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New look at classical Wilson Cycle concept

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In spite of the lack of any Cenozoic examples, passive margins are among the first to have been proposed as candidate locations for the nucleation of new subduction zones. The broad acceptance of these tectonic settings arises from the role that they play in the Wilson Cycle, which describes the repeated opening and closing of ocean basins. The classical Wilson Cycle concept hypothesizes spontaneous conversion of passive continental margins into subduction zones. This process, however, is impeded by the high strength of passive margins, and it has never occurred in Cenozoic times.

Here, we introduce and test a new hypothesis for triggering subduction initiation along passive margins: mantle suction force. This force can be induced by neighboring subduction zones and mid-mantle slab remnants. In Atlantic passive margins, mantle suction flow can be induced either from the long-lived subduction zones of the North and East Pacific Ocean and Nazca Plate, including the Aleutians, Cascadia, and Andean subduction zones, or from the remnants of the Farallon and Phoenix slabs in the mid-mantle. Based on this hypothesis, we suggest a modified version of the Wilson Cycle concept in which the closing phase is facilitated by mantle flow. We test our hypothesis using 2-D numerical models. Models suggest that subduction initiation induced by mantle suction flow along passive margins is possible but it is a long-term process, thus explaining the lack of Cenozoic examples. We suggest that there are at least two localities on Earth where subduction may form along passive margins as a result of induced forces from mantle suction flow that are the Argentine passive margin and the US East Coast. We infer that subduction initiation in these areas is in the initial stage of shear zone formation in the upper parts of the lithosphere, and self-sustained subduction may be initiated in a few 10s Myr.