

Hydrocode modeling of impact craters: Chiemgau low-altitude airburst impact strewn field, Germany

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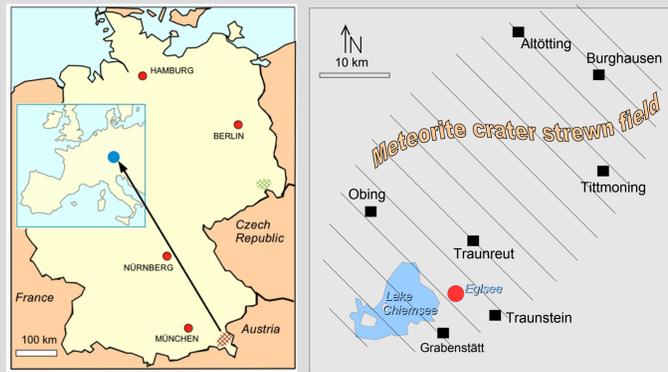
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Introduction:

Hydrocode modeling of impacts uses computer programs to simulate extreme, short-duration events such as, as here discussed, impact cratering. It models the behavior of materials under extreme conditions, e.g., shock waves, and simulates pressures, temperatures, stresses, and material deformations and movements, where physical testing is impossible or too costly. Here, for the first time in impact research, we present hydrocode modeling, which we apply to impacts in a very large crater strewn field created by a low-altitude touchdown impact in loose sediments.

The Chiemgau impact [1]:

The Chiemgau meteorite impact, suggested some 20 years ago, is now established as the world's currently largest Holocene impact site, which has been dated to 900-600 B.C. in the Bronze Age/Celtic era. We have been using the Digital Terrain Model DTM (DGM 1 in Germany [2]) with extreme 1 m horizontal and 0,1 m vertical terrain resolution for several years to systematically search the Chiemgau impact strewn field for new impact findings applying this extremely high-resolution method, which has now led to well over 100 new structures with diameters up to 1,300 m [e.g., 3-6]. In addition, the DTM has led to the Chiemgau crater strewn field being now understood as the result of a low-altitude "touchdown" airburst impact with associated crater shapes, some of which are highly complex [4].



Location maps

The Chiemgau impact hydrocode modeling

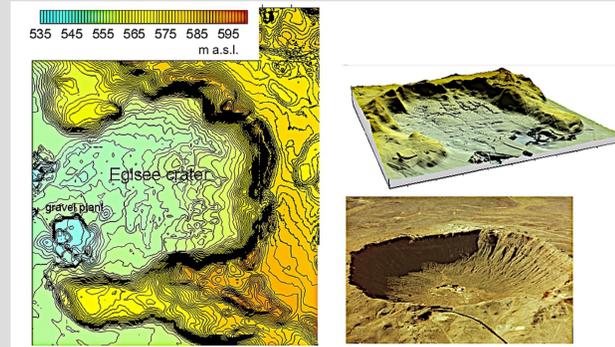
Although the origin of the impact has been clearly proven for many years (despite being ignored by the so-called impact community), using all internationally recognized impact criteria, it has only recently become increasingly understood that the Chiemgau impact event, with its practically unmistakable large impact inventory, can only be understood as a low-altitude airburst, which we would like to substantiate here with two examples of hydrocode modeling.

Model parameters

Chiemgau strewn field - age 900-600 B.C. - 1.2 km comet - entry 30 km/s at 15°, 2 km/s at ground level - density 500 kg/m³ - comet breaks up 100 km high - fragments up to 100 m - 70 km x 8 km debris field - shallow craters up to 1.3 km - energy 18,000 Mt - temperature >1,800 K - shock speed 6 km/s - pressure >5 GPa - tonnes of glass, spherules - shocked minerals (quartz, feldspar, mica, calcite)

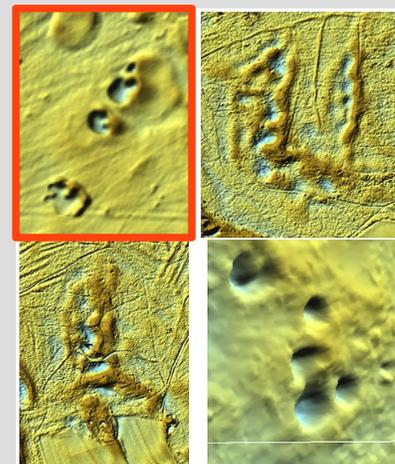
The Eglsee 1.3 km-diameter crater

The Eglsee crater is the largest crater in the strewn field so far.



Eglsee crater, DGM 1 contour map. 1 m contour interval. Right: Eglsee crater, DGM 1 surface map and Barringer (Meteor) crater of the same size; NASA.

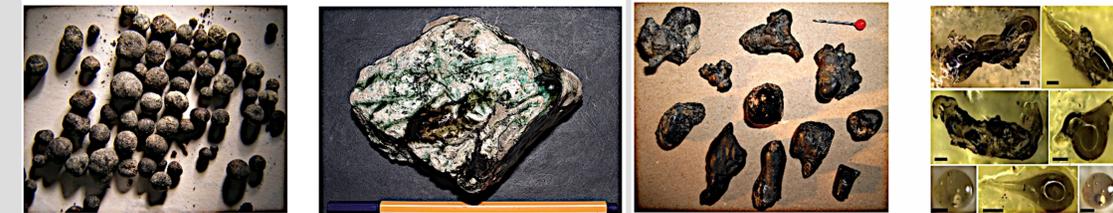
The modeled Crater chain:



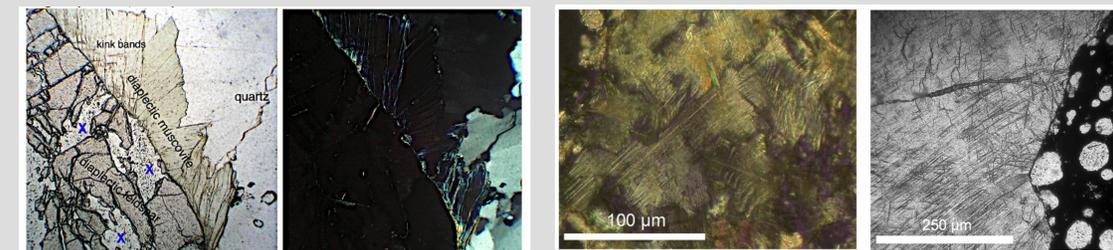
Typical crater chains in the Chiemgau impact strewn field: Digital Terrain Model DGM 1, 3D surface. Top left: Hydrocode modeled.

Hydrocode modeling, touchdown airburst impact and impact-petrographic documents:

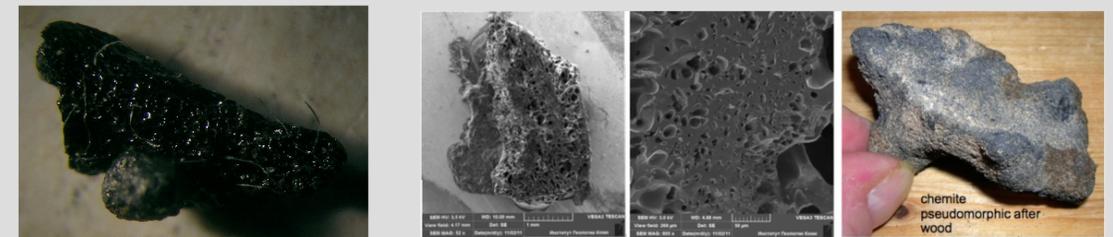
From the far northeast (craters 004, 001) to the southwest (Lake Tüttensee) of the impact ellipse, the impact is widespread in craters and directly on farmland, where a wide variety of impactites with and without shock metamorphism, spherules, and melt glasses can be collected. A very limited selection is shown in the next Figures.



Widespread carbon spherules precipitated from vaporized trees, mm-sized. Meltglass, widespread over large areas. Black glass particles, widespread. Microtektites, 100 µm scale bars.

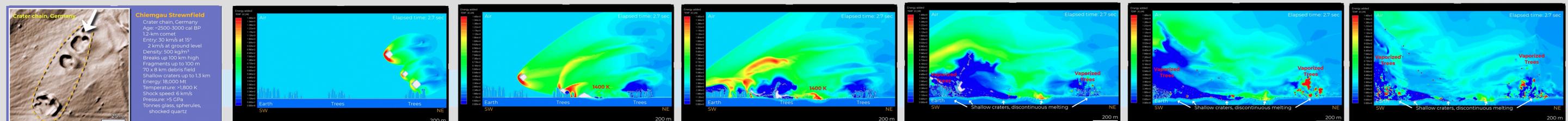


Diaplectic feldspar and muscovite. PPL and crossed polarizers. Planar deformation features PDFs in plagioclase and quartz, contacting melt glass; crossed polarizers.



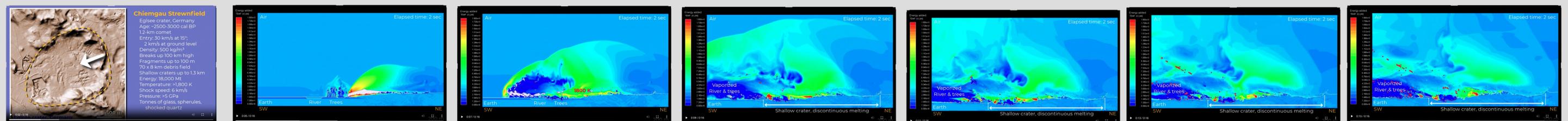
Black glass with spherules. Chiemite, new impactite composed of more than 90% carbon with diamonds and carbines requiring 2,500 - 4,000°C and several GPa. Airburst-shocked vegetation, peat and wood.

References: [1] www.chiemgau-impact.com (and references therein). [2] Geodaten Bayerische Vermessungsverwaltung. [3] Ernstson K. and Poßekel J. (2025) MetSoc. Meeting 2025, Abstract #5312. [4] Ernstson K. and Poßekel J. (2024) LPSC 2024, Abstract #1658. [5] Ernstson K. and Poßekel J. (2020) 11th PPC 2020, Abstract #2019. [6] Ernstson K. and Poßekel J. (2024) AGU 2024, Abstract #EP01-29.



Hydrocode Modeling of the Chiemgau airburst impact, crater chain. Video still images.

As far as we know, this is the first hydrocode modeling ...



Hydrocode Modeling of the Chiemgau airburst impact, Eglsee crater. Video still images.

... of a low-altitude touchdown airburst impact.