POSSIBLE IMPACTOR REMNANTS ON SHATTER CONE SURFACES FROM THE STEINHEIM BASIN, SW GERMANY

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Introduction: Shatter cones may carry useful information towards the nature of the crater-forming projectile. Earlier studies [1] described exotic melting- and vaporization-related microfeatures adherent to shatter cones, e.g., from the Vredefort Dome, South Africa. Recent studies [2] reported primary remnants of an iron meteorite (e.g., brecciated schreibersite grains) on the surface of a limestone shatter cone from the Agoudal impact structure, Morocco, suggesting a correlation of the impact site with the iron meteorite strewn field in the surroundings of the structure. Motivated by this finding, we investigated shatter cones from the Steinheim impact structure in SW Germany.

Samples and Sample Localities: The ~3.8 km Steinheim Basin is a well-preserved complex impact structure with a prominent central uplift and well-developed shatter cones in different target lithologies [3]. We analyzed the surfaces of eleven shatter cones from concretions of the Middle Jurassic Opalinus Claystone exposed on the central uplift, and three shatter cones in Upper Jurassic limestones of the structural crater floor.

Composition of Coatings: Most shatter cone surfaces are covered by thin mineral coatings. The coatings of the Opalinus Claystone shatter cones analyzed by SEM–EDS geochemically resemble the marly, sideritic, or phosphatic cementing material of the host nodules. Ni, Co, and Cu (in the percent range) and an abundance of small aggregates of native gold were encountered. The surfaces of the Upper Jurassic limestone shatter cones are covered by coatings rich in Ca and Mn. Fe, Ni, and Co are concentrated in patches within these coatings. The surface of a third shatter cone of this type exhibits numerous minute Au aggregates, as well as geochemically variable Fe, Ni, Co, Cu, Pt, and Au-rich mineral assemblages.

Possible Origin of Coatings: The exotic shatter cone coatings could either stem from the impacted sedimentary target rocks, the crater basement, or might represent meteoritic matter from the Steinheim impactor, probably an iron meteorite [4], remobilized during impact-induced hydrothermal activity. The marker elements (e.g. V, Sr, Zn, Cr) characteristic for the target sediments and for the Au-bearing ores in the Variscan basement (e.g. Ag, Zn, As) were not detected in the shatter cone coatings. In contrast, the coatings show elevated concentrations of Fe, Ni, Co, Cu, Pt and Au, compatible with an iron meteoritic source.

Conclusions and Hypothesis: The elements enriched on the surfaces of the Steinheim shatter cones suggest a general affinity towards an iron meteoritic source, as opposed to the sedimentary and underlying crystalline-metamorphic target rocks that are generally poor in these exotic metals. The most plausible explanation for the exotic shatter cone coatings is that they probably represent redistributed impactor matter remobilized in a hydrothermal system that developed in response to the Steinheim impact.

References: [1] Gibson H.M. and Spray J.G. 1998. *Meteorit. Planet. Sci.* 33, 5–23. [2] Schmieder, M. et al. 2015. *Geological Magazine*, doi: 10.1017/S0016756815000047 [3] Schmieder and Buchner E. 2013. *ZDGG* 164, 503–513. [4] Buchner E. and Schmieder M. 2010. *Meteorit. Planet. Sci.* 45:1093–1107.