An eight kilogram chunk and more: evidence for a new class of iron silicide meteorites from the Chiemgau impact strewn field (SE Germany)

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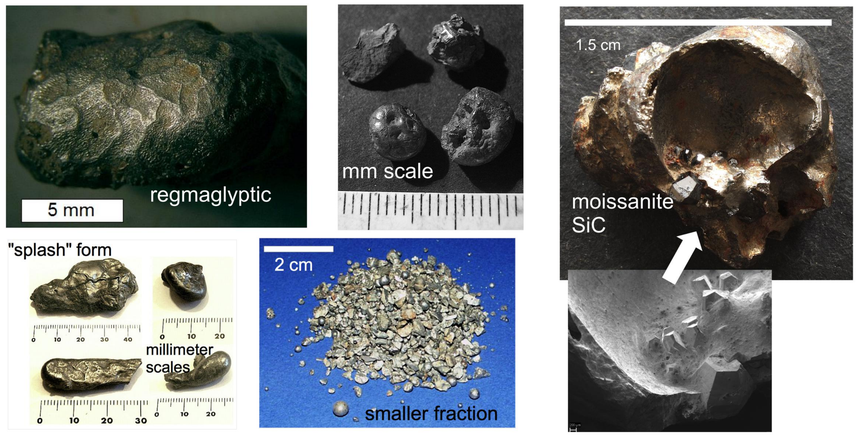
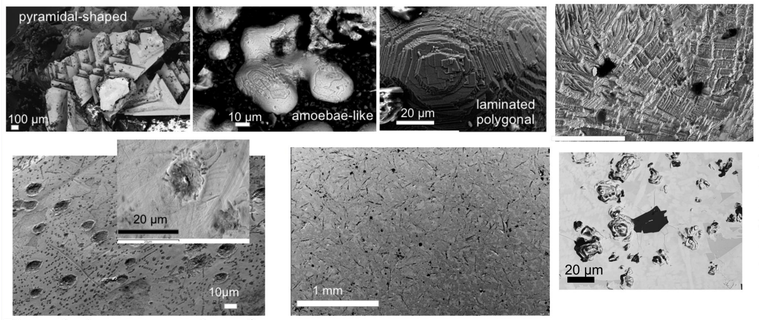




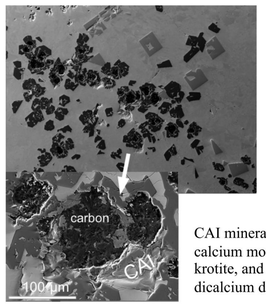
Zirconium (zircon or/and baddeleyite) possible exsolution lamellae in iron silicide.

Peculiar ornate structures in the iron silicide matrix. Possibly spotty melting of the matrix.

Rimmed micro-craters on the surface of an iron silicide piece - cosmic particle impacts?

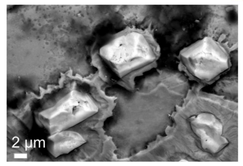
Multiple sets of subparallel, mostly open fractures in iron silicide matrix - shock spallation?

zircon, uranium

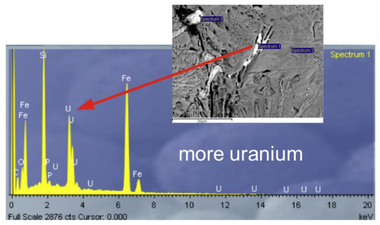


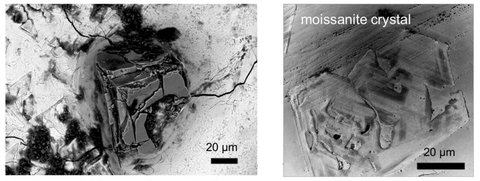
Typical texture of many iron silicide particles: titanium carbides TiC, khamrabaevite (Ti,V,Fe)C, $TiC_{0.63}$ off-stoichiometric (dark gray), silicon carbide (cubic moissanite SiC, black crystals) and CAI (whitish rims) in a matrix of intergrowth of various iron silicide minerals (gupeiite, xifengite, hapkeite, fersilicite, ferdisilicite, traces of suessite).

CAI minerals are $CaAl_2O_4$, calcium monoaluminate, krotite, and $Ca_2Al_2O_5$, dicalcium dialuminate.



Zircon crystals with white uranium tips have impacted a plastic or liquid iron silicide matrix that seems to have frozen during the disturbance.





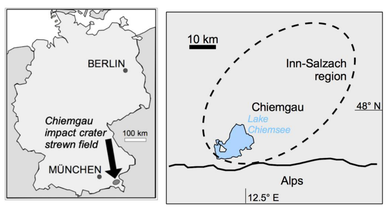
titanium carbide crystal strongly fractured open, tensile fractures: dynamic shock spallation (?)

Multiple sets of planar features - probably a shock effect.

Introduction: The find of a big 8 kg weighting iron silicide chunk found some 30 years ago in the Chiemgau meteorite impact strewn field [1, 2, and references therein] has strongly supported the earlier formulated hypothesis [1, 2, and references therein] of an extraterrestrial origin for the abundant occurrences of iron silicides in connection with the craters in the elliptically formed strewn field sized about 60 km x 30 km. Up to now some thousands of iron silicide particles have been sampled, mostly by metal detectors, roughly amounting to a mass of a few kilograms (apart from the 8 kg chunk). Here we report on new analyses, which establish an obviously common formation and origin.

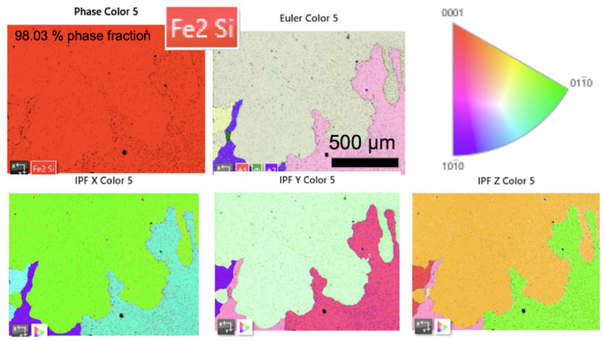
The Chiemgau meteorite impact event and the enigmatic world of the external and SEM internal structure of the iron silicides

The discovery of the Chiemgau meteorite crater strewn field was directly paralleled by the abundant finds of **iron silicides comprising gupeiite, xifengite, hapkeite, naquite and linzhite**, and containing various **carbides like, e.g., moissanite SiC, titanium carbide TiC and khamrabaevite (Ti,V,Fe)C**, and **calcium-aluminum-rich inclusions (CAI), minerals krotite and dicalcium dialuminate.** With regard to this exotic mineral assemblage and the extreme purity of the carbide crystals that obviously was not achieved under terrestrial conditions, an industrial or a geogenic origin was discarded, in particular with regard to the very specific sampling situations. Hence a cosmic origin got increasing evidence. So far the total mass of the iron silicides has amounted to about two kilograms sampled from the whole strewn field with metal detectors, and the largest specimen was a few centimeters tall and weighed 160 g. Against this background the recovery of an iron silicide "monster" from the crater strewn field weighting eight kilograms proved to become a scientific stroke of luck.



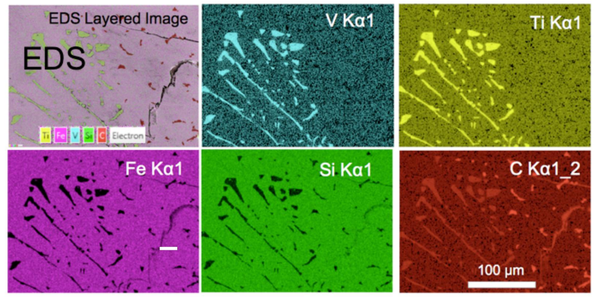
Methods

Optical microscopy, SEM, TEM and EBSD analyses, Raman spectroscopy.



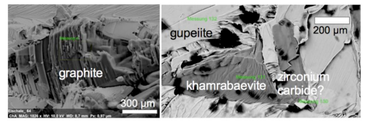
From the 8 kg iron silicide "monster"

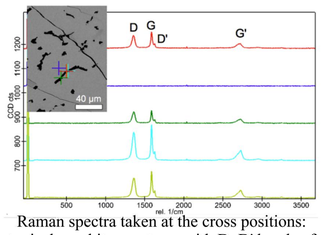
EBSD reveals nearly 100% Fe_2Si, **hapkeite**, with conspicuous grain boundaries.



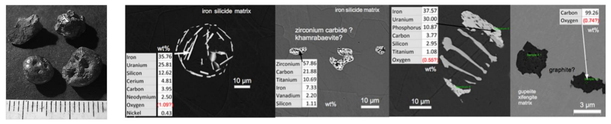
Two clusters of inclusions within the iron silicide matrix: irregular orientation of carbon particles and aligned particles near to khamrabaevite, (Ti,V,Fe)C.

Inclusions within the iron silicide matrix. Graphite has been established by Raman spectroscopy (Fig. to the left). EDS data suggest gupeiite, khamrabaevite and possibly zirconium carbide.





Raman spectra taken at the cross positions: typical graphite spectrum with D, D' bands of disordered graphene.



SE-EDS micrographs and analyses; samples to the left. Quite comparable analyses have been made in the 8 kg iron silicide chunk and in earlier analyses of various finds.

Conclusion

Enigmatic internal structures and exotic composition for all sizes of iron silicide samples from the Chiemgau impact crater strewn field establish a common formation process and a common source. Artificial production, geogenic formation (and e.g. fulgurite formation) can be excluded, which is basically also supported by the find situations in the field [1, 2]. The iron silicides are of extraterrestrial origin. The iron silicides in their entity belong to the Chiemgau meteorite impact strewn field. They should constitute a new class of meteorites. For reasons of definiteness we suggest to name the trigonal Fe_2Si polymorph hapkeite-2T possi-bly rating a new mineral name [2].

References

[1] Rappenglück, M. A., Rappenglück, B., Ernstson. K. (2017) Cosmic collision in prehistory - The Chiemgau Impact: research in a Bavarian meteor- ite crater strewn field (in German). - Zeitschrift für Anomalistik, 17, 235-260. [2] Ernstson, K., Mayer, W., Neumair, A., Rappenglück, B., Rappenglück, M.A., Sudhaus, D., Zeller, K.W. (2010) The Chiemgau Crater Strewn Field: Evidence of a Holocene large impact event in Southeast Bavaria, Germany. Journal of Siberian Federal University. Engineering & Technologies, 1, 72-103.