Iron redox and viscosity of Erebus volcano phonolite lava (Antarctica): implications for lava lake convection and degassing processes

CHARLES LE LOSQ[1*], DANIEL R. NEUVILLE[1], ROBERTO MORETTI[2,3], DOMINIQUE DE LIGNY[4], YVES MOUSSALAM[5], FRANÇOIS BAUDELET[6], CLIVE OPPENHEIMER[5]

[1]Géochimie&Cosmochimie, IPGP, Paris, France, lelosq@ipgp.fr (* presenting author)
[2]Centro Interdipartimentale di Ricerca in Ingegneria Ambientale (CIRIAM) & Dipartimento di Ingegneria Civile, Napoli, Italia, moretti@ov.ingv.it
[3]Istituto Nazionale di Geofisica e Vulcanologia, Napoli, Italia, moretti@ov.ingv.it
[4]Laboratoire de Physico-Chimie des Matériaux Luminescents, Université Lyon 1, Villeurbanne, France, dominique.de-ligny@univ-lyon1.fr
[5]Geography Dept, Cambridge, UK, co200@cam.ac.uk
[6]SOLEIL, St Aubin, France, francois.baudelet@synchrotron-soleil.fr

Erebus is an intraplate volcano associated with extensional tectonics, mantle upwelling and high heat flow. It is famous for its long-lived lava lake, a rare phenomenon seen at just a few other volcanoes. Such lava lakes imply steady-state magma input, convection and degassing. They represent particularly convenient “windows” into the behaviour of magma plumbing systems. The Erebus lava lake is further distinguished by its phonolitic composition, with abundant megacrysts of anorthocolase feldspar. The eruptive activity is characterised by two kinds of behaviour: (i) passively degassing lava lake, and (ii) intermittent Strombolian eruptions. An important question to address is what physico-chemical mechanisms drive these contrasting styles of eruption. One hypothesis is that the lava lake activity is associated with open-system degassing, while the Strombolian phases are related to closed-system degassing.

Observations of the emissions of passive and explosive degassing and analysis of the sulfur contents of melt inclusions from the Erebus magmatic lineage are both consistent with a reducing-upwards redox trend in the magma system. Oxygen fugacity changes, occuring between the magma chamber and the lava lake surface, will control the redox state of sulfur and iron, impacting both the melt’s thermodynamic and rheologic properties.

The next key step is to make direct measurements of redox conditions in Erebus samples to test model results. Moreover, no rheological data exist on Erebus lava. Therefore, we performed X-ray absorption spectroscopy (XAS) at the iron K-edge experiments under controlled atmosphere at high temperature, and viscosity experiments on the lava. The obtained data bring informations about the oxygen fugacity evolution of the lava between the magma chamber and the surface, and its rheology in the superficial lava lake. These data will constrain the existing eruptive models, and allows to better understand the Erebus dynamic and behavior.

Holocene deposition of atmospheric REE in Europe

GAËL LE ROUX[1,2,*], NATHALIE FAGEL[3], FRANCOIS DE VLEESCHOUWER[1,2], NADINE MATIELLI[4] AND WILLIAM SHOTYK[5]

[1]Université de Toulouse; INP, UPS; EcoLab (Laboratoire Ecologie Fonctionnelle et Environnement); ENSAT, Avenue de l’Agrobiopole, 31326 Castanet Tolosan, France, gael.leroux@ensat.fr
[2] CNRS; EcoLab; 31326 Castanet Tolosan, France
* presenting author
[3] AGEs, Department of Geology, Liège University, Belgium,

[4] IPE, Sciences de la Terre et Environnement, Université Libre Bruxelles, Belgium
[5] Department of Renewable Resources, University of Alberta, Edmonton, Alberta T6G 2H1 Canada

Abstract

Three peat bogs from Eastern French Pyrenees, German Black Forest and Swiss Jura provide three parallel records of REE deposition in Europe. The Swiss site shows considerable variation in dust deposition during the past 15,000 years with abrupt changes in fluxes at 12 k.y. cal. BP, 9.2 k.y. cal. B.P., 8.4 k.y. cal. B.P., 7.2 k.y. cal. B.P. and 6 k.y. cal. B.P [1]. Using Nd isotopes and Rare Earth Elements, it is possible to clearly distinguish between volcanic inputs and those driven by climate change such as the long-term aridification of the Sahara and regional erosion due to forest clearance and soil cultivation. Our results indicate that a major dust event in Central Europe precedes the 8.2 k.y. cold event by 200 years. The French and German sites show also considerable variation in dust deposition but represent only respectively 10,000 and 8,000 years of peat accumulation. Unlike the French and Swiss sites located on a limestone plateau, the German peat bog is located on a granite massif, which strongly influences the chemical composition of aerosols falling into the peat. These findings show that the inorganic fraction of high-resolution peat records can provide remarkably sensitive indicators of dust load and its local and remote sources. Our study supports the priority to better identify the impact of dust cycles during the Holocene in terms of direct and indirect impacts on environmental and climate changes.

[1] Le Roux G. et al. Volcano- and climate-driven changes in atmospheric dust sources and fluxes since the Late Glacial in Central Europe. Geology, in press