Mind-blowing giant crystals—what can they teach us?

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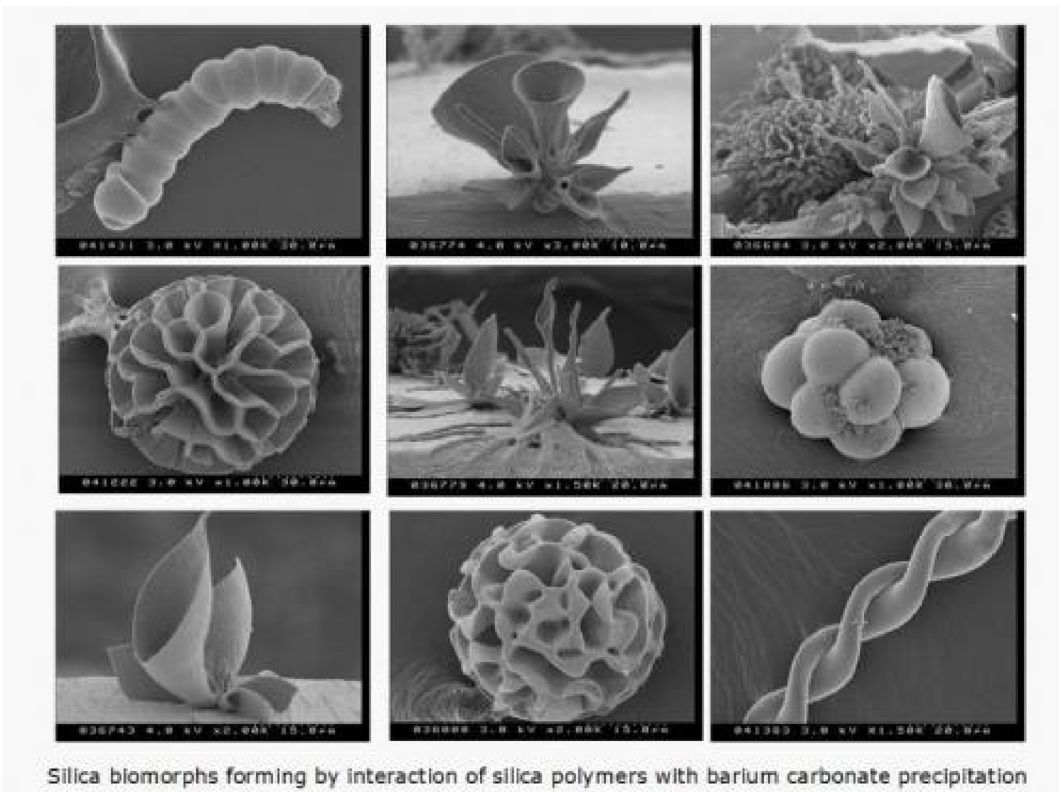

Picture of silica biomorphs formed by the interaction of silica polymers with barium carbonate precipitation. Juan Manuel García-Ruiz, a researcher and professor for Spain's National Research Council at the University of Grenada is investigating whether the ability of silica to trigger self-organization may have played a catalytic role in the formation of organic molecules from inorganic minerals and even triggered chemical reactions that lead to complex organic molecules. Credit: Matthias Kellermeier/Stephen Hyde/Juan Manuel Garcia-Ruiz

Giant gypsum crystals—some of which are in excess of 30 feet long and half a million years old—are found deep within the Naica mine in Chihuahua, Mexico and are renowned for their spectacular beauty. While large gypsum crystals can also be found at sites around the world, such as Segóbriga and Pulpí in Spain, and the El Teniente mine in Chile, Naica boasts the most exceptional ones.

But the beauty of these crystals isn't entirely on their outside. Tiny gases trapped inside the crystals are revealing secrets about crystal growth and morphology under conditions difficult to replicate within a laboratory because of the amount of time required to grow crystals of that enormous size.

The lessons of these giant, ancient crystals will be explored at the International Union of Crystallography (IUCr) Congress and General Assembly meeting next week in Montreal, Canada. There, Juan Manuel García-Ruiz, a researcher and professor for Spain's National Research Council at the University of Grenada, as well as the founder and director of the Laboratory for Crystallographic Studies, will describe how they are formed and what they are teaching us.

"In Naica, several geologic conditions have been fulfilled to form the giant crystals—including the existence of two minerals with reverse solubility vs. temperature, a hot point, and very slow cooling for thousands of years," says.

In Montreal, García-Ruiz will present a plenary lecture entitled "From the Crystal to the Rose: The Route to Biomimetic Self-assembled Nanostructured Materials," a movie "The Mystery of the Giant Crystals," and a poster exhibition about the role of crystals in our everyday life.

García-Ruiz first became interested in giant crystals years ago while focusing on obtaining tiny crystals of proteins—a cornerstone technique in modern biology that scientists use to solve the structures of molecules relevant to human health and disease. At that time in his life, growing a crystal of proteins only a few hundred microns equated to a big success.

Then he received an invitation to study the formation of large gypsum crystals in Segobriga, Spain, which had been described during Roman times by Pliny the Elder as "lapis specularis." He was hooked. "These crystals were the precursors of what we now call glass windows. It's a fascinating story that explains the terminology confusion surrounding the words 'crystal' and 'glass' in some languages," García-Ruiz said.

In the movie "The Mystery of the Giant Crystals," García-Ruiz travels with documentary filmmaker Javier Trueba to four different caves where these spectacular examples of the mineral world have been found and explores how they were formed.

Origins of Life on Earth

Another topic García-Ruiz will discuss in Montreal is his own research looking at how mineral self-organization can provide answers to big questions about primitive life detection and the origins of life on Earth.

"For many years, it was believed that living organisms and crystalline minerals belonged to two separate worlds of symmetry, because life is able to create complex shapes with continuous curvature that were considered impossible as the product of mineral precipitation," he explained.

So morphology has traditionally been used as a tool for biogenesis when searching for the oldest remnants of life on the planet or elsewhere—can we find evidence, in other words, of ancient biological molecules based on the morphology of shapes seen in the fossil record.

"We've demonstrated, however, that under similar conditions to the primitive earth, silica interacts with carbonates to form complex self-assembled purely inorganic structures with shapes that are indistinguishable from those considered to be remnants of the oldest life on Earth," García-Ruiz said.

"This means that morphology alone can't be used as the sole criterion for biogenecity," he added. "We need to develop new analytical tools to reveal when life appears in this planet and if whether or not there is life elsewhere."

This finding made García-Ruiz question whether silica can perform a similar role to the one played by organic matter in biomineralization. He's currently exploring whether this ability of silica to trigger self-organization may have played a catalytic role in the formation of organic molecules from inorganic minerals and even triggered chemical reactions that lead to complex organic molecules.

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