Geochemistry of the Othris Ophiolite, Greece: Towards a solution of the "ophiolite conundrum"

M. G. BARTH[1], P. R. D. MASON[1], G. R. DAVIES[2], AND M. R. DRURY[1]

[1] Faculty of Earth Sciences, Utrecht University, The Netherlands (barth@geo.uu.nl)
[2] Faculty of Earth and Life Sciences, Free University Amsterdam, The Netherlands (davg@geo.vu.nl)

Ophiolites are markers of past plate tectonic activity and have helped to reconstruct aspects of ocean crust formation that cannot be studied through deep sea drilling or dredging. However, there is ongoing debate as to what tectono-magmatic process ophiolites exactly represent (e.g., Shervais, 2001).

The Othris Ophiolite, Central Greece, shows conflicting evidence for an intra-oceanic and a supra-subduction zone (SSZ) tectonic setting with the presence of plagioclase lherzolite that may represent an area of either incomplete melt extraction or melt impregnation and accumulation. Of particular interest is how the degree, style (dry vs. hydrous), and age of partial melting have varied with respect to the position (and depth) within the ophiolite. This study aims to systematically resolve the presence of mid-ocean ridge (MOR) and/or SSZ signatures in the mantle section of the Othris peridotite massif. Different rock-types have been studied within selected sub-massifs in order to quantify local (100m) and regional (10km) variations in the extent and style of partial melting.

A 3 km continuous section of the Fournos Kaïtsa sub-massif, consisting of layers of harzburgite, plagioclase harzburgite and plagioclase lherzolite provides accurate stratigraphic, structural, and petrographic control. Mineral major and trace element concentrations show refractory, Cr-rich spinel compositions and depleted clinopyroxene rare earth element (REE) patterns in the harzburgites, which are consistent with ~15% partial melting in the spinel stability field. Simple batch and fractional melting models are not sufficient to explain the composition of residual phases and a polybaric hybrid batch-fractional model with some melting in the garnet stability field is proposed. The plagioclase peridotites have higher Ti and REE contents in the pyroxenes but similar refractory spinel compositions to the harzburgites, indicating that they may be products of impregnation of harzburgites with a fractionating melt. These observations are in good agreement with previous structural studies and suggest that the moderately depleted mantle section of the Fournos Kaïtsa block most probably originated at a slow-spreading mid-ocean ridge. Geochemical data will be presented from other peridotitic and crustal sections, stressing that Othris was formed in more than one tectonic setting.

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Chemistry of high-temperature fluids in Fe-oxide Cu-Au systems

E. N. BASTRAKOV[1], V. KAMENETSKY[2], R. G. SKIRROW[1], & T. P. MERNAGH[1]

[1]Geoscience Australia, GPO Box 378, Canberra, ACT 2601
[2]School of Earth Sciences, University of Tasmania, GPO Box 252-79, Hobart, Tasmania 7001

The Stuart Shelf basement of the Gawler Craton of South Australia hosts the giant Olympic Dam Cu-U-Au deposit, as well as a number of small Cu-Au±U prospects. Regionally, two types of alteration assemblages are associated with the Cu-Au mineralisation: (1) calcsilicate – alkali feldspar ± magnetite ± pyrite ± chalcopyrite (CAM), and (2) hematite – sericite – chlorite – carbonate ± pyrite ± Cu-Fe sulphides ± U, REE minerals (HSCC). Significant Cu-U-Au mineralisation is associated with the relatively oxidised and lower temperature HSCC assemblage.

The CAM alteration stage is characterised by three petrographically distinct fluid inclusion types: multiphase brine inclusions (V+L+nS, MBI), liquid-dominated inclusions (L+V), and vapour-dominated inclusions (V+L). MBI are considered to be primary inclusions associated with CAM. Identified solid phases in MBI include halite, ferropyrosmalite, calcite, trioctahedral K-Na mica, iron oxides, and chalcopyrite. Salinity of the aqueous phase in MBI is in the order of 40 wt% NaCl equiv. Upon heating, MBI tend to decrepitate at temperatures above 400ºC, prior to complete homogenisation. Previously reported quartz-magnetite isotopic temperatures for CAM are 510–550ºC. PIXE analysis of chalcopyrite-free MBI suggest that the tapped fluids transported up to 500 ppm Cu. The Br/Cl ratios (0.003–0.1) lie beyond the range of typical magmatic values, and are permissive of sedimentary basin or crystalline basement brine origins.

These observations are in contrast with data on magmatic-hydrothermal fluids associated with melt inclusions in quartz phenocrysts of the Gawler Range Volcanics and comagmatic Roxby Downs granite, which hosts the Olympic Dam deposit. At a late magmatic stage, our data suggest co-existence of silicate and silica-carbonic melts, hypersaline brine, and CO_2-rich fluid. These data imply a two-stage evolution of hydrothermal system at the Olympic Dam, with a change from a relatively high-pressure CO_2-rich fluid system to a lower pressure CO_2-poor fluid system. The transition could have occurred as temporally separate events, or as a result of system depressurisation accompanied by CO_2 loss.

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