Geochemical development of altered horizons along nonconformities

KE LI [1]* AND CHLOE BONAMICI[1]

[1] New Mexico Tech, Socorro, NM, USA
*correspondence: ke.li@student.nmt.edu

Geochemical alteration of crystalline rocks along nonconformities can produce regionally extensive horizons with unique fluid-transmission and geomechanical properties. Recent induced seismicity located in crystalline basement beneath re-injection reservoirs implicates the altered nonconformity horizon (ANH) in propagation of fluid pressures over long distances. The geochemical development of the ANH likely includes contributions from weathering, diagenesis, and hydrothermal alteration. To better understand the relative contributions of these processes, we combine field characterization of laterally extensive outcrops of the Great Unconformity, whole-rock geochemistry, and microscale mineralogic and textural analysis. The degree of alteration is strongly correlated with protolith lithology. Amphibolites show pervasive alteration of mafic minerals to smectite clays, chloritization, and alteromorphic replacement of plagioclase by clay, calcite, and Fe-oxide. In contrast, granitic orthogneisses show variable alteration of plagioclase to clay, sericite, and minor pore-filling calcite, along with angular quartz indicating significant silica dissolution, but the orthogneiss mineralogy remains largely recognizable. Whole-rock based indices of chemical alteration do not accurately reflect degree of alteration, likely due to extensive overprinting of weathering signatures by later, higher-temperature processes. For example, the Weathering Index of Parker values of some altered mafic samples is >100, which erroneously indicates fresh rock. Textural evidence for multiple generations of later fluids moving along the nonconformity includes at least two different vein sets. We conclude that weathering destroys metamorphic fabrics of the crystalline precursor rocks and enhances porosity, which is later exploited by diagenetic and hydrothermal fluids that can promote further mass loss and permeability development within the ANH.