ELECTRON BACKSCATTER DIFFRACTION INVESTIGATION OF ZIRCONIUM-BEARING PHASES IN SUEVITE FROM RIES CRATER, GERMANY.

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Introduction: Impact cratering events can generate superheated impact melts and vapor, the amount of which scales with impactor size [1]. While the high temperatures and pressures of impact events have been theorized and modeled for some time [e.g., 2–4], crystallographic evidence of these temperatures and pressures have only been identified in impact melt rocks over the past six years [e.g., 5–9]. Typically, these studies target zirconium-bearing phases, primarily zircon ($ZrSiO_4$), which is also used for geochronology and geothermometry. Zircon and its related phases can be used to understand impact conditions. At high pressures zircon is converted to reidite (a polymorph of zircon), and at high temperatures to $ZrO_2 + SiO_2$ [10]. The zirconia can be tetragonal or cubic, depending on the temperature, and generally reverts to a monoclinic structure (baddeleyite) at ambient conditions. Relics of these phases can be preserved in impact rocks and provide windows into the pressures and/or temperatures these grains experienced.

Here we study Zr-bearing minerals in suevite from the ca. 15 Ma, 26-km-diameter Ries Crater in southern Germany [11]. We seek to understand the pressure and temperature conditions involved in creating the suevite via a coordinated microanalytical campaign of two suevite thin sections. The samples, 16RS03a and 16RS08, are from Otting Quarry, at 48.8777° N, 10.7921° E, approximately 4 km outside the eastern rim of Ries Crater. These samples are from the outer suevite, a discontinuous layer of polymict impact breccia that occurs outside the central ring of Ries, up to 22 km from the center of the crater. The outer suevite is composed of clasts of crystalline basement rocks, mineral fragments, impact glass, and has a clastic matrix [11].

Methods: We used the Cameca SX100 electron probe microanalyzer (EPMA) and the Hitachi S-4800 scanning electron microscope (SEM) located in the Kuiper Materials Imaging and Characterization Facility (KMICF) at the University of Arizona to obtain elemental X-ray maps, backscattered electron images, and energy dispersive X-ray spectroscopy (EDS) maps of the samples. We used the JEOL 7900F SEM at the Astromaterials Research & Exploration Science (ARES) at NASA Johnson Space Center (JSC) to obtain electron backscatter diffraction (EBSD) maps and EDS maps of select grains of interest from the sections. The EBSD data were collected under electron beam conditions of 20 kV and ~9 µA, with step sizes varying from 0.05 to 2 µm. After collection, the EBSD data were processed using AZtecCrystal and MTEX, a free MATLAB toolbox.

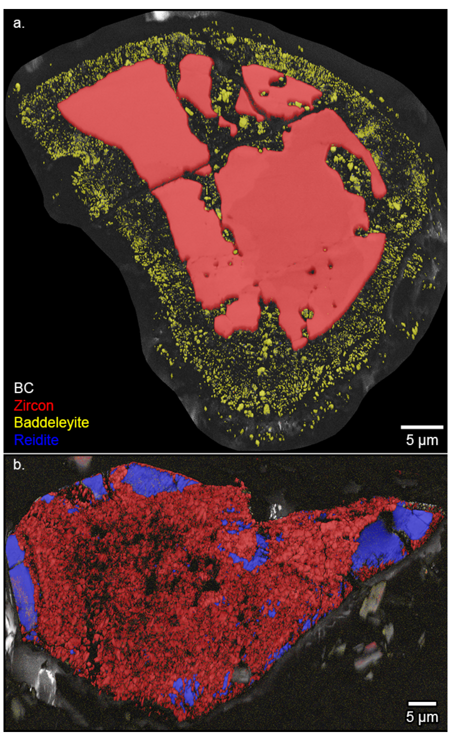

Figure 1. Electron backscatter diffraction (EBSD) phase maps for two Zr-rich grains in 16RS08. (a) Grain with a core of zircon (red) surrounded by vermicular baddeleyite (yellow). (b) Grain of granular zircon (red) with domains of reidite (blue). Grayscale in both images is band contrast (BC).

Results: We have identified grains of zircon, zircon with reidite, and zircon with baddeleyite (Fig. 1). These grains have been mapped with EBSD and indicate the high temperatures and pressures these grains underwent. The presence of reidite may indicate that the sample experienced pressures upwards of 30 GPa, while the baddeleyite rim indicates temperatures potentially above 2370 °C. Using the crystallographic data from the EBSD maps, we are able to characterize the precursor minerals to the baddeleyite and the granular zircon (Fig. 1).

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