U-series isotopic disequilibrium produced during experimental melting of granitic crust: Implications for shallow-level assimilation and pluton remobilisation

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Although the production of U-series disequilibria during metasomatic and partial-melting processes in Earth's mantle is well studied, the effects of melting and assimilation processes during ascent and storage of magma in the crust are less well understood. To investigate disequilibria arising via this mechanism, we have conducted U-series measurements on the products of laboratory experiments in which granite was melted at low pressure (Knesel and Davidson, 1999).

Th and U concentrations and isotopic ratios for hand-picked separates of quenched melt (glass) and residual minerals were determined by TIMS. Chemical-separation and purification techniques and analysis methods were similar to earlier work (Turner et al., 1997).

The experiments demonstrate that partial melting of granitic crust in the presence of residual accessory phases can generate disequilibria among the isotopes of U and Th; (^{230}Th/^{238}U) activity ratios of our experimental melts range from 0.93 to 1.13. Thus, the small to moderate amounts of disequilibria observed in some intermediate to silicic lavas may reflect fractionation during assimilation or thermal rejuvenation of shallow-level granitic plutons. Mineral-melt (^{230}Th/^{232}Th) and (^{238}U/^{232}Th) relationships from the experiments also indicate that internal isochronal arrays in magmas generated in this way may have little to do with the duration of magma storage and differentiation in the crust. We therefore suggest that U-series disequilibria might not provide meaningful chronological constraints in certain cases, and they should be interpreted with caution and consideration of other types of petrographic and geochemical evidence.

References

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