Overview of the Australian Uranium Industry

A geologist’s perspective
Introduction

• Uncertainty
• As others have discussed there are plenty of reasons to expect an increased demand for U
  – Clean fuel
  – Greenhouse mitigation
  – New reactors permitted and planned
Exploration Activity

**$U_3O_8$ price versus exploration on uranium in the Western World: 1950-2010**

**Exploration Expenditures**
(June 2011 US$m)

- Exploration Spend
- Uranium Price

**Uranium Price**
(June 2011 US$/lb $U_3O_8$)

In recent years there has been a strong correlation between price and spend.

Source: Richard Schodde – MinEx Consulting
From OECD Red Book
### History of Discovery

#### Selected Deposits

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Initial Discovery</th>
<th>t U3O8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rum Jungle</td>
<td>1949</td>
<td>3,520</td>
</tr>
<tr>
<td>Valhalla</td>
<td>1954</td>
<td>24,765</td>
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<td>Mary Kathleen</td>
<td>1954</td>
<td>12,000</td>
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<td>Westmoreland</td>
<td>1956</td>
<td>16,000</td>
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<tr>
<td>Ranger</td>
<td>1969</td>
<td>58,906</td>
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<td>Beverly</td>
<td>1969</td>
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<tr>
<td>Koongarra</td>
<td>1970</td>
<td>14,540</td>
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<tr>
<td>Narbelek</td>
<td>1970</td>
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<td>Jabiluka 1</td>
<td>1971</td>
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<td>Honeymoon</td>
<td>1971</td>
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<tr>
<td>Yeelirrie</td>
<td>1972</td>
<td>57,760</td>
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<td>Wiluna</td>
<td>1972</td>
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<tr>
<td>Angela</td>
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<tr>
<td>Jabiluka 2</td>
<td>1973</td>
<td>163,000</td>
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<tr>
<td>Manyingee</td>
<td>1974</td>
<td>12,000</td>
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<tr>
<td>Ben Lomond</td>
<td>1975</td>
<td>10,600</td>
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<td>Mulga Rock</td>
<td>1979</td>
<td>54,700</td>
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<td>Kintyre</td>
<td>1985</td>
<td>25,274</td>
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<tr>
<td>Four Mile</td>
<td>2005</td>
<td>25,900</td>
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<tr>
<td>Theseus</td>
<td>2009</td>
<td>3,600</td>
</tr>
<tr>
<td>Thunderball</td>
<td>2009</td>
<td>766</td>
</tr>
<tr>
<td>Skevi</td>
<td>2011</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Diagram

- **Cumulative Discovery History for Australia**
  - Long gap between drinks post Kintyre & collapse of U market
  - Excluding OD in 1975
  - Early successes at RumJ & NW Qld
  - Spectacular E. Alligator R successes
Exploration History

1944-to late 50s
“crude but effective”

- Driven by government incentives
- Start of learning curve
- Prospecting phase:
  - scintillometers, radon cups
- But early uranium discoveries relied extensively on airborne radiometric surveys.
- Near surface and outcropping deposits
- Historical mineral fields the focus
Exploration History

Mid-60s to mid-80s “Golden Age”

- Increased expenditure due to the oil shocks of 1973 and 1979
- Many countries introduce nuclear power programmes
- Exploration driven by airborne radiometrics of increasing sophistication and quality
- Increasing understanding of deposit controls yield successes
- Main phase of identifying Australia’s currently known deposits
2005-2012 surge

- Rising uranium prices again lead to surge in uranium exploration activity
- Increased application of AEM, gravity & seismic complementing traditional approaches
- Significant recycling of old prospects
  - Small successes, e.g. Warrior
- Prospecting approach still working
  - Skevi, Thunderball
- Mineral systems approach applied with growing success
  - Especially for palaeo channels, e.g. Four Mile, Samphire; but also Theseus
Australia’s U Endowment

- **SA**
  - Honeymoon
  - **Four mile**
  - Beverley
  - OD

- **WA**
  - Kintyre
  - Yeelirrie
  - Mulga Rocks
  - Wiluna
  - Paleochannels

- **NT**
  - Ranger
  - Jabiluka

16/11/16 www.csaglobal.com
Types of Deposits

Modified from Cuney (2009). in *Uranium Mining in Virginia* 2012
Biggest Producers
So what deposit type is best?

Those that you can make the most money from!

1. Sandstone hosted
2. Unconf. Assoc.
3. Calcrete
What’s missing in Australia?

• Compared to similar geological environments globally, giant deposits of several different types appear to be under-represented in Australia
  – sandstone-hosted (similar to those in Kazakhstan)
  – magmatic-related (similar to the Rössing deposit, Namibia)
  – volcanic-hosted (like those at Streltsovka, Siberia)

• Sandstone-hosted deposits are a very significant producers of uranium & the ingredients for them are present in Australia

• Rossing & Streltsovka are probably unique (like Olympic Dam)
Kazakh-style deposits

- Sandstone hosted
- Redox-controlled
- Classic roll-fronts

- Very large deposits ➔ 12,000-64,000t U
- Mostly exploited by ISR
- Nearly 40% of world U production

- Setting is found globally
- Missing giants in AUS
How to find them?

• Do things differently and with more smarts e.g.

  ➢ Minerals Systems approach

  ➢ New exploration tools
Sandstone U Mineral systems

- Lakewater
- Bittern brine
- Basinal brine
- Meteoric/ground water
- Metamorphic fluid
- Oil / gas

'Sandstone' U styles:
- tabular
- rollfront
- paleochannel

'Unconformity-related' U style (basement hosted)

'Westmoreland' style U

weathered granite
high-U granitic basement
proximal fans
Area Selection

Use the new tools we are developing:

• More, cheaper, seismic - both active and passive
• Gravity and Passive EM systems
• Regional AEM
• Revisit gas geochemistry
• Improved inversion & modelling software
• Co-inversion and integrated interpretation
Tools for Exploration

Sharpen the focus

- CT rigs - more metres for less cost = more data (DET-CRC)
- Give access for logging tools
- Hydrogeochemistry, incl Rn
- Multielement geochemistry and spectral mineralogy (Lab-at-rig)
- 3D modelling for integrated interp

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Where to go...

Kazakh style systems
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- Project reviews, program design & management.
- Operational audits and improvement strategies.
- Code compliant reports e.g. JORC, NI 43-101, etc.
- Concept to feasibility studies.
- Gap analysis, fatal flaw studies & due diligence.
- Expert reports, valuations & specialist advice.
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2009: Additional Australian branch office opened in Darwin, Northern Territory.
2010: Indonesian office opened, new headquarters in West Perth, Western Australia.
2011: Third Australia branch office opened in Brisbane, Queensland.
2013: Established CSA Global Rus in Moscow to service the CIS region.
2014: CSA Global Singapore office established.