Disputed, Forgotten, Revitalized: Alemonite - an Enigmatic Impact Breccia Probably Linked to the Ries Crater (Germany) Impact Event

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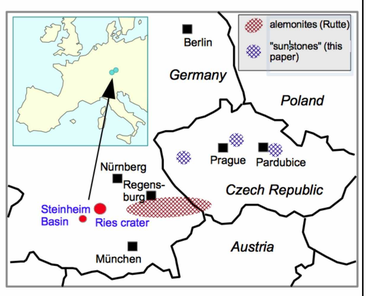
Introduction



- The 25 km-diameter Ries crater impact event, 15 Ma years ago in the Upper Miocene; Steinheim basin as a smaller companion crater (location map to the right).
- In the early seventies: the reputable Bavarian geologist Erwin Rutte published a new hypothesis on a much more far-reaching Ries impact event causing quite a strong recognition in the geologic community [1-5].
- Vehement rejection by the traditional German impact researchers and the Bavarian Official Geologic Survey - ignorance and oblivion [2, and references therein].
- Alemonites: A particularly puzzling component of this then completely new impact hypothesis and recent findings put the hypothesis in a new light.

Alemonite

- First described by Rutte in 1971 [1] as having originated during and related with the Ries impact event. Name after the Roman name *alemona* for the Altmühl, river in the main distribution area of the Alemonite.
- Alemonitization (Rutte): Formation of stones of polymytic impact breccias (alemonites in the narrower sense) and silicification and brecciation of whole rock complexes and in whole regions; concentration in the *Altmühlalb* and Upper Palatinate, and a certain extent to South Bohemia and Austria (site plan!) . - HERE: addressing the impact stone breccias only.
- Rutte: Alemonites were formed 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, Tertiary and crystalline rocks of various lithologies thus forming a variety-rich and characteristic new rock [2].
- Alemonites (in the narrower sense) 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 and is still enigmatic, that the "melt rock mass" and the embedded breccia components of all lithologies continuously consist of >98% silica.
- 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.

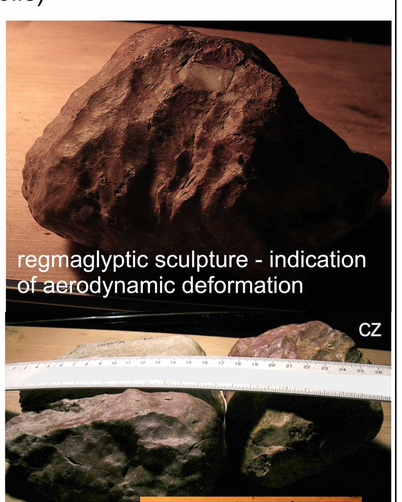
Alemonite: Disputed - forgotton - revitalized

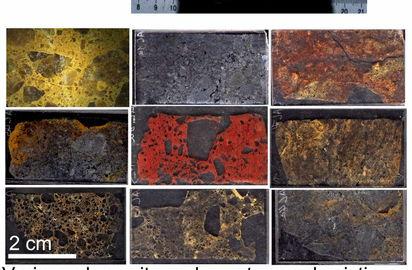
Disputed:
- The new hypothesis - not a sudden invention but based on years of extensive and meticulous field work with a dozen of students and on their theses and related publications (e.g. [6]) .
- Provoked protest and absolute rejection from the Bavarian official geologic survey:
  - All smaller craters 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 [7].

Forgotton:
- At that time a few members of the Ries crater research group undertook a short field trip into the new area postulated by Rutte
- The rejection by the German impact researchers followed on the foot.
- Logical consequence of the rejection and disregard of official geology and German impact research: best to forget the whole thing.
- Rutte continued his work with a number of publications.
- A decisive weakness of Rutte's 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, recently revitalized the Rutte hypothesis.
- He 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.***
- 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 as exemplified in the follwing.

Alemonite and sunstone samples from the field (Germany, Czech Republic)



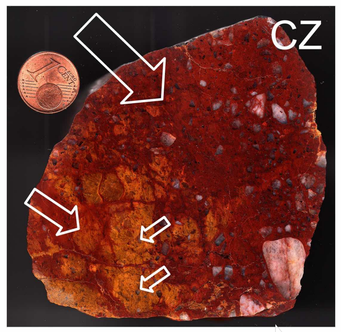


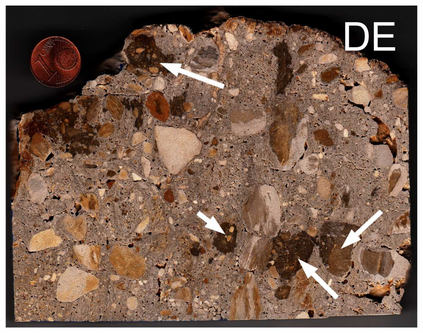
Various alemonite and sunstone polymictic breccias; thin section photomicrographs, reflected light.

A possible confusion with silcrete formation is later discussed.

Sculpture reminding of ablation regmaglypts on meteorites.

Alemonite and sunstone samples from the field (cont.)





1st breccia generation → 2nd → 3rd

breccia-within-breccia, arrows

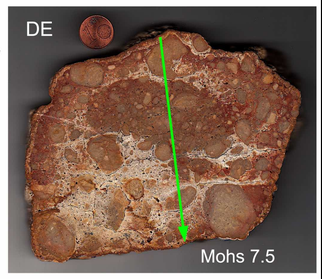
Multiple breccia generations (three to the left) are a characteristic geologic impact feature and rarely known from "normal" geological processes. Cut and polished samples.

Polymictic graded brecciation

Polymictic breccia with flow texture and finest brecciation

Monomictic breccia with mortar texture and aligned, fitting fragments pointing to brecciation, transport and emplacement under high confining pressure.

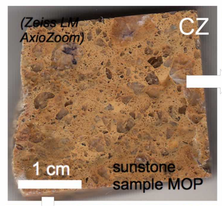
Cut and polished samples.

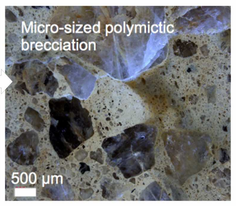


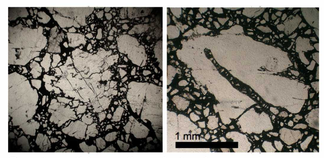
Polimictic breccia with whitish dikelets, flow texture and breccias-within-breccia. Like all alemonites and sunstones Mohs hardness continuously proves to be ca. 7.5.

A possible confusion with silcrete formation is later discussed.

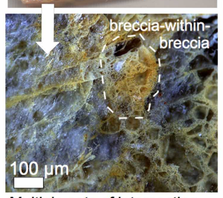
Going into more detail



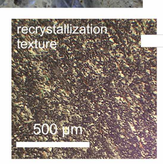




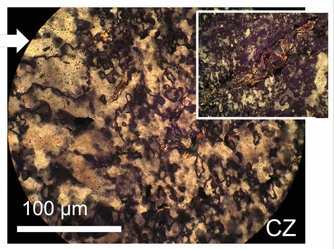
Sunstone thin section photomicrograph: sample SU 5b: complex deformation/brecciation process.

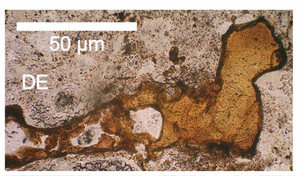


Multiple sets of intersecting, closely spaced subparallel fractures in quartzite.

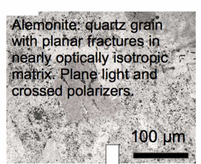


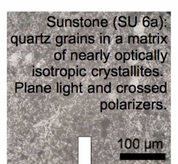
Sunstone shock(?) metamorphism: quartzite dynamic bulging recrystallization, few kinked mica. Thin section photomicrograph, crossed polarizers. Sample Al 14.

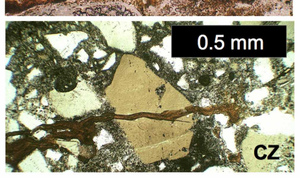




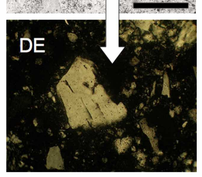
Alemonite: glass particle with schlieren.

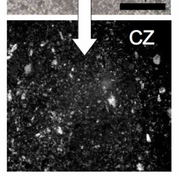




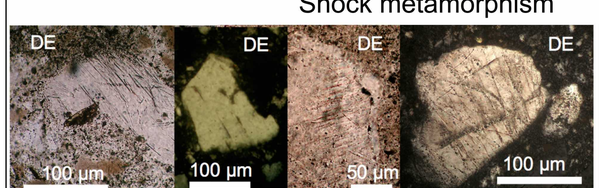


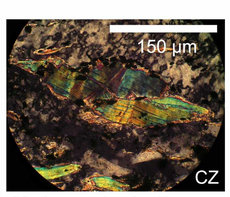
Sunstone: glass veinlet cutting through a quartz fragment.





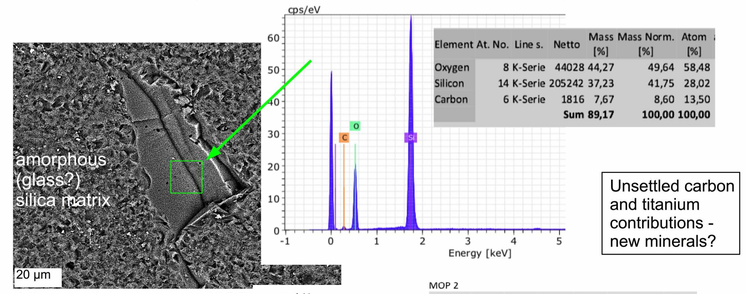
Shock metamorphism





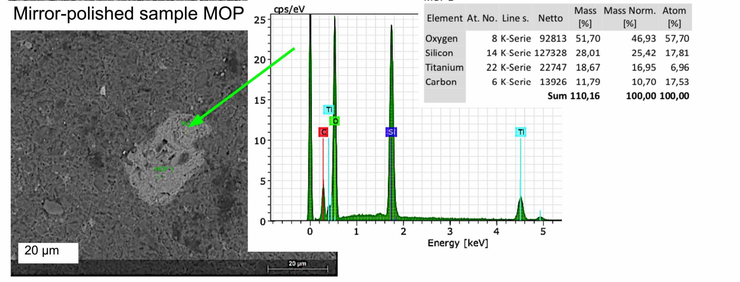
Moderate shock effects (planar deformation features (PDF) and planar fractures (PF) in quartz, strong kink banding in mica) from alemonite (DE) and sunstone (CZ) samples.

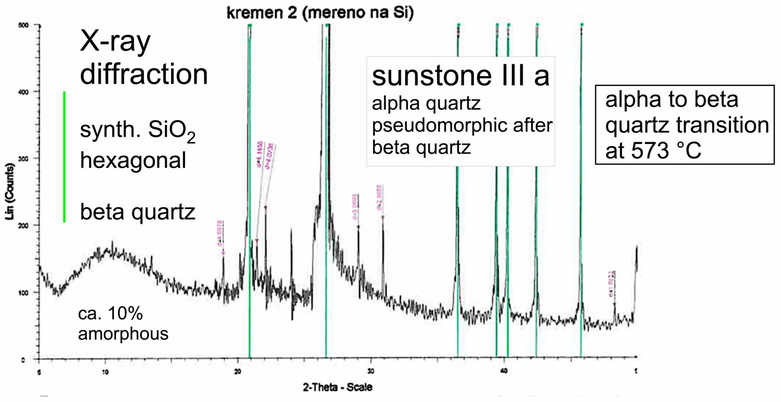
Sunstone: preliminary SEM-EDS and X-ray diffraction



Unsettled carbon and titanium contributions - new minerals?

Mirror-polished sample MOP





alpha to beta quartz transition at 573 °C

Sunstones and the vital point of the Czech silcrete occurrences

The Czech sunstones are commonly 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 [8-10]. The Czech sunstone alemonites have many common characteristics with silcretes and both may easily be confused on cursory inspection. The most obvious differences in particular:
◇polymictic breccias strongly and sharp-edged shattered down into the micro range ◇up to three breccia generations in only one small sample ◇regmaglyptic, aerodynamic? sculpture of individual stones ◇complete silification of all breccia lithologies and continuous Mohs hardness of >7 ◇glass inclusions ◇moderate shock effects ◇hexagonal beta quartz that forms at temperatures >573 °C and excludes silcrete relations ◇ dynamic quartzite bulging recrystallization, t > ≈ 250-400°C.

Discussion and conclusions

- **Czech sunstones/alemonites and silcretes have much in common and my be confused.**
- According to generally accepted impact criteria, the here presented sunstone features, phenomenology and internal texture, speak for the character of meteorite impact breccias.
- The Czech sunstones described so far must be considered in a differentiated way, and silcretes and alemonite-like impact breccias must be carefully separated in relevant geological considerations. With regard to frequently similar matrix facies **it cannot be ruled out and is even probable that older silcrete occurrences were later transformed into impact breccias**.
- The new and abundant finds of the alemonite-related Czech sunstone impact breccias cast a completely new light on Rutte's hypothesis of alemonitization and alemonite breccia formation in Bavaria and adjacent regions.
- According to Rutte's comprehensive research, 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.
- This should apply also to the far reaching Czech sunstone/alemonites, for which a possible Miocene age is discussed [8].
- 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.
- The discussion should not end without briefly pointing out the peculiar coexistence of the distribution of the Czech sunstone alemonites with the tektites (moldavites), which, because of their age equivalence, are generally thought to have developed together with the Ries impact and have their main distribution area in the Czech Republic.
- Posthumously the new research brings justice to this great Bavarian geologist Prof. E. Rutte. It shows that the spontaneous rejection at that time by the German Ries impact research group and the regional official geology was short-sighted.
- 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] Rutte, E. (1972) Die Naturw., 59, 214-216. [4] Rutte E. (1974) Oberrhein. Geol. Abh., 23, 66-105. [5] Rutte E. (1975) Z. Dt. Geol. Ges., 126, 183-197. [6] Roos, W.F. (1976) Oberrhein. Geol. Abh., 25, 75-95. [7] Eichhorn, R. et al. (2012) Nicht von dieser Welt - Bayerns Meteorite (LFU, ed.) , 126 p. [8] Cílec, V. http://old.speleo.cz/soub-ory/speleo/sp20/silkrety.htm [9] Cílek V. & Bednářová J. (1993) Čes.kras (Beroun), XVIII: 4-13 [10] Musil, R. et al. (1993) GEO program, 55-65, Brno. [1-7] in German, [8-10] in Czech.