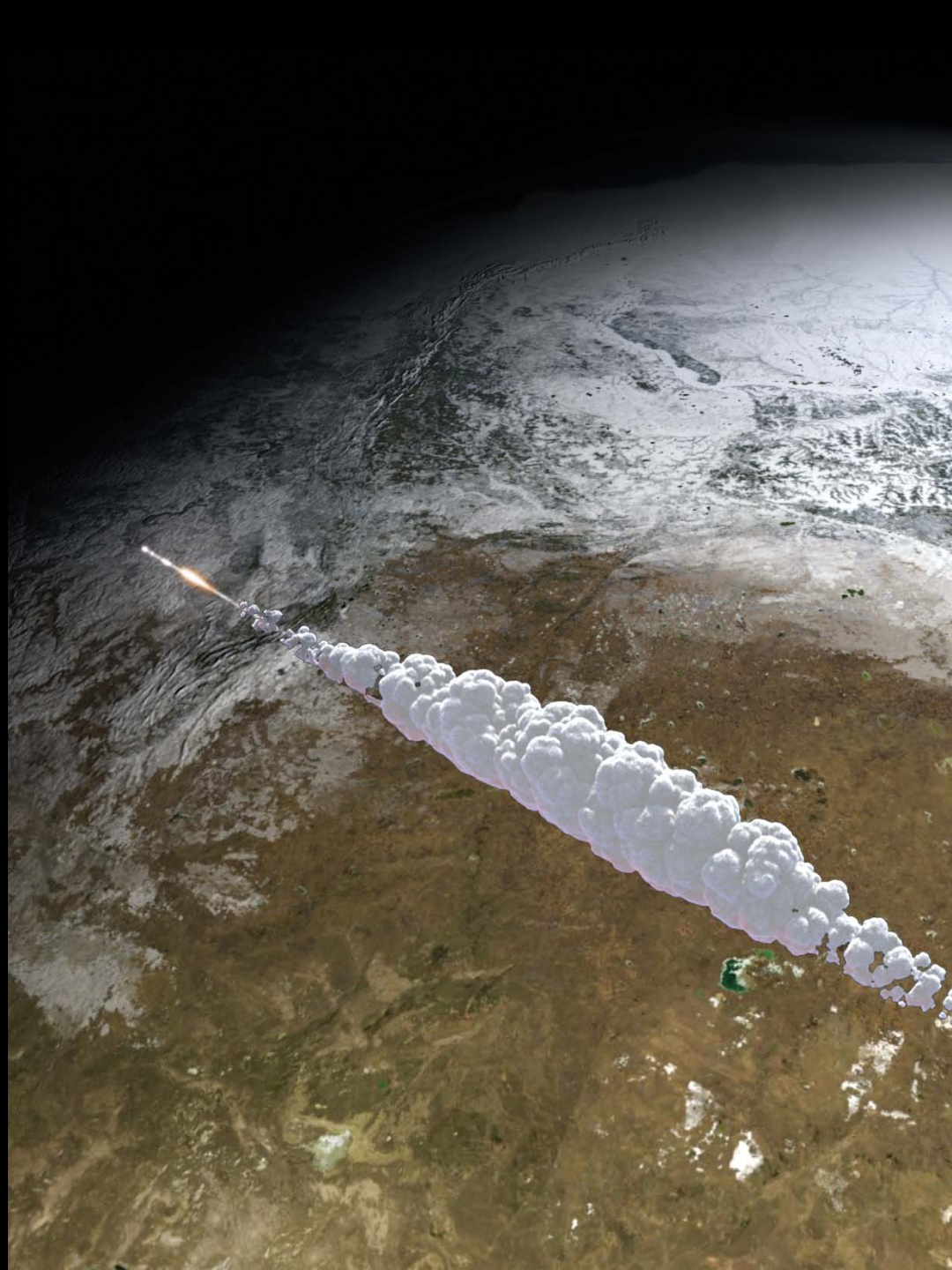
Do Natural Glasses Overestimate the Danger from Airbursts?



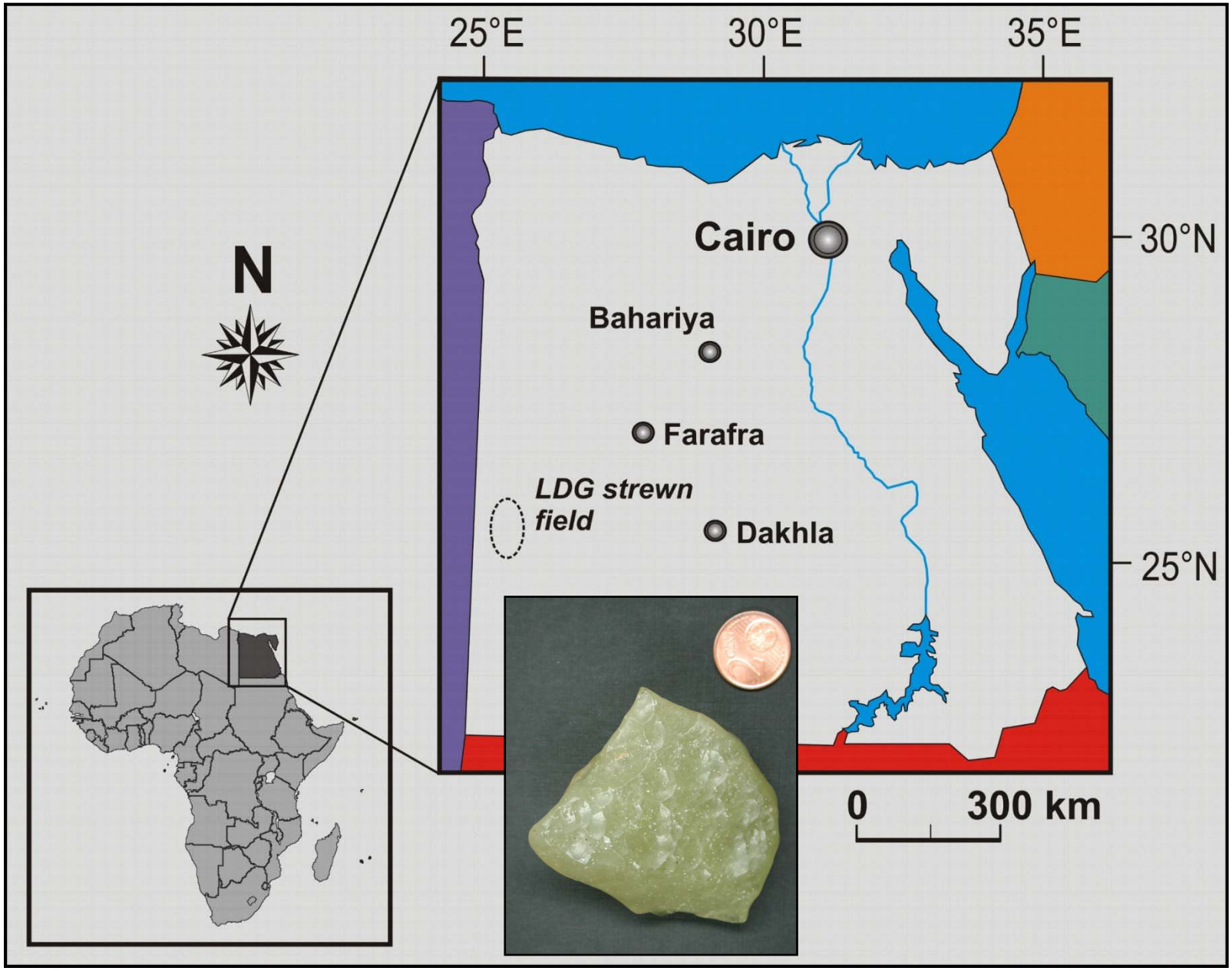
Christian Koeberl

University of Vienna; Vienna, Austria

Libyan Desert Glass (LDG)

- is an enigmatic type of natural glass
- found in an area with an extension of several thousand square kilometers.
- literature values on the extent vary between about 2000 and 6500 km²
- strewn field is located between sand dunes of the southwestern corner of the Great Sand Sea in western Egypt, near the border to Libya.

Libyan Desert Glass strewn field



In the LDG strewn field

In the LDG strewn field

- BP and Oasis are the only known impact structures in Libya

- Proximity to the Libyan Desert Glass (LDG) strewn field in the Libyan Desert (on the Egyptian side) led to the suggestion that these craters might be related to the LDG

- In macroscopic examination, the glass shows irregular shapes with signs of sand abrasion and other erosion features
- The fission track age of LDG has been determined to be about 29 Ma
- LDG is a very silica-rich natural glass with about 96.5-99 wt.% SiO_2, and shows a limited variation in major and trace element abundances.
- So far rather few trace element studies of LDG exist, but the available data (e.g., REE) indicate abundances and interelement ratios that are typical for upper crustal rocks
- Isotope data also agree with upper crust origin

Summary of shocked quartz studies:

Discovery of shock-produced planar microdeformation features, i.e., planar fractures (PFs), planar deformation features (PDFs), and feather features (FFs), in quartz grains from bedrock samples from within the LDG strewn field.

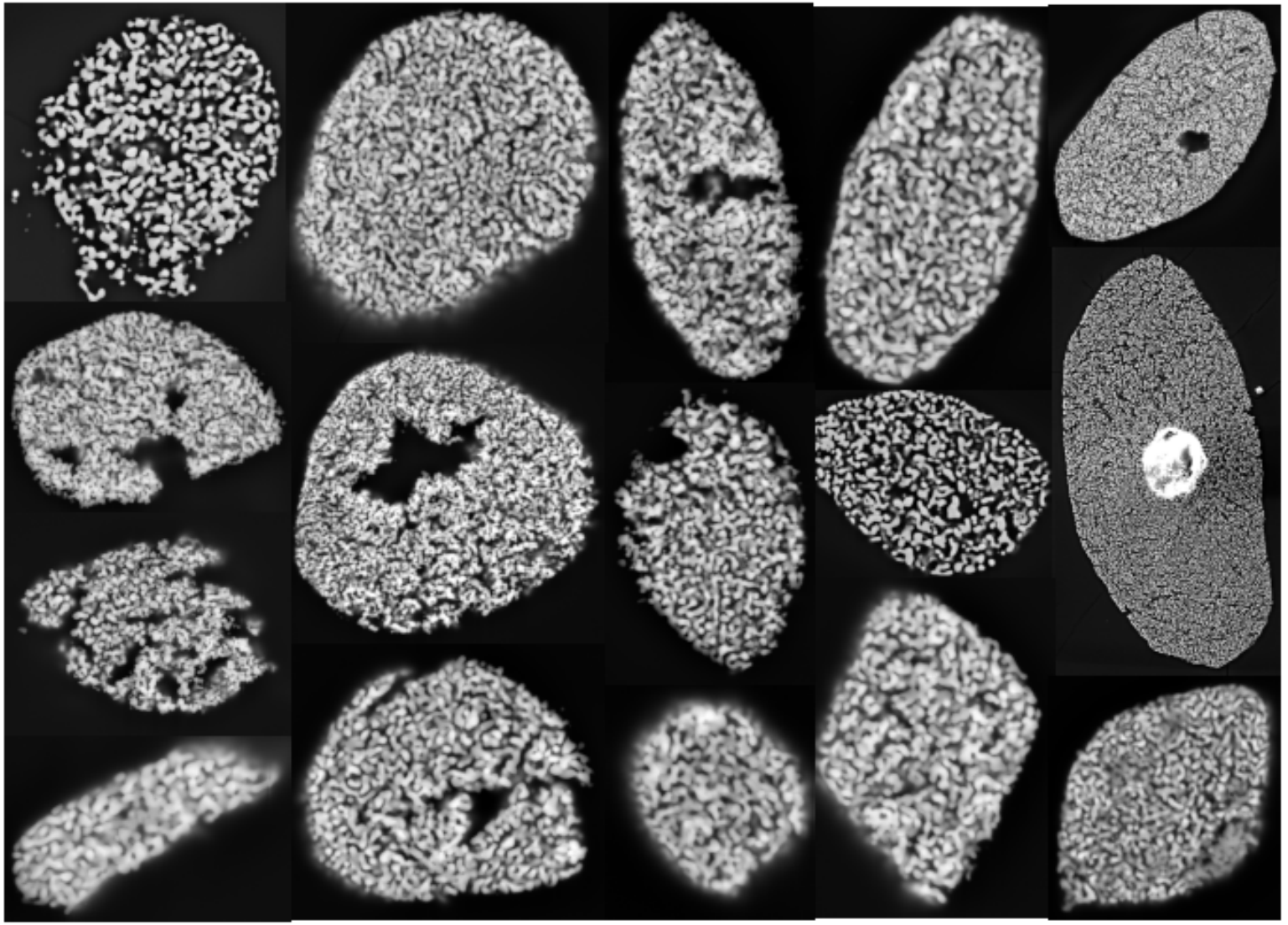
The observations show that the investigated samples were shock to moderate pressure, likely not more than about 20 GPa.

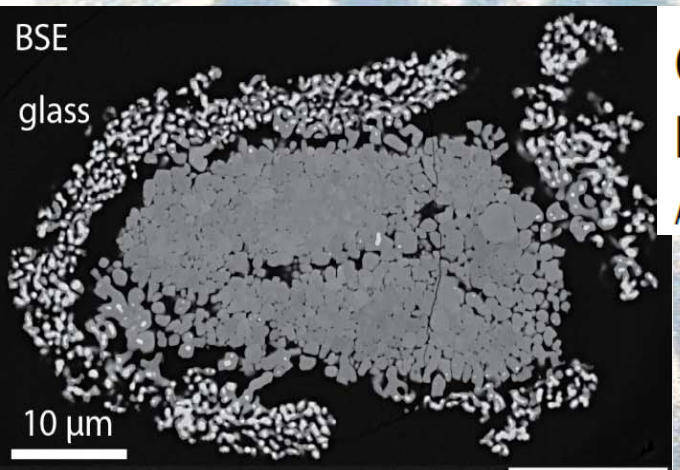
We interpret these observations to indicate that there was a physical impact event, not just an airburst, and that the crater has been almost completely eroded since its formation.

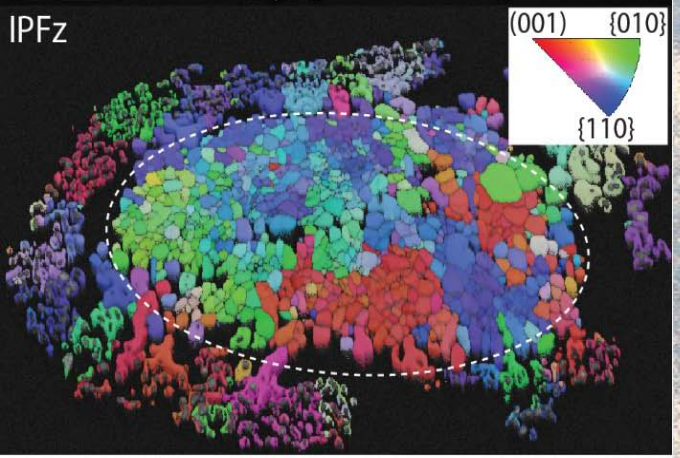
Zircon in Libyan desert glass: 90 % dissociated to ZrO_2

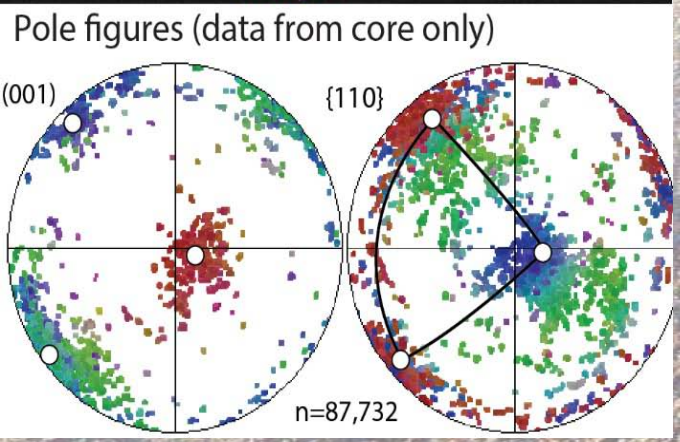
All grains are <50 µm

Most < 25 µm









Overestimation of threat from 100 Mt–class airbursts? High-pressure evidence from zircon in Libyan Desert Glass

Aaron J. Cavosie[1] and Christian Koeberl[2,3]

FRIGN zircon identified in LDG

evidence of former reidite; 30 GPa

High-pressure mineral = shock wave shock wave = impact crater

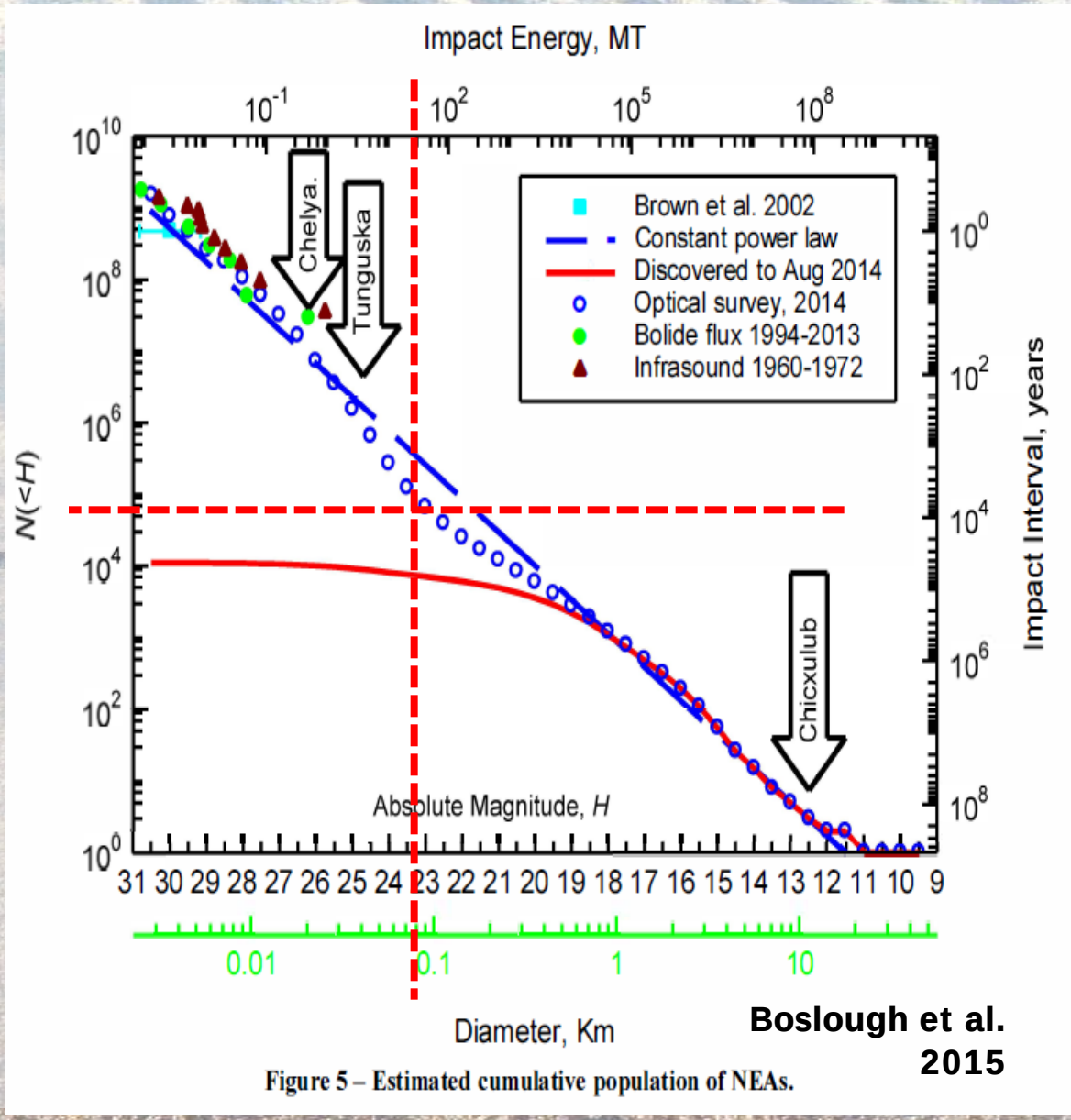
Cavosie and Koeberl, 2019, Geology

LDG has been suggested to have resulted from a 100 Mt airburst

Optical surveys of NEOs predict that a 100m object, sufficient to generate a 100 Mt airburst, should impact Earth orbit every ~10,000 years

But: the geological record does not support formation of 500 LDG-forming events over the last 5 Myr (or any interval...)

this is a very good thing...

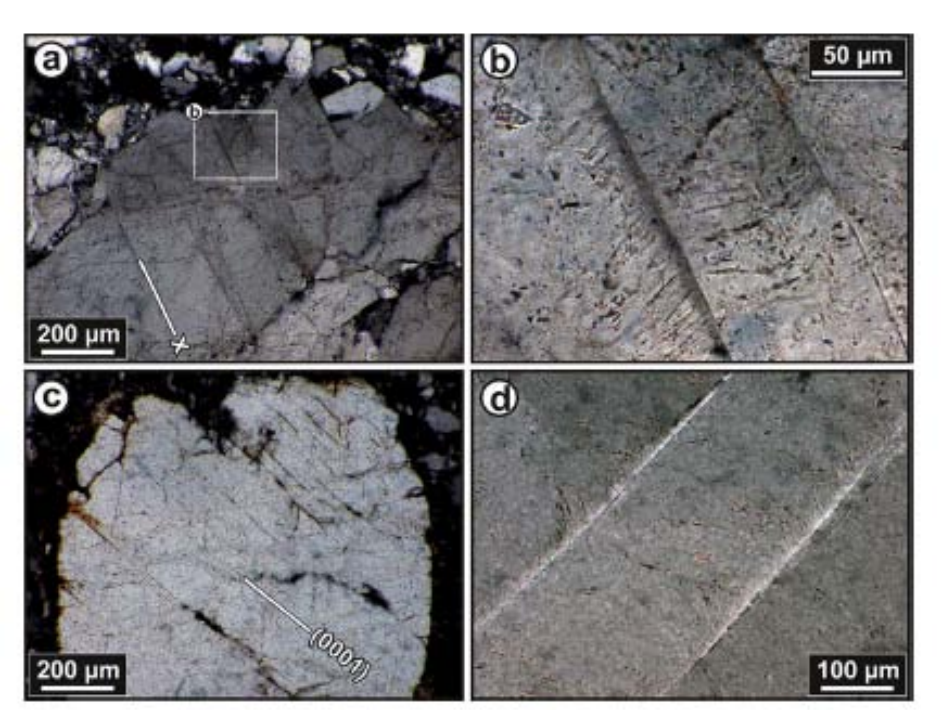


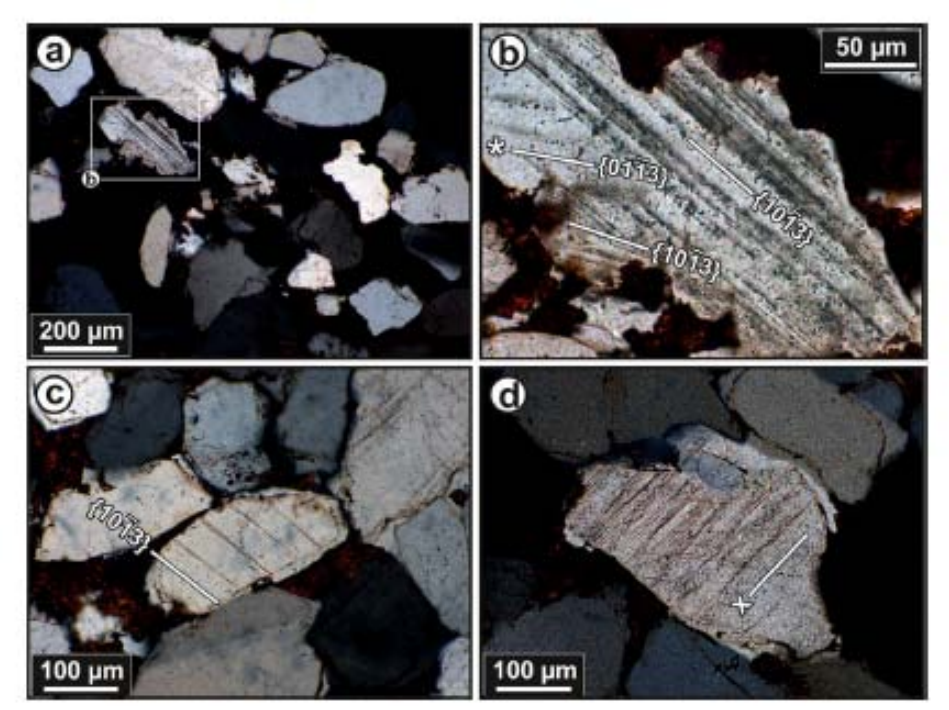
Boslough et al. 2015

Figure 5 – Estimated cumulative population of NEAs.

Consistent with recent shocked mineral discoveries

Shocked quartz in sandstone outcrops - LDG field





Kleinmann et al. 2001;
Koeberl and Ferriere 2019

Conclusion:

All these observations strongly indicate that there was a physical impact event, not just an airburst, and that the crater has been almost completely eroded since its formation.

Conclusions 2:

Other glasses of disputed origin that contain zircon with evidence of former reidite, such as Australasian tektites, similarly were also likely made during crater-forming events. Public-policy discussions and planning to mitigate hazards from airbursts caused by NEOs are clearly warranted, but should be cautious about considering LDG or other glasses with evidence of high-pressure shock deformation as products of an airburst. At present, there are no confirmed examples of products from a 100 Mt–class airburst in the geologic record.

Thanks to L. Ferriere and A. Cavosie for collaboration and some slides