Natural history is not at its end – bridging past and presence of meteorite impacts at the museum using online observation tools

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Abstract

The Noerdlinger Ries is regarded as one of the best studied terrestrial impact craters. Because of its accessibility and its excellent preservation this area continues to be a research target for numerous international students, geoscientists and impact researchers. Here astronauts from the Apollo 14 and 17 missions studied the identification and sampling of impact rocks to prepare for their trip to the Moon. Today it is a regular training area for ESA astronauts and project planners. As an 'In-crater museum', the Ries Crater Museum offers insights into the spectacular event 15 million years ago. It illuminates the significance and the larger context of the Ries event to a wider audience: our Solar System, comets, asteroids, meteorites, and the special role of impacts in the evolution of our Solar System and Earth. Permanent didactic challenges in this context are: Most of the relevant processes cannot be observed directly. The time scale considered is very large and very different from that of a human being. Large impact-events took place long ago (Millions and billions of years ago) and were/are very rare events by human standards. Also, only remains of large and relatively new impacts are preserved and visible to some extent. All this often leads to the conclusion that impact processes are part of the past without actual relevance except at the cinema. In reality objects from space hit Earth every day, every hour, every minute, every second. But since they are usually very small, their fall is rarely spectacular and usually not noticed. We are currently working on the renewal of the meteorite area in our museum. In this context we plan to draw visitors' attention to recent fall events and to show their special importance for science and society. To demonstrate the ongoing bombardment of the earth we present online or 'near online' observations to make visible the usually invisible to the 'normal' eye. We try to overcome the restrictions of timescale and take a sharp look into the present by reducing time slots and using a 'magnifying glass'. We present concepts and approaches. Suggestions and comments are welcome!

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PRESENTED AT:

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1. THE NÖRDLINGER RIES

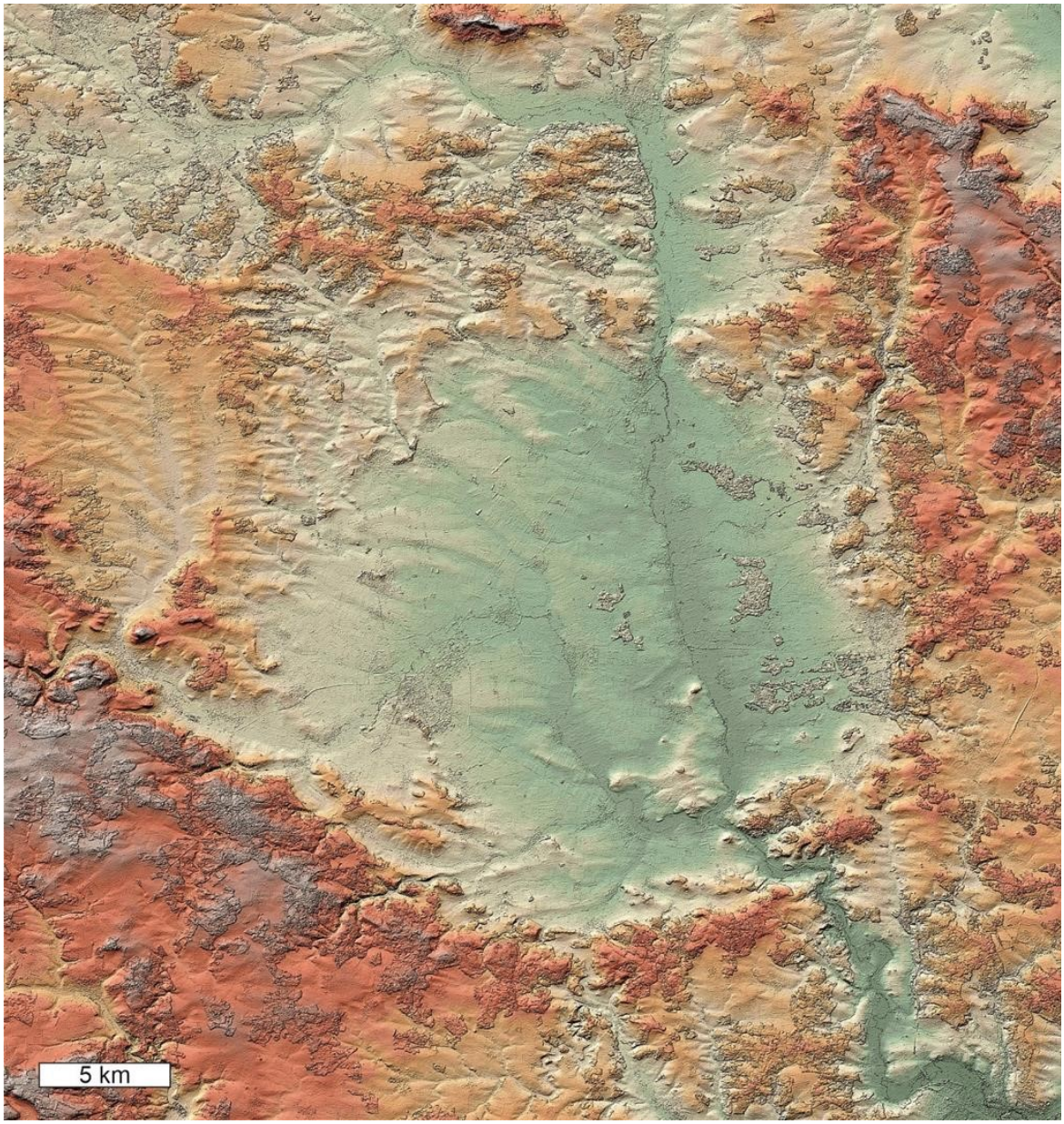

Fig. 1: DEM hillshade of the Ries Crater, Manfred Gottwald, DLR

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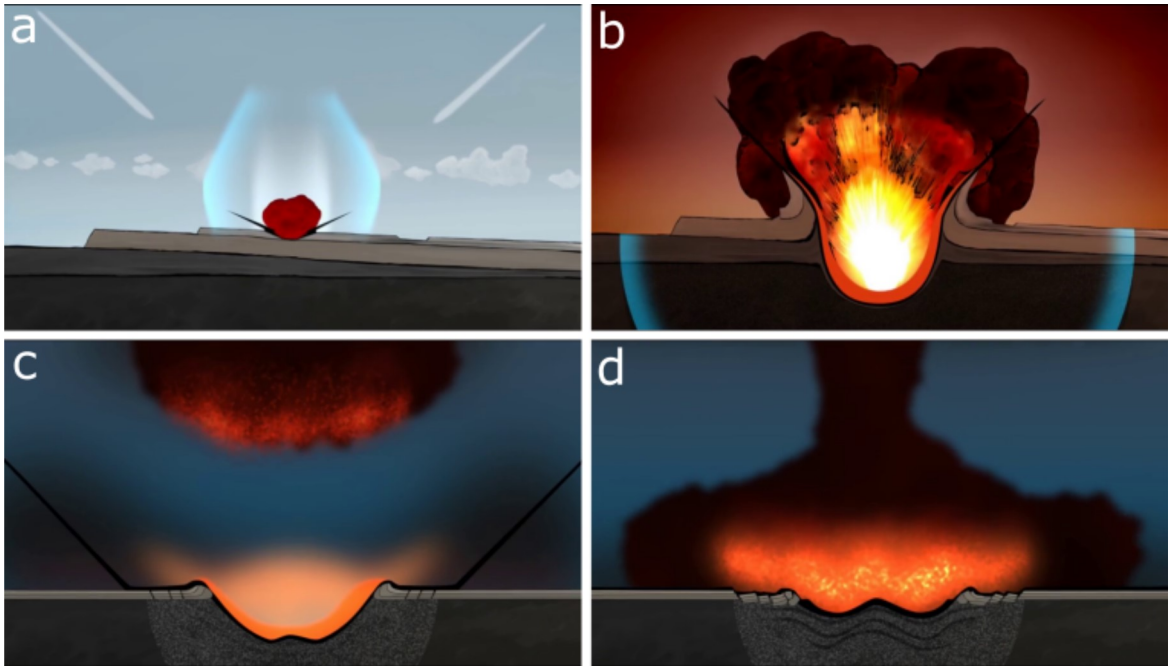


Fig. 2: The formation of the Ries crater:

a) Travelling faster than 20 km/s the > 1 km in diameter projectile impacts into the surface of the earth, in what is today southern Germany. Milliseconds before impact a pressure wave sweeps over the landscape.

b) The asteroid penetrates into the underground and comes to a stop as a highly compressed gaseous body. It explodes, ejecting vaporized, melted and fragmented rock. In the meantime, in the crater underground a shockwave propagates at about 70 000 km/h.

c) For a brief time, an unstable crater about 15 km wide and ca. 4.5 km deep is formed. Ejecta masses deposit on the crater rim with several hundred meters thickness. The crater floor begins to move upwards.

d) The central mushroom shaped cloud begins to collapse. A glowing hot mixture of solid, liquid and gaseous components falls back into the crater and on top of the ejecta blanket. Huge blocks slide from the crater rim inwards and enlarge the diameter to about 25 km.

Today the Nördlinger Ries is an outstanding natural area with many protected areas (https://riesnatur.de/) and it is a national geopark (https://www.geopark-ries.de/en/). With its fertile soils it has been settled since the Stone Age. The traces of this settlement activity and the traces of the impact have a decisive influence on the face of the Ries.

3. DIDACTIC CHALLENGES - DEEP TIME

Most of the relevant processes in geosciences cannot be observed directly. The time scale considered is very large and very different from that of a human being.

Fig. 4: Timeline on the floor in the Riescratermuseum, showing Earths history on 11.40 m length.

Fig. 5: Permanent exhibition on cosmic bodies, which shall be renewed.

Meteorites can tell us a lot about formation of the solar system and even about the interior of the planet we call home. Many of these questions are adressed in the current exhibition, but a common theme is difficult to find, especially for visitors without a guided tour.

A usual impression is that extraterrestrial material coming down to Earth, and especially impact processes are part of the past without actual relevance for us today, except at the cinema.

4. RENEWAL OF THE PERMANENT EXHIBITION

In reality objects from space hit Earth every day, every hour, every minute, every second. But since they are usually very small, their fall is rarely spectacular and usually not noticed.

The last night: Optical detection of meteors

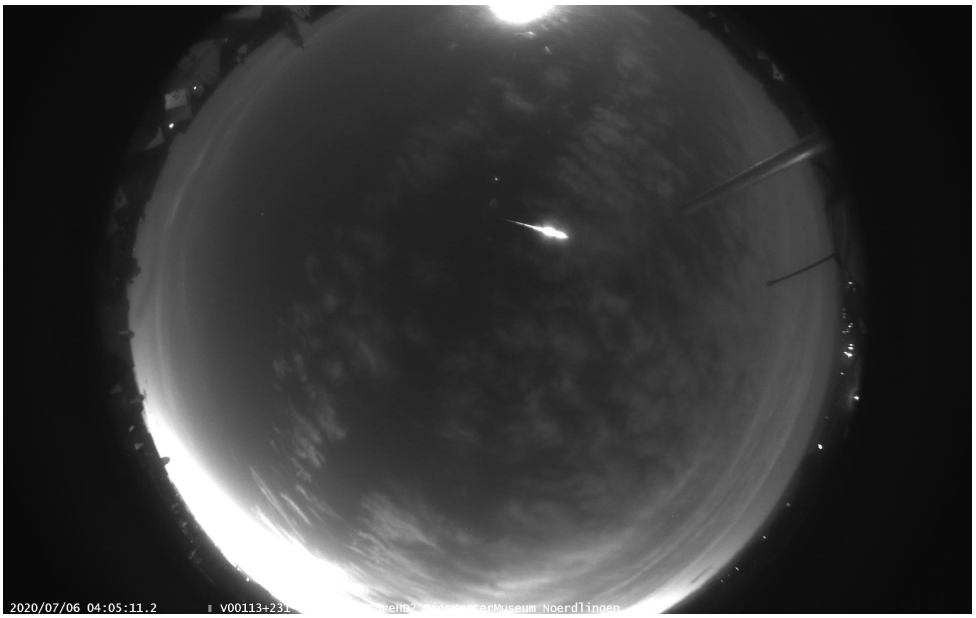
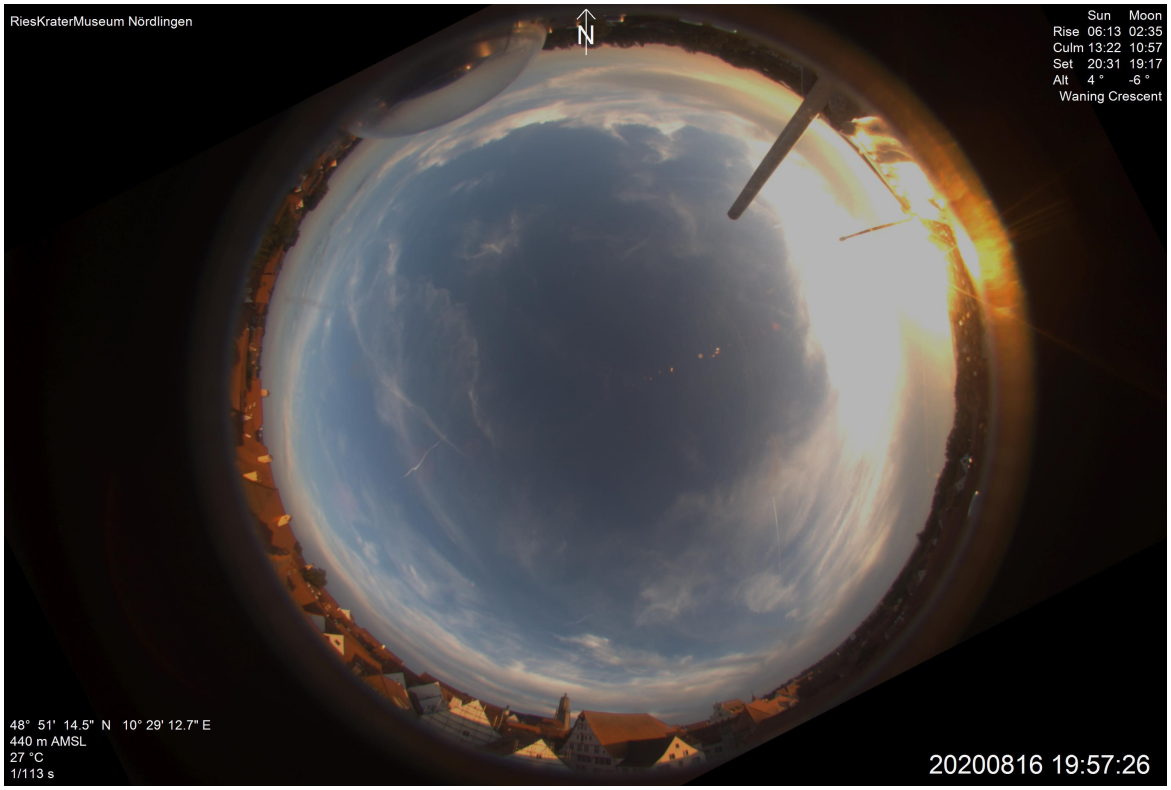


Fig. 6: With the meteor camera on top of the museums roof, one can watch meteors and fireballs over Nördlingen without staying awake at night. It records automatically when a meteor falls. Videos and pictures of the meteors of e.g. the last night, the last months or the last year will be shown in the museum.

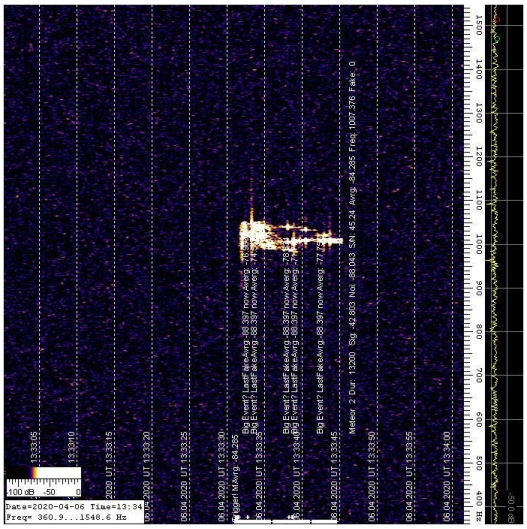


(http://www.rieskrater-museum.de/index.php/de/versteckt)

Fig. 7: Camera on the roof of the museum, showing the view of the sky above Nördlingen. Klick to get to the live page. Also a timelapse of the previous night (http://media.rieskrater-museum.de/20201118.mp4) can be watched on our website.

The last hour: Meteorscattering

When cosmic particles burn up in the atmosphere, their trail of ionised air reflects radiosignals. By detecting these reflections, meteors can be observed independent of weather and daytime.



(https://www.sternwarte-muenchen.de/media/projekte/latestMeteorShot.jpg)

Fig. 8: Reflections of a meteor detected in April 2020 by the radioastronomy group of the Bayerische Volkssternwarte, Munich (https://www.sternwarte-muenchen.de/projekte.html), Germany (Michael Holzner from the VSW). Klick to see the latest meteor shot.

You can also check the hourly rate of meteors detected in Munich here (http://www.volkssternwarte-muenchen.de/media/projekte/latestMeteorscatterChart-highres.Png). The diagram is updated every 15 minutes.

Every Second: Micrometeorites

Cosmic dust particles and micrometeorites fall down to earth every second. Micrometeorites are smaller than one mm and only visible under the microscope.

Fig 9: Micrometeorite (https://www.micrometeorites.org) collected by Thilo Hasse from the Museum für Naturkunde Berlin.

Every day: Meteorites

Larger meteorites statistically fall down every day on earth, but not a lot of them are found because some fall in remote areas, into the ocean or their fall is not observed, so no one knows where to search.

Fig. 10: The Neuschwanstein meteorite is the first meteorite that was recorded by cameras falling down to earth and consequently found in the area, calculated due to the direction of the fall. It fell in the year 2002 and its bright green trail in the atmosphere was observed by several thousand people in Bavaria.

Every 10 to 100 years: Smaller Asteroids

Processes of the past or science fiction? No - in contrast, we know that asteroid impacts on earth are bound to happen in the future, the only question is when. An example on how dangerous also smaller asteroids can be (which come to earth statistically on the order of 10-100 years) was the around 17 m large asteroid, which exploded in the atmosphere above the city of Chelyabinsk in Russia, in the year 2013.

There is ongoing research on how to protect our planet from asteroids. A mission to test if an asteroid can be deflected from its course by a 'kinetic impactor' is currently being prepared (Fig. 11).

Fig. 11: Sketch of a 'kinetic impactor': a space probe with high mass and speed impacts on an asteroid, with the aim to deflect it on a different trajectory and to steer it away from the orbit of the Earth.

Information on near-earth objects and impact risk as well as asteroid impact avoidance is either outdated or not mentioned at all in our museum in the current exhibition.

2. THE MUSEUM

[VIDEO] https://www.youtube.com/embed/KObdTeqHv1M?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0

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Fig 3: Old town of Nördlingen. The church is built of suevite, a breccia that was formed during the impact, containing rock and glass fragments as well as high-pressure minerals such as coesite and diamond.

The museum is located in the medieval old town of Nördlingen, which is a small town (ca. 20 000 inhabitants) in a rather rural area in Germany. We have around 30 000 visitors per year from which some are amateurs, such as school children and families, but also a large number of professionals and geoscience students from univiersities visit us.

5. CONCLUSION AND OPEN QUESTIONS

In our view, there are two major aspects:

1. Deep time and today: The processes that formed the Earth are ongoing today and in future. On human timescales we can look at these processes with a magnifying glass.

2. The tales of meteorites: how did they form and where do they come from? What do they tell us about the solar system and our home, the Earth.


What do you think of our approach?


Do you have suggestions how we could connect the two main aspects in a way, understandable for everybody?


Do you want to know more?

Please contact us. We hare happy to discuss suggestions and comments!

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