Chromite chemistry in SNC meteorites

Conference or Workshop Item

CHROMITE CHEMISTRY IN SNC METEORITES. J. C. Bridges and M. M. Grady, Dept. of Mineralogy, Natural History Museum, London SW7 5BD, UK. (j.bridges@nhm.ac.uk).

Introduction: We present the results of new EPMA studies of chromite in primitive basaltic shergottites (SAU005, EETA7001A, DAG476) and ALH84001 and Chassigny. Chromite grains from basic and ultrabasic rocks are sensitive indicators of melt compositions and the Fe^{3+}-Cr-Al compositions of the cores can help to distinguish between partial melting and crystal-melt fractionation histories in the SNC parent melts.

Results and Discussion: SAU005, DAG476 and EETA79001(A) have overlapping, limited ranges of chromite core compositions with 100Cr/(Cr+Al) atomic ratios of 74-87, $100Mg/(Mg+Fe^{2+})$ 12-36 and $100Fe^{3+}/(Fe^{3+}+Cr+Al)$ 0-5. TiO_2 contents are ≤ 1 wt%. Chromite in the lherzolitic shergottite ALHA77005 has similar compositional patterns [1]. In contrast, the outer rims of chromite in these meteorites' groundmasses show Ti-enrichment. Rims of chromite in the groundmass have TiO_2 ≤ 18 wt% and high and low $100Fe^{3+}/(Fe^{3+}+Cr+Al)$ ratios of either 14-20 or 1-4 related to the presence of a miscibility gap [2]. However, X-ray mapping and point analyses of chromite grains enclosed within megacryst olivine grains of the basaltic shergottites did not show the Ti-enrichment which appears to be a feature of exposure to fractionated melt compositions [1,3].

ALH84001 and Chassigny chromite grain core compositions have 100Cr/(Cr+Al) 77-83 and 73-89; $100Mg/(Mg+Fe^{2+})$ 16-21 and 12-19; $100Fe^{3+}/(Fe^{3+}+Cr+Al)$ 4.5-10 and 4-10; and TiO_2 ≤ 2.7 and 5.4 wt%.

These results are shown on a Fe^{3+}-Cr-Al diagram (Fig. 1). The basaltic shergottite chromite core data (plotted together here) show no signs of melt fractionation, the limited Cr-Al variation, low Ti contents and lack of Fe^{3+} enrichment indicate that the chromite chemistry has a partial melting control and reflects the Al-depleted martian mantle source composition. For this reason the 100Cr/(Cr+Al) ratios of SNC chromite are high compared to those of basic rocks on Earth e.g. MORB chromite has ratios of 30-60 [4]. The shergottite chromite $100Mg/(Mg+Fe^{2+})$ ratios are consistent with equilibration with co-existing olivine of Fo_{60-80} at 1200°C [4]. Such olivine is present in the megacrysts of the primitive basaltic shergottites and in the lherzolitic shergottites [5]. The 100Cr/(Cr+Al) ratios of ALH84001 and Chassigny overlap those of the shergottites. The clearest distinguishing feature is the higher Fe^{3+} and Ti contents in the cores of Chassigny and ALH84001 chromite grains, which are characteristic features of shallow level fractional crystallization. Chromite chemistry shows the parent melts of the shergottite megacryst assemblages and similar lherzolites did not undergo this and were close to the compositions of partial melts from the martian mantle.

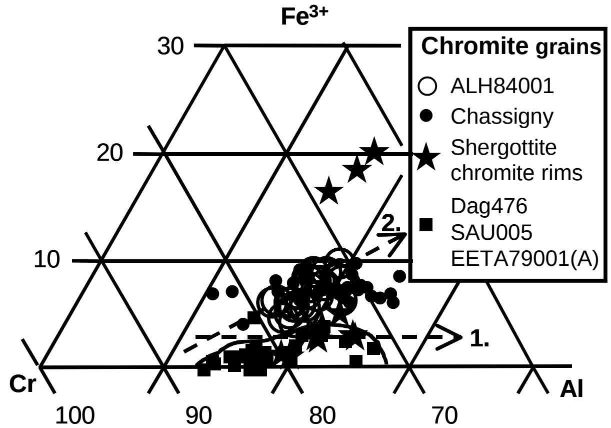

Figure 1. Fe^{3+}-Cr-Al at. compositions of chromite grains from basaltic shergottites (EETA79001A, DAG476, SAU005, 3 meteorites plotted together in field), ALH84001 and Chassigny. Arrow 1. is partial melting line, 2. is fractional crystallization trend for chromites [4]. Rims of chromite grains in shergottites show Ti-enrichment and sometimes Fe^{3+} enrichment. EPMA analyses Cameca SX50 at 20 kV, 25 nA and JEOL 5400 ASEM.

References: [1] McSween H. Y. and Treiman A. H. (1998) in *Planetary Materials* (ed. J. J. Papike) Min. Soc. Am. [2] Sack R. O. and Ghiorso M. S. (1991) *Am. Mineral., 76,* 827-847. [3] Goodrich C. A. (2001) *LPS XXXII,* #1166. [4] Dick H. J. B. and Bullen T. (1984) *Contrib. Mineral. Petr., 86,* 54-76. [5] Wadhwa R. C. et al. (2001) *Meteoritics & Planet. Sci., 36,* 195-208.