U-series disequilibria in the Izu and Mariana island arcs

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U-Th-Ra-Pa results are presented for Holocene basalts and andesites from three Izu volcanic front (VF) islands, the Sumisu Rift behind the Izu VF, and the Kasuga seamounts behind the Mariana VF. They are interpreted as indicating mobility of only U and Ra in the slab-derived component of the Izu arc, but mobility of all four elements in the Mariana arc. The difference is associated with the greater involvement of a sedimentary component in the Marianas, in part added >350,000 years before volcanism and perhaps transported by a melt phase. The most recent slab component caused flux melting only a few millenia before the resulting volcanism in both arcs. Some Pa in-growth during convection of the mantle wedge is likely in both arcs, but slab-derived Pa also is present in the Kasugas.

All Izu rocks have 20-40% excess U, but their $^{230}Th/^{232}Th$ ratios range from 1.0-2.0 and the different islands do not define a chord with potential age significance. In contrast, Kasuga samples range from 20% excess Th to10% excess U and lie along the same chord as samples from the Mariana VF. U-enrichment increases as the geochemical evidence for sediment increases, indicating recent as well as ancient "sediment addition" in the Kasugas. $^{226}Ra/^{230}Th$ ratios exceed 2.5 in both groups but do not reach the maxima of the Mariana VF. $^{231}Pa/^{235}U$ ratios are lower in Izu (1.1-1.3) than Kasuga (1.4-2.1) and correlate negatively with $^{230}Th/^{238}U$ in both cases, precluding explanation solely by U-addition and subsequent equilibrium melting.

The palaeohydrogeological evolution of the deep groundwater system from Sellafield (NW England), recorded by late-stage fracture-lining calcite

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Introduction

Late-stage fracture-lining calcite mineralisation, associated with hydraulically-conductive open fractures from Sellafield (N.W. England), is being studied to evaluate the evolution of the modern deep groundwater system. The observations are being compared with those from other UK and European sites as part of the EC Framework 5-funded PADAMOT project. The calcite is being characterised in detail using optical and cathdoluminescence (CL) microscopy, SEM and BSEM, EPMA, laser ablation microprobe-ICP MS, stable isotope (C, O) analysis, and microthermometric and microchemical fluid inclusion (FI) analysis methods. The objective is develop and apply mineralogical observations from such late mineralisation as palaeohydrogeological tools for use in waste repository site investigations and performance assessments.

Observations

The late calcite coincides with groundwater flow. It varies systematically in crystal morphology from c-axis flattened forms (freshwater zone) to c-axis elongated forms (saline zone). FI data indicate mineralisation from waters similar to the range of present-day groundwater compositions. Freshwater calcites are strongly-zoned, brightly luminescence Mn-calcite and non-luminescent Mn-free calcite. Saline zone calcites display moderately to brightly luminescent (high Mn:Fe) and dull-luminescent (low Mn:Fe) zoning. Saline transition zone (STZ) calcite has a complex CL fabric, with saline-type calcite overgrown by freshwater-type calcite, and its crystal morphology changed progressively from a c-axis elongate to a c-axis flattened form.

Discussion and conclusions

Late calcite corresponds closely to the present day groundwater system. Freshwater and saline zone calcites are distinct and careful examination of the growth zoning characteristics provides an insight in the evolution and stability of the groundwater system.

References

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