Zircon under extreme shock conditions from the Ries Crater, Germany

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Zircon, $ZrSiO_4$, is increasingly becoming one of the most commonly used minerals in planetary sceince, especially for shock metamorphic studies. This is due to two reasons; first, zircon responds mechanically in unique, crystallographically-controlled manners during impact events producing diagnostic microstructures that can be preserved in the geological record. Second, resetting of the U-Pb system due to shock metamorphism can be used to precisely constrain the age of impact events deep in geological history. While several studies have characterized shock deformation in zircon from a variety of impact structures and laboratory experiments, systematic empirical studies of zircon deformation in different types of target rocks as a function of bulk shock pressures and temperatures recorded by the major phases (i.e., quartz and feldspar) are still lacking.

We report shocked zircon from granitic and gneissic target rock clasts entrained in Suevite, impact-melt-bearing breccia, of the Ries Crater, Germany. We focus on highly shocked clasts in which the major framework silicates have been partially to completely amorphized (shock stage 2), the major minerals have become further fluidized and vesiculated (shock stage 3), the bulk of the sample has transfomed to melt (shock stage 4). While many of the other mineral phases may have either annealed or experienced complete melting at these high shock levels, zircon remained relatively refractory and recorded various diagnostic shock textures. These microstructures include discrete crystallographic-controlled lamellae of the high-pressure $ZrSiO_4$ polymorph reidite (shock stage 2), polycrystalline aggregates and monocrystalline domains of reidite (shock stage 3), diaplectic (amorphous) zircon domains (shock stage 3), granular textured zircon (shock stage 3), dissociation reaction textures to dioxide constituents ZrO_2 and SiO_2 (shock stage 4). This study helps to place zircon microstructures into the context of long-established shock stages for major phases/bulk rock. Future work will investigate the effects of these shock microsctructures on U – Th – Pb systematics.