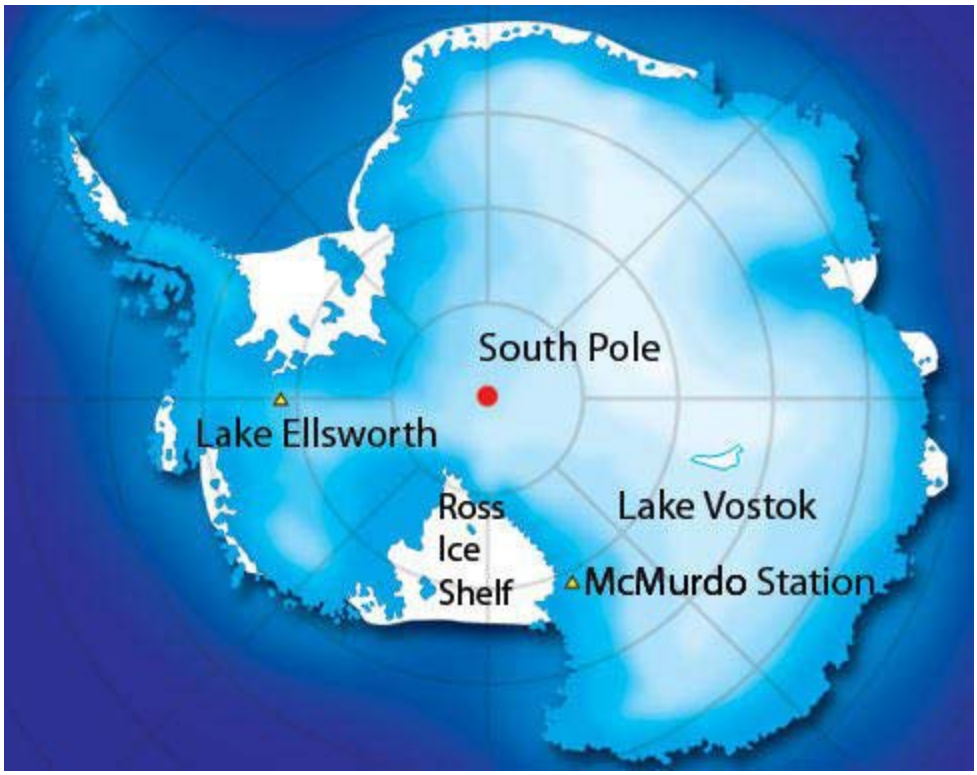
Credit: U.S. Antarctic Program Photo Library

# *Aliens Under The Ice?*

*Will researchers find new life forms thriving beneath the Antarctic Ice Sheet?*

BY THOMAS M. CIESLA

Welcome to your vacation destination Lake Ellsworth, West Antarctica, located an hour away by plane and three days away by tractor train from the nearest research station. Winter has settled on the area – bitter months of total darkness, minus 60 degrees Fahrenheit temperatures and vicious winds racing across the landscape. The only human presence to find here is a 70-ton collection of materials and equipment left by five British scientists a month or so ago.

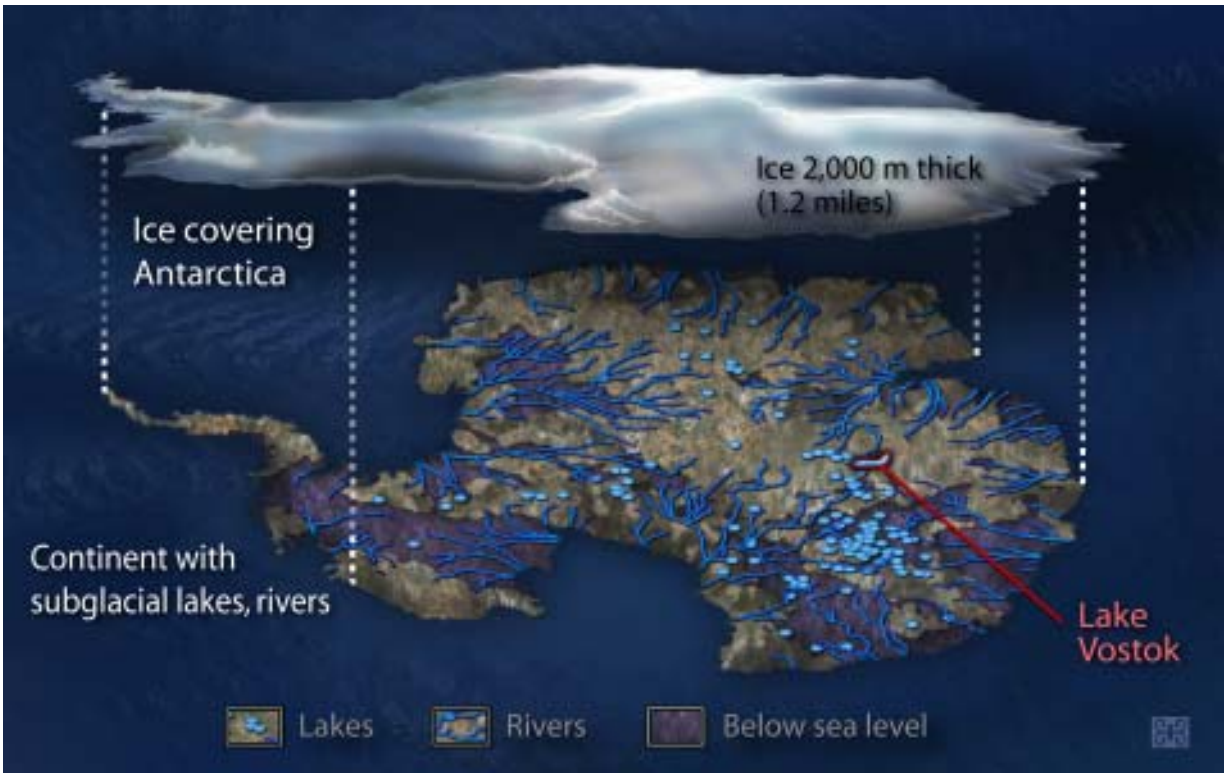



Location of Lake Ellsworth and Lake Vostock. Credit: Paul Wooton

The team will return in the Antarctic summer (November 2012) to wake-up the research outpost and explore the waters of Lake Ellsworth. There is a complication though, the lake is buried under a two-mile thick layer of ice. Using a specially designed hot-water drill equipped with a 2.3 mile long hose, once drilling begins the teams expects to reach the surface of the water within three days.[1] Probes will then be lowered into the lake to take water and sediment samples – and the team hopes – find new forms of life.

Lake Ellsworth is what is known as a subglacial lake, one of 387 such lakes discovered under the Antarctic ice cap. These lakes vary in size depth and age, offering a wide spectrum of conditions for scientists to explore. Some of these lakes, like Lake Vostok and possibly Lake Ellsworth are isolated bodies of water, while many others are connected to each other via a vast network of subglacial rivers. Using radar and satellite surveys, scientists can measure

[1] To minimize contamination the water will be passed through filters and then exposed to ultraviolet radiation.



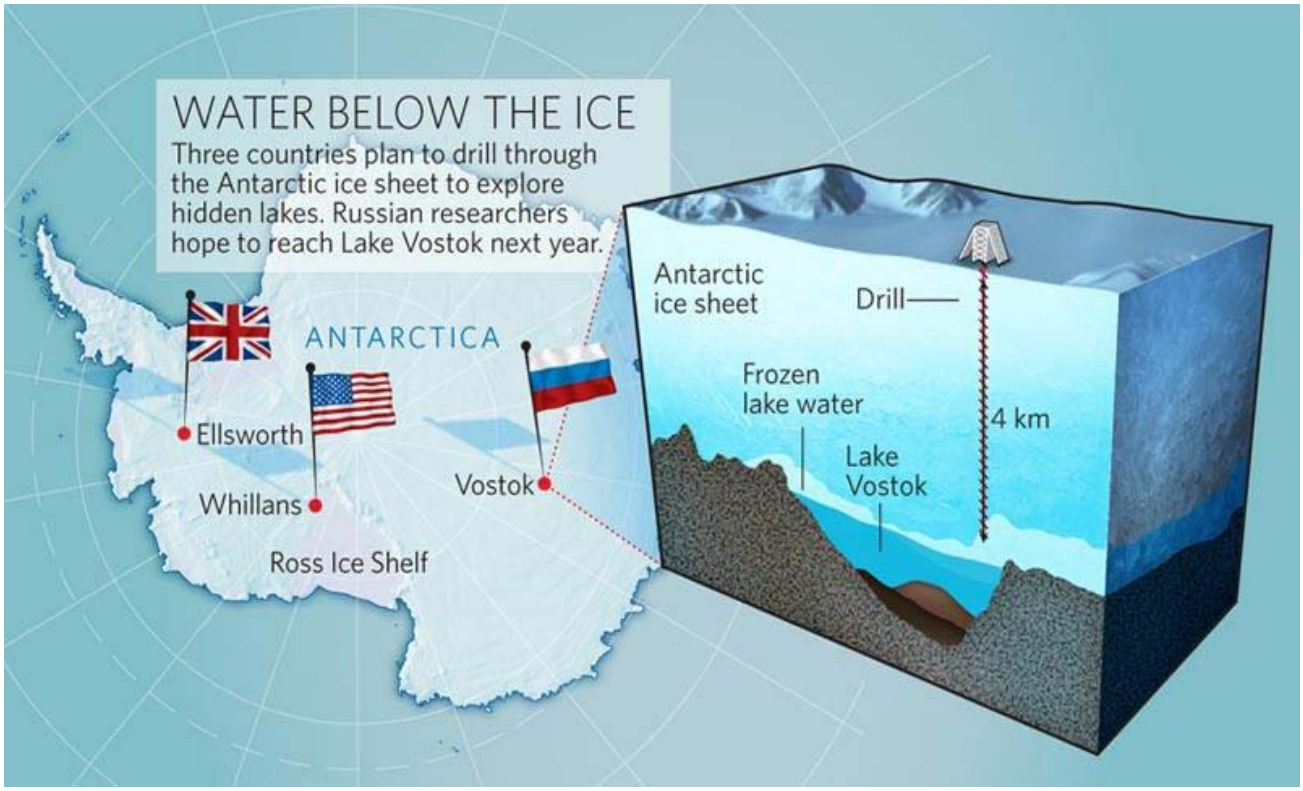

Credit: Zina Deretsky NSF

the rise and fall of the ice above these lakes which tindicates when a lake discharges into a neighboring lake, and then slowly refills.

Lake Ellsworth is relatively small: seven miles long, one mile wide, and 500 feet deep. The best known subglacial lake on the continent is Lake Vostok[2] in East Antarctica, roughly the size of Lake Ontario in the United States. A Russian team of scientists have been drilling to reach Lake Vostok for several years and expect to reach the lake's surface in 2012.[3] Back in West Antarctica, an American team is willattempt to reach Lake Whillans near the Ross Ice Shelf during the 2012-2013 summer season. Lake Whillans is an 'active lake' meaning it drains into the ocean under the Ross Ice Shelf. The American scientists will drill into the lake to sample the pristine environment, and also send a submersible under the Ross Ice Shelf to study how the lake's outflow interacts with the ocean.

[2]Lake Vostok is approximately 250 km long, 50 km wide, and 510 m deep.

[3]The Russian team had to abandon drilling at only 90 meters from the lake surface do to the arrival of winter. Scientists around the world protested when they discovered that the team poured kerosene into the borehole so it wouldn't refreeze. If not removed before drilling resumes, the kerosene would enter the lake and destroy the sensitive ecosystem




When the Russian team came within ~80 meters of Lake Vostok, they encountered large, dense ice crystals that slowed drilling progress to a crawl.

Why do scientists endure the isolation, personal hardship and dangerous environment to perform this research? From the international scientific community point of view, is this really worth the millions and millions of dollars it requires to work on this harsh and remote continent? Two primary issues drive these research efforts: 1) Understanding the impact of human activity on the Antarctic ice cap, and 2) Searching for life in extreme environments isolated from the rest of the planet to expanding our knowledge in fields of evolution, biochemistry and astrobiology.

Antarctica's ice shelves have shrunk appreciably over the last 50 years. Perhaps the most dramatic events were the disappearance of the Larsen A & B shelves in the late 1990's, and the frighteningly rapid disintegration of the Wilkins Ice Shelf in 2008. Numerous lesser known ice shelves have also been lost, and considering that this continent contains ninety percent of the planets fresh water, changes here could have a dramatic impact on sea levels around the world. Ice shelf calving may be dramatic, but it has little

[4] Similar changes are happening to the ice caps of Greenland and Iceland.

impact on sea levels because the ice shelf is already sitting on top of the sea. The outflow of subglacial lakes, however, has a direct impact on sea levels as much of this water originates from land-based glaciers.

Anglerfish. Credit: Jared Benney

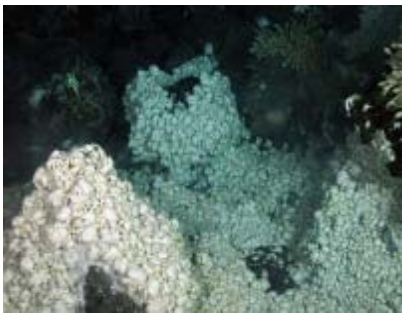
## Life Under Ice

Life is more resilient than we could ever have imagined. Over the last 50 years, scientists have been surprised to discover life thriving in some of the most inhospitable environments on the planet. It was once believed that life could not exist in the cold, pitch black, high pressure deep sea environment. Deep sea diving vessels have shown us that life not only inhabits this world, it thrives even five miles below the surface. Of course by adapting to this severe environment, this is life as we don't know it, resembling aliens from science fiction. These creatures utilize transparency, bioluminescence and the ability to sense electrical impulses of others in order to survive. The scary looking anglerfish brandishes a bioluminescent lure at the end of an antenna to attract other fish, while the glass squid uses full body transparency to escape detection.

The Dumbo Octopus is found at depths from 300 - 5,000M. Credit: MBARI 1999

The Blackdragon fish even has teeth on its tongue. Credit Dr. Julian Finn

Yet, there are creatures that exhibit abilities even stranger than deep sea creatures – the extremophiles.[5] These are the viruses, bacteria and microbes that have evolved to survive extreme environments such as deep sea thermal vents, inside nuclear reactors, petroleum lakes, and deep within the Earth's crust. They can survive in oxygen-free environments, tolerate temperature extremes, survive exposure to outer space, and grow by using arsenic instead of phosphorus.[6] Extremophiles are what scientists expect to find in subglacial lakes.



A swarm of Yeti crabs off the coast of Antarctica. The crabs feed on minerals flowing from volcanic vents. Credit: NERC Chessis Consortium

[5] An extremophile is an organism adapted to unusual limits in one or more abiotic factors.

[6] A team of scientists found bacteria in Mono Lake, CA that substitutes arsenic for phosporus in order to sustain its growth.

Artist impression of Polar Dinosaurs. Credit: Smithsonian Magazine, December 2007

## Green Continent, White Continent

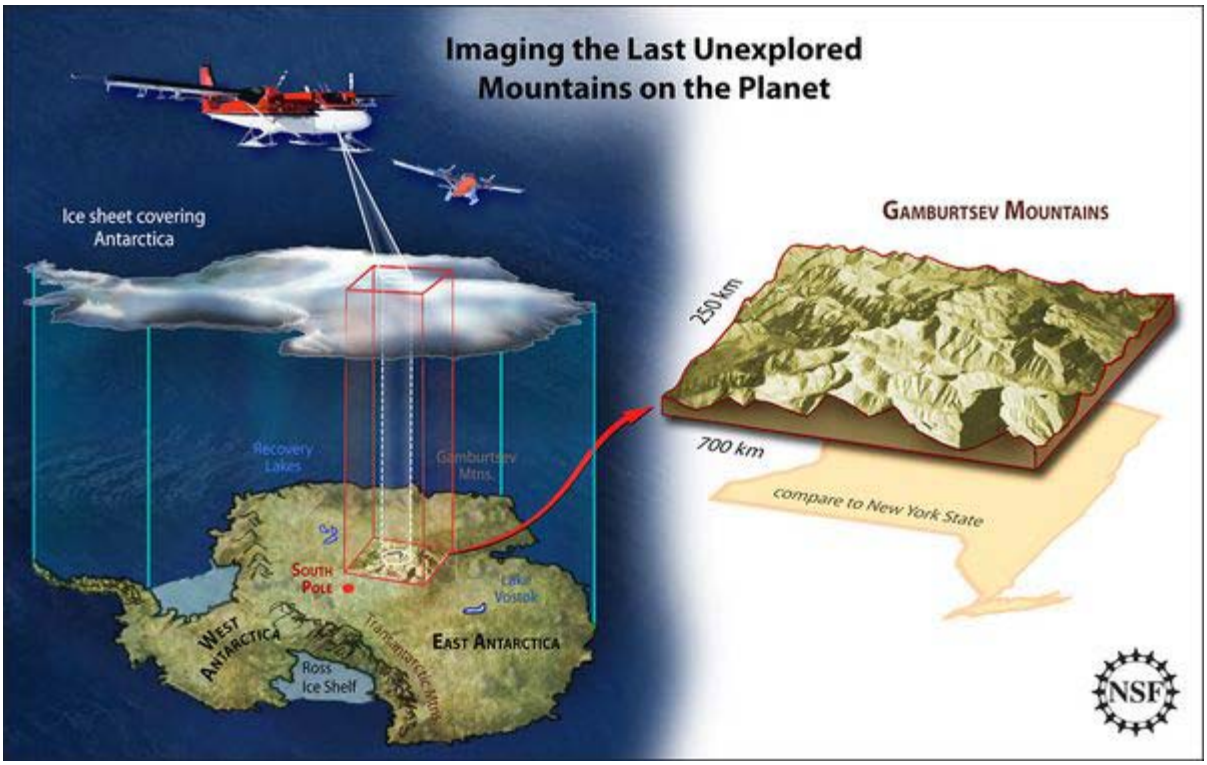
Two hundred million years ago (MYA) Antarctica was still part of the supercontinent Gondwana and was covered by coniferous forests. As Gondwana began to break up, Australia and Antarctica remained stuck together and lightly attached to South America. Around 80 MYA Australia separated from Antarctica, but the southern most tip of South America remained in contact with Antarctica. Seventy MYA Antarctica was a verdant continent with mountains, lakes, rivers, volcanoes and varieties of flora and fauna – including dinosaurs[7] — some of which resemble those that lived in other parts of the world some 60 million years earlier.[8]

Conditions remained the same on the continent until the southern most tip of South America separated from Antarctica around 50 MYA, allowing ocean water to flow between the two continents. This created the East Wind Drift (a.k.a. Antarctic Circum-polar Current), isolating the continent from warmer waters. Glaciers began forming around 23 MYA, then around 15 MYA an ice cap covered the continent. By six MYA the ice cap reached its present state.[9]

[7] Known as the 'polar dinosaurs,' also found in Alaska, scientists have discovered the fossils of at least three distinct dinosaur species in East and West Antarctica.

[8] Some scientists have posited that Antarctica's remoteness made it the last oasis for the dinosaurs as flowering plants spread across the rest of the world and out-competed the pine tree relatives that warmer climate dinosaurs ate.

[9] The coldest temperature ever recorded on our planet was minus 129 degrees Fahrenheit at Russia's Vostok Station in East Antarctica.




The Gamburtsen Mountains in East Antarctica. Credit: NSF

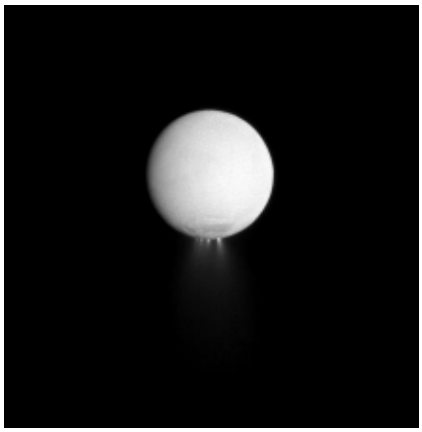
## The Deep Freeze

For the last five million years, Antarctica has been encased in a deep freeze that obliterated the once luxurious flora and fauna and buried its mountains[10] and lakes under miles of ice. Despite this wild swing from green continent to white continent, today the waters surrounding Antarctica percolate with all manner of life, from tiny krill to giant squids. In 2009, scientists detected microbes sealed off from the rest of the world for 1.5 million years in the meltwater flowing from Taylor Glacier[11] in East Antarctica.

Scientists theorize that these microbes are remnants of a larger population that once lived in a fiord that was cut off when sea levels dropped and left a pool behind which was then capped off by a flowing glacier. Over the millennia, the pool (which is believed to be no more than 3 miles wide) left behind has developed salinity levels four times that of ocean water and contains no free oxygen. Genetic tests indicate the microbes are similar to others found in marine environments today, yet they are quite different.

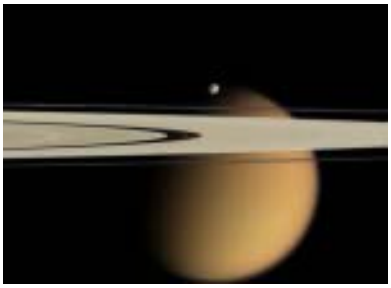
[10] The Trans Antarctic Mountains in West Antarctica are visible above the ice cap. The Gambursten Mountains in East Antarctica were only discovered in the mid-1900's. With peaks rising to 15,000 feet, this European Alps-like mountain range is completely buried under ice.

[11] Samples were taken from Blood Falls, a curious blood-red waterfall like feature that flows from the edge of Taylor Glacier. Analysis revealed that the glacier water held microorganisms that use sulfur compounds to extract iron from the bedrock below; hence the rusty hue of the water.



The Cassini spacecraft captured this image of a cryovolcanoe eruptiion from the south pole of Enceladus. Credit: NASA

This discovery and a plethora of other findings around the continent serve as the impetus for exploration of the subglacial lakes. Though it is unlikely that we will find alien creatures or the great, great, great, great grandchildren of a second biological genesis; the extremophiles we do find may appear so bizarre as to seem alien to us. What is exciting about this research is how it may shed light on how microorganisms could survive on alien worlds. If bacteria and viruses can survive in the freezing, oxygen-free conditions of the subglacial lakes, then it's not too far-fetched to believe the same can happen around the polar caps of Mars, in the ice covered oceans of Jupiter's moon Europa, or in the ice covered oceans on Saturn's moon Enceladus.



The orange haze of Titan's hydrocarbon atmosphere is in stark contrast to Saturn's icy rings in this Cassini photo. Credit: NASA

## Further Reading:

**British Antarctic Survey**
http://www.antarctica.ac.uk/

**European Polar Board**
http://www.esf.org/research-areas/polar-sciences.html

**Lake Ellsworth Project**
www.asoc.org

**Russian Arctic & Antarctic Research Institute**
http://www.aari.nw.ru/index_en.html

Water exists on two of the four terrestrial planets and beyond the asteroid belt, our Solar System is rich with water in the form of ice or ice covered oceans. One thing we know for certain, here on Earth, where there is water there is life. Who knows the extent of life – albeit microbial life – that exists just within our solar system? At the time of this writing, 755 exoplanets have been confirmed; the result of exploring only a tiny sampling of stars in our galaxy. These exo-solar systems come in strange configurations (compared to our solar system) containing exotic worlds, many likely possessing moons that possibly contain water.[12] Just as in the outer reaches of our solar system, wherever we look out into the Galaxy we find the fingerprint of water and the basic building blocks of life. Research being done in Antarctica may one day serve as a type of Rosetta stone for finding life "out there".

[12] As reported in 2009,NASA's LCROSS probe discovered beds of water ice at the lunar south pole when it impacted the moon. Long thought to be a dead, desiccated object, suddenly this is not your father's Moon.