MY DARLING SERPENTINE

Bénédicte Ménez - I started looking into those rocks we call serpentinites as part of the work carried out here at the IPGP, on the issue of geological storage of CO_2. They come from the oceanic crust and make up most of the ocean floor where slow-spreading ridges occur. Large faults, caused by the extensive tectonic activity, reveal a significant amount of the rocks from the Earth's mantle. These rocks are highly reactive to water because they are not designed to be surface rocks. The seawater circulation then produces the process we call serpentinisation. And that's useful in the geological storage of CO_2 because these rocks will release cations such as magnesium or calcium, which means that we can combine those cations with gaseous CO_2 and make solid carbonates. That makes it possible to provide permanent storage for excess CO_2 in the atmosphere, and limit the problem that it represents.

When those rocks hydrate they produce massive amounts of hydrogen because they are made up of silicates that oxidize. And so we can expect the hydrogen to combine with the CO_2 which comes from the mantle or the seawater. At this point we get a tremendous chemical reaction that produces abiotic organic molecules, methane, organic acids. And those are potential sources of sustainable energy, which could be harnessed in the future.

Those rocks are amazing! For a long time, they were seen as the less glamorous part of the oceanic lithosphere, very few people studied them. And yet they hold incredible potential for the development of life: when the minerals are hydrated, the resulting hydrogen and methane represent a source of energy for microorganisms. As a geomicrobiologist – someone who tries to understand how life develops in rocks, to what depth it can colonize the crust – what we have is a super-process, which living organisms can use.

To get the rocks at the bottom of the ocean, submarines can be used to collect pieces. Or dredging techniques are used, with metal baskets dangling at the end of cables several kilometers long, dropped from the back of boats and dragged alongside a promising looking outcrop, previously identified with geophysics.

One of last year's scientific adventures, working with Italian colleagues, was to recognize in the rocks' small pores organic carbon of biological origin, providing evidence of deep ecosystems which fed on serpentinisation products. This means that we do have proof that life has colonised the oceanic lithosphere to a depth of several kilometers. So the thinking then went: if life can develop at great depth, far from any photosynthetic source of energy, if the organic carbon does not come from the surface and was not buried deep by flowing seawater, then there is a way to create life from nothing, using a purely chemical process. Which explains why people are now turning to serpentinites. Perhaps living organisms have just used something that has been around since plate tectonics? Perhaps living organisms just added themselves to an already existing geochemical process, without inventing anything, just making use of something which existed in the natural state? So the really exciting thing now is to explore all the reactive surfaces of these rock-forming minerals in the oceanic lithosphere and to see to what extent they are capable of producing the first organic molecules, the first organic acids, the first proteins. And perhaps even of producing the first cells which might have been consolidated in the rocks' pores!

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