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Advancing trenches: tectonic significance and dynamic implications

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Recent global kinematic studies reveal that most of the trenches roll back but a significant number of them advance toward the upper plate. Those advancing trenches are mostly located in the Western Pacific and correspond to the subduction of very old, Mesozoic oceanic lithosphere. While retreating trenches are commonly explained by the slab pull action of the descending lithosphere, the origin of advancing trenches is still debated. Since this relationships is dependent upon the adopted reference frame, we select region where geological studies show the variability of trench migration style with time. The Izu-Bonin-Mariana (IBM) region represents a key example. The detailed reconstruction of the trench migration of the IBM subducting system reveals that after a long episode of asymmetric rollback, the IBM trench recently started advancing. We propose that this change from retreating to advancing trench mode results from the subduction of progressively older and stiffer lithospheric material. We test this hypothesis by means of two-dimensional (2-D) numerical models, reproducing the effects of the lithospheric aging during subduction. The result of our numerical tests show that the entrance of old and stiff lithosphere forces the trench to advance because the increasing stiffness of the slab prevents the slab to unbend once it has subducted.