

Geochemical modelling of hyperalkaline spring water and precipitates at the Oman ophiolite

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Introduction

Hyperalkaline spring water (pH > 11) has been known to issue from the partly serpentinized peridotite (Barnes et al., 1978). If serpentinization is a present-day near-surface phenomenon, formation and evolution of the hyperalkaline water are important for understanding of interaction between groundwater and peridotite/serpentinite. Since serpentinized peridotite is one of the major components of the ocean crust (Cannat et al., 1995), the alteration of peridotite may play a much larger role than previously thought in determining the solute chemistry of seawater. In this context, hyperalkaline spring water, surface water, and precipitates around the springs in the northern Oman ophiolite were investigated to model the formation and evolution of hyperalkaline spring water and related precipitates.

Methods

All water samples were filtered (0.2 µm PTFE filter) at the time of collection and were split into acidified and raw fractions for the appropriate chemical analyses. The mineralogy of precipitates was identified by XRD and XRF. Geochemical reaction modelling was performed using geochemical code React in The Geochemist's Workbench® 3.2 (Bethke, 1996).

Results and discussion

The spring water is characteristically hyperalkaline, reducing, low-Mg, Si and HCO₃⁻, and high Ca, while the surface water is moderately alkaline, oxidizing, high Mg and HCO₃⁻. The calculated results from the reaction between the surface water and minerals found in dunite and harzburgite imply that the dissolution of Ca-bearing pyroxene, serpentinization and isolation from carbonate ions are necessary for the production of hyperalkaline spring water with the above characteristics. Although Ca-carbonates (aragonite) are the most common precipitates formed by mixing of the spring water and the surface water, brucite and hydrotalcite were also observed in the different mixing ratios.

References

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Effect of internal Sr isotope re-equilibration in biotites: implication for the real thermal history.

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The effect of the thermally induced internal Sr isotope re-equilibration between the crystalline phase of the biotite and the disturbed domains and the secondary minerals phases in this biotite was revealed.

The biotites were selected from three samples of the Archean gneisses. These gneisses experienced Svekofennian regional metamorphism at 1.9-1.8 Ga and contact metamorphism associated with the Caledonian alkaline-ultrabasic intrusion at 0.36 Ga. The studied samples correspond to the different degree of thermal influence of the intrusion on the gneisses. The Rb-Sr ages of the biotites from these gneisses are intermediate between 1.66 Ga and 0.36 Ga.

The Rb-Sr isotope composition of the primary biotite (P) and of the biotite after treatment in the hot HCl acid solution (R) was investigated. The difference between the apparent Rb-Sr (whole rock-biotite) isotope age of the (R)biotite and the apparent Rb-Sr age of the (P)biotite for the different samples changes from positive (+116 Ma) to negative (-200 and -106 Ma) value when intensity of the contact metamorphism influence on the gneisses increases. These data explicitly indicates on the thermally induced radiogenic ⁸⁷Sr lost from the crystalline structure of the biotite (residue after leaching) and the complimentary capture of radiogenic ⁸⁷Sr by the disturbed domains and secondary minerals phases in the biotite to be removed into the leachate.

Thus leaching experiment allows to correct interpretation of obtained Rb-Sr biotite ages [TRb-Sr(bt)]. In a case when TRb-Sr(bt-R) > Rb-Sr(bt-P) the obtained Rb-Sr age can correspond to the time of closing of Rb-Sr system in the biotite during rock cooling. On the other hand, if TRb-Sr(bt-R) < TRb-Sr(bt-P) the obtained Rb-Sr age unambiguously is a result of incomplete thermally induced re-equilibration of Rb-Sr system of the biotite with other mineral Rb-Sr systems and has no geochronological sense.