POLYMICT BRECCIAS FROM THE RIES IMPACT STRUCTURE – DEFORMATION DURING SHOCK-LOADING, -UNLOADING, BRECCIATION, MIXING AND EMPLACEMENT

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Abstract: Polymict impact breccias containing components originating from both, the sedimentary cover and basement of mixed-target impact structures, potentially contain information on the deformation conditions during shock-loading, -unloading, brecciation, mixing and emplacement. The 15 Ma, 26 km-diameter Nördlinger Ries impact structure (Germany) contains Suevite that is interpreted to be dominated by basement components (Moldanubic gneisses and metagranites) affected by strongly varying shock conditions. The underlying polymict Bunte Breccia is typically dominated by sedimentary components affected by relatively low shock conditions. Here, we analyse polymict breccias that almost equally comprise shocked gneisses and sedimentary components that show no apparent shock effects. They occur sandwiched between Suevite and underlying Bunte Breccia at the Aumühle quarry located at the northeastern rim of the Ries impact structure.

There, clasts up to a few decimeters in diameter are embedded in a fine-grained lithic matrix, where no glass fragments (*Flädle*) are observed. Gneiss clasts are amphibolites and metagranite breccias. The amphibolites contain maskelynite, with only a few remnants of the former plagioclase being preserved, as indicated by Raman spectroscopy and analytical scanning electron microscopy (SEM, including, energy dispersive x-ray spectroscopy (EDS) and electron back scatter diffraction (EBSD)), indicating shock pressures of > 30 GPa [1]. The amphiboles show cleavage cracks and (-101) mechanical twins, which are documented from endogenous pseudotachylyte-bearing fault rocks and indicative of differential stresses > 400 MPa [2]. Metagranite-breccia components show quartz with a high density of rhombohedral planar deformation features. Despite these shock effects, there is no thermal remanent magnetization with reverse polarity, as it is typically formed in Suevites during the impact event. In contrast, the sedimentary clasts (sandstones, limestones), which do not show any apparent shock effects, reveal remanent magnetizations with directions close to that typical of the Suevites, which they probably acquired by hydrothermal alteration of hot fluids at the contact to the Suevite. Based on these observations, the described polymict breccias are interpreted to represent a gneiss-rich component associated to the Bunte Breccia, emplaced before the Suevite, as opposed to represent a mixed horizon of Suevite and Bunte Breccia that formed during turbulent emplacement of the Suevite on top of the Bunte Breccia. They record a considerable mixing of basement and sedimentary cover components.

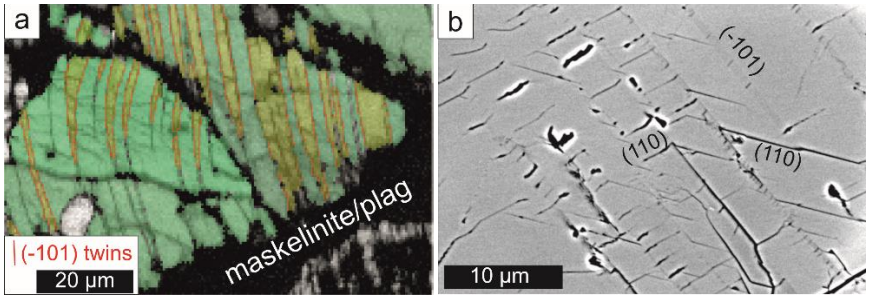

Fig. 1: *Deformed amphiboles, amphibolite clast in polymict breccias (sample R2004) at the contact between Suevite and Bunte Breccia, Aumühle, Nördlinger Ries. (a) EBSD map showing twinned amphibole surrounded by maskelynite (black) with remnants of shocked plagioclase (grey). (b) SEM image of twinned amphibole showing deflected (110) cleavage cracks by (-101) twins.*

References:

[1] Stöffler, et al. (2018) Shock metamorphism of planetary silicate rocks and sediments: Proposal for an updated classification system: *Meteoritics and Planetary Science*, v. 53, p. 5–49, doi:10.1111/maps.12912

[2] Brückner, L.M., Trepmann, C.A. (2021) Stresses during pseudotachylyte formation - evidence from deformed amphibole and quartz in fault rocks from the Silvretta basal thrust (Austria). *Tectonophysics* 817 (2021) 229046, https://doi.org/10.1016/j.tecto.2021.229046.