Recreating Extraterrestrial Oceans

Lorna Campbell explains how a particle accelerator is teaching us about the ocean on one of Saturn's moons.

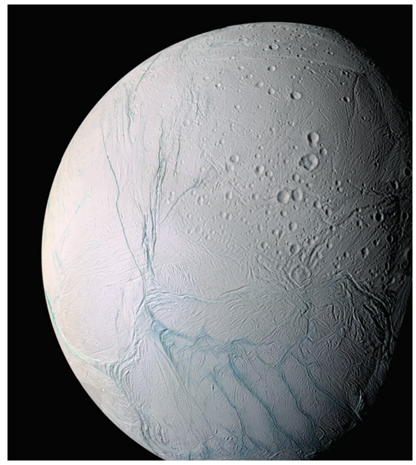
One of the amazing things scientists can do at the UK's national synchrotron, Diamond Light Source, is recreate conditions in other parts of the Universe. Recently they used this remarkable ability to peer into the salty waters hidden underneath kilometres of ice on Enceladus, one of Saturn's moons. Enceladus is one of the few places in the Solar System where liquid water is known to exist, and its deep ocean is one of the most promising places to look for extraterrestrial life.

A team of experimental astrophysicists based at Diamond and Keele University (UK) have been recreating Enceladus's salty ocean in Oxfordshire. They have been using Diamond's astoundingly bright light to investigate one of the more mysterious properties of water—its ability to form clathrates when cooled under pressure. Clathrates are ice-like structures that behave like tiny cages, and can trap molecules such as carbon dioxide and methane.

The conditions on Enceladus may be just right for the formation of clathrates, and understanding more about how they form could provide clues about what is happening in Enceladus's ocean. For the experiments at Diamond, the researchers filled tiny tubes with water and different amounts of magnesium sulphate. The tubes were cooled down, and carbon dioxide was fed into the frozen water, where it became trapped in the clathrates that formed in the tubes.

Shining Diamond's high energy X-rays into the tubes allowed the scientists to examine what was happening, using a technique called X-ray Power Diffraction. The way in which X-rays were deflected by the contents of the sample tube showed how the molecules of water, gas and salt interacted. Compared to previous experiments using pure water, the presence of magnesium sulphate interfered with clathrate formation in much the same way that putting table salt on a slippery path in winter melts the ice. The results also showed that the salt causes subtle changes that make clathrates more likely to sink. If clathrates filled with carbon dioxide are sinking to the bottom of the ocean, that may be a good place to start looking for signs of life.

> The deep ocean of Enceladus is one of the most promising places to look for extraterrestrial life



The enhanced colour view of Enceladus seen here is largely of the southern hemisphere and includes the south polar terrain at the bottom of the image. Image credit: NASA/JPL/Space Science Institute.

The advantage of using Diamond is that lots of data can be gathered very quickly. Sarah Day, Senior Support Scientist at Diamond, is excited to be able to match results from experiments here on Earth with what we already know about Enceladus. 'Creating that link is very exciting, matching up with what might be happening on other worlds,' she said.

Clathrates are just as important on Earth. Millions of tonnes of methane are tied up in clathrates in the deep oceans and arctic permafrost. Understanding their behaviour could be valuable as climate change warms up these previously frozen regions.

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A dramatic plume sprays water, ice and vapour from the south polar region of Saturn's moon Enceladus. Cassini's first hint of this plume came during the spacecraft's first close flyby of the icy moon on February 17, 2005. Credit: NASA/JPL/Space Science Institute.