Goalpara隕石中の炭素質物質
Carbonaceous matter in the ureilite Goalpara

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Ureilites comprise a major group of primitive achondrites. They show highly fractionated igneous features, and at the same time they also show primitive characteristics, such as planetary-type noble gases and O-isotopic compositions [1-3]. Ureilites contain a huge amount of noble gases whose characteristics are similar to those of the Q-gases in primitive chondrites. The carrier of these noble gases is known to be diamond [4] and the origin of the diamond has been debated for years. There are two hypotheses. One is that diamond was transformed from graphite by shock-induced high pressure. The other one is that they formed by chemical vapor deposition (CVD).
All mineralogical observations [5-8] support that ureilite diamonds formed via transformation from graphite by shock. There is no mineralogical observation to support the presence of CVD diamonds. A strong support for CVD diamonds comes from simulation experiments of trapping noble gases in CVD diamonds and shock-produced diamonds [9, 10]. To better understand the origin of the diamond and ureilites, we have launched the project to examine carbonaceous matter in ureilites.
2.85 g of Goalpara, provided by The Smithsonian National Museum of Natural History, was treated alternately with HF-HCl and HCl to remove silicates followed by H_3BO_3 treatment to completely dissolve fluorides. The residue was treated with $HClO_4$ at 205°C for 2 hours four times to ensure that reactive carbonaceous materials would be destroyed. We examined the oxidized residue with a field-emission scanning electron microscope JEOL JSM-7000F at The University of Tokyo. Of the 67 grains examined, 54 grains were carbonaceous, 12 grains were Si-rich grains, and one grain was Al-Mg-Fe-Si-rich oxide.
We examined Raman spectra of the grains in the residue. Silicon-rich grains showed peaks at 787-788 cm^{-1} and 967-968 cm^{-1}. These peaks are consistent with those of 6H-SiC [4].
Many carbonaceous grains in our Goalpara sample show peaks at 1320 –1332 cm^{-1}. Since the peak of diamond is expected to be at 1332 cm$^{-1,}$ thus the peaks of the grains were shifted toward the lower wave number. Such a shift was also observed in diamond from the ureilite Almahata Sitta, where a peak center ranged between 1318.5 cm^{-1} and 1330.2 cm^{-1} [11]. The shift has been attributed to the presence of lonsdaleite, or shock-produced diamond. Alternatively, it has been caused by laser-induced heat [12].

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