American Mineralogist, Volume 107, pages 377–384, 2022

Characterization of carbon phases in Yamato 74123 ureilite to constrain the meteorite shock history

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Abstract

The formation and shock history of ureilite meteorites, a relatively abundant type of primitive achondrites, has been debated for decades. For this purpose, the characterization of carbon phases can provide further information on diamond and graphite formation in ureilites, shedding light on the origin and history of this meteorite group. In this work, we present X-ray diffraction and micro-Raman spectroscopy analyses performed on diamond and graphite occurring in the ureilite Yamato 74123 (Y-74123). The results show that nano- and microdiamonds coexist with nanographite aggregates. This, together with the shock-deformation features observed in olivine, such as mosaicism and planar fractures, suggest that diamond grains formed by a shock event (≥15 GPa) on the ureilitic parent body (UPB). Our results on Y-74123 are consistent with those obtained on the NWA 7983 ureilite and further support the hypothesis that the simultaneous formation of nano- and microdiamonds with the assistance of a Fe-Ni melt catalysis may be related to the heterogeneous propagation and local scattering of the shock wave. Graphite geothermometry revealed an average recorded temperature (T_{max}) of 1314 °C (±120 °C) in agreement with previously estimated crystallization temperatures reported for graphite in Almahata Sitta ureilite.

Keywords: Carbon phases, diamond, graphite, ureilite meteorites, shock, impact event