

The craters that never were: Anthropogenic origins of alleged impact structures in the Chiemgau region

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Abstract—Public fascination with impact craters often drives bold speculations, but rigorous verification is critical. In southeastern Bavaria, numerous depressions have been proposed to represent impact craters associated with a catastrophic event in Celtic times (between 900 BC and 600 BC)—the so called “Chiemgau Impact.” To date, the evidence presented in support of the proposed Chiemgau Impact has not been independently validated as diagnostic of a confirmed impact event, and this interpretation has been repeatedly challenged in the scientific literature. More recently, numerous newly identified, predominantly small-scale structures have been presented as further evidence supporting this claim. Many, however, lack precise geographic information, complicating independent verification. We localized and critically examined these structures in the field as well as using publicly available high-resolution LIDAR data, aerial imagery (historic and recent), and development plans. The majority of these images show structures which are demonstrably anthropogenic, including gravel pits, WWII bomb craters, retention basins, and—most notably—golf course features such as bunkers and ponds. Other depressions correspond to glacial landforms characteristic of the Inn-Chiemsee foreland. None of the structures examined exhibit characteristics that would support a formation by a cosmic impact. The repeated misinterpretation of recently constructed golf course elements as impact craters highlights a striking lack of methodological rigor and illustrates how extraordinary claims can arise from neglecting simple cross-checks with publicly available geospatial and planning data and indicates that the postulated impact in Chiemgau belongs to the realm of myths.

INTRODUCTION

Traces of natural disasters fascinate people around the world as they reveal both the unbridled power of nature and the vulnerability of humankind. Remnants of such calamities are relatively rare and difficult to identify, but in recent years, a large number of reports have appeared documenting traces of meteorite impacts, earthquakes, and tsunamis around the world. Such publications on past hazards reliably attract public

attention and are therefore also attractive subjects for research. In particular, numerous studies on past cosmic impact events have been published in recent years, some of which have been the subject of intense and controversial debate (see, e.g., Day et al., 2023; Reimold, 2007). In southeastern Bavaria (Germany), a group of researchers and amateurs (The Chiemgau Impact Research Team [CIRT]) has proposed an extensive impact scatter field as evidence for a cosmic catastrophe that they argue was responsible for the decline of the local Celtic

culture. This interpretation has also been linked to the ancient Phaethon tradition, which has been suggested as a possible cultural memory of the proposed cosmic catastrophe (Rappenglück et al., 2010). It is important to note that the proposed “Chiemgau Impact” has not been independently established as a confirmed impact event. Although proponents have presented a range of geological, mineralogical, and archeological observations as evidence for an impact (Rappenglück et al., 2010), these interpretations have been repeatedly questioned in the scientific literature. Critical assessments have challenged the interpretation of purported impact-related geological, mineralogical and geomorphological features (Doppler et al., 2011; Endlicher, 2025; Huber et al., 2020; Reimold et al., 2014). Other studies have questioned the interpretations of the archeological evidence, regional settlement history and the mythological arguments linking the proposed event to Celtic culture and the Phaethon tradition (James & van der Sluijs, 2016; Rösch et al., 2021; Völkel et al., 2012). Thus, while various observations have been presented in support of the Chiemgau Impact, no independent body of evidence has so far established the event as an accepted impact structure or impact event.

The affected area is located in the Alpine foothills, which have been intensively shaped by the Quaternary glaciation history of the Inn-Chiemsee glacier (e.g., Darga, 2009a; Ganss, 1977; Knauer, 1935; Troll, 1924). This has resulted in a wide variety of landforms, including moraine hills, valleys, kettle holes, and other glacial features. In addition to these glacial influences, extensive anthropogenic modification has further shaped the landscape, as the Chiemgau region has been inhabited for thousands of years. Overall, the area has been exceptionally well studied for decades and its glacial genesis is undisputed (e.g., Darga, 2009a; Ganss, 1977; Knauer, 1935; Penck, 1882; Troll, 1924). Nevertheless, several glacial features located in this region such as kettle holes, moraine arcs, and a large number of smaller depressions have been interpreted as impact craters (Ernstson & Poßekel, 2024, 2025; West & Ernstson, 2026), many of those solely based on their circular, concave form.

Much of the alleged evidence previously attributed to the so-called “Chiemgau Impact” has since been shown to be of glacial or anthropogenic origin (Darga, 2009b; Endlicher, 2025; Smith et al., 2019), including Lake Tüttensee (Huber et al., 2020; Rösch et al., 2021), which has been asserted as the largest crater (Rappenglück et al., 2010). However, many of the smaller depressions described as craters remain unexamined, with neither independent confirmation nor refutation.

Recently, at the Meteoritical Society Annual Meeting 2025 and Lunar and Planetary Science Conference 2026

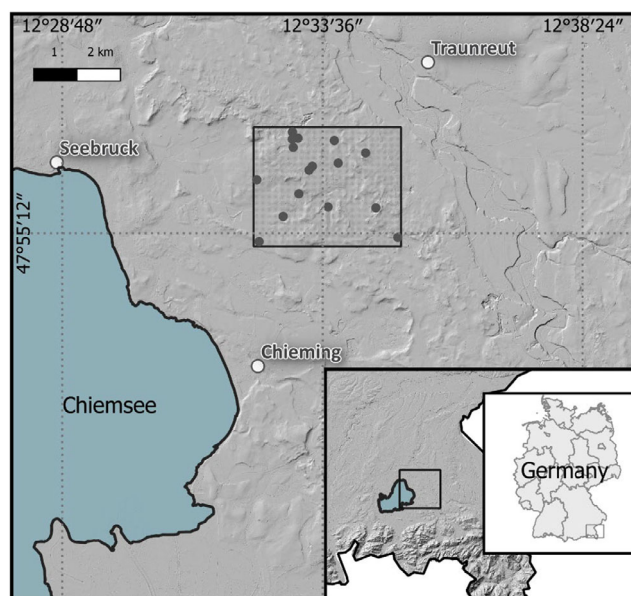


FIGURE 1. Map showing the location of the identified structures discussed in this publication which all are located in the Chiemgau region, south-eastern Bavaria, Germany (inner caption). Background map: © Bayerische Vermessungsverwaltung (2026), data source: Geoportal Bayern www.geoportal.bayern.de.

further depressions were proposed as crater structures (Ernstson & Poßekel, 2025; West & Ernstson, 2026). We became aware of several of these features after local residents contacted us, having discovered the corresponding extended abstracts on the internet. According to them, several of these structures are located on a golf course and others are gravel pits. Since these are easily accessible and a large amount of background data are publicly available for that region, we have examined these structures in more detail in order to weigh up the postulated impact genesis of these structures against other explanations such as glacial formation or anthropogenic origins.

METHODS

We used the illustrations and accompanying texts mentioned above as reference material. In particular, we used the Figures 1, 3, and 4 published by Ernstson and Poßekel (2025). These figures contain 24 individual pictures of crater-like structures. Furthermore, we analyzed Figures 1, 2, and 4 from the extended abstract of West and Ernstson (2026), which include eight additional images of crater-shaped surface features.

Unfortunately, the coordinates of the depressions presented are not given there. However, the vague references to their approximate location mentioned in the material enabled us to identify them based on their typical

and distinctive outlines and structures. To do this, we used publicly accessible geodata services provided by the Bayerische Vermessungsverwaltung via the BayernAtlas tool (<https://atlas.bayern.de/>). Specifically, we utilized the LIDAR based hillshade layer, which enables the terrain relief to be depicted with high precision (1 m resolution) and the smallest structures to be identified. The localization of the features presented by the authors mentioned above was achieved through visual landscape matching, using characteristic and spatially persistent features visible in the imagery. These included the orientation of agricultural furrows, road alignments, and the morphology and spatial distribution of geomorphological elements, particularly the depressions discussed in this paper.

As the individual images in Ernstson and Poßkel (2025) and West and Ernstson (2026) are neither labeled nor numbered, they will hereinafter be referenced according to publication year (I = 2025; II = 2026) and original figure number. For ease of reference, we refer to each panel within these authors' figures sequentially using lowercase letters (a–z), starting in the upper-left corner and following the authors' arrangement line by line. These images will in general be indicated as “CIRT image.” In our Figures 2–5, we have summarized these individual structures in the outlines presented by these authors as hill shade representations and labeled them as explained above (CIRT image I3a–II4e). Where possible, we visited the sites of the structures and interviewed local residents to gather additional information.

We also used publicly available recent and historical aerial photographs taken during different years, namely those provided by the Bavarian Aerial Photography Center (Bayerisches Luftbildzentrum, <https://nea.geofly.eu/>) as well as the historical aerial photographs (2003—today) provided via the BayernAtlas.

Furthermore, we used available historical cadastral maps from the 19th century made available via the BayernAtlas and we reviewed public administrative documents such as development plans and land use plans from the Traunstein district and the municipality of Chieming to identify human origins of structures.

RESULTS

We identified the bounding coordinates for the majority of the structures documented by Ernstson and Poßkel (2025) and West and Ernstson (2026) based on their characteristic shapes and features using publicly available LIDAR data (see Table 1). The morphological features shown in four images were too ambiguous to allow reliable location identification. We found that almost all identified features are located on the eastern side of Lake Chiemsee; only one CIRT image shows a

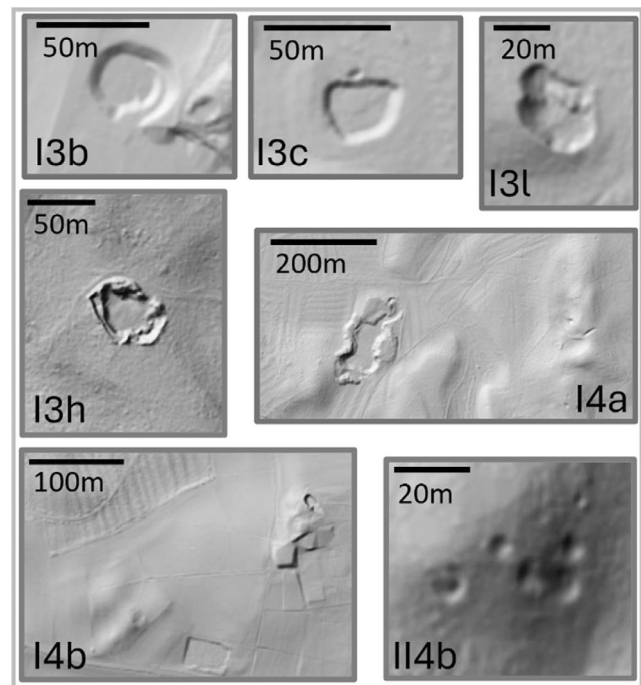


FIGURE 2. Hillshade representations of gravel pits (I3c, I3h, I3l, and I4a), bomb craters (II4b), a water retention basin (I3b) and farm structures (I4b) corresponding to the outlines shown in Figures 3 and 4 of Ernstson and Poßkel (2025) who identified these structures as impact craters. Coordinates are given in Table 1. Background map: © Bayerische Vermessungsverwaltung (2026), data source: Geoportal Bayern www.geoportal.bayern.de.

series of depressions on the western side of the lake. The identified coordinates enabled us to locate these structures across multiple data sources, including LIDAR data sets, historical aerial photographs, maps, and allowed field visits and observations. In addition, this approach facilitated the identification of relevant administrative documents for some of the sites.

The structures named the Eglsee, Hart, and Manholding craters by Ernstson and Poßkel (2025) were readily localized based on their place names and distinctive large-scale geomorphology, including the prominent arcuate ridges visible in the digital elevation model. Available geological maps (Ganss, 1977; Jerz et al., 2023) indicate a terminal moraine chain at these locations, which is consistent with the characteristic poorly sorted, mixed grain-size (diamictic) sedimentological composition of these structures noted in the field.

CIRT Image I3b (Figure 3) was georeferenced from its spiral-shaped basin outline, the adjacent straight road to the west, and the hill to the east with its slight southern indentation. A development plan of the municipality of Chieming (Gemeinde Chieming, 1993) covering the location shown in CIRT Image I3b was identified. The

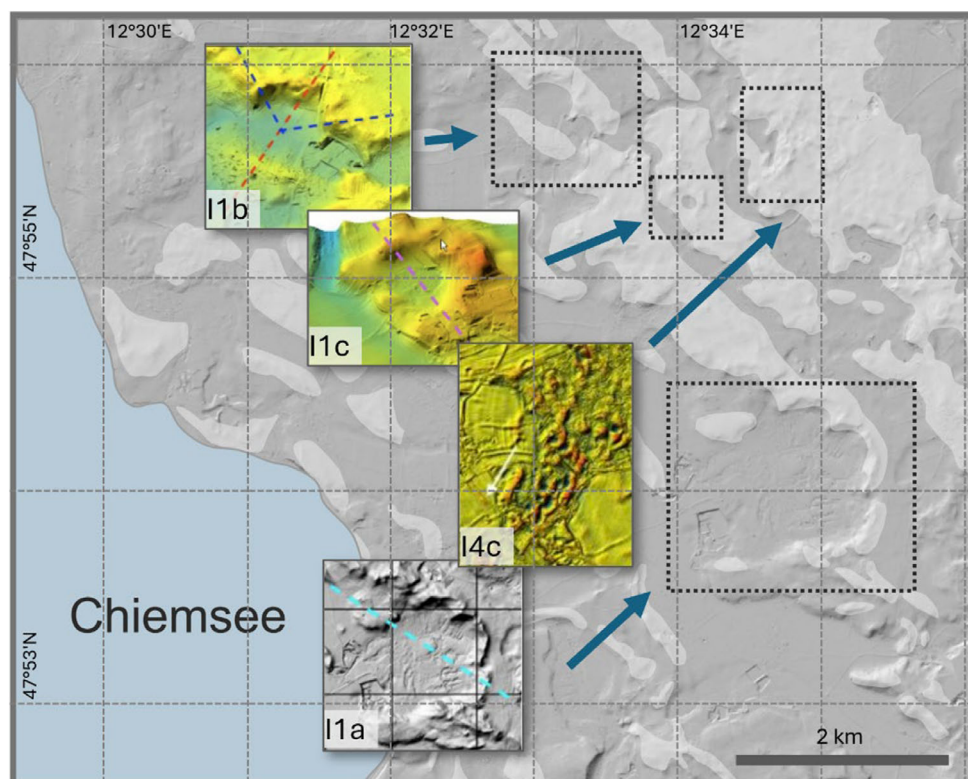


FIGURE 3. Locations of the moraine arcs (I1a, I1b, I1c), interpreted as large impact craters by Ernstson and Poßkel (2025) and West and Ernstson (2026), and the hummocky moraine zone (I4c), interpreted as a ‘crater set’. The light gray areas indicate Würm-age terminal moraine series marking stagnation phases of the Chiemsee Glacier (Troll, 1924). Coordinates are given in Table 1. Background map: © Bayerische Vermessungsverwaltung (2026), data source: Geoportal Bayern www.geoportal.bayern.de.

plan designates an area for the regulation of water runoff and indicates a rainwater treatment and retention basin within this area. During a field visit, the presence of an artificial rainwater retention basin near the local fire station in the village of Hart was verified at this location. The basin is absent from aerial photographs taken prior to 1993, suggesting that it was constructed after this date.

Several structures could be identified as gravel pits or remnants of past excavation activities during field visits (CIRT images I3c, I3h, I3l, and I4a; see Figure 2). Historical aerial photographs additionally document the temporal development of most of these features:

CIRT Image I3c (Figure 2) was localized using the shape of the central depression, the smaller depression to the north, the slight topographic rise, and the surrounding smooth terrain. The structure shown in CIRT image I3c first appears as a gravel pit in aerial imagery from 1971. Subsequent aerial images show a progressive enlargement of the excavated area over time. Extraction ceased in the 1980s, followed by a process of renaturalization. The structure visible today in the field is a small pond, representing the final remnant of the former excavation area.

The structure shown in CIRT image I3h (Figure 2) could be localized based on its nearly heart-shaped depression, the adjacent linear embankment, the approaching track, and the elongated ridge on which it is situated. In modern aerial photographs, it appears as a gravel pit which first becomes visible from 2003. Subsequent imagery shows a continuous expansion of the pit area in successive stages. Active extraction is documented in the 2020 aerial image, where a truck with a trailer can be observed being loaded. The largest expansion can be observed in 2022, after which the gravel pit appears to have been less intensively exploited, as indicated by increasing vegetation cover. In the field, this gravel pit appears to have been abandoned. Much of the pit has been backfilled and is being reforested. Only a small portion of it is still in use and shows fresh signs of mining.

CIRT image I4a (Figure 2) was georeferenced using the elongated rectangular depression, surrounding embankments, agricultural furrows, the terraced ridge, the adjacent ditch, and the surrounding track pattern. It shows, on the left side, a gravel pit that first appears in aerial photographs from 1963, as well as, on the right side,

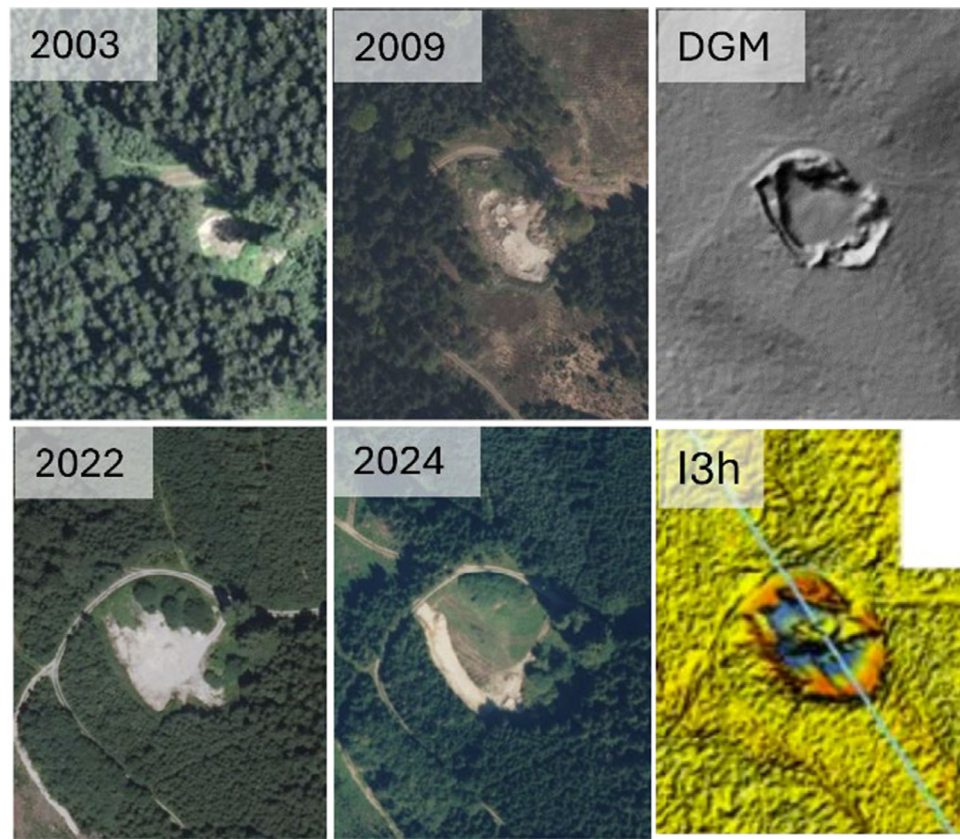


FIGURE 4. Temporal evolution of the gravel pit depicted in CIRT image I3h. Gravel extraction started in the early 2000s and continued during the last 25 years until the site was abandoned and reforested. Today, only a small section of the gravel pit is still active. For reference, the original CIRT image published by Ernstson and Poßekel (2025) which displays vertical exaggeration artifacts, and the corresponding DEM used to match the image to its geographic location are shown. Coordinates are given in Table 1. DGM map and aerial images: © Bayerische Vermessungsverwaltung (2026), data source: Geoportal Bayern www.geoportal.bayern.de.

a hill with an irregularly shaped western flank. The subsequent time series of aerial photographs documents a gradual and continuous expansion of the excavation area radiating outward from an access road. The largest expansion of the gravel pit can be observed for 1992. In aerial images from 1994 onward, the location appears to be abandoned, which is further indicated by increasing development and the construction of buildings on the former extraction area.

CIRT image I3I (Figure 2) was localized from the distinctive hill with three lobe-like indentations, forming a characteristic ginkgo leaf-shaped outline. For this feature shown in CIRT image I3I, no clear first appearance can be determined from the available aerial imagery due to the dense vegetation cover. However, the LIDAR hillshade model reveals three lobe-shaped depressions cut into the southeastern end of a narrow, elongated hill. The features converge toward a common access route and form a fan-shaped arrangement.

Characteristic geometric embankments, path network, agricultural furrows, and the prominent road in the lower left allowed georeferencing CIRT image I4b (Figure 2). The structures shown in the right upper part of I4b correspond to elements of an agricultural complex that are clearly visible in recent aerial imagery and were confirmed during a site visit. The farm initially was established in the 1980s and expanded in the early 1990s. The structures are not visible in aerial imagery acquired prior to 1987. Today, the site comprises riding halls and utility buildings belonging to an equestrian club. Based on the available aerial imagery and present-day site conditions, we could not reproduce or verify the identification of crater chain-like structures at this location as proposed by Ernstson and Poßekel (2025).

CIRT Image II4b (Figure 2) was localized from the characteristic arrangement of the circular depressions near the crest of a smooth hill. These circular structures can be unequivocally attributed to an Allied aerial bombing raid



FIGURE 5. Geographic features illustrated in Figures 3 and 4 (I3i-I3m, I4d+e, II1b, II4c) of Ernstson and Poßkel (2025) and West and Ernstson (2026), identified by those authors as impact craters, correspond to structures within a golf course (Golfclub Chieming) that today function as greens, sand bunkers, and ponds. Coordinates are given in Table 1. Background map: © Bayerische Vermessungsverwaltung (2024), data source: Geoportal Bayern www.geoportal.bayern.de.

at the end of World War II. According to eyewitness testimony, multiple bombs impacted both the forested area near the village Prutdorf and its surrounding fields in 1944. These bomb craters are also visible in aerial photographs taken in 1945. Whereas the craters in the agricultural land were subsequently filled and leveled, those within the forest were preserved and remain visible in the present-day topography.

Georeferencing CIRT images I4d and I4e (Figure 5) could be achieved by matching the pattern of numerous irregular depressions visible in these images. Once the area had been identified, several individual structures (I3i, I3j, I3k, I3m, II4b, and II4c, Figure 5) were readily. The landforms shown in CIRT images I3i, I3j, I3k, and I3m, I4d and I4e, as well as II1b and II4c, are all part of a golf course (Figures 5 and 6), which we were able to confirm during field visits. The design of the area was planned in two phases, for which we found development plans for the

years 1986 and 2006 (Gemeinde Chieming, 1986, 2006). Historical aerial photographs demonstrate that each structure emerged during the conversion of farmland into the golf course.

In detail, a small pond is designated at the location of I3i (Figure 5) in a development and landscape plan from 1986 (Gemeinde Chieming, 1986). Correspondingly, the feature is first clearly visible in aerial photographs from 1987, where it appears as a dark, distinctly outlined pond within the golf course, whereas earlier imagery shows farmland at this location. Subsequent photographs document the progressive transformation of the area in line with the 1986 development plan. Today this pond is hidden by dense vegetation.

The structure at I3j was identified during the field survey as a sandy golf bunker (Figure 6). It is first recognizable in aerial imagery from 2007. The area consisted of meadow or agricultural land prior to 2006.

TABLE 1. Geographic coordinates, source information and comments for all CIRT images discussed in the text. Coordinates are given in decimal degrees (WGS84).

CIRT image	Latitude	Longitude	Comment
I1a	47.90096	12.57903	End moraine arc
I1b	47.92882	12.55178	End moraine arc
I1c	47.92182	12.56572	End moraine arc
I3b	47.92809	12.55267	Rain water retention basin
I3c	47.92346	12.54786	Pond, gravel pit
I3h	47.91916	12.58317	Gravel pit
I3i	47.93375	12.55681	Pond, golf course
I3j	47.93952	12.55240	Sand bunker, golf course
I3k	47.93931	12.55067	Sand bunker, golf course
I3l	47.91830	12.54049	Gravel pit
I3m	47.94078	12.55070	Pond, golf course
I4a	47.92541	12.56181	Gravel pit (left part)
I4b	47.93097	12.53979	Farm
I4c	47.92561	12.57706	Hummocky moraine zone
I4d	47.93294	12.55579	Golf course
I4e	47.93762	12.55095	Golf course
II1b	47.93463	12.55234	Sand bunkers, golf course
II4b	47.83258	12.30550	Bomb craters
II4c	47.93463	12.55234	Sand bunkers, golf course (same as II1b)

This change corresponds to the documented expansion of the golf course according to the 2006 development plan.

Similarly, the feature at **I3k** (Figure 5) was verified during the field survey as a sand-filled golf bunker. It first becomes visible in aerial imagery after 2006, whereas earlier imagery shows cultivated farmland at this location. Likewise, the kidney-shaped feature at **I3m** (Figure 5) is absent from aerial photographs prior to 2006 and first appears in later imagery as a small artificial pond integrated into the golf course layout. The appearance of both features is consistent with the expansion and landscaping of the golf course.

CIRT image **I4e** (Figure 5) provides an overview of a larger section of the older part of the golf course, which was developed after 1986. Within this area, the artificial pond depicted in CIRT image **I3i** described above is visible in the right upper part of the image as part of the designated golf course landscape. The slightly elevated flat ellipsoid areas visible in **I4e** correspond well with the structures indicated in the development plan and could be identified in the field as tee areas. The irregularly shaped, circular to amoeboid depressions shown in this image could be identified in the field as sand bunkers as part of the golf course.

A larger part of the golf course built after 2006 is shown in CIRT image **I4d** (Figure 5). In the upper part of the image, one can see the outlines of the structures that are also shown in CIRT images **I3m**, **I3j**, and **I3k** and



FIGURE 6. The sand bunker (upper image, view toward SW; approximately 10 m of the 20 × 10 m structure are visible) which represents the structure illustrated in CIRT image **I3j** and an artificial pond (lower image, view toward SW; approximately 80 m along its largest diameter) which represents the structure illustrated in image CIRT **I3m**. Both are part of the golf course (sixth hole) near Chieming, not cosmic impact craters as claimed by Ernstson and Poßekel (2025) and West and Ernstson (2026).

have already been described in detail. In addition, several irregularly shaped depressions are visible in the right and lower parts of the image, all of which correspond to sand bunkers. Several distinct, flat, ellipsoidal, slightly elevated areas observed in the lower and right sections of the image were identified during the site visit as tees and greens of the golf course. CIRT images **II1b** and **II4c** (Figure 5) show the same structures, located in the central part of the golf course, south of **I4e**. These three irregularly shaped depressions appear in the field as sand bunkers and were confirmed as such during field visits.

All these structures were developed following the conversion of farmland into a golf course. They did not exist before and are clearly documented in aerial photographs and administrative documents, with their current forms representing actively used golf course features.

DISCUSSION

Our results show no evidence supporting the interpretation of the structures by Ernstson and Poßekel (2025) and West and Ernstson (2026) as impact craters. On the contrary, most of the depressions shown by these authors can be reliably identified and located,

and the majority have clear and convincing non-cosmic explanations.

Characteristic glacial landforms associated with the former Chiemsee Glacier are readily identifiable in the map sections presented by these authors (Figure 3). Ernstson and Poßkel (2025) show numerous hills and depressions in their CIRT image **I4c** localized near Manholding which can best be described as a hummocky moraine landscape. This interpretation is consistent with the geomorphological description by Jerz et al. (2023), who describe the area as part of a broad moraine ridge characterized by numerous hummocks and kettle holes. Similar hummocky moraine landscapes have been described from the Alpine Foreland in relation to Late Pleistocene glacier retreat and dead-ice melting processes (Salcher et al., 2010). Such hummocky moraines are characteristic features of ice-decay landscapes and develop in areas of stagnant glacier ice during deglaciation, where the melting of debris-covered dead ice produces an irregular topography of hummocks and intervening depressions (Evans, 2009).

The lobe-like structures near Eglsee, Hart and Manholding shown in Ernstson and Poßkel (2025) Figure 1 and West and Ernstson (2026) Figures 1 and 2 are undoubtedly part of terminal moraine stages of the Chiemsee Glacier (Huber et al., 2020; Troll, 1924). These features are situated along the same terminal moraine belt and correspond to the same former ice-margin position, which was assigned by Troll (1924) to the “Ebersberger” phase of the Chiemsee Glacier. Their spatial arrangement reflects the lobate geometry of the former glacier front during this stillstand, with individual moraine arcs representing segments of a continuous ice-margin position. Such arcuate moraine patterns are characteristic of piedmont-style glaciers in the Alpine Foreland, where variations in ice flow, topographic confinement and sediment supply controlled the configuration of the glacier margin and the resulting morphology of terminal moraine ridges (e.g., Troll, 1924; Benn & Evans, 2010; Evans, 2009). Unlike impact craters, which represent point-source landforms related to an individual impact event, terminal moraines are line-source landforms recording successive positions of a retreating glacier margin. Their geometry therefore reflects the configuration of the ice front rather than circular excavation around a central point.

More than half of the images presented by Ernstson and Poßkel (2025) and West and Ernstson (2026), we could localize depict anthropogenic features, not impact structures. Their man-made origin is unambiguous, as the period of construction can be documented with precision to within a few years using aerial photographs. For some of the structures interpreted as impact craters by these authors, it was even possible to identify development

plans that clearly prove the date of construction and the planning context.

The anthropogenic structures identified in this study can be assigned to two principal categories according to their mode of formation: excavation-related landforms and engineered landscape architecture. Excavation-related features include both extraction-related depressions and purpose-built excavations, whereas engineered landscape structures represent larger scale modifications of the terrain.

Excavation-related landforms identified here exhibit distinct diagnostic features, including sharp boundaries, artificial slopes, access features, and geometries controlled by the purpose of the excavation. A representative example of a purpose-built excavation is the structure identified in CIRT image **I3b**. It represents a small engineered water-management structure that can clearly be interpreted as an artificial rainwater retention basin, as documented in the 1993 development plan mentioned above (Gemeinde Chieming, 1993). Its regular morphology, sharp boundaries, and engineered embankments and spiral-like terraced internal configuration (Figure 2) are consistent with a man-made water management structure rather than a natural depression. Historical aerial imagery confirms its construction and subsequent use as a rainwater retention basin as part of the local water management infrastructure.

A different type of excavation-related feature is represented by gravel extraction sites. Modern, larger gravel pits display rather regular, angular boundaries, terraced excavation faces, and engineered slopes (Dávid, 2010) reflecting operational planning, property boundaries, and regulatory constraints (Ringler et al., 1995; **I3c**, **I3h**, **I4a**; Figure 2), whereas smaller historical extraction sites (**I3i**) may show more irregular morphologies resulting from progressive excavation, local accessibility, and the limitations of available technology. Both types observed are further characterized by the presence of access roads or tracks. Although abandoned gravel pits have been backfilled and reclaimed such as the one depicted in CIRT image **I3c**, their excavation origin usually remains recognizable from those subtle morphological features, particularly when interpreted in their geomorphological context (Valjavec, 2014). These smaller gravel extraction sites were typically small-scale rural workings, exploited only intermittently by farmers for local construction needs. They are characterized by shallow, concave cuts into hillsides (Ringler et al., 1995), which is consistent with the observed features of the structure shown in CIRT image **I3i**. Historical aerial imagery documents the progressive development (Figure 4) of the observed gravel extraction sites shown in CIRT images **I3c**, **I3h**, and **I4a** over several decades, from the onset of excavation through periods of active extraction to their eventual abandonment and

reclamation, leaving no doubt as to the anthropogenic origin and function of these structures.

Beyond this chronological evidence, these examples demonstrate that anthropogenic features can often be identified from geomorphological characteristics reflecting the technological, geological, and economic conditions of their formation. The location of extraction sites is commonly controlled by the availability of suited geological materials, accessibility, local topographic conditions, and transport-related economic considerations (Dávid, 2010). Consequently, their morphology records not only the extraction methods applied but also the constraints influencing where and how excavation took place.

Gravel mining has long been an important economic activity in the Chiemgau region, where sand and gravel represent the most important mineral resources (Ganss, 1977; Jerz et al. 2023). During the second half of the twentieth century, extraction shifted from numerous small, farm-operated pits to large-scale commercial operations. Ebers (1966) described this transition as an “open-pit catastrophe,” noting that many of the abandoned small gravel pits were subsequently used as landfill sites. Consequently, the Chiemgau landscape contains numerous abandoned gravel pits and related anthropogenic landforms, which should be considered in any geomorphological interpretation of the region. Their widespread occurrence highlights the necessity of considering anthropogenic landforms as a fundamental component of the regional geomorphological context before invoking uncommon cosmic explanations.

The most surprising finding was that a large number of the depressions described as impact craters are not natural morphological features but recently constructed elements of engineered landscape design associated with golf course construction. Golf course infrastructures exhibit characteristic features allowing them to be distinguished from natural landforms such as impact craters. Although golf courses intentionally incorporate depressions, ponds, and sand bunkers, these elements occur within a carefully planned landscape.

They are intentionally shaped to be clearly distinguishable from their surroundings, allowing players navigating the course according to the rules of the game Graves and Cornish (1998).

Modern golf course design follows principles of harmony, proportion, and balance, resulting in characteristic curvilinear forms, smooth transitions, and coherent spatial arrangements. Features such as greens and sand bunkers are therefore intentionally shaped and positioned to create aesthetic, geometrically coherent elements while remaining functionally integrated into the course layout Graves and Cornish (1998). Such combinations of regular geometry, spatial organization,

and functional design are not consistent with patterns generated by natural landscape-forming processes.

This anthropogenic signature becomes particularly evident when photographs are analyzed together with LIDAR terrain models, which reveal the engineered morphology, systematic landscape design, and intensive maintenance that characterize the golf course terrain. Ultimately, field verification provides the most direct means of confirming the anthropogenic origin of these features, as the artificial nature of the landscape becomes immediately apparent during on-site inspection (Figure 6). Combined with publicly available planning documents (Gemeinde Chieming, 1986, 2006), the chronological record provided by historical aerial imagery allows the evolution of the golf course landscape to be reconstructed. The first construction phase, initiated in 1986, and the subsequent northern expansion beginning in 2006 can be directly correlated with the appearance of newly created landscape elements within an area that was previously used exclusively for agriculture. This temporal relationship provides clear evidence for the anthropogenic origin of these depressions and excludes the possibility that they represent preexisting impact structures that were later modified, reused, or incorporated into the golf course design.

It is difficult to understand how and why the authors could misinterpret such a large number of obviously anthropogenic landforms and instead develop a rather bold thesis that they are part of an impact strewn field. Given the extraordinary nature of the claim that southeastern Bavaria is littered with impact craters, extreme care should be taken in its evaluation. At the very least, it is generally considered good practice not to rely solely on remote sensing data when diagnosing impact craters (Koeberl, 2004). Further, Cavosie et al. (2026) presented a set of diagnostic criteria endorsed by the Impact Cratering Committee (ICC) of the Meteoritical Society for the confirmation of impact structures. The studies under discussion neither evaluate any of these proposed diagnostic criteria nor do previously reported evidence to support the Chiemgau Impact, such as allegations of planar deformation features (PDFs), meet modern diagnostic standards (Reimold et al., 2014). In particular, Cavosie et al. (2026) emphasize that rigorous documentation of geological context is essential to demonstrate that the investigated material is not detrital, which is challenging in the glacio-fluvial setting of the Chiemgau region. Accordingly, particularly stringent testing of impact indicators is required, which apparently has not been sufficiently undertaken.

In contrast, however, Ernstson and Poßkel (2025) and West and Ernstson (2026) treat the Chiemgau Impact as established despite limited supporting evidence and without demonstrating compliance with ICC criteria.

Their interpretation relies substantially on high-resolution 3-D LIDAR-derived geomorphological data, while independent validation using readily available aerial imagery and basic cross-checks of the presented concave landforms is not documented.

In particular, the obstacles on the golf course should have been readily recognizable as such at first glance (Figures 5 and 6). Their nature as part of a golf course is unlikely to be mistaken for other interpretations as they are easily accessible and the authors are in fact well connected with local sources. Nevertheless, West and Ernstson (2026) continue to claim that these structures are of extraterrestrial impact origin and even attempt to model impact scenarios for their formation using numerical simulations.

This introduces a stark methodological paradox: invoking numerical modeling to explain ordinary golf course features. In impact physics, numerical simulations are meant to constrain verified events, not to invent “cosmic” origins for anthropogenic landforms (Boslough et al., 2026). Simulating the precise physics of an explosion without any evidence that an impact ever took place inverts the scientific method.

So how can we explain why these authors refrained from conducting even a superficial review of the impact thesis?

In recent years, considerable effort has been devoted to promoting the claim that a catastrophic impact event shaped the landscape of southeastern Bavaria during the Celtic period, leaving characteristic features such as lakes and numerous depressions. This interpretation contradicts well-established evidence that the southeastern Bavarian Prealps are of glacial origin (e.g., Darga, 2009a; Ganss, 1977; Knauer, 1935; Troll, 1924).

To date, no evidence presented in support of the proposed Chiemgau Impact has been independently established as diagnostic of a cosmic impact event within the scientific impact-cratering community. In this respect, the Chiemgau case is not unique, but forms part of a broader range of proposed impact structures and impact-related interpretations discussed by Pinter and Ishman (2008) and Holliday et al. (2023).

Nevertheless, the notion that an impact occurred in the Chiemgau has attracted considerable public interest and has also received local political support. For example, a regional support association (Chiemgau Impakt e.V.), a museum in the village Grabenstädt, and an educational trail at Lake Tüttensee actively promote the impact interpretation. This broader context may also encourage the continued dissemination of interpretations based on limited or insufficiently substantiated evidence.

The explanation aligns closely with the institutional and psychological drivers identified by Boslough et al. (2026). When a controversial scientific concept

becomes a self-perpetuating narrative—tied to local tourism, museums, and private funding—the primary motivation shifts from rigorous falsification to the preservation of that narrative. This may also explain the authors’ systematic rejection of the presence of a Quaternary piedmont glacier (see Ernstson & Poßkel, 2025) in the region, a position that preserves the proposed narrative in the context of well-established glacial evidence and may result in reduced consideration of the role of detrital material.

Overall, the attempt to interpret roundish anthropogenic structures as impact craters solely on the basis of their morphology follows a pattern of earlier misinterpretations, in which, for example, human-made materials such as coal, slag, or fertilizer by-products were incorrectly attributed to impact processes (e.g., Endlicher, 2025; Fehr et al., 2004; Smith et al., 2019). This systematic neglect of potential anthropogenic origins does not increase the plausibility of an impact event in the Chiemgau event; rather, it undermines its scientific credibility.

CONCLUSIONS

Our analysis of depressions in southeastern Bavaria, which were interpreted as being of impact origin in recent publications, shows that the majority of the proposed “impact craters” are, in fact, clearly identifiable anthropogenic structures, including gravel pits, bomb craters, water retention basins, and numerous golf course features, with origins documented in historical maps, development plans, and aerial imagery. None of the examined features provide credible evidence for an impact origin, and many can be traced to specific construction phases within the last few decades. These findings are consistent with the existing evidence base, in which the proposed Chiemgau Impact has not been supported by independently verified impact evidence. The persistence of the impact-crater interpretation despite readily available contradictory evidence highlights the importance of applying systematic verification methods to exclude anthropogenic origins—such as cross-checking with historical and cartographic sources—before advancing extraordinary geological claims.

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