The Deep Water Cycle at Subduction Zones

Professor Julia Ribeiro

Guangzhou Institute of Geochemistry
Chinese Academy of Sciences

Subduction zones efficiently cycle seawater from the Earth's surface into its deep interior. Seawater is removed from the oceans during alteration of the oceanic plate, and it is released back to the surface during dehydration of the sinking plate, which ultimately generates subduction zone magmas. However, whether subducted seawater is recycled beyond subduction zones has remained an open question; and this ultimately depends upon the extent to which the slab dehydrates at subduction zones (i.e., beneath the fore-arc, the arc front and the back-arc basin). Slab dehydration is dictated by the slab thermal model, which postulates that cold slabs have released most of their subducted water beneath the arc front; while warmer slabs mostly dehydrate beneath the fore-arc. Following this view, arc lavas from cold subduction zones should record greater involvement of slab-derived water (≥ 60%), while hot subduction zone arc magmas should be drier. The water flux delivered into the fore-arc mantle is still an open question; and estimates, which mostly derive from numerical modeling, have so far been untested. Here, I seek to provide new constraints on how water is cycled at subduction zones by investigating the Mariana convergent margin, a typical end-member of cold subduction zones. I explore the origin and transport of water through subduction zones to better comprehend water recycling within the deep Earth, and whether enough slab water can bypass the depth of generation of subduction zone magmas to contribute to mantle plumes.

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Enquires: 3943 9624 essc@cuhk.edu.hk