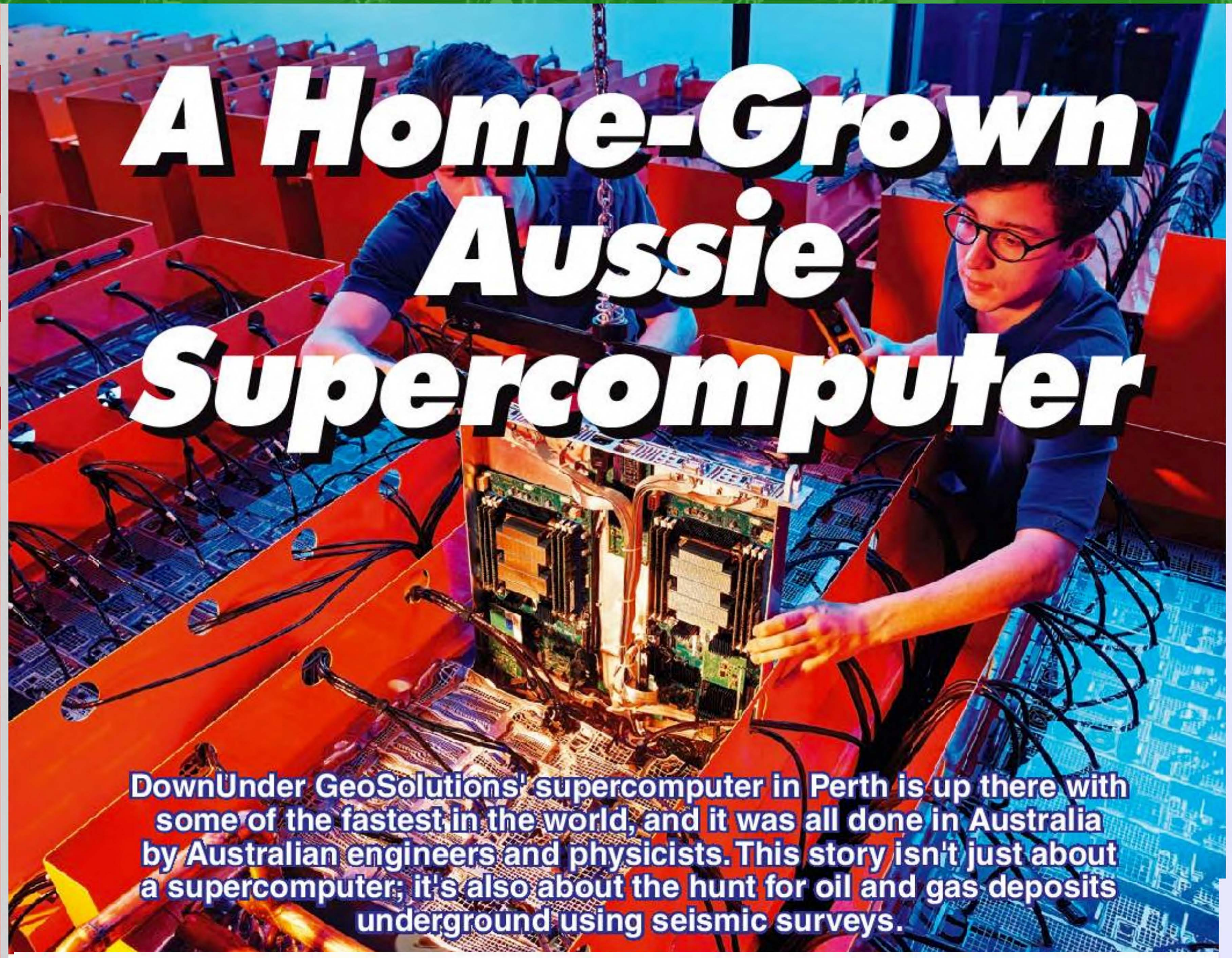
A Home-Grown Aussie Supercomputer



DownUnder GeoSolutions' supercomputer in Perth is up there with some of the fastest in the world, and it was all done in Australia by Australian engineers and physicists. This story isn't just about a supercomputer; it's also about the hunt for oil and gas deposits underground using seismic surveys.

It might not always be apparent but the power of computers, and supercomputers in particular, is growing at a staggering pace.

Three years ago, in the July 2015 issue, we reported on the Pawsey Supercomputing Centre in Western Australia that housed Magnus, a supercomputer capable of 1.6 petaflops (1.6 million billion floating point operations per second) – see siliconchip.com.au/Article/8704

But it has already been overshadowed by a home-grown computer built by DownUnder GeoSolutions (DUG) also in Perth, Western Australia, which has a theoretical speed of 22 petaflops. That's 22,000,000,000,000,000 calculations per second!

Since the two computers are optimised for different roles, it's difficult to directly compare them. But by any measure, the DUG supercomputer is very fast. And it was built in-house at a fraction of the cost of the Pawsey facility.

It's hard to get your head around how much computing power a petaflop represents.

Think of it this way: the DUG supercomputer does its calculations about a million times faster than your desktop computer could. So a calculation that would take the supercomputer one minute would take two years on your computer.

To build a supercomputer of this power, you need to be innovative. DUG are using standard hardware with Intel's top-of-the-line processor designed for cluster computing, the Intel Xeon Phi.

What's innovative is that these are submerged in huge tanks of dielectric fluid which draw the heat away while providing near-perfect electrical insulation.

By Geoff Graham

If you have a limited budget, you also need to be pragmatic, so the Intel chips are mounted in standard server racks (immersed in the fluid) and a standard 10Gb/s network is used to interconnect them. This is all housed on the ground floor of an ordinary office building in West Perth.

DownUnder GeoSolutions specialise in analysing geophysical seismic data and, using their enormous computing power, they can generate accurate three-dimensional maps of the rock strata under the surface.

These allow geoscientists to precisely locate possible oil and gas deposits, potentially saving hundreds of millions of dollars in failed drilling attempts.

Seismic Surveys

The technology behind seismic surveys is just as interesting as the supercomputer used to process the data. In simple terms, sound waves are created in the rock and the reflections (or echoes) from the layers under the surface are recorded. This can be done on the ocean or on land and the work that DUG does is evenly split between the two.

A marine survey involves an ocean-going survey vessel towing multiple lines of hydrophones behind it. These are called streamers and there could be up to ten streamers, each up to 12km long, with as many as 10,000 hydrophones being towed.

Every ten seconds, a sequence of air guns on the rear of the boat fire, creating a shaped sound wave through the water. When this wave hits the sea bottom, part of it travels through to the various rock layers underneath and on hitting them, is reflected back to the hydrophones.

Considering the huge number of multiple reflections from the ocean bottom and rock layers, and that there can be up to 10,000 hydrophones, and that this repeats every ten seconds, you get a sense of the mass of data that is recovered.

A full survey can take months of continuous seismic shots so the DUG supercomputer must process hundreds of terabytes of data and condense it into something meaningful.

This is why they needed to build one of the fastest supercomputers in the world. Even with their awesome computing power applied to the task, processing the data from a single survey can take months.

A land survey typically results in a smaller data set but it can require more intense number crunching. In this case, microphones are planted in the soil and a truck will thump (or vibrate) a huge iron plate placed on the ground. The ground reflections are recorded and the truck moves a short distance to thump again.

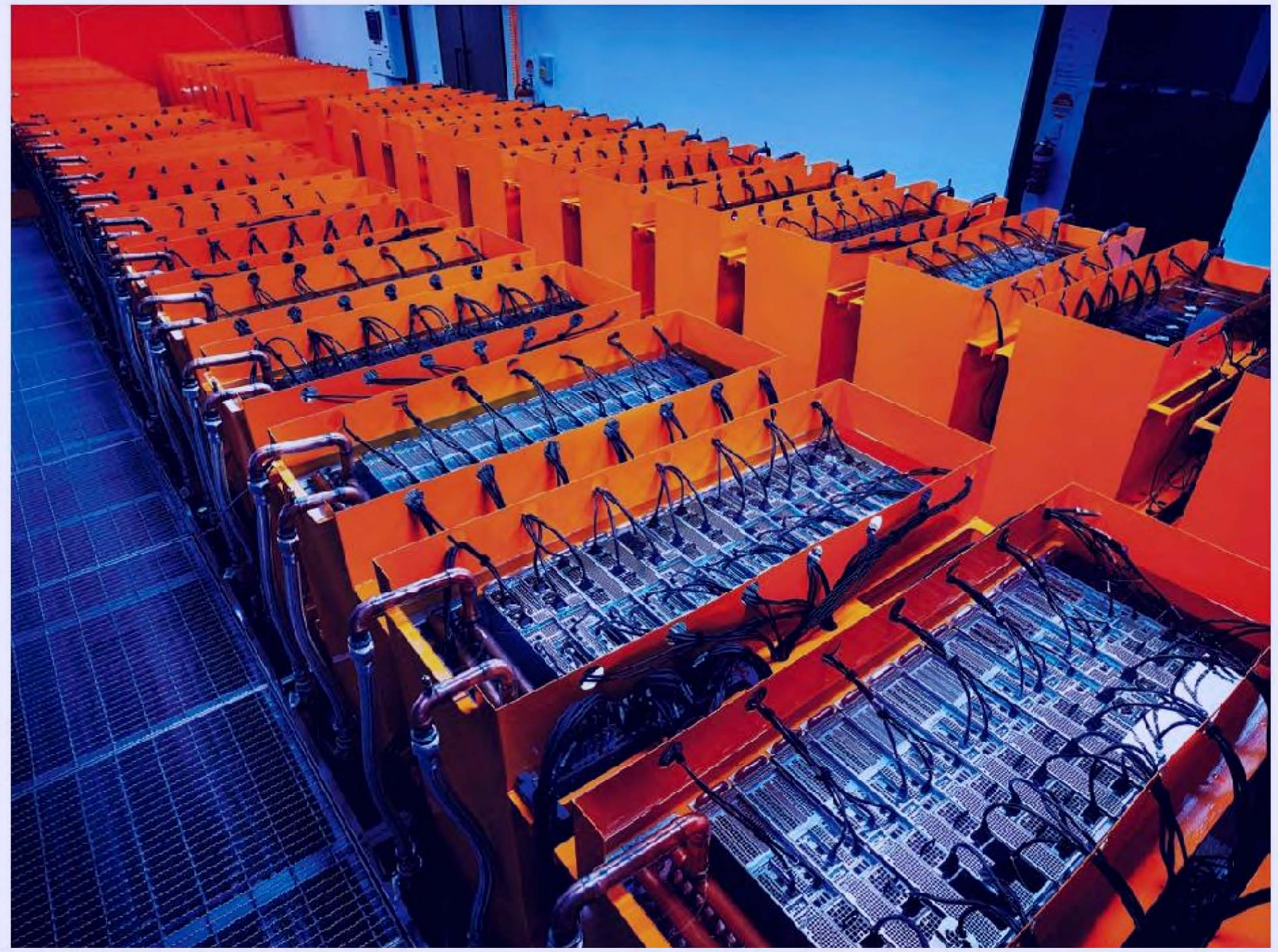
Land surveys generally cover a small area but the density of data recorded can be very large so these also take a lot of supercomputing time to process it.

Processing the data

Because of the amount of data involved in a survey (hundreds of terabytes up to a few petabytes), it is not feasible to transfer the data over the internet or communications lines.

Instead, it is recorded onto many tape cartridges of up to 10TB each and couriered to the processing centre. You could call it an alternative high-bandwidth network (often referred to as a "sneakernet"!).

The first task is to eliminate noise in the data created by ocean waves, wind, surface conditions etc and specialised software routines are used for this.



Each of the DUG supercomputer facility's fluid-filled tanks hold up to 80 rack-mounted high-performance servers. At the left end of each tank, you can see the heat exchangers which transfer heat from the dielectric fluid to circulating water which dumps the heat into the atmosphere via radiators, cooled by evaporating water. *Credit: DownUnder GeoSolutions*