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Experimental studies of fluid properties and fluid-mineral interactions: Implications for hydrothermal systems and CO_2 mineral trapping

PASCALE BÉNÉZETH

Géosciences Environnement Toulouse-CNRS

Presenting Author: pascale.benezeth@get.omp.eu

Accurate experimentally derived thermodynamics and kinetics of fluid speciation and mineral-fluid interactions are fundamental to model the complex processes associated with fluid flow and the transport of matter and energy in the Earth's crust. For nearly 30 years, our work has been focused on measuring metal complex equilibria, solubility of metal hydroxides, oxides and carbonate-bearing minerals, and the dissolution/precipitation rates of various minerals, from far to very near equilibrium. All of these measurements are made possible by taking advantage of several state-of-the-art techniques (*e.g.*, in situ pH-measurements, flow-through and closed reactors, UV-Vis spectrophotometry) [1], spanning conditions (temperature, pressure, salinity) relevant to natural and industrial systems. Some data obtained on the speciation of metals (Al, Zn), mainly derived from the solubility of oxides and hydroxides [2-4], and on the dissolution/precipitation rates of some minerals, very close to equilibrium [5], will be presented. The effects of anthropogenic CO_2 injections in mafic and ultramafic reservoirs have been also the focus of our fundamental research, in the past two decades, to assess the feasibility of its sequestration in the form of stable solid carbonate phases (mineral trapping), for which geochemical modeling depends strongly on reliable thermodynamic and kinetic data of aqueous CO_2 speciation and carbonate-bearing minerals. As such, data obtained on the aqueous speciation of CO_2, including cation-ion pair formation and the solubility of various carbonate minerals up to high temperatures (<300°C) [1,6,7] will also be presented as well as some results obtained recently on mineral carbonation in mafic and ultramafic rocks [8]. By incorporating these data into thermodynamic databases, which are used in conjunction with various computer codes, we can improve our understanding of aqueous speciation and water-rock interactions in various natural and industrial settings.

[1] Bénézeth *et al.* (2013), *Rev. Min. Geochem.,* **76,** 81; [2] Bénézeth *et al.* (2001), *GCA,* **65,** 2097; [3] Wesolowski *et al.* (1998), *GCA*, 62, 971; [4] Bénézeth *et al.* (2002), *J. Sol. Chem.*, 31, 947; [5] Schott *et al.* (2012), *C.R. Geosci.,* 344, 568; [6] Stefánsson *et al.,* (2014), *GCA*, 138, 21; [7] Bénézeth *et al.* (2018), *GCA*, 224, 262; [8] Bénézeth *et al.* (2022), doi.org/10.2139/ssrn.4274163.