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Erta Ale volcano (Afar, Ethiopia) plumbing system architecture, magma source and differentiation series.

JULIETTE PIN[1,2], GILLES CHAZOT[3], DR. LYDÉRIC FRANCE[2,4], BÉNÉDICTE ABILY[3], ANDREY GURENKO[2] AND HERVÉ BERTRAND[5]

[1]Université de Bretagne Occidentale, IUEM, LGO
[2]Université de Lorraine, CNRS, CRPG
[3]Université de Bretagne Occidentale
[4]Institut Universitaire de France (IUF)
[5]ENS Lyon

Presenting Author: juliette.pin@univ-brest.fr

The Afar region is the unique place on Earth where magmatic continental rifting and associated ongoing break-up processes are exposed onshore. It contains several active magmatic segments characterized by contrasted morphologies, crustal thicknesses, magma production rates, and magma-tectonic styles. In Erta Ale Range (EAR) rift segment, the extension is magmatically accommodated, making this place the more suitable to study the magmatic behavior of a mature rift segment. EAR is composed of 6 sub-segments with magma composition ranging from basaltic to rhyolitic. One of them is Erta Ale Volcano (EAV), where only basaltic composition has been reported so far. Here we present the first direct evidence of endogenous growth and extreme melt evolution at EAV, with new cognate plutonic blocks giving us unique access to an unknown mushy part of the EAV plumbing system. To constrain the origin and evolution of these samples, we use new bulk major, trace and isotopic analysis, as well as *in-situ* major, trace and isotopic analysis on various minerals, interstitial glasses, and melt inclusions. Those data, together with textural relationships, and oxy-thermobarometry calculations, provide the basics to discuss the magma source, differentiation, crustal contamination, and the storage conditions. Comparison of our results with thermodynamic models performed with rhyolite-MELTS [1] highlights that protracted fractional crystallization is the main process of magma evolution, eventually forming the evolved compositions that are observed (up to 75wt% SiO_2). Models output also allow us to quantify the various steps of igneous differentiation in both deep crustal reservoirs and in shallower ones. Along with mantle source information given by radiogenic isotopes data (Sr-Nd-Pb), and constraints on interaction between magmas and wall rocks given by stable isotopes data (O), we are able to build a general model of the magmatic plumbing system architecture at EAV. We discuss this model in the scope of the larger geological contexts of EAR rift segment, and Afar region. Our new data provide the community with petrological, geochemical, and thermodynamic constraints on the magma sources, differentiation paths and advancement, and on the plumbing architecture of the EAV system.

[1] Gualda et al. (2012) Journal of Petrology, 53, 875-890.