DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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MAGNESITE IN SOUTH AUSTRALIA - A SUMMARY

GEOLOGICAL SURVEY

by

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ABSTRACT

Major resources of magnesite are included as sedimentary interbeds within Late Proterozoic Skillogalee Dolomite of the Adelaide Geosyncline. Magnesite mud was deposited as an almost pure chemical precipitate in shallow marginal marine lagoons and mud flats. Most magnesite has been reworked by storm and tidal activity into widespread interclast conglomerates of variable grainsize and sorting, with variable detrital silt and dolomite within the matrix.

Skillogallee Dolomite extends the length of the geosyncline from near Adelaide for 820 km to the Northern Flinders and Willouran Ranges.

Magnesite interbeds are best developed in the northern area from Leigh Creek to the Willouran Ranges, and are exposed over a strike length of 80+ km. Small pits at Copley, Old Myrtle Springs, and Witchelina have supplied 18 000 tonnes of magnesite, and 3 larger quarries at Myrtle Springs produced 30 000 tonnes in 1984-5. Quarries expose between 13 and 60 magnesite interbeds, 0.3 m to 1.5 m thick, within a stratigraphic thickness of approximately 300 m to 700 m.

Late Proterozoic Balcanoona Formation in the northeastern Flinders Ranges within the Gammon Ranges National Park includes a large resource of approximately 20 million tonnes of replacement magnesite.

INTRODUCTION

South Australia has produced a total of 44 thousand tonnes of magnesite to the end of 1986. Prior to 1984, production averaged 500 to 1 000 tpa, primarily by F.H. Faulding and Co. Ltd for pharmacutical and chemical use, with lesser amounts by A.C.I.

Resources Ltd and Commercial Minerals Ltd for industrial uses, and minor amounts for agricultural use, and refractory uses by BHP. In 1984-85, 30 000 tonnes was produced by Commercial Minerals for use in water filtration by Queensland Alumina Ltd at Gladstone.

MAGNESITE BEDS IN ADELAIDEAN SEDIMENTS

Magnesite has been mined from sedimentary interbeds within Burra Group (Upper Proterozoic) primarily from Skillogallee Dolomite, with minor amounts in underlying River Wakefield Sub group.

Skillogalee Dolomite extends the length of the Adelaide Geosyncline (Preiss, 1987, p 340-343) from near Adelaide north to the Peake and Denison Ranges, a distance of 820 km, and is commonly 800 to 1 200 m thick. The dolomite is finely laminated, with ripple marks, desication cracks, stromatolite layers, and minor cherty layers. Detrital content is variable; dolomite is locally dominated by silt and sand. The unit contains only minor limestone, and represents the thickest accumulation of dolomite in the geosyncline.

Skillogalee Dolomite intertongues with overlying Woolshed Flat Shale, forming the Mundallio Subgroup of Uppill (1983). Skillogalee Dolomite is informally divided into the 'lower beds' and 'upper beds' (Preiss, 1987), corresponding to the Nathaltee/Nankanbunyana Formations and Yadlamalka Formation of Uppill (1983).

The 'upper beds' contain numerous magnesite interbeds which are best developed along the western margin of the geosyncline on the western flanks of the central and northern Flinders Ranges, and near Yednalue in the central Flinders Ranges.

GEOLOGY OF SEDIMENTARY MAGNESITE

Magnesite mud was deposited as a chemical precipitate from alkaline water in shallow marginal marine lagoons. Magnesite mud is visible as fine laminae within dolomite, and as rare beds of structureless fine grained magnesite up to 20 cm thick, with rare desication cracks. Most magnesite has been reworked by storm and tidal action into intraformational conglomerates, ranging in thickness from 2 cm to 3.5 m. Thicker beds can have an observed strike length in excess of 10 km.

Textures observed in the magnesite conglomerates are as follows:

- Grainsize varies from 1 to 30 mm, and the terminology granular (less than 3 mm), pelletal (less than 10 mm), and conglomeratic (coarser than 10 mm) is adopted.

- Magnesite clasts are well rounded; coarser clasts are often elongate and bent (almost sinusoidal), obviously fragments of desicated, but still plastic, sediment which has undergone little transport.

- Granular and pelletal magnesite is usually well sorted (monomodal), and magnesite conglomerate is usually poorly sorted (polymodal).

- Magnesite conglomerate varies from matrix supported to grain supported. Matrix includes finer magnesite clasts, and detrital quartz and feldspar.

- Granular to pelletal magnesite comprises interlocking approximately polygonal shaped clasts with minimal matrix, probably representing well sorted and rounded magnesite clasts deposited as grain supported conglomerate, with subsequent compaction.

- Upward coarsening cycles resulting from deposition is a storm environment (Uppill, 1983), and upward fining cycles are common; coarser conglomerates are usually structureless with no obvious layering. Granular magnesite contains rare ripple marks and cross beds up to 10 cm.

- Top and bottom contacts are abrupt and well defined, often with coarser conglomerate on one or both contacts, and more rarely with thin magnesite mud on the basal contact.

- It is obvious that many of the beds were deposited as a single event; individual magnesite beds are up to 1 m thick. Thicker accumulations represent superimposed beds.

Magnesite is almost always reworked into an intraformational conglomerate, whereas dolomite less commonly shows signs of reworking, reflecting differences in environment of deposition (e.g. water depth) within transgressive and regressive cycles.

Primary magnesite mud was probably pure, approaching 47% MgO. Reworked beds containing little or no matrix remain close to this composition, whereas beds containing more matrix include detrital quartz and dolomite clasts within the matrix and are of proportionally lower grade.

SEDIMENTARY DEPOSITS

Throughout much of the Adelaide Geosyncline, magnesite forms only thin laminae, or is represented by clasts dispersed in dolomite. Magnesite is thick enough to be economic along portions of the western flank of the geosyncline, where magnesite is usually steeply dipping, in rugged terrain, and mining sites have been chosen for ease of access and mining.

MOUNT LOFTY RANGES

Torrens Gorge 15 km east of Adelaide

Thin highly siliceous magnesite conglomerates (72% $MgCO_3$, 65% $CaCO_3$, 21.6% SiO_2) grade laterally into dolomite/magnesite conglomerate.

CENTRAL FLINDERS RANGES

Port Germein Gorge 220 km north of Adelaide

BHP produced 2 000 tonnes for trial refractory use from shallow open cuts and underground workings in 1947-50. High grade magnesite ($MgCO_3$, 86 to 98%; $CaCO_3$, 0.1 to 4%; SiO_2, 1 to 6%) is confined to a 1 m thick bed, separated from a similar 0.3 to 0.6 m thick bed by 0.3 m of impure magnesite and chert.

Mundallio 300 km north of Adelaide, 13 km east of Port Augusta

Thin magnesite beds are exposed for a north-south strike length of 15 km. From 1940 to 1953, 2 500 tonnes was produced from shallow trenches on hill slopes, and adits from valley floor. The main workings are confined to a single 1 m thick bed with similar grade as Port Germein Gorge.

Yednalue 340 km north of Adelaide, 95 km north east of Port Augusta

Skillogalee Dolomite strikes north-south for 6 km, dipping steeply west, on the western flank of the Worumba Diapir, and includes 5 to 10 magnesite interbeds up to 1 m thick in a 400 m thick section. These interbeds include some fine grained primary magnesite mud (?), and magnesite and enclosing dolomite are partially recrystallised. Limited testing shows variable silica and calcium content: MgO, 37 to 44%; CaO, 0.7 to 8.3%; SiO_2, 1.5 to 16%, dependant on percent matrix in the reworked magnesite.

NORTHERN FLINDERS RANGES - WILLOURAN RANGES

This area includes the major resource of sedimentary magnesite in the geosyncline, in terms of number and thickness of beds, and strike length (Fig. 1).

Magnesite interbeds are continuous from near Leigh Creek/Copley northwest to Myrtle Springs, a strike length of 40 km, then reappear near Witchelina around the nose of a southerly plunging syncline. Northwest of Witchelina, Skillogalee Dolomite including numerous magnesite interbeds is continuous along strike for 40 km along eastern and western sides of the Norwest Fault. East of the syndepositional Bungarider Fault, Skillogalee Dolomite is dominated by detrital sand (Murrell, 1977) and includes only rare magnesite.

Copley 530 km north of Adelaide, 3 km northwest of Leigh Creek

A sequence of approximately 60 magnesite interbeds, dipping steeply east, and ranging in thickness from 5 cm to 3 m, is visible for 1.5 km along strike in the upper 300 m of Skillogalee Dolomite. Within this sequence, a central zone, 20 m thick, includes 25 magnesite interbeds in excess of 0.3 m thick.

Detailed surface sampling showed the following compositional variations within 21 beds totalling 13.4 m thickness:

MgO, 33.2 to 46.9%, weighted average 42.7%
CaO, 0.35 to 11.6%, weighted average 4.4%
SiO_2, 1.4 to 31.6%, but generally less than 5%, weighted average 4.6%

F.H. Faulding and Co. Ltd produced 6 000 tonnes from costeans and cuts at the south of the deposit in the early 1940's from siliceous (5 to 20% SiO_2) magnesite interbeds (Johns, 1976). Within the costeans, 30% of the sequence is magnesite, and 70% is enclosing dolomite and silty dolomite with minor chert and persistent thin stromatolitic layers.

Myrtle Springs 555 km north of Adelaide, 26 km northwest of Leigh Creek

Commercial Minerals Ltd opened a new quarry in 1984, and by 1985 had shipped 30 000 tonnes to Queensland for water filtration in aluminium refining.

In excess of 13 magnesite beds, striking northwest, and dipping steeply east, have been mined over a strike length of 400 m in 3 quarries.

- No. 1 quarry, to the southwest and lowest in the stratigraphic sequence, exposes 4 beds, up to 1 m thick, of often coarsely conglomeratic magnesite including excess dolomite and silica in the matrix.

- No. 2 quarry, to the southeast and higher in the stratigraphic sequence, exposes 5 beds up to 1.5 m thick.

- No. 3 quarry is northwest along strike from No. 2, exposing 8 main beds up to 2 m thick and has supplied most production. Dolomite: magnesite is approximately 3:1. Working from east to west, overburden in the hanging wall of each magnesite bed is blasted and removed, then magnesite is knocked down by rock pick and screened to remove - 10 mm fraction.

Myrtle Springs, Old Workings 560 km north of Adelaide, 30 km northwest of Leigh Creek

Northwest along strike from the Myrtle Springs quarry, slots expose the thickest magnesite bed (1.5 to 2 m), dipping 65° east. Magnesite forms prominent outcrop in flat arid terrain, traceable along strike for several kilometres. Production totals 7 000 tonnes.

Witchelina 600 km north of Adelaide, 68 km northwest of Leigh Creek

Skillogalee Dolomite, dipping 35° to 45°, is exposed in a shallow southerly plunging syncline. Five magnesite beds range from 2 to 5 m, separated by approximately 50 m of dark grey dolomitic siltstone. Outcrop is subdued, and the complete stratigraphic succession is not exposed.

From 1964-74 shallow pits supplied 5 000 tonnes of blue-grey granular, to white coarsely conglomeratic magnesite.

Screechowl Creek 635 km north of Adelaide, 105 km northwest of Leigh Creek

Reconnaissance stratigraphic sections measured by Belperio (1987) indicate approximately 15 major magnesite interbeds within a 650 m thick zone within Skillogalee Dolomite (which totals 1 230 m thick), striking northwest and dipping steeply west on the western side of the Norwest Fault. A 55 m thick zone near the top of the sequence included 37 magnesite interbeds totalling 16.5 m of magnesite. The thickest magnesite is 3.5 m, comprising 7 stacked beds; a further 6 interbeds are 0.5 m plus thick, and remaining interbeds are 0.2 to 0.4 m.

Analysis of 9 interbeds indicate MgO, 39.8 to 47.2%, average 43.1%; CaO 0.9 to 7.4%, average 4.3%; SiO_2 0.4 to 8.3%, average 3.4% (Crettenden, 1987).

Belperio (1987) records a similar sequence 12 km to the southeast with 29 magnesite interbeds 0.3 to 1 m thick in a 760 m stratigraphic sequence.

REPLACEMENT MAGNESITE

Balcanoona 670 km north of Adelaide, 100 km east of Leigh Creek (in Weetootla Gorge, Gammon Ranges National Park).

Irregular bodies of coarsely crystalline magnesite were formed by metasomatic replacement of northwesterly dipping dolomite of Sturtian Umberatana Group, Balcanoona Formation, on the southeast limb of the Arkaroola Syncline near the Paralana Fault System. Replacement is discordant to conformable with bedding, but stratigraphically restricted; unreplaced dolomite interbeds extended through the ore bodies.

A trial parcel of 660 tonnes was produced from 3 exploratory adits in 3 separate ore bodies by BHP, and contained $MgCO_3$ 95.7%, $CaCO_3$ 0.7%, SiO_2 0.8%, Fe_2O_3 1.8%, Al_2O_3 0.5%. Inferred reserves total 20 million tonnes in 4 ore bodies.

Similar but smaller deposits are found near Mt Fitton and Mt Livingstone, 60 km to the north.

RESIDUAL MAGNESITE

Robertstown 115 km north-northeast of Adelaide

Skillogalee Dolomite strikes north northwest for 40 km from Robertstown to Burra, dipping steeply east, and including thin pelletal magnesite interbeds.

Small open cuts on hill tops extending north from Robertstown for 16 km expose a thin cap of residual magnesite. Nodular magnesite forms a 1 m thick massive capping over fractured and weathered dolomite/magnesite, and is dispersed through brown/green mottled clay (decomposed silty dolomite); fine grained magnesite infills fractures extending 2-3 m below surface. Nodules (3-30 cm) are white, pure (45 to 46.5% MgO) and hard. The higher grade magnesite appears to be restricted to one or more 10-20 m wide stratigraphic zones, and 8 000 tonnes was mined to 1984.

Magnesite on the surface is coated by thin Quaternary calcrete. It is suggested that residual magnesite is related to the early (or pre) Tertiary weathering profile, and was substantially eroded prior to the Quaternary calcrete.

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BIBLIOGRAPHY

Belperio, A.P., 1987. Stratigraphic sections measured in Adelaidean (Burra Group) rocks in the Willouran Ranges, Curdimurka area. South Australian Department of Mines and Energy report 87/56 (unpublished).

Crettenden, P.P., 1985. Magnesite in South Australia, a historical review, 1915-1984. South Australian Department of Mines and Energy report 85/62 (unpublished).

Forbes, B.G., 1960. Magnesite of the Adelaide System: Petrography and descriptive stratigraphy. Transactions Royal Society, South Australia, 83: 1-9.

_____, 1961. Magnesite of the Adelaide System: A discussion of its origin. Transactions Royal Society, South Australia, 85: 217-222.

Johns, R.K., 1963. Limestone, dolomite and magnesite resources of South Australia. Bulletin Geological Survey, South Australia, 38.

Johns, R.K., 1976. Magnesite - South Australia. Economic Geology of Australia and Papua New Guinea. 4. Industrial minerals and rocks. Australasian Institute of Mining and Metallurgy, p 219-220.

McCallum, W.S., 1986. Camel Flat magnesite deposit, near Copley, northwestern Flinders Ranges. Geological investigations, 1984 and 1985. South Australian Department of Mines and Energy report 86/17 (unpublished).

McCallum, W.S., and Barnes, L.C., 1986. Magnesite in the Adelaide Geosyncline. Geological Society of Australia. Abstracts No. 15, Earth Resources in time and space, Adelaide 1986: 247.

Preiss, W.V. (Compiler), 1983. Adelaide Geosyncline and Stuart Shelf: Precambrian and Palaeozoic Geology (with special reference to the Adelaidean). 1:600 000 scale. Department of Mines and Energy, Adelaide.

Preiss, W.V. (Compiler), 1987. The Adelaide Geosyncline - late Protozoic stratigraphy, sedimentation, palaeontology and tectonics. Bulletin Geological Survey, South Australia, 53.

South Australian Department of Mines and Energy, 1984. Magnesite. Mineral Industry Quarterly, South Australia Department of Mines and Energy, 36: 25-27.

The Broken Hill Proprietary Company Limited, 1979. Magnesite, Balcanoona, SA. Mineral Leases 4059-4067. South Australian Department of Mines and Energy, closed file Env. 3639 (unpublished).

Uppill, R.K., 1979. Stratigraphic and Depositional Environments of the Mundallio Sub-group (new name) in the late Precambrian Burra Group of the Mt Lofty and Flinders Ranges. Transactions Royal Society, South Australia, 103(2): 25-43.

Uppill, R.K., 1983. Depositional Environments of the dolomite-magnesite facies association of the Mundallio Subgroup. Geological Society of Australia, (S. Aust. Div.). Abstracts No. 10, AGSETS Symposium, Adelaide, 1983: 17-18.

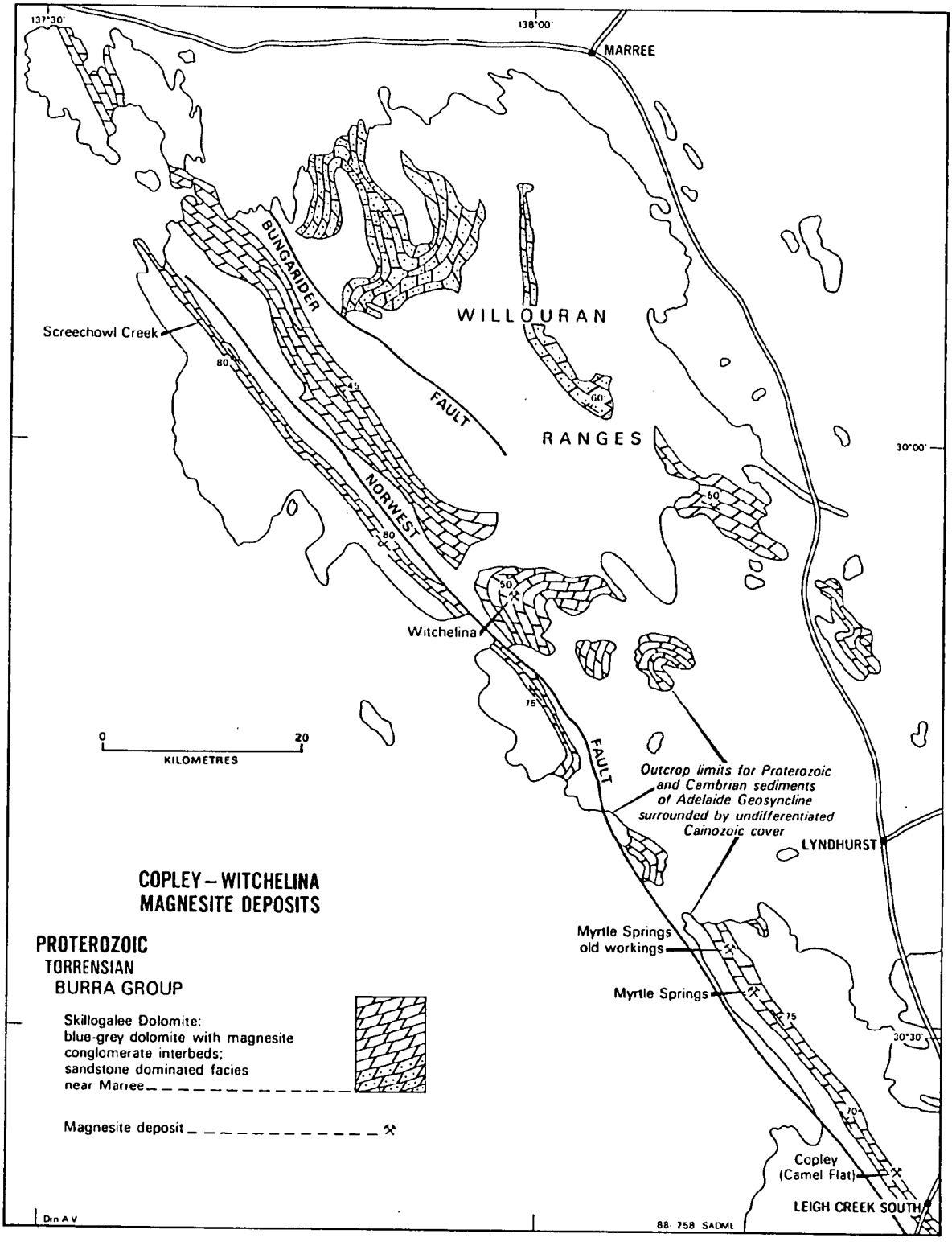

Figure 1

COPLEY - WITCHELINA MAGNESITE DEPOSITS
GEOLOGICAL SETTING