VUB 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

Ryoga Maeda

to obtain the degree of Doctor of Sciences

Joint PhD with ULB

Title of the PhD thesis:

Chemical and isotopic characterization of Antarctic meteorites: the chemical and isotopic effects of thermal processing and terrestrial weathering on the (re-)distribution of trace elements in chondrites

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

The defense will take place on
Monday, March 6, 2023 at 16h in auditorium E.0.04

The defense can also be followed through a livestream via: https://teams.microsoft.com/l/meetup-join/19%3ameeting_YTAwYzYwY2UtMjBiMi00M2Y1LTkzOTctNjgyZTA5MDA0YWU0%40thread.v2/0?context=%7b%22Tid%22%3a%22695b7ca8-2da8-4545-a2da-42d03784e585%22%2c%22Oid%22%3a%22b02744b4-554c-4b61-aede-7ad39020fd8d%22%7d.
Meeting ID: 367 135 841 582
Passcode: VZ4fgm

Members of the jury

Prof. dr. Yue Gao (VUB, chair)
Prof. dr. Nadine Mattielli (ULB, secretary)
Dr. Conel M. O'D. Alexander (Carnegie Institution of Washington)
Prof. dr. Martin R. Lee (University of Glasgow)

Curriculum vitae

Ryoga Maeda obtained his BSc and MSc at Tokyo Metropolitan University in Japan. In 2018, he started as a PhD researcher at the Vrije Universiteit Brussel where his research focused on a detailed chemical and isotopic characterization of Antarctic meteorites using several state-of-the-art instrumentations. He has (co-)authored 5 international peer-reviewed articles of which 4 as first author (one is accepted with minor revisions while another is currently submitted) and has presented his work at multiple international conferences. During his PhD, Ryoga Maeda also participated in 2 international scientific internship programs and 1 research expedition in Antarctica.

Abstract of the PhD research

Meteorites, any natural solid objects from interplanetary space that survived their passage through Earth's atmosphere and reached the surface, represent the only large volume of extraterrestrial material available on the Earth today. These precious extraterrestrial samples retain critical information regarding the Solar system processes, and thus they have been investigated from various research perspectives to refine our understanding of the history of the Solar system. More than 41,000 meteorites have been collected in Antarctica, which today constitute more than 60% of the population of meteorites by number. Moreover, Antarctic meteorites include many "rare" types of meteorites such as martian and lunar meteorites, and hence the Antarctic meteorite collection plays a pivotal role for cosmochemistry. Before these meteorites were collected in Antarctica, they were buried in the ice sheets for a long time, on average on the order of hundreds of thousands of years. Following their long residence time, Antarctic meteorites can be altered mineralogically and chemically to some extent, which means that information on their parent bodies and the processes they underwent was modified and lost. Therefore, the effects of Antarctic weathering have been assessed extensively to determine whether or not the results obtained represent the original information. However, the underlying mechanisms of the alteration and weathering affecting meteorites remain relatively poorly constrained.

My PhD research aims to encompass a detailed chemical and isotopic characterization of Antarctic meteorites to improve our understanding of the (re-)distribution of various trace elements in specific meteorite types and the effects of the (re-)distribution on radiogenic isotope systematics. As Antarctic meteorites can be affected by alteration, the first task of this work has been dedicated to assessing the effects of Antarctic alteration on the chemical and isotopic compositions of H group of ordinary chondrites, the most abundant class of meteorites. The main focus is placed on the systematic study of rare earth elements including their isotope systematics such as Sm-Nd and Lu-Hf.

This PhD thesis first demonstrates that the effects of Antarctic alteration on the Sm-Nd and Lu-Hf systems in bulk HCs are generally limited and thus the Sm-Nd and Lu-Hf systems preserve their original compositions during Antarctic alteration. Secondly, the underlying mechanism of Antarctic alteration observed in the first PhD study was investigated using in-situ measurement techniques including state-of-the-art instrument laser ablation-inductively coupled plasma-time of flight-mass spectrometry (LA-ICP-TOF-MS). Simultaneously, the potential of LA-ICP-TOF-MS as a novel technique to study the elemental distribution is examined and evaluated. Finally, the distribution of lithophile elements among the constituent minerals in H chondrites is documented at the microscale and their re-distribution during thermal metamorphism on the parent body(ies), i.e., the thermal effects of the lithophile element distribution are quantified and discussed, with a direct link to the heterogeneity recorded in the Sm-Nd and Lu-Hf isotope systematics of bulk chondrites. Overall, this thesis confirms the generally pristine nature of Antarctic meteorites and asserts the thermal processes that took place on the parent bodies of ordinary chondrites.