DISPUTED, FORGOTTEN, REVITALIZED: ALEMONITE - AN ENIGMATIC IMPACT BRECCIA PROBABLY LINKED TO THE RIES CRATER (GERMANY) IMPACT EVENT. K. Ernstson[1], M. Molnár[2], M. Hiltl[3], K. Ventura[4] [1]Faculty of Philosophy I, University of Würzburg, D-97074 Würzburg, Germany (kernstson@ernstson.de) [2]Resselovo nám. 76, Chrudim 537 01, Czech Republic (molnar@ego93.com) [3]Carl Zeiss Microscopy GmbH, D-73447 Oberkochen, (mhiltl@online.de) [4]Faculty of Chemical Technology, University of Pardubice, 53002 Pardubice, Czech Republic (karel.ventura@upce.cz)

Introduction: The Ries crater impact structure in Germany measuring about 25 km in diameter, formed almost 15 million years ago in the Upper Miocene. In the early seventies, when the Ries impact origin began to replace the earlier volcanic explosion theory among most geologists, research results of the reputable Bavarian geologist Erwin Rutte caused quite a stir, because they described the Ries (and Steinheim) impact event as much more far-reaching than the traditional German impact researchers believed at that time [1, 2 and references therein]. This was followed by a strong recognition in the geological community, replaced by a vehement rejection of the whole hypothesis and a subsequent ignorance and oblivion. Here we report on a resumption of research on a particularly puzzling component of this then completely new impact hypothesis, which is put in a new light with new findings.

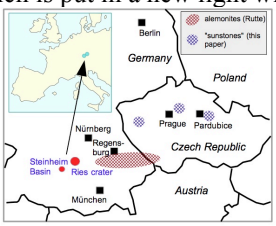

Fig. 1. Location map for the Ries and Steinheim Basin impacts and the here discussed alemonite occurrencies.

Alemonite: First described by Rutte in 1971 [1], alemonite originated during the Ries impact event, when pressure, temperature and delivery of vast quantities of cosmic silica initiated heavy fracturing and melting of local Jurassic, Cretaceous and crystalline rocks of various lithologies thus forming a variety-rich and characteristic new rock [2]. Depending on the source rocks, breccias and silicifications of various whole rock units were formed, which led Rutte to speak of alemonitization, which should have affected entire regions with a concentration in the *Altmühlalb* and Upper Palatinate, and some extension to South Bohemia and Austria. Parallel and closely connected with the alemonitization, whole strewn fields of smaller meteorite craters should have been created by the impact of projectiles accompanying the Ries impact. From an impact-related point of view, the alemonites were a very special phenomenon in the narrower sense. They appear as fist- and head-sized cobbles up to meter-sized blocks, forming real strewn fields (Fig. 1). These are polymictic breccias with features (according to Rutte) of an impact melt rock with shock effects. At that time it is not clear, what has not changed until today, that the "melt rock mass" and the embedded breccia components of all primary lithologies continuously consist of >98% silica,

Disputed: The new hypothesis, which was not a sudden invention but based on years of extensive and meticulous field work with a dozen of students, provoked protest and absolute rejection from the Bavarian official geologic survey. All postulated smaller craters were generally dismissed as karst phenomena. The polymictic breccias evidencing high *PT* should have been formed in a weathering period with warm climatic conditions or in case of water level fluctuations of freshwater lakes. Even today, Bavarian official geologists (LfU) insists on these explanations [3].

Forgotten: At that time a few members of the Ries crater research group undertook a short field trip into the new area postulated by Rutte, and the rejection by the German impact researchers followed on the foot. A logical consequence of the rejection and disregard of official geology and German impact research was best to forget the whole thing. Rutte continued his work with a number of publications, but what was ultimately a decisive weakness of his research was that not a single one of his partly impressive publications had appeared internationally in English but all in German.

Revitalized: Author M.M., without knowing the Ries history and related alemonites, revitalized the Rutte hypothesis, when he recently asked for the formation of a special kind of silicified rocks extended in the Czech Republic, which in the population are in general called *sunstones*. For author K.E. the sunstones sent to him proved to be more or less an exact copy of the brecciated alemonites as described by Rutte suggesting a possible interrelation between both occurrences (Fig. 1) as exemplified in the follwing.

Alemonite and sunstone samples from the field: The sunstones found in the Czech Republic, which are absolutely similar to Rutte's alemonites when picked up quickly (see the later discussion on silcretes), have identical properties even on closer inspection (Fig. 2). This is the brecciated, sometimes diamictic, character, the mostly smooth rounded surface as well as its partly pronounced regmaglyptic sculpture (Fig. 2), as it is known from ablation processes of meteorites. The regmaglypts suggest at least superficial melt or strong plasticity and aerodynamic deformation. The identity of Rutte's alemonites and the sunstones goes so far that hardness tests on the cut surfaces of many samples show a uniform Mohs hardness of 7.5, and this without

any noticeable offset across the entire cut surface by matrix and components.

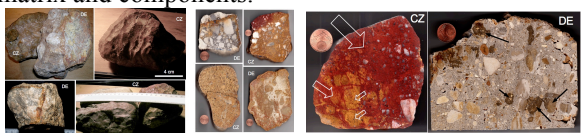

Fig. 2. Alemonites (DE) and sunstones (CZ) from the field. Left: Whole samples. Note the meteorite-like regmaglyptic surface sculpture (see text). Middle: Polished cut of CZ and DE breccias. Right: Polished cut of sunstone (CZ) and alemonite (DE) polymictic breccias. Note breccia generations (arrows; three in the CZ breccia).

The polymictic breccia character becomes particularly clear in the cut of the cobbles and boulders from both occurences (Fig. 2), whereby particularly the frequently occurring breccia generations (breccias-within-breccias) are noticeable, therefore, because such breccia generations are practically unknown in normal geological processes but represent a characteristic of impact processes with rapidly successive phases of excavation, ejection, landing of ejecta with mixing with local material and finally movements of crater modification.

Thin sections, SEM-EDS, X-ray diffraction Shattered quartz grains down to microscopic size (SEM-EDS, Fig. 3), quartzite fragments, but also well-rounded quartzite pebbles occur in a microcrystalline and/or amorphous silica groundmass. From X-ray diffraction measurements of sunstones the amorphous component yields a few, up to ten percent beside practically pure hexagonal quartz. This points to beta quartz, more correctly to pseudomorphs of alpha quartz after beta quartz. Therefore these sunstones must have experienced temperatures >573°C for the alpha to beta quartz transition.

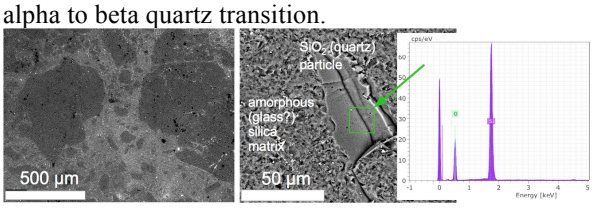

Fig. 3. Preliminary SEM-EDS. Left: Sunstone breccia in SEM image. Right: EDS spectrum of quartz fragment in glass (?) matrix.

Matrix-within-matrix flow texture is frequently accomponied by strong gradation of quartz fragments. Glass inclusions and glass veinlets are common (Fig. 4). Shock metamorphism already reported by Rutte is found in the new alemonites and also in the sunstone samples, however mostly on a moderate level (PFs, PDFs in quartz; Fig. 4) and not very abundant.

Discussion: ***The Czech sunstones*** In general, the Czech sunstones are regarded as silcretes (silicified, hardened, conglomeratic, crust-like soil formations), which have formed especially on the territory of the Bohemian Massif (with the distinction of Elbe and Rudná types) and are of unclear age and origin [4-6].

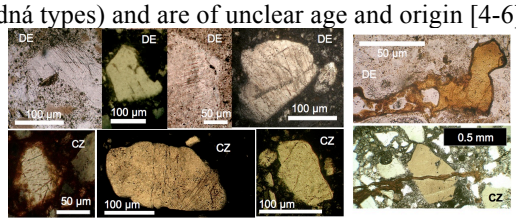

Fig. 4. Shock effects (multiple sets of PFs and PDFs) in alemonites (DE) and sunstones (CZ). Photomicrographs, crossed polarizers. - To the right: Glass particle with schlieren and glass veinlet cutting through a quartz fragment. Plane light.

This interpretation may be correct in many cases, but confusions may occur without precise analyses. The Czech sunstone alemonites differ in spite of some common characteristics with silcrets in particular by polymictic breccias shattered down into the micro range, up to three breccia generations in only one small sample, glass inclusions, moderate shock effects, and hexagonal beta quartz that forms at temperatures >573 °C. According to generally accepted impact criteria, these features, phenomenology and internal texture speak clearly for the character of meteorite impact breccias, as is the case with Rutte's alemonite breccias. According to Rutte's research in Bavaria, the alemonitizations occurred at the same time as the Ries crater event whereby the alemonites are by no means distal ejecta but must have originated more or less locally, which should apply also to the far reaching Czech sunstone/alemonites, for which a possible Miocene age is discussed [4].

Conclusions: The question about the process of the mysterious formation of the alemonite breccias is not answered here either, but urges us to look at the Ries crater and its formation with new eyes in the sense of Rutte, posthumously bringing justice to this great Bavarian geologist. It shows that the spontaneous rejection at that time by the German Ries impact research group and the regional official geology was shortsighted, and, in order to remain with the Ries crater and the probable connection with the alemonites, it underlines that phenomena can occur with large impacts, which are still enigmatic and inexplicable. We will continue to investigate the alemonite phenomenon.

References: [1] Rutte, E. (1971) *Geoforum*, 7, 84-92. [2] Rutte, E. (2003) Land der neuen Steine, 110 p., Regensburg (Univ.Verlag). [3] Eichhorn, R. et al. (2012) Nicht von dieser Welt - Bayerns Meteorite (LFU, ed.) , 126 p. [4] Cílec, V. http://old.speleo.cz/soubory/speleo/sp20/silkrety.htm [5] Cílek V. & Bednářová J. (1993) Čes.kras (Beroun), XVIII: 4-13 [6] Musil, R. et al. (1993) GEO program, 55-65, Brno. [4-6] in Czech.