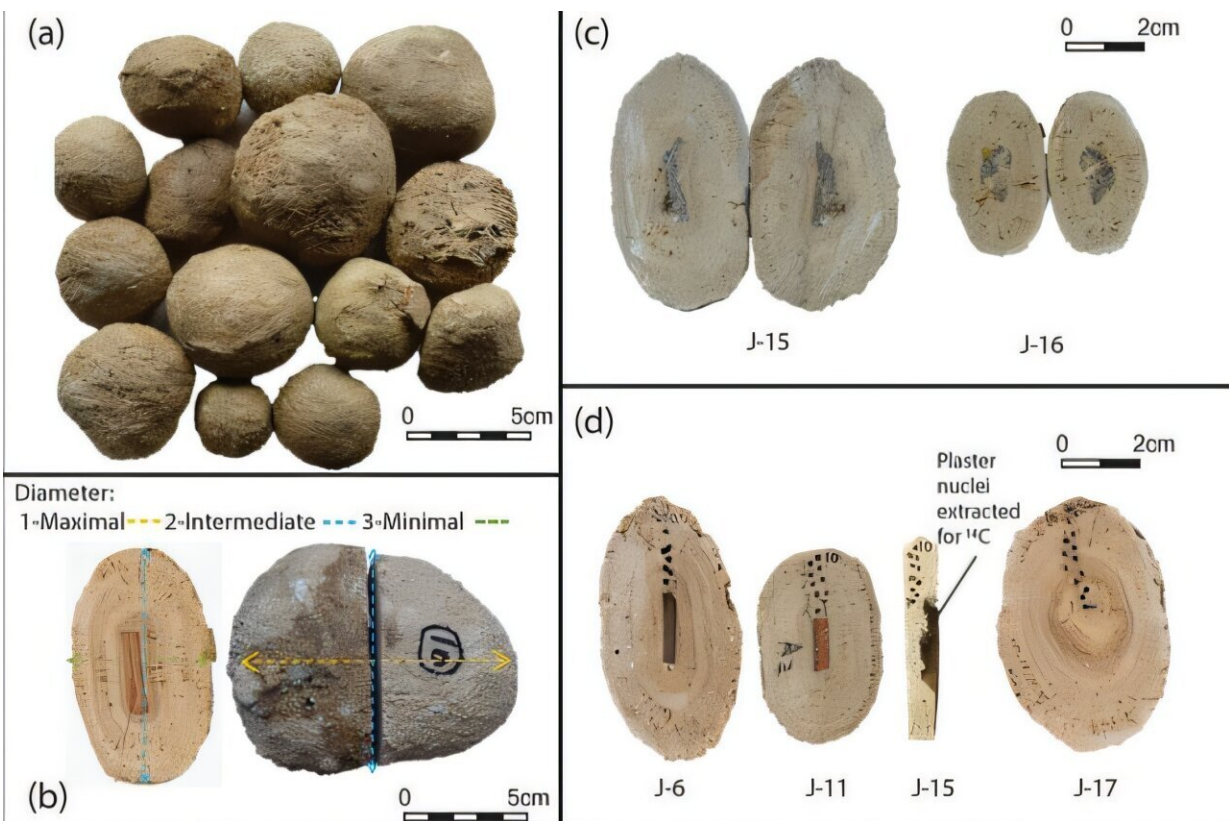


Study finds first cave pearls containing archaeological artifacts in ancient Jerusalem tunnel

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Cave pearl assemblage. (a) Sample of cave pearls before analysis. Notice the variety in size, rough surfaces and brownish color. (b) Pearl J-10 with a pottery sherd nucleus, displaying measurement methods: diameter 1, maximum; diameter 2, intermediate; and diameter 3, minimal. (c) Pearls formed on a plaster, containing charcoal used for ^{14}C dating. (d) Pearls used for the measurement of stable isotopes. (e) Pearl J-25 formed on limestone. (f) Three

slabs along pearl J-28's main axis (intermediate diameter). Notice that pearl initial growth was on a marl nucleus (1, black arrow), while later a secondary nucleus consisting of a piece of plaster was added (3, red arrow). (g) The largest pearl, J-29. Credit: *Archaeometry*. <https://doi.org/10.1111/arcm.13031>

A study conducted by Dr. Azriel Yechezkel of the Hebrew University of Jerusalem and his colleagues from the Hebrew University and Tel Aviv University, [published](#) in the journal *Archaeometry*, discovered the largest known cave pearl deposit in the southern Levant. What makes these 50 cave pearls so unique is that some of them contain archaeological artifacts, making them the first in the world to contain man-made objects.

Cave pearls are a type of speleothem found in caves. They are round, [pearl](#)-like formations usually between 0.1 mm and 30cm long. They form around central nuclei, such as sand grains covered in layer upon layer of mineral deposits.

Unlike most speleothems, which take thousands of years to form, cave pearls can form over the course of a few hundred years. To form, cave pearls need a number of conditions met, namely, the presence of saturated water, nuclei, a flattish cave floor with a shallow pool of water, water movement in the form of drips or slow-flowing water, and changes in the soil chemistry over time.

The cave pearls Dr. Azriel Yechezkel and his colleagues, Dr. Yoav Vaknin, Mrs. Shlomit Cooper Frumkin, Dr. Uri Ryb, Prof. Ron Shaar, Prof. Yuval Gadot and Prof. Amos Frumkin found, came from the Joweizeh spring tunnel (ST). STs are artificial tunnels designed to extract subsurface water from a perched aquifer and bring it to the surface.

The Joweizeh ST is one of the longest in the southern Levant and one of the oldest STs discovered worldwide. It spans 232m and flows northwest into a wadi (dry valley or channel) before contributing to the Refaim stream southwest of Jerusalem's old city.

It consists of various sections, including the first section, built of hewn stone and roofed with stone slabs, and a second section carved directly into the bedrock.

It was within the second section that the cave pearls were discovered, although this discovery was completely by accident, says Dr. Yechezkel. "Our initial research focused on mapping and surveying for [archaeological artifacts](#) within the spring tunnel. Cave pearls, a rare type of speleothem, were not the primary objective of our investigation. The discovery of these formations, and even more surprisingly, the presence of archaeological remains like [pottery shards](#) within them, was an unexpected and significant find."

In a previously sealed-off and undiscovered section of the tunnel, the researchers discovered 50 cave pearls. Further analysis revealed that 14 of these pearls contained pottery, while another two contained ancient plaster.

It was found that most of the pottery dated to the Hellenistic periods (333–63 BCE), Roman (63 BCE–324 CE), or Byzantine (330–636 CE) periods with only two exceptions. One pottery sherd may have come from the Middle Bronze Age II (ca. 17th century BCE), while the other dates to around the Early Hellenistic, Iron Age, Persian, or Babylonian periods.

Despite their best efforts, most of the pottery fragments' original forms and purposes could not be determined, says Dr. Yechezkel. "Despite our efforts, we could not definitively identify the remaining pottery

fragments embedded in the cave pearls. Nevertheless, it is evident that these fragments span various historical periods and are composed of a range of materials."

However, two fragments were found to contain a cobalt-rich coating. The manufacturing of cobalt-coated pottery was not characteristic of local pottery but had been observed in Cyprus and Ephesus (Turkey) during the second and first centuries BCE. Such coatings were typical for ceramic lamps, other examples of which have been found in luxurious Jerusalem houses.

Dr. Yechezkel explains why such an expensive imported lamp would have found its way into the ST, "It's my hypothesis that the manual labor of excavating and removing the debris was carried out by the workers. Yet, the overall project was undoubtedly overseen by engineers with expertise in hydrology and geology.

"Evidence of such engineers, though from later time periods, has been discovered in numerous other tunnels both in Israel and internationally. The imported lamp could have belonged to one of these engineers."

Based on the findings in the cave pearls as well as Proto-Aeolic capital relief in the first section of the ST, it was determined that the Joweizeh SP was initially constructed during the Iron Age II (8th and 7th centuries), likely as part of a royal estate near Jerusalem.

The tunnel was repeatedly visited and maintained, including after Jerusalem's destruction by the Babylonians in 586 BCE, and continued to be used through the Persian (586–333 BCE) and Hellenistic periods.

During the Hellenistic period, however, it may have undergone significant renovations, as evidenced by the plaster pieces and many pottery fragments found in the cave pearls that date to this era. It was

also around this time that the first cave pearls likely began to form. The ST continued to be used throughout the Roman and Byzantine periods before it was abandoned.

Besides ancient looting, the only evidence of more recent visitation is the installation of a clay pipe through the tunnel, which was laid down in the 20th century.

More information: Azriel Yechezkel et al, Dating an ancient spring tunnel using archaeological artefacts functioning as nuclei of cave pearls, *Archaeometry* (2024). [DOI: 10.1111/arcm.13031](https://doi.org/10.1111/arcm.13031)

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