VUB SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Archaeology, Environmental Changes & Geo-Chemistry

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

Jérôme Roland

to obtain the degree of Doctor of Sciences

Joint PhD with Université Libre de Bruxelles

Title of the PhD thesis:

Condensation processes in impact-related vapor plumes evidenced by isotope fractionation

Promotors:
Prof. dr. Steven Goderis (VUB)
Prof. dr. Vinciane Debaille (ULB)

The defense will take place on

Wednesday, January 17, 2024 at 16h in auditorium AY2.112 (Solbosch, ULB)

The defense can also be followed through a live stream on Teams

Members of the jury

Prof. dr. Nadine Mattielli (ULB, chair)
Prof. dr. Christophe Snoeck (VUB, secretary)
Prof. dr. Paolo Angelo Sossi (ETH Zürich, Switzerland)
Prof. dr. Mark Rehkämper (Imperial College London, UK)

Curriculum vitae

Jérôme Roland (1995) completed his B.Sc. and M.Sc. in Geological Sciences at the Université Libre de Bruxelles. During his Master, he took great interest in cosmochemistry and the history of the early solar system. Following the successful datation of several martian meteorites, he decided to pursue a PhD. He started his PhD project in October 2019, funded by the F.R.S-FNRS, working on evaporation and condensation effects in meteorites. Jérôme presented his work at several international conferences and published his work in various international, peer-reviewed journals.

Abstract of the PhD research

This PhD thesis focuses on the comprehensive chemical and isotopic characterization of various meteorite types, aiming to enhance our understanding of the processes that shaped the early solar system. The study centers on the volatility-controlled evaporation and condensation of elements related to asteroid impacts, specifically investigating isotopes of moderately volatile elements zinc, gallium, copper, and iron. The first part of this project was dedicated to the development of a Ga purification technique for precise isotope measurements. Once established, this method was applied to meteorite samples. Most meteorites are regarded to be pristine objects, which is not always the case. Some processes such as thermal metamorphism, aqueous alteration or impact-shock can significantly alter the chemical and isotopic composition of a meteorite. To investigate this, we studied the bulk isotopic compositions of metal-rich equilibrated ordinary chondrites (H6). The studied isotope systems show a correlation between the absolute range in isotopic compositions and the 50 % condensation temperature, with the more volatile elements exhibiting a wider range of fractionation. The range of fractionation observed does not appear to be linked to the shock stages or weathering grades of the samples. Their compositions could thus be inherited from the early solar nebula and accretion processes of the ordinary chondrites parent bodies, with minor effects from thermal metamorphism. In a next chapter, metal-rich CB- and CH-type carbonaceous chondrites are studied, which are thought to have originated in an impact-vapor plume. We investigated their bulk elemental compositions and Zn, Ga, Cu, and Fe isotopic compositions. The observed distinctions at the isotopic level suggest complex formation processes. This work concludes that metal in CB and CH chondrites originated from different locations within the same impact-related vapor plume. Some CB chondrites appear to have originated in an environment with slower cooling rates and higher temperatures, while other CB and CH chondrites formed under faster cooling rates, without reaching equilibrium. The last part of the thesis focuses on a martian meteorite that was found in Antarctica in 2012. This sample has been characterized for its major and trace elements compositions and dated using the Lu-Hf and Sm-Nd isotopes systems. Overall, this PhD dissertation enhances our understanding of meteorite evolution and their formation in the early solar system.