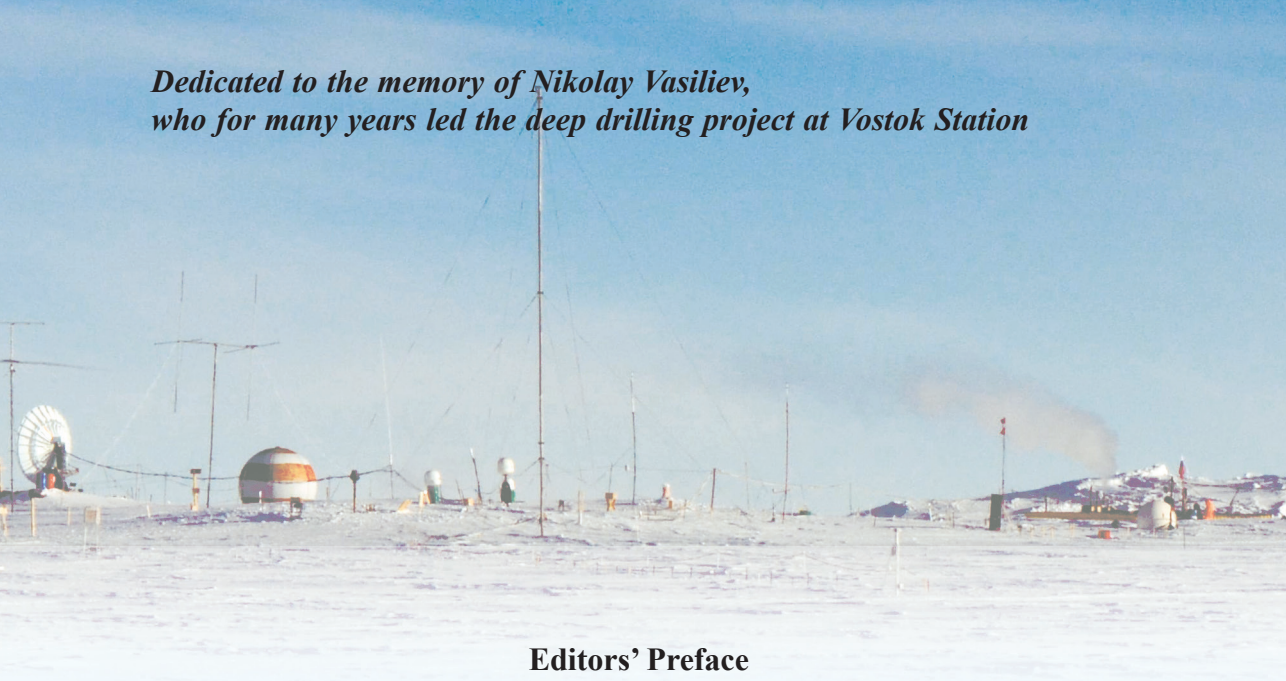
Dedicated to the memory of Nikolay Vasiliev,
who for many years led the deep drilling project at Vostok Station



Editors' Preface

Lake Vostok and other subglacial lakes emerged as an important new frontier in Antarctic science at the end of the last century. Today, the exploration of subglacial Antarctic environments, which are thought to affect ice sheet dynamics, house unique microbial ecosystems, and hold yet unmatched sedimentary records of past climate change, is one of the priorities for Antarctic research set by the 1st SCAR Horizon Scan in 2014 for the next two decades and beyond.

With an area exceeding 15000 km^2 and water depth reaching 1200 m, Lake Vostok, buried beneath the 4 km thick East Antarctic ice sheet, is the largest subglacial water body on our planet. The origin and the contemporary state of Subglacial Lake Vostok (SLV) are closely related to the geologic evolution, climatic history, and development of ice cover of the Antarctic continent. As an old, deep tectonic lake isolated from the open atmosphere and surface biota for millions of years, Lake Vostok has great potential for harbouring exotic life. A success in the search for life in the lake's environments (accreted ice, lake water, and sediments) would yield exciting microbiological and biogeochemical findings, which might provide new insights into development of life on Earth and have important methodological and motivational implications for the exploration of extraterrestrial icy ecosystems.

SLV is located in the traditional area of scientific and logistic activity of the Russian Antarctic Expedition. Vostok Station was established in 1957, long before the discovery of Lake Vostok. By a happy coincidence, it was built at the southern end of the lake, which not only favours Russian efforts to explore the lake, but also makes such efforts almost mandatory.

In 1999–2013, including the International Polar Year 2007/08, Russian exploration at Lake Vostok was carried out as part of a special project within the framework of the long-term "World Ocean" Federal Targeted Programme, sub-programme "Antarctica". This project was implemented by a consortium of eight Russian research institutions led by the Arctic and Antarctic Research Institute (AARI) of Roshydromet.

During this period, geophysical, geodetic, and glaciological traverses were carried out all over the lake and its surroundings. The main output of this large-scale field activity was a series of 1:1 000 000 maps of the lake water table limits, the ice and water body thickness, and the bedrock relief. Coordinated field and modelling efforts yielded improved estimates of the contemporary distribution of the accreted (lake) ice thickness, its age, and freezing rates along the Vostok flow line. The laboratory analyses of accreted ice, extracted as a core from the deep boreholes drilled at Vostok, provided the first important insights into the environments and hydrological regime of the subglacial water body. Biological and chemical studies performed using state-of-the-art decontamination procedures led to a preliminary conclusion that the lake water from which this ice was

formed may have a very low microbial content, suggesting that the main water body of SLV may also be an extremely dilute biological solution, and that life in the lake, if any, is restricted to the bottom sediments.

Drilling of deep borehole 5G began at Vostok Station in February 1990 and reached the surface of Lake Vostok only after more than two decades of complex operations. In 1999–2001, researchers at the AARI and St. Petersburg State Mining Institute proposed an environmentally friendly approach to the unsealing of SLV. However, the chance to put the technology that was developed into action came only in 2012, when, on February 5, borehole 5G-2, the second deviated branch borehole at Vostok, broached the surface of the subglacial lake for the first time. This landmark milestone in the history of Antarctic research reverberated around the world, and in the December 2012 issue of *Nature*, the first unsealing of Lake Vostok was listed among the biggest scientific breakthroughs of the year.

The pre-entry phase of SLV's exploration has been completed. The results of research into accreted ice and lake water frozen in the hole after the lake's unsealing often led to ambiguous (and sometimes conflicting) evidence about life in the lake, the biogeochemistry of the lake water, and the possible influence of hydrothermal activity in SLV. The general consensus is that existing discrepancies will not be resolved until water and sediments are collected *in situ* and analyzed in laboratories under clean conditions. The next grand challenge ahead is to develop technologies and tools that will allow clean entry into the lake, conduct *in situ* studies, and sample the SLV water column and bottom sediments. We hope that with the commissioning of the new wintering complex at Vostok station, the time for this new Antarctic venture will come.

This special issue of *Arctic and Antarctic Research* was originally conceived to mark the tenth anniversary of the first unsealing of Lake Vostok. But we ran over time, and it so happens that it will now be published a decade after the second successful unsealing of the lake on January 25, 2025. The papers presented here cover most areas of research related to the exploration of SLV and other Antarctic subglacial lakes: ice drilling technology, accreted ice analyses, molecular biological and mineralogical studies, and the geophysical survey of the lake.

The authors of this special issue dedicate it to the memory of Nikolay Vasiliev (1948–2021), a renowned professor at the St. Petersburg Mining University. His name is inextricably linked to the most exciting achievements in the legendary venture to drill through the ice at Vostok Station. For many years he was the key person leading this project, which played a vitally important role in the study of past climate change on our planet. It is under his leadership, and with his direct participation, that Lake Vostok was unsealed for the first time, making it possible to study the core of accreted ice and opening the door to further exploration of this unique under-ice water body.

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