

Where are the Uranium resources?

Harikrishnan Tulsidas



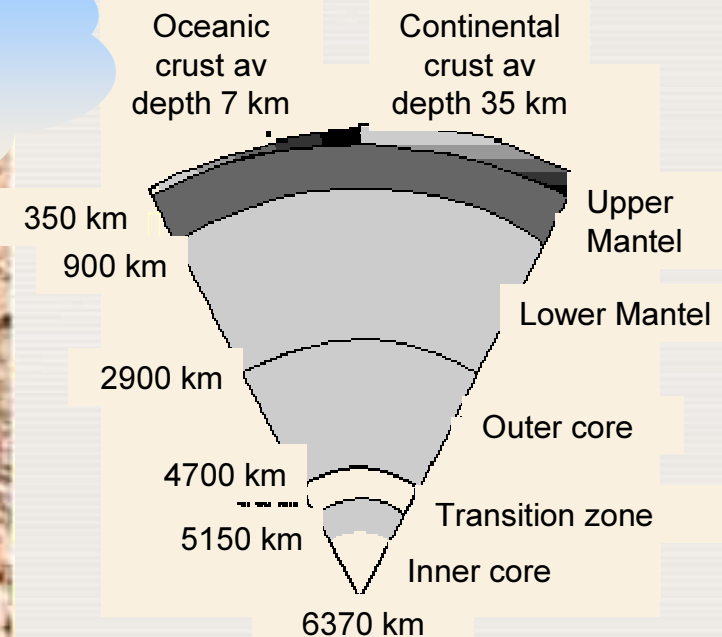
Uranium in earth

Meteorites -	0.008 ppm U
Primitive mantel –	0.021 ppm U
Depleted mantle –	0.004 ppm U
Continental crust -	2.8 ppm U
Granite -	4-5 ppm U
Sedimentary rocks-	2 ppm U
Seawater-	0.003 ppm U

Uranium was produced in one or more supernovae

Very high-grade ore - 20% U
High-grade ore - 2% U,
Low-grade ore - 0.1% U,
Very low-grade ore - 0.01% U

In the geological past, local concentrations of uranium have occasionally achieved natural criticality - the Oklo reactors.



Uranium Minerals

Primary (endogene) minerals - uraninite (pitchblende), coffinite, brannerite and davidite - the element in quadrivalent state

Uraninite: UO_2

Pitchblende: UO_2

Coffinite: $\text{U}(\text{SiO}_4)_{1-x}(\text{OH})_{4x}$

In the presence of metal ions such as Na^+ , K^+ , Ca^{+2} , Mg^{+2} , Cu^{+2} , V and Fe^{+2} , hundreds of Secondary uranyl minerals form

Carnotite: $\text{K}_2(\text{UO}_2)_2(\text{VO}_4)_2 \cdot 3\text{H}_2\text{O}$,

Tyuyamunite: $\text{Ca}(\text{UO}_2)_2(\text{VO}_4)_2 \cdot 5-8\text{H}_2\text{O}$

Autunite: $\text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 10-12\text{H}_2\text{O}$

Torbernite: $\text{Cu}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8-12\text{H}_2\text{O}$



Pithchblende



Uraninite

Autunite



Tobernite

Types of Uranium Deposits

In Production

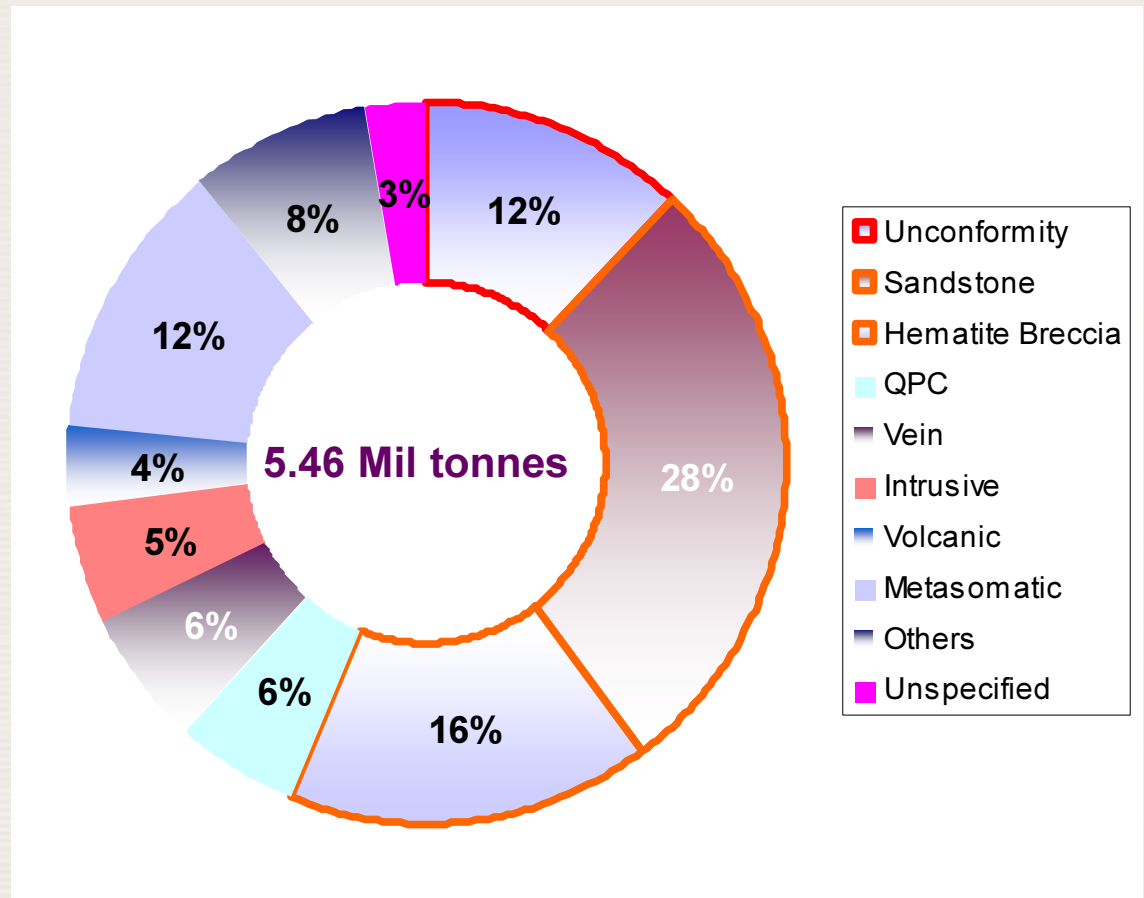
1. Unconformity-contact deposits
2. Sub-unconformity-epimetamorphic
3. Vein type deposits
4. Sandstone deposits
5. Collapse breccia pipe deposits
6. Surficial deposits

Co- or -by product

7. Quartz-pebble conglomerate deposits
8. Hematite Breccia deposits
9. Intrusive deposits
10. Phosphorite deposits

Possible future or past production

11. Volcanic deposits
12. Metasomatite deposits
13. Synmetamorphic deposits
14. Lignite
15. Black shale deposits

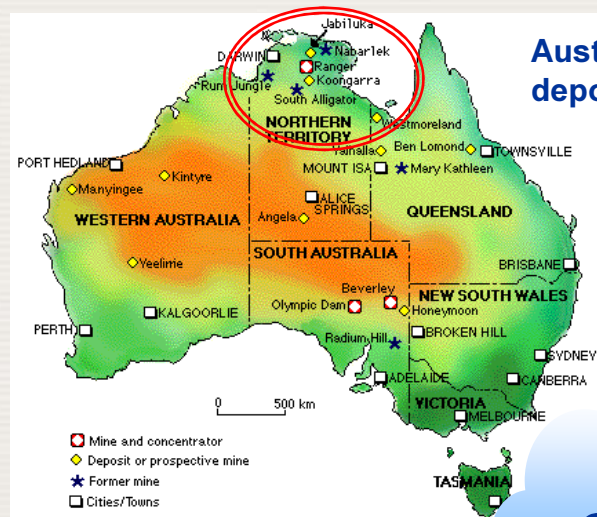
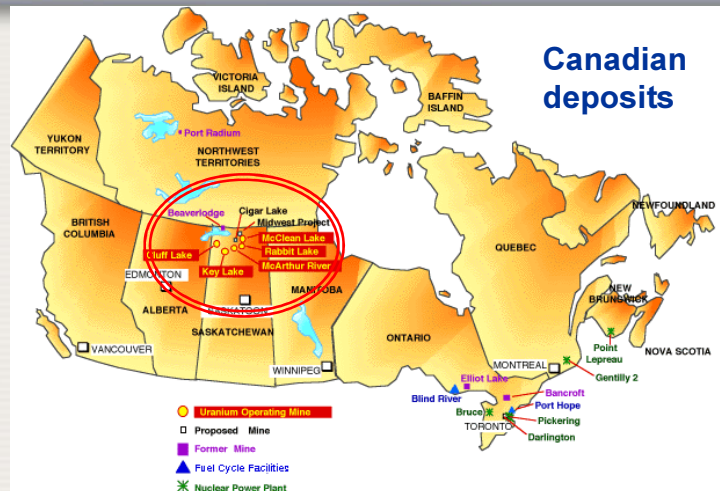


Undiscovered Resources: 7.77 million tU

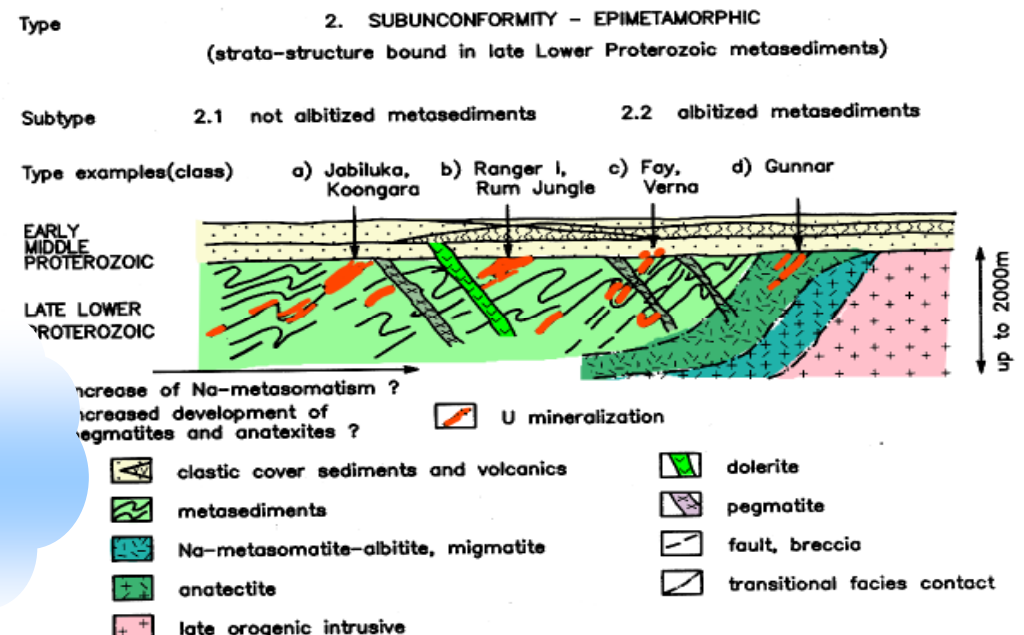
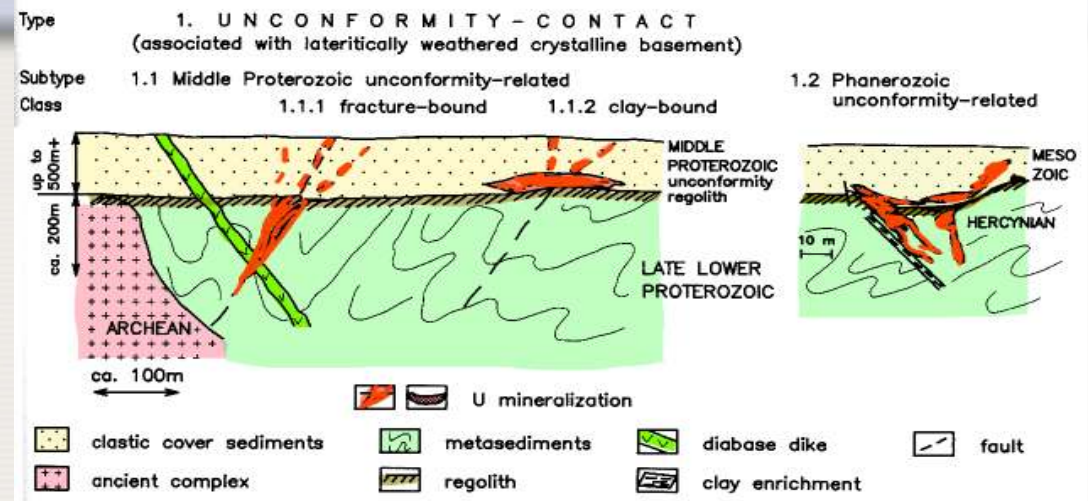
Unconventional Resources: ~7.3 – 22 million tU

Seawater: 4 billion tU

Unconformity type

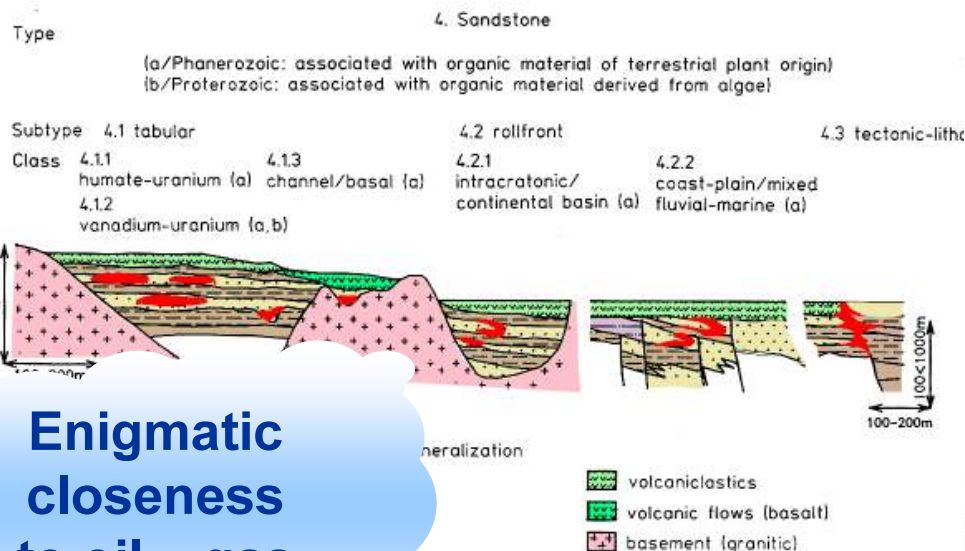


**“Hot”
Granite
Source**

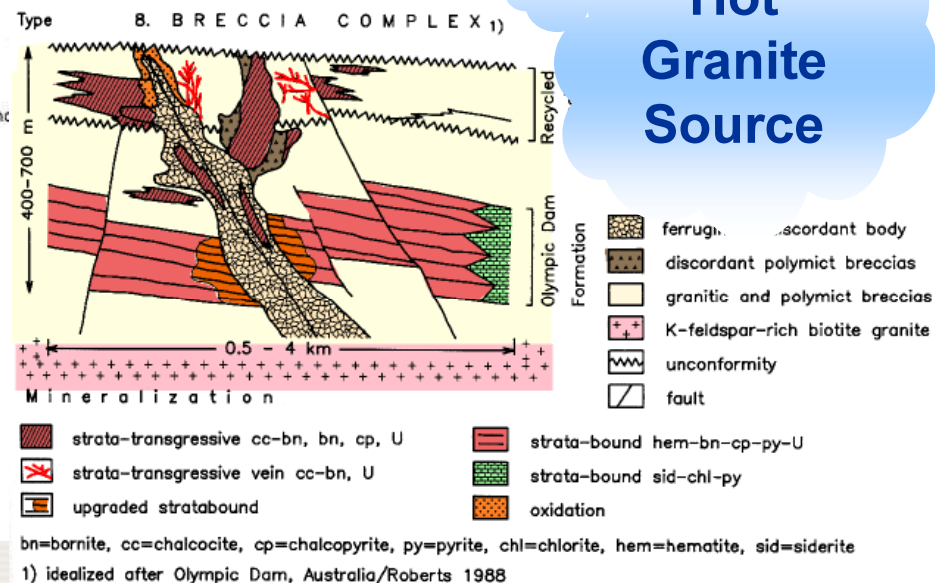


Sandstone & Hematite Breccia type

**“Hot”
Granite
Source**



**Enigmatic
closeness
to oil – gas
fields ?**



Uranium distribution in geological time

Generation 5: (500/400-0 Ma)

– Sst, Surfical, Some
Unconformity related,
Volcanic, Granite-related vein

28%

Generation 4: (700 – 500 Ma)

– Vein, Intrusive

11%

Generation 3: (1500 – 900
Ma) – Unconformity contact,
pegmatite, peralkaline syenite,
H. Breccia

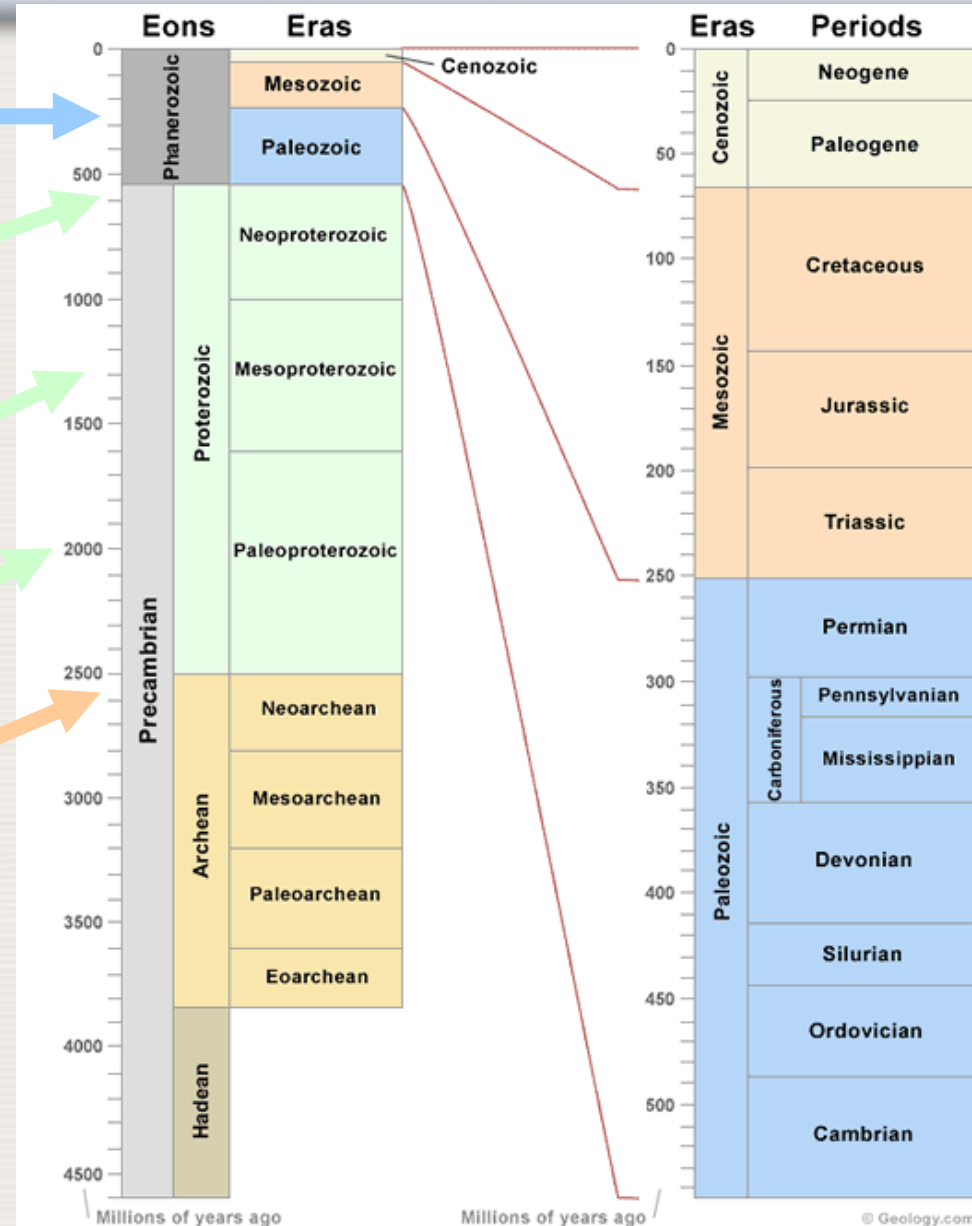
~16%

Generation 2: (2200-1900-
1700 Ma) – SSt type (Oklo),
Synmetamorphic stratiform,
epimetamorphic vein like

~12%

Generation 1: (2800-2200
Ma) – QPC type

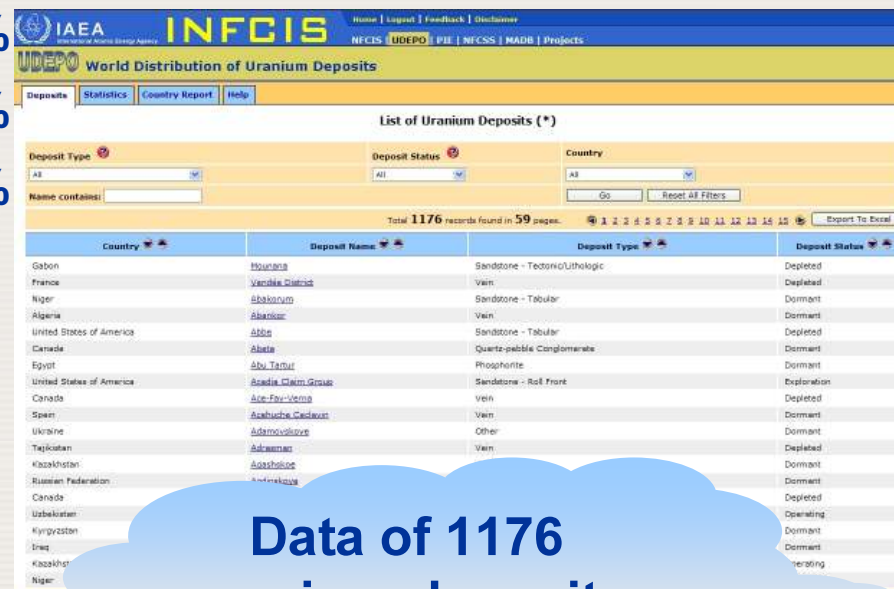
6%



World distribution of uranium resources

	Red Book	tU	
	Australia	1,243,000	22.7%
	Kazakhstan	817,000	14.9%
	Russia	546,000	10.0%
	South Africa	435,000	8.0%
	Canada	423,000	7.7%
	United States	342,000	6.3%
	Brazil	278,000	5.1%
	Namibia	275,000	5.0%
	Niger	274,000	5.0%
	Others	941,000	17%
	Total	5,469,000	100%

INFICIS - UDEPO



INFICIS - UDEPO

World Distribution of Uranium Deposits

Deposits | Statistics | Country Report | Help

List of Uranium Deposits (*)

Deposit Type: All | Deposit Status: All | Country: All

Name contains: [] Go | Reset All Filters

Total 1176 records found in 59 pages.

Country	Deposit Name	Deposit Type	Deposit Status
Gabon	Moukoko	Sandstone - Tectono/Urbologic	Depleted
France	Verdille, Gascogne	Vein	Depleted
Niger	Abakoum	Sandstone - Tabular	Dormant
Algeria	Abakoum	Vein	Dormant
United States of America	Abakoum	Sandstone - Tabular	Depleted
Canada	Abakoum	Quartz-pebble Conglomerate	Dormant
Egypt	Abakoum	Phosphorite	Dormant
United States of America	Abakoum	Sandstone - Roll Front	Exploration
Canada	Abakoum	Vein	Depleted
Spain	Abakoum	Vein	Dormant
Ukraine	Abakoum	Other	Dormant
Tajikistan	Abakoum	Vein	Depleted
Kazakhstan	Abakoum	Dormant	Dormant
Russian Federation	Abakoum	Depleted	Depleted
Canada	Abakoum	Operating	Operating
Uzbekistan	Abakoum	Dormant	Dormant
Kyrgyzstan	Abakoum	Dormant	Dormant
Iraq	Abakoum	Dormant	Dormant
Kazakhstan	Abakoum	Dormant	Dormant
Niger	Abakoum	Dormant	Dormant

Data of 1176
uranium deposits
from 71 countries

Total 19,193,456 tU

Undiscovered Resources: 7,771,100 tU

IAEA /OECD NEA *Uranium 2007: Resources, Production and Demand*

<http://www-nfcis.iaea.org>

Reserves Vs Grade

Original Reserves

Original Grade		< 500	500 - 1,000	1000-10000	10,000 - 100,000	> 100,000	Total
	< 0.03	3	9	65	32	6	115
	0.03 - 0.10	13	26	96	31	6	172
	0.10 - 1.00	33	106	282	89	7	517
	1.00 - 5.00	5	3	13	10	0	31
	> 5.00	0	0	1	0	2	3
	Grand Total	54	144	457	162	21	838

UDEPO Data

Exploration for Uranium

Airborne Surveys



MEGATEM, Dash 7

For exploration programs where a promising mineral showing is discovered, it will take at least 7 to 10 years before the start of a new mine!

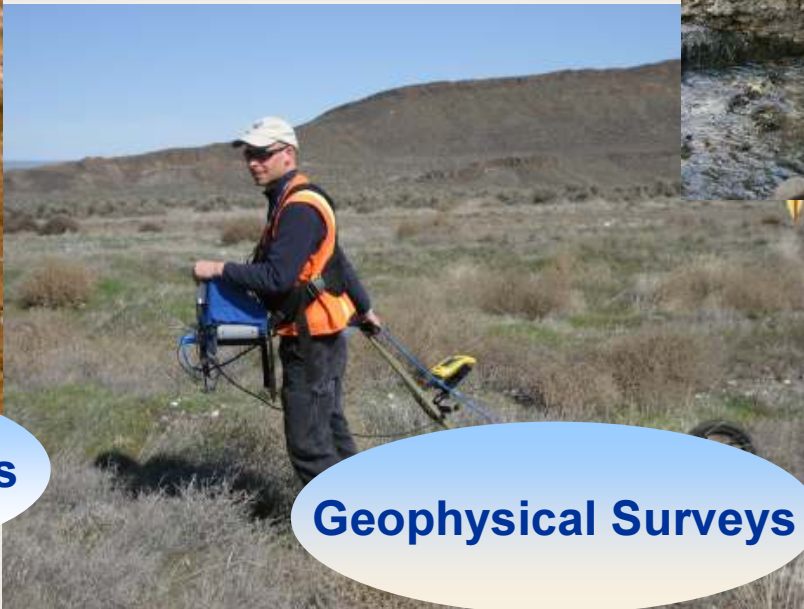
Geochemical Surveys



Foot Surveys



Geophysical Surveys



Drilling



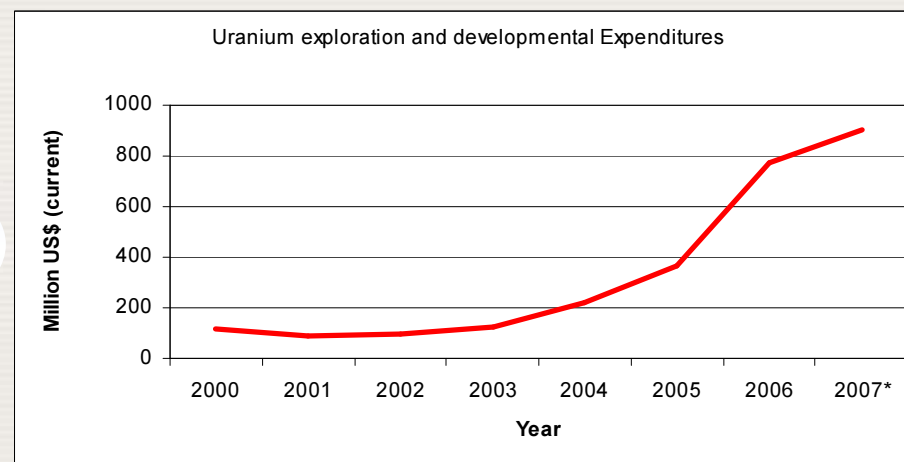
First Mover Vs Elephant Country

**“Greenfield”
exploration**
- looking for a deposit
in an area where
uranium has not been
found before.

**“Brownfield” exploration - search for
additional deposits near a known mine.**



**Fewer than 1 in 10000
mineral showings
discovered actually
become a mine!**



* Expected expenditure

Red Book 2007

Thanks

