

Impact melting signatures in Beardsley chondrites (H5).

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Introduction: Beardsley was originally classified as a normal H5 equilibrated chondrite. This chondrite has a unique alkaline chemical signature in particular an enrichment of Rb abundance in the whole rock and K₂O concentration (up to 8 wt.%) in the matrix [1,2]. Hidaka et al. [3] performed Cs/Ba isotope measurements on Beardsley and Zag. These two chondrites have Cs/Ba values similar to the CAI of carbonaceous chondrites, indicating that they may have preserved the elemental composition of the solar nebula and that the alkaline elements may have originated from the solar nebula. Despite the unique chemical properties of Beardsley, a detailed petrological study is still lacking. In this study, we conduct petrological and mineralogical studies for Beardsley to clarify the petrogenesis of this chondrite especially the shock metamorphism.

Sample and Method: A fragment of Beardsley was provided by Arizona State University. We made two polished sections [4] and examined them under an optical microscope and a scanning electron microscope with EDS. Major chemical compositions were analyzed using an electron probe microanalyzer. All analyses were performed at Okayama University of Science.

Results: Beardsley consists of two different lithologies of brown and gray without clear boundaries [4]. Major constituents for both lithologies are olivine, pyroxene, Fe-Ni metal, troilite, and feldspar glass. We also found chondrules in both lithologies that maintained the globule shapes.

The brown lithology consists of abundant coarse-grained (CG) silicate minerals (~430 μm) and Fe-Ni metal often with a rusty rim. Furthermore, fractures in CG silicates were sometimes filled with rusty materials. Fine-grained (FG) olivine and pyroxene (~30 μm) embedded in glassy matrix filled interstitials of CG minerals, have few fractures. The compositions of CG and FG pyroxenes are $\text{En}_{45.7-84.0}\text{Fs}_{5.9-19.4}\text{Wo}_{0.8-44.6}$ and $\text{En}_{47.4-83.9}\text{Fs}_{5.4-22.1}\text{Wo}_{1.3-45.6'}$, respectively. We observe no compositional differences between CG and FG olivine. Interstice of the fine-grained minerals are filled with glass that have close to feldspathic compositions ($\text{Ab}_{23.4-83.5}\text{An}_{11.0-74.0}\text{Or}_{2.6-7.5}$).

The gray lithology consisted mostly of FG minerals (~30 μm) without fractures and interstitial glass. CG silicates show abundant fractures. Shock darkening was observed in this lithology under an optical microscope. Several deformed Fe-Ni metals were observed only in the gray lithology. The compositions of CG and FG pyroxene were $\text{En}_{49.9-84.1}\text{Fs}_{5.7-16.2}\text{Wo}_{1.0-44.4}$ and $\text{En}_{48.8-84.0}\text{Fs}_{5.2-15.6}\text{Wo}_{1.2-45.6'}$, respectively. CG pyroxene grains are sometimes accompanying Ca-rich rims ($\text{Wo}_{41.9-46.0}$). We do not find compositional differences between CG and FG olivine, $\text{Fa}_{16.3-18.1}$ and $\text{Fa}_{16.8-18.8'}$, respectively. The composition of the interstitial glassy materials was nearly feldspathic composition with $\text{Ab}_{27.7-83.0}\text{An}_{8.0-70.3}\text{Or}_{2.0-63.8}$. We found a potassium-rich material in the matrix with a K₂O content of 11.5 wt.%.

Discussion and Summary: The brown lithology is dominated by CG minerals, while the gray lithology is dominated by FG minerals and interstitial glass. CG olivine and pyroxene in the brown lithology were slightly Fe-rich compositions that could be measured near veins formed by rusty materials. Excluding this data, no differences in mineral composition were observed between the two lithologies, indicating that the brown and gray lithologies share the same origin. Differences between the two lithologies could be formed due to different degrees of shock melting: the gray lithology experienced strong impact melting compared to the brown lithology.

Reference: [1] Gast P. W. (1962) *Geochim. Cosmochim. Acta*, 26, 927-943. [2] Niihara T. et al. (2023) *LPSC LIV*, Abstract#2052. [3] Hidaka H. et al. (2001) *Earth Planet. Sci. Lett.* 193, 459-466. [4] Konishi R. et al. (2024) *LPSC LV*, Abstract#2037.

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