The Ries Impact Crater

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Time and location

- Formed 12 Ma ago (Miocene)
- 120 km northwest of Munich in the district of Donau-Ries.

Ries Crater

[http://www.unb.ca/passc/ImpactDatabase/EuropeMap.jpg]

[http://www.unb.ca/passc/ImpactDatabase/images/ries-105.jpg]

- Suevite (type of impact breccia) quarry in NE of crater

[http://www.unb.ca/passc/ImpactDatabase/images/ries-100.jpg]

- Aerial view

[http://www.unb.ca/passc/ImpactDatabase/images/ries-103.jpg]

- Crater rim

Inner basin

- Almost circular, relatively flat, inner basin
- 150 m below surface at center.
- 12 km in diameter.
- Covered by postimpact lake sediments.

Crater rim

- Outside the inner rim, a system of concentric faults extending to a diameter of 24 to 26 km.
- Referred to as *displaced megablocks*.
- “hummocky”!

Preimpact layerage

- Sedimentary deposits 620-750m thick
- Crystalline, mainly granitic, basement

Postimpact layerage

- 0-350m down: Post-impact lake sediments.
- 350-750m down: thick suevite layer
  - Suevite: “a polymict clastic breccia primarily derived from crystalline basement containing all stages of shock metamorphism, including melt.”

Impact

- Immediately after meteorite hit, *transient crater* formed of roughly 4 km deep.
- Unclear what caused the crater floor to be only 1 km deep.
  - *Structural uplift*, characteristic of many complex craters?

Analysis and Modeling

- Wünnemann, Morgan, and Jödicke of Imperial College and Institut für Geophysik reanalyzed data collected from Ries in the 1970s with modern analysis techniques
  - Seismic refraction data
  - Magnetotelluric depth soundings
  - Numerical simulations

Structural uplift

- Structural uplift associated with
  - increase in seismic velocity
  - increase in density
  - change in the magnetic or electrical signature
- Wünnemann et al. reanalyzed seismic refraction data to investigate whether there is an increase in seismic velocity.

[Wünnemann et al., Figure 2]

[Wünnemann et al., Figure 3]

6.0 m/s velocity boundary is reached at different depths inside crater and outside crater, suggesting structural uplift.

<- Inside crater

<- Outside crater

Magnetotelluric Investigation

- Wünnemann et al. further studied the distribution of electrical conductivity of the deep structure below the Ries crater by means of magnetotelluric (MT) measurements.
- The MT method is used to detect highly conductive structures in deep subsurface.
- Used measurements over a 73 km profile, with spacing of about 5 km between measurements.

[Wünnemann et al., Figure 5]

- Note: slant of area of high conductivity to left, Model III excludes deep-reaching fractures below crater.

Numerical Simulation

- Wünnemann et al. finally used the well-known SALE hydrocode with these parameters:
  - Rock: yield strength, pressure, temperature, internal friction, cohesion
  - Acoustic fluidization: viscosity, decay time
    - Strongly linked with fragmentation size of rocks underneath structure.

[Wünnemann et al., Figure 7]

- Main conclusion I took away was that the top layer is composed of melt-rich material that corresponds to the suevite layer.

[Wünnemann et al., Figure 8]

- Wow, >50 Gpa is a lot of pressure.

References

- K Wünnemann, JV Morgan, H Jödicke. *Is Ries crater typical for its size? An analysis based upon old and new geophysical data and numerical modeling.* In: T. Kenkmann, F. Hörz and A. Deutsch, Editors, Large Meteorite Impacts III, Geol. Soc. Am., Boulder, CO (2005), pp. 67–83 Special Paper 384.
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