Pb isotopes of the Izu Bonin volcanic arc trace slab evolution through time

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Volcanic arcs are active on timescales of tens of millions of years, yet their evolution is difficult to reconstruct since lavas are either eroded or buried under younger series. However, distal fallout tephra layers in marine sediments form a temporal eruption record that can bridge the gaps. Fallout tephra from ODP Site 782A provide a record for the ~50 Ma evolution of the Izu-Bonin arc (IB) with high temporal resolution. Geochemical and isotopic data have been obtained from separated pristine ash-sized tephra particles (glass, pumice, scoria). Figure 1 shows how Pb isotopes trace the evolution of the subducted slab.

- The Pb from the subducted slab has lower isotope ratios than the subducting sediments. In Pb isotopes vs Nd/Pb space this source can be clearly identified as the subducting basaltic oceanic crust. Thus, the arc traces the temporal evolution of sediment and basaltic ocean crust.
- "Unradiogenic" Pb emerges in IB abruptly at ~42 Ma and may indicate onset of steady-state IB evolution after arc initiation. Notably, the timing follows closely the chain of plate tectonic events that began with the subduction of the Izanaghi-Pacific spreading center beneath the Eurasian margin at ~60-55 Ma. This event forced motion changes in the Australian and Pacific plates around ~53-50 Ma that are considered to have initiated the IBM and Tonga-Kermadec subduction systems around ~50 Ma (Hall et al., 2003*; Whittaker et al., 2007*).

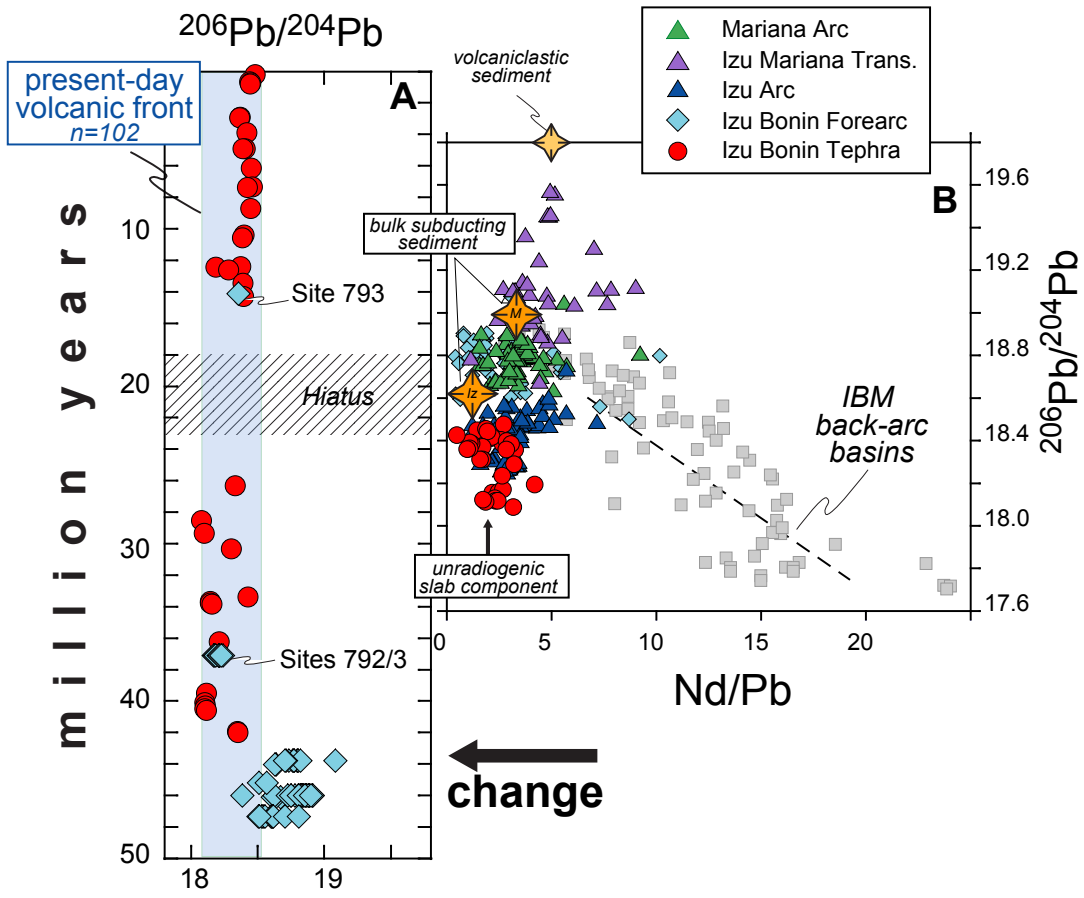

Figure: (A) $^{206}Pb/^{204}Pb$ vs time in the Izu Bonin arc. Tephra data are from this study and Schmidt (2001). Despite a subtle overall increase, all $^{206}Pb/^{204}Pb$ <43 Ma ratios plot within the range of present-day Izu arc. (B) $^{206}Pb/^{204}Pb$ vs Nd/Pb of present-day IBM arc front lavas, Eocene Izu lavas and tephra. At low Nd/Pb values, the arc lavas do not trend towards the IBM back-arc basins (Shikoku and Parece Vela Basin, Mariana Trough) but implies a slab source of unradiogenic Pb. IBM arc and back-arc data are compiled from Taylor and Nesbitt (1998), Ishizuka et al. (2007)*, Elliott et al. (1997)*, Woodhead et al. (1987)*, Reagan et al. (2008)*, Hickey-Vargas (1991*; 1998*)and Gribble et al. (1998)*, sediment data are from Plank and Langmuir (1998)* and Plank et al. (2007)*.*

*References listed in appendix A.