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# Giant crystals enjoyed perfection

**With lengths over 11m, the giant gypsum crystals found in Mexico's Cueva de los Cristales are a great natural wonder.**

Now, a Spanish-Mexican team thinks it can explain how these marvels acquired their immense form.

The scientists studied tiny pockets of fluid trapped in the crystals and conducted back-up lab experiments.

They report in the journal Geology that the solution from which the crystals grew must have been kept in a very narrow, stable temperature range.


The cave was discovered in 2000

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The researchers' analysis leads them to believe there are other dramatic caves waiting to be discovered in the Naica mine complex south-east of Chihuahua city.

"If the theory we propose for the 'genetic' mechanisms of the crystals is right, then I would not be surprised if miners find more of these caves in the next few years," Juan Manuel Garcia-Ruiz, from the University of Granada, Spain, told BBC News.

**Bigger than 'swords'**

Already two remarkable caves are known at Naica, which has yielded some of the world's most significant deposits of silver and lead.

The 120m-deep Cueva de las Espadas (Cave of Swords), discovered in 1912, is named for its metre-long shafts of gypsum (a calcium sulphate mineral that incorporates water molecules into its chemical formula).

And although individually there are fewer crystals in the 290m-deep Cueva de los Cristales, its beams are considerably bigger.

Professor Garcia-Ruiz and colleagues believe they can now show how these differences emerged.

The team studied tiny fluid samples embedded inside the crystals themselves.

These watery inclusions record tell-tale chemical details of the saline and temperature conditions of the saturated solution from which the mammoth structures developed.

**'Perfect conditions'**

Both caves owe their origin to the volcanism which laid down the metal sulphides - the ores - that have proved so valuable.

Copious amounts of calcium sulphate would also have been created towards the end of this mineralisation process more than 20 million years ago - but in the hot fluids that infused the cracks and cavities in the rock, this calcium sulphate would have taken the form of anhydrite.

Anhydrite has the same chemical formula as gypsum, except that it excludes water. Only as the magma chamber deep under the Naica mountain cooled did the hot fluids above start to fall to a temperature at which anhydrite could switch to gypsum.

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Professor Garcia-Ruiz and colleagues say their studies indicate that the deeper of the two caves - Cueva de los Cristales - must have been kept just below the transition temperature for many hundreds of thousands of years.

"The conditions were perfect. By maintaining the temperature just below 58 degrees for a very long time you get a few, very big crystals," said Professor Garcia-Ruiz.

"You can see that many areas on the cave's walls are empty; they have no crystals. The walls are red because of the iron oxide. The reason we know this happened for many years is because we studied the fluid inclusions inside the crystals."

It is likely the upper cave - Cueva de las Espadas - fell below the transition temperature much more rapidly and consequently grew many, smaller crystals.

**Heritage future?**

The particular crystalline form taken by the gypsum is selenite which is known for its translucency.

Their future will be dependent on the fate of the mine.

At the moment, access is restricted to prevent damage to the soft crystals.

And humans can only get in the caves at all because of the continuous pumping operations that keep them clear of water.

If, when Naica's ores are no longer viable, the mine is closed and the pumping is stopped, then the caves will be submerged - and the crystals will start growing again.

"I've recommended to the mining company that they try to preserve them and I would like to see Unesco get involved," explained Professor Garcia-Ruiz.

"Later on we should decide whether to keep them available for people to visit and enjoy, or let the natural scenario return."

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