ZIRCON-REIDITE RELATIONS IN BRECCIAS FROM THE CHESAPEAKE BAY IMPACT STRUCTURE. Laura Malone[1], Suporn Boonsue[1], John Spray[1] Axel Wittmann[2], [1]Planetary and Space Science Centre, Dept. of Geology, University of New Brunswick, 2 Bailey Drive, Fredericton, NB, E3B 5A3, Canada, laura.malone@gmail.com, [2]Lunar & Planetary Institute, 3600 Bay Area Blvd. Houston, Tx. 77058.

Introduction: The 80-95 km Ø Chesapeake Bay impact structure (CBIS) formed in the late Eocene on the continental margin of what is now Virginia. The marine impact involved a target with a water depth of 0-340 m above 400-1500 m of unconsolidated, siliciclastic sediments overlying a Neoproterozoic crystalline basement [1]. Polymict impact breccias (PIB) were recovered in the Eyreville-B drill core from the annular moat, 9 km from the crater center. Reidite, a high pressure polymorph of zircon, was first described from ejecta of the CBIS [2] and since in the Eyreville drill cores [3,4]. This allows the rare opportunity to study the martensitic transformation of zircon to reidite in natural samples. The aim is to resolve differences between nature and shock experiments [5] and discuss these findings in the context of hypervelocity impact.

Samples and Methods: An Eyreville core sample of a PIB at a depth of 1481.37m was studied. Using Energy Dispersive Spectroscopy and Scanning Electron Microscopy (SEM), $ZrSiO_4$ grains were located in the thin section. Raman spectroscopy was performed to identify reidite in these grains and to map its relative abundance with regard to coexisting zircon. Electron microprobe analyses of $ZrSiO_4$ phases yielded compositional data. Field-Emission SEM and SEM with Cathodoluminescence (CL) imaging were used to image textures and zoning patterns within zircon-reidite grains identified by Raman spectroscopic analysis.

Results: The studied zircon-reidite grain is hosted in a shock stage II or III lithic clast (Fig. 1).

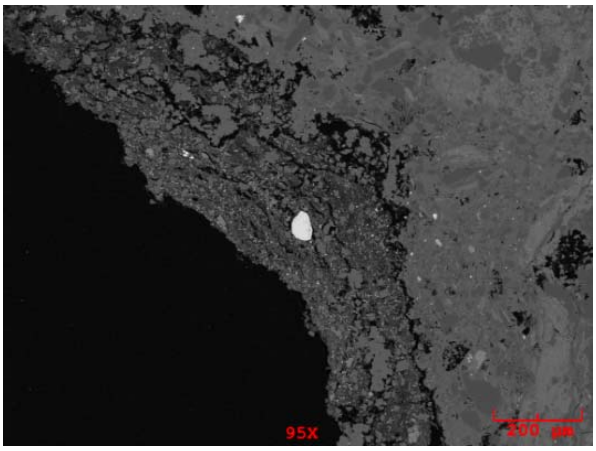

Fig. 1 Zircon-reidite in host clast of PIB sample E1481.37m, BSE-SEM image.

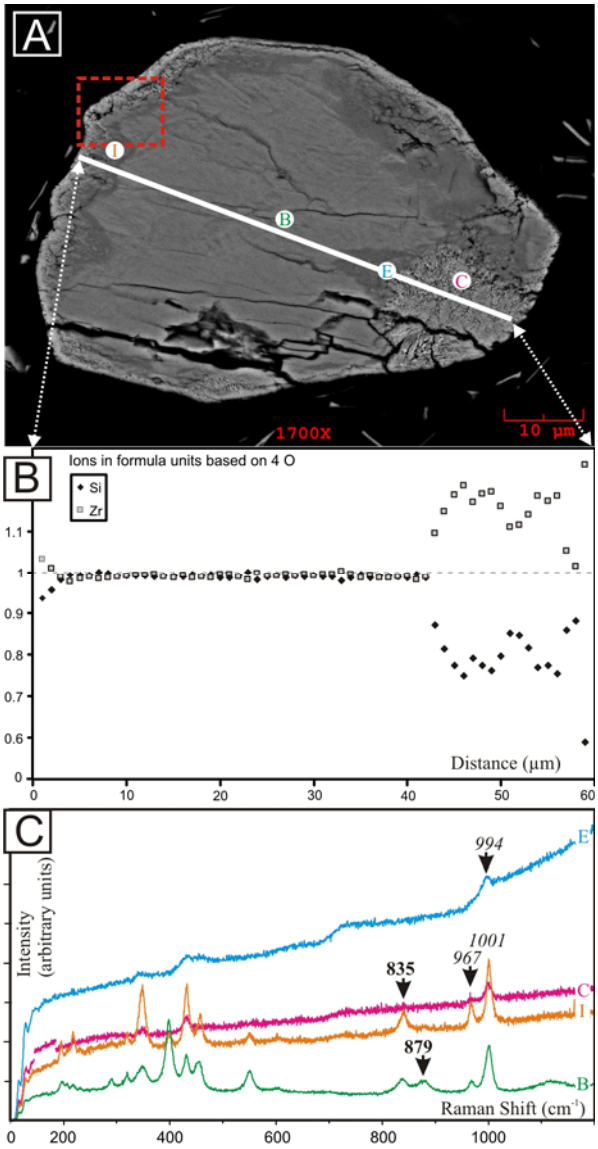

Fig. 2. Zircon-reidite grain in PIB sample E1481.37m. (A) SEM-BSE image with EMP measurement traverse of 58 points spaced at 1 µm and Raman-spectroscopy spots. (B) Ratios of Zr and Si formula units based on 4 O atoms, and (C) Raman spectra of measurement spots indicated in (A); indicative Raman bands of zircon (italic) and reidite (bold).

The host lithic clast underwent selective mineral melting at shock pressures of 45-60 GPa and post-shock temperatures of ~900-1500°C [6]. Three texturally distinct domains occur in the zircon-reidite grain. Microscopic and SEM imaging suggests the outer, ~5-25 µm thick rim of this grain shows a typical decom-

position texture with vesicles and an excess of ZrO_2 (Fig. 2 A-B, Fig. 3) [4]. This decomposition front apparently produced a poorly crystallized domain towards the core with low mass contrast (Fig. 2 C, spectrum E; Fig. 3). Beyond this thermally overprinted domain is a core of well crystallized coexisting zircon and reidite (Fig. 2 C, spectrum B; Fig. 3).

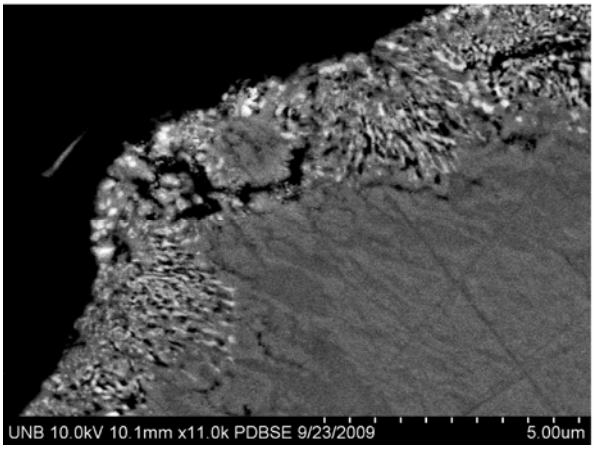

Fig. 3 Decomposition front of reidite-zircon domain indicated in Fig. 2A. Field Emission SEM-BSE image.

Raman mapping of 299 measurement spots across the whole area of the grain (step-size: 3.2 x 3.8 µm) shows higher relative intensities of the reidite 845 cm^{-1} band coexisting with zircon in the lower left region of the grain. This corresponds to the dark green CL effect (Fig. 4 iv), suggesting that the dark green is the CL effect of a high proportion of reidite. The brightest yellow CL effect (Fig. 4 ii) is seen in the zone that surrounds the decomposition front towards the core, which may be due to reverted zircon. As indicated by Raman spectroscopy, the inner core of the grain consists of coexisting zircon and reidite and is characterized by a texture with faint planar elements that likely relate to the transition of zircon to reidite [5]. This coincides with mottled CL, of variable proportions of zircon with slightly brighter, green CL and reidite in regions with darker green CL (Fig. 4 iii). Electron microprobe data and Raman spectroscopy indicate that the outermost sieve-textured zone is disordered, non-stoichiometric and depleted in SiO_2 (Fig. 2 B-C). Also, it shows little to no CL (Fig. 4 i). Nonetheless, Raman mapping confirmed the presence of poorly crystallized reidite in the outer domains that indicate incipient decomposition.

Discussion: Zircon-reidite grains in shock stage III lithic clasts are characterized by complex textures (compare to zircon-reidite grains from the Ries crater in [7]). These textures relate to the martensitic transformation of zircon to reidite. In contrast to experimentally shocked zircon grains [5,7], this transformation is not complete above 40 GPa, because in natural samples, some relic zircon coexisting with reidite apparently always remains. Possibly, as a result from the interaction with selectively melted minerals (e.g., feldspar in felsic gneiss), a decomposition front forms in zircon-reidite grains in shock stage III clasts. The phase diagram of zircon under ambient pressures [8] suggests onset of decomposition at a temperature of 1676°C. However, under vacuum, zircon starts to slowly decompose at ~1500°C. It is possible that the mineral melt could have acted as a flux agent to depress the decomposition temperature for zircon-reidite. Another explanation could be that much higher temperatures than the maximum ~1500 °C assumed for stage III components [6] are briefly reached in stage II components. So far, the kinetics of decomposition of zircon-reidite are poorly constrained. Thus, a possible interpretation is that the decomposition occurred in zircon-reidite and was not the result of the breakdown of zircon alone. With this regard, it is intriguing that reidite is still detectable in naturally shocked zircon grains that were subjected to incipient decomposition. Clearly, experimental constraints on the thermal stability of reidite and reidite-zircon intergrowths would be useful to verify textural implications for its durability.

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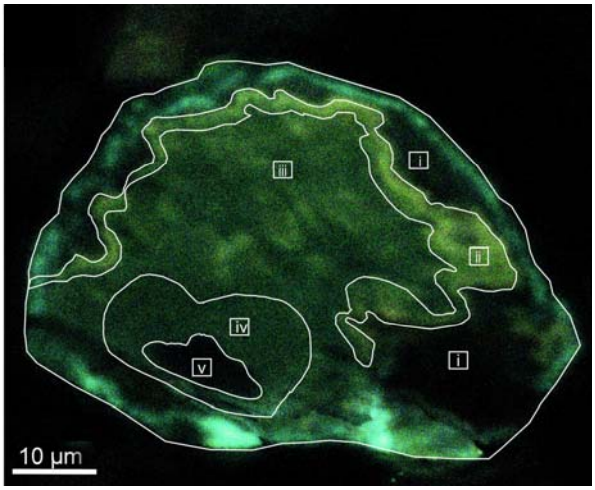

Fig. 4 SEM-CL image of zircon reidite grain with outlined domains of uniform CL.