MAGNESITE DEPOSITS AT RUM JUNGLE, N.T., AUSTRALIA - GENESIS AND ASSOCIATION WITH URANIUM AND POLYMETALLIC SULFIDES

(VOLUME I)

by

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SAMPLE NUMBER CODE

The following letters were used to designate the geographical areas from whence samples were collected:-

A	Rum Jungle Complex, E.L. 1349
B	Beestons Formation, E.L. 1349
C	Celia Formation, E.L. 1349
D	Crater Formation, E.L. 1349
E	Coomalie Dolomite, E.L. 1349
G	Whites Formation, E.L. 1349
MF	Mt. Fitch Deposit
WO	Whites Deposit
WO-KF	Whites Deposit (collected : K Fuzikawa)
WO-RJ	Whites Deposit (Adelaide University collection)
IN	Intermediate Deposit
DY	Dysons Deposit
BR	Browns Deposit
WM	Mt. Minza
WC	Woodcutters Prospect
BALC	Balcanoona, South Australia
N	Kharidunga, Nepal

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University, nor to the best of my knowledge and belief, does it contain any material previously published or written by another person, except where due reference is made in the text.

Y. Bone.

SUMMARY

The major aspect of this study concerns the magnesite deposits at Rum Jungle, Northern Territory, Australia, which occur within the Lower Proterozoic Celia Dolomite and Coomalie Dolomite. The magnesite is spatially associated with the U and polymetallic sulfide deposits within the Rum Jungle area, one of the U fields of the Pine Creek Geosyncline.

The processes responsible for the formation of the magnesite have been studied with the objectives of (1) determining the genesis of the magnesite, (2) determining the role played by magnesite in the formation of the U and polymetallic sulfide deposits, and (3) delineating sufficient tonnage of silica-free magnesite which could be mined by open-cut methods.

Extensive work on the genesis of carbonates by previous workers shows that exceptional conditions are required for the precipitation of primary magnesite in the sedimentary environment, i.e. an alkaline, shallow, lacustrine situation with a Mg-rich groundwater input and a periodically high evaporation rate. Field observations of stromatolites (*Conophyton*, stratiform and cryptalgal types), tepee structures and the absence of evidence of the prior presence of evaporite minerals from gypsum upwards support the notion of a shallow water environment.

The presence of a palaeokarst surface at the interface of the magnesite and the overlying sequence further supports the sedimentary environment, as do the associated fluvial clastic sediments. The trace element geochemistry of the magnesite suggests an alkaline lacustrine environment, i.e. low Na, K and Sr, high F, Fe and Mn, notwithstanding diagenetic and metasomatic alteration. Ubiquitous detrital and/or authigenic intragranular grains of tourmaline, quartz, apatite, rutile, ilmenite, K-feldspars and clays suggest a primary chemical sediment, as

does the $\delta^{34}S$ signature of the diagenetic pyrite.

The magnesite is completely recrystallized. The fluid inclusion study indicates that the temperature of the fluids involved in this event ranged from 98°C to > 400°C, with a mean of 153°C for 444 samples. This recrystallization resulted in two distinctly different magnesite morphologies - a bladed form and a rhomb form. These two forms have previously been mistaken as pseudomorphs after gypsum and halite. However, the fluid inclusion study shows that the bladed form usually results from the recrystallization of magnesite from a fluid with a temperature greater than 160°C; whereas the rhomb form results when the temperature is below 160°C. Observations made during a pace and compass survey of 320 magnesite outcrops in the area showed no correlation between morphology and grain size or impurity content.

Analyses by electron microprobe of the fluids in fluid inclusions in the magnesite and its associated quartz show the presence of a range of cations and anions, namely Na, Ca, Mg, Fe, K, Cl and S (probably as SO_4).

The absence of any anionic spectrum for some samples suggests the presence of CO_3 or HCO_3, which proved to be an important consideration in the formation of ore fluids and their transport, particularly for U.

The microthermometric fluid inclusion studies also indicate the presence of several fluids, the mixing of which produced a wide range of salinities, often with inverse temperature relationships. Because $CaCl_2$ appeared to be present in amounts far larger than NaCl, salinities have been presented in wt.% equivalence of $CaCl_2$.

Other diagenetic alteration included pervasive stylolitisation, producing the following types:-

(a) sutured seam solution, particularly at the boundary between the Coomalie Dolomite and Whites Formation (the site of most mineralisation),

(b) non-sutured seam solution, which has given rise to nodular and chicken-wire fabric, breccias and zoned rhombs,

(c) non-seam solution.

Stylolitisation played an important role in the formation of the mineral deposits. Stylolitised magnesite ought to be considered a pathfinder.

Both field observations and laboratory studies suggest that there has been stratigraphic duplication of the two lowermost sedimentary formations by gravity thrusting down the flanks of the diapirically uprising Basement Complexes. This makes the names of either the Beestons Formation and the Celia Dolomite or the Crater Formation and the Coomalie Dolomite redundant.

As the so-called Dolomite Formations are predominantly magnesite throughout their extent, it is suggested that they be officially renamed either the Celia Formaton or the Coomalie Formation (and because they also contain extensive silicified areas and intercalations of "mafic schists" and tourmalinites). Such stratigraphic nomenclature changes do not affect either the magnesite genesis model or the findings on U and polymetallic sulfides, even though the mineral deposits all show a strong stratigraphic and lithological control.

Many different mineralisation models have been proposed by workers in the Pine Creek Geosyncline. This study shows that:-

(1) the magnesite was involved in producing a fluid suitable for

the formation and transport of U and metal complexes, e.g. uranyl carbonate complex:

(2) the magnesite was not the major source of the U or the metals:

(3) the Basement Complexes are enriched in U, and presumably constitute one of the major sources:

(4) Whites Formation is enriched in both U and metals, and presumably also a source:

(5) the mineralising fluids were predominantly low temperature, often highly saline and frequently $CO_2 \pm CH_4$ rich:

(6) shear zones, which were co-incident with the Coomalie Dolomite-Whites Formation boundary, were preferential pathways for mineralising fluids:

(7) stylolitisation processes were involved in the formation of mineralised breccias:

(8) the range of $\delta^{34}S$ values obtained indicate that the disseminated stratiform pyrite (which has reduced biogenic sulfate characteristics) was the source for the polymetallic sulfides, as indicated by the low temperature of remobilization via pervasive hydrothermal fluids:

(9) the sulfide phases present support the low temperature data obtained from the fluid inclusion studies, e.g. pyrite-marcasite -villamaninite-bravoite/siegenite:

(10) there were exceptionally high concentrations of Cu+Co+Ni+Fe to form the rare disulfides and thiospinels.

(11) the tourmalinites present support the premise of a continental type rift environment.

Magnesite from Balcanoona, South Australia, and Kharidunga, Nepal, was studied for comparison purposes. Polymetallic sulfides were discovered at the boundary of the magnesite and the overlying graphitic schist at Kharidunga. These were predominantly pyrrhotite, with veinlets of chalcopyrite.

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