DISCOVERY OF POSSIBLE METEORITIC MATTER ON SHATTER CONES AND SLICKENSIDES – 1. RIES CRATER, SOUTHERN GERMANY.

E. Buchner[1,2] and M. Schmieder[3,4]. [1]HNU – Neu-Ulm University of Applied Sciences, Wileystraße 1, 89231 Neu-Ulm, Germany. E-mail: elmar.buchner@hs-neu-ulm.de. [2]Institut für Mineralogie und Kristallchemie, Universität Stuttgart, Azenberstraße 18, 70174 Stuttgart. [3]Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston TX 77058, USA. [4]NASA–SSERVI.

Introduction: Shatter cones may carry useful information towards the nature of the crater-forming projectile. Recent studies reported primary remnants of an (iron?) meteorite (e.g., brecciated schreibersite grains) on the surface of a limestone shatter cone from Agoudal, Morocco [1]. [2] described the occurrence of rare elements including native gold on limestone shatter cone surfaces from the Steinheim Basin that might represent meteoritic matter of the projectile, remobilized during impact-induced hydrothermal activity. In the frame of the "Shatter Cone Coatings Project", we investigated shatter cones and slickensides from the Ries crater in southern Germany.

Samples, Sample Locality, and Analytical Methods: The ~24 km Ries crater [e.g., 3] formed in crystalline basement rocks and overlying sedimentary units of the Swabian-Franconian Alb in southern Germany in the Middle Miocene some ~14.8 Ma ago. Shatter cones in crystalline basement rocks produced by this impact event are only exposed in brecciated basement rocks ("polymict crystalline breccia") of the Wengenhausen quarry located at the western inner ring of the Ries crater. Macroscopically observable mechanical striations on the brecciated crystalline rocks fulfill all criteria for slickensides. Sometimes, slickensides overprint shatter cone surfaces and, thus, can be regarded as impact-related features. All rock samples of amphibolite and kersantite shatter cones and slickensides investigated in this study were sampled at the abandoned Wengenhausen quarry. The shatter cone and the slickenside surfaces are often covered by dark coatings that are characterized by an enrichment of rare elements as well as metal and metal oxide aggregates. The coatings were analyzed by SEM-EDS, EPM, and WDS methods.

Characterization of Coatings: The shatter cone and slickenside coatings rich in Mn and Fe locally contain patches and aggregates with high concentrations of Fe, Ni, P, and Co oxide phases, oxidized Fe-Ni-Co spheres with Ca-Mn coating, and Fe-Ni-Co metal and metal oxide aggregates. Furthermore, we detected some brecciated Fe-Ni phosphide particles with a chemical composition very close to schreibersite. On some of the Wengenhausen shatter cone and slickenside surfaces, spheres, veinlets, and brecciated flakes of Fe-Ni-Cr-Co metal oxides also occur. Similar metal oxide particles were recently described by [4] from fracture surfaces of shattered fossils (belemnites) from a limestone block of the eastern Ries crater rim.

Origin of Coatings: The enrichment of rare elements in shatter cone and slickenside coatings could potentially stem from the target rocks, mobilized during impact-induced hydrothermal activity. In contrast, the rare elements, Fe-Ni-Co metal oxides and, in particular, phosphide and metal aggregates (i.e., grains of schreibersite and Fe-Ni-Co metal) support an interpretation of these particles as likely remnants of the impacting body. Fe-Ni-Cr-Co veinlets in basement rocks of the Ries crater, interpreted as condensed matter from the vaporized Ries impactor [5], and similar particles on Wengenhausen shatter cone and slickenside surfaces and shattered belemnites from the eastern crater rim essentially feature identical composition and interelement ratios [4]. This provides further arguments for an impactor-derived origin of the rare Fe,Ni–metals and metal oxides on the shatter cone and slickenside surfaces.

The Ries impactor: Most of the impact melt and suevite samples do not show any unambiguous enrichments of meteoritic matter. On the basis of rather high concentrations of Ni, Cr, Co, and Ir in a few of the suevite samples, some authors [e.g., 6] favored an achondritic projectile (aubrite). [5] found Fe-Cr-Ni-Co veinlets in rocks of the Ries research drill core FBN73 in crystalline basement rocks immediately below the suevite. These authors claimed that these veinlets have a chondritic signature (carbonaceous chondrite?). [6] concluded that there is no clear evidence for an enrichment of platinum group elements in the Ries impactites. Therefore, the nature of the Ries impactor is uncertain, although an achondritic projectile is favored by some. The occurrence of high Fe, Ni, and Co concentrations in shatter cone and slickenside coatings and of schreibersite particles on a shatter cone surface, as well as the interelement ratios of Fe/Ni and Ni/Co in our samples might indicate an iron meteorite as the Ries impactor. On the other hand, these metal and metal oxide particles may represent the remnants of the metallic portion of a chondritic or achondritic projectile. We conclude that it is not possible to classify the Ries projectile satisfyingly on the basis of the geochemical data available yet, and, thus, further studies are required. Laser-ICP–MS analyses on Ge, Ga, and the platinum group elements particulary in the Fe-Ni-Co metal and metal oxide grains are planned.

References: [1] Schmieder M. et al. 2015. *Geological Magazine* 145:586–590. [2] Buchner E. & Schmieder M. 2015. Abstract #5007. 78th Conference of the Meteoritical Society. [3] Stoeffler D. et al. 2013. *Meteoritics & Planetary Science.* 48:515-589. [4] Buchner E. & Schmieder M. 2015. Abstract #1025. Conference Bridging the Gap III. [5] El Goresy A & Chao E. C. T. 1976. *Earth and Planetary Science Letters* 31:330–340. [6] Schmidt G. & Pernicka E. 1994. *Geochimica et Cosmochimica Acta* 58:5083–5090.