For nearly ten years on Kamchatka, our team of geoscientists has been collecting data on tsunami deposits, both historical and pre-historical. Abundant Holocene tephra on Kamchatka permit constraints on the timing of both historical and prehistoric tsunamis, which we take as proxies for subduction-zone earthquakes. Millennial-scale histories are one goal of these studies (e.g., Pinegina and Bourgeois, 2003; Pinegina et al., 2003a&b). Another goal is enhanced investigation of historical tsunamis (as catalogued by Zayakin and Luchinina, 1987; plus 1997 Kronotskoye), both to generate benchmarks for older tsunami deposits, and also, as shown below, to elucidate earthquake-tsunami linkages during these remote, recent events.

1969 Ozernoi earthquake and tsunami

On 22 November 1969, 23:09:35 GMT (locally midday, 23 November), an earthquake jolted the Ozernoi Peninsula, with local shaking of 7-8 MM (Fedotov and Gusev, 1973). The epicenter was located at 57.8°N, 163.6°E, just off the Ozernoi Peninsula. Fedotov and Gusev (1973) interpreted this earthquake as an oblique slip event with a significant component of left strike slip, but as early as 1975, it had been reinterpreted as a thrust fault (Cormier, 1975), based on data from global and Canadian seismograph networks. Using body waveform analysis, Daughton (1990) also found a thrust fault-plane solution, striking N50°-80°E and dipping 5°-10°NW, and assigned a moment magnitude of 7.8. Various magnitude for this earthquake have been published (7.3-7.8); a tsunami magnitude Mt=7.7 based on the tsunami height at Hawaii is consistent with a moment magnitude of 7.7-7.8.

The 1969 Ozernoi earthquake was followed by a tsunami with local runup reported to be 5-7 m from the village of Ivashka south around the Ozernoi Peninsula to the Ozernaya River, and a local maximum of 10-15 m south of Cape Ozernoi (Olkhovaya River) (Zayakin, 1981). Runup was 1-3 m north to Lavrova Bay and southeast to Bering Island, and the tsunami was recorded on tide gages in the town of Ust’-Kamchatsk and faintly in Petropavlovsk-Kamchatskiy. Based on the presence of tsunami deposits above the 1964 Shiveluch tephra or the 1956 Bezymianni tephra, we have expanded the runup catalogue for this event to all our field sites in the southwest Bering Sea. Moreover, we have evidence of post-1956 subsidence at the northern and southern extremes of the Ozernoi Peninsula, which we interpret to be co-seismic with 1969 event. Using these data and the tide gage record, a fault-plane solution was reconstructed that can generate this tsunami, with 4 m of offset, or about 3.5-m shortening using the Daughton solution.

Based on the record of pre-historic tsunami deposits, the recurrence interval for 1969-like events is on the order of 100-200 years (Bourgeois, Pinegina and others, in prep., various sites). If we take the maximum of 200 years, and if we use a 4-m shortening for 1969, the «Bering Block» would be moving at a rate of 15-20 mm/y toward Kamchatka, about half the rate of the Komandorsky Island Block (McElfresh et al., 2002; Gordeev et al., 2001). The significance of these findings is further discussed in Pedoja et al., this meeting.

1997 Kronotskoye earthquake and tsunami

The 1997 Kronotskoye earthquake (Mw 7.8; see Gordeev et al., 2001 for recent summary and references) occurred near midnight in early December, and the ensuing local tsunami was not observed along the remote Kamchatka coast. Local tide gage records for the tsunami were incomplete, and a brief post-tsunami survey found evidence of only about 2 m runup on Kronotsky Cape, the northern limit of the survey. A summer 2000 field survey for tsunami
deposits north of Kronotsky Cape uncovered unexpected tsunami deposits, most likely from 1997, indicating runup as high as 4-8 m between Big Chazhma and Andrianovka rivers in south Kamchatskiy Bay. Subsequent location and interview of an eyewitness confirmed some effects of the tsunami. Using field observations and topographic profiles, we have modeled local tsunami runup using three different tsunami-source configurations. Only a segmented double rupture (consistent with seismicity) can explain low runup on Kronotsky Cape (and south), with high runup to the north. Modeled runup is also consistent with variations in tsunami-deposit distribution along 100 km of coastline. This joint geological-modeling effort is the first time tsunami deposits have been used to modify our understanding of a recent historical earthquake and tsunami.

References