The FE-EMPA – Applications for the sub-micron analysis in geosciences

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The use of a thermal field-emission cathode in an electron microprobe (JEOL Hyperprobe JXA-8500F) has opened a new window in the analysis of structures in the sub-micron range. Small electron-probe beam size (< 50 nm) with variable probe current (5–200 nA) at low accelarating voltage (5–10 keV) allow a sub-micron spatial resolution for single spot analyses and detailed X-ray mapping of composition contrast in the range of 100 nm. The results are afflicted by reduced intensities of the X-rays (high energy K-lines are not excited, demanding the use of L- and M-lines), peak overlapping, a higher current density, and contamination. The quality of the sample polish and the thickness of the coating layer are essential. New measurement strategies and unconventional approaches are required to overcome these problems.

A selection of examples should demonstrate the improved possibilities of the FE-EMP as a tool between conventional EMP and TEM:

- Measurement of the chemical composition and the internal zoning of exsolution lamellae and symplectite in feldspars.
- Characterization of small reaction rims in natural samples in order to study the transport mechanism for the rutile-titanite transformation via a fluid phase.
- Study of the complex, diffusion-controlled growth of orthopyroxene reaction rims (zonation of Fe and Mg).
- Investigation of inclusions in minerals (unaffected by their host) down to 500 nm size, depending on composition and density.
- "Chemical" age dating of Th–U-containing minerals occurring as microinclusions in other minerals.
- Characterization of complex zoning patterns of small areas in accessory minerals (zircon, monazite, xenotime, etc.).

Preliminary characterization of São Jorge island mantle source (Azores)

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The Azores archipelago, formed by nine islands spread along the Azores Plateau, is situated in a complex tectonic setting, containing the junction of three tectonic plates, the American, Euroasiatic and Nubia plates. East of the MAR is located the central group island where São Jorge island developed (38º46' – 38º33'N and 28º20' – 27º45'W). This is an elongated shape island (WNW-ESE) with aligned volcanic cones and dikes unveiling the importance of the regional tectonic setting during volcanic activity. Stratigraphically, the island developed during three main volcanic phases (Forjaz & Fernandes, 1975), giving place to Topo complex in the SE, Rosais complex in the NW and to Manadas complex that covered the centre of the island.

São Jorge lavas are dominantly alkaline with $Y/Nb \leq 1.0$, and experience some degree of differentiation extending from basanite and tefrite to basaltic trachyandesite composition. The analyses of REE and incompatible elements of the more primitive samples ($Mg\# \geq 0.44$ and $Ni \geq 110$ ppm) can be good indicators of the petrogenesis of the three complexes.

The REE diagram shows LREE enrichment, relative o HREE, as is common in ocean island where garnet is present in the source. We also found, in Topo complex , differences between Caldeira and Cubres sequences as for instance REE ratios [(Tb/Yb)n] and incompatible elements patterns. Primitive lavas from Rosais, when compared with other lavas, are relatively enrich in La, Rb, Ba and Th contrasting with only a small K anomaly and relatively high Ba/Ce ratio. This could be explain if during partial melting Rosais lavas sampled a slightly different compositional source, constituted by a K enriched phase as reported in other Azores islands as Corvo (França *et al*., 2006) and Atlantic islands (Halliday *et al*., 1995, Ribeiro, 2001).

The question is how source composition and partial melting affected magma composition in these continuous lava sequences and the relation with the remaining Azores islands and seamounts in the Azores region.

References

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