A PETROGRAPHICAL, GEOCHEMICAL, AND SHOCK METAMORPHIC STUDY OF SUEVITE FROM THE EYREVILLE DRILLCORE, CHESAPEAKE BAY IMPACT STRUCTURE, USA. K. Bartosova[1], C. Koeberl[1], R.-Th. Schmitt[2], W. U. Reimold[2], and L. Ferrière[1], [1]Center for Earth Sciences, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria (katerina.bartosova@univie.ac.at, christian.koeberl@univie.ac.at, ludovic.ferriere@univie.ac.at), [2]Museum of Natural History (Mineralogy), Humboldt University, Invalidenstrasse 43, D-10099 Berlin, Germany (ralf-thomas.schmitt@museum.hu-berlin.de, uwe.reimold@museum.hu-berlin.de).

Summary: In the Eyreville drillcore, which was drilled within the central part of the Chesapeake Bay impact structure, about 154 m of suevite were recovered [1]. We present a petrographical and geochemical study of the suevite; furthermore, the proportions of unshocked and shocked quartz grains are evaluated based on systematic analyses of quartz grain properties.

Introduction: The Late Eocene Chesapeake Bay impact structure, which has a diameter of 85 km, is one of the largest and best preserved impact structures on Earth [2]. The impact crater is now buried beneath 250-500 m of post-impact sediments in the region of the southern Chesapeake Bay, its surrounding peninsulas, and the continental shelf east of the Delmarva Peninsula. Based on geographic position, age, and chemical data, previous studies have confirmed that the Chesapeake Bay impact structure is the source of the North American tektites [3, 4]. The Chesapeake Bay impact structure was drilled in 2005 as a project of the International Continental Scientific Drilling Program (ICDP) and the US Geological Survey at Eyreville farm near Cape Charles on the Delmarva Peninsula. Three stacked drillcores (Eyreville A, B, and C), intersecting the impact structure to a total depth of 1766 m, were recovered within the central zone of the structure in the deep crater moat. The crater fill comprises post-impact sediments, sediment clast breccias and sedimentary megablocks (interpreted as resurge breccias), a granitic and an amphibolitic megablock, gravelly sand, suevites and cataclasites, and granites/pegmatites and mica schists [2]. Suevite occurs between 1397 and ~1551 m depth [1], and also as thin dike breccia occurrences in the schist and pegmatite unit [5].

Petrography: We have investigated 27 suevite samples from the depth interval 1397 to 1551 m of the Eyreville B drillcore. Suevite has a grayish, fine-grained clastic matrix and consists of a variety of rock and mineral clasts, melt particles, as well as secondary minerals (e.g., phyllosilicates). Lithic fragments comprise sedimentary (siltstone, mudstone, shale, sandstone, and greywacke), metamorphic (schist, phyllite, gneiss, and quartzite), and igneous lithologies (granite, pegmatite, and dolerite). Mineral clasts include quartz, K-feldspar, plagioclase, muscovite, biotite, opaque (mostly pyrite) and other accessory minerals (incl. epidote, zircon, garnet, apatite, tourmaline). Both sedimentary and crystalline rock clasts are present throughout the suevite section (sedimentary clasts at 23 vol% and crystalline clasts at 17 vol%, on average), but their ratio varies significantly (based on point-counting investigations of 27 samples; Fig. 1). The proportion of matrix (material <0.2 mm) varies from 7 to 67 vol%, and the amount of melt and partly melted material varies from about 1 to 77 vol% in our suevite samples (Fig. 1). Melt particles are most abundant near the top of the suevitic unit (up to 34 vol% in the interval 1399-1422 m) and around 1450 m (up to 77 vol%). Millimeter- to centimeter-sized melt particles (up to 5 cm in size observed) are frequently ovoid to amoeboidal in shape and commonly show flow structures (Fig. 2). Most of the particles are devitrified and altered; only at depths around 1415 m fragments of clear to brownish (or rarely greenish) non-altered glass were observed.

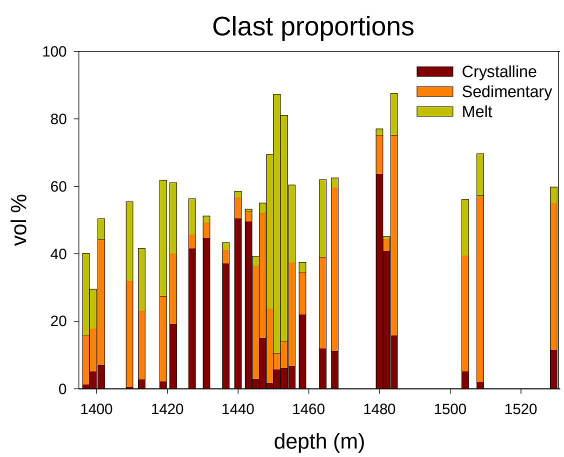

Fig. 1: Proportions (in vol%) of sedimentary clasts, crystalline clasts, and melt fragments (based on point-counting investigations of 27 samples, 155 points per thin section on average); each column represents one sample from the depth shown on the horizontal axis.

Geochemistry: Major and trace element concentrations have been determined in all suevite samples by XRF and INAA. Suevite samples show a decrease in the content of SiO_2 combined with a slight increase of the abundances of TiO_2, Al_2O_3, and Fe_2O_3 with increasing depth. The average Na_2O content in suevite from above 1447 m is elevated by a factor of about 2 compared to the suevite from below 1447 m. All suevite samples have similar rare earth element (REE) patterns with negative Eu anomaly (Fig. 3). Concentrations of siderophile elements are lower than mean continental crust contents. So far no evidence of an extraterrestrial component in the suevites has been found, but platinum-group element (PGE) analyses of samples with elevated siderophile element contents are in progress.

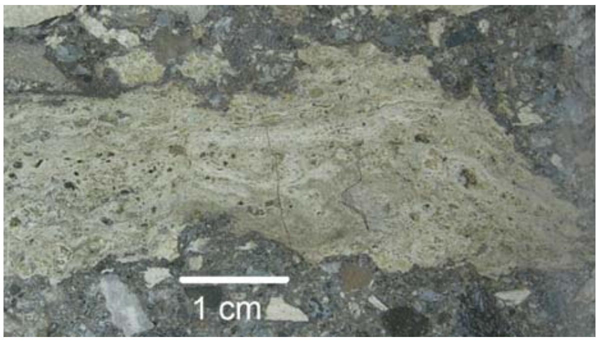

Fig. 2: Amoeboidal melt particle in suevite from Eyreville B drillcore, depth 1412.2 m.

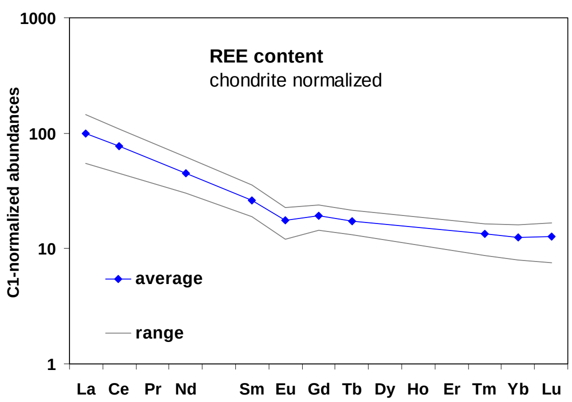

Fig. 3: Average and range of chondrite-normalized REE distribution patterns for 27 suevite samples from the Eyreville drillcore. Normalization factors from [6].

Shock metamorphism: Quartz grains in suevite show a variety of shock effects: planar fractures [PFs] (one and, rarely, two sets), planar deformation features [PDFs] (1-2 and, rarely, more sets; some sets are decorated with tiny fluid inclusions). Toasted appearance is very common. Ballen quartz occurs in melt-rich samples from depths around 1450 m. Rare feldspar grains with PDFs or mica with kink banding were observed. A systematic analysis of the properties of ~300 quartz grains per thin section was carried out, to determine the following properties: proportions of unshocked vs. shocked grains; abundance of grains with PFs and with PDFs; number of sets of PDFs; toasted appearance. On average, about 15 rel% of all quartz grains in these suevite samples are shocked (i.e., are grains with PFs and/or PDFs). Single quartz grains in groundmass (which represent a significant part of all the grains counted) are shocked to a similar percentage (about 14 rel%). A larger proportion of shocked quartz occurs in polycrystalline quartz clasts, whereas quartz-bearing clasts of schist show almost no shock effects. Most of the sedimentary clasts are too fine-grained (siltstones, mudstones) for studying shock effects in their grains.

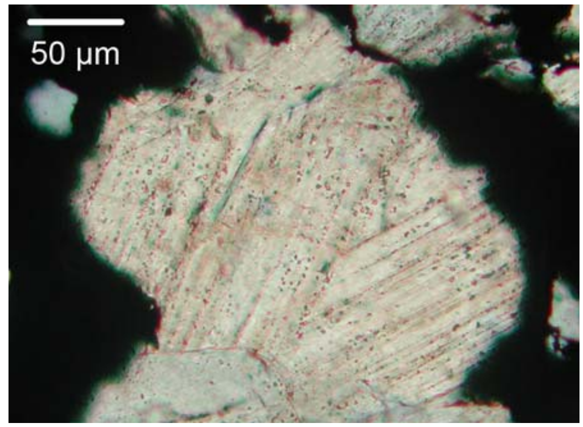

Fig. 4: Quartz grain with two sets of decorated PDFs. Suevite from the Eyreville B drillcore, depth 1427 m.

Conclusions: The amount of melted material in our suevite samples occurs in a wide range of 1-77 vol%. Proportions of sedimentary and crystalline clasts vary through the suevite section, but there is no obvious trend with depth. The SiO_2 contents decrease, whereas the contents of some other major oxides increase with increasing depth. Siderophile element contents are lower than crustal values. The proportion of shocked quartz grains is 15 rel%, on average, but is variable in clasts of different lithologies. A study of the proportion of shocked grains is still in progress.

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