SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Physical Geography

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

Mary John Kisaka

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Volcanic history and controls on fluoride contamination of water resources at Mt. Meru, Northern Tanzania

Promotors:
Prof. dr. Matthieu Kervyn (VUB)
Prof. dr. Karen Fontijn (ULB)
Dr. Ceven Shemshanga (University of Dodoma)
Dr. Ines Tomašek (Université Clermont Auvergne)

The defense will take place at Vrije Universiteit Brussel, in room D2.01 on
Monday, February 20, 2022 at 14h00

Members of the jury

Prof. dr. Benoît Smets (VUB, chair)
Prof. dr. Martine Leermakers (VUB, secretary)
Prof. dr. Steven Goderis (VUB)
Prof. dr. Pierre Delmelle (UCL)
Prof. Dr. Nadine Mattielli (ULB)

Curriculum vitae

Mary Kisaka holds a bachelor of science in Geology from the University of Dar es Salaam (Tanzania) and a MSc degree in Environmental Management and Technology from Ardhi University, Dar es salaam (Tanzania). She has benefited from a VLIR-UOS PhD scholarship for her research in the department of Geography, VUB. She has published one scientific article from her PhD research in the international peer-reviewed Journal of Volcanology and Geothermal Research. She frequently presented her work at different international conferences. Her research interest is in volcanology and environmental geology in the context of natural hazards.

Abstract of the PhD research

Mt. Meru, in northern Tanzania, is an active stratovolcano. Earlier studies suggested that the volcanic geology of Mt. Meru is dominated by debris-avalanche deposits (DAD), lava flows, and major pyroclastic formations indicative of Plinian-style eruptions. However, the stratigraphy, geochemistry, petrology, spatial extent, and chronology of these pyroclastic deposits had not been systematically documented, resulting in only limited knowledge of the tephro-stratigraphic relationship and understanding of the magmatic evolution of Mt. Meru. In addition, the impacts that Meru deposits might have on the quality of the groundwater resources are not well characterised. Yet, the surface and groundwater around Meru have been shown to be heavily contaminated by fluoride (F^-), often exceeding the WHO threshold of 1.5 mg/L for drinking water.

Based on extensive field mapping and deposit characterisation, indicate that Meru had at least three moderate-to-large-scale explosive eruptions over the past 40,000 years. The better preserved and larger MXP3 deposits suggest a minimum bulk volume of 2.5 km^3 corresponding to a magnitude of 5.4. The volcanic rocks of Mt. Meru range in composition from nephelinite to phonolite. Compositional variations largely reflect fractional crystallisation, with an influence of magma mingling. Subtle variations in whole-rock composition and mineralogical characteristics between and within Meru deposits suggest the existence of a chemically zoned magma chamber beneath Mt. Meru. The total F^- analysis indicated F^-occurs in all rock types with a mean value varying from 1740 ± 400 mg/kg to 3060 ± 2000 mg/kg. Dissolution experiments revealed the highest soluble F^-, ca. 15-50%, in the analysed DAD samples. Among others, amphibole, titanite, biotite, and apatite were petrographically confirmed as fluorine-bearing minerals. Comparing the abundance and the composition of the glassy groundmass with the mineral phases, the former contains most of the total F^-content. The high total F^- in rocks is related to the alkaline nature of the rock compositions, having high proportions of halogen-bearing minerals and glass. The high F^- release from DAD is linked to surface weathering processes progressively weakening the mineral structures and glass matrix.

Understanding the eruption history of Mt. Meru, the geochemical characteristics of its rocks, and the potential sources and processes controlling fluoride enrichment are contributing to future hazard assessment, water resource management, and environmental protection in Arusha and other semi-arid regions along the rift.