Quantifying Subsurface Mixing of Groundwaters at the Coast Range Ophiolite Microbial Observatory

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Serpentinization is the aqueous alteration of olivine and pyroxene minerals in ultramafic rocks, ongoing in the seabed and in continental sites, such as at the Coast Range Ophiolite (CRO) in CA, USA. Serpentinization-related mineral transformations yield high pH waters with characteristic cation and dissolved metals, transmitting $CH_4/H_2/CO$ gas mixtures from depth; deep life in ultramafic terrains is thought to be fueled by chemical energy derived from related geochemical fluxes. Monitoring of groundwater wells in the CRO since 2011 shows that deeply sourced, serpentinization-influenced waters (shown by correlated pH, Ca/Mg ratio, oxidation-reduction potential) are mixing with regionally important water types. Geochemical data (ICP-AES, IC, Brown University Environmental Chemistry Facility) and YSI 556 multiprobe meter data (e.g., pH, TDS) for well waters cluster tightly except for CSW1_4 (strong $HCO_3^- + CO_3^{2-}$ signal, open to the atmosphere) and the primary wells (CSW1_1, strongest SO_4^{2-} signal; QV1_1, strongest Ca^{2+} signal).

Aqueous geochemical dynamics are aptly explained by 3-component mixing with other volumetrically important water bodies in the subsurface. Incorporation of a serpentinization-derived water component is evident even at shallow depths (<32 m). A deep saline component is required to explain the TDS and anion loads in particular. Complexion Spring is the most saline spring in the vicinity (~35 km distant) and is geochemically suitable as a crucial endmember in subsurface mixing.

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