

ELECTRON MICROPROBE STUDY OF MICROSTRUCTURE AND COMPOSITION OF HIGH TEMPERATURE SYNTHETIC SOLID METAL AND LIQUID METAL. Menghua Liu(1), Michael.E. Fleet(1), and Tassos Grammatikopoulos(2). (1)Department of Earth Sciences & Planetary Science Program, The University of Western Ontario, London, Ontario, N6A 5B7, Canada; (2)Department of Geology, University of Patras, Patras, 265 00 Greece. Email: mliu@uwo.ca

Microstructure and composition of high temperature synthetic solid metal and liquid metal have been studied by using back-scattered electron imaging and WDS quantitative analysis with JEOL JXA-8600 Superprobe. The solid metals and liquid metals were synthesized at different temperatures from 1000°C to 1400°C and they showed corresponding microstructure features under electron microscope. Some siderophile elements in trace amounts were added in the experimental starting material and partition in the two equilibrium phases – solid metal and liquid metal. The concentrations of the trace siderophile elements in solid metal and liquid metal have been obtained by WDS quantitative analysis with an electron microprobe. The partition coefficients of the trace siderophile elements between solid metal and liquid metal that is a significant indicator of metal behaviour have been calculated based on the quantitative composition analysis[1].

Solid metal are blebs and cones, and liquid metal are quenched alloy dendrites and quenched final liquid of fine-scale mixture of sulfide-alloy under electron microscope. The content of solid metal increased with increasing temperature from 1000°C to 1400°C. The proportion of quenched alloy dendrite in liquid metal increased and quenched final liquid in liquid metal decreased with increasing temperature. Some quenched rims enclosing blebs of solid metal were observed (Fig.1). Good evidence for a quenched origin for these products is their continuity with quenched alloy dendrite. In most cases, blebs of SM were homogenous and well equilibrated with LM (Fig. 2).

Since the dendrites were not distributed evenly, dendrites and final liquid were analyzed separately. Dendrites were analyzed by focussed beam and quenched final liquid by the beam rastered over an area of $\sim 20 \times 30 \mu\text{m}^2$. And then, the modal proportion of dendrite and final liquid were obtained by digital analysis of backscattered electron images and were converted into weight proportions by combining density of dendrite and final liquid. The method of analyzing separate fractions proved extremely difficult for liquid metal at 1400°C that was very rich in dendrite and had a very small fraction of final liquid. Firstly, the above area method was used for analysis, but instead of the beam rastered over an area, a focussed beam was used to analyze the final liquid since there were no large areas for raster analysis. It was noticed then that final quenched liquids of experiments with Sn and Ag were extremely heterogeneous. Therefore, the method of analysis was changed to raster the beam over a sufficiently large area ($\sim 35 \times 45 \mu\text{m}^2$) to cover both dendrite and final quenched liquid. The two methods of analysis achieved similar decent results.

The study of composition combining microstructure of high temperature synthetic solid metal and liquid metal concludes: When the molar fraction of S in LM approaches 0 in the Fe-S and Fe-Ni-S systems, the siderophile affinity for siderophile elements is in the order:

Ru>Pt>Os>Re>Ir>Ga>Ni>W>Mo>Ge>Si>As>Au>Pd>Sn>Ag

The sulfur-avoidance affinity for siderophile elements in the Fe-S and Fe-Ni-S systems varies from strong to weak (i.e. increasing chalcophile tendency) as follows:

Os>Re>Ir>Si>Ru>Pt>W>Ge>Ga>As>Mo>Au>Pd>Ni>Sn>Ag

References

[1] Menghua Liu and M.E. Fleet. *Geochimica et Cosmochimica Acta* (2001) 65, 671-682



Figure 1. EPMA backscattered electron image of iron alloy blebs of SM (white) in quenched LM. Darker rims on the blebs crystallized during quenching. Experiment at 1200 °C with minor abundances of W and Si.

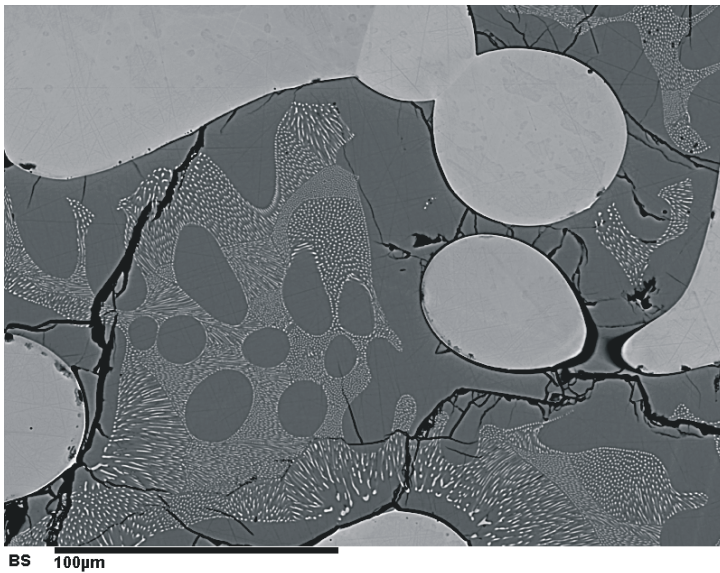


Figure 2. EPMA backscattered electron image of iron alloy blebs of homogeneous SM (light grey) in quenched LM consisting of only final liquid (fine-scale quenched sulfide-alloy material). Experiment at 1000 °C with minor abundances of Ge.