

Delamination in Collisional Orogens: Insights from Thermally-Controlled Buoyancy and Physical Modeling

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Delamination of the crust from the lower lithosphere has occurred in several collisional orogens, most notably the Alps, Pyrenees, and Canadian Cordillera. Some workers suggest this process to be similar to the tectonic wedging and stratigraphic delamination associated with triangle-zone development, known to depend on the kilometer-scale pattern of mechanical layering in foreland fold and thrust belts.

More than 35 orogens explored by deep geophysical techniques have been reviewed with no obvious correlation between crustal composition and a tendency to delaminate. Delamination of subducting passive margins is more common than tectonically and/or volcanically active overriding margins.

Estimates of lithospheric density show that the lower lithosphere of cool passive margins may contain greater negatively buoyant mass than warmer active margins. The top of the densest layer of lower lithosphere is aligned with a weak zone located near the base of the crust. Because passive margins have a denser lower lithosphere, they show a greater tendency for delamination during collisional orogenic events than active margins.

Scaled physical models with a model continental crust weakly coupled to a negatively buoyant mantle layer delaminate during shortening. In contrast, weakly coupled models with a positively buoyant mantle layer exhibit no tendency for delamination or wedging, despite a weak horizon at the base of the model crust. This change in behavior indicates that the mass distribution within the lithosphere, in contrast to mechanical layering, is a primary control on the process of collisional delamination.