

## Sharp tectonic and volcanic unrest at 2800-2900 <sup>14</sup>C 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 <sup>14</sup>C BP; Ksudach, 1800 <sup>14</sup>C BP, Avachinsky, ca 2000 <sup>14</sup>C BP, Klyuchevskoy 2850 <sup>14</sup>C BP, and Khangar, 6900 <sup>14</sup>C BP. The main ash markers for Three Sister river are the tephras of Ksudach (1000 <sup>14</sup>C BP), Khodutka (2500 <sup>14</sup>C BP), Dikii Greben (4500 <sup>14</sup>C BP) volcanoes and Kuril lake caldera (7600 <sup>14</sup>C 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 <sup>14</sup>C BP. Two younger terraces of 0.5 m and 1 m height reveal an age of about 1000 and less than 900 <sup>14</sup>C 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 <sup>14</sup>C BP. At the southernmost tip of Kamchatka, at Three sister river valley, we found two terraces, which have ages of 8000 and 2800-2900 <sup>14</sup>C 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 <sup>14</sup>C BP, respectively. At Savan river we have dated seven terraces. The age of three older terraces range from 10000 to 8300 <sup>14</sup>C BP. The other four are 4300, 2900, 2600 and 1000 <sup>14</sup>C years old.

Thus, two main stages of tectonic activity can be distinguished for the most part of the peninsula: Early Holocene (8000 – 10000 <sup>14</sup>C BP) and Late Holocene (2900 – 600 <sup>14</sup>C BP) separated by a mid-Holocene tectonic repose period (3000 – 8000 <sup>14</sup>C 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 <sup>14</sup>C BP at southern, eastern and northern parts of Kamchatka. Tectonic movements ca 2900-3000 <sup>14</sup>C 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 <sup>14</sup>C 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 <sup>14</sup>C BP could be regarded as a time of whole-Kamchatka sharp and sudden increase of tectonic and volcanic activity.

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**References:**

- Bazanova, L. I., Braitseva O. A., Dirksen O.V., Sulerzhitsky L. D., and Danhara T., (2005) Ashfalls from the largest Holocene eruptions along the Ust'-Bol'sheretsk - Petropavlovsk-Kamchatsky traverse: sources, chronology, recurrence. *Volcanol. and Seismol.*, (6), 30–46, (In Russian)
- Dirksen, O. V., Melekestsev I. V., (1999), Chronology, evolution and morphology of plateau basalt eruptive centers in Avacha River area, Kamchatka, Russia, *Volcanol and Seismol.*, 21(1), 1–28.
- Dirksen, O., Bazanova L., Portnyagin M., (2003), Chronology of the volcanic activity in the northern part of Sredinny Range (Sedanka lava field) in the Holocene, in *Volcanism and geodynamics, Materials of the II Russian symposium on volcanology and paleovolcanology*, Ekaterinburg, 871–874.
- Pevzner, M. M., Ponomareva V. V., Sulerzhitsky L. D., (2006), Holocene soil-pyroclastic successions of the Central Kamchatka depression: ages, structure, depositional features, *Volcanol. and Seismol.*, (1), 24–38, (In Russian).
- Ponomareva V.V., Kyle P.R., Pevzner M.M., Sulerzhitsky L.D., Hartman M., (2007) Holocene eruptive history of Shiveluch volcano, Kamchatka Peninsula. In: Eichelberger J., Gordeev E., Kasahara M., Izbekov P., Lees J.( Eds) "Volcanism and Subduction: The Kamchatka Region", American Geophysical Union Geophysical Monograph Series, Volume 172: 263-282.