FROZEN LIFE:

Microbial diversity and ecology of antarctic subglacial environments

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Antarctic Lake Vostok, placed under almost four km of pure ice, is one of the most hostile and dangerous liquid environments for life. Once considered sterile, now is known that it could give shelter to a very stable, diverse and complex microbial community. Through several years after the discovery of this cold oasis, scientists have performed metabolic and metagenomic analyses of the ice core above the very surface of the lake. The purpose is to find new molecules from those most extreme psychrofilyc microorganisms with industrial or clinical potential, and also because lake Vostok is a great model to evaluate how the life could be on frozen worlds, like Europe, Encedalus, or even Mars.

SOME LIKE IT COLD

Some microorganisms have evolved adaptations for living in extremely cold environments: Cryoprotective molecules, cold-adapted enzymes and special membrane lipids are some of the most important

ICE WARRIORS

Vostok microbiome seems to be very complex. It's been found 8 bacterial phyla (Proteobacterias, Firmicutes, Actinobacterias, Bacteroidetes, Chlorobi, Chloroflexi, Cyanobacteria, Planctomycetes), as well as many Eukaria (basically fungus), and two species of termophylic metanothrophic Archaea. The most of them are psychrophilic or contain genes that increase the fitness in cold environments.

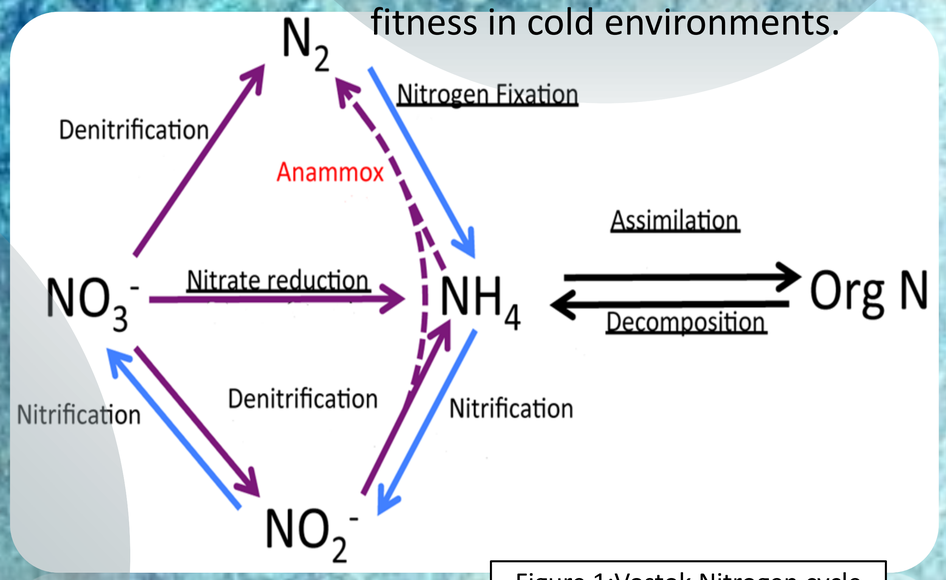

Figure 1:Vostok Nitrogen cycle

A FEAST OF ICE

As the diversity is so complex, so is the ecological and metabolic network. It's been found sequences from heterotrophic and autotrophic bacteria with potential for sulfur reduction, ammonia oxidation, a complete cycle of nitrogen (including anammox reactions) and also many genes involved in the cycle of carbon (Krebs cycle, pentose phosphate pathway, as well as many photosynthetic genes, possibly non-functional)

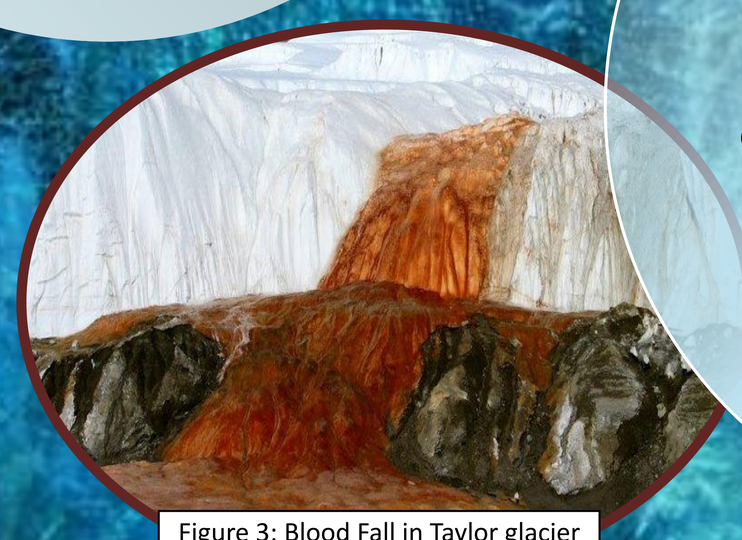

Figure 3: Blood Fall in Taylor glacier (photo by Hassan Basagic)

BLOOD AND ICE

There is no clue about a complete cycle of sulfur in Lake Vostok. In other subglacial environments, like the basal sediments of Taylor glacier, it's been found sequences that may allow what is called a catalytical sulfur cycle. The result is the accumulation of Fe2+ in the sediments. Sometimes, the ice breaks and the moist sediments arise. As a result, this process lead to what is called a "blood fall", a waterfall of ferruginous silt.

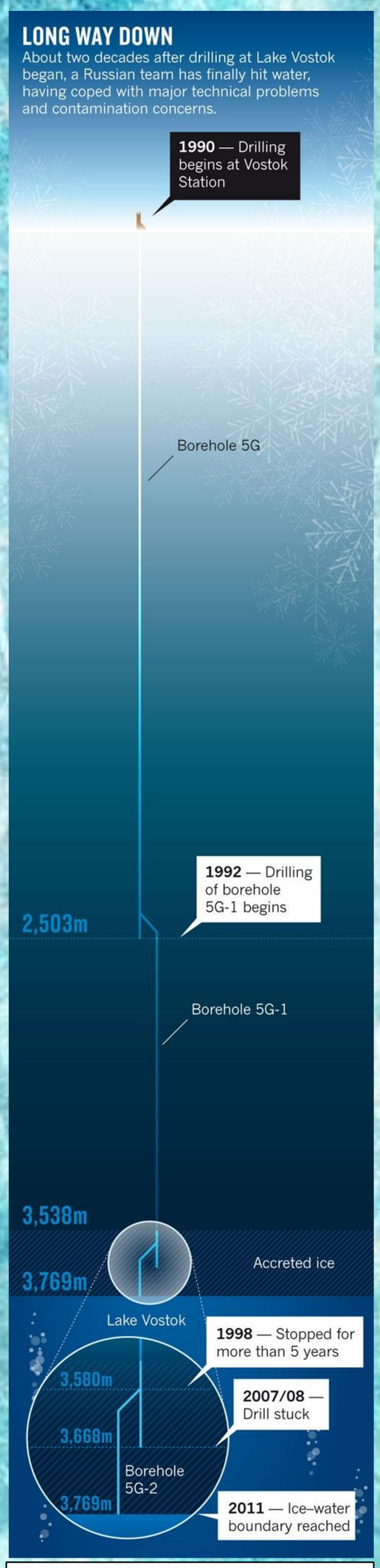

Figure 2: History of Lake Vostok drilling experiments

Our knowledge about Lake Vostok is far from being enough. There are very little studies from a very reduced group of investigators. Also, we only have data of the sequences entrapped in the accretion ice, and it's not known if all these microorganisms are really living in the lake or not. There are a lot of unsolved questions about that mysterious oasis in the ice, and is needed to investigate more to reveal the answers. Although, one thing is clear: Lake Vostok might be frozen, but definitely not dead.

Figure 2: Lukin, V. & Bulat, S. 2011. Vostok Subglacial Lake: Details of Russian plans/activities for drilling and sampling. Geophys. Monogr. Ser. 192, 187–197 (2011).
Figure1: Shtarkman, Y. M., Koçer, Z. A., Edgar, R., Veerapaneni, R. S., D'Elia, T., Morris, P. F., & Rogers, S. O. (2013). Subglacial Lake Vostok (Antarctica) accretion ice contains a diverse set of sequences from aquatic, marine and sediment-inhabiting bacteria and eukarya. PloS one, 8(7), e67221.