UNIVERSITÄT BERN

Institute of Geological Sciences Kolloquium Seminar

Monday, 31th March 2025

at 16:15 Studer Auditorium, 2 OG

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"The Archean geological water cycle"

The geological water cycle (or the deep water cycle) consists of water-rock interactions between the hydrosphere/atmosphere and lithosphere. This water plays a critical role in geological processes, for example, promoting melting and the formation of new continental crust, the mobilisation of economic metals, rock reactivity and rheology, and seismic activity. In the modern day, the most dominant form of the geological water cycle is the uptake of water in mantle-derived rocks in the oceans, and release of this water during subduction to melt overlying lithologies and form volcanic arcs. In the Archean, however, the geological water cycle is less well understood. This is particularly because (i) there are rare ophiolites from this timeframe, and lithologies responsible for water uptake and release may have been different and (ii) because the mode of tectonics is argued, meaning that the geodynamics and therefore conditions of water release are not well understood. This presentation will focus on the processes of hydration and dehydration of ultramafic to mafic rocks from Archean greenstone belts (komatiites and komatiitic basalts). Geochemical evidence, such as trace element and oxygen isotopic data, suggest that these rocks were initially hydrated on an Archean oceanic plateau after their eruption. During this process, they sequestered fluid mobile elements such as boron from the seawater, and produced molecular H2 by the oxidation of Fe, a possible source of energy for early chemosynthetic life. Most greenstone belts have been metamorphosed to greenschist-amphibolite facies, indicating that they experienced some form of burial during Earths earlier history. Phase equilibria modelling shows that if komatiites are buried to higher temperature conditions (>750 °C), the breakdown of hydrous phases could release significant quantities of water into the surrounding rocks, promoting fluid-fluxed melting of surrounding lithologies. In the case of the Barberton Greenstone Belt, which contains ~8 % komatiite and ~20% basalt by volume, fluid release from the komatiite into the basaltic lithology would promote wet melting of basalts to form tonalite-trondhjemite-granodiorite (TTG) series rocks, important constituents of Archean continental crust. While not abundant in the geological record, the role of ultramafic rocks in the Archean geological water cycle is evident, as is their importance in ocean floor processes and the formation of the Earth's first TTG crust.