ELEMENTAL ABUNDANCE DISTRIBUTIONS IN BASALT CLAYS AND METEORITES: IS IT A BIOSIGNATURE? M. R. Fisk[1], M. C. Storrie-Lombardi[2], and J. Joseph[1]. [1]Oregon State University, College of Oceanic and Atm. Sci., Corvallis, OR 97331 mfisk@coas.oregonstate.edu, [2]Kinohi Institute, 530 South Lake Avenue, Pasadena, CA 91101 USA.

Introduction: Volcanic glass altered by microorganisms exhibits distinctive textures differing significantly from abiotic alteration [1-4]. We have previously presented morphological evidence of bioweathering in sub-oceanic basalt glass [5] and olivine [6], and noted similar alterations in Nakhla [7]. We have also introduced an autonomous Bayesian probabilistic classification methodology to identify biotic and abiotic alteration in sub-oceanic basalts using elemental abundance data [8]. We now present data from multiple sub-oceanic sites addressing the more general question of utilizing elemental abundance distribution in clays as a valid biosignature for the exploration of putative clay alteration products in meteorites.

Method: A total of 166 basalt samples were obtained from 9 sites cored by the Ocean Drilling Program and the Deep Sea Drilling Project from beneath the ocean floor. Petrographic photographic and elemental abundance acquisition techniques and analytical algorithms have been previously described [8, 9]. Briefly, petrographic examination was accomplished using an petrographic microscope. Quantitative eleven-element (Na^{11}, Mg^{12}, Al^{13}, Si^{14}, P^{15}, Cl^{17}, K^{19}, Ca^{20}, Ti^{22}, Mn^{25}, and Fe^{26}) electron microprobe analyses were acquired with a four-spectrometer CAMECA SX-100 at Oregon State University. Samples were visually classified on the basis of petrographic textural alterations. Elemental abundance values were qualitatively classified by unsupervised, autonomous Principal Component Analysis and Hierarchical Cluster Analysis. Finally, a Bayesian Probability of correctness of classification was generated by a stochastic artificial neural network.

Prediction	Unaltered	Abiotic	Biotic
Elemental Abundance	18	87	36
Petrographic Examination	18	97	51
Agreement	100%	89.7%	70.6%

Table 1. Morphological and chemical classification of 166 samples from 9 sub-oceanic sites.

Results: The 11-element abundance distributions easily distinguished all 18 unaltered samples from both biotic and abiotic clays as expected (Table 1). Distinctive chemical signatures were obtained almost 90% of the time for abiotic alteration, but only 70.6% of the time for biotic samples. Unaltered basalt glass contained high concentrations of calcium, phosphorous, and sodium. Abiotic alteration reduces these levels by

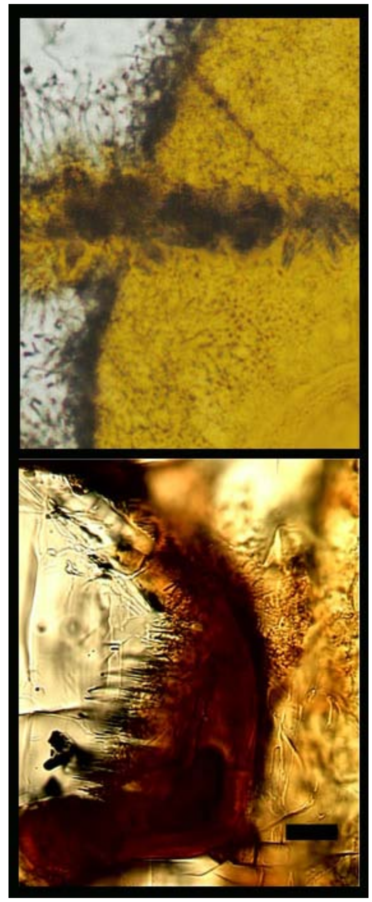

Figure 1. A sub-oceanic basalt core exhibiting abiotic (A) and biotic (B) alteration. Unaltered basalt glass (G) appears in upper left corner. Examination of a section of the Nakhla meteoritie reveals tubular structures (T) extending into unaltered pyroxene (O) olivine (O) along an alteration front (F).

more than an order of magnitude. Biotic activities produces less severe mobilization of these elements and is characterized by moderate elevation in titanium abundance.

Site location of the classification disagreements was not randomly distributed. Four of the nine sites accounting for only 68 samples produced 19 of the 25 disagreements. Most interestingly, neural network prediction of the accuracy of classification using elemental abundances was higher if the chemical prediction agreed with the petrographic analysis. The finding emphasizes once again the importance of combining mrophological and chemical information.

Future Research: Work is currently underway applying these analytical strategies to evaluation of Nakhlite samples. Near-term efforts are focusing on understanding the impact of local environmental conditions on residual trace signatures. Alterations in temperature, pH, pressure, and salinity could produce marked alteration in the biotic/abiotic signature differentials for a given site. Developing a reference data base of distributions characterizing particular habitats would be of considerable utility for exploration of the Mars regolith.

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