Physical models of plate tectonics and intracontinental deformation, applied to South America

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Physical modelling has reached a stage of development, where it is possible to reproduce plate motions and their effects on intracontinental deformation. The models here described are composed of 5 successive layers: sand (for brittle crust); silicone putties (for ductile crust and mantle lithosphere); and sugar solution (for asthenosphere). Layer thicknesses and material properties are scaled, so as to represent either oceanic or continental lithospheres. Plates are driven horizontally by pistons. Subduction zones and transform faults initiate spontaneously or can be forced.Horizontal shortening of a model continent has been obtained, either through continent-continent collision, or through rapid convergence and subduction at an ocean-continent boundary. The resulting deformation pattern is sensitive to (1) the shape of the continent, (2) its buoyancy, (3) its mechanical resistance and internal weaknesses, (4) the configurations, motions, resistances and buoyancies of surrounding plates.During the Cenozoic, the oceanic Nazca plate underwent rapid oblique subduction beneath continental South America. In corresponding physical models, the margins of South America underwent localized deformation, while the entire continent rotated clockwise about a vertical axis, in response to applied torques. Internal deformation was limited to localized wrench zones. Crustal thickening at the western margin was very sensitive to mechanical weaknesses, which in nature may be inherited or thermally induced. The experimental results correlate well with the known distribution of Cenozoic deformation in South America.