Elastic and viscoelastic parameters of the Philippine Sea plate under the Ryukyu trench near Taiwan

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Abstract

The termination of the Ryukyu trench against Eurasia and the oblique subduction of the Philippine Sea plate result in folding of the subducting slab in the depth range 50-100 km. A viscoelastic Maxwell model is used to simulate the dominant wavelength of the folding (~250 km). Three key parameters: the in-plane elastic strain, the effective elastic/viscous thickness (h) of the slab, and the viscosity ratio between the slab and the upper mantle, are still unresolved. We calculate the strain tensor by summing seismic moment tensors of all earthquakes in this region. The compressional component of the strain rate is strike-parallel in this depth range, in accord with the folding hypothesis, with a magnitude of $-5.8\text{x}10^{-15}$ s^{-1} and the azimuth and plunge 281° and 11°, respectively. The time scale is derived from the subducting rate and distance, yielding a preliminary estimate of 5 Myr. The accumulated in-plane elastic strain that is associated with the folding is taken to be 3%, which is not an extreme value. We estimate h by fitting bathymetry and gravity along profiles across the Ryukyu trench. The thickness h of the Philippine Sea plate at the central Ryukyu trench is about 25-30 km, while h in the southwestern Ryukyu trench near the folding axis is ~17 km. It suggests that the large curvature of slab folding results mainly from the weak rigidity of the slab. Given the estimated strain and h, the Maxwell model constrains the viscosity ratio between the slab and the upper mantle at about 200 ~ 300.