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The northern edge of Pacific plate position near Kamchatka-Aleutian junction

Boris Gordeychik (1), Tatiana Churikova (1,2), Anna Volynets (1,2), Gerhard Wörner (2), and Paul Layer (3)

(1) Institute of Volcanology and Seismology FED RAS, Petropavlovsk-Kamchatski, Russia (gordei@mail.ru), (2) GZG Abteilung Geochemie, Universität Göttingen, Göttingen, Germany (gwoerne@gwdg.de), (3) University of Alaska Fairbanks, Department of Geology and Geophysics, Fairbanks, USA (player@gi.alaska.edu)

Two geochemical transects were carried out through Kamchatka: one previously studied SE-NW across the arc and one SW-NE trending along the Sredinny Range (SR) back arc zone. These data with Ar-Ar dating constrain magma source in space and time and allows us to relate these to tectonic position setting of the region at a given time.

The cross arc transect from Gamchen volcano in Eastern Volcanic Front (EVF) through Central Kamchatka Depression (CKD) to Ichinsky volcano in SR based on Quaternary rocks showed continuous geochemical zonation from arc front to back arc of present subduction zone, including strong and gradual increase in LILE, LREE and HFSE in whole rocks.

The transect along the SR from the Achtang lava field to Tekletunup volcano (the back arc zone) comprises two age groups of volcanic rocks each with uniform in geochemical features. Late Miocene-Pliocene rocks (3-6 Ma) represent voluminous plateau lavas of depleted basalts with low HFSE and HREE. Fluid-mobile elements are enriched and enrichment patterns are in fact similar to the typical arc front lavas. The younger group of Quaternary rocks (<1 Ma) is represented by monogenetic cones and stratovolcanoes that combine the typical LILE/HFSE-enrichment of a subduction setting with enrichment in all incompatible elements.

In Eocene-Miocene times SR represented the active volcanic front of the Proto-Kamchatka subduction zone. In later times Kamchatka arc system has been modified by the accretion of the Kronotsky terranes. The time of accretion and the SE-outward 200 km shift of the subduction zone to the presently active EVF has been estimated from 40 to 2 Ma.

Our data can help to better constrain the timing of this event by arguing that the systematic change in SR rock geochemistry with time is the result of this arc shift and has been facilitated by a massive slab roll-back event. In this scenario the SR plateau lavas represent the volcanic front until as recently as 3 Ma. The younger Quaternary rocks at SR are the present back arc lavas of the recent subduction zone. Both, the systematic geochemical zonation from contemporary arc front to back arc and the uniformity of geochemistry of young volcanic rocks along the SR show that the volcanism of the region is explained by the only one mechanism – subduction of the Pacific Plate below Kamchatka. A trend is documented from fluid-dominated melting in the EVF, through the upwelling of a strongly fluid-fluxed mantle below the CKD to melting of a fluid-enriched mantle aided by strong upwelling and decompression in the SR back arc zone.

Magmatism has continued to be active in SR up to the Holocene even though seismic data today do not show a signal for a downgoing plate below this region. But the absence of the seismicity does not mean the absence of plate because at temperatures higher than 600-700°C seismicity is lost.

We argue that the northern edge of the Pacific Plate is represented by a wide (150 km) boundary as a set of transform faults which can be projected on Kamchatka surface from the morphology of the downgoing oceanic plate. Also this edge is marked by the termination of Holocene volcanoes on surface along of SR. The absence of the young volcanism to the north of the on-land projection of the Alpha fault marks the plate boundary at depth.