SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Analytical, Environmental and Geo-Chemistry

has the honor to invite you to the public defense of the PhD thesis of

Pim Kaskes

to obtain the degree of Doctor of Sciences

Joint PhD with ULB

Title of the PhD thesis:

Reconstructing the first moments after the Cretaceous-Paleogene boundary impact event: high-resolution petrography and geochemistry of proximal and distal Chicxulub impactites

Promotors:

Prof. dr. Philippe Claeys (VUB)
Prof. dr. Nadine Mattielli (ULB)
Prof. dr. Steven Goderis (VUB)

The defense will take place on

Wednesday, April 26, 2023 at 15h in auditorium D.2.01

The defense can also be followed via a livestream:
https://us06web.zoom.us/j/5835317669?pwd=R1B3bkMvdENTUXJFVUVOKyswb2Rrdz09
Meeting ID: 583 531 7669
Passcode: pdBN11

Members of the jury

Prof. dr. Yue Gao (VUB, chair)
Prof. dr. Karen Fontijn (ULB, secretary)
Prof. dr. Sean Gulick (UT Austin, USA)
Prof. dr. Natalia Hauser (University of Brasília, Brazil)
Prof. dr. Lutz Hecht (Museum für Naturkunde, Berlin, Germany)

Curriculum vitae

Pim Kaskes obtained his BSc and MSc degree (cum laude) in Earth Sciences at the Vrije Universiteit Amsterdam after which he worked for Naturalis Biodiversity Center. In October 2017, he started a PhD at AMGC-VUB and ULB on drill core material from the IODP-ICDP Expedition 364 from the Chicxulub crater in México. In June 2018, he was granted a FWO PhD fellowship dedicated to the study of well-preserved Chicxulub impact ejecta deposits in North and South America. During his joint PhD, Pim has (co-)authored 21 international peer-reviewed articles of which 3 as first author (one is currently submitted), he has presented his work at 12 conferences, and has supervised 11 BSc/MSc thesis students. He is a recipient of the Shoemaker, Barringer and Pierazzo international awards for meteorite impact research.

Abstract of the PhD research

The Chicxulub meteorite impact, ~66 million years ago, marks one of the most catastrophic events in Earth's history. This event is linked to abrupt climate change and the Cretaceous-Paleogene (K-Pg) boundary mass extinction, responsible for the demise of 75% of life including the iconic non-avian dinosaurs. Fractured, molten, and vaporized rocks from the impact site were rapidly ejected into the atmosphere. This likely triggered the environmental stress at the K-Pg boundary, but the timing and exact mechanisms of these impact-induced processes are still poorly understood. The ~200-km-wide Chicxulub impact crater, buried below the Yucatán Peninsula in México, forms a unique natural laboratory to study these processes. This crater is the only impact structure on Earth associated with ejecta preserved worldwide, which allows for a direct comparison between material from the source area and its global deposits. In this PhD thesis, I present high-resolution geochemical and petrographic results from rocks from the Chicxulub crater region and on well-preserved K-Pg boundary ejecta deposits. This work allows for a new, detailed reconstruction of the sequence of geological and biological events that occurred in the moments prior, during and in the direct aftermath (minutes - years) of the Chicxulub impact.

The first part of this thesis is centered around crater suevites (impact-melt-bearing breccias) obtained from the Chicxulub northern peak ring by the recent IODP-ICDP Expedition 364 drilling campaign. The ~100 m thick suevite sequence is likely formed within 1 day after impact by the rapid arrival of ocean water in the crater that interacted with the underlying melt and subsequently flooded the crater basin. The overlying sediments are capped by a marlstone that is rich in iridium, likely formed by settling of meteoritic dust (<20 years after impact). Based on the novel clumped isotope thermometry technique, we found hot secondary carbonate phases formed deep within the Chicxulub crater, which likely represent the recombination of CaO and impact-released CO_2. The second part of the thesis focuses on terrestrial K-Pg boundary sections at a distance of 2000-3000 km from the Chicxulub crater. Micro-X-ray fluorescence (μXRF) and grain-size analysis of the K-Pg boundary sediments are combined with climate modelling. Our results show that not sulfur or soot but a massive plume of micrometer-sized silicate dust with a long atmospheric lifetime of ~15 years was a key factor driving the K-Pg impact winter, steering the photosynthetic shutdown, and ultimately triggering the dinosaur mass extinction.