

Archaeologists are unlocking the secrets of Maya lime plasters and mortars



Enlarge / Archaeologists analyzed samples of Maya plasters collected from the Copan archaeological site in Honduras. Rodriguez-Navarro et al., 2023

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There is a rich body of scientific research investigating the secrets behind the remarkable durability of ancient Roman concrete. But ancient Maya masons had their own secrets when it came to making the lime plasters, mortars, and stuccos used

to build their magnificent structures, many of which still stand today. A team of Spanish scientists has analyzed samples of Maya plasters from Honduras and confirmed that the Maya added plant extracts to improve the plasters' performance, according to a new paper published in the journal *Science Advances*.

As we've reported previously, like today's Portland cement (a basic ingredient of modern concrete), ancient Roman concrete was basically a mix of a semi-liquid mortar and aggregate. Portland cement is typically made by heating limestone and clay (as well as sandstone, ash, chalk, and iron) in a kiln. The resulting clinker is then ground into a fine powder, with just a touch of added gypsum—the better to achieve a smooth, flat surface. But the aggregate used to make Roman concrete was made up of fist-sized pieces of stone or bricks.

Mayan lime plaster draws on similar ancient knowledge, according to Carlos Rodriguez-Navarro and his colleagues at the University of Granada. The use of lime plaster dates back to around 10,000 to 12,000 BCE, and the manufacturing process typically involved the calcination of carbonate rocks like limestone to produce quicklime, which was then slaked to create portlandite. It seems the Maya independently developed their own lime pyrotechnology around 1100 BCE, and the plasters, mortars, and stuccos they produced exhibit impressive resistance to granular disintegration, fracturing, or scaling, despite more than 1,200 years of exposure in a hot and humid tropical environment.

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With regard to Roman concrete, in 2017, scientists analyzed the concrete from the ruins of sea walls along Italy's Mediterranean coast, which have stood for two millennia despite the harsh marine environment. That analysis revealed that the recipe involved a combination of rare crystals and a porous mineral. So exposure to seawater generated chemical reactions inside the concrete, causing aluminum tobermorite

crystals to form out of phillipsite, a common mineral found in volcanic ash. The crystals bound to the rocks, preventing the formation and propagation of cracks that would have otherwise weakened the structures.

In 2021, archaeologists analyzed samples of the ancient concrete used to build a 2,000-year-old mausoleum along the Appian Way in Rome, widely considered one of the best-preserved monuments on the famous road. They discovered that the tomb's mortar was similar to the walls of the Markets of Trajan: volcanic tephra from the Pozzolane Rosse pyroclastic flow, binding together large chunks of brick and lava aggregate. However, the tephra used in the tomb's mortar contained much more potassium-rich leucite. The potassium in the mortar dissolved in turn and effectively reconfigured the binding phase.

And earlier this year, archaeologists analyzed samples taken from the concrete walls of the Privernum archaeological site near Rome and found that the Romans employed "hot mixing" with quicklime, among other strategies, to give the material self-healing functionality. When cracks begin to form in the concrete, they are more likely to move through the lime clasts. The clasts can then react with water, producing a solution saturated with calcium. That solution can either recrystallize as calcium carbonate to fill the cracks or react with the pozzolanic components to strengthen the composite material.

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