NEW INSIGHTS INTO THE STEINHEIM CENTRAL UPLIFT – PART II: ORIENTATION OF SHATTER CONES AND IMPLICATIONS FOR THEIR FORMATION

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Introduction: Shatter cones from the ~3.8 km Steinheim Basin (Baden-Württemberg, Germany) count among the most typically developed shatter cones on Earth. Generally accepted as macroscopic shock metamorphic features [1;2], shatter cones are widely thought to have a systematic preferential orientation within the shocked crater basement at the larger scale. Recent studies, however, underlined that the local shatter cone orientation pattern is usually less strictly defined [3].

New Observations: In addition to the well-known shatter cones in Upper Jurassic limestones that occur at the rim of the Steinheim Basin (some of which show apexes in opposite directions within the same rock specimen), newly discovered shatter cones in up to dm-sized claystone nodules of the otherwise incompetent Middle Jurassic 'Opalinuston' clay at the center of the central uplift (Steinhirt) [4] represent unconventional cone types. The shatter cones commonly run through the claystone nodules in one main direction (Fig. 1 left) and sometimes radiate outward from a concretionary core inside the nodule, causing a 3D 'sun-like' arrangement of the individual cones (Fig. 1 right).

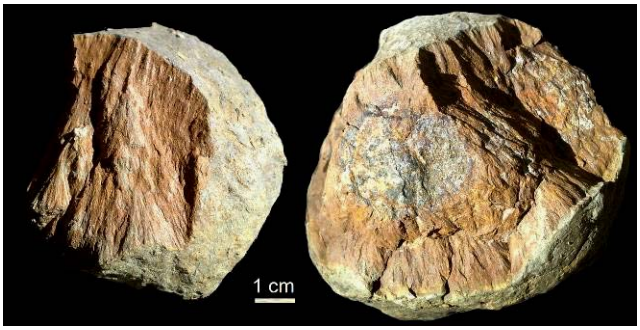

Fig. 1: Shatter cones in claystone nodules from the Middle Jurassic 'Opalinuston' claystone, central uplift of the Steinheim Basin. Left: unidirectional set of shatter cones penetrating a nodule. Right: 'shatter cone sun' surrounding a concretionary core.

Discussion: The variability of shatter cone orientations within the 'Opalinuston' at Steinheim suggests that the formation of these features is strongly influenced by lithologic heterogeneities at the very local scale [2] and that even incompetent clays can be conductive to shock wave propagation [4]. It is, moreover, inferred that both the external surface of the claystone nodules (as a sharp interface between the incompetent surrounding soft host clay and the solid nodule itself) and coarser-crystalline concretionary cores inside the nodules may act as lithologic inhomogeneities from which the individual cones tend to emanate in greatly variable directions with respect to the point of impact.

References: [1] Dietz R. S. 1960. *Science* 131:1781-1784. [2] Baratoux D. and Melosh H. J. 2003. *Earth and Planetary Science Letters* 216:43-54. [3] Ferrière L. and Osinski G. R. 2010. Abstract #1392. 41st Lunar & Planetary Science Conference. [4] Buchner E. and Schmieder M. 2010. This volume.