Seismic Anisotropy in the Izu-Bonin Subduction System

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Using broadband seismic data from 12 IRIS Global Seismic Network (GSN) stations, we evaluated shear wave splitting in local S and teleseismic sS phases from earthquakes that sample the Izu-Bonin subduction system backarc to examine the dynamics of slab deformation and mantle flow (Anglin and Fouch, 2005).

We utilized the particle motion analysis method of Silver and Chan (1991) to measure the best fitting splitting parameters, fast polarization direction (φ) and splitting time (δt), on all waveforms. For teleseismic S splitting analyses, we first corrected the waveform for station-side anisotropic effects by rotating and time-shifting the waveform according to either splitting derived from teleseismic S on the same waveform (Fischer and Yang, 1994) or published SKS splitting parameters from IRIS GSN stations. SKS corrections generally produced simpler waveforms and clearer splitting results; we therefore applied published SKS corrections to sS waveforms.

Splitting times for local S phases range from 0.6 to 1.7 s and 0.9 to 3.2 s for teleseismic sS phases. Fast polarization directions range from ~NW-SE to ~ENE-WSW and suggest complex mantle deformation across the region. Shear wave splitting parameters from this study demonstrate more complexity than earlier work by Fouch and Fischer (1996), who found relatively simple, convergence-parallel fast polarization directions across the region.

Our preferred interpretation of the dataset is that splitting variations reflect a rapid change in mantle flow direction across the Izu Bonin region. To the south (region I), variations are likely caused by a combination of convergence parallel mantle flow, trench parallel shear along the plate boundary, and inherent slab fabric. In region II to the north, δt values from local events are smaller and φ values exhibit more complexity. Here, phases sample a larger volume of mantle wedge and exhibit a first-order rotation in φ values, suggesting that mantle flow in this region is diverted from NW flow to NE-SW flow. This diversion is likely due to trench parallel subslab mantle flow behind the oceanward side of the Philippine Sea plate south of the Philippine Eurasian trench.

We propose that several yet uninvestigated subduction systems may also exhibit signatures of trench parallel subslab mantle flow, indicating that subslab mantle near some subduction zones is either partially or fully decoupled beneath subducting slabs. An analysis of waveforms from IRIS GSN stations will enable more a comprehensive documentation of this component of the subduction system. If confirmed for other regions, this constraint must be incorporated in future dynamic models of subduction.