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# Back-arc rifting favoured by a hot and wet continental lithosphere

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Understand how rifting is initiated promotes a better understanding of the subsequent rifting process. Many quantitative modelling studies have shown how rifting evolves with time for given boundary and other conditions (e.g., Braun & Beaumont, Can. Soc. Petr. Geol., Mem., 12, 241, 1987; Takeshita & Yamaji, Tectonophysics 181, 307, 1990; Buck, JGR, 96, 20,161 1991; Huismans & Beaumont, Geology, 30, 211, 2002; Yamasaki & Stephenson, J.Geod., 47, 47, 2009), but how rifting was initiated has usually been ignored. This is mainly because of poor constraints on the pre-rift structure of the lithosphere and the origin and magnitude of the responsible driving forces.

In this study, using a simple one-dimensional pure shear stretching model, tectonic subsidence data observed in several back-arc basins in the Tethyan belt of Europe and in the western Pacific are examined to infer something about the initiation of rifting and its subsequent evolution in back-arc settings. The origin of the force driving back-arc rifting is relatively better known than for rifting in other tectonic settings: the negative buoyancy force of subducted oceanic lithosphere (e.g., Uyeda & Kanamori, JGR, 84, 1049, 1979; Uyeda, Tectonophysics, 81, 133, 1982), which allows an examination of rifting initiation in relation to the behaviour of the subducting oceanic lithosphere.

The results show that back-arc rifting is initiated only after a certain magnitude of tensional force has been reached. Thus, the timing of back-arc rifting initiation can be explained in terms of the behaviour of the subducting oceanic lithosphere, assuming a balance between continental and oceanic lithospheric deformation. Back-arc rifting is initiated after subduction has already progressed to a point such that the negative buoyancy force of the oceanic lithosphere becomes large enough to deform oceanic lithosphere that has more strength than the overriding continental lithosphere.

The tectonic subsidence data require the magnitude of the tensional tectonic force to abate with time once rifting has started. This indicates that the rifting process is rapid enough that weakening due to an increasing geothermal gradient exceeds strengthening due to crustal thinning and thermal diffusion. This is achieved, given the currently accepted magnitude of slab subduction force, only if the thickness of the thermal lithosphere of the overriding continent is significantly less than 125 km and it has a wet rheology.

Sedimentary basin formation has often been discussed according to tectonic setting, but any aspect of rifting dynamics, such as the magnitude of driving force and the rheology of the lithosphere, has been poorly examined in such discussions. This study describes how the dynamics of back-arc rifting can be characterised in a general way as a first-order approximation. Although the focus was only on back-arc rifting, the results provide a reference for further discussion about the processes controlling rifting in other tectonic settings.