Magnesium isotopic composition of back-arc basin lavas and its implication for the recycling of serpentine-derived fluids

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Dehydrated fluids expelled from serpentinized mantle in the subducted slab are gradually recognised as a vital role in generating arc magmatism and element cycling in the Earth. However, it remains not clear about their recycling at various depth in subduction zones and if slab serpentine-derived fluids contribute to the genesis of lavas from the back-arc basins. Here, we study the magnesium (Mg) isotopic compositions of lavas from the Okinawa Trough (OT) and Lau basin (LB) as Mg isotopes have shown great potential to trace dehydration of slab serpentinites in recent years. Overall, lavas from the OT and LB have averagely heavier Mg isotopic compositions relative to the mid-ocean ridge basalt (MORB) mantle, which could be attributed to the involvement of slab serpentine-derived fluids rather than crustal assimilation or input of subducted sediments as indicated by the isotopic modelling results. The δ²⁶Mg values of the southern OT (SOT) and southern LB (SLB) are generally higher than the middle OT (MOT) and northern LB (NLB), respectively, with an average of -0.11 ± 0.06‰ (2SD, n=5) for the SOT, -0.20 ‰ ± 0.04 (2SD, n=5) for the MOT, -0.13 ‰ ± -0.08 for the SLB (2SD, n=6) and -0.19 ‰ ± 0.06 (2SD, n=10) for the NLB. The binary modelling results have shown that various amounts of serpentine-derived fluids could explain the variations in Mg isotopic compositions observed in the OT and LB. Combined published δ²⁶Mg values in subduction zones with our data, the thermal structure of inter-subduction zone may play a first control on the signal of Mg-rich serpentine-derived fluids. By contrast, the contributions of these fluids to different segments in a specific subduction zone may depend on the slab depth beneath magmatic activity sites.