Heard the rumour about the demise of Australia’s natural resources boom? As the Chinese and Indian economies slow, doomsday economists have expressed fears the bonanza is over.

But the signs at UNSW are showing the opposite. Industry is requiring more mining and petroleum graduates than we can supply, new chairs and links with industry are being established, and vital research is barrelling ahead in areas of hard-to-access resources, new mapping and positioning techniques, and long-term sustainability.

“There were a couple of articles in the financial media recently that said the resources boom was over – that things were going off the boil,” says Professor Bruce Hebblewhite, Head of the School of Mining Engineering. “But that is not the case. Yes, economies around the world are slowing and yes, that means that mining companies are probably pausing and taking a more considered point of view as to whether they should jump into a new project. But it’s not at all an end to the boom – it’s a slow-down and probably a very necessary slow-down.”

Bruce says one of the key indicators is that the school currently has the largest number of students ever – with 274 undergraduates and 276 postgraduates – and industry demand for graduates is still increasing. “We know that the current national supply is way short of demand. Even if you factor in the reduced projections by 10, 20, 30 percent, we’re still way short of the target.”

The School of Mining Engineering is aiming to increase intake numbers by 50 percent (to about 100 per year) by 2014. “Australia last year graduated 225 new mining engineers. And the industry’s projection is that they need 450–500 graduates a year.” One of the ways the school is addressing this shortage is postgraduate courses for civil engineers, geologists, surveyors and mechanical engineers who want to enter the mining industry.

Professor Val Pinczewski, Head of the School of Petroleum Engineering, says the petroleum industry is experiencing an even bigger boom than mining. “The investments currently being made in developing Australia’s conventional gas and coal-seam gas reserves are some of the biggest resource investments in the history of the country and are set to make Australia one of the world’s largest liquefied natural gas exporters, if not the biggest,” he says. “With massive emerging economies in China, India and South-East Asia, the demand for energy is expected to increase significantly over the coming decades and the massive investments in the development of gas both in Australia and worldwide are aimed at addressing this demand.”

Val says Australia is well on the way to becoming a “gas economy”. “All you are currently seeing is increasing oil prices, which is creating opportunities for other alternative energy sources. If you look at the financial pages to see where investment is going you will see that the major alternative is gas. At current projected rates of consumption Australia is estimated to have sufficient gas reserves to meet its energy needs for at least a few hundred years. Most of this gas will be exported and this will have a massive impact on Australia’s economy over the coming decades.”

We’ve got gas

In July this year, Professor Bob Clark was appointed Professor and Chair of Energy Strategy and Policy at UNSW. His primary task is to explore the potential of Australia’s deep shale gas reserves. In the USA, shale gas has been tapped for some time and Bob says Australia’s resource is huge, found 1–4km underground, primarily in the Canning, Perth, Cooper and Otway basins.

“On paper, there’s 400 trillion cubic feet sitting there – the largest gas resource we have,” he says. “It may be that there is twice as much as that. Or half as much as that due to recoverability issues. We don’t know. You’ve got to get in and find out. But at first blush, if we were going to supply Australia with shale gas, it would supply our gas needs for 400 years.”

Formerly the Chief Defence Scientist of Australia, Bob describes
himself as a “complex problem solver” and says his role is “to provide frank and fearless advice to the government”.

“First I have to understand the nature of Australia’s end-to-end energy and its security in both a carbon-constrained economy and a global context, and then, within that framework, drill down deep to look at shale gas in the mix. Can we better gauge our capacity and can we extract it? Is it economically feasible to do so? Can we put in place environmental safeguards that will provide public confidence? How will it contribute to reducing our CO2 emissions in the medium term? How does it fit in with clean energy programs?”

Bob says he is working to understand how shale gas could fit into Australia’s entire energy mix.

“I can’t look at shale gas and say ‘renewables are not my problem’, ‘nuclear is not my problem’, ‘coal is not my problem’. I think, ultimately, like everything in life, things are a compromise. There needs to be an evolutionary transition to renewables. It’s not going to happen tomorrow. Meanwhile, I am concerned about our CO2 emissions, but I’m not taking a zealotry passage on the path to renewables.

“For electricity production, 2011 Australian Treasury projections map a reduction in emissions intensity from 0.85 down to below 0.2 tonnes of CO2 per megawatt-hour by 2050, to meet our goal. Conventional gas-fired power plants can play an important bridging role down to the 0.4 tonnes CO2/MWh level.

“I believe it is very important for a mature nation to understand its resources – why are we leaving this in the ground? Equally, in a situation where Australia is ‘awash’ with gas, why would we pull it out?

“If I find it is environmentally better than coal-seam gas, and it gets jobs and manufacturing industries in Australia, it still doesn’t mean Australia is going to do it, but it means we’re getting a better understanding of the resource. It’s all going to be down to economics at the end of the day – can we make a buck?”

For more than 20 years Professor Sheik Rahman, in the School of Petroleum Engineering, has been a passionate proponent of using Australia’s geothermal resources – underground rocks at temperatures of 300–350°C – for power. “It can support all of Australia’s energy needs for hundreds and hundreds of years,” he says. However, geothermal power is currently too expensive to produce, by a factor of 10, and so he is working on improving hydraulic fracturing – advances that will hopefully bring the cost of geothermal power down,
but will also help access the shale gas resources. “Currently, jacking apart fractures takes a huge amount of energy,” Sheik says. “We need a better understanding of the geometry of fractures.”

Mine craft

Meanwhile, another chair has been established at UNSW with Rio Tinto/Northparkes. “That chair will develop and lead a growing research team in regards to the geotechnical issues of block caving,” Bruce says.

Block caving is a relatively inexpensive underground mining technique suitable for mining many large, low-grade ore bodies. It relies on natural breakage and fragmentation to get the rock continually dropping down into the recovery zone, where it is extracted. “The research challenges are in terms of rock characterisation, design and planning – how do you get continual and consistent rock breakage in a controlled manner?” Bruce says. Broad adoption of the block-caving method will require greater automation of loaders and other equipment to ensure the safety of personnel.

Bruce says there are many technical challenges as industry attempts to access resources in difficult areas. Mines are getting deeper, and a number are now near or under major existing infrastructure and townships. “There are some difficult or marginally economic mineral deposits that people might have walked away from 20–30 years ago,” he says. “In order to consider mining such deposits today we need better safety, better technologies, better predictability and better support systems.” Bruce points to the work of people such as Associate Professor Serkan Saydam and Dr Paul Hagan in the School of Mining Engineering, who are working on preventing catastrophic failure of mining bolts used for support underground, as well as some of the latest work being done with mapping and imaging, which will help with safety and the monitoring of mining’s effects.

Associate Professor Linlin Ge, in the School of Surveying and Geospatial Engineering and Dr Simit Raval from the School of Mining Engineering work in the Laboratory for Imaging of the Mining Environment (LIME). The laboratory is developing technologies that use images and information from satellites or small, low-flying unmanned aeroplanes to accurately pinpoint many aspects of a mining operation – such as surface subsidence, environmental impacts such as earth movements caused 5km away from the mine, accurate surveying of huge stockpiles, which would be too dangerous or time-consuming for a human surveyor, or surveying in rough terrain such as the Blue Mountains, NSW.

“We’re using innovative technologies to provide mining companies with better intelligence,” Linlin says. “We provide them with feedback and say ‘this is what you’ve done, and this is the impact’.”

By taking multiple images from different angles, the technology can now identify horizontal movement as well as vertical subsidence.

LIME has been approached by the Federal Government to look at the impact of fracking, as well as how much the
ground uplifts during CO₂ capture and storage. Linlin says one of the interesting potential uses of optical satellites is to study how vegetation changes in an area where CO₂ has been stored underground – the vegetation can be a visual clue to detect if the CO₂ is leaking.

Associate Professor Christoph Arns, in the School of Petroleum Engineering, is using complex imaging equipment, such as magnetic resonance and computed tomography scans, to gain more accurate and efficient models of underground geological structures. “It reduces the amount of testing, and reduces the amount of uncertainty,” he says. “We know more about what’s in space than what’s under the ground. But now if I have fancy rock, with different rock types, I can accurately work out what they are and how this affects physical measurements.”

On a mine site, rapid 3D mapping of the whole environment is becoming increasingly valuable. Professor Chris Rizos, Head of the School of Surveying and Geospatial Engineering, is quick to point out that although rapid mobile mapping wasn’t developed specifically for mines, the fact that a mine is such a dynamically changing environment makes it ideal for the technology. “In a mine you are digging up many, many tonnes per hour. That’s significantly changing your topography. Nothing is static.”

He says ultimately each mining machine will produce new mapping information while they are operating, and real-time information will be fed back to each machine. “Then it becomes a tightly coupled loop. The machines know where they are, but in addition they can work out where everything else is – where faults are, the ore body, other machines – they are getting a sense of the environment as they map the terrain,” Chris says. “The technology is already there to do this, and the new generation of mines will be implementing them as they come on stream.”

Another long-term project that Chris has been part of is the augmentation of GPS with Locata. An Australian company, Locata Corporation and UNSW have had an ongoing productive relationship for more than a decade, developing, refining and testing the technology. With a dozen mobile stations positioned around a mine site, they can provide centimetre-level accuracy positioning information in areas where satellite signals can’t reach. “So now you don’t have to trade off accuracy with availability of signal,” Chris says. “Immediately you can move drills and trucks to areas where they couldn’t get a signal before.”

Such advanced positioning will prove vital as the industry moves to more automation and remote mine operations, moving personnel away from the more hazardous zones. In the Pilbara at the moment, the West Angelas Rio Tinto mine is trialling remotely controlled automated machinery, with most personnel based in a Perth operations centre.

Bruce Hebblewhite says this will be the way of the future. “It doesn’t necessarily mean fewer personnel, but more effective and smarter use of personnel in a safe work environment. Moving people away from the more hazardous zones in a mine is a bigger driver than simply looking at any labour costs that might accrue.”
He says that the industry is also likely to see an increasing use of high-powered, high-capacity conveyor systems rather than relying as much on trucking for transport. This will mean there will need to be improvements in rock-breakage systems to create more easily handled material.

**Sustainability**

“The power of the community has been one of the most significant changes in mining in the last decade in both the developed and developing world,” says Associate Professor David Laurence, Director of the new Australian Centre for Sustainable Mining Practices, in the School of Mining Engineering at UNSW. “The obtaining of the ‘social licence to operate’ will become more and more critical in the next few decades.”

David says that the Centre is researching a wide range of issues in sustainable mining, including better mine closure modelling, improved environmental and social impact assessment using visualisation and virtual-reality platforms, and investigating the impact of coal-seam gas extraction on aquifers.

“We’re very interested in working on issues in Australia such as environmentally responsible mine development and the balance of corporate social responsibility,” says Research Director of the Centre, Professor Ros Taplin.

In July last year, the Centre released a handbook of sustainability guidelines for the industry that has been endorsed and distributed by the Federal Government. “And the invitation for David to be on an interim advisory panel for the Federal Government working group on coal-seam gas is an acknowledgement of the Centre’s role,” she says.

Ros emphasises that independent researchers, such as those at the Centre, have a vital role in informing and shaping the debate about our resources. “The scientific contribution in the coal-seam gas debate is very important – there’s a tendency for the debates to become polarised.”

She highlights seabed mining and the impact mining has on aquifers, as two of the big issues the Centre will continue to address. “There’s a whole host of issues that we are really keen to look at though – and we’re keen to expand in 2013 with new PhD students.” Currently there are 10 staff and students working in the Centre.

Its reputation is already established overseas and David has been running short courses in Mexico and Peru on leading practices in sustainable mining. “That’s pretty exciting,” Ros says. “The South American impact of the mining boom means that the leading practice on sustainable mining is coming from Australia. Our work goes beyond Australia to Asia and Africa and South America.”