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Bioalteration textures in ancient submarine lavas: A petrographic signature of early life on Earth

H. Furnes (1), N. R. Banerjee (2), H. Staudigel (3), K. Muehlenbachs (4), A. Simonetti (4), M. de Wit (5), M. Van Kranendonk (6)

(1) Department of Earth Science, University of Bergen, Allegt. 41, 5007 Bergen, Norway, (2) Department of Earth and Atmospheric Sciences, University of Western Ontario, London, Ontario, Canada N6A 5B7, (3) Scripps Institution of Oceanography, University of California, La Jolla, CA 92093-0225, USA, (4) Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3, Canada, (5) AEON and Department of Geological Sciences, University of Cape Town, Rondebosch 7701, South Africa, (6) Geological Survey of Western Australia, 100 Plain St., East Perth, Western Australia 6004, Australia

Microtextures related to bioalteration are common in glassy volcanic rocks (pillow lava and hyaloclastite) of the upper part of *in situ* oceanic crust (0-170 Ma). These textures are comparable in size and form to microorganisms, and are invariably rooted in fractures. They appear as individual or, more commonly, as myriads of coalesced bodies of either spherical and/or tubular shape. We regard the formation of these microtextures to be the result of congruent dissolution of the glass by chemoautotrophic microbial action and subsequent filling by precipitation of amorphous material.

Textures comparable in terms of shape and size with these bio-generated textures in modern oceanic basalts have also been found in ancient pillow lavas and hyaloclastites, i.e. Phanerozoic ophiolites and Archean greenstone belts, and we infer a similar origin. This inference is supported by geochemical and carbon isotope data. The best examples of purported bio-generated textures, represented by titanite-filled tubular textures, have been found in pockets of interpillow hyaloclastite in the Mesoarchean Barberton Greenstone Belt (South Africa) and the Pilbara Craton (Western Australia). The timing of formation of the titanite-filled tubules is constrained by either overlapping metamorphic and magmatic ages from the pillow lavas, or by direct dating of the titanite by *in situ* laser ablation muliti-collector-ICP-MS. Bio-generated textures can

thus be traced back to ∼3.5 Ga. We suggest that petrographic evidence in originally glassy volcanic rocks may provide a significant tracer of life in submarine volcanic environments throughout the Earth's history.

It appears that the biotextures in the extremely thick volcanic successions of greenstone belts are generated only in narrow thermal windows, at temperatures that allow life to exist. Hence it may be unlikely that they exist throughout the thick volcanic successions of greenstone belts.