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A supervolcano in Western Australia?

Abstract from Report 118 Geochemical evolution of rhyolites of the Talbot Sub-basin and associated felsic units of the Warakurna Supersuite

Large-volume felsic volcanic sequences yield valuable information about crustal architecture, crust–mantle interactions, and regional tectonic evolution. Eruptions of super-volcano size (i.e. >450 km^3 of material erupted) are very rare in the geological record. We present new geological, geochemical, isotopic, and geochronological data from the felsic volcanic sequences of the Bentley Supergroup in the Mesoproterozoic Ngaanyatjarra Rift, which includes several volcanic deposits of supervolcano size.

The Ngaanyatjarra Rift in central Australia is the main crustal expression of the Mesoproterozoic Giles Event. This event included emplacement of the regional Alcurra Dolerite dyke swarm during the evolution of the early (c. 1075 Ma) Warakurna Large Igneous Province (LIP). However, magmatism continued for >50 m.y. thereafter and included the development of a silicic LIP over a period of >30 m.y. This igneous province was formed by a series of large rhyolite eruptions, including some of supervolcano size, interleaved with regional tholeiitic basalt flows. These formed the Talbot Sub-basin and, on a more regional basis, represent the dominant stratigraphic component of the Bentley Basin — the fill of the Ngaanyatjarra Rift.

In the Talbot Sub-basin, at least 20 separate felsic volcanic units can be recognized, forming layers of very high-temperature (some >900°C) rhyolitic and rheomorphic ignimbrites and rhyolitic flows. All of these are isotopically juvenile, reflecting direct mantle extraction with only minimal crustal input. Combining preserved volumes of extruded basalt with volumes of parental basalt required to produce the felsic volcanic rocks gives a minimum of 227 000 km^3 of mantle-derived magma to produce the total preserved felsic and mafic volcanic pile of the Talbot Sub-basin. Notably, of the total required mantle-derived magma, <5% erupted as basalt. The Talbot Sub-basin is only one of several sub-basins of the Bentley Basin. At least five additional felsic units are recognized within the other, less well-studied sub-basins. Extrapolating magma volume calculations for the Talbot Sub-basin across these other sub-basins provides speculative estimates of initial volumes of mantle-derived magma of approximately $2.19 \times 10^6 km^3$. These calculations ignore the giant layered Giles (G1) intrusions and associated massive gabbros (G2) of the Warakurna Supersuite, the basalts of the lower Kunmarnara Group into which those intrusions were emplaced, and the rocks of the Warakurna LIP.

Mantle-derived magmatism of more than 30 m.y. duration in a single isolated region is difficult to relate to a mantle plume. Even a conservative drift rate of 2 cm/year removes the crustal plate by more than 600 km from a stationary asthenospheric plume source, and even much further if we consider the entire duration of the Giles Event. The duration of magmatism does not favour a fortuitous sequence, or cluster, of plumes. Rather, the region reflects a zone of persistently very high crustal temperatures linked to a crustal architecture that was established as an amalgamation of Proterozoic cratonic Australia, which locked the region between three thick and rigid cratonic masses.

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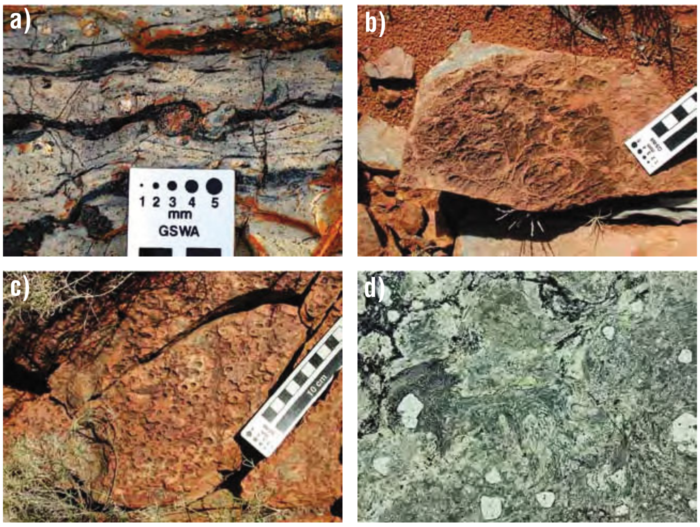

Figure 1. Various textural variations in rhyolites of the Talbot Sub-basin, including; a) rheomorphic flow banding, b) perlite, c) spherulites, and d) pumice fragments

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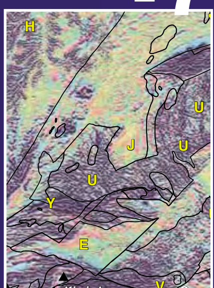

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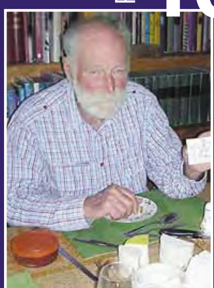

What's inside?

Enhancements to the WAPIMS database

Western Australian Petroleum Information Management System (WAPIMS) is a world-renowned database system providing data from Western Australia's petroleum wells (including any reports related to the well and geophysical logs), seismic surveys and petroleum titles.

In January 2013, the Department of Mines and Petroleum (DMP) completed a major upgrade of the system including data entry, data loader and data release modules of WAPIMS. WAPIMS now operates under Internet Explorer 9.

These upgrades were required in order to match the changing data being supplied by the petroleum industry and to allow the system to move towards online submission of data by industry. The upgrade of the WAPIMS system also maintains the interoperability of the core modules of WAPIMS to other DMP applications relying on the WAPIMS system.

WAPIMS offers a data browser, with a search functionality (eSearch) to query the data, and an exploration map to query the data by location. It also enables the viewing and analysis of information using a collection of browsing and visualization tools such as lists, queries, maps, graphs, and reports.

WAPIMS is updated every day and represents an important source of free information, including free data downloads, from our web site at <www.dmp.wa.gov.au>.

Key enhancements

Key enhancements of the system include standard and advanced access features as follows:

Seabed advanced E&P datastore system – this data repository integration provides searching, browsing, and visualization of Seabed data as well as:

- support of Seabed data types such as fields, leases, wells, boreholes, deviation surveys and logs, LAS (LASer file format for 3D point cloud data) export and access to directional surveys data
- viewing of Spatial Data Engine (SDE) layers from Seabed projects in the Decision Point GIS map module component
- support of Seabed projects secure data entitlement.

Standard Data access – this model provides the basic tool for data search and data access, GIS and hierarchical navigation including:

- GIS map
- data availability
- image viewer
- documents and reports.

GIS map

This model provides map-based access to data items such as wells, seismic surveys and lines, cultural data, and any other information that can be represented on a map. GIS map allows the user to select data items and view relevant reports and applications, including the ability to export data to other formats such as Word, Excel, and XML.

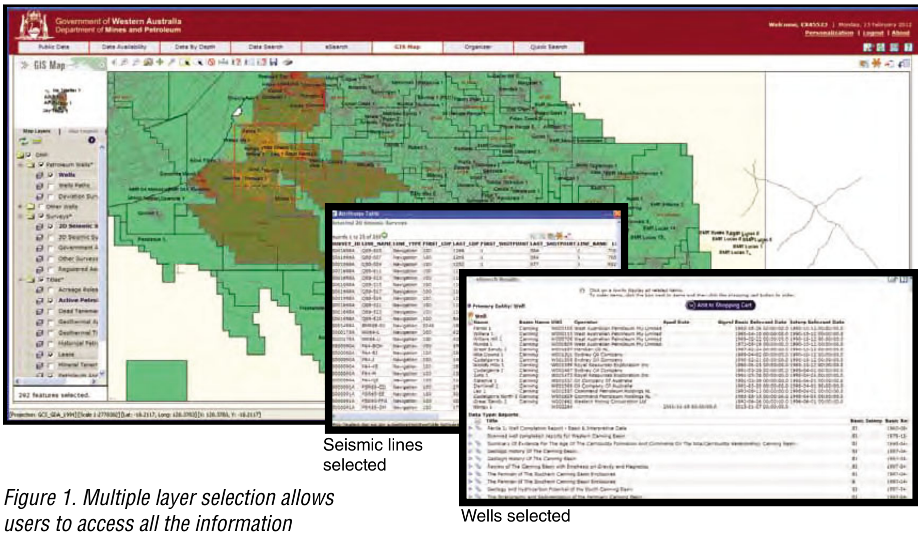

Figure 1. Multiple layer selection allows users to access all the information available for a specific area.

Introduction to eSearch

This online search enables users to access eSearch asset data through Decision Point. The eSearch component can be accessed:

- from an iTab
- by accessing a list in the Data View component and selecting eSearch
- by selecting an object in the map and accessing the eSearch icon in the GIS map component.

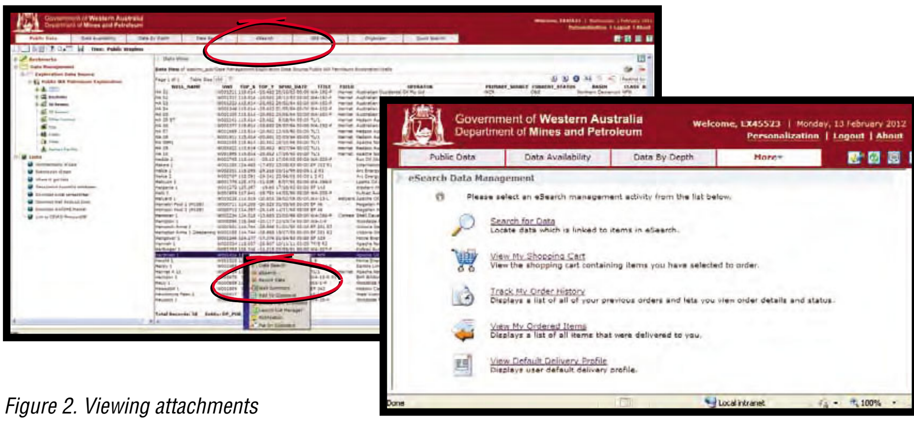

Figure 2. Viewing attachments

View attachments

This features enables users to view file attachments in their native format.

Note: The attachments icon (paperclip) is displayed in the search results if a file has been attached to the data.

For more information, please contact Felicia Irimies (felicia.irimies@dmp.wa.gov.au).

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From c. 1220 to 1020 Ma, it was:

- the site of one of the world's largest and longest-lived (c. 1220 to 1150 Ma) belts of mid-crustal ultra-high-temperature conditions
- the site of one of the world's largest layered mafic intrusions (the 1078 to 1075 Ma Giles intrusion)
- the focal point of the c. 1075 Ma Warakurna LIP
- the site of possibly the worlds longest-lived sequence of high-temperature supervolcano eruptions, forming possibly the world's most voluminous juvenile input of felsic material into the crust outside a subduction zone.

Throughout the Giles Event, the magmatic and tectonic evolution of this thermally weakened zone was possibly a far-field response to tectonic processes operating along the margins of the combined Proterozoic Australian craton. Crustal structure and thermal history were the primary controls on magmatic and tectonic evolution, rather than deep-seated mantle upwelling or mantle plume activity.

For more information, contact Hugh Smithies (hugh.smithies@dmp.wa.gov.au).

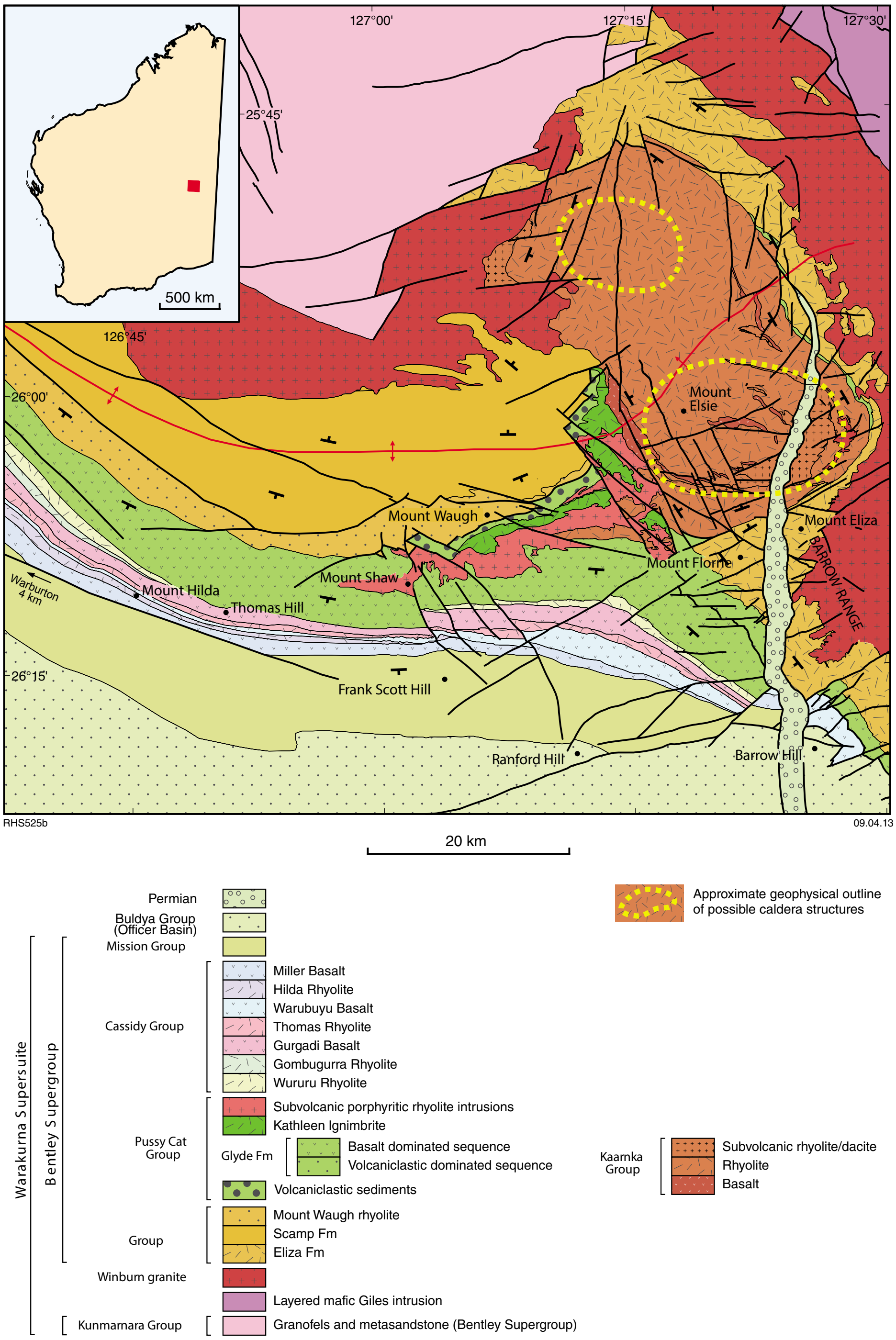


Figure 2. Detailed interpreted bedrock geology of the Talbot Sub-basin

Historical mining tenement maps (public plans)

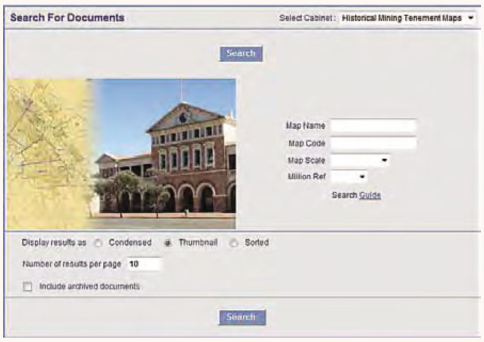


Figure 1. Textual search tool to find historical tenement maps

Before the computerized TENGRAPH system was implemented, DMP maintained hard copy maps showing the location of mining tenements within Western Australia. These historic mining tenement maps, often referred to as Mines Department Public Plans, have been scanned and are available for viewing in PDF format that can be downloaded free of charge.

In addition to tenements, many of these historical maps contain the location of mine sites, exploration licence release details, cadastre, topography and proposed land tenure changes.

Each historical tenement map name is attributed with the following properties:

- edition number — as a map became worn or cluttered with mining tenements, it would be replaced with a new edition. Each new map edition is given a sequential number
- map code — the map number issued.
- start date — the date a new map was adopted
- end date — the date a map was cancelled or a map series discontinued. A map was discontinued when replaced by a map drawn at a different scale or when TENGRAPH was implemented
- 250 000 reference — the 1:250 000 map sheet code the historic map falls within
- million reference — the map code of the 1: 1 000 000 index map the historic map falls within
- scale — scale at which the map was drawn
- in general, localities that were heavily pegged by gold mining leases were drawn at a large scale. Many of the older maps were centred on historic gold discoveries at a scale of 20 chains to an inch (1:15 840).

  the more modern maps are drawn at 1:25 000, 1:50 000, or 1:100 000 metric scales based on the AGD84 datum.

  many of the older maps, particularly those in the South West Mineral field, had tenement applications plotted onto copies of imperial-scale maps produced by the Lands Department (formerly) Department of Land Information now Landgate.

  small-scale 1:1 000 000 and 1:250 000 historic index maps are also available. Many show the position of localized maps, old temporary reserves and exploration licence boundaries.

Access to the historical mining tenement maps is via DMP's online systems link. Users are taken to a page that provides an option of either a textual search or by selecting a point or area of interest on a simple-to-use interactive map.

Currently the spatial location affecting the old imperial-scale maps are based on 1:100 000 footprints. A more accurate depiction of their location will become available in future software releases. In the first release there will be 9549 historic maps available to search. This is not a complete dataset and will be increased in the coming months.

The interactive map has been designed to open with the outline of Western Australia displaying towns and the DMP's Historical Tenement Map (Public Plans) Index. The spatial search will return all the historic maps that are available for a selected area.

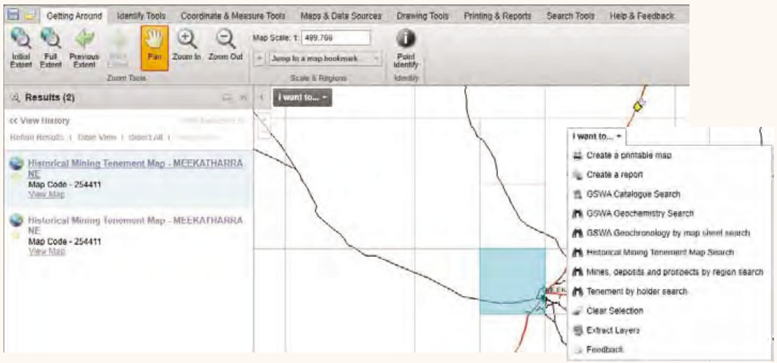


Figure 2. Spatial search tool finds historical tenement by geographic location

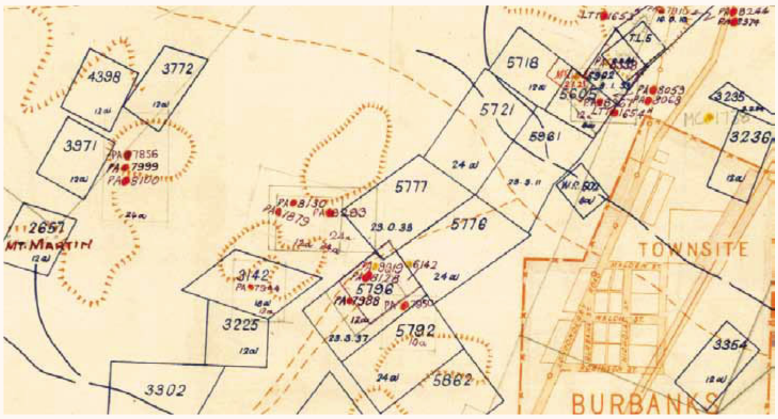


Figure 3. A typical 20 chains to an inch historical mining tenement map

Whether you are interested in finding the location of old mining tenements or you are a history buff, you are sure to find something of interest in this new online system.

For more information, contact Neville D'Antoine (neville.d'antoine@dmp.wa.gov.au).

Imaging crustal structure in the west Musgrave Province

Abstract from Report 114 Imaging crustal structure in the west Musgrave Province from magnetotelluric and potential field data

The west Musgrave Province in central Australia occupies a position at the intersection between the South, West, and North Australian Cratons, and was a focal point for tectonic activity from the Mesoproterozoic through to the latest Proterozoic. The series of tectonic events includes two Mesoproterozoic orogenic events (the Mount West and Musgrave Orogenies), a major intraplate rift event (the Giles Event), and two episodes of compressional intraplate orogenesis (the Petermann and Alice Springs Orogenies). As a result of this activity, the west Musgrave region may be prospective for several types of mineral deposits, principally Ni–Cu–PGE, for which the world class Nebo–Babel deposit is the major occurrence, but also nickeliferous laterites, orogenic and intrusive gold, and, potentially, iron oxide – copper – gold. Here, we use magnetotelluric (MT), gravity, and magnetic data to determine the crustal structure of this region, with a particular focus on identifying the geometry of large-scale faults and shear zones that may be prospective for mineralization.

MT data were collected specifically for this work along two orthogonal profiles. These profiles show that the region is dominated by resistive lithosphere, within which several conductive zones are recognized. Several of these relate to deep-penetrating faults or shear zones that may have been important pathways for mineralizing fluids. Petrophysical data (density and magnetic susceptibility) were collected for the main lithological groups, and were used to constrain potential field modelling of crustal structure. 2D gravity and magnetic forward modelling provides a broad overview of crustal structure, and develops a link between geological observations and the lithospheric structure revealed in the MT data. These results are built on by the construction of an interpretative 3D model. Subsequent gravity and magnetic inversions show that this model is acceptable given the petrophysical constraints, although alternative geometries are also investigated.

Together, the results of these geophysical investigations suggest that the west Musgrave Province is dominated by the structure of the Giles Event and the Petermann Orogeny. The Giles Event was characterized initially by the intrusion of enormous quantities of mafic magma along an east-southeasterly to west-northwesterly trending rift axis. Subsidiary east-northeast trends are observed later in the event. This intrusive event was followed by the deposition of thick volcanic–sedimentary packages of the Bentley Supergroup. The forward models indicate that primary layering within these units dips shallowly to the south to southwest, although this is disrupted in many places by faulting and folding that took place in the later stages of the Giles Event. Previous studies indicated that the Petermann Orogeny was characterized by three types of deformation: 1)low-angle thrust faulting and nappe-style folding dominates in the footwall of the Woodroffe Thrust; 2) low-angle thrusts and crustal flow zones dominate in the hanging wall of the Woodroffe Thrust; and 3) high-angle transpressional shear zones dominate in the core of the orogen, south of the Mann Fault. Our models are consistent with this, and also show that the intensity of the Petermann Orogeny decreases to the south and west. The crustal structure revealed by these studies defines the geometries of numerous features that are potentially prospective for mineralization, including the large Giles Suite mafic intrusions, and major crust-penetrating shear zone networks.

For more information, contact Hugh Smithies (hugh.smithies@dmp.wa.gov.au).

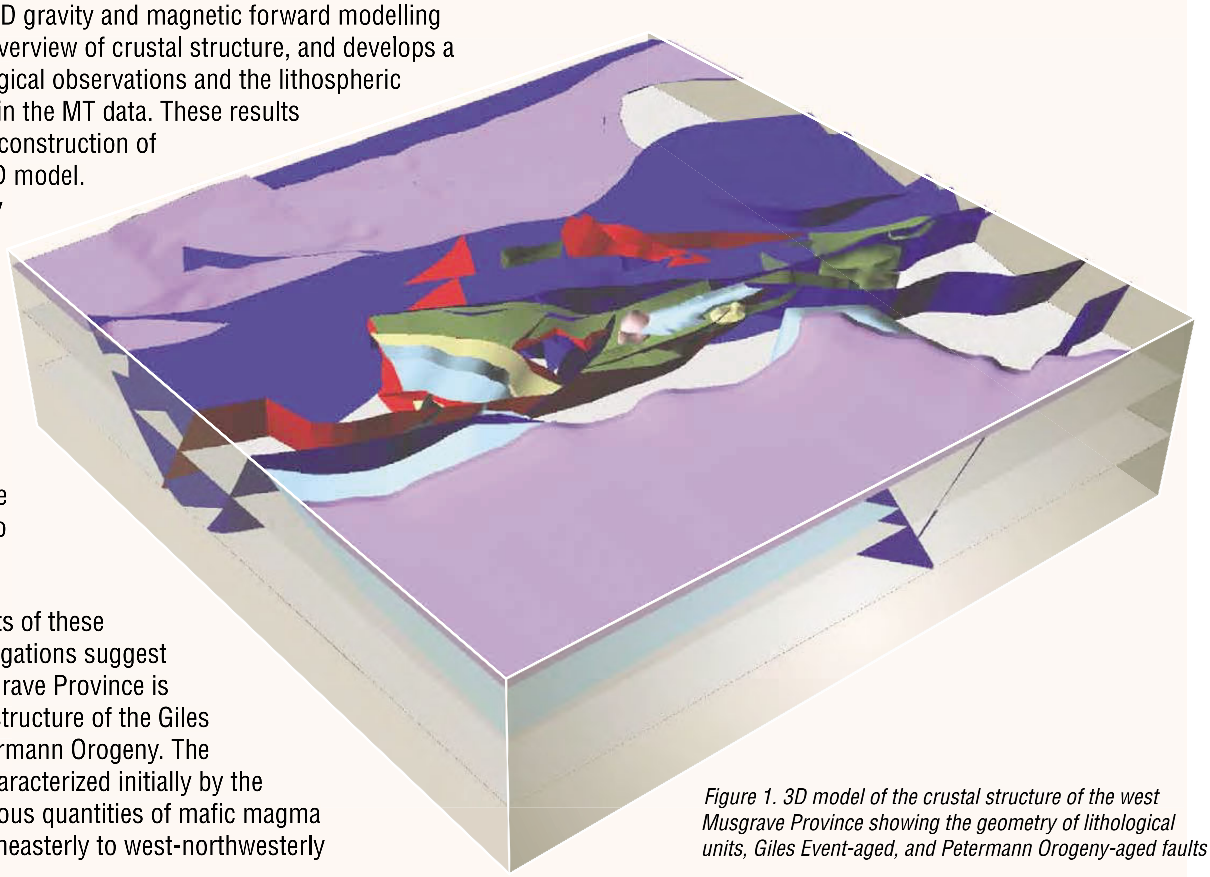


Figure 1. 3D model of the crustal structure of the west Musgrave Province showing the geometry of lithological units, Giles Event-aged, and Petermann Orogeny-aged faults

Eucla basement stratigraphic drilling

As part of the Exploration Incentive Scheme (EIS), the Geological Survey of Western Australia (GSWA) has recently completed drilling five deep holes into the basement below the Eucla Basin, with a major aim to help drive greenfields exploration into this virtually unexplored, remote region (see also What's beneath the Eucla?, July 2012, Fieldnotes 63, p. 4–5). Three of the holes were drilled close to the South Australian border, east of the Mundrabilla Shear Zone, and represent the first diamond core ever retrieved from the Forrest Province (Fig. 1). The other two holes were drilled into the Madura Province; one to the northeast of the Loongana intrusion, and the other to the west of it, not far from the Rodona Shear Zone. The choice of localities was based on identifying geophysical domains from recently acquired, 200 m line-spacing aeromagnetic data and 2.5 km grid gravity data, freely available from Geoscience Australia's Geophysical Archive Data Delivery System (GADDS).

A total of 1511 m of top-quality PQ and HQ diamond core has been recovered (Fig. 2), comprising some cover rocks but mostly basement rocks. Most of the Eucla Basin cover was drilled with a reverse circulation (RC) precollar, and for MAD002 the cover was drilled using mud rotary. Table 1 shows the localities and drilled hole depths, which were angled at a dip of -80°.

The basement core consists of a variety of lithologies ranging from granitic gneiss, granites of variable compositions, and mafic and ultramafic rocks. Some of these are variably altered. In hole FOR010 we also encountered 108.4 m of sandstone of unknown age unconformably underlying the Eucla Basin, above the basement rocks. In the coming months, analysis of the core will include hylogging, structural analysis, petrographic work, geochemical analysis including some assaying, isotopic analysis, and geochronology. We also plan to drill two more holes in the 2013–14 financial year.

The results from the drilling will greatly assist in the interpretation of the deep crustal seismic reflection lines acquired in 2012. Line AF3, which follows the Trans-Australian Railway from just east of Karonie through to Haig, has been processed and is currently being interpreted. Planning is underway to continue this line to the South Australian border.

GSWA would like to thank K&J Drilling (RC component) and Sanderson Drilling (mud rotary and diamond component) for persevering with drilling in challenging ground conditions in remote country. We would also like to thank the local pastoralists from Mundrabilla and Gunnadorrah Stations for all their help and enthusiasm. The success of this project is due to the tremendous team effort by all involved.

For more information, contact Catherine Spaggiari (catherine.spaggiari@dmp.wa.gov.au).

Hole_ID	Longitude	Latitude	Base of Eucla Basin (m)	Total depth of hole (m)
FOR004	128.55396	-31.28008	389.90	570.40
FOR011	128.17583	-30.61716	284.87	500.10
FOR010	128.36604	-30.51860	249.20	527.80
MAD014	127.08571	-30.47861	242.00	459.50
MAD002	125.83145	-30.97575	389.10	591.60

Table 1. Locations and drilled depths of the Eucla basement stratigraphic drill holes

Figure 1. HQ diamond core of foliated metagranite with mafic horizons from hole FOR011, Forrest Province

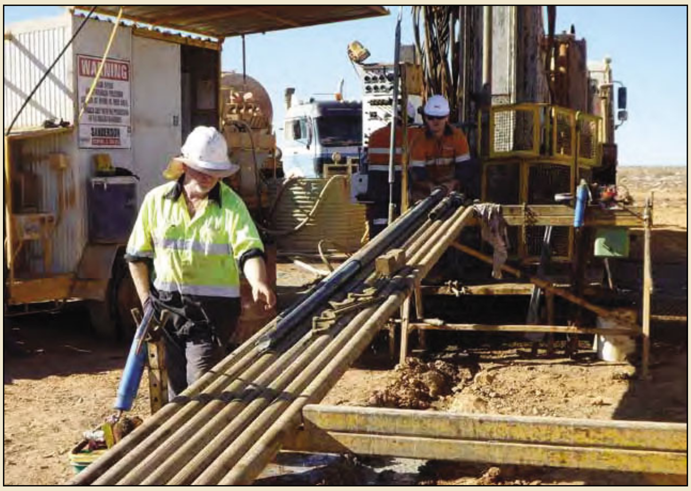


Figure 2. Diamond drill rig in operation at site MAD014 showing solid HQ core being extracted from the tube

An integrated geological and geophysical study of the west Arunta Orogen and its mineral prospectivity

Abstract from GSWA Report 113

Under the Exploration Incentive Scheme (EIS), the Geological Survey of Western Australia (GSWA) contracted the Centre for Exploration Targeting (CET) at The University of Western Australia to provide exploration targeting products on a terrane-by-terrane basis. Such products are designed to help junior-to-mid-sized exploration companies translate the geoscientific datasets being provided by EIS into actual ground acquisition, and aid critical decision making for drill targets.

The new exploration targeting products include:

- a study of the 4D architecture of each terrane based on an integration of geological and geophysical data
- a mineral system analysis of selected commodities and mineral deposit types
- the creation of a series of 'Predictor Maps'.

The first area in Western Australia to be analysed is the under-explored Paleoproterozoic of the west Arunta Orogen and its cover rocks, located in remote east-central Western Australia (GSWA Report 113). The three principal objectives were to:

- define the present day geometry in 3D and then understand the 4D evolution of the terrane, based on an integrated geological–geophysical approach incorporating all available geoscientific data to interpret the gross structure and deformation history
- determine which mineralizing systems and deposit types are most likely to be present
- identify the most prospective areas for each deposit type using a GIS-based prospectivity analysis of the resulting geological and geophysical maps. Prospectivity analysis was undertaken for orogenic and intrusive gold, surficial and unconformity-style uranium, and sediment-exhalative (SedEx) type base metals with the aim of an improved understanding of the geology and mineralization potential.

The west Arunta Orogen is interpreted as a basement-involved, thick-skinned, fold–thrust terrain with fault blocks comprising both the Paleoproterozoic basement and rocks from overlying sedimentary basins. Two major deformation events control the current architecture of the west Arunta Orogen. The earliest (D1) trend west-northwest, and are controlled by the Central Australian Suture (CAS), which has a long and complex history. Reactivation of D1 structures during the Alice Springs Orogeny was mostly responsible for the present structural configuration, modified by northeast-trending D2 structures at or near the margins of the Neoproterozoic Murraba Basin and Phanerozoic Canning Basin.

For the gold prospectivity analysis, both a knowledge-driven fuzzy model and a data-driven weights-of-evidence (WofE) model were implemented. The output from both analyses was compared identifying the most prospective areas for gold exploration in the west Arunta Orogen along the CAS and the D1 structures.

A knowledge-driven prospectivity analysis was carried out for unconformity-related uranium, surficial uranium, and SedEx lead–zinc deposits. Potential targets for unconformity-related uranium deposits highlight very similar areas to the prospectivity analysis for gold. Lake Mackay appears to be the best area in which to conduct further investigation for surficial uranium deposits. The west Arunta Orogen has low prospectivity for SedEx deposits due to the low lead and zinc values in the available geochemical dataset, as well as the absence of evaporite in the area analysed.

For more information, contact Ian Tyler (ian.tyler@dmp.wa.gov.au).

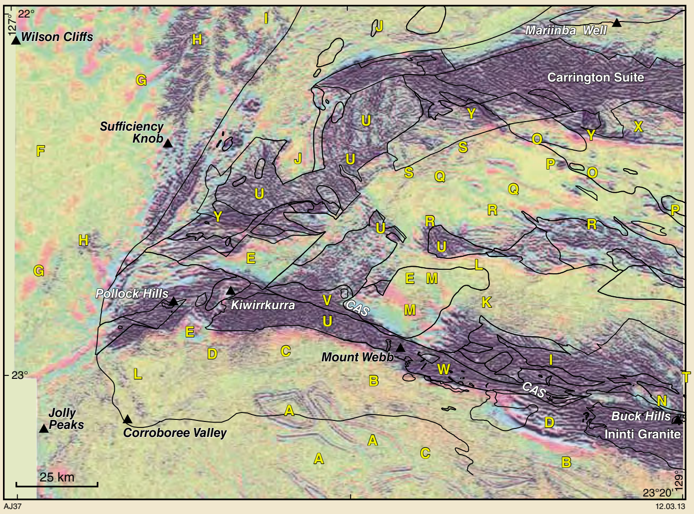


Figure 1. High-pass filtered image of the west Arunta Orogen Total Magnetic Intensity (TMI) map. Major geological boundaries are shown as thin black lines, localities as triangular symbols. Letters refer to particular areas that are described in section 'Interpretation of gravity and magnetic data'

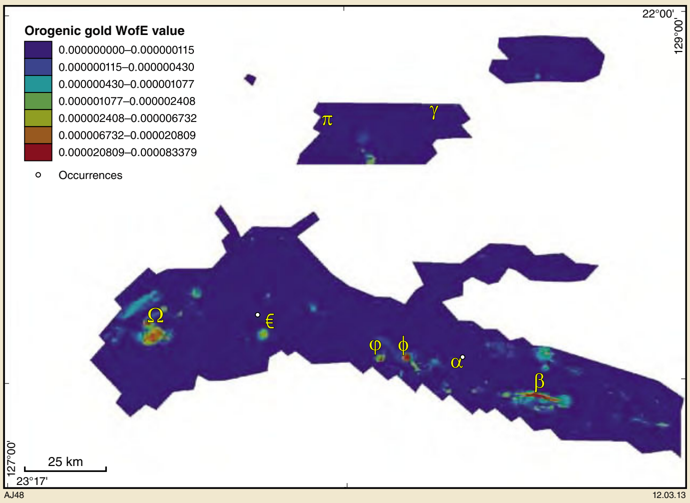


Figure 2. WofE prospectivity model for the orogenic gold mineral system. The granite as a source predictor is disregarded

The crustal evolution of the Rudall Province

The Rudall Province lies to the east of the Archean East Pilbara Terrane and records the Proterozoic amalgamation of Australia. The region contains a range of Neoproterozoic mineral systems, including Zn–Pb, Cu, U, and Au–Cu. The isotopic signature of basement units in this region is of significance for constraining the influence of crystalline substrate in younger magmatic mineralizing systems. GSWA Report 122 uses temporally constrained Hf, Nd and oxygen datasets to chart the crustal evolution of the Rudall Province.

The Paleoproterozoic rocks of the Rudall Complex can be divided into three terranes, known as the Talbot, Connaughton, and Tabletop Terranes. The southern two terranes (Talbot and Connaughton) were affected by magmatism related to the collision of the West and North Australian Cratons during the 1800–1765 Ma Yapungku Orogeny. However, the Tabletop Terrane is dominated by weakly deformed and metamorphosed felsic and mafic igneous rocks of the Krackatinny Suite emplaced between c. 1590 and c. 1550 Ma.

The Rudall Province is considered in terms of two very different evolutionary models:

- terranes within the Rudall Province are (para) autochthonous, an indigenous component of the West Australian Craton (WAC), and related to thickening of the Proterozoic margin of the Pilbara Craton
- terranes within the Rudall Province are exotic entities, possibly reflecting terrane transfer from the North Australian Craton (NAC) during accretionary orogenesis.

The Paleoproterozoic deformation and metamorphic history of the Rudall Complex is broadly synchronous with that of the Arunta Orogen in central Australia (part of the NAC), and also the Capricorn Orogen in central Western Australia (part of the WAC). Zircon crystals within the Talbot and Connaughton Terranes indicate crustal residence ages of 3.7 – 2.4 Ga, with strong Hf and Nd isotopic and, in the case of inheritance, temporal affinity to detritus that originated from Capricorn Orogen basement sources (e.g. 2005–1970 Ma Dalgaringa Supersuite of the Glenburgh Terrane). Furthermore, the range of Hf isotopic compositions in c. 1800 Ma magmatic zircons in the Rudall Province has similarity to that in the c. 1800 Ma Bridget Supersuite, which has a clear association with the Pilbara Craton. The c. 1800 Ma Bridget Suite forms a north-northwest trending intrusive belt within the East Pilbara Terrane, adjacent and subparallel to the Paterson Orogen. Hence, sources for isotopic compositions of the Talbot and Connaughton Terranes can be found within the proximal WAC. There is no necessity to invoke transfer of exotic NAC lithotectonic units to the WAC margin and to suggest an accretionary style of orogenesis for the Rudall Province.

The Tabletop Terrane has been considered as a different far-travelled block with crust unique to the other components of the Rudall Province, based on the resemblance of magmatism in this terrane to that in the northern Gawler and Musgrave regions. However, the currently available isotopic database shows similarity of source compositions throughout all three terranes of the Rudall Province. This implies that the Tabletop Terrane was derived from crust of similar composition to the Connaughton and Talbot Terranes, and that this crustal block was simply reworked at a different time. These data also indicate that the major suture between the NAC and the WAC lies to the east of the Rudall Province (present-day coordinates).

For more information, contact Chris Kirkland (chris.kirkland@dmp.wa.gov.au).

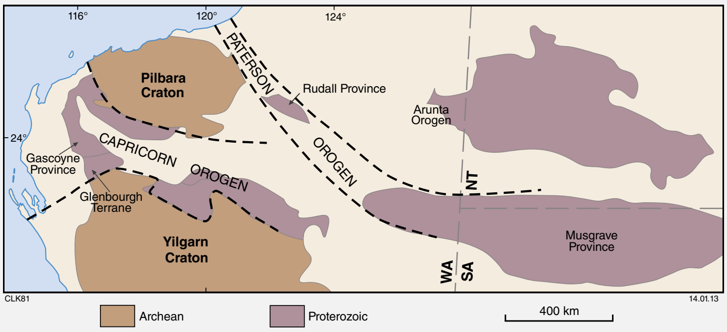


Figure 1. Simplified geological map indicating the location of the Rudall Province relative to other Proterozoic orogens and Archean cratons in west-central Australia

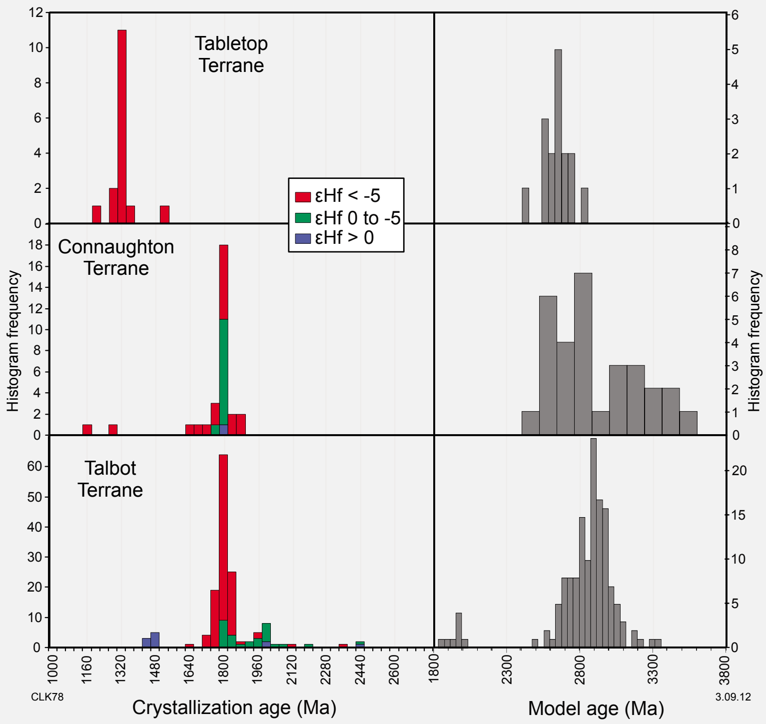


Figure 2. Magmatic crystallization ages (left) and two-stage Hf model ages (right) for zircons from the Rudall Province

Petrogenesis of gabbros of the Mesoproterozoic Fraser Zone

Abstract from Record 2013/5 Petrogenesis of gabbros of the Mesoproterozoic Fraser Zone: constraints on the tectonic evolution of the Albany–Fraser Orogen

by RH Smithies, CV Spaggiari, CL Kirkland, HM Howard and WD Maier

Forty-five samples of metagabbro sheets from the c. 1300 Ma Fraser Zone of the Albany–Fraser Orogen have been analysed for major and trace element geochemistry. The geochemical range corresponds with previously published ranges for metagabbros from this region. Two broad groups can be recognized: the ‘main gabbros’, which show no field, petrographic, or geochemical evidence of having interacted with country rock, and the ‘hybrid gabbros’, which show considerable evidence of such interaction. The hybrid gabbros can be further subdivided geochemically into low La/Th rocks that have incorporated material from contemporaneous high-Th monzogranitic sheets (Group 1 hybrid gabbros), and high La/Th rocks that have assimilated low-degree partial melts of metasedimentary country rock at the level of emplacement (Group 2 hybrid gabbros). The main gabbros are parental to the hybrid gabbros but escaped hybridization during ascent or emplacement. However, they still contain an enriched crustal component acquired at a deeper level. Previous accounts have suggested that this enrichment reflects a subduction addition to the mantle sources that formed a series of discrete, subsequently accreted, ocean island arcs. All previous and recent Nd- and Hf-isotopic data are inconsistent with that interpretation and trace element enrichments are better explained in terms of assimilation of basement that included a Sr-depleted component of Archean — or reworked Archean — crust. Following early basement contamination, the main gabbro sheets that comprise the dominant component of the Fraser Zone were emplaced into a lower crustal hot zone where they variably mixed with contemporaneous granite magma and country rock melts. The presence of voluminous gabbroic sheets, regional granite magmatism, and previously published peak metamorphic conditions of >800°C and >8 kbars in metasedimentary rocks are all indicative of a regional thermal anomaly from at least 1305 to 1290 Ma that coincided with the formation of the Fraser Zone. Based on these findings, and on a range of other recent geological evidence, the preferred tectonic setting is either a distal back-arc or an intercontinental rift.

For more information, contact Hugh Smithies (hugh.smithies@dmp.wa.gov.au).

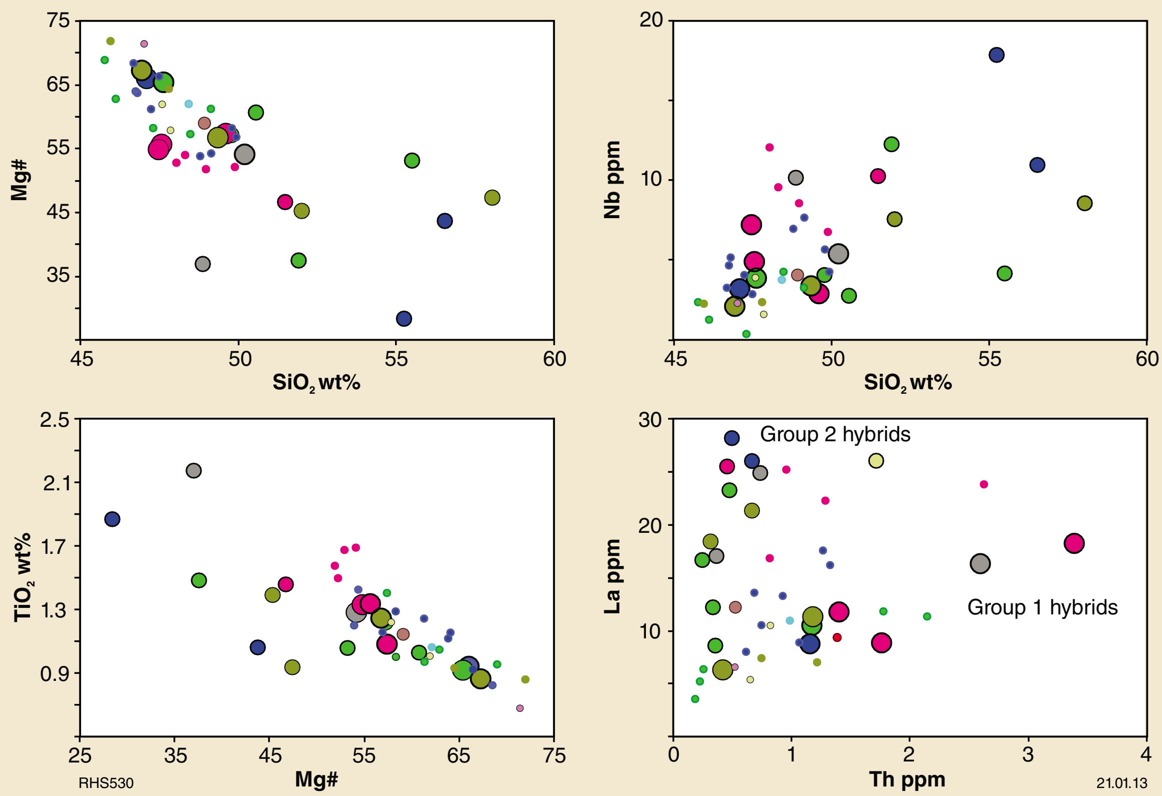


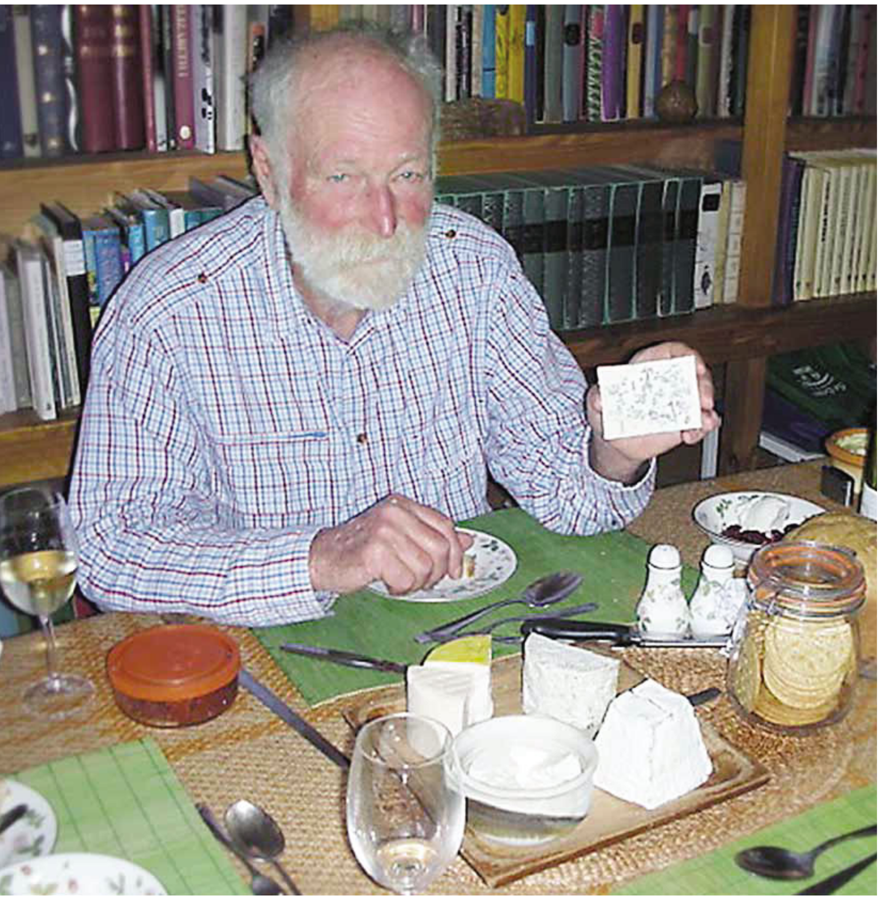
Figure 1. Compositional variation diagrams showing the distinction between main and hybridized gabbros. Symbol colours reflect samples taken at geographically different sites. Large symbols denote Group 1 hybrid gabbros, medium-sized symbols denote Group 2 hybrid gabbros, and small symbols denote main gabbros.

Alec Trendall: geologist, explorer, and cheese maker

Alec Trendall was born in Middlesex, UK, on 8 December 1928. After early schooling in India with his brother, Alec returned to the UK in 1937. While at Imperial College in London, he was greatly influenced by Robert Shackleton, who taught petrology. Shackleton supervised Alec's Honours thesis, and subsequently his PhD in 1949.

Later, Alec was invited to join a six-man expedition led by Duncan Carse to South Georgia to survey this major sub-Antarctic island. Carse led three South Georgia surveys. On the 1951–52 expedition, Alec dislocated his left knee that necessitated him being sent back to England for specialist treatment. During Alec's recuperation, Carse asked whether he was interested in going to South Georgia for the 1952–53 season. Alec declined but eventually accepted Carse's invitation to join the 1953–54 expedition while at Keele University. They sailed south two months after Alec's marriage to Kathleen Waldon, a nurse he had met while recuperating.

On his return from South Georgia, and after writing up his geological results, Alec joined the Geological Survey of Uganda and stayed for eight years. With Uganda independence looming, Alec accepted a position with the Geological Survey of Western Australia (GSWA) as petrologist in May 1962. He had little idea that the banded iron-formations of the Hamersley Group were to become a consuming interest for the rest of his geological career. This interest grew out of an investigation into the occurrence of blue asbestos (crocidolite) in the banded iron-formations of the group in which he was the lead researcher from 1964. It rapidly became apparent that a study of the origin of the banded iron-formations was an important part of this investigation, particularly as these rocks are the primary source of the iron ore deposits that were being actively explored and developed at that time. This work culminated in GSWA Bulletin 119 — The iron formations of the Precambrian Hamersley Group, Western Australia, co-authored with John Blockley.



Alec received worldwide recognition for his work on banded iron-formations and was invited to participate in one of the Dahlem Conferences organized by the Freie Universität of Berlin. The proceedings of this 1983 conference, with Alec as one of the editors, were published under the title, Patterns of change in Earth evolution.

Alec recognized that work on the Precambrian rocks of Western Australia depended on accurate geochronological data. He had long been of the opinion that a numerical nomenclature for the Precambrian would enable Precambrian stratigraphy to 'start anew', rather than follow the approach used in the Phanerozoic. He articulated this in his 1966 paper, Towards rationalism in Precambrian stratigraphy. In 1968 he and John De Laeter [head of Applied Physics at the Western Australian Institute of Technology (WAIT), now Curtin University] established a joint program whereby GSWA supplied the samples and WAIT did the geochronological analyses.

Alec served as Director of GSWA from 1980 to 1986. One initiative during his term was to produce an updated account of the geology and mineral resources of the State. This was a large task and when Alec retired, his successor, Phil Playford, gave Alec the task of overseeing the completion of what became Memoir 3 — Geology and mineral resources of Western Australia — which was published in 1990 along with a new State geological map.

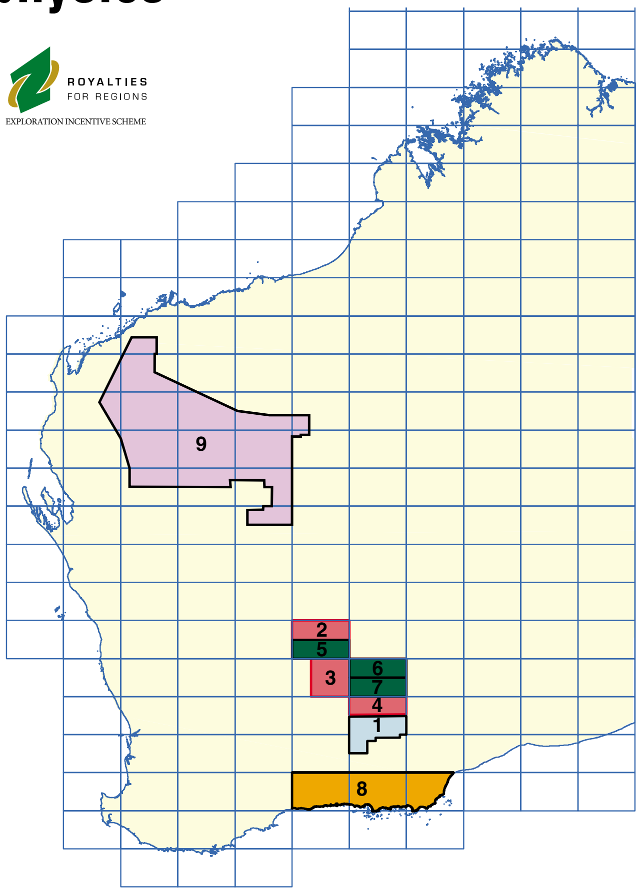
Alec was awarded a DSc for his work on banded iron-formations by the University of London, the Clarke Medal of the Royal Society of New South Wales in 1977, and the Gibb Maitland Medal by the Western Australian Division of the Geological Society of Australia in 1987. Trendall Crag in South Georgia is named after him.

Alec Trendall died peacefully at home near Denmark south of Perth, after a short illness.

This is an abridged version of an article written by Tony Cockbain, based on an auto-obituary started in Albany Hospital on 19 January 2013, supplemented by details from Alec's book Putting South Georgia on the map, with assistance from Kathleen and Jasper Trendall, and John Blockley.

Figure 1. Alec Trendall 1928–2013 (Photograph courtesy PE Playford)

Western Australia regional geophysics surveys: July 2013 update



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Airborne magnetic and radiometric surveys
'Goldfields 100 m' program

- Airborne surveys completed
- Airborne surveys 2013–14 (in progress)
- Remaining program 2014–15+

Other surveys

- Ground gravity surveys 2013–14
- Airborne EM surveys 2013–14

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

Airborne magnetic and radiometric surveys

ID	Area/Name	Line spacing and direction	Line-km	Acquisition Start	Acquisition End	Current Status	Prliminary Release [1]	Final Release
	2012–13 Program							
1	Widgiemooltha South 2012	100 m E-W	130 000	Nov-12	Apr-13	Released	—	6-Jun-13
	2013–14 Program							
2	Menzies North	100 m E-W	92 000	Jul-13*	Dec-13*	Contract		
3	Kalgoorlie East	100 m E-W	122 000	Jul-13*	Jan-14*	Contract		
4	Widgiemooltha North	100 m E-W	92 000	Jul-13*	Dec-13*	Contract		
	2014–15 Program							
5	Menzies South	100 m E-W	92 000	TBD	TBD	Proposal		
6	Kurnalpi North	100 m E-W	92 000	TBD	TBD	Proposal		
7	Kurnalpi South	100 m E-W	92 000	TBD	TBD	Proposal		

Ground gravity surveys

ID	Area/Name	Station spacing	Stations	Acquisition Start	Acquisition End	Current Status	Prliminary Release [1]	Final Release
8	Esperance 2013	2.5 km grid + 1 km road traverses	7 000	Jul-13*	Oct-13*	Contract		

Airborne reconnaissance EM surveys

ID	Area/Name	Line spacing and direction	Line-km	Acquisition Start	Acquisition End	Current Status	Prliminary Release [1]	Final Release
9	Capricorn 2013	5 000 m; N/S	29 000	Aug-13*	Oct-13*	Quotation		

Notes
* Asterisk indicates an estimated date based on delivery information currently available. Subscribe to the newsletter for release alerts.
1. Preliminary releases are made on a case-by-case basis and consist of ECW images and ERMapper grids of partially processed or unchecked data.

Colour legend *Data released* *Release date set* *In progress* *Under consideration*

Information current at: 1 Jul 2013

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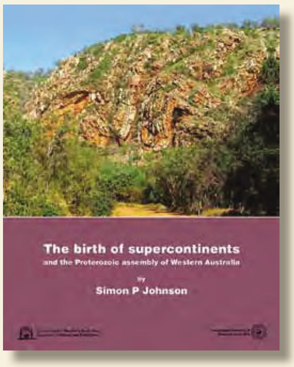

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