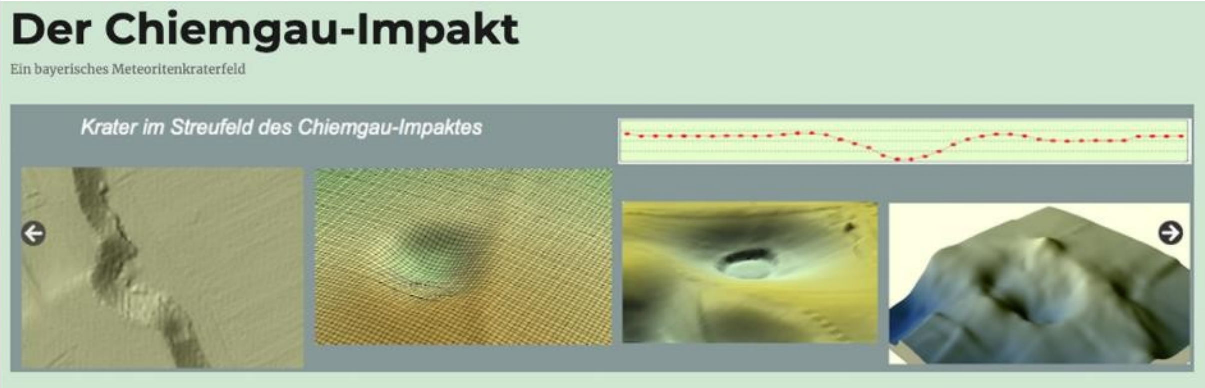

The Dead Ice Basin Hiking Trail from Haag i.Obb. and the Digital Terrain Model DTM 1: The ice age dead ice holes turn out to belong to a meteorite crater impact scatter field

by Kord Ernstson and Jens Poßekel

August 2025

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by Kord Ernstson[1] and Jens Poßekel[2]

Summary. - The market town of Haag in Upper Bavaria has a geological feature consisting of a roughly 1-2 km^2 measuring accumulation of depressions measuring a few decameters, which are relics of the last ice age known as dead ice holes. Fourteen of these have been made accessible with a circular hiking trail, the Toteiskessel-Wanderweg, which provides detailed and appealing scientific explanations. The hypothesis of the formation of dead ice formations in the Alpine foothills, mostly in the form of rounded depressions, is textbook knowledge of ice age geology and geomorphology, but it remains controversial, with the questionable argument that to date there is apparently not a single geological finding proving that any of the alleged dead ice formations in the Alpine foothills can actually be traced back to such a genesis. Over the last 20 years, this topic has been hotly debated in connection with the discovery of a large meteorite crater field, the Chiemgau impact, whereby all of the dead ice arguments put forward by ice age geologists have ultimately been proven *absurd* in light of the more than 100 crater structures that have now been found. This is the starting point for this article, in which we use the innovative, extremely high-resolution Digital Terrain Model DGM 1 to show that the Hague dead ice basins are in fact also meteorite impact structures. Pronounced ring walls, some central hills, and significant morphological symmetries of the depressions down to the decimeter and centimeter range definitively rule out dead ice genesis. The Haag-Joppenpoint geotope, designated as a moraine landscape by the Bavarian State Office for the Environment (LfU), also proves to be dominated by impact. A probable connection with the Chiemgau impact scatter field located not far to the south is being discussed. The northern extension of the Inn Glacier, which is determined, among other things, by the dead ice holes near Haag, must also be discussed. Other areas in the region where the LfU has designated several geotopes as ice age relics, dead ice basins, and ice decay landscapes must also be reinterpreted as belonging to the impact event according to DGM 1 analyses. As with the Chiemgau impact, all findings indicate that this event was a so-called "low-altitude touchdown airburst" of a comet or very loosely bound asteroid. An immediate local and temporal connection with the Chiemgau impact, which is dated to 900-600 BC, is obvious.

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[1]Faculty of Philosophy I, University of 97074 Würzburg, (kernstson@ernstson.de); [2] Geophysics Poßekel Mülheim (possekeljens@gmail.com);

Contents

1 Introduction

The background for the Haag Dead Ice Basin Trail, the only one of its kind in Germany (Figs. 1, 2), is the landscape between Haag and Wasserburg, which is generally believed to have been formed during the last ice age (Würm glaciation) approximately 20,000 years ago. At that time, the ice masses of the Inn Glacier extended from the Alps to the Haag and Gars area, bringing with them large quantities of stones, gravel, and sand. As the climate warmed, the melting ice masses left behind a varied landscape with the so-called dead ice kettles and lakes discussed here, a geological feature unique to the region. The connection to the Ice Age was already highlighted over 100 years ago with the establishment of the Haag Glacier Garden and has recently been documented by the Dead Ice Basin Trail east of Haag, which is also promoted for tourism.

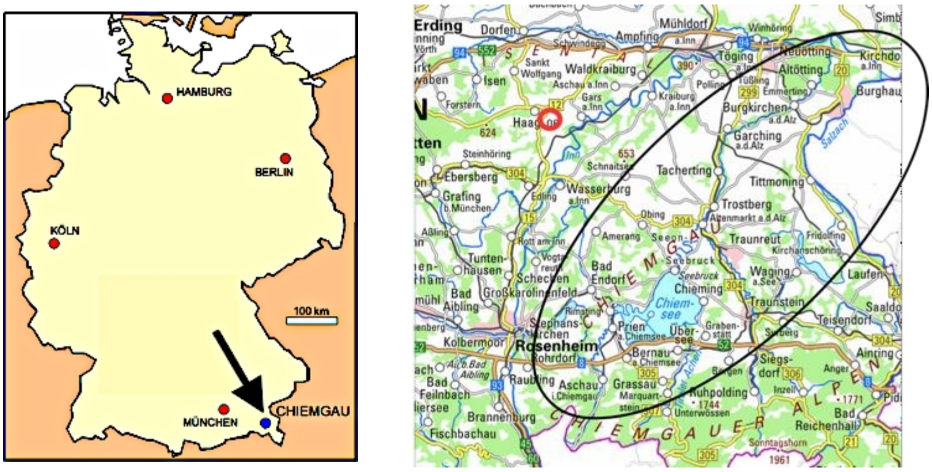


Fig. 1. Site plan for the Chiemgau impact in southeastern Bavaria and the location of the Haag impact scatter field (red circle) discussed here, northwest of the scatter ellipse of the Chiemgau impact.

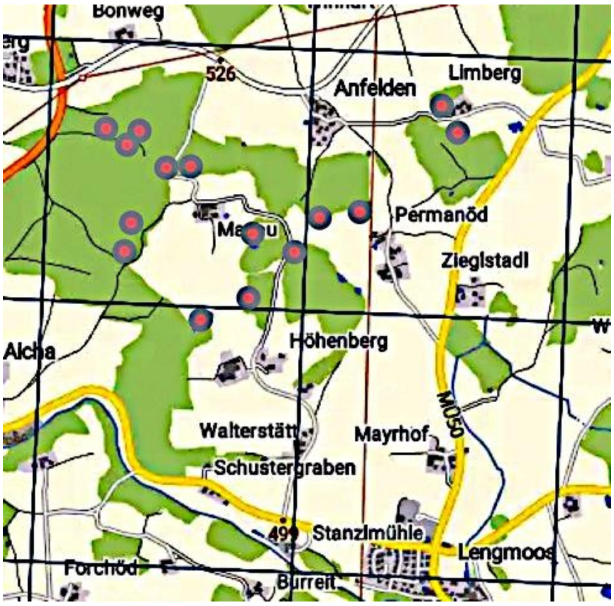


Fig. 2. The location of the depressions accessible by hiking trail and considered to be dead ice basins. Transferred to the four tiles of DGM 1 of the Bavarian Surveying Administration.

As the map in Fig. 1 shows, the region of Wasserburg, Haag, Gars and the district of Mühldorf am Inn is relatively close and almost northwest of what is now considered the world's most important Holocene meteorite crater scatter field of the Chiemgau impact (www.chiemgau-impakt.de, www.chiemgau-impact.com, https://museum.chiemgau-impakt.de). While at the beginning of research into the Chiemgau impact around 20 years ago, the initial discoverers from local history and amateur archaeology had carefully described and documented around 80 impact craters, the number has recently increased to an estimated several hundred thanks to the free release of data from the DGM 1 digital terrain model for the whole of Bavaria. The original size of the impact ellipse, roughly 60 km x 30 km, has not remained unchanged, but has shifted the focus and search in all directions around

around the ellipse, which ultimately led to a focus on the district of Mühldorf and the Haag ice age landscape.

The hypothesis of dead ice basins, dead ice holes. Dead ice troughs

Model and reality: The model of dead ice genesis (Fig. 3) for the Bavarian pre-Alpine lakes is an "invention" of geographers at the turn of the 19th/20th century. Since then, this model has been passed down from generation to generation of geographers and geologists in the truest sense of the word, without this hypothesis ever having been proven by field studies. There is no geological or other geoscientific evidence for such an origin for any of the so-called dead ice holes/basins in the Alpine foothills today (Martin 2014). A typical example of a probable misinterpretation is the Wolfsgrube dead ice hole near Dachau/Fürstenfeldbruck, which is considered by the LfU to be one of Bavaria's most beautiful geotopes, but probably has a completely different origin. More critical ice age researchers (e.g., Martin 2014) question the unique characteristics of dead ice holes anyway and can cite a whole range of other possible origins.

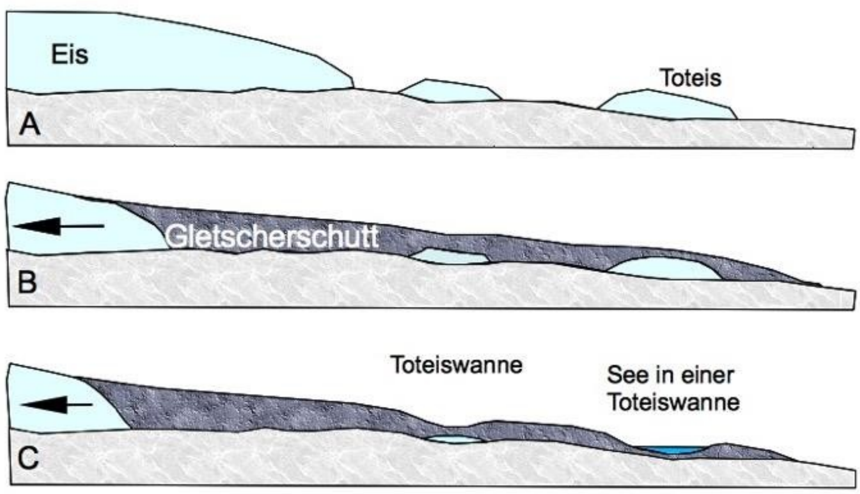


Fig. 3. Model of the formation of dead ice holes. (A) Individual isolated ice blocks ("dead ice") remain behind when the glacier retreats. (B) They are covered with rock debris by flowing rivers and thus protected from heat and solar radiation. (C) After the blocks melt slowly, hollow shapes are created, known as dead ice holes, dead ice basins, or dead ice troughs. If the dead ice troughs extend down to the groundwater and are lined with sealing layers at the bottom, lakes can form.

However, in the case of the Tüttensee crater of the Chiemgau impact, it is no longer possible to speak of an error on the part of local and regional geologists, after the geologists from the LfU ignored all the geological, geophysical, mineralogical, geochemical, and strictly impact-specific evidence presented in recent years for a meteorite crater (Ernstson et al. 2010, Rappenglück et al. 2017 and extensive citations therein; Ernstson & Poßekel 2025), they have also crowned Tüttensee as a

Bavarian Ice Age dead ice geotope, thereby making themselves look rather ridiculous (CIRT 2019).

In the case of the Haager Toteiskesselweg and the LfU's dead ice geotopes in the district of Mühldorf, the historical perspective is somewhat different. For over 100 years and to this day, the "invention" of geographers at the turn of the last century has been treated as established, irrefutable textbook knowledge with extensive literature consisting of images and descriptions of the Ice Age, and an alternative explanation has never been considered.

This is the starting point for this article, in which we show that with the postulated paradigm shift in impact research (Ernstson & Poßekel 2024), when applying the extremely high-resolution Digital Terrain Model DTM 1, the dead ice basin hypothesis for the Alpine foothills must no longer be considered valid by Ice Age geologists and geomorphologists, and that general considerations regarding the advance of the ice during the Würm glaciation are also called for.

2 The digital terrain model DGM 1

The digital terrain model (DTM), which is unknown and rarely used by many engineering and geology firms and government agencies in Germany, with its inexhaustible possibilities in geology, hydrogeology, and engineering geophysics, is presented in this article as another example of a special application in impact research, where it has apparently not yet been noticed by the so-called "impact community." The basis for this is LiDAR data of the Earth's surface in a regular grid down to 1 m with an elevation resolution of up to 10 cm and interpolation down to the decimeter and centimeter range. This allows special features, especially of young meteorite craters, to be precisely revealed that would never be detected in field work and topographic maps. An invaluable feature of the DGM is that it shows the bare earth's surface independently of vegetation, even in dense forests. (X,Y,Z) files are made available for download online by the relevant authorities and can be used with data processing (filtering, gradient formation, etc.) to produce various map representations and terrain profiles. In Bavaria, this service is now free of charge, with coverage and provision of approximately 70,000 tiles measuring 1 km x 1 km with a grid of 1 m x 1 m and a height resolution of approximately 10 cm (DGM 1). The following explanations use precisely this DGM 1. *The source of the DGM 1 data used here is the "Bavarian Surveying Administration – www.geodaten.bayern.de".*

3 Data processing

With the appropriate computer programs, the DGM 1 data can be used to create topographic maps with freely selectable contour line intervals and color scales, 3D block images of the terrain surface with freely selectable orientation and viewing direction in space, maps of the shaded relief (shading), and the freely selectable extraction of elevation profiles. The data itself can be subjected to a wide variety of filtering methods and other mathematical procedures with corresponding graphics.

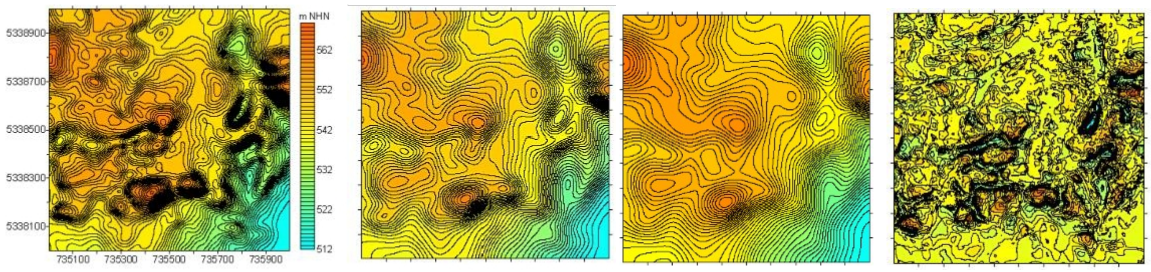


Fig. 4. As an example of data preparation, the DGM 1 tile from Haag-Joppenpoint (see below). Contour line spacing 1 m in all maps. From left: The topographic map, original data - Weak low-pass filtered data (moving average over the area) - The same, slightly deeper, longer wavelength filtering. - Residual field, difference field between original field and trend field. It should be noted that the difference calculation using the moving average reduces the amplitudes of individual structures depending on the wavelength.

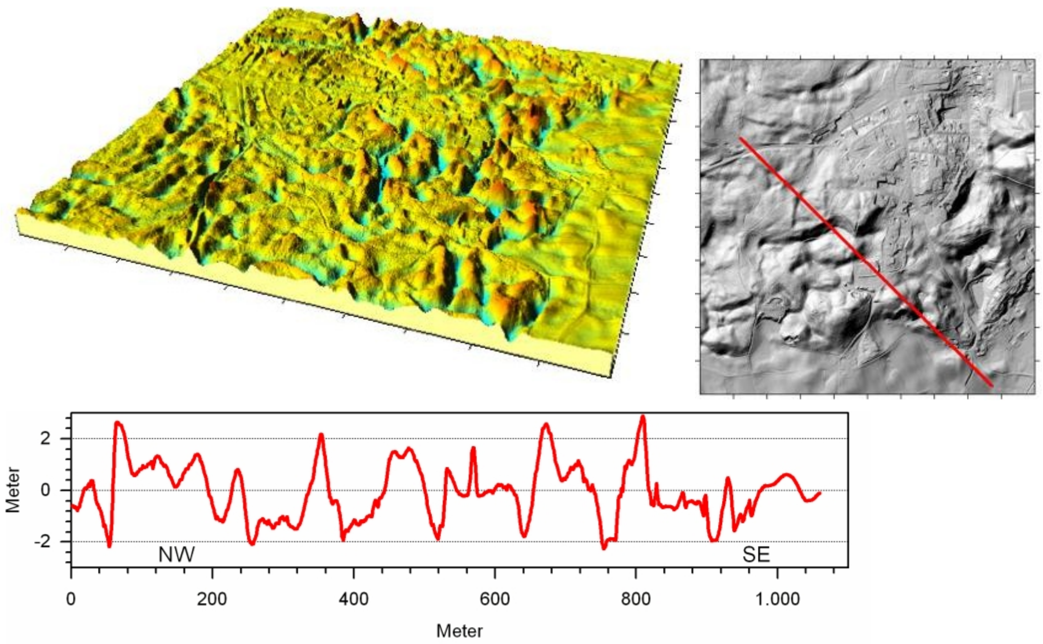


Fig. 5. Other display options for the DGM 1: The Haag-Joppenpoint tile (left) as a 3D map of the terrain surface. Right: The same tile as a shaded relief (shading). Below: The DGM 1 profile along the red line.

4 Results

The investigations conducted by DGM 1 have yielded a wealth of results, and it is important that these are compiled in such a way that the overview is not lost. For this reason, we have decided not to integrate the collection of illustrations into a connecting text. Instead, only the corresponding illustrations are listed one after the other, each accompanied by a caption of varying length.

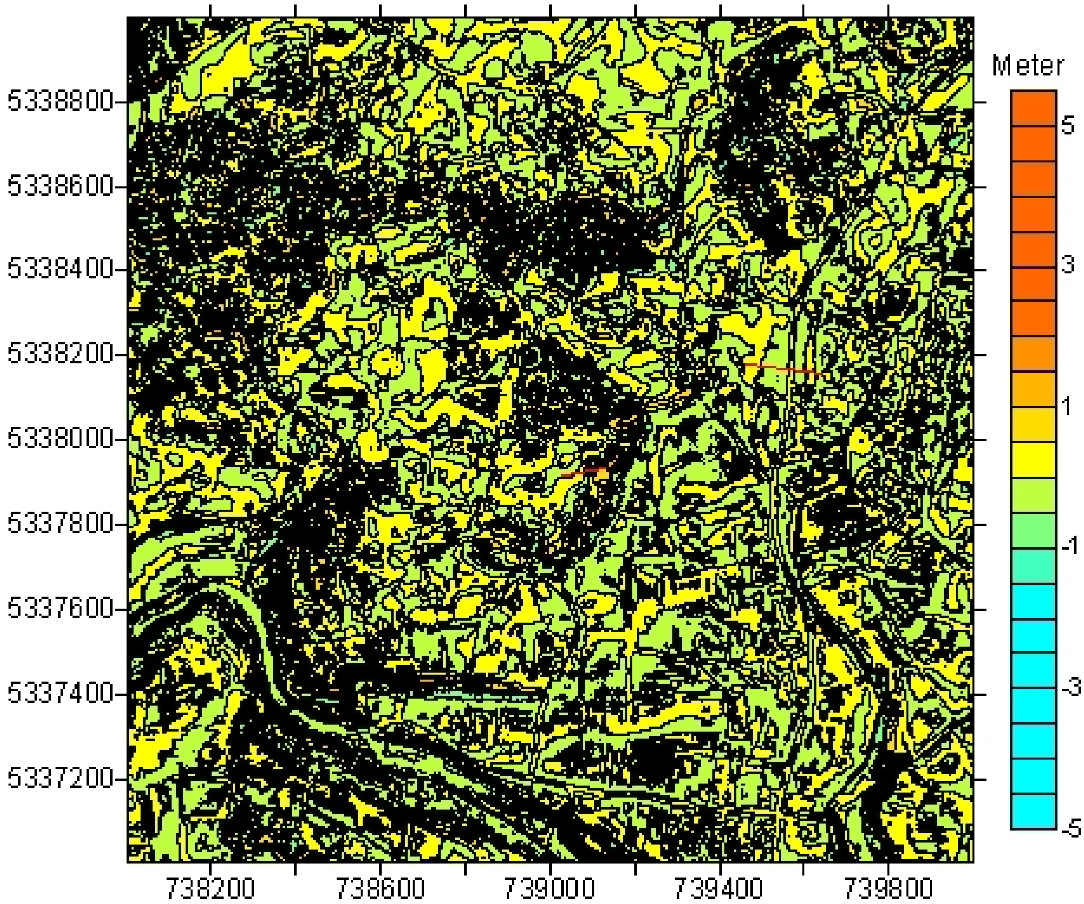
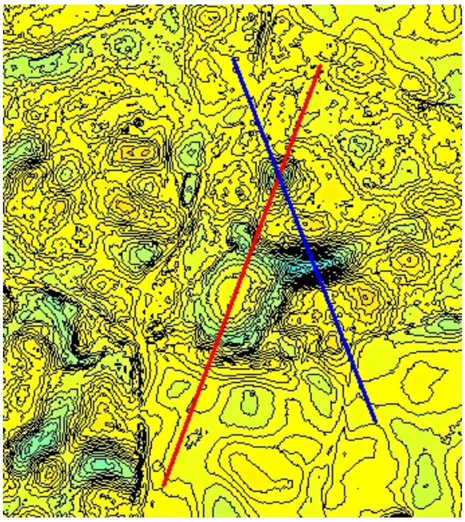
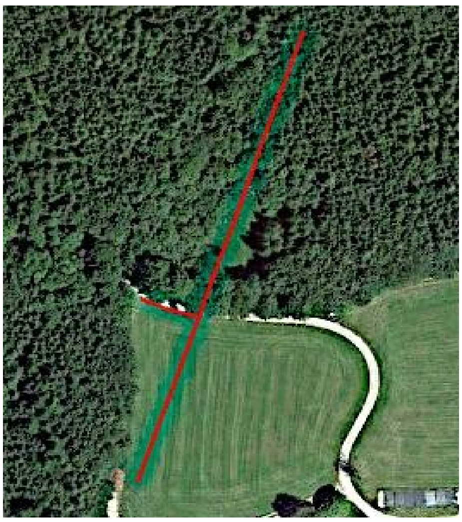


Fig. 6. The DGM 1 topographic map of the four tiles (2 km x 2 km) from Fig. 2. Contour line spacing 50 cm. Remaining field after deduction of the trend field (see Fig. 4).

DGM 1 of the four structures of the hiking trail: 4, 5, 6, and 8

The basin 4





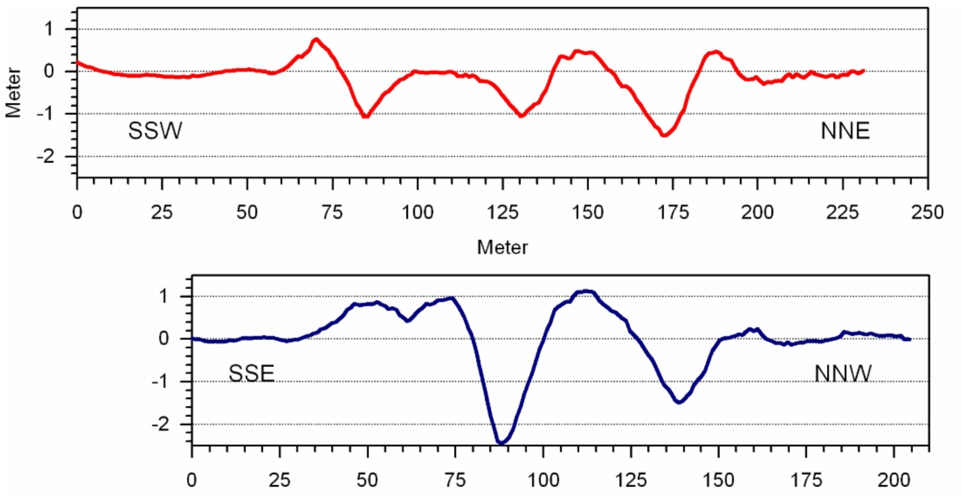


Fig. 7. DGM 1 of basin no. 4 of the hiking trail with topographic map (contour interval 20 cm), Google Earth aerial image, and DGM 1 terrain profiles. Basin no. 4 shows a whole ensemble of round structures extending beyond the southern edge of the forest, where they have lost their original relief due to cultivation. Note the broad central hump between 100 and 125 m at the large circular structure with the ring ditch on the red profile.

Basin 6

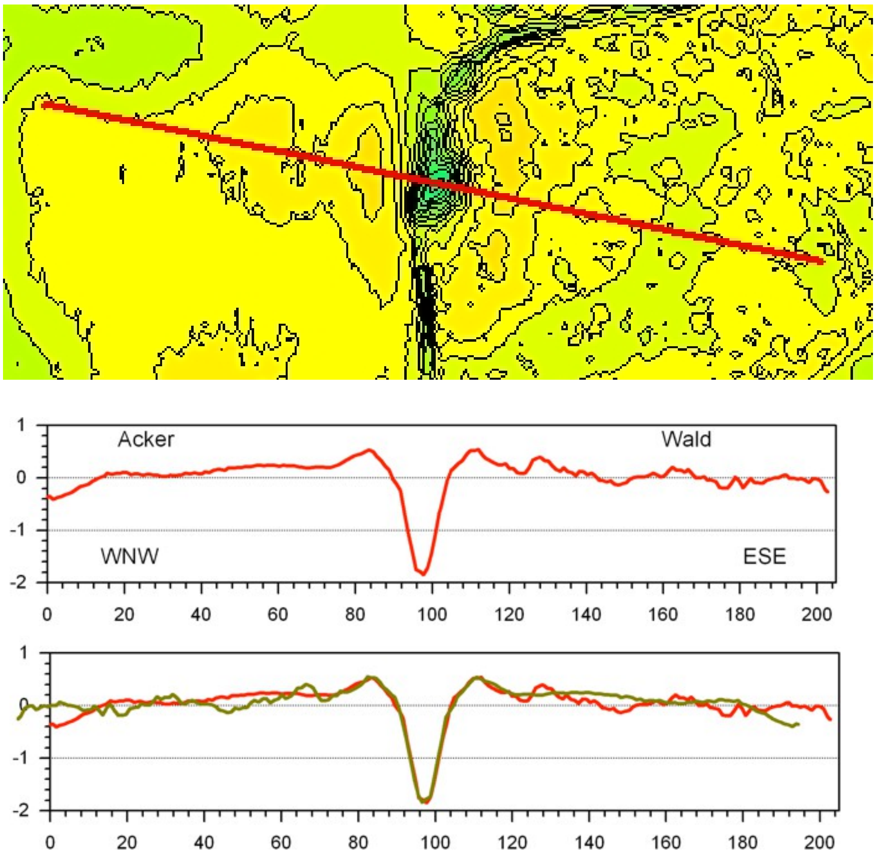


Fig. 8. DGM 1 of No. 6 of the hiking trail with topographic map (contour interval 20 cm) and DGM 1 terrain profile. What will be discussed in more detail later is already impressively evident here with the congruent mirror image of the elevation profile (blue), which conveys a pronounced symmetry of the crater beyond the ring wall. Endogenous geological (dead ice basin) and anthropogenic formations are ruled out.

The basin 8

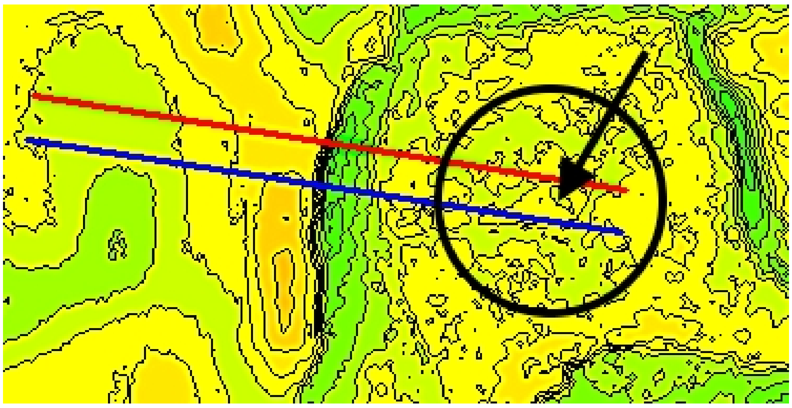


Fig. 9. DGM 1 of No. 8 of the hiking trail with topographic map. Quote from the hiking trail guide: "In the central area (arrow) of the basin (circle), a wet forest has developed, surrounded by a ring ditch."

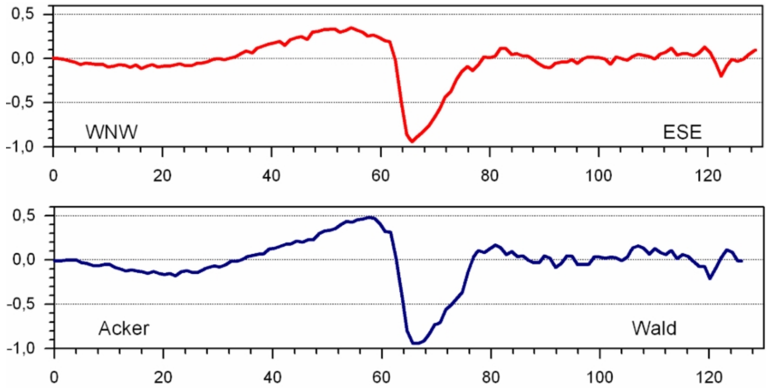
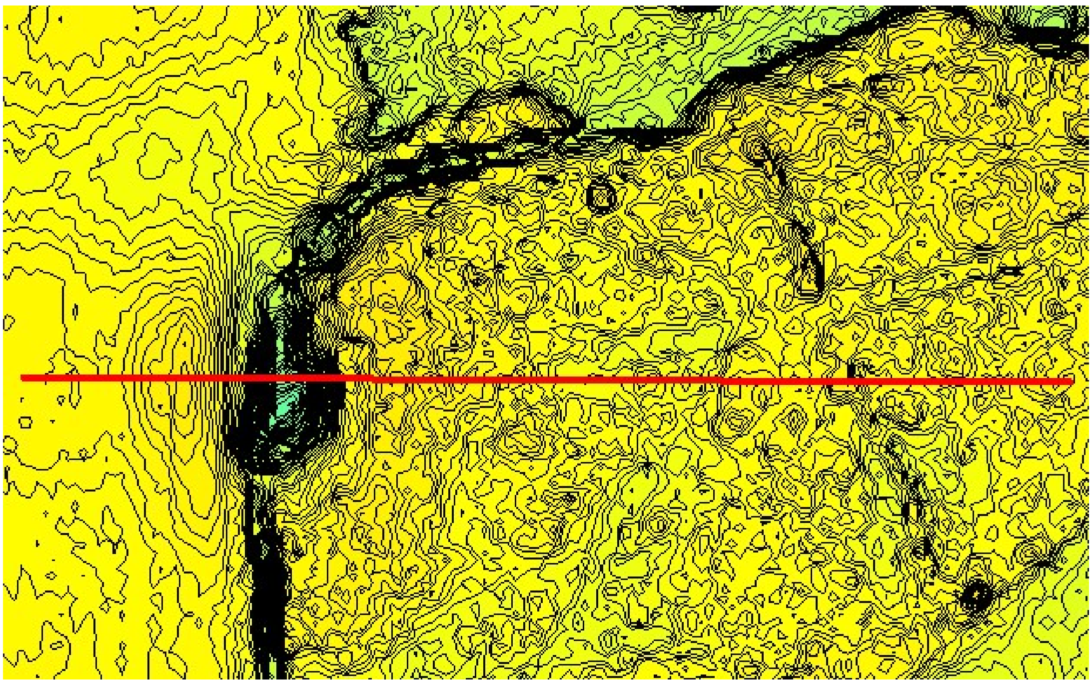


Fig. 9 A. The two DGM 1 profiles show the approximately 20 m wide elongated depression with ridges on both sides at the edge of the forest, which is specified in Fig. 9 B with a further profile. Basin 8 connects to the east, which is shown more clearly in the excerpts in Figs. 9 B-C.



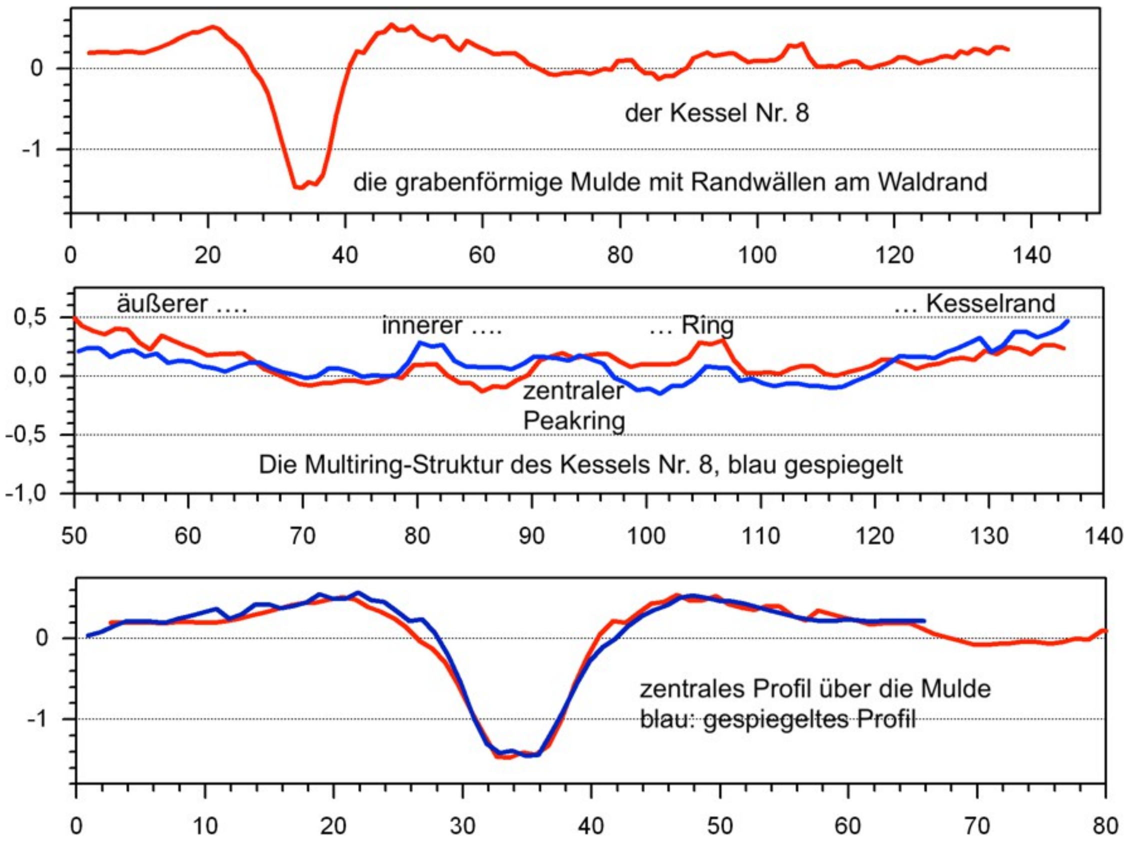


Fig. 9 B. Detail from the map above (Fig. 9) with higher resolution, 5 cm contour interval, and additional profile divided into two separate sections. In both sections, the mirror symmetry is impressive, even incorporating the multi-ring structure of basin No. 8.

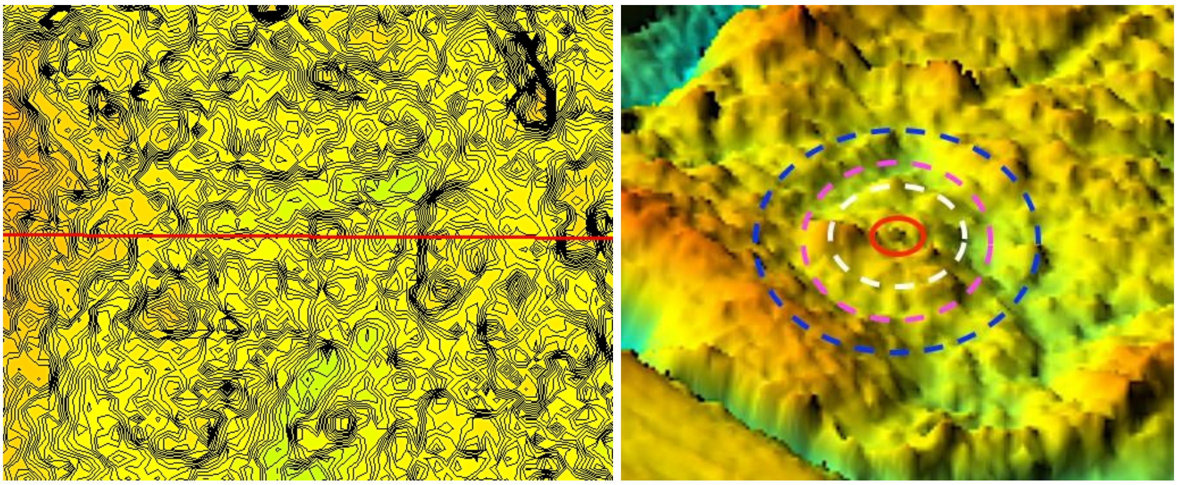


Fig. 9 C. Section of the map with 2.5 cm interpolated contour line spacing and the multi-ring structure as a 3D surface. Boiler No. 8 can hardly be described as a boiler anymore.

Boiler 5

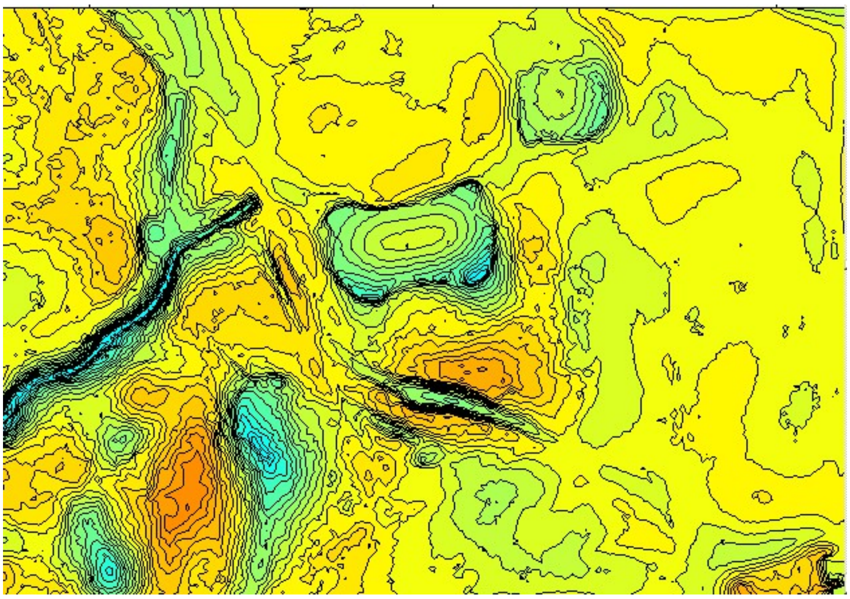


Fig. 10. The heavily artificially overprinted basin No. 5, which will not be analyzed further.

Crater away from the hiking trail

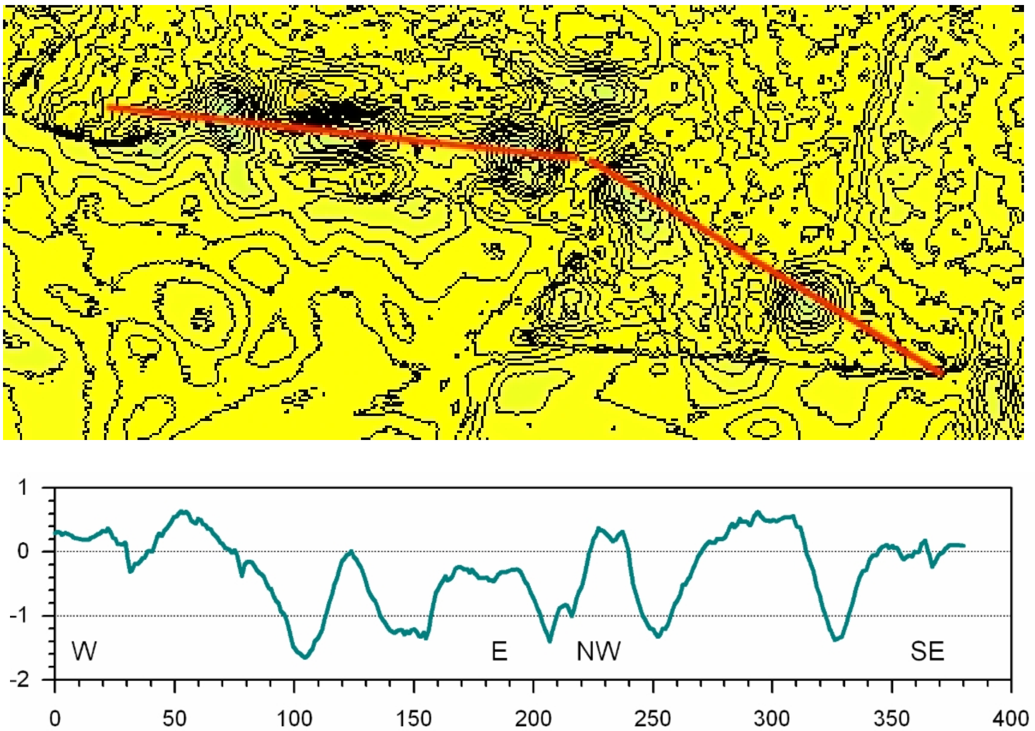


Fig. 11. A chain of five craters measuring roughly 30 m in a row.

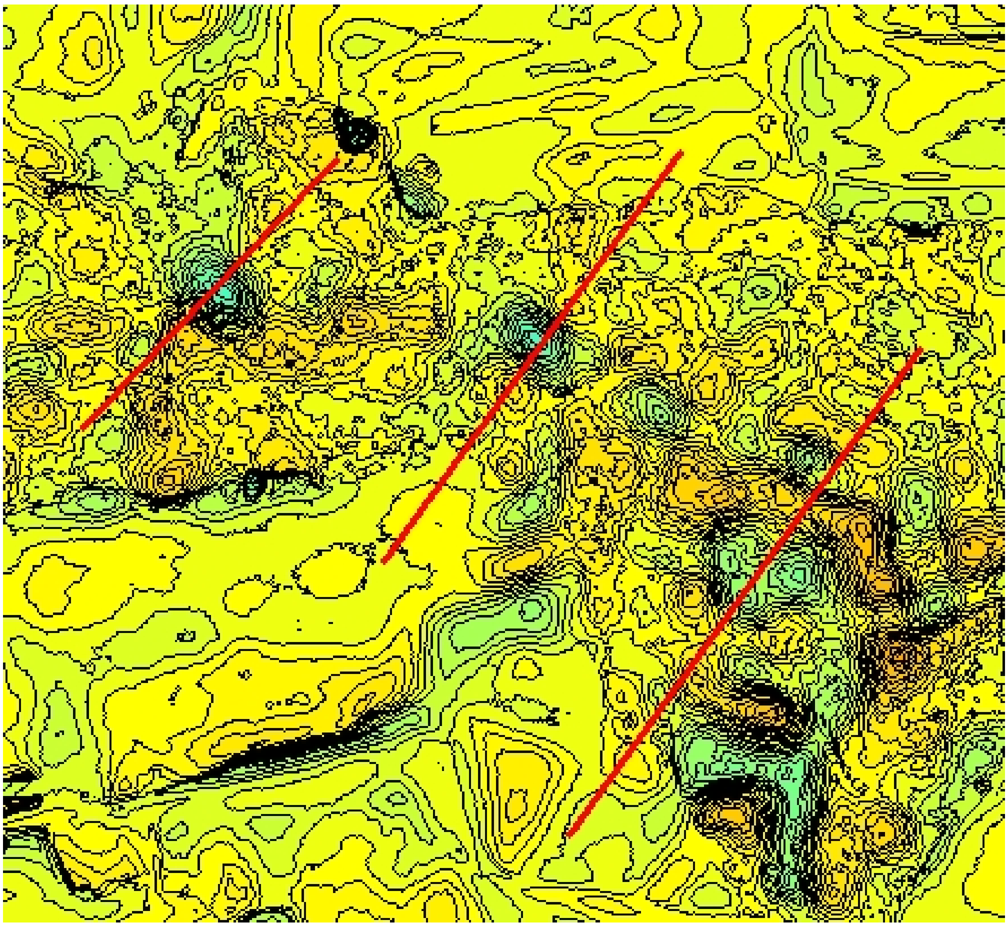


Fig. 12. Ensemble of walled craters with profiles (Fig. 13).

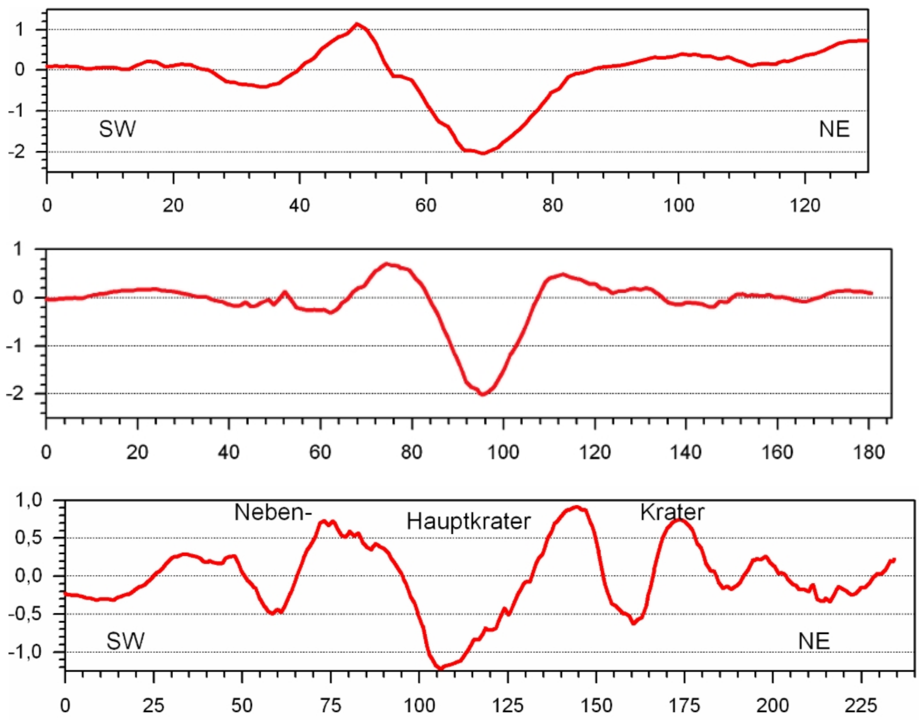


Fig. 13. DGM 1 profiles of the craters from Fig. 12.

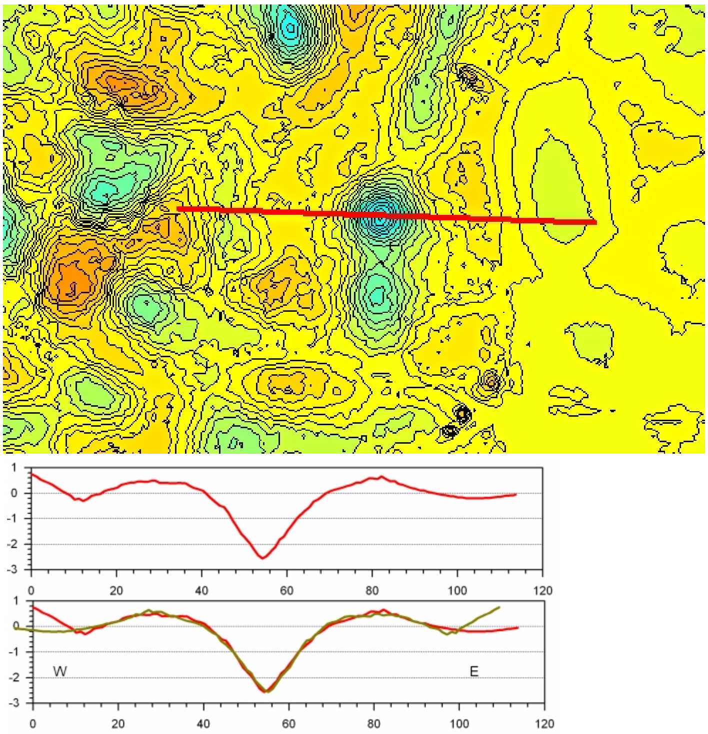


Fig. 14. Crater ensemble with ring walls. The profile of the most significant crater stands out due to its exact mirror symmetry, with a congruence of 15 m to 85 m and differences of no more than 20 cm.

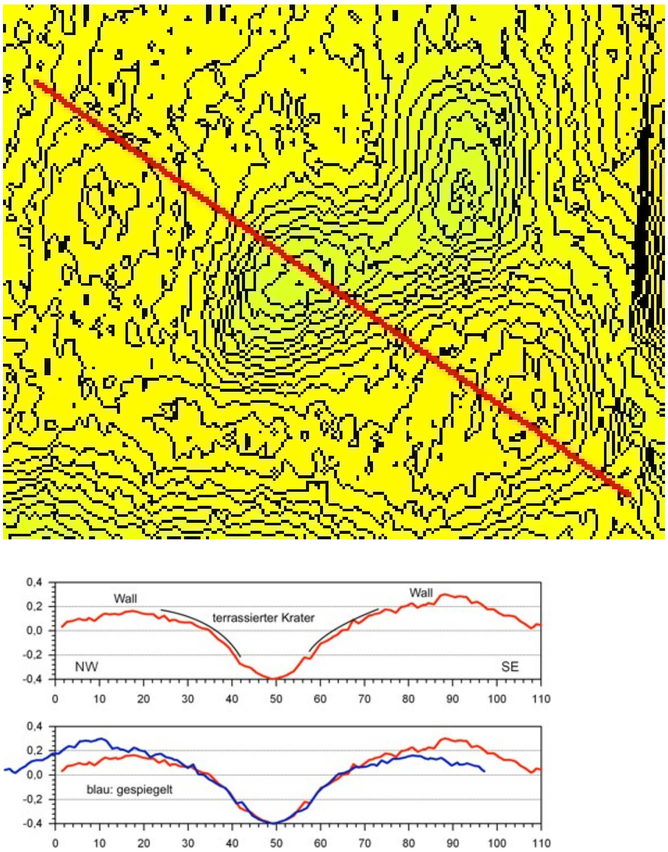


Fig. 15. Very flat, slightly terraced crater with a diameter of 70 m (wall crowns) and a perfect mirror image profile on farmland. It was probably heavily leveled by agricultural cultivation.

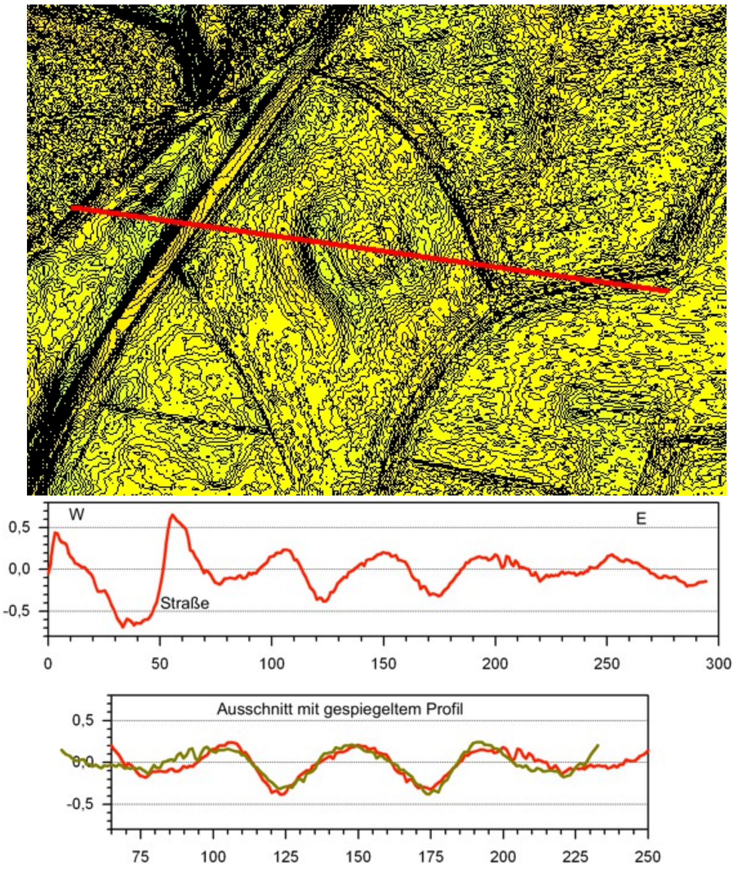


Fig. 16. Walled crater with central bulge

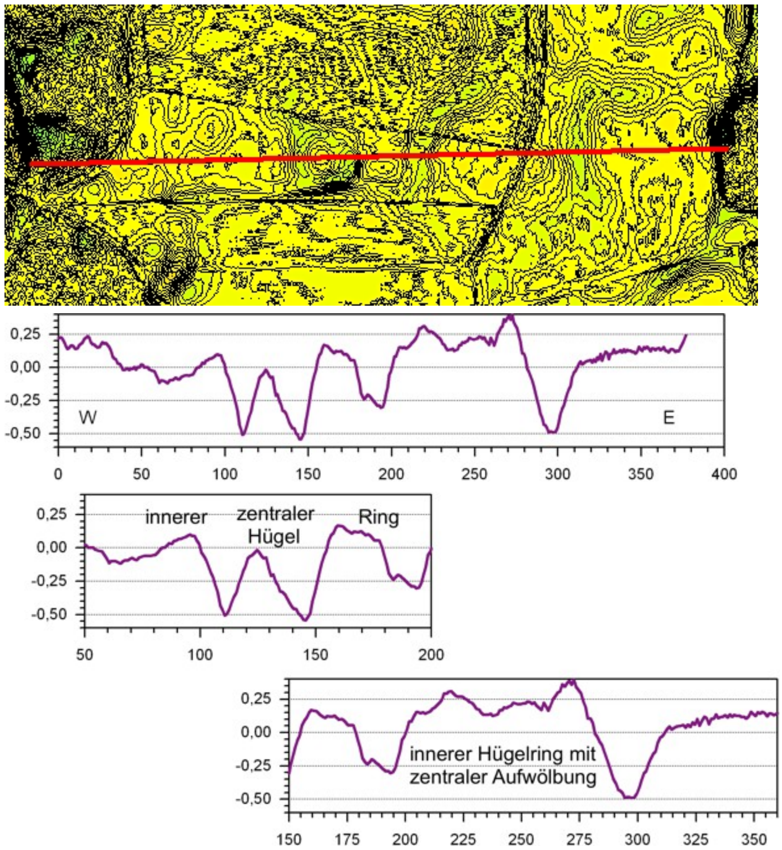


Fig. 17. Two multi-ring structures with central bulges.

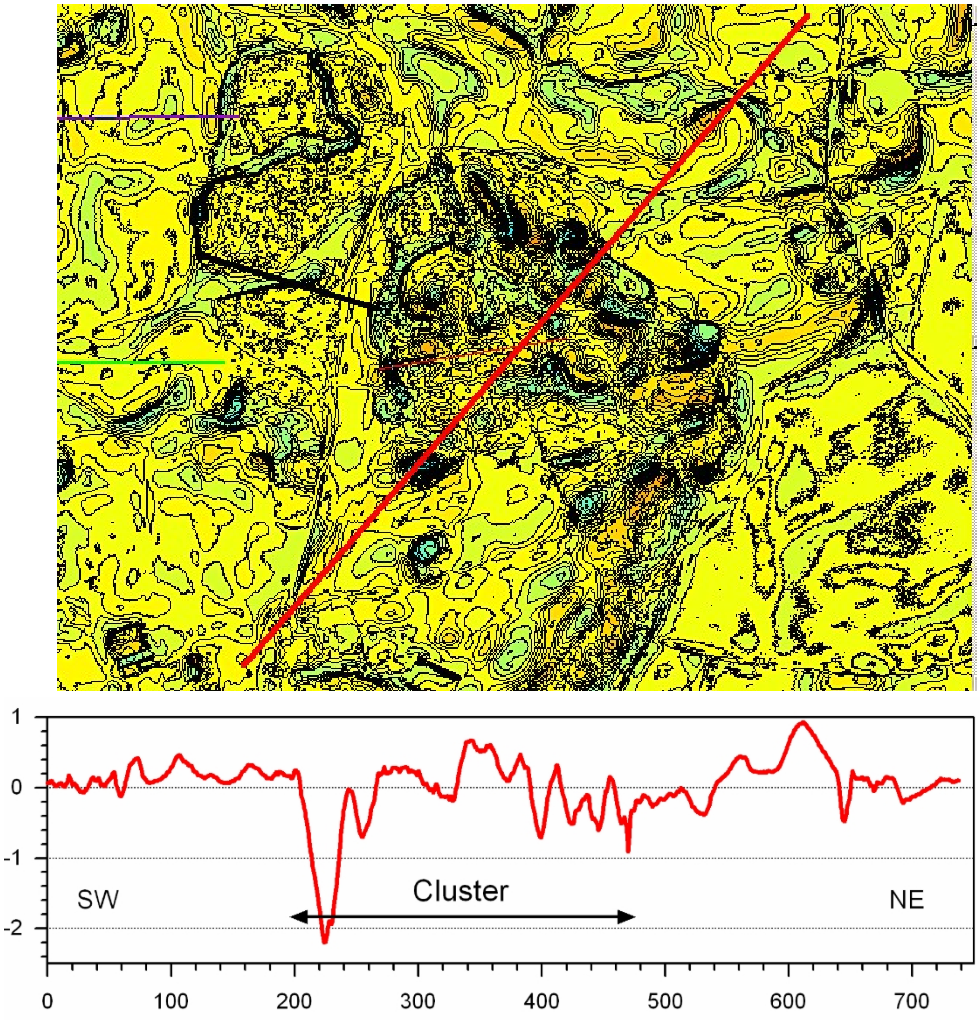


Fig. 18. Cluster of individual craters.

5 LfU geotope Haag-Joppenpoint "Moraine landscape"

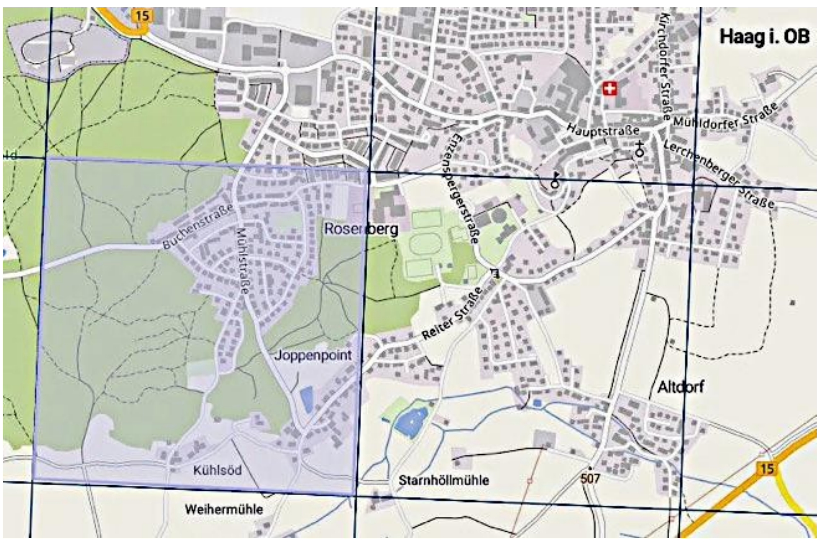


Fig. 19. DGM 1: Tile 1 km x 1 km southwest of Haag.

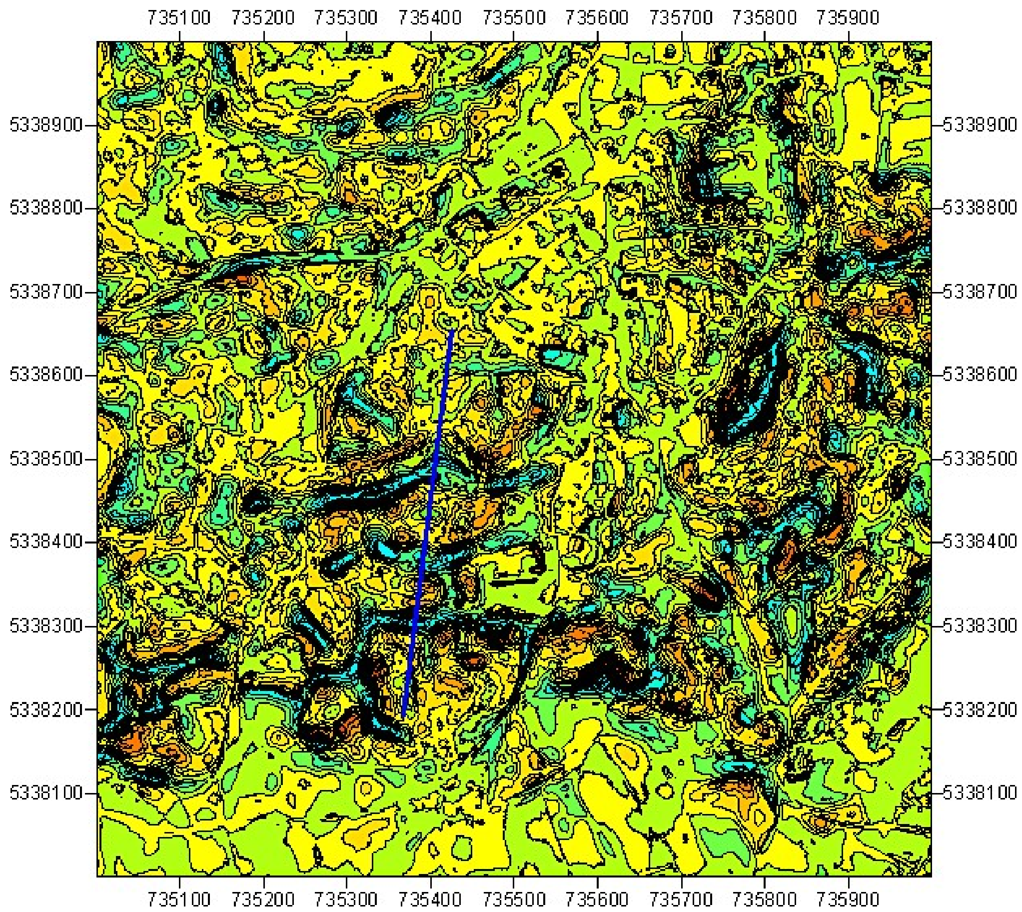


Fig. 20. The DGM 1 tile with a pronounced multiring structure. Profile in Fig. 21.

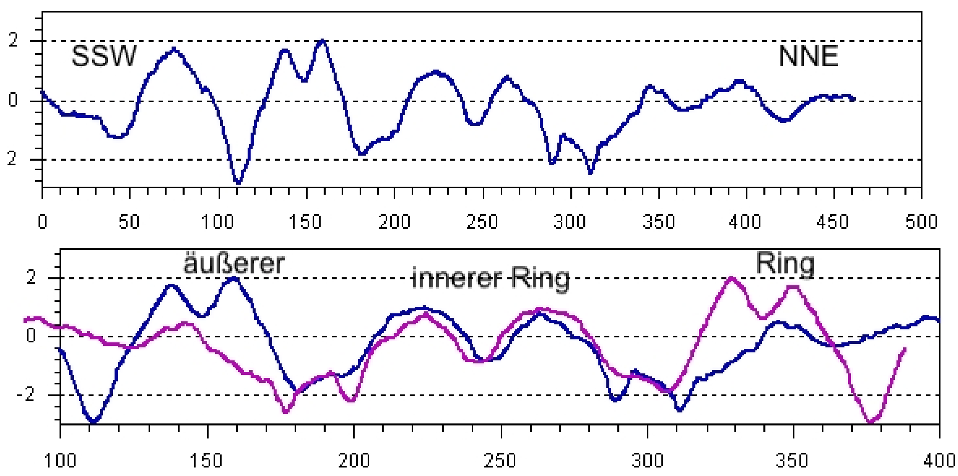


Fig. 21. The DGM 1 profile of the multi-ring structure with the superimposed mirrored profile. The symmetry of the structure is striking.

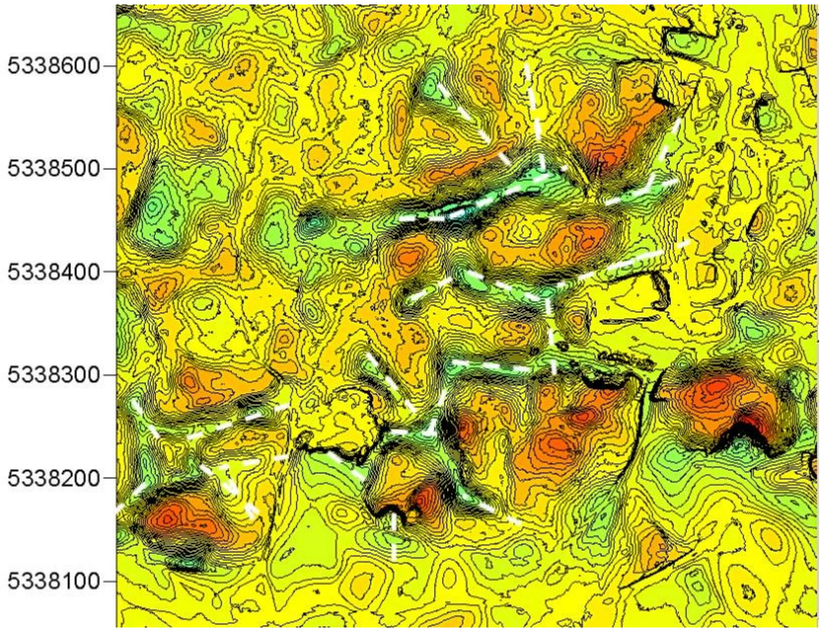


Fig. 22. Detail of the above multi-ring structure emphasizing a radiating, rib-like morphology that is not entirely consistent with the LfU's postulated moraine landscape.

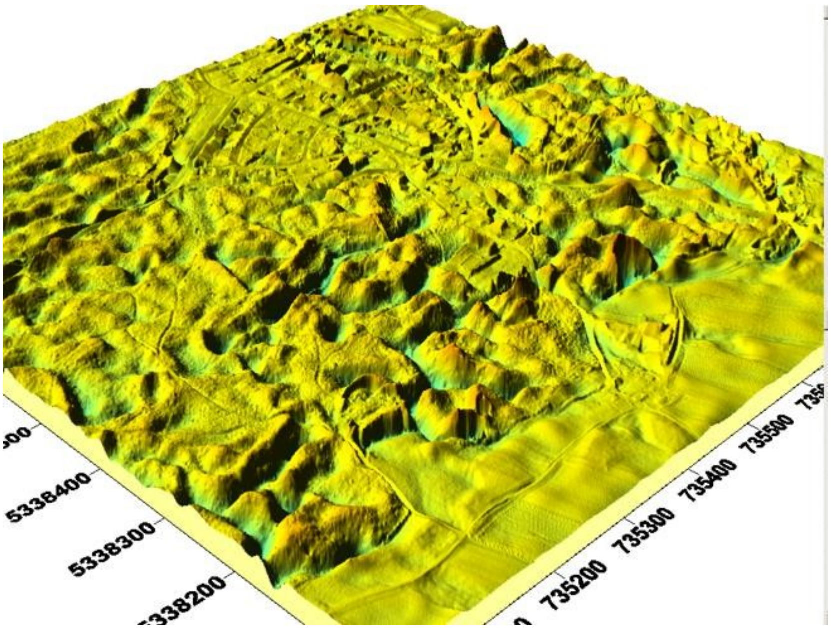


Fig. 23. The Joppenpoint tile as a DGM 1 terrain surface in an oblique view. The abrupt difference in morphology between the northern forest area and the southern arable land with a comparable structural pattern is striking and is likely to be due to long-term leveling by agriculture. Note the strong elevation in the DGM 1 image. An interpretation as a moraine landscape is highly questionable.

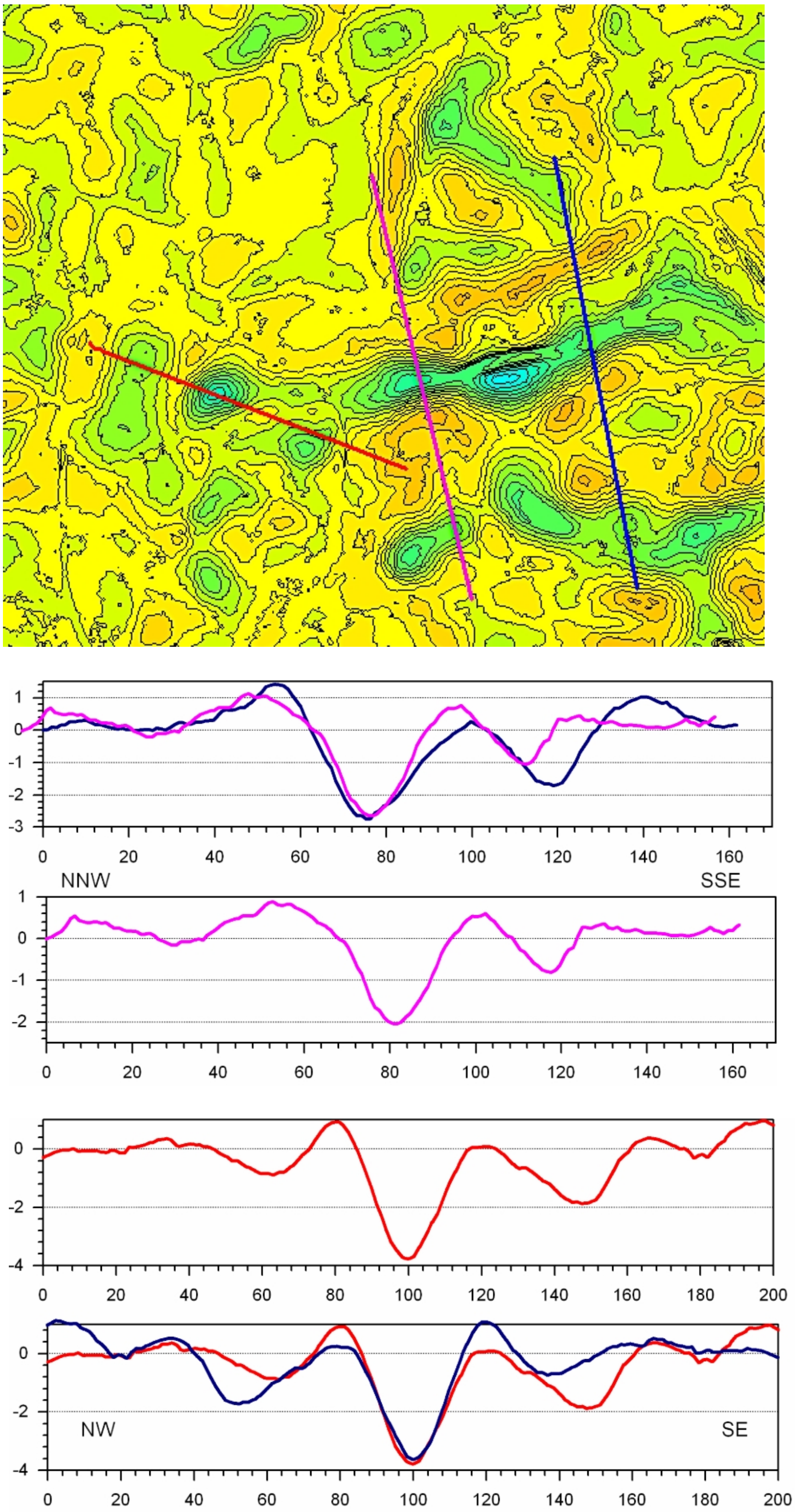


Fig. 24. Wall-accompanied channel structures and craters. Striking similarity in the parallel profiles pink and blue of the two channel structures (top). - Mirror-symmetrical profile through the crater with an unfolding wavy border (bottom)

6 The impact rocks of Mühldorf/Haag

The impact signatures of the impact in the form of craters and other impact structures refuting the dead ice hypothesis are accompanied by impact-marked boulders in the gravel fields, as are already well known further south in the area of the Chiemgau impact scatter ellipse.

Fig. 25. Boulders of carbonate rock that have apparently been completely transformed into monomictic breccia. Fluvial transport from the Alps with possible brecciation there can be ruled out. On the right, for comparison, is an analogous monomictic breccia from the Chiemgau impact.

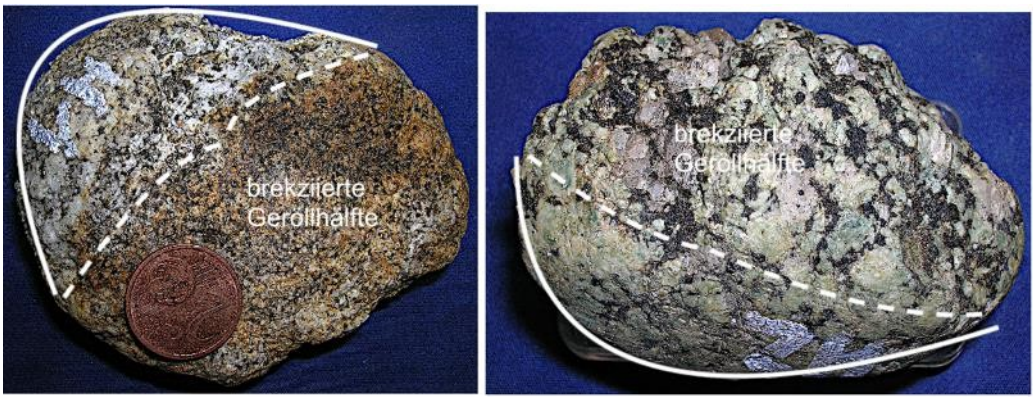


Fig. 26. Boulders with halved brecciation. Fig. 28 provides an interpretation of the enormous stress.

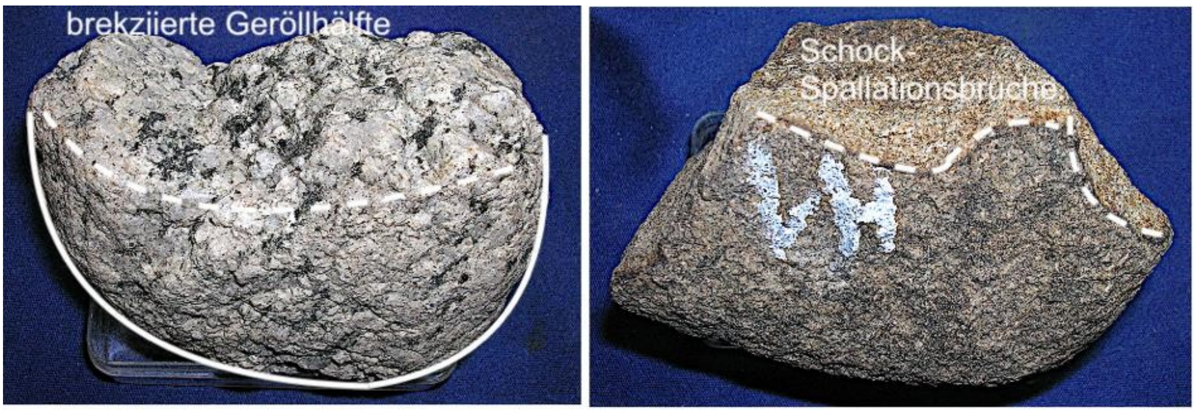


Fig. 27. Brecciated boulder half and spallation fractures; explanation in Fig. 28.

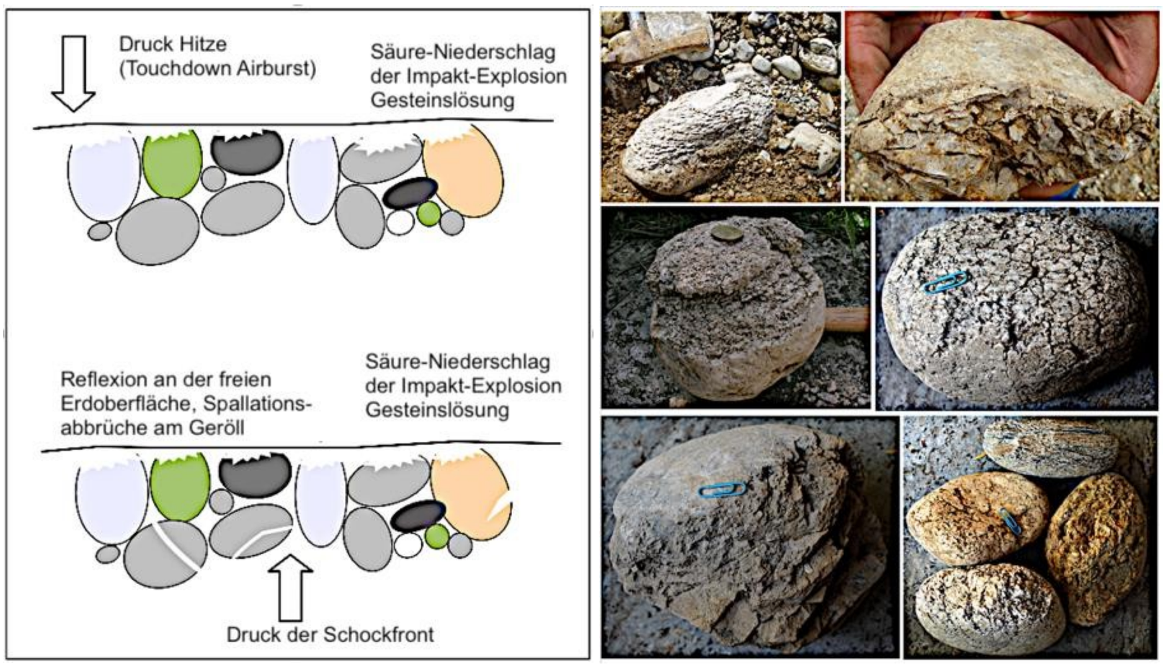


Fig. 28. Chiemgau impact, Vogelöd gravel pit: comparable boulders with half-brecciation and an interpretation by a touchdown airburst.

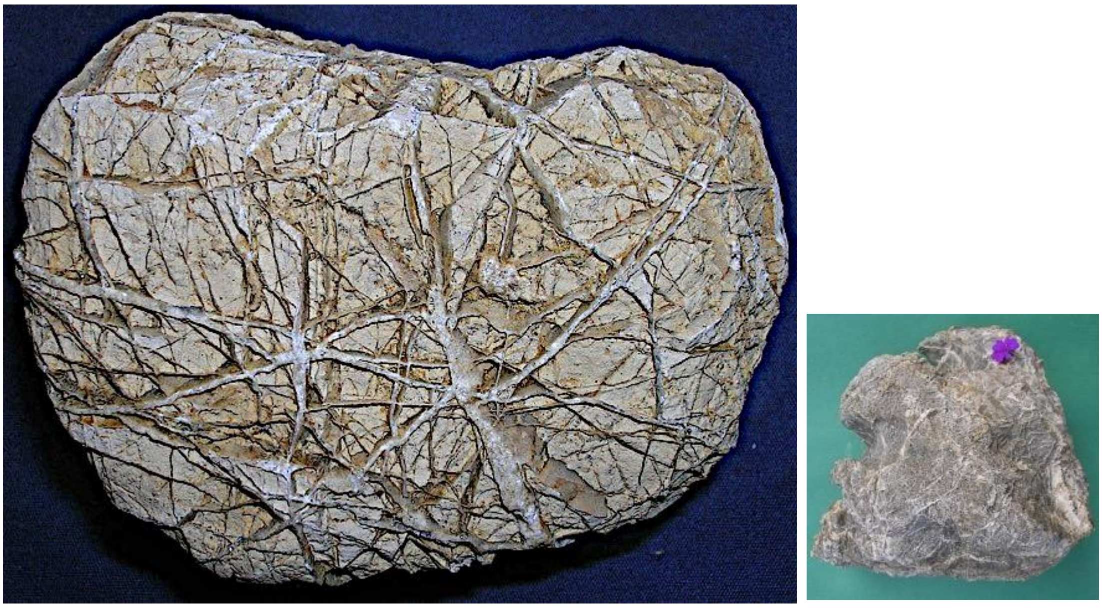


Fig. 29. Alpine boulder: limestone with a network of quartz-filled fissures. The heat and acidity of the impact created this sculpture due to the highly variable solubility of the rock material. On the right, a comparable sculpture from the Chiemgau impact.

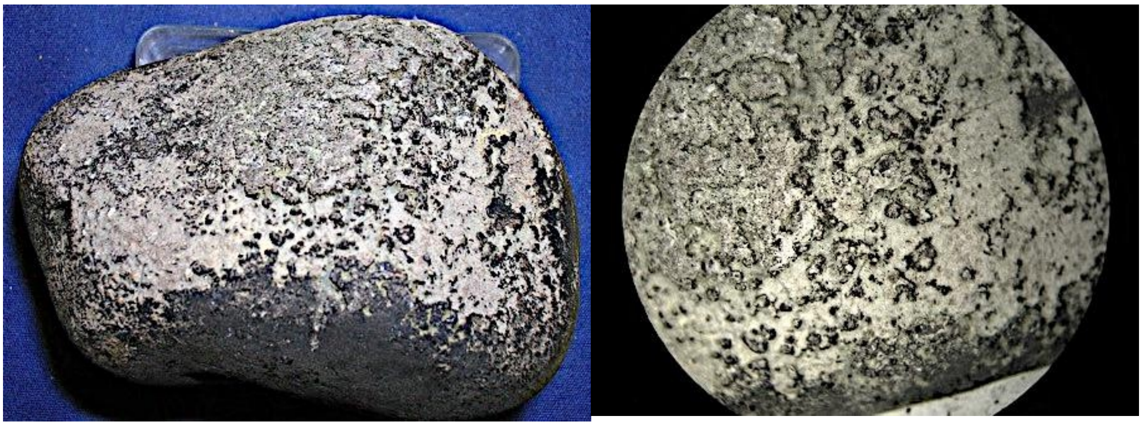


Fig. 30. Limestone boulder with severe surface corrosion due to melting and/or acid dissolution during the impact. On the right under the binocular microscope. Significant transport of the boulder with this stress can be ruled out.

Fig. 31. Noteworthy: debris-in-debris deformation. One explanation is a brief plastic deformation of the large rubble, into which the smaller rubble was pressed under pressure before the complex solidified again. Such extremely short-lived plasticity and solidification is well known from limestones in other impacts (e.g., Azuara-Rubielos de la Cérida impact in Spain). Exactly what happens during this process is still unknown. There may be a connection with so-called acoustic fluidization, as considered a possible mechanism by H. J. Melosh (1989, Impact Cratering. A Geologic Process).

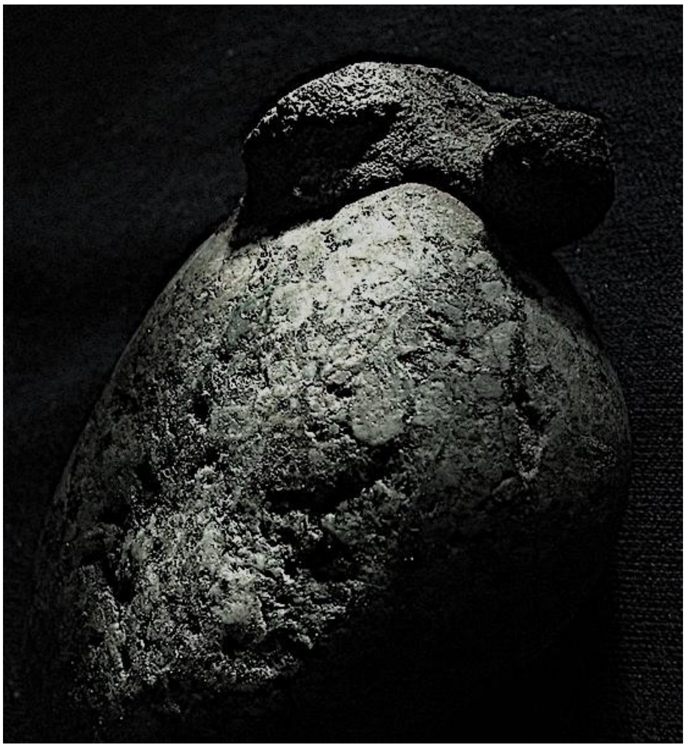


Fig. 32. Another example of short-term plastic deformation (acoustic fluidization?) of a boulder that was pressed against the large boulder below under pressure and deformation and became baked together with it.

Fig. 33. Examples of sections through polymictic breccias, typical of impact.

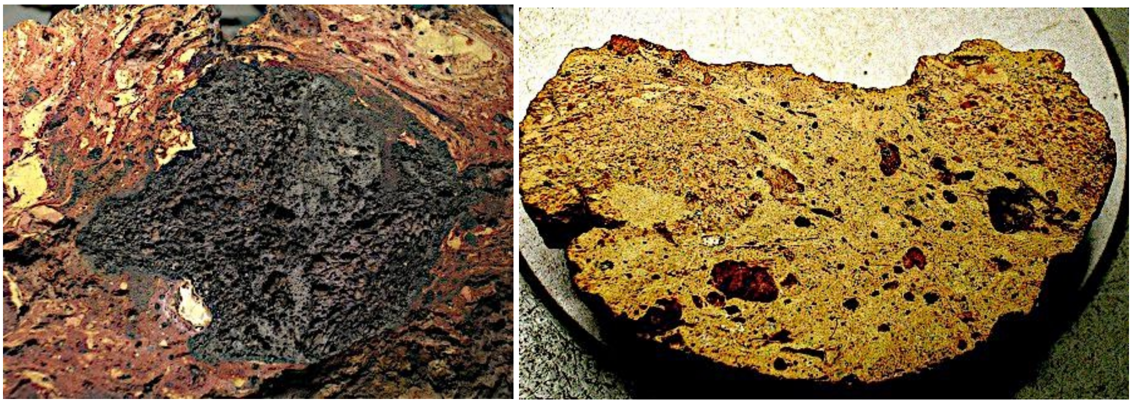


Fig. 34. Detail of the breccia in Fig. 33, top left. Chunks of slag-like melt rock in a flow structure. - Bottom center of Fig. 33: Flow structure with mostly aligned breccia components.

Fig. 35. Breccia bottom right in Fig. 33. Partially breccia-in-breccia, typical of impact brecciation. - Middle left: Diamictic breccia composed of rounded and sharp-edged components.

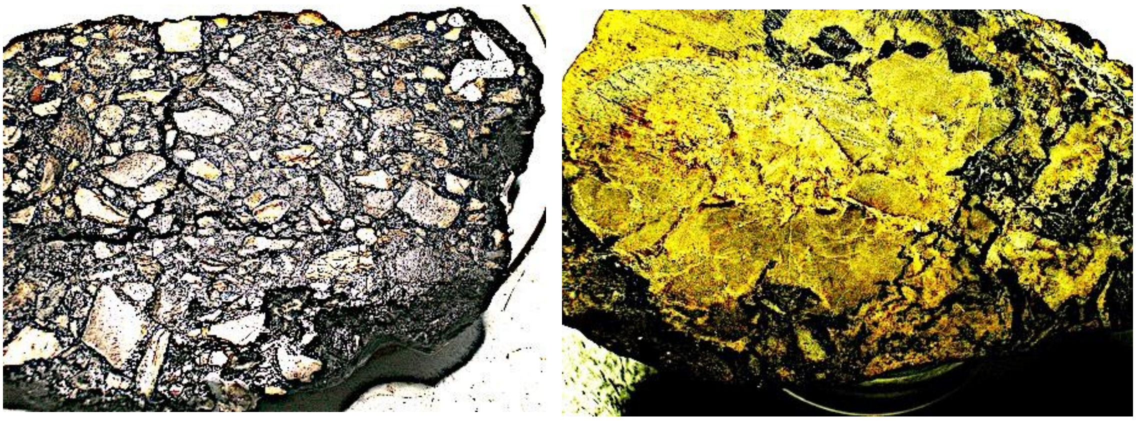


Fig. 36. Top right Fig. 33: Breccia generations typical of impact and practically unknown in "normal" geology. - Center in the middle Fig. 33: Breccia generations, breccia-in-breccia-in-breccia.

7 Discussion

7.1 The "dead ice basins," vegetation, and the DGM 1

The location of the depressions accessible from the hiking trail and considered to be dead ice basins in the four DGM 1 tiles considered here (Fig. 2) are located in the forest area and on its edges, which is related to the fact that the consistently flat depressions on the fields have been dominated by agriculture and have mostly disappeared and also become unattractive for tourism. This impressively demonstrates the enormous potential of the DGM 1 digital terrain model, for which the forest and dense vegetation do not pose any limitations for recognizing and precisely measuring the morphology on the bare ground.

While the previous interpretation as dead ice holes could, in the absence of other hypotheses of origin, refer solely to the water-filled, mostly clearly irregular depressions that are also visible in the forest, the dead ice basin hiking trail was naturally also focused on this. The aim of the following discussion is therefore to compare a photograph of some of these typical depressions, as presented to visitors, with the actual morphology of the DGM 1. All photos are by Franz Moser, Haag, under Wikimedia Commons, licensed under https://de.wikipedia.org/wiki/Creative_Commons.

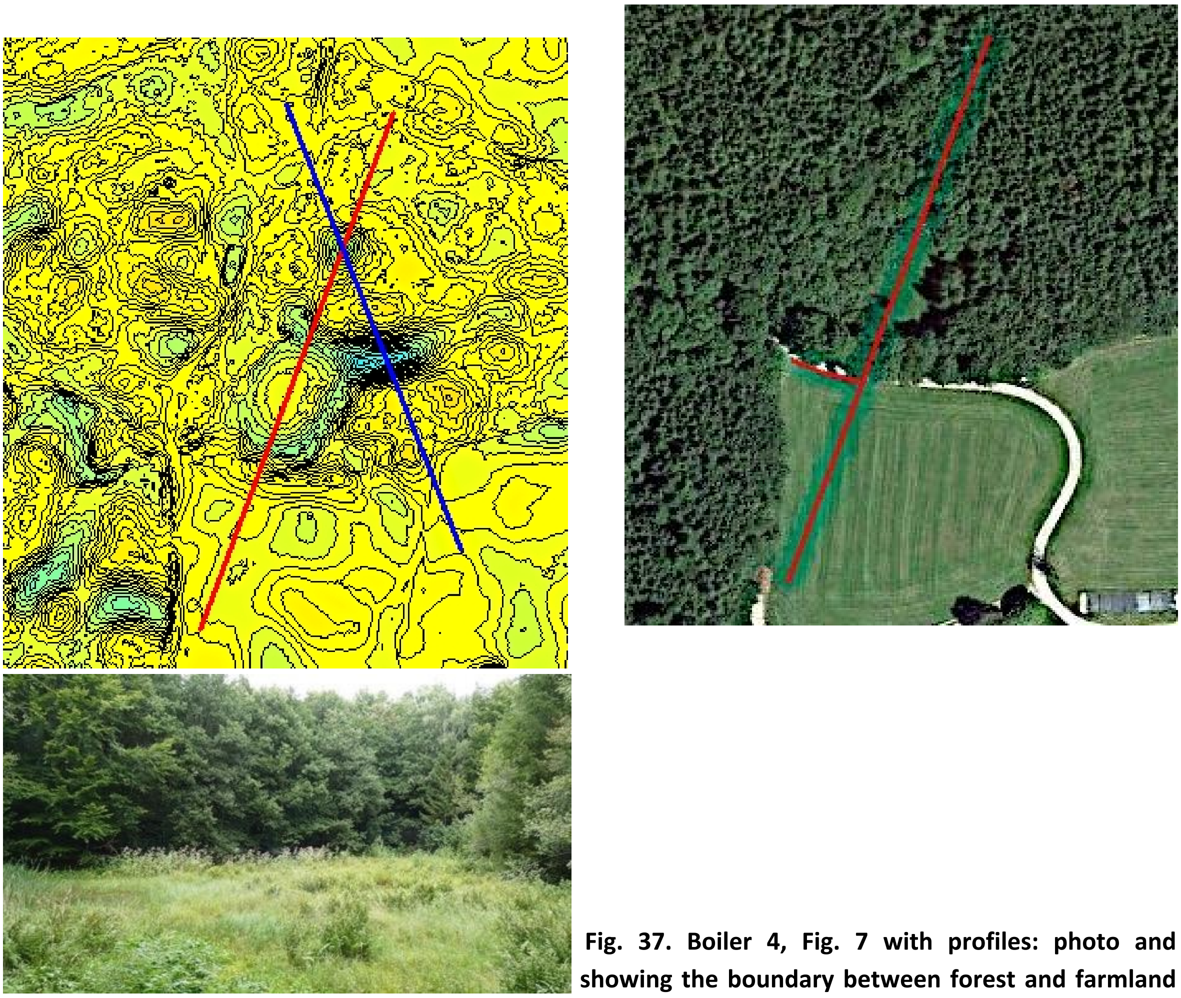


Fig. 37. Boiler 4, Fig. 7 with profiles: photo and showing the boundary between forest and farmland impressively demonstrates the potential of DGM 1 (here with contour lines spaced 20 cm apart). The so-called "dead ice holes" can be traced continuously further south in identical configuration, only extremely leveled by agriculture.

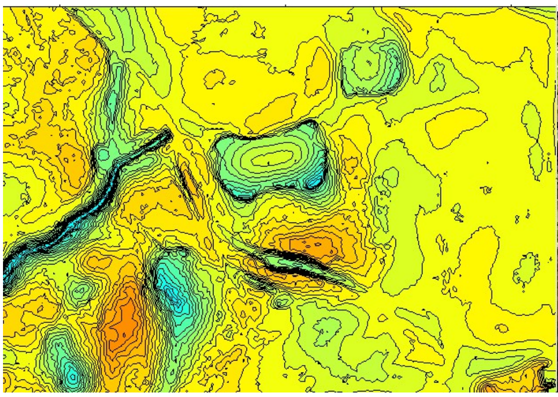


Fig. 38. Basin 5 (Fig. 10): The heavily artificially modified basin was not analyzed further and cannot be identified in the terrain in this geometrically strict form.

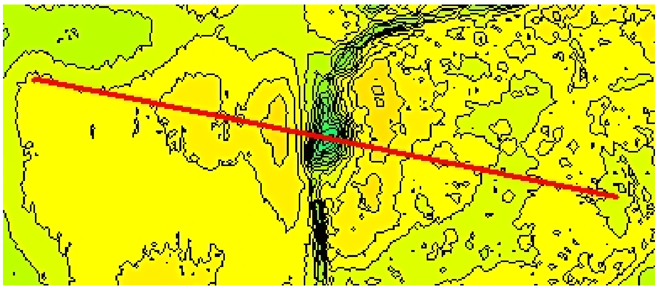


Fig. 39. Basin 6 of the hiking trail with topographic map (contour interval 20 cm) (Fig. 8) and photo. What the photo with the water-filled depression does not reveal to the visitor is the fact that the chain-like arrangement with the distinct embankment of the main depression (Fig. 8) definitely rules out a dead ice hole.

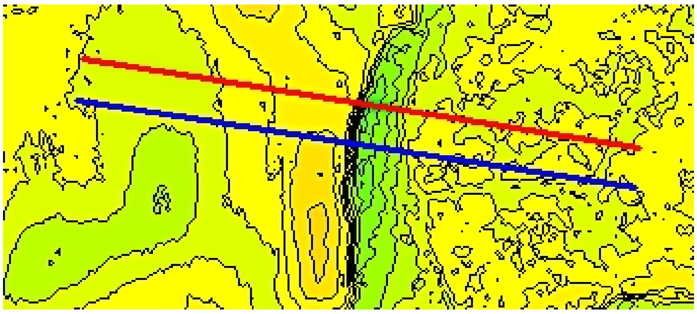


Fig. 40. Basin 8 (Fig. 9, Fig. 9A-C). With the profiles and explanation in Fig. 9, basin 8 cannot possibly be associated with dead ice.

7.2 The complex basin structures

What has already been mentioned in relation to the "tourist-developed" depressions along the hiking trail is highlighted here once again and documented with two further examples.

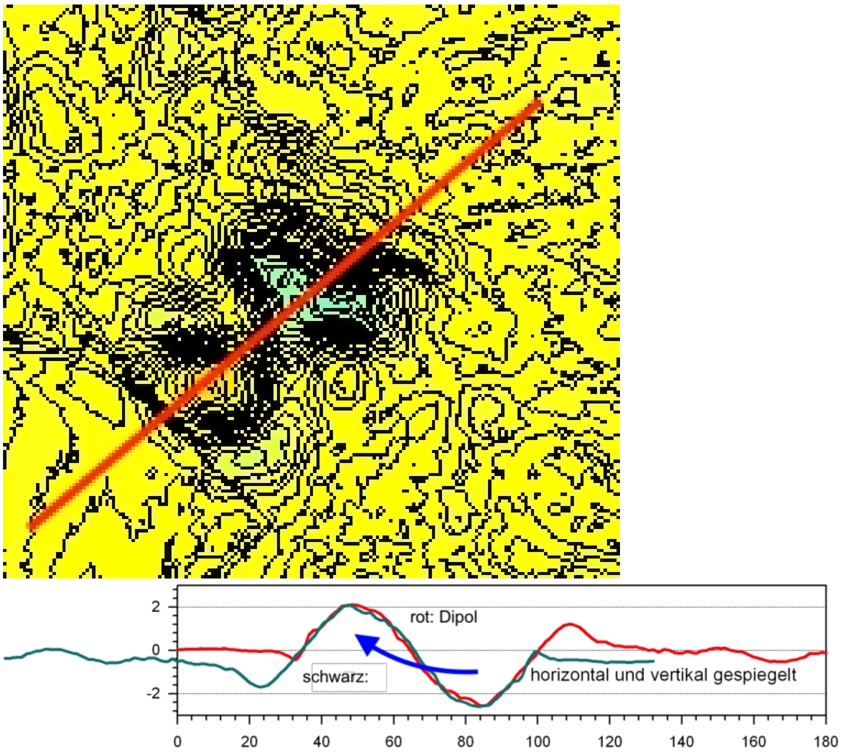


Fig. 41. Bipolar structures in which a crater depression is combined with an adjacent hump. In the profile on the right, the red line has been mirrored both horizontally and vertically and superimposed as a black profile. The arrow indicates that the shape and volume of the crater and hump are identical on a diametric section of the structure, which must be explained by the fact that the excavation of the depression formed the hump over a distance of at least 60 m with identical mass. More on this in 7.4.

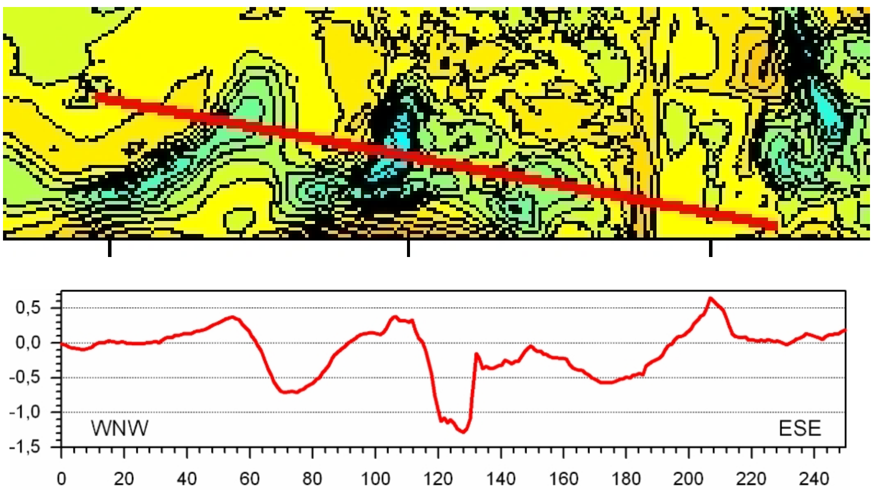


Fig. 42. Complex sequence of elongated hollow and wall structures as an expression of a complex impact event, which will be discussed further.

7.3 The strict morphological symmetry of the basins

Probably the most impressive feature that the high-resolution digital terrain model DGM 1 provides for the latest advances in impact research is the exact morphological symmetry of crater, hump, and ridge structures, some of which are up to several hundred meters in size with minimal deviations down to the decimeter and centimeter range. This is particularly significant in young Pleistocene and Holocene loose sediments and the extremely flat impact structures formed there, as can be observed in a touchdown airburst.

While it is obvious that such precise morphological symmetries are neither geogenic nor anthropogenic, an airburst impact explosion just above the Earth's surface is virtually predestined for such a scenario, which is discussed in more detail in section 7.6.

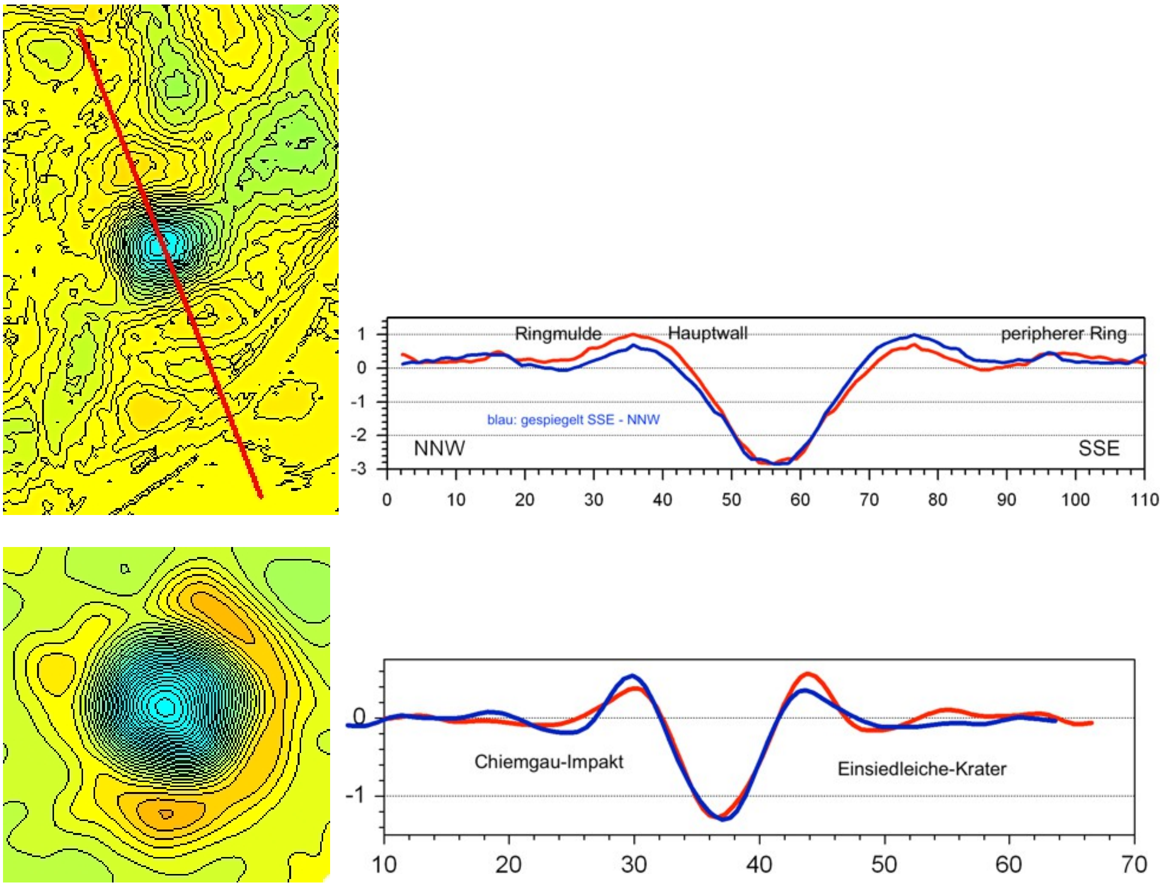


Fig. 43. Top: A significant crater structure in the Haag impact scatter field with a diametric elevation profile and its morphological mirror image: prototype of a circular impact crater with ring wall, ring depression, and peripheral ring. The deviations over a profile length of approximately 90 m do not exceed 50 cm anywhere, in almost perfect symmetry. - Bottom: For comparison, an impact crater from the Chiemgau impact crater scatter field with an analogous shape and mirror symmetry.

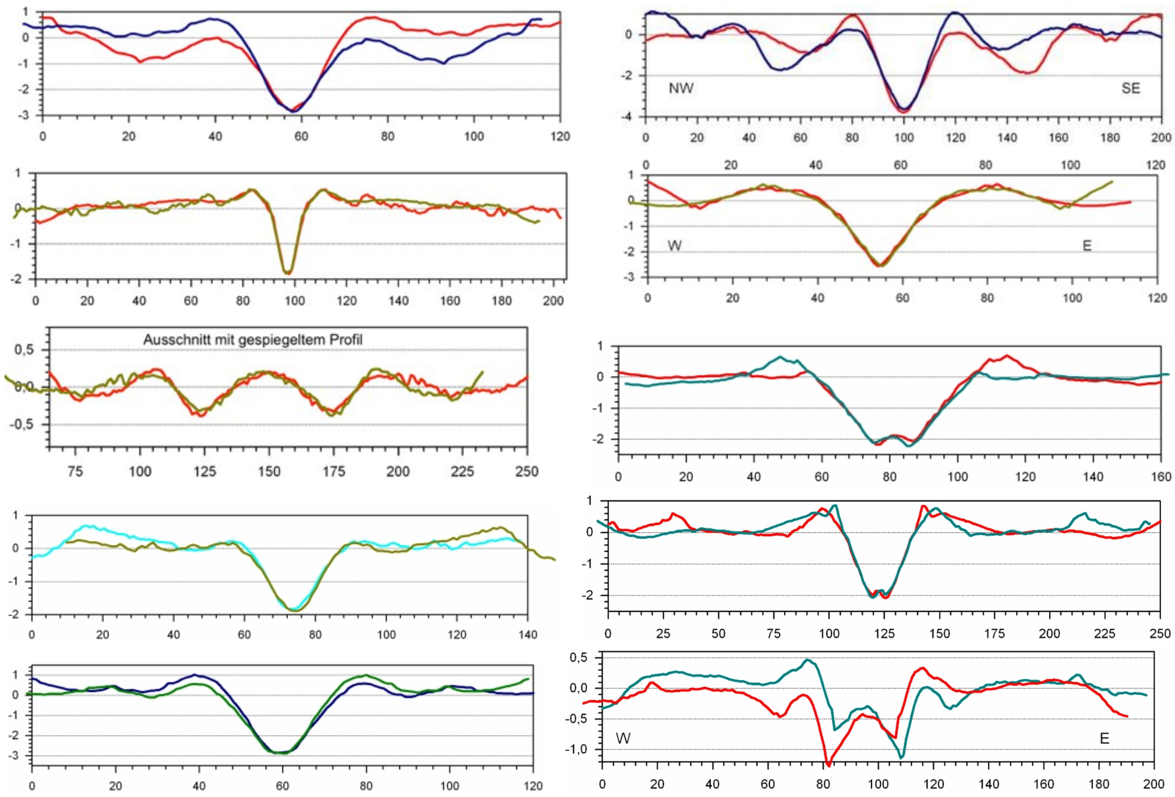


Fig. 44. A selection of craters of different morphology from the Haag scatter field, which, in conjunction with the mirrored terrain profile, impressively demonstrate the symmetry of the structures. We see simple trough craters, funnel-shaped craters, craters with slight central and massive central bulges, craters with relatively flat rim walls and those with pronounced wavy frames, with diameters (wall crowns) ranging from decameters to 200 m. This compilation once again underlines that geological processes such as sinkholes and natural dead ice basins, or even human influence, can definitely be ruled out.

7.4 The analogous crater structures from other impact scatter fields

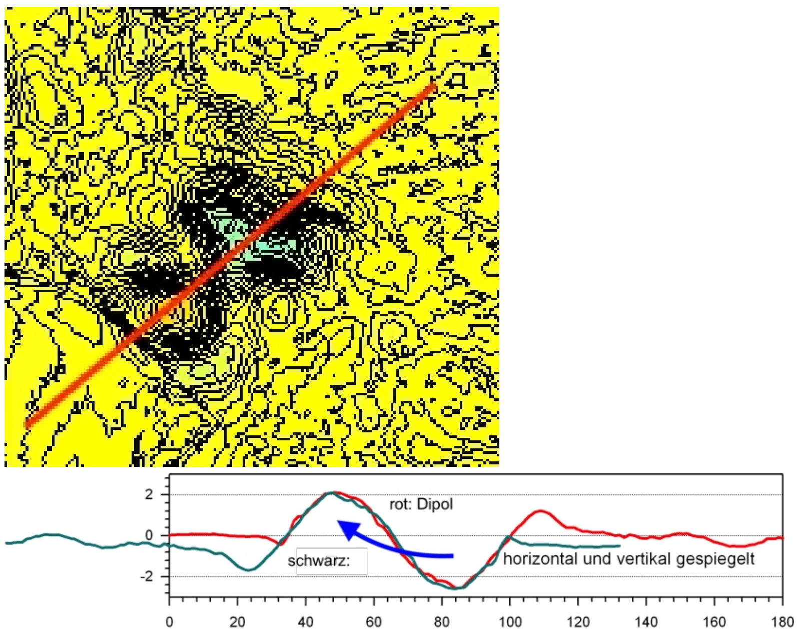


Fig. 45. Bipolar structure of Haag.

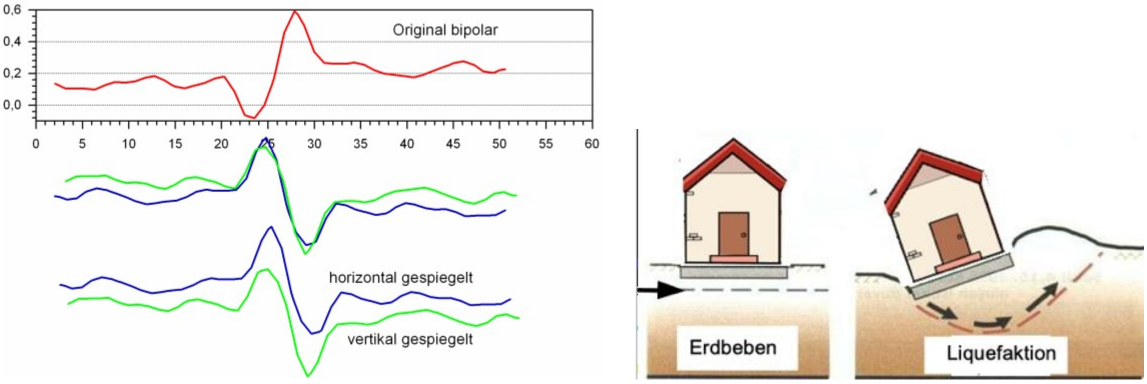


Fig. 46. Bipolar structure of the Saarland impact and model comparison with the formation of analogous structures through soil liquefaction during strong earthquakes.

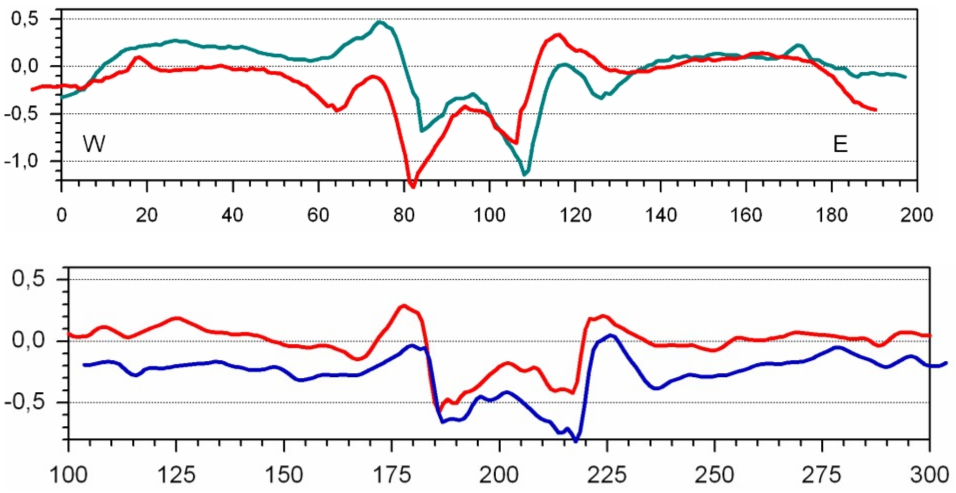


Fig. 47. Multiple structure with central peak ring. Haag above and Hohengüstow (Brandenburg) below.

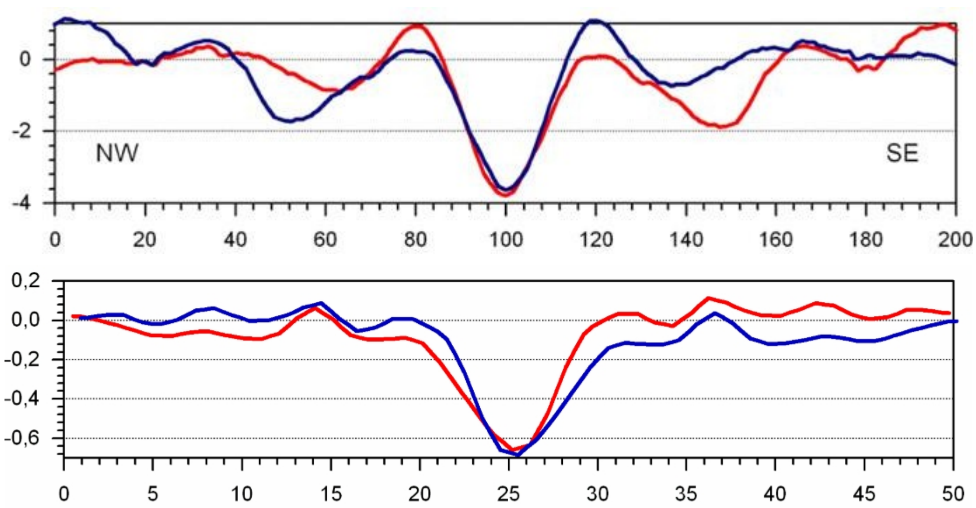


Fig. 48. Multiple-wave crater rim. Haag above, Saarland impact below.

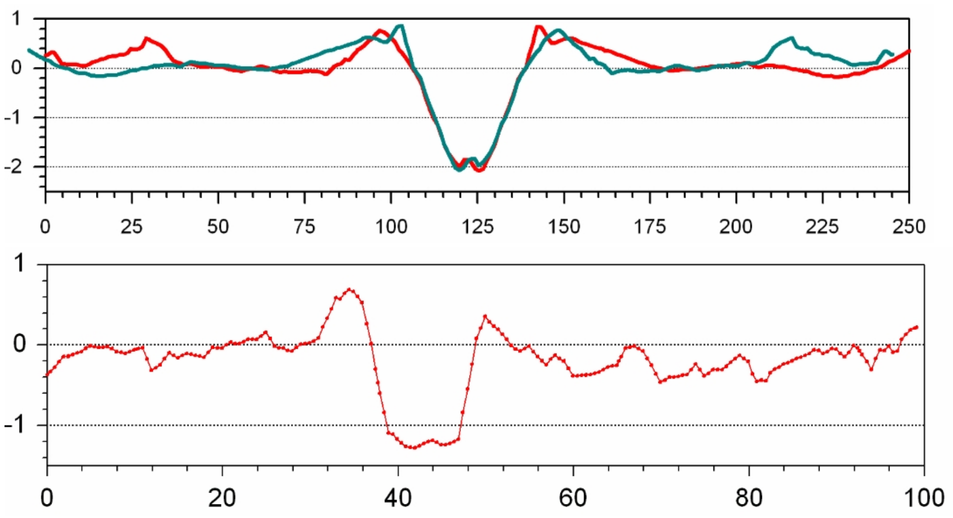


Fig. 49. Crater with strong rim and slight central bulge. Haag at top and Surberg crater (Chiemgau) at bottom.

7.5 The concentrated impact clusters in forest areas

We will discuss a striking observation that sees a connection between a distinctly structured morphology and its largely limited occurrence in forest areas, as shown in Fig. 50. If we add a section with a higher magnification (Fig. 51), we see a surrounded hummocky landscape that should rule out human activity, but bears a striking resemblance to an impact scatter field in the Czech Republic. One interpretation sees an agricultural overprinting due to the leveling of the originally widespread morphology outside the forest. Another interpretation considers it possible that the soil in the forest and on the agriculturally favored fields is very different, which would have left a correspondingly different signature in the case of a flat-appearing airburst impact. This must remain open for the time being, but it impressively demonstrates the capacity of the DGM 1 to address such questions.

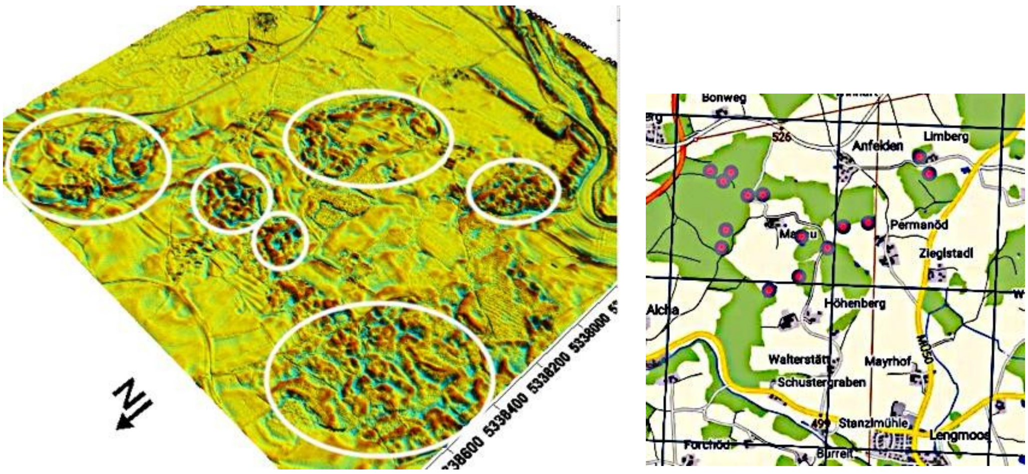


Fig. 50. The complete field of the four tiles in the DGM 1 surface map

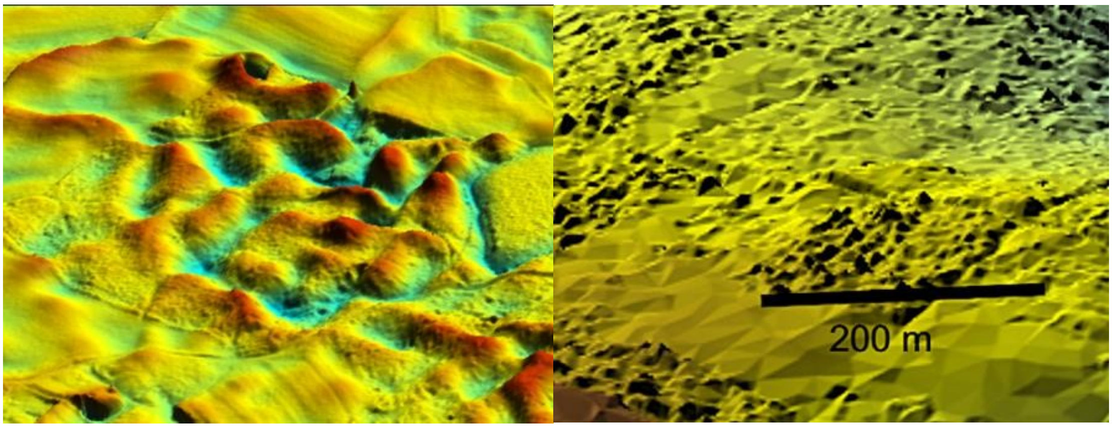


Fig. 51. Clusters of hump structures in the Hague scatter field and in an impact scatter field in the Czech Republic.

7.6 The airburst impact ("low-altitude touchdown airburst impact")

In impact research, the term impact crater formation generally refers to the impact of cosmic bodies (asteroids, comets) that leave behind craters of varying sizes and depths. More recently, this view has been expanded to include the assumption that a comparatively large number of impact events have taken place in the form of airburst impacts with cosmic explosions at lower altitudes above the Earth's surface, which is documented in detail elsewhere with many examples from all over Central Europe, including the large Chiemgau meteorite crater strewn field.

Here we emphasize that the Hague impact scatter field discussed in this article can be attributed precisely to such an airburst impact, which makes it plausible that it belongs to the Chiemgau event. What is discussed in more detail elsewhere will be addressed here in a few key points.

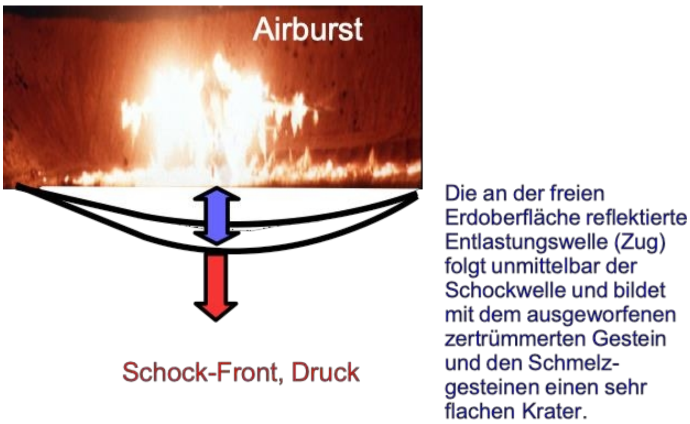


Fig. 52. A shallow airburst impact as an approximate point source at a low altitude above the Earth's surface generates a spherical shock front, which, upon hitting the Earth's surface, allows a spherical segmented shock front to penetrate, immediately followed by a tensile wave reflected at the free surface with the formation of a shallow circular crater.

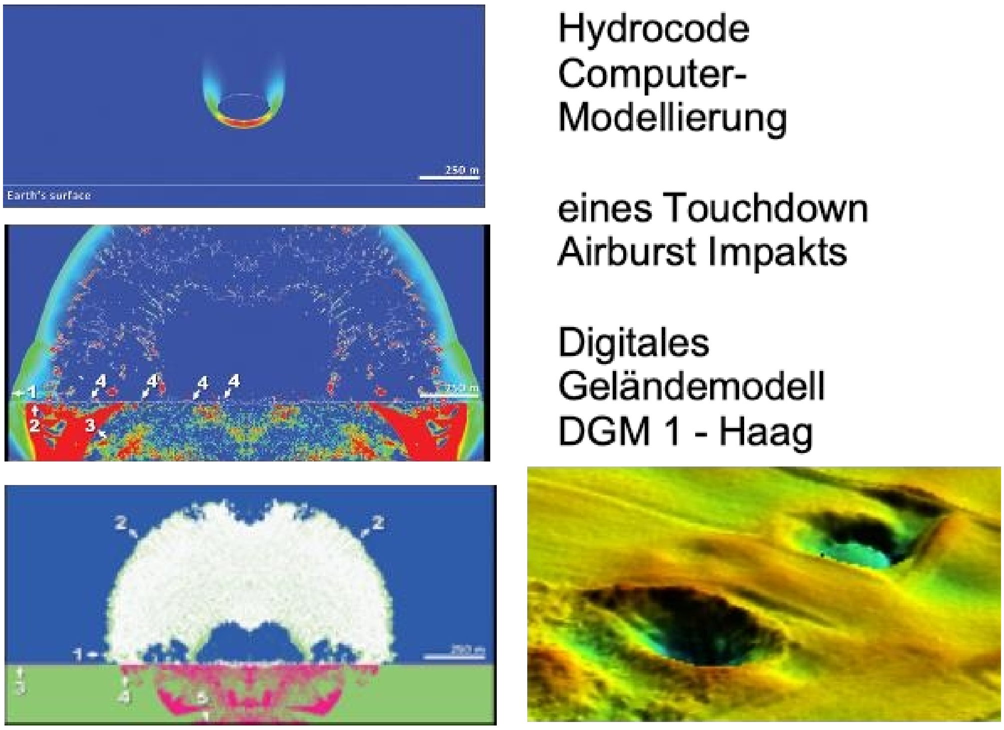


Fig. 53. Phases of hydrocode modeling of a comet that, during an airburst above the Earth's surface, causes a front of extreme pressures and temperatures to impact the Earth's surface. From West et al. (2024).

In some respects, all impacts on Earth are characterized by a strong similarity to strong earthquakes. We have a sudden deformation in the subsurface, from which, according to physics, waves of different characteristics (space waves, surface waves) propagate (Fig. 54).

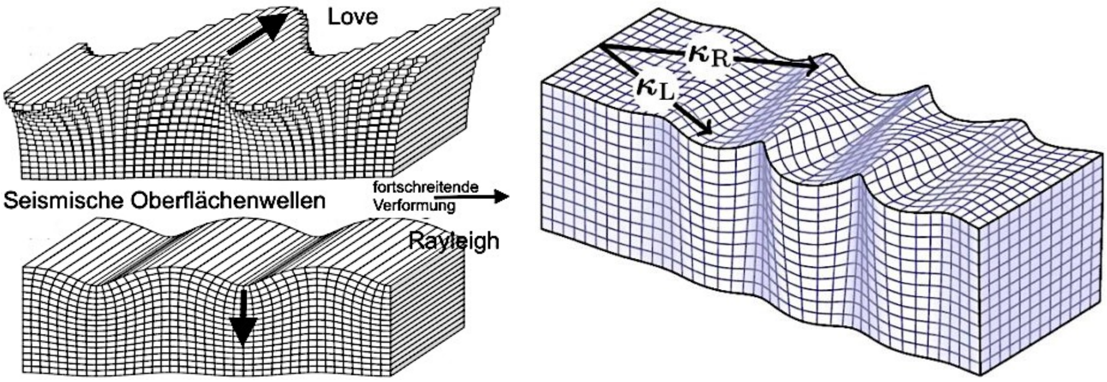


Fig. 54. Models of seismic surface waves and superposition with rib formation. (heavily modified after Shearer 2009, left), Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, Stefano Maranò (right). A model for rib formation during impact "earthquakes" suggests itself.

Of particular significance are surface waves, which can indeed deform the Earth's surface in a wave-like manner, producing periodic patterns. With the crackling of an airburst impact, e.g., of a comet swarm, and multiple explosions of entire showers of debris from larger and smaller objects falling to Earth (Fig. 53), it is easy to imagine that seismic impact surface waves spread from the impacts, interfere with each other, and ultimately imprint complex rib and multi-ring patterns on the ground. This is exactly what we now see and understand when we study and analyze airburst impact scatter fields geologically and geomorphologically. And the Hague impact is no exception, as the following examples show.

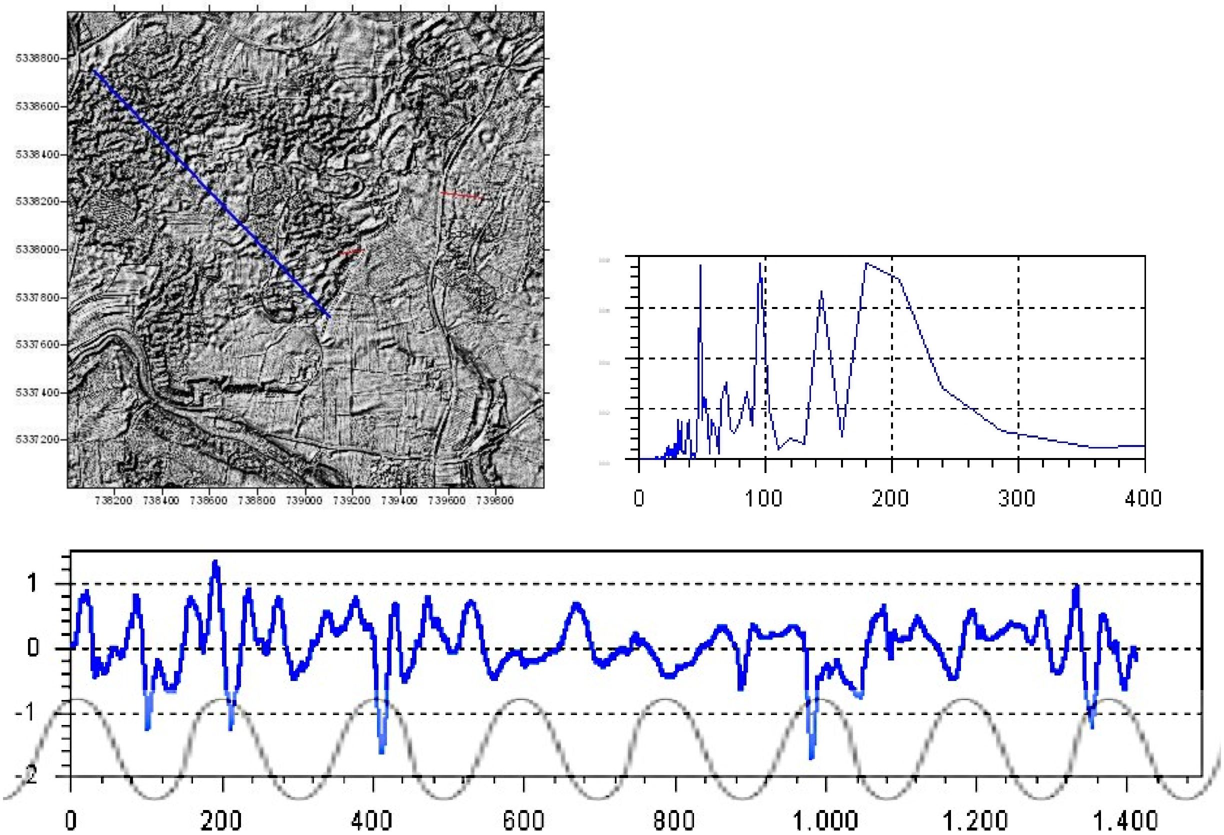


Fig. 55. The digital terrain model DTM 1 of the four Hague tiles as a shaded relief map with a DTM 1 profile extraction (below). A wave-like progression of the blue curve with different periods is unmistakable, which we interpret as an expression of a superposition of surface waves originating from individual separate impacts. This can be mathematically substantiated if we subject the curve to a so-called Fourier analysis and generate a power spectrum as a periodogram (top right). Prominent peaks can be seen, some of which are visible to the naked eye in the original curve. The 200 m period can be approximated quite well with a sine curve.

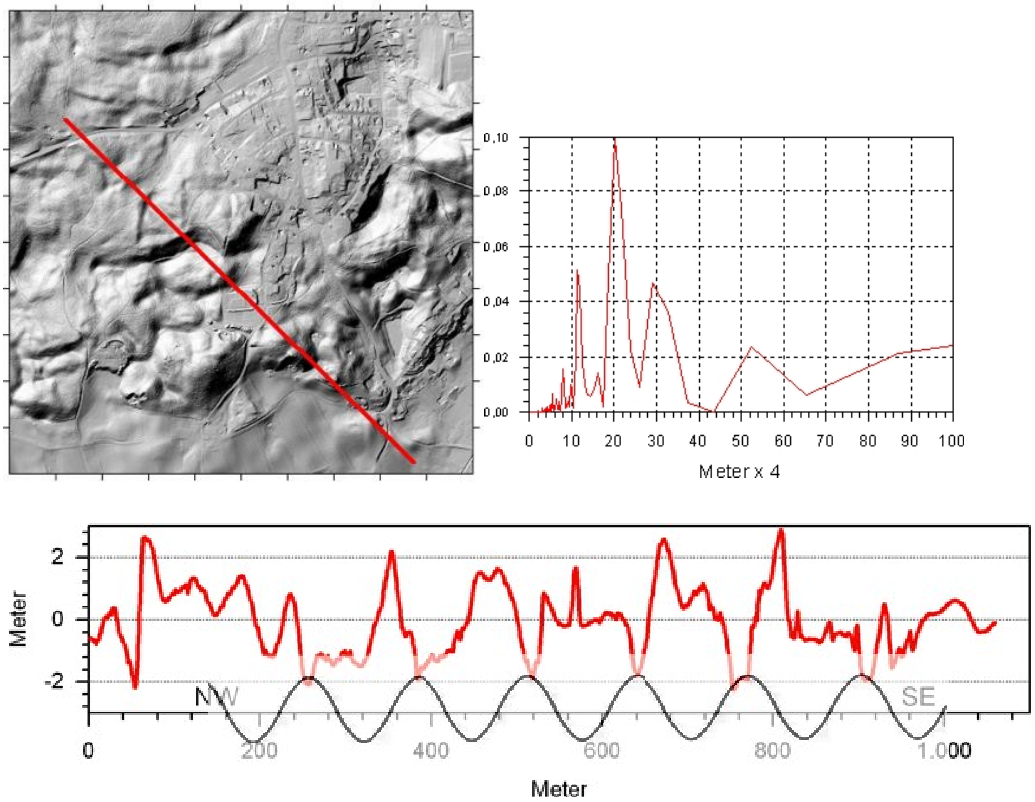


Fig. 56. An analogous example of a profile from the Joppenpoint tile. Note the factor of 4 on the period scale in the periodogram at top right.

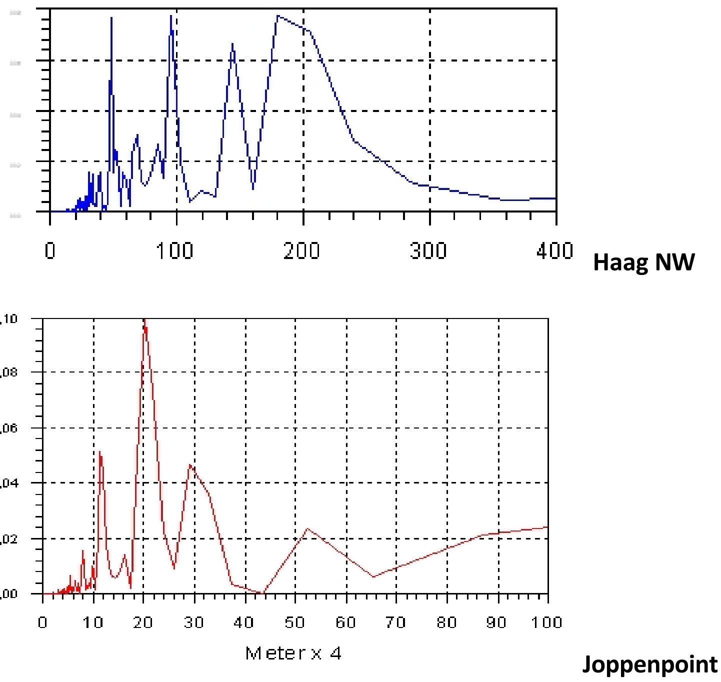


Fig. 57. Comparison of the periodograms of the Haag and Joppenpoint tiles. The similarity of the spectra is impressive and emphasizes the validity of the airburst model with wave-like ground deformations caused by impact seismic surface waves. It should be noted that the periods of the spectra, as one-dimensional measures, also depend on the strike directions of the crossed profiles.

What is particularly striking in the two power spectra are the almost equally spaced main peaks of the periods. This is exactly what is also found in seismics. Here, harmonics of impact-seismic surface waves (as are generally known from acoustics) are likely to be evident, i.e., harmonics that can occur in seismic surface waves, especially Rayleigh waves and Love waves. These harmonics are frequency (or period) components that are multiples of the fundamental frequency (fundamental period) of the wave and are caused by scattering, reflection, and the complex composition of the earth's subsurface.

8 The dead ice kettles and moraine geotopes of the LfU in the district of

Mühldorf Example geotope 183R011 W of Löfflmoos ("dead ice kettle")

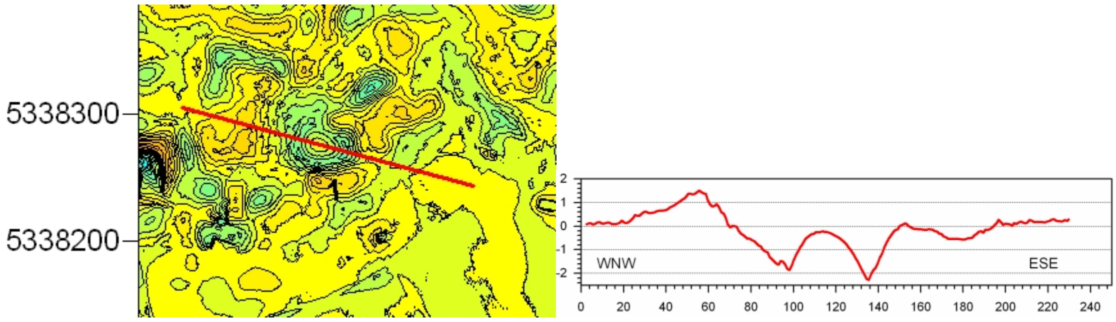


Fig. 58. A crater approximately 100 m in diameter with a pronounced central peak. A dead ice basin can be ruled out. A small walled crater overlaps in the northeast.

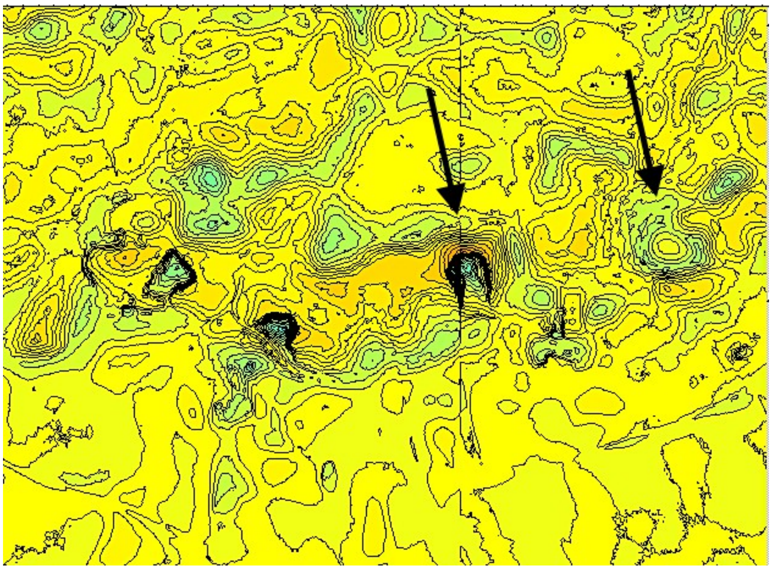


Fig. 59. According to the LfU's geotope list, it is not entirely clear which is the "dead ice hole." The right arrow points to the hole shown here in Fig. 58, for which the LfU has posted the coordinates on the web. However, according to the description there, it is more likely to refer to the left crater with the more distinct ring wall. In the original topography, however, it is only 20 m high and not 40 m as described. To the west and north, there are further depressions with ring walls, which can also be ruled out as dead ice depressions.

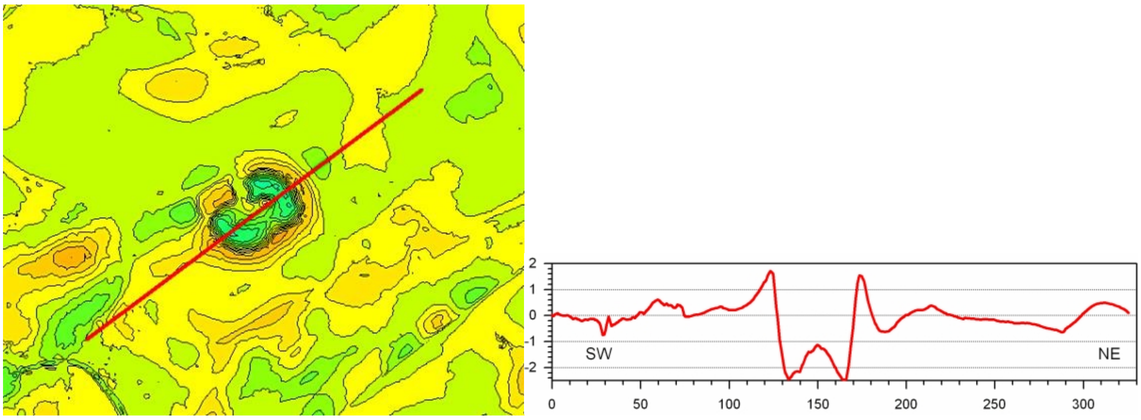


Fig. 60. Another crater north of Löffelmoos with a distinctive ring wall in a hollow-shaped frame and a central bulge.

Example Geotope 183R008 Ice-eroded landscape N of Gänsgerbl

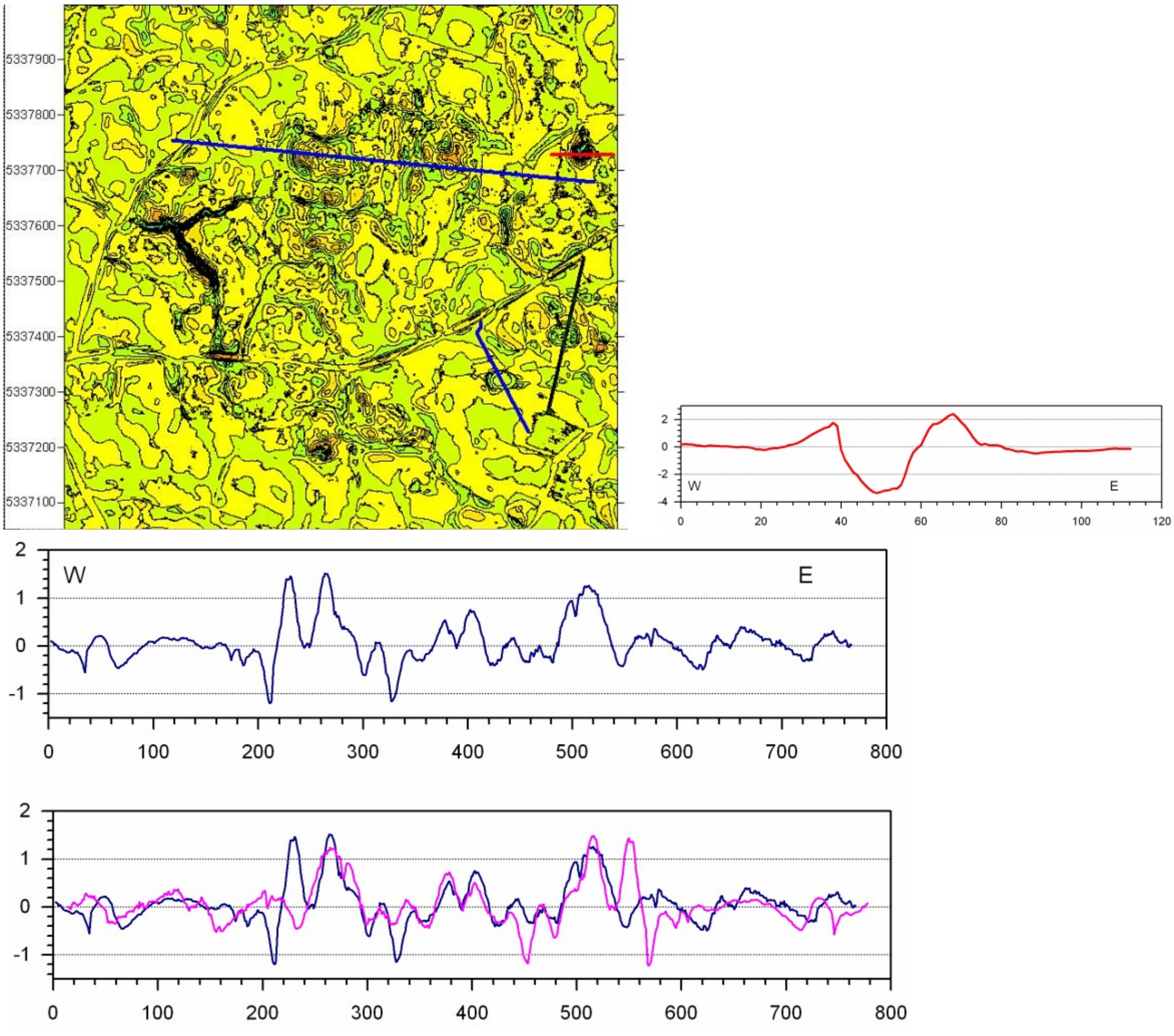


Fig. 61. DGM 1 tile with a multi-ring structure more than 300 m in diameter and an astonishing mirror signature of the long profile. On the eastern edge, there is a small (30 m) crater that is nevertheless almost 4 m deep.

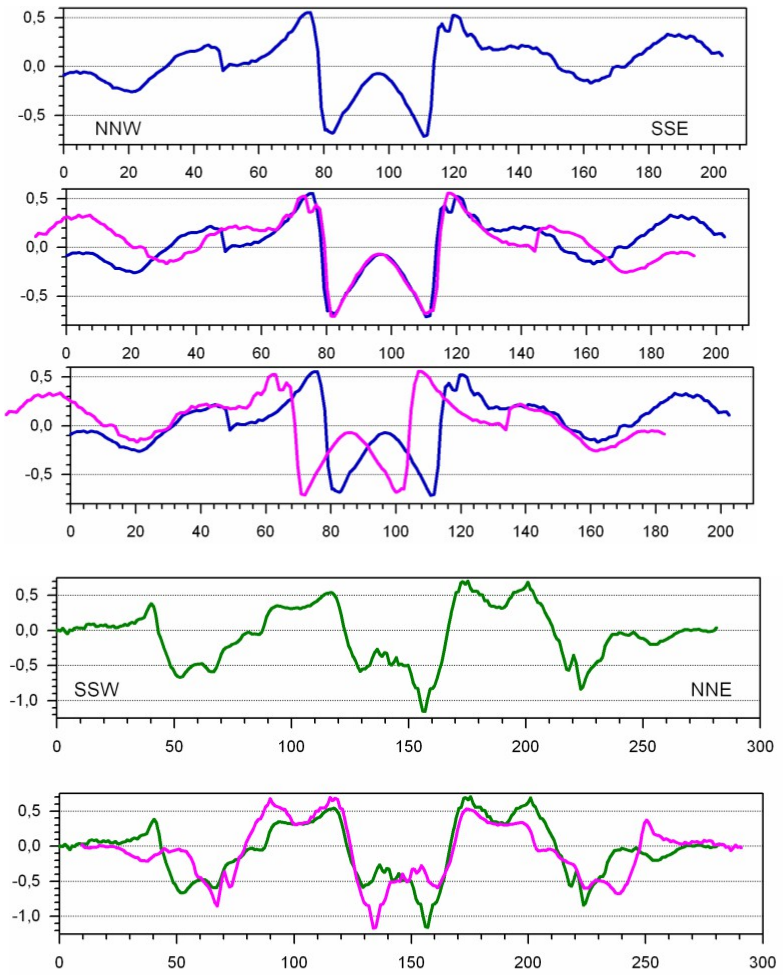


Fig. 62. Two further larger multi-ring structures with their mirrored diametrical profiles. Color assignment of the map. An ice decay landscape cannot be reconciled with this morphology.

Example geotope 183R004 NE of Höller ("dead ice basin," red square)

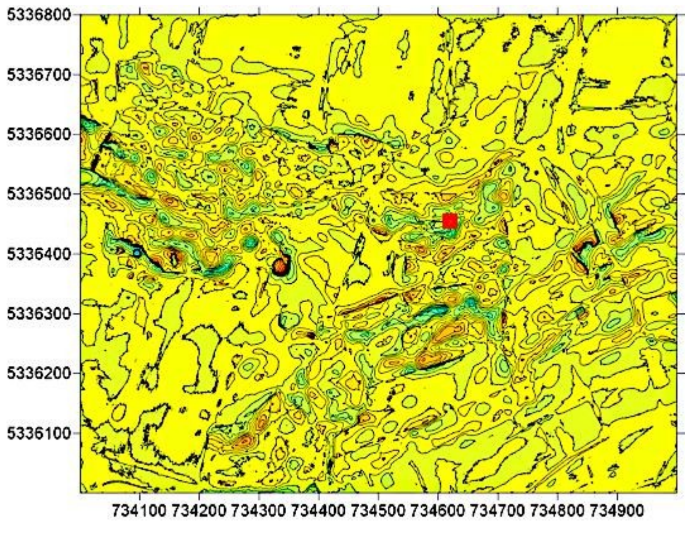
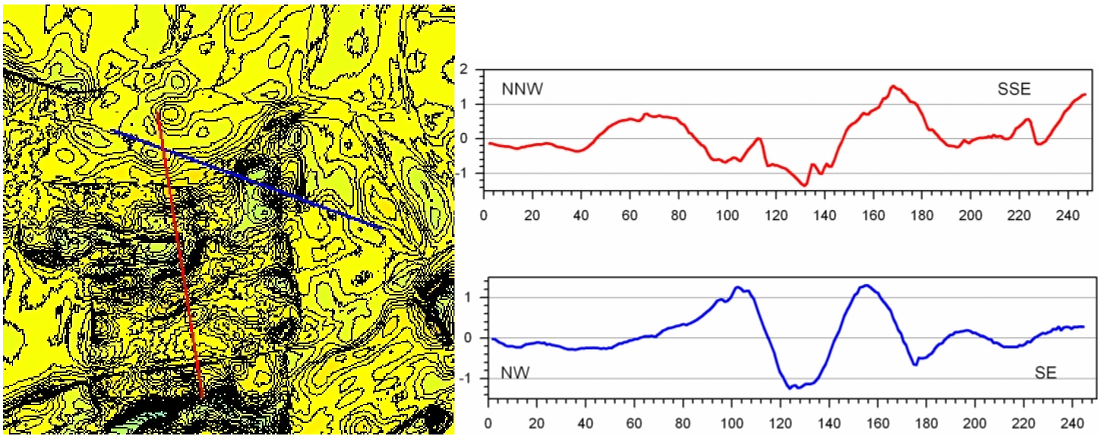
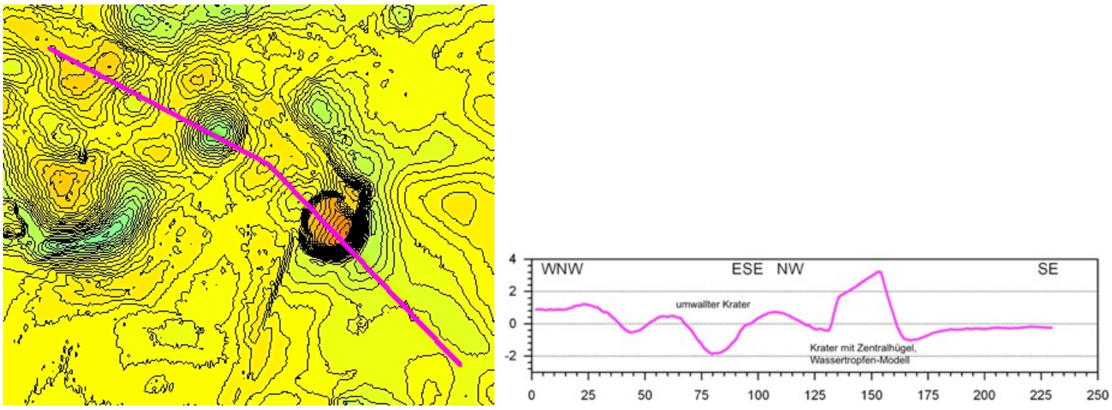


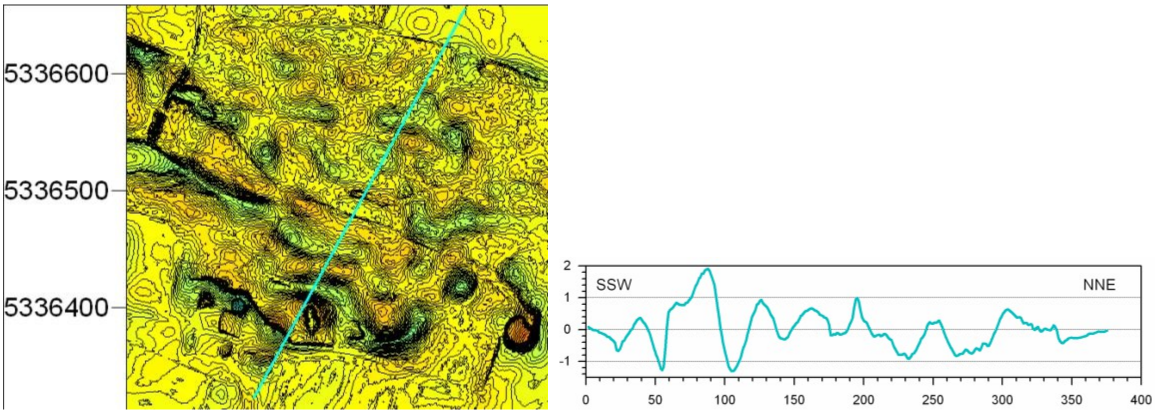
Fig. 63. The DGM 1 tile shows a wealth of depressions and rib structures, which are discussed in the following figures (Fig. 64).



Multiple walled structures.



Crater and 30 m hump with ring depression. Another hump with pronounced ring depression at the left edge of the image.



Periodic rib pattern of bulges and hollows. Impact seismic surface waves?

Fig. 64. Accumulation of differently shaped structures on an impact-marked subsoil. The geotope of the presumed dead ice basin appears somewhat lost here.

Example geotope 183R017 SW Maitenbeth (dead ice hole in ice decay landscape)

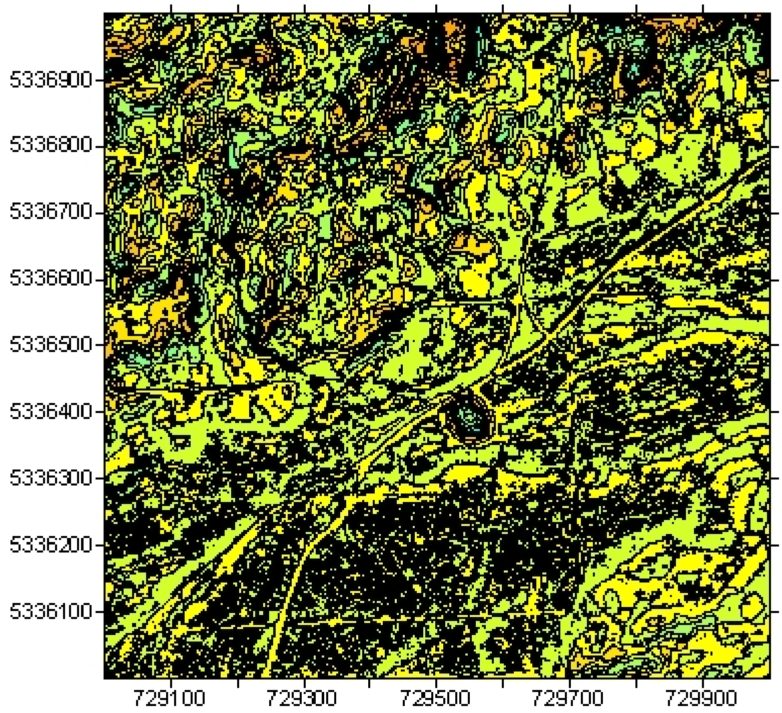


Fig. 65. The DGM 1 tile of the difference field with the basin in the center.

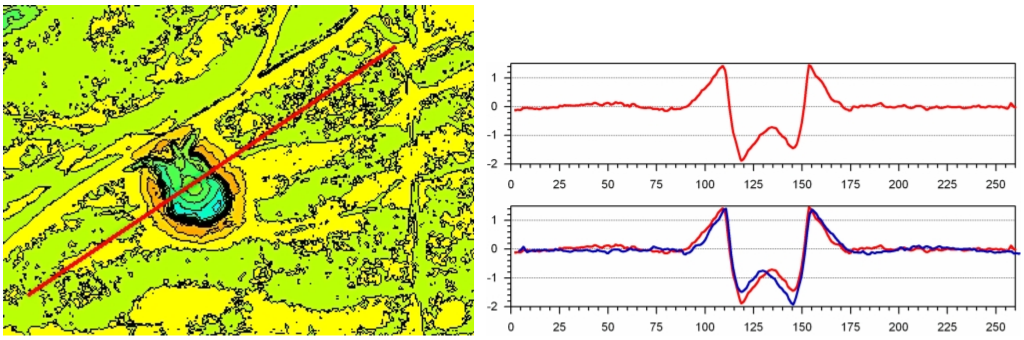


Fig. 66. The geotope basin. Contour line spacing 50 cm. A pronounced wall, central mountain, and perfect mirror symmetry rule out a dead ice basin. The perfect match over 250 m also definitively rules out other geological and anthropogenic processes.

Fig. 67. The geotope basin as a DGM 1-3D terrain surface. A dead ice basin can be ruled out.

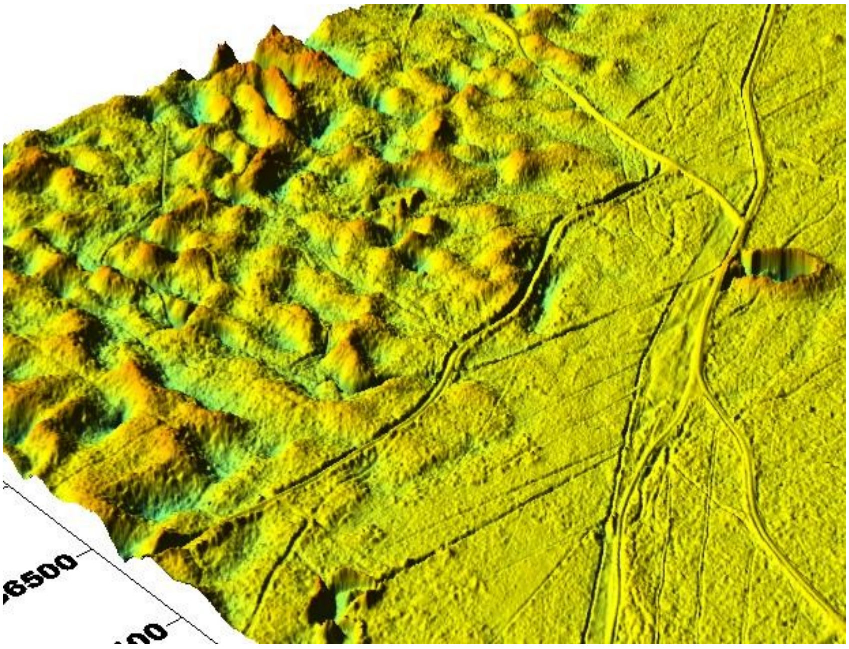


Fig. 68. Northwestern part of the tile as a DGM 1 3D terrain surface. The regular grid pattern is not an effect of ice decay.

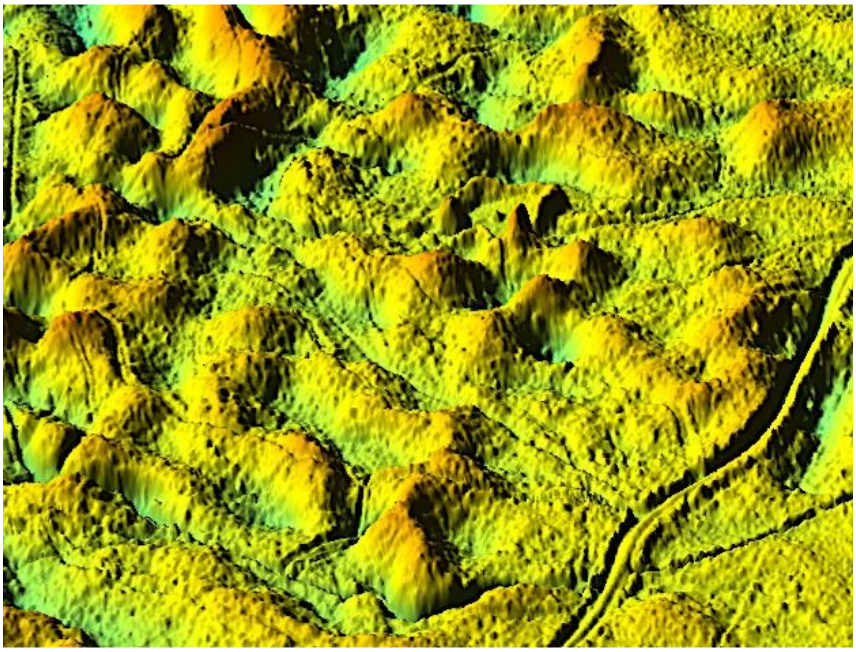


Fig. 69. Detail: Periodic grid pattern of trenches and hills. Ice decay in such an extremely regular pattern can definitely be ruled out.

Example geotope 5,338,516 Dead ice basin N of Bachenöd, east of Haag

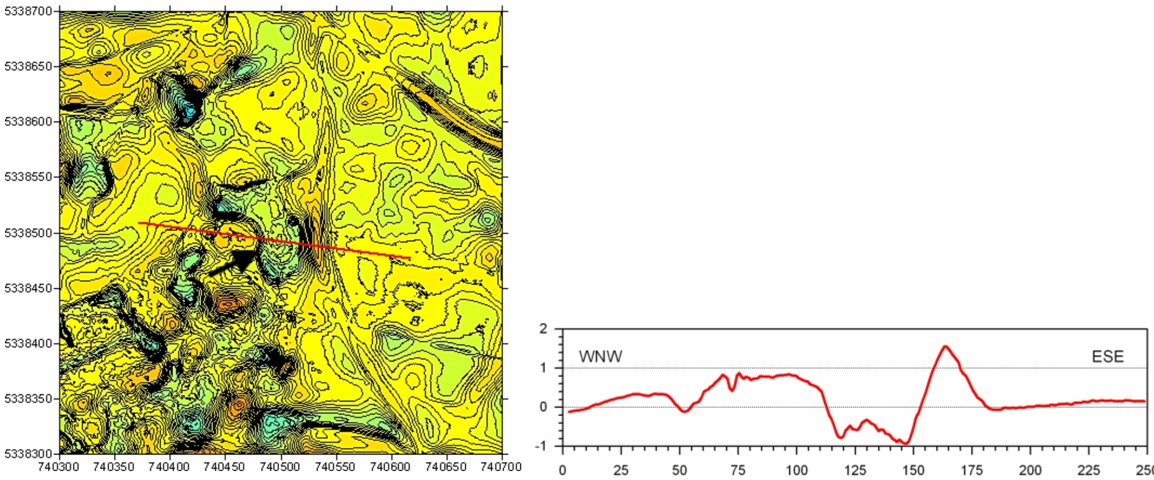


Fig. 70. Anything but a kettle, and certainly not a dead ice hole. Multiple walled impact structure with accompanying central bulge. The arrow marks the geotope. The surrounding area also shows numerous walled depressions, presumably created by impacts.

9 The ice age boulders and the impact

The discussion to date about the highly questionable to inaccurate description of the so-called dead ice kettles on the Haag hiking trail, as well as the ice age geotopes declared as such in the Mühldorf region, naturally raise the question of whether the Inn (valley) glacier of the Würm glaciation ever advanced this far north. Previous ice age research and the LfU's designations have always made this seem plausible, but scientific findings, even textbook knowledge, are not eternal.

The completely new possibilities and easy access to the data of the extremely high-resolution Digital Terrain Model DTM 1 prove that the dead ice basins and ice age geotopes discussed here, as evidence of the Inn Glacier that has been proven to date, must find a completely new and definitely different explanation.

The exhibits in the Haag Glacier Garden, which has existed for over 100 years (Figs. 71, 72), are also seen in this context and are considered evidence of the edge of the ice during the Würm glaciation.

What is remarkable about practically all of the exhibits is the extremely sharp edges of the sculptures, which make one wonder whether these chunks could have survived the 60 km journey to the edge of the Alps in this form, transported by glaciers, and also survived the Würm glacier retreat, which may have lasted 20,000 years, without any external smoothing.glacier retreat perhaps 20,000 years ago without any external smoothing.

Various interpretations can be discussed. If, according to current investigations with the DGM 1, such extensive Würm glaciation appears highly questionable, the boulder relics could have been transported here by ice during the Riss glaciation, which raises the question of how the angular fracture sculpture could have survived for such long geological periods.

Regardless of whether they are Würm or Riss relics, the postulated impact could provide an answer with its extensive surface airburst fragmentation, which would make geological sense.

Fig. 71. The Haag Glacier Garden with a collection of boulders (erratic blocks, large debris) from the area of the Toteiswanderweg (Google Street View). On the right is a large boulder from Chiemgau; found directly before the start of the Alpine ascent. The perfectly smooth sculpture contrasts impressively with the sharp-edged erratic blocks from Haag.

Fig. 72. The Haag glacier garden with its sharply broken erratic blocks, described as relics of the Würm glaciation. Google Street View.

10 Conclusions

The observations made using the maps and profiles of the extremely high-resolution terrain models with DGM 1 data support a paradigm shift in impact research, which, as in earlier studies on *low-altitude touchdown* airburst impacts, also applies here in the region of Mühldorf am Inn, with a focus on the Haag Dead Ice Kettle Hiking Trail and the LfU's ice age geotopes.

For the large scatter field of the Chiemgau impact ellipse, the science of impact research and all "relevant" findings and results of the internationally recognized impact criteria have already proven that the vehement objections and counterarguments of Bavarian ice age research and its geologists are invalid and could largely be reduced *to absurdity*.

The Mühldorf Ice Age area with its presumed dead ice pools (there is hardly any other way to describe them) was not to be dismissed out of hand. Ice Age relics such as ice decay landscapes, moraine ridges, and numerous depressions were and still are textbook knowledge for Ice Age geologists and Ice Age geomorphologists.

As conclusions from our investigations, we must now counter this and assert that the Inn Glacier probably never advanced as far as the Inn near Mühldorf, because all the morphologies examined here so far can be attributed to an extensive airburst impact in a completely unconstrained and geologically and physically convincing manner.

The following morphological features, which are widely and extensively documented by the DGM 1, are fundamentally incompatible with the ice age dead ice basins of the Haager Wanderweg and the numerous geotopes of the LfU:

-- continuously present, sometimes sharply cut ring walls, in many cases framed by a wave-like trough structure

-- in many cases, more or less pronounced central humps

-- multiple ring systems with central peak rings

-- strict morphological symmetries of diametrical profiles over exactly circular and elongated structures, in which differences in mirrored and superimposed profiles do not exceed a few centimeters or decimeters, even in craters measuring decameters to multiring structures measuring hundreds of meters. It should be emphasized once again that geogenic and anthropogenic processes and, of course, the ice age must be fundamentally ruled out here, requiring a roughly point-like source of deformation above the Earth's surface.

-- In the DGM 1, ice-melt landscapes reveal themselves to be geometrically shaped, narrow ribbed and grid-like structures consisting of humps and hollows, which, according to mathematical Fourier analysis, are interpreted as expressions of impact seismic surface waves (Love and Rayleigh waves) with their harmonics.

With these observations and precise data, ice age geologists, especially those at the LfU, are called upon and challenged to offer coherent and well-founded alternative solutions for the Würm glaciation.

We also fear that the Haager Toteiskessel hiking trail will continue to mislead visitors. Instead, those responsible should perhaps consider whether it would not make more sense for visitors to the hiking trail to follow in the footsteps of their Bronze Age/Celtic ancestors, who presumably experienced an immeasurable natural disaster in the context of the Chiemgau impact.

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