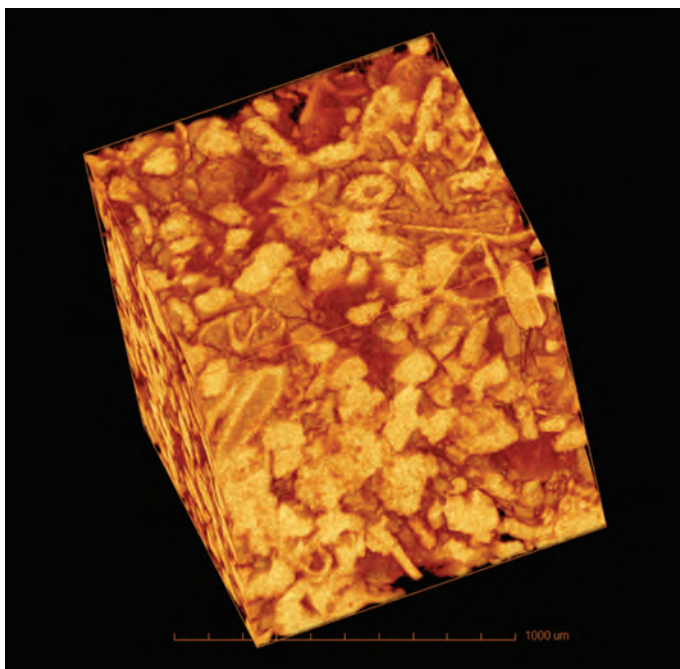


## ROCK PROPERTIES

# Applying The 'New' Math

NEW PARADIGM FOR ASSESSING PERMEABILITY IN RESERVOIR ROCK



**PROponents of a new method** of determining rock permeability are quick to correct those who describe the process as “measuring” permeability.

“It’s not measuring, but computing,” says California geophysicist Amos Nur, the retired university professor helping to lead the effort to commercialize the new method. With 30 years of teaching geophysics at Stanford University under his belt, Nur is well-qualified to discuss the subject.

The most common method to derive permeability is to draw cylindrical rock cores from the reservoir, take them to the lab and subject them to pressure and flow tests. The process has its drawbacks and is known for

being slow. It might be days or weeks before permeability is determined, and in the digital age, patience is a less common virtue.

Perhaps the most useful advantage Nur’s team claims for its method is saving time. Instead of days, exploration managers may wait just hours to get reliable and accurate permeability figures, thanks to the numerical simulation methods the new technology uses. Originally patented by Stanford, the methods have been licensed to Ingrain Inc., the Texas company led by Nur and his colleagues.

Boiled down to its basics, Ingrain uses tomography to make X-rays of rock samples. Unlike typical medical CAT (computed

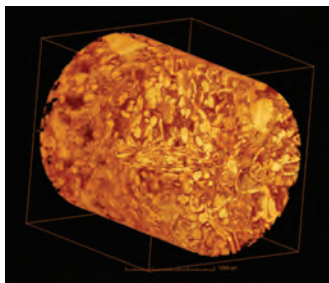
axial tomography) scans, however, Ingrain’s computer-automated tomography cameras generate high-resolution images that are fed into a computer for further processing. The numerical simulation is sophisticated enough to reproduce the rock’s internal structure, even from simple drill cuttings or sidewall cores, if whole cores are not available.

“We obtain a high-resolution, three-dimensional image of the pore structure of a rock sample,” says Nur. “Using mostly CAT-scans, we take the complicated pore space structure as it is, and then simulate or compute the way fluids would flow through the pore space.”

In effect, the Ingrain team lays aside the original core after making a CAT-scan. From that image, the team builds a virtual, three-dimensional model of the rock within the computer, then “runs” virtual “fluids” through the pore spaces to determine flow rates and permeability. What is different are the mathematical equations and algorithms the scientists rely on to create the simulation.

## PERMEABILITY

Three-dimensional CAT-scan rendering of a cut-out (left) and core (below) from carbonate rock.



Hence, they “compute” permeability in a model that simulates and reproduces the properties of the original core sample. Although sophisticated, the CAT-scanning itself is not the key element in the new process. Computer simulation is the key, according to Henrique Tono, Ingrain director and chief executive officer.

“At the heart of what we do is the actual computation of physical properties within the complex pore space. To be able to simulate [fluid] flow through rock in a rigorous way that solves the flow equations through a complex pore space: that’s the heart of what we do,” he says.



At the end of the day, Ingrain’s number-crunching yields more than just permeability. It also calculates porosity, electrical conductivity and elastic properties. Apart from being a faster process than the usual way of measuring rock properties, the Ingrain process is also more accurate, due to the rigour of the methodology, Tono says.

Apart from analyzing conventional cores such as sandstone, Ingrain’s method can also handle shales, carbonates, tight gas sandstones and even oilsands samples. While each sample brings its own challenges for those assessing rock properties, the final, “computed” result is nonetheless reliable, Tono says.

In business since August 2007, Houston-based Ingrain only recently began marketing its service to oil and gas producers in Canada, the United States and elsewhere. Current plans are to open offices in Rio de Janeiro, Calgary and Saudi Arabia. While describing its methodology as commercial, the company nonetheless declined to disclose the names of clients or companies currently using its services. [ntm](http://ntm.com)

— By James Mahony

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