Life here and out there
Tapping, Ken

Publisher's version / Version de l'éditeur:
http://doi.org/10.4224/23001725
Skygazing: Astronomy through the seasons, 2017-03-21

LIFE HERE AND OUT THERE

Ken Tapping, 21st March, 2017

The Earth formed along with the rest of the Solar System some 4.6 billion years ago, and life appeared maybe 300 million years after, 4.3 billion years ago. These life traces were found in rocks of the Nuvvyagittuq Supercrustal Belt, in Northern Quebec, where, along with some locations in Australia, there are ancient rocks that have not been eroded away or recycled by plate tectonics.

These ancient life-forms lived around hydrothermal vents, like those along spreading plate boundaries in our oceans. If life began here on Earth around hydrothermal vents, this opens new possibilities for life on other worlds. It's not just a matter of a planet being at the right distance from its star for liquid water to exist on its surface. It's more a need for hydrothermal vents at the bottom of an ocean.

All stars and planets form from the same ingredients: the materials in the dust and gas clouds common in our galaxy and others. Those clouds are mostly hydrogen, the key ingredient for making stars. However, there are also rock dust and ice particles, and chemicals like water, methane, carbon monoxide, carbon dioxide, ammonia, various alcohols, formaldehyde and hydrogen cyanide. Thousands of different chemicals have been identified so far. We have found out from laboratory experiments that if we pass simulated lightning through a bottle containing the mixture of chemicals we believe to form the atmospheres of newborn planets, we get aminoacids, the building blocks of proteins.

With life possibly appearing as early as 300 million years after the Earth formed, it must have happened as soon as the planet had cooled enough for liquid water to exist on it, suggesting that life gets started as soon as the circumstances are right. Since all planets are made from the same set of ingredients. It's likely these "right circumstances" must have arisen on many worlds: the same sort of primordial atmosphere, a warm, liquid water ocean, and some hydrothermal vents. This ocean might be warmed by the planet's sun, or volcanically, from beneath. Hydrothermal vents and volcanic heating are both driven by volcanism; the planet has to be "geologically active". If the ocean is volcanically heated, that moon or planet may be located in the cold, far from its sun, with the ocean under a protective layer of ice. How then can we spot geologically active bodies?

In the outer reaches of the Solar System, we would expect things to have been frozen solid for billions of years. They would be covered with craters – the record of a history of being hit by objects. An absence of craters suggests a surface that is being reprocessed over no more than the last few million years. If in addition the surface shows signs of cracking, melting and having been moved around, the case is reinforced. In some cases there are geysers of liquid, vapour or both, jetting into space. In regions where the temperature might be -200C or less, this is a strong indicator of internal heat. This suggests under the icy surfaces of Jupiter's moons Europa and Ganymede; Saturn's moons Titan and Enceladus, and Neptune's moon Triton, there could be liquid water oceans and hydrothermal vents, and maybe life. Data from the New Horizon spacecraft shows Pluto is geologically active.

Here on Earth we find living creatures in near-boiling, acidic hot springs, deep in the rock or living on the Arctic and Antarctic Ice. There are things living in lakes buried 4 km under the Antarctic ice. These lakes have been isolated for some 15 million years and are home to over 1500 species of living creatures. It might be easier to identify planets and moons where there is little prospect of life, and then be prepared to be proved wrong.

Mars lies low in the Southwest after sunset. Jupiter rises around 9pm and Saturn in the early hours. The Moon will be New on the 27th.

Ken Tapping is an astronomer with the NRC's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.

Tel (250) 497-2300, Fax (250) 497-2355

E-mail: ken.tapping@nrc-cnrc.gc.ca