Nanoparticulate reverse weathering products in focused and diffuse hydrothermal flow

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Authigenic clay phases can occur as hydrothermal deposits and inclusions in massive sulfides. In contrast to previous observations of these phases as localized, larger-scale deposits, we demonstrate the formation of nanoparticulate Mg- and Fe-bearing silicate phases in the mixing zone between high-temperature, anoxic hydrothermal fluids and seawater at 9°N East Pacific Rise. Scanning electron microscopy reveals that these particles are approximately 50 nm in diameter and aggregate on 0.2 μm filters. Diffraction patterns obtained from transmission electron microscopy identify mineral phases including kaolinite, Fe-rich micas, and talc/lizardite. These phases co-occur with metal (Cu, Zn, and Fe) sulfide nanoparticles and are present both in focused and diffuse flow environments. Particle size and uniformity, in addition to the inclusion of Mg, suggests that these particles form from solution in rapid reverse weathering reactions rather than representing entrained pieces of basement rock or chimney. We argue that the formation of hydrothermal silicates may be more widespread than previously documented and have an impact on the ocean's silica, iron, and ion (Al, Mg, K) budgets. Further work will constrain (nano)particle behaviour and potential for long-distance transport away from vent sites.