EVIDENCE FOR PHYLLOSILICATE PRECURSORS IN AN APHANITIC SPHERULE FROM NWA 7533.

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Introduction: Phyllosilicates, the products of aqueous weathering of igneous rocks, have been reported in Noachian terrains on Mars [1]. The discovery of a polymict breccia, NWA 7533 (and paired stones) [2-3], opens a source for direct laboratory studies of ancient Martian weathering products. NWA 7533 contains no original phyllosilicates, but is dominated by impact melt clasts containing plagioclase and orthopyroxene [4]. However, evidence of pervasive pre-impact weathering has been recognized in the mineralogy of NWA 7533 [5]. We now report the results of chemical studies of an aphanitic spherule from NWA 7533, the protolith of which is inferred to be a phyllosilicate-rich sedimentary rock.

Methodology: A 3-mm diameter aphanitic spherule from NWA 7533 Section SP7 was analyzed for its chemical composition by LA-ICP-MS following methodology of [3]. Aphanitic areas were analyzed with a 100 µm spot; a line scan (50 µm spot, 10 µm/s) was conducted across the entire spherule; a bulk raster (150 µm spot, 50 µm/s) of 80 mm^2 was performed.

Results: The rounded spherule is partly altered in several areas and cross-cut by veins filled with hyalophane, sulfides, and other secondary minerals. The average chemical composition of four aphanitic, least altered, areas is similar to the bulk composition of SP7 with several prominent exceptions. The Na (0.37), P (0.25) and S (0.07) contents were depleted relative to the bulk NWA 7533 SP7 composition, while the abundances of K (5), Rb (68), Cs (157) and Tl (153) were strikingly enriched in the aphanitic areas relative to Th and bulk SP7. No enrichments of As, Sb, and Pb relative to bulk SP7 were observed. The aphanitic sections of the spherule were somewhat higher in Fe and Ni than bulk SP7, but lower in Ir (2 ppb vs. 14 ppb). The line scan revealed that the K-Rb-Cs-Tl enrichments were highest in regions showing the least alteration, and were lowest in the veins.

Discussion and Conclusions: The striking enrichments of K, Rb, Cs, and Tl, and the depletion of Na, are characteristic chemical signatures of terrestrial clay minerals in marine shales and in altered mid-ocean ridge basalts [6]. Hydrothermal enrichment is excluded based on the lack of enrichment in As, Sb and Pb, which are mobile under hydrothermal conditions [7]. An igneous enrichment is excluded since Th and REE are not enriched relative to bulk SP7. Leaching of clays under acidic conditions results in net loss of all alkalis relative to Al and Ti, which is not observed here. The line scan analysis ruled out enrichment of these elements during Martian or terrestrial weathering. We conclude that the large spherule in NWA 7533 SP7 formed by impact melting of basaltic dust altered underwater to phyllosilicates in neutral conditions during the Phyllosian [1], providing new constraints on Martian weathering.

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