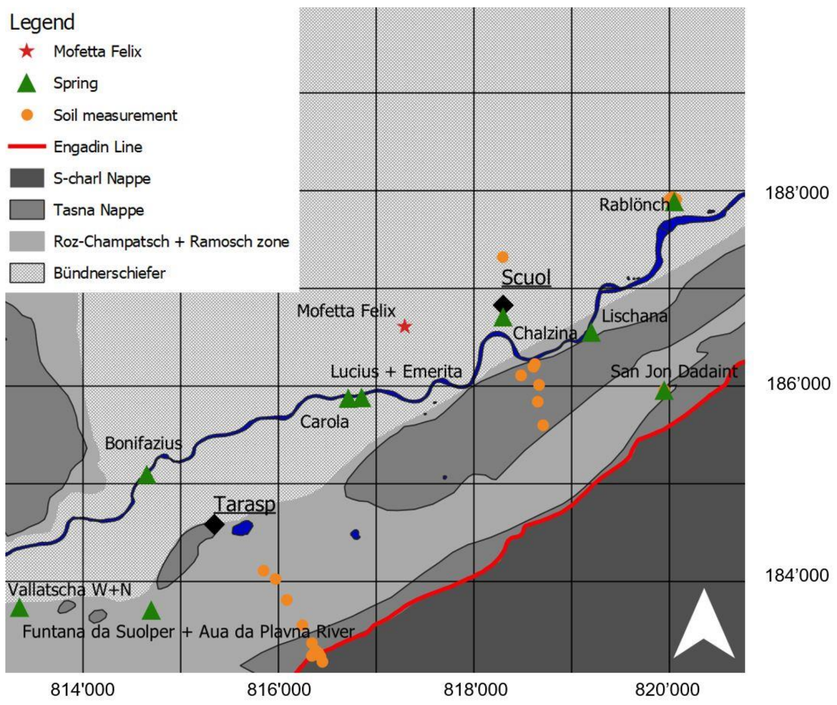
Exploration of natural hydrogen in the Lower Engadin window, Switzerland

Philipp Hänggi, Eric C. Gaucher, Christoph Wanner
Institute of Geological Sciences, University of Bern, Switzerland

UNIVERSITÄT BERN

Introduction and location of field work

The area around Scuol, (Grisons, Switzerland), was chosen for a first hydrogen exploration because of the presence of a deep strike-slip fault, the Engadin line, associated to serpentinite. The area lies within the tectonic window of the Lower Engadin.
A special feature of this area are the carbogaseous spring waters and the dry CO_2 exhalations (mofettes) in the Scuol region. The $\delta^{13}C_{CO2}$ of exhaled gases (-4‰) is consistent with a deep mantle origin but could also be explained by other processes (Wexsteen et al., 1988). The concentrations of hydrogen in the gas mixture of the outgassing springs and the dry exhalations have never been studied.



Geological structure of the study area (Swiss Topographic Grid, unit: meters). Modified after (Bissig et al., 2006)

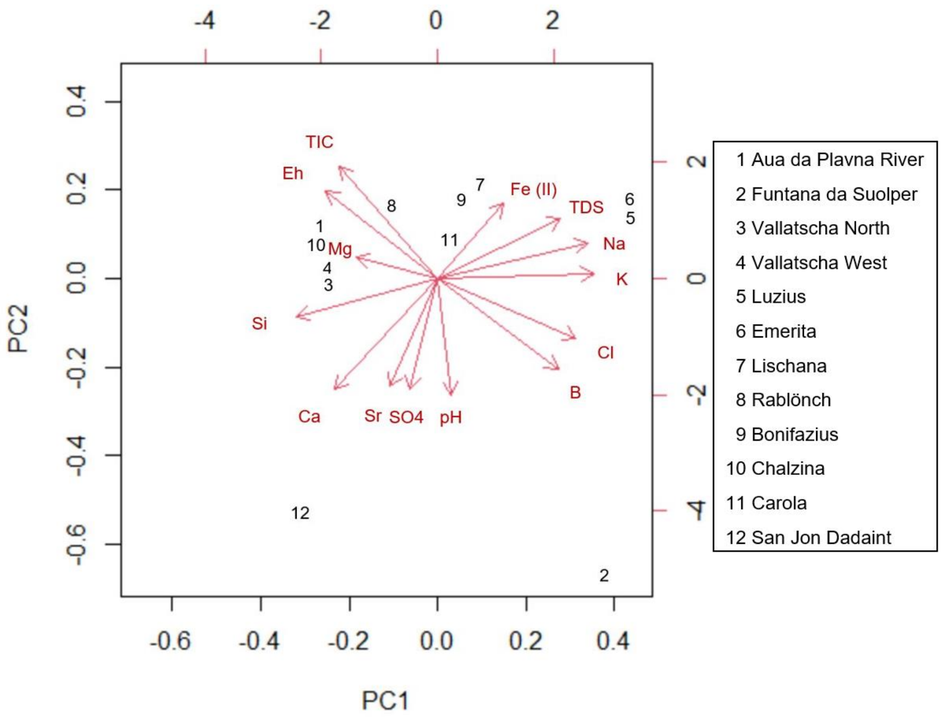
Methods

Two methods were applied for the hydrogen exploration:

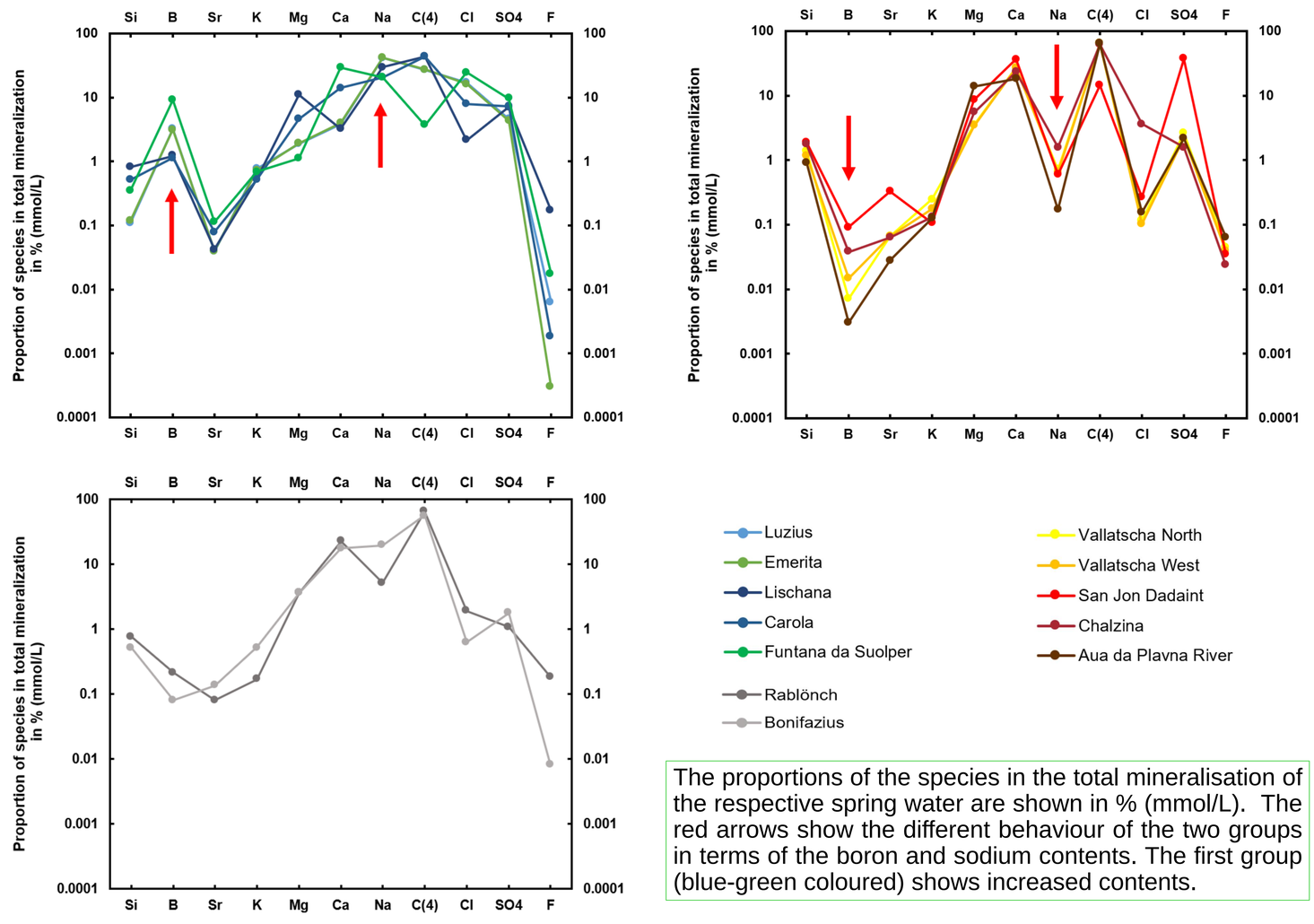
- The analysis of soil gases with a mobile gas analyzer. For this purpose, holes with a depth of about 1 meter were drilled into the soil with a percussion drill and then the gas composition (O_2, CO_2, CO, CH_4, H_2S and H_2) was measured.
- The sampling of springs and the determination of their chemical composition by means of on-site measurements, ion chromatography and ICP-OES.

Results

On the northern slope of the village of Scuol, several spots of dry gas exhalations are known. The most famous spot is called "Mofetta Felix". Gas measurements in holes revealed **reproducible H_2 concentrations of over 320 ppm**. CO_2 is the main gas (90%) and traces of CH_4 (0.3%) are also detected. From the composition of the springs, a principal component analysis (PCA) was performed. In addition, the elements of the spring waters were plotted as proportions in total mineralization. Based on the boron and sodium contents, the sources can be roughly divided into two groups. The two springs Bonifazius and Rablönch represent mixtures of the two groups. This is consistent with the PCA.



PCA of the composition of the spring waters, for the elements the proportion of species in total mineralisation was used

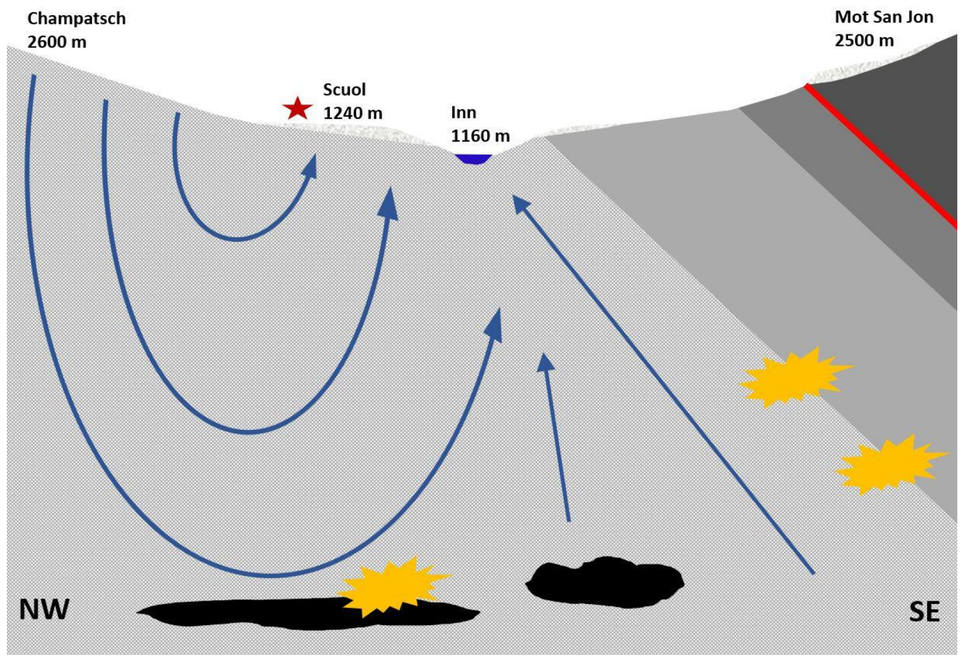


The proportions of the species in the total mineralisation of the respective spring water are shown in % (mmol/L). The red arrows show the different behaviour of the two groups in terms of the boron and sodium contents. The first group (blue-green coloured) shows increased contents.

Conclusion and further actions

The origin of the significant hydrogen amount of the “Mofetta Felix” is unknown but could be related to a deep serpentinization process. The geological composition of the subsurface in the core of the Lower Engadin window is assumed to be the Bündnerschiefer series, which is about 10 kilometres thick (Hitz 1996). The ophiolite lenses trapped in it represent a possible origin of the hydrogen measured at the surface. Due to the high permeability of the Bündnerschiefer, deeper ultrabasic rocks may also be the hydrogen source. The origin and production of the hydrogen will continue to be investigated with a permanent monitoring of the mofettes. The two most probable origins of the hydrogen found are marked in yellow in the figure.

In a next step, the chemical composition of the two possible host rocks will be investigated, and with it their ability to produce hydrogen by serpentinization. Further, all measured springs are degassed with a degasser. The collected gas is analysed and its hydrogen content is examined. Since the springs of the first group are located along the transition zone of the Bündnerschiefer and the Roz-Champatsch/Ramosch unit, increased H_2 concentrations in those springs would indicate a production within the rocks of the Roz-Champatsch/Ramosch unit. If no significant differences of the H_2 concentrations between the two spring groups can be observed, the ophiolite lenses within the Bündnerschiefer or another source as origin is to be preferred.



Conceptual groundwater fluxes and possible H_2 production sites in the underground in the region of Scuol, modified after (Bissig et al., 2006)

References

Wexsteen, P., Jaffé, F.C. and Mazor, E. (1988) Geochemistry of cold CO_2-rich springs of the Scuol-Tarasp region, Lower Engadin, Swiss Alps. Journal of Hydrology 104, 77-92.

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