Redox state of the molten Earth's mantle

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We will present two complementary ongoing projects sharing the common goal of refining our knowledge on the redox state of the hot Earth's mantle. In both cases, we identify the need for a sub-micron X-ray beam at the ID-18 beamline of the ESRF in order to perform *in situ* determination of the Fe^{3+}-content, using Mossbauer spectroscopy, of the nanograins present in our samples.

(i) Mantle redox state after crystallization of the magma ocean: The redox state of the deep mantle is complicated by the great affinity between Fe^{3+} and Al^{3+} in the $(Mg,Fe)(Si,Al)O_3$ bridgmanite, which induces the Fe^{2+} disproportionation into Fe^{3+} and Fe^0. The coexistence of Fe^0 and Fe^{3+} in the largest Earth's reservoir is likely to have dominated the redox state of the entire planet along its history. An experimental challenge remains the determination of phase relations, in particular the Fe^{2+} and Fe^{3+} partitioning, between different solid and liquid phases generated at very high pressures and temperatures in the laser heated diamond anvil cell.

(ii) Redox state of magmas and of their mantle sources: There is an on-going debate about the origin of the variations in $Fe^{3+}/\Sigma Fe$ of magmas. It could arise owing to differences in mantle fO_2 or to late differentiation processes occurring close to the Earth's surface. We have access to highly primitive magmas trapped as melt inclusions in pristine mantle olivines, which can provide unique information about the redox state of Fe in mantle sources. For this, we need a careful $Fe^{3+}/\Sigma Fe$ characterization of the melt inclusions that are often smaller than 20µm and a complex reservoir of various glassy, crystalline and/or fluid phases. It would definitely improve our understanding of the processes involved in the production of magmas.