

MINEX CRC ANNUAL REPORT

1 July 2021 – 30 June 2022

MinEx CRC report number: 2022/75



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3.1 Executive Summary

MinEx CRC research remains on track after completing Phase 1 of three planned phases of research in December 2021. This success can be measured by the completion of all 14 Commonwealth Milestones and 315 of the required 318 quarterly milestones. This impressive achievement occurred despite the backdrop of the Covid pandemic.

Stage 2 commenced as planned on 1 January 2022, and by 30 June 2022, 51 of 70 Phase 2 quarterly project milestones had been met, with staffing shortages the main contributor to delays.

A highlight of the past year has been the successful commissioning and drilling undertaken by the revolutionary Coil Tube (CT) drilling rig, which drilled 19 drill holes for a total of 5200m in four areas.

The CT rig outperformed conventional drilling methods and showed significant WHS and environmental advantages in the same environment. In addition, the CT Rig acted as a platform for testing fluid management systems (developed in Project 1) and the borehole total count gamma tool (Project 4), streaming data from the bottom of the hole. An optic fibre-distributed acoustic sensor and cable were also successfully tested inside the coil of the CT rig.

In addition to testing equipment aligned with the CT rig, optic fibre sensors were successfully tested on an industry site in the Pilbara whilst being towed behind a vehicle for rapid data acquisition. The prototype laser downhole assay tool was also deployed in laboratory experiments, and progress is continuing on track with automated 3D modelling software.

Completing the East Tennant National Drilling Initiative (NDI) campaign in collaboration with the Northern Territory Geological Survey and Geoscience Australia was a significant success for 2022. Post-drilling analyses of drill cuttings and drill core continues, with a significant conclusion on the age of the basement rocks. The rush for tenements in the Northern Territory, stimulated by the MinEx NDI campaign, has continued, with over thirty companies holding exploration tenements and active industry exploration underway.

The NDI then moved to South Australia for the Delemairan Orogen NDI Campaign in collaboration with the Geological Survey of South Australia. Twenty-three drill holes spanning 7650m were achieved using conventional and CT drilling methods. Associated data was released to the public via the Geological Survey of South Australia's drilling atlas.

Additional workflows for classifying drill hole geochemical data, new techniques to improve airborne geophysical interpretations and patterns, and geology modelling in the Delamerian NDI campaign area have been undertaken. A continent-scale map of the age of rocks and mineralisation is under construction, complementing a map of mineral prospectivity being constructed and utilising an improved understanding of the Cu mineral systems.

Our Education and Training program continues from strength to strength. As of 30 June 2022, MinEx CRC had 35 Higher Degree by Research (HDR) students enrolled; we also welcomed our first two student completions.

Communication outputs have successfully showcased the technical achievements of our research. Our media footprint remains strong (132 press articles generated), and our YouTube channel (3.1k views) and website continue to be our key communication channels to promote our research.

MinEx CRC is committed to an ethos of equal opportunity and fair treatment of all associated with MinEx CRC-related activities, regardless of diversity. We welcome the appointment of our EDI Committee and Policy to MinEx CRC.

3.2 Achievements

The following summarises key achievements of MinEx CRC in the year July 1 2021 — June 30 2022.

HEAD OFFICE AND STAFF

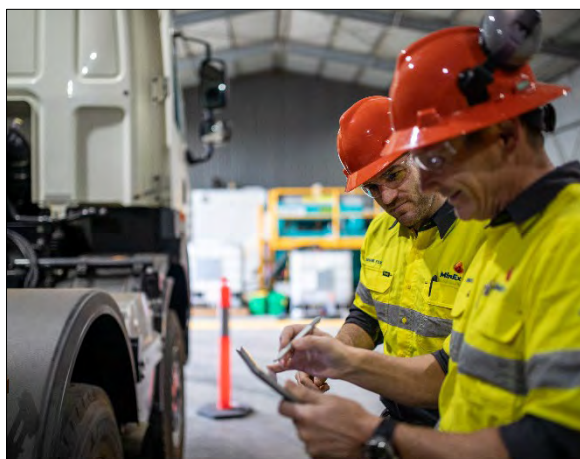
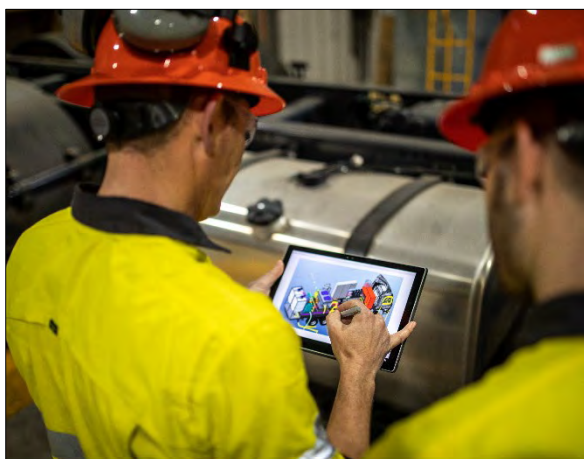
- Cameron Jackson was hired full-time as Drilling Manager in February 2022, based at the University of South Australia.
- Anthony Schofield, Program 3 Researcher (Geoscience Australia), was seconded as interim Program 3 Leader from March-August 2022.

RESEARCH MANAGEMENT

- Phase 1 projects were completed on 31st December 2021 and Phase 2 projects commenced on 1st January 2022.
- 318 of 318 Phase 1 quarterly milestones have been met.
- Researchers achieved 20 of 20 quarterly milestones associated with Opportunity Fund projects that were due on 30 June 2022.
- At 30 June 2022, 51 of 70 Phase 2 quarterly project milestones that were due had been met. Researchers were behind schedule on 19 milestones and ahead of schedule on 9 milestones.
- All 14 Commonwealth Milestones that were due during the reporting period were achieved.

AWARDS

- MinEx CRC awarded Company of the Year – Mining and Metals by APAC Business Headlines.
- The Delamerian NDI Drilling Campaign was selected as a Finalist for the 2022 SA Science Excellence and Innovation Awards, with the outcome to be known in November 2022.
- iFluid drilling system that automates the composition and delivery of drilling fluid selected as a finalist for the 2022 Curtin Innovation Awards, the winner of which, will be announced in November 2022.
- Internal MinEx CRC awards were presented at the Annual Conference as follows:
 - MinEx CRC 2021 Publications Award:
Fernando Fontana (UniSA), Steve Tassios (CSIRO), Jess Stromberg (CSIRO), Caroline Tiddy (UniSA), Ben van der Hoek (UniSA) and Yulia Uvarova (CSIRO) for *"Integrated laser-induced breakdown spectroscopy (LIBS) and multivariate wavelet tessellation: A new, rapid approach for lithogeochemical analysis and interpretation."*
 - MinEx CRC Team Player Award 2021: Stuart Addinell, Program 1 Researcher (CSIRO).
 - MinEx CRC Team Player Award 2021: Rian Dutch, Program 3 Researcher (GSSA).
 - MinEx CRC Team Player Award 2021: Alan (Charlie) Kerr, Program 1 Researcher (UniSA).



Program 1 Researchers Soren Soe (left) and Shane Fox (right) at UniSA.

EQUITY, DIVERSITY, AND INCLUSION (EDI)

MinEx CRC is committed to growing and supporting an equitable, diverse, and inclusive environment where everyone feels safe, valued, supported, and treated fairly with dignity and respect.

MinEx CRC undertook the following EDI actions during the reporting period:

- The MinEx CRC 'Code of Conduct' was established in July 2021 to ensure a collegiate, inclusive and encouraging atmosphere is maintained when undertaking the work of the CRC.
- The MinEx CRC 'Diversity and Inclusion Action Plan' was endorsed by the Executive Management Committee in October 2021.
- The MinEx CRC EDI Committee was appointed in May 2022.
- The MinEx CRC EDI Policy was finalised in May 2022 and publicly made available on the MinEx CRC website. A copy of this policy is included as Appendix E.
- The MinEx CRC Board (excluding the CEO) comprises six members, 50% male and 50% female.
- The MinEx CRC Executive Management Committee, including the CEO, comprises eight members, 62.% male and 37.5% female.
- Research Leads for the nine primary programs are 78% male and 22% female.

PARTICIPANTS AND AFFILIATES

The following tables summarise Participants and Affiliates of MinEx CRC to June 30 2022.

List of Participants during the reporting period

PARTICIPANT'S NAME	ABN OR ACN	ORGANISATION TYPE	CATEGORY
Anglo American Services (UK) Limited	N/A (International)	Industry	Large Miner
Australian National University	52 234 063 906	Research	University
BHP Billiton Iron Ore Pty Ltd	46 008 700 981	Industry	Large Miner
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	41 687 119 230	Government Body	Statutory Body
Curtin University	99 143 842 569	Research	University
Epiroc Rock Drills AB	N/A (International)	Industry	METS
Geological Survey of New South Wales	38 755 709 681	Government Body	Geo Survey
Geological Survey of South Australia	83 768 683 934	Government Body	Geo Survey
Geological Survey of Western Australia	69 410 335 356	Government Body	Geo Survey
Geoscience Australia	80 091 799 039	Government Body	Geo Survey
Geotec Boyles Bros SA	N/A (International)	Industry	METS
Imdex Ltd	78 008 947 813	Industry	METS
LKAB Wassara AB	N/A (International)	Industry	METS
McKay Drilling Pty Ltd	21 009 392 625	Industry	METS
Micromine Pty Ltd (Withdrawn 31/12/21)	52 000 047 745	Industry	METS
Minerals Research Institute of Western Australia	86 779 457 072	Government Body	Statutory Body
Rio Tinto	12 002 183 557	Industry	Large Miner
Sandvik Mining and Construction Oy	N/A (International)	Industry	METS
South 32 Ltd	74 601 343 202	Industry	Large Miner
The University of Adelaide	61 249 878 937	Research	University
University of Newcastle	52 234 063 906	Research	University
University of New South Wales	57 195 873 179	Research	University
University of South Australia	37 191 313 308	Research	University
University of Western Australia	37 882 817 280	Research	University

List of Affiliates during the reporting period

AFFILIATE'S NAME	ABN OR ACN	ORGANISATION TYPE	CATEGORY
Alfa Laval (Withdrawn 30/12/21)	65 000 016 197	Industry	METS
AuScope	33 125 908 376	Government Body	Statutory Body
Coresafe	63 161 969 786	Industry	Junior Miner
Datacode	N/A (International)	Industry	METS
Encounter Resources Limited	47 109 815 796	Industry	Junior Miner
EnviroCopper Ltd	19 635 434 721	Industry	Junior Miner
Evident (prev known as Olympus)	N/A (International)	Industry	METS
Geological Survey of Queensland	59 020 847 551	Government Body	Geo Survey
Geological Survey of Victoria	83 295 188 244	Government Body	Geo Survey
HiSeis Pty Ltd	83 136 507 429	Industry	METS
IFM Efactor Pty Ltd	48 083 423 938	Industry	METS
Inca Minerals	26 128 512 907	Industry	Junior Miner
Lodestone Mines Limited	67 150 740 613	Industry	Junior Miner
Matsa Resources	88 613 060 352	Industry	Junior Miner
MGPalaeo	66 149 377 097	Industry	METS
Middle Island Resources	70 142 361 608	Industry	Junior Explorer
Minalyze AB	N/A (International)	Industry	METS
Mineral Resources Tasmania	36 388 980 563	Government Body	Geo Survey
Demetallica (prev Minotaur Exploration Ltd)	16 061 595 051	Industry	Junior Explorer
Northern Territory Geological Survey	84 085 734 992	Government Body	Geo Survey
Santos QNT Pty Ltd	80 007 50 923	Industry	Large Miner
Sercel SAS	N/A (International)	Industry	METS
Strategic Energy Resources Ltd	14 051 212 429	Industry	Junior Explorer
The Virtual Explorer (TVE)	17 101 120 576	Research	Other
University of Tasmania	30 764 374 782	Research	University

Changes to Affiliates & Participants during the reporting period

AFFILIATE'S NAME	RETIRING, WITHDRAWING OR NEW	DEPARTMENT APPROVAL
Coresafe	New	Yes
Inca Minerals	New	Yes
MGPalaeo	New	Yes
Middle Island	New	Yes
University of Tasmania	New	Yes
Alfa Laval	Withdrawn	n/a
Evident (prev known as Olympus)	Transferred from Participant to Affiliate	Yes
HiSeis	Transferred from Participant to Affiliate	Yes
PARTICIPANT'S NAME	RETIRING, WITHDRAWING OR NEW	DEPARTMENT APPROVAL
Rio Tinto	New	Yes
Micromine	Withdrawn	n/a
University of New South Wales	Transferred from Affiliate to Participant	Yes

EDUCATION AND TRAINING

- On June 30 2022, MinEx CRC had 35 Postgraduate students enrolled.
- MinEx CRC had its first completions during this reporting period:
 - Saurabh Pandit (Masters by Research): 3D modelling of the Mount Isa South project area, University of Western Australia
 - Adrienne Brotodewo (PhD): Geochemical signature of zircon in relation to mineral systems, University of South Australia
- The Mid-year 2022 Postgraduate Workshop was held online in May with 80 attendees.
- Nine video conferences were held throughout the reporting period to engage students and ensure they feel supported within the CRC environment.
- Fifteen students presented at the Annual Conference held in November 2021.
- Two students undertook internships with industry end-users CSIRO and the Geological Survey of South Australia throughout the reporting period.
- Version 4 of the Postgraduate booklet was published digitally on the MinEx CRC website in July 2021.

COMMUNICATIONS AND EVENTS

- Three quarterly editions of the MinEx CRC vNews were published on MinEx CRC TV (the MinEx CRC Annual Conference serves as the Q4 update for researchers and sponsors).
- Eight videos were published on MinEx CRC TV, with three thousand views in total.
- A promotional video was released on the CT Kapunda Field Trials featuring key researchers and community leaders.
- 132 press articles generated.
- 27 thousand visitors to the MinEx CRC website, with 62 thousand page views in total.
- The '2021 Year in Review' summary document was released and included as Appendix A.
- The annual Mid-year Project Integration Workshop was held online in June with 81 attendees.
- MinEx CRC's third Annual Conference: Frontier Exploration was held on 15-16 November 2021 in a combined online and in-person format, with three in-person hubs in Perth, Adelaide and Canberra. Over 180 delegates from 35 organisations attended the conference.

SME ENGAGEMENT

- Field trials of the MinEx CRC CT drilling platform (including drill rig and hydraulic processing system) were conducted at the Kapunda field site of Affiliate EnviroCopper.
- MinEx CRC-designed measurement, monitoring and control systems ("DTrol") have been installed on two drill rigs, a Reverse Circulation percussion drill rig and a Diamond drill rig, operated by MinEx CRC Participant McKay Drilling.



MinEx CRC CT drill rig on site during the GSSA NDI Campaign.

- MinEx CRC maintained its relationship with OMNI GeoX to coordinate and manage aspects of the Delamerian South NDI campaign.
- Participant Imdex Limited provided significant in-kind contributions of people and equipment to research projects and logging 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 conducted field trials at Anglo American and BHP field sites.

INTERNATIONAL COLLABORATION:

- Cooperation is ongoing with European based METS companies Sandvik, Epiroc, LKAB Wassara and Sercel. Staff from the Anglo American London office have become involved with pull-through of MinEx CRC CT drilling technology, which has prompted discussions with international companies interested in commercial manufacture of the CT platform. Chilean based drilling company Geotec Boyles remains an active participant in Project 1, with field trials in South America being planned for calendar year 2023.

PUBLICATIONS

- 29 peer-reviewed scientific publications with MinEx CRC byline or acknowledgments (28 articles in scientific journals and one peer-reviewed conference papers).
- There were 18 MinEx CRC Technical Reports published during the reporting period including 14 Commonwealth Milestone Reports.

RESEARCH MANAGEMENT

Phase 1 projects were successfully completed on 31st December 2021 and Phase 2 projects commenced on 1st January 2022. Program 1 and 2 projects rolled over into Phase 2 with only minor changes in staffing and with Phase 2 yearly milestones and Phase 2 Year 1 quarterly milestones in place, following consultation with Participants in Q3 and Q4 2021. Program 3 has been restructured into a single Project with five subprojects (P7.1 through P7.5) which reflect the research priorities identified by GSO Participants during the Phase 2 planning process (beginning March 2021).

At 31 December 2021 researchers had achieved 315 of the 318 Phase 1 quarterly project milestones that were due. The remaining three milestones were completed in Q1 2022. At 30 June 2022 researchers had achieved 51 of the 70 Phase 2 quarterly project milestones that were due. Researchers were behind schedule on 19 milestones and ahead of schedule on 9 milestones. Cumulative progress against all Phase 2 core project milestones was 23.6% compared to a target of 26.7%. Of the six active Opportunity Fund projects Researchers had achieved 20 of 20 quarterly milestones that were due on 30 June 2022.

Program 1 researchers Soren Soe (left) and Shane Fox (right) at UniSA.

All 14 Commonwealth Milestones due during the reporting period were achieved, with reports uploaded to the MinEx CRC sharepoint for dissemination to Participants and Affiliates.

RESEARCH HIGHLIGHTS

Drilling optimisation

- The first-of-a-kind discreet impact experimental setup for percussion drilling ("Woody") is now fully commissioned and producing experimental data. *Woody* is designed to investigate the fundamentals of percussion drilling performance in unprecedented detail. Researchers can now conduct each single impact experiment in 30 seconds resulting in more than 1500 experiments and 1Tbyte of data. These data will provide insights into the physical mechanisms controlling

the anecdotal "sweet spot" of percussion drilling and inform the design of more efficient bottom hole assemblies and operating parameters.

- MinEx CRC-designed measurement, monitoring and control systems ("DTrol") have been installed on two drill rigs, a Reverse Circulation percussion drill rig and a Diamond drill rig, operated by MinEx CRC Participant McKay Drilling. Program 1 researchers established two-way communications between rig control and DTrol systems. They completed a commissioning and debugging exercise within a (relatively) well-controlled drilling environment in the Swan Valley close to Perth. Both rigs have been mobilised to McKay drilling operations, where the DTrol systems will be tested in a real-world drilling environment during the second half of 2022.

Fluid management for Diamond and Coiled Tubing drilling

- The prototype fluid management system for Coiled Tubing drilling, CTiFluid, has been incorporated into the Hydraulic Processing System for Coiled Tubing drilling and deployed in drilling trials at Mawson Lakes and Kapunda and during 24-hour production drilling operations for the Delamerian National Drilling Initiative (NDI) campaign. The total field deployment time for CTiFluid, as of June 30 2022, was approximately 700 hours for 5248 meters of drilling. All CTiFluid deployments to date have been conducted in South Australia, with CTiFluid being remotely controlled by Curtin University researchers from their offices in Perth. During much of this time, the system ran in auto-pilot mode. With continuous monitoring and automated adjustment of fluid properties, CTiFluid was able to provide consistent mud properties, mitigate fluid loss and ensure borehole stability. During the Delamerian NDI deployment, some operational issues with the prototype CTiFluid led to intermittent drilling disruptions. Program 1 Researchers isolated the root cause of the most disruptive issues and performed upgrades of CTiFluid. These upgrades improved the performance of CTiFluid and resulted in increased drilling "up-time" throughout the program.

Coiled Tubing drilling trials and NDI deployment

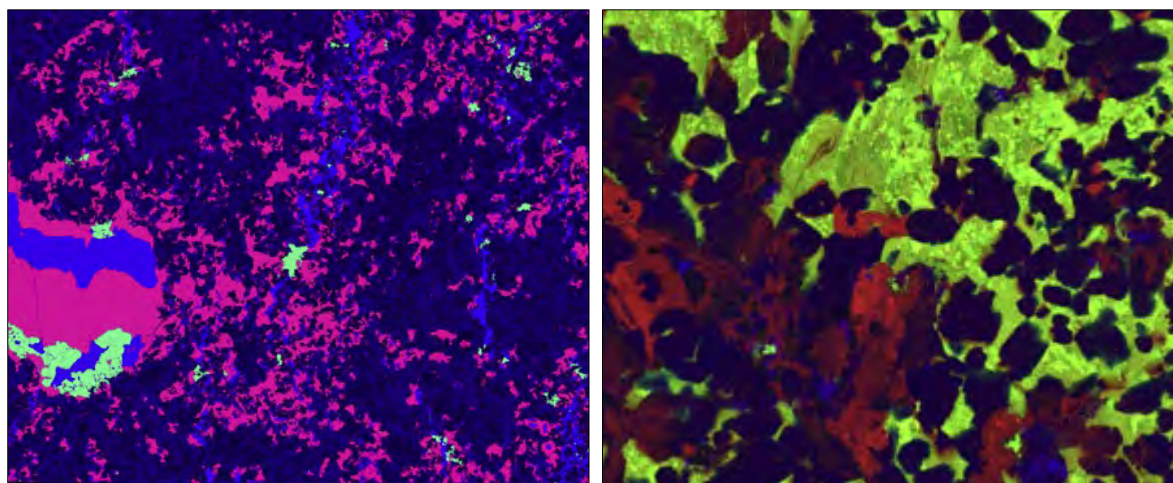
- Coiled Tubing drilling trials were conducted at UniSA Mawson Lakes campus (July-August 2021) and Kapunda (September 2021), and the CT drilling platform was deployed to the Delamerian NDI campaign (October 2021 to April 2022). Researchers completed 19 drill holes for a total of 5211m during the reporting period – almost tripling the total number of meters drilled on the CT platform. The trials were used to test and improve the drilling infrastructure (CT drill rig, bottom hole tools, HPS and CTiFluid) and operating procedures and benchmark against conventional drilling. The MinEx CRC CT platform outperformed conventional drilling methods in the same environment during the Delamerian NDI campaign (based on average penetration rates, speed of hole completion, borehole integrity, sample quality, water and fuel consumption) and delivered significant WHS and environmental advantages. Along with high-quality drill cuttings, the CT rig delivered bottom-of-hole drill core from 16 of the 17 holes drilled in the Delamerian NDI campaign. Highlights of the Delamerian NDI campaign are summarised in the following table:

CATEGORY	MEASURE	HIGHLIGHTS/COMMENTS
Safety	0	<ul style="list-style-type: none"> • There were two safety incidents investigated during the Delamerian NDI campaign but none resulted in any injuries.
Environment	One spill	<ul style="list-style-type: none"> • One minor leak of drilling fluid at the drill collar
Number of holes	17	<ul style="list-style-type: none"> • 17 holes drilled in 130 shifts (excluding mob/demob)
Water consumption	86 litres/m	<ul style="list-style-type: none"> • <1/10th of rotary mud + diamond drilling in same formation
Fuel consumption	4.5 litres/m	<ul style="list-style-type: none"> • <60% of rotary mud + diamond drilling in the same formation
Meters drilled	4652.1m	<ul style="list-style-type: none"> • 481.7m hole (NDIAW_D04_CT) is the deepest hole yet drilled with the RoXplorer® CT rig
Pre-collar and casing	477m	<ul style="list-style-type: none"> • Average ROP drilling pre-collar 8m/hr • Max PQ casing was 51m (in three holes) • 21m of PQ casing could not be retrieved from one hole
HQ casing	235m	<ul style="list-style-type: none"> • 235m is the deepest casing inserted and retrieved with the RoXplorer® CT rig
CT rotary mud and percussion drilling	4132.5m	<ul style="list-style-type: none"> • Average ROP while drilling 13m/hr • Best 12h shift 192m • 98% of cuttings samples recovered
Diamond coring	42.7m	<ul style="list-style-type: none"> • Core recovered from 16 of 17 holes drilled • Average ROP while coring 1m/hr • Max coring interval 4.2m • Core recovery 58% to 100% depending on ground conditions
Hole integrity		<ul style="list-style-type: none"> • No stuck drill pipe • Near-surface casing + fluid management with LiqiCTrol ensured hole integrity in 16 of 17 drill holes. • The pre-collar in the first hole (NDIAW_D06_CT) was abandoned at 33m and re-drilled. Fluid loss at the basement/cover interface (~230m) in the same hole could not be mitigated by drilling additives. Circulation was recovered after inserting a 235m HQ casing.
Hole deviation	<10%	<ul style="list-style-type: none"> • Max deviation was ~10% measured as (lateral deviation*100/depth) for the vertically collared hole.

The MinEx CRC prototype LIBS downhole assay tool has been built and deployed in laboratory experiments with version 2 of our SmartHole. The downhole prototype includes a new design of front-end optics and two independent spectrometers (for visible and UV wavelengths). Code has been developed to seamlessly stitch the two spectra. The SmartHole has been built from decimetre-scale slabs of well-characterised samples with centimetre-scale mineralogical and chemical heterogeneity. Comparison of LIBS spectra with the known chemistry and mineralogy of the SmartHole has allowed us to improve analytical data models to extract elemental concentrations directly from the LIBS data. Experiments to assess the performance of LIBS on water-saturated samples and samples with centimetre-scale surface roughness are underway. SmartHole2 blocks that were left to soak over three days in water could be analysed quite easily by LIBS. Ability to analyse very rough surfaces will likely need a fast auto-focusing system.

Logging-while-drilling (LWD) for petrophysics and geo-steering

- The MinEx CRC borehole total counts gamma tool (Gamma GeoSub) was deployed on the Coiled Tubing drilling rig at Kapunda in September 2021. The tool was integrated with the CT "Smart bottom hole assembly" (Smart BHA) with multiple data streams (gamma, three component accelerations, gyro hole orientation and temperature) successfully transmitted to the surface from the bottom of the hole.
- The laboratory prototype of the MinEx CRC swept EM tool (including sensor, control board, wireless data transfer and battery pack) has been built with a form factor that will allow it to be incorporated into a drilling sub for deployment with the Coiled Tubing drilling rig. Preliminary laboratory tests indicate that the tool is highly sensitive. A sensor housing, intended to withstand pressure and temperature conditions within a 1000m borehole, is made from fibreglass to ensure transparency with respect to electromagnetic fields.
- Program 2 Researchers incorporated an optic fibre distributed acoustic sensor (DAS) along with copper wire into a multi-purpose communication and sensing cable, which was fitted inside the Coiled Tubing for the CT drilling rig. Researchers tested the potential for the cable to be used as a logging-while-drilling seismic receiver during the Delamerian NDI campaign – using both surface weight drops and energy from the drill bit as the seismic source. The results were encouraging and have prompted further work, which will aim to streamline data transfer from the drill rig via an optic fibre slip ring mounted on the drill coil.



Cross section of LIBS analysis data.

Seismic in the drilling workflow

- Program 2 Researchers conducted 3D seismic surveys using optic fibre distributed acoustic sensors (DAS) at the BHP Bonobo prospect in the Pilbara. Four different cable designs (standard telecoms, engineered, helically wound and tight buffer cables) and compared against standard geophones with one-meter spacing. Compared to a buried cable, standard telecom cables were tested for their potential as "land streamers" – towed over the land surface behind a vehicle for rapid data acquisition. The land streamer signal suffered from more wind noise but had comparable coupling to the sub-surface as the buried cable. The land streamer data were used to invert for surface wave velocities in the top 60 meters – which provide a useful constraint on rock properties and depth to basement.
- Researchers completed a field trial of a WellSense drop-down fibre (VLI) shuttle to assess its potential to effectively deploy optic fibre into a borehole.

Automated 3D modelling

- Researchers are implementing an online self-service platform that will enable third-party users to access and run the software tools and applications developed by MinEx CRC and the broader Loop consortium (e.g. map2loop, dh2loop, Tomofast-x, loopUI) on remote high-performance computers (HPC). With enterprise-grade security, this will enable users to store and manage their data locally and access HPC resources from their workstations.

East Tennant National Drilling Initiative (NDI) campaign

- Post-drilling analyses of drill cuttings and drill core (including geochronology, thermochronology, geochemistry, petrology and geophysics) have confirmed that the basement rocks in the East Tennant NDI campaign area are of comparable age and characteristics to the rocks which host the well-known copper-gold Tennant Creek mineral deposits. The pegging rush which accompanied the East Tennant NDI campaign in 2020 has continued, with over thirty companies now holding exploration tenements in the area and active exploration (including geophysical surveys and drilling) now underway.



Discrete impact drilling experiments at Curtin University.

Delamerian National Drilling Initiative (NDI) campaign

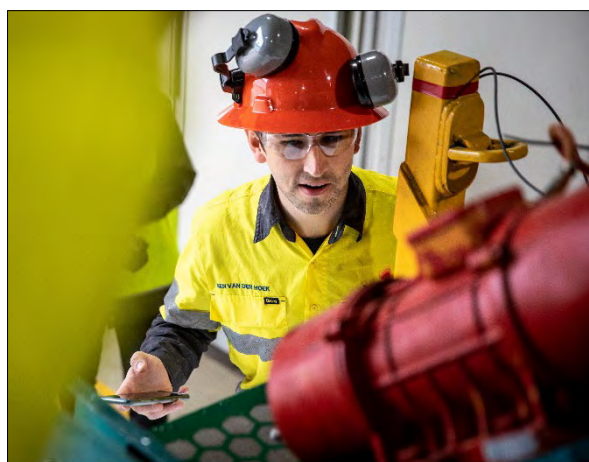
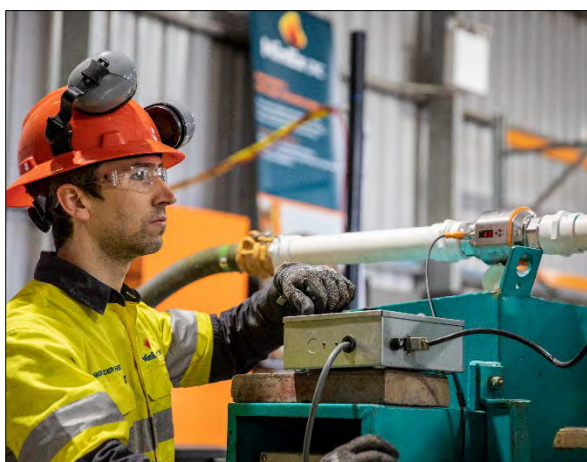
- Six rotary mud/diamond drill holes (1976m) and 17 Coiled Tubing drill holes (4652m) were completed between October 2021 and April 2022 as part of the Delamerian National Drilling Initiative (NDI) campaign in eastern South Australia. Drilling data, wireline geophysical logs, geological logs, core photos, and portable XRF data on drill cuttings were collected during the drilling campaign and made available to the public via the South Australian Drilling Atlas, which can be reached via the MinEx CRC webpage. Preliminary data provide strong support that the basement rocks in the Delamerian NDI campaign area were formed in a back-arc tectonic setting of the Cambro-Ordovician age, with the potential to host base and precious metal deposits similar to known mineral systems in western Tasmania. The post-drilling sampling and analytical program have been planned and prioritised, with results expected in financial year 22/23.

Geological Architecture and Evolution

- Program 3 Researchers have developed a workflow for objective classification of drill hole portable XRF geochemical data into geological units. Portable XRF delivers a restricted range of elements (22 used in our study) but can be deployed quickly and at a low cost at the drill site or core yard. The workflow uses machine learning clustering techniques to identify like groups of analyses and define geological boundaries at the edges of like domains. The technique will be beneficial to aid in the objective logging of drill cuttings – where subtle lithological variations may be difficult to identify with visual logging.
- Researchers are implementing new techniques to improve airborne electromagnetic (EM) inversions so that the output is more likely to honour stratigraphic layering and the location of paleochannels. "Occam" layered inversions provide an objective means of estimating the most-probable number of layers in the near subsurface. Conductivity values are assigned, which minimise variations within each layer and highlight the contrast between layers – with a closer intuitive match to geology than "smoothed" unconstrained inversions. Researchers have used 2D surface images (e.g. satellite or magnetic images) to locate better the boundaries of narrow features (e.g. paleochannels) in EM inversions. The algorithms will be applied to the thousands of line kilometres of airborne EM data collected by Geoscience Australia and the various State Geological Survey Organisations over the last decade and are planned to continue over the life of MinEx CRC.
- 3D unconstrained gravity and magnetic inversions and 2.5D forward models were constructed to understand better broad-scale variations in density and magnetic susceptibility in the Delamerian NDI campaign area. The resulting 2D and 3D models indicated several zones with contrasting rock properties and provided first-order constraints on the sub-surface geometry, which the drilling could test.
- Researchers continue to build a continent-scale set of argon-argon thermochronological data (collaborating with the National Argon Map initiative, also supported by AuScope). MinEx CRC researchers contributed over 90 analyses to the National Argon Map during the reporting period, with notable case studies from the East Tennant and Delamerian NDI campaign areas. The East Tennant argon-argon data demonstrate a long and complex history of multiple thermal and fluid flow events beginning soon after the major igneous and metasomatic event at ~1850Ma and lasting until the Cambrian period at ~500Ma.
- Researchers have committed to developing in-situ Re-Os and Lu-Hf geochronological techniques suited to dating minerals formed during mineralisation (e.g. sulphides, carbonates, phosphates and garnet). Promising age standards have been selected for apatite, calcite, garnet (Lu-Hf) and molybdenite (Re-Os). They have been characterised by LA-ICP-MS and μ XRF (for identifying and mapping internal heterogeneity) and high-precision TIMS (for establishing the age standard).

Mineral systems and prospectivity assessment

- Researchers have progressed our understanding of Cu-isotope fractionation in mineral systems with parallel studies of modern-day sites (volcanos and seafloor hydrothermal vents) and ancient volcanic sequences (e.g. the 1590Ma Gawler Range Volcanics) and mineralising systems, including the Cambro-Ordovician Kanmantoo Cu deposit in the Adelaide Hills and the Tennant Creek Cu-Au mineral system. Cu-isotopes have the potential to fingerprint mineral systems and constrain important mineralising processes such as magmatic fractionation, devolatilisation, hydrothermal alteration and weathering.
- Researchers used data from the Delamerian NDI campaign area to develop and test a new method to level regional geophysical data collected over regions with variable cover depth. Human intuition and machine learning algorithms are limited in their ability to make sense of magnetic and gravity data due to the ambiguity between source depth, geometry and rock properties inherent in potential field techniques. The new method involves a variable upward continuation of the geophysical data to a common "depth-above-basement". This allows geophysical anomalies and patterns to be interpreted on a level playing field across the survey area.
- Mineral potential (or prospectivity) models have been constructed for the Cobar and Victorian Goldfields NDI campaign areas using various knowledge- and data-driven techniques. The models will inform drill hole targeting and prioritisation for the NDI campaigns scheduled for 2023 and 2024.



Program 1 Researcher Ben van der Hoek conducting experiments at UniSA.

3.3 Research Case Study

Delamerian National Drilling Initiative (NDI) campaign

The Delamerian NDI campaign is a first-of-a-kind collaboration between MinEx CRC researchers at the University of South Australia (UniSA), Curtin University (Curtin), CSIRO, Imdex Limited (Imdex) and the Geological Survey of South Australia (GSSA). The aims of the campaign are twofold; 1) to uncover a new mineral province beneath the shallow marine deposits and sand dunes of the Murray Basin in the eastern boarder regions of South Australia, and 2) to provide a field trial for innovative drilling and data collection technologies under development within MinEx CRC.

In Australia, a microcosm of the global minerals industry, there is a fundamental impediment to current and future mineral exploration. Most rocks with the potential to host new mineral discoveries are buried by a veneer of sedimentary rocks and weathered materials, which deny explorers the option of direct observation, obscure the geophysical and geochemical response and increase the cost of sampling and analyses because drilling is required. Drilling has inherent safety risks and environmental impact (through its footprint on the landscape, its consumption of water and fuel and emission of carbon dioxide) and is time-consuming and expensive. The combination of high drilling costs and uncertain outcomes means fewer holes are drilled in these 'covered' geological terranes. Key geological questions remain unresolved, and prevailing uncertainty inhibits further exploration investment. This vicious cycle lies at the heart of the 'challenge of cover'.

MinEx CRC is addressing the challenge of cover from two sides; 1) by reducing geological uncertainty by drilling and sampling under areas of cover; and 2) by reducing the cost, improving the safety and minimising the environmental impact of drilling. A key part of the MinEx CRC strategy has been developing Coiled Tubing (CT) drilling for mineral exploration, primarily driven by the MinEx CRC Drilling Engineering research team based at UniSA. The CT drilling platform developed by MinEx CRC includes a drill rig with 500m of continuous steel drilling pipe spooled onto a reel, coupled with a hydraulic processing system (HPS) designed to manage the drilling fluid and ensure the collection of high-quality samples. Both the CT drill rig and HPS are bottom-up engineering projects, unlike any commercially available mineral exploration drilling platform. Their design has been informed by fundamental research (mechanical engineering, materials science, fluid mechanics, separation science and sampling theory, optic fibre sensing and communications) conducted within MinEx CRC and building on the legacy of Deep Exploration Targeting CRC (2010-2018).

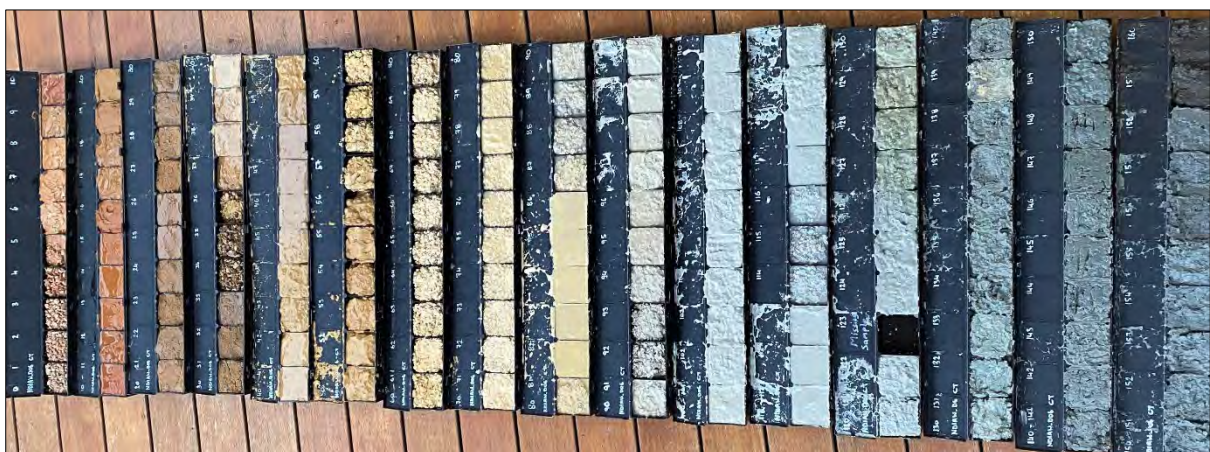


MinEx CRC CT drill rig on site during the GSSA NDI Campaign.

The MinEx CRC CT drilling platform provides an efficient tool for exploration under cover and is a commercialisation opportunity in its own right. The Delamerian NDI campaign has allowed us to test and improve our CT drilling infrastructure and workflows and to benchmark the performance of the CT drilling platform with conventional drilling technologies. In total, there were 23 holes drilled in the Delamerian NDI campaign; six holes were drilled with a conventional rotary mud/diamond rig (1976m), and 17 holes were drilled with the CT drilling platform (4652m). Five of the CT holes (1779m) were drilled adjacent to the six conventional drill holes in the southern part of the Delamerian area. The CT holes were drilled more quickly, with less water, lower fuel consumption and lower carbon footprint than the conventional drill holes, delivering significant cost savings and environmental advantages.

A key component of the successful Delamerian NDI campaign was the deployment of CTiFluid technology, developed by the MinEx CRC Drilling Optimisation research team based at Curtin University. CTiFluid is a prototype fluid management system for CT drilling, including a plumbing system, sensors for constant online monitoring of fluid properties and automated mixing of fluid additives in response to changing conditions. CTiFluid was incorporated in the HPS during the Delamerian NDI campaign, where it was remotely controlled by Curtin University researchers from their offices in Perth. During much of this time, the system ran in auto-pilot mode. With continuous monitoring and automated adjustment of fluid properties, CTiFluid was able to provide consistent mud properties, mitigate fluid loss and ensure borehole stability.

Through the Delamerian NDI campaign, the Geological Survey of South Australia (GSSA) has expanded its mandate to map the geology of South Australia. That mandate now includes drilling previously unexplored rocks beneath the Murray Basin cover sequences. Before drilling, GSSA researchers synthesised prior work, collected new geophysical data and reprocessed existing data, conducted prospectivity mapping (in collaboration with MinEx CRC researchers based at CSIRO) and targeted new drill holes. A vital component of the GSSA contribution was landholder consultation, environmental evaluations, and cultural surveys to ensure stakeholder engagement, minimise impact and manage land access at industry-leading standards. During the drilling campaign, GSSA researchers collected in-field geochemistry, and rapidly uploaded it to a data portal developed by the GSSA for the NDI Delamerian campaign (https://energymining.sa.gov.au/minerals/geoscience/gssa_projects/delamerian_ndi). The workflow developed by GSSA provides a model for near real-time dissemination of geological data from the drill site, which Researchers expect to become industry standard in the coming years.



CT drilling chip trays.

Samples from legacy and NDI drill holes are being analysed by MinEx CRC researchers at the GSSA, UniSA, the University of Adelaide and the Australian National University, including novel geochronology and isotopic tracing of mineral systems. This ongoing work is partly conducted by PhD students engaged through the MinEx CRC Education and Training program. The picture emerging is of a Cambrian (~500 million year old) back-arc tectonic setting, comparable to the modern Sea of Japan, with potential for base- and precious metal mineral deposits. In addition to the geological constraints provided by the NDI Delamerian drilling campaign, the framework for collaboration has enabled a new workflow for the GSSA – built on a +150-year legacy of geological mapping and updated to include drilling as a mapping tool.

The most significant potential benefits of the Delamerian NDI campaign will come from the discovery of new mineral deposits resulting from increased investment in mineral exploration and the use of more efficient exploration tools. It is too early to predict the scale and number of potential discoveries. To ensure equal access for potential explorers and maintain the pre-competitive nature of drilling results, the South Australian Department of Energy and Mining (DEM) has placed a moratorium on new exploration licences in the Delamerian NDI campaign area. Once the moratorium is lifted, lead time from 'greenfields' exploration to producing mines maybe decades. However, Researchers will be able to assess the short-term impact of the NDI Delamerian drilling campaign by tracking applications for mineral exploration licences, exploration expenditure (which has economic benefits in its own right) and initial exploration results.

The other significant benefit of the Delamerian NDI campaign has been the proof-of-concept of the CT platform in a production drilling environment. This validation is an essential step toward commercialising the CT drilling platform - a process that MinEx CRC will undertake in collaboration with its METS and exploration industry partners over the next three years. The global minerals drilling market is projected to reach US \$4.4 billion by 2030. The MinEx CRC CT drilling platform offers the potential to access a significant portion of this market. The MinEx CRC consortium includes drilling manufacturers (EPIROC, Sandvik), drilling service providers (Mackay Drilling) and drilling support services (Imdex) who are well-placed to take advantage of this opportunity. A Press Release on the conclusion of this campaign is included as Appendix F.



MinEx CRC CT drill rig on-site during the GSSA NDI Campaign.

3.4 Risks & Impediments

MinEx CRC recognises that it operates in an uncertain environment where identification and management of risk and mitigation of impediments are important to our success. Risk management has been built into MinEx CRC structures and reporting requirements from the project to the 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 the effect on MinEx CRC has not been significant to date. 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 and staff follow safety and working guidelines from their respective authorities and institutions.
- The budget accounting for ongoing reduced travel costs and reduced levels of fieldwork but with this easing towards the end of the reporting period.
- Social distancing and compliance procedures in place where required, which resulted in reduced laboratory efficiency and increased administrative processes to ensure an ongoing safe operating environment, particularly in the first half of the reporting period.
- Additional support for some at-risk students continued.
- Some project milestones were revised, but all were ultimately achieved.

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

RISK AREA	RISK ISSUES	CONTROLS IN PLACE	MITIGATING FACTORS
RESEARCH	Crisis Management Business Continuity and crisis management. Failure to develop and implement suitable strategies, including management of Covid19 risks	* Active diversity and inclusion strategy * Market-based employment conditions * Monitoring of staff turnover and diversity	* MinEx CRC track record and reputation established * Depth of experience of pool of candidates increasing * Management focus in these areas
MARKETS	Public Image Damage to Public Image or reputation	* Funds committed by NDI and Industry participants are from friendly clients * Ability to reduce costs * Detailed planning and budgeting	* Potential to offset costs through usage in MinEx CRC projects * Additional drilling contracts or funds * Ongoing R&D * Maturity of system
MARKETS	OHSE Performance Failure to develop policies and achieve satisfactory OHSE performance and comply with Client specific and/or legal obligations	* Clear commercialisation criteria in place in all current agreements * Commercialisation strategy included in relevant Project agreements in Phase 2	* Understanding by key personnel of Commercialisation pathways * Commercial METS partners

CAPABILITY	Inadequate Research Information Integrity, including material IT system exposure Protection and security are inadequate, including IT exposure As highlighted by increased focus from Commonwealth	* Maintain strong Relationships with all parties * Continue to report progress to Stakeholders * Participant funds ahead of schedule * Ongoing interaction with Existing Participants and engagement with potential new Participants	* Spread of Contributions from Participants * Rare for CRC funds to be reduced * Review of MinEx CRC value proposition
CAPABILITY	Research Outcomes not Achieved Research staff are not capable of achieving project outcomes, including due to Covid-19 restrictions	* Objectives and milestones are monitored on an ongoing basis * Separate Education Committee in place with approved strategy, business plan and action items * Monitoring of high-risk students	* Successful commencement in implementing the Education program * Quota of students to date on track
CAPABILITY	Failure to Execute Drilling Projects a) Reliability of required drilling equipment, spare parts and support b) Community and Land access issues c) Integration of the Drilling Campaign with the Research Projects	* Regular review of Management performance by the Board * Ongoing reporting, feedback and monitoring processes by the CEO * Well-defined business plans and objectives	* Experienced management team and Board with over four years of stable team and satisfactory outcomes
CAPABILITY	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	* Regular internal review of Board performance * Well-defined Board governance policies * Regular CRC external reporting regime	Experienced and well-qualified independent Board with a wide range of skills and knowledge
FINANCE & COMPLIANCE	Research Portfolio Failure to: a) Meet industry requirements b) Maximise outcomes from Opportunity Fund	* 10 Year CRC Strategy developed * 3 Year Strategy rolling review	* Clear Vision, Mission, and Values * CT Rig Strategy approved by Board

FINANCE & COMPLIANCE	Cyber Security Head Office Unauthorised access to systems, loss of key data, and inability to operate IT systems	* Internal compliance calendar based on legal and reporting requirements of these agreements and internal monitoring and reporting regime	* CRCs Operate in a highly regulated environment that involves extensive external reporting * CRA Board participation by the CEO
RESEARCH	Staff Retention and Diversity Failure to achieve satisfactory Staff retention and diversity of Head Office Management and Researchers	* Best practice risk management controls * Insurance broker with relevant experience chosen * Reputable, secure insurers providing cover * Risks monitored to ensure adequate coverage of evolving projects	Risks requiring insurance coverage can be clearly identified, and insurance market provides suitable levels of cover.
RESEARCH	Low Productivity of Drill Crew and Equipment resulting in insufficient revenue to cover costs : a) Insufficient demand for CT drilling b) Inability to execute CT drilling c) Equipment not suitable for ongoing use d) Breakdown and maintenance of CT Drilling system	* Agreed process in place to define & value NSIK contributions for Research Projects * Research Project agreements include NSIK	* Diversification of NSIK contributions across researchers and participants * Data NSIK from Geo-Survey's is 75% of total NSIK and can be clearly identified and valued
RESEARCH	Commercialisation Outcome Failure Failure to achieve commercialisation outcomes	* Expert professional support of IP Attorney * Clear IP Management and contractual frameworks * Agenda Item at PRP meetings	* Understanding by key personnel of Background IP * IP strategy in place and communicated

3.5 Education and Training (E&T)

MinEx CRC's key education goals are; 1) to achieve 50 post-graduate completions, and 2) to develop a framework for Vocational Education and Training (VET) in coiled tubing (CT) drilling.

Vocational Education and Training

MinEx CRC have recognised the need for VET driller training to meet the increasing demand for drilling crews required to deliver MinEx CRC's commitments to the National Drilling Initiative and prepare for commercialisation of the CT drilling platform in the coming years. These needs are mapped to an in-house Training Needs Analysis (TNA) conducted by the E&T Committee in 2020. The TNA was undertaken in the context of the current state of research and development of MinEx CRC's CT drill rig and the associated HPS system. Formal driller training schedules and an in-house Verification of Competency for the MinEx CRC CT drilling platform have been developed and are continually refined based on learnings from NDI drilling activities. A new project for developing a virtual reality (VR) training platform for CT drillers and offsideers has been established.

Higher Degree by Research (HDR) Program

MinEx CRC has a target of 50 higher degree by research (HDR) completions. Student enrolments, progress and completions are tracked by a student pipeline developed as part of the Postgraduate Education Business Plan. On June 30 2022 there were 35 students enrolled in the HDR program (five Masters by research and 30 PhD) students, including ten students enrolled during the reporting period. One Masters by research and one PhD student had completed during the reporting period. Two Masters by research and one PhD student submitted their theses for examination during the reporting period. The PhD student and one of the Masters by research students qualified for their degree shortly after the reporting period (for a total of 4 completions by October 2022). Enrolment numbers and completions are on track with the student pipeline. A student register listing all active students and project details as of June 30 2022, is attached as Appendix B.

MinEx CRC support for HDR students

The MinEx CRC Education and Training Committee maintains oversight of the HDR and VET programs, including development of new projects, monitoring student progress and providing support to the HDR cohort. Within the reporting period, the method for advertising student projects was changed from a hard-copy booklet released annually to an online format on the MinEx CRC website, where projects can be continually updated. Projects were also advertised online through social media and professional societies. The advertising attracted significant interest and continues to do so.

High-risk students are a specific agenda item at quarterly E&T Committee meetings. Supervisors and the students monitor student progress towards completion, and factors including difficulty with experimentation, analysis and impacts of Covid-19 are considered. Students listed as high-risk are contacted regularly to offer support as appropriate and are further supported by their supervisors and the student cohort through monthly online video conference sessions.

MinEx CRC has implemented the following strategies to help attract and retain HDR students and encourage timely completion:

- **A \$20,000 per annum bursary for each HDR student** (three years x \$20,000 = \$60,000 for PhD students, two years x \$20,000 = \$40,000 for Masters by research students). This funding is provided irrespective of whether the student holds other scholarships or stipends. The funding is intended to support the student and their project depending on the individual needs of each student as determined by the supervisory panel. Common uses of the bursary include scholarship support, scholarship top-up, project operational expenditure (travel and analyses) and conference support.
- **A completion bonus** of \$3,000 for PhD students and \$2,000 for Masters by Research students.

- **Financial support for Honours and Masters by coursework students** undertaking MinEx CRC-related research activities and who may go on to undertake a MinEx CRC postgraduate research project. This initiative raises the profile of MinEx CRC with undergraduate students and allows the advertising of projects across multiple universities. Nine Honours and five Masters by coursework students completed their projects during the reporting period and there are two Honours and six Masters by coursework students currently enrolled. Research topics are summarised in Appendix B. Two students who have been supported by the Honours and Masters by Coursework initiative have gone on to join the MinEx CRC HDR program.
- **HDR candidates are deeply connected to government, mining industry and METS Partners.** Involvement of end-users in the development and supervision of MinEx CRC postgraduate students and projects is ensured through all MinEx CRC students being required to have a MinEx CRC Participant or Affiliate industry co-supervisor listed as part of their project before being registered as a MinEx CRC student. This process requires sign-off from a MinEx CRC Participant or Affiliate industry representative with whom the project aims and objectives have been co-developed with academic supervisors. Industry/end-user co-supervisors include staff from Anglo American, BHP, CSIRO, Department of Energy and Mining/Geological Survey of South Australia, Encounter Resources, Geological Survey of New South Wales, Geological Survey of Victoria, Geological Survey of Western Australia, Geoscience Australia, Inca Resources, McKay Drilling, Middle Island Resources, Northern Territory Geological Survey, South32 and Strategic Energy Resources.

Students regularly engage with end-users, particularly industry co-supervisors, in regular project meetings. Students are involved and present at quarterly Project Review Panel meetings and workshops for MinEx CRC Participants and Affiliates where appropriate. For example, Project 3 PhD students attended and presented at a face-to-face Participants meeting held at CSIRO in Perth. The 2022 MinEx CRC Project Integration Workshop had a theme (conducted over two sessions) dedicated to postgraduate research, with supervisors presenting student research from their perspective.

Three students (Travis Batch, Richard Hill, Ruiqi Zheng) are undertaking projects that are directly affiliated with MinEx CRC industry partners. These projects are concentrated on industry partner case study areas and undertake research complementary to the broader MinEx CRC research program. Partners involved include Demetallica, Encounter Resources, Inca Resources, Lodestone Mines, Middle Island Resources and Strategic Energy Resources. Two students undertook internships with industry end-users CSIRO and the Geological Survey of South Australia throughout the reporting period.



Postgraduate experiments at the University of Adelaide.

- **HDR candidates are strongly connected to core MinEx CRC research programs.** 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, therefore, tightly integrated with MinEx CRC's research, which is fundamental in ensuring student involvement with CRC Activities.

Student research is regularly featured in all forms of MinEx CRC reporting and is particularly significant in MinEx CRC meeting its milestones in the following areas:

- Project 1: Research being undertaken by Curtin University students on 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: Students at the University of South Australia involved in testing laser-induced breakdown spectroscopy (LIBS) for generating semi-quantitative geochemical data and developing machine learning algorithms to generate synthetic data to train predictive models for automated interpretation of LIBS Spectra. (Ivan Gutierrez Agramont, Fernando Fontana)
- Project 4: Curtin University student research using geophysics for drilling trajectory control. (Aruni Rajanayake)
- Project 5: Development of borehole seismic imaging techniques and processing and inversion of seismic data using artificial intelligence and automated machine learning at Curtin University. (Emad Al-Hemyari, Anatolii Pakhomenko, Sana Zulic)
- 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. (Ranee Joshi, Saurabh Pandit, Mahtab Rashidifard, Nuwan Suriyaarachchi)
- Program 3: Students at multiple MinEx CRC-affiliated universities undertaking projects on signatures of alteration, basin analysis, thermochronology, geochronology and geophysics for understanding metal fertility and prospectivity in buried terranes. (Andreas Bjork, Mitchell Bockmann, Adrienne Brotodewo, Millicent Crowe, Stacey Curtis, Alex van Leeuwen, Naina, Angus Nixon, Bianca Palombi, Joe Shifano, Alex Simpson, Darwinaji Subarkah, Lucy Mathieson, Alejandra Bedoya Meija, Zhufu Shao, Luke Tylkowski, Zara Woolston, Jie Yu, Mosayeb Khademi Zahedi)

- **There are dedicated HDR sessions at MinEx CRC conferences and events** including financial support to travel and participate in events.

All students presented a digital poster at the 2021 Annual Conference and there was a session dedicated to student presentations. There were fifteen student presentations, including short introductions from seven new students and longer presentations, with detailed project updates from eight students in the second or third year of candidature. Due to the conference being online, separate networking events were held at the conference hubs in South Australia and Western Australia and an online event for those unable to attend a conference hub. The networking sessions were attended by invited industry and government representatives from each local area, including Anglo American, CSIRO, Geoscience Australia, Geological Survey of South Australia and South32. A member of the MinEx CRC Board of Directors also attended the South Australia event.

A mid-year Postgraduate Workshop was held online in May 2022. This was a one-day online event where 32 students gave an individual live presentations. Presentations were of variable length and allowed new students to introduce themselves, and senior students presented their research progress and outcomes. The session allowed the students to engage with the broader

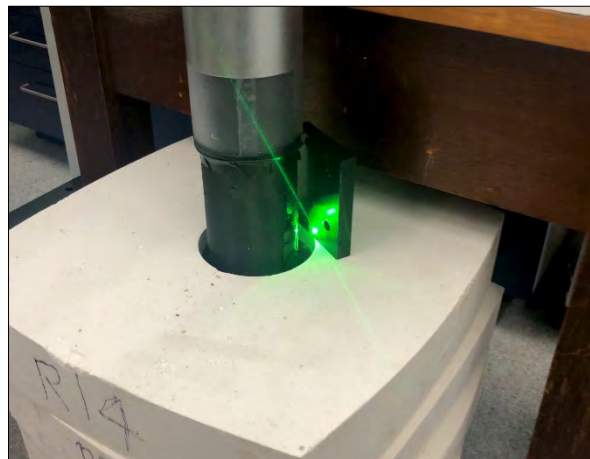
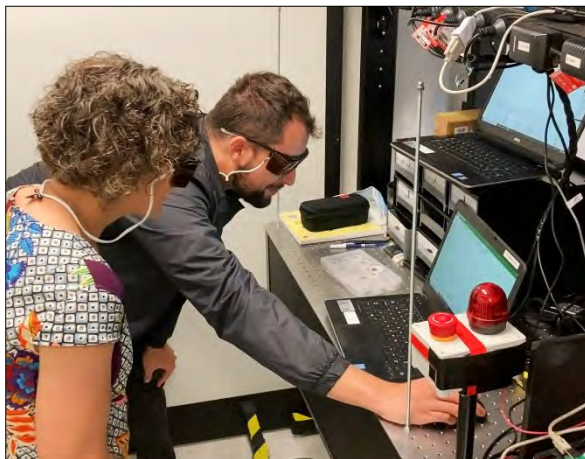
CRC community and was attended by approximately 80 MinEx CRC Participants, Affiliates and Researchers.

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 has run these sessions with support from the MinEx CRC Project Officer. The sessions included a career talk from the MinEx CRC Project 1 Leader; a member of the Superstars of STEM community speaking on Science Communication; an external speaker addressing mental health; three Geological Survey representatives speaking on MinEx CRC National Drilling Initiative case study area selection, planning and drilling campaign execution; and sessions dedicated to discussion on student involvement within MinEx CRC events, preparation for the 2021 Annual Conference and the May 2022 Postgraduate Workshops.

Graduate destinations

The two HDR students who completed during the reporting period have been employed by MinEx CRC Participants:

- Saurabh Pandit (Masters by Research): Resource Development Geologist, Rio Tinto, Western Australia.
- Adrienne Brotodewo (PhD): MinEx CRC Postdoctoral Researcher, University of South Australia, South Australia.



MinEX CRC Education and Training Coordinator Caroline Tiddy (left) and postgraduate student Fernando Fontana conducting experiments at UniSA.

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 open-source software being developed. Aspects of Project 5 may also be published freely at times.
- IP will be licensed and 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 the IP developed by that project.

MinEx CRC currently holds:

- Seventy-two properties across nine patent families. Of the 72, nine are Australian, and 64 are overseas.
- Fifteen properties across three design families and three trade mark registrations. Of the 15, six are Australian, and nine are overseas.
- 22 Licences/Options / Assignments (LOAs) are active between MinEx CRC and end-users (unchanged from 2021).

A list of Registered IP (patents, trademarks, designs) held by MinEx CRC is included in the MDQ and Appendix C. 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 fifth year of operations out of a 10-year funding life and has commenced discussions on the commercialisation of specific outputs, notably the CT drill Rig. The intention of the commercialisation negotiations is to have preliminary builds of significant capital equipment over two years until the end of Phase 2 of MinEx CRC, with the possibility of extensions into Phase 3 of MinEx, but with scope remaining to revise, withdraw or re-offer commercial offerings in the last years of MinEx CRC (2027-28).

In addition, commercial consideration in FY22-23 will be given to aspects of Project 1 (Fluids) and Project OP7.1 (Visualisation).

The wind-up arrangements for MinEx CRC will see even greater rates of commercial uptake as Phase 3 on Minex is intended to be the commercialisation phase, following the current phase of 'practical completion of a majority of research projects, as per the original plan and Commonwealth Milestones.

3.8 Financial Management

MinEx CRC commenced operations on April 12 2018. The financial tables provided below compare the current FY22, with FY21, FY20 and FY19 (includes the period from 12 April 2018 to 30 June 2018).

REF	TITLE
Table 1	Revenue and Expenditure by Financial Year to date Including Cumulative Total
Table 2	Statement of Financial Position by Financial Year to date
Table 3	Cash Report, including a comparison to the Commonwealth Agreement budget.
Table 4	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 FY22.

Cash Balance and Surplus

The CRC had a deficit for FY22 of \$1.2M, with the CRC Life to date restricted surplus reducing to \$12.5M. With some Participant funds being received in advance in FY19 and FY20, the CRC generated a significant surplus, which will gradually reduce to Nil over the ten-year life of the CRC. The cash balance on June 30, 22 was \$13.1M compared to June 30, 21 of, \$14.8M and June 30, 20, \$18.2M. All of these funds are committed to future research programs, drilling campaigns, education and training activities and management of operational activities.

The NDI drilling campaigns commenced in September 2020, and CT Drilling field trials commenced in May 2021 have reduced the cash balance by approximately \$8.6M in FY21 and \$4.4M in FY22. It is expected that the NDI drilling campaigns will reduce the cash balance further during FY23.

Participant Contributions

Total participant contributions received of \$5.5M (\$6.8M in FY21 and \$5.3M in FY20) exceeded the Commonwealth Agreement Budget (CAB) amount of \$2.6M by \$2.9M. This was primarily due to payments made in advance and additional contributions of \$1.6M compared to the Agreement.

Research Projects

Phase 1 of the research projects came to completion in December 2021, with six months of the Phase 2 projects underway at the end of the financial year. Payment to researchers is made quarterly in arrears based on actual expenditure. Project expenses were \$5.8M for FY22 (\$6.2M in FY21 and \$5.5M in FY20).

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. Total interest income earned to date is \$607.5K. Interest rates continued to drop over the year due to COVID but are currently on the rise.

CRC Contributions

Cash payments from the Commonwealth were \$5.5M in the period (\$5.8 for FY21 and \$6.6M for FY20). Payments from the Commonwealth are paid quarterly in arrears, following the completion of the quarterly CRC Report.

National Drilling Initiative (NDI) Campaigns

The field trials with the CT Rig commenced in August 2021 at Mawson Lakes, and the first of the NDI drilling campaigns with the CT Rig followed on October 21. The GSSA Delamerian North campaign was completed during the year, with drilling of the last hole at the GSSA Delamerian South campaign being finalised in late July 2022. In addition to these NDI Campaigns, CT drilling commenced with Anglo American in August 2022 and is expected to continue to December 2022.

Table 1 - Revenue & Expenditure (\$'000)	FY22	FY21	FY20	FY19	Cumulative Total
Revenue					
Commonwealth Funding	5,500.0	5,798.5	6,597.0	2,729.5	20,625.0
Participant Contributions	5,600.0	7,023.0	4,811.8	12,067.5	29,502.3
Affiliates Contributions	210.0	185.1	285.0	150.0	830.1
DET CRC Unspent Participant Contributions	-	-	-	113.6	113.6
Non-financial asset acquired for Nil Consideration	-	-	850.0	-	850.0
Interest Income	70.1	112.9	300.5	124.0	607.5
Royalty Income	52.1	34.1	-	-	86.2
Other Income	79.8	9.6	122.2	30.8	242.4
Total Revenue	11,512.0	13,163.2	12,966.5	15,215.4	52,857.1
Expenditure					
Research Program Expenditure					
- Program 1	1,905.5	2,576.7	2,121.4	486.1	7,089.7
- Program 2	1,292.8	1,610.1	1,524.6	544.8	4,972.3
- Program 3	5,686.0	10,405.2	1,859.8	653.5	18,604.5
- Opportunity Fund & Other Projects	580.2	204.8	-	-	785.0
Total Research Program Expenditure	9,464.5	14,796.8	5,505.8	1,684.4	31,451.5
Education & Training	432.3	504.4	384.5	200.0	1,521.2
Management Expenses	745.9	440.2	492.3	503.8	2,182.2
Salaries & Wages - Drill Crew	987.8	97.2	-	-	1,085.0
Salaries & Wages - Head Office (incl Directors Fees)	1,049.8	1,046.7	996.9	1,005.3	4,098.7
	3,215.8	2,088.5	1,873.7	1,709.1	8,887.1
Total Expenditure	12,680.3	16,885.3	7,379.5	3,393.5	40,338.6
Restricted (Deficit)/ Surplus	(1,168.3)	(3,722.1)	5,587.0	11,821.9	12,518.5

Table 2 - Statement of Financial Position (\$'000)	30-Jun-22	30-Jun-21	30-Jun-20	30-Jun-19
Assets				
Cash at Bank	13,148.8	14,794.8	18,167.3	13,688.1
Trade Receivables	596.2	369.8	-	255.0
Other Receivables	395.2	442.2	396.6	166.4
Prepayments & Accrued Income	135.7	101.8	84.3	100.4
Mining Bonds	-	39.9	-	-
Property Plant & Equipmment	962.2	1,251.6	1,031.2	9.2
Total Assets	15,238.1	17,000.1	19,679.4	14,219.1
Liabilities				
Trade Payables & Accruals	2,544.4	3,081.2	2,205.6	2,366.2
Employee Provisions	165.0	97.8	59.7	21.3
Lease Liability - Premises	10.2	134.3	5.2	9.7
Total Liabilities	2,719.6	3,313.3	2,270.5	2,397.2
Net Assets	12,518.5	13,686.8	17,408.9	11,821.9
Current Year Restricted (Deficit)/ Surplus	(1,168.3)	(3,722.1)	5,587.0	11,821.9
Retained Restricted Surplus	13,686.8	17,408.9	11,821.9	-
Equity	12,518.5	13,686.8	17,408.9	11,821.9

Table 3 - Annual Cash Report (\$'000)			
	ACTUAL	PER AGREEMENT	VARIANCE
Cash Carried Forward	14,794.8	10,596.1	4,198.7
Receipts			
CRC Program Funds for the period	5,500.0	5,500.0	-
Participant Contributions	5,460.0	2,625.0	2,835.0
Other Firm Cash/Third Party Cash	279.5	-	279.5
GST Received	1,066.8	-	1,066.8
Interest	51.8	-	51.8
Total Receipts	12,358.1	8,125.0	4,233.1
Expenditure			
GST Paid	1,234.0	-	1,234.0
Capital Expenses	18.1	-	18.1
Employee Expenses	6,871.0	6,320.0	551.0
Supplier Expenses	5,881.0	5,833.9	47.1
Other Expenses	-	-	-
Total Expenditure	14,004.1	12,153.9	1,850.2
CASH BALANCE CLOSING	13,148.8	6,567.2	6,581.6

Table 4 - Cumulative Cash Report (\$'000)	FY22	FY21	FY20	FY19	Cumulative Total
Cash Carried Forward	14,794.8	18,167.3	13,688.1	-	-
Receipts					
CRC Program Funds for the period	5,500.0	5,798.5	6,597.0	2,729.5	20,625.0
Participant Contributions	5,460.0	6,858.1	5,311.9	11,957.5	29,587.5
Other Firm Cash/Third Party Cash	279.5	104.7	97.6	139.7	621.5
GST Received	1,066.8	1,222.7	1,068.6	1,404.3	4,762.4
Interest	51.8	142.4	303.1	74.5	571.8
Total Receipts	12,358.1	14,126.4	13,378.2	16,305.5	56,168.2
Expenditure					
GST Paid	1,234.0	937.7	1,370.0	1,061.6	4,603.3
Capital Expenses	18.1	215.0	237.0	-	470.1
Employee Expenses	6,871.0	5,559.3	5,323.1	1,035.1	18,788.5
Supplier Expenses	5,881.0	10,786.9	1,968.9	520.7	19,157.5
Other Expenses	-	-	-	-	0.0
Total Expenditure	14,004.1	17,498.9	8,899.0	2,617.4	43,019.4
CASH BALANCE CLOSING	13,148.8	14,794.8	18,167.3	13,688.1	13,148.8

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Appendix A

2021 Year in Review

2021 YEAR IN REVIEW

MinEx CRC South Nicholson NDI drill site.

KEY NUMBERS

9/9

Commonwealth Milestones
achieved.

2

National Drilling
Campaigns completed.

0

reportable WHSE incidents.

50/50

gender split on MinEx
CRC Board of Directors
(excluding CEO)

3967_M

drilled during the East Tennant
NDI Campaign in collaboration
with GA and NTGS.

1750_M

drilled during the South
Nicholson NDI Campaign in
collaboration with GA and NTGS.

244/261 (93%)

quarterly project milestones achieved on time.

30

Higher Degree by Research students aligned with research
projects and with end-user supervision.

1% AHEAD

of cumulative research targets as Phase 1
draws to a close.

RESEARCH MANAGEMENT

Six new projects commenced, each designed to explore new methods of collecting, analysing and visualising data from drilling;

- Improved prediction of mineralogy using coupled XRD and chemistry
- Distributed optic fibre sensing for mineral CT drilling
- Fluorescence for real-time field identification of minerals
- Recovery of lithological and stratigraphic data from drillhole databases
- Immersive analytics for drilling data
- Getting the most out of 40Ar/39Ar thermochronology.

RESEARCH FOCUS

MinEx CRC remains focused 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.

COMMUNICATIONS

- MinEx CRC's third Annual Conference: Frontier Exploration was held in a combined online and in-person format on 10-11 November 2020 with over 200 delegates spanning 43 organisations.
- Mid-year Science Review held in April 2021.
- Project Integration Workshop held in June 2021.
- Ten videos were published to MinEx CRC TV, including four quarterly vNews episodes.
- Four press releases and one Federal Ministerial release distributed.
- 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.

ADVANCING TECHNOLOGY

Prototype *iFluid* systems for Diamond and CT drilling have been completed. CT-*iFluid* has been incorporated in the HPS and deployed in field drilling trials.

Improved formulation of *Liqi-CTrol* fluid additive has improved performance, is easier to manage and contains no hazardous ingredients.

Build of the Hydraulic Processing System (*HPS*) is complete, and the system has been deployed in field drilling trials. 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.

Prototype coarse-fraction sampling technology, selective interval coring tools, downhole positioning, 'Smart BHA' and drill string power and communications cable have been deployed in field drilling trials.

Our laboratory prototype LIBS downhole geochemistry tool is complete. Experiments to simulate different borehole conditions and response to varying rock types will continue in 2022.

Our field prototype downhole total count gamma tool is complete and has been deployed in drilling trials with the CT drill rig.

We have designed and built a remotely operated DAS seismic system, which can be deployed at any site by non-experts and operated by our expert team based in Perth.

TomofastX software for extraction of geological information from inverted and forward-modelled geophysical data has been released in open source.

National Drilling Initiative (NDI) campaigns in the East Tennant (10 holes for 3967m) and South Nicholson (one 1750m deep hole) areas of the Northern Territory are complete.

Hundreds of samples from the Northern Territory NDI campaigns are the subject of geological and mineral systems characterisation, including detailed petrology, whole rock geochemistry, stable isotope geochemistry, mineral chemistry, geochronology and thermochronology.

>200
Annual Conference
attendees

125
press articles
generated

3K+
YouTube views

15K+
website visitors

RESEARCH ENGAGEMENT

- **IMDEX** and **Minalyzer** technologies utilised in NT National Drilling Initiative (NDI) campaigns.
- **Datacode** are a participant in our 'Stratigraphy from drillhole data' opportunity fund project.
- Distributed acoustic sensing (DAS) seismic trials at Pilbara field site with **BHP**.
- **Sercel** DAS interrogators utilised in seismic trials.
- Drilling optimisation field trials with **Mackay Drilling**.
- **Sandvik** drill rig incorporated in Curtin experimental drilling platform.
- **EPIROC** and **LKAB Wassara** tools integrated into Coiled Tubing (CT) drilling bottom hole assembly.
- **Alpha Laval** and **IFM** technology integrated into Hydraulic Processing system (HPS) for CT drilling.
- CT drilling trials at **EnviroCopper** field site, Kapunda SA.
- **Encounter Resources**, **Inca Minerals**, **Middle Island Resources** and **Strategic Energy Resources** are supporting PhD projects in the East Tennant area, NT.
- **Minotaur Exploration** are supporting a PhD project in the northern Gawler Craton, SA.
- **Lodestone Mines** are supporting a PhD project in the Adelaide Rift Complex, SA.
- **BHP** and **Matsa** are supporting a PhD project assessing the value of exploration data.
- **Geological Surveys of South Australia**, **Western Australia**, **New South Wales** and **Victoria** involved in preparations for upcoming NDI drilling campaigns.

GENDER DIVERSITY

- The Diversity and Inclusion Committee was established to drive equality, diversity, and inclusion actions across MinEx CRC.
- The MinEx CRC Board (CEO excluded) 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.

REVENUE & EXPENDITURE (\$'000)

Revenue	FY21	FY20
Commonwealth Funding	5,798.5	6,597.0
Participant Contributions	7,023.0	4,811.8
Affiliates Contributions	185.1	285.0
DET CRC Unspent Participant Contributions	-	-
Non-financial asset acquired for Nil Consideration	-	850.0
Interest Income	112.9	300.5
Other Income	9.6	122.2
Total Revenue	13,163.2	12,966.5

Expenditure	FY21	FY20
Research Program Expenditure		
- Program 1	2,576.7	2,121.4
- Program 2	1,610.1	1,524.6
- Program 3	10,405.2	1,859.8
- Opportunity Fund & Other Projects	204.8	-
Total Research Program Expenditure	14,796.8	5,505.8

Education & Training	504.4	384.5
Management Expenses	440.2	492.3
Salaries & Wages (incl Directors Fees)	1,143.9	996.9
Total Expenditure	16,885.3	1,873.7

Restricted Surplus/(Deficit)	3,722.1	5,587.0
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Majors, METS and Survey Participants



Research Participants and Affiliates



MinEx CRC Kapunda field trial drill site.

MinEx CRC Limited

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Appendix B

Student Register

Student Register

Postgraduate students

#	Student	University	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
1	Alejandra Bedoya Meija	UoA	Stijn Glorie	David Kelsey (GSWA)	PhD	Thermochronology of the margins of 'The Gap', Western Australia	7	20/12/2021	19/12/2024	27/01/2022
2	Alexander Simpson	UoA	Stijn Glorie	Anthony Reid (GSSA)	PhD	Thermochronological and geochemical footprints of fluid alteration, recorded in apatite	7	15/03/2019	15/03/2022	13/02/2019
3	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	7	26/03/2018	17/04/2022	16/09/2019
4	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
5	Andreas Bjork	UniSA	David Giles	James Austin (CSIRO)	PhD	Application of the multi-sensor core logger for petrophysical analysis and geophysical modelling	7	18/04/2022	17/04/2025	2/06/2022
6	Angus Nixon	UoA	Stijn Glorie	Geoff Fraser (GA)	PhD	Thermochronological Evolution of the McArthur Basin and Surrounding Basement Areas	7	19/03/2018	1/01/2022	13/02/2019
7	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
8	Bianca Palombi	UoN	Brett Neilan	Chris Folkes (GSNSW), Nathan Reid (CSIRO)	PhD	Microbial diversity and their genetic basis for heavy metal resistance in regolith	7	1/03/2022	1/03/2025	23/03/2022
9	Darwinaji Subarkah	UoA	Alan Collins	Amber Jarrett (NTGS), Geoff Fraser (GA)	PhD	Shale geochemistry and geochronology of the greater McArthur Basin	7	2/06/2019	1/06/2022	3/06/2019

#	Student	University	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
10	Emad Al-Hemyari	Curtin	Andrej Bona	Tim Dean (Anglo American)	PhD	Seismic data processing and inversion with distributed acoustic sensing and artificial intelligence	5	9/05/2022	9/05/2025	3/06/2022
11	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
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	Ivan Gutierrez Agramont	UniSA	Caroline Tiddy	Neil Francis, Yulia Uvarova (CSIRO)	PhD	Generating synthetic data for training predictive spectroscopic models	3	12/07/2021	12/07/2024	12/07/2021
14	Jie Yu	UoA	Martin Hand	Rian Dutch (GSSA)	PhD	Tectonic systems and IOCG mineralisation in the Gawler Craton	7	15/10/2018	15/10/2021	26/03/2019
15	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
16	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	7	1/03/2019	1/07/2021	18/04/2019
17	Lucy Mathieson	Curtin	Chris Kirkland	Klaus Gessner (GSWA), Anthony Reid (GSSA)	PhD	Mapping radiogenic Pb loss in space and time: a new tool to track fluid rock interaction	7	7/03/2022	6/03/2026	21/03/2022
18	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	7	1/3/2021	1/03/2024	4/03/2021
19	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

#	Student	University	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
20	Millicent Crowe	UNSW	Bryce Kelly	Robert Musgrave (GSNSW), Ian Roach (GA), Andrew King (CSIRO)	PhD	Integrating AEM and hydrogeochemistry: Implications for water resources	7	29/01/2020	29/01/2023	19/02/2020
21	Mitchell Bockmann	UoA	Martin Hand	Rian Dutch (GSSA)	PhD	The tectonic setting of early Mesoproterozoic mineral systems in the Gawler Craton	7	19/03/2018	19/03/2021	26/03/2019
22	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
23	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	7	29/03/2019	29/03/2022	6/05/2019
24	Nuwan Suriyaarachchi	UWA	Mark Jesssell	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
25	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
26	Richard Hill	UoTas	Rob Scott	David De Tata (representing consortium of SEG, Encounter Resources, Middle Island Resources and Inca Minerals)	PhD	Exploring the East Tennant region: Unravelling the crustal architecture, tectonic evolution and mineral systems potential of an undercover Proterozoic terrane through the integrated use of geophysics, drill hole data and machine learning/geodata analysis techniques	Company	2/08/2021	5/08/2024	13/09/2021
27	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
28	Ruiqi Zheng	UoA	Juraj Farkas	Erick Ramanaidou (CSIRO)	PhD	Geological and geochemical constraints on the origin and diagenetic history of Neoproterozoic Breamar ironstones (SA) based on new metal isotope (Fe, Cr) and REE proxies	Company	31/01/2022	30/01/2025	25/03/2022

#	Student	University	Supervisor	Industry co-supervisor	Degree	Project title	Project	Start Date	Finish date	Date registered
29	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
30	Siew Hong Chai	Curtin	Masood Mostofi	Phillip Fawell (CSIRO)	Masters	Drilling fluid automation	1	1/07/2019	31/07/2021	25/10/2019
31	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
32	Stacey Curtis	UniSA	Justin Payne	Mark Pawley (GSWA)	PhD	Integrated framework for the magmatic evolution of the greater Delamerian Orogen	7	10/02/2020	9/02/2023	1/04/2020
33	Travis Batch	UniSA	Caroline Tiddy	Tony Belperio, Glen Little (Demetallica)	PhD	Magnetite and monazite chemistry for iron oxide-copper-gold exploration	Company	30/09/2021	30/09/2024	5/10/2021
34	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	7	1/3/2021	1/03/2025	7/04/2021
35	Zhufu Shao	UoA	Juraj Farkas	Charles Verdel (NTGS)	PhD	Novel isotope techniques for basin exploration: In-situ dating and metal isotope analysis of glauconite/apatite from the Georgina Basin	7	29/11/2021	29/11/2024	21/02/2022

*part-time student

Honours-Masters by Coursework Students

Student	Affiliation	Degree	Project Title	Primary Supervisor	Co-Supervisor(s) & Affiliation(s)
Adrian McCafferty	UniSA	Honours	Plant sampling for geochemical exploration at Blue Rose Cu Prospect, Olary Domain SA	Justin Payne	Anna Petts, Carmen Krapf (GSSA)
Chloe Thiel	Curtin	Honours	Single phase and two-phase flow simulation of reverse circulation drilling	Dimple Quyn	Masood Mostofi
Digby Emmett	Curtin	Honours	Development of Control System for Oscillatory Fluid Displacement with Application in Drilling Fluid Automation	Dr Siavash Khaksar	Masood Mostofi, Thomas Richard (Curtin)
Dylan Verrier	Curtin	Honours	Experimental study of shale stability using different additives in water based drilling fluid	Masood Mostofi	
Oliver Pring	UoA	Honours	The fractionation of copper isotopes in granitic and mafic intrusions: mafic enclaves in the Mannum granite, a case study	Lucy McGee	Justin Payne (UniSA); Juraj Farkas (UoA)
Samuel Rasch	UoA	Honours	Dating and characterising a newly discovered sedimentary basin in the East Tennant region	Alan Collins	
John Evgeniy Zhovnyak	UniSA	Honours	Low-torque drilling tools (Joint Project)	Michael Evans	Tim Lau, Soren Soe, Shane Fox, Ben van der Hoek (UniSA)
Max Ivan Jiegs Cabato					
Rajveer Singh Jindir					
kl	Curtin	Masters by Coursework	Flocculant dosing benchmark in the presence of long chain synthetic polymer solutions	Ferial Hakami	Masood Mostofi
Nothando Ndlovu	UniSA/ University College London	Masters by Coursework	How current Government Policies impact on the ability to mineral undertake exploration using developing technology	Caroline Tiddy	David Giles (UniSA); Alex Norori-McCormac (UCL)

Student	Affiliation	Degree	Project Title	Primary Supervisor	Co-Supervisor(s) & Affiliation(s)
Tianyi Gao	UniSA/ University College London	Masters by Coursework	A mineralogical and geochemical toolkit for ore deposit targeting (Joint Project)	Caroline Tiddy	Alex Norori-McCormac (UCL)
Wei Yao					
Zhenghao Li					

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Appendix C

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 D Publications

Publications

MinEx CRC researchers are underlined in the author lists.

Brotodewo, A., Tiddy, C., Zivak, D., Giles, D., Light, S. and Forster, B. (2021) Recognising Mineral Deposits from Cover; A Case Study Using Zircon Chemistry in the Gawler Craton, South Australia. *Minerals*, Volume 11, Issue 9

Clark, A., Morrissey, L., Doublier, M., Kositcin, N., **Schofield, A.** and Skirrow, R. (2022) A newly recognised 1860–1840 Ma tectono-magmatic domain in the North Australia Craton: Insights from the Tennant Region, East Tennant area, and the Murphy Inlier. *Precambrian Research*, Volume 375, July 2022, Article number 106652

Cox, G., **Collins, A., Jarrett, A.**, Blades, M., Shannon, A., Yang, B., **Farkas, J.**, Hall, P., O'Hara, B., Close, D. and Baruch, E. (2022) A very unconventional hydrocarbon play: The Mesoproterozoic Velkerri Formation of northern Australia. *AAPG Bulletin* 2022, Volume 106, Number 6, pp. 1213-1237

De Vries Van Leeuwen, A., Morrissey, L., Raimondo, T. and Hand, M. (2022) Prolonged high thermal gradient metamorphism in the Curnamona Province, south-central Australia, during the latter stages of Nuna assembly. *Precambrian Research*, Volume 378, August 2022, 106775

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Appendix E

MinEx CRC EDI Policy

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ABN: 66 625 533 913

MinEx CRC Equity, Diversity, and Inclusion (EDI) Policy

Document details:

VERSION	DATE	REVISION DESCRIPTION	APPROVED
V1	May 2022	N/A first version	EMC Committee
V2	May 2022	Minor grammatical changes	Anna Porter

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PURPOSE

MinEx CRC is committed to growing and supporting an equitable, diverse, and inclusive environment where people feel safe, valued, supported, and treated fairly with dignity and respect.

MinEx CRC is dedicated to building an inclusive culture where differences are recognised and valued. MinEx CRC aims to provide access to equal opportunities irrespective of gender, culture, sexual orientation, disability, mental health status, or career stage/academic position.

MinEx CRC considers the rich diversity of those involved as a resource that should be drawn upon to enable workplace participation, sharing of ideas, and foster innovation.

This Equity, Diversity and Inclusion (EDI) Policy aims to lay a core framework for which those participating in MinEx CRC should operate.

SCOPE AND RESPONSIBILITIES

This Policy applies to all MinEx CRC associated people, including directors, officers, researchers, contractors, consultants, participants and postgraduate students.

It is the responsibility of all those associated with MinEx CRC to maintain compliance with this Policy and report suspected breaches of this Policy to any member of the EDI committee or MinEx CRC Management.

A list of EDI Committee contacts can be found via the MinEx CRC EDI webpage:

<https://minexcrc.com.au/diversity-and-inclusion/>

OUR COMMITMENT

MinEx CRC commits to:

Promoting Diversity

MinEx CRC will provide an equal opportunity for all participants and increase the visibility of our people by ensuring diverse and equitable representation at internal and public forums, including internal Program meetings and external conferences and media opportunities.

Attract and retain

MinEx CRC will implement programs to attract and develop a skilled and diverse participant profile, including providing equal opportunities for developing and advancing diverse talent at all career stages.

Safe Workplace and Environment

MinEx CRC, across all institutions and organisations and workplaces, encourages the provision of inclusive work environments that celebrate differences and are free from bullying, discrimination, harassment, sexual harassment, workplace violence and aggression. MinEx CRC will establish safe and effective avenues for all participants to raise concerns, for those concerns to be addressed, and encouragement for bystanders to speak up.

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**Culture and community**

MinEx CRC will foster EDI at all levels, that reflects the communities we operate within, and that embraces the benefits of diverse experiences and perspectives, in which differences are encouraged, and where everyone demonstrates and promotes inclusive practices.

Leadership, talent and training

MinEx CRC will improve diversity by upskilling, building awareness on the benefits of embracing an inclusive culture, and by developing our people to best prepare them for career success. In doing so, MinEx CRC will actively develop the next generation of diverse and inclusive leaders.

Flexible workplace

MinEx CRC encourages all participating institutions and organisations to support flexible working arrangements to meet the differing needs of all employees.

Measurable objectives

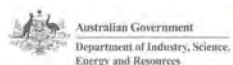
MinEx CRC will implement an accessible and inclusive EDI Policy and Action Plan which will communicate its principles, targets and initiatives.

MinEx CRC will establish an EDI Committee, which will oversee all diversity and inclusion matters. This committee will provide actions and track measurable objectives including diversity and inclusive behaviours across, and throughout, the life of MinEx CRC.

MINEX CRC MANAGEMENT

MinEx CRC management agrees to take responsibility for applying the EDI Policy and will follow up with complaints and concerns to a participant's organisation if and where appropriate.

Management will take an active role in promoting and communicating EDI across all participating institutions and organisations and to external stakeholders.



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Appendix F

Delamerian NDI Press Release

NEW TECH PROMISES SMALLER CARBON FOOTPRINT IN SOUTH AUSTRALIAN DRILLING CAMPAIGN

Monday 17 October 2022.

MinEx CRC, in collaboration with the Geological Survey of South Australia (GSSA), has successfully completed a 24-hole, scientific drilling campaign of the Delamerian Orogen in eastern South Australia, unlocking the region's mineral potential and trialing more environmentally friendly, cost-saving drilling technology.

The campaign was the second round of the world-first National Drilling Initiative (NDI), 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.

In collaboration with Geoscience Australia and geological survey organisations in every state and territory, the NDI is delivering a seven-year program with multiple drilling campaigns across Australia.

The Delamerian NDI campaign has confirmed that the 500-million-year-old basement rocks buried beneath sedimentary sequences of the Murray Basin were formed in a geological setting conducive to the formation of base and precious metal mineral deposits.

MinEx CRC CEO Andrew Bailey said geologists have long speculated that eastern South Australia contains basement rocks equivalent to the mineral-rich Mount Read belt of western Tasmania.

"Although relatively shallow, the cover sediments of the Murray Basin are difficult to drill and have proven to be a significant deterrent to exploration," he said.

"The Delamerian NDI campaign was designed to overcome the technical challenge of drilling beneath the Murray Basin cover and characterising the basement rocks beneath."

The drilling campaign included both conventional drilling and innovative coiled tubing (CT) drilling techniques developed by MinEx CRC.

The Delamerian NDI campaign was the first production-scale field trial of the MinEx CRC CT drilling platform, with over 5000m drilled in 18 holes. This concerted effort has allowed researchers and drill crews to improve the CT drilling infrastructure and workflows and to benchmark performance against conventional drilling techniques.

The CT drill holes were drilled significantly faster, with less water, lower fuel consumption and subsequent carbon emissions than the conventional drill holes, delivering significant cost savings and environmental advantages.

Drill cuttings delivered by the MinEx CRC CT platform were logged and assayed by portable XRF in field providing near real-time geological feedback during the drilling campaign. Comparison between geochemistry and gamma logs indicates that the CT cuttings can be confidently attributed to a depth interval, with good sample integrity.

The Delamerian NDI campaign also saw the first deployment of MinEx CRC's CT selective diamond coring capability, which was used to collect bottom-of-hole drill core in 16 of the 18 CT holes.

"We think the newly developed coring capability is a game-changer for the MinEx CRC CT platform," MinEx CRC's Chief Scientific Officer Professor David Giles said.

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“Now geologists have the option to collect high-quality core samples, containing valuable textural and structural information, from any depth of their choosing”.

Before drilling, the GSSA conducted an extensive review and synthesis of prior work, collecting new geophysical data and applying cutting-edge machine learning techniques to target and prioritise drill holes. A vital component of the GSSA contribution was landholder consultation, environmental evaluations, and cultural surveys to ensure stakeholder engagement, minimise impact and manage land access at industry-leading standards.

Geological and geophysical logs and in-field geochemistry collected during the drilling campaign are now [available via the South Australian Drilling Atlas](#). This Atlas was the first time the GSSA had released as near real-time data as possible during the drilling campaign. This allowed the GSSA, as well as companies and researchers to gain early access and visualise raw data.

Drill core and cuttings samples from the NDI drill holes will be the subject of in-depth analysis over the coming year, designed to add detail to the emerging geological model and provide guidance on the exploration techniques most likely to lead to the discovery of new deposits.

Videos on the Delamerian Orogen NDI Campaign can be found via the MinEx CRC YouTube channel:

- [NATIONAL DRILLING INITIATIVE \(NDI\) DELAMERIAN PROJECT](#)
- [NATIONAL DRILLING INITIATIVE \(NDI\) DELAMERIAN PROJECT – SAMPLING WORKSHOP](#)

ABOUT MINEX CRC

MinEx CRC is the world's largest mineral exploration collaboration with a 10-year life and bringing together Industry, Government and Research Organisations with \$220M of funding comprising of:

- \$50M cash from the CRC Program
- \$41M cash from geological surveys and industry
- \$51M non-staff in-kind
- \$78M or 311FTE staff in-kind

www.minexcrc.com.au

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MinEx CRC CT drill rig on site during the "Delamerian" NDI campaign.