A tomography-based plate tectonic reconstruction of the northwest Pacific Ocean basin since 100 Ma

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Magnetic lineations presenting ages decreasing to the northwest within the Pacific basin (e.g. 'Japanese' lineations; Nakanishi et al., 1989) imply that the present northwest Pacific Ocean once had a 'proto-Pacific' parent plate, which has been named the 'Izanagi' plate (Woods and Davies, 1982). Detailed reconstructions of the Pacific and proto-Pacific realms, however, are challenging because >6000 km of plate convergence since ~80 Ma have consumed oceanic lithosphere. In particular, published plate tectonic reconstructions for the last ~100 Myr show significant variability in two areas: (1) the possible existence and configuration of an 'Izanagi-Pacific seafloor spreading ridge'; and, (2) the possible existence and location of vanished East Asia marginal basins.

Here we present a plate reconstruction of the Pacific and proto-Pacific realms near northeast Asia since 100 Ma using subducted slab constraints from tomography. The Pacific plate was reconstructed by unfolding the Pacific slabs imaged in tomography models between 10°N and 54°N latitudes following the method of Wu et al. (2016), and from the identification of a 4000 km-long, northeast-trending 'slab gap' between the Pacific and Izanagi slabs. We show that this slab gap is the tomographic signature of the subducted Izanagi-Pacific ridge based on a comparison to published global mantle flow models (Flament et al., 2017). A conjugate Izanagi slab was then quantitatively modeled using the software GPlates from the geometry of the unfolded Pacific slab and the synthetic seafloor isochron ages of Seton et al. (2012).

Our reconstructed Pacific and Izanagi slabs imply that the Izanagi-Pacific spreading ridge subducted at 55±10 Ma between Kamchatka and the central Ryukyus at a low-angle to the northeast Asian margin. Our predicted ridge-trench interaction corresponded to a regional 55 to 46 Ma magmatic gap within Japan and the Russian Far East. Geochemical data reveal a sharp increase in ε Nd values and a decrease in strontium isotope ratios after the magmatic gap. The reconstructed Izanagi slabs account for a maximum subduction time of ~100 Ma between southwest Japan, the Okhotsk-Chukotsky arc, and westernmost Alaska. Subduction of the Izanagi plate may have been restricted to east of westernmost Alaska, and south of Japan. We discuss the implications of our results for the tectonic histories of western Alaska, Russian Far East, Japan, and eastern China, including tomographic evidence for potential vanished East Asia marginal seas.

Keywords: Pacific plate, Izanagi, slabs

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