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REF ID: A11111

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Received - 8 SEP 1983					Magistrate
Answered					E & IL
DEPT. OF MINES					
REF. No. 8267/83					

EXPLOITING THE MAGNESITE DEPOSITS OF NORTHWEST TASMANIA -

A REPORT BASED ON THE VIEWS OF EUROPEAN AND
AUSTRALIAN SCIENTISTS AND TECHNOLOGISTS

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August 1983

Mineral Chemistry Communication

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83-2043

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1. INTRODUCTION

Visits were made to mines, beneficiation plants and refractory-brick manufacturing plants in Austria and Greece. Subsequently, discussions were held with personnel from Australian companies involved in the production of basic refractories. This report describes how these Europeans and Australians (listed in the Appendix) view the state of the industry today, points out the technical problems which they consider important, and which may have not been emphasised before here, and makes recommendations on how the reserves of magnesite in Tasmania could be developed further.

2. HISTORICAL

Since the war, the industry has moved from a situation of excess demand to one of over-supply. For example, up to about 1960, when the Austrians were the main suppliers of magnesite, demand was so great that even underground mining (e.g., at Radenthein and Hochfilzen) became economic. Since then many substantial deposits of magnesite have been discovered and exploited. Those in Greece, Turkey and Czechoslovakia were developed quickly, and more recently very large deposits have been exploited in Korea, China and Brazil. In addition to the use of natural magnesite, magnesia was extracted increasingly from seawater. Japan and the USA satisfy most of their demand in this way.

In parallel with steadily increasing reserves, technical advances have forced traditional producers to improve their products. For example, the growing demand for high-purity, low-Fe MgO forced the Austrians to develop and utilize more the higher-purity Greek products. The problems associated with MgO from seawater containing high B-levels and brucite-derived MgO producing inferior quality refractory bricks had also to be overcome.

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The sharp rise in fuel costs in the 1970s affected seawater MgO production more severely than natural magnesite production. But the whole industry has been set back severely by the resulting recession in world steel production and by steel producers requiring much less MgO/unit of steel.

3. THE PRESENT STATE OF THE INDUSTRY

It is estimated that currently world production is running at 30-40% of capacity, and that even if steel production were to treble, present world magnesite production could meet demand. Apart from the fact that current steel production has fallen by about 20%, consumption of magnesia per tonne of steel has fallen from 10 to 2 kg (BHP use 2.7 kg). This trend in consumption is considered likely to continue.

As a result of the fall in demand, many seawater plants have closed (e.g., in Ireland). The recently commissioned \$140M Billiton plant owned by Shell is reported to be producing currently at a rate of 8000 t/year, compared with a total capacity of 100,000 t/year.

The Japanese plants are producing at less than half their total annual capacity of 800,000 t. Low-grade magnesite is being used less and less. For example, because of its impure composition and because mining costs are very high, very little Radenthein magnesite is being mined. Instead, the mining company, General Refractories use the much purer Greek magnesite with that from Hochfilzen, which is purer and can be mined by open-cut methods.

4. THE EXPLOITATION OF TASMANIAN MAGNESITES

Several technical and economic problems associated with the exploitation of Tasmanian magnesites were raised. Both the Austrian and Greek magnesite producers had considered the possibility of developing Tasmanian magnesites and had rejected the idea, mainly on the grounds of poor quality. However, recent exploration work by CRA and IMI, and the mineralogical investigations undertaken at the Division of Mineral Chemistry, CSIRO [1], suggest that these deposits should not be dismissed out of hand. The following three problem areas may be defined.

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4.1 THE QUALITY OF RAW MATERIAL

Tasmanian magnesite contains appreciable amounts of dolomite and quartz with minor talc and pyrite. These impurities are by no means exceptional. For example, the Hochfilzen magnesite contains little silica but appreciable dolomite which is removed mainly by flotation. Some of the quartz and dolomite in Tasmanian magnesites is disseminated finely - a distribution that would cause problems in beneficiating by flotation. But the proportion of impurities distributed in this way is considered small, although more detailed quantitative stereological data should be collected to confirm this. It is therefore likely that physical beneficiation methods could produce products with qualities, in terms of their Ca/Si ratio and dolomite content, comparable with natural magnesites elsewhere.

The problem related to the Fe present in the magnesite lattice is more serious, especially as there is a continuing trend for purer MgO refractories. This Fe can be removed by treatment by Cl_2 , and the IMI/CSIRO method removes it through complete solution of Mg and precipitation [2]. This latter method raises further problems, which will be discussed in detail later, concerned with the physical characteristics of the refractory that is produced, and in the energy costs involved.

One important feature of the Tasmanian orebodies, of which Europeans were unaware when they considered mining the ore, is that the Fe-content varies across the orebody, falling to below 1% Fe_2O_3 . Now refractory-brick manufacturers offer a range of products based on composition and physical characteristics. For example, the Greek company Scalistiri that markets under the trade name Fimisco, offer bricks with 42 different compositions, ranging from 0.7 to 10% Fe_2O_3 . General refractories sell refractory bricks under the trade name Radex with 128 compositions which include a similar range of Fe_2O_3 compositions. Therefore, the range in compositions found naturally in the Tasmanian magnesites may prove very valuable in easily providing the required range in composition of the refractory product. In addition, some experts consider that it would be feasible to coat brick centres made of relatively high-Fe MgO, with a much purer variety. Selective mining of the orebody could satisfy a range of needs, and form the basis of a complete range of refractory products.

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4.2 PHYSICAL CHARACTERISTICS OF THE REFRACTORY PRODUCTS

It is accepted within the industry that, after the composition exceeds 95-96% MgO, composition becomes much less important. Crystal size and shape, porosity and strength become the critical factors in determining the durability of the refractory brick.

The quality of the refractory is influenced considerably by the particular raw material used. In spite of the considerable advances during the last decade in the understanding of the effect of chemical composition and processing conditions on microstructure, slag resistance and high temperature properties of basic refractories, it is not possible to predict the quality of a refractory brick from an untried source of MgO. As an example, the Fimisco refractory bricks are composed of "strangely shaped" interlocking crystals and this texture is claimed to be an important factor in their high durability. But these microstructures were obtained by trial and error from a specific natural magnesite.

It would therefore be of considerable relevance to ascertain the physical characteristics of refractories produced from Tasmanian magnesites, which were obtained by physical beneficiation methods. But it would be of even greater importance to determine the physical characteristics of the bricks obtained from the raw material which had been derived from the IMI/CSIRO beneficiation method, because the purified MgO is derived unusually by way of basic hydrated carbonates. It is possible that material derived in this way would behave in a manner similar to that of material produced from seawater. Two firings of MgO from sea water are needed to produce correctly textured refractories, so if the product from the IMI/CSIRO beneficiation is similar, there would be a sharp rise in energy consumption which would seriously disadvantage this beneficiation process.

4.3 ENERGY REQUIREMENTS

Some specialists consider that the cost of the raw material is so insignificant that the sale of MgO for refractories is effectively a sale of energy. This analysis may be an oversimplification, which underestimates the technological knowledge of production. Nevertheless,

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the cost of energy in the process is very important in any analysis of the economic viability of an industry based on magnesite. That the industry is active in reducing the number of firings required to produce bricks is indicative of this. Natural magnesite undergoes two firings (one to produce MgO and the second to form the bricks) but seawater magnesite requires one to produce CaO and two more to produce bricks of a satisfactory texture, although Steetly's may have developed recently a method that requires only two firings. It is because of the likely high energy costs of the IMI/CSIRO beneficiation method that many doubt its viability. Therefore it is of great importance to direct further research effort in determining energy requirements accurately and minimizing the amount of energy used in this process.

It is also important to note the generally held opinion that profits and return on investment are made by the manufacturer of refractories rather than through the mining of magnesite. The advantages in vertical integration of raw material and refractory production can be considerable, especially in energy savings and through the producer's more intimate knowledge and control of the raw material. If this economic assessment is correct, it may be necessary to encourage the manufacture of refractories in northwest Tasmania. A very detailed analysis of the economics of such an industry, which would not only consider production and capital costs, but would also analyse factors such as transport costs, markets and competitors, would need to be performed. The technical studies could then be conducted in a framework of economic restraints.

5. THE ROLE OF CSIRO

CSIRO's role so far has been concerned with evaluating the quality and size of the orebodies and in developing possible beneficiation methods. The important additional subject which needs to be addressed is the evaluation of the refractory product that can be produced from either physically or chemically beneficiated Tasmanian magnesite. CSIRO could play an important role in this evaluation. In addition, if it were considered that a refractory industry could be developed in Tasmania, CSIRO could initiate, with some help from industry, a more long-

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term research program. This program would seek to understand more fully the processes that are involved in producing high-quality MgO-based refractories, and would investigate a range of beneficiation paths with the aim of reducing energy costs and improving quality. There are therefore four main areas in which CSIRO could contribute.

- 1) An evaluation of the size and grade of the orebodies. This would include the determination of proportions of magnesite and other phases throughout the deposits, the amount of Fe in the magnesite lattice, and how this varied through the orebody, and the particle size distribution of magnesite and other minerals found associated.
- 2) An evaluation of the possible methods of beneficiating the ore. This would include investigation of flotation methods and chemical methods of extracting Fe.
- 3) An evaluation of the optimum processing conditions for the manufacture of refractory bricks and the characterization of the physical properties (porosity, microstructure, strength) of the refractories that would be produced from Tasmanian magnesite.
- 4) An evaluation of the factors that determine microstructures and the corrosion of basic refractory bricks, with a view to modifying manufacture to produce bricks of superior specification.

6. CONCLUSIONS

World economic conditions and changing technology have caused great difficulties in the basic refractory industry. Any short-term development of Tasmanian magnesite appears to be imprudent. Some previously little appreciated qualities of the magnesite orebodies in Tasmania support the view that long-term development should be considered seriously. It is unlikely that mining crude ore will produce much financial return, so that any development depends on the viability of creating a refractory industry in northwest Tasmania. If a thorough economic analysis suggested that this was possible, CSIRO would be well placed to contribute in helping to solve the technical problems associated with beneficiation of the ore and the production of refractory products.

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APPENDIX

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