American Mineralogist, Volume 91, pages 1499–1508, 2006

Identifying the effects of petrologic processes in a closed basaltic system using trace-element concentrations in olivines and glasses: Implications for comparative planetology

JUSTIN J. HAGERTY,[1,3,*] CHARLES K. SHEARER,[1] DAVID T. VANIMAN,[2] AND PAUL V. BURGER[1]

[1]Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, MSCO3-2050, Albuquerque, New Mexico 87131-0001, U.S.A.
[2]Los Alamos National Laboratory, Earth and Environmental Sciences, MS D462, Los Alamos, New Mexico 87545, U.S.A.
[3]Current address: Los Alamos National Laboratory, Space Science and Applications, MS D466, Los Alamos, New Mexico 87545, U.S.A.

ABSTRACT

We use trace-element concentrations in olivines and glasses from a closed basaltic system to identify the effects of petrologic processes on the trace-element record of that system. The closed basaltic system in question is the Makaopuhi Lava Lake (MLL), which is closed with respect to magma mixing. Detailed studies of this lava lake have provided important information about system variables and petrologic processes that have been measured and observed at the lake. These previous studies show that olivine crystallized from the lava lake at all stages of the lake's evolution, which means that olivine and residual glasses contain a record of the lake's petrologic history. We use this information, in conjunction with variations in trace-element concentrations in olivines and glasses, to show that mineral crystallization, gravitational settling, convective flow, filter pressing, and mineral-melt interface kinetics have characteristic effects on the trace element record of a closed basaltic system. These results are pertinent to the field of comparative planetology because they can be used to evaluate petrologic information in small samples from other planetary bodies, where information about system variables and/or petrologic processes is limited.

Keywords: Makaopuhi Lava Lake, Hawaii, Basalt, Trace Elements and REE, Distribution Coefficients, Olivine, Glass, Comparative Planetology, Geochemistry