



SPQ Module 17 - A Day at the Beach



We told Ray, Richard and Kevin that after their expedition was complete we were treating them to a well-deserved beachside rest at Lake Vostok. They seemed very pleased with the offer. Lake Vostok is a pristine body of water the size of Lake Ontario, untouched by the clutter and traffic of powerboats and human paraphernalia. Convinced, the three of them packed their bathing suits. The only detail we forgot to mention is that Lake Vostok is buried below more than 12,000 feet of ice.

The notion that there are lakes in Antarctica seems counterintuitive. How can there be lakes with running water in a place that is completely frozen year round? There are in fact over 140 lakes in Antarctica, the largest of these being Lake Vostok. Lake Vostok lies directly under the Russian research base Vostok station, yet the Russians did not know it existed until they and a team of British scientists discovered it in 1996, buried deep beneath the Antarctic Ice Cap.

Antarctic lakes were discovered by scientists using radar technology to map the floor of the ice cap. Most of the floor upon which the ice cap sits is rock, which appears rough, irregular and contoured on radar images. However, in certain locations the radar images revealed smooth flat areas underlying the ice sheet. Some of these smooth areas were quite large. The scientists determined that the only thing that could be causing such smooth flat radar images was a water ice interface. They concluded that what they were looking at, were subglacial lakes.

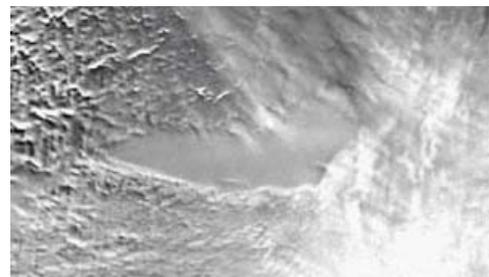


Figure 1: RADARSAT image of Lake Vostok (Source: NASA)

The Antarctic subglacial lakes appear to be interconnected by a system of rivers that flow from one to another. This system of interconnected waterways is thought to function as a 'lubricant', promoting the flow of the Antarctic Ice Cap.

Lake Vostok is the largest of the subglacial lakes, measuring 225 kilometers long, and 50 kilometers wide, which makes it about the size of Lake Ontario. It is also very deep, reaching a maximum depth of a little under 3,000 feet, containing roughly 5,400 cubic kilometers of water. But why, with four-kilometer thick ice resting on top of it, is Lake Vostok not frozen solid?



Figure 2: Location of Vostok Lake (Source:

There are three physical properties that contribute to the formation of liquid water in the lakes of Antarctica.

- The water has a reduced freezing point.
- There is heat produced from the earth underlying the lake.
- The lakes are covered by ice caps which form a thermal blanket.

What happens to a glass bottle with liquid in it that has been left outside in the winter, or forgotten in the freezer? It explodes. This is because when water freezes it expands, and the glass is broken. However if the bottle were not of glass but of a stronger material such as steel, the water would have difficulty expanding, and it would not freeze until a much lower temperature. A similar process is precisely what is causing the reduction of freezing point in Lake Vostok, except the pressure is caused not by a bottle, but by the weight of the ice cap pushing down on the lake.

The core of the earth is very hot, as witnessed by the periodic release of heat in the form of volcanic eruptions. This core planet heat (geothermal heat) is radiated gradually to all the surface of the earth. In Antarctica this heat is prevented from escaping by the overlying ice cap that acts like a giant blanket. The combination of these three factors, the reduced freezing point of water, geothermal heat, and the thermal blanket of the ice cap act to form and maintain liquid lakes in Antarctica. As a consequence while the temperature on top of the ice cap often dips below minus 50 degrees C, the temperature four kilometers below rests near the freezing point.

Did You Know

If there were no life forms in Lake Vostok, it would be the first and only sterile lake in the world.

It is believed that the waters of Lake Vostok have been isolated from the outside world since the start of the formation of the Antarctic Ice Cap 35 million years ago. Scientists speculate that the lake may contain a completely unique ecosystem with previous unknown microorganisms. Although the sun does not penetrate the lake, energy from geothermal heat could be adequate to sustain life forms. If organisms are found in the lake this could provide a remarkable window on the evolution of life on the planet, as these organisms have been effectively sealed

off from the rest of the world for millions of years. However, any microorganisms living in the lake would have to survive in a nutrient deficient environment, without sunlight, and in cold water under extreme pressure.



Figure 3: Artists image of the cryobot submersible (Source: NASA)

The possibility of discovering unique microorganisms in Lake Vostok from water and sediment samples is tantalizing to scientists. The difficulty lies in reaching the lake and obtaining samples without introducing contaminants. In 1998 Russian scientists drilled down into the ice cap to a depth of 2.2 miles, reaching a point just 130 meters above the lake. Toward the bottom these samples contained microorganisms - however some have alleged that these were a product of contamination from the drill.

Ice core holes collapse if they are not filled with a substance as dense as ice, and so the Russians filled the hole with a mixture of diesel fuel and Freon (standard practice at the time). This toxic column remains suspended above the lake, and further drilling has since been suspended while an international group of scientists try and establish how best to access Lake Vostok.

Work has been underway to design a “cryobot”, a heated robot probe that would melt its way through the ice cap to the lake surface and release a little radio controlled submersible that would swim about the lake taking samples and images. The question remains how this probe could be kept free of biological and chemical contaminants so as not to “infect” or pollute the lake.

Eleven countries are represented on the scientific committee overseeing the study of the Antarctic lake system, and all are committed to preserving this unique environment. How this will be accomplished remains to be determined, which leads us to a final concern. How will we decontaminate Ray, Richard and Kevin when they fulfill their planned Lake Vostok beach holiday? We do not want to discredit our expedition by having the I2P team be the source of the contamination of the Antarctic lake system.

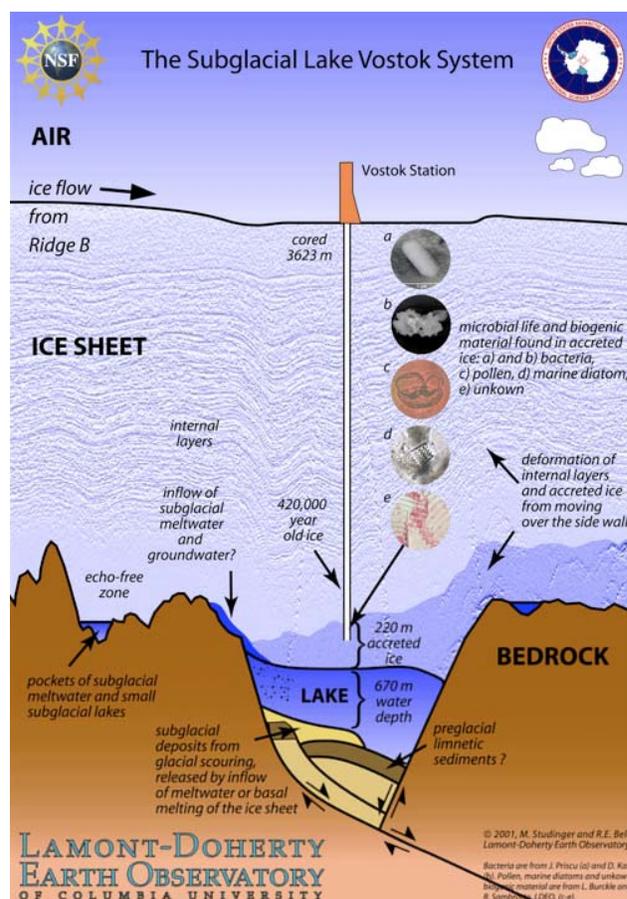


Figure 4: Source: NASA

Did You Know

As the Antarctic Ice Cap flows over Lake Vostok, like a massive bulldozer it pushes material and water into one side of the lake and removes material and water from the other side. It is estimated that the entire contents of the lake are replaced every 50,000 years.

Did You Know?

Fundamental biochemical molecules and reactions that define life as we know it, can only survive within a specified range of temperature. The temperature limits on life are now believed to be between -13°C to $+121^{\circ}\text{C}$