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Different stages of collision zones on examples of Gujarat province (India) and Caucasus

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In this study we present seismic structures of the crust and upper mantle beneath two regions: Kachchh Gujarat region (India), and Caucasus that may represent different stages of the collisional processes. In both cases, the 3D seismic models were obtained based on tomography inversion of arrival times of P and S seismic waves from local and regional earthquakes.
Collisional processes in the Caucasus region began 35 million years ago with the closure of the Tethys Ocean, and continues to this day. The rate of shortening between the Scythian and the Arabian plate is currently 1-2.2 mm/year. The tomography inversion used the dataset provided by several seismic agencies of the Caucasus region that contained 23,071 P- and 21,598 S-picks from 1374 events. The obtained P and S velocity models clearly delineate major tectonic units in the study area. A high velocity anomaly in Transcaucasian separating the Great and Lesser Caucasus possibly represents a rigid crustal block corresponding to the remnant oceanic lithosphere of Tethys. Another high-velocity pattern coincides with the southern edge of the Scythian Plate. Strongly deformed areas of Great and Lesser Caucasus are mostly associated with low-velocity patterns representing thickened felsic part of the crust and strong fracturing of rocks. Most Cenozoic volcanic centers of Caucasus match to the low-velocity seismic anomalies in the crust. We propose that the mantle part of the Arabian and Eurasian Plates has been delaminated due to the continental collision in the Caucasus region. As a result, overheated asthenosphere appeared nearly the bottom of the crust and facilitated melting of the crustal material that caused the origin of recent volcanism in Great and Lesser Caucasus.
The Kachchh province, in contrast to the Caucasus, is far from any boundaries of major lithospheric plates. However, this area is one of the most seismically active in India. It is suggested that it may be a site of the lithosphere rupture and initiation of a new collision zone. For the tomography inversion of the Kachchh region we selected the data of 4105 earthquakes with arrival times 29660 P and 30278 S waves. Based on the obtained seismic anomalies, we identify the left-lateral displacement to approximately 70 km along a hidden fault. We suggest that this fault can be associated with a series of ridges having the SW-NE direction, which are clearly seen on the bathymetry of the Indian Ocean bottom. Northwards displacement of the Indo-Australian Plate and contraction with Asia causes strong compression deformations in the broad areas of the Indian Plate. The curved geometry of the western boundary of the Indo-Australian plate and orientations of the fracture zones presume both shear and compressional displacements along faults. The presence of both thrust and strike-slip mechanisms of earthquakes in the Kachchh province may support the existence of such combined deformations leading to initiation of a new collision belt.