Three-Dimensional dynamics of asthenospheric flow and plate motion in the Boso Triple Junction: Phase 1 Model Construction

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Over the last two decades, subduction zone modeling has evolved towards accounting for the third dimension. The spatial correlation between arc volcanism within subduction zones and the underlying slab depth contour has been well studied from a geochemical and two-dimensional geodynamic perspective. However, observations indicate that arc volcanism also occurs adjacent to the termination of the trench, suggesting these "of axis" volcanoes cannot be explained by a simple 2D framework. Missing from a two dimensional model is the mantle movement around the free subducting slab edge. The dynamics of this flow have been spatially linked to volcanism that occurs near the lateral trench termination (Jadamec & Billen, 2010). Therefore, numerical case studies performed on realistic plate geometries are vital in order to investigate further the mantle dynamics in subduction zones.

The Boso Triple Junction (BTJ) is an example of a subduction setting requiring a three-dimensional framework. The BTJ is located southwest of Japan at the juncture of the Pacific plate, the Eurasian plate, and the Philippine Sea plate. The BTJ is an active trench-trench-trench triple junction characterized by both gaps in and anomalous clustering of Holocene volcanoes. This study uses high-resolution, 3D geodynamic modeling to investigate the dynamic interaction of the slabs at depth, the resulting asthenospheric flow, and how these relate to the patterns in volcanism on the surface. Here we present results from Phase 1 of the study comprised of the geographically referenced, high-resolution model design of the natural BTJ system.

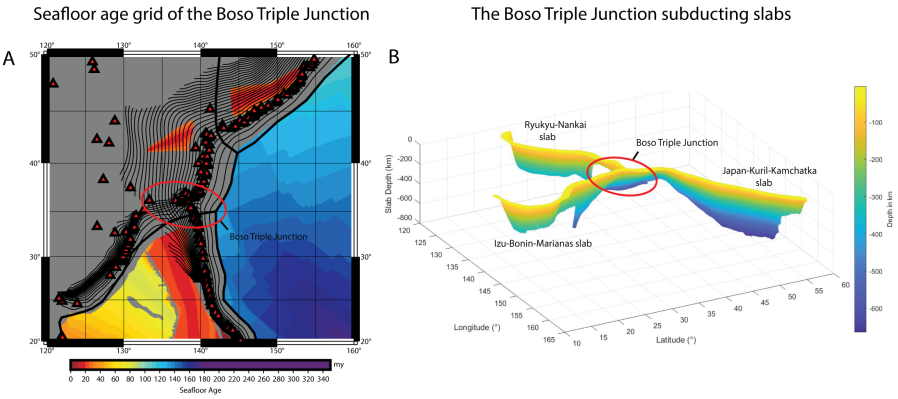

Figure 1: Tectonic constraints on BTJ model design. Slab geometry data (Hayes et al., 2018) shown as thin black lines (left) and as surfaces (right). Thick black lines are plate boundaries (Bird, 2003); Holocene volcanoes (Venzke, 2013) in red triangles show both clustering and volcanic gap in the BTJ. Seafloor age grid (Seton et al., 2020).

References

Jadamec, M. A. & Billen, M. I. Reconciling surface plate motions with rapid three-dimensional mantle flow around a slab edge. Nature 465, 338-341, doi:10.1038/nature09053 (2010).

Seton, M., Müller, R. D., Zahirovic, S., Williams, S., Wright, N. M., Cannon, J., et al. (2020). A global data set of present□day oceanic crustal age and seafloor spreading parameters. Geochemistry, Geophysics, Geosystems, 21(10), e2020GC009214.

Hayes, G. P., Moore, G. L., Portner, D. E., Hearne, M., Flamme, H., Furtney, M., & Smoczyk, G. M. (2018). Slab2, a comprehensive subduction zone geometry model. Science, 362(6410), 58-61.

Bird, P. An updated digital model of plate boundaries. Geochemistry, geophysics, geosystems : G3 4, 1027-n/a, doi:10.1029/2001GC000252 (2003).

Venzke, E. e. (2013). Global Volcanism Program. Volcanoes of the World, v. 4.9. 1.