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Numerical modeling of West Antarctic Rift System extension and Transantarctic Mountains uplift

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The Transantarctic Mountains form a major tectonic boundary that bisects the Antarctic continent, separating the West Antarctic Rift System from the East Antarctic craton. The mountains have peaks up to 4.5 km high, and recent gravity and seismic analyses suggest the presence of a small underlying crustal root. As the Transantarctic Mountains are non-collisional in nature, their origin remains enigmatic. Many processes have been proposed to explain the uplift of the Transantarctic Mountains, including flexure, transform-flank uplift, thermal buoyancy induced uplift, and gravitational collapse of an elevated plateau. Recent tomographic results indicate that the upper mantle beneath the West Antarctic Rift System is warm and that mantle temperatures decrease beneath the Transantarctic Mountains toward the East Antarctica.

For the Ross Sea region, we examine the possibility of a direct relationship between the uplift of the mountains, the formation of the rift zone, and a pre-existing asymmetric lithosphere. 2D numerical models of extension with an asymmetric lithospheric structure consistently result in the formation of a mountain range and a rift system similar to modern seismic images of the Transantarctic Mountains and adjacent West Antarctic Rift System. The mountains form in an area of slightly depressed Moho, and an asymmetric rift zone, interpreted as the West Antarctic Rift System, develops with a focused region of crustal thinning interpreted as the Terror Rift. The numerically predicted crustal thickness and upper mantle thermal structures agree well with results of receiver functions analysis, seismic reflection, seismic tomography, and free-air gravity anomalies.