

How one professor re-creates the extreme interiors of planets in an ASU lab

Using high-pressure experiments, physical chemist and mineralogist Sibó Chen explores how planets work deep below the surface and what makes worlds livable

By David Rozul, ASU News
January 29, 2026

Despite decades of research, we may not understand the Earth as well as we think.

In grade school, we learn about the planet's layers — the Earth's crust, mantle, core — and see colorful diagrams that make the planet feel neatly mapped and complete. But beneath our feet, far beyond where drills can reach, Earth's interiors remain one of the least explored places in science.

[Sibó Chen](#), assistant professor in Arizona State University's [School of Molecular Sciences](#) and [School of Earth and Space Exploration](#), studies what happens to rocks, minerals and water deep inside Earth and other planets, to understand how worlds evolve and remain habitable.

"Mars is the sister planet of Earth, but today it doesn't have liquid water on its surface or a magnetic field," Chen said. "Those differences are closely tied to what's happening inside the planet. Understanding how planetary interiors evolve helps us ask whether Earth could someday lose its liquid water or magnetic field and become more like Mars."

Chen's research re-creates in the lab the intense pressure and heat found deep within planets, conditions that can rearrange how atoms bond, how minerals form and how water is stored or released underground.

Using massive presses inside ASU's [FORCE Lab](#) — one of the most advanced high-pressure research facilities in the world — Chen's research compresses materials to mimic environments between 10 to 500 vertical miles below Earth's surface.

Under these conditions, materials can transform dramatically.

“Take carbon,” Chen said. “Graphite, like what’s in a pencil, is soft and dark. But under extreme pressure and temperature, that same carbon can turn into a diamond, super hard, bright and transparent. It’s the same element. What changes is how the atoms are arranged. That’s the kind of transformation we’re interested in.

“We know surprisingly little about Earth’s interior. A lot of what we think we know is based on indirect evidence and assumptions. My goal is to test those assumptions.”

From Earth to Mars

In a recent [PNAS paper](#), Chen used the water-bearing mineral lawsonite to show that earthquake velocity data alone can’t reliably reveal where water is stored deep inside Earth.

Now, in ongoing work, Chen is investigating whether water or hydrogen could exist near the boundary between the mantle and core of Mars.

“Mars’ surface looks like a desert now,” Chen said. “But that doesn’t mean it was always that way, or that water couldn’t still exist deep inside.”

To investigate the presence of water and hydrogen in Earth and Mars, Chen measures how materials behave while they are still under extreme pressure and temperature, rather than analyzing them only after the pressure is released.

Using high-pressure instruments at the FORCE Lab, along with powerful synchrotron X-rays at national facilities such as Argonne National Laboratory and Lawrence Berkeley National Laboratory, he can observe chemical reactions and physical properties inside materials in real time, which is crucial to his work.

“If you release the pressure, many properties of materials revert back to what they were,” Chen said. “You miss the most important part. We want to measure what’s happening in real time.”

His interdisciplinary research continues to position ASU as a leader in materials and planetary science, and a hub for collaboration.

“Our goal is to make FORCE an open facility,” Chen said. “This isn’t just for ASU. We want researchers from across the country and around the world to come here and solve problems together.”

Curiosity as a scientific compass

Originally trained as a geophysicist studying earthquake data, Chen was drawn to high-pressure sciences through an evolution of his curiosity.

Seismic signals could show where something unusual was happening inside Earth, but not why.

“I wanted to understand the cause,” he said.

That curiosity still guides his work and his teaching. Chen now teaches an introductory programming course for chemistry and biochemistry students and emphasizes exploration over certainty.

“Science isn’t about already knowing the answer,” Chen said. “It’s about asking better questions.”

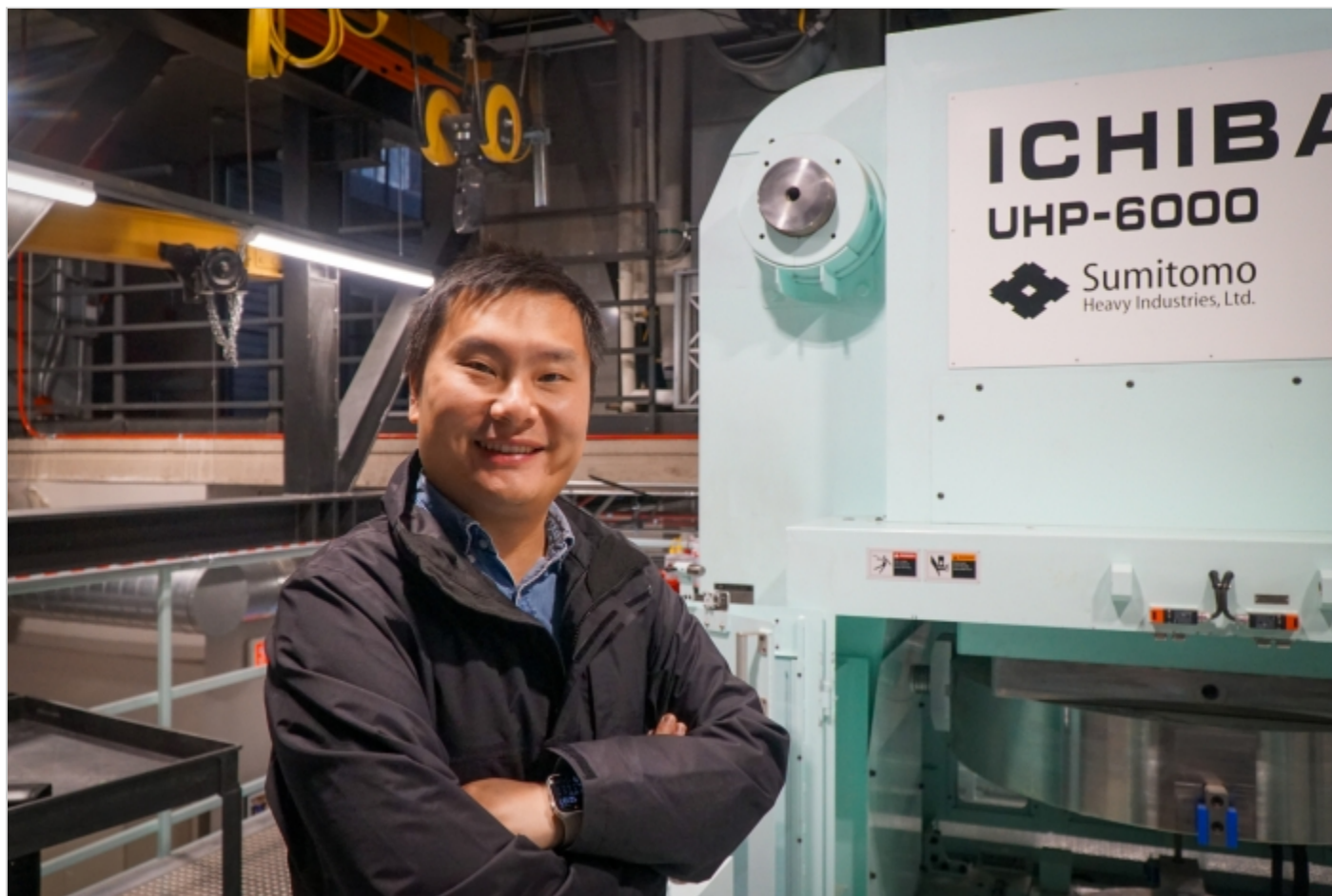
For Chen, the biggest misconception he hopes to change is the idea that Earth is a solved puzzle.

“We know less about Earth’s interior than people realize,” he said. “If we want future generations to live well on this planet, we need to understand our home better, starting from the inside out.”

Sibo Chen is actively recruiting undergraduate, graduate and postdoctoral students to participate in similar projects and join his lab. If interested, email Sib0 Chen at schen413@asu.edu.

This story originally appeared on [ASU News](#).

Main image



Sibo Chen, assistant professor in ASU’s School of Molecular Sciences and School of Earth and Space Exploration, stands beside Ichiban, a two-story tall, 6,000-ton uniaxial multi-anvil press in

ASU's FORCE Lab, where researchers re-create the extreme conditions found deep inside planets. Photo by David Rozul/ASU

Text image(s)



ASU Assistant Professor Sibor Chen demonstrates preparing a sample for Ichiban, ASU's 6,000-ton multi-anvil press in the FORCE Lab. In its assembly, four tungsten-carbide anvils surround a sealed sample before being compressed inside Ichiban to re-create the extreme pressures and heat of planetary interiors. Photo by David Rozul/ASU