Using Hf isotopes to trace mantle dynamics in the Tonga arc – Lau backarc system

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The lavas from the northern region of the Tonga-Kermadec island arc in the southwest Pacific combine input from subducted oceanic lithosphere, including the Louisville Seamount Chain and overlying sediments, and Samoa plume material. These components provide an opportunity to trace the pathways of different elements through this complex arc-backarc system.

We use fluid immobile high-field strength element (Ti, Zr, Hf, Ta, Nb) concentrations and Hf isotopes data to trace the individual components, since these elements are less affected by subduction input. We present new data from the Tonga arc, the active backarc spreading centres, the subducting Louisville seamounts and Pacific sediments. Using this comprehensive dataset we examine along-arc variations, as well as varying mantle composition perpendicular to the trench. Along the Tonga arc we observed an opposed behaviour in Nd and Hf-isotope ratios. Whereas εNd decreases northwards along the Tonga segment of the arc (Ata to Tafahi), εHf values are highest in the northernmost Tonga islands of Tafahi and Niuatoputapu. Lavas from these two islands contain a Pb contribution from the subducting Louisville Seamount Chain, but this component cannot explain the high εHf for a given εNd. Instead, the decoupling of εHf and εNd may result from the extreme depletion of the northern Tonga mantle, leaving a refractory peridotite (high εHf), which was later re-enriched by melts with higher εNd.

Furthermore, we use εHf to trace the extent of Samoan mantle and the location of the boundary between Indian and Pacific type mantle in the present-day northern Tonga-Lau Basin region. By comparing these results with εHf for a new suite of Tonga fore-arc lavas and old basement rocks from Fiji, a reconstruction of the changes in mantle flow, spreading initiation and Samoa mantle flow over the past 51 Ma is possible.