

# Are Rifts Brittle Fractures?

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Ice shelf rifts are through-cutting fractures that penetrate the entire ice depth. Most treatments of rift propagation assume that the fracture process can be treated as brittle (i.e. ice is treated as an elastic material and viscous effects are neglected). In this approach the rift is treated as a thin planar crack in the ice. However, over the time scales of rift propagation (years to decades), viscous strains exceed elastic strains by several orders of magnitude, making this an inappropriate assumption. In contrast, ice shelf flow is treated by assuming that ice flows viscously - a process which precludes crack formation. We suggest that a more realistic formulation is to consider the rifting process as the result of strain localization due to a plastic instability in the flow - sometimes called the "necking instability". In this theory deformation occurs in a zone with a characteristic length scale of several ice thicknesses. Although this approach has not been applied to ice shelf rifts before, it has been used to successfully explain many topographic features of lithospheric rifts on Earth and on Venus. Here we present the linear stability analysis which leads to plastic necking under plane strain conditions and determine the conditions where small perturbations in either the bottom profile or surface profile of the ice shelf become amplified. The predicted surface topography expected from a small initial thickness perturbation is compared with GLAS elevation profiles across a rift, as well as topography of typical lithospheric rifts