Natural and experimental multiscale F diffusion profiles in biotites from the Serido micaschists, Northeastern Brazil

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We examined the F distribution in Seridó Fold Belt biotite at the regional, contact, and grain scale through electron probe microanalysis. At the regional scale biotites show largely homogeneous F contents varying from 0.30 to 0.40wt%. The uniform concentration suggests the biotites equilibrated with F-poor fluids (log fH_2O/fHF = 4.5 to 5.0) at upper amphibolite metamorphic conditions. At the contact with pegmatoid intrusions, schist biotites are enriched at different levels F= 0.5 to 2.5wt%, similar to those observed for biotites in the pegmatoid biotites. This suggest that schist biotites were locally reequilibrated at 600-700°C by pegmatoid related F-rich fluids (logfH_2O/fHF = 3.8 to 4.3).

At pegmatoid contacts the F contents of schist biotites decrease to background contents in metric and centimetric diffusion profiles. At the Areias pegmatoid sill the F content of biotites decrease from 0.95wt% to the regional background F=0.30wt% in 2.5m. In the same distance the F contents of amphiboles decrease from 0.47 to 0.32wt% and apatites show a near constant content F=2.8-3.0wt%. At the Pedra Lavrada pegmatoid stock the F content from biotites in a schist enclave decrease from F= 0.43 to 0.37wt% in the narrow range 20 cm. The obtained diffusion profiles can be related to the interplay of three major factors: (i) fluid fH_2O/fHF chemical gradient, (ii) thermal gradient and (iii) fluid advection into micaschists.

AFSQ-buffered experiments on a mixture of two Seridó biotites (F=0.3 and 2.5wt%) at 750ºC, 0.4 GPa produced strong F zonation. X-ray maps show zontations from F-rich borders to F-poor cores, with F-rich incursions along the c-perpendicular direction. A 40 micron profile perpendicular to the c-axis from F=3.0wt% on the border to F=0.5wt% in the core was fitted using $C_i = 1 - C_0\ \mathrm{erf}[x\ (4D)^{-1/2}]$ to produce an F diffusivity in biotite $D = 2.75 \times 10^{-15}\ m^2/s$. The value is 1 order of magnitude higher than F diffusion in apatite and 4 orders higher than F diffusion on tremolite. The constant F contents of apatites at the Areias sill should be related to its poor cleaved non permeable structure.

The Geochemical Atlas of Europe – Continent-wide distribution patterns of elements

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The European geochemical baseline survey covers 26 countries, and provides invaluable information about the natural and human-induced concentrations of chemical elements in different sample media of the near-surface environment (topsoil, subsoil, humus, stream sediment, stream water and floodplain sediment). This is the first multi-national project of its kind – performed using harmonised sampling, sample preparation and analytical methodologies, and producing high quality compatible data sets across national borders. Over 60 determinands were studied, most for both total and aqua regia extractable concentrations. The results of the project are published in a two-volume set, which is freely available for viewing and downloading from www.gtk.fi/publ/foregsatlas together with the analytical data and photograph archive.

Over 400 maps were plotted and interpreted. The geochemical distribution maps show distinct geographical differences in the levels of potentially harmful elements, for example, arising from natural geogenic sources, including lithology and mineralisation, and from natural processes, such as climate, which influence the original concentrations.

The data from minerogenic samples reflect mostly geological variation in element distribution throughout Europe. In contrast, stream water data tends to reflect both the results of exogenic processes and the anthropogenic input of elements to the surficial deposits, although some elements give a direct signal related to the chemical composition of the bedrock. In central Europe, nitrate concentrations in stream water form a large anomalous area due to intensive agricultural practices. In northern Europe, stream water is more acidic than in central and southern Europe due to the low base cation capacity of the metamorphosed bedrock and the high concentration of humic and fulvic acids typical of the boreal climate. These low pH waters result in higher solubility of aluminium and some transition metals. Another striking feature is a relatively large anomaly of REEs detected in stream water in the area of southern Fennoscandia extending to northern Germany and Scotland. Reasons for this regional anomaly are unknown.

The geochemical maps may be used to delineate areas of ore potential interest across Europe. They may also be used to identify potential geohazard and health risks in particular regions that may warrant more detailed investigation. The observed geochemical variations do, however, illustrate the difficulty in defining a single guideline value for '*water*', '*soil*' and '*sediment*' to be applied throughout Europe.