Evidence of biological activity in Hawaiian subsurface basalts

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Abstract: The Hawaii Scientific Drilling Program (HSDP) cored and recovered igneous rock from the surface to a depth of 3109 m near Hilo, Hawaii. Much of the deeper parts of the hole is composed of hyaloclastite (fractured basalt glass that has been cemented in situ with secondary minerals). Some hyaloclastite units have been altered in a manner attributed to microorganisms in volcanic rocks. Samples from one such unit (1336 m to 1404 m below sea level) were examined to test the hypothesis that the alteration was associated with microorganisms. Deep ultraviolet native fluorescence and resonance Raman spectroscopy indicate that nucleic acids and aromatic amino acids are present in clay inside spherical cavities (vesicles) within basalt glass. Chemical mapping shows that phosphorus and carbon were enriched at the boundary between the clay and volcanic glass of the vesicles. Environmental scanning electron microscopy (ESEM) reveals two to three micrometer coccoid structures in these same boundaries. ESEM-linked energy dispersive spectroscopy demonstrated carbon, phosphorous, chloride, and magnesium in these bodies significantly differing from unoccupied neighboring regions of basalt. These observations taken together indicate the presence of microorganisms at the boundary between primary volcanic glass and secondary clays. Amino acids and nucleic acids were extracted from bulk samples of the hyaloclastite unit. Amino acid abundance was low, and if the amino acids are derived from microorganisms in the rock, then there are less than 100,000 cells per gram of rock. Most nucleic acid sequences extracted from the unit were closely related to sequences of Crenarchaeota collected from the subsurface of the ocean floor.

Keywords: Hawaiian deep drilling, basalt, microorganisms, DNA staining, Raman spectroscopy, environmental scanning electron microscope

KeyWords Plus: Ultraviolet resonance Raman, Scientific Drilling Project, marine planktonic Archea, endogenous amino-acids, clay-dye systems, acridien-orange, microbial activity, ocean crust, spectroscopy, deep ocean drilling

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