

## ERDA of hydrogen content in hydrous and nominally anhydrous mantle phases

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Nuclear methods, more especially ERDA (Elastic Recoil Detection Analysis) are used since a long time to determine the bulk hydrogen content of any kind of matrix material. The advantage of this method is that (1) the analysis is absolute with respect to H with an uncertainty of less than 10% relative, (2) all the H is characterized, not only H bonded with oxygen, (3) the samples are investigated on a micrometric scale. Whereas the method is extremely reliable to quantify hydrous geologic samples (e.g. Bureau *et al.*, 2003), the few attempts made to characterize anhydrous phases were not so successful because of too high backgrounds usually observed on the ERDA spectra, due to surface's H (e.g. Sweeney *et al.*, 1997). During the past four years, we have tried to improve the ERDA method in the nuclear microprobe of the Pierre Süe laboratory. The setup has been modified, we perform scannings on large sample areas (200x800µm<sup>2</sup> at maximum) in order to reduce the H loss due to the 3 MeV incident <sup>4</sup>He beam (4x16µm<sup>2</sup> during the ERDA analysis). The maps are processed using a specific software (RISMIN, Daudin *et al.*, 2003). Therefore different areas of a same sample can be selected in order to measure their respective H contents. The detection limit has been measured on dehydrated San Carlos olivine to be 130 ppm wt H<sub>2</sub>O (15 ppm wt H). Another advantage is that RBS (Rutherford Back Scattering) and PIXE (Proton Induced X-Rays Emission) are performed simultaneously providing a chemical characterization of the sample with respect to major and some trace elements. In this presentation we will review a few recent results: we have measured the hydrogen content of various kind of geological samples: volcanic glasses and glassy inclusions; synthetic and natural nominally anhydrous minerals (see also Carraro and co-workers, this issue).

### References

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## Tracking groundwater contribution to rivers by combining hydrogen isotopes and cation concentrations

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While the hydrological response of a basin to various water inputs may be described by models based on hydrographs only, isotopic and chemical analyses are often necessary to understand the mechanism of groundwater flows as well as the interactions between water, soils and rocks.

We worked on the upper basin of the Moselle river (France). Samples were collected every 10 days during 18 months and comprised various water compartments such as i) precipitations, ii) groundwater sources, iii) main tributaries and iv) the river itself at 3 different sites. Meteorological and physical parameters were used along with hydrogen isotopes, major and trace elements analyses.

Major groundwater sources in the area yielded homogeneous δD values over the year and very similar to the composition of the weighted average of annual precipitations. This suggests a long residence time of water in the underground reservoirs. Furthermore, the δD values measured for river water during low flow periods are also very comparable to that of groundwater sources, suggesting a major contribution of groundwater to rivers during these periods. During flood periods, the shift in δD values measured in river water implies that only 30-40% of the total water flow may be attributed to precipitation (or snow melt), leaving 60-70% of the water discharge due to an increased contribution from groundwater (piston effect).

Positive relationships are found between dissolved cation (Ca, Mg, K) fluxes and water discharge at a given locality and over the 18 months of sampling. This implies that the increasing water discharge after precipitation events do not lead to a simple dilution of the dissolved species. Rather, an increase of the groundwater input is needed to increase dissolved cation flux. At one site, the relationship is very similar for the three cations, suggesting a simple larger contribution of the groundwater present during the low discharge periods. At other sites, different relationships are found for Ca, Mg or K, suggesting that more than one groundwater mass contributed.