

Fieldnotes



Government of Western Australia
Department of Mines, Industry Regulation
and Safety

Geological Survey of
Western Australia



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Canning Basin gets another boost in petroleum potential

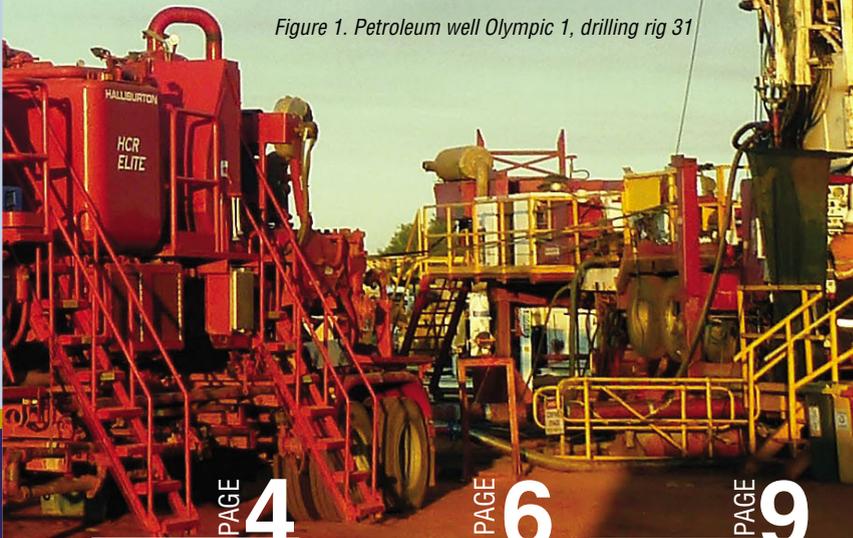
After nearly a century of sporadic petroleum exploration, the Canning Basin is still relatively underexplored with regards to petroleum potential. Studies have suggested the Basin may have the capacity to generate tens of billions of barrels of oil and several hundred trillion cubic feet (TCF) of gas. A number of small oil and gas fields has been discovered, most recently the Ungani Field on the Broome Platform; however, a large discovery in the Canning Basin remains elusive.

Four active petroleum systems have been identified in the Canning Basin. The oldest system consists of Ordovician–Silurian sedimentary rocks and may contain the best source rocks to generate liquid hydrocarbons. A critical component to any petroleum system is the presence of a source rock with the ability to generate hydrocarbons. The Ordovician–Silurian petroleum system has four source intervals, in ascending order: Nambheet Formation, lower Goldwyer Formation, upper Goldwyer Formation, and a more localized source interval, the Bongabinni Formation.



Figure 1. Petroleum well Olympic 1, drilling rig 31

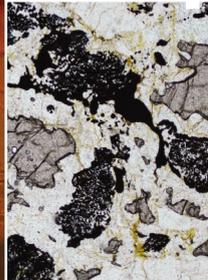
continued on page 3



PAGE 4

PAGE 6

PAGE 9



What's inside?

- NAMBEET FORMATION, CANNING BASIN 1, 3
- TECHNOLOGY NEWS 2
- MUSGRAVE PROVINCE 4
- REGOLITH CHEMISTRY 5
- IN MEMORIAM 6, 7
- HYLOGGER 8
- STAFF RETIREMENT 9
- WHERE WE ARE WORKING 10
- GEOPHYSICAL SURVEYS 11
- EVENT: GSWA IN THE GOLDFIELDS 11
- PRODUCT RELEASES 12
- VIRTUAL TOURS 12

New system hits the streets — TENGGRAPH Web

TENGGRAPH Web is an online mapping system displaying the position of Western Australian mining tenements and petroleum titles in relation to other land information. It gives a current and accurate picture of land under mining activity and is used to determine ground that is available for mineral exploration.

‘The old TENGGRAPH has served the department well over the years and we have had a great return on our investment, but it does not provide the seamless coverage of the entire State that the new browser-based system does,’ Mineral Titles Executive Director, Dr Ivor Roberts said. ‘It also doesn’t provide image data and all the other bells and whistles that the new system offers.’

Dr Roberts said that the new TENGGRAPH Web is a more business-oriented system with a strong focus on tenements, approvals and increased functionality. ‘It is streets ahead of the old system, but it will not be a totally new experience for people using Department of Mines, Industry Regulation and Safety’s (DMIRS) interactive geological mapping system, GeoVIEW.WA, because there are commonalities with the TENGGRAPH Web interface,’ he said.

TENGGRAPH Web provides links to other DMIRS systems including:

- Mineral Titles Online (MTO)
- Petroleum and Geothermal Register (PGR)
- mining tenement open-file exploration reports (WAMEX)
- mine site and mineral deposit information (MINEDEX).

Being solely web based, users access TENGGRAPH Web directly through the department’s servers, rather than through a separate (CITRIX) platform.

TENGGRAPH Web benefits external users through:

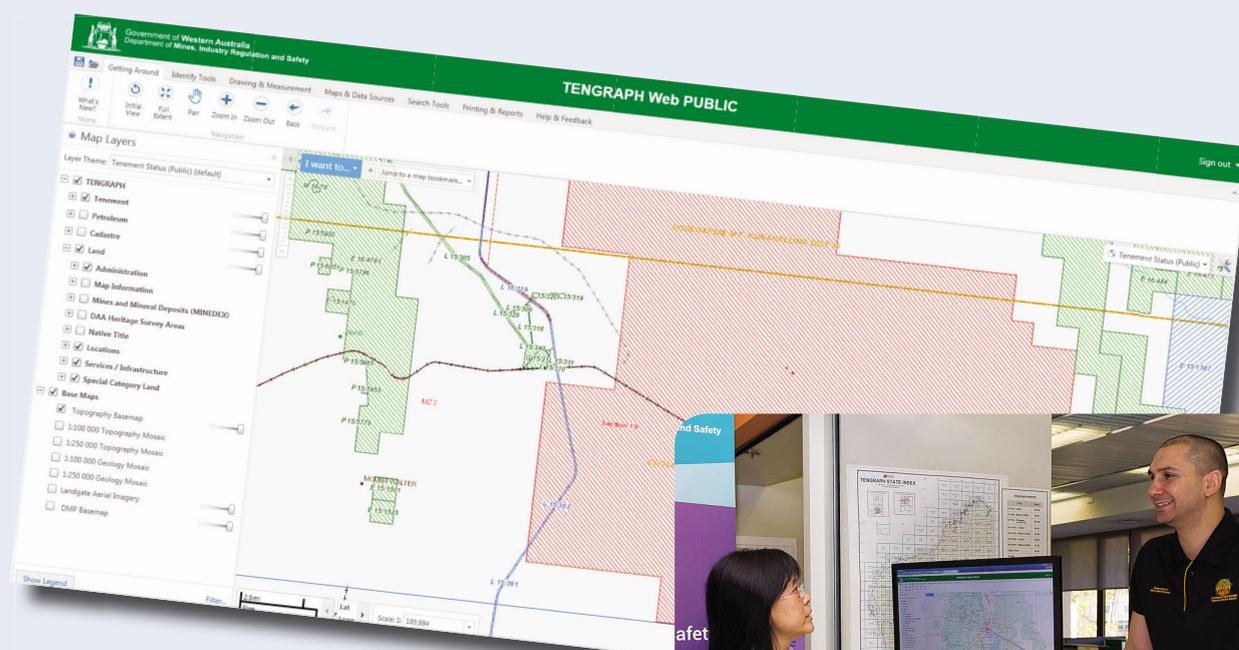
- improved access to the department’s spatial and non-spatial information
- better service delivery with enhanced functionality
- improved appraisal processes integrated with eLodgement
- ability to rapidly respond to industry or legislative change because TENGGRAPH Web is consistent with the department’s spatial data infrastructure.

Dr Roberts said that high-quality maps could be produced with TENGGRAPH Web. It has a new interface that uses the same pan and zoom mouse commands as Google Maps, and has the ability for users to include overlays of geology and topography.

Dr Roberts said that the new system would operate in tandem with the old TENGGRAPH for a period of time so that people had the ability to use either system until they were comfortable with TENGGRAPH Web.

There will be opportunities for people to register for training in Perth and Kalgoorlie, and instructional videos will be posted on the DMIRS website.

For more information, email mineraltitles.enquiries@dmirs.wa.gov.au.



continued from page 1

The Goldwyer Formation (upper and lower) has been the primary source interval used to estimate shale gas potential in the Canning Basin, whereas the Bongabinni Formation has only been confirmed as a source interval at the northern edge of the Willara Sub-basin in the Admiral Bay Fault Zone. The Nambeet Formation was identified as a limited petroleum source interval in five wells on the Broome Platform and Pender and Mowla Terraces but has received little interest in the past due to relatively low total organic carbon (TOC) and inadequate sampling.

Recent drilling of the petroleum exploration well Olympic 1 on the central Broome Platform (Fig. 1) by Buru Energy (May–June 2015) has confirmed the presence of a potential petroleum source-rock interval in the upper Nambeet Formation of the Canning Basin. Olympic 1 continuously cored through Ordovician strata resulting in a total of 319.53 m of 63.5 mm diameter core. The majority of the core was drilled through the Nambeet Formation from 1175.25 – 1447.53 m (272.28 m), which equates to an increase of 27% over the pre-existing cumulative 1009.02 m of core available for this formation for the entire Canning Basin.

The Olympic 1 cored section revealed two distinct organic-rich mudstone intervals in the upper part of the Nambeet Formation. One hundred and fifty-eight samples were collected over the two mudstone intervals and were analysed for TOC. Where TOC >0.5 %, Rock-Eval pyrolysis analysis was completed, resulting in 151 data points. Analyses confirmed fair to very good source quality, with TOC reaching a maximum of 3.28%, and fair to good hydrocarbon generating potential with a maximum S₂ of 5.05 mg HC/g rock. Initial geochemical results indicate a Type II/III, gas-prone petroleum source with fair to good petroleum potential.

This new data from Olympic 1 provides evidence that the Nambeet Formation should not be overlooked as a potential source interval in the Canning Basin. The presence of oil shows within the sandstones of the lower Nambeet Formation is also



Figure 2. Isolated trilobite head

promising for the development of reservoirs that can be filled by adjacent source intervals. Furthermore, correlation of the two source intervals identified in the Olympic 1 well across the Canning Basin indicates good lateral continuity of this prospective source.

A systematic review and further analysis can be conducted on existing Nambeet Formation samples from other wells. A regional TOC estimate from wireline logs may be undertaken in the future, using Olympic 1, and the large dataset collected from it, as a baseline. Additionally, resampling of available core and cuttings would compliment any TOC estimation from wireline models. Although better analytical techniques have evolved over time, sample degradation and drilling-induced contaminants are sometimes an issue with older samples.



Figure 3. Wellsite geologist on-site in logging shack

Additional work on the Olympic 1 samples would include detailed characterization of the kerogen types, by analysis of maceral composition, pyrolysis-gas chromatography (Py-GC), extraction of organic matter (EOM), and gas chromatography mass spectrometry (GC-MS). These analyses will not only assist to clarify the organic facies but also help with oil-to-oil and oil-to-source correlations. Kerogen kinetics measurements are also required to better understand the potential timing of hydrocarbon generation. Analysis of isotopes and diaminoid biomarkers combined with thermal maturity modelling will also help develop our understanding of this potential hydrocarbon source.

Report 169 Petroleum source potential of the Ordovician Nambeet Formation, Canning Basin: evidence from petroleum well Olympic 1 by LS Normore and LM Dent, and **Report 170 Assessment of thermal maturity using bitumen, graptolite and bioclast reflectance in the Ordovician Nambeet Formation, Olympic 1, Canning Basin** by LM Dent and LS Normore were published in June 2017. Both Reports are free to download from <www.dmp.wa.gov.au/ebookshop>.

For more information, contact Leon Normore (leon.normore@dmirs.wa.gov.au).

New products shine light on the Musgrave

Recent PhD recipients, Chris Medlin and Roland Seubert (Monash University), and Alec Walsh (University of Adelaide), carried out studies on the volcanology of the Kathleen Ignimbrite, the petrogenesis of the mafic-ultramafic Giles intrusions and the thermo-mechanical evolution of orogeny in the Musgrave Province, respectively. Their studies have culminated in three new products for the Geological Survey of Western Australia (GSWA).

Chris Medlin's study on the Kathleen Ignimbrite outlines its physical volcanology, paleoenvironment and geochemistry. The Kathleen Ignimbrite was emplaced in a shallow-water marine shelf-type or large lake-type paleodepositional environment and forms part of a thick bimodal volcanic-sedimentary succession in the Talbot sub-basin. It is an intra-caldera fill-sequence that resulted from a very large explosive caldera-forming eruption involving high volumes of juvenile mantle-derived felsic magma.

Roland Seubert's study on the Giles intrusions focuses on detailed analysis of three large layered intrusions, namely Bell Rock, Latitude Hill and Wingellina Hills intrusions. The petrogenesis and emplacement of the Giles Suite and its prospectivity for orthomagmatic Ni-Cu-PGE sulfide ore deposits are investigated. A combination of traditional knowledge-driven methods of data analysis and interpretation is used as well as modern data-driven multivariate statistical techniques. The results of the study are used to assess the relative importance of plate- and mantle-dynamics and to constrain the tectonic setting of the Musgrave Province during the Giles Event.

Alec Walsh's study of the metamorphic and structural evolution of the Musgrave Province investigates how the physical properties of crustal lithosphere change through time in response to the metamorphic processes that occur during orogenesis. The role that Grenvillian-aged high-temperature metamorphic events played in providing the lithospheric framework for younger crustal reworking is explored. The mechanical response of the lithosphere to this crustal reworking, within an intraplate setting, is also explored to evaluate the thermo-mechanical evolution of intraplate orogeny.

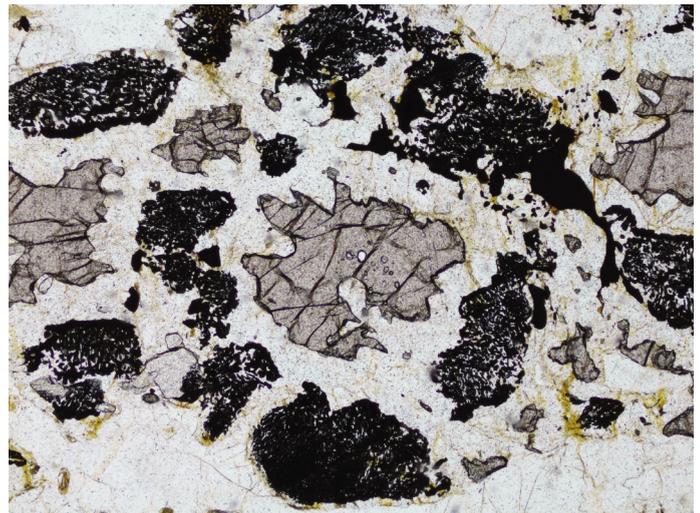


Figure 1. Photomicrograph of metapelite from Cohn Hill, showing a resorbed garnet porphyroblast surrounded by a multilayer corona of cordierite-plagioclase and spinel-magnetite-cordierite. Such assemblages provide evidence for a Grenvillian-aged high-temperature metamorphic event

These three research projects in the west Musgrave Province were supported by GSWA. The three Reports are free to download from the department's ebookshop at <www.dmp.wa.gov.au/ebookshop>.

Report 166 Thermo-mechanical evolution of orogeny in the Musgrave Province by A Walsh

Report 171 The volcanology, petrogenesis, and economic potential of the Mesoproterozoic shallow-water, intra-caldera, lava-like rheomorphic Kathleen Ignimbrite, west Musgrave Province, central Australia by CC Medlin

Report 172 Petrogenesis of the mafic-ultramafic intrusions of the Mesoproterozoic Giles Event, Musgrave Province, central Australia by REB Seubert

For more information, contact Heather Howard (heather.howard@dmirs.wa.gov.au).

Figure 2. View of the north side of the Kathleen Ignimbrite at Mount Glyde



Potential for SEDEX-style mineralization in the Ngururrpa area of northeastern Western Australia

Regional geochemistry and stratigraphic revision carried out in the regolith-dominated Ngururrpa area of northeastern Western Australia (Fig. 1) indicates a potential for sediment-hosted exhalative (SEDEX) mineralization. The regional geochemistry program (www.dmp.wa.gov.au/geochem) includes samples collected on transects across regional faults to determine if the fine fraction of regolith could detect the presence and composition of any fault-controlled fluid. Higher concentrations of lithophile, chalcophile, rare earth elements (REE), some base metals (Zn, but not Cu or Pb), and even elements at extremely low concentrations (e.g. Tl) occur in regolith coincident with the Stansmore Fault (GSWA Record 2017/2, p. 26–27). Spinifex collected along one transect across the same fault shows some REE and Zn (but not Cu or Pb) enrichment close to the fault.

Stratigraphic revision of parts of the Murraba Basin in the Ngururrpa area (GSWA Record 2017/4) has identified carbonate-bearing rocks equivalent to the Bitter Springs Group in an area where a high proportion of regolith samples have anomalous Zn concentrations (i.e. >26 ppm; Fig. 1). Equivalent carbonate-rich

rocks of the Bitter Springs Group to the south of the Ngururrpa area on WEBB geological map sheet are being explored for SEDEX-style mineralization (e.g. by Cassini Resources Limited, at the Enceladus and Iapetus prospects southwest of Kiwirrkurra).

Both the Zn content of regolith in the part of the Murraba Basin assigned to the Bitter Springs Group, and the chemistry of regolith and spinifex close to periodically reactivated and deep-penetrating faults, indicate the potential for both exposed and buried SEDEX mineralization in the Ngururrpa area.

Record 2017/2 GSWA 2017 Extended abstracts: promoting the prospectivity of Western Australia and Record 2017/4 Geological reconnaissance of the southern Murraba Basin, Western Australia by PW Haines and HJ Allen are available to download as free PDFs from www.dmp.wa.gov.au/ebookshop.

For more information, contact Paul Morris (paul.morris@dmirs.wa.gov.au).

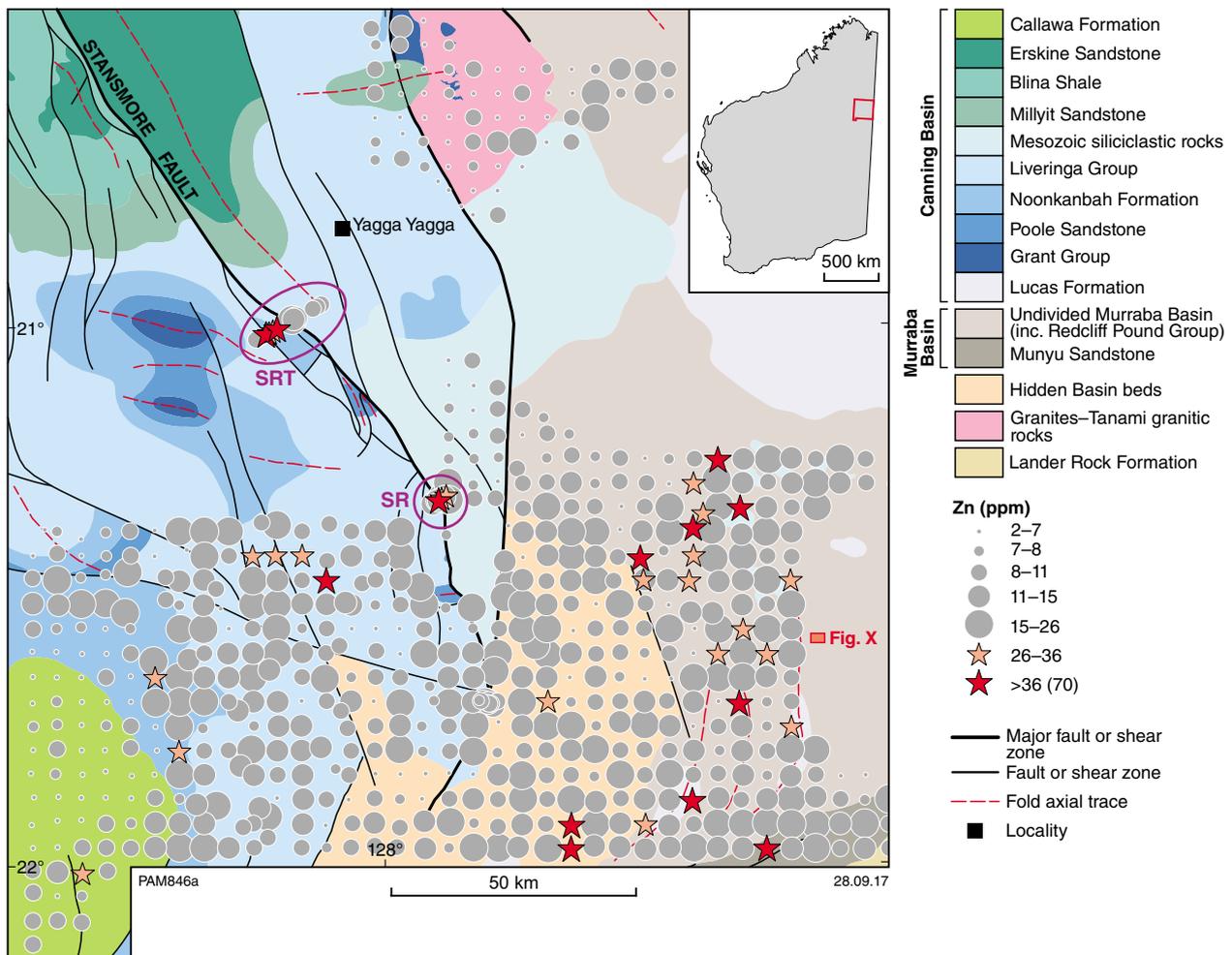


Figure 1. Concentration of Zn (ppm) in the <50 μm of regolith and 1:500 000-scale interpreted bedrock geology and structures. Bubble diameter proportional to Zn concentration, with stars indicative of samples with statistically anomalous Zn levels. SRT and SR are locations of transects across the Stansmore Fault. Fig. X is the traverse location of Haines and Allen (2017) that includes rocks assigned to the Bitter Springs Group

Phil Playford — geologist, historian, explorer



Figure 1. At Lost Valley between Limestone Spring and Hawkstone Creek in the northwest Napier Range (1994)

In 1953, 22-year-old Phil Playford started work at the Bureau of Mineral Resources, mapping the Carnarvon Basin along Australia's west coast. That same year WAPET (West Australian Petroleum Pty Ltd) discovered oil at Rough Range, and lured Phil and several others away.

Three major passions of Phil's life quickly followed; two were in July 1954 while working around Shark Bay. First, he and Daryl Johnstone discovered stromatolites at Hamelin Pool, and then later Tom Pepper, head stockman at Tamala Station, showed Phil items he had found from a shipwreck at the foot of the cliffs south of Tamala. Phil set out to find the wreck site the next day, and after much research deduced the ship was the *Zuytdorp*, an 18th century trading ship of the Dutch East India Company which left the Netherlands in 1711, bound for Batavia (now Jakarta). Then in 1956, he was introduced to the Devonian reef complexes of the Canning Basin, perhaps his greatest geological interest. Aboriginal cave paintings in the limestone ranges sparked a parallel interest in Aboriginal anthropology and the mapping of tribal boundaries in the Kimberley.

Phil undertook a PhD at Stanford University in 1959, and then in 1962 joined the Geological Survey of Western Australia (GSWA) as Supervising Geologist of the newly formed Sedimentary (Oil) Division. One of Phil's first recommendations was to ask the Minister for Mines to encourage WAPET to drill the anticline beneath Barrow Island. This led to the discovery of oil in commercial quantities in 1964 and the dawn of petroleum production in Western Australia. He worked for the Mines Department, and its successors, in various positions (except for a short time with Abrolhos Oil in 1970–71), rising to GSWA Director in 1986 before retiring in 1992. A condition of his acceptance of all administrative positions was that he could

devote time each year to geological research, including annual trips to the reef complexes and other localities such as Shark Bay, the Zuytdorp Cliffs, and Rottnest Island.

In 1966 GSWA published Bulletin 118, the first major instalment of Phil's work on the Devonian reef complexes. Ongoing fieldwork and papers on various aspects of Western Australia's Phanerozoic basins (mostly reef-related) continued throughout Phil's career with GSWA, and demonstrated that Phil clearly saw Bulletin 118 more as a beginning than the final word. Periodic field excursions for Australian and international geologists to show the many facets of the reefs were always popular and well attended. Early excursions included flights over the exhumed paleogeography of the reef complexes. The Canning reef complexes were the subject of lecture tours by Phil in the US and Europe in the 1970s and 1980s, and he also visited many ancient reefal outcrops while overseas.

'Retirement' in 1992 was merely the start of a renewed phase of research on the reefs, together with work on other areas of interest including the Quaternary geology of Shark Bay and Rottnest Island, early voyages around Western Australia, Dutch shipwrecks, and possible mega-tsunamis. The subsequent years saw Phil produce:

- Carpet of Silver (1996), detailing his research on the *Zuytdorp* wreck
- Voyage of Discovery to Terra Australis: by Willem De Vlamingh, 1696–97 (1998), following Phil's discovery of de Vlamingh's personal journal
- GSWA Bulletin 145 Devonian reef complexes of the Canning Basin (2009), which also covered Permian glaciation and its

imprint on the reefs; accompanying maps show all Aboriginal place names recorded during decades of fieldwork

- GSWA Bulletin 146 The geology of Shark Bay (2013), which included much of the history of the Shark Bay region extending back to the early Dutch explorers, topics arising from Shark Bay research, particularly possible records of tsunamis along Western Australia's coastline, and Quaternary geology and tectonism along the western margin
- The Life and Times of Dirk Hartog (2016), which marked the 400th anniversary of Dirk Hartog's landing on the island that bears his name.

Phil was diagnosed with cancer late in 2015 and, surrounded by his family, he passed away in July 2017. He was unable to complete his report on Rottneest Island, intended to be GSWA Bulletin 147, and the finale to a trilogy of bulletins.

Phil was a field geologist first and foremost. He stressed the importance of 'going bush' and reinforced to geologists of all ages that there is no substitute for walking on the rocks. He lived by British geologist HH Read's words, 'the best geologist is he who has seen the most rocks', with the qualifier, 'and appreciated the most rocks'. Phil certainly did.

by Roger Hocking and Tony Cockbain

Roger Hocking worked with Phil on the reefs since 1992, and has been associated with Phil since he first joined GSWA in 1974 after Phil described the Carnarvon Basin as near the ocean and having a nice climate in winter.

Tony Cockbain served as Paleontologist, Supervisor (Fossil Fuels Division), and then Assistant Director GSWA under Phil, and was Phil's co-worker on the reefs from 1968 to 1992.



Figure 2. At the Classic Face, Windjana Gorge (1980s)



Figure 3. At the Classic Face, Windjana Gorge (1981 excursion)



Figure 4. At Henwood Spring on Fossil Downs a few kilometres west of the Mueller Ranges (2005)

Industry and academia get up close with GSWA's HyLogger

Members of the public recently had the opportunity to visit and work with the Geological Survey of Western Australia (GSWA) HyLogger, during an annual workshop held in mid-June at the Perth Core Library in Carlisle. Designed by the CSIRO, the HyLogger is a highly automated system that enables rapid and non-destructive spectroscopic logging and digital imaging of core and rock samples, using continuous visible and infrared spectroscopy. The GSWA HyLogger was installed at the Perth Core Library in 2009, and forms part of the AuScope National Virtual Core Library (NVCL) consortium, a collaborative State and Federal initiative aimed at providing a standardized and openly available mineralogical record of drillcore across Australia.

Despite the large volume and potential usefulness of HyLogger data already made publicly available, the datasets currently remain under-utilized. As part of an initiative to rectify this, GSWA invited postgraduate students and geologists from industry and external institutions to learn about the HyLogger system and its role in the NVCL, during a two-day interactive workshop jointly run by GSWA and CSIRO staff.

On the first day, attendees were taught the fundamentals of spectroscopic analysis and given a guided tour of the HyLogger

facility, which included the opportunity to scan a personal rock specimen each. Case studies were then presented on the use of HyLogger data for the Exploration Incentive Scheme (EIS) co-funded drilling from the Golden Mile gold deposit (Kalgoorlie Terrane), Abra polymetallic deposit (Capricorn Orogeny) and the Windimurra V-Fe deposit (Murchison Terrane). Workshop participants manually logged the relevant drillcore on the day, and compared their observations with the HyLogger results.

The second day of the workshop was dedicated to introductory training for The Spectral Geologist (TSG 8) software package, used to display and interpret data from the HyLogger and other spectral devices. Each attendee was provided with a one-day licence for the software, and HyLogger datasets from the case studies.

A similar workshop is planned for May 2018.

Read more about the GSWA HyLogger at www.dmp.wa.gov.au/hylogger.

For more information, contact Lena Hancock (lena.hancock@dmirs.wa.gov.au).



Figure 1. Participants at the HyLogger Workshop observing sections of previously scanned drillcore

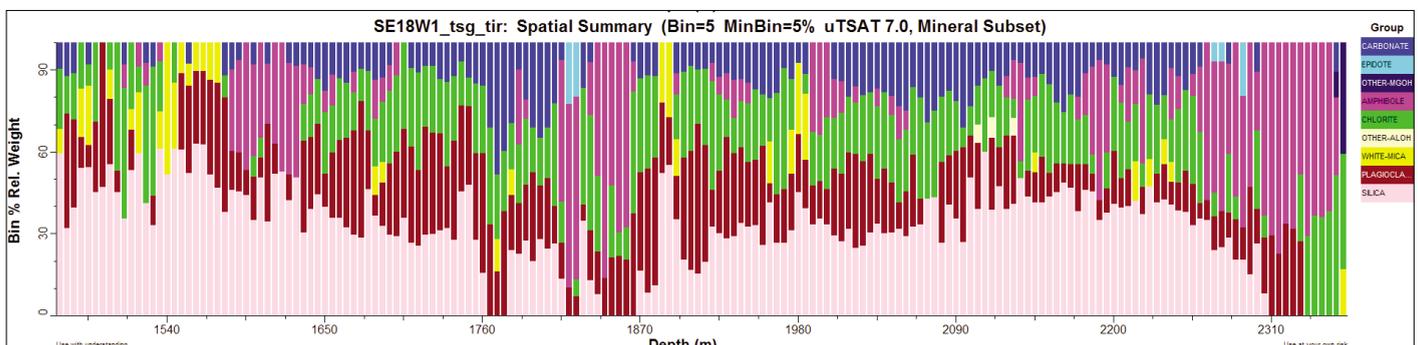


Figure 2. Example of the TSG mineral summary plot (Thermal Infrared) from a HyLogger Scan (Golden Mile Drillhole SE18)

Stephen Wyche calls it a day



After more than 28 years at the Geological Survey of Western Australia (GSWA), Stephen Wyche is hanging up his hammer and bidding farewell to a life of mapping in the Yilgarn.

Stephen came to GSWA in March 1989 after spending ten years mapping in the Proterozoic of the Northern Territory. In Western Australia, he stepped back in time to the Archean when he joined the newly developed GSWA 1:100 000-scale mapping program, commencing in the Davyhurst area northwest of Kalgoorlie. This was the beginning of a long relationship with the Yilgarn Craton.

Stephen spent four years in GSWA's Kalgoorlie Regional Office in the early 1990s. Colleagues included notable GSWA stalwarts and Kalgoorlie alumni such as Tim Griffin, Cees Swager, Wally Witt and Tony Ahmat. The mapping focus at that time was the northern Eastern Goldfields where the 'hot' exploration property was in the Yandal greenstone belt. It was also the beginning of the revolution in geological mapping with the arrival of high-precision geochronology using the sensitive high-resolution ion microprobe (SHRIMP) at Curtin University, the first detailed regional aeromagnetic data for the Eastern Goldfields, the first Yilgarn deep crustal seismic survey in 1991, reliable GPS units, and the availability of multispectral satellite imagery.



After returning to Perth in late 1995, Stephen led mapping programs in the central Yilgarn and the Murchison regions. Since 2006, he has managed all Yilgarn mapping projects. The past ten years have seen the advent of digital mapping using tablet computers. Orthophotos have replaced stereophotos, books of explanatory notes have been replaced by an explanatory notes database, and handwritten field notebooks have been replaced by a field observations database.

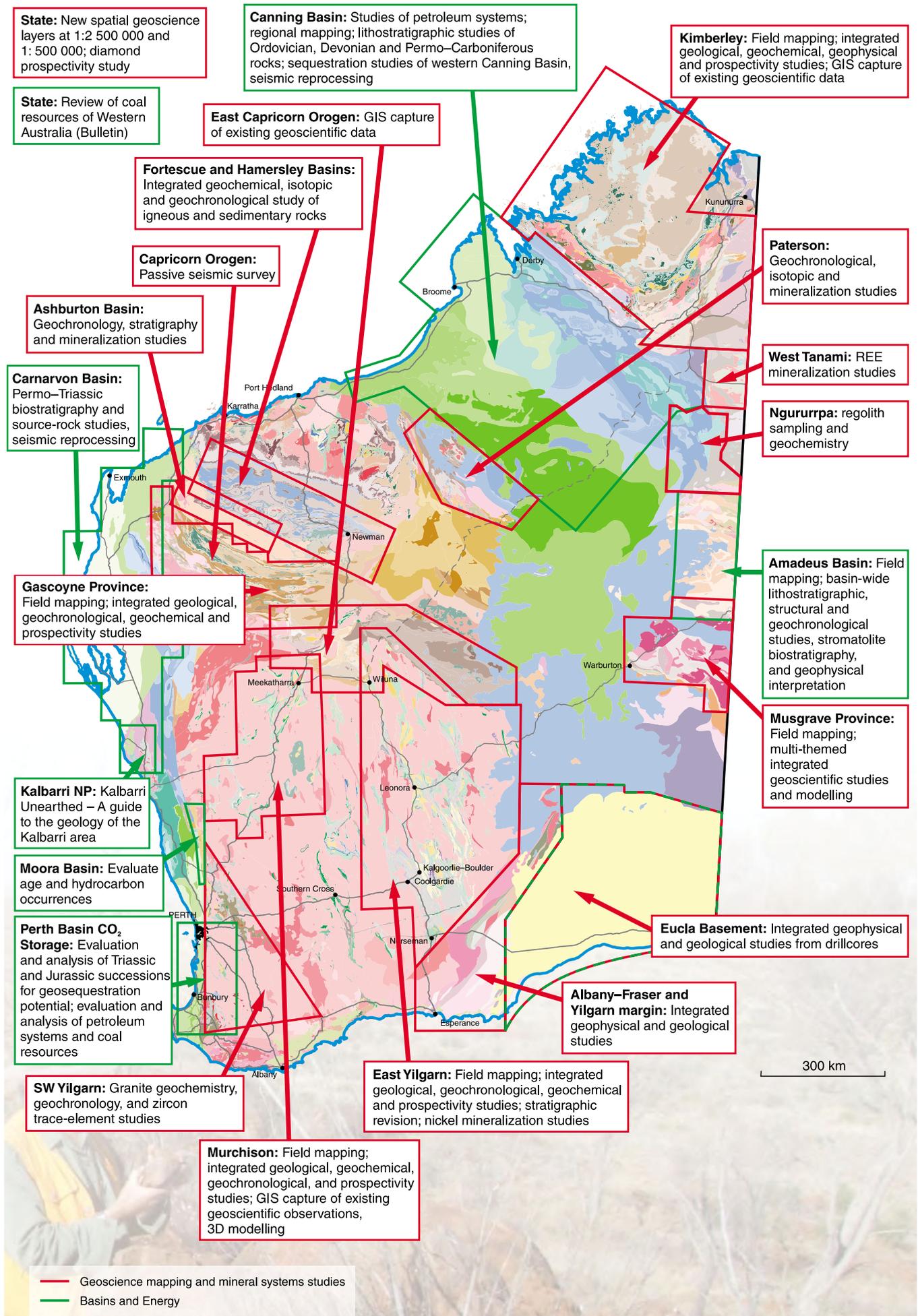
Stephen has been an integral part of the new developments in Yilgarn geology. He has led programs to reinterpret legacy mapping and to use the wide range of new data types to produce a comprehensive stratigraphic scheme to cover the whole of the Yilgarn, beginning in the Eastern Goldfields and Murchison regions.

Many would know Stephen through his involvement in Yilgarn-related conferences, workshops and field trips such as the Kalgoorlie 93, 97, and 07 conferences; and the 3rd, 4th, and 5th Archean Symposia. Throughout his career at GSWA, he has seen many geologists come and go, with many gaining much from his mentoring ... and enjoying his dry humour and frank opinions!

We wish Stephen well in the new phase of his life.



Where we are working



GSWA regional geophysics surveys: 2 October update

Data downloads

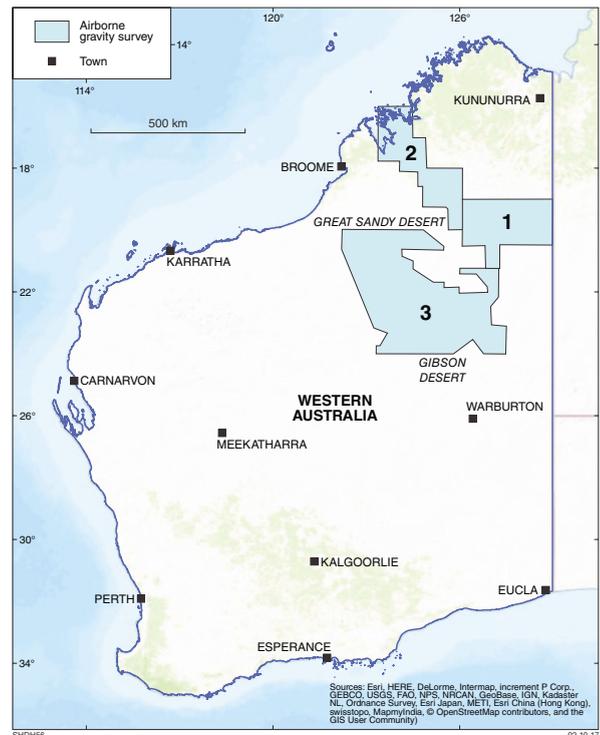
Located data — Geophysical Archive Data Delivery System <www.ga.gov.au/gadds>.

Grids and images — search in GeoVIEW.WA under Government Surveys layers.

Subscribe to the GSWA eNewsletter for alerts of preliminary and final data release dates. Go to <www.dmp.wa.gov.au/gswaenewsletter>.

Survey outline shapefiles are available online at <www.dmp.wa.gov.au/geophysics>.

For more information, contact David Howard (david.howard@dmirs.wa.gov.au).



ID	Area/Name	Method	Configuration	Size	Status	Start	End	Release
1	Tanami 2017	Air Grav	2500 m, N-S	26 000 km	Processing	15-06-17	13-08-17	(Nov-17)
2	NE Canning 2017	Air Grav	2500 m, N-S	24 000 km	Survey 54%	17-08-17	(Oct-17)	(Jan-18)
3	Kidson 2017	Air Grav	2500 m, N-S	70 000 km	Survey 39%	21-07-17	(Dec-17)	(Mar-18)

Dates in parentheses are estimates.

Event

GSWA in the Goldfields

The Geological Survey of Western Australia (GSWA) will open its doors with 'GSWA in the Goldfields' on **Thursday 16 November**. This event will feature a number of free events at different venues during the day and will culminate with three talks as part of the Raglan Drilling Geology Lecture Series at the Hannans Club.

SCHEDULE

Joe Lord Core Library, corner Broadwood and Hunter Streets, West Kalgoorlie

1–4 pm Recent deep stratigraphic drilling around Kalgoorlie including several presentations, core viewing and discussions.

Core will be available for viewing from:

- Kambalda stratigraphy – St Ives
- Kambalda discovery hole – KD1
- Black Swan nickel deposit
- Brindabella Au–Ag prospect (near Nimbus)
- Lake Raeside impact structures.

The Joe Lord Core Library closes at 4 pm.

The Raglan Drilling Geology Lecture Series at Hannans Club, 44 Brookman Street, Kalgoorlie

5.30 pm for 6.00 pm start

Talks

- Provenance fingerprinting of gold from the Kurnalpi Goldfield
Lena Hancock
- A formal stratigraphy for the Eastern Goldfields
Stephen Wyche
- Geochemical barcoding of Eastern Goldfields stratigraphy
Hugh Smithies

Please contact <deenikka.preedy@dmirs.wa.gov.au> to register for this free event.

GSWA database and online systems training is available on the same day. More information is available at <www.dmp.wa.gov.au/training>. Register at <publications@dmirs.wa.gov.au>.

RECORDS

Record 2017/7 Towards a geochemical barcode for Eastern Goldfields Superterrane greenstone stratigraphy — preliminary data from the Kambalda–Kalgoorlie area

by *Smithies, RH, Morris, PA, Wyche, S, De Paoli, M and Sapkota, J*

With accompanying zip file

Record 2017/8 The deep seismic reflection profile 11GA-Y01 in the west Musgrave Province: an updated view

by *Quentin de Gromard, R, Howard, HM, Smithies, RH, Wingate, MTD and Lu, Y*

Record 2017/9 Metamorphosed VMS mineralization at Wheatley, southwest Western Australia

by *Hassan, LY*

With accompanying zip file

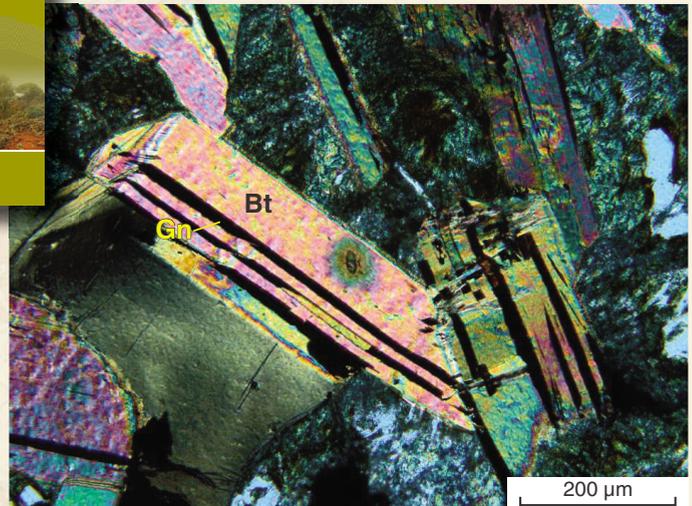
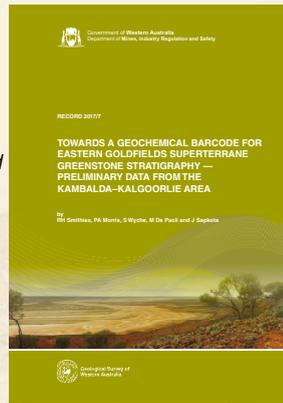
Record 2017/10 Alteration associated with the Austin–Quinns VMS deposits

by *Hassan, LY*

With accompanying zip file

Record 2017/11 NW biogeochemistry and beyond project

by *Lintern, M, Ibrahim, T, Pinchand, T and Cornelius, A*



LYH211

28.04.17

Galena replacing biotite along cleavage (Record 2017/9)

Virtual tours

Virtual view of meteorite impact structures

The most recent release in the range of free virtual tours available from the Geological Survey of Western Australia (GSWA), offers an in-depth armchair guide to seven meteorite impact structures in Western Australia.

The tour, **Meteorite impact structures of Western Australia**, includes a detailed set of terms to aid the novice geologist as well as a set of references for further reading.

'The tour provides in-depth information on seven of the State's most important impact sites, including the well-known Wolfe Creek crater,' General Manager, Stephen Bandy said. 'To make full use of all the features of the tour, it should be run on Google Earth Pro. The Keyhole Markup Language (KML) file can be downloaded to a USB or saved to a local drive on your PC.' The tour features photos, geological maps and geophysical images to take users on a virtual journey to the sites.

Two other free virtual tours are available from the department's eBookshop: **Virtual tour of the mafic–ultramafic intrusions of the Youanmi Terrane** and **Discovery trails to early earth — a virtual tour to the east Pilbara of Western Australia**.

Approval is required from the department for entry into the Dalgarranga and Veevers impact crater **geoheritage reserves**. Applications should be submitted at least two months prior to the date of the intended visit. Go to <www.dmp.wa.gov.au/geoheritage> to download an application form.

Go to <www.dmp.wa.gov.au/ebookshop> to download the tours.

For more information, contact Stephen Bandy (stephen.bandy@dmirs.wa.gov.au).

The Geological Survey of Western Australia (GSWA) has released almost 5000 geological products including books, maps and data packages. These can be found on our website at <www.dmp.wa.gov.au/GSWApublications>.

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