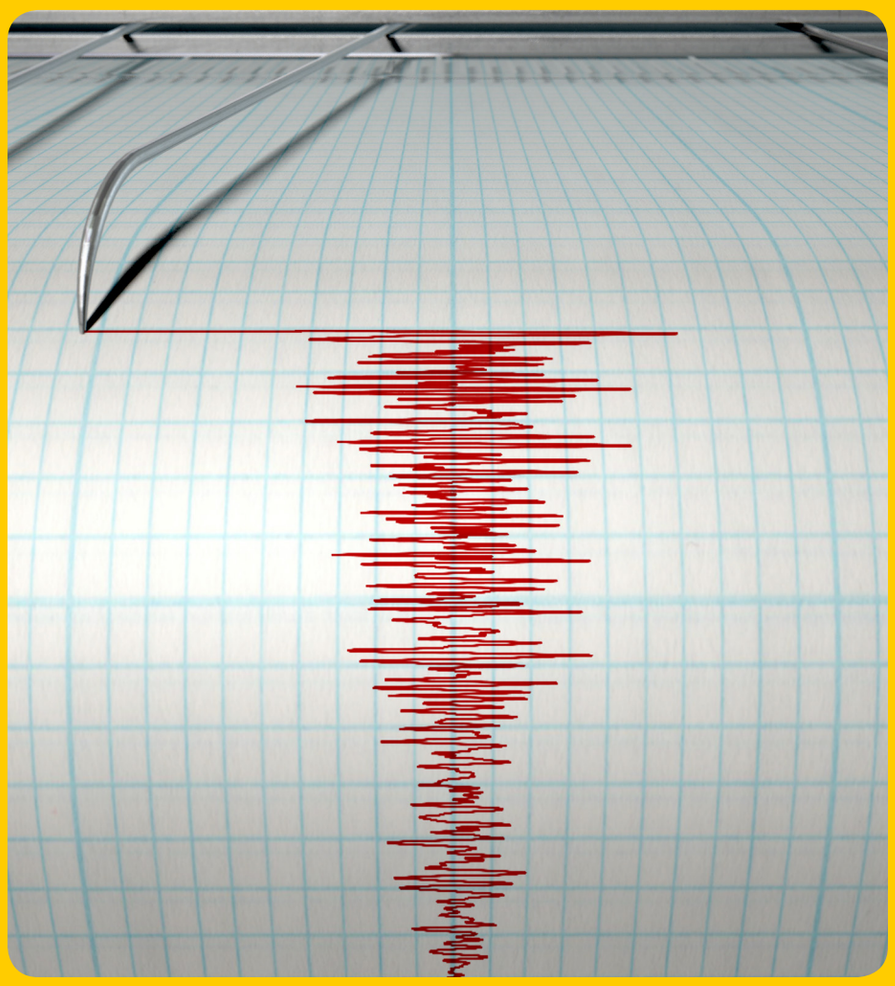
PAWSEY
supercomputing centre

PARTNER INSTITUTION
THE UNIVERSITY OF WESTERN AUSTRALIA



Seismograph machine needle drawing a red line on graph paper depicting seismic and earthquake activity

PROJECT LEADER
PROFESSOR JEFF SHRAGGE

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Main collaborators
Rie Kamei
Toby Potter
Taka Miyoshi

SYSTEM
MAGNUS

TIME ALLOCATED
10,000,000 HOURS

AREA OF SCIENCE
Resources

PRODUCING SAFER CARBON STORAGE OUTCOMES

Associate Professor Jeffrey Shragge, in collaboration with other researchers at The University of Western Australia, is using the Pawsey Supercomputing Centre's resources and expertise to perform large-scale simulation, imaging and inversion of 3D passive elastic seismic wavefields. 3D and time-lapse (4D) seismic imaging are central to the exploration and monitoring the production of Western Australia's hydrocarbon resources as well as achieving a better subsurface understanding in CO_2 geosequestration projects.

2015

LARGE-SCALE COMPUTATIONAL MODELLING OF 3D PASSIVE ELASTIC SEISMIC WAVEFIELDS

THE CHALLENGE

Passive seismology, which uses continuously recorded ambient seismic wavefields without the explicit use of man-made sources, is increasingly becoming an important part of modern hydrocarbon and CO_2 geosequestration projects. Passive seismic imaging and velocity inversion involves processing ambient recordings to determine the internal structure of the Earth and recover estimates of physical properties. Passive seismic monitoring over calendar time can be useful for imaging subsurface fluid flow and revealing subsurface geomechanical alteration.

"These waves have a lot of information about the structure of the Earth, the velocity and other material property parameters of the Earth," says Assoc. Prof Shragge.

According to Assoc. Prof Shragge, while the computation of a numerical solution to a individual wave equation is fairly straightforward, the compact 'stencil' operations used in these solutions have to be repeated many thousands of times over a large grid for industry-scale projects, making the process extremely computationally expensive.

"The key is, without supercomputing we're really inhibited by the scale we can work with.
"These complex 3D and 4D seismic wavefields are a large computational problem and a significant high performance computing issue because we're talking about very computationally expensive kernels, which have to be repeated up to tens of thousands of times."

THE SOLUTION

Assoc. Prof Shragge and UWA collaborators Prof. David Lumley, Dr. Rie Kamei, Dr. Toby Potter and Dr. Taka Miyoshi are using a combination of existing and in-house codes on the Pawsey Supercomputing Centre's petascale 'Magnus' supercomputer.

"We represent our wave equations as very compact 'stencils', which can be shifted around all over our grid," says Assoc. Prof Shragge.

"Because we have these compact stencils combined with very large grids, we can really leverage the parallelism inherent in the Pawsey Centre computing architecture."

This approach, combined with the processing power of Magnus, allows researchers to simulate realistically sized 3D models.

"One of the key things is just the scale of the cluster is allowing us to move fully into 3D active- and passive-source imaging and inversion. In order to be really relevant to local industry, we have to be able to do these things in 3D, as the world is inherently 3D and complex," says Assoc. Prof Shragge.

OUTCOME

By being able to simulate realistically sized 3D models, Assoc. Prof Shragge and his collaborators can provide more detailed and accurate information to support projects like the National Geosequestration Laboratory (NGL), a collaboration between UWA, CSIRO and Curtin University that enables research and development of commercial-scale carbon storage options for Australia.

**"The other thing is that we have a lot of partnerships through our UWA:RM (UWA Reservoir Management) Research Consortium consisting of industrial sponsors," says Assoc. Prof Shragge.
"A lot of the research that we do, we collaborate closely with our industrial partners in terms of solving advanced seismic imaging and inversion problems. Largely, this is focused on the North West Shelf of WA and the oil and gas fields there.**

**"A lot of the practical benefits come from working closely and the technology transfer to local, national and international industry."
Assoc. Prof Shragge says access to the Pawsey Centre allows public institutions like WA to deliver internationally competitive results.
"Machines like Magnus are enabling technologies that allow us to do what we know we need to."**