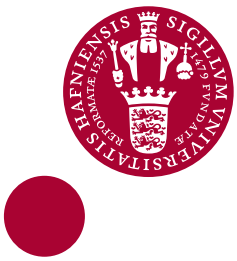

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SHOCKED QUARTZ GRAINS IN THE EARLY CAMBRIAN VAKKEJOKK BRECCCIA, SWEDEN – EVIDENCE OF AN IMPACT.

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Introduction: The Vakkejokk breccia, a Lower Cambrian up to 25 m thick polymict breccia, situated in northernmost Sweden, has been known for a long time as an anomalous unit in the local stratigraphic sequence [1]. The breccia, which outcrops for several kilometers along a steep hillside, consists of a basal sedimentary breccia (10-20 m thick) with occasional crystalline mega-clasts (LPB), overlain by 1-3 m of normal graded polymict breccia, dominated by crystalline clasts (GPB). The GPB, in turn, is overlain by a <30 cm thick arenitic sandstone (TS) [2]. Here we present evidence, in the form of planar deformation features (PDFs) in quartz grains, that the Vakkejokk breccia was formed by an impact.

Material and Methods: Thin sections of samples of the LPB, GPB and TS subunits from a number of localities along the main breccia section, as well as from two distal more or less coeval sandstone beds (15 km NE and 20 km SE of the main section, respectively), were prepared and searched for shock metamorphic features in quartz grains under optical microscope. Quartz grains displaying PDFs were further studied using a 5-axes universal stage and the crystallographic orientations of identified PDFs were determined according to techniques described in [3].

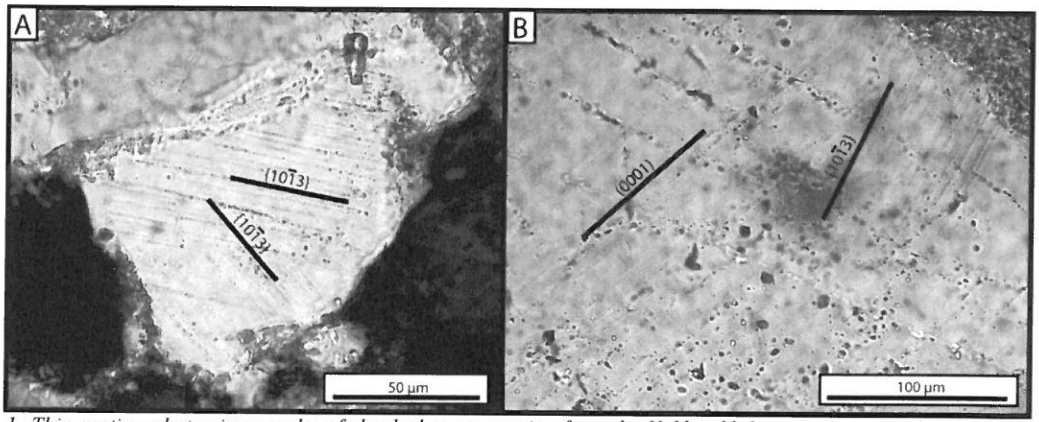

Figure 1. Thin section photomicrographs of shocked quartz grains from the Vakkejokk breccia (uncrossed polars). A) Quartz grain from the TS displaying two sets of decorated PDFs, both oriented parallel to ω {10$\bar{1}$3} equivalent orientations. A third set of PDFs, not visible on this image but observable under the U-stage microscope, is oriented WNW-ESE. This set is also oriented parallel to ω {10$\bar{1}$3} equivalent orientations. B) Part of quartz grain from the GPB with two sets of decorated PDFs oriented parallel to c (0001) and ω {10$\bar{1}$3} orientations. Note also the fresh appearance of the PDFs, despite being both old and located in an area with a rather complex tectonic history.

Results and Discussion: Shock metamorphic features in the form of PDFs in quartz grains are present in samples of the TS and in the upper parts of the GPB (Fig.1). Occasional quartz grains displaying PDFs are also found in samples from both distal localities. No PDFs have so far been identified in the lower parts of the GPB or in the LSB. Measurements of the orientations of the PDFs reveal that they are oriented parallel to crystallographic planes typical for impact-related shock metamorphosed quartz; notably to c (0001) and ω {10$\bar{1}$3} orientations [e.g., 4].

Based on the general geological appearance of the breccia unit, it has been interpreted as a proximal ejecta layer associated with a shallow marine impact crater [2]. The distribution of the shocked material within the breccia is in accordance with this interpretation, with the LPB and lower parts of the GPB representing proximal, low-shock semi-autochthonous bombarded strata and near-field ejecta, and the upper parts of the GPB and the TS representing more distal, and thus more highly shocked ejecta that has been transported back towards the crater through water resurge. Whether the two distal localities are primary products of the impact or if the shocked material has been incorporated during later reworking, is a matter for ongoing studies, but their unique appearances in the stratigraphy and the stratigraphic correlation with the Vakkejokk Breccia strongly support a causal connection.

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References [1] Kulling O. 1964. Sveriges Geologiska Undersökning Ba 19:1–166. [2] Ormö J. et al. 2016. 79th Annual Meeting of The Meteoritical Society, submitted. [3] Ferrière L. et al. 2009. *Meteoritics & Planetary Science* 44, 925–940. [4] French B. M. and Koeberl C. 2010. *Earth-Science Reviews* 98, 123–170.