Element segregation during star formation

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A variety of arguments are presented to show that heavy elements are preferentially retained in dust and excluded from stars during the star formation process. The result is that stars are depleted in heavy elements relative to the clouds from which they form and relative to their circumstellar dust disks. The evidence for this hypothesis comes from the size distributions of interstellar and interplanetary dust grains, observations of interstellar extinction and gas-phase depletions, and observed variances between the compositions of interstellar gas and stars. The consequences of the proposed elemental segregation are especially important for studies of interstellar dust, but also have implications for the composition of preplanetary and interplanetary grains. Possible mechanisms for excluding heavy elements during star formation include ambipolar diffusion in the collapsing cloud, separating out charged grains during the infall phase; and sedimentation in the circumstellar disk, forming grains too large to be accreted. Both processes are expected to affect the formation of low-mass stars more strongly than high-mass stars, which is consistent with observations of stellar composition.

Time scales of formation of zoned magma chambers: U-series disequilibria in the Fogo trachytes

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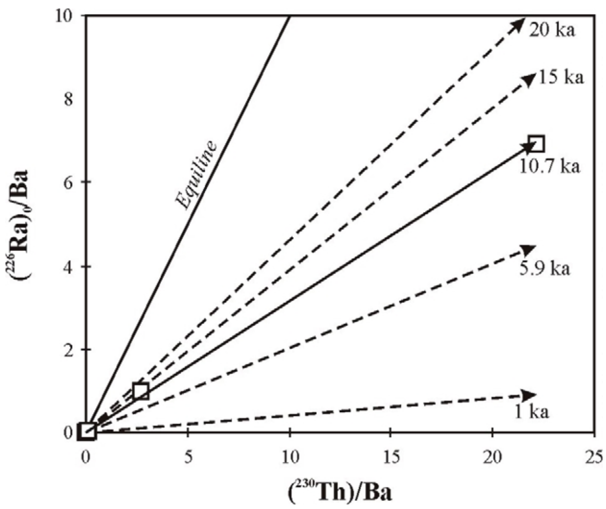
Introduction

The Fogo A and Fogo 1563 volcanic deposits associated with the Fogo volcano in Sao Miguel, Azores, are chemically zoned trachyte deposits erupted ~4.6 ka BP and 439 y BP respectively. The chemical variations within these deposits have been interpreted to reflect chemical variation present in a magma chamber prior to eruption. The chemical variations can be explained by fractionation of the observed phenocryst assemblage minerals, suggesting that closed system fractional crystallisation can explain the observed chemical zonation.

Results

High precision measurements of ^{226}Ra-^{230}Th-^{238}U disequilibria in the trachytes were made using plasma ionisation multicollector mass spectrometry, in order to constrain the time scales of magma zonation and residence prior to eruption. ^{226}Ra-^{230}Th isochrons can be explained by continuous fractionation models, and indicate magma residence times of 4-11 ka for Fogo A and 500-1,100 y for Fogo 1563, based on bulk D_{Ra} = 1-2 times bulk D_{Ba}.



Conclusions

Our results allow constraints to be placed on the time scales for the development of chemical zonation within the Fogo magma chamber, and suggest that longer magma residence times may result in larger volume eruptions. Our data further highlight the applicability of high-precision U-series disequilibria data in investigations of magma differentiation time scales.