

Fieldnotes



Government of Western Australia
Department of Mines and Petroleum

Geological Survey of
Western Australia



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New funding gives incentive to explore

The State Government has just launched an \$80 million initiative to boost mineral and petroleum exploration in Western Australia and aid in the discovery of valuable new deposits. The Exploration Incentive Scheme (EIS), funded by Royalties for Regions over five years, aims to stimulate exploration for the long-term sustainability of the State's resources sector.

Most of the activities in the EIS are focused in under-explored greenfield regions where new mineral and energy discoveries will significantly increase knowledge of the State's geology and resources, and help increase employment opportunities.

Regional Development Minister Brendon Grylls and Mines and Petroleum Minister Norman Moore announced the incentive scheme in Kalgoorlie on 3 April.

'The current economic downturn has seen a decline in global commodity prices and reduced exploration activity in the last six months. The Government is committed to identifying new opportunities and ensuring the future prosperity of WA's resources sector,' said Mr Moore.

The EIS will be managed by GSWA on behalf of the Department of Mines and Petroleum (DMP), now the State's lead agency dedicated to servicing the future development of Western Australia's resources industry. The following six programs will be funded over for five years beginning in 2008/09:

Exploration and environmental coordination in DMP (\$1.5 million)

Program 1 – Improving online mineral and petroleum tenement application processes.

Innovative drilling (\$26.9 million)

Program 2 – Supporting innovative drilling in greenfield areas. See page 6 for more details of this program. Total funding of \$26.9 million includes \$20.5 million for Industry–Government co-funded drilling.

Geophysical and geochemical surveys (\$32.5 million)

Program 3 – Providing new data through airborne

geophysics, and ground-based seismic, gravity and geochemical surveys.

3D geological mapping (\$13.8 million)

Program 4 – Developing a system that allows all geoscience databases to be accessed seamlessly online to create customised geoscience reports and maps.

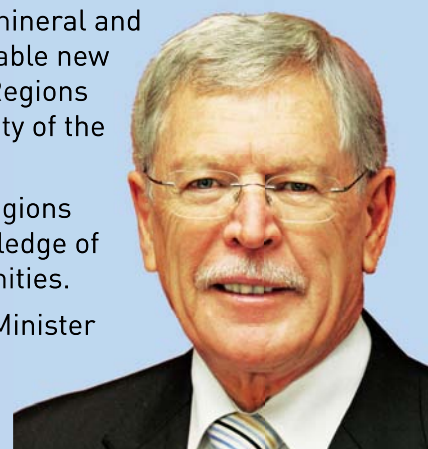
Promoting strategic research with industry (\$2.3 million)

Program 5 – Supporting the rapid transfer of new geoscience concepts, skills and technologies into the minerals exploration industry.

Sustainable relations with Indigenous communities (\$3 million)

Program 6 – Providing initiatives designed to assist indigenous and environmental approvals for exploration and production.

For further information, contact Margaret Ellis (margaret.ellis@dmp.wa.gov.au) or see DMP's website <<http://www.dmp.wa.gov.au/eis>>.



Minister for Mines and Petroleum, Hon Norman Moore

What's inside?

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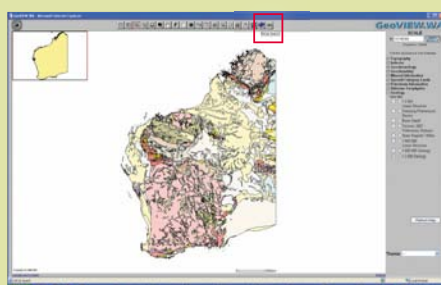
T-BREAK takes a look at the latest in information technology GSWA is using to better serve customers from industry, the public, and other government departments.

For more information, see
[<http://dmp.wa.gov.au/GSWA>Related Links>GeoVIEW.WA>Access to GeoVIEW.WA>].

Using GeoVIEW.WA to find products

The Department of Mines and Petroleum's (DMP's) GeoVIEW.WA web mapping application has the facility to search spatially for GSWA reports and maps.

The KitCat search button  allows the user to search for commodities or areas of interest by drawing a square over the area; this identifies products that are relevant to the area selected.

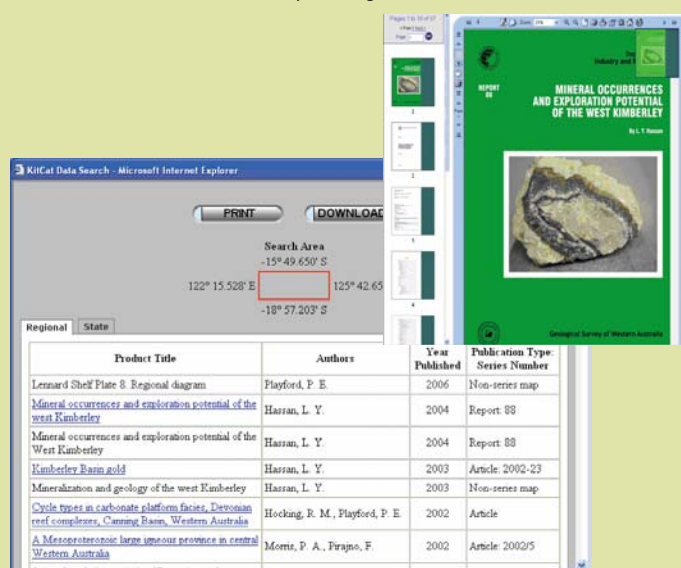


The Regional tab enables the user to see products specific to the region selected. The State tab gives the user access to State-wide publications such as the Compilation of Geochronology data.

The download button will then deliver a listing of all products identified in the search area. Information is provided as a comma separated value (CSV) file that allows the user to perform more complex filtering and sorting through a software package such as Microsoft Excel.

Users can view the product by clicking on the hyperlink; it is then possible to read, print or download the product. This is particularly useful if the product is a report or a map.

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



New Department of Mines and Petroleum

Three new WA Government departments have been established to emphasise the priorities of the State Government. The new departments, that incorporate the functions of the former Department of Industry and Resources, began operating on 1 January 2009.

Department of Mines and Petroleum

The new **Department of Mines and Petroleum** (<http://www.dmp.wa.gov.au>) has a stronger focus on the resources sector, maintaining a mining and petroleum regulatory role and incorporating the resources safety responsibilities from the former Department of Consumer and Employment Protection (DoCEP).

Department of State Development

The new **Department of State Development** (<http://www.dsd.wa.gov.au>) provides a strong focus on the strategic development of Western Australia, particularly major state development

projects and strategic economic development policy. This department also incorporates the functions of the former Office of Development Approvals Coordination, which was within the Department of Premier and Cabinet.

Department of Commerce

The Science and Innovation functions of the former Department of Industry and Resources (DoIR) have been transferred to the new **Department of Commerce** (<http://www.commerce.wa.gov.au>), which incorporates the Department of Consumer and Employment Protection. Functions that have been transferred from DoIR include Innovative Industries, Science and Enterprise and Aboriginal Economic Development.

Please note that email addresses reflect the new departments. Department of Mines and Petroleum email addresses now contain 'dmp' instead of 'doir'.



Highlights from GSWA Seminar and Poster Display 2009

GSWA 2009: promoting opportunities for mineral and onshore energy exploration in Western Australia

The GSWA Seminar and Poster Display on 19 February included a focus on the opportunities for energy exploration, and also highlighted the latest insights into the geology of greenfields mineral exploration in Western Australia. Extended Abstracts of the seminar presentations are available in GSWA Record 2009/2. The presentations and posters can be downloaded from the DMP website at <http://www.dmp.wa.gov.au/gswapublications>.



(Above) DMP Acting Director General, Tim Griffin (second from right) with Minister for Mines and Petroleum, Norman Moore (left)



Display room and 1:1 million geology map of Australia (on floor)

Energy

- Uranium mineralization in Western Australia; deposits types and regulatory requirements for mining were reviewed. See article on page 4 and 5.
- Geothermal studies in Western Australia were discussed.
- Petroleum potential of the Carboniferous – Permian within the frontier Canning Basin was highlighted.
- Progress of Geoscience Australia's Onshore Energy Security Program; new pre-competitive data for energy exploration in Western Australia were identified.

Archean Yilgarn Craton

- New mapping and improved geochronology clearly demonstrate that the Burtville Terrane in the Eastern Goldfields Superterrane in fact should be divided into two western domains and a Yamarna Terrane. The former two domains resemble the Youanmi Terrane whereas the latter is more similar to the Kalgoorlie and Kurnalpi Terranes.
- The greenstones and extensive mafic–ultramafic intrusions in the Murchison Domain of the Youanmi Terrane are interpreted as having formed in a rift setting.

Proterozoic Musgrave Complex and Capricorn Orogen

- Ongoing mapping in the Proterozoic greenfields areas of the Musgrave Complex and the Gascoyne Complex highlights the importance of high-quality SHRIMP (Sensitive High Resolution Ion Microprobe) U–Pb zircon and phosphate mineral geochronology.
- Musgrave Complex and Gascoyne Complex reveal very different and complex histories of reactivation and crustal reworking. Both processes had a major influence on the evolution of the mineral systems in each tectonic unit.
- Innovative studies of gold mineralogy and trace element chemistry show there were at least two periods of hydrothermal gold mineralization during the Proterozoic in the Capricorn Orogen, and at least one period of secondary gold formation during the Phanerozoic.
- The depositional setting and mineralization of the syn-sedimentary, polymetallic Abra deposit within the Edmund Basin and the implications of a breccia-pipe model for further exploration were discussed.



Attendees of the GSWA 2009 Open Day in display room

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



Uranium mineralization in Western Australia

Ivor Roberts' presentation on Uranium mineralization and deposits in Western Australia, attracted much interest at GSWA's recent seminar and poster display.

Western Australia is well endowed with uranium deposits, with 188 000 t of established resources of U_3O_8 (triuranium octoxide) in 28 on going projects. Uranium deposits and prospects are scattered throughout the State, in a variety of depositional settings. The significant settings are: calcrete-hosted, such as at Yeelirrie, Lake Way, Centipede, Thatcher Soak, and Lake Maitland; unconformity-related, such as Kintyre; roll-front-related, such as at Manyingee, Oobagooma, and possibly Mulga Rock; and carbonatite-hosted, such as at Cummins Range. Settings of lesser importance are pegmatite-hosted, and vein- and conglomerate-hosted deposits.



Mulga Rock landscape

Calcrete-hosted uranium is the dominant type of uranium mineralization in Western Australia. The term 'calcrete' is used for limestone deposits associated with valley-fill sediments in ancient valleys and existing trunk-drainage systems. Calcrete occurrences are concentrated in the northeast of the Yilgarn Craton, north of the so-called 'Menzies line', which is a line of separation between groundwaters of different chemical compositions. North of the line the groundwater is typically neutral to alkaline and less saline than

groundwater south of the line. The calcrete has been eroded west of the 'Meckering line' due to rejuvenated south- and west-flowing river systems (Butt et al., 1977).

Uranium enrichment takes place at the final stage of calcrete formation from the precipitation of carnotite, with occurrences generally restricted to areas of granitic bedrock containing high background levels of uranium ('hot' granites). North of latitude 30°S, but south of the 'Menzies line', carnotite mineralization is present within playa lakes without the development of calcrete.

Three types of calcrete-hosted mineralization have been documented by Butt et al. (1977), namely: trunk-valley calcrete, with mineralization in channels, platforms, and channel deltas; playa lakes with near-surface gypsiferous and calcareous clays or carbonaceous sediments below the surface enriched in uranium; and dissected calcrete containing uranium mineralization in terraces above the present watertable.

Most of the calcrete-hosted uranium deposits were discovered in the early 1970s. Yeelirrie is the largest, containing in 1993 an estimated 35 Mt resource* of uranium, with an average grade of 1.5 kg/t U_3O_8 , to give a total of 52 000 t of contained U_3O_8 . This is the largest uranium deposit in Western Australia, and possibly the largest of its style in the world. Other major calcrete-hosted uranium deposits include Hill View, Hinkler Well, Lake Maitland, Lake Way, Nowthanna, and Thatcher Soak.

Located in the Neoproterozoic Paterson Orogen, the Kintyre uranium deposit is an unconformity-related type with pitchblende the dominant uranium mineral in veining within chloritized schist. In section, the Kintyre deposit is a shallow-dipping lens with a maximum depth of 150 m below the surface. The estimated resource for Kintyre is 35 000 t of contained U_3O_8 , with an average resource grade of 1.5 kg/t U_3O_8 , making it Western Australia's second largest uranium deposit.

Uranium mineralization related to a roll-front is formed at the interface between rocks or groundwater under reducing conditions and oxidized, uranium-enriched groundwater, and thus marks the oxidation interface or redox boundary.

* Some of the resource estimates are historic and may not conform to the JORC standards.

Uranium mineralization

Major deposits of this type include Manyingee, Oobagooma, and possibly Mulga Rock.

Uranium mineralization at Oobagooma, in the form of uraninite and pitchblende, is hosted by the Lower Carboniferous Yampi Sandstone of the Canning Basin. Keats (1990) reported that two mineralized levels are present, with the upper level containing higher grade zones in classic roll-fronts. The total uranium resource is estimated as 8.2 Mt, with an average resource grade of 1.2 kg/t U_3O_8 , for 9900 t of contained U_3O_8 .

A number of roll-front uranium deposits are present within Permian and Cretaceous sandstone formations of the Southern Carnarvon Basin. The most significant is the Manyingee deposit within the Cretaceous fluviodeltaic Birdrong Sandstone in paleochannels cut into basement granite and overlain by shale (Keats, 1990). Resources are estimated as 14.7 Mt, with an average grade of 0.8 kg/t U_3O_8 , for 12 000 t of contained U_3O_8 . Significant exploration potential exists in the Southern Carnarvon Basin, particularly adjacent to the Gascoyne Complex along the eastern margin of the basin.

Hosted by organic-rich clay within an Eocene buried paleochannel, the Mulga Rock uranium deposit is the third largest in Western Australia. The uranium mineralization in the paleochannel is interpreted to be the result of the absorption of uranium-bearing complexes by fine-grained carbonaceous sediments, and is spatially controlled by redox boundaries (Keats, 1990). Total resources (JORC Code compliant inferred resources), as recently reported by Energy and Minerals Australia Ltd, are 24.2 Mt, averaging 0.556 kg/t U_3O_8 for 24 820 t of contained U_3O_8 .

Between June 2002 and September 2008 the right to mine uranium ore was excluded from the 1475 mining leases granted in Western Australia. During the same period, exploration for uranium was not prohibited. Following the recent State elections (and change of Government), uranium mining is now permitted in Western Australia, and action is being taken to remove the uranium exclusion from these mining leases.

Uranium mining and export require both State and Commonwealth Government approvals and need to address actual risks, while taking into account community concerns. Besides the usual State mining requirements, approvals are required

under Australia's Environmental Protection and Biodiversity Conservation Act, the Nuclear Non-Proliferation (Safeguards) Act, and the Radiation Protection and Nuclear Safety Act. Under the Customs (Prohibited Exports) Regulations, an export licence is necessary for the export of radioactive material and the transport of uranium must be conducted in accordance with the Commonwealth Radiation Protection and Control (Transport of Radioactive Substances) Regulations. Using best practice developed in other Australian jurisdictions, the Western Australian Department of Mines and Petroleum will ensure that all State and Commonwealth approvals are integrated.



Toro Energy on site

Uranium should be considered as just another commodity and uranium mining as just another mining operation, albeit one with particular regulatory requirements to meet Australia's international obligations and to cover the radioactive nature of the material.

REFERENCES

Butt, CRM, Horwitz, R and Mann, AW 1977, *Uranium occurrences in calcrete and associated sediments in Western Australia: Australia, CSIRO, Division of Mineralogy, Minerals Research Laboratories, Report FP16, 67p.*

Keats, W 1990, *Uranium, in Geology and mineral resources of Western Australia: Geological Survey of Western Australia, Memoir 3, p. 728-731.*

For more information, contact Ivor Roberts (ivor.roberts@dmp.wa.gov.au) or Don Flint (don.flint@dmp.wa.gov.au).



Exploration drilling



Government Co-funded Exploration Drilling — call for proposals

The Co-funded Government–Industry Drilling Program is being funded by the State Government to provide a stimulus to geoscience exploration and contribute to the economic development of greenfield regional areas of Western Australia. As part of the five-year \$80 million Exploration Incentive Scheme funded out of the Royalties for Regions Initiative, in April 2009 the Western Australian Government announced that \$3 million would be made available in 2009–2010 to stimulate innovative exploration drilling in under-explored areas of the State. The new program is administered by the Department of Mines and Petroleum (DMP).

Geoscience exploration includes mineral, petroleum, and geothermal exploration with drilling to be undertaken in areas that have economic mineral, petroleum, or geothermal

potential, but where various geological or other factors have discouraged investment.

DMP is now seeking proposals from applicants to undertake exploration drilling projects jointly funded by the successful applicants and the Department. The Government contribution to each successful project will be limited to \$150 000.

In 2009–2010 the co-funded drilling program will preferentially fund high-quality, technically and economically sound proposals that promote new exploration concepts and new exploration technologies.

For more information, contact Margaret Ellis, Coordinator Exploration Incentive Scheme, (margaret.ellis@dmp.wa.gov.au), 08 9222 3509 or see the website at <<http://www.dmp.wa.gov.au/eis>>.

<i>Important dates for the 2009–2010 Co-funded Drilling Program</i>	
8 April 2009	Call for co-funded drilling proposals
15 May 2009	Closing date for project proposals (5 pm deadline)
22 June 2009	Planned announcement of successful proposals
22 June – 30 June 2009	Agreements signed by applicants and DMP
1 July 2009 – 30 September 2010	Term of funding agreement for 2009–2010 co-funded drilling
30 June 2010	Last date for acceptance of interim reports and invoices and drillers receipts for 2009–2010 drilling projects (5 pm deadline) (Note: failure to meet this deadline means that the Funding Agreement is null and void)
30 September 2010	Last date for submission of final report (including core) for 2009–2010 drilling projects (5 pm deadline)



Government of Western Australia
Department of Mines and Petroleum



ROYALTIES
FOR REGIONS

Government Co-funded Exploration Drilling

As part of the Royalties for Regions funded Exploration Incentive Scheme (EIS), the Department of Mines and Petroleum is calling for applications for the 2009/10 program of Co-funded Exploration Drilling.

This program will co-fund up to 50% and up to \$150,000 of direct drilling costs per project.

Application forms and details are available at www.dmp.wa.gov.au/EIS

Applications close at 5pm on 15 May 2009.





Geophysics surveys

Western Australia regional geophysics surveys:

April 2009 update

Data access

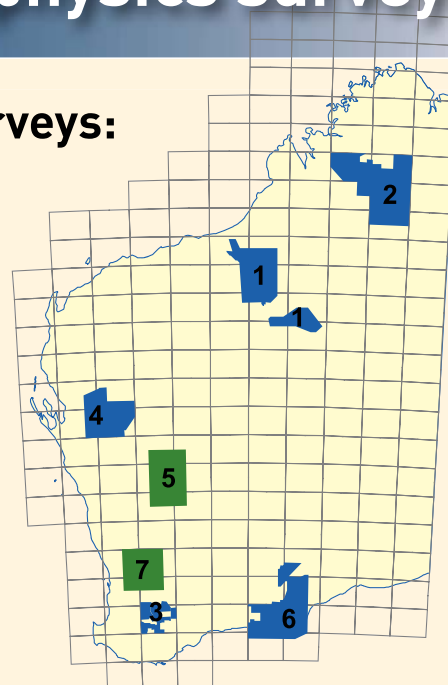
Download final data releases from the Geoscience Australia Data Delivery System at <http://www.ga.gov.au/gadds>. Download preliminary and final grids and images from GSWA website at <http://www.dmp.wa.gov.au/regionalgeophysicalsurveys>.

Subscribe to the GSWA mailing list

(see <http://www.dmp.wa.gov.au/GSWA> — News and Events page) to keep informed of preliminary and final data release dates.

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

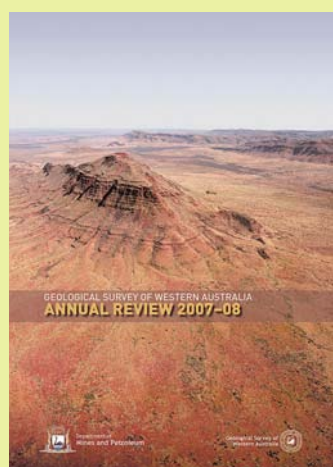
In progress
■ Airborne
■ Gravity



ID	Area/Name	Orgn	Method	Specifications	Size	Status	Start	End	Release
1	Paterson 2007	GA	AEM	1, 2, 6 km x 121 m; E/W	29 000 km	Processing	Sep-07	Sep-08	April-09
2	South Kimberley 2007	GSWA	Mag-Rad	400 m x 60 m; N/S	163 000 km	Released	Jan-08	Oct-08	20-Nov-08
3	Dumpleyung 2008	SWCC GSWA	Mag-Rad	100 m x 30 m; 400 m x 60 m N/S	70 000 km	Released	Mar-08	Dec-08	19-Feb-09
4	Byro 2008	GSWA	Mag-Rad	400 m x 60 m; E/W	90 000 km	Released	Apr-08	Jul-08	2-Oct-08
5	Windimurra 2008	GSWA	Gravity	2.5 km grid	5 200 stns	Released	Aug-08	Sep-08	20-Nov-08
6	Esperance 2008	GSWA	Mag-Rad	400 m x 60 m; E/W	84 000 km	Released	Sep-08	Dec-08	26-Mar-09
6	Balladonia 2008	GSWA	Mag-Rad	400 m x 60 m; E/W	43 000 km	Released	Dec-08	Jan-09	26-Mar-09
7	Cunderdin 2009	GSWA	Gravity	2.0 km grid	6 000 stns	Survey	Jan-09	Apr-09*	May-09*

Information current at: 2 April 2009 * Estimated date

GSWA Annual Review 2007-08 now available



The GSWA Annual Review 2007-08 showcases overviews, technical papers, program reviews, and outlines the activities of GSWA for the previous year. Former Executive Director Dr Tim Griffin, now Acting Director General, gives a detailed review of the year itemising all the program areas, products, and projects.

Abey Abeyasinghe and Don Flint have written an in-depth overview of mineral exploration in Western Australia for 2007 to 2008. The overview shows that the value of mineral production in the State increased by six per cent to a new record of \$39 billion (excluding petroleum) despite a fall in production in some commodities including nickel, gold, manganese, chromium, and lead.

There are two technical papers included in the publication. In the first paper, GSWA geologists

Mark Pawley, Sandra Romano, Charlotte Hall, Steven Wyche and Michael Wingate collaborate on 'The Yamarna Shear Zone: a new terrane boundary in the northeastern Yilgarn Craton?'.

The Yamarna Shear Zone can be related to events recognized in structural syntheses proposed for other parts of the Eastern Goldfields Superterrane.

The second paper, 'A new lithostratigraphic scheme for the northeastern Murchison Domain, Yilgarn Craton', was written by Martin Van Kranendonk and Tim Ivanic. Martin and Tim's work presents this area as a working model and suggests that previously published schemes require revision.

The GSWA project managers have given detailed reviews of their individual program areas and provided the highlights and activities for the year, products produced, as well as outlining future work for the upcoming year.

The appendices include the list of products produced during the year, external publications written and planned achievements.

The Annual Review 2007-08 is available to view and download at <http://www.dmp.wa.gov.au/GSWA>.

Product releases

All prices include 10% GST

RECENT RELEASES

■ GEOLOGICAL MAPS

MOUNT AUGUSTUS 2nd edition 1:100 000 Geological Series
by DMcB Martin, AM Thorne, and S Sheppard

YINNETHARRA 1:100 000 Geological Series
by S Sheppard, SP Johnson, PB Groenewald, and TR Farrell

PDFs available on website free of charge

■ NON-SERIES MAPS

Iron ore deposits of the Yilgarn Craton 2009
by RW Cooper and DJ Flint

Major resource projects Western Australia — 2009
by RW Cooper and DJ Flint

Mines — operating and under development Western Australia — 2009
by RW Cooper

Industrial minerals in Western Australia 2008 Plate 1
by JM Fetherston

Industrial minerals in Western Australia 2008 Plate 2
by JM Fetherston

PDFs available on website free of charge

■ RECORDS

2008/16 Industrial minerals in Western Australia: the situation in 2008
by JM Fetherston

2008/19 The west Musgrave Complex — new geological insights from recent mapping, geochronology, and geochemical studies
by RH Smithies, HM Howard, P Evins, CL Kirkland, S Bodorkos, and MTD Wingate

2009/2 GSWA 2009 extended abstracts: promoting the prospectivity of Western Australia

PDFs available on website free of charge

■ MISCELLANEOUS PUBLICATIONS

Geological Survey of Western Australia Annual Review 2007–08

Overview of mineral exploration in Western Australia for 2007–08
by PB Abeysinghe and DJ Flint

Western Australia atlas of mineral deposits and petroleum fields 2009

by RW Cooper, PB Abeysinghe, and DJ Flint
PDFs available on website free of charge

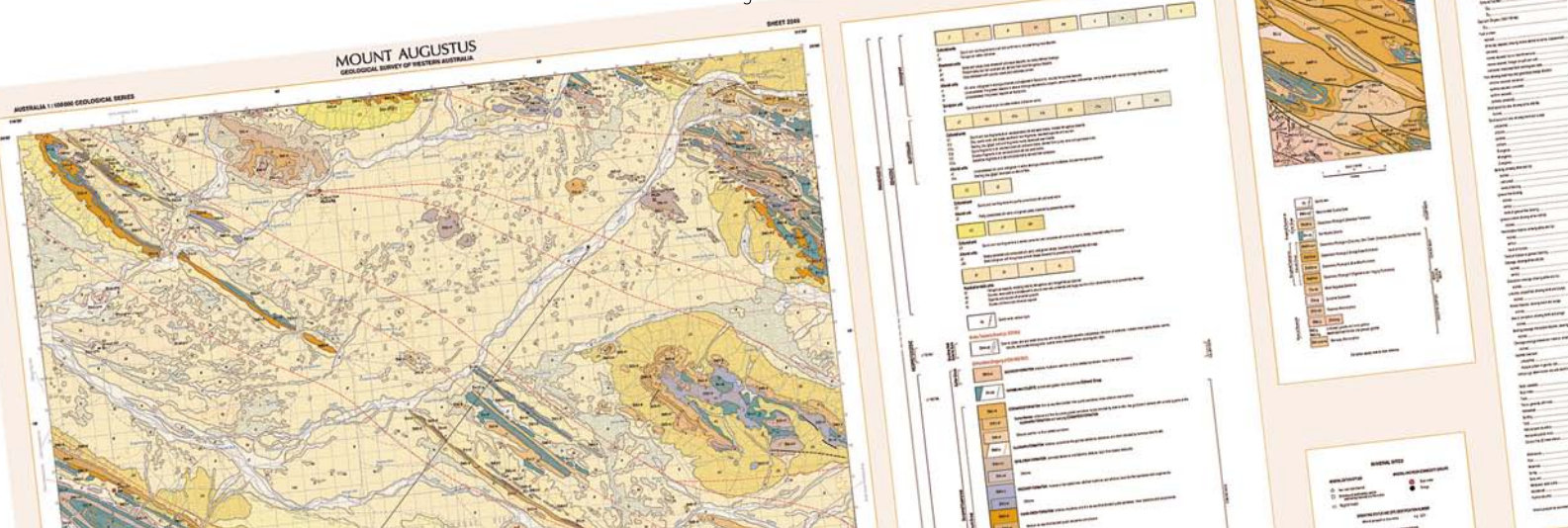
■ GEOLOGICAL INFORMATION PACKAGE (DVD)

Pilbara 1:100 000 Geological Information Series 2008
by AH Hickman \$55.00

■ DIGITAL PRODUCTS

Western Australian petroleum acreage release, September 2008

Geothermal acreage release 2 – August 2008
Download from website free of charge



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Hardcopy publications including CDs and DVDs are available from the Information Centre, First Floor, Mineral House, 100 Plain St, East Perth, WA 6004, AUSTRALIA Phone: +61 8 9222 3459; Fax: +61 8 9222 3444

or can be purchased online from the bookshop at <http://www.dmp.wa.gov.au/ebookshop>.