Geophysical Research Abstracts
Vol. 12, EGU2010-574, 2010
EGU General Assembly 2010

Europium in silicate glasses at different oxygen fugacity

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Synthetic silicate glasses corresponding to compositions relevant for the Earth sciences were used to study the dependence of the redox states of a Rare Earth Element (Eu) on the bulk melt composition and at different values of oxygen fugacity (from air to IW-2).
Rare Earth Elements (REE) have demonstrated to be important geochemical indicators; in fact, the distribution of REE in igneous rocks are frequently used to constrain the mineralogy of the source materials, the degree to which magma composition has been modified by crystal fractionation, and to identify the mineral phases removed from the magma during differentiation. Moreover, the variation of the Eu+2/(Eu+2 + Eu+3) ratio can be used to determine the oxygen fugacity conditions prevailing during mineral formation. As the Eu+2/Eu+3 buffer is located at very low oxygen fugacity, the Eu+2/(Eu+2 + Eu+3) ratio can be used to constrain the formation conditions within a very large range of oxygen fugacity down to few log units below the Fe/FeO buffer. The Eu+2/(Eu+2 + Eu+3) ratio is therefore very useful in the study of meteoritic material and in studying planetary evolution.
The samples have been analyzed via Eu LIII-edge X-ray Absorption Spectroscopy (XAS) to study the Eu oxidation state and environment. Eu LIII-edge XANES peak analysis allowed the semi-quantitative assessment of Eu redox ratio; literature data report a difference of 7 – 8 eV between Eu+2 and Eu+3 in the experimental spectra and this energy shift is evident enough to well differentiate between the two oxidation states and to determine the Eu oxidation state in the glasses under investigation. Moreover, the Eu LIII-edge EXAFS data allowed to determine the structural environment around divalent and trivalent europium in the studied glasses.
A complete understanding of transition and REE elements is important for the geochemical and petrological interpretations of magmatic processes and partition properties between melt and crystals.