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FOREWORD



FOREWORD

I think this will prove to be the biggest development in drilling technology since the advent of reverse circulation drilling 50 years ago.



Richard Hillis
Chief Executive Officer

As the research program for Deep Exploration Technologies CRC (DET CRC) concludes, eight-years after it was established, I feel extremely proud of the outcomes knowing that we achieved what we set out to do – on-time and on-budget.

DET CRC was created to develop cheaper, faster and safer methods of discovering mineral deposits hidden under deep cover. Specifically, we were tasked with addressing the most significant challenge to the future of the minerals industry – the reduction in mineral resources inventory in Australia due to high production rates and low mineral exploration success.

Through DET CRC, we leveraged the expertise and financial support of Government, industry and researchers in a collaborative environment to deliver on our three key research pillars.

The RoXplorer® Coiled Tubing Drill Rig – the showpiece of DET CRC which was honoured with the CRCA Excellence in Innovation award – was taken from a concept, to a design, to pieces of steel and finally, to a working prototype. I think this will prove to be the biggest development in drilling technology since the advent of reverse circulation drilling 50 years ago. DET CRC's Board has accepted a commercialisation proposal for the RoXplorer® Coiled Tubing Drill Rig from Imdex.

The two other pillars of our three pillars have also delivered. Lab-at-Rig® is successfully providing assay at the drill site and has been licenced to Imdex. The driller-deployed AutoSonde is successfully measuring natural gamma, magnetic susceptibility, resistivity and IP properties of rocks drilled, requiring negligible extra rig time and without the need to mobilise a separate wireline logging crew. The driller-deployed AutoShuttle is successfully measuring spectral gamma properties. Both have been licenced to Boart Longyear.

Our fourth major success has been the Wireless Sub which records drilling parameters and has also been licenced to Boart Longyear. In all of these areas of 'real-time sensing' we note recent parallel industry developments and believe the vision articulated by, and success of DET CRC has already significantly influenced the industry.

I'd like to personally thank the many partners who have supported DET CRC over the last eight years. Given some of the issues that have impacted on the sector during that time, it hasn't always been easy. I'm thankful for the commitment and belief entrusted to us by our Participants and Affiliates, and believe the outcomes we've delivered will help build a stronger, thriving minerals exploration industry well into the future.

BACKGROUND



BACKGROUND

Mineral resources make-up about 50% of the nation's exports, and yet 80% of Australia's mineral production is from mines discovered more than 30 years ago.

DET CRC was established in 2010 to address one of the most significant challenges facing the minerals industry and more broadly, the Australian economy.

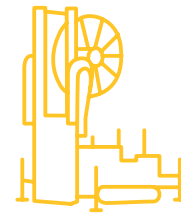
Mineral resources make-up about 50% of the nation's exports, and yet 80% of Australia's mineral production is from mines discovered more than 30 years ago.

There are few, if any, remaining major, new mineral deposits to be found in Australia that are exposed at the surface, meaning mineral exploration is moving from Australia to less well explored countries.

With A\$155M of cash and in-kind funding from the Government of Australia and supporters, DET CRC was the world's best-supported independent research initiative in mineral exploration.

Our vision was clear – to develop transformational technologies for successful mineral exploration through deep, barren cover rocks to be utilised and commercialised by the mineral exploration industry, addressing declining mineral resource inventories and enabling continued improvement in global standards-of-living.

DET CRC was focussed on three key areas of innovation:



DRILLING

Improving the cost-effectiveness, safety and environmental impact of drilling.



LOGGING AND SENSING

Improving analysis of rocks intersected by drilling.



TARGETING

Improving early information on the extent of subsurface ore bodies.





ACHIEVEMENTS



ACHIEVEMENTS

TOP 10 PROGRAM HIGHLIGHTS

1/6
COST OF
DIAMOND
DRILLING

1/3
COST OF
REVERSE
CIRCULATION
DRILLING

“Involvement in the DET CRC has facilitated the building of bridges between smaller entities and large mining/drilling companies. It has been the catalyst for game changing exploration technologies that may never have been developed without the collaboration and funding brought about by the DET CRC.”

GORDON STEWART
GLOBALTECH

1 RoXplorer® Rig

Design, fabrication and deployment of the RoXplorer® coiled tubing drilling system for mineral exploration.

- The RoXplorer® is a revolutionary drill rig for mineral exploration that utilises a continuous, malleable steel coil, removing the need to add individual drill rods as a drill hole deepens, thereby making drilling faster, cheaper and safer, estimated to be 1/6th cost of diamond drilling and 1/3rd cost of reverse circulation drilling.
- RoXplorer®'s drill bit is driven by a motor within the drill string near the base of the hole as opposed to conventional rotation of the entire drill string by the drill rig at the surface.
- Small lightweight rig, small drill pad, fluid recycling (no sumps), and lower consumables (e.g. fuel) all render coiled tubing more environmentally friendly than conventional drilling methods.

2 RoXplorer® Research

Numerical modelling, laboratory analysis and fieldwork to overcome the key challenges to deploying coiled tubing drilling in mineral exploration.

- Increasing from approximately 30 to 1,000 the number of trips in and out of the borehole that coiled tubing can undertake prior to fatiguing, by utilising new materials, positioning the reel directly above the drill hole and numerous other design features.

- Drilling hard rocks with low weight-on-bit using percussion and high speed rotary (full-face diamond) drilling methods driven by downhole motors and turbines.

- Developing fluid systems that can sufficiently clean dirty water and cuttings-loaded recirculated drilling fluids to drive the downhole motors.

- Developing the CTrol® and CTrolX drilling fluids which control fluid loss from the borehole into the formation being drilled.

3 RoXplorer® Trials

Successful field trials of the RoXplorer® coiled tubing drill rig at our Brukunga Drilling Research & Training Facility (South Australia), Port Augusta (South Australia) and Horsham (Victoria).

- The Port Augusta trial demonstrated that the RoXplorer® system can successfully drill the consolidated Adelaidean cover of the Gawler Craton that overlies the Olympic Dam iron-oxide-copper-gold province.
- The Horsham trial demonstrated that the system can successfully drill unconsolidated Murray Basin cover and underlying prospective basement.
- Both trials achieved rates of close to 100 metres per 12 hour shift. This has provided strong encouragement that the aim of \$50/metre coiled tubing drilling can be achieved.
- Recovering a geologically representative sample from

100
METRES PER
12 HOUR SHIFT

10%
INCREASE
IN DIAMOND
DRILLING
PRODUCTIVITY

“Extremely well run and successful CRC that will set the bar for all future research collaborations.”

AARON BAENSCH
OLYMPUS

RoXplorer® coiled tubing-drilled holes. Assays of the cuttings from the Port Augusta trial show a remarkable match to assays of diamond drill core from an adjacent hole, including across a one metre zone of low grade copper mineralisation at 400 metres depth.

- Operating in temperatures from <0°C (Horsham) to ~40°C (Port Augusta).
- Overcoming potential hole deviation problems and drilling straight and vertical holes in the trials.

4 Wireless Sub

Design, fabrication and deployment of the Wireless Sub and associated software. The Wireless Sub is an instrumented connector ('sub') that couples the drill rig to the drill string in conventional diamond drilling. It provides measurements of drilling parameters independent of, and more accurately than, the existing gauges on the drill rig in order to monitor and optimise drilling. Field trials at our Brukunga Drilling Research & Training Facility (South Australia), Oberon (NSW) and on the Eyre Peninsula (South Australia) have demonstrated that the Wireless Sub alone can result in an approximately 10% increase in diamond drilling productivity.

5 AutoSonde

- Design, fabrication and deployment of the AutoSonde for acquisition of total count natural gamma, magnetic

susceptibility, resistivity and IP (induced polarisation) data from conventional diamond drilled boreholes. The AutoSonde passes through the inside of the drill rods and protrudes beyond the drill bit. Physical property data is acquired as the driller recovers the drill rods. Extensive field testing has shown results consistent with conventional wireline data but at higher resolution.

6 AutoShuttle

- Design, fabrication and deployment of the AutoShuttle for acquisition of spectral natural gamma data from conventional diamond drilled boreholes. The AutoShuttle sits within the core barrel assembly and continuously acquires data during drilling. Both the AutoSonde and AutoShuttle can be deployed by the driller, removing the need to and expense of mobilising a separate wireline logging crew and risk of losing the hole prior to logging. Both operate autonomously meaning there are no wires connecting the tool to the surface. All data captured are transmitted wirelessly to a handheld device on return to the surface. These technologies will both improve the productivity of conventional diamond drilling and were a stepping stone to developing similar downhole sensing technologies for coiled tubing drilling.

7 Lab-at-Rig®

Design, fabrication and deployment of the Lab-at-Rig® for real-time determination of geochemistry and mineralogy from

ACHIEVEMENTS PROGRAM HIGHLIGHTS

diamond drill cuttings at the drill site. Extensive field testing has demonstrated decimetre (~10 cm) fidelity to core and resolution of horizons. Lab-at-Rig® utilises XRF (X-Ray Fluorescence) to determine geochemistry and XRD (X-Ray Diffraction) to determine mineralogy. A prototype Lab-at-Rig® has also been demonstrated for the coarser and wetter coiled tubing drilling samples

8 Field Trials

Extensive successful field trials of the Wireless Sub, AutoSonde and Lab-at-Rig® technologies in field drilling programs with Geoscience Australia/Geological Survey of Victoria (Stavely, 2014), Anglo-American (Oberon, 2014) and with the Geological Survey of South Australia (Eyre Peninsula, 2015-2016). The trials advanced the technology readiness level of these technologies by one level, generally from 'Prototype System' to 'Demonstration System'. The latter being a level higher than that to which the DET CRC originally intended to develop its technologies.

9 Software for Geochemistry and Mineralogy

SwiftMin® software developed for automated processing of XRD data. GeoLIBS® software developed for improved processing of LIBS (laser-induced breakdown spectroscopy) spectra including reliable sub-ppm gold detection. Progress on GeoPIXE for XRF spectral deconvolution and on software for coupled XRF/XRD inversion. Software suite will facilitate

the rapid analysis of samples by Lab-at-Rig® required to keep pace with rapid coiled tubing drilling.

10 EM and Seismic Geophysics

Key developments in electromagnetic and seismic geophysical methods to complement improvements in drilling and sampling.

- Joint inversion of co-located electromagnetic and seismic data improved the resolution of subsurface geophysical modelling leading to more confident geological interpretation and drill hole targeting, including in specific case studies such as the Kevitsa mine (Finland).
- Successful field acquisition of cost-effective seismic data in mineral exploration, notably at the Hillside copper-gold deposit in South Australia, and imaging of steeply dipping structures, notably by pre-stack diffraction imaging.
- Vertical seismic profile successfully acquired using optic fibre distributed acoustic sensors. Data collected ~5 times faster than conventional methods and of higher quality.
- Database of seismic surveys in mineral exploration.

“DET CRC is by far the best research collaboration that our organisation is involved with and that I have personally been involved with. There is daylight between this and the next best!”

STEVE HILL
GEOLOGICAL SURVEY
OF SOUTH AUSTRALIA

ADDITIONAL MAJOR ACHIEVEMENTS

Inputs

Increased end-user financial cash support from \$20.6M (original Commonwealth Agreement Budget) to \$33.7M during the lifetime of DET CRC and increased in-kind support from \$61.5M to \$93.1M, despite the mining downturn of 2011-2016 and the associated collapse in mineral exploration activity.

Industry-Led

Engagement of 63 Participants, Other Participants and Affiliates with a very strong industry focus as witnessed by the following.

- Head Office embedded in industry.
- ~30% of research funds flowing to industry.
- Engagement with 110 industry-based researchers (~27 cash-funded industry FTE person years and ~78 in-kind FTE person years), comprising approximately one third of DET CRC's total research FTE.
- Strong engagement of industry in the Science Steering Committee and on project reviews.
- Approximately half of the attendees at each annual conference being from industry.

Communications

A successful communications program with, for example, 43,000 views of 81 videos on DET CRC's YouTube Channel.

Students

Completion of 36 postgraduate research students to-date (and another 7 theses submitted) and training of 407 driller trainees.

Prospecting Drilling

The RoXplorer® coiled tubing drill rig combined with DET CRC's other new technologies will open the Gawler Craton, Murray Basin, and indeed the ~70% of Australia where mineral deposits are hidden by barren cover rocks, to 'prospecting drilling' which will enable progressive vectoring towards concealed mineral deposits using multiple, cheap holes in a single drilling campaign.

Technology Awards

DET CRC awarded an annual prize for the best technological advance based on the following criteria:

- degree of innovation and technical challenge overcome;
- relevance to DET CRC's core purpose and vision, and;
- positive impact on sponsor's view of DET CRC.

The awardees were as follows.

DATE	TECHNOLOGY	PROGRAM	PROJECT PARTIES
2017	CTrol® and CTrolX® Drilling Fluids	Program 1	Boart Longyear, Curtin University, CSIRO, Imdex
2016	RoXplorer®	Program 1	Boart Longyear, Curtin University, CSIRO, Imdex
2015	Wireless Sub	Program 1	Boart Longyear, CSIRO, Epslog, Globaltech
2014	Lab-at-Rig® Sample Handling and Sensor System	Program 3	CSIRO, Curtin University, Imdex, Olympus, University of Adelaide

~27
CASH-FUNDED INDUSTRY
FTE PERSON YEARS

43K
VIEWS ON
YOUTUBE

~78
IN-KIND INDUSTRY
FTE PERSON YEARS



THE ROXPLOER®



THE ROXPLOER®

The RoXplorer® coiled tubing drilling system provides cheaper, faster, safer and more environmentally friendly drilling, estimated to be one sixth of the cost of conventional diamond drilling and one third of the cost of conventional reverse circulation drilling. The RoXplorer® coiled tubing drilling system was the recipient of a CRC Association 'Excellence in Innovation' Award in May 2018.

The CRC has delivered an excellent series of outputs through the step change in drilling technology, drill sensing ability and the real-time, or near real-time analytical technologies. It has also trained a new generation of earth scientists and engineers in these novel technologies.

ALAN COLLINS
UNIVERSITY OF ADELAIDE





WEIGHT
(without the coiled tubing reel)
12,471kg



**NUMBER OF
ELECTRICAL
CONNECTIONS**
753



**LITRES OF
DRILLING FLUID
IN ROXPLOER®'S
500M COIL**
475



HEIGHT
10.60m



**NUMBER OF
HYDRAULIC HOSES**
241



**MAN HOURS
TAKEN TO
ASSEMBLE**
4,481hrs



MAXIMUM SPEED
5kph



**LITRES OF
HYDRAULIC FLUID**
759



**LINES OF CODE
IN ROXPLOER®'S
CONTROLLER AND
OPERATOR CONSOLE**
3,553

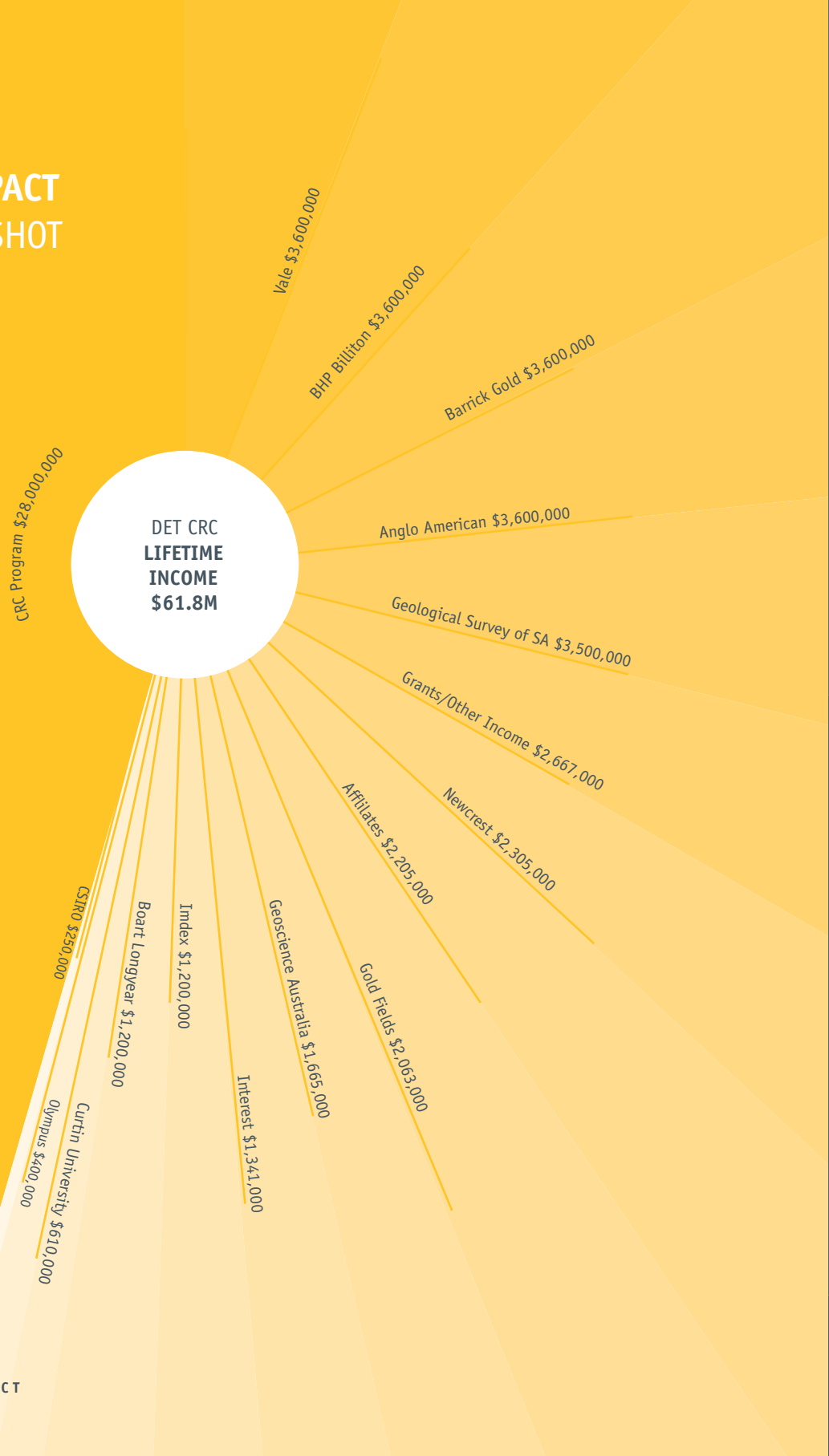


ECONOMIC IMPACT

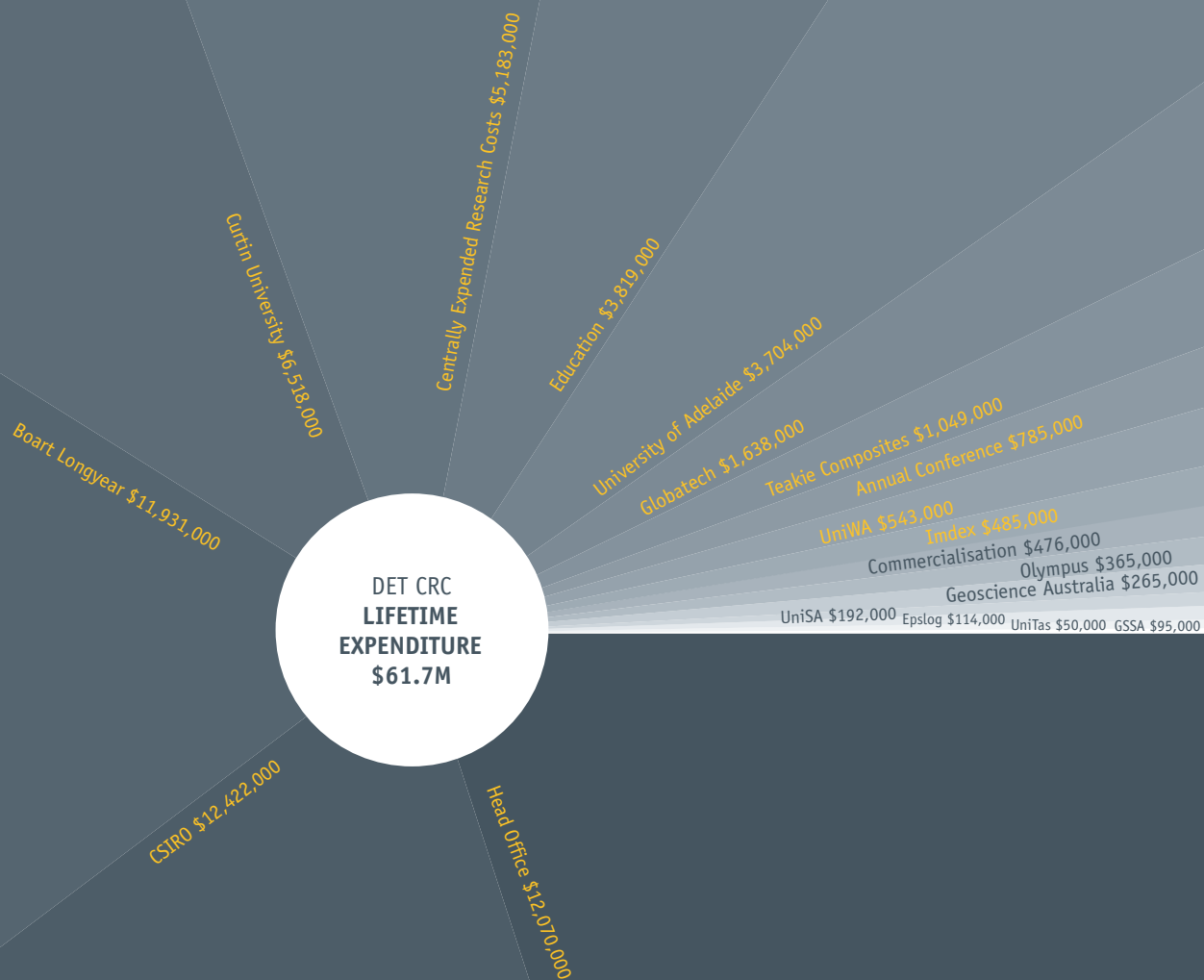


ECONOMIC IMPACT FINANCE SNAPSHOT

LIFETIME INCOME



LIFETIME EXPENDITURE



ECONOMIC IMPACT
ECONOMIC BENEFITS
OF DET CRC'S
TECHNOLOGY

Coiled Tubing Drilling

The economic benefit of DET CRC's coiled tubing drilling system can be considered in three ways:

01
Value of savings to drilling costs which can be estimated.

02
Value of new discoveries resulting from lower drilling costs, which can be estimated, but with significant uncertainty.

03
Value of discoveries due to a new approach to mineral exploration, which cannot be estimated.

SAVINGS

A\$140M

EACH YEAR BY REPLACING HALF OF AUSTRALIA'S DIAMOND DRILLING

OR

METRES DRILLED

2.5

TIMES OR

1.4M

METRES

ADDITIONAL DRILLING IN AUSTRALIA EACH YEAR.

DISCOVERIES

2.5

EXTRA MODERATE DISCOVERIES EACH YEAR IN AUSTRALIA

OR

VALUE OF DISCOVERIES

US\$200M

EXTRA IN VALUE EACH YEAR IN AUSTRALIA

US\$2BN

EXTRA OVER 10 YEARS IN AUSTRALIA

US\$16BN

EXTRA OVER 10 YEARS GLOBALLY

SAFETY

50%

OF WORKPLACE INJURIES WILL BE ELIMINATED

AND

CO₂

EMISSIONS AND SURFACE CONTAMINATION RISKS SIGNIFICANTLY REDUCED



These figures do not make any allowance for smarter mineral exploration due to, for example, improved knowledge of the distal footprints of mineral deposits that result from additional coiled tubing drilling. It also doesn't attempt to place an economic benefit on the AutoSonde and AutoShuttle (for real-time downhole determination of rock properties), or on the Lab-at-Rig® (for real-time top-of-hole determination of geochemistry and mineralogy). The AutoSonde, AutoShuttle and Lab-at-Rig® replace existing technologies at lower cost, but the savings will be smaller than those outlined above and their real value is in the routine collection of more and better quality data to assist smarter mineral exploration, the value of which cannot be reasonably quantified.

“The way industry has interacted, and CRC management/researchers have responded to industry priorities was a major highlight compared to historical industry-university research interaction.”

TONY BELPERIO
MINOTAUR EXPLORATION

Wireless Sub



**A\$38M
EACH YEAR**

BASED ON A 10%
INCREASE IN THE
PRODUCTIVITY OF
CONVENTIONAL
DIAMOND DRILLING

ECONOMIC IMPACT
ECONOMIC BENEFITS
OF DET CRC'S
TECHNOLOGY

**Benefits to the South
Australian Government**

The South Australian Government has been one of DET CRC's key supporters. Headquartered in Adelaide, DET CRC provided significant benefits to the State during its eight-year lifespan.

\$6M

**cash invested by South
Australian Government**

200+

**South Australian
companies collaborated
with or supplied
services to DET CRC**

\$31M

**cash expenditure
in South Australia**

407

**driller trainees at the
Brukunga Drilling Research
& Training Facility**

265

**FTE years of employment
in mining services and
advanced manufacturing**

20 PhD

**students supported
with scholarships**

43

**completed Honours
research projects and 3
completed coursework
Masters research projects**

8000

**metres drilled in
Gawler Craton**

80%

of South Australia covered by barren rocks and requiring DET CRC'S new technologies for exploration

20

South Australian based suppliers involved in fabrication of the world's first coiled tubing drill rig for mineral exploration in South Australia

5

conferences for national and international delegates with an average of 150 attendees at each, providing significant benefits for numerous local suppliers

Mineral Systems Drilling Program

\$8M

cash and in-kind Mineral Systems Drilling Program (MSDP) developed from \$2.5M cash contribution from the South Australian Government

100

South Australian based suppliers supported by MSDP

The Mineral Systems Drilling Program uncovered new mineralised provinces in the Gawler Craton, uncovered the new technologies required to explore beneath barren

cover and built collaboration between junior explorers, METS sector, government and research organisations in South Australia.



COMMERCIALISATION AND UTILISATION



COMMERCIALISATION AND UTILISATION

ALL
55
COMMONWEALTH
OUTPUT
MILESTONES
ACHIEVED

ALL
41
COMMONWEALTH
UTILISATION
MILESTONES
ACHIEVED

12
TECHNOLOGIES
LICENCED

IOCG Prospectivity Index Licenced September 2014 to Imdex	Lab-at-Rig® Licenced September 2015 to Imdex	Wavelet Tessellation Software Licenced November 2015 to Imdex
Post-Stack Diffraction Software Licenced November 2015 to HiSeis	Hydrophone Baffle System Licenced November 2015 to HiSeis	Wireless Sub Licenced October 2016 to Boart Longyear
Automated XRD Processing Software Commercialisation proposal from Olympus accepted August 2017	Drilling Optimisation Software Licenced September 2017 to Boart Longyear	Pre-Stack Diffraction Software Licenced April 2017 to HiSeis
RoXplorer® CT Drilling System* Commercialisation proposal from Imdex accepted May 2018	Multi-Sensor AutoSonde Licenced May 2018 to Boart Longyear	AutoShuttle Licenced May 2018 to Boart Longyear

It was never the intention of DET CRC to commercialise via spin-off companies. Mining companies wished IP to be commercialised via licencing agreements with existing METS companies.

DET CRC's rights and obligations with respect to the above mentioned commercialisation licence agreements and in the associated background IP and royalty agreements will be assigned to MinEx CRC consistent with the approach outlined in the Wind-Up Plan.

Licencing Agreements relating to the AutoSonde, AutoShuttle, Lab-at-Rig®, Wireless Sub and the RoXplorer® coiled tubing drilling system are expected to have the greatest impact on the mineral exploration industry and revenue generation.

		THREE PILLARS			ADDITIONAL KEY TECHNOLOGIES & THREE PILLAR DEVELOPMENTS								INCOMPLETE TECHNOLOGIES	
		CT Rig	Total y Auto-Sonde	XRF & XRD Lab-at-Rig®	Wireless Sub	Mag Susc. for Autos.	Resist. for Autos.	Spectra l y for Auto-Shuttle	Titl e & y for CT	Optical Imager for CT	LIBS for Lab-at-Rig®	Lab-at-Rig® Percuss'n	Composite Rods	Automated Rod Handling
Full commercial application	9	role of commercialiser (ROC)			role of commercialiser (ROC)								ROC	
First of a kind commercial system	8	role of commercialiser (ROC)			role of commercialiser (ROC)								ROC	
Demonstration system (e.g MSDP)	7	2017	2017	2016	2017							ROC	no further progress	no further progress
Prototype system (e.g Brukungu)	6	2016	2016	2015	2015	2017	2017	2017					no further progress	no further progress
Large scale prototype (lab/Bruk.)	5	2016	2015	2014	2014	2016	2016	2016	2017	2017	ROC	2017		
Small scale prototype (Lab)	4	2016	2014	2014	2013	2015	2016	2015	2017	2017		2017		
Applied Research	3	2012-15	2013	2013-14	2013	2013-15	2013-15	2013-15	2016	2016	2016-17	2016	2013	2013
Technology Formulation	2	2011	2012	2013	2012	2012	2012	2012	2016	2016	2015-16	2015-16	2012	2012
Basic Research	1	2011	2011	2012	2012	2011	2011	2011	2016	2016	2014-15	2015-16	2011	2011
Idea	0	2010	2010	2012	2012	2010	2010	2010	2015	2015	2013	2014	2010	2010

Progress of DET CRC's key technologies through Technology Readiness Levels

COMMERCIALISATION AND UTILISATION



The Lab-at-Rig[®], Commercialisation

The technology is a world-first, delivering near real-time analysis of geochemistry and mineralogy of the cuttings from diamond drilling, thereby facilitating rapid decision-making in mineral exploration.

The Lab-at-Rig[®], while not yet a fully commercial product, was a model collaborative research project involving research organisations, industry suppliers and industry end-users.

The Lab-at-Rig[®] was an 18-month, \$1M cash, \$2M in-kind 'Opportunity Fund' Project to produce a prototype top-of-hole analysis system for diamond drilling. The technology is a world-first, delivering near real-time analysis of geochemistry and mineralogy of the cuttings from diamond drilling, thereby facilitating rapid decision-making in mineral exploration. The project brought together a research team from CSIRO, Imdex and Olympus.

Project management was strongly influenced by the industry partners and was best practice at each stage including work undertaken to scope the project, landscape reviews of existing technologies and to confirm freedom to operate. The outputs of the project, in addition to the demonstrated prototype, included a detailed Opportunity Assessment Report and Technology Transfer Pack suitable for a commercialiser to assess the business opportunity. The technology was offered for commercialisation in October 2014. A commercialisation proposal from Imdex was accepted in January 2015 and a licence agreement was executed in September 2015.

The Lab-at-Rig[®] was extensively deployed by Imdex on the Geological Survey of South Australia funded Mineral Systems Drilling Program in 2015 and 2016. This provided an invaluable opportunity to build confidence in the technology as well as undertake product development with a 'friendly' client.

In 2016 Imdex entered into a 'Kickstarter Agreement' with Barrick Gold whereby the two companies (a supplier and an end-user) now have a strategic relationship to further develop and deploy the technology. A pre-commercial trial of Lab-at-Rig[®] was carried out by Imdex at a Barrick site in Nevada during 2017. This trial fed into a process of value modelling conducted jointly between Imdex and Barrick and has led to a decision to automate the technology. The initial stages of this automation work is now underway.

There is great potential for the technology to be applied to other forms of drilling other than diamond drilling, including Reverse Circulation (RC) drilling and to Coiled Tubing (CT) drilling.

REGISTERED IP

DET CRC's patent portfolio.

TITLE	PROJECT	COUNTRY	APPLICATION NO.	PRIORITY DATE	STATUS
Borehole Logging Methods and Apparatus	AutoSonde	International	2013904475	19 Nov 2013	Managed by Boart Longyear. Patent applications lodged in numerous countries
Sampling and Analysis System and Method for use in Exploration Drilling	Lab-at-Rig®	International	2014904646	19 Nov 2014	Managed by Imdex: Patent applications lodged in numerous countries
Drying apparatus and related method	Lab-at-Rig®	International	2014904649	19 Nov 2014	Managed by Imdex: Patent applications lodged in numerous countries
Capture of drilling fluid returns	Lab-at-Rig®	Australia	2015903272	14 Aug 2015	Managed by Imdex: Patent applications lodged in numerous countries
High Speed Downhole Coring System	RoXplorer® CT Rig	Australia	2017101088	10 Aug 2017	Managed by DET CRC: Innovation patent granted
Mobile Coiled Tubing Apparatus	RoXplorer® CT Rig	International	2017050508	18 Jan 2017	Managed by Imdex: PCT application submitted
Sample Collection System and Parts Thereof	RoXplorer® CT Rig	Australia	2017903541	1 Sep 2017	Managed by Imdex: Provisional application submitted
Rotary Drill Head for Coiled Tubing Drilling Apparatus	RoXplorer® CT Rig	International	2017051098	11 Oct 2017	Managed by Imdex: PCT application submitted
Drilling Fluids and Uses Thereof	RoXplorer® CT Rig	Provisional	2018901763	21 May 2018	Managed by Imdex: Provisional application submitted

DET CRC's registered design portfolio.

TITLE	PROJECT	COUNTRY	APPLICATION NO.	PRIORITY DATE	STATUS
Fluids Capture Apparatus 1	Lab-at-Rig®	Australia	201514172	14 Aug 2015	Registered, managed by Imdex
Fluids Capture Apparatus 2	Lab-at-Rig®	Australia	201514173	14 Aug 2015	Registered, managed by Imdex
Mobile Coiled Tubing Apparatus	RoXplorer® CT Rig	International	201710287	18 Jan 2017	Registered, various countries, managed by Imdex
A Cone Member for a Cone Splitter	RoXplorer® CT Rig	Australia	201715232	1 Sep 2017	Registered, managed by Imdex

DET CRC's trademark portfolio.

TITLE	COUNTRY	APPLICATION NO.	CLASSES	FILING DATE	STATUS
DET CRC Logo	Australia	1410230	37, 42 & 45	22 Feb 2011	Registered, managed by DET CRC
Lab-at-Rig®	Australia	1581982	7, 9, 37 & 42	23 Sep 2013	Registered, managed by Imdex
RoXplorer®	Australia	1664080	7,37	11 Dec 2014	Registered, managed by Imdex
GeoLIBS®	Australia	1754508	9 & 42	24 Feb 2016	Registered, managed by DET CRC
SwiftMin®	Australia	1825962	9 & 42	15 Feb 2017	Pending
CTrol®	Australia	11827061	1	21 Feb 2017	Registered, managed by Imdex



INTERNATIONAL IMPACT AND ENGAGEMENT



INTERNATIONAL IMPACT AND ENGAGEMENT

During its lifetime, DET CRC had global reach and engagement that included:

Canada

Annual sponsor updates at Prospectors & Developers Association of Canada

Technical input into projects from Barrick Gold and provision of samples to assist Lab-at-Rig® Futures Project

Technical input into projects from Vale

Worked with First Quantum Minerals on the provision of Kevitsa reflection dataset

Sensor design for AutoSonde and AutoShuttle with University Laval

Worked with the University of Alberta on hyperspectral characterisation of mineral systems

USA

Collaboration with Tenaris Coiled Tubing on the development of the coiled tubing

Development of sensor technologies for Lab-at-Rig® with Olympus USA

Extended deployment of prototype RoXplorer® by Imdex, Barrick Gold and DET CRC

Development of sample handling system for Lab-at-Rig® with Honeybee Robotics

Collaboration with Tempress Technologies for development of downhole turbines for RoXplorer® coiled tubing rig

Collaboration with DataDrill on the development of down hole data capture for CT Rig

Collaboration with Power Hydraulics on the development of the reel for CT Rig

Collaboration with Tempress Technologies on the development of turbines for the CT Rig

Collaboration with Drilex on the development of drilling motors for CT Rig

Collaboration on the development of drilling motors for CT Rig with Toro Downhole Tools

Extensive collaboration with Boart Longyear to develop novel bits for coiled tubing drilling

Collaboration with Cobra Downhole on the development of drilling motors for the CT Rig

United Kingdom

Collaboration on the development of tubing for CT Rig with Limar Oil Tools

Design and manufacture of Fluid Management System with NICO 2000

Belgium

Design strain gage amplifier/signal conditioner module of the Wireless Sub with Nomics SA



Sweden

Collaboration with Wassara on development of hammer technologies for CT Rig

Work on seismic reflection dataset at Neves Corvo with Lundin Mining

Work on Kevitsa reflection dataset with the University of Uppsala

Ukraine

Provision of scintillation crystals for AutoSonde and AutoShuttle from Institute of Single Crystals

Finland

Use of joint inversion of co-located electromagnetic and seismic data in Kevista mine

Italy

Collaboration on the development of a water pump for the CT Rig with Interpump Group

South Africa

Samples from Anglo-American from Kumba iron ore mine analysed by XRD and LIBS techniques

Technical input into projects from Anglo-American and provision of samples to assist Lab-at-Rig® Futures Project

Gawler Craton, South Australia
World-first Minerals Systems Drilling Program

RoXplorer® coiled tubing rig field trial

Adelaide Hills
Brukunga Drilling Research & Training Facility

Staveland, Victoria
RoXplorer® coiled tubing rig field trial and early concept Lab-at-Rig trial

New Zealand
Collaboration with Flexidrill on trials of downhole tooling

Pilbara, Western Australia
Field trials of the AutoSonde

Adelaide, Australia
DET CRC headquarters

Oberon, NSW
Trials of the Wireless Sub, Autosonde and Lab-at-Rig





SME ENGAGEMENT



SME ENGAGEMENT

DET CRC's key engagement activity with SMEs was the Affiliate program. There were three groups of Affiliates (known as Colleges). Junior mining or exploration companies (defined as those with market capitalisation of less than \$1BN, all of which are SMEs as defined by <200 employees) constituted one college. METS (Mining, Equipment, Technology and Services) suppliers constituted the second college and geological surveys (who are Commonwealth and State government agencies) constituted the third college. Each college was entitled to a vote on the Science Steering Committee equal with that of each of the Essential Participants. Each Affiliate paid a \$10,000 membership fee each year.

Affiliates engaged with DET CRC through:

- Accessing the network of mining companies, supplier companies, geological surveys and research organisations participating in the CRC
- Understanding the R&D priorities of the major mining company and geological survey sponsors
- Utilising the Brukunga Drilling Research & Training Facility
- Utilising research outcomes
- Being an active Project Party and receiving funding for research
- Of DET CRC's 47 Affiliates over its lifetime, 33 were SMEs.

AFFILIATE JUNIOR EXPLORER SME'S

ABM Resources

Blackthorn Resources

Carpentaria Exploration

Heathgate

Investigator Resources

Kingston Resources

Minotaur Exploration

Nautilus Minerals

Monax Exploration

Paladin

Rex Minerals

AFFILIATE SUPPLIER SME'S

Australian Drilling Industry Association (ADIA)

Australian Training Alliance (ATA)

CSA Global

Century Engineering

Corporaal Enterprises

Diarotech

Downhole Surveys

Diamant

Drillco Tools

Epslog

Flexidrill

GeoMole

Globaltech Downunder

Hardcore Diamond Products

HiSeis

ioGlobal

JKTech

Leapfrog

SAGE Automation

Teakle Composites

Training Prospects

Wassara

“The biggest news in decades in the mineral exploration industry arrived quietly last month with the unveiling of the RoXplorer drill rig.”

DAVID UPTON
JOURNALIST

Key SME outcomes

HiSeis, an Affiliate Supplier SME, licenced three technologies from DET CRC related to seismic exploration techniques and is developing these technologies into commercial products and services.

Another Affiliate Supplier SME, Globaltech was a key research party in the Wireless Sub and AutoSonde/AutoShuttle projects. Globaltech received in excess of \$1M research funding from DET CRC. In the course of DET CRC, Participant Supplier Boart Longyear developed a strategic relationship with Globaltech and took a significant shareholding in the company.

Teakle Composites has expertise in composite materials which was utilised for the development of composite fibre drill rods and coiled tubing. Teakle Composites received in excess of \$1M research funding from DET CRC and as a direct result was able to build its capacity by obtaining specialised equipment such as a pultrusion winding machine and by taking on additional personnel. New steel coiled tubing products were in the end selected for the RoXplorer® rig, but composites remain an exciting area for future research.

Affiliate Junior Explorer SMEs, Minotaur Exploration and Kingston Resources partnered with DET CRC and the Geological Survey of South Australia to undertake an extensive drilling program on Eyre Peninsula (South Australia) during 2015-2016. Minotaur Exploration and Kingston

Resources contributed cash and in-kind resources for drilling using DET CRC technologies to be undertaken on their tenements. They benefited from access to new, real-time data while new technologies benefited from extensive field trialling and industry feedback regarding their use in a real exploration context.

Wassara, an Affiliate Supplier SME, has developed specialised water-driven downhole drilling hammers and an underground coiled tubing system to drill blast holes in Swedish iron ore mines. DET CRC utilised the Wassara water hammer system in our greenfields, exploration-focused RoXplorer® coiled tubing drilling system. There was also extensive collaboration between DET CRC and Wassara regarding water-driven downhole hammers and the application of coiled tubing drilling to mineral exploration and mining.

New Zealand-based Affiliate Supplier SME, FlexiDrill tested its high frequency drilling motors at the Brukunga Drilling Research & Training Facility.

Affiliate SME Suppliers, the Australian Training Alliance (ATA) and Training Prospects offered a practical element to their VET courses by utilising the Brukunga Drilling Research & Training Facility, including access to Boart Longyear's drilling rig and drilling crew. Over 400 trainees utilised the Brukunga Drilling Research & Training Facility during the lifetime of DET CRC.



An aerial photograph of a construction or mining site. A large pile of reddish-brown rocks and debris is visible on the left side of the image. To the right, a river flows, with a person standing on its bank. In the lower-left corner, there are several white and blue containers, some equipment, and a few workers. The background shows a dirt road and more vegetation.

EDUCATION AND TRAINING



EDUCATION AND TRAINING

DET CRC allocated \$3.8M to Education and Training, principally via \$75,000 to the host university per PhD student and \$50,000 per Masters by Research student enrolled with DET CRC support. A \$3,000 bonus was awarded to PhD students on completion and a \$2,000 bonus to Masters by Research students.

DET CRC had the goal of completing 40 postgraduate research students, a goal that will be achieved. To-date the status of DET CRC's postgraduate research students is:



Dr Masood Mostofi
(Project 1.2 PhD student)

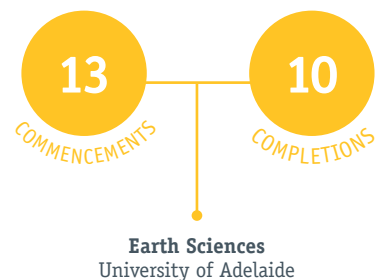
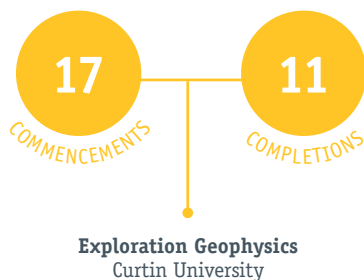
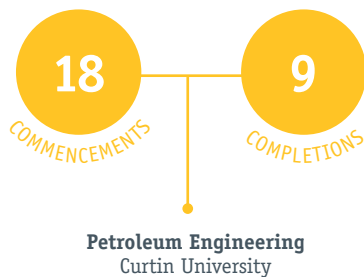


Dr Masood Mostofi attained a Bachelor and Master of Drilling Engineering from the Petroleum University of Technology of Iran, and also holds a Master of Petroleum Engineering from Curtin University. After working in two research centres in Iran, Masood undertook a PhD at Curtin University from 2011-2014 in DET CRC Project 1.2. Masood's project investigated the drilling response of impregnated diamond bits through modelling and experimental investigation. The results of this research were used in the second phase of DET CRC for development of interpretation software for drilling action of impregnated diamond bits. Masood received a top-up scholarship from MRIWA at 2015, and the quality of Masood's research was highlighted when he received a Dean's Commendation for his Doctoral Thesis in 2014. Masood is now a Lecturer at the Curtin University WA School of Mines where he teaches

undergraduate and postgraduate students in drilling engineering fundamentals. Since completing his postgraduate studies, Masood has stayed strongly connected with DET CRC and has become a key researcher within DET CRC Project 1.1 investigating borehole stability, borehole erosion and particle tracking in the coil tubing drilling system. Masood played an integral role in the DET CRC RoXplorer® field trials at Port Augusta and Horsham through his research into drilling fluid properties and fluid management system associated with the coiled tubing drill rig. Masood has supervised eight DET CRC postgraduate students, three of whom have qualified for their postgraduate degree.

"It has been a great opportunity for me to be part of DET CRC, and I am very happy that I can continue my work and research in this community." Dr Masood Mostofi

Commencements and completions by University and School/Department at June 2018



EDUCATION AND TRAINING

Annual Student Prize winners

An Annual Student Prize was awarded for the best one-minute presentation and poster at the Annual Conference. The winning student accompanied the DET CRC team to the world's biggest mineral exploration-related conference, the PDAC Convention (Prospectors & Developers Association of Canada) in Toronto with all their expenses being met by DET CRC. The winners have been as follows.



YEAR	STUDENT	PROGRAM	DEGREE	UNIVERSITY
2011	Stephanie McLennan	3	Earth Sciences	University of Adelaide
2012	Amir Mokaramian	1	Petroleum Engineering	Curtin University
2013	Sebastian Schnaidt	2	Earth Sciences	University of Adelaide
2014	Mohammad Hossain	3	Exploration Geophysics	Curtin University
2015	Stuart Addinell	1	Petroleum Engineering	Curtin University
2016	Eline Baudet	3	Earth Sciences	University of Adelaide
2017	Hongyang Zhang	1	Petroleum Engineering	Curtin University



**STUDENT
COUNTRIES
OF ORIGIN**

Note data correct
as of May 2018

Note data correct
as of May 2018

**Driller trainees accessed the
Brukunga Drilling Research
and Training Facility in
28 courses largely at the
Certificate II Level.**

Masters by Coursework students have undertaken the research component of their degrees on DET CRC-related research projects.

Honours students have undertaken the research component of their degrees on DET CRC-related research projects.

Postgraduate research students have had industry co-supervisors.

**Drillers, driller assistants
and field technicians
trained in the use of DET
CRC's new technologies.**



PARTICIPANTS AND COLLABORATIONS



PARTICIPANTS AND COLLABORATIONS

Participants

- There was a total of 63 Participants, Other Participants and Affiliates engaged by DET CRC, with very strong industry collaboration achieved through:
- Head office embedded in industry
 - Approximately 30% of research funds flowed to industry
 - Engagement with 110 industry-based researchers (approximately 27 cash-funded industry FTE person years and approximately 78 in-kind FTE person years), which corresponded to about one third of DET CRC's staffing both in terms of individuals and FTE years.
 - Strong engagement of industry in the Science Steering Committee and on project reviews
 - Approximately half of annual conference attendees from industry.

DET CRC HAD 16 PARTICIPANTS AND OTHER PARTICIPANTS OVER ITS LIFETIME		
Anglo American	Participant	2011-2018
Barrick Gold	Participant	2011-2018
BHP	Participant	2011-2018
Boart Longyear	Participant	2011-2018
Geological Survey of South Australia	Participant	2010-2014
Gold Fields	Participant	2011-2018
Imdex	Participant	2011-2018
Newcrest Mining	Participant	2010-2015
Vale	Participant	2011-2018
CSIRO	Participant	2011-2018
Curtin University	Participant	2011-2018
University of Adelaide	Participant	2011-2018
University of South Australia	Participant	2017-2018
Geoscience Australia	Other Participant	2011-2018
Olympus	Other Participant	2013-2018
University of Western Australia	Other Participant	2011-2018

16
PARTICIPANTS
AND OTHER
PARTICIPANTS

110
ENGAGEMENT
WITH
INDUSTRY-BASED
RESEARCHERS

DET CRC, with its end-user driven collaboration of METS companies, miners, government (geological surveys) and research institutions, helped meet the aims of METS Ignited Sector Competitiveness Plan

Relevant Publications by Participants

There have been 236 formal publications by Participants during the lifetime of DET CRC. Much of DET CRC's work remains unpublished due to its commercial-in-confidence nature and DET CRC's Centric Project Management Systems contains 1,153 documents.

In addition to uncovering new technologies, DET CRC helped uncover new relationships both within Australia's METS sector and between Australia's METS Sector and research organisations. These relationships will outlive DET CRC and are part of a significant 'soft' legacy that adds to the 'hard' legacy of the new technologies that DET CRC has developed.

Australia's Mining Equipment Technology and Services (METS) Sector contributes over \$90 billion in gross annual revenue to the country's prosperity. It exports over \$15 billion of products and services to every corner of the globe and invests \$4 billion in R&D.

\$90
BILLION IN GROSS ANNUAL REVENUE

\$15
BILLION OF PRODUCTS AND SERVICES

\$4
BILLION IN R&D INVESTMENT

PARTICIPANTS AND COLLABORATIONS



AutoSonde and AutoShuttle Collaboration

Previously such data required a separate wireline logging crew to be mobilised to often remote drill sites, costing significant time and expense, and with the risk that the borehole may collapse prior to vital information being obtained.

The AutoSonde and AutoShuttle are downhole sensing technologies that add value to conventional diamond drilling. They permit key information on the physical properties of the rocks that a borehole has intersected to be determined by the drilling crew in the routine course of drilling. Previously such data required a separate wireline logging crew to be mobilised to often remote drill sites, costing significant time and expense, and with the risk that the borehole may collapse prior to vital information being obtained.

The AutoSonde and AutoShuttle:

- Were developed collaboratively by scientists and engineers from Curtin University and Perth-based METS SME Globaltech.
- Have been licenced by Boart Longyear, one of the world's biggest drilling companies.

In the course of the project:

- Boart Longyear acquired a significant shareholding in Globaltech.
- Globaltech moved its offices to co-locate with Boart Longyear's Forrestfield Facility in Perth.
- Globaltech negotiated the manufacturing rights for TRUPROBE, Boart Longyear's commercial version of the AutoSonde, creating new high technology, METS sector employment in Australia.
- Boart Longyear sponsored a Chair in Geophysical Instrumentation at Curtin University held by the leader of DET CRC's AutoSonde and AutoShuttle project, Professor Anton Kepic.

PARTICIPANTS AND COLLABORATIONS



Lab-at-Rig® Collaboration

Its near real-time assay can preclude months of delays and enable instant decisions on extending or terminating holes, or drilling new holes, without demobilising and remobilising drill rigs and their crews to remote areas.

The Lab-at-Rig® analyses rock cuttings from drilling, determining both their geochemistry (i.e. assay) and mineralogy. Its near real-time assay can preclude months of delays and enable instant decisions on extending or terminating holes, or drilling new holes, without demobilising and remobilising drill rigs and their crews to remote areas.

The Lab-at-Rig®:

- Did not exist in DET CRC's original research roadmap and developed as research evolved due to interactions between researchers from CSIRO, Olympus and the participant mining companies.
- Commenced as an Opportunity Fund project to deliver a prototype system which was developed collaboratively by scientists and engineers from CSIRO, Imdex and Olympus and in the end constituted one of DET CRC's key projects.
- Was licenced by Imdex, a Perth-based METS company specialising in drilling fluids, downhole instrumentation, geoscience technologies and data analytics and after licensing underwent extensive pre-commercial field trialling at Participant, Barrick Gold's site in Nevada.

In the course of the project:

- Olympus elevated their membership from Affiliate to Other Participant, which delivered extra cash and in-kind resources to the project.
- Imdex acquired then Affiliate ioGlobal which produces industry-leading software for analysis of geochemical data and cloud-based data management systems.
- Imdex recruited then Project Leader for the Lab-at-Rig® project, James Cleverley, from CSIRO.
- Imdex developed a commercial relationship with Olympus for the rental and use of portable XRF analysers as part of their real-time geochemical analysis solutions.
- Australian-based Imdex's development and support of Lab-at-Rig® will help to grow METS sector employment and exports.

PARTICIPANTS AND COLLABORATIONS



Stavelly Drilling Program Collaboration (Victoria)

The program was successful and contributed to the more rapid development and field-testing of DET CRC's new technologies.

14
HOLES
DRILLED

3
KEY
TECHNOLOGIES
DEPLOYED

10
COLLABORATING
ORGANISATIONS

DET CRC originally planned to develop technologies to the level of demonstrating prototypes at the Brukunga Drilling Research & Training Facility prior to offering them for commercialisation. While invaluable, the Brukunga Drilling Research & Training Facility only provides one particular set of subsurface (geological) conditions within which drilling and sensing technologies can be tested. Furthermore, activities there are not subject to the time pressures of operational drilling where there is a strong focus on maximising the number of metres drilled per day. Hence, in order to advance technologies further towards commercial products, field drilling and technology testing programs such as the Stavelly Drilling Program and Mineral Systems Drilling Program were undertaken.

One of DET CRC's major activities in 2014-2015 was the Stavelly Drilling Program. Geoscience Australia and the Geological Survey of Victoria wished to undertake drilling in the relatively poorly geologically known Stavelly Province of western Victoria in order to improve knowledge of the mineral potential of the area. DET CRC collaborated with Geoscience Australia and the Geological Survey of Victoria in order that the drilling project was also used to trial DET CRC's new technologies. Boart Longyear undertook the drilling and assisted with the deployment of DET CRC's technologies.

Fourteen holes were drilled in the program with in excess of 1km of sonic drilling and in excess of 1km diamond drilling. The University of Melbourne contributed additional funding to deepen one of the holes in the program in order to undertake palaeoclimatic studies. By 'piggy-backing' on the existing drilling project, the University of Melbourne was able to avoid mobilisation and site remediation charges and Geoscience Australia received additional core from the deepened hole at no extra cost to them.

The key technologies deployed by DET CRC were its Lab-at-Rig® and AutoSonde. Lab-at-Rig® routinely provided geochemical and mineralogical data to Geoscience Australia and the Geological Survey of Victoria that was also uploaded to the REFLEX Hub (Imdex's cloud-based data storage/analytics system). The availability of near real-time geochemical and mineralogical data was greatly valued by the geologists from Geoscience Australia and Geological Survey of Victoria and enhanced their analysis of the core recovered. The majority of holes were also logged by the AutoSonde, providing a log of the natural gamma radiation of rocks intersected by the holes.

The program was successful and contributed to the more rapid development and field-testing of DET CRC's new technologies. Prolonged field-testing was invaluable for modifying and ruggedizing the technologies for field operation and the research teams learnt invaluable lessons on the operation of the technologies. It was also an excellent example of inter-organisational cooperation involving Boart Longyear, CSIRO, Curtin University, DET CRC, Geological Survey of Victoria, Geoscience Australia, Globaltech, Imdex, Olympus and University of Melbourne.

PARTICIPANTS AND COLLABORATIONS



Mineral Systems Drilling Program Collaboration (South Australia)

The Mineral Systems Drilling Program (MSDP) was a world-first collaboration of:

- Government (Participant, Geological Survey of South Australia)
- Mineral explorers (Affiliates, Minotaur Exploration and Kingston Resources)
- Driller (Participant, Boart Longyear)
- Major and SME suppliers (Participants, Imdex and Olympus and Affiliates, Bureau Veritas, Epslog and Globaltech)
- Research institutes (Participants, CSIRO, Curtin University, and University of Adelaide)

WIRELESS SUB
2,197
METRES OF DRILL
HOLE LOGGED

AUTOSONDE
WITH GAMMA
4,876
METRES LOGGED

LAB-AT-RIG® XRF
5,809
METRES SAMPLED

The Geological Survey of South Australia supported the MSDP in order to elucidate regional signatures of mineral systems under cover in the Gawler Craton (northern Eyre Peninsula). The Geological Survey of South Australia wished to work in collaboration with the mineral exploration industry and invited the industry to propose locations for a co-funded drilling program. The proposals selected by the Geological Survey were submitted by Kingston Resources and Minotaur Exploration and focused on the southern Gawler Craton. The Geological Survey was also supportive of helping develop DET CRC's new mineral exploration technologies, because such technologies are required for more successful exploration of areas of deep, barren cover such as the Gawler Craton.

The MSDP was funded by \$3.5M cash (\$2.5M from the Geological Survey of South Australia's PACE Frontiers programme, \$400K from Minotaur Exploration, \$250K from Kingston Resources and \$345K from DET CRC). There was a further \$4.1M in-kind contribution from those parties. Fourteen holes were drilled in a continuous program from August 2015 to April 2016 to a total of 7,868 m. The MSDP also utilised in excess of 100 South Australian-based suppliers from providing water-trucking services to road-grading to catering 3,225 meals served at remote field camps.

The MSDP involved almost all of DET CRC's projects. As well as thoroughly testing individual technologies, it was the first time that several of DET CRC's technologies were integrated and operating at the same time in a drilling operation. It provided invaluable field trialling for a suite of technologies, specifically:

- Wireless Sub (2,197 m of drill hole logged)
- AutoSonde with gamma and magnetic susceptibility sensors (4,876 m logged by gamma sensor and 728 m logged by magnetic susceptibility sensor)
- AutoShuttle with gamma (88 m logged)
- Lab-at-Rig® (5,809m sampled for geochemistry by XRF and 2,747 m sampled for mineralogy by XRD)
- Fluid Management System (2,800 m sampled)
- Seismic methods (surface reflection seismic lines and borehole-based vertical seismic profiles acquired)

The MSDP also made drilling results remotely available in real-time. The Real-Time Drill Site Project, which was funded by a \$350K grant from the South Australian Government's MIPO (Mining Industry Participation Office), provided a platform on which to show live data from the Wireless Sub, AutoSonde and Lab-at-Rig®. A demonstration of the Real-Time Drill Site Project took place on 14 April 2016 with Participants in Australia and internationally simultaneously viewing real-time and near real-time results from the remote MSDP drill site in South Australia.

PARTICIPANTS AND COLLABORATIONS

	# INDIVIDUAL RESEARCHERS	CASH FTE YEARS IN-KIND	IN-KIND FTE YEARS	TOTAL YEARS	NUMBER OF ORGANISATIONS
RESEARCH ORGS	190	88	126	214	7
INDUSTRY	110	27	78	105	12
TOTAL	300	115	204	319	19

Breakdown by research organisations and industry organisations of the number of individual researchers, cash and in-kind-funded FTE years and number of organisations supported by DET CRC resources.

Collaborations

Additional key collaborations included:

- Researchers from Curtin University and Globaltech Corporation collaborated with BHP in order to conduct field trials of a reverse circulation (RC) drilling version of the AutoSonde at BHP Area-C iron ore deposit in the Pilbara. Learnings from the trial were invaluable for the research team and BHP gained an increased understanding of the technology prior to its commercialisation.
- Researchers from Imdex, CSIRO and Olympus collaborated with Anglo American to conduct Lab-at-Rig® field trials at Anglo's Bushranger exploration project (Oberon, New South Wales). Researchers from CSIRO, Globaltech and Boart Longyear collaborated with Anglo American to conduct Wireless Sub trials at the same project. The deployments were organised at the request of Anglo American and served as a model for collaboration, assisting end-users to understand the role that our emerging technologies may play in their business, and assisting researchers to optimise their technologies for real world conditions.
- The assembly of the RoXplorer® coiled tubing drill rig involved personnel from Century Engineering, Boart Longyear, OmniLogix and DET CRC.
- The field testing of the RoXplorer®, throughout the first half of 2017, was a significant collaborative effort involving a team of drillers, driller assistants, technicians, scientists and engineers from Boart Longyear, Curtin University, CSIRO, Imdex, Omnilogix, University of South Australia and the DET CRC. In addition, the Geological Surveys of South Australia and Victoria provided permitting, logistical, safety and geological expertise.
- The Real-Time Drill Site (RTDS) project was supported by the Minerals Industry Participation Office of the South Australian Department of State Development and involved collaboration with the Geological Survey of South Australia, Imdex Limited and information technology companies Australian Semiconductor Technology Company (ASTC), SRA Information Technology and Innodev.

We see the Wireless Sub as being a game changer for the industry.

JOHN BROCKLESBY
(FMR) ANGLO AMERICAN

1153
DOCUMENTS
ON CENTRIC

236
FORMAL
PUBLICATIONS
BY PARTICIPANTS

Unsuccessful Projects

Not all DET CRC Projects achieved their goals. The Commonwealth Government and sponsors recognise that research progress cannot be guaranteed, despite the best endeavours of all parties. Initial (Phase I) project contracts ended around the time of DET CRC's Major Performance Review (late 2013-early 2014). The outcomes of the Major Performance Review and guidance from the Science Steering Committee led to three projects not continuing into Phase II and to two projects being combined.

With respect to the projects that did not continue into Phase II, opinions on the causation of such would vary depending on those canvassed. A key point to note is that DET CRC sought greater focus at this time in order to try to ensure the success of its core, three pillar projects.

DET CRC developed a project management process that helped address the risks of project non-delivery, which included:

- Detailed and carefully reviewed Project Agreements (research contracts) typically of two, three or four years' duration
- Outcome-oriented annual and quarterly milestones (the former set in Project Agreements at project commencement and the latter set annually reflecting ongoing progress/developments)
- Use of KDPs (key decision points) for clear decision-making around project priorities as research evolves
- Clarity around the technology readiness levels (TRLs) at which projects operate and successfully complete
- SMART (Specific, Measurable, Attainable, Realistic, Time-bound) project performance targets
- All combined with quarterly project reporting reviewed by the programme leader, industry reviewer and CEO, resulting in a simple traffic light assessment of each project each quarter

The extent to which projects were meeting quarterly milestones provided a responsive indication of project progress and the status of quarterly milestones played an important role regarding whether projects continued into Phase II.





SUPPORTERS



SUPPORTERS

Participants



Business
Cooperative Research
Centres Programme



Affiliates



