

Archean komatiite volcanism controlled by the evolution of early continents

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Komatiites are rare, ultra-high temperature (~1600°C) lavas erupted almost exclusively prior to 2.5 billion years ago and are vital to our understanding of the Earth's thermal evolution. These hot and highly turbulent flows entrained discrete sulfide liquids that concentrated nickel, copper and the platinum group elements locally to economic proportions.

The spatio-temporal occurrence of the largest, most high temperature mineralized komatiites is poorly understood as they appear to be heterogeneously distributed within Archean Cratons. In addition, current mineralization models do not explain the geodynamic setting and the large range of metal concentrations that are observed in mineralized komatiites.

In this study we demonstrate a dynamic link between the formation, stabilization and evolution of the early continental crust, and the location, volcanology and extent of komatiite volcanism. We combined Lu-Hf isotopes and U-Pb geochronology to map the four-dimensional evolution of the Yilgarn Craton, Western Australia, and reveal the control of the progressive development of an Archean micro-continent on the geodynamic setting of komatiite volcanism. We show that the evolution of the first continents controlled the location of major volcanic events, crustal heat-flow and the addition of deep mantle material to the surface environments of the early Earth.

In addition, we used sulfur isotope measurements on sulfides from komatiites and local volcanogenic and sedimentary country rocks to show that sulfur degassing was a critical component of the volcanic and mineralizing processes. Rapid and pervasive sulfur degassing (>90%) associated with such voluminous and cataclysmic eruptions was most likely a contributing factor for economic mineralization. This komatiite 'redox filter', whereby reduced sulfur in the sulfide liquid was exchanged for oxidized sulfur in the fugitive gas, had the potential to influence the geochemical evolution of the atmosphere and ocean on the Archean Earth.

Jeudi 16 janvier 2014 à 11h
Salle de conférences d'ISTerre

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