NWA 7533: AN OVERVIEW OF MELT ROCKS AND BRECCIA ASSEMBLY HISTORY

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Introduction: NWA 7533 is a martian regolith breccia containing fine-grained clast-laden melt rocks and noritic-monzonitic melt rock. The latter crystallized zircons at 4.428±25 Ga that were reset at ~1.4 Ga [1,2]. The large bodies of clast-laden melt rock ("amoeboid clast-rich vitrophyres" [3]) and other debris in NWA 7533 might have been deposited in the zircon-resetting event or within the Pre-Noachian. The relationships between the different types of melt rocks are crucial in deciding when the breccia was assembled.

Petrology: The fine-grained clast-laden melt rocks have textures characteristic of impact melts, and some occur as sculpted bodies, as in suevitic breccias [1,2]. Melt rocks with normal igneous textures include slightly coarser microbasalts with rare clasts, medium grained clasts with zoned pigeonite and augite, and medium grained zircon-bearing noritic and monzonitic clasts [1]. These rocks differ mainly in clast abundance, grain size and extent of fractionation; all have concentrations of siderophile elements equivalent to ~5% chondrite component, like matrix [2]. Although the clast-laden melt rocks are like those known on other planetary bodies [5], they contain unique oval aggregates or clots of orthopyroxene granules with plagioclase aureoles. These may be derived from similar pyroxene clusters resembling little dust balls seen in breccia matrix. Key observations are that inclusions of monzonitic and noritic melt rock are found as clasts in the fine-grained melt rock and both feldspar and pyroxene show exsolution suggesting formation at depth. Thus the NWA 7533 breccia was not formed instantaneously: it is an accumulation of melt rock bodies and matrix, somewhat younger than the noritic and monzonitic clasts they both contain.

Chronology: NWA 7533 records a strong disturbance in the Amazonian at 1.357 ±81Ga [2,4] affecting zircon, alkali feldspar and chlorapatite, after or during the lithification of the breccia. We consider the two possibilities: (1) the lithification age is ~4.3 Ga and all subsequent disturbances reflect later events that affected the Pre-Noachian breccia; (2) The lithification age is ~1.4 Ga [3]. Resolving these two models is essential to fully reading the record of ancient Mars from this breccia. Clast-laden melt rocks, microbasaltic melt rocks and spherules do not have ages constrained by individual isochrons but appear to have the same zircon and plagioclase crystallization ages as the monzonitic clasts. Specifically a clast of (micro-) basaltic trachyandesite composition [6] contains concordant and discordant zircons [7]; zoned-pyroxene clast 7533-4-K has a plagioclase model age near 4.5 Ga with apatite and K feldspar reset [4]. The new Sm-Nd dating of bulk breccia chips and mineral separates, including a wide sampling of pyroxene, yields an age of 4.42±7 Ga [8], indistinguishable from the zircon crystallization ages. These data suggest that all the rock types making up the breccia formed within a very short lapse of time.

Environment: Dating of NWA 7533 places all its components in the earliest Noachian terrains, characterized by phyllosilicate alteration in remote sensing. The geochemical evidence that the precursors of the monzonites and some spherules were altered and clay-rich [9] is consistent with this. Thus phyllosian conditions are indicated before 4.43 Ga (PreNoachian). The zircons record high $\Delta^{17}O$ values attributed to photochemically induced isotope fractionation and transfer of the atmospheric signal to precursor rocks by surface alteration [10]. The monzonitic melt incorporated this signature from a wet Pre-Noachian terrain with phyllosian weathering effects. Thus, the atmosphere was thin enough to create reactive reactive ^{17}O species *before* impact melting and zircon crystallization 4.43 Gyr ago. Evidence of wide spread occurrence of breccias like NWA 7533 in the PreNoachian would have interesting implications for early water abundance and atmosphere evolution.

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