Amorphous carbon in the weakly shocked Y-8448 ureilite. Y. Nakamuta[1], [1]Kyushu University Museum, Kyushu University.

Introduction:

Amorphous carbon has been reported to exist in ureilites associated with graphite, diamond, and lonsdaleite. Raman spectrum of C-mineral identified as amorphous carbon usually shows a strong D-band together with a broad G-band corresponding to ill-crystallized graphite. Then, so-called amorphous carbon is not amorphous in its structure but has an aromatic disordered structure as observed in ill-crystallized graphite.

In this study, SEM observations and Raman analyses of weakly shocked Y-8448 ureilite reveal that C-mineral which shows a broad G-band without D-band was found in intimate association with well-crystallized diamond. The Raman spectrum of such C-mineral corresponds to that of tetrahedral amorphous carbon (ta-C). The association of ta-C with diamond in ureilites gives important information on the genesis of diamond in ureilites.

Samples and Experiments:

Ten carbon grains, a few hundred microns in size, were selected from a disaggregated sample of the Y-8448 ureilite at NIPR. XRPD patterns of the grains were obtained using a 114-mm-diameter Gandolfi camera. SEM observation of the carbon grains put on a C-coated glass plate were performed using a JEOL JSM-7001F (accelerating voltage: 15 kV; sample current: 5 nA). Micro Raman spectra of carbon grains were recorded with a Jobin Yvon T64000 triple-grating spectrometer, equipped with confocal optics and a nitrogen-cooled CCD detector. A microscopy was used to focus the 514-nm Ar excitation laser beam to a 1-μm spot for accumulation over a 120-s time period. The laser power on the sample was 2 mW.

Results and discussion:

Carbon grains selected from a disaggregated sample of Y-8448 ureilite are platy in shape of a few hundreds μm in width and a few tens μm in thickness. The XRPD pattern of a carbon grain reveals that the grain is composed of graphite and diamond associated with a small amount of kamacite and troilite. The surface of a platy carbon grain is observed by SEM. In some areas, individual diamond crystals show triangular faces parallel to the surface of the grain (Fig. 1). The form of each diamond crystal appears to be triangular prism rather than octahedron.

Raman spectra at 1 and 2 positions in Fig. 1 were obtained (Fig. 2). The Raman spectrum of a triangular-shape crystal in high relief (position 1 in Fig. 1) is assigned to that of diamond. The Raman spectrum obtained at a triangular pit (position 2 in Fig. 1) shows very broad Raman band at 1580 cm^{-1} together with a band at 1332 cm^{-1} which is assigned to diamond. The band at 1580 cm^{-1} may be assigned to G-band of graphite, however, is anomalously broad, suggesting that the crystallites are very disordered and small in size [1]. Disordered and small crystallites of graphite usually show strong D-band at around 1350 cm^{-1} like as glassy carbon [2], however, the spectrum of Fig. 2b does not show D-band. Like this characteristic pattern is observed distinctively for tetrahedral amorphous carbon (ta-C) [1]. The ta-C was prepared as thin films on various substrates by deposition of filtered beam of C^+ ions having medium energy (20-500 eV) [1]. As ta-C in the ureilite occurs only in pits, the mode of occurrence of ta-C in the ureilite is difficult to explain by deposition of C^+ ions. Kelires [3] showed that ta-C is also formed by quenching of C-liquid at high pressures not only by deposition of C^+ ions on a substrate. If iron coexists, carbon melts at relatively low temperature. Then, the presence of ta-C in pits suggests that the triangular pits have been formed by melting of carbon followed by quenching at a high pressure and reveals that diamond in the weakly shocked ureilites has been formed by catalytic transformation of graphite with iron as a catalyst.

References:

[1] Robertson, J. (2002) *Materials Science and Engineering* **R37**, 129-281. [2] McCulloch,D.G., Prawer,S. & Hoffman,A. (1994) *Physical Review B* **50**, 5905-5917. [3] Kelires,P.C. (1994) *Physical Review Letters* **73**, 2460-2463.

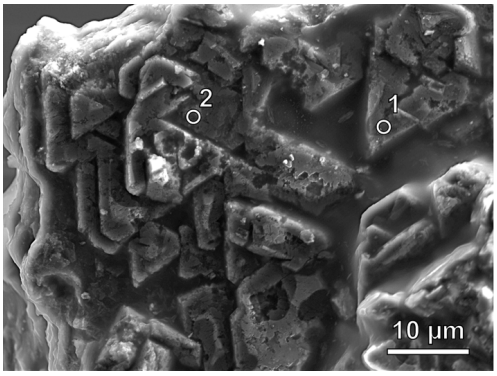

Fig. 1 SEM image of a part of a carbon grain. 1, 2: positions where Raman spectra were obtained.

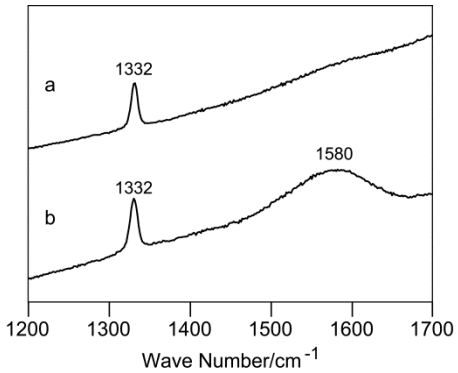

Fig. 2 Raman spectra obtained at positions 1, 2 in Fig. 1.