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NWA 7325 – not a typical olivine gabbro, but a rock experienced fast cooling after a second (partial) melting event.

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Abstract

Northwest Africa 7325 is classified as an ungrouped cumulate olivine gabbro [1]. This classification as a "gabbro" suggests that NWA 7325 should be a slowly cooled plutonic rock. However, detailed studies show that this is not the case: The rock has experienced a second (partial) melting event with fast cooling. Based on the weak shock effects in olivine an impact process for the melting can be ruled out.

1. Introduction

Northwest Africa 7325 is a 345 gram greenish-looking rock that was found in the Sahara in February 2012 and studied by Irving et al. [1]. These authors found mineralogical and chemical characteristic (e.g., Al/Si- and Mg/Si-ratio) that are rather consistent in composition with Mercury surface rocks [2] and classified the meteorite as a "reduced, iron-poor cumulate olivine gabbro from a differentiated parent body".

2. Results - Secondary melting of NWA 7325

At first glance NWA 7325 appears relatively coarse-grained with plagioclase-rich domains (50-60 vol% estimated), which appear very dull or "frosty" [1] in transmitted light (Fig. 1). This behavior of plagioclase may result from (a) the clusters of sulfide and metal (as also detected by [1]) or by (b) the assimilation of tiny Ca-pyroxenes resulting from dissolution (Fig. 2). Clear indications for a secondary melting event are found within the rock: Around the mafic minerals, on grain boundaries between Ca-pyroxene and within Ca-pyroxenes (probably on pre-existing cracks) plagioclase-rich veins are present (Figs. 2-4). Occasionally, SiO_2-normative mesostasis was found within these areas. The secondary plagioclase contains significantly more Na (up to ~An_{70}) than those found within the coarse-grained plagioclase areas (~An_{90}). Concerning the mineral chemistry of olivine and Ca-pyroxene we confirm the results of [1]: The olivine is very forsteritic (~$Fa_{2.4-2.9}$) and the Ca-pyroxene has about 0.7-2 mol% Fs and 44.4-45.3 mol% Wo. Besides Fe-sulfides, metal grains with unusually high Co-concentrations (~3.5 wt%) were found as opaque minerals. More details on the mineralogy of the sample are given by [3] using Infrared and Raman spectroscopy.

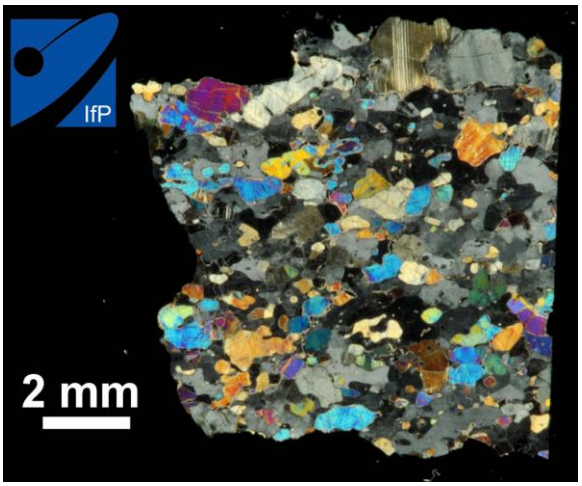

Figure 1: Overview of a thin section in polarized light, crossed polarizers. Grey phase: mostly plagioclase; colored ones: olivine and Ca-pyroxene.

The olivine is only very weakly shocked (S2) as indicated by undulatory extinction in olivine [4]. Irving et al. [1] speculated that a shock event may caused melting of plagioclase, but the shock pressure causing the undulatory extinction in olivine was certainly not strong enough to trigger large-scale melting. The occurrence of SiO_2-normative melts together with more sodic plagioclase as found for

example in Ca-pyroxene (Fig. 4) may indicate in-situ formation of a late partial melt starting at grain boundaries and filling pre-existing fractures. Re-melting has been also found in several eucrites and it was suggested that reheating by a dike-like intrusion during metamorphism could be one possibility to trigger the rapid reheating followed by fast cooling (contact metamorphism; [5]).

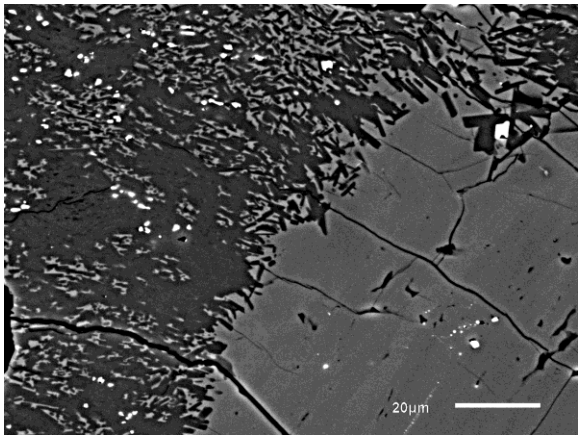

Figure 2: Contact between Ca-pyroxene (light gray) and plagioclase (dark grey) in NWA 7325 showing the dissolution of pyroxene. Also note the tiny sulfide and metal particles (white) scattering throughout the plagioclase and Ca-pyroxene. BSE-image.

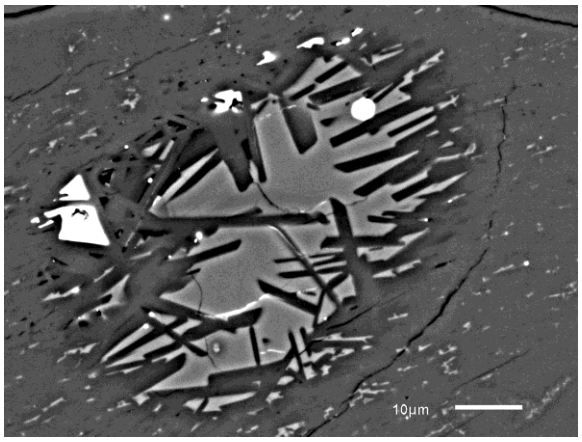

Figure 3: BSE-image showing the resorption of Ca-pyroxene and fast crystallization of plagioclase laths.

3. Summary and Conclusions

Meteorite NWA 7325 was classified as a cumulate olivine gabbro, a plutonic rock. The texture clearly shows that the rock experienced a secondary heating event with fast cooling and formation of lath-like and zoned plagioclase inconsistent with being a plutonic rock. Impact melting is highly unlikely since the olivine shows shock features consistent with a very weak degree of shock metamorphism.

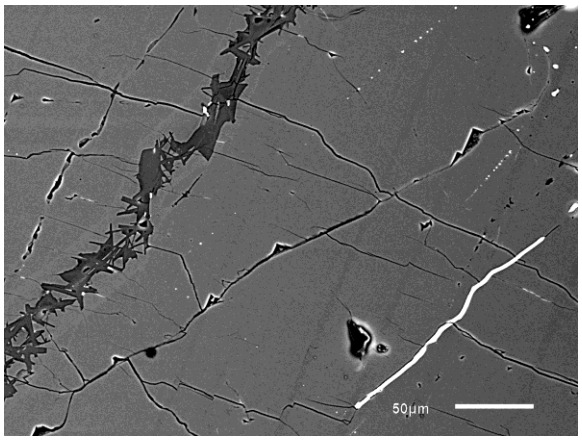

Figure 4: Indications for secondary melting and crystallization in NWA 7325: (a) FeS (white) and (b) lath-shaped plagioclase (dark grey) in veins within Ca-pyroxene. BSE-image.

Acknowledgements

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