region of Attica, the most ancient marble producing centre of the world, the famous Pentelikon is located. This calcitic marble has been widely exploited



during classic antiquity and the Hellenistic period and has been used in the construction of the famous immortal masterpieces of sculpture and architecture in Greece. Quarrying activity in the southwestern slopes of Penteli was terminated in 1976, due to measures taken for environmental protection. The white marble quarrying

has been restricted ever since in the northern part of Penteli Mountain.

Today, systematic marble exploitation (mainly via underground quarrying methods) is carried out in the Dionysos area, to the north of the old quarries of Pentelikon mt. Dionysos marble, stratigraphically overlying Pentelikon marble, is white to semi-white and exhibits very good quality features. Furthermore, in the Aghia Marina area (N-E of Dionysos), the semi-white marble of the same commercial name is quarried. The total annual production of the two aforementioned areas is about 55.000 tpa.

OTHER REGIONS

Besides the above-mentioned important production and processing centres, some quantities of marble are also quarried in many other districts of Greece such as:

The banded or breccia form beige limestone of Karnezeika and the oolitic limestone of Ligourio, Argolis Prefecture.

The blackish fossiliferous limestone of Vytina area, Arkadia Prefecture.

The green ophealcite of Tinos island.



The coarse-grained calcitic marble of Naxos under the commercial name "Crystallina of Naxos".

The ash-white calcite marble of Paros island.

The ash coloured dolomite of Moundros at Rethymno, Crete.

The white to semi-white marble of Talea mts in Crete.

The nummulitic limestone of Messolonghi area, Aetolia/Akarnania Prefecture.

The cipolin and cipolin plates karystos, Euboea.

The Neogene travertine deposits in Aridaea (Pella Prefecture), Koupa-Skra (Kilkis Prefecture), Vamvakofyto (Serres Prefecture), Kapandriti (Attica Prefecture), Pitsa (Corinth Prefecture).

PERSPECTIVES

Although the competition today is very hard in the international market of ornamental stones, the Greek marble

industry is at a very satisfactory level and has very good potential and capacity for further development. In fact, an increasing number of marble quarrying companies direct their activities with great success into the international market.

In general, the quality of the Greek marble types is excellent and their physical and mechanical properties, as they have being defined by specialized laboratories, are fully in compliance with the end-user's specifications.

The sector of ornamental stones is deemed to be of high priority concerning investments, mainly in specific fields such as quarrying, sophisticated processing and artwork manufacturing.

GREEK LEGISLATIVE FRAMEWORK AND PROCEDURES FOR OBTAINING THE RIGHT AND LICENCE FOR MINERAL EXPLORATION AND MINING WORKS.

According to the related Greek mining legislation, natural ores are divided into two categories, namely: metallic ores and quarry minerals (i.e. industrial minerals, marble and aggregates).

1. Metallic Ores

The following natural raw materials are defined as metallic ores/minerals:

- Native metals (such as copper, gold, etc.).
- Compounds of all metals
- Rare earth group minerals
- Radioactive minerals
- Native sulphur, graphite, phosphorite, mica, feldspars, aluminium, clays, mineral sodium chlorite and associated salts, cryolite, sodium nitrate, compounds of boron, bromium and iodine, dolomite with more than 21% magnesium oxide.
- Gem stones
- All natural solid fuels including peat.
- Natural concentrations of organic fertilizers.
- All hydrocarbons in solid, liquid or gaseous form and their oxidation products.
- Resinous minerals
- Gaseous helium and natural gases
- Geothermal resources.

According to the Greek Mining Code, the exploration and exploitation rights for the following minerals belong exclusively to the State:

- Liquid and gaseous hydrocarbons
- Solid fuels (lignite, peat etc)
- Minerals containing radioactive elements in exploitable quantities
- Geothermal resources
- Natural gases
- Emery
- Mineral Sodium Chloride
- Natural concentrations of organic fertilizers

1.1. Procedures for Carrying Out Mineral Exploration Works.

1.1.1. Procedures for Obtaining the Right for Mineral Exploration (MER)

Submission of an application to the local Prefecture authorities accompanied by :

- Topographic diagram of the area in scale 1:100.000, in relation to the National Trigonometric Network.

- Fee of Euro 190.75

- Certificate of Nationality and, in case of legal entities, abstract of the Statute including the registered head office of the company and its objectives.

The Prefecture authorities then grant the Mineral Exploration Rights (MER) valid for a three-year period, provided that no issues concerning national security are raised.

It should be noted that direct granting of MER to foreign natural or legal persons is not permitted (except for those of EU member-states), whilst MER granting to foreign entities is permitted only if the MER is transferred from Greek natural or legal persons and this is approved by the Board of Ministers.

1.1.2. Procedure for Obtaining a License for Mineral Exploration Works (MEL)

If the site where mineral exploration works are planned is part of an area designated as a Forest, it is then necessary to submit the following supplementary technical studies:

- An Environmental Impact and Rehabilitation study to the Ministry of Environment and Public Works.

- A technical report describing in detail the planned exploratory campaign to the Ministry of Development.

1.2. Procedure for Obtaining Mining Rights

If within the term of validity of the MEL the holder decides to carry out full scale mining works in that area, he has to submit a feasibility study to the local Prefecture authorities, providing the exploration results and the techno economic data relevant to the exploitation of the reserves found there.

The feasibility study is assessed by the Ministry of Development after detailed examination of the adequacy and accuracy of the data provided and following consultation

with the Institute of Geology and Mineral Exploration (IGME).

If the feasibility study is approved, the mining rights are granted for a 50 year period with the possibility of obtaining two extensions of 25 years each, following a certain procedure.

In case the feasibility study submitted is not approved, an extension of the Mineral Exploration Works Licence for one more year can be granted, and within that year the holder must submit a new feasibility study for re-assessment.

It should be noted that besides the feasibility study, the person/company wishing to obtain the mining rights is required to submit a letter of guarantee of Euros 2.641 or Euros 3.815 for concessions covering an area under or above 5 km², respectively.

1.3. Procedure for Obtaining a License for Mining Works

Submission to the Ministry of Environment and Public Works of an Environmental Impact and Rehabilitation Study dealing with the planning of mining and rehabilitation works that will be employed.

Submission for approval to the Ministry of Development of a technical study describing the mining method planned for that particular deposit.

Submission of a report for obtaining the license to install and operate the equipment/ installations required for the exploitation of the deposit.

1.4. Procedure for Lease and Exploitation of Public Mines.

The Greek State has the right to exploit itself various mining areas. This right can be transferred to persons/companies usually through auction and, in some cases, by direct assignment. The procedures to be followed in order to obtain licenses for mineral exploration and mining works in Public Mines are as described in the above paragraphs 1.1.2 and 1.3

2. Quarry Minerals

All minerals not classified as Metallic Ores are considered as Quarry Minerals. The right to the

exploration and exploitation of Quarry Minerals lies with the landowner. The Quarry Minerals are divided in the following categories:

Industrial minerals
Marble
Aggregates

2.1. Procedures for Obtaining Exploration and Mining Licences for Industrial Minerals and Marble in State Owned Areas.

2.1.1. Procedure for Obtaining the Right for Mineral Exploration

Submission of an application to the Secretary General of the Region accompanied by:

Topographic diagram of the area of scale 1:5.000, in relation to the National Trigonometric Network.

The area cannot exceed 100.000 m² (in the case of marble)

Letter of guarantee of Euros 1.467

The Secretary General of the Region grants the Right for Mineral Exploration and this is valid for a one (1) year period, provided that no prohibitive reasons exist. The validity of the Right for Mineral Exploration can be extended for one (1) more year following an approval of the Mines Directorate.

2.1.2. Procedure for Obtaining a License for Mineral Exploration Works

Submission to the Ministry of Environment and Public works of an Environmental Impact and Rehabilitation Study dealing with the planning of mineral exploration works.

Submission of a technical report to the Ministry of Development.

2.1.3. Procedure for Obtaining Mining Rights (Lease).

Submission of an application to the Secretary General of the Region accompanied by:

Topographic diagram in scale 1:5.000

Drawing of the broader area
Pre-feasibility study

The Mining Rights are granted by the Secretary General of the Region, provided that no prohibitive reasons exist, and last for 25 years with the possibility of extension for another 15 years.

2.1.4. Procedure for Obtaining a License for mining Works.

Submission of an application to the Secretary General of the Region with:

- Topographic diagram
- Drawing of the broader area
- Technical Report
- Environmental Impact and Rehabilitation Study approved by the Ministry of Environment and Public Works.

A license for the installation and operation of the mineral processing equipment required should be also submitted.

In case of forest areas, an “Approval for Mining Works”, as quoted in Law 998/79, is also required.

It should be noted that mining rights cannot be directly granted in areas where exploitation has been carried out in the past or exploration works have been undertaken by the **Institute of Geological and Mining Research** (IGME). Mining rights in those areas are granted through auction.

Investment Incentives

The Greek Development Law 2601/98 provides incentives for both mining and processing the quarried material. These incentives take the form of cash grants ranging from 15%-45% or of tax relief ranging from 40%-100% depending on the area in which the investment is located and the type of the project. In both cases an interest subsidy ranging from 15%-45% on any long-term loan used for the partial financing of the investment cost is also provided.

These incentives cover practically all investment costs, excluding cost of land.

Investors seeking to receive incentives under L.2601/98 should apply to the Ministry of National Economy (or ELKE if the investment exceeds 9 million EURO or 3 million EURO and at least 50% of own equity is in foreign capital). The approval of the application takes a period of three months. The disbursement of the cash grant is in three stages; 60% (in two instalments) during construction, 20% upon completion of construction and 20% upon operation.

Limitations

The cash grant and the leasing subsidy cannot exceed the amount of EURO 45,000 per job created by the investment except for the production of innovative products, as defined by the Ministry of Development.

Equity provided by the investor cannot be less than 40% of the eligible expenses.

Investments above EURO 75 million

In the case of investments of at least EURO 75 million with the creation of at least 300 permanent jobs, both incentive options are alternatively applicable. Also, divergences can be made from the limitations in the own participation, the submission deadlines, the procedure for the award of the grants, the size of the grants, the interest subsidy (duration and percentage), the maximum amount of the bank loan, the percentages of tax allowances and allowances in the leasing of equipment, the conditions of company shares' transfer, as well as the possibility of public corporations participating in the investment. The aforementioned limitations do not apply.

Labour incentives

These incentives include:

1. Subsidies for personnel training programmes (up to 100 trainees and 200 training hours)
2. Subsidies for the creation of new jobs when employing people registered as unemployed for at least 6 months
3. Subsidisation of the total labour cost of an enterprise (up to 10% of total labour cost in some regions of northern Greece; cannot receive subsidy for the creation of new jobs simultaneously)

Incentives provided by L.2601/98

	Up to
Cash Grant	45%
Loan Interest Subsidy	45%
Lease Subsidy	45%

or

	Up to
Tax Allowance	100%
Loan Interest Subsidy	45%

N.B.: This is a summary of the law. Please refer to the complete version for application.

