

Geophysical constraints on geodynamic processes at convergent margins: A global perspective

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Convergent margins, being the boundaries between colliding lithospheric plates, form the most disastrous areas in the world due to intensive, strong seismicity and volcanism. We review global geophysical data in order to illustrate the effects of the plate tectonic processes at convergent margins on the crustal and upper mantle structure, seismicity, and geometry of subducting slab. We present global maps of free-air and Bouguer gravity anomalies, heat flow, seismicity, seismic Vs anomalies in the upper mantle, and plate convergence rate, as well as 20 profiles across different convergent margins. A global analysis of these data for three types of convergent margins, formed by ocean–ocean, ocean–continent, and continent–continent collisions, allows us to recognize the following patterns.

- (1) Plate convergence rate depends on the type of convergent margins and it is significantly larger when, at least, one of the plates is oceanic. However, the oldest oceanic plate in the Pacific ocean has the smallest convergence rate.
- (2) The presence of an oceanic plate is, in general, required for generation of high-magnitude ($M_N 8.0$) earthquakes and for generating intermediate and deep seismicity along the convergent margins. When oceanic slabs subduct beneath a continent, a gap in the seismogenic zone exists at depths between ca. 250 km and 500 km. Given that the seismogenic zone terminates at ca. 200 km depth in case of continent–continent collision, we propose oceanic origin of subducting slabs beneath the Zagros, the Pamir, and the Vrancea zone.
- (3) Dip angle of the subducting slab in continent–ocean collision does not correlate neither with the age of subducting oceanic slab, nor with the convergence rate. For ocean–ocean subduction, clear trends are recognized: steeply dipping slabs are characteristic of young subducting plates and of oceanic plates with high convergence rate, with slab rotation towards a near-vertical dip angle at depths below ca. 500 km at very high convergence rate.
- (4) Local isostasy is not satisfied at the convergent margins as evidenced by strong free air gravity anomalies of positive and negative signs. However, near-isostatic equilibrium may exist in broad zones of distributed deformation such as Tibet.
- (5) No systematic patterns are recognized in heat flow data due to strong heterogeneity of measured values which are strongly affected by hydrothermal circulation, magmatic activity, crustal faulting, horizontal heat transfer, and also due to low number of heat flow measurements across many margins.
- (6) Low upper mantle Vs seismic velocities beneath the convergent margins are restricted to the upper 150 km and may be related to mantle wedge melting which is confined to shallow mantle levels.

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