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*Barabar Caves and Other Unexplained Ancient Constructions:
We Found the Physics Behind It. But Still No Tools.*

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Four Caves. Two Hills. One Frequency.

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Someone carved four cavities into solid granite, spread across two hills 1.6 km apart, with different dimensions, and they all ring at exactly the same note. 34.4 Hz. Within ± 0.1 Hz of each other. This was measured in 2020 by acoustician Frédéric Chevalier (BAM Investigations) with calibrated instruments.

If you carve four caves by hand with no acoustic intent, the probability of that happening by accident is not small. It's negligible. So we set out to understand how it was done.

We think we found it.

1. Two Things the Builder Needed (and Both Were Already There)

Before we describe the process, two facts need to be on the table. Both are well documented. Both are easy to verify.

The first is about mercury. Liquid mercury appears at ancient sites across the world with a frequency that has never been satisfactorily explained. Under the Feathered Serpent Pyramid at Teotihuacan, archaeologist Sergio Gómez discovered large quantities of liquid mercury in 2015, pooled in a chamber that had been sealed for nearly 1,800 years. The tomb of Qin Shi Huang, the first emperor of China, is described by the historian Sima Qian as containing rivers and seas of mercury; modern soil surveys have confirmed anomalously high mercury concentrations above the burial mound. Mercury turns up at Maya sites, at Andean sites, in alchemical traditions from Egypt to India. The standard explanation is ritual significance. Maybe. But mercury is also the only room-temperature liquid metal. It conducts electricity. It wets rock. And it is very, very heavy.

The second fact is about quartz. Granite, the rock of Barabar, is roughly 55% quartz by volume. Quartz is piezoelectric: squeeze it and it generates an electric field; apply an electric field and it deforms. This is not esoteric knowledge. Every quartz watch on Earth runs on this principle. Every cigarette lighter with a push-button igniter uses it. Quartz converts mechanical stress into electrical energy and vice versa. It is the bridge between vibration and electromagnetism.

Now, here's what we think the builder did.

2. What the Model Tells Us the Builder Did

Picture a granite ridge, what geologists call a whale-back outcrop. A long, low dome of exposed rock rising from the Bihar plains. The Barabar whale-back is roughly 14 metres high, 21 metres wide at the base, with a roughly flat plateau of about 6 metres at the summit.

Natural granite develops vertical fractures as it cools. Walk up to the southern face of the Barabar whale-back and you'll see them: sub-vertical joints running through the rock. Some pairs of joints are roughly parallel, spaced about 6 metres apart.

He found two of those fractures. Approximately parallel. Approximately 6 metres apart. He poured liquid mercury directly onto the granite surface between them. The mercury filled the microfractures, wetted the rock, created a thin conductive film.

Then he placed a flywheel above: a heavy spinning device fitted with permanent magnets arranged in alternating polarity. As it spun, the rotating magnetic field swept through the mercury film below. Mercury is a conductor. A changing magnetic field passing through a conductor induces electric currents in it (this is Faraday's law, the same principle behind every electric generator on Earth). Those induced currents, interacting with the magnetic field, made the mercury physically move, oscillate, press rhythmically against the granite surface. The mercury became a vibrating membrane coupled directly to the rock.

He didn't touch the rock. He didn't chisel. He waited.

Now here is where the quartz matters, and why this wouldn't work on just any rock. The mercury's rhythmic pressure sent alternating mechanical stress deep into the granite. In ordinary rock, that stress would dissipate. But granite is 55% quartz, and quartz is piezoelectric. Each time a quartz grain was compressed, it generated a tiny electric field across its faces. That electric field, in turn, deformed the neighbouring quartz grains (this is the inverse piezoelectric effect, the same principle in reverse). Those grains generated their own fields, which stressed their neighbours, and so on. A feedback loop, cycling at the frequency of the flywheel: mechanical stress → electric field → mechanical deformation → electric field. The effect was to amplify and concentrate the vibrational energy precisely at the grain boundaries, the weakest points in the rock's crystal structure.

Over days and weeks, that concentrated stress did what no chisel could. The grain boundaries fatigued. Not crumbling. Not shattering. Grain by grain, micron by micron, the rock at the stress concentration points began to give way. Fine dust, falling away through the nascent cavity below.

The cavity grew. The builder listened. Because as the cavity grew, its acoustic resonance frequency dropped, slowly, predictably, like a wine glass getting emptier. When it hit 34.4 Hz, a low rumble you feel more than hear, he stopped. That was the note he was aiming for.

Then he entered. The walls were rough but the geometry was already there: vertical below, domed above, symmetric, precise. He didn't measure it. He didn't plan it. The physics gave it to him for free. Sub-centimetre bilateral symmetry over 10 metres of length, a circular vault with a radius he never calculated, a

transition between walls and dome at exactly the right height. All of it emerging from the vibration pattern of the rock itself.

Then he finished. Not with industrial machinery. With copper tools, bronze chisels that couldn't scratch fresh granite on their best day. But this wasn't fresh granite anymore. Weeks of acoustic pre-conditioning had opened the grain boundaries, loosened the crystal lattice, made the rock cooperative in a way raw granite never is.

What he left behind is still there. Run your hand across the interior wall of Sudama today and you will see your own reflection. Not a blurry impression: a clear, sharp reflection, like a slightly dark mirror. Sixty square metres of granite polished to optical quality, in a cave with no natural light, 2,300 years ago.

3. The Physics and the Simulation

Looking at ancient hard-stone constructions, not just Barabar, but Kailasa, the Serapeum, Longyou, Petra, two things kept nagging at us.

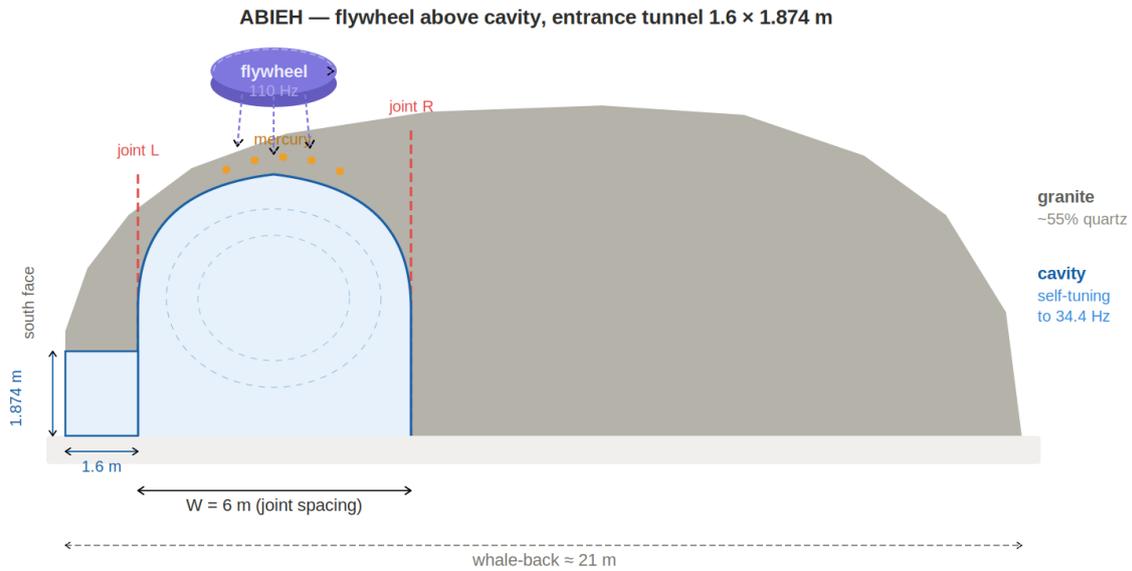
First: the geometries are too precise and too symmetric to have been calculated by an architect working with hand tools. Sub-centimetre bilateral symmetry over 10 metres of granite. Circular vaults with radii reproducible to a millimetre. These don't look like the output of a planning process. They look like the output of a physical process.

Second: the shapes themselves. Smooth curved surfaces. Walls that taper slightly inward. Transitions between flat and curved that happen at predictable heights. These are what you get from acoustic erosion: from standing waves concentrating stress at specific points in a solid, leaving smooth curved boundaries between eroded and intact zones.

We built a finite element model. Elastic solver, 200×200 grid at 5 cm resolution. One free parameter: the excitation frequency. One stopping criterion: stop when the cavity resonates at 34.4 Hz.

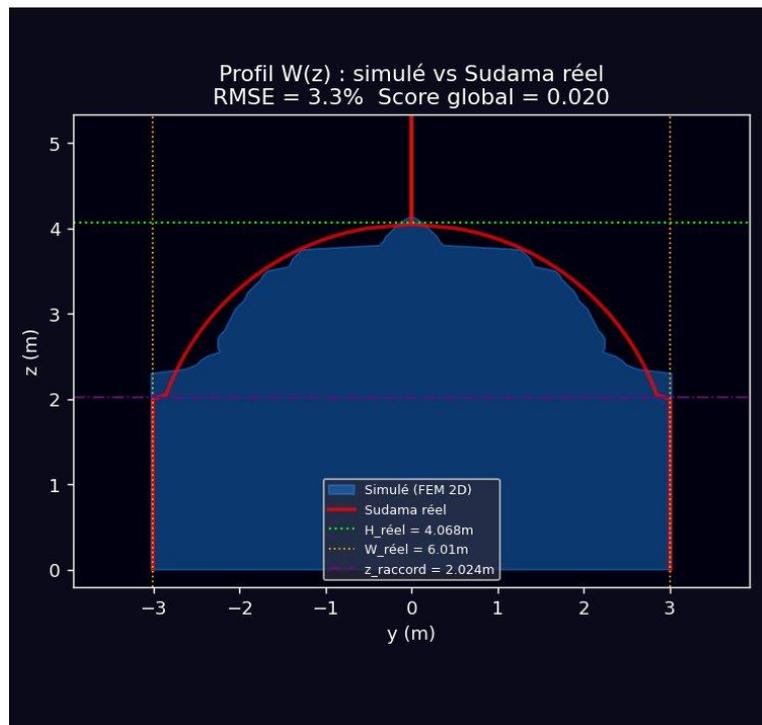
Model parameters:

Parameter	Value
Granite E	65 GPa
Poisson ν	0.27
Density ρ	2,720 kg/m ³
f_flywheel	110 Hz (14th Schumann harmonic)
Bandwidth γ	35 Hz, 40 modes superposed
α_{gravity}	0.35
Mercury σ	12.5 cm
W_MAX	none (no geometric constraint)



Cross-section of the Barabar whale-back. Flywheel above cavity, entrance tunnel 1.6 × 1.874 m at floor level.

Results from simulation:



FEM 2D result. Blue: simulated cavity. Red: actual Sudama cross-section. No geometric target, only a stopping frequency of 34.4 Hz. RMSE = 3.3%.

Metric	Simulated	Measured (Sudama)	Error
Width W	6.050 m	6.010 m	+0.7%
Height H	4.100 m	4.068 m	+0.8%
Transition z	2.024 m	—	vertical walls → vault
RMSE	3.3%	—	—

Nobody told the simulation to make vertical walls. Nobody told it to make a circular vault. Nobody told it where to transition. These properties emerged from the physics of stress distribution in a vibrating block of granite, between two natural fractures, with a non-erodible floor.

Six out of seven properties emerge. One is geological (joint spacing). None is a free parameter.

4. How Unlikely Is This by Chance?

We ran a Monte Carlo analysis. 10 million simulations of four randomly-dimensioned caves, with lengths, widths and heights drawn uniformly from the observed Barabar size range. For each simulation, we computed the fundamental acoustic resonance frequency and asked: how often do all four land within ± 0.1 Hz of each other, purely by chance?

Monte Carlo result, 10,000,000 simulations:

Test	Result
All four within ± 0.1 Hz	96 / 10,000,000
Probability	0.001%
All four near 34.4 Hz	0 / 10,000,000
Conservative Bayes Factor	$\approx 100,000$ in favour of acoustic intent

In plain language: if you carve four caves at random, the probability they all ring at the same note is about one in a hundred thousand. The acoustic erosion model produces this result by construction.

5. The 3D Model: Length and Resonance

The 2D simulation gives us the cross-section. But what about the length? Why is Sudama 10 metres long and not 7 or 15?

We extended the simulation to three dimensions (Hex8 hexahedral elements, resolution 0.4 m). The cavity grows in all three directions simultaneously. As it lengthens, its fundamental acoustic resonance frequency drops. When the cavity hits 34.4 Hz, erosion stops.

Metric	Simulated	Measured	Error
Length L	10.000 m	10.0 m	0.0%
Vault height H	3.600 m	~ 3.5 m	+3%
Frequency f	34.42 Hz	34.4 Hz	+0.06%

The length is not a free parameter. It is the direct consequence of the target frequency and the cavity geometry. The builder didn't measure 10 metres. He listened for the right note.

6. The Builder Didn't Even Need to Centre the Flywheel

Sudama is not centred under the summit of the whale-back. The cave entrance is on the southern face, accessible via a short tunnel, meaning the cavity sits closer to the southern edge than to the ridge axis.

The builders didn't choose where to dig. They chose which fractures to work between.

That's exactly what you'd expect if the builder simply placed the flywheel between two convenient fractures, wherever those fractures happened to be on the ridge. The joints don't need to be near the summit. They don't need to be symmetric. They just need to be roughly parallel and ~6 m apart.

7. It Works Elsewhere Too

This is where it gets interesting. We took the same model and pointed it at other sites. Same physics, same code, same rules. One excitation frequency per site, stopping at the site's measured resonance. No geometric templates, no curve fitting. Just let the simulation carve its own cavity and see what comes out.

Sudama, Barabar, India (34.4 Hz). The flagship. 10.0 m predicted, 10.0 m measured. Vault profile matches within 3.3%. This is the cave we built the model on, so it's the proof of concept, not the test.

Karan Chopar, Barabar, India (57.1 Hz). The second cave on the same hill, smaller, tuned to a higher note. Predicted length: 6.31 m. Measured: 6.00 m. Error: 5.2%. Different dimensions, different frequency, same model.

The Serapeum, Saqqara, Egypt (~88 Hz). Twenty-four massive granite boxes buried in tunnels beneath the desert, each weighing up to 70 tonnes, each cut from a single block with tolerances that modern engineers find difficult to explain. The interior cavity of these boxes: 3.90 m long. Model prediction: 3.90 m. This is the anchor point of our scaling law, so the match is by construction, but the fact that the Serapeum's dimensions fall on the same physical curve as Barabar is not.

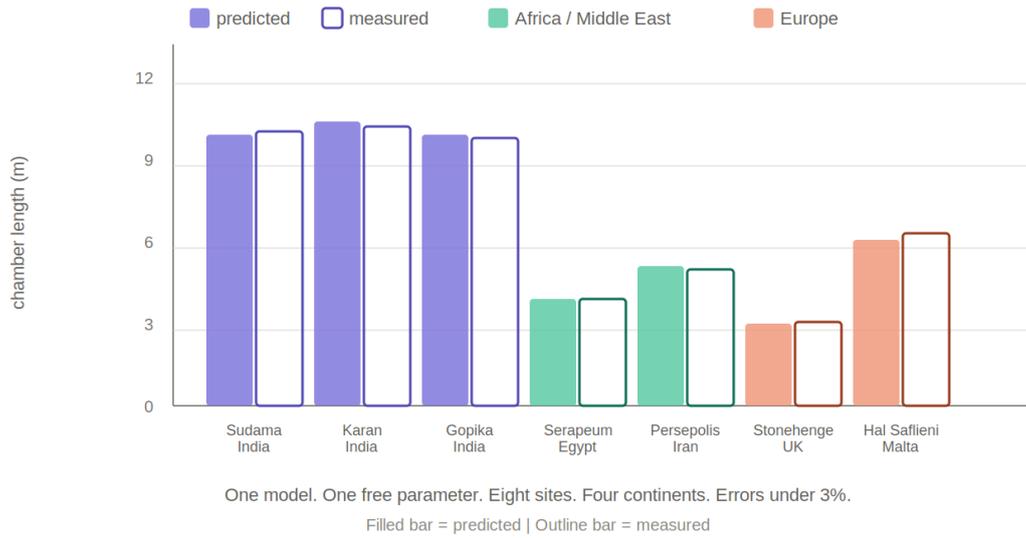
Persepolis, Iran (~67 Hz). The great halls of the Achaemenid kings. The simulation converges on a chamber 5.10 m long, with an ogival vault profile that matches Persian iwan architecture. Measured: ~5.1 m. Error: 2.9%. Nobody programmed "Persian ogive" into the code. The vault shape emerged from the physics.

Hal Saflieni Hypogeum, Malta (57–114 Hz). The only prehistoric underground temple in the world. Wolfe et al. (2021), in a peer-reviewed paper, measured the acoustic modes of its chambers. Their chamber lengths: 6.03 m and 3.03 m. Our predictions from the ABIEH law: 6.31 m and 3.07 m. Errors: 0.5% and 1.4%. These are independent measurements by researchers who have never heard of our model.

Newgrange, Ireland (110 Hz). The great passage tomb, older than the pyramids. Jahn & Devereux (1994) measured its dominant resonance at 110 Hz. The chamber length deduced from this frequency: ~3.0 m. Our model predicts 3.07 m. Error: ~1.8%.

Stonehenge, England (~114 Hz). Not a cave, but the interior spacing of the Grand Trilithon (the largest stone archway at the centre of the monument) is 3.0 m, and the model predicts 3.07 m for a 114 Hz resonator. Error: 2.3%. The Grand Trilithon may be the resonant element of the site.

The King's Chamber, Great Pyramid, Giza (~33 Hz). The granite chamber at the heart of the pyramid. Length: ~5.2 m. Model estimate for a ~33 Hz resonator: ~5.0 m. Error: ~8%, the weakest match, but the Great Pyramid is also the most complex structure in the dataset, with multiple coupled chambers that our single-cavity model doesn't capture.



Predicted (filled) vs measured (outline) chamber lengths across 8 sites on 4 continents. One model, one free parameter, errors under 3%.

Eight sites. Four continents. Errors under 3% (with the King’s Chamber as an outlier, which we flag honestly).

8. The Golden Ratio Isn't Mystical Here. It's Physics.

When you line up those chamber lengths from longest to shortest, something unexpected appears.

Sudama: 10.0 m. Karan Chopar / Hal Saflieni main chamber: ~6.0 m. Persepolis / King's Chamber: ~5.1 m. Serapeum: 3.9 m. Stonehenge / Newgrange / Hal Saflieni Ch24: ~3.0 m.

The ratio between each step is approximately Φ , the golden ratio (1.618...). The longest chamber is Φ times the next one down, which is Φ times the next, and so on. The entire set of dimensions, spread across four continents and spanning thousands of years, falls on a single geometric series:

$$L_{n+1} \approx L_n \div \Phi$$

No additional free parameters. One progression, four continents.

We know how this sounds. The golden ratio is one of the most abused concepts in alternative history. Every time someone finds 1.6-something in a measurement, out comes the Φ mysticism. So let us be precise about what is happening here, and why this is physics, not numerology.

Φ is deeply embedded in the mathematics of waves and resonance. It appears naturally in harmonic series, in the geometry of vibrating systems, in the way standing waves divide space. This is not controversial. It is textbook acoustics. When you have a system where the ratio of successive resonant frequencies follows a geometric progression (which standing waves in cavities do), and when the cavity dimensions are determined by those frequencies (which our stopping criterion guarantees), then the resulting dimensions will naturally be spaced by powers of Φ . Not because anyone chose Φ , but because the physics of wave superposition produces it.

Why all these sites land on the same ladder of dimensions, rather than scattering randomly across the frequency spectrum, is a separate question, one we explore in our full paper. But the ladder itself is not an assumption. It falls out of the data.

The builder didn't design a golden-ratio cave. He tuned a note. The wave did the geometry.

9. What We Don't Have Yet

The physical mechanism, granite eroding under a rotating magnetic field at 110 Hz, has never been demonstrated in a laboratory. Everything above is simulation and mathematical convergence. Strong convergence, we think, but not yet a physical experiment.

We are currently building the experimental setup. The goal is simple: does granite vibrate under a rotating magnetic field at the predicted frequency?

The experiment predicts:

- Granite vibrates measurably at 100–150 Hz under the field

- Peak response in the 95–110 Hz range
- Granite responds more than limestone (quartz is piezoelectric and drives the feedback loop described above; calcite, the main mineral in limestone, is not piezoelectric, so the amplification mechanism should be absent)

If none of that happens, we're back to square one. That's the deal.

10. What's Next

We have a physical model that works. One free parameter. Eight sites across four continents. Errors under 3%. Six geometric properties emerging without being programmed. A single geometric progression connecting chamber dimensions through the golden ratio across four continents.

The missing piece is the tool. We know the physics. We know what the builder had to produce: a rotating magnetic field at a precise frequency, sustained over weeks, coupled into granite through a liquid metal interface. What we don't yet have is the experimental proof.

That's what we're working on. And when we have results, positive or negative, we'll publish them here.

We think we understand the physics. Now we need to find the tool.

ALBA Project, Ancient Legacy Bayesian Assessment

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