SHOCK TEMPERATURE RECORDS IN GRAPHITE FROM THE NORTHWEST AFRICA 6871 UREILITE

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Introduction: Ureilites are coarse-grained ultramafic achondrites consisting mainly of olivine and pyroxene [1]. In addition, some contain carbon in concentrations of up to 8 wt.% [2], which occurs mainly in form of graphite and diamond. Although the presence of diamond in ureilites is know for more than a century [3], the formation process of these diamonds remains a higly debated topic. Recent publications regarding this topic proposed that ureilitic diamonds formed either in a large planetary body [4] or during impact events with destroyed the ureilite parent body catalyzed by the presence of (Fe,Ni,Co)-C melts [5,6,7,8]. Based on this, we investigated the ureilite Northwest Africa 6871 with the same methological approach as [6] in combination with a graphite-geothermometer, to understand if microdiamond is a common feature of shocked ureilites and to further characterize the shock event which destroyed the ureilite parent body.

Sample and Methods: Northwest Africa 6871 is a find from 2011 which was classified as a highly shocked (S6) ureilite [9]. We used scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS) to identify carbon bearing aggregates throughout the sample. After identifying aggregates based on their chemistry, they were cut out of the sample for phase identification by micro-Raman spectroscopy (MRS) and micro-X-ray diffraction (XRD). In addition to the phase identification, we applied a graphite-geothermometer based on micro-Raman spectroscopy [10,11].

Results and Discussion: XRD revealed that the carbon bearing aggregates consist of nanographite, nanodiamond and microdiamond, but also metallic iron and sulfides. Detailed observations of the diffractograms reveal that graphite is partly compressed and that diamond shows stacking-disorder. Both, compressed graphite and the diamond stacking faults can be used as shock indicators [12,13]. On the basis of MRS data, the graphite based geothermeter delivered a mean temperature of about 1412°C. The occurrence of "compressed" nanographite [12], nanodiamond (with stacking-disorder) and microdiamond aggregates, which are intergrown with metallic iron and sulfides, supports the theory that diamond in ureilites were formed by one or more shock events.

Conclusions: Our results are similar to those of [6,7,8] and show that microdiamond is a general constituent of carbon bearing aggregates in shocked ureilites. The formation of microdiamond took place during an impact event which effected the ureilite parent body and triggered the transformation of graphite to diamond, catalyzed by (Fe,Ni,Co)-C melts at pressures as low as 15 GPa [6]. Compared to available literature data, the temperature of 1412°C measured by MRS on graphite represents the highest temperature recorded for a ureilite so far [7,8,11]. Further, it exceeds the magmatic temperature for ureilites obtained by two-pyroxene thermometer which is 1190–1250 °C [14]. Hence, we ascribe the temperature recorded by graphite to the shock event which destroyed the ureilite parent body, reduced the size of graphite to nanometric and formed the diamonds [15].

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