Concentrations and signatures of stable isotopes of methane and hydrogen in hydrothermal fluids of the Mid-Atlantic Ridge

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Introduction

We have measured concentrations of dissolved methane and hydrogen in a set of fluid samples recovered by ROV from hydrothermal systems located on the Mid-Atlantic Ridge (MAR) at 15°N and between 4° and 10°S under the auspices of the German SPP 1144 project. Fluids investigated originate from different settings comprising peridotitic to basaltic host rocks, hot and diffuse vents, and water depths between 1500m and 3000m.

Results and discussion

Fluid endmember concentrations calculated based on the Mg content were up to 3.5 and 19 mmol/L for CH_4 and H_2, respectively, for fluids from the Logatchev hydrothermal field. Similar exceptional high concentrations with 1.4 mmol/L of CH_4 and 11.6 mmol/L of H_2 were also found in fluids of the recently discovered smoking crater Drachenschlund located at 08°18'S and characterised by ultramafic host rocks alike the Logatchev hydrothermal field.

Much lower gas concentrations were found in the fluids of basalt hosted systems. Among these, a black smoker of the Turtle Pits field (4°49'S) emanating vigorously boiling fluids with temperatures of up to 407°C at 3000m depth showed the highest fluid endmember concentrations of 0.3 mmol/L H_2 and 0.018 mmol/L CH_4. Black smoker fluids with no indication of phase separation revealed significantly lower gas concentrations.

Signatures of stable C isotopes for CH_4 covered a range from $\delta^{13}C$ -9.2 to -13.7‰ for all fluids sampled from vents at about 3000m water depth with no systematic difference between the various settings. Only CH_4 in fluids of the Lilliput hydrothermal field (9°33'S) emanating at 1500m water depth with temperatures < 20°C revealed $\delta^{13}C$ values of about -32‰. This might be attributed to distinct p/T conditions during abiotic CH_4 generation or to a significant microbial contribution. δ^2H values of H_2 were used to estimate temperatures of emanating fluids.

Conclusion

Hydrogen dominates over methane among reactive gases within black smoker fluids. Host rock composition and phase separation processes strongly affect the gas concentrations in hydrothermal fluids but not the stable isotope distributions within the gases.

Evaluation of geothermometers for a zircon-rutile-corundum intergrowth

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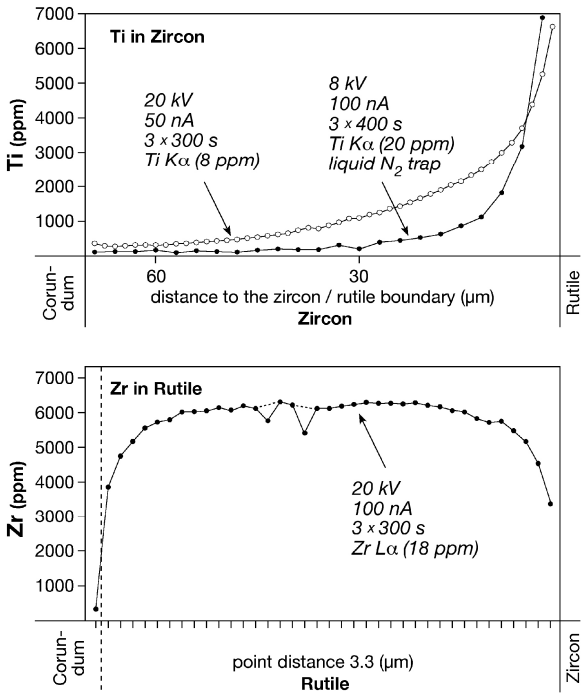
A corundum megacryst (7x5 mm) from residues of an alkali basalt from SE Saxony (Germany) includes zircon and rutile. It provides a suitable specimen to test recently published geothermometers "Ti-in-zircon" and "Zr-in-rutile" (Watson *et al*., 2006), and may be revealing about the origin of this mineral paragenesis, which is uncommon for basalts.

Rim-core-rim traverses of the trace elements Ti and Zr in zircon and rutile, respectively, were performed using an electron microprobe JXA-8500F under different analytical conditions (see figures below, detection limits in brackets).

Calculated temperatures are about 1100 °C for zircon (distance of analysis points to rutile >60 µm), but about 1015 °C for the core of rutile and 940 °C for the rim of rutile.

The shape of the traverses are discussed in consideration of secondary fluorescence, temperature, and chemistry of the crystallizing medium.



Reference

Watson E. B., Wark D.A. and Thomas J.B., (2006). *Contrib. Mineral. Petrol.* **151**. 413-433