Geophysical Research Abstracts
Vol. 14, EGU2012-6847, 2012
EGU General Assembly 2012

Raman Spectroscopic Characterisation of Australian Banded Iron Formation and Iron Ore

M.A. Wells and E.R. Ramanaidou
CSIRO, Australian Resources Research Centre (ARRC), 26 Dick Perry Av, Kensington, Perth, WA 6151

In Australia and world-wide over the past 5–10 years, declining reserves of premium, high-grade (>64% Fe), low-P bearing iron ore, have seen iron ore producers increase their utilisation of lower Fe-grade, higher P/Al/Si ore. In Australia, the channel iron deposits (CID), bedded iron deposits (BID) and, more recently, BIF-derived magnetite iron deposits (MID) have seen increased usage driven mainly by the increased demand from Chinese steel mills (Ramanaidou and Wells, 2011). Efficient exploitation and processing of these lower-grade iron ores requires a detailed understanding of their iron oxide and gangue mineralogy and geochemistry. The common Fe-bearing minerals (e.g., hematite, magnetite, goethite and kenomagnetite) in these deposits, as well as gangue minerals such as quartz and carbonates, are all strongly Raman active (e.g., de Faria et al., 1997). Their distinct Raman spectra enable them to be easily detected and mapped in situ in either unprepared material or samples prepared as polished blocks. In this paper, using representative examples of Australian CID ore, martite-goethite bedded iron deposit (BID) ore and banded iron formation (BIF) examined as polished blocks, we present a range of Raman spectra of the key iron ore minerals, and discuss how Raman spectroscopy can be applied to characterising iron ore mineralogy.

Raman imaging micrographs, obtained using a StreamLine Plus Raman imaging system, clearly identified the main Fe-oxide and gangue components in the CID, BID and BIF samples when compared to optical micrographs. Raman analysis enabled the unequivocal identification of diamond in the CID ore as a contaminant from the polishing paste used to prepare the sample, and confirmed the presence of hematite in the BID ore in the form of martite, which can be morphologically similar to magnetite and, thus, difficult to otherwise distinguish. Image analysis of Raman mineral maps could be used to quantify mineral abundance based on the number of 'pixels' identified for each phase normalised to the total number of 'pixels' for each area scanned.

Shifts in the main phonon lines of goethite and hematite mapped in the CID samples examined were used to estimate the Al substitution in these phases (e.g., Ramanaidou et al. 1996) which were consistent with electron microprobe data. The Raman data demonstrated the Al-free nature of hematite (0.5 mol% Al) and showed that goethite in the CID cortex was more Al-rich (10 mol%) than goethite in the CID matrix (3 mol% Al). Shifts in the excitation bands of carbonate mapped in the BIF sample were well related to the Mg content of Fe-carbonate, based on the work of Rividi et al. (2010) and confirmed by in situ spot analysis using energy dispersive spectroscopy (EDS) and scanning electron microscopy (SEM). This data confirmed the first world-wide occurrence of a high Mg-bearing siderite (pistomesite) in BIF.

Detailed, in situ characterisation of the iron oxide and gangue mineralogy of iron ore deposits as provided by Raman spectroscopy provides a step change to current characterisation methods. Understanding and defining their mineralogy and geochemistry is critical in developing strategies to best manage and process existing BID and CID ores, as well as the newly emerging MID ores.

References

De Faria, D.L.A., Silva, S.V. and de Oliveira, M.T. 1997. Raman microspectroscopy of some iron oxides and hydroxides. Journal of Raman Spectroscopy, 28, 873-878.

Ramanaidou, E.R., Tapley, V., and van Bronswijk, W., 1996. Determination of aluminium substitution in hematite and goethite by vibrational spectroscopy. in: Proceedings of the 2nd Australian Conference on Vibrational Spectroscopy, 2-4 October 1996, Queensland University of Technology, p. 35-36.

Ramanaidou, E.R. and Wells, M.A. 2011. Raman I Do – Raman spectroscopy for the mineralogical characterisation of banded iron formation and iron ore. In: Iron Ore 2011 Conference, The Australasian Institute of Mining and Metallurgy, 11-13 July 2011, Perth, p. 345-349.

Rividi, N., van Zuilen, M. Phillipot, P., Menez, B., Godard, G. and Poidatz, E. 2010. Calibration of carbonate composition using micro-Raman analysis: Application to planetary surface exploration. Astrobiology, 10 (3),

293-309.