

The influence of gangue minerals on
the composition and mineralogy of
magnetite in high-grade metamorphic
iron ore deposits: Implications for the
Warrambooo deposit.

Thesis submitted in accordance with the requirements of the University of
Adelaide for an Honours Degree in Geology.

Kelsy J Dyer
November 2015



THE UNIVERSITY
of ADELAIDE

THE INFLUENCE OF GANGUE MINERALS ON THE COMPOSITION AND MINERALOGY OF MAGNETITE IN HIGH-GRADE METAMORPHIC IRON ORE DEPOSITS: IMPLICATIONS FOR THE WARRAMBOE DEPOSIT.

ABSTRACT

Understanding the influence that gangue minerals have on the composition and mineralogy of magnetite in high-grade metamorphic deposits is important for the sustainability of iron ore production in Australia. LA-ICP-MS and electron microprobe data from the granulite-facies Warramboe magnetite gneiss and the greenschist-facies Price Metasediments of the southeast Gawler Craton are used to investigate trace element partitioning between the oxide and gangue minerals, with a particular focus on the manganese content of garnet and magnetite. The data indicates that magnetite formed prior to garnet resulting in the partitioning of manganese and iron into magnetite, and consequently restricting these elements from garnet. However, during the development of garnet coronas on magnetite, manganese is redistributed into garnet leaving magnetite comparatively depleted in manganese. The partitioning of manganese during the growth of garnet coronas does not affect the iron content, or impact the ore grade, of the magnetite. Additionally, the proportion of garnet in the Warramboe magnetite gneiss and the Price Metasediments does not correlate with manganese content. The collection of HyLogger spectroscopic data to determine proportion and composition of garnet in the Warramboe gneiss was proven to be an ineffective technique. The HyLogger scanner did not correctly identify the mineral proportions in the samples, nor identify the presence of oxide minerals. By comparing the equivalent lower grade Price Metasediments to the Warramboe gneiss it was confirmed that the enrichment of magnetite through metamorphism did not remove impurities in the form of trace elements from the mineralogy. The results presented here will benefit industry to better understand high-grade magnetite deposits and the effect gangue minerals have on the grade of iron ore deposits.

KEYWORDS

Iron ore, Trace elements, Gawler Craton, LA-ICP-MS, HyLogger, high-grade metamorphism.

TABLE OF CONTENTS

The influence of Gangue Minerals on the composition and mineralogy of magnetite in high-grade metamorphic iron ore deposits: Implications for the Warramboe deposit.....	i
Abstract.....	i
Keywords.....	i
List of Figures and Tables	3
Introduction	4
Geological Setting	7
Gawler Craton	7
Warramboe iron deposit system	8
Methods	12
Petrography	12
Laser Ablation Induced Coupling Plasma Mass Spectrometry (LA-ICP-MS) and Electron microprobe (EPMA)	12
HyLogger	13
Results	14
Samples.....	14
SAMPLE 111512	14
SAMPLE 111516	14
SAMPLE IRD204-31A	15
SAMPLE IRD204-31B	16
SAMPLE IRD204-02B	16
Price Metasediments	17
SAMPLE WDH31541 (GARNET POOR).....	17
SAMPLE WDH41368 (GARNET RICH).....	18
HyLogger	20
Trace Elements.....	22
Magnetite textures overall.....	22
Garnet textures overall	24
Garnet against magnetite per sample.....	24
Rare Earth Elements (REE'S) normalised to chondrite.....	26
Impurities	28
Discussion.....	31
HyLogger as an effective tool.....	31

Rare Earth Elements.....	33
Mn correlation and the elemental partitioning during ore genesis.....	35
Impurities in Magnetite and Future Implications	37
Conclusions	39
Acknowledgments	39
References	1
Appendix A: Samples-Thin section slides.....	4
Appendix B: Images showing Laser analysis sites on all Samples	4
Appendix C: Raw LA-ICP-MS data processed through Glitter (ppm)	9

LIST OF FIGURES AND TABLES

Figure 1. Geology and TMI aeromagnetic imaging.

Figure 2. TMI aeromagnetic imaging of Warramboe deposit and location of samples.

Figure 3. Cross section of the deposit, showing structure.

Figure 4. Photomicrographs of samples in PPL and RL

Figure 5. HyLogger Data

Figure 6. Graph showing the iron against manganese content (ppm) for the magnetite of each sample and texture from Warramboe and the Price Metasediment.

Figure 7. Graph showing the iron against manganese content (ppm) for the garnet of each sample and texture from Warramboe and the Price Metasediment.

Figure 8. Binary diagrams of Fe55 against Mn57 content of both magnetite and garnet from each sample.

Figure 9. Spider diagram showing the Rare earth element patterns against the Chondrite normalised values for each minerals and its respective textures.

Figure 10. Graph showing the iron against aluminium content (ppm) for the magnetite of each sample and texture from Warramboe and the Price Metasediment.

Table 1. Comparison between HyLogger data and QXRD data.

Table 2. LA-ICP-MS Rare Earth Element data, averaged and normalised to chondrite.

Table 3. Averages of the data used for trace element figures with a full data set in

Appendix C.