



Restoring lithospheric slab dynamics and mantle evolution beneath the Japanese islands

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An interaction of the Pacific, Okhotsk, Eurasian, and Philippine Sea plates with the deep mantle around the Japanese islands is complicated by active subduction of the plates and back-arc spreading, which cannot be understood by the plate kinematics only. We present and discuss the results of quantitative dynamic restoration of thermal state of the mantle beneath the Japanese islands and their surroundings. The restoration is based on the assimilation of present temperature inferred from seismic tomography, present plate movements derived from geodetic measurements, paleogeographic and paleomagnetic plate reconstructions up to 40 million years. As time goes back to the past, the high temperature anomaly beneath the back-arc Japan Sea basin splits into two hot anomalies that move downward to meet the large sub-slab hot anomaly moving slowly also down westward. Our dynamic restorations show that back-arc hot upwellings are likely to have originated in the sub-slab mantle and penetrated through breaches/tears of the subducting Pacific plate into the mantle wedge. The back-arc upwellings based on our scenario are consistent with the rapid subsidence in the sedimentary basins of the Japan Sea suggesting back arc spreading origin and the change in the source of magmatic rocks from enriched to depleted mantle. We propose that a hot sub-slab mantle may play an important role in the dynamics of descending lithosphere and unravelling the process contributing to back-arc opening in this region and, possibly, elsewhere.