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Kinematic reconstruction of the northwest Pacific region since the Late Cretaceous, and the fate of the Pacific-Izanagi ridge

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In Eocene time (∼50 Ma), a major plate reorganization induced an absolute plate motion change of the Pacific plate and the formation of the Hawaii-Emperor bend. The driver of this reorganization remains highly controversial. Recently, authors postulated that subduction of the Izanagi-Pacific ridge below the East Asian margin at 55-50 Ma, or a subduction polarity change in the NW Pacific, triggered the inception of westward subduction of the Pacific Plate, resulting in the plate motion change. Here we show that margin-wide subduction of the Izanagi-Pacific ridge below the East Asian margin cannot be reconciled with the onshore geological record of NE Asia, and that ridge subduction was restricted to the margin south of Hokkaido. We provide a plate-kinematic reconstruction of the northwest Pacific region since Late Cretaceous time, based on quantitative kinematic constraints from the geological record integrated with existing reconstructions of the oceanic plates underlying the Pacific Ocean, and tested against both a compilation of available paleomagnetic data and seismic tomographic images of mantle slab remnants. We present a new evolutionary model of the plate boundary configuration and marginal basin evolution in the NW Pacific from the Late Cretaceous to Present. Our model shows that two adjacent oppositely-dipping intra-oceanic subduction zones were active in the northwest Pacific region from ∼85 Ma to the Eocene. Paleomagnetic data indicate that a southward-dipping subduction zone below the Olyutorsky-Nemuro arc formed at a weakness zone close to the Izanagi-Pacific ridge at ∼85 Ma, confirming a recently published inference, but that subsequent northward roll-back rates of this subduction zone far exceeded Pacific plate motion rates. This formed a new plate separated from the Pacific plate by a back-arc ridge that likely re-activated the former Pacific-Izanagi spreading center, whose Paleogene relics are found in the accretionary prism of east Kamchatka. The subduction polarity reversal that followed upon the obduction of the intra-oceanic volcanic island-arc onto the NE Asian margin at 55-45 Ma therefore initiated subduction of a plate that was separated from the Pacific Plate by a spreading ridge. The second intra-oceanic Kronotsky island-arc was formed above northward-dipping subduction zone east of the Olyutorsky arc and consumed oceanic lithosphere of the Kula plate from ∼85 Ma until its cessation at ∼40 Ma possibly upon Kula-Pacific ridge subduction, after which the Kronotsky arc became part of the Pacific plate. We show how oblique collision of the Kronotsky arc with the western Aleutian arc led to the formation of the Bowers trench and ridge, and the opening of the Komandorsky basin in Cenozoic time. Our results imply that the Pacific plate did not yet subduct below NE Asia ∼50 Ma, and that subduction neither polarity reversal, nor ridge subduction, are straightforward drivers of the Pacific plate motion change, whose causes remain enigmatic.