

Role of garnet and amphibole fractionation in the genesis of high Mg# granitoids

O. MÜNTENER^{1*}, P. ULMER² AND R. ALONSO PEREZ²

¹Institute of Mineralogy and Geochemistry, University of Lausanne, Switzerland

(*correspondence: othmar.muntener@unil.ch)

²Institute of Mineralogy and Petrography, ETH Zürich, Switzerland

In this contribution we examine experimental phase equilibria relevant for the differentiation of primary and derivative arc magmas of the deep roots of island arcs to test the role of amphibole and garnet on the genesis of high Mg# granitoids. Contrary to differentiation at relatively shallow pressures (below ~ 0.7 GPa), where fractionation of Fe-Ti oxides plays an important role on the Mg# of derivative liquids, high pressure experimentation on H₂O undersaturated liquids demonstrate that oxide fractionation is less important compared to the role of amphibole and garnet. Garnet has a rather high Fe/Mg solid/liquid partition coefficient (0.78-0.92 at 0.8-1.5 GPa) and tends to produce 'high-Mg' liquids unlike amphibole that has considerably lower K_d's (0.32-0.45 at 0.8-1.5 GPa), comparable to olivine and pyroxenes and, thus, extracts Mg more efficiently leading to higher FeO*/MgO liquids at a given SiO₂-content. Bulk rock data from the plutonic rocks from the Alps and the Kohistan batholith indicates that high Sr/Y granitoid rocks display lower FeO*/MgO at a given SiO₂ than comparable rocks with low Sr/Y ratios, supporting a potential role of garnet in producing "high-Mg# granitoids". New experimentally determined trace element partition coefficients on garnet and amphibole, and straight forward trace element models using these partition coefficients demonstrate that fractionation of garnet and amphibole exert an important control on geochemical ratios (e.g. La/Yb, Sr/Y and Nb/Ta) on derivative liquids. We will discuss possible processes where amphibole and/or garnet are involved (e.g. lower crustal dehydration melting of amphibolite, amphibolite melting in subduction zones, high pressure fractionation) and propose that the physically most plausible explanation are fractionation processes in the roots of island arcs, either in the lowermost crust or the uppermost mantle. We thus concur with Annen *et al.* (2006) that the bulk of the major and trace element signatures of island arc plutonic rocks is acquired in 'arc hot zones'.

Atmospheric oxygen rise in the Paleoproterozoic revealed by weathering model

TAKASHI MURAKAMI AND KOHEI YOKOTA

Department of Earth and Planetary Science, the University of Tokyo, Tokyo 113-0033, Japan

(murakami@eps.s.u-tokyo.ac.jp,

yokota@eps.s.u-tokyo.ac.jp)

It is widely accepted that the atmospheric oxygen level increased between 2.5 and 2.0 Ga. However, the exact quantitative pattern of the increase has remained highly elusive. Paleosols, containing records at the time of weathering, can be a powerful tool to estimate atmospheric oxygen levels quantitatively. The behavior of Fe during weathering was modelled and the model was applied to Fe(II) and Fe(III) concentrations in paleosols to estimate atmospheric oxygen levels between 2.5 and 2.0 Ga.

The model considers the factors affecting dissolved Fe(II) concentrations in a weathering profile which are: i. dissolution rates of Fe(II)-bearing primary minerals, ii. oxidation rates of dissolved Fe(II), and iii. flow rates of ground water. The assumptions for the model are: (a) a weathering profile is formed horizontally and weathering proceeds normal to the surface, (b) ground water and thus Fe(II) flow one-dimensionally and horizontally, (c) Fe(II) dissolved from primary minerals remains in the profile as oxidized and instantaneously precipitated Fe(III) or flows out of the profile as dissolved Fe(II), and (d) rate-controlling factor of the formation of Fe(III) secondary minerals is the oxidation of dissolved Fe(II).

A change in Fe(II) concentration in a weathering profile is expressed by $d[\text{Fe(II)}]/dt = f + g + z$ (f: oxidation term, g: ground water flow term, z: dissolution term) (1). The total amounts of Fe(II) dissolved and flowing out were calculated based on equation (1), and then, the relationships between phi values and atmospheric oxygen levels were derived where phi was defined as a ratio of a total amount of oxidized Fe(III) from dissolved Fe(II) to that of Fe(II) dissolved from primary minerals. The calculated relationships were applied to those observed in laboratory (Sugimori, 2007), which verified the validity of the model. Then sensitivity analysis of the model by changing the parameter values was carried out, which reveals that pH and ground water flow rate are the main factors that affect Fe behavior during weathering. The model applied to the phi-age relation obtained from paleosols reveals that the atmospheric oxygen levels increased gradually, linearly on the logarithmic scale, from about 10⁻⁶ to 10⁻³ atm between 2.5 and 2.0 Ga.