STRATIGRAPHY, PETROLOGY, AND SHOCK PETROGRAPHY BASED ON WELL LOGS AND SELECTED SAMPLES FROM THE EYREVILLE DRILL CORE: CHESAPEAKE BAY IMPACT STRUCTURE, VIRGINIA.

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Stratigraphy: Well logs of the ICDP-USGS Eyreville cores show that the 85 km Chesapeake Bay impact structure is filled by >1.3 km of sands, breccias, and megabreccias. The lower part of the composite core (1770-1551 rmcd) consists of blocks and megablocks of cataclastic and non-cataclastic schist, gneiss, and granite which contain suevitic veins and which may be imbued with dark carbonaceous material. The next interval (1551-1393 rmcd) consists of layers of suevite and polymict breccia intercalated with blocks of gneiss underlying a sequence of very coarse sands (1393-1371 rmcd). Granite megablocks (1371-1095 rmcd) overlie those sands. Above the granites (1095-818 rmcd) are sands composed of slumped and partly disaggregated megablocks of the Potomac Formation, separated and intruded by dikes of impactoclastic sands. Between 818-527 rmcd is mostly Potomac-sourced impactoclastic sands containing clay blocks and gravel layers and 527-451 rmcd consists of impactoclastic breccias. Finally, the uppermost impact interval (451-444 rmcd) consists of glauconitic sands terminating in a 0.5 m zone of laminated silty clays.

Stratigraphic Interpretations: We suggest that the lower part of this succession is the product of early mixing of wall-hugging suevites with comminuted and fractured basement breccias. Coarse sands below the granite megablock contains weakly to unshocked sedimentary clasts and may represent initial resurge and collapse of the higher transient crater wall. The granite megablock, we interpret, subsequently foundered off the central peak. Continued collapse and resurge produced a sequence of sedimentary blocks and sands capped by settling deposits and washed-back fallout ejecta.

As with other marine impact structures (e.g., Wetumpka [1, 2], Chesapeake Bay shares the same dichotomy between the upper slump and resurge megabreccias and lower mixtures of target blocks and polymict breccias (with relatively little melt). This dichotomy indicates a profound change in modification-stage processes driven in large part by the return of sea water.

Petrology and Shock Petrography: We examined over fifty selected samples from the ICDP/USGS Chesapeake Bay impact structure deep drilling project Eyreville core and have analyzed them all petrographically using a standard petrographic microscope and, where needed, a petrographic microscope fitted with a U-stage. Supplemental analyses conducted on a sub-set of samples include Raman spectroscopy, electron microprobe (EM), XRD, and scanning electron microscopy (SEM).

The sample succession above the granite megablock zone (<1095 rmcd) displays sparse notable examples of shock metamorphism. We have not seen quartz with well-developed planar deformation features (PDFs) within the granite.

Coarse sands under the granite (~1375 rmcd) consist of angular quartz grains with a variety of fluid inclusion trail patterns, strong mosaicism, and a toasted appearance not observed in higher units. Between the upper granite and suevite section there is significant mixing of highly shocked and unshocked clasts also not detected above. The bottom of this interval contains rip-up clasts from an underlying suevite which hosts what appear to be altered glass microspheres. They have an average normalized composition (*anc*) (wt%) of 62.8 SiO_2, 21.9 Al_2O_3, 3.3 MgO, 8.5 FeO, 1.7 CaO, 0.5 K_2O, and 0.2 Na_2O and have radially fibrous chamosite rims.

The lower suevites contain abundant mm- to cm-size bodies of white and amber-brown altered glass. The former have *anc* (wt%) of 88.7 SiO_2, 6.9 Al_2O_3, 0.9 MgO, 1.6 FeO, 0.6 CaO, 0.2 K_2O, and 0.5 Na_2O. They contain spindle-shaped greenish glasses with *anc* (wt%) of 65.9 SiO_2, 20.0 Al_2O_3, 2.8 MgO, 9.9 FeO, 0.9 CaO, 0.1 K_2O, and 0.0 Na_2O. The amber glass has *anc* (wt%) of 83.2 SiO_2, 10.0 Al_2O_3, 0.8 MgO, 4.2 FeO, 0.7 CaO and contain Ti, Si-rich lamellae likely derived from rutilated quartz. Very small fragments of spinels rich in Ni and Cr were determined to be within these glasses. The stoichiometry was calculated from consistent quantitative analyses from EM and SEM data.

Petrologic and Shock Petrographic Interpretations: We have interpreted evidence of at least low levels of shock deformation in each section of the stratigraphic column of the Eyreville core as outlined by [3]. Our preliminary results [4] showed shock distributions consistent with previous, pre-Eyreville research [5].

Polymict clay-matrix clasts at the top of the Exmore beds may represent proximal lithic or altered melt ejecta washed back into the crater. This uppermost lithic breccia section contains scattered quartz grains with

PDFs, while the underlying section (upper granite block) displays other evidence of minor shock deformation. This evidence includes grains of potassium feldspar with vesiculated cores as well as albite, which displays alternated twin alteration likely due to asymmetric isotropization.

The suevites display a diverse array of shock features (Fig. 1) and also likely the highest shock pressures. Three compositions of silicate glass determined in this section are listed above. Numerous textural features have been observed in silica such as spherules, ballen, and schlieren.

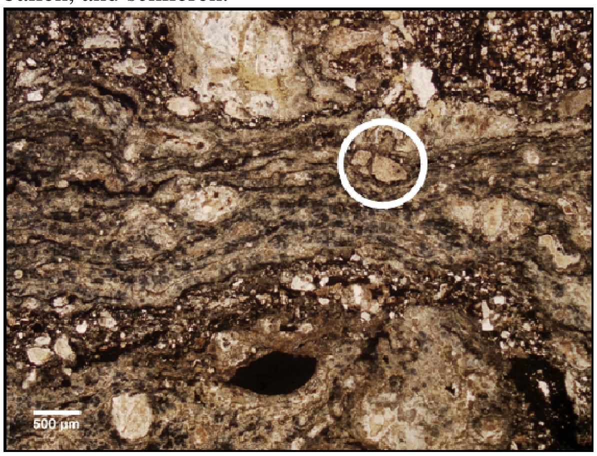

Fig. 1. Suevite sample displaying flow banding (middle region of image, PPL). White circle surrounds toasted quartz grains that contain PDFs (not visible at this scale) located within the banded melt.

The schist/pegmatite and lower granite section contains a probable cataclasite (~1665 rmcd), kink-banding in muscovite, planar fractures and possible incipient PDFs in quartz, and fine, mechanical micro-twinning in microcline.

Quartz grains display a wide range of shock effects throughout the drill core. PDF orientations have been extensively measured to estimate the pressures experienced in the various sections.

In the upper suevites, there are shocked quartzose clasts that contain decorated and non-decorated PDFs in close proximity. This diversity may be the result of varying amounts of water in the original quartz grains [6]. The suevites also contain ballen quartz with vesicle-like structures where spherulitic growths are centered on individual 'balls' (Fig. 2). Melt breccias from other impacts discussed by [6] have displayed similar features and may indicate the textures are relict structures of melts formed from high-pressure compression of wet silica grains and are not re-crystallization features. Lower suevites contain relatively large quartzose clasts with abundant PDFs dominated by {10-13} with subordinate {21-31} and {51-61} orientations.

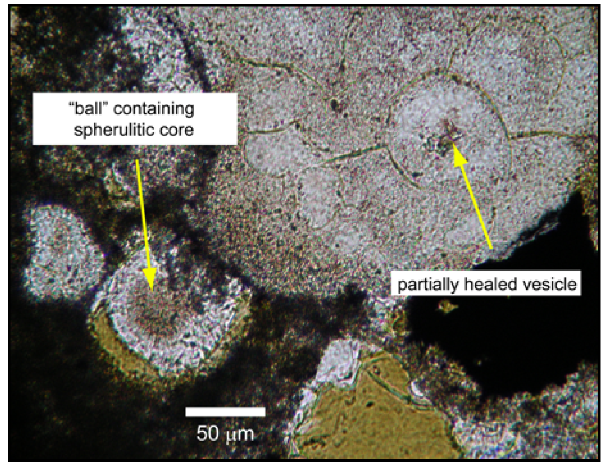

Fig. 2. Quartz in an upper suevite sample with ballen texture (PPL). Arrows point to features that could show the melt may have formed from high-pressure compression of wet silica grains.

The very fine-grained particles present in indentions in altered melt glass of a suevite sample were concluded to be Ni- and Cr-rich spinels (Fig. 3). The spinels could be re-condensed material originating from a LL- or L-chondritic bulk composition impactor.

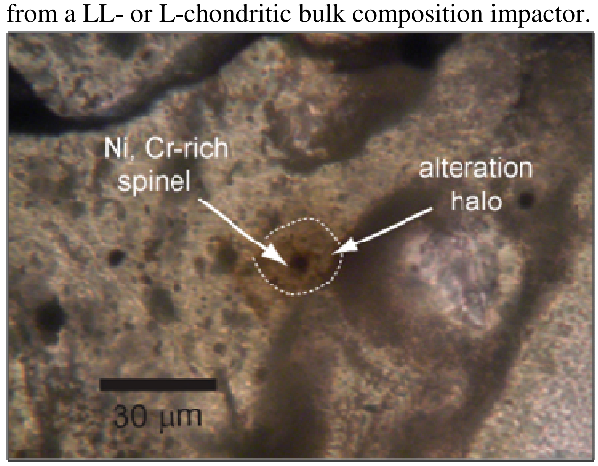

Fig. 3. Spinel grain in altered melt glass (PPL). This fragment has a composition anomalously high in Ni and Cr, indicating an extraterrestrial origin.

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