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Petrographic and Raman Analysis of Fractured Glassy Basalt Joint Fragments, Coastal Oregon: Insight into the Alteration of High-Level Nuclear Waste Glass

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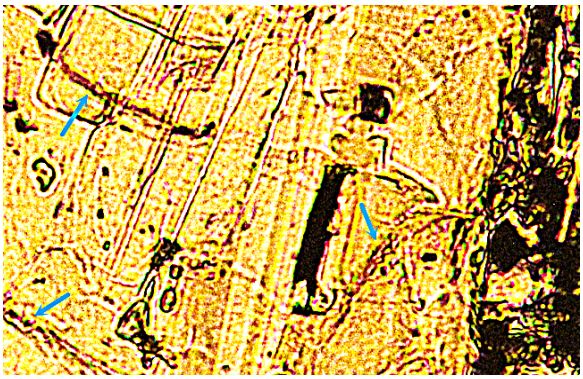

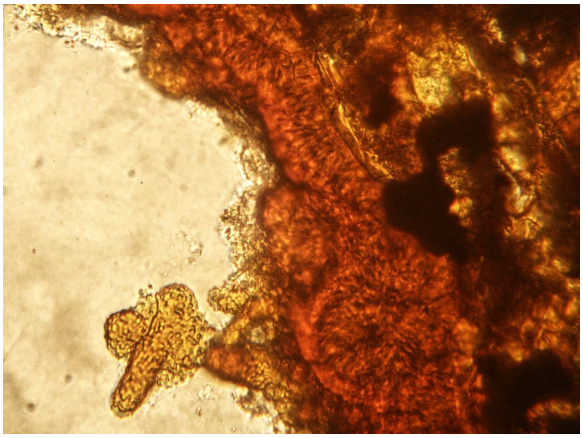

Basaltic glass has often been utilized as an analogue to study long-term behavior high-level nuclear waste glass. The high-level nuclear waste glass log is expected to be tensile fractured during cooling and the exposed surface area susceptible to hydration is therefore increased due to fracturing, potentially affecting the volume of radionuclide released. This study looks at another mechanism of surface area increase, which is the translocation of condensed palagonitic-gel not spatially tied to the parent glass.

Basaltic glassy pillar fragments with outer palagonite rinds from the Yachats Basalt were collected in Waldport, Oregon. The emplacement of these Eocene basalts appear to be in the sub-aqueous marine environment. Some sideromelane filled vesicles that have palagonitic banding in the hydration rind zone also have evidence of bacterial action associated with the immobile product layer. Petrographic analysis provided spatial information concerning sideromelane alteration to palagonite along various petrographic fracture features in the basalt. The preponderance of these fractures appear to predate glass hydration.

One such petrographic feature that is a focus of this study consists of micro-fractures that cross from a glassy groundmass through calcic-plagioclase feldspar laths. There is no sideromelane filling in the feldspar phenocryst fractures, yet these fracture-flow conduits contain spherical palagonite patches where drops of gel have condensed. The sideromelane parent dissolution source in each case appears to be the glassy groundmass of the basalt. Open fractures that trend across feldspar phenocrysts not associated with the zones transmissive aqueous solutions, centralized with in the pillar fragments have no sideromelane infilling. It appears that palagonite gel formation in basic pH environments that have a fluid flux (possibly capillary controlled) occur downstream beyond the immediate surface of the zone of hydration-dissolution. This may be a consideration with respect to the prediction of the radionuclide releases from the high-level nuclear waste source term in service environments that are associated with fluid flow.

Raman analysis (532nm) of palagonite from different petrographic associations in the Yachats Basalt were determined using a polymerization index ($I_p = A_{500}/A_{1000}$) vs Vmax Si-O Stretching Bond to assist in studying the relative degree of bonding during palagonite reorganization.