Chief Scientist

AUSTRALIA 2025: SMART SCIENCE

THE CONVERSATION

We live in a 'wide brown land' – but we need to figure out how to use it sustainably. Duncan Rawlinson, CC BY-NC

Groundbreaking earth sciences for a smart – and lucky – country

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AUSTRALIA 2025: How will science address the challenges of the future? In collaboration with The Conversation we're asking how each science discipline will contribute to Australia now and in the future. Written by luminaries and accompanied by two expert commentaries to ensure a broader perspective, these articles run fortnightly and focus on each of the major scientific areas. In this instalment we delve into earth sciences.

It is difficult to think of an area of our lives that is not touched by the earth sciences – whether it relates to the energy used to fuel our vehicles and homes or the natural disasters that dominate the evening news, to the dependence of our daily lives on weather forecasting or the precious metals used in electronic devices – to name a few.

Australia is richly endowed with mineral and energy resources and our economy depends heavily on the ease with which we can mine wealth from the earth.

The opening words of the final chapter of Donald Horne's 1964 book The Lucky Country read:

"Australia is a lucky country, run by second-rate people who share its luck."

I don't know about you; I don't mind being lucky, but I'd much rather be smart than second rate.

The Australian mining community knows that there are no more easy pickings at the Earth's surface in Australia – any remaining world-class ore deposits lie beneath the Earth's surface – so we now need to be much smarter, and apply a diverse range of skills and tools in order to explore and exploit the sub-surface.

Coober Pedy opal mine. Georgie Sharp/Flickr, CC BY-NC

In other words, we can no longer rely on luck.

We need to be a smart country – even if we want to continue to base much of our economy on mining – or face the risk of being second rate.

I use the example of mining because it is the most obvious way that earth resources contribute to Australian economic prosperity. It is widely recognised that advanced economies must transition from dependence on natural resources and physical labour to knowledge economies that are based on intellectual assets and know-how that are used to create wealth.

How well is Australia tracking in this transition? While we dig wealth from the ground, we are also a leading supplier of mining technologies and services to other countries.

Not only are we China's mine, but Australian revenues from education, which includes a large contribution from educating China's growing and increasingly affluent middle class, makes education the largest service export industry in Australia.

Flexing our geoscientific muscles

We are doing quite a few things well, but we are in a competitive world and complacency won't help. We still depend heavily on a finite natural endowment and need to continue along the path of transitioning to a knowledge-based economy.

How can the earth sciences help Australia in this journey? Just as geological and climatological phenomena touch so many areas of our lives, their widespread importance also means that the earth sciences can contribute significantly to Australia's ongoing security and prosperity. Let me give just a few examples.

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Geoscientific expertise has been central to the discovery and extraction of fossil fuels that have driven global economic transformation since the industrial revolution.

Our economy is addicted to carbon and will remain this way for some time to come despite the fact that we need greener and cleaner energy. Knowledge is key to this necessary transformation.

Capturing and storing carbon emissions is technically challenging, but knowledge of the underground reservoirs that held hydrocarbons for millions of years is now fundamental to understanding how to store captured carbon into the future.

Geoscientists must work closely with engineers and others to achieve this ambition. In the meantime, increasing the efficiency of hydrocarbon extraction is key to keeping energy costs down.

Australian physicists, chemists, mathematicians and engineers have combined forces to develop three-dimensional imaging technology to visualise the tiny pore spaces between sediment grains in rocks, which is important for enhanced extraction of oil and gas from their natural reservoirs.

This Australian know-how has recently attracted major international investment that will accelerate use of this clever technology in the global hydrocarbon industry.

Known unknowns

Australia is one of the more geologically stable parts of our planet. But our neighbours to the north, who have rapidly developing economies, live with the daily threat of geological hazards, including volcanic eruptions, earthquakes, tsunamis, and landslides. Our geological know-how has the potential to benefit the quality of life and economy of our neighbours.

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How? Through helping to monitor, assess, and potentially forecast and mitigate risks to populations that increasingly live in mega-cities that are often highly vulnerable to natural hazards.

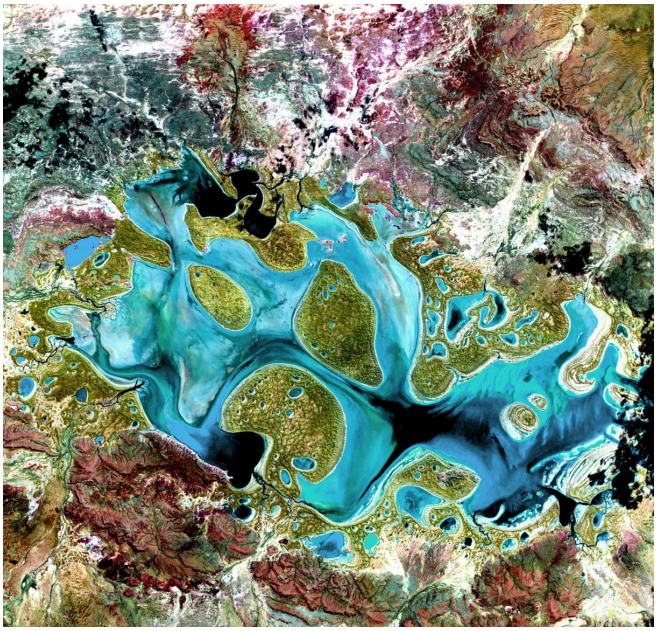
What about our climate future? How will rainfall change regionally around Australia as a result of ongoing climate change? How will this affect water resources and agriculture? How fast will sea level rise and how will this affect coastal infrastructure, property values, and long-term investment strategies?

Even climate sceptics must recognise that increasing atmospheric carbon dioxide emissions will lead to greater acidity of the oceans, which will cause the skeletons of corals to dissolve.

How will this affect Australia's outstanding natural resources and the tourist economy associated with the Great Barrier Reef? How will this affect food chains and marine resources, including fisheries? The climate system is complicated and there is much to learn about its workings – ongoing research is needed.

Knowledge of the climate system, and of the natural and human-induced factors that cause it to change, is crucial to most sectors that contribute to the economy. Climate science will increasingly influence investment decisions, infrastructure planning, and insurance premiums.

Smart, collaborative and hard working



Lake Carnegie, WA. NASA, CC BY.

In all of the above examples, Australia is well placed to rise to future challenges and is endowed with outstanding talent in the earth sciences – in the university sector, federal and state agencies and industry.

I am a believer in the extraordinary ingenuity of the human species and our ability to devise solutions to tough problems. I have seen enough to make me optimistic about the ability of the earth sciences to continue to contribute to wealth creation in Australia.

But is this enough? Increasingly, in knowledge-based activities, any single company or institution lacks the complete range of expertise needed to solve key problems.

Cooperation across such boundaries is increasingly needed, including better interactions between industry and academia, with development of productive long-term, strategic relationships.

We also need to develop a more advanced innovation system – in which there are strong incentives for interaction among these various actors to transform ideas into marketable processes, products or services.

These challenges are considerable and international competition is great. We need to be smart, collaborative and hard working, not just lucky, much less second rate, to make the most of our intellectual assets to drive the future prosperity of Australia.

Mike Sandiford

As Andrew points out, the prerequisite for meeting the many challenges of sustaining prosperity is a more detailed knowledge of the earth system. But I suggest we also need a new way of framing the purpose of that knowledge, in recognition that our species is no longer just an innocent bystander to the earth system.

Bruce Irving/Flickr, CC BY

As a geologist I find no starker illustration of this than in the realisation that human society is currently headed to a primary energy consumption rate of 44 trillion watts by 2060.

This is the average rate of energy transferred by plate tectonics each year – the process that makes the planet's mountains, volcanoes and earthquakes.

With around 90% of human energy needs sourced from fossil fuels, meeting the challenge of how to secure the prospects of both present and future generations will require a much better understanding of the implications of our use of such resources.

In this context, the perspective of earth scientists will be essential to help reconceptualise our relationship with the planet and its resources. I suggest earth scientists should follow the lead of their colleagues in ecology, who have long framed their thinking about functioning of ecosystems in terms of services.

By explicitly branding such services we are able to attribute value to them, focus on threats and limitations, and evaluate trade-offs between immediate and long-term needs for such services. I see a key challenge is rethinking our planet as the essential service provider, including not only the biosphere but also the atmosphere, oceans and lithosphere.

Katy Evans

There are two fundamental attributes of geologists that will prove essential as we make the transition from a planet that absorbs human activity to one that is affected by it.

1. A geologist's comprehension of time is honed by the study of processes that operate over timescales that last from seconds to hundreds, or even thousands, of millions of years. This sense of time is complementary to that of politicians, whose timescale, of necessity, is bounded by a ticking time bomb set to go off at the next election. We all need to practice a geologist's sense of time if we are to understand the implications of our ability to change the planet.

2. Geology involves appreciation of, and compensation for, missing and uncertain data. The geological record is never complete, and the geological record is like a photograph album where the photographs have been stacked, superimposed, and put through a washing machine. As humans change natural systems to unprecedentedly large degrees and with unprecedented rapidity, the capacity of geologists to operate sensibly in a data-sparse environment will prove increasingly valuable.

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We need geologists, not only to answer the practical and immediate questions posed by the planet, but also to understand this astonishingly beautiful and complex Earth sufficiently well that we can head towards the brightest possible future.