School of Minerals and Energy Resources Engineering

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RESEARCH CAPABILITY AND FACILITIES

UNSW SYDNEY

Contents

About UNSW

Research Excellence

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> $300M+ awarded across 208 research grants in 2024

> 12,826 research publications in 2024, 59% from international collaborations

> 4425 higher degree research candidates in 2024

UNSW, Australia's Global University

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Vision

UNSW Sydney is a world-leading university known for driving progress that benefits everyone.

Collectively, we aim to make a positive global societal impact, improving and transforming lives through excellence in research and outstanding education.

Values

In pursuing the University's vision to make a real difference, members of the UNSW community will demonstrate:

- Partnership: working in teams to best serve our communities.
- Integrity: transparency and ethical decision-making, inspiring openness, courage, and trust.
- Respect: listening and engaging with each other and our communities.

An international influencer in education

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UNSW is a leading education and research-intensive university, delivering outstanding teaching alongside cutting-edge research. Established in 1949, UNSW has a unique focus on the scientific and professional disciplines.

UNSW is one of the world's top 100 universities and has a proud tradition of sustained innovation, focussing on areas critical to its future, from climate change and renewable energies to lifesaving medical treatments and breakthrough technologies. The University aims to make an impact on people's lives globally through excellence in research and education, and a commitment to advancing society. Its research informs policy and expert commentary on key issues facing society.

UNSW is a founding member of both the Group of Eight, a coalition of Australia's leading research intensive universities, and the prestigious Universitas 21 international network. Working in partnership with leading businesses, community organisations and governments, and major universities across the world, the University amplifies its expertise to help solve the world's biggest issues, whilst developing innovative solutions and emerging cutting-edge technologies.

Fast Facts

> 6 Faculties
Arts, Design & Architecture
Business School
Engineering
Law & Justice
Medicine & Health
Science

> 1 College
UNSW Canberra

> 45 Schools

> 57 Centres and Institutes

> 4100+ beds on campus

UNSW at a glance

Australia's Global University

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> 82,272 students
> 43,839 Domestic
> 38,433 International

> 4425 Higher Degree Research Candidates

> 3610 Academic staff

> 4708 Professional staff

> 404,000+ alumni in 165 countries

20th
in the world
2026 QS World University Rankings

83rd
in the world
2025 THE World University Rankings

12th
globally in the 2025 QS Sustainability Rankings

80th
2025 ARWU (Academic Ranking of World Universities)

UNSW Engineering

UNSW Engineering is Australia's largest engineering faculty, producing the most graduates and having the greatest breadth of research and education opportunities. The Faculty is a powerhouse of innovation in Australia and the region, housing more than 800 researchers and educators, and expertise across eight schools of engineering, 36 research centres and three institutes. It is home to state-of-the-art facilities valued by industry and our world-leading academics.

Since its inception in 1949, UNSW Engineering has a proud history of developing technologies that have a world-changing impact including membranes for water filtration, bionic eyes, soft contact lenses, quantum computing, and silicon solar photovoltaics. UNSW Engineering achieves the level of impact in translating research into real-world solutions by working closely with industry.

UNSW Engineering **ranks 1st for Engineering Faculty** in Australia and **25th for Engineering Faculty** in the 2025 QS World University Rankings. Under QS Rankings, Times Higher Education World University Rankings and Academic Ranking of World Universities, the disciplines within the Faculty of Engineering are consistently ranked in top place in subject rankings in Australia.

UNSW Engineering offers industry innovative solutions by drawing upon extensive expertise from leading experts and specialists across the eight schools of engineering:

> **School of Minerals and Energy Resources Engineering**

> School of Chemical Engineering

> School of Civil and Environmental Engineering

> School of Computer Science and Engineering

> School of Electrical Engineering and Telecommunications

> School of Mechanical and Manufacturing Engineering

> School of Photovoltaic and Renewable Energy Engineering

School of Minerals and Energy Resources Engineering

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The School of Minerals and Energy Resources Engineering is a leading provider of innovative world class engineering education and research for more than 75 years. The School continues to thrive with highly sought-after undergraduate and postgraduate programs, along with an increase in our internationally acclaimed research output.

From the bronze age to the digital age, minerals and energy resources have always played a critical role in the evolution of humankind – from farming to space technology. As we transition to a more sustainable way of life, minerals and energy resources have taken on a new, innovative role in shaping our future.

At the School of Minerals and Energy Resources Engineering, we cultivate changemakers and immerse them in experiences that few have the opportunity to explore. Whether it's discovering the lithium that powers electric vehicles, leading sustainable geoenergy exploration and development, investigating methods for carbon dioxide and energy geostorage, or developing technology to extract water and minerals from the Moon and Mars, we are at the forefront of innovation.

Where others see a limited resource, we have the imagination to see further and bring new life to those essential things that cannot be grown. We generate ideas and technologies that will continue to inform how society uses and thinks of energy, minerals, and resources into the future.

1st in Australia
Mineral & Mining Engineering, QS Subject Rankings 2025

2nd in the World
Mineral & Mining Engineering, QS Subject Rankings 2025

About the School

The School of Minerals and Energy Resources Engineering has a long-standing history of technological advancements and fundamental insights, developed in collaboration with the Australian petroleum and mining industries—two of the nation's largest economic drivers. Our school is uniquely positioned to tackle the grand challenges of the 21st century by integrating cutting-edge technologies and innovations that ensure safety, protect the environment, and meet the growing demands for energy and minerals.

We continue to drive the national agenda across the breadth of Minerals and Energy Resources Engineering, enhancing the quality of life for humanity in a sustainable way.

This brochure outlines some of the key challenges relevant to mineral and energy resources engineering and highlights our commitments to address them through research.

Research Facilities

> **Advanced Visualisation Lab**
Virtual reality and augmented reality technologies for site operations, including a hologram table/wall.

> **Tyree X-ray**
X-ray computed microtomography for rock/materials characterisation and quantification.

> **Space Resources Environmental Analogue Facility**
Extreme environment testing facilities, including Dirty Thermal Vacuum Chamber, an indoor Moon Yard.

> **MIoT & IPIN Lab**
Integrated technologies for Mine Internet of Things and Indoor Positioning Indoor Navigation.

> **Low-Field NMR Laboratory**
Nuclear Magnetic Resonance (NMR) characterisation of fluids and transport in porous media.

> **Multiphysics Geomechanics Laboratory**
Analysis of mechanical, thermal, hydraulic, and chemical processes affecting rock deformation.

> **Petrophysics Laboratory**
Core flooding equipment for the study of flow and transport in rocks.

> **Mine Geomechanics Laboratory**
Equipment to study the mechanics of rocks and materials at mining conditions.

> **Mineral Processing Laboratory**
Design and development of innovative technologies for the advancement of mineral separation.

> **Advanced Geochemistry Laboratory**
Electrochemistry and hydrometallurgy related to extraction of minerals from ore bodies.

> **Underground Ventilation and Environment Laboratory**
Optimisation of air movement and underground work environment for mine sites.

> **Clean Energy Transition Lab**
Power to X facility including low-carbon and renewable fuel production using electrolyser technologies.

> **Laboratory for Imaging of the Mining Environment (LIME)**
State-of-the-art sensing facilities including multispectral, hyperspectral, LiDAR and LIBS sensors providing capabilities to monitor land (displacements), water (pollutants), vegetation (rehabilitation) and air (greenhouse gases)

Our Vision & Commitment

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The School of Minerals and Energy Resources Engineering (MERE) has the vision to develop fundamental insights that lead to technological advancements, facilitating the discovery and extraction of future minerals and energy resources with minimal environmental impact, increased safety, and improved productivity.

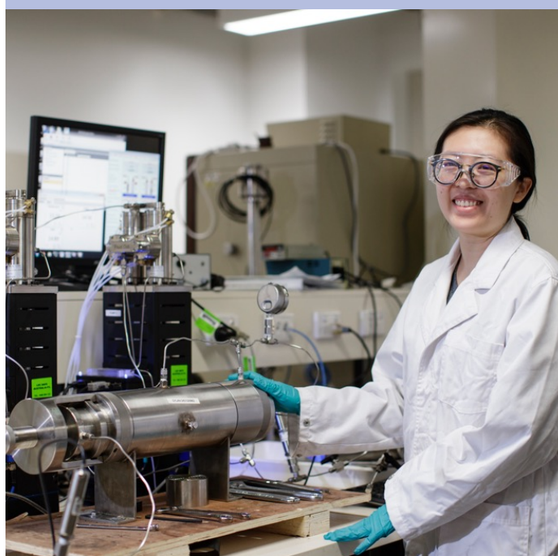
MERE Fast Facts

> 20 Academic Staff

> 18 Professional & Technical Staff

> 15 Postdocs and Research Associates

> $19M+ Research funding



We are committed to:

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Technology development & integration
Advance the uptake of state-of-the-art technologies for minerals and energy resources industry to achieve sustainable technology-integrated operations.

Advance the knowledge of extractive industries
Develop novel mining systems and sustainable practices for mineral separation, waste disposal, mine tailings, ground and surface water interactions, and *in situ* mining approaches.

Reduce the energy footprint of extractive industries
Deploy hybrid renewable energy technologies by co-developing and designing effective solutions for energy transition including deep subsurface storage of CO_2 and geothermal energy.

Development of energy storage solutions
Expand the effective recovery of essential minerals for the onset of renewable technologies and the storage of thermal energy and compressed gas in underground reservoirs.

"An enduring source of energy, minerals and resources for future generations."

Professor Ismet Canbulat, FIEAust, FAusIMM, RPEQ
Head of School

Australia's past and future economic success is undeniably linked to the resources industry. Producing minerals and energy resources is crucial for global socio-economic development and is linked to almost every industry value chain.

As an enabler of technological innovations and knowledge, the School of Minerals and Energy Resources Engineering aims to engage with industries to develop current and future extraction technologies that improve upon current techniques and drive forward future energy and minerals supplies.

Our primary focus is to drive forward technologies that address the growing demand for minerals needed for renewable energy sources, improve the sustainable extraction of resources, and reduce the carbon footprint of the extraction industry.

Our unique approach will bring together expertise from both academia and industry, to address the grand challenges around future energy and minerals supplies and drive sustained economic development.

Our Research Strengths

Geoenergy & Geostorage

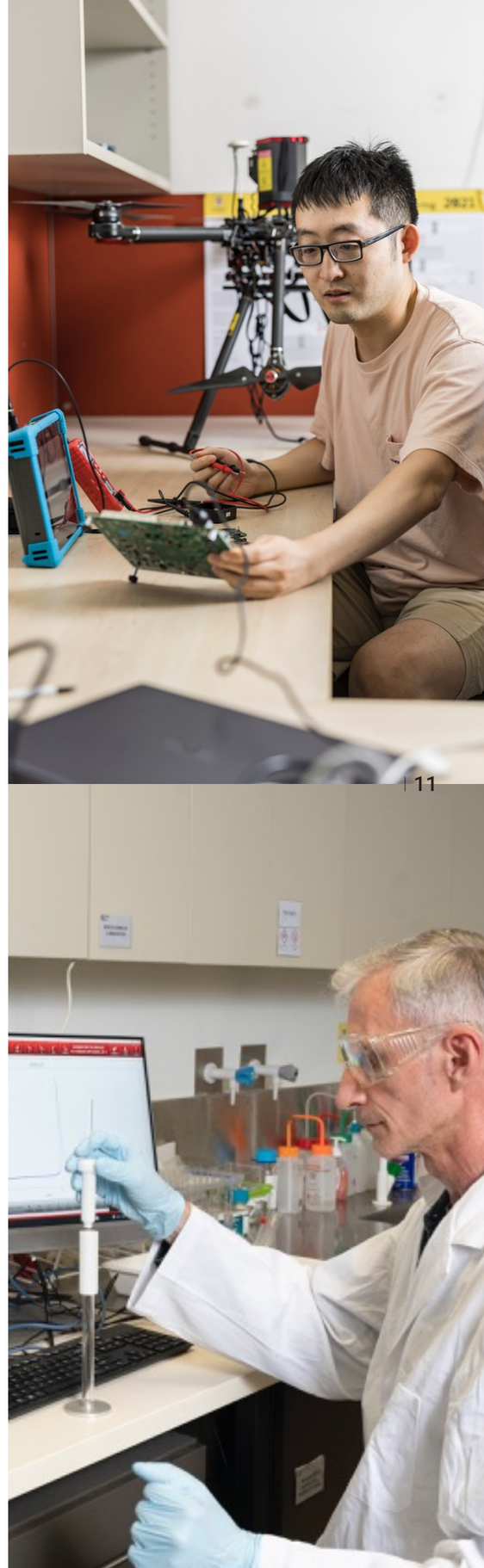
This theme focuses on fundamental and applied research in minerals, energy extraction and storage, with particular emphasis on CO_2 storage and Geothermal energy. Traditional knowledge and expertise in petroleum and mining engineering combined with transformative technologies will drive the development of new technologies for the geological storage of CO_2 and hydrogen, in situ recovery of energy minerals, and geothermal energy extraction.

Strategic Minerals

This theme focuses on sustainable exploration, extraction and processing of strategic and critical minerals (strategic minerals). Our strengths are oriented towards achieving net zero goals for the future. Specific focuses are advanced geophysical and geochemical methods for orebody mapping and modelling to improve orebody knowledge, minimising environmental impact. The theme also highlights the importance of mineral processing technologies in enhancing recovery rates of valuable minerals, efficiently extracting low-grade minerals and rare earth elements, and minimising waste and environmental impact.

Transformative Technologies

This theme focuses on developing innovative technologies to enhance operational excellence and accelerate the transformation of the minerals and energy resources sectors. A key priority is adopting scientific knowledge and emerging technologies from other disciplines and tailoring them to these sectors. This includes advanced ubiquitous sensing, integrated monitoring, digitisation, data analytics, and communication technologies to improve safety, efficiency and environmental sustainability. The integration of these transformative technologies is pivotal in driving the future of the minerals and energy resources sectors towards sustainable and responsible production.



Geoenergy and Geostorage

Our research theme Geoenergy & Geostorage is supported by our multidisciplinary team and state-of-the-art facilities across the university, uniquely positioning us to tackle complex, real-life challenges of the industry. By advancing knowledge in energy extraction, storage, and sustainability, we develop innovative solutions that drive global energy transition to a sustainable net-zero future. The Geoenergy & Geostorage theme integrates cutting-edge research across Multiscale Reservoir Engineering, Integrated Storage and Recovery Systems, and Coupled Geotechnical Systems to address critical global energy challenges.

Integrated Storage and Recovery Systems

Emerging energy technologies require innovative storage and recovery systems. CO_2 geo-sequestration in deep aquifers and hydrocarbon reservoirs is a promising carbon capture utilisation and storage (CCUS) method. The emerging hydrogen economy also provides an opportunity for large-scale hydrogen energy storage in geological formations. Other storage and recovery technologies associated with energy include the safe disposal of waste related to extractive industries.

Our recent projects include fundamental research into understanding and enhancing residual CO_2 trapping, CO_2 modification to improve geostorage in oil reservoirs, co-optimisation of hydrocarbon recovery and CO_2 storage, seal integrity studies, assessments of long-term subsurface storage, subsurface hydrogen gas storage, and waste disposal.

Research Spotlight

Associate Professor Furqan Hussain's research enhances the feasibility of CO_2 geosequestration in heterogeneous and low-pressure formations to maximise storage capacity.

Dr Yu Jing is leading research on characterising fractured formations to gain insights into gas transport through fracture networks for the purpose of optimising CO_2 geological storage.

Coupled Geotechnical Systems

Geomechanics plays a central role in minerals and energy resources engineering. Our integrated approach combines laboratory tests, numerical modelling, and field measurements to analyse rock mass behaviour and ground support optimising design and safety during geostorage and resource extraction. Geomechanics required in recovering various resources drives the need for coupled thermal, hydro, chemical, and mechanical modelling of multiscale systems. Our experts are working on unique physics-based approaches with the integration of data-driven algorithms to guide industry decisions, optimise recovery, ensure safety, and drive innovative approaches for asset management. Applications include gas drainage, CO_2 geostorage, mining impact on groundwater, basin dynamics and exploration studies, in-situ stress estimation, fracture propagation and activation, ground subsidence, and recovery of unconventional resources.

Research Spotlight

Our mining geomechanics team is dedicated to understanding the coupled behaviour of fluid flow and rock mechanics using theoretical analysis, laboratory testing, and numerical simulation, from lab-scale to field-scale challenges.

Professor Hamid Roshan's advanced multiphysics laboratory hosts the next generation of equipment for coupled geomechanics - offering state-of-the-art academic and technical services.

Research Spotlight

Professor Christoph Arns is a pioneer in the area of Digital Rock Physics and specialises in the area of computational pore-scale physics based on tomographic images including the integration of digital and conventional core analysis.

Dr Zhixi Chen is leading research on well stability, drilling fluids, and cementing with a focus on geostorage of CO_2 and future energy storage of hydrogen gas.

Multiscale Reservoir Engineering

Heterogeneity of structure and mineralogy affects reservoir performance at multiple scales. We provide fundamental insights into the physics of flow and transport in multiscale heterogeneous environments and practical approaches to provide predictive models. Our approach considers flow and transport from the nanometre length scale to field scale operations in integrated workflows to provide high-fidelity models for the management of subsurface resources. A key to the approach is the combination of multiscale experiments and numerical simulation for the development of integrated subsurface modelling and characterisation.

Applications include geothermal energy, CO_2 and hydrogen geostorage, natural gas recovery, unconventional reservoirs, colloid and contaminant transport, digital rock physics, and waste storage related to extractive industries.

Strategic Minerals

Our research theme on strategic minerals focuses on the sustainable exploration, extraction and processing of critical minerals and strategic materials to support net-zero goals. We employ advanced non-invasive exploration technologies for orebody mapping and modeling, develop efficient extraction techniques for low-grade minerals, and minimise environmental impact by reducing waste and tailings. Additionally, we explore circular economy benefits and the economic drivers of supply and demand. By prioritising safe and sustainable operations, we aim to enhance value extraction, improve recovery rates, and reduce the environmental footprint.

Critical Minerals

Renewable energy technologies will increasingly drive demand on mineral resources, reshaping how minerals are extracted and processed. This shift present new challenges in sustainability and environmental impact, while also fostering innovative technologies. Our research focuses on both fundamental and applied studies inn mineral separation, and environmental impacts related to mineral extraction and recovery.

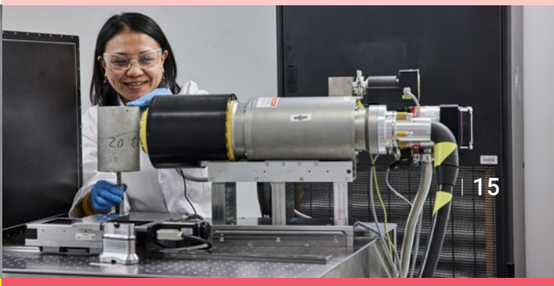
We aim to develop smart methods for exploring minerals and delivering sustainable extraction and recovery technologies and separations to minimise losses of high value minerals, environmental impact, and energy/water consumption.

Our work covers a range of applications including the design of new and innovative techniques for processing of low grade and complex ores, utilisation of mine tailings, sustainable mine waste management, mineral exploration and characterisation, and in situ recovery technologies.

Research Spotlight

Dr Ying Da Wang specialises in deep learning for 3D characterisation of critical minerals and green steel iron ore. He developed the DualSR method, a highly efficient 3D super-resolution technique, and integrates AI with advanced imaging technologies.

ARC DECRA Fellow Dr Jing Zhao focuses on sustainable solutions for resource recovery and environmental rehabilitation through advanced biotechnological approaches, including biohydrometallurgy and microbially driven rehabilitation. Her research is dedicated to driving innovation for a more sustainable future.



Mine Safety

Mining operations require high-precision geotechnical knowledge and advanced numerical techniques to ensure safety. Australia has unique mineral resources that require novel approaches. We focus on suitable mining methods that are capable of safe, efficient, and productive resource recovery.

Our research maintains Australia in its leading role in operating best practice mines and applying state of the art technologies, which leads to improved safety and increased productivity in mining operations.

Applications include ground support and ground control, rockburst projects, mechanisms of floor heave, mine subsidence, corrosion failure, and seismic monitoring, numerical modelling of rock mass behaviour, and novel geotechnical methods.

We work collaboratively with our industry partners on mine safety and design, coupled geomechanical systems, and exploration/production systems.

Research Spotlight

The ground control research group at MERE, led by Professor Ismet Canbulat, Associate Professor Guangyao Si, Professor Serkan Saydam, Associate Professor Chengguo Zhang, Associate Professor Joung Oh and Dr Hamed Lamei Ramandi, addresses both fundamental and practical aspects of ground control optimisation in challenging underground environments. Recent achievements include the development of high-capacity dynamic rock reinforcement, the development of an AI-driven digital ground control management plan, the quantification of microbiologically induced stress corrosion cracking and its effective management, and evaluation of using shotcrete and thin spray-on liners. The research team has a strong track record of multi-disciplinary research in collaboration with industry partners and securing competitive grants. By integrating research with practice in underground mining, the team has made significant contributions to safer, more efficient, and sustainable mining practices.

Mineral Resource Extraction and Production

Extraction and production systems are fundamental to the recovery of mineral resources. Our focus is on developing low-impact mining methods that support downstream value creation and ensure the supply of certified green products. This approach is crucial for facilitating the accelerated deployment of net-zero technologies, which are essential to meeting global decarbonisation targets. To achieve these goals, we employ numerical simulations and conduct experimental studies tailored to exploration and production systems operating in complex and extreme environmental conditions. Our research and development efforts are comprehensive, encompassing operations safety and hazard management, operational optimisation, emerging effective planning techniques, and novel extraction methods and systems for deep and unconventional deposits. We take pride in our collaborations with industry partners, working together to refine current techniques and drive forward innovations. These partnerships are vital for translating our research into practical applications that benefit the industry and contribute to a more sustainable future.

Research Spotlight

Professor Seher Ata's research focus is on mineral processing, particularly in froth flotation. Her work is dedicated to the efficient and sustainable recovery of strategic critical minerals from both primary and secondary resources.

Dr Ghislain Bournival's research focus is in the field of mineral processing. He has a particular interest in the fundamental aspects of froth flotation and the use of data to uncover insights in circuit performance.

Our researchers are leading research on the in-situ recovery of minerals from orebodies, ore characterisation using deep learning, and mineral recovery from metallic/non-metallic ores and mine tailings.

Transformative Technologies

Our team working in the field of Transformative Technologies focuses on innovations with game changing potential for industry. Of particular interest is to adopt scientific knowledge and emerging technologies from other disciplines tailored for the minerals and energy resources sectors.

Our innovations draw upon advances in engineering disciplines. This includes data analytics for resources engineering, Mine Internet of Things, exploring & engineering extreme environments, and low emission technologies. We work collaboratively with our domestic and international partners to find innovative and efficient ways to ensure sustainability and redefine industry practices.

Research Spotlight

Associate Professor Binghao Li collaborates with industry partners to develop cutting-edge Mine IoT solutions, including collision awareness, underground communication and sensing, and vibration energy harvesting, aimed at enhancing the productivity and safety of mining operations.

Associate Professor Simit Raval is specialised in the integration of Smart Sensing technologies. He leads a group of researchers focused on utilising data from sensors mounted on various platforms, from satellite through to UAVs/drones, to visualise, identify and monitor the environmental and safety aspects of the operations.

Data Analytics and Digital Integration for Resources Engineering

AI and digital integration are revolutionising various industries, including minerals and energy resources sector. The minerals and energy resources industries are swiftly advancing these technologies as they become increasingly digitally connected. The Internet of Things (IoT) involves digitally integrating the physical workplace with sensors, communications, processing capabilities, software, and other technologies to enable data connectivity and exchange. These technologies are essential for ensuring safe, efficient, and automated operations in the remote environments typical of minerals and energy resources engineering. Our machine learning efforts concentrate on integrating AI technologies into industry workflows and identifying opportunities to overcome current hardware limitations.

Applications include digital core imaging and characterisation, automated seismic and core interpretation, subsurface characterisation, automation, computer vision for materials, data analytics, site monitoring and assessment, inertial measurement units, global navigation satellite systems, wireless communication technologies, LIDAR and robotics.

Net Zero Technologies

The resource and energy sectors are making a step change to embrace the zero-carbon or carbon-neutral future. The extraction of minerals and energy resources results in significant greenhouse gas emissions. This requires Australian industries to adopt innovative approaches to manage their carbon emissions. We focus on developing analytical models and numerical simulation as well as laboratory solutions to enable companies to reduce their environmental footprint, by reducing carbon emissions during extraction and processing of raw earth materials.

Applications include carbon capture and utilisation, ventilation air methane abatement, ventilation strategies, battery electric vehicles (BEVs), clean coal technologies, and Hydrogen storage and CO_2 storage in abandoned mines and unconventional deposits.

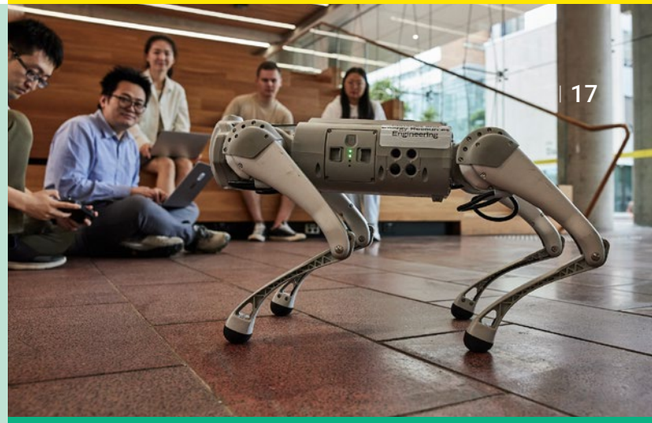
Research Spotlight

Associate Professor Guangyao Si is dedicated to reducing greenhouse gas emissions from the mining industry and decarbonising high-production mines, using technologies such as mine methane capture, ventilation methane abatement, ventilation on demand, and diesel fleet electrification.

Associate Professor Rahman Daiyan's research is developing systems and understanding their techno-economic feasibility for Power to X (converting surplus renewable electricity into other energy forms or chemicals) applications including renewable ammonia, methanol and sustainable aviation fuel. His key interest and strength is bringing lab-scale electrolyser technologies to market.

Exploring and Engineering Extreme Environments

Meeting the future minerals demand while reducing environmental impact is challenging, mainly because strategic minerals are often found in low-grade deposits in extreme environments, such as deep underground, deep sea or deep space, requiring more intensive extraction processes. In this research theme, we aim to analyse technologies specific to operating in these extreme environments. Our capability and proven expertise in Space Resource Utilisation research have connected us with the mining and space industries, leading to close collaborations with NASA, the European Space Agency and other industry partners. Exploration in remote environments requires specific instruments engineered for restricted payload weights and size for operating in extreme conditions. Applications include environmental impact and resource optimisation, integrated economic modelling, and extraction technologies for extra-terrestrial operations and deep-sea resources.



Research Spotlight

Professor Serkan Saydam's research addresses the current needs and future challenges faced by the minerals industry, and he leads projects on space resources engineering, ground control, mining systems design, and technology integration and management.

Associate Professor Chengguo Zhang focuses on integrating data analysis, numerical modelling, and visualisation technologies into the assessment of rock mass behaviour and management of risks and hazards in deep hard rock mines, dynamic rock failures, and mine subsidence.

Future ahead...

Our role in Future Energy

The need for reliable and affordable energy is vital in today's world. To meet the increasing future demand while cutting the harmful by-products and emissions from our current energy sources, alternatives need to be found. These can be a mix of primary energy sources such as wind electricity, hydropower and solar, and secondary energy carriers, of which hydrogen can contribute as a low or zero-emissions fuel.

Our excellent renewable energy, mining and subsurface engineering research capabilities give UNSW a natural advantage and the potential to conduct research on implementing these technologies into the energy and resources sector.

The conflict between global energy demand and the conservation of natural resources provides an opportunity for novel engineering solutions.

Our experience with extraction technologies, geomechanics, flow and transport processes, and industry engagement provides a prime platform to address the challenge of future energy.

We are focusing our research on new extraction technologies for alternative energy resources and exploring ways to minimise the environmental impact of raw material extraction.

As energy demand is ever growing, a diverse collection of technologies will be required to address the need since the utility of each technology is not equivalent. We are therefore focusing on natural gas as a transition fuel, geological storage of CO_2 to mitigate current technologies, and geothermal energy as an alternative energy source. What we are doing today in our discipline will change; however, the conflict between energy and the environment will remain a pressing question needing new insights, novel research, and technological innovations all of which are driven by our school.

It is our aim to be at the forefront of the energy transition with novel technological innovations.

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