FORMER REIDITE IN GRANULAR NEOBLASTIC ZIRCON GRAINS (FRIGN ZIRCON) IN THE MIEN IMPACT STRUCTURE, SWEDEN J. Martell, C. Alwmark, P. Lindgren, L. Johansson. Dept. of Geology, Lund University, Sölvegatan 12, 22362 Lund, Sweden (josefin.martell@geol.lu.se)

Introduction: Here we report the first documentation of so called "FRIGN zircon" (Former Reidite in Granular Neoblastic zircon) in a Swedish impact structure. FRIGN zircon is a type of texture where granules occur as systematically oriented neoblasts, typical for the high-pressure phase reidite. It was first described by Cavosie et al. [1] from the Meteor Crater, and has since then been reported from other impact structures such as the Acraman [2], Luizi, and Pantasma impact structures [3] and also recently from the Lappajärvi impact structure [4].

Reidite in impact structures: Lab experiments have shown that pressures ≥30 GPa are required for the formation of reidite [5, 6], which means that on Earth, reidite most likely forms by hypervelocity impacts. The search for reidite is therefore highly relevant for identifying impact structures. Despite this, reidite has only been found in a few locations [7, 8]. Because of the few discoveries of natural reidite, recent studies of FRIGN zircon by [1, 3] have both led to new insights about zircon behaviour at extreme conditions, and is suggested by [3] to be considered a diagnostic criteria for the identification of an impact structure on Earth, alongside e.g. planar deformation features (PDFs) in quartz.

Granular zircon has been found in shocked target rock (i.e. terrestrial impact melts or breccias), and also in tektites [9] and meteorites [10]. However, granular zircon can be found in non-impact settings as a result of tectonic shear or progressive metamorphism (e.g. [11]) and is thus not exclusive for shock-metamorphic conditions. Identification of FRIGN zircon can be conducted with electron backscatter diffraction (EBSD) orientation analysis, and requires that neoblasts occur in domains 90° perpendicular from each other, so that all (001) are orthogonal and coincides with a {110} direction from another domain (described in detail in [3]).

Overview of the Mien Impact Structure: The Mien impact structure is located in south eastern Sweden (56.41812°N 14.85785°E), and has been dated to 118±2.3 Ma [12]. The original rim-to-rim diameter (pre-erosion) is estimated to ~ 9 km and the current topographic diameter is 6-7 km [13]. The target rock is composed of granite and gneiss. No outcrops are available at Mien, but samples of impactites occur as erratic boulders around the lake. Drill cores obtained from a central island of the lake are composed mostly of impact melt rocks of varying compositions, but they also contain a horizon of melt-bearing breccia and lithic brecciated granitic gneissic sections at the base of the cores [14]. Evidence of shock metamorphism in Mien rocks includes shocked quartz grains with planar deformation features (PDFs) [15].

Samples: Impactites were collected during an expedition to Lake Mien in early fall 2017. Three samples were chosen for further analysis: (i) clast rich impact melt rock, (ii) clast poor impact melt rock and (iii) melt-bearing breccia. From these impactites, two thin sections were made from each lithology. Granular zircon grains occurred mainly in the impact melt rocks, and thin sections from these rocks were used in this study.

Methodology: Each thin section was imaged and analysed in a Tescan Mira3 High Resolution Schottky field emission scanning electron microscope (FE-SEM) equipped with Oxford EDS detector and an EBSD system located at Lund University. Before the EBSD-analysis, thin sections were polished with colloidal silica, coated with a 5 nm carbon layer and mounted on a 70° pre-tilted specimen holder. Post-processing of EBSD data include removal of wild spikes and nearest neighbour correction in Channel 5 software packages Mambo and Tango.

Results: Thin sections contained a total of seven granular grains, four of which identified as FRIGN zircon (two from each impact melt rock type). These were between 50 and 80 µm in length and partially or fully granular with an average neoblast diameter of ~ 2 µm. Pole figures (Fig. 1A-C) were constructed and all show ~ 90° orthogonal clusters with coincidence between (110) and (001) and high-angle misorientations between neoblasts, in accordance with [3].

Discussion and conclusion: The identification of reidite in impact melt rocks sheds new light on the Mien impact event as the pressure conditions can be constrained to ≥30 GPa. In a recent study, [4] showed that FRIGN zircon might be better suited for U-Pb studies than "regular" granular grains that do not display this particular neoblast relationship. The reversion from reidite to zircon implies that the U-Pb system would be reset in the neoblasts [4], which is crucial for geochronological dating. Thus, the newly discovered FRIGN zircon grains in Mien are prime candidates to improve the accuracy and precision of the Mien impact.

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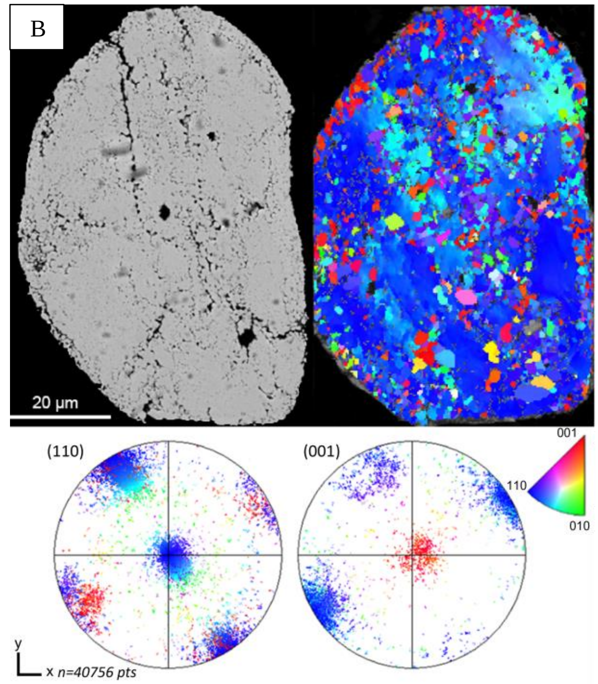
References: [1] Cavosie, A. J. et al. (2016), *Geology 44*, 703-706 [2] Timms, N. E. et al. (2017) *ESR 165*, 185-202 [3] Cavosie, A. J. et al. (2018) *Geology 46*, 891-894 [4] Kenny, G. G. et al. (2019) *GCA 245*, 479-494 [5] Kusaba, K. et al. (1985*) EPSL 72*, 433-439 [6] Leroux, H. et al. (1999) *EPSL 169*, 291-301 [7] Glass, B. P. & Liu, S. (2001) *Geology 29*, 371-373 [8] Erickson, T. M. et al. (2017) *Contrib. Min. & Petr. 172,* 6p [9] Cavosie, A. J. et al. (2017) *Geology 46,* 203-206 [10] Zhang, A.-C. et al. (2011) *MAPS 46*, 103-115 [11] Piazolo, S. et al. (2012) *Am. Min. 97*, 1544-1563 [12] Bottomley, R. J. et al. (1978) *Contrib. Min. Pet. 68*, 79-84 [13] Åström, K. (1998) *Geophys. J. Int. 135*, 215-231 [14] Stanfors, R. (1973) *PhD thesis, Lund University* [15] Engelhardt, W.v. & Stöffler, D. (1965) *Sci. of Nature 52*, 489-490.



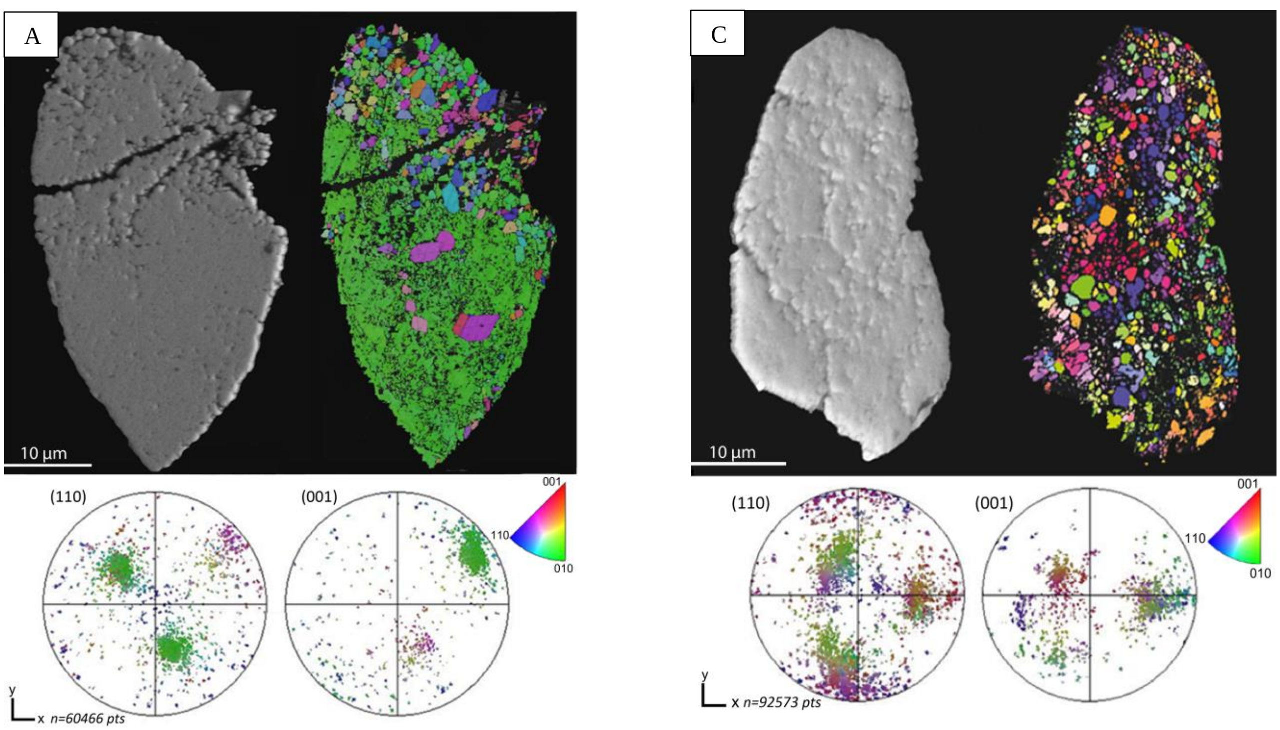


Figure 1. EBSD data for granular neoblastic (FRIGN) zircon grains from the Mien impact structure. All top images show a backscatter-image (left) and the same grain with inverse pole figure color (IPF; right) where each color represents an orientation. Pole figures below show the orientation data, with two or three dominant ~ 90° orthogonal clusters, and coincidence between (110) and (001). A) partly neoblastic grain from a clast rich impact melt rock, B) fully neoblastic grain from a clast poor impact melt rock, C) fully neoblastic grain from a clast poor impact melt rock.