Sr-Nd-Pb isotope constraints on magma genesis in the Sangihe Arc, North Indonesia

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The NNE-SSW trending Sangihe Arc in North Indonesia is currently in a process of complex collision with the Halmahera Arc, whereby the Molucca Sea Plate gradually disappears. Active volcanism accompanies westward subduction under the Sangihe Arc and eastward subduction under the Halmahera Arc. We carried out a regional Sr-Nd-Pb isotope and trace-element study along the entire 350-km Sangihe Arc, covering active volcanic centres in the chain of islands between Sulawesi and the Philippines and its continuation on the North arm of mainland Sulawesi.

Ranges in isotopic ratios of basalts and basaltic andesites (47.4-57.7 wt.% SiO_2) are modest, and do not appear to be influenced to a significant degree by contamination of arc crust. There is no clear along-arc trend. The ratios of $^{87}Sr/^{86}Sr$ (0.7037-0.7041), $^{143}Nd/^{144}Nd$ (0.5129-0.5130), $^{206}Pb/^{204}Pb$ (18.34-18.56), $^{207}Pb/^{204}Pb$ (15.56-15.64) and $^{208}Pb/^{204}Pb$ (38.30-38.64) tend to plot just outside local I-MORB type values, as defined by the Celebes Sea basement, which suggests a contribution of subducted sedimentary material. If the mantle component is assumed to be constant in the entire arc, the sedimentary component should be isotopically diverse. Mixing models are consistent with different Pacific Ocean type sediments as possible end-members. However, heterogeneity in the mantle component is plausible as well, given the complex tectonic history of the region.

Whereas there is a large overlap in Sr and Nd isotopic signatures of the Sangihe Arc and Halmahera Arc, mixing arrays in Pb isotope space do not coincide, which suggests involvement of different source components, despite the fact that both systems have the subducting Molucca Sea plate in common. We speculate that this may be related to an asymmetry in the arc-arc collision setting, as the Halmahera fore-arc has been forced to thrust under the Sangihe fore-arc, inducing favourable conditions for differences in the nature and amount of source components involved.

How to assess controls of Al in acidified soil solution

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Introduction

Based on research from the 1980's onward, the major sources of acid deposition have been identified, and measures for their reduction have been taken in many countries. However, questions on the effects on forest vitality (largely attributed to high levels of Al in soil solution), and on how we can effectively monitor/predict if and when the soil ecosystem will fully recover, still remain. An important recurrent question thereby, is what precisely controls Al levels in soil solution.

Conceptual reasoning

Basically, there are three different possible controls for the activity levels of solutes in the soil solution: a mineral solid phase (= thermodynamically fixed activity level), a mineral or organic exchange phase (variable activity level), and the vegetation (net input or net uptake). These controls can induce different states: that of true equilibrium, a non-equilibrium steady state, or a non-equilibrium transient situation. From theoretical considerations it can be argued that only two realistic steady-state end-situations can be reached:

1) Non-equilibrium dissolution of a primary mineral phase (in combination with the net flux from the vegetation); equilibrium of solution phase and exchange phases with a secondary mineral phase through fast precipitation. In this situation the activity level of Al in all phases except the primary mineral phase is the same, as fixed by the secondary mineral phase.

2) Non-equilibrium dissolution of a primary mineral phase (in combination with the net flux from the vegetation); non-equilibrium precipitation of a secondary mineral phase; equilibrium of the solution phase with the exchange phases. In this situation the combined kinetics, not the equilibirum with the exchange phase, determine the steady state activity in the solution phase.

Conclusion

Focus in soil acidification research is on dissolution kinetics and analysis of the soil solution's equilibrium state. For the second situation, however, these approaches are inadequate in predicting activity levels in soil solution, as precipitation kinetics and transport need to be considered as well.