The cause of potassium variation in arc magmas: Evidence from Bougainville

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The origin of K_2O (and LILE) variation in arc magmas remains a matter of some debate. At any particular silica content, magmatism on Bougainville Island shows a significant range in K_2O (i.e., by a factor of between 2 and 3). This makes Bougainville a perfect natural laboratory in which to study the parameters that influence K_2O variation arc magmas. Bougainville represents the northwestern extension of the Solomon Islands Arc. It is broadly a northwest - southeast trending island initially formed as a response to southwesterly subduction of the Pacific Plate along the now inactive Kilinailau Trench. Arc reversal occurred during the Miocene, with subsequent subduction of the Solomon Sea Plate in a northeasterly direction along the New Britain - San Cristobal Trench. Subduction in this direction continues to the present day and is responsible for ongoing volcanism on Bougainville.

New data for some 140 samples indicate that the range in potassium is not a function of the distance of magmatism from the trench, nor does it appear to be explained by variations in the composition of the subducted component introduced into the mantle wedge. Figure 1 illustrates the strong correlation between the Pb-isotope composition of selected lavas and K_2O. This may be explained by either a variation in the magnitude of the slab-derived flux, or the assimilation of pre-existing crust, and evidence for each will be presented and tested.

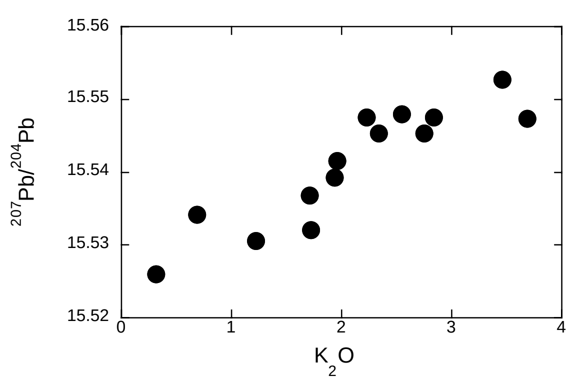

Figure 1. K_2O (wt.%) vs $^{207}Pb/^{204}Pb$ for 14 samples of Bougainville arc rocks selected to cover a range in potassium.

Dust to dust: Cosmic-ray exposure histories of meteorites

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Cosmic rays (CR) have probably permeated the Milky Way ever since it formed. Anywhere that cosmic rays interact with matter - whether in the interstellar medium, or the early solar nebula, or the diverse bodies of the solar system - they must induce nuclear reactions and may leave detectable traces in the form of cosmogenic nuclides. The concentrations of these cosmogenic nuclides record exposure histories that extend back to the birth of the solar system and even earlier. The irradiation effects of the last 1 to 1000 My usually dominate in bulk samples of the most abundant extraterrestrial materials - meteorites. Accordingly, the construction of cosmic-ray exposure (CRE) histories normally begins with that most recent period of irradiation. Such histories can often be specified with four parameters: the duration of the exposure in space (the CRE age); the size the meteoroid (given by the radius of a nominal sphere); the depth of the sample within the meteoroid; and the time elapsed since the meteorite arrived on Earth (its terrestrial age). All of these parameters are of interest, but the CRE ages (Figure 1) have received the most attention.

A significant challenge for CRE historians is to trace the courses of meteorites prior to their most recent irradiation and as far back in time as possible. Some micrometeorites have collected cosmogenic nuclides for times longer than Poynting-Robinson drag would seem to allow. They probably "remember" earlier irradiations on larger bodies. Similarly, lunar meteorites retain cosmogenic nuclides made close to the Moon's surface as well as those made in transit to Earth. Ordinary chondrites record collisions that took place after they left their parent bodies. The solar wind (SW) gases found in many meteorites indicate exposure to cosmic rays before meteorite assembly, perhaps when the Sun was young. Small anomalies in the isotopic abundances of, e.g., Mg, K, and Cr may have been produced by an intense outpouring of nuclear-active particles from the young Sun. Dust-size interstellar grains found in primitive meteorites appear to contain cosmogenic nuclides made during transport to the solar system.