IN SITU GRANULAR ZIRCON FROM THE VREDEFORT IMPACT STRUCTURE.

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Introduction: Deformation patterns of accessory phases can tell about tectonic regime and deformation history of the host rocks and geological units [1]. The presence of shocked minerals is one of the most robust criteria for identifying impact structures [2]. The main types of deformation microstructures in zircon, which are indisputably formed by hypervelocity impact events, are (a) planar deformation features (PDFs) [3], (b) shock microtwins [4,5], (c) inclusions of high-pressure polymorphs [6,7] and (d) granular, or neoblastic textures [8,9,10]. In zircon, (a)-(d) consequently occur with increasing shock pressure [7]. Zircon, which underwent complete shock recrystallization, forms granular textures (d) [7,8,9,10,11], and is composed of hundreds of individual grains or neoblasts of ~1 µm in diameter. Granular zircon grains were not yet extensively studied with the modern techniques (e.g. EBSD, Raman spectroscopy), and the exact mechanism of such recrystallization is not known. Recently, it has been suggested that polycrystalline texture might be caused by transformation into high-pressure polymorph reidite and back [12].

Motivation: The first study of shocked zircon in the Vredefort impact structure investigated heavy fraction separates from the pseudotachylitic breccia in granite [10]. Since then, there were several similar studies of accessory minerals from the Vredefort impact structure, but all of them investigate either heavy fraction separation or material from alluvial deposits [3,4]. I conducted *in situ* investigation of shocked granular zircons, which were not removed from their petrological context and thus spatial distribution within the impacted rock is preserved.

Sample: Sample for this study came from the Vredefort Granophyre, which is long considered to be a remnant of the impact melt sheet [13]. The sampled granite clast was supposedly captured by the impact melt at the upper levels of now deeply eroded impact crater and carried downwards during the emplacement of the granophyre dykes [14]. The clast contains pseudotachylite vein and multiple shocked zircon and monazite crystals.

Data: Shocked zircon in the sample is presented in three varieties: granular zircon, zircon with microtwins and zircon with planar fractures. Granular zircon is abundant, but only occurs inside the pseudotachylite vein and in its wall rocks at a distance not farther than 1 cm from the vein. Zircon with microtwins is scarce and only occurs inside the vein, with one exception. Zircon with planar fractures is found in a wall rock at a distance of > 1 cm from the pseudotahylitic vein, beyond the zone with granular zircon.

Granular zircon consists of hundreds of sub-rounded neoblasts, from < 0.5 µm to 3-4 µm in size. The orientations of the neoblasts is not random, and their axes usually form two or three widely spread clusters. C-axes of these clusters are oriented roughly at 90° to each other, and one of the <110> axis coincides for pairs of clusters. Neoblastic zircon grains often preserve initial growth zoning, with some growth zones yielding very weak EBSD pattern, or no pattern at all. Remarkably, each individual neoblast is also zoned, with poor-crystalline core and well-crystalline rim, defined by the quality of EBSD pattern. These properties of neoblasts were also noticed by [12], who studied neoblastic zircon from much younger meteorite craters.

Discussion: The remarkable spatial distribution of shocked zircon with respect to the pseudotachylite vein leaves no doubts about the impact origin of the vein. We also conclude that the shock deformation of zircon took place before pseudotachylite development. High amount of intensely shocked zircon grains indicate that the clast was derived from the upper levels of the impact crater, where the shock pressures, affected the granite, were higher. Lack of zircon with microtwins shows that some other shock deformation mechanism was triggered at these conditions. Whether or not this was a transition to reidite, remains to be tested with Raman spectroscopy and radiation damage calculations.

References: [1] Kovaleva E. et al. (2014) *Solid Earth* 6:1799-1861. [2] French B. M. and Koeberl C. (2010) *Earth-Science Reviews* 98:123-170. [3] Erickson T. M. et al. (2013) *American Mineralogist* 98:53-65. [4] Moser D. E. et al. (2011) *Canadian Journal of Earth Sciences* 48:117–139. [5] Timms N. E. et al. (2012) *Meteoritics and Planetary Science* 47:120-141. [6] Knittle E. and Williams Q. (1993) *American Mineralogist* 78:245-252. [7] Timms N. E. et al. (2017) *Earth-Science Reviews* 165:185-202. [8] Bohor B. F. et al. (1993) *Earth and Planetary Science Letters* 119: 419-424. [9] Krogh T. E. et al. (1993) *Earth and Planetary Science Letters* 119:425-429. [10] Kamo S. L. et al. (1996) *Earth and Planetary Science Letters* 144:369-387. [11] Moser D. E. (1997) *Geology* 25:7-10. [12] Cavosie A. J. et al. (2018) *LPS 49*, Abstract #2083. [13] Dietz R. S. (1961) *The Journal of Geology* 69:499-516. [14] Kovaleva E. et al. (2018) *South African Journal of Geology* 121:9-26.

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