Origin of a Broad Melt Vein in the Lherzolithic Shergottite Y-000027

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The paired meteorites Y-000027, Y-000047 and Y-000097 were recovered from Antarctica in 2000 and recently classified as new members of lherzolitic shergottites (Misawa et al. 2006). Lherzolitic shergottites are supposed to originate from the same parent source on Mars due to similar petrology, identical crystallisation history and cosmic ray exposures ages. Y-000027 shows a unique broad melt vein of about 1.5 mm thickness, which is more than one order of magnitude thicker than typical impact related melt veins in other Martian meteorites, pointing to a longer shock duration. This may suggest an impact with a projectile up to two orders of magnitude larger than that causing the ejection of classical Martian meteorites (Langenhorst and Poirer 2000). The vein straightly cuts the host rock and separates it into a poicilitic and a non-poicilitic part. The former is predominantly composed of large Ca-poor pyroxenes enclosing rounded olivine crystals and minor amounts of chromite, whereas the non-poicilitic part contains additional amounts of maskelynite (Mikouchi and Kurihara 2007).

In order to investigate the conditions under which such a unique melt vein has formed, we analysed the petrology and the shock metamorphic state of the melt vein. A ca. 5 x 5 mm large thin section has been analysed by optical microscopy, scanning electron microscopy and transmission electron microscopy (TEM).

All areas of Y-000027 thin section indicate severe shock metamorphism. Pyroxene and slightly stained olivine grains show strong mosaic extinction, former plagioclase converted completely to maskelynite. Fine pigeonite exsolution lamellae along (100) are visible in the optical microscope within (001) lamellae and point to a high formation temperature. The melt vein is composed of 3-5 μm large olivine grains, tiny chromites and a residual basaltic andesite melt. Some larger olivine and pyroxene fragments occur, showing generally an irregular surface and strongly deformed exsolution lamellae in pyroxene. The composition of olivine alternates from core to rim, from Fo_{71} over Fo_{85} back to more iron-enriched rims. These oscillating variations are observed across a few microns, indicating a partial remelting of such grains. Further TEM micro-structural analyses will be applied to resolve the formation conditions of that unique melt vein. Shock pressures are estimated to have reached 40 GPa.

References

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