Metasomatic processes of Paleozoic lithosheric mantle of Scotland Terranes

M. COLTORTI [1], C. BONADIMAN [1], P.G. HILL[2], L. PALUDETTI [1] AND B.G.J. UPTON[2]

[1]Department of Earth Sciences, University of Ferrara Italy (clt@unife.it)
[2]Grant Institute of Earth Science, University of Edinburgh, U.K. (Brian.Upton@glg.ed.ac.uk)

Mantle melting events occurring intermittently from the late Carbonifeous to mid-Permian in northern and north-western Scotlandand relate on lithospheric extension, generated small volumes of silica-deficient basic magmas, which in some case, contain peridotitic xenoliths The present work concerns mantle peridotites from several localities of the Northern Highlands Terrane (Rinibar,Orkney- and Streap Com'laidh) of Midland Valley Terrane (Rudduns Point). A comparison with rare peridotite xenoliths from Hebridean Terrane, Grampian Highland Terrane and Southern Uplands Terrane which also experienced variable metasomatic enrichment is also put forward, with the aim of studying the evolutionary history of Scottish lithospheric mantle and highlighting the metasomatic agents which affected this portion of mantle during Paleozoic. Attention was mainly focussed on major and trace element contents of minerals, namely clinopyroxenes. In the Northern Highland Terrane, clinopyroxenes from Streap Com'laidhare less LREE-enriched and present less pronounced Ti and Zr anomalies (La/YbN 2.8-4.5; Zr* 0.42-0.57; Ti* 0.57-0.62) than clinopyroxenes from Rinibar. Clinopyroxenes from Rinibar have been variably enriched in LREE, with La/YbN ratios ranging from 2.7 to 32.2. Remarkable Ti and Zr negative anomalies, although to variable extent, are noticed (Zr* 0.10 - 0.86; Ti* 0.07 - 0.28). Phlogopite is present, and can account for the pronounced Ti negative anomaly in some clinopyroxenes.Two different enrichment styles can be identified in the Orkney's lithospheric mantle: one presenting LREE-enrichment and remarkable Zr (and Hf) and Ti negative anomalies, the other with LREE-depletion (compared to MREE) and less pronounced Ti (and Zr) negative anomalies, associated with the presence of high-TiO_2 phlogopite. The two kind of clinopyroxenes compare well with clinopyroxenes related to carbonatite and kimberlite metasomatism respectively. A progressive enrichment processes may also be envisaged between clinopyroxenes in xenoliths from Midland Valley Terrane, and those from Hebridian Craton.

REE distribution in grandites from the Crown Jewel gold skarn deposit: A LA-ICP-MS study

M.G. GASPAR[1,2], C. KNAACK[1], L.D. MEINERT[3] AND G. OTTONELLO[4]

[1]Department of Geology, Washington State University, Pullman, USA (mgaspar@mail.wsu.edu, knaack@wsu.edu)
[2]CREMINER, GeoFCUL, Lisboa, Portugal
[3]Department of Geology, Smith College, Northampton, USA (Lmeinert@smith.edu)
[4]Dipartimento per lo Studio del Territorio e sue Risorse, Università di Genova, Italy (giotto@dipteris.unige.it)

Garnets from the Crown Jewel Au-skarn deposit, north-central Washington, range in composition from $Adr_{30}Gr_{70}$ to almost pure andradite ($Adr_{>99}$). Fe-rich garnets are isotropic whereas Al-rich garnets significantly deviate from cubic symmetry and are anisotropic, often showing sectorial dodecahedral twinning.

In situ LA-ICP-MS analyses of those garnets reveal a positive correlation of ΣREE^{3+} (<1-47 ppm) with Al content (0-2.6 a.p.u.f.), and consequently with their grossular component. REE patterns for Al-rich garnets show HREE-enrichment and LREE-depletion, and weak positive and negative Eu anomalies. Fe-rich garnets ($Adr_{>90}$) have much lower ΣREE and exhibit LREE-enriched and HREE-depleted patterns, with a strong positive Eu anomaly. Presence of magnetite, implying a reduced environment with fO_2 below the HM buffer, indicates that Eu is present as Eu^{2+}, which in part explains its different behaviour from the other REEs and the consequent Eu/Eu* anomalies. Incorporation of REE into garnet is partially controlled by its crystal chemistry. REE^{3+} follow a coupled, YAG-type substitution mechanism ($[X^{2+}]^{VIII}_{-1}[REE^{3+}]^{VIII}_{+1}[Si^{4+}]^{IV}_{-1}[Z^{3+}]^{IV}_{+1}$), while Eu^{2+} substitutes for X^{2+} cations. Thermodynamic data (*e.g.*, Hmixture) suggests preferential incorporation of HREE in grossular and LREE in andradite.

Textural evidence, optical characteristics and major and trace element geochemistry, show that variations observed in the Crown Jewel garnets are largely controlled by external factors (fluid composition, W/R ratios, mineral growth kinetics, and diffusive vs. advective metasomatism). The data are consistent with Al-rich garnets being formed by diffusive metasomatism, under low W/R ratios, and in equilibrium with metasomatic fluids whose composition is locally buffered by the host rocks. On the other hand, Fe-rich garnets growth rapidly by advective metasomatism, under relatively high W/R ratios, and in equilibrium with a magmatic-derived fluid, consistent with an increase in porosity by fracturing.