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Uplift history of rifted margins

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Rifted continent margins form after stretching and thinning of continental lithosphere. This process is predicted to result in subsidence and sediment deposition. A compilation of rifted margins of the world shows that margins undergo a phase of uplift starting just prior to rupture. This uplift ranges from ∼500 m to ∼2000 m, and is found on all margins, both magmatic and magma-starved. After breakup subsidence resumes, but may be interrupted by later periods of (relative) uplift. The uplift changes the lateral distribution of potential energy of the lithosphere, increasing deviatoric tension and facilitating breakup.

We investigated processes that could be responsible for the observed uplift around the time of continent rupture. Dynamic uplift by mantle flow only contributes several hundred meters to the uplift. Phase transitions in the shallow mantle may theoretically result in up to 1 km of uplift. Isostatic calculations suggest that removal of mantle lithosphere is a necessary and effective mechanism for the observed uplift. The combination of mantle phase transitions and a very thin mantle lid produces an excess potential energy state and a positive geoid anomaly, and leads to tensional forces favorable for rupture. We propose a new model for continental rupture which includes removal of mantle lithosphere (by detachment or instabilities). Observations of depth-dependent thinning on rifted margins and geochemical data support the model.