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## Results of the Russian studies of the subglacial Lake Vostok



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### Results of the Russian studies of the subglacial Lake Vostok

During the season of 2000-2001, Russia continued studies of the subglacial Lake Vostok that have been started on a regular basis in 1995. In the framework of the activities under the Russian Antarctic Expedition Program, the field studies included ground radar and seismic surveys to investigate the characteristics of the internal lake structure. The laboratory studies aimed at glaciological and microbiological investigation of the ice cores from the low horizons of the deep borehole drilled at Vostok station to a depth of 3623 m.

The radio-echo sounding of the ice sheet strata and the determination of the type of the reflecting surface (water or bedrock) were conducted by a discrete-continuous digital system with a carrier frequency of 60 MHz towed by a caterpillar vehicle. As a result of these studies, the coastline position in the southern area of the lake was obtained. The total length of radio-echo-sounding profiles comprised 1200 km where 58 points of the lake coastline determined by the change of the radiowave passage medium (water column-bedrock) were recorded. The assumed coastline boundary was described in the general plan at the map of the glacial daytime surface tilts. Special high precision work for mapping the coastline was undertaken and its details were specified approximately for one third of the water table of the lake in its southern area. According to the data obtained, the eastern shore of the subglacial Lake Vostok is located in the submeridional direction along  $107^{\circ}\text{E}$  at a distance of more than 70 km. The southern shore has a complicated configuration characterized by a small inlet and a cape protruding to the lake over more than 6 km. The western coast is strongly dissected. In the southwestern area, there is a round-shaped bay entrenched to the land over 6 km. At a distance of about 170 km from Vostok station northward, there is a system of bays and capes. The southernmost of them elongates submeridionally approximately along  $104^{\circ}20'\text{E}$  protruding to the lake over a distance of about 15 km at a width of about 7 km. Here, a round-shaped bay is located intruding to the land over a distance of about 20 km. Farther north, there is an L-shaped peninsula with a size of approximately  $30 \times 15$  km.

The ice sheet thickness above the lake changes from 3700 m in the southern area to 4350 m in the western part. The latter is the largest thickness ever measured by Russian (Soviet) specialists in Antarctica. In the general plan, the glacier thickness increases northward and eastward from the Vostok station. The glacier foot above the lake is located in heights between  $-700$  m to  $-200$  m relative to sea level. In the southern area of Lake Vostok there is a lowland plain with depths around  $-200$  m directly adjoining the lake. The character of radar signatures suggests the presence of small water-filled depressions of about  $1 \times 1$  m in size.

The study of the spatial structure of the water column and the bottom sediment layer was continued by means of seismic methods. According to these data, there are two "deepwater" troughs in the southern lake area with the water layer 600-700 m thick directly under the Vostok station and up to 1200 m north of the station. The trough situated under the station is characterized by the thickest layer of bottom sediments up to 200-300 m. The northern portion of the lake presents a shallow water area with the layer thickness less than 200 m. Similar decreases are also noted in the layer of bottom sediments where they have a thickness of several tens of meters.

An analysis of the measurements of the ice isotopic composition and electrical conductivity and the size of ice grains and the number of mineral inclusions in the ice core obtained at Vostok allowed a conclusion that the boundary between the glacier ice of atmospheric origin and the frozen at the lower ice base congelation ice formed from subglacial lake water occurs

and the frozen at the lower ice base congelation ice formed from subglacial lake water occurs at a depth of 3538 m. The study of the crystalline structure of lake ice by means of the x-ray topography method has revealed that this ice is characterized by an almost ideal structure and low density of the crystalline dislocation lattice. The maximum shear ice deformations occur in the 3460-3538 m layer that beds directly above the contact of glacial and lake ice. The calculations made on the basis of ice core data using a model of helium diffusion in ice have shown that the flowing ice sheet erodes to the upper surface of the lake ice layer with a rate of 2-8 mm/year. Thus, assuming the total thickness of the ice growth layer to be 220 m, one can calculate that the period of a full renewal of lake ice in this area comprises approximately 45 kyr.

The microbiological studies of the ice core deep layers were aimed to study the morphological diversity of microorganisms and obtain evidence of a possible preservation of their viability in the glacial strata. The results of these studies have indicated the presence of microorganisms in the lake ice belonging to different taxonomic groups. The numbers of bacteria vary from horizon to horizon reflecting a periodic character of the formation of layers of this zone. The morphological assessment of the detected microorganisms has revealed their significant diversity although slightly less compared to glacial ice. The molecular-biological investigation of microbial communities in the lake ice layer has indicated the absence of cyano-bacteria compared to surface snow specimens and the absence of the known forms of arche-bacteria (three divisions). A clone (DNA) of unknown origin was detected at this that may present a bacteria or arche-bacteria unknown to science. In addition, fungi DNA were found in the lake ice samples.

The obtained results of investigating the subglacial lake indicate a wide range of possible scientific interests in this natural phenomenon. The Russian Federation plans to continue both in-situ (radio-echo-sounding, seismic surveys and probably, drilling of ice with a thickness of not greater than 50 m) and laboratory (glaciology and microbiology) studies in the framework of the Russian Antarctic Expedition activities and at the research institutions of the country.