The role of transform faults during back-arc spreading centre jumps

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Jumps in the location of back-arc spreading centres are a common feature of back-arc basins, but the controlling factors are not understood. In several narrow subduction zones with a long subduction history, such as the Scotia arc or Tyrrenhian Sea, several spreading centres have been active in the course of history with regular, quasi-instantaneous jumps towards the retreating trench. A prominent feature of these regions are large bounding transform (‘STEP’) faults. However, whether STEP faults influence the (unknown) dynamics spreading centre jumps remains to be explored.

We therefore run 3D-models to simulate a long narrow subducting slab, bound by continents, which retreats and creates necessary STEP-faults self-consistently. The results offer a new mechanism for back-arc spreading jumps: After the creation of a back-arc spreading centre in the retreating subduction system, transform faults between trench and back-arc basin form. Spreading jumps are thus a consequence of the fact that these constantly elongating transform faults, which decouple the overriding plate from neighbouring plates, fail to remain active once a threshold length (~1.3x plate width) is reached. Subsequently, the back-arc basin and neighbouring plates are strongly coupled, and ongoing trench retreat localizes stresses and rapidly ruptures the overriding plate closer to the trench while the old spreading centre is abandoned. In a parameter study, the results further explain why the narrowest subduction zones, such as the Calabrian Arc, experience more frequent and closer spreading jumps than the long-period jumps of a wider subduction zone such as the Scotia Arc. The widest subduction zones should not undergo any back-arc spreading jumps with this mechanism, consistent with other natural examples.