1996 Gordon Research Conference on the Interior of the Earth, Plymouth, NH, USA

Reference: Fischer, K.M., M.J. Fouch, and D.A. Wiens, Inferring mantle flow in subduction zones from seismic anisotropy, Gordon Research Conference on the Interior of the Earth, Plymouth, NH 1996.

Inferring Mantle Flow in Subduction Zones from Seismic Anisotropy

Karen M. Fischer, Matthew J. Fouch Department of Geological Sciences, Brown University, Providence, RI, 02912

Douglas A. Wiens Department of Earth and Planetary Sciences, Washington University, St. Louis, MO, 63130

We have obtained constraints on the strength and orientation of anisotropy in the upper mantle, transition zone, and lower mantle beneath the Tonga, southern Kuril, Japan, and Izu-Bonin subduction zones. We determined shear-wave splitting parameters (fast directions and splitting times) for S phases from local earthquakes and for teleseismic core phases such as *SKS*. We modeled the observed splitting using a method that predicts shear-wave splitting on individual phase paths and determines the strength, orientation and depth extent of anisotropy that best fits observed splitting times and fast directions.

Modeling results indicate that shear-wave splitting in the lower mantle is not required in any of these subduction zones and is ruled out beneath the southern Kurils and Tonga/Fiji. This result is most plausibly explained by an absence of significant anisotropy widely distributed within the lower mantle. Transition zone anisotropy is ruled out beneath 410 km in Izu-Bonin and beneath 520 km in Tonga, but transition zone anisotropy is required beneath the southern Kurils. All the data are consistent with a model in which the lower transition zone (520-660 km) and lower mantle are largely isotropic, and in which anisotropy, possibly due to preferred orientation of ß-spinel, occurs intermittently in the upper transition zone (410-520 km).

Assuming that the component of splitting from the upper mantle is produced by preferred orientation of olivine, the observed fast directions indicate that back-arc strain varies between two-dimensional and three-dimensional patterns beneath the back-arc regions of the western Pacific rim. Beneath Izu-Bonin and Tonga, where the overriding plate is oceanic and active back-arc spreading is occurring, fast directions are roughly convergence-parallel and may be explained by two-dimensional subduction-induced corner flow and/or back-arc extension. However, beneath the Japan Sea/western Honshu and Sakhalin Island, where the overriding plate is quasi-continental with a complex history of deformation, fast directions are highly oblique to convergence and indicate a component of back-arc flow that is roughly parallel to the strike of the subducting slab. Such slab-parallel flow in the back-arc mantle would be consistent with the azimuth of transpressional shearing observed in crustal rocks from Sakhalin Island to northern Honshu, suggesting that in this region the sense of back-arc strain is uniform over the crust and upper mantle.