Well-log characterization of hydration and dehydration processes in oceanic lithosphere: from mid-ocean ridges to subduction zones

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Hydration and dehydration of oceanic lithosphere are known to be central to understand geodynamics processes from mid-ocean ridges, to intraplate tectonics and magmatism, to seismogenesis and material cycles facilitated by subduction zones. Recent and proposed drilling efforts at various subduction zones particularly highlight the significance of lithosphere hydration by faults evolved in incoming plate (e.g. “Bend-fault serpentinization (BFS) and Bend-Fault Hydrology in Old Incoming Plate (H-ODIN)”). Although undertaking sub-meter to sub-centimeter scale observations on cored materials has been much desired approach in investigating the nature of lithosphere, drilling through faulted lithosphere and deeper crust has been, indeed, a challenging task throughout the history of scientific drilling, let alone obtaining continuous core materials with high to perfect recovery rates. Borehole informatics using downhole physical properties logging has been a known strategy to complement our understanding of drilled intervals with no core recovery in establishing the most optimal downhole lithostratigraphy model in hard rock drilled sites. Using case studies from the mid-ocean ridge and interaplate volcanic settings, we introduce that (1) downhole physical properties logging can also be utilized to further characterize lithosphere hydrogeology and associated alteration processes over time; and (2) microresistivity imagery logging profiles not only enable us to conduct detailed mapping of the orientation and distribution of hardly-recovered in situ fracture networks, but also to estimate void space abundances in crustal material and the determination of complex lithology-dependent void geometries. Together with petrological and rock magnetic evidences in terrestrial serpentinized lithosphere, we propose that sub-meter scale well-log characterization of drilled holes in the faulted lithosphere in incoming plate will enable us, at multiple scale, to delineate where seawater can permeate and serpentinization takes place, in turn, where microbes are possibly reside.

Keywords: oceanic lithosphere, hydration, serpentinization

