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WATER ISOTOPE BUDGET OF SUBGLACIAL LAKE VOSTOK (ANTARCTICA)

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We have measured the isotope composition (delta D and delta 18O) of the deepest section of the Lake Vostok (LV) accretion ice core with a resolution of 50 cm between 3611 m and 3623 m depths and with a resolution of 1.5 cm along the two selected ice-core increments: 3571.4-3574.0 m and 3620.0-3621.0 m representing accretion ices 1 and 2, respectively. It is shown that the original isotopic heterogeneity, which is likely a characteristic of the lake ice soon after its formation, must have been substantially smoothed due to the fast diffusion of water isotopes at elevated temperature. The effective "diffusion length" is about 8 cm as estimated from the isotopic profiles in the transition zone between meteoric and accretion ices (3538.4 - 3538.8 m).

A simple model is proposed to predict the time evolution of the isotopic compositions of the lake water and accretion ice. In contrast with earlier developments, the model is not based on the assumption about a constant volume or/and isotopic steady-state of LV. It allows for additional (besides the ice sheet bottom melting) source of water and takes into account mixing between melt and resident water in the lake. Applying the model to interpret available data on isotope composition of accretion ice core has allowed estimation of the isotope composition of the lake water for a number of scenarios with different parameters of hydrological regime and accretion ice formation process in LV. The reconstructed isotopic composition of melt water (delta D = -444.25 per mil, delta 18O = -57.17 per mil) appears to be different from that of accretion ice (delta D = -442.7 per mil, delta 18O = -56.27 per mil). This suggests non-stationary isotopic state of LV or/and the existence of an additional water source characterized by unusual for meteoric water isotope composition. Most likely this additional source is hydrothermal waters that can contribute to LV through the fault vents at the lake bottom, the scenario consistent with the recent biological findings, geological evidences and helium isotope studies in accretion ice.