

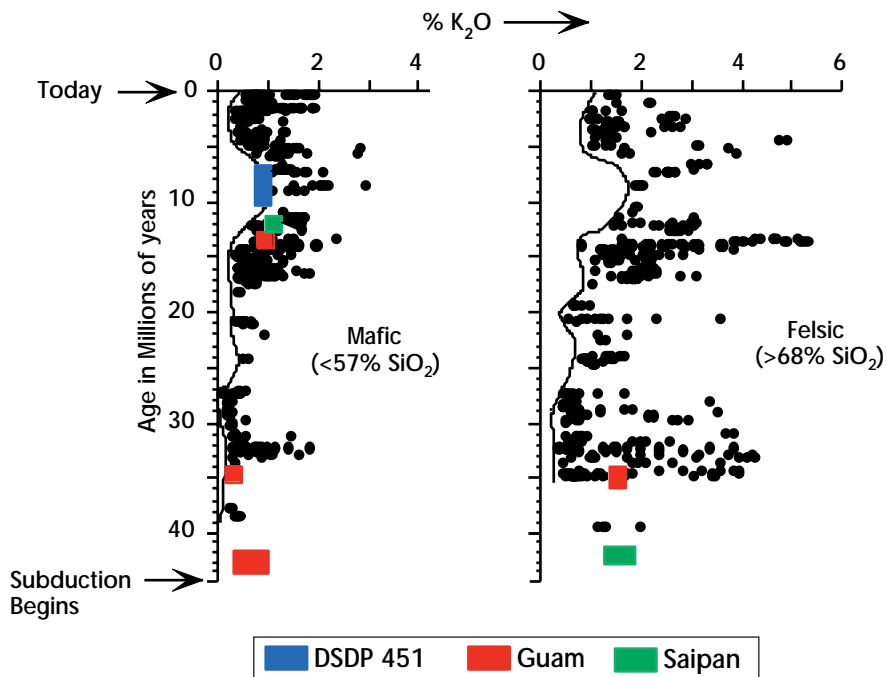
Tephra glass record of island arc magmatic evolution

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It is important to know how the composition of arc magmas change through the life of an arc, because this constrains models of how the source regions of arc magmas evolve as a result of coupled interactions between subducted materials, the mantle beneath the arc, and the thickening arc crust. A continuous record is difficult to obtain from exposures on land or by drilling through the lava sequence. Because many arc eruptions violently eject ash into the air, which settles out slowly downwind, it is possible to study arc magmatic evolution by separating ash particles (tephra) from appropriately located deep sea cores. The scientist can use paleontologically-determined ages for tephra-bearing horizons to determine approximately when individual tephra were erupted, then painstakingly separate small (16 to 150 microns) shards of glass and analyze these with an electron microprobe. We used this approach to separate and analyze over 1800 samples of tephra

from DSDP cores taken around the Mariana Island Arc (DSDP Sites 53, 54, 447A, 448, 449, 451, 453, 458, and 459) to study how this arc's magmatic system evolved over the last 40 million years. A small increase in potassium content is detectable for both mafic and felsic tephra over this time period, perhaps indicating the mantle beneath the arc was being enriched in potassium from the subduction zone faster than arc magmas could deplete it. Potassium contents jumped and remained elevated from about 12 to 6 million years ago, probably indicating changes in the mantle associated with rifting of the Mariana Arc to form the Mariana backarc basin.

Reference:
Lee, J., R.J. Stern, and S.H. Bloomer, Forty million years of magmatic evolution in the Mariana Arc: The tephra glass record, *Journal of Geophysical Research*, 100, 17,671-17,687, 1995.



The content of potassium (percent K₂O by weight) is plotted for two types of tephra, mafic and felsic, as a function of time. Individual analyses are shown as black dots, and lines approximate the minimum potassium content for mafic and felsic tephra over the last 40 million years. Tephra data provide a much more comprehensive view of how Mariana Arc magmas have evolved through time than is afforded by studying exposed rocks of the Mariana islands (Guam and Saipan) or drilling into volcanic basement (DSDP Site 451).