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An EMPA investigation of the redox state of natural glasses from mantle xenoliths and mantle-derived boninitic magmas.
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The recent developments of the electron microprobe analytical procedures in our laboratory allow the direct measurement of the glass ferric-ferrous ratios at a scale of a few micrometer. The determination of the oxidation state of iron is based on the measure of the self-absorption induced shift of the emitted Fe L peak [1, 2, 3]. This method is well suited for the study of glassy phases of few tens of squared micrometers disseminated in a mineral matrix. It can be operated on common petrographic thin sections and, thus, it can be easily coupled with conventional chemical analyses by electron probe microanalysis (EPMA). This latter point is essential because the total Fe content of the glass must be precisely measured by EPMA to scale the corresponding Fe-L [U+F020] peak position relative to the calibration curves giving the Fe3+/SFe ratios.
The samples studied are spinel lherzolite from the French Massif Central, and low Ca type 1 boninites from dykes cutting serpentinized peridotite at Népoui, New Caledonia.
Glass occurs commonly in mantle xenoliths as small (<10 micrometers) patches in reactional rims but its origin remains controversy and has been interpreted in relation to mantle processes or to interactions with the xenolith host magma. We have previously demonstrated that these xenoliths have been metasomatized, and that the glasses are reaction products between mantle phases and migrating melts [3, 4]. The consensus emerging from different studies is that metasomatism is oxidizing relative to both primitive shallow (spinel-bearing) and deep (garnet-bearing) lithosphere [5, 6, 7]. It is thus of great interest to measure directly the glass ferric-ferrous ratios at a scale of a few μm. In the lherzolite, the glassy pockets formed around primary spinel contain small (10-30 micrometers) secondary phases and abundant bubble-like voids, suggesting a former high content of volatiles removed during degassing. The glasses have a phono-tephrite to trachy-andesite, a composition in the range of that reported for world-wide peridotite xenoliths [6], with low FeO ($\sim$3 wt.%) and H2O (< 1wt.%) contents. The boninites contain abundant (48 vol. %) fresh glass of dacitic composition with low FeO (2 wt. %) and rich in H2O ($\sim$5-6 wt. %). In both samples, the glass is in contact with Cr-spinel which shows (in mantle xenolith) or not (in boninite) a sieve-textured rim resulting from a coupled dissolution-precipitation process. The secondary spinels of the rim are enriched in Cr and depleted in Al. With or without a sieve-textured rim, the spinel shows a hematite rim at the contact with the glass.
The high (0.6-0.8 $\pm$0.04 at 1sigma) [U+F020] EMP Fe3+/SFe ratio measured in the glass from the lherzolite samples strongly contrasts with the calculated melt fO2 (FMQ $\pm$ 1) from the composition of secondary phases. Thus, the measured ratio does not reflect the original redox state of the migrating melt but is consistent with the late-stage reworking of the sample under oxidized conditions (hematite deposition).
Measuring the Fe3+/SFe ratios in highly hydrated glasses, such as those in boninite (up to 6 wt% H2O) is

challenging, due to beam damage caused during the analysis. Nevertheless values in the range Fe3+/SFe=0.7-0.8 were measured for the glass, in good agreement with the Fe3+/SFe ratios for the iron oxides formed as late epitaxial layers grown onto the early cristallized spinels.

[1] Fialin et al. (2001) Am. Mineral. 86, 456-472. [2] Fialin et al. (2004) Am. Mineral., 89,654-662. [3] Wagner et al. (2008) Am. Mineral., 93, 1273-1281. [3] Wagner and Deloule (2007) Geochim. Cosmochim. Acta, 71, 4279-4296. [4] Wagner and Fialin (2008) Goldschmidt Conf. 2008, Geochim. Cosmochim. Acta. 72, A990. [5] Balhaus et al. (1991) Contrib. Mineral. Petrol., 107, 27-40. [6] Amundsen and Neumann (1992) Redox control during mantle/melt interaction. Geochim. Cosmochim. Acta, 56, 2405-2416. [7] Creighton et al. (2009) Contrib. Mineral. Petrol., 157, 491-504. [6] Coltorti et al., 2000, EPSL, 183, 303-320..