Palaeontology Technical Division

Dallol (Ethiopia), Extremophiles, and the Possibility of Life on other Planets

Speaker: Philip Benham, assistance provided by Enku Mulugeta and Ryan Benham
Location: Room B108, Mount Royal University
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Abstract

Most life is adapted to exist within a narrow range of environments and conditions. Take corals, for example, which generally exist within a salinity range of 32 to 35 PPT but can tolerate barely up to 40 PPT salinity, and can't live below 18 Celsius or above 40 Celsius which is when they begin to expel their symbiotic partners causing widespread reef bleaching. Or consider fragile humans who can't go without oxygen for a few minutes or survive not intaking water for a period of three days. In spite of this there is a very significant number of organisms which fall under the category of extremophiles, those who can live in extreme conditions that other lifeforms cannot. Organisms that adapt to these extreme conditions are often able to proliferate in the absence of predators and other competition. We often see lagoons where there is an abundance of one type of trace fossil because that creature has been able to adapt to wildly fluctuating salinities, temperatures, periodic exposure and hi turbidity. In the depths of the oceans, with complete absence of sunlight, we see whole communities of organisms adapted around hydrothermal vents spewing noxious chemicals and H2S gases at boiling temperatures. Somehow these organisms find a way to find fuel and energy from the minerals that are being emanated from these vents. But there are more extreme organisms, those that can live in boiling temperatures in Hot Springs and places like Yellowstone, or plants that just survive being frozen in the Arctic tundra for a period of 30,000 years and have their seeds germinate. If that's not tough enough for you, bacteria have been extracted from 250 million-year-old salt cord in the Gulf of Mexico, and there are recent reports of organisms detected in 830 million-year-old Proterozoic salts from the brown formation in Australia.

The Afar Triangle is a triple plate junction, part of which is the east African rift zone, which extends through much of eastern Africa to the south and continues north through the Red Sea, ending near the Dead Sea in Jordan. This is the only place on the planet where you can observe both a triple junction and a rift zone going into the ocean. The rift zone suffers periodic inundations by the ocean and subsequent evaporation, depositing thick layers of salt over a short geological period of time. This salt basin is also dotted with active volcanos such as Erta Ale, sporting a semi-permanent lava lake. Of most interest to us is a volcano which lies under several hundred metres of Salt and creates a low hydrothermally active mound on the salt plane. This region is considered to be one of the hottest places on the earth, regularly reaching 50 Celsius. The hydrothermal pools exhibit the nightmarish survival conditions of boiling temperatures, incredibly high salinity (around 35% salt), and are also highly acidic (often reaching a pH of zero). All kinds of extremophiles have evolved to survive, even thrive, in boiling, salty, or acidic waters, but what if you have all three of these conditions at once? Some of the pools are even anoxic, containing CO2 gases, which hang heavy over the waters creating a deadly trap for the birds and insects drawn to them. These pools were sampled by scientists and a recent study showed no forms of life. This may be the only place on the surface of Earth where no life appears to grow. So, we are able to start to understand the limits of life here on Earth. This will allow us to now expand our view a little bit further to Mars and Venus.

In this talk we will compare and contrast the varying geological history of Venus, Mars and Earth. We will look at the possibility of there being conditions for life on those other planets in the presence of oceans and atmospheres which are supportive of the kinds of gases that the cycle of life will use. We'll also look at how those histories are fairly similar at the beginning of the formation of the planets, then began to diverge. This in turn will help us understand why life flourished on Earth, and why the conditions for life subsequently suffered on both Mars and Venus.

Figure: Dallol, Ethiopia.

Dallol is situated in the Afar region of Ethiopia. It is 125m below sea level and regularly reaches 50 degrees Celsius. It is not a comfortable place to visit, and is a challenging place for any form of life to take hold.

Biography

Philip Benham is a retired Shell chief geologist. He is the lead author for the ongoing Go Take A Hike series and book. He is also former C.S.P.G. paleontology division chair and A.P.S. technical program director.

Enku Mulugeta is a geologist based in Ethiopia, who runs tours to this region on behalf of the company Volcano Discovery.

Ryan Benham is an assistant writer and holds affection for tardigrades, one of the tougher forms of extremophile life.

Information

This event is presented jointly by the Alberta Palaeontological Society (APS), the Department of Earth and Environmental Sciences at Mount Royal University, and the Paleontology Division of the Canadian Society of Petroleum Geologists (CSPG). To present a talk in the future, please telephone APS Coordinator Harold Whittaker at 403-286-0349 or contact programs1@albertapaleo.org. You can also contact the CSPG Palaeontology Division Chair Jon Noad at jonnoad@hotmail.com. You can also visit the APS website for confirmation of event times and upcoming speakers: http://www.albertapaleo.org/.