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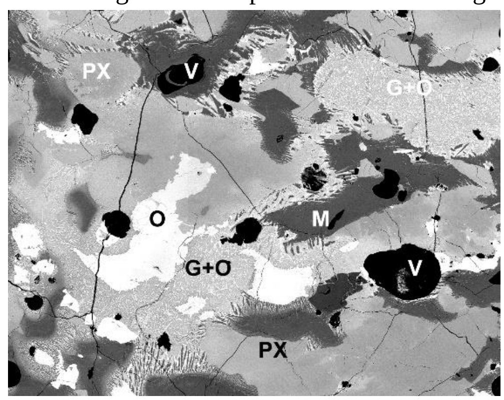
Introduction: NWA 14672 has olivine a little more ferroan than in the olivine-phyric shergottite NWA 8686, and their pyroxene compositions partly overlap [1]. A closer match is found in pyroxene in the basaltic shergottites Queen Alexandra Range QUE 94201 [2] and Los Angeles [3]. Its average feldspar matches that in QUE 94201 with very low K. The spinel is ulvöspinel not chromite. Many other shergottites have accumulated olivine autocrysts, but here the most magnesian olivine and pyroxene are close to equilibrium, suggesting the rock represents a liquid composition.

Fine-Grained Melt Components: Both glass with olivine dendrites and an assemblage with fine plagioclase bars are present as interstitial patches. The glass and the barred plagioclase assemblage contain large (up to 100μm) Fe sulfides (FeS-Fe_9S_{10}) globules, often attached to vesicles and poikilitically enclosing (Ti) magnetite. In other shergottites, olivine dendrites are common in shock veins. NWA 4797 [4] and 5298 [5] have radiating plagioclase dendrites in glass and/or parallel fingers of low-Ca pyroxene and plagioclase, associated with crystallization of melted maskelynite, and analogous to the plagioclase bars we observe. Our two fine-grained components are intermingled and there is glass with both olivine and plagioclase dendrites. This is an indication of two coexisting partial melts.



O olivine, G glass, PX pyroxene, V vesicle.

Patchy pyroxene: Pyroxene occurs as patchily zoned masses with irregular "cores" within late magmatic ferroan pigeonite, as in many shergottites. The pigeonite mesh is penetrated by glass with dendrites and the barred plagioclase assemblage (offshoots from large fine-grained domains).

Granular aggregates: Aggregates of fine olivine, pyroxene, and ilmenite granules occur in the fine-grained components. Olivine near fine-grained material has coarse dendritic overgrowths. The granular aggregates resemble neoblasts but could result from disaggregation and rapid crystallization. They are found in other strongly shocked shergottites: baddelyite and zircon in NWA 5298 [5], and chromite in Allan Hills (ALHA) 77005 [6]. Granular olivine and pyroxene were observed in NWA 5298 [6], Lewis Cliffs 88516 [7], and NWA 6342 [8].

Vesicles and maskelynite: Vesicles are observed in the most heavily shocked shergottites, along with granular aggregates. NWA 14672 contains **12%** vesicles, in maskelynite throughout, and indications of flow. The frequent departure of plagioclase bars from masses of maskelynite also suggests that it has been melted. The Raman signature of our vesiculated 'maskelynite' is similar to that of plagioclase with peaks at ~480 and ~510 cm^{-1}, as in [10].

Shock conditions and Coesite: Silica particles consist of coesite, quartz, and silica glass, or quartz and silica glass. The coesite extends from the particle margins inwards, suggesting that in this case the coesite grew during cooling of the silica melt. Shock experiments on basalt at 47 GPa formed maskelynite and small vesicles and, at 57 GPa, totally melted basaltic matrix with abundant vesicles was observed [9]. For the most shocked ALHA 77005 feldspar (> 45GPa estimated), in the form of vesiculated glass and crystallized plagioclase, the Raman spectra departed from the maskelynite signature and showed both ~480 and ~510 cm^{-1} peaks [10]. Our 'maskelynite' has a similar Raman spectrum and we therefore interpret it as plagioclase recovered or crystallized after a strong shock.

Conclusion: NWA 14672, like other highly shocked shergottites, contains vesiculated maskelynite and granular aggregates, as in shock stage S6 of [11]. Based on [11], at peak shock we envisage liquid plagioclase, liquid silica, liquid sulfide, and heterogeneous Fe-Mg-bearing melts locally containing remnants or concentrated nuclei of olivine, etc., plus relict grains. During cooling, plagioclase, coesite, quartz, sulfide, and both dendrites and some granular aggregates of olivine, etc., crystallized.

References: [1] Nicklas R.W. et al. (2022) *Meteoritics & Planetary Science* 57. [2] Mikouchi et al. (1998) *Meteoritics & Planetary Science 33*, 181-189. [3] Rubin A. E. et al. (2000) *Geology* 28:1011–1014. [4] Walton et al. (2012) *Science* 47, 1449–1474. [5] Darling et al. (2016) *Earth Planet. Sci. Lett.* 444, 1-12. [6] Walton E. L.and Herd C. D. K., (2007) *Meteoritics & Planetary Science* 42, 63-80. [7] Treiman A. H. et al. (1994) *Meteoritics* 29, 581-592. [8] Irving A.J. et al. (2011) *LPSC XLII*, Abstract #1608. [9] Niihara T. et al. (2012) *Earth Planet. Sci. Lett.* 341, 195-210. [10] Fritz J. et al. (2005) *Antarct. Meteorite Res. 18*, 96-116. [11] Fritz J. et al. (2017) *Meteoritics & Planetary Science* 52, 1216-1232.