A SUPER-HARD, TRANSPARENT CARBON FORM, DIAMOND AND SECONDARY GRAPHITE IN THE HAVERÖ UREILITE: A-FINE-SCALE MICRORAMAN AND SYNCHROTRON TOMOGRAPHY.

A. El Goresy[1], Ph. Gillet[2], L. Dubrovinsky[3], M. Chen[4] and T. Nakamura[5], [1]Max-Planck-Institut für Chemie, 55128 Mainz, Germany. E-mail: goresy@mpch-mainz.mpg.de, [2]Ecole Normale Supérieur de Lyon, 69364 Lyon, France, [3]Bayerisches Geoinstitut, Universität Bayreuth, 95440 Bayreuth, Germany, [4]Guangzhou Institute of Geochemistry, CAS, 510640 Guangzhou, China, [5]Dept. Earth and Planet. Sci., Fac. of Sci. Kyushu Univ., Hakozaki, Fukuoka 812-8581, Japan.

Introduction: The Haverö ureilite was subjected to a strong shock event that induced the inversion of the primary carbon phase to diamond [1,2]. Our microscopic inspection of polished sections revealed that the carbon islands contain different carbon polymorphs in a remarkable petrographic setting and depicting contrasting relief with consistent spatial arrangement: (a) low relief fine-grained opaque matrix of diamond and graphite, (b) very high-relief (up to 12 µm high) ragged transparent islands (< 40 µm in diameter) of carbon with heavily gouged surfaces, and (c) a > 30 µm layer of polycrystalline graphite separating the carbon islands from the surrounding olivine and pyroxene matrix.

Results: Laser microRaman investigations revealed that the low-relief lithology consists of diamond with the characteristic one-phonon band at 1331 cm^{-1} and secondary graphite depicting the characteristic G band at 1582 cm^{-1}. Evidently this lithology does not contain compressed graphite [3]. The spectra of the high-relief lithology depict the following bands: 336, 380, 468, 567, 750, 863, 1027, 1122, 1211, 1419, 1508, 1604, and 1700 cm^{-1} in addition to the characteristic Raman band of diamond at 1329 cm^{-1} and the "D" band of graphite at 1375 cm^{-1} [4]. The outer layer of polycrystalline graphite reveals a small Raman band of diamond at 1322 cm^{-1}, small graphite "D" and a sharp G band at 1364 cm^{-1} and 1572 cm^{-1}, respectively. This polycrystalline graphite is secondary formed by pervasive back transformation of diamond or relaxation of compressed graphite (or both) at high post-shock temperatures [5].

Discussion: The Haverö ureilite contains a super-hard carbon form that was not encountered naturally, produced in static or dynamic high-pressure experiments or predicted by theoretical calculations. Polishing hardness of this phase is superior to that of diamond. The petrographic setting is indicative of maximum densification in the inner most regions of the carbon islands. The outer most regions of the islands were subjected to high post-shock temperatures thus leading to pervasive back transformation of shock-induced diamond or recrystallization of compressed graphite to highly ordered polycrystalline graphite. Fine-scale synchrotron investigations of the super-hard form are in progress. The nature of the precursor carbon species, if graphite books, kerogenes, polycrystalline graphite or poorly graphitized carbon is unknown. Scrutinizing the nature of the precursor carbon will also be addressed by synchrotron microbeam tomography.

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