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Microanalysis of Melt Pockets within Martian Meteorite DaG 476

S. Boonsue and J.G. Spray

Planetary and Space Science Centre, University of New Brunswick, NB, Canada E3B 5A3

Dar al Gani (DaG) 476 (2015 g) is an olivine basaltic shergottite found in 1998 from the Dar al Gani region (~27°089N and 16°059E) in the Libyan Sahara. It has porphyritic textures and consists of olivine megacrysts up to 5 mm in size embedded in a fine-grained groundmass (Fig. 1). The proportions of phases described by Zipfel et al. [1] are: 15.5% olivine, 52.7% pigeonite, 2.8% augite, 3.5% orthopyroxene, 15.5% maskelynite, 3.2% opaque minerals, 4.3% melt pockets, and 2.5% carbonates. The pockets and veins appear reddish-brown stained under an optical microscope. The crystallization age of DaG 476 is estimated to be 474 ± 11 Ma [2], and the ejection time, based upon cosmogenic isotope studies, is estimated to have been 1.05 ± 0.10 Ma ago [3].

Here we report the presence of interstitial feldspathic glass and microcrystalline phases in melt pockets using Field Emissions Scanning Electron Microscopy and Raman Spectroscopy. Secondary and Back-scattered electron images reveal vesiculated, fragment-rich melt pockets with abundant crystallites, blebs of immiscible Fe-sulphides (Fig. 2). EDS analysis shows that most fragments in the pocket are pigeonite, olivine and feldspathic glass embedded in a matrix of Ca-poor clinopyroxene glass and tiny blebs of Fe-sulphide. The interstitial glass is labradorite in composition. Raman spectra of fragments in and near the pocket display intense peak at 665 and 1011 cm-1, and less intense peaks at 326 and 392 cm-1 of clinopyroxene structure while the Raman spectrum of feldspathic glass exhibits a broad spectrum between 400 to 500 cm-1. The olivine megacrysts display intense peaks at 819 and 850 cm-1.

We believe that the vesicular melt pockets in DaG 476 are formed during shock compression, which evolve to a molten state during pressure release. Post-shock temperatures facilitate crystallization and microcrystallite development from the liquid matrix. Cold fragments within the melt act as dendrite allowed dendritic neucleation of the melt extend out from their external wall (Fig. 2). The vesiculation**,** dendritic nucleation and nanocrystallization of phases in melt pockets are indicative of quenching at high post-shock temperatures. Based on our results to date, we have not found any high pressure mineral polymorphs in these melt pockets.

References

[1] J. Zipfel et al., MAPS 35, 95-106 (2000)
[2] Borg et al., LPSC XXXI #1038 (2000)
[3] Nishiizumi, K. et al, LPSC XXXII (2001)

FIG. 1. Martian meteorite DaG 476 has porphyritic textures and consists of olivine megacrysts up to 5 mm in size embedded in a fine-grained groundmass.

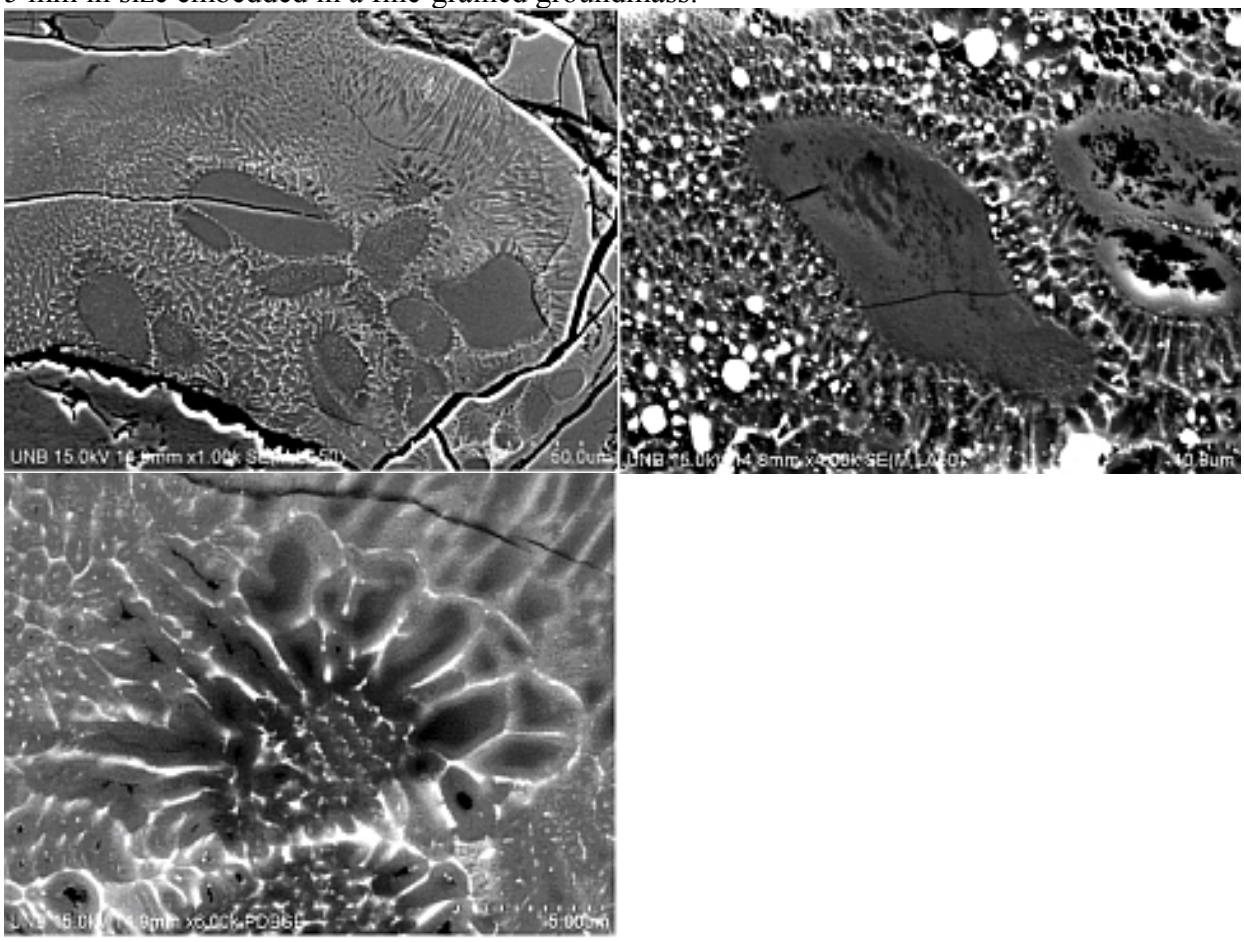

FIG. 2. SE and BSE images of DaG 476 reveal vesiculated, fragment-rich melt pockets with abundant crystallites, blebs of immiscible Fe-sulphides.

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