THERMAL HISTORY OF NORTHWEST AFRICA 8114

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Introduction: The first clastic meteorites from Mars, Northwest Africa (NWA) 8114 and its pairs [1-3], provide a unique opportunity to study the processing and oxidation history at a Martian impact site. Formed in an impact ejecta blanket from precursor magmatic assemblages, with ancient zircons of 4.4 Ga (U-Pb) [3], the whole rock ages of 2.1 Ga (Rb-Sr) [1] and 1.5 Ga (U-Pb) [4] are associated with impact regolith processes. Our study combines mineralogical work [5-7] with examination of alteration and breakdown textures in order to unravel the thermal history.

Methods: Textural and mineralogical data from a polished section was obtained on a Quanta 600 ESEM. An X-ray micro-CT scan of the 1.6 g remaining sample was obtained using a Nikon Metrology XT H 225. SEM, EPMA and *Diamond* synchrotron beamlines I-18 and B-22 were used to obtain XRD, XRF, XANES, FTIR [5-7].

Results: Figure 1A shows the wide range of mineralogy, sizes, shapes and textures. Some pyroxene clasts, $Wo_2En_{65-72}Fs_{26-33}$, have a porous texture and feldspar border, some have exsolution lamellae varying in width, indicating a crystallisation temperature above 900°C [5]. Cryptoperthite alkaline feldspar $Ab_{8-20}Or_{80-92}$ and plagioclase An_{24-43} indicate more than one magmatic source. The exsolution and cryptoperthite textures indicate slow cooling.

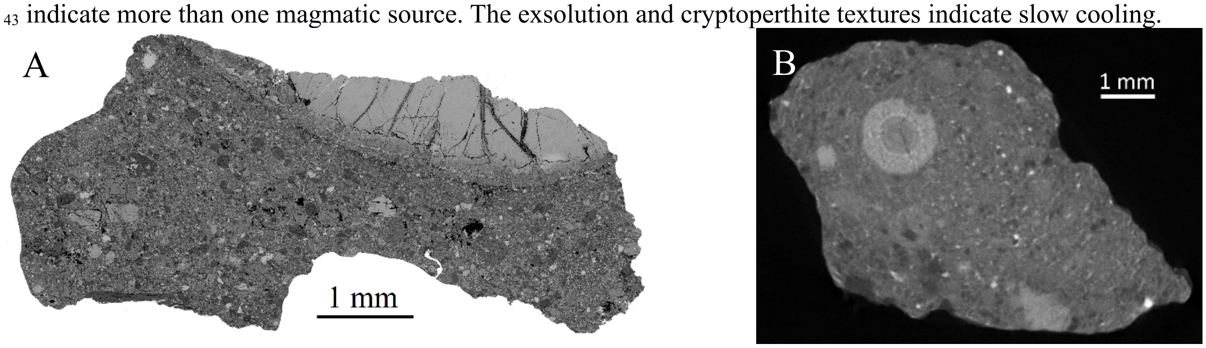

Fig. 1: (A) BSE image of a section, with a large pigeonite clast (top) containing veins truncated by a partially melted rim. The rim is primarily composed of andesine with some iron oxides and the veins contain andesine with a small amount of anorthoclase. (B) CT-scan image showing a spherical accretionary pellet-like structure (upper left).

Iron oxide grains have been seen in a full range of pyroxene clasts, from low Ca to high Ca, and in clasts with exsolution textures, where the grains are larger and often along cracks. TEM showed that the large pigeonite clast with Fe oxide grains (Fig. 1A, top), $Wo_{12-18}En_{31-34}Fe_{47-56}$ has partially re-crystallised to form magnetite and amorphous Al silicate at a submicron scale, showing the effects of high temperature and oxidation of up to 25% $Fe^{3+}/\Sigma Fe$ during regolith formation [6]. FTIR shows this area to be anhydrous. The feldspar-rich veins that crosscut it contain primarily andesine with a small amount of anorthosite, evidence of in-situ partial melting near or at the basaltic eutectic ~900° C. Similar andesine is also seen in the rim.

Discussion: After aggregation into a regolith blanket, high temperatures were maintained, sometimes above the basaltic euctectic point, as seen from the evidence of feldspar veins and recrystallized material. The anhydrous partial breakdown of pyroxene to Fe oxide, also seen by [8] for Ca-rich pyroxenes, has analogies with the breakdown of pyroxene in ureilites by impact smelting [9]. In some ureilites ~50% of the pigeonite has been reduced by impact smelting and contains sprinklings of Fe-metal [9]. The impact event(s) on Mars took place under oxidising conditions with lower shock, so we see iron oxide grains (rather than Fe metal) and an amorphous Al silicate material. Shock is associated with a change in pyroxene Fe^{3+}/Fe_{tot}, and to a greater degree for high-Ca pyroxene [10].

Our work shows that the mineral assemblages of pyroxene-rich clasts in NWA8114 are dominated by the effects of shock and partial breakdown to Fe oxides, followed by slow cooling from basalt eutectic temperatures within the martian regolith.

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