

Student questions: Jan Amend colloquium on “The marine deep subsurface biosphere: team-science discoveries over the last decade”

4/21/21

How huge are the geothermal gradient changes for the seamount of the Juan de Fuca ridge? Horizontal gradients are often extremely high, from 350-400 C in the vent fluid coming up through the chimneys to around 2-4 C just 10s of cm lateral distance in background seawater.

Are there significant compositional variations in marine sediments globally, and could these affect the redox chemistry that can exist there?

There are certainly mineralogic differences in sediments globally, depending on proximity to continents, depth, temperature, etc. Regarding redox chemistry, the main driver here is with depth and the oxidation of organic matter that is deposited on the seafloor and then buried at different rates in the sediments. More organic matter will result in O₂ being used up faster, and sediments becoming anoxic at shallow depths. In open ocean sediments, D'Hondt and colleagues have shown that the often thin sediment blankets (10s to a few 100 meters) can be oxic all the way to basement, because of the very limited organic matter deposition.

Why were the bacteria in the photos glowing?

They were stained a dye that when attached to certain biomolecules (in many cases nucleic acids) fluoresces.

What are the lowest and highest pH at which living organisms have been known to survive?

Some organisms can actually survive slightly negative pHs and grow happily (even optimally) at pH in the 1-2 range. On the upper pH end, there is evidence of microbial activity at pH 12-13.

Has any work been done regarding the evolutionary history of the life that is found in the subsurface?

Whether life in the subsurface that is in maintenance mode or barely eeking out a living is actually evolving in the classic sense, is a major research question. Perhaps these cells have adapted to their environments. It does seem that many of the cells deep in marine sediments came from surface or near-surface environments.

How often does wildlife, like Mr. octopus from the presentation photos, interact with or affect these ocean sites?

Octopusses, shrimps, clams, tubeworms, etc. are often part of – and very much interact with -- the seafloor environments. Many have symbiotic relationships with bacteria that harvest geochemical energy sources.

The reentry holes seem to be more useful, why aren't all the drilled holes reentry holes?

CORKs are very expensive! People have, however, developed and deployed CORK-lite (stripped down versions) that are much cheaper – though still more expensive than simply abandoning drill holes.

Are sea sediments enriched in microbes near any specific geologic feature other than hydrothermal systems?

Certainly. Microbial communities are often enriched on the seafloor near cold seeps, methane seeps, fresh rock surfaces, and even whale falls (dead whales that sink to the bottom).

Why does the arctic have generally greater sediment thickness?

Very high rates of physical weathering of continents delivering a lot of sediment.

By studying microorganisms in the subsurface, can we gather any new information about how life was formed on Earth?

Many in the origin of life community favor a hydrothermal vent origin. The pros to this theory are numerous, including large amounts of naturally occurring geochemical (redox) energy sources, ubiquitous presence of such systems on early Earth and probably other planetary bodies, and protection from impacts.

What is the life-span of the microorganisms that are found in the subsurface?

Life span of microbial cells is difficult to address, because growing cells often split into two and those split into two, etc. Morono et al. recently published on reviving cells from very old samples.

Did you have any issues with the marine life interfering with your equipment or measurements?

Not really, no. At one location – the Dorado Outcrop – we actually used the presence of octopuses to find where slightly warmer water was emanating from the subsurface.

Have there been any eukaryotic studies in the deep sea cores/holes/CORKs?

Yes, fungi (euks) are sometimes detected. Contamination questions often arise, but Ginny Edgecomb at WHOI is one of the leading experts in this area.

What is the difference between using CO₂ NH₄ CH₄ and Mn?

While these are all redox-sensitive compounds, different organisms use or produce them. The geochem profiles can tell us about the metabolic diversity.

Why did it take so long for the CORK idea and plan to be created and used?

Before subsurface microbiology became a major research focus, there was apparently no pressing need to reseal the holes and let the system return to pre-drilling conditions.

Can you go into greater detail on what the void space reservoir is and what it means for subsurface lifeforms?

The void space is filled by aqueous solutions and cells. If the void spaces are connected, it provides a conduit from A to B.