

## Geodynamic reconstruction of Eocene subduction initiation along Philippine Sea Plate margins

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In terrestrial planets, the transition from a stagnant lid regime to the present mode dominated by plate forces necessitates the initiation of subduction zones. Internally driven mechanisms such as plume-induced subduction initiation, however, are fundamentally different from end-member models of Cenozoic subduction initiation. We present an alternative and holistic approach in exploring subduction initiation by considering it as a plate-scale process.

The juvenile arc section of northern Zambales ophiolite (Barlo locality) consists of boninite and boninite-series volcanics. This makes northern Zambales the lone middle Eocene boninite locality in the Philippine Sea Plate apart from the Ogasawara Islands, Guam and their submarine equivalent in the IBM forearc. The overall volcanic stratigraphy of the extrusive sequence at Barlo resembles Holes U1439 and U1442 drilled by IODP Expedition 352 in the Izu-Ogasawara (Bonin) trench slope. Subduction initiation stratigraphy deduced from diving, dredging and drilling programs in the Izu-Ogasawara (Bonin)-Mariana forearc is recognized in Zambales ophiolite as well.

Zambales boninite is geochemically distinct from Ogasawara boninite. Based on HREE abundances and spinel Cr#, Zambales boninite is derived from a mantle source that is less depleted than samples from the type locality. Trace element ratios also show that aqueous fluids released from shallow sub-arc depths, rather than slab melts, are the dominant slab components in Zambales boninite and boninite series volcanics. Previous studies have shown that the fertile to moderately depleted Acoje mantle section is comprised of harzburgite and lherzolite with spinel Cr# ranging from 0.18 to 0.56. So far, highly refractory harzburgites with Cr# greater than 0.7 are yet to be found in Zambales ophiolite.

As emphasized by Stern and Gerya (2018), numerical models of incipient subduction should be based on robust geological data. It is essential to consider not just the Izu-Ogasawara-Mariana forearc but geologic constraints from the entire Philippine Sea Plate as well. We advocate that geodynamic models of subduction initiation along Philippine Sea Plate margins incorporate a pre-Eocene, north-verging subduction zone associated with Cretaceous terranes forming the overriding plate, a doubly-vergent subduction initiation as well as the interplay of plate forces and mantle upwelling (e.g. Oki-Daito plume) during incipient subduction.

We also highlight the relevance of Zambales ophiolite in addressing scientific objectives of several active IODP proposals (e.g. Izu-Bonin-Mariana Arc Middle Crust and Fore Arc Mohole-to-Mantle).

Keywords: Zambales ophiolite, boninite, Philippine Sea Plate, subduction initiation