

Experimental study of sulfur-CO₂-H₂O solubility in dacitic melt from the 2009 eruption of Redoubt Volcano, Alaska

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Dacitic – rhyolitic melts erupt as the liquid phase in many intermediate - felsic arc magmas, with some such eruptions threatening life and property. Eruptions of Redoubt Volcano, Cook Inlet, Alaska, threaten aircraft with flight paths near Anchorage (~175 km), shown by the temporary all-engine failure of KLM flight 867 during the 1989 eruption and are known to produce lahars. In March 2009, Redoubt first erupted porphyritic low-Si andesite with microlite-free dacitic melt, progressing to high-Si andesite with microlitic rhyolitic melt by June 2009. Anomalous gas emissions commenced 5 months prior to the first eruption and were initially CO₂-rich before transitioning to CO₂-poor and SO₂-rich once magmatic eruptions began [1]. The goal of this study is to contextualize petrologic data with real time gas monitoring observations from the 2009 eruption by conducting a series of experiments to construct an equilibrium degassing model for Redoubt melts.

Using an Ar-pressurized rapid-quench TZM-like vessel, we equilibrated natural dacite (approximately the same bulk composition as the glass in Redoubt andesite) with SOH and CSOH fluids at 950°C, 100 and 200 MPa, and a range of oxygen fugacities ($\log fO_2 \approx -12.6$ to -7.5) to determine the interdependent solubilities of CO₂, SO₂, and H₂O in molten dacite. Dacite crystallizes Fe-Ti oxides at high fO_2 (Re-ReO₂ and MnO-Mn₃O₄ buffers), but no crystalline phases are present in either Ni-NiO or Fayalite-Magnetite-Quartz buffered runs. However, earlier pilot experiments included higher bulk sulfur concentrations and an insoluble sulfide phase formed when buffered at $fO_2 \leq$ Ni-NiO. Erupted products from Redoubt Volcano show that dacitic melt was in equilibrium with magnetite and trace sulfide at an $fO_2 \approx 1.35$ log units higher than the Ni-NiO buffer [2]. Therefore, our experimental setup seems to replicate the crustal scale petrogenetic environment beneath Redoubt Volcano.

Work is underway to calculate the species present in the vapor in equilibrium with dacitic melt at the applied T-P- fO_2 conditions and to compare these with the 2009 Redoubt gas compositions described in [1].

[1] Werner et al. (2013) JVGR, 259. 270-284.

[2] Coombs et al. (2013) JVGR, 259. 349-372.