SUBGLACIAL ANTARCTIC LAKE VOSTOK VS. SUBGLACIAL SOUTH POLE MARTIAN LAKE AND HYPERSALINE CANADIAN ARCTIC LAKES –PROSPECTS FOR LIFE

*Sergey Bulat[1]

1. NRC KI - Petersburg Nuclear Physics Institute, Saint-Petersburg-Gatchina, Russia

The objective was to search for microbial life in the subglacial freshwater Antarctic Lake Vostok by analyzing the uppermost water layer entered the borehole following successful lake unsealing at the depth 3769m from the surface. The samples included the drillbit frozen and re-cored borehole-frozen water ice. The study aimed to explore the Earth’ s subglacial Antarctic lake and use the results to prospect the life potential in recently discovered subglacial very likely hypersaline South Pole ice cap Martian lake (liquid water reservoir) [1] as well as similar subglacial hypersaline lakes (reservoirs) in Canadian Arctic [2].

The Lake Vostok is a giant (270 x 70 km, 15800 km2 area), deep (up to 1.3km) freshwater liquid body buried in a graben beneath 4-km thick East Antarctic Ice Sheet with the temperature near ice melting point (around -2.5°C) under 400 bar pressure. It is extremely oligotrophic and poor in major chemical ions contents (comparable with surface snow), under the high dissolved oxygen tension (in the range of 320 –1300 mg/L), with no light and sealed from the surface biota about 15 Ma ago [3].

The water frozen samples studied showed very dilute cell concentrations - from 167 to 38 cells per ml. The 16S rRNA gene sequencing came up with total of 53 bacterial phylotypes. Of them, only three phylotypes passed all contamination criteria. Two phylotypes were reported before [4] - hitherto-unknown and phylogenetically unclassified phylotype w123-10 likely belonging to *Parcubacteria* Candidatus *Adlerbacteria* and 3429v3-4 showing below-genus level (93.5%) similarity with *Herminiimonas glaciei* of *Oxalobacteraceae* (*Beta-Proteobacteria*) –water-inhabited ultramicrobacterium isolated from a deep Greenland ice core. The new third finding (the phylotype 3698v46-27) proved to be conspecific with several species of *Marinilactobacillus* of *Carnobacteriaceae* (*Firmicutes*). All three bacterial phylotypes may represent ingenious microbial communities in the subglacial Lake Vostok.

Two newly discovered (RES) subglacial hypersaline lakes (5 and 8.3km2 areas) in the Canadian Arctic are settled in bedrock throughs beneath 560 and 740m ice cap with modeled temperature below -10.5°C [2] and isolated by a glacier for at least 120 Ky ago. The biology is not yet studied (lakes are not unsealed), but the life potential is rather high (while dissimilar to the Lake Vostok). Their estimated salinity (140-160 psu) is in a range of that observed for brine-rich water body beneath Taylor Glacier (–7.8°C, 125 psu) and the ice-covered Lake Vida (–13°C, 200 psu) in Antarctica, both inhabited by active unique microbial communities.

The just discovered (RES) 20km-wide subglacial lake beneath the South Pole ice cap on Mars [1] should be ultra-hypersaline because it is buried beneath a 1.5km water ice cap with modeled temperature -68° C. It is well below known low-temperature limits supporting terrestrial microbial cell propagation and metabolism as well (-18°C and -33°C, respectively [5]). Such conditions may indicate zero-level life potential for this lake from the Earth-bound point of view, but its exploration may give us surprises.

In general, all three subglacial lakes (complexes) –two Earth-bound and one Martian, may host unique life forms never met before but their exploration (unsealing) is challenging as it happened with the Lake Vostok.

The reported study was partly funded by RFBR according to the research project №18-55-16004.

References:

[1] Orosei et al 2018 Science 361_490-3

[2] Rutishauser et al 2018 Sci Adv 4_eaar4353

[3] Bulat et Petit 2015 Encyclopedia of Astrobiology, Vol 1, pp.1-6 (Ch. 1765-2)

[4] Bulat 2016 Phil Trans Royal Soc A Math Phys Eng Sci 374 (2059)_20140292

[5] Rummel et al 2014 Astrobiology 14_887-968

Keywords: Antarctica, Subglacial Lake Vostok, Subglacial Mars South Pole ice cap lake, Subglacial hypersaline Canadian lakes, Bacterial 16S rRNA genes, Astrobiology

SUBGLACIAL ANTARCTIC LAKE VOSTOK VS. SUBGLACIAL SOUTH POLE MARTIAN LAKE AND HYPERSALINE CANADIAN ARCTIC LAKES – PROSPECTS FOR LIFE

Sergey Bulat[1]
[1]*NRC 'Kurchatov Institute' - Petersburg Nuclear Physics Institute, St. Petersburg-Gatchina, Russia*. E-mail: bulat@omrb.pnpi.spb.ru

Keywords:
Antarctica, subglacial Lake Vostok, Mars, subglacial South Pole ice cap lake, subglacial hypersaline Canadian lakes, Lake Vostok unsealing, frozen water, life, extremophiles, bacteria, 16S rRNA genes, astrobiology

Introduction:
The objective was to search for microbial life in the subglacial freshwater Antarctic Lake Vostok by analyzing the uppermost water layer entered the borehole following successful lake unsealing at the depth 3769m from the surface. The samples included the drillbit frozen and re-cored borehole-frozen water ice. The study aimed to explore the Earth's subglacial Antarctic lake and use the results to prospect the life potential in recently discovered subglacial very likely hypersaline South Pole ice cap Martian lake (liquid water reservoir) [1] as well as similar subglacial hypersaline lakes (reservoirs) in Canadian Arctic [2].
The Lake Vostok is a giant (270 x 70 km, 15800 km2 area), deep (up to 1.3km) freshwater liquid body buried in a graben beneath 4-km thick East Antarctic Ice Sheet with the temperature near ice melting point (around -2.5°C) under 400 bar pressure. It is extremely oligotrophic and poor in major chemical ions contents (comparable with surface snow), under the high dissolved oxygen tension (in the range of 320 – 1300 mg/L), with no light and sealed from the surface biota about 15 Ma ago [3].
The water frozen samples studied showed very dilute cell concentrations - from 167 to 38 cells per ml. The 16S rRNA gene sequencing came up with total 53 bacterial phylotypes. Of them, only three phylotypes passed all contamination criteria. Two phylotypes were reported before [4] - hitherto-unknown and phylogenetically unclassified phylotype w123-10 likely belonging to *Parcubacteria* Candidatus *Adlerbacteria* and 3429v3-4 showing below-genus level (93.5%) similarity with *Herminiimonas glaciei* of *Oxalobacteraceae* (*Beta-Proteobacteria*) – water-inhabited ultramicrobacterium isolated from a deep Greenland ice core. The new third finding (the phylotype 3698v46-27) proved to be conspecific with several species of *Marinilactobacillus* of *Carnobacteriaceae* (*Firmicutes*). All three bacterial phylotypes may represent ingenious microbial communities in the subglacial Lake Vostok.
Two newly discovered (RES) subglacial hypersaline lakes (5 and 8.3km2 areas) in the Canadian Arctic are settled in bedrock throughs beneath 560 and 740m ice cap with modeled temperature below -10.5°C [2] and isolated by a glacier for at least 120 Ky ago. The biology is not yet studied (lakes are not unsealed), but the life potential is rather high (while dissimilar to the Lake Vostok). Their estimated salinity (140-160 psu) is in a range of that observed for brine-rich water body beneath Taylor Glacier (−7.8°C, 125 psu) and the ice-covered Lake Vida (−13°C, 200 psu) in Antarctica, both inhabited by active unique microbial communities.
The just discovered (RES) 20km-wide subglacial lake beneath the South Pole ice cap on Mars [1] should be ultra-hypersaline because it is buried beneath 1.5km water ice cap with modeled temperature -68°C. It is well below known low-temperature limits supporting terrestrial microbial cell propagation and metabolism as well (-18°C and -33°C, respectively [5]). Such conditions may indicate zero-level life potential for this lake from the Earth-bound point of view, but its exploration may give us surprises.
In general, all three subglacial lakes (complexes) – two Earth-bound and one Martian, may host unique life forms never met before but their exploration (unsealing) is challenging as it happened with the Lake Vostok.
The reported study was partly funded by RFBR research project №18-55-16004.

References:
[1] Orosei et al 2018 Science 361_490-3
[2] Rutishauser et al 2018 Sci Adv 4_eaar4353
[3] Bulat et Petit 2015 Encyclopedia of Astrobiology, Vol 1, pp.1-6 (Ch. 1765-2)

