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Rift jump and microcontinent formation in back-arc settings

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Back-arc basins often present multiple spreading centres that form one after the other (e.g. Mariana subduction zone), propagate and rotate (e.g., Lau Basin) following trench retreat. In some cases, rift jumps can create continental fragments or microcontinents (e.g., Coral Sea, Central Mediterranean, Scotia Sea). The processes controlling rift jumps and possible formation of continental fragments are still not fully understood, but they are certainly related to the dynamics of subduction.

In this work, we show how episodic trench retreat shapes the morphology of back-arc basins and can produce rift jumps. We use the finite element code ASPECT to model the rifting of continental lithosphere in 2D with boundary conditions that simulate the asymmetric type of extension caused by the trench retreat. We perform a parametric study in which we systematically vary the duration of different extensional phases, simulating episodes of trench retreat. Our results show that when extension is continuous, continental break-up occurs and a spreading centre develops. On the other hand, rift jump occurs in models with multiple extensional phases resulting in more complex morphologies that go from a hyperextend margin, to microcontinent formation, to spreading centre jumps within the newly formed oceanic lithosphere. In the first two cases (i.e., hyperextended margin and microcontinent), the length of the rift jump ranges from about 40 to 100 km and the timing varies from about 2 to 6 Myr. In the latter case (i.e., spreading centre jump within oceanic lithosphere) the length of the jump is significantly lower, 10-15 km, and the time needed for the ridge jump to occur is <2 Myr. These values depend on the rheological properties of the lithosphere, but, importantly, we show that the resulting scenario is controlled by the duration of the first extension stage and of the break before the next one.