ARE THERE MULTIPLE COMMUNITIES OF EUENDOLITHIC MICROBORING ORGANISMS IN BASALT GLASSES OF THE OCEAN BASINS? EXAMPLES FROM HAWAI'I. Anthony W. Walton, Department of Geology, The University of Kansas, Lawrence, Kansas 66044. twalton@KU.edu.

Tubular and granular structures suggest that multiple communities of microbes inhabit the subsurface basalt glasses of the oceans. Such euendolithic microborings are abundant and widespread in oceanic crust and ocean islands [1], [2], [3], [4]. Modern euendolithic microborings of the ocean crust display association with elements important in metabolic processes and appropriate isotopic signatures [2], [5]. They also have morphology and textural relationships that preclude inorganic origin, and some are associated with DNA [2], [3]. Finally, such microborings have indications of behavior that are incompatible with inorganic origin. No non-refutable alternative hypotheses for inorganic origin have been advanced [6]. Morphologically similar structures are present in altered or metamorphosed basalt glass in ophiolites and pillow lavas from rocks as old as Archean. Where chemical or isotopic signatures are preserved in ancient rocks, they support the organic origin of such features. [7], [8].

Because of compelling evidence of microbial origin of the structures, they are considered to be trace fossils. Two ichnogenera and 5 ichnospecies of euendolithic microborings have been defined. One ichnogenus and one ichnospecies include the so-called granular microbial alteration, a cluster of minute cavities that extends into glass from margins of fragments, from fractures, and from the walls of vesicles in irregularly quasi-hemispherical masses. Individual cavities are of sub-micron scale and occur in masses measuring microns to 10s of microns across. The second ichnogenus comprising the remaining ichnospecies are tubular structures that also extend from free surfaces of the glass. Such tubules are 1 to a few μm in diameter and extend 10s to over 100 μm into the glass. [9] Boring into basalt glass is one form of behavior of the tubule- and granule-forming microbes. It is likely that the organisms were mining vital elements from the glass, another form of behavior.[6]

Euendolithic microborings in hyaloclasts, basalt sand grains, the glassy margins of pillow lavas, and glassy pillow breccia fragments are common in the Hawai'i Scientific Drilling Project (HSDP) #2 core and in samples from the Hilina slope off the Big Island of Hawai'i

i. [3], [6] One suite of microborings meets the definitions of the defined tubular ichnogenus and displays evidence of the same behaviors found in many samples from rocks of the ocean crust, boring and mining. These tubules may terminate in grape-like clusters. A few samples contain granular alteration. However, the dominant form of euendolithic microborings in both sets of Hawai'ian samples is distinctly different: They display peridophylic behavior, bending toward olivine phenocrysts and microlites, even those that they do not reach. Furthermore, they avoid plagioclase crystals. The peridophylic microborings are highly associated with patches of alteration to smectite and Ca-Ti-Si spherules, more or less stained with iron hydroxides. These peridophylic microborings also display morphologic features and development with age that differ from the common tubules reported in other samples of oceanic basalt glass. They develop minute branches from nodes along their length, and they age to form steep cones, flared like the bell of a trumpet at their origin along the glass margin. The cones range up to about 20 μm in diameter at their thickest. None of those features are reported in the described samples of samples from the ocean crust, as opposed to the ocean-island basalts from Hawai'i. In these behavioral, morphologic, and aging characteristics, the common, i.e. peridophilic, microborings differ from the other suites of microborings in the Hawai'ian rocks as well as those in the ocean crust. The various morphologies of microborings are not associated with each other in the Hawai'ian samples. The peridophylic tubules originate at the margin of shards. They formed early in the alteration sequence, before palagonite and are preserved in a somewhat modified state during marginal replacement of glass by palagonite . The simple tubular and granular structures in the deepest part of the core grow from the interface between palagonite and unaltered glass, and developed after the formation of palagonite if they, like the peridophylic forms, would not have been effaced as the marginal alteration proceeded.

Differences in timing, morphology, association, aging, and recorded behavior suggest that the organisms responsible for the various structures are members of different species or consortia of microbes. Because the HSDP core samples nearly 2.5 km of subsea depth, and presumably a comparable range of original depth of deposition, one might suggest that the various forms are depth zoned and represent different pressure or temperature conditions in the lithic accumulation. The alternative that the various forms represent stages in the progressive alteration of the rock is rejected because the forms are not associated.

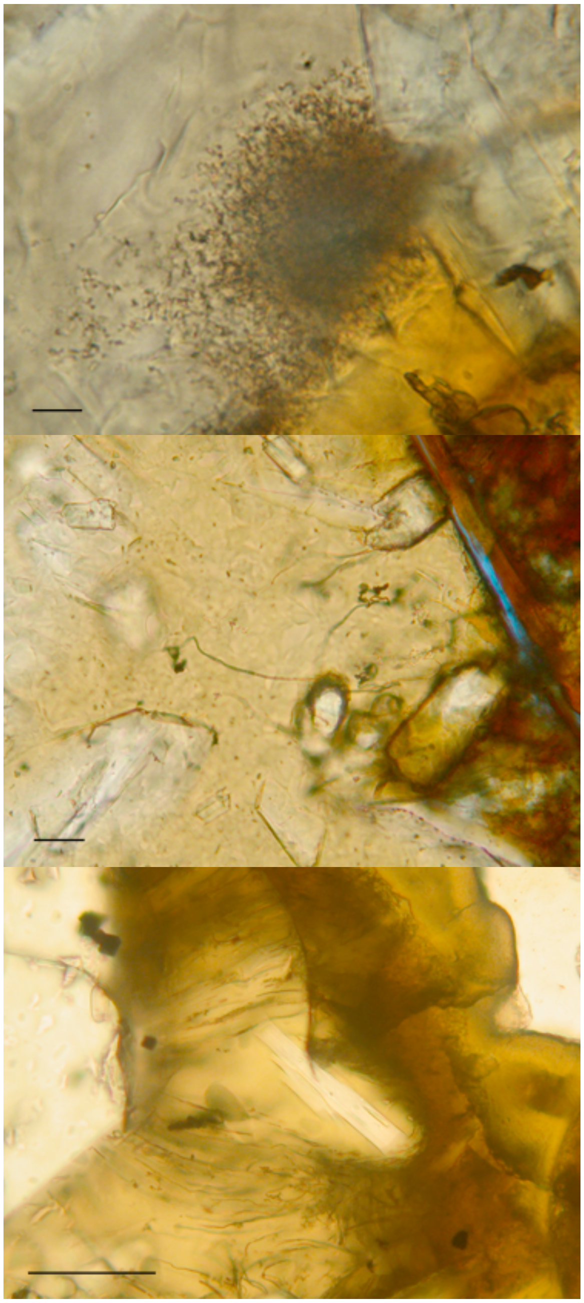

Figure 1. Top:Granular alteration initiating at interface between palagonite (lower center) and unaltered glass (upper left). Olivine crystal on right. (HSDP 3377.6 meters below sea level, mbsl). Center: Simple tubule with grape-like cluster at termination. Path of the tubules remains in glass, unaffected by nearby crystals of olivine and plagioclase. (HSDP 3317.9 mbsl). Bottom: Abundant peridophylic tubules originate at shard margin, pass through palagonite, and loop around plagioclase lath to terminate against olivine phenocrysts. (HSDP 1461.6 mbsl) All scale bars: 10µm

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