

MinEx CRC Annual Report

1 July 2020–30 June 2021

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3. Written Annual Report

3.1 Executive Summary

MinEx CRC has completed another extremely successful year of operations despite the ongoing challenges posed by COVID-19. To date, the effect of Covid19 has not been significant, and risk registers have been reviewed to ensure that Covid-19 is adequately addressed. MinEx CRC is on track to meet all Commonwealth Milestones and is ahead on aggregate on Project milestones to complete the first three-year phase of research at the end of 2021.

All operations were undertaken in the past year with no significant workplace health and safety incidents. MinEx CRC is also striving to have improved diversity throughout the organisation, led by the Board, which comprises 50% male and 50% female members.

Numerous researchers have achieved awards in various forums in the past year. As of 30 June 2021, MinEx CRC had 27 Higher Degree by Research (HDR) students, including six Masters by Research and 21 PhD students enrolled in the postgraduate program. The concern in 2020 of a drop-off in student numbers has not materialised. Our second Annual Conference in November 2020, with a combined online and in-person format, had over 200 delegates from 43 organisations.

MinEx CRC currently has 17 Major Mining, Mining Equipment and Technology Services (METS) and Geological Survey Participants and seven research organisation Participants and 20 Affiliates, with five new affiliates joining during the reporting period.

To facilitate publicity of our strong year, four general Press Releases and one Ministerial Press Release were published, with 125 press articles generated. Internal releases included four editions of the MinEx CRC vNews and ten videos with 3,909 views and 15,677 visitors to the MinEx CRC website. In addition, there were 23 peer-reviewed scientific publications.

Research highlights occurred across all nine primary research projects, highlighted by the applying learnings from research to conventional and coil tube drilling operations. In addition, a significant aspect of applying research and development undertaken across all MinEx projects occurs in the National Drilling Initiative (NDI) drilling programs. The first programs were completed in the Northern Territory in the past year. Data from the programs were made available to the public, triggering significant tenement uptake by exploration and mining companies.

MinEx CRC retains a significant cash balance and is well placed on funding the planned research programs, drilling campaigns, education and training activities and management of operational activities.

Andrew Bailey

Chief Executive Officer
MinEx CRC

3.2 Achievements

The following summarises the key achievements of MinEx CRC in the year 1 July 2020 — 30 June 2021.

Governance

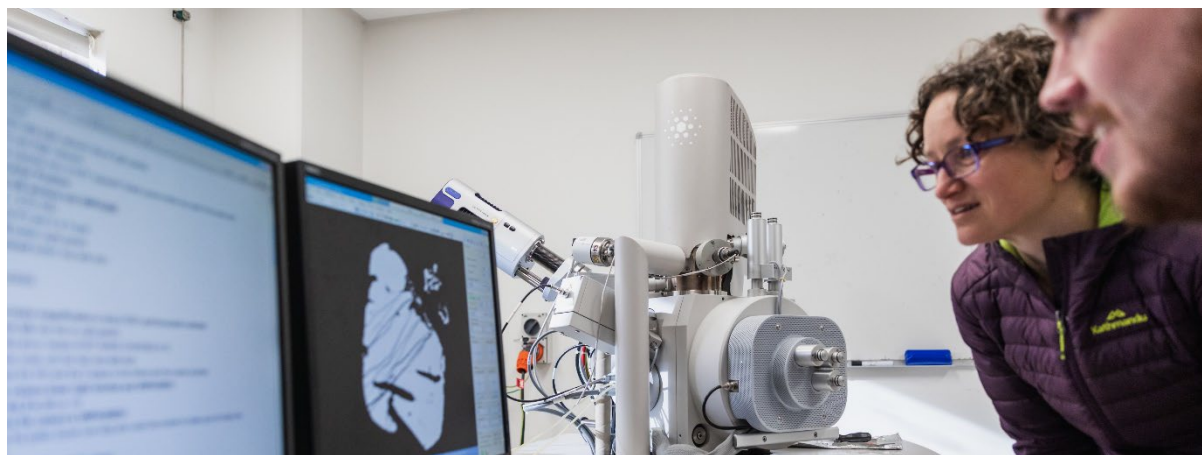
- Neil Francis (CSIRO) was appointed as OP2 Project Leader in July 2020.
- Mark Jessell (UWA) was appointed OP6 Project Leader in January 2021.
- Marnie Foster (ANU) was appointed as OP8 Project Leader in January 2021.
- Tom Raimondo (UniSA) was appointed as OP7 Project Leader in March 2021.
- Brett Harris (Curtin University) was appointed OP4 Project Leader in April 2021.
- Nigel Spooner (University of Adelaide) was appointed as OP5 Project Leader in May 2021.

Dual Headquarters

- MinEx CRC continues to base its WA Head Office at the Australian Resources Research Centre. A joint facility shared by CSIRO, Curtin University, Natural Resources and Energy Australia, University of WA, National Geosequestrian Laboratory and the Pawsley Supercomputer Centre.
- MinEx CRC's SA-based headquarters are based at the Future Industries Institute, University of South Australia.

Awards

- Education and Training Program Coordinator Caroline Tiddy (UniSA) was the Geological Society of Australia Garry Davidson Medal recipient.
- Program 3 Researcher Laura Morrissey (UniSA) received an Australian Research Council's Discovery Early Career Researcher Award.
- Program 3 Researcher Emily Finch (Geological Survey of Western Australia) named one of the 60 Superstars of STEM for 2020-2021. An initiative of Science and Technology Australia.
- MinEx CRC Board Member Kelly Keates was named the winner of the 2020 Winnovation Awards in the Engineering category.
- Postgraduate student Anatolii Pakhomenko (Curtin University) was awarded 1st place, Geospatial Datathon competition, WA Data Science Innovation Hub.
- Postgraduate student Mahtab Rashidifard (UWA) received the Australian Society of Exploration Geophysicists (ASEG) student award for 2021.
- Postgraduate student Ranee Joshi (UWA) received the best student poster presentation award, AESC 2021.



Education and Training Program Coordinator Caroline Tiddy (UniSA).

- Internal MinEx CRC awards were presented at the Annual Conference as follows:
 - MinEx CRC 2020 John Emmerson Team Player Award:
 - 1. Yulia Uvarova, Program 2 Leader, CSIRO
 - 2. Ian Roach, Program 3 Researcher, Geoscience Australia
 - 3. Monique Stagg, Administration Officer, University of South Australia.
 - MinEx CRC 2020 Annual Publications Award:
 - Jérémie Giraud, Mark Lindsay, Mark Jessell, and Vitaliy Ogar (The University of Western Australia): *'Towards plausible lithological classification from geophysical inversion: Honoring geological principles in subsurface imaging. Solid Earth, Volume 11, Issue 2'*.

Gender Diversity

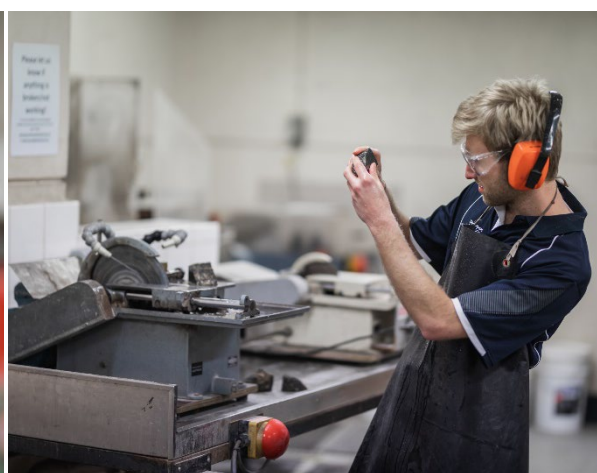
- The MinEx CRC Board (CEO included) comprises 50% male and 50% female members.
- The MinEx CRC Executive Management Committee, including the CEO, comprises eight members, five male and three female.
- There are nine male and two female research Leads for the nine primary research projects.

Participants and Affiliates

- MinEx CRC currently has 17 Major Mining, Mining Equipment and Technology Services (METS) and Geological Survey Participants and seven research organisation Participants.
- MinEx CRC currently has 20 Affiliates, with five new affiliates joining during the reporting period.

Education and Training

- As of 30 June 2021, MinEx CRC had 27 Higher Degree by Research (HDR) students including six Masters by Research and 21 PhD students enrolled in the postgraduate program.
- All student projects are aligned with MinEx CRC goals. Each project is signed off by the MinEx CRC Project Leader, Program Leader, Industry co-supervisor, and the Chief Scientific Officer.
- Version 3 of the Postgraduate Booklet has been compiled and uploaded to the MinEx CRC website for advertising postgraduate projects.
- All HDR students attended the second MinEx CRC Annual Conference in November 2020 where 21 students presented in a session dedicated to HDR research.
- Mid-year Postgraduate Workshops were held online in July 2020 (77 attendees) and June 2021 (59 attendees).



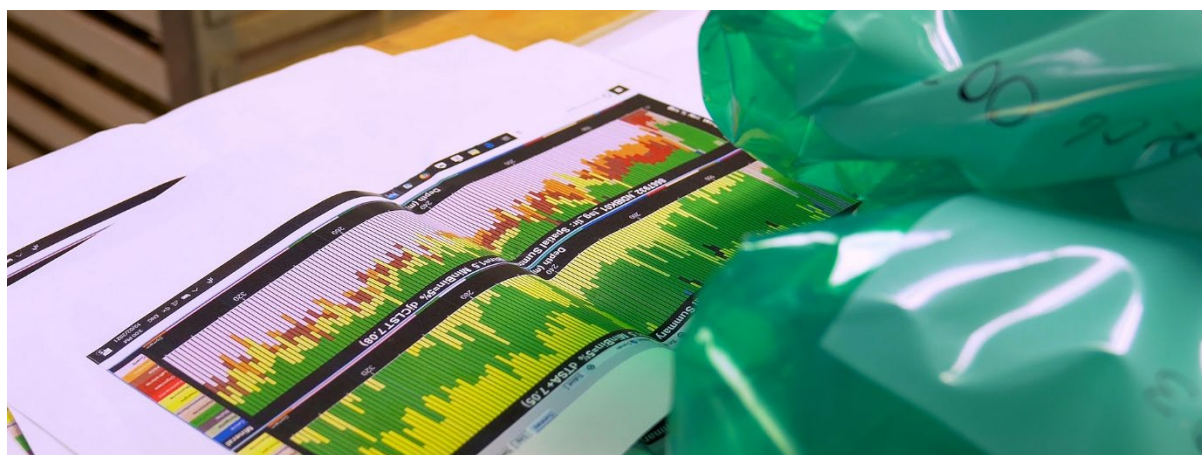
MinEx CRC Postgraduate student Angus Nixon (UniSA).

Communications and Events

- MinEx CRC's second Annual Conference: Frontier Exploration was held on 10-11 November 2020 in a combined online and in-person format, with three in-person hubs in Perth, Adelaide and Canberra. Over 200 delegates attended the conference spanning 43 organisations.
- The MinEx CRC Mid-year Science Review was held online in April 2021 with 107 attendees.
- The MinEx CRC Project Integration Workshop was held online in June 2021 with 77 attendees.
- Four Press Releases were distributed titled:
 - 'Drilling Program Unlocks Hidden Mineral Potential in The East Tennant'
 - 'Drilling Helps Unearth Resource Potential of Under-Explored South Nicholson Basin'
 - 'Drilling Data Unlocks Mineral Potential in The Northern Territory'
 - 'Drilling Data Reveals New Energy and Mineral Potential in The Northern Territory'.
- There was one Ministerial Press Release, released jointly by the Hon Keith Pitt MP, Minister for Resources, Water and Northern Australia, and The Hon Nicole Manison MLA, Northern Territory Minister for Mining and Industry, titled:
 - 'National Drilling Initiative Reveals Golden Opportunity for Northern Australia'.
- The preliminary data release for the South Nicholson NDI Campaign was officially announced by The Hon Keith Pitt MP, Minister for Resources, Water and Northern Australia, at the Northern Territory Annual Geoscience Exploration Seminar (AGES) in April 2021 and is available via the MinEx CRC YouTube channel.
- Four quarterly editions of the MinEx CRC vNews were published on MinEx CRC TV.
- Ten videos were published on MinEx CRC TV, with 3,909 views in total.
- 125 press articles generated.
- There were 15,677 visitors to the MinEx CRC website, with 50,207 page views in total.
- A '2020 Year in Review' summary document was released in December 2020 and is included as Appendix A.

Publications

- There were 23 peer-reviewed scientific publications with MinEx CRC byline or acknowledgments during the reporting period (19 articles in scientific journals and four peer-reviewed conference papers).



MinEx CRC TV.

SME Engagement

- Participant McKay Drilling provided access to and drilling time on an RC drill rig on a working drill site in the Pilbara region of Western Australia. The rig was instrumented with more than 50 sensors by the Project 1 research team, with 4GB data collected over 12 hours and hundreds of meters of drilling. The interaction provided invaluable research data to MinEx CRC and aided McKay Drilling to understand some of their workflows and methodologies.
- MinEx CRC has engaged OMNI GeoX to coordinate, staff and manage the NDI drilling program in the Northern Territory in 2020. Through the coordination and management of OMNI GeoX, the project was completed successfully over 18 months and a spend of ~\$7M.
- In-kind contributions of equipment from Imdex, a significant Participant in various MinEx CRC projects, also provided drilling and logging support equipment for the NDI drilling program. The equipment was a valuable aid to the project and provided Imdex with important feedback on the use and development of recently released products.
- MinEx CRC's seismic research project has undertaken field trials on Anglo American, BHP and Matsa Resources sites with valuable learnings for the research team and the generation of exploration targets on the ground surveyed.

International Collaboration:

- Cooperation is ongoing with Sandvik, Epiroc, LKAB Wassara and Sercel who are all European Based METS companies and service providers, as well as with Olympus and Geotec Boyles in the Americas. Support and the exchange of ideas is ongoing.

Research Highlights

Drilling Optimisation

- We progressed our work on the Diamond drilling optimisation system referred to as DTrol. First, to measure the performance of diamond bits under a range of drilling parameters at simulated depths from 15m to 1,000m. Second, to confirm a sweet spot for optimal drilling performance in hard and non-abrasive rocks. Third, to commission a wireless sub with a 100-1,000 Hertz sampling rate (sufficient to closely monitor and manage drilling within the sweet spot) which is a key component of the DTrol system. Preparations are underway for a field trial of DTrol on a diamond drill rig operated by MinEx CRC Participant McKay Drilling in September 2021.

Fluid Management for Diamond and Coiled Tubing Drilling

- We developed prototype iFluid systems for both Diamond and Coiled Tubing (CT) drilling. The iFluid systems enable precise fluid management and additive dosing by a remote operator and are a critical step on the pathway toward automated fluid management. The system is informed by real-time fluid monitoring (temperature, pressure, flow rate, rheology, solid load) at multiple points in the fluid circuit. The CTiFluid prototype was incorporated in the Hydraulic Processing System (HPS) and commissioned for CT drilling trials in the second half of 2021.
- We have developed V4.4 of the 'all-purpose' drilling additive LiqiCTrol. The new formulation contains no hazardous ingredients, is easier to manage, improves shale inhibition and provides better lubrication without the need to add an independent lubricant to the drilling fluid. We are gearing up to increase production rates of LiqiCTrol in preparation for CT drilling trials in the second half of 2021.

Coil Tube Drilling to 1000m

- We completed the build and commissioning of the RoXplorer® 1000 CT drill rig in preparation for drilling trials in the second half of 2021. The commissioning processes included integrating the RoXplorer® 1000 with the Smart Bottom Hole Assembly (BHA), HPS, coarse-fraction

sampling, and CTiFluid subsystems to deliver a self-contained CT drilling fluid management platform.

- We commissioned a bespoke 1,000m long composite communication cable for the RoXplorer® 1000 containing copper wire and optic fibre for power delivery and communications through the CT drill string. The communications cable has been threaded through the drill coil and integrated with the electronics of the Smart BHA. The optic fibre presents the opportunity for distributed temperature and strain measurements along the drill coil, which may be used in future for seismic measurements or drill monitoring and positioning.

Sample Quality for CT Drilling

- Build of the V1 prototype coarse-fraction sampling system is complete, and the system has been mounted on the HPS in preparation for field trials in the second half of 2021. The prototype uses a shaker table with +150µ screen (typically accounting for approximately half the sample volume of CT cuttings) and will deliver three parallel sample streams to enable duplicate samples to be taken at any time during drilling. We developed an algorithm to describe shaker performance which can be integrated with the algorithm for up-hole cuttings transport to deliver a predictive model for sample source depth and quality.
- We have completed the build of a prototype selective interval coring system for CT drilling in preparation for field trials in the second half of 2021. The system is based on the Epiroc 60TT core barrel system, provided in-kind by MinEx CRC Participant Epiroc, which has been combined with a MinEx CRC downhole motor.

Positioning for CT Drilling

- Development of our downhole positioning system has progressed by integrating an existing navigation module, provided in-kind by MinEx CRC Participant Wassara, with the Smart BHA electronics. The tool has yet to be tested in a drill hole. However, data from the navigation tool and Smart BHA has been communicated to the (virtual) surface via the same optic fibre link that has been inserted in the drill coil. A second Wassara navigation module has been received in preparation for field deployment with the RoXplorer® 1000 in the second half of 2021.

Hydraulic Processing System

- Build of the Hydraulic Processing System (HPS) is complete. The HPS is an all-in-one, truck-mounted fluid management system for CT drilling - including fluid additive mixing and dosing, solids removal and solids sampling. Fluids are entirely recirculated within the HPS, removing the need for drill sumps or external tanks.



RoXplorer® 1000 CT drill system.



- The HPS incorporates coarse-fraction sampling and the CTiFluid system, which allows remote and automated fluid management. The HPS can be transported efficiently over long distances, allows all-terrain access and can be set up safely and quickly by one person. The HPS has been commissioned in combination with the RoXplorer® 1000 in preparation for field trials in the second half of 2021.

Downhole Assay by Laser-Induced Breakdown Spectroscopy (LIBS)

- The build of the V1 prototype downhole LIBS tool is complete. The tool is an original design that incorporates a bespoke laser, front-end optical geometry, back-end spectrometer and protective tool housing designed to operate in deep, wet conditions in slim-line drill holes. The tool has been mounted vertically on a winch system to enable simulation of downhole assay – including different tool velocities, wet and flooded boreholes and various compositions of drilling fluid.
- We have compiled an extensive set of LIBS experiments on a diverse set of rocks and ore samples. These experiments serve both to test instrument performance and build a database of LIBS analyses of rocks that have been characterised in detail by other techniques (e.g. micron-scale mineralogy and chemistry using the Maia Mapper). This library will allow us to build predictive models of rock type (chemistry + mineralogy + texture) from raw LIBS analyses.

Logging-While-Drilling (LWD) for Petrophysics and Geo-Steering

- The build of the V1 prototype total count gamma instrument is complete. The instrument has been integrated with RoXplorer® 1000 borehole communications, with data being sent via the fibre optic link to the (virtual) surface. The metal housing for the CT-LWD-Gamma tool has been fabricated. The instrument will be mounted in the housing in Quarter 3 2021, and performance tested in the laboratory before being deployed in drilling trials with the RoXplorer® 1000 in the second half of 2021.
- We have developed a logging-while-drilling (LWD) simulator to aid in the design of LWD tools and the interpretation of LWD data. The software generates a type of borehole digital twin which predicts the response of our prototype gamma and swept EM LWD tools to user-defined geological scenarios. The simulations demonstrate how these data can be used to steer the drill hole toward a downhole or off-hole target.

Seismic In the Drilling Workflow

- We completed two field experiments to test the application of optic fibre DAS receivers in different mineral exploration scenarios. In the first experiment, collaborating with MinEx CRC Participant BHP, we pulled an optic fibre DAS cable behind a vehicle (effectively a DAS land streamer) at an iron-ore project in the Pilbara region of Western Australia. The experiment showed that DAS cables can withstand the stretching forces and abrasion inherent to this mode of deployment but highlighted the need for higher energy sources such as vibrator truck or heavyweight drop sources than are required for 'static' DAS acquisition. The second experiment, in collaboration with MinEx CRC Affiliate Matsa Resources, was a follow up to the salt-lake 3D surface experiment conducted in early 2020 and involved additional 2D surface acquisition, walkway vertical seismic profiling (VSP) and passive recording at Matsa's Red October gold project in the eastern goldfields of Western Australia.
- We have designed and built a remotely operated DAS seismic system for deployment at instrumented drill sites.

Automated 3d Modelling

- A large BHP Pilbara iron ore database has been provided to the Project 6 team. The database includes downhole geochemistry, mineralogy, petrophysics and geophysics from 538 drill holes (~46,000 meters of drilling) along with airborne and ground geophysics and 1:50K geological mapping.
- The TomofastX software developed by the Project 6 team to extract geological information from inverted and forward-modelled geophysical data has been released in open source.

National Drilling Initiative (NDI) Northern Territory Drilling Campaigns

- In December 2020, we completed the first National Drilling Initiative (NDI) campaigns in the East Tennant and South Nicholson areas of the Northern Territory. The East Tennant campaign included ten drill holes for 3,969m, and the South Nicholson campaign was a single deep drill hole, Carrara 01, of 1,750m. MinEx CRC contracted drilling to DDH1 Drilling, and drill site management was contracted to OMNI GeoX. Drilling data, wireline geophysical logs, geological logs, core photos, and portable XRF data were collected in the field. Hyperspectral logging of the drill core and XRF scanning using Minalyzer® was completed at the Northern Territory Geological Survey core yard.
- Field and core yard data from the Northern Territory NDI campaigns were incorporated into Geoscience Australia's database and uploaded on the NDI portal in an innovative Borehole Completion Report Tool, which provides data in graphic logs as downloadable data files for easy consumption by end-users.
- The East Tennant sampling workshop (March 1-9 at the NTGS Alice Springs core library) involved researchers from GA, NTGS, ANU and UniSA, with a follow-up visit by Adelaide University researchers in late March. Core observations and sampling decisions were informed by geological logging, pXRF, Minalyser and Hylogger data captured during the drilling campaign. Samples were taken from all drill holes, with most samples dispatched to GA and thereafter will be distributed to other research organisations.

Preparation for Delamerian NDI Campaign in South Australia

- Preparation for the Delamerian NDI drilling campaign, due to begin in Quarter 3 2021, is almost complete. Drill sites have been prioritised, environmental and native title clearances are nearing completion, landholders have been notified, and site visits have been undertaken.



Core samples from the MinEx CRC Northern Territory NDI campaign.

- An exhaustive legacy data capture program conducted in preparation for drilling in the Delamerian NDI area has been made available online by MinEx CRC Participant the Geological Survey of South Australia. The data include; ~60,000 surface geochemical analyses, ~153,000 downhole geochemical analyses and ~516,000m of drill hole data, including ~428,000m of lithological logging, logging of ~90 drill holes supported by thin-section petrology on 260 samples, reinterpretation of the basement geology, reprocessed regional geophysical data and images (including MT resistivity models, gravity and magnetics, depth to basement estimates based on drilling and geophysical data).

Mineral Systems and Prospectivity Assessment

- The Delamerian prospectivity assessment is complete, including those areas planned to be drilled in the 2021 NDI campaign. This will allow us to assess the impact of drilling on prospectivity assessment.
- Unsupervised clustering of magnetic and gravity data has been used to derive a map that will be used to help plan and prioritise drill sites in the East Yilgarn NDI area in 2022.

Coupled Interpretation of XRD and Geochemistry

- We created an algorithm for rapid, automated interpretation of lab-based XRD spectra and a second algorithm for coupled interpretation of XRD and geochemistry. The coupled algorithm has been evaluated against standard mixtures of known composition with excellent results – removing ambiguity, improving the accuracy of quantitative mineralogy and providing a pathway to estimating the chemistry of individual mineral phases. The algorithms have been applied to real-world datasets, and mineralogy predictions were consistent with observations from other instrumentation.



Program 1 researchers operating the Hydraulic Processing System (HPS).

3.3 Case Study

National Drilling Initiative East Tennant campaign

In December 2020, MinEx CRC successfully completed its first National Drilling Initiative (NDI) campaign in the East Tennant area of the Northern Territory. The program comprised ten exploration drill holes for 3,969m of drilling, as summarised in Table 1.

The NDI is a world-first scientific drilling program conducted as a collaboration between Geological Survey Organisations in every state and territory, Geoscience Australia, the CSIRO and seven Australian universities brought together by MinEx CRC. The NDI is designed to understand the evolution of the Australian continent, provide clues about where to search for new mineral deposits and bring forward the next generation of mineral exploration technology. NDI drilling programs are planned over the life of MinEx CRC in multiple jurisdictions, targeting under-explored areas where prospective rocks are buried beneath a cover of younger sediments. The potential for mineral wealth in these covered regions is vast – in many areas, geophysical evidence suggests that well-endowed mineral provinces (e.g. Mount Isa Inlier, Yilgarn Craton, Tennant Creek Inlier) continue beneath the cover where they have barely been explored. There are two significant roadblocks to undercover exploration: 1) It's expensive. Geophysical data collected from the surface provides valuable clues to the types of rocks and their distribution. However, exploration ultimately requires physical sampling and analysis of the prospective rocks, and this requires drilling. Conventional drilling and analytical techniques are slow and expensive. 2) It's uncertain. The time and financial cost of drilling results in relatively few samples being taken within large volumes of the exploration space with little chance of achieving the density of sampling required to assess exploration potential. Exploration requires careful assessment of risk vs reward. In areas where the geological fundamentals are unknown, neither risk nor reward can be adequately assessed. This leads to a vicious cycle that drives exploration investment away from covered areas: lack of data = uncertainty, uncertainty + high cost = no investment, no investment = lack of data...

The NDI seeks to break this cycle by; 1) investing in drilling and analyses to generate the first wave of pre-competitive data in selected covered areas (i.e. reducing geological uncertainty) and 2) providing a testing ground for new, more efficient drilling and in-field analytical technologies including those developed by MinEx CRC (i.e. reducing the cost and time taken to sample the deep cover exploration space). The East Tennant drilling campaign was focussed on capturing pre-competitive data using conventional drilling techniques (with MinEx CRC Coiled Tubing drilling technology in year two of its R&D agenda and not yet ready for campaign-scale deployment) augmented by in-field portable XRF data, novel drilling sensors, new-to-market core-yard geochemical scanning provided by MinEx CRC affiliate Minalyze and hyperspectral + high-resolution core imaging via the Northern Territory Geological Survey's HyLogger instrument.

MinEx CRC contracted drilling to DDH1 Drilling, and drill site management was contracted to OMNI GeoX. The drilling campaigns were conducted between September and December 2020, during COVID 19 travel restrictions. As a result, access to the drill site by MinEx CRC, Geoscience Australia and Northern Territory Geological Survey personnel was limited. Drilling data, geological logging and in-field analyses were communicated regularly from the drill sites allowing key decisions (most importantly, the depth of hole terminations and prioritisation of drilling order) to be made remotely.

Uncovering potential for Au and Cu mineralisation

While gold and copper has been mined from the Paleoproterozoic rocks around Tennant Creek since the early 1930s, there has been almost no mineral exploration in the covered rocks to the east of Tennant Creek in the 90 years since. The East Tennant drilling campaign was designed to test the hypothesis that the basement rocks east of Tennant Creek are comparable to those which host the Tennant Creek mineral field (similar rock types, age of rocks, geological structures and alteration) and thus have a high chance of hosting comparable mineral deposits.

The drill holes were targeted in an exhaustive process, beginning in 2018 (at the commencement of MinEx CRC) and using regional potential field geophysics (gravity and magnetics), seismic, magnetotelluric and airborne electromagnetic data recently acquired and/or reprocessed by Geoscience Australia as part of the Exploring for the Future initiative. The final list of priority drill targets was chosen to enable characterisation of the stratigraphy, prominent igneous rock types and various structural domains within an approximately northeast-southwest corridor where the inferred depth to basement (typically <500m) would allow economic mining if exploration is ultimately successful.

An early result of the drilling was to constrain the cover materials and their thickness, with prospective basement typically concealed beneath less than 200m of Georgina Basin sediments and less than 30m of Cambrian basalt of the Kalkarindji Suite. This is important information that helps explorers to plan their drilling programs with reduced uncertainty. Beneath these rocks, the drilling program has uncovered a range of igneous and metasedimentary rocks with heterogeneous structural and metamorphic overprint and variable degrees of hydrothermal alteration. Detailed analyses of these rocks, including a comprehensive suite of geochronology and isotope geochemistry, structural and metamorphic analyses, alteration studies and ore mineral paragenesis, are ongoing and expected to be delivered in late 2021 and early 2022. In the meantime, preliminary data collected at the drill site and core yard within days and weeks of drilling were released to the public via the MinEx CRC NDI portal in February 2021. These data have already contributed to a greater understanding of the area's structure, stratigraphy, and magmatic history and helped to support and refine pre-drilling interpretations of the region's prospectivity. Key outcomes include:

- The East Tennant area contains metasedimentary rocks of the same type and age as the rocks which host Au-Cu mineralisation in the Tennant Creek mineral field.
- Felsic igneous rocks are comparable in age and chemistry to felsic igneous rocks in the Tennant Creek mineral field and show evidence of potassium and iron-oxide alteration characteristic of the Tennant Creek mineralisation.



MinEx CRC NDI East Tennant Drill Site.

- Sulphide minerals, including the copper ore mineral chalcopyrite, occur at percentage concentrations in association with veining and wall rock alteration in one drill hole, confirming the presence of a copper-bearing mineral system.

"We are proud to be a participant of the MinEx CRC through our Exploring for the Future program, which identified the region as a highly prospective frontier. The drilling results confirm this view and will support the continued development of the Barkly Region," Geoscience Australia's Chief of Minerals, Energy and Groundwater Division, Dr Andrew Heap, said.

"Projects like this reveal the geology underneath the vast sedimentary cover that extends across most of Australia and open up frontier regions for exploration and resource discovery. In the future, the new geological knowledge and methods that we've used here can be applied in other similar prospective geological terranes across the country."

Ian Scrimgeour, Executive Director of the Northern Territory Geological Survey (NTGS), said the East Tennant NDI drill core provides an exciting opportunity to understand the potential of the underexplored Barkly area.

"The range of ancillary datasets that have been acquired during the drilling campaign, coupled with the ongoing research activities on the drill core, will transform the understanding of minerals systems in the region," he said.

"NTGS is delighted to provide value-add datasets with the acquisition of hyperspectral data and high-resolution imaging of the drill core through our HyLogger instrument."

A significant measure of the impact of the NDI is the exploration interest and investment that the East Tennant NDI campaign has triggered. In 2019, before the East Tennant drilling campaign, there was minimal tenement coverage in the East Tennant campaign area (Figure 1, blue areas). Following the East Tennant campaign, tenement coverage of the priority corridor incorporating the MinEx CRC NDI drill holes was complete (Figure 2, pink and orange areas), with new tenements granted to a combination of major mining companies (e.g. Newcrest) and junior explorers. Four of these junior explorers (Encounter Resources, Inca Minerals, Middle Island Resources and Strategic Energy Resources) have become affiliate members of MinEx CRC and formed a consortium to support a PhD project focussed on East Tennant, which commenced in August 2021.

Description	Numbers	Comment
Holes drilled	10	
Meters drilled	3,969	(1,345 RC and 2,624 DD) at ~20m / shift average
Size	HQ3	
Time	101 days	Avg 10 days per hole, double shifting
Total Cost	\$2.5M	Includes clearances, admin and some sampling costs
Total personnel involved	~ 14	

Table 1: East Tennant program summary statistics.

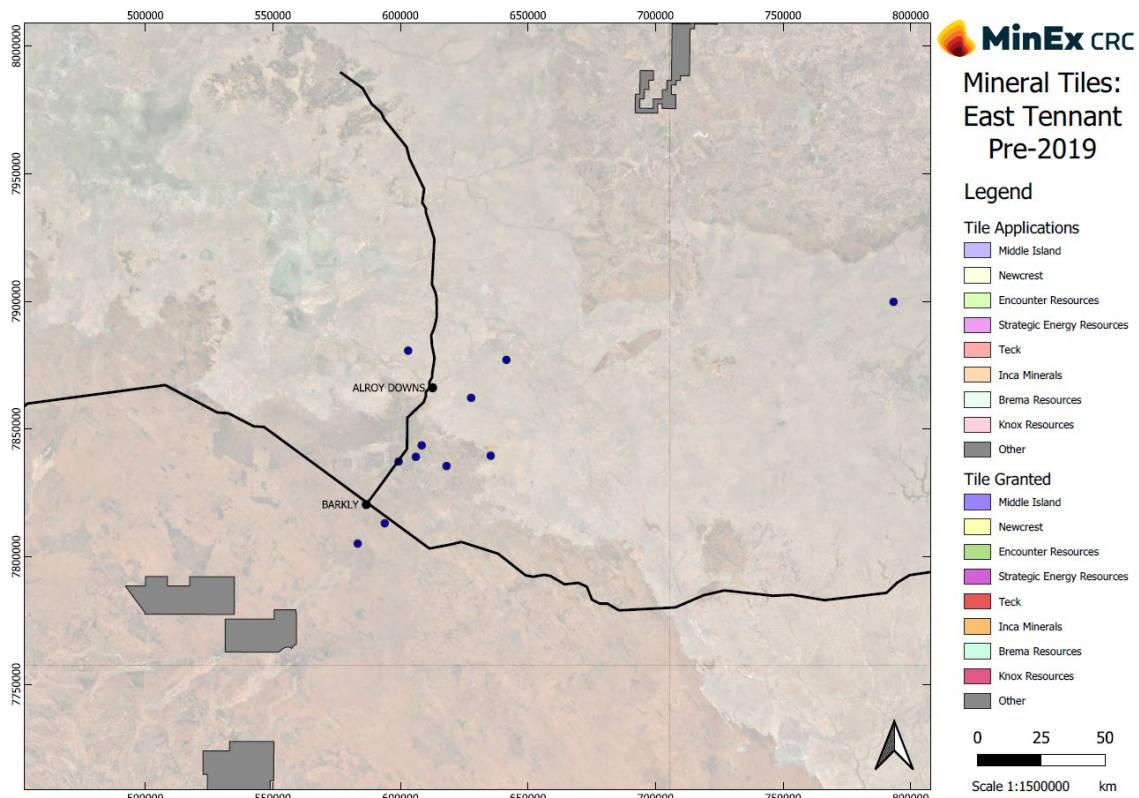


Figure 1: East Tennant campaign area.

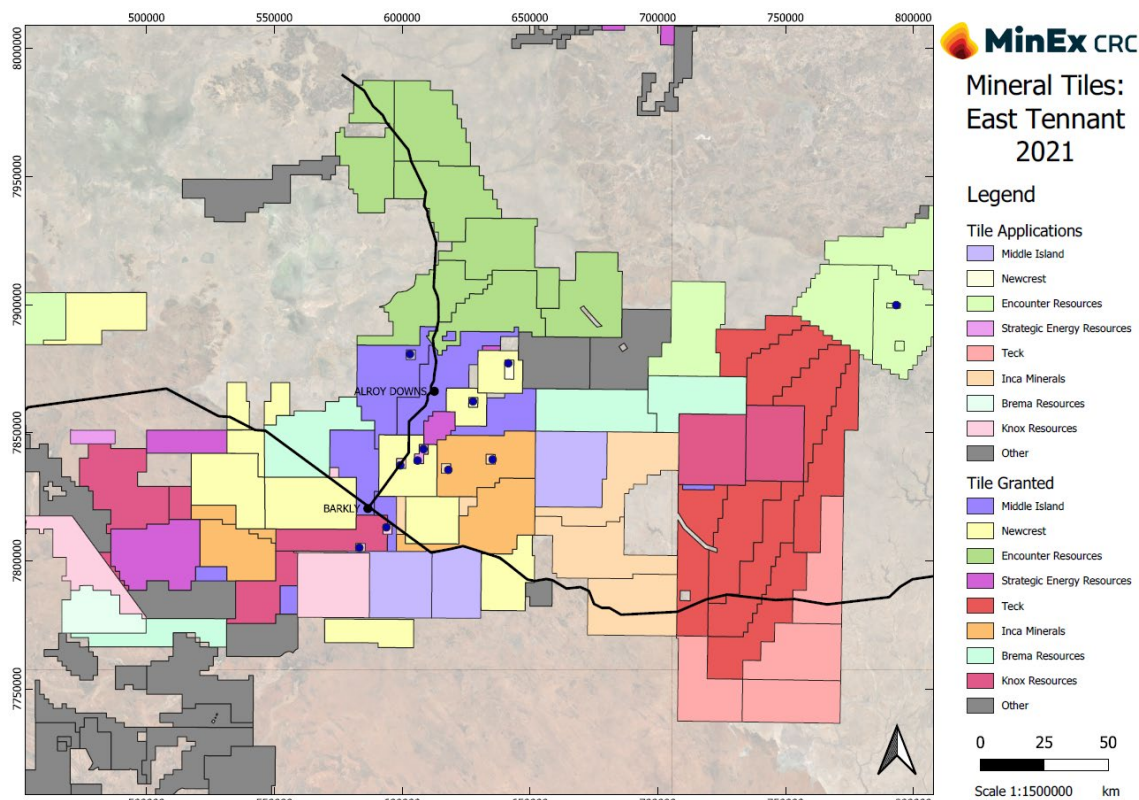


Figure 2: Tenement coverage of the priority corridor incorporating the MinEx CRC NDI drill holes.

3.4 Risks & Impediments

MinEx CRC recognises that it operates in an uncertain environment where identifying and managing risk and mitigation of impediments are important to our success. Risk management has been built into MinEx CRC structures and reporting requirements from project to Board level. The Board Audit and Risk Committee provides oversight on risks that may impact MinEx CRC's ability to achieve our vision.

Covid-19 continues to be a risk to MinEx CRC, but to date, the effect has not been significant. Risk registers have been reviewed to ensure that Covid-19 is adequately addressed.

Specific steps to address the Covid-19 risks have included:

- Ensuring staff safety, including working from home when required, and emphasis on available help, together with the MinEx CRC Employee Assistance Program.
- Research partners follow safety and working guidelines from their respective authorities and institutions.
- Social distancing and compliance procedures in place, which have resulted in reduced laboratory efficiency and increased administrative processes to ensure an ongoing safe operating environment.
- Additional support for some students is at risk, including due to reduced fieldwork and sampling restrictions.
- Some project milestones have been altered, but there is no material risk to Project or Commonwealth milestones.
- The budget accounting for ongoing reduced travel spend and ongoing reduced levels of fieldwork.

The risks rated as extreme or high for MinEx CRC are summarised below. The strategies adopted to address the risks are listed as controls in place and mitigating factors that exist.

Risk Area	Risk Issues	Controls in Place	Mitigating Factors
CAPABILITY	Crisis Management Business Continuity and crisis management. Failure to develop and implement suitable strategies, including management of Covid19 risks	* Risk Register process and Management controls * Approved Crisis Communications plan	* Experienced Board and Management Team * Initial Crisis Management Plan
MARKETS	Public Image Damage to Public Image or reputation	* Monitor ongoing compliance with legal and contractual requirements * Communications Strategy * Key Management focus	* Experienced Board * Crisis Management Plan

RESEARCH	Inadequate Research Information Integrity Protection and security is inadequate, including IT exposure As highlighted by increased focus from Commonwealth	* Research Organisations have a high level of experience in this area * Legal advice on contracts	Diversification of research information and IT systems across research projects and research institutions
RESEARCH	Research Outcomes not Achieved Research staff are not capable of achieving project outcomes, including due to Covid-19 restrictions	* Regular monitoring of research project outcomes and staff performance	* Track record of staff achieving research outcomes, * Modification of Milestones and work practices
RESEARCH	Failure to Execute NDI Drilling a) Lack of required drilling equipment, including Coil Tube Drill accessibility b) Community and Land access issues c) Drilling Program Failure d) Integration of the Drilling Campaign with the Research Projects	* Drill equipment and CT long-lead items in the current workflow * Proactive approach adopted for ground access * Expert drilling advice being utilised * Structure and process in place to maximise integration	* Experienced personnel and learnings between states. * Process has commenced in a timely manner and regularly monitored * Alternative drilling techniques available
CAPABILITY	OHSE Performance Failure to develop policies and achieve satisfactory OHSE performance and comply with legal obligations	* OHSE Policy in place * OHSE reporting regime in place * Detailed OHSE Risk Assessment completed for 2020 NDI drilling campaigns	* Apart from Drilling Campaigns, most CRC activities are relatively low risk
FINANCE & COMPLIANCE	Cash Management and Fraud a) Loss of funds or income due to fraud c) Loss of funds or income due to poor debtor management b) Loss of funds or income due to poor investment returns	* Best practice fraud prevention in place * Low-risk investment policy * Rigorous debtor management and small number of Debtors & Invoices	* Spread of funds across accounts & low-risk Banks * Conservative investment policy
RESEARCH	Research Portfolio Failure to: a) Meet industry requirements b) Maximise outcomes from Opportunity Fund	* Project agreements with Milestones & budgets * Ongoing Project reporting & tracking * Project review panels include Participants	Diversification of research portfolio across sectors, researchers and participants

CAPABILITY	Cyber Security Head Office Unauthorised access to systems, loss of key data, and inability to operate IT systems	<ul style="list-style-type: none"> * Expert professional support * Regular review and updates * Current best practice * Experienced staff 	Diversification of information and IT systems across various independent platforms
CAPABILITY	Staff Retention and Diversity Failure to achieve satisfactory Staff retention and diversity of Head Office Management and Researchers	<ul style="list-style-type: none"> * Active diversity and inclusion strategy * Market-based employment conditions * Monitoring of staff turnover and diversity 	<ul style="list-style-type: none"> * MinEx CRC track record and reputation established * Depth of experience of the pool of candidates increasing * Management focus in these areas

Table 2: Risk and Impediments table.



Program 1 researchers on site during RoXplorer® 1000 CT drill testing.

3.5 Education and Training

Executive summary

- As of 30 June 2021, MinEx CRC had 27 Higher Degree by Research (HDR) students enrolled (21 PhD and six Masters by Research) and is progressing towards its target of 50 postgraduate student completions (from 60 commencements) within the 10-year life of the CRC.
- One PhD and one Masters student submitted their theses for examination during the reporting period.
- The concern in 2020 of a drop-off in student numbers has not materialised.
- All student projects are aligned with MinEx CRC goals. Each project is signed off by the MinEx CRC Project Leader, Program Leader, Industry co-supervisor, and the Chief Scientific Officer.
- Strategies for attraction and support for MinEx CRC postgraduate students have been implemented as planned and continue to be developed and refined.
- Students have been supported through the ongoing global Covid-19 pandemic through regular videoconference sessions that generate collegiality within the cohort and create opportunities for interaction with MinEx CRC Participants and Affiliates.
- Threats to student progress are continually assessed through a risk matrix that considers the impact of Covid-19 on student activities.
- MinEx CRC's driller training requirements have been refined in the context of the evolving drilling technology within the CRC. Development of formal driller training schedules and verifications is underway.

The extent to which the CRC is on target to achieve its Education / Training outputs and the strategies in place to address any issues

MinEx CRC's key education goals are to assist in training 200 VET students in specific aspects of drilling and mineral exploration fields and a target to produce 50 postgraduate completions. MinEx CRC is making significant progress in both areas.

MinEx CRC's driller training requirements and strategy for engaging appropriate partnering organisations, including Registered Training Organisations and TAFE, have been refined. This work has built upon an in-house Training Needs Analysis conducted in the previous reporting period with modification and refinement undertaken in the context of the current state of research and development of MinEx CRC's coiled tubing drill rig and the associated HPS system. The MinEx CRC E&T Committee has engaged with drilling training provider DDH1 and is in the early phase of developing formal driller training schedules and verifications.



MinEx CRC postgraduate student Mitchell Brockman (UofA).



The target of 50 HDR student completions is being sought from 60 student commencements in recognition that not all students will complete their program within the lifetime of MinEx CRC. Student enrolments, progression and completions are tracked via a student pipeline that has been developed as part of the Postgraduate Education Business Plan. As of 30 June 2021, MinEx CRC had six Masters by Research, and 21 PhD students enrolled in the HDR program, which is on track with the student pipeline (Appendix B). Two new Masters by Research and six new PhD students were registered within the reporting period, with one of the new PhD students withdrawing soon after commencement. One PhD and one Masters student submitted their theses for examination during the reporting period. Concerns of a drop-off in student numbers due to Covid-19 have yet to not materialise. The student register listing all active HDR students and project details as at 30 June 2021 is attached (Appendix C).

As part of our strategy to attract students into our HDR program, MinEx CRC financially supports both Honours and Masters by coursework students undertaking MinEx CRC-related projects. This initiative raises the profile of MinEx CRC with undergraduate students and allows the advertising of projects across multiple universities. The initiative supported ten Honours and six Masters by coursework students during the reporting period and has attracted one student into the MinEx CRC HDR program. A list of Honours and Masters by Coursework students and projects during this reporting period is attached (Appendix C).

Details of the Education / Training activities conducted during the reporting period

The MinEx CRC Education and Training Committee maintains a portfolio of potential PhD projects, collated into a Postgraduate Booklet, which it updates annually in consultation with Participants. Version 3.0 of the Postgraduate Booklet has been compiled and uploaded to the MinEx CRC web page for the purpose of advertising HDR projects in time for the quarter four 2021 scholarship rounds at Australian universities. Advertising was done online through the MinEx CRC website, social media, professional societies, SEEK and Earthworks.

A session dedicated to student presentations and discussion was held as part of the MinEx CRC 2020 Annual Conference, Frontier Exploration, held in November 2020. Twenty-one students presented in the session. A breakout session was held to allow students to network with conference delegates. Where possible, students were able to attend the conference through their local hub.



MinEx CRC postgraduate student Alex Simpson (UofA).



A mid-year 2020 Postgraduate Workshop was held online in July of this reporting period. This was a one-day event where individual students gave a live, short presentation to introduce themselves and their research project and progress. All postgraduate students active in the CRC at this time gave a presentation. The session was attended by approximately 80 representatives of the MinEx CRC community.

A mid-year Postgraduate Workshop was held online in June 2021. This event involved groups of 3-6 students giving pre-recorded video presentations. Groups were arranged according to the research theme. Twenty-six postgraduate students contributed to the video presentations. The one-day event was split into three sessions, with time dedicated to the discussion within each session, and was attended by 77 delegates.

Nine videoconference sessions were held throughout the reporting period to engage students and ensure they feel supported within the CRC environment. The E&T Coordinator ran these sessions with support from the MinEx CRC Project Officer. The sessions included presentations from the MinEx CRC Communications Manager, a representative of MinEx CRC Participant South32, sessions dedicated to discussion on student involvement within MinEx CRC events and preparation for the 2020 Annual Conference and the July 2020 and June 2021 Postgraduate Workshops. The MinEx CRC E&T Committee engaged with drilling training provider DDH1 in initiating the development of formal driller training schedules and verifications in the context of the current state of development of MinEx CRC's CT drill system. This has been undertaken in parallel with the refinement of MinEx CRC's driller training requirements and fits within the strategy for engagement of potential partnering organisations developed during an in-house Training Needs Analysis conducted in the previous reporting period.

Evidence of the level of student involvement in the CRC's activities

The approval process for MinEx CRC postgraduate students to be registered as CRC students requires sign off on the project topic by a MinEx CRC Project Leader, Program Leader, Industry Co-supervisor(s), E&T Committee Coordinator and the CSO. All projects are tightly integrated with MinEx CRC's Research, which is fundamental in ensuring student involvement with CRC Activities. Student research is regularly reported at MinEx CRC project meetings, workshops and conferences and is featured in external communications via the MinEx CRC webpage. Two students were involved in the development of "60 seconds with..." videos. These videos are available for students to promote their work and have been promoted by MinEx CRC through social media channels and are used on the website to advertise the postgraduate program.

Student research is key to meeting the vision and mission of MinEx CRC, with specific examples including:

- Project 1: Curtin University students' research in drilling fluid automation, cuttings transport, rock-bit interactions, impregnated diamond bits and down-hole percussive drilling. (Hing Hao Chan, Siew Hong Chai, Rui Huang, Snehal Jayakumar, Joao Victor Borges dos Santos).
- Project 3: University of South Australia student Fernando Fontana's research in testing laser-induced breakdown spectroscopy (LIBS) for generating semi-quantitative geochemical data.
- Project 4: Curtin University student research in using geophysics for drilling trajectory control. (Aruni Rajanayake).
- Project 5: Curtin University student research in the development of automated machine learning inversions of seismic data. (Anatolii Pakhomenko).
- Project 6: Student projects at the University of Western Australia developing methods for automated multi-scale 3D geological models and uncertainty predictions from geophysical data. (Rane Joshi, Saurabh Pandit, Mahtab Rashidifard, Nuwan Suriyaarachchi).

- Program 3: Signatures of alteration, basin analysis, thermochronology, geochronology and geophysics for understanding metal fertility and prospectivity in buried terranes in projects undertaken in multiple MinEx CRC-affiliated universities. (Mitchell Bockmann, Adrienne Brotodewo, Millicent Crowe, Stacey Curtis, Alex van Leeuwen, Naina, Angus Nixon, Joe Shifano, Alex Simpson, Darwinaji Subarkah, Luke Tylkowski, Zara Woolston, Zoe Wyllie, Jie Yu).

Evidence of the level of involvement of end-users in developing and conducting E&T activities, including the supervision of postgraduate students

End-users are directly involved in the development and supervision of MinEx CRC postgraduate students and projects. All MinEx CRC postgraduate projects require approval before they can be assigned to a student. This process requires sign off from a MinEx CRC Participant or Affiliate industry representative and with whom the project aims and objectives have been co-developed with academic supervisors. All MinEx CRC students must have a MinEx CRC Participant or Affiliate industry co-supervisor listed as part of their project before registering as a MinEx CRC student. Industry/end-user co-supervisors include staff from Anglo American, BHP, CSIRO, Geological Survey of New South Wales, Geological Survey of South Australia, Geological Survey of Victoria, Geological Survey of Western Australia, Geoscience Australia, McKay Drilling, Northern Territory Geological Survey and South32.

Where appropriate, students are involved and present at quarterly Project Review Panel meetings. Students regularly engage with end-users, particularly industry co-supervisors, in regular project meetings. Students have attended and presented at formal workshops held by MinEx CRC Participants. Project 6 students presented at Loop workshops held on Rottneest Island, Busselton and online for a European audience, and at the UWA Centre for Exploration Targeting research day. Project 8 students presented at the Geological Survey of South Australia Central Gawler Craton Workshop.

Support structures for postgraduate students, including the opportunities for interaction between students working in different parts of the CRC

Strategic planning by the E&T Committee has been undertaken to support and attract postgraduate students in the current environment where there is a strong competing demand from industry for graduates with expertise in mineral exploration coupled with limited student mobility due to Covid-19.



MinEx CRC postgraduate student Adrienne Brotodewo (UniSA).

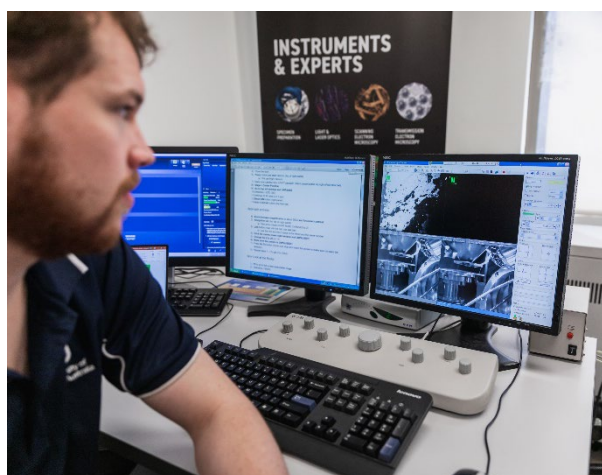
Financial support offered to MinEx CRC HDR students includes:

- All HDR candidates are awarded a MinEx CRC bursary valued at \$60,000 per PhD (three annual payments of \$20,000) and \$40,000 per Masters by Research (two annual payments of \$20,000).
- Bursaries can be used in any way to support the HDR candidate and their research, including; stipends, scholarship top-ups, fieldwork, travel and conferences, training and courses, project-related computing needs and analyses.
- A \$3,000 bonus to PhD students paid on completion.
- A \$2,000 bonus to Masters by Research students paid on completion.
- Financial assistance for MinEx CRC postgraduate students to attend the MinEx CRC Annual Conference, freeing up bursary funds to be re-allocated to student research projects.
- Single payments of \$1,000 to Honours and Masters by Coursework students undertaking MinEx CRC-related research activities and who may undertake a MinEx CRC postgraduate research project.

Non-financial support offered to MinEx CRC HDR students includes:

- across project and program boundaries and socialise the challenges of postgraduate research – particularly in light of Covid-19.
- Mid-year postgraduate workshops and dedicated sessions at MinEx CRC annual conferences, including presentations (and advice on life-after-research) from mineral exploration professionals across the spectrum of MinEx CRC Participant organisations.
- "End-user" mineral exploration professionals included in all MinEx CRC supervisory panels.
- Opportunity to engage with mineral exploration professionals in Mentor/Mentee relationships.

The MinEx CRC E&T committee maintains a risk matrix to monitor progress, identify potential problems, consider student welfare and develop individualised student support if required. The risk matrix includes the potential impact of Covid-19 on all active students. Two students have been significantly affected by the Covid-19 pandemic. One of these students has been unable to return to Australia through the reporting period and is considered at high risk of non-completion. This student has been strongly supported by his supervisors who are working with academics in the student's home country so that he can continue his studies remotely until he can return to Australia. The second student has been supported in changing host institutions, from the University of Newcastle to the University of New South Wales, to accommodate a change in supervision.



MinEx CRC postgraduate student Alexander De Vries Van Leeuwen (UniSA).

Graduate destinations

There were no HDR graduates during the reporting period.

Evidence that the Education / Training activities are meeting the needs of end-users

MinEx CRC postgraduate students are directly engaged with research projects of industry relevance, as evidenced by each student having an Industry co-supervisor. Postgraduate students regularly engage with end-users involved in individual projects, particularly their industry co-supervisor(s).

Three students undertook internships with industry end-users SANTOS and the Geological Survey of South Australia throughout the reporting period.

3.6 Intellectual Property Management

The following principles are applied in MinEx CRC under the guidance of a board sub-committee:

- IP resulting from MinEx CRC research is legally owned by MinEx CRC and beneficially owned according to project shares defined in individual Project Agreements. The only exception in Projects 1 to 6 is Project 6, where MinEx CRC legally and beneficially owns the IP due to developed open-source software.
- IP will be licensed, offered initially to the existing MinEx CRC METS participants.
- IP is to be diffused into the METS supplier sector as rapidly as possible as enhanced technology and/or services to mining companies. The mining companies that sponsor MinEx CRC have preferential terms of access.
- The METS supplier sponsoring each major project will have the first right to submit a commercialisation plan regarding IP developed by that project.

MinEx CRC currently holds:

- 73 properties across nine patent families. Of the 73, nine are Australian, and 64 are overseas.
- 15 properties across three design families and three trademark registrations. Of the 15, six are Australian, and nine are overseas.
- A total of 22 Licences/Options/Assignments (LOAs) are active between MinEx CRC and end-users (unchanged from 2020).



MinEx CRC postgraduate student Angus Nixon (UofA).



A list of Registered IP (patents, trademarks, designs) held by MinEx CRC is included in the MDQ and as Appendix D. Note that the majority of Intellectual Property patents and families listed above originated in the DET CRC and were deeded to Minex CRC on the termination of DET CRC in 2018.

3.7 CRC Future Plans and Transition Arrangements

MinEx CRC is in its fourth year of operations out of a 10-year funding life and is on track to commence Phase two of three planned phases in 2022. Phase Three of MinEx CRC, commencing in 2025, will consider wind-up arrangements for MinEx CRC.



MinEx CRC RoXplorer® 1000 CT drill rig.

3.8 Financial Management

MinEx CRC Ltd commenced operations on 12 April 2018. The financial tables below compare the current FY21, with FY20 and FY19 (which includes the period from 12 April 18 to 30 June 18).

REF	TITLE
Table 3	Revenue and Expenditure by Financial Year to date Including Cumulative Total
Table 4	Statement of Financial Position by Financial Year to date
Table 5	Cash Report, including a comparison to Commonwealth Agreement budget.
Table 6	Cash Report by Financial Year to date Including Cumulative Total

The following key points provide an overview of the financial performance of the CRC during FY21.

Cash Balance and Surplus

The CRC had a deficit for FY21 of \$3.7M compared to a restricted surplus for FY20 of \$5.6M and FY19 of \$11.8M. The cash balance at 30 June 21 was \$14.8M compared to 30 June 20 of \$18.2M and 30 June 19 \$13.7M. These funds are committed to future research programs, drilling campaigns, education and training activities and management of operational activities. The NDI drilling campaigns, which commenced in September 2020, and preparation for the field trials, which commenced in May 2021, reduced the cash balance by approximately \$8.6M in total. It is expected that the NDI drilling campaigns will reduce the cash balance by a further \$4.0M during FY22.

Participant Contributions

Total participant contributions received of \$6.8M (\$5.3M in FY20 and \$12.0M in FY19) exceeded the Commonwealth Agreement Budget (CAB) amount of \$2.8M by \$4.0M, primarily due to payments made in advance.

Research Projects

Research projects commenced in January 2019, with most approaching the completion of Phase 1 in December 2021. Payment to researchers is made quarterly in arrears based on actual expenditure. Project expenses were \$14.8M for FY21 (\$5.5M in FY20 and \$1.7M in FY19).

Interest Income

Cash balances are being invested in a mixture of short- and medium-term cash deposits appropriate for cash flow requirements. No interest income was included in the original CAB. The total interest income earned to date is \$537K. Interest rates have dropped over the year and remain very low.

CRC Contributions

Cash payments from the Commonwealth were \$5.8M in the period (\$6.6M for FY20 and \$2.8M for FY19). Payments from the Commonwealth are paid quarterly in arrears, following completion of the quarterly CRC Report.

National Drilling Initiative (NDI) Campaigns

The NDI drilling campaigns commenced in September 2020 and the East Tennant and South Nicholson campaigns were successfully completed and rehabilitated by June 2021.

Table 3 - Revenue & Expenditure (\$'000)	FY21	FY20	FY19	Cumulative Total
Revenue				
Commonwealth Funding	5,798.5	6,597.0	2,729.5	15,125.0
Participant Contributions	7,023.0	4,811.8	12,067.5	23,902.3
Affiliates Contributions	185.1	285.0	150.0	620.1
DET CRC Unspent Participant Contributions	-	-	113.6	113.6
Non-financial asset acquired for Nil Consideration	-	850.0	-	850.0
Interest Income	112.9	300.5	124.0	537.4
Royalty Income	34.1	-	-	34.1
Other Income	9.6	122.2	30.8	162.6
Total Revenue	13,163.2	12,966.5	15,215.4	41,345.1
Expenditure				
Research Program Expenditure				
- Program 1	2,576.7	2,121.4	486.1	5,184.2
- Program 2	1,610.1	1,524.6	544.8	3,679.5
- Program 3	10,405.2	1,859.8	653.5	12,918.5
- Opportunity Fund & Other Projects	204.8	-	-	204.8
Total Research Program Expenditure	14,796.8	5,505.8	1,684.4	21,987.0
Education & Training	504.4	384.5	200.0	1,088.9
Management Expenses	440.2	492.3	503.8	1,436.3
Salaries & Wages (incl Directors Fees)	1,143.9	996.9	1,005.3	3,146.1
	2,088.5	1,873.7	1,709.1	5,671.3
Total Expenditure	16,885.3	7,379.5	3,393.5	27,658.3
Restricted (Deficit)/ Surplus	(3,722.1)	5,587.0	11,821.9	13,686.8

Table 3: Revenue and Expenditure

Table 4 - Statement of Financial Position (\$'000)	30-Jun-21	30-Jun-20	30-Jun-19
Assets			
Cash at Bank	14,794.8	18,167.3	13,688.1
Trade Receivables	369.8	-	255.0
Other Receivables	442.2	396.6	166.4
Prepayments & Accrued Income	101.8	84.3	100.4
Mining Bonds	39.9	-	-
Property Plant & Equipment	1,251.6	1,031.2	9.2
Total Assets	17,000.1	19,679.4	14,219.1
Liabilities			
Trade Payables & Accruals	3,081.2	2,205.6	2,366.2
Employee Provisions	97.8	59.7	21.3
Lease Liability - Premises	134.3	5.2	9.7
Total Liabilities	3,313.3	2,270.5	2,397.2
Net Assets	13,686.8	17,408.9	11,821.9
Current Year Restricted (Deficit)/ Surplus	(3,722.1)	5,587.0	11,821.9
Retained Restricted Surplus	17,408.9	11,821.9	-
Equity	13,686.8	17,408.9	11,821.9

Table 4: Statement of Financial Position

Table 5 - Annual Cash Report (\$'000)			
	ACTUAL	PER AGREEMENT	VARIANCE
Cash Carried Forward	18,167.3	18,167.3	0.0
Receipts			
CRC Program Funds for the period	5,798.5	5,798.5	0.0
Participant Contributions	6,858.1	2,823.1	4,035.0
Other Firm Cash/Third Party Cash	104.7	-	104.7
GST Received	1,222.7	-	1,222.7
Interest	142.4	134.3	8.1
Total Receipts	14,126.4	8,755.9	5,370.5
Expenditure			
GST Paid	937.7	41.3	896.4
Capital Expenses	215.0	-	215.0
Employee Expenses	5,559.3	8,468.6	(2,909.3)
Supplier Expenses	10,786.9	7,817.2	2,969.7
Other Expenses	-	-	0.0
Total Expenditure	17,498.9	16,327.1	1,171.8
CASH BALANCE CLOSING	14,794.8	10,596.1	4,198.7

Table 5: Annual Cash Report

Table 6 - Cumulative Cash Report (\$'000)	FY21	FY20	FY19	Cumulative Total
Cash Carried Forward	18,167.3	13,688.1	-	-
Receipts				
CRC Program Funds for the period	5,798.5	6,597.0	2,729.5	15,125.0
Participant Contributions	6,858.1	5,311.9	11,957.5	24,127.5
Other Firm Cash/Third Party Cash	104.7	97.6	139.7	342.0
GST Received	1,222.7	1,068.6	1,404.3	3,695.6
Interest	142.4	303.1	74.5	520.0
Total Receipts	14,126.4	13,378.2	16,305.5	43,810.1
Expenditure				
GST Paid	937.7	1,370.0	1,061.6	3,369.3
Capital Expenses	215.0	237.0	-	452.0
Employee Expenses	5,559.3	5,323.1	1,035.1	11,917.5
Supplier Expenses	10,786.9	1,968.9	520.7	13,276.5
Other Expenses	-	-	-	0.0
Total Expenditure	17,498.9	8,899.0	2,617.4	29,015.3
CASH BALANCE CLOSING	14,794.8	18,167.3	13,688.1	14,794.8

Table 6: Cumulative Cash Report

MinEx CRC Limited

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PO Box 1130, Bentley, WA, 6102, Australia
admin@minexcrc.com.au



Appendix A

2020 Year in Review

2019-2020 YEAR IN REVIEW

KEY NUMBERS

31

end-user Participants and Affiliates (increased from 23 at June 2019), including mining companies, drilling equipment and service providers, exploration service providers and geological survey organisations.

7

research organisation Participants.

40

full time equivalent researchers (increased from 13.6 at June 2019) engaged in.

12

laboratory, workshop and field intensive research projects (increased by 3 from June 2019).

20

Higher Degree by Research students (increased from 9 in June 2019) aligned with research projects and with end-user supervision.

0

reportable WHSE incidents.

8/8

Commonwealth Milestones achieved.

137/139

Project Milestones achieved.

7% AHEAD

of cumulative research targets at mid-point of Phase 1 project agreements.



RESEARCH FOCUS

MinEx CRC remains focussed on delivering 1) safer, more efficient, environmentally friendly drilling technologies, 2) in-field sensing and data science to enable informed decisions while drilling and 3) pre-competitive geoscience data to de-risk exploration in frontier mineral provinces, delivered by the National Drilling Initiative.

RESEARCH MANAGEMENT

3 New projects commenced;

- Hydraulic Processing System (HPS) for CT drilling,
- Centrifuge Optimisation for fluid management,
- HPS accelerator and fines sampling.

Designed to bring CT drilling to the National Drilling Initiative in 2021.

RESEARCH ENGAGEMENT

4 industry Partners were involved in field trials of MinEx CRC technology including:

- iDrill drill rig recording system trialled on a **McKay Drilling** rig whilst operating in the Pilbara.
- Optic fibre distributed acoustic sensing (DAS) surface and borehole seismic survey conducted at **Anglo-American** coal mine in Queensland.
- Surface DAS seismic survey conducted over hyper-saline lake in WA in collaboration with **HiSeis** and **Matsa Resources**.

4 industry Partners contributed proprietary technology to MinEx CRC research projects:

- A drill rig provided in-kind by **Sandvik** will be a key component of the Curtin University experimental laboratory drilling platform "Arnie", which will be commissioned in early-2021.
- An experimental centrifuge has been provided in-kind by **Alfa Laval** to support the centrifuge optimisation for fluid management project.
- Designs are complete for a selective interval coring system for CT drilling based on a modified core barrel provided in-kind by **EPIROC**.
- A downhole positioning module provided in-kind by **Wassara** has been integrated into the beta version of the MinEx CRC 'smart' bottom hole assembly for CT drilling.

5 Geological survey organisations contributed **13.9 FTE** in preparation for National Drilling Initiative drilling campaigns, in the Northern Territory (to commence in Q3 2020), Western Australia and South Australia (2021), New South Wales and Victoria (2022).



ADVANCING TECHNOLOGY

3 GB of multi-parameter drilling data recorded by iDrill system over 360m of operational RC drilling in the Pilbara.

Commissioning of Dynamic Loop experimental facility able to simulate complex fluid and cuttings behaviour in boreholes up to **500m** deep.

Engineering calculations and designs for a CT rig with **1000m** reach are complete. Rig refurbishment is due for completion in the second half of 2020.

Downhole laser induced breakdown spectrometer (LIBS) prototype has passed its first "fast fail" trials, where it was able to characterise and differentiate rock types at **< 1 cm** resolution whilst moving past the target at speeds comparable to drilling ROP.

Built and tested a prototype **25 mm** diameter total counts gamma (TCG) logging-while-drilling sensor to fit within specifications of CT bottom hole assembly.

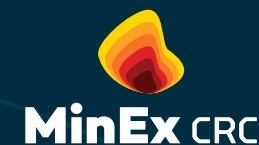
Combined borehole and surface optic fibre DAS seismic survey clearly imaged coal seams at **380m** depth in area where near-surface basalts hamper surface seismic techniques.

Built 3D model of the entire Hamersley Basin by stitching **24** one-degree models built from GSWA surface mapping and constrained by GSWA drilling database.

116 continent-scale map layers accessible via the NDI web portal, including borehole data, geology, geochemistry, geophysics, remote sensing, 3D models and inversions, cadastral and tenement information, mineral potential models.

Alteration in the covered East Tennant NDI campaign area constrained to **1850Ma**, comparable to the age of mineralisation in the Tennant Creek Inlier.

New data used to update prospectivity analysis of the East Tennant NDI area and prioritise **10** drill targets for the upcoming NDI campaign.



COMMUNICATIONS

- MinEx CRC's first Annual Conference: 'Frontier Exploration' was held 12-14 November 2019 in Perth, WA.
- 175 delegates attended the conference (66 % from industry/end-user organisations and 34 % from research organisations).
- 85% of Participant organisations and 52% of Affiliate organisations were represented.
- Project Integration Workshop held 29 April 2020 with 66 attendees.
- Eleven videos published on MinEx CRC TV.
- ~6,000 visitors and ~31,000 page views on the MinEx CRC website
- 122 press articles generated.

175
Annual Conference
attendees

6K+
website visitors

122
media hits

11
videos on
MinEx CRC TV

HEAD OFFICE AND STAFF

- Caroline Tiddy (University of South Australia), Education and Training Program Coordinator was nominated for a Women in Innovation Award, September 2019.
- MinEx CRC has lean management, with 4 full time equivalent head office staff based at two locations, the ARRC in Perth and UniSA in Adelaide.
- Masood Mostofi (Curtin University) Project 1 Leader and the Curtin Drilling Mechanics team were recipients of the Curtin University 2019 Emerging Research Team Award.



Australian Government
Department of Industry,
Innovation and Science

Business
Cooperative Research
Centres Programme

REVENUE & EXPENDITURE (\$'000)

Revenue	FY20	FY19
Commonwealth Funding	6,597.0	2,729.5
Participant Contributions	4,811.8	12,067.5
Affiliates Contributions	285.0	150.0
DET CRC Unspent Participant Contributions	-	113.6
Non-financial asset acquired for Nil Consideration	850.0	-
Interest Income	300.5	124.0
Other Income	122.2	30.8
Total Revenue	12,966.5	15,215.4

Expenditure	FY20	FY19
Research Program Expenditure		
- Program 1	2,121.4	486.1
- Program 2	1,524.6	544.8
- Program 3	1,859.8	653.5
- Opportunity Fund & Other Projects	-	-
Total Research Program Expenditure	5,505.8	1,684.4

Education & Training	384.5	200.0
Management Expenses	492.3	503.8
Salaries & Wages (incl Directors Fees)	996.9	1,005.3
Total Expenditure	1,873.7	1,709.1

Restricted Surplus/(Deficit)	5,587.0	11,821.9
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Majors, METS and Survey Participants



Research Participants and Affiliates



MinEx CRC Limited

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Appendix B

Student Pipeline

MinEx CRC's student pipeline

Institution	2019					2020					2021					2022					2023					2024					2025					2026					2027					2028 (to 30 June)				
	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS	Y1 students	Y2 students	Y3 students	Y3.5 students	COMPLETIONS										
Australian National University	1					1																																												
Curtin University	4					3	4				3	3	4			4	3	3	4			4	4	3	3	4	3	4	4	3			3	4	4	3			3	4						3				
University of Adelaide	5						5				0		5			1			5			2	1		5	1	2	1	0	0		1	2	1			1	2	1			1	2				1			
University of Newcastle						3					1	3					1	3					1	3			1			1				1					1						1					
University of New South Wales						1						1							1			1		1				1										1						1						
University of South Australia	2					3	2				3	3	2			3	3	3	2			3	3	3	3	2	4	3	3	3		4	3	3	3			4	3	3				4	3			4		
University of Western Australia	1					1	1				1	1	1			1	1	1	1			1	1	1	1	1		1	1	1						1	1						1							
CRC TOTAL	13	0	0	0	0	11	13	0	0	0	8	11	13	0	0	9	8	11	13	0	11	9	8	11	13	9	11	9	8	24	0	9	11	9	32	0	0	9	11	41	0	0	0	9	52	0	0	0	0	61

- Years refer to calendar years, except for 2028 which is to 30 June (end of MinEx CRC)
- Pipeline assumes 60 PhD student starts, each of which take 3.5 years to complete. The pipeline does not account for any Masters by Research starts, who will be expected to complete within 2 years.
- Numbers in each cell are respectively the numbers of first, second, third, fourth (to 3.5 years since commencement) and completed postgraduate students
- Colours indicate the progress of a year cohort.
- Non-completions are not accounted for within the pipeline. MinEx CRC aims to complete 50 students from 60 starts (83% completion rate).
- The pipeline allows for student commencements at each university as per the allocation based on the Participant universities overall involvement.

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**MinEx CRC**

ABN: 66 625 533 913

Appendix C

Student Register

Student Register

Postgraduate students

#	Student	Uni	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
1	Adrienne Brotodewo	UniSA	Caroline Tiddy	Adrian Fabris (GSSA)	PhD	Zircon as a geochemical exploration tool for iron oxide-copper-gold deposits: A case study of the Gawler Craton, South Australia	8	3/07/2017	3/07/2020	5/02/2019
2	Alexander Simpson	UoA	Stijn Glorie	Anthony Reid (GSSA)	PhD	Thermochronological and geochemical footprints of fluid alteration, recorded in apatite	8	15/03/2019	15/03/2022	13/02/2019
3	Angus Nixon	UoA	Stijn Glorie	Geoff Fraser (GA)	PhD	Thermochronological Evolution of the McArthur Basin and Surrounding Basement Areas	8	1/01/2019	1/01/2022	13/02/2019
4	Darwinaji Subarkah	UoA	Alan Collins	Amber Jarrett (NTGS), Geoff Fraser (GA)	PhD	Shale geochemistry and geochronology of the greater McArthur Basin	8	2/06/2019	1/06/2022	3/06/2019
5	Jie Yu	UoA	Martin Hand	Rian Dutch (GSSA)	PhD	Tectonic systems and IOCG mineralisation in the Gawler Craton	8	15/10/2018	15/10/2021	26/03/2019
6	Joe Shifano	UNSW	David Cohen	John Greenfield (GSNSW)	PhD	Regional biogeochemical mapping (and associated regolith studies) of the Cobar Basin for mineral exploration at regional to local scales	9	1/03/2019	1/07/2021	18/04/2019
7	Mitchell Bockmann	UoA	Martin Hand	Rian Dutch (GSSA)	PhD	The tectonic setting of early Mesoproterozoic mineral systems in the Gawler Craton	8	19/03/2018	19/03/2021	26/03/2019
8	Naina	ANU	Marnie Forster	Anthony Reid (GSSA), Geoff Fraser (GA)	PhD	Cambro-Ordovician magmatism and deformation at the eastern margin of Gondwana, South Australia: Insights into tectonic processes and mineral potential	8	29/03/2019	29/03/2022	6/05/2019
9	Ranee Joshi	UWA	Mark Jesssell	Tim Ivanic (GSWA)	PhD	Multi-scale 3D geological modelling of the Yalgoo-Singleton Greenstone Belt using the Loop Platform	6	22/01/2019	22/01/2022	26/02/2019
10	Alexander De Vries Van Leeuwen	UniSA	Tom Raimondo	Rian Dutch (GSSA), Joel Fitzherbert (GSNSW)	PhD	Timing, duration and conditions of metamorphism and crustal melting in the Curnamona Province	8	26/03/2018	17/04/2022	16/09/2019

#	Student	Uni	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
11	Siew Hong Chai	Curtin	Masood Mostofi	Phillip Fawell (CSIRO)	Masters	Drilling fluid automation	1	1/07/2019	31/07/2021	25/10/2019
12	Hing Hao Chan	Curtin	Masood Mostofi	Aaron Earl (McKay Drilling)	Masters	Experimental investigation on fundamentals of rock-bit interactions using impregnated diamond bits	1	1/07/2019	1/07/2021	28/10/2019
13	Joao Victor Borges dos Santos	Curtin	Thomas Richard	Bevan Eagle (McKay Drilling)	PhD	Experimental study of down-hole percussive drilling	1	30/07/2019	30/07/2022	10/01/2020
14	Mahtab Rashidifard	UWA	Mark Lindsay	Steven Micklethwaite (Anglo American), Richard Chopping (GSWA)	PhD	Constraining regional geophysics with sparse high-resolution data	6	21/10/2019	20/10/2022	3/12/2019
15	Nuwan Suriyaarachchi	UWA	Mark Jessell	Lachlan Hennessey (Anglo American), Richard Chopping (GSWA)	PhD	Integrated passive seismic/EM characterisation of cover as constraints on drilling	6	21/10/2019	20/10/2022	3/12/2019
16	Millicent Crowe	UNSW	Bryce Kelly	Robert Musgrave (GSNSW), Ian Roach (GA), Andrew King (CSIRO)	PhD	Integrating AEM and hydrogeochemistry: Implications for water resources	8	29/01/2020	29/01/2023	19/02/2020
17	Fernando Fontana	UniSA	Caroline Tiddy	Steve Tassios, Jess Stromberg, Neil Francis, Yulia Uvarova (CSIRO)	PhD	Laser-induced breakdown spectroscopy (LIBS) analysis for real-time downhole chemical assay	3	10/02/2020	10/02/2023	11/02/2020
18	Stacey Curtis	UniSA	Justin Payne	Mark Pawley (GSWA)	PhD	Integrated framework for the magmatic evolution of the greater Delamerian Orogen	8	10/02/2020	9/02/2023	1/04/2020
19	Anatolii Pakhomenko	Curtin	Andrej Bona	Ashley Grant (BHP)	Masters	Machine learning to invert surface-wave data	5	18/05/2020	18/05/2022	19/06/2020
20	Rui Huang (Eric)	Curtin	Masood Mostofi	Yevhen Kovalyshen (CSIRO)	Masters	Fundamentals of rock fragmentation of impregnated diamond bits	1	1/04/2020	1/04/2022	22/06/2020
21	Snehal Jayakumar	Curtin	Masood Mostofi	Yevhen Kovalyshen (CSIRO)	PhD	Cutting transport in RC drilling using compressible fluids	1	15/06/2020	15/06/2023	7/09/2020
22	Saurabh Pandit	UWA	Mark Jessell	Christian Seiler (Anglo American)	Masters	3D modelling of the Mount Isa South project area	6	1/7/2020	30/06/2021	3/11/2020
23	Aruni Rajanayake	Curtin	Brett Harris	Fiona Best (South32)	PhD	Innovative geophysics for drilling trajectory control	4	01/02/2021	1/02/2021	16/02/2021

#	Student	Uni	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
24	Mosayeb Khademi Zahedi	UniSA	Dave Giles	Teagan Blaikie (CSIRO)	PhD	Linking geophysics and geology through borehole data	5	8/2/2021	8/02/2024	18/02/2021
25	Luke Tylkowski	UniSA	Caroline Tiddy	Rob Duncan (GSV), Rob Thorn (CSIRO)	PhD	Resistate indicator minerals as an exploration tool for orogenic gold mineralisation: a case study from the Murray Basin, southeastern Australia	8	1/3/2021	1/03/2024	4/03/2021
26	Zara Woolston	UoA	Juraj Farkas	Anna Petts, Alicia Caruso (GSSA), Phil Gilmore, John Greenfield (GSNSW)	PhD	Tracing subsurface ore deposits through the isotope analysis of regolith/cover in Australia: Coupled Cu and S isotope approach applied to a rock-soil-water-plant system	8	1/3/2021	1/03/2025	7/04/2021
27	Sana Zulic*	Curtin	Andrej Bona	Sara Jakica (GSWA)	Masters	Advanced Borehole Seismic Imaging Techniques for Mineral Exploration	5	1/12/2016	1/02/2022	26/05/2020

*Part time student

Honours-Masters by Coursework Students

First Name	Last Name	Affiliation	Degree	Project Title	Primary Supervisor	Co-Supervisor(s) & Affiliation(s)
Oscar	Leon	Curtin	Masters by Coursework	Passive seismic imaging in mining applications	Andrej Bona	Milovan Urosevic (Curtin University)
Conaine Imtiaz	Nandolia	Curtin	Masters by Coursework	Experimental Study of Drilling Fluid Contamination	Masood Mostofi	
Bithiah A.	Esabunor-Nukie	Curtin	Honours	Predictive Simulink Modelling of Cuttings Velocity in Drilling Fluid for Depth Matching	Masood Mostofi	
Liowellyn	Pola	Curtin	Honours	Simulation of Power Hydraulic Systems using Simulink and Simscape	Masood Mostofi	
Sahal Rashed N	Mousa	Curtin	Honours	Testing autonomous data interpretation algorithms	Masood Mostofi	
Kelly	MacDonald	UoA	Honours	Tracking the sources of metal-carrying fluids in the crust	Martin Hand	Laura Morrissey (University of South Australia)
Erica	van der Wolff	UoA	Honours	The Adelaidean... But in New South Wales... What is that all about!?!	Alan Collins	Morgan Blades (Univeristy of Adelaide), Chris Clark (Curtin University), Phil Gilmore (GSNSW)
Peter	Keller	UoA	Honours	Oxygen in the Cryogenian Seas	Morgan Blades	Alan Collins (Univeristy of Adelaide), Phil Gilmore (GSNSW), Adrian Fabris (GSSA)
Alicia	De Groot	UoA	Honours	Tectonic Geography and Provenance of the Renner Group, Tomkinson Province, NT	Alan Collins	Morgan Blades, Bo Yang (University of Adelaide), Jo Whelan (NTGS), Amber Jarrett (GA)
William	Rowe	UoA	Honours	Regional implications for mineralisation in the Delamerian Orogen: the Kanmantoo Cu-Au Deposit	Lucy McGee	Laura Morrissey (University of South Australia), Juraj Farkas (University of Adelaide), Peter Rolley (Hillgrove), Adrian Fabris (GSSA)
Violet	Perry	UoN	Honours	Geochemistry of the Loch Lilly-Kars volcanics and correlation along the Tasman Line, Eastern Australia	Robin Offler	Ryan Dwyer, David Boutelier, Alisatair Hack (UoN), John Greenfield (GSNSW)
Travis	Batch	UoN	Honours	Investigations into the geology of the tumut Trough, Lachlan Orogen, NSW: Implications for mineral prospectivity	Robin Offler	Ryan Dwyer (UON), Mark Eastlake (GSNSW)

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Appendix D

Registered IP (Patents, Trademarks, Designs)

Registered IP (Patents, Trademarks, Designs)

Patents

PATENT FAMILY	RELATES TO	COUNTRY	APPLICATION NO.	FILING DATE	STATUS	MANAGEMENT
Borehole Logging Methods an Apparatus	AutoSonde	International	2013904475	19 Nov '13	Patent applications lodged in numerous countries by Boart Longyear	Boart Longyear
Sampling and Analysis System and Method for use in Exploration Drilling	Lab-at-Rig®	International	2014904646	19 Nov '14	Patent applications lodged in numerous countries by Imdex	Imdex
Drying apparatus and related method	Lab-at-Rig®	International	2014904649	19 Nov '14	Patent applications lodged in numerous countries by Imdex	Imdex
Capture of drilling fluid returns	Lab-at-Rig®	International	2015903272	Aug '15	Patent applications lodged in numerous countries by Imdex	Imdex
Mobile Coiled Tubing Drilling Apparatus	CT Rig	International	2017050508	30 May '17	Patent applications filed in numerous countries by POF on behalf of MinEx	POF (MinEx)
High Speed Downhole Coring System	CT Rig	Australia	2017101088	10 Aug '17	Innovation Patent Granted, 8 years Next renewal 10 Aug '22	POF (MinEx)
Sample Collection System and Parts Thereof	CT Rig, LAR for CT	International	2018050938	31 Aug '18	Patent applications filed in numerous countries by POF on behalf of MinEx	POF (MinEx)
Rotary Drill Head for Coiled Tubing Drilling Apparatus	CT Rig	International	2017051098	11 Oct '17	Patent applications filed in numerous countries by POF on behalf of MinEx	POF (MinEx)
Drilling Fluids and Uses Thereof	CTrol, CT Rig	International	2019050486	21 May '19	Patent applications filed in numerous countries by POF on behalf of MinEx	POF (MinEx)

Registered Designs

DESIGNS	COUNTRY	APPLICATION NO.	FILING DATE	STATUS	MANAGEMENT
Fluids Capture Apparatus	Australia	AU201514172	14 Aug '15	Registered, 10 years, expiry due 14 Aug' 2025	Imdex
Mobile Coiled Tubing Drilling Apparatus	International	AU201710287	18 Jan '17	Registered various countries on behalf of MinEx	POF (MinEx)
A Cone Member for a Cone Splitter	Australia	AU201715232	1 Sep '17	Registered, 10 years, renewal required at 5 yrs	POF (MinEx)

Trademarks

TRADEMARK	COUNTRY	APPLICATION NO.	CLASSES	FILING DATE	STATUS	MANAGEMENT
Lab-at-Rig®	Australia	1581982	7, 9, 37 & 42	23 Sep '13	Registered, 10 years	Imdex
RoXplorer®	Australia	1664080	7,37	11 Dec '14	Registered, 10 years	POF (MinEx)
CTrol®	Australia	1827061	1	21 Feb '17	Registered, 10 years	POF (MinEx)

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Appendix E

Publications

Publications

MinEx CRC researchers are highlighted and underlined in the author lists.

Armistead, S.E., Collins, A.S., Buckman, S. and Atkins, R. (2021) Age and geochemistry of the Boucaut Volcanics in the Neoproterozoic Adelaide Rift Complex, South Australia. Australian Journal of Earth Sciences, Volume 68, Issue 4, Pages 580-589

Brotodewo, A., Tiddy, C., Zivak, D., Fabris, A. and Giles, D. (2021) Geochemical discrimination of igneous zircon in the Gawler Craton, South Australia. Australian Journal of Earth Sciences, Volume 68, Issue 4, Pages 557-579

Caruso, A. S., Clarke, K. D., Tiddy, C. J. and Lewis, M. M. (2021) Airborne hyperspectral characterisation of hydrothermal alteration in a regolith-dominated terrain, southern Gawler Ranges, South Australia. Australian Journal of Earth Sciences, Volume 68, Issue 4, Pages 590-608

Cave, B., Lilly, R. and Hong, W. (2020) The effect of co-crystallising sulphides and precipitation mechanisms on sphalerite geochemistry: A case study from the Hilton Zn-Pb-(Ag) deposit, Australia. Minerals, Volume 10, Issue 9, Pages 1-22, September 2020, Article number 797

Chen, G. Y., Fox, S., Lancaster, D. G. and Soe, S. (2021) Temperature-Compensated Interferometric Torque Sensor with Bi-Directional Coiling. Journal of Lightwave Technology, Volume 39, Issue 12, Pages 4166-4173, 15 June 2021, Article number 9186273

De Vries Van Leeuwen, A. T., Hand, M., Morrissey, L. J. and Raimondo, T. (2021) Th–U powered metamorphism: Thermal consequences of a chemical hotspot. Journal of Metamorphic Geology, Volume 39, Issue 5, Pages 541-564, June 2021

Fontana, F. F., Tassios, S., Stromberg, J., Tiddy, C., van der Hoek, B. and Uvarova, Y. A. (2021) Integrated laser-induced breakdown spectroscopy (LIBS) and multivariate wavelet tessellation: A new, rapid approach for lithogeochemical analysis and interpretation. Minerals, Volume 11, Issue 3, Pages 1-22, March 2021, Article number 312

Grose, L., Ailleries, L., Laurent, G. and Jessell, M. (2021) LoopStructural 1.0: Time-aware geological modelling. Geoscientific Model Development, Volume 14, Issue 6, Pages 3915-3937, 29 June 2021

Guo, J., Li, Y., Jessell, M. W., Giraud, J., Wu, L., Li, F. and Liu, S. (2021) 3D geological structure inversion from Noddy-generated magnetic data using deep learning methods. Computers and Geoscience, Volume 149, April 21, Article number 104701

Hall, P.A., McKirdy, D.M., Halverson, G.P., Jago, J.B., and Collins, A.S. (2021) Biogeochemical status of the Paleo-Pacific ocean: clues from the early Cambrian of South Australia. Australian Journal of Earth Sciences, Volume 68, No. 7, Pages 968-991

Jessell, M., Ogarko, V., de Rose, Y., Lindsay, M., Joshi, R., Piechocka, A., Grose, L., de la Varga, M., Ailleries, L. and Pirot, G. (2021) Automated geological map deconstruction for 3D model construction using *map2loop* 1.0 and *map2model* 1.0. Geoscientific Model Development, Volume 14, Issue 8, Pages 5063-5092

- Lloyd, J. C., Blades, M. L., Counts, J. W., **Collins, A. S.**, Amos, K. J., Wade, B. P., Hall, J. W., Hore, S., Ball, A. L., Shahin, S. and Drabsch, M. (2020) Neoproterozoic geochronology and provenance of the Adelaide Superbasin. *Precambrian Research*, Volume 350, November 2020, Article number 105849
- Martin, R., **Giraud, J.**, **Ogarko, V.**, Chevrot, S., Beller, S., Gegout, P. and **Jessell, M.** (2021) Three-dimensional gravity anomaly data inversion in the Pyrenees using compressional seismic velocity model as structural similarity constraints. *Geophysical Journal International*, Volume 225, Issue 2, Pages 1063-1085, 1 May 2021
- McQueen, K., Alorbi, A., **Schifano, J.** and **Cohen, D.** (2021) Nickel uptake by cypress pine (*Callitris glaucophylla*) in the miandetta area, australia: Implications for use in biogeochemical exploration. *Minerals*, Volume 11, Issue 8, August 2021, Article number 808
- Nixon, A.L.**, **Glorie, S.**, **Collins, A.S.**, Whelan, J.A., Reno, B.L., Danisik, M., Wade, B.P. and Fraser, G. (2020) Footprints of the Alice Springs Orogeny preserved in far northern Australia: An application of multi-kinetic thermochronology in the Pine Creek Orogen and Arnhem Province. *Journal of the Geological Society*, Volume 178, Issue 2, Article 173
- Payne, J. L.**, **Morrissey, L. J.**, Tucker, N. M., Roche, L. K., Szpunar, M. A. and Neroni, R. (2021) Granites and gabbros at the dawn of a coherent Australian continent. *Precambrian Research*, Volume 359, 1 July 2021, Article number 106189
- Rashidifard, M.**, **Giraud, J.**, **Ogarko, V.**, **Jessell, M.** and **Lindsay, M.** (2020) Cooperative inversion of seismic and gravity data using weighted structure-based constraints. 3rd Conference on Geophysics for Mineral Exploration and Mining, Held at Near Surface Geoscience 2020, Virtual Online, 7 December 2020 – 8 December 2020, 167187
- Shulakova, V., Tertyshnikov K., Pevzner, R., Kovalyshen, Y., **Bona, A.** and Gurevich, B. (2020) Ambient seismic noise in urban environment: Case Study using Downhole DAS at Curtin University Campus. EAGE Workshop on Fiber Optic Sensing for Energy Application in Asia Pacific 2020, Virtual Online, 9 November 2020 – 11 November 2020, 170014
- Sidenko, E., **Bona, A.**, Pevzner, R., Issa, N. and Tertyshnikov K. (2020) Influence of interrogators' design on DAS directional sensitivity. EAGE Workshop on Fiber Optic Sensing for Energy Application in Asia Pacific 2020, Virtual Online, 9 November 2020 – 11 November 2020, 170014
- Simpson, A.**, Gilbert, S., Tamblyn, R., **Hand, M.**, Spandler, C., Gillespie, J., **Nixon, A.** and **Glorie, S.** (2021) In-situ Lu–Hf geochronology of garnet, apatite and xenotime by LA ICP MS/MS. *Chemical Geology*, Volume 577, 5 September 2021, Article number 120299
- Tertyshnikov K., Yurikov, A., **Bona, A.**, **Urosevic, M.**, Pevzner, R. and Critall, J. (2020) 3D VSP for coal seams exploration using permanently installed DAS. EAGE Workshop on Fiber Optic Sensing for Energy Application in Asia Pacific 2020, Virtual Online, 9 November 2020 – 11 November 2020, 170014
- Tiddy, C.**, **Zivak, D.**, **Hill, J.**, **Giles, D.**, Hodgkison, J., Neumann, M. and **Brotodewo, A.** (2021) Monazite as an exploration tool for iron oxide-copper-gold mineralisation in the Gawler Craton, South Australia. *Minerals*, Volume 11, Issue 8, Article number 809
- Yang, B., **Collins, A. S.**, Cox, G. M., **Jarrett, A. J. M.**, Denyszyn, S., Blades, M. L., **Farkas, J.** and **Glorie, S.** (2020) Using Mesoproterozoic sedimentary geochemistry to reconstruct basin tectonic geography and link organic carbon productivity to nutrient flux from a Northern Australian large igneous Province. *Basin Research*, Volume 32, Issue 6, Pages 1734-1750, December 2020



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