On the fO2 of slab fluids in subduction zone systems

Timm John1, Esther Schwarzenbach1, Jay Ague2, and Jilei Li3

1 Freie Universität Berlin, Institute of Geological Sciences, AB Mineralogie-Petrologie, Berlin, Germany (timm.john@fu-berlin.de)
2 Yale University, New Haven, USA
3 Chinese Academy of Sciences, Institute of Geology and Geophysics, Beijing, China

One of the most pressing riddles of the subduction cycle to be solved is linked to the fO2 of the slab-released fluids. It is now well accepted that the fluids liberated during slab dehydration play a crucial role in subduction zone seismicity, element cycling, and arc magmatism. However, whether these slab fluids are oxidizing or reducing transport agents is poorly understood and thus, there is still a lot we need to understand. This is of particular importance for gaining a mechanistic view on the formation processes of economically important arc related ore deposits, which certainly require understanding of the behavior of redox sensitive mobilities of the relevant elements. In brief, while some field-based studies from the slab perspective are suggesting rather reduced conditions (e.g., based on sulfides and sulfur isotope work, ref. 1) others, mainly related to higher temperature systems (e.g., based on bulk-rock – rutile systems and molybdenum isotope work, ref. 2), are indicative of more oxidizing slab fluids. Especially for mélange-like structures developed at the plate interface, studies on sulfur-bearing minerals result in contrasting fO2 of the related slab fluids (ref. 3 vs ref. 4). It appears that at least during retrogression along the plate interface the reactively flowing fluids tend to have a more oxidizing potential (ref. 5). Interestingly, the prime fluid source of subducting slabs, i.e. dehydrating slab mantle serpentinites, is thought to release reduced fluids (ref. 6) but melt inclusions in arc volcanic rocks are often oxidized. Recent studies suggest that this is likely linked to fluid-rock interaction at local scales (ref. 7) and/or possibly within the magma reservoirs that comprise rather low-melt-fraction mush (ref. 8). This in turn would suggest that the slab fluids might change their fO2 during reactive intra-slab fluid flow, or would not need to be oxidized prior to melt inclusion entrapment and that the oxidizing potential of the fluids may be the result of magmatic processes during melt ascent in the arc. In this contribution we review the current state of knowledge, provide new ideas and models regarding channelized though reactive intra-slab fluid flow, and illustrate the next steps to unravel this exiting and thus far poorly understood topic of subduction zone element cycling.


