ZIRCON, BADDELEYITE, AND REIDITE FOUND IN RIES CRATER SUEVITE. A. C. Stadermann[1], J. J. Barnes[1], T. M. Erickson[2], and Z. D. Michels[3], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721 (stadermann@email.arizona.edu), [2]Jacobs – NASA Johnson Space Center, Houston, TX 77058, [3]Department of Geosciences, University of Arizona, Tucson, AZ 85721.

Introduction: Impact events can generate super-heated impact melts and even vapor [1]. In the past decade, evidence of the high temperatures and high pressures of the impact process has been found in the impact melt from terrestrial craters (e.g., Mistastin Lake [2], Meteor Crater [3]) and even on the Moon [4–5]. Often, these studies involve zircon or zirconium-bearing phases. Zircon is a particularly useful mineral, due to its robustness and durability against weathering. It is used principally for chronology, but it has a multitude of geologic applications, including geothermometry and fingerprinting magma sources. Here we focus on its capability of recording impact conditions. Grains of zircon ($ZrSiO_4$) are converted at high temperature and/or pressure during an impact event to reidite (a high-pressure polymorph of $ZrSiO_4$) or to tetragonal-ZrO_2 + SiO_2 [6]. Reidite and tetragonal-ZrO_2 leave identifying relicts in the rocks, markers of the high pressures and/or temperatures these rocks underwent.

Ries Crater is a 26-km-diameter peak ring crater in southern Germany that formed approximately 15 Ma [7–9]. Ries is the type locality of the polymict impact breccia known as suevite.

Here, we report a microanalytical study of suevite from the Ries impact structure. These analyses are used to inform our understanding of the pressure and temperature conditions involved in creating a polymict impact breccia such as suevite in a peak ring crater.

Sample Description: The sample, denoted 16RS08, originates from Otting Quarry, at 48.8777° N, 10.7921° E, approximately 17 km from the center of the Ries Crater in Germany (approximately 4 km outside the crater rim). The material recorded in sample 16RS08 is therefore considered an outer suevite. The outer suevite is 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 [9].

Lithic clasts in the outer suevite consist primarily of crystalline basement rocks (gneiss, granite, amphibolite), with less than 5% of lithic clasts being overlying sedimentary rocks (limestone, sandstone, shale) [9]. The thin section studied contains variably shocked lithic and

Figure 1. Plane polarized light (PPL) image of thin section 16RS08, with the locations of two areas of interest (shown in Fig. 2) labeled with white boxes. This section contains an array of impact melt, both as glass and partially crystallized, in addition to lithic and mineral clasts, all embedded in a brecciated matrix. Section is approximately 4 cm in width.

mineral clasts, impact glass, and interstitial minerals that make up the matrix of the breccia (Fig. 1) [9].

Methods: We used a Cameca SX100 electron probe microanalyzer (EPMA) located in the Kuiper Materials Imaging and Characterization Facility (KMICF) at the University of Arizona to obtain 15 elemental X-ray maps of 16RS08. We next 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 energy dispersive X-ray spectroscopy (EDS) maps of select portions of the section. The EBSD data were collected under beam conditions of 20 kV, and ~9 µA, with step sizes varying from 0.05 to 2 µm. Following EBSD data collection, we processed the data using AZtecCrystal and MTEX, a free MATLAB toolbox.

Results: We used the elemental X-ray maps to identify the areas of interest in the section, particularly phosphates and Zr-bearing grains. These areas of interest were then targeted for follow up EBSD and EDS analyses.

We have identified, through combined EBSD and EDS analysis, the presence of zircon, reidite, and monoclinic-ZrO_2 (baddeleyite) in 16RS08. In 16RS08, we have found singular grains of zircon, zircon with a vermicular baddeleyite halo (Fig. 2a), and granular zircon with reidite (Fig. 2b).

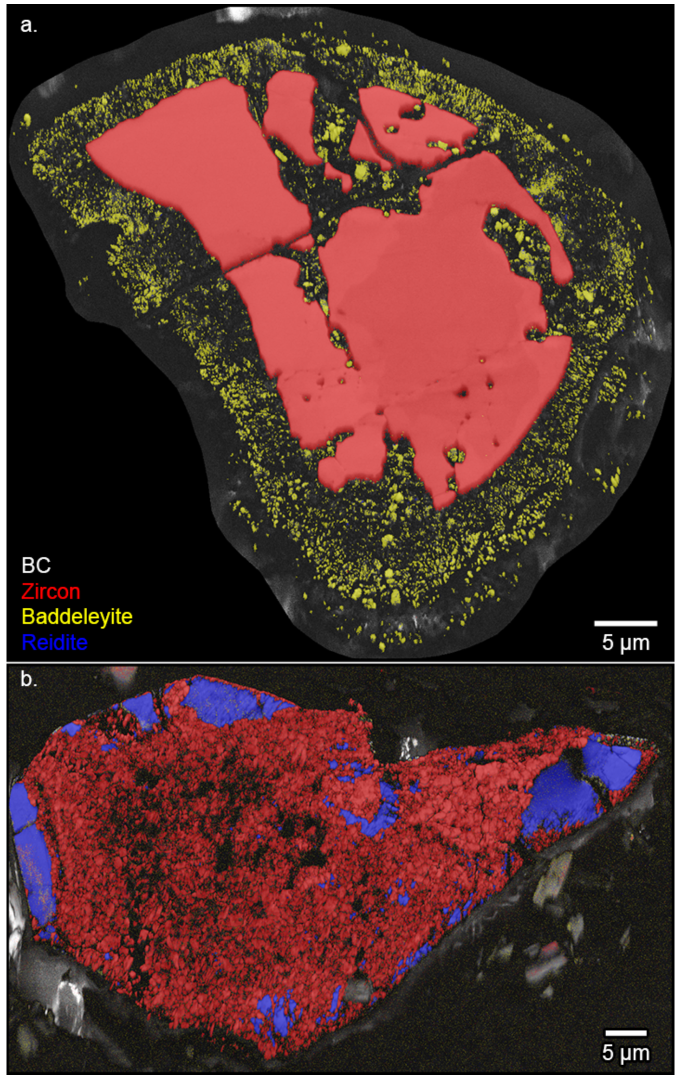

Figure 2. Electron backscatter diffraction (EBSD) phase maps for two Zr-rich grains in 16RS08. (a) Grain with a core of zircon (red) surrounded by granular baddeleyite (yellow). (b) Grain of granular zircon (red) with regions of reidite (blue). Grayscale in both images is band contrast (BC).

The different Zr-rich phases and their corresponding textures signifies that this sample underwent a broad spectrum of pressure and temperature conditions during the impact event. For example, zircons surrounded by a vermicular baddeleyite and SiO_2 intergrowth (i.e., Fig. 2a) have been shown to preserve evidence of the extremely high temperatures of impact melt, upwards of 2370 °C [2, 6]. Similarly, reidite and granular zircon (i.e., Fig. 2b) have been shown to preserve evidence of high pressure, as the transition to reidite occurs >30 GPa [3, 6].

Future Work: Next, we will process the EBSD and EDS data for these Zr-rich grains, specifically looking for indicators of cubic- or tetragonal-ZrO_2 in the baddeleyite remnants and of shock-precursors to the reidite. To further inform our work, we will also obtain BSE images of these grains using a Hitachi S-4800 SEM in KMICF at the University of Arizona, as well as geochemical spot analyses via EPMA. The data collected will be used to constrain the formation conditions of the Ries Crater outer suevite.

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