



**Uranium Exploration
Australia Limited**

ABN 65 112 714 397

Strategic Exploration Tool

Prompt Fission Neutron

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Presentation Outline

- Natural Uranium and Nuclear Radiation
- Uranium Detection using Gamma Tools
- Disequilibrium
- Prompt Fission Neutron (PFN)
- Historic Use and Commercial Availability
- Applicability to Uranium Exploration
- Summary



Natural Uranium

- Natural uranium (U^{nat}) consists of a mixture of uranium isotopes
 - 99.283% U^{238}
 - 0.711% U^{235}
 - 0.006% U^{234}
- All three isotopes are naturally radioactive



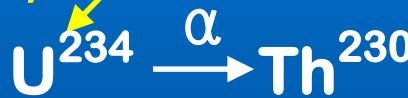
Natural Nuclear Radiation

Three main types

- Alpha radiation
- Beta radiation
- Gamma radiation



U²³⁸ Decay Series



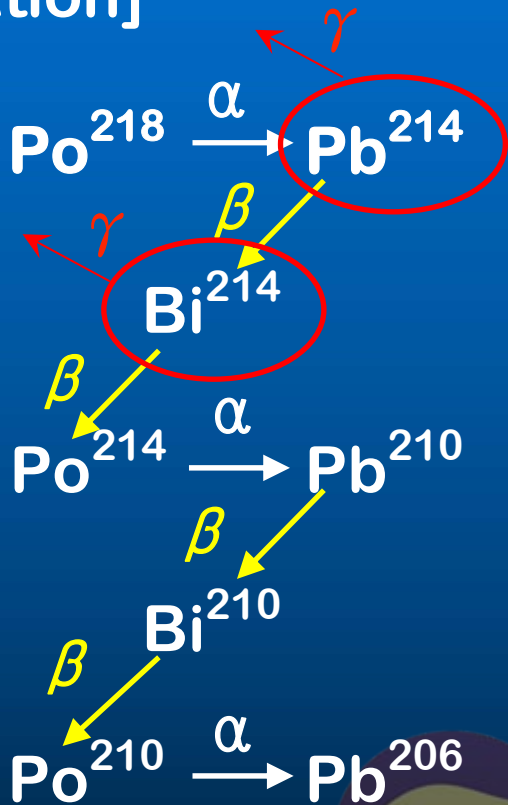
Gamma can be used to calculate uranium concentration as eU3O8
 [Indirect determination]

Valid only if daughters in equilibrium with parent!

α = alpha decay radiation

β = beta decay radiation

γ = gamma radiation



Disequilibrium

- In certain sedimentary uranium deposits, recent geochemical processes may have separated the uranium and the daughters
- The subsequent uranium deposit will not be in equilibrium with its daughters
- In certain cases, there may be an absence of any significant gamma signature from a uranium bearing section of a deposit



The Trap

- Using gamma alone while exploring for uranium could lead to

failure to identify a uranium intercept

- The cost of '*stepping over*' a uranium deposit might be

A\$LOVE millions

Lost Oppportunity, Very Embarrassing



The Solution

Prompt Fission Neutron (PFN)
technology for green-field
uranium exploration



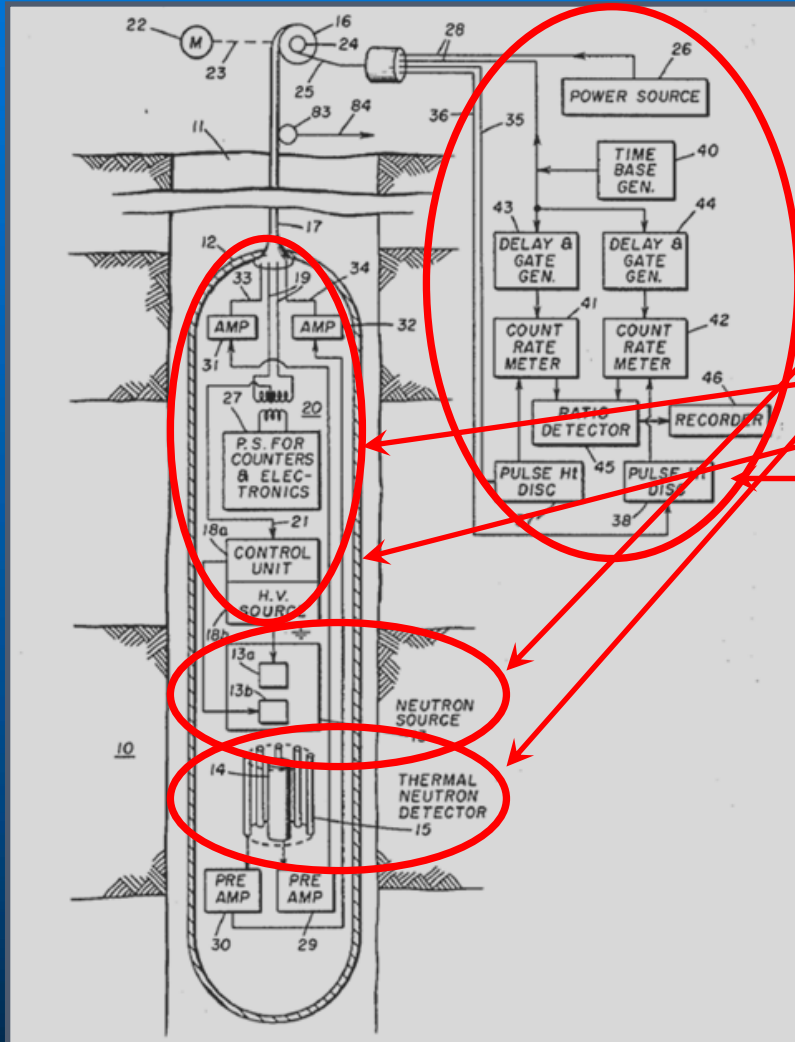
PFN Patent

United States Patent [19]		[11]	4,180,730
Givens et al.		[45]	Dec. 25, 1979
[54]	LOGGING TECHNIQUE FOR ASSAYING FOR URANIUM IN EARTH FORMATIONS	[56]	References Cited
[75]	Inventors: Wyatt W. Givens; William R. Mills, Jr., both of Dallas, Tex.	U.S. PATENT DOCUMENTS	
[73]	Assignee: Mobil Oil Corporation, New York, N.Y.	2,920,204 1/1960	Youmans 250/265
[21]	Appl. No.: 868,948	3,385,969 5/1968	Nelligan 250/265
[22]	Filed: Jan. 12, 1978	<i>Primary Examiner</i> —Alfred E. Smith	
	Related U.S. Application Data	<i>Assistant Examiner</i> —Janice A. Howell	
[63]	Continuation-in-part of Ser. No. 759,929, Jan. 17, 1977, abandoned.	<i>Attorney, Agent, or Firm</i> —C. A. Huggett; W. D. Jackson; W. J. Scherback .	
[51]	Int. Cl. ² G01V 5/00	[57]	ABSTRACT
[52]	U.S. Cl. 250/265; 250/269	A borehole logging tool includes a source of fast neutrons, an epithermal neutron flux detector, and a thermal neutron flux detector. A count rate meter is connected to each detector. A ratio detector provides a signal indicative of the ratio of the count rates of the two detectors obtained during the time that prompt neutrons are emitted from neutron fission of uranium in the formation.	
[58]	Field of Search 250/262, 264, 265, 266, 250/269, 390	13 Claims, 4 Drawing Figures	

- PFN Technology protected for twenty years under US Patent
- Patent expired in 1999



Prompt Fission Neutron



- Major components of a PFN tool include
 - neutron source
 - neutron detectors
 - internal electronics
 - tool casing, and
 - surface electronics
- Commercially available tool is ~75mm diameter by ~3.4 metres long (Geolnstruments Inc.)



Advantages of PFN

- Eliminates the possibility of missing uranium in the borehole, irrespective of disequilibrium
- Provides fool-proof and immediate analysis of uranium within the borehole
 - allows in-field drill program adjustments
- Analyses a larger mass of host rock than core sample or drill cuttings
 - Neutrons penetrate up to 500mm into formation



Advantages of PFN

- Reduces analytical costs by identifying
 - barren core or drill cuttings
 - samples with false gamma signature from U daughters, potassium, or thorium
- Eliminates need for core sample collection in initial exploration stages



Summary

- Traditionally gamma has been used for uranium exploration
- Using gamma alone could lead to missing a uranium intercept and stepping over a uranium deposit
- Unlike gamma tools, PFN
 - measures uranium directly
 - provides fool-proof and immediate analysis of uranium within the borehole





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