



A Si-Cl geothermobarometer for the reaction zone of high-temperature, basaltic-hosted mid-ocean ridge hydrothermal systems

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The chemical composition of mid-ocean ridge hydrothermal vent fluids is thought to reflect conditions within a deep-seated reaction zone. Although temperature and pressure conditions within this region are key parameters to characterize the seafloor hydrothermal regime and the cooling of mid-ocean ridges, they are still poorly constrained. In this paper, we developed a model in which high temperature, vapor-type (low-salinity) vent fluid Silica (Si) and Chlorine (Cl) concentrations can be used to infer temperature and pressure conditions at the top of the reaction zone where fluids start to upflow. Both Si and Cl concentrations define lines in pressure-temperature space whose intersection is used to estimate conditions at the top of the reaction zone, under the simplifying assumption that Si and Cl reflect a common point of equilibration. We apply this model to various basaltic-hosted mid-ocean ridge sites. Little variation is observed in inferred temperatures which range from 415-445 °C. This lends support to the fluxability model in which upwelling hydrothermal plumes rise at temperatures that maximize the energy flux. Re-equilibration due to quartz precipitation during upflow will tend to lower temperature and pressure estimates and can artificially indicate shallower transition from reaction to upflow zone. However, maximum equilibration pressures are site dependent and compare well with depth to magma chamber imaged by seismic studies. This suggests that vapors circulate close to magma chambers and is difficult to reconcile with models in which mid-ocean ridge hydrothermal circulation occurs in two layers with a substantial layer of convecting brine. Equilibration pressure predicted by our model can also be used to infer the depth of the magma chamber at sites where seismic data are not available but where vapor-like fluids have been collected and analyzed.