**MELT INCLUSIONS IN THE SECOND CHASSIGNITE NWA 2737.** Q. He[1,2], L. Xiao[1], H.Y. McSween[2]. [1]Faculty of Earth Science, China University of Geosciences, Wuhan, 430074, China. [2]Planetary Geosciences Institute and Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996-1410, USA.

**Introduction:** The Martian SNC meteorites are invaluable sources of information about Martian magmatism and thermal evolution history. However, this information has proven difficult to extract because of the partly cumulate nature of many meteorites. For cumulates, the bulk composition does not represent their primary melt composition. However, intercumulus melts are sometimes trapped as melt inclusions in cumulus crystals [1]. Melt inclusions may be useful tools in retrieving magma compositions from rocks that have experienced complex igneous histories [1, 2]. Here, we report a petrographic study of olivine-hosted melt inclusions in the second chassignite, NWA 2737.

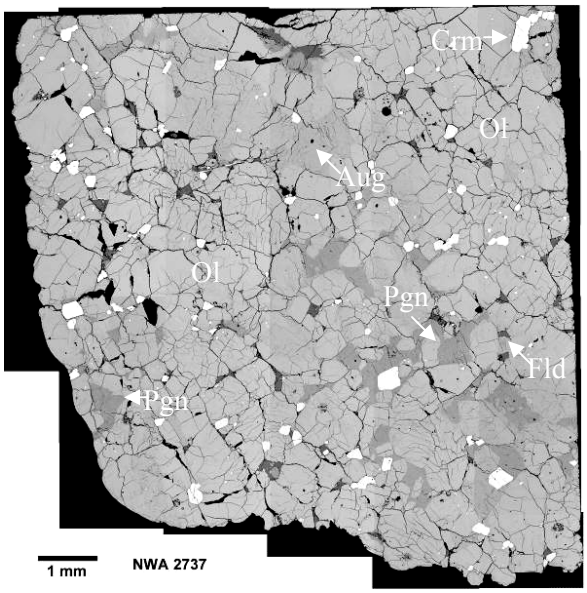


Fig.1. Backscattered-electron (BSE) image of the NWA 2737 examined in this study. Ol-Olvine, Aug-Augite, Pgn-Pigeonite, Crm-Chromite, Fld-Feldspar glass.

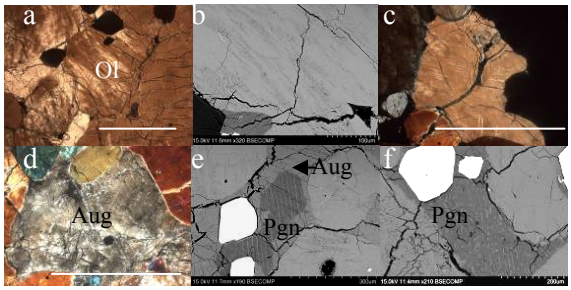


Fig.2. a-c, Ol; d-f, Py. a, photomicrograph with transmitted plane light; c, d under cross light; b, e, f, BSE images. The white lines in the images are 1mm long.

**Petrology:** NWA 2737 has a cumulate texture very similar to Chassigny; it consists mainly of anhedral to subhedral olivine crystals, with rare poikilitic augite (Fig. 1). Plagioclase is absent, but minor sanidine and/or K-rich glass is present [3, 4]. The most distinctive feature is that the olivine is dark brown; the coloration is interpreted as shock-induced, solid-state precipitation of nanometer-sized particles of metallic iron [5-7].

From optical and Back-Scattered Electron (BSE) microscopy, some shocked olivine crystals are not brown wholly but contain light and dark bands and stripes (Fig. 2a). In BSE images, these stripes appear dark gray (Fig. 1b), indicating a density difference. Some grains exhibit sets of sub-perpendicular planar defects (Fig.2c). Pyroxenes mainly occur as interstitial minerals (Fig. 2d). Low-Ca pyroxenes in some cases exhibit thin exsolved augite lamellae or droplets (Fig. 1e, f). Augites under cross-polarized light exhibit feldspar-like extinction (Fig. 2d).

**Melt inclusion types:** Inclusions were identified optically and then examined by SEM. Up to eight mineral phases may be present within the olivine-hosted melt inclusions, including olivine, low-Ca pyroxene, augite, kaersutite, chlorapatite, chromite, troilite, and alkali feldspar-rich glass. Some melt inclusions contain hydrous kaersutite amphiboles ($TiO_2$=~7 wt %).

Based on their occurrences, six variants of melt inclusions can be distinguished. Type I inclusions (Fig. 3a) are very rare. This type of inclusion consists principally of olivine, pyroxenes and glass, and the olivine crystallized on the walls of the original inclusions. Type II (Fig.3b) are generally spherical with a large range of size from 20-100µm in diameter. These inclusions contain prismatic low-Ca pyroxenes (orthopyroxene and pigeonite) and K-rich glass; some also contain minor olivine, augite and chromite crystals. A few also contain kaersutite laths. Type III (Fig. 3c) are also spherical or elliptical but usually very large (~ 200-300µm in diameter). These inclusions generally have a crystallized wall of low-Ca pyroxenes, and contain coarse augite and kaersutitic amphibole crystals and K-rich glass, with minor chromite or ilmenite. Type IV (Fig. 3d) are very small (~5-20 µm), and multiple

inclusions within single host grain are common. They are round and consist of glass, chromite and apatite, without pyroxene. Type V (Fig. 3e, f) show sub-angular to angular shapes. These inclusions are also very large (~ 200-300μm). They contain low-Ca pyroxenes and glass as essential constituents, and minor augite, chromite, kaersutite, sulfide and phosphate as accessory minerals. Type VI (Fig. 3g) are usually small with odd shapes. The shape may be a result of lengthwise shearing at some point after crystallization of the inclusion. The mineral assemblages within this type are similar to the Type Ⅱ or Type Ⅲ. Some of these inclusion types may actually be unrepresentative slices through other types; detailed mineral analyses may help determine that.

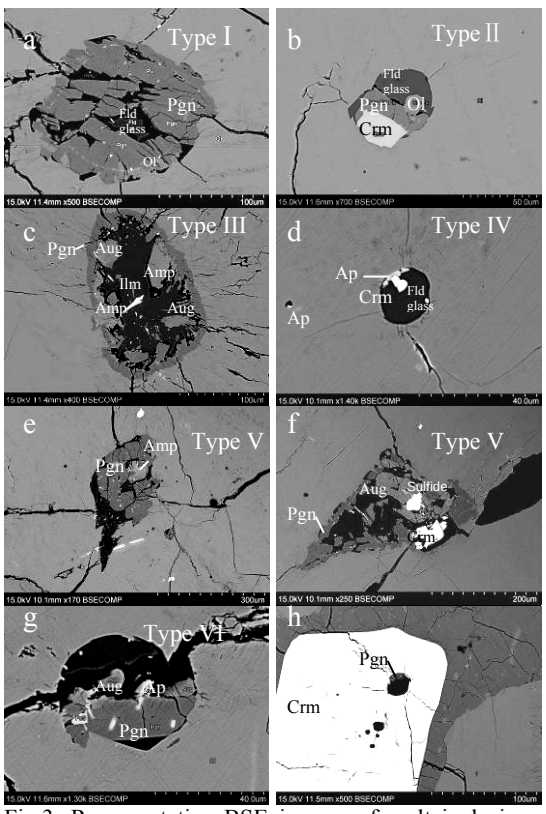


Fig.3. Representative BSE images of melt inclusions in NWA 2737. Ol-Olvine, Aug-Augite, Pgn-Pigeonite, Crm-Chromite, Amp- amphiboles, here it is actually kaersutite amphibole. Ap- Apatite, Ilm- Ilmenite. The dark phase filling part of the volume of the inclusions is the feldspar glass. The small bright crystals in the glass or on the surface of the pyroxene are apatite crystals (in a, c, e, f, g images), and some of them even consist of an internal boundary of the inclusions (a, f).

Chromites sometime also contain melt inclusions (Fig. 2h). These inclusions are usually small size (~ 5-30μm) and consist of K-rich glass and minor low-Ca pyroxene.

**Discussion:** Inclusions trapped at different stages of evolution of the melts will record fractionation of the magmatic system. However, caution must be exercised when using melt inclusion suites to determine magma composition. Melt inclusions that represent the parent magma may be uncommon because of post-entrapment effects. Correction for the proportion of secondary olivine should be done because it is likely that olivine grew on the walls of the inclusions [8].

The type I inclusions show that olivine grew on the wall of the inclusion and the composition of the olivine is now indistinguishable from the host olivine crystal (Fig. 3a). However, these olivine walls can be distinguished because they were apparently unaffected by the shock event. The types I to III inclusions are vitrophyric, and of all the inclusion types these are most likely to have entrapped representative bulk magma [2]. Pyroxene is the major mineral constituent of these inclusions; the paragenetic sequence, as best determined from the larger melt inclusions, is olivine →pyroxene → amphibole→ chlorapatite ± chromite ± troilite→ glass. The type IV, apatite and glass assemblage inclusions may represent the primary melt or the composition of middle or late stage is unknown. The type V, large and angular inclusions that contain ~85% crystalline regions (Fig. 3e, 3f), may comparable in the mineralogy to the mesostasis. These inclusions may not be actually be trapped melt, but instead may be patches of mesostasis exposed in crystal embayments. Chemical analysis may confirm their nature.

Further work on the analysis of these inclusions is in progress. These melt inclusion compositions also might be used in the future to contribute new data on the elemental and isotopic composition of Martian mantle-derived magmas.

**References:** [1] Treiman, 1993, *GCA*, 57, 4753-4767; [2] Harvey and McSween, 1992, *EPSL*, 111, 467-482; [3] Beck et al.,2006, *GCA*, 70, 2127-2139;[4] Meyer, 2008, *Mars Meteorite Compendium*; [5]Reynard et al., 2006, *LPSC XXXVII* (abs#1837); [6] Treiman et al., 2007; *J. Geophys. Res*. 112, E04002; [7] Van de Moortèle et al., 2007, EPSL, 261, 469-475; [8] Floran et al., 1978, *GCA*, 42, 1213-1229.