Evaluation of thermodynamic data and activity coefficient models for the geochemical modeling of CO_2 storage systems

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The selection of adequate CO_2 geological storage systems and the evaluation of their storage capacity and behavior rely largely on geochemical modeling, whose results are strongly dependent on the selection of appropriate thermodynamic data and approaches.

In this study, two groups of geochemical calculations were carried out to gain insight into the influence of those issues. In the first group of calculations, the saturation state of several dilute groundwaters with respect to different mineral phases potentially relevant in geologícal storages for CO_2 was assessed by using different geochemical codes and thermodynamic databases. For the second group of calculations, the geochemical evolution in the direct vicinity of a hypotethical well during the dessication caused by the injection of supercritical CO_2 into two types of saline aquifers was simulated with the assistance of the PHREEQC code (Parkhurst and Appelo, [1]) by using two different databases and approaches for the calculation of activity coefficients included with the code: (1) the Wateq4f.dat database with an ionic association approach, and (2) an improved version of the pitzer.dat database with the specific ion interaction approach developed by Pitzer [2].

In the calculations for the dilute groundwaters, signifficant differences in the saturation indexes are only obtained for minerals for which varieties with different cristalinity are included in the databases (remarkably for dolomite). For the modelling exercises focused on the evolution of saline waters, the main differences between the results obtained by the two model approaches described above, are mainly related to the order and dessication degree at which different mineral phases precipitate and to the amounts of precipitated minerals throughout the simulations.

[1] Parkhurst and Appelo (1999) *Water Resources Research Investigations Report* **99**-4259. [2] Pitzer (1973) *J. Phys. Chem.*, **77**, 268–277.

Age and origin of alkaline lavas from Tore-Madeira Rise: Interactions between complex lithosphere motion and multi-components source

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The Tore-Madeira Rise (TMR) is an alignment of seamounts of 1000×50 km oriented SSW-NNE, extending from the Tore seamount, located 300 km west of Lisbon, to the archipelago of Madeira. Here, we document the petrology, geochemistry and isotopic characteristics of TMR lavas from 22 dredging sites, located on 13 seamounts and 5 localities on Tore seamounts. The exclusive occurrence of alkaline lavas (mafic and differentiated) substantiates the importance of alkaline magmatism in the TMR edification. The dredged basalts display typical OIB-like incompatible elements and REE characteristics similar to those observed in Madeira basalts. Reliable $^{40}Ar/^{39}Ar$ and U/Pb ages suggest five magmatic phases on the TMR and surrounding areas that can be related to the motion of the Iberian plate. No specific isotopic characteristics can relate to a given magmatic phase. Regardless of their age, the Pb isotopic compositions of the basaltic rocks plot below the NHRL, in the field of the Madeira archipelago lavas while the differentiated lavas display a trend from this field toward high $^{207}Pb/^{204}Pb$ which is interpreted as a contamination by the sub-continental lithospheric mantle (SCLM) of the Iberian margin. This precludes the involvement of two distinct mantle plumes (Canary and Madeira) in the genesis of the TMR lavas, as previously suggested. The isotopic composition of the basaltic lavas requires at least three distinct components. The main isotopic characteristics are related to a mixture between a depleted asthenosphere-like mantle and a HIMU-like component. The contribution of an EMI-like component is also required in particular to explain the isotopic characteristics of the Seine-Isabelle-Godzilla seamounts. Considering the position of these seamounts close to the southern branch of the Azores-Gibraltar Fracture zone, we interpret this EMI-like component as due to a sliver of SCLM trapped in the asthenosphere. However, this SCLM is distinct to those involved in the genesis of the differentiated samples.