Seismic structure of the Bonin ridge

Shuichi Kodaira, Narumi Takahashi, Takeshi Sato, Mikiya Yamashita,
IFREE JAMSTEC

Petrological studies have suggested that oceanic crust is formed during the initial stage of subduction. However, there is little geophysical evidence for the formation of oceanic crust in the fore‐arc region. We conducted an active‐source seismic survey in the fore‐arc region of the Izu‐Bonin intraoceanic arc to examine processes of crustal formation associated with the initiation of subduction. These data show a remarkably thin crust (<10 km thick) along the northern half of the Bonin ridge and abrupt crustal thickening (to ~20 km) toward the south of the ridge. Comparison of velocity–depth profiles of the thin fore‐arc crust of the Bonin ridge with those of typical oceanic crusts showed them to be seismologically identical. Boninitic magmatism is evident in the area of thin crust and tholeiitic–calcalkaline andesitic volcanism in the area of thick crust. High‐precision dating of the volcanic rocks showed that the thin fore‐arc oceanic crust was created soon after initiation of subduction (48–45 Ma) and that the nonoceanic thick crust was created with tholeiitic–calcalkaline andesitic magmatism after the boninitic magmatism was ceased. Our seismological image strongly supports the view that fore‐arc oceanic crust was formed by fore‐arc spreading during the initial stage of subduction along the Izu‐Bonin intraoceanic arc.

Although this longitudinal profile shows remarkably thin forearc crust (<10 km thick) along the northern half of the ridge, a profile across the Bonin ridge shows a thicker crust. In order to take into account data acquired two crossing profiles at the center of the Bonin ridge, recently we re-processed the seismic and gravity data. Re-modeling of the seismic data showed a north-south aligned area of thin crust (~10 km thick) at the center of the Bonin ridge; this structure was confirmed by gravity data. The seismic data at the eastern end of the across-arc profile suggests that the crust thickens beneath the trenchward slope of the Bonin ridge. However, a petrological model suggests a trenchward extension of forearc oceanic crust that formed during the initial stage of subduction. Although further detailed investigation is required, we suggest that this contradiction can be explained either by the subduction of buoyant crust immediately beneath the forearc oceanic crust, or by the presence of a serpentinized mantle wedge beneath the forearc oceanic crust.