NEOTECTONICS NEAR THE NW CORNER OF THE PACIFIC PLATE: MARINE TERRACES ON OZERNOI AND KAMCHATSKY PENINSULAS, KAMCHATKA, RUSSIA

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On Kamchatka, four regional-scale peninsulas are present on the eastern shore, from south to north, Shipunskiy, Kronotskiy, Kamchatskiy, and Ozernoi peninsulas. We studied marine terrace sequences on the northern two peninsulas, which show moderate to strong uplift rates as well as tectonic segmentation such as faulting and tilting. While the Kamchatskiy Peninsula is relatively well understood tectonically as collisional (e.g., Geist & Scholl, 1994; Freitag et al., 2001), the Ozernoi Peninsula remains tectonically enigmatic.

The simplest tectonic configuration for this region incorporates the existence of a three plates, Pacific, North America and the Komandorsky Island Block (KIB) (McElfresh et al., 2002). But in fact various alternative plate models have been proposed. This area is also of interest to geoscientists because in the northwestern Pacific, there is a «dramatic shift in subduction dynamics» (Yogodzinski et al., 2001; Levin et al., 2002), where the subducting Pacific plate meets a 90-degree change in its plate boundary. The Komandorsky Basin lies north of the KIB and is characterized by transtensional and extensional elements: high heat flow, magnetic lineaments, and transcurrent faults (Baranov et al., 1991). The Ozernoi Peninsula lies on the eastern margin of the Komandorsky Basin, north of the active subduction zone. The western half of the peninsula principally comprises a Quaternary volcano, Nachikinsky. Eastern Ozernoi is undergoing active uplift and in 1969 experienced a Mw 7.7 compressional earthquake. Possible sources for this compression and uplift include 1) shear distributed from the Pacific Plate, north of the KIB (McElfresh et al., 2002), 2) convergence generated from a spreading Komandorsky Basin (Baranov et al., 1991) or 3) convergence generated by a rotating Bering Block (Mackey et al., 1997; Gordeev et al., 2001).

This report is based primarily on the field season of 2003. Field techniques included physical measurement of Holocene beach profiles and transects of Pleistocene marine terraces using a digital altimeter calibrated for barometric drift and tied to local sea level corrected for tides. On the Kamchatskiy Peninsula, three Late Pleistocene and one Holocene marine terrace were mapped over more than 20 km of rocky coast north of Cape Africa. Late Quaternary uplift rates range from 0.1 to 1.0 mm/yr. On the NE part of the Ozernoi Peninsula, one Holocene and two Pleistocene marine terraces are generally present, and remnants of at least two older terraces are detectable Uplift rates range from 0.1 to 0.3 mm/yr.

Based on fission-track ages of apatites, Freitag et al. (2001) report long-term (over millions of years) uplift/exhumation rates for the Kamchatskiy Peninsula of 0.2 to >1 mm/y, increasing toward the south. Our rates agree in order of magnitude, and in general trend. However, in the NE region of the peninsula, Freitag et al. report only moderate rates (0.2 mm/y), but in this same region, we documented rates from 0.1 to 1.0 mm/yr, on a late Quaternary time scale (over the last half million years). Differences may be due partly to the time scale, but our study has a denser array of measurements in this northern region, so we believe we are documenting more segmentation and tilting than observed by Freitag et al. (see also Kravchynovskaya et al., this meeting).

Prior to our study, no one had quantified uplift rates for the Ozernoi Peninsula. These rates are comparable to, if less than, rates on the Kamchatskiy Peninsula, a small collisional orogen. Both peninsulas show increasing uplift toward the east and south, with lowlands toward the west. Moreover, Ozernoi exhibits seismic activity consistent with a compressional regime. On 22 November 1969, 23:09:35 GMT, an earthquake jolted the Ozernoi Peninsula, with an
offshore epicenter at 57.8°N, 163.6°E. Fedotov and Gusev (1973) interpreted this earthquake as an oblique slip event, but as early as 1975, it had been reinterpreted as a thrust fault. Using body waveform analysis, Daughton (1990) also found a thrust fault-plane solution, striking N50°-80°E and dipping 5°-10°NW. Current Mw assigned to this earthquake is 7.7-7.8, and it generated a tsunami of magnitude 7.7. Using a tide gage record and runup data from observations and tsunami deposits, we have calculated a displacement of about 4 m, or about 3.5 m of shortening (see Bourgeois and Titov, this meeting). From the record of pre-historic tsunami deposits, the recurrence interval for 1969-like events is on the order of 100-200 years (Bourgeois et al., in prep.). If we take the maximum of 200 years, and if we use a 3-m shortening for 1969, the «Bering Block» would be moving at a rate of 15 mm/y toward Kamchatka, about half the rate of the KIB (McElfresh et al., 2002; Gordeev et al., 2001).

As noted above, there are at least three plausible mechanisms to generate this convergence. We cannot currently distinguish among these three. Studies of Pleistocene Nachikinsky and Khailiulia volcanoes may contribute to our understanding. Whereas the behavior of the Ozernoi Peninsula coast can hardly be called a subduction zone, it exhibits tectonic activity and Quaternary volcanism that have yet to be explained. In any case, the nature of Ozernoi Peninsula must be accounted for in any geodynamic model of the northwest Pacific (e.g. the «torn slab» model (Yogodzinski et al., 2001; Levin et al., 2002).

References