An Overview of Uranium Mineralisation in South Australia

Tania Wilson
Presentation Outline

South Australian Overview
- Existing Mining Operations
- Developing Projects
- Exploration Projects

PACE2020 Projects
- IOCGU Mineral Potential Modelling & Prospectivity
- Cariewerloo Basin Unconformity Uranium Project
  *PIRSA – Saskatchewan Geological Survey*
- Frome AEM
  *Geoscience Australia – PIRSA*
- Frome/Curnamona
- Recent Product Releases

www.minerals.pir.sa.gov.au
South Australia’s Mining Pipeline

March 2011

Government of South Australia
Primary Industries and Resources SA

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**Olympic Dam – Copper-Gold-Uranium-Silver**
BHP Billiton Ltd

- Worlds largest uranium deposit, fourth largest remaining copper deposit and fifth largest gold deposit, also contains significant quantities of silver.

- Total Resource 9075 Mt at 0.027\% U\(_3\)O\(_8\).

- Ore reserve 598 Mt at 0.058\% U\(_3\)O\(_8\).

- Production 2009/10 – 2279 t U\(_3\)O\(_8\).
Current expansion activities:

- Environmental Impact Statement.

New 70 Mtpa Olympic Dam will have an approximate annual production of:
- 730,000 t Cu
- 19,000 t U₃O₈
- 800,000 oz Au
- 2,091,000 oz Ag
Beverley Mine – Uranium
Heathgate Resources Ltd

• Production commenced in 1999. At that time was one of the largest ISR mines in the world.

• Total Resource 7.7 Mt at 0.27% U₃O₈ containing 21 000 t U₃O₈.

• Production 2009/10 – 650 t U₃O₈.


• Successful exploration drilling has identified further mineralisation at Beverley East and Deep South.
Beverley North (Pepagoona) – Uranium
Heathgate Resources Ltd

- Discovered in 2009 in a region of PACE funded, shallow (up to ~30m) drilling program for calcrete-hosted uranium mineralisation.

- Uranium mineralisation is predominantly hosted by the Eocene Eyre Formation, however, some occurs in the lower Namba Formation (Miocene).

- Pepagoona deposit is approximately 100 metres from granite outcrop on the ranges.

- Field leach trials.
Four Mile – Uranium
Quasar Resources – Alliance Resources Ltd

- Tertiary sandstone-hosted mineralisation in two distinct zones: Four Mile West and Four Mile East.
- Indicated and Inferred Resource of 9.8 Mt at 0.33% U₃O₈ containing 32 000 t U₃O₈.
- Potential production of ~1360 tpa U₃O₈.
Honeymoon – Uranium
Uranium One Inc – Mitsui & Co. Ltd

- Indicated Resource 1.2 Mt at 0.24% U₃O₈ containing 2900 t of U₃O₈.
- Construction commenced on in situ recovery mine.
- Production to commence in 2011 with an estimated annual production of 400 t of U₃O₈.
- Expected mine life of 6 years.
Oban – Uranium
Curnamona Energy Ltd

- Inferred resource 8.2 Mt at 260 ppm eU$_3$O$_8$ containing 2100 t of eU$_3$O$_8$.
- Field leach trials approved in 2009 and commenced in 2010.
- Roll-front style pitchblende mineralisation.
Mullaquana – Uranium
Uranium SA Ltd

- First major uranium discovery in the Pirie Basin.

- Blackbush Prospect: Inferred Resource of 45.5 Mt at 280 ppm for an estimated 12 700 t U₃O₈.

- Plumbush Prospect: potential economic mineralisation indicated in 13 drillholes.

- Additional prospects: Sugarbush, Emubush and Samphire Prospects.

- Field leach trials proposed for late 2011.
Crocker Well – Mt Victoria – Uranium
Sinosteel PepinNini Curnamona Management Pty Ltd

- Crocker Well: Inferred Resource 18.8 Mt at 281 ppm containing 5290 t of U₃O₈.

- Mount Victoria: Inferred Resource 25 000 t at 0.16% U₃O₈.

- Mining Lease application submitted.

- Intended production 200-400 tpa of U₃O₈, mine life 7-15 years.
 Projects to Watch

- **Vulcan**: Drilling of mag/grav targets. Assay results include 53m of 0.1% Cu, 0.04 g/t Au and 0.02 kg/t U₃O₈.

- **Oak Dam South**: PACE supported drilling of geophysical target to commence early 2011.

- **Goulds Dam**: Indicated resource 1.7 Mt at 0.12% containing 2000 t U₃O₈.

- **Junction Dam**: Discovered late 2009 in Yarramba Palaeochannel. Drilling intersected 5.95m at 423 ppm eU₃O₈ with a peak grade 7551 ppm eU₃O₈ (GT of 0.252).

- **Pundinya**: Assay results indicate grades of up to 3200 ppm U₃O₈.

- **Yarranna -1**: Drilling in Narlaby Palaeochannel returned 8m at 626 ppm U₃O₈.

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www.minerals.pir.sa.gov.au
PACE Funding Graph 2004 to 2014

Financial Year

Funding Level ($ Million)


Total Government Expenditure

$51.9M
PACE2020
Uranium Projects

- Statewide Uranium Map
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  Unconformity Uranium Project
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- Frome Embayment/Curnamona
  Uranium Mineral Systems
- Eucla & Statewide Palaeodrainage Map
- Mt Painter Mapping
- Hydrogeochemistry (Eucla & Gawler)
PACE2020
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PACE2020 Projects

Uranium Occurrences Map (4th Edition)

- Known uranium occurrences and significant geological parameters for each deposit type have been collated and represented spatially as a ‘key ingredients’ map
- 4th edition released
- Significant number of additions
- Classification scheme

URANIUM MINERAL SYSTEMS and FLUIDS

MAGMATIC-RELATED U SYSTEMS
(7) Volcanic
(8) Intrusive
(9) Vein

Magmatic-hydrothermal fluids

HYBRID U SYSTEMS
(1, 3, 9, 10, 11)

Meteoric, seawater
(10, 12, 13, 14)

(4) Calcrete U
Groundwaters

(1) Shallow U-bearing hematite IOCG

(3) Sandstone U (V, Cu)
Formation waters / connate waters

(2) Unconformity U (PGE, Au)

‘METAMORPHIC’-RELATED U SYSTEMS
(6)

‘Metamorphobic’ fluids
(incl. metamorphic rock-buffered)

Volcanic

Deep (mgt) IOCG

Mixing

Mixing

BASIN- and SURFACE-RELATED U SYSTEMS

(7) Volcanic

(5) Metasomatic
Vein

(9) Vein

(10, 12, 13, 14)

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Vein

(6)

(1, 5, 9, 10, 11)

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Vein

(6)

Courtesy Roger Skirrow, GA

(#) represent deposit types from IAEA Red Book & Dahlkamp (1990)

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PACE2020 Projects

Uranium Mineralisation and Mineral Systems in South Australia

Tania Wilson and Martin Fairclough

Report 2009/14

Accompanies the revised South Australian Uranium Occurrences Map (4th Edition).
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Mineral Potential Modelling – Eastern Gawler Province

- IOCG ±U
- Work in progress
- Under deep cover
- Few basement intersecting drillholes
- Driven by potential field data and interpretation
  - Gravity
  - TMI
  - Derived datasets:
    - Worms
    - Depth to Magnetic Basement
    - Potential Field Inversions
IOCG ±U modelling current inputs:

- Coincident gravity and TMI anomalies
  - Generated from residual potential field grids
- Solid Geology
  - Based on drillhole data and magnetic interpretation
- Depth To Basement
- Worms
  - Generated from gravity and RTP TMI
  - Proxy for structure
PACE2020
Mineral Potential Modelling – Eastern Gawler Province

- IOCG±U Potential – Uses
  - Preliminary exploration site selection
  - 3D visualisation
Investigation into the use of radon and soil sampling on Yorke Peninsula (RB 2010/18)

Fabris, A.

• Radon emanometry (‘track etch’ style system) investigated as a surface exploration technique

• Surveys undertaken on IOCG style deposit.

• Results indicate that it is a viable technique for target generation in areas of thin to moderate cover thicknesses.
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Uranium Projects

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MAGMATIC-RELATED U SYSTEMS

(7) Volcanic
(8) Intrusive
(9) Vein

Meteoric, seawater

(10,12,13,14)

(4) Calcrete U Groundwaters

(1) Shallow U-bearing hematite IOCG

(3) Sandstone U (V, Cu)
Formation waters / connate waters

(2) Unconformity U (PGE, Au)

Diagenetic fluids

(7) Volcanic

HYBRID U SYSTEMS (1,3,9,10,11)

Deep (mgt) IOCG

(5) Metasomatic (9) Vein

‘METAMORPHIC’-RELATED U SYSTEMS

(6)

Volcanic

‘Metamorphic’ fluids (incl. metamorphic rock-buffered)

BASIN- and SURFACE-RELATED U SYSTEMS

 Courtesy Roger Skirrow, GA

("#) represent deposit types from IAEA Red Book & Dahlkamp (1990)

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Primary Industries and Resources SA
URANIUM MINERAL SYSTEMS and FLUIDS

BASIN- and SURFACE-RELATED U SYSTEMS

‘METAMORPHIC’-RELATED U SYSTEMS

HYBRID U SYSTEMS

MAGMATIC-RELATED U SYSTEMS

Metamorphic fluids

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Courtesy Roger Skirrow, GA

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URANIUM MINERAL SYSTEMS and FLUIDS

Courtesey Roger Skirrow, GA

(1) Shallow U-bearing hematite IOCG
(2) Unconformity U (PGE, Au)
(3) Sandstone U (V, Cu)
(4) Calcrete U Groundwaters
(5) Metasomatic
(6) Magmatic-related U systems
(7) Volcanic
(8) Intrusive
(9) Vein
(10,12,13,14) Formation waters / connate waters

Deep (mgt) IOCG

MAGMATIC-RELATED U SYSTEMS

HYBRID U SYSTEMS

‘METAMORPHIC’-RELATED U SYSTEMS

‘Metamorphic’ fluids
(incl. metamorphic rock-buffered)

(1,5,9,10,11)

(7) Volcanic

BASIN- and SURFACE-RELATED U SYSTEMS

Mixing

Mixing

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Cariewerloo Basin Project

‘Potential for Unconformity-related Exploration Targets in the Pandurra Formation’

• Early March 2009 Memorandum of Understanding signed between PIRSA and the Saskatchewan Ministry of Energy and Resources, Canada.

• Resulting in substantial benefits for both – given both jurisdictions long history, experience and knowledge in the uranium mining industry.

• Analogies between Cariewerloo Basin, SA, and Athabasca Basin, Canada.

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Generalized geological elements of simple and complex unconformity-associated uranium deposits in the eastern part of the Paleoproterozoic Athabasca Basin.

- **Simple Type:**
  - lower total REE
  - HREE/LREE > 1
  - basement hosted

- **Complex Type:**
  - high total REE
  - HREE/LREE ~ 1
  - U, Ni, Co, Cu, As
  - sandstone hosted

After Sibbald-Hoeve, Thomas et al., Ruzicka, McGill et al., and EXTECH IV team
Athabasca Basin Modelling

Geophysical Modelling
Athabasca Basin Modelling

Athabasca Basin – 3D modelling work
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Cariewerloo Basin Project

- Existing company data collated in 1990 (Cowley).

- Four stratigraphic members within the Pandurra Formation.

- Verify four member stratigraphy and map across the Cariewerloo Basin.
PACCE2020 Projects

Cariewerloo Basin Project

- Ten parameter logging technique used in Athabasca Basin.
  - HyLogger
  - Niton
  - GR320 Spectrometer
  - Magnetic Susceptibility
PACE2020 Projects
Cariewerloo Basin Project

- Niton XRF Analyser
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Cariewerloo Basin Project

- Cariewerloo Basin – 3D modelling work - base of Pandurra
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Cariewerloo Basin Project

- Cariewerloo Basin – 3D modelling work - Member 1
PACE2020 Projects

Cariewerloo Basin Project

• Cariewerloo Basin – 3D modelling work - Member 2
PACE2020 Projects

Cariewerloo Basin Project

- Cariewerloo Basin – 3D modelling work - Member 3
PACE2020 Projects
Cariewerloo Basin Project

- Cariewerloo Basin – 3D modelling work – Member 4
PACE2020 Projects

Cariewerloo Basin Project

- Cariewerloo Basin – 3D modelling work – Top of Pandurra
PACE2020 Projects

Cariewerloo Basin Project

- Cariewerloo Basin
  3D modelling – HyLogger
PACE2020 Projects
Cariewerloo Basin Project

3D modelling – HyLogger
PACE2020 Projects

Cariewerloo Basin Project

• Cariewerloo Basin AEM Survey
  (collaboration with GA)

AuScope funded the acquisition of PIRSA’s HyLogger™

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Cariewerloo Basin Project

Multi-parameter lithostratigraphic logging

Hyperspectral logging

AEM survey

Magnetic depth to basement

Geophysical Interpretation

Adobe 3D pdf

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Frome AEM Survey

- Collaboration with Geoscience Australia. Funded by GA OESP and PACE. Cost: $2.5M (PACE $0.25M).
- Regional airborne geophysical survey.
- Northern Murray Basin to north of Flinders Ranges.
- 95,000 km² total area, 25,000 line km.
- GA / PIRSA will use the data to produce geological maps, datasets and 3D models that have direct application to exploration in the area.
PACE2020 Projects

Frome AEM Survey

- Flown using the Fugro TEMPEST™ AEM system.
- Contractor supplied AEM data to be released March 31st.
- AEM data available in digital format at SAREIC, May 2011.
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PACE2020 Projects

Factors Affecting Uranium Reduction and Sedimentary Residence

Michaelsen, B. and Fabris, A.

- Uranium reduction and sedimentary residence in the Mesozoic and Tertiary sediments
- Basin-wide approach
  - Eyre Formation
  - Namba Formation
- Lithofacies and relation to organic facies
- Nature and distribution of reductants
- Detrital or mobile reductants
- Poster presentation at SAREIC 2011
Organic facies under the microscope (FOV = 320 µm)

Namba Fm: Organic Facies 1
Excellent U reductant

Namba Fm: Organic Facies 2
Very poor U reductant

Incident light; FOV = 320 µm; white light & UV excitation (fluorescence-mode)
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**CNNC and IAEA Collaboration**

- October 30, 2007 a Memorandum of Understanding (MOU) was signed between the Geological Survey of South Australia (GSSA), PIRSA, and Chinese National Nuclear Corporation (CNNC).

- CNNC are the lead agency in China for all matters in uranium.

- MoU aims to:
  - Promote cooperation in geosciences and mineral exploration particularly for uranium
  - Expert exchange
  - Training and workshop delivery
  - Sharing of technical information
  - Development of geoscientific research for the assistance of mineral explorers

- New links with IAEA-CNCC being developed through Martin Fairclough
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