

Sharp tectonic and volcanic unrest at 2800-2900 ¹⁴C BP – evidences from river terrace and monogenetic volcanoes dating

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Tephrochronological investigations conducted under the umbrella of KALMAR project have allowed us to determine the age of the lake and river terraces as well as date the paleolandslides, i.e. the events which trace the tectonic activity, at northern (Two-Yurts lake) and southern (Three sister river) parts of Kamchatka. We also correlated the results with previously obtained data on other parts of Kamchatka to get a regional time-schedule of tectonic and volcanic activity.

Detail study of distal tephras around Two-Yurts lake established the main marker ash layers at this area. These are the ashes of different Kamchatka volcanoes: Shiveluch, 900, 1400, 1750, 2800, 4700, 4800 and 8300 ¹⁴C BP; Ksudach, 1800 ¹⁴C BP, Avachinsky, ca 2000 ¹⁴C BP, Klyuchevskoy 2850 ¹⁴C BP, and Khangar, 6900 ¹⁴C BP. The main ash markers for Three Sister river are the tephras of Ksudach (1000 ¹⁴C BP), Khodutka (2500 ¹⁴C BP), Dikii Greben (4500 ¹⁴C BP) volcanoes and Kuril lake caldera (7600 ¹⁴C BP). We used these local tephrostratigraphical scales to reconstruct the timing of landscape change, in particular to date the formation of lake and river terraces and the landslide events. Both features can be regarded as indicators of increased tectonic activity.

The oldest Holocene lake terrace found near Two-Yurts lake is ca. 3 m high above the present day level of the lake. The age of the terrace is about 2900-3000 ¹⁴C BP. Two younger terraces of 0.5 m and 1 m height reveal an age of about 1000 and less than 900 ¹⁴C BP. We also found several Holocene landslides which probably were the results of strong earthquakes which, in turn, could also testify for tectonic activity. The ages of landslides were estimated as ca. 4000, 2900 and 2000-2100 ¹⁴C BP. At the southernmost tip of Kamchatka, at Three sister river valley, we found two terraces, which have ages of 8000 and 2800-2900 ¹⁴C yrs, respectively.

At the junction of Levaya Avacha and Vershinskaya rivers we discovered six river terraces. They are either 1, 1.5, 2, 4, 7.5 and 11 m above the recent holm. The ages of these terraces are about 600, 2000, 2900, 7500 and 9000 ¹⁴C BP, respectively. At Savan river we have dated seven terraces. The age of three older terraces range from 10000 to 8300 ¹⁴C BP. The other four are 4300, 2900, 2600 and 1000 ¹⁴C years old.

Thus, two main stages of tectonic activity can be distinguished for the most part of the peninsula: Early Holocene (8000 – 10000 ¹⁴C BP) and Late Holocene (2900 – 600 ¹⁴C BP) separated by a mid-Holocene tectonic repose period (3000 – 8000 ¹⁴C BP). These periods of unrest are characterized by numerous tectonic movements that resulted in sequences of river and lake terraces and landslides. The most dramatic event was the beginning of the Late Holocene stage. According to our data, the sharp increase of tectonic activity occurred at 2800 – 2900 ¹⁴C BP at southern, eastern and northern parts of Kamchatka. Tectonic movements ca 2900-3000 ¹⁴C BP were detected for the Central Kamchatka Depression (Pevzner et al., 2006). It was also the time of sharp increase of volcanic activity. Several large monogenetic volcanoes erupted 2800-2900 ¹⁴C BP at Tolmachev Dol, upper stream of Avacha river, Sedankinsky Dol, and probably Tolbachinsky Dol (Dirksen, Melekestsev, 1999, Dirksen et al., 2003, etc.). Strong eruptions of stratovolcanoes also occurred at that time (Bazanov et al., 2005, Ponomareva et al., 2007, etc.). Thus, we suppose, that the time of 2800-2900 ¹⁴C BP could be regarded as a time of whole-Kamchatka sharp and sudden increase of tectonic and volcanic activity.

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