Silicification and Base Metal Mineralisation within the Earaheedy Basin, Western Australia

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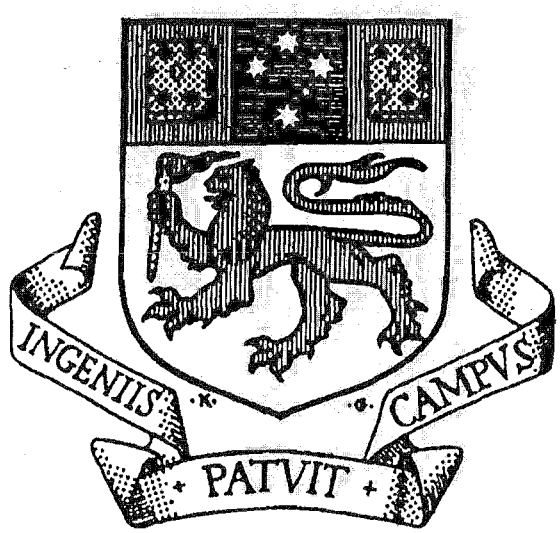

A research thesis submitted in partial fufillment of the degree of

Bachelor of Science with Honours

Centre for Ore Deposit and Exploration Studies

University of Tasmania

November, 1996

"Only when you've walked through the deepest valley
can you truly appreciate the veiw from the highest mountain"

Richard Nixon
"P.S. I am not a crook"

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in the university and, to the best of the authors knowledge and belief, contains no material previously published or written by another person, except when due reference is made in the text.

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ABSTRACT

Mississippi Valley Type (MVT) base metal mineralisation has been recognised at several localities in the Paleoproterozoic Earaheedy Basin, Western Australia, where it is associated with areas of silicification. The Earaheedy Group (ca. 1800-1900 Ma) lies within the Capricorn Orogen, between the Yilgarn and Pilbara cratons, and comprises two subgroups, the Tooloo and the Miningarra. At the base of the Tooloo Subgroup, the Yelma formation unconformably overlies Archean basement and comprises a ~300m thick package dominated by two units of shallow marine shelf carbonates, the Iroquois and Navajoh dolomites. Both dolomite units are intensely silicified. Base metal mineralisation is primarily contained within the Navajoh dolomite is strongly associated with silicification. 10km to the southeast of the study area, a major comet impact structure (the Teague Ring) formed at ~1630 Ma.

Numerous small occurrences of galena and sphalerite have been noted along strike, with five prospects over a strike length of ~50km investigated in detail during the current study. Mineralisation in the Navajoh dolomite occurs within styolites, bedding parallel and discordant veins, as a matrix within intraformational breccias, and in vugs and microbialite cores. Typical grades for base metal mineralisation are 20m @ 0.88% Zn and 0.1% Pb, including 2m zones of up to 1.6% Zn.

Three paragenetic stages have been identified. Stage I encompasses diagenesis of the host dolomites, and comprises three dolomite generations and the formation of diagenetic pyrite (Py_1). Py_1 has $\delta^{34}S$ values between 5.7 and 26.5‰, consistent with the occurrence of a sulphate-minimum zone within the Proterozoic oceans. Stage I barite records a seawater $\delta^{34}S$ sulphate value of 15.4‰.

Stage II was the main stage of ore deposition. Microcrystalline quartz, chalcedony, spherulitic chalcedony and quartz are intimately associated with sulphide mineralisation (mainly pyrite, sphalerite, galena and chalcopyrite with minor bornite and tetrahedrite) in stage II bedding sub-parallel veins within the Navajoh dolomite. Stage II fluids had

moderate homogenisation temperatures (97 to 189°C), high salinities (21.8 to 23.9 eq.wt % NaCl), and $\delta^{18}O_{(fluid)}$ values between 0.9 and 2.2‰, consistent with derivation from a connate brine. Wide variations in $\delta^{34}S$ values from stage II sulphides (-6.1 to 30.5‰) reflect a complex sulphur source consistent with a connate brine leaching a varied sedimentary package. Zinc ratio calculations suggest that minor variations in regional fluid chemistries and depositional processes resulted in varying levels of Pb and Zn saturation across the study area. Terrane-specific lead modelling techniques have constrained the age of stage II mineralisation to ~1780 to 1740 Ma. Preferential replacement of dolomite by silica along permeable layers caused an increase in fluid pH and resulted in sulphide precipitation with quartz in the center of the veins. Strong similarities in paragenetic sequences at each prospect through the study area indicate that stage II fluids were of regional scope, rather than discrete hydrothermal systems. Regional fluid flow is interpreted to have been driven by southwards-directed compression within the Capricorn Orogen on the north side of the basin.

Stage III consists of bedding-discordant quartz/carbonate veins with minor base metal mineralisation (pyrite, sphalerite, galena). Stage III fluids produced a second stage of silicification, and had higher homogenisation temperatures (108 to 246°C), but lower salinities (3.3 to 16.5 eq.wt % NaCl) than stage II. Calculated stage III $\delta^{18}O_{(fluid)}$ values obtained from quartz ranged from -9.9 to +13.3‰ and were probably due to fluid mixing, $\delta^{18}O$ buffering, and temperature variations. Most of the calculated stage III $\delta^{18}O_{(fluid)}$ values were between -1.3 and 5.5‰, consistent with a connate brine source similar to stage II fluids. Carbon-oxygen isotopic analyses of dolomite ($\delta^{13}C_{(fluid)}$ -4.9‰, $\delta^{18}O_{(fluid)}$ +2.0‰) concur with a connate brine source, and show that extensive fluid-rock interaction of stage III fluids and host dolomite occurred. Regional decreasing temperature gradients from the southeast to the northwest, and isotopic anomalies suggest that stage III mineralisation developed from connate brines that were redirected by comet impact at the Teague Ring. These fluids had the potential to remobilise stage II mineralisation.

Acknowledgements

I've firstly gotta thank Cookie for the immense time and effort he put into supervising this thesis. He began with a chemical moron and ended with an exhausted moron. Honestly Cookie, the work you put in is appreciated immensely by all of us no matter how ratty and irratable we may get sometimes (some of us.....lots of times!!). Cheers Cookie, thanx for everything. I also want to thank Bruce Gemmell for his helpful supervision and encouragement during the year. Actually thanks to **everyone** at CODES who has been so helpful and amicable throughout the year, I'll leave with heaps of great memories (and some a little more vague).

I'd also like to thank everyone at RGC who provided me with support, advice, and most importantly, beer. Special thanks to Bruce McQuitty who envisaged this project and provided the momentum for its instigation. Thanks also to Jamie, Simon, Jock, Paul and Bob for all the help and soccer.

Thanks heaps to Cathryn who helped so much and put up with me during these exceptionally stressful last few weeks and taught me about the neccesity of eating good food (any food!!). To the critters (;bad egg' was used), thanks for some very memorable social occasions during the year. Each event was quite respectable and invloved no debauchery and for that I thank-you, you are true gentlemen. Talking about the current crop of bad eggs, who can forget Jonty boy and Bad Lover who provided such a thrilling start to the year, cheers eggs. To all the honours crew, fist half and second, thanks for some great times.

Special thanks must also go to Annette and Simon in the rock store, Pete in the everywhere, and June with whom I played with during many a long freehand session, and Cathy in the rock store.

Most of all, thanks to my family who have always believed that I could go that one step further than the fish factory.

Bring on that hill!

Table of Contents