Creating a new frontier in detection and data integration for exploration through cover

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SUMMARY

A new wave of technologies and data products are needed to address the decline in greenfields exploration activity and discovery success in Australia. Australia is an old continent with much of its remaining mineral endowment obscured by a thick cover of weathered rock, sediment and soil materials. This presents a critical challenge for mineral exploration now and into the future, as the industry currently lacks the fundamental data, scientific knowledge and technological tools needed to discover new, world-class ore deposits buried beneath this cover. UNCOVER, is a national vision in Australia for the future for mineral exploration geoscience research to tackle the geological barriers to more tier 1 discoveries. Harnessing capabilities, a well-defined focus and virtuous collaboration on the task of developing this new technology coupled with strong industry engagement can address this challenge.

Key words: UNCOVER, mineral exploration, disruption, technology.

The technology imperative

UNCOVER as a national initiative, has the potential to position Australian exploration geoscience research for a shift in collaboration for this next generation technology development, one that tackles the exploration through deep cover challenge as one of major national importance. As we move into exploring the deeper cover regions of Australia, we need to determine detectable signatures of buried mineral systems and ore systems from a number of varied sample media and with different technologies. Arguably, the challenge posed by the depth of cover to find the mines of the future is going to be in the 100s of m, given current mining practices from the surface combined with the economic realities. Future discovery success requires diversification of the search and discovery space through this cover and to greater depths. Industry has identified and prioritised the development of a new suite of tools and workflows to explore through Australia's cover as articulated in the UNCOVER vision (Australian Academy of Sciences, 2012) and the AMIRA Industry roadmap for UNCOVER (launched in 2015).

Firstly though, we need to know the extent of that thickness of cover, its stratigraphy, lithogeochemistry and physical properties. Comprehensive data that will in turn aid in more effective processing and interpretation of the regional data-sets collected e.g. magnetics, and increase confidence in our geological models of the sub-surface. While the cover is a barrier it also presents an opportunity and detection through cover may lead to new resource discovery within the cover itself.

Onshore basins, particularly in the Northern Territory and central/western regions of Australia, have enormous potential for gas - coal seam gas and shale/tight gas as well as for mineral resources. The ultimate aim is for the overlying regolith cover to become 'transparent', by more precise imaging and profiling of subsurface rock properties. Developing a toolkit to better navigate through the subsurface will add significant value to the wealth of geological and geophysical data that already exist. The full potential of these data remains untapped, mainly because there is a lack of appropriate interpretation technologies. By linking these methods to rock physics (digital rock), and by discovering, understanding and modelling relationships between remotely-acquired geophysical observables and in-situ rock properties, the uncertainty associated with exploration through this cover needs to be be reduced. This means that further drilling and collection of geophysical data can be more efficient and achieved at lower risk.

Our ability to detect an anomaly in exploration though, rests not only in the direct detection itself but also in being able to place the data point into a regional geological context. For example, research on the geochemistry of the Fortescue Group volcanics assessing burial metasomatism effects places perceived geochemical and mineralogical anomalism from similar lithologies into a broader geological and indeed regional context. Similarly, regional hydrogeochemistry data through analysis of farm bores reveals the sub-surface chemistry directly related to the buried geology. Integrated exploration geoscience research requires that regional context if we are to define new regional to cam scale exploration tools, collaborative multi-disciplinary projects can help us cross this bridge.

Collaboration is key

The SIEF, MRIWA, GSWA and industry supported Capricorn distal footprints project between CSIRO, UWA and Curtin University teams reflects a highly collaborative approach to the challenge, including in a highly multi-disciplinary manner with the development of a very strong cohort of early career researchers and students. A key aspect of the project has been to collect and develop data and

approaches that are useful, usable and used by the geological surveys and industry as target end users. The impact achieved in the project to date is nicely summarised in the SIEF Independent impact review of 2017: "The toolkit of information and test results developed from this research will enable the exploration of areas where mineral detection and extraction have been previously deemed too technically difficult or not cost effective. Further, a better understanding of the mineralisation of an area could also inform decisions on how best to develop any resource that might be found. The project has led to exploration activity with tenement uptake in at least one area as a direct result of the research. Over the next 10 years, it is anticipated that more explorers will use the data and outputs as part of their targeting activities. On a broader basis, the tools and approaches will be used elsewhere across Australia and even internationally. The project has a benefit cost ratio of over 5".

From a research perspective some highlights for the research are:

- Local 'anomalism' placed in a regional context, improved decision making and risk management.
- Integrated geophysical data from deep crust to shallow cover (MT-AEM), new pre-competitive data in a region where previous regional data was sparse and poor.
- Split stream analysis making heavy mineral concentrate analysis cheaper and more significant.
- Zn isotopes as a useful indicator for vectoring.
- Manganese crusts as a sample media
- Archean sulphur signatures in Proterozoic geology (MIF)
- Hydrogeochemistry identifies local anomalies and potential targets.
- Next generation of industry researchers.

Figure 1. (Next page) The project area and research activities conducted in the SIEF supported Capricorn Project.

Australian researchers have long played a globally leading role in developing new approaches and technologies to support the minerals industry in exploration, most often through collaboration involving multiple organisations and with close industry engagement. Co-operative research centres (e.g. MinEx CRC bid) and Centres of Excellence are vehicles that have been very important in the focus and drive for innovation to support the industry to tackle technical challenges involved with mineral exploration in Australia. It is imperative that we develop a similar collaborative and focussed approach to deliver against the research roadmap recently developed for Exploration Through Cover, outline which explicit technologies are now needed to address the individual problems and gain the crucial industry support that is required to deliver.

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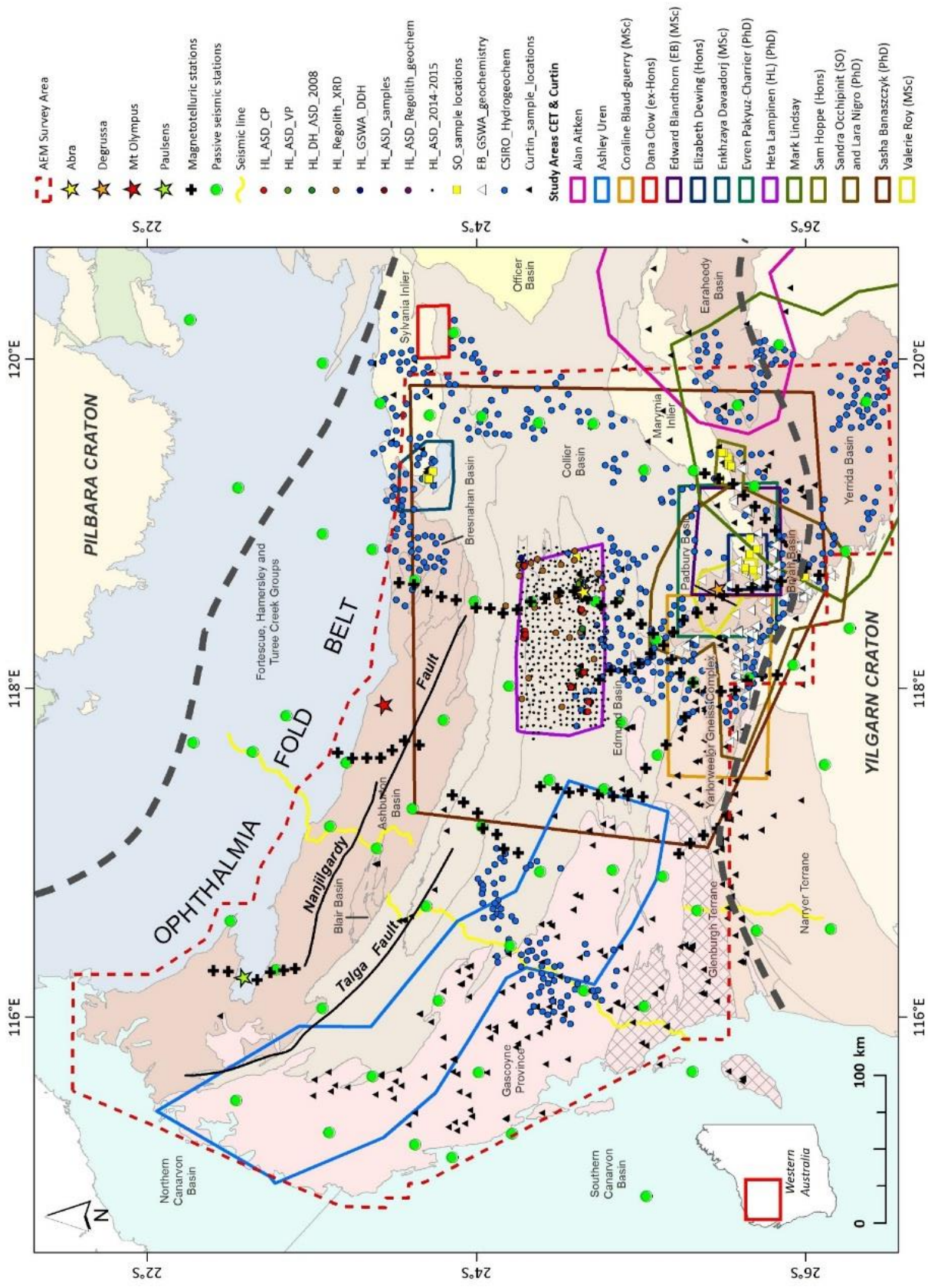
AEM Survey Area
Abra
Degrussa
Mt Olympus
Paulsens
Magnetotelluric stations
Passive seismic stations
Seismic line
HL_ASD_CP
HL_ASD_VP
HL_DH_ASD_2008
HL_Regolith_XRD
HL_GSWA_DDH
HL_ASD_samples
HL_ASD_Regolith_geochem
HL_ASD_2014-2015
SO_sample locations
EB_GSWA_geochemistry
CSIRO_Hydrogeochem
Curtin_sample_locations
Study Areas CET & Curtin
Alan Aitken
Ashley Uren
Coraline Blaud-guerry (MSc)
Dana Clow (ex-Hons)
Edward Blandthorn (EB) (MSc)
Elizabeth Dewing (Hons)
Enkhzaya Davaadorj (MSc)
Evren Pakyuz-Charrier (PhD)
Heta Lampinen (HL) (PhD)
Mark Lindsay
Sam Hoppe (Hons)
Sandra Occhipinit (SO) and Lara Nigro (PhD)
Sasha Banaszczyk (PhD)
Valerie Roy (MSc)
22°S
24°S
26°S
116°E
118°E
120°E
PILBARA CRATON
OPHTHALMIA FOLD BELT
YILGARN CRATON
Fortescue, Hamersley and Turee Creek Groups
Sylvania Inlier
Officer Basin
Earahoedy Basin
Marymia Inlier
Collier Basin
Bresnahan Basin
Yerrida Basin
Padbury Basin
Bryah Basin
Edmund Basin
Yarlweelor Gneiss Complex
Ashburton Basin
Nanjilgardy Fault
Talga Fault
Blair Basin
Glenburgh Terrane
Narryer Terrane
Gascoyne Province
Northern Carnarvon Basin
Southern Carnarvon Basin
Western Australia
N
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100 km