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Seafloor alteration of basaltic glass: Textures, geochemistry and endolithic microorganisms

I. H. Thorseth, C. Kruber, H. Hellevang and R. B. Pedersen

Department of Earth Science, University of Bergen, Norway (Ingunn.Thorseth@geo.uib.no / Fax: +47 55583428)

The incipient low-temperature alteration of glassy margins of recent seafloor lavas from the arctic Mohns Ridge is characterized by scanning electron microscopy (SEM) and bulk chemical analyses of major and trace elements, aimed to estimate the endolithic microbial biomass, and to identify relations between alteration textures and microbial growth, and the chemical processes that take place during the alteration. Along vesicles and intersecting fractures the basaltic glass is typically altered to rust colored, concentrically zoned, amorphous gel-palagonite. In most fractures microorganisms of various morphologies are observed both at the outer surfaces of palagonite rims, within porous zones of the rims, and frequently also at the glass-palagonite interfaces, where they attach to the fresh glass. The cells clearly act as nucleation sites for precipitation and become heavily encrusted and partially embedded in the altered material by time. Alternating zones of porous palagonite with numerous hollow subspherical and filamentous, apparently fossilized microbial cells, and zones of compact palagonite without any distinct cell structures indicate that the microbial growth is discontinuous. An average organic carbon content of 0.9 wt% ($\delta^{13}C_{org}$: –21.7 per mill) in the palagonite, indicating around 10^8 cells/cm^3 seafloor basalt, suggest that endolithic microbial communities in ocean floor basalt may be an important carbon sink. The microbial growth and biomineralization have a major control on porosity and texture of the palagonite and thus likely also on the chemical exchange between glass and seawater. Pit marks of different sizes in the fresh glass, in fractures with and without the presence of microbes, indicate that microbial as well as abiotic processes may mediate pitting. The elemental and isotope data of glass-palagonite pairs show that the transformation of basaltic glass to gel-palagonite results in i) a nearly complete loss of Si and alkali elements to seawater; ii) formation of Fe and Al oxyhy-

droxides; iii) a complete exchange of alkali earth elements like Sr with seawater; iv) retention of V, Cu, Y, Pb, Th, U and trivalent REE, followed by a strong gain of these and other elements from seawater. Lower Fe/Ti ratios in gel-palagonite than in the parental glass suggest that the palagonite represents a mixture of Fe-Ti oxyhydroxides derived from the glass as well as from seawater. The Nd- and Sr- isotope compositions of palagonite compared to a two-component mixing calculation of fresh basaltic glass and seawater suggests a rock/water ratio of $1:45*10^6$.