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The identification of a bioalteration texture occurred in low-grade metamorphosed greenrocks

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Bioalteration textures found within greenrocks of ancient oceanic crusts outcropped on-land are the keys to characterize ancient microbial activity within oceanic crusts before the Jurassic. However, there is difficulty with identifying those textures as a bioalteration texture because most of them have experienced metamorphism and often recrystallized.The aim of this study is, therefore, bioalteration textures found within metabasalts from early to middle Permian Ibara dismembered ophiolite from the Maizuru tectonic belt, southwest Japan are examined to discuss the identification as a bioalteration texture by means of morphology, mineralogy, and elemental mapping analysis. Original structures and textures are well-preserved in the Ibara greenrocks. The Ibara greenrocks are divided into four zones based on their metamorphic mineral assemblages; zone I for prehnite-pumpellyite facies, zone II for prehnite-actinolite facies, zone III for greenschist facies, and zone IV for amphibolite facies. The mineral assemblages and chemistry suggest that all zones have experienced a low-pressure metamorphism, and the distribution of metamorphic mineral assemblages indicates it as the ocean-floor metamorphism. Granular and tubular bioalteration textures are found within quench glass of the basaltic pillow lavas in three locations. Granular bioalteration textures occur form irregular clusters along either veins or clacks within altered basaltic glass, and they are approximately less than 10 micrometers in diameter and consist of titanite. Tubular bioalteration textures occur from clacks or veins extended into altered basaltic glass, and are less than 20 micrometers in width and less than 400 micrometers in length. Tubular bioalteration textures are morphologically divided into four types; (1) unbranched tube with spiral tube, (2) unbranched tube with larger diameter at the end of tube, (3) branched tube with larger diameter at the end of tube, and (4) others. Although minute original textures are often not well-preserved, but the occurrence and preserved morphology resemble the bioalteration textures found within in-situ oceanic crust in previous study. Based on diagnosis of bioalteration textures (McLoughlin et al., 2009), granular texture and tubular textures from (1) to (3) could correspond to *Granulohyalichnus vulgaris* isp., *Tubulohyalichnus spiralis* isp., *Tubulohyalichnus annularis* isp., and undefined, respectively. Elemental mapping analysis performed by SEM-EDS on a tubular bioalteration texture showed a significant concentration of C at some parts within the tube and at the rim of the tube. The concentrated C within tube shows positive correlations with Si, Al, and K. On the other hand, the carbon concentrated part at the rim of tube do not exhibit significant concentration of Si, Al, K, Ca, Fe, and Mg. The concentration of P is also observed at the rim of tube. The elemental mapping analysis exhibited significant concentrations of biophile elements C and P within a tubular bioalteration texture. Because the observed C at the rim of tube does not show positive correlations with Ca, Fe, and Mg, it could not be originated from carbonates. This result suggests that the C could be originated from microbes at the rim of tubular texture. Also, phosphate minerals observed within the tube would be possibly originated from microbes. Based on our study, the bioalteration textures occurred in the Ibara greenrocks have disfeatured their minute textures of original morphology because of recrystallization by ocean-floor metamorphism. These facts suggest that bioalteration textures in the greenrocks experienced higher metamorphism than prehnite-pumpellyite facies could lose their original morphology. However, this study suggests that bioalteration textures within low-grade metamorphic greenrocks could be identified by occurrence, morphology, and mapping analysis of biophile elements.

Keywords: bioalteration texture, greenrock, criteria, Maizuru belt, biophile elements, elemental mapping analysis