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Experimental calibration of an Fe^{3+}/Fe^{2+}-in-amphibole oxybarometer and its application to shallow magmatic processes at Shiveluch Volcano, Kamchatka

ANDREA E. GOLTZ[1], MIKE KRAWCZYNSKI[2], MOLLY MCCANTA[3] AND DARBY DYAR[4,5]

[1]Arizona State University
[2]Washington University in St. Louis
[3]University of Tennessee at Knoxville
[4]Planetary Science Institute
[5]Mount Holyoke University

Presenting Author: aegoltz@asu.edu

Oxygen fugacity is an important but difficult parameter to constrain for primitive arc magmas. In this study, the partitioning behavior of Fe^{3+}/Fe^{2+} between amphibole and glass synthesized in piston cylinder and cold-seal apparatus experiments is developed as an oxybarometer using x-ray absorption spectroscopy. The amphibole oxybarometer is applicable to hydrous magmas at subduction zone settings, and is here applied to amphibole in mafic enclaves, cumulates, and a basaltic tephra erupted from Shiveluch volcano in Kamchatka with measured Fe^{3+}/Fe_{Total}. The f_{O2} of primitive melts at the volcano is approximately NNO+2 and is faithfully recorded in amphibole from an amphibole-rich cumulate and the basaltic tephra. Apparently higher f_{O2} recorded by amphibole in mafic enclaves likely results from partial dehydrogenation of amphibole during residence in a shallow andesite storage region. Using a combination of the new oxybarometer and diffusion modeling, we identify three pulses of mafic magma recharge within two weeks of, a month before, and two to three months before eruption, and find that, at each of these times, the host andesite was recharged by at least two magmas at varying stages of differentiation. Application of the amphibole oxybarometer not only gives insight to magmatic f_{O2} but also potentially details of shallow magmatic processes.