Aqueous alteration of Nakhlites: implications for water on Mars

Conference or Workshop Item

AQUEOUS ALTERATION OF NAKHLITES: IMPLICATIONS FOR WATER ON MARS. Monica M. Grady[1], M. Anand[2], J. C. Bridges[1], V. K. Pearson[1], I. A. Franchi[1] and I. P. Wright[1]. [1]Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK; [2]Dept. Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD, UK. E-Mail: m.m.grady@open.ac.uk.

Introduction: The nakhlites are all clinopyroxenites that vary mainly in grain size rather than composition. They are almost unshocked rocks that formed at or near the Martian surface in a slowly-cooled, thick cumulate pile, with the various members of the group thought to be derived from different depths within the intrusion [1]. The rocks bear traces of low temperature aqueous processes that can be used to infer conditions on the Martian surface. The meteorites have been altered by weathering, leading to the production of secondary minerals associated with which are low concentrations of Martian organic material [2, 3]. There are at least two populations of martian weathering products within nakhlites: (1) 'clay minerals' formed *in situ* within olivines, by the alteration and hydration of silicates and (2) precipitation of carbonates and sulphates within cracks.

Several parameters have been employed to infer a differential alteration sequence amongst the nakhlites. Bridges and Grady [2] modelled an evaporation sequence on the basis of mineral assemblages. Mikouchi et al. [4] used olivine core and rim compositions to deduce a depth of crystallisation within the nakhlite magma pile. We have taken these two models, and applied them to the seven currently known nakhlites, in order to determine whereabouts in the cumulate sequence the meteorites fit. Specifically, we are looking at the modal abundance of clay minerals (determined by phase mapping using SEM) and the abundance and isotopic composition of carbonates (determined by acid dissolution and mass spectrometry). We are testing the hypothesis that the clay minerals and carbonates formed from two separate fluid reservoirs. Carbonates were produced by surface waters in contact with the atmosphere percolating down through the magma pile, and clay minerals were produced by melted ground water circulating at depth. If the hypothesis is correct, then there might be opposing gradients in alteration product abundance, with carbonate abundance decreasing down the pile, and clay mineral abundance increasing.

Our first result concerns MIL 03346, which has the least equilibrated of all nakhlite olivines [5]. If equilibration is a marker for depth within the cumulate pile [1, 4], then MIL 03346 must derive from the outermost edge of the intrusion, perhaps even a chilled margin. MIL 03346 seems to contain only sparse carbonates (< 5 ppm), although its olivine grains are broken by clay veinlets. It is possible that the outer edge that MIL 03346 represents is of the bottom of the intrusion, and not the top.

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