THEME 3:
Volatiles of the Earth

Session 3.4:
Hydrothermal solutions and their input to the biosphere and hydrosphere

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The interaction between the geosphere, hydrosphere and the biosphere has been the focus of intense research during the last few decades. This emerging branch of multi-disciplinary research provides important insight into the development of Earth systems. In particular, active hydrothermal systems provide settings where the linkage between these three spheres is the most striking and will undoubtedly provide us with new discoveries in the years to come. In this session, we encourage contributions on the physical and chemical aspects of hydrothermal solutions in all kinds of geological environments, including topics such as processes affecting their compositions, e.g. with respect to salinity, pH, Eh, gas content, formation of organic compounds, mineral-fluid reactions and the geochemical structure of active geothermal systems. Results of studies on fossil geothermal systems are also encouraged. Topics of particular interest include discharge of hydrothermal fluids into the hydrosphere and atmosphere and its effect on life and on water and air quality. Numerical modelling of fluid evolution through progressive water-rock interaction, giving insight into flow paths, fluxes and time scales, are highly relevant.

3.4.11
CO_2 emissions from geothermal areas

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The sources of CO_2 in geothermal systems include magma, limestone, and organic sediments. CO_2 in Icelandic systems is mostly mantle derived. Early experimental work indicated that CO_2 in geothermal systems may be derived solely from water-rock interaction but more recent evidence such as the observed excess CO_2 in Krafla and Námafjall during the Krafla fires (1975-1984) suggested that CO_2 may be controlled by water-rock-gas interaction. Thermodynamic calculations have shown that the composition of the geothermal fluid in these systems must have evolved that way.

The CO_2 concentration in geothermal fluids is temperature dependent and can be used as a geothermometer, by assuming equilibrium between CO_2 and a specific mineral buffer (clinozoisite, calcite, quartz, H_2O/prehnite, CO_2) [1]. This geothermometer is only applicable close to upflow in systems that are not cooling down. In old systems with poor permeability and on the peripheries of systems CO_2 tends to stay in solution upon cooling resulting in too high geothermometer temperatures.

CO_2 is not only emitted at the surface through springs and fumaroles but also to a considerable extent via unfocussed emissions through soil directly from the mantle or intrusions, or from boiled geothermal fluid. Where the extent of such emissions has been measured it has been shown to be a substantial part of the total CO_2 emissions.

An attempt to model the maximum CO_2 emission from Iceland´s neo-volcanic zone using data for mass of magma that releases CO_2 and concentration of CO_2 in undegassed and degassed magma gives an emission of 0.8×10^9 kg/year CO_2. Earlier estimates of CO_2 emission based on heat flow suggest $1.1\text{-}2.2\times10^9$ kg/year [2,3] and estimates for 3 different areas give a total of 0.28×10^9 kg/year CO_2 [3]. Direct measurements in the Hveragerdi and Reykjanes areas with results integrated over the whole neo-volcanic zone suggest values of the order $9\text{-}10\times10^9$ kg/year CO_2. Thus either the estimates of CO_2 emission from individual areas are overestimates or more CO_2 reaches the surface of the geothermal areas than the model accounts for.

References

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