

CHARACTERISTICS OF A HOLOCENE IMPACT LAYER IN AN ARCHEOLOGICAL SITE IN SE-BAVARIA, GERMANY. A. Neumair¹, K. Ernstson², W. Mayer¹, B. Rappenglück¹, M. Rappenglück¹ and D. Sudhaus³ ¹Institute for Interdisciplinary Studies, Gilching, Germany (andreas.neumair@arcor.de, info@mayer-chiemgau.de, Barbara.Rappenglueck@evtheol.uni-muenchen.de, mr@infis.org) ²University of Würzburg, Germany (kernstson@enstson.de), ³University of Augsburg, Germany (dirk.sudhaus@gmx.net)

Introduction: In 2007, an archeological excavation in Chieming-Stöttham (47°54'26'' N, 12°31'29'' E; Fig. 1) at the border of Lake Chiemsee in the Alpine Foreland in SE Bavaria, Germany, revealed a diamictic layer embedded in an archeological stratigraphy from Bronze Age to Roman times and featuring all aspects of a catastrophe obviously related with the Chiemgau Holocene impact event [1, 2].

Geology: The site under discussion is located in Quaternary sediments of the Alpine Würm glaciation comprising mostly moraine and fluvio-glacial material. Lithologically, carbonate and, subordinate, silicate pebbles and boulders dominate in association with loamy and clayey beds.

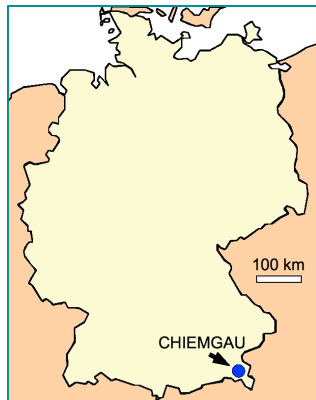


Fig. 1. Location of the Stöttham excavation site in the Chiemgau region, Germany.

Archeological excavation: Ordered by local authorities, the excavation at Stöttham village [3] was carried out by a private archeology company. During the ongoing work the intriguing diamictic layer was only be casually recognized by a local history researcher leading to a sound geoscientific investigation. The archeological situation as found in the excavation that has been covering roughly 300 square meters is most clearly reflected in Fig. 2. Loamy ground moraine material at the base is overlaid by a colluvium horizon containing archeological finds from Stone and Bronze Age and defining a lower occupation layer. In the diamictic layer, artifacts are also found dating from >2,500 B.C. till the Celtic era and including a potsherd dated 800-480 B.C. and one iron lump. An upper colluvium overlaying the diamictite is interspersed with artifacts from Bronze Age and Urnfield culture up to

Roman Age with a well preserved Roman paving defining an upper occupation layer.

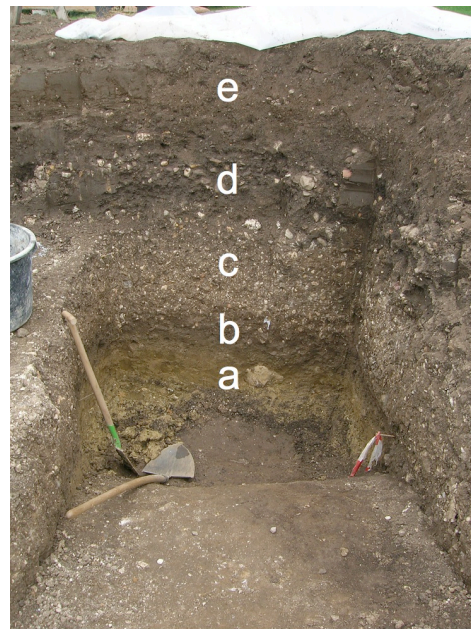


Fig. 2. Geologic/archeological stratigraphy. a: moraine, b: lower colluvium/lower occupation layer, c: diamictite/catastrophic layer, d: upper colluvium/upper occupation layer with Roman paving, e: soil.

Catastrophic layer: Geologically this layer has the characteristics of a diamictite, a term to be understood purely descriptive as a poorly or non-sorted sediment composed of angular to well rounded matrix-supported clasts of largely varying size. The sandy-clayey matrix similar to the facies of the colluvium above and beneath the diamictite is more or less continuously grading into a breccia of heavily disintegrated clasts interspersed with cobbles and boulders otherwise typically found in the surrounding gravel pits but exhibiting also strong external influence (Fig. 3). Charcoal, in part strongly fractured bones and teeth and other organic material, and, as above-mentioned, archeological objects continuously contribute to the diamictite, and in this composition the term *catastrophic layer* seems to be well applicable. There is evidence that the layer extends well beyond the excavation site since a comparable layer, however reduced in thickness, was accidentally center-drilled at 60 cm depth 400 m apart.

Lithology. Compared with the common spectrum of about 80% carbonate and 20% silicate rocks in the surrounding gravel pits, the carbonate fraction of the pebbles and cobbles in the diamictite is reduced to only 50% pointing to a selective process of erosion and/or deposition. Independent of lithology all pebbles and cobbles of the diamictite are very sensitive to weathering and mostly disintegrate within a few months.

Evidence of high pressure. Apart from the strong brecciation in the diamictite the distinct coherence of many broken clasts within the soft matrix is striking giving evidence of high confining pressure upon deposition underlined by quite a few limestone cobbles and boulders displaying intense criss-cross striations and mirror polish all-around. Moderate shock metamorphism in a few clasts is indicated by planar deformation features (PDFs) in quartz and distinct kink banding in mica. Spallation fractures are observed pointing to a macroscopic shock deformation of cobbles.

Evidence of high temperature. High-temperature signature is given by partly melted silica limestone cobbles, a typical rock from the Alps, and a sandstone clast with sporadically interspersed glass. A formation of the melt from shock release is possible. Particles of a dirty brown glass, possibly molten soil, contribute to the diamictite. Some minerals, e.g. amphiboles, show loss of water and indication of possible shock melting. Evidence of heat disintegration of limestone pebbles by decarbonization and/or partial melting is abundant resulting in shells of white calcareous powder or, under slight compression, in a complete disintegration to white powder, which gives the typical white-spotted appearance to the diamictite as seen in Figs. 2, 3.



Fig. 3. Close-up of the diamictic layer in Fig. 2.

Corrosion. Drastic chemical or physical corrosion of carbonate pebbles, frequently leading to distinct skeleton sculptures, is abundant. Also silicate pebbles may show significant corrosion.

Spherules. Elutriation of the diamictite matrix revealed carbon, glassy and magnetic spherules.

Discussion: Diamictites can be produced by a wide range of geologic processes as are, e.g., tectonics, volcanism, glaciations, large landslides, and meteorite impact, with a most common origin from submarine mass flow. Because of the incorporation of Bronze Age artifacts an origin of the diamictite from any glaciations that ended many thousand years before can be excluded, as is the case with completely unknown volcanism and, obviously, with submarine mass flow. A landslide can be discarded because of lacking relief, and any anthropogenic origin from Bronze Age/Celtic era provides basic difficulties to explain thickness and extension of the layer. With regard to the high-pressure and high-temperature signature including melt rocks and shock effects, a deposition from meteorite impact is the only reasonable explanation substantiated by the occurrence of various magnetic, glass and carbon spherules. Since the Stöttham outcrop is located in the strewn field of the Holocene Chiemgau impact event proposed to have produced more than 80 craters in the diameter range of a few meters up to 600 m (the Tütensee crater) [1, 2], a relation is compelling evidence at the same time adding more insight into this extraordinary young geologic event. No crater has so far been found as a source for ejected material constituting the Stöttham diamictite deposit. A nearby possible candidate is a 200 m-diameter depression that however was completely filled in the past not allowing simple geological access. A delivery of the Stöttham proposed impact ejecta material from a suspected crater located offshore in Lake Chiemsee and delineated by sonar soundings is currently discussed.

Conclusions: Lacking serious alternate explanations, the Stöttham layer must be considered an impact horizon having originated from meteorite impact in early history times thus also dating the Holocene Chiemgau impact event with some more precision to the Bronze Age/Celtic era. It is obviously for the first time that a cosmic catastrophe experienced by mankind is shown to be integrated in a clear archeological stratigraphy, although the proposed Younger Dryas large impact in North America [4] with the possible extinction of the Stone age Clovis people will sometime reveal a comparable situation.

References: [1] Rappenglück, M.A. and Ernstson, K. (2008) *Int. Conf. 100 Years Since Tunguska Phenomenon, June 26-28, Moscow, Abstracts*, 234. [2] Ernstson, K. et al. (in press) *Proc. Intern. Conf., "Tunguska-2008", Krasnoyarsk, J. Siberian Fed. University. Engineering & Technologies*. [3] Möslin, S. (2008) *Report to the Stöttham local authorities*. [4] Firestone, R.B. (2009) *Journal of Cosmology*, 2, 256-285.