

Noble Gases in Carbonatite Magmatism: Oldonyo Lengai

Abstract

Oldonyo Lengai, Tanzania, is the only volcano on Earth that is actively erupting carbonatitic lavas. In order to further constrain the origin of the Oldonyo Lengai magmas, an expedition to Oldonyo Lengai in July 2005 sampled volcanic gases. Two fumaroles were sampled, one with a discharging temperature of 124 °C, the other more than 168 °C. The chemical composition of discharging gases is dominated by H₂O (approx 77 mol%) and CO₂ (approx 22 mol%), SO₂, H₂S and HCl make up less than 1 mol%, combined. The inert gases (N₂, He, He/Ne) show that these samples contain virtually no air. He/Ne ratios are between 2000 and 6500 and He/Ar ratios are up to 0.3 [Fischer et al, 2006, this volume]. The ³He/⁴He ratio of 6.7 - 6.8 R_a is consistent with an upper mantle origin of these gases. We have also measured Ne and Xe isotopic compositions of several aliquots of the sampled gases using a multicollector noble gas mass spectrometer (HELIX-MC). The additional precision afforded by multicollection allows us to identify noble gas isotopic anomalies at the sub 5 per mil level. Despite the excellent purity (low atmospheric content) of the gases, as evidenced by extremely high He/Ne ratios, the isotopic compositions of both Ne and Xe are very close to those of the atmosphere: a 2 per mil excess in ¹²⁹Xe/¹³⁰Xe ratio was observed (the remaining Xe isotope ratios being indistinguishable from air) and ²⁰Ne/²²Ne up to 10.3 was measured (50 per mil higher than air) in a split of the sample that has He/Ne = 6500. Although isotopically anomalous Ne was observed, it is not possible to determine if this is indeed mantle - derived Ne or if the ²⁰Ne excesses result from kinetic fractionation of air entrained within the volcano's plumbing system: the composition of the three Ne isotopes (²⁰Ne, ²¹Ne and ²²Ne) are consistent with mass fractionation processes. Our results are most readily interpreted as atmospheric entrainment prior to sampling. However, further measurements of the remaining noble gases (principally the ⁴He/⁴⁰Ar ratio) and results of ongoing experiments on the solubility of noble gases in carbonatite melts will clarify this situation.