

IAEA Support To Member States for Exploration and Discovery of Undiscovered Uranium Resources

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Talking Points



- IAEA Uranium Production Cycle & UPC Team
- Application of UPC Team Outputs
- Assessment of Undiscovered Mineral Resources
- Examples / Case Studies

IAEA Nuclear Fuel Cycle & Materials Section (NFCMS), Uranium Production Cycle (UPC) Team...

- Mission...
 - Collect & share knowledge of uranium resources and support the development of a sustainable uranium production cycle in Member States



https://nucleus.iaea.org/sites/connect/UPCpublic/Pages/default.aspx

IAEA NFCMS UPC Team Outputs (Resources-Related)

- Authoritative, objective, and reliable information
- Databases...
 - UDEPO, ThDEPO, INFCIS, etc.
- Publications & technical meetings...
 - Red Book, technical documents and nuclear energy series, proceedings
- Inputs for assessing / modelling future raw material supply...
 - Resource & statistical data
 - Geology & metallogeny
 - Deposit types, models, and distribution
 - Assessment methodologies



Databases & Data Explorers... Integrated Nuclear Fuel Cycle Information Systems, UDEPO & ThDEPO



Publications... Uranium Deposit Types and Models

Descriptive Uranium Deposit and Mineral System Models





Publications... Resource Assessment & Mineral Potential



Methodologies... Assessing / Modelling Future Raw Material Supply

 UPC Team outputs support Member States to utilize rigorous statistical approaches for evaluation of undiscovered uranium resources and multi-resource integrated assessment applications...



Assessment of Undiscovered Mineral Resources



- Concepts and methods/techniques utilized in early exploration are "predictive"...
 - Optimizes later, boots-on-the-ground, exploration activities
 - Can determine where uranium mineralization is possible and unlikely





Assessment of Undiscovered Mineral Resources... What, Where, How Many, How Much?



Assessment of Undiscovered Mineral Resources...

- Typical data inputs...
 - Exploration history
 - Statistical (grade, tonnage, etc.)
 - Geologic
 - Deposit-scale
 - Regional-scale metallogenic
 - Infrastructure / accessibility
 - Environmental / ecologic
 - Hydrogeologic / water
 - Socioeconomic



Quantitative Mineral Resource Assessment (3-Part)



Mineral Potential Modelling / Prospectivity Mapping



Assessment of Undiscovered Uranium (and other)



Assessment of Undiscovered Uranium (and other)

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Diamond Tract Map and Endowm

Let's Look At Some Examples...



Quantitative & Mineral Prospectivity Assessment for Undiscovered Uranium Resources, Texas, USA



Sources: Mihalasky et al. (2015), Van Gosen and Hall et al. (2017)

Combined Quantitative and Mineral Prospectivity Mapping Resource Assessment



Where... Delineate Permissive Areas



After Singer

Where... 3 Areas Permissive for Sandstone Roll-Front Uranium Mineralization (Permissive Tracts)



Where... Favourable & Prospective Areas

 "Mineral systems" approach to identify what mappable criteria can be used to delineate the favourable and prospective areas within the permissive tracts





Where... Combine Deposit-Indicator Evidence Maps

Evidence Maps

- Geology
- Paleochannels
- Sand thickness

Faults & structures

- · Aero-radiometrics · Oil/gas field locations · And more...

Well-hole stratigraphy



Weights-of-Evidence



Where... Permissive, Favourable, Prospecitive Areas Older... ...Younger Tract 1: Tract 2: Tract 3: ·Claiborne-·Catahoula-· Goliad-Willis-Jackson Oakville Lissie 00 500 Ber In **Tract Classification: Prospective** Permissive

How Many... Estimating What? Define a Deposit?



After Singer

How Many... Estimating What? Define a Deposit?

254 "Occurrences" of Known Roll-Front Uranium Mineralization



- 169 Deposits sites with recorded production or in-place resources
- 74 Prospects sites with some level of exploration
- 6 Showings sites of interest that have been investigated
- 5 Anomalies sites with indications of mineralizing processes

How Many... Expert-Estimated Number of Undiscovered Roll-Front Uranium Deposits



- Experts estimate for 3 levels of "confidence" or "certainty"...
 An analogy:
 - 90%... I'll invest *my money*
 - 50%... I'll invest your money
 - 10%... I'll invest a stranger's money



How Much... Regional Data on Uranium Deposit Grade & Tonnage



How Much... Combine With How Many



How Much... Combine The Number Undiscovered

working prineer	ory Input			
Warking Direct	ory: Select fo	lder	browse	Set working directory
Background Inf	ormation			
Tract ID: Enter	Tract ID here	Run ID	: Enter Run ID her	e
Input Files				
GT Model Inpu	t (GT deposits	>= 20)		
Select a file		browse		
Estimates file f	or NegBinomia	al Type:		
Select a file		browse		
Seed informati	in'			
Create Randor	n Seed Set Sp	ecific Seed		
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Diff medali	a dia			
Colort a model				
Enter N90, N50 If no estimates	N10, N05, & M	N01 percentiles [M and N01: use the l	lark3 Option Only] value from N10	
NA				
Truncate?:				
Select true or f	alse			
Distribution Ty	pe: (Kde should	t be only used if the	he GTM model has	> 50 deposits)
Select a type	•			
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Monte Carlo approach to combine probabilistic estimates of undiscovered mineral deposits with empirical models of grade and tonnage...



Sources: Ellefsen (2017); Jason Shapiro

How Much... Mean Amount of Undiscovered Calcrete and Roll-Front Uranium Resources



Multi-Resource Integrated Assessment (MRIA)



A Framework for Data Integration, Analysis, and Management of Disciplines. A Framework for Data Integration, Analysis, and Management of Disciplines.



Multi-Resource Integrated Assessment (MRIA): Anosy, Southeastern Madagascar



- Mineral & natural resource potential (including uranium resources)
- Areas of elevated mineral potential
- Highlight suitable priority areas based upon mineral, water, environmental, and socioeconomic resource considerations
- Promising growth poles & corridors





MRIA: Anosy, Geospatial Modelling Approach





MRIA: Anosy – Fuzzy Logic Favourability Map for All Mineral Commodities Combined: 3 Priority Areas

Isoanala-Inabanda

Industrial & Colored Stone, Sand & Gravel, Crushed & Dimension Stone (some potential for metallic resources and precious stones)

Mananetina

Bauxite, Ilmenite, Diamond (some potential for building material)

Tranomaro-Maromby

Industrial & Colored Stone, Crushed & Dimension Stone, Sand & Gravel (some potential for metallic resources and precious stones)

		Prospective	Favorable	Permissive
	Brick Clay		0.5	0.1
Construction Material	Sand & Gravel		0.5	0.1
	Crushed Stone	0.8	0.5	0.2
	Dimension Stone	<u>}</u>	0,5	0.1
	ام ما ب را م ما	Prospective	Favorable	Permissive
	inciuaea		0.5	0.1
Industrial and Colored Stone	Graphite	0.7	0.3	0.2
	uranium	0.8	0.5	0.2
	Silica			0.5
	Sillimanite		0.4	0.1
		Prospective	Favorable	Permissive
Coastal	Bauxite	0.8	0.5	0.2
Alteration &	Diamond	0.3	0.2	0.1
Erosion	Ilmenite	1.0	0.4	0.2
		Prospective	Favorable	Permissive
	Pla blocene			0.2
Metallic Continental	Tin Aard Rock	0.4	0.2	0.1
	Tin-Placer			0.1
	U-Th-Ap-Hard Rock	0.6	0.2	0.1
	U-Th-Placer			0.1
				100 A 10
		Prospective	Favorable	Permissive
Colored Stone	Diamond	0.3	0.2	0.1
	CS-Hard Rock	0.8	0.4	0.1
	00 01	0.0	0.4	0.4

MRIA: Anosy – Integrate Mineral Favourability Map with Socioeconomic "Resource" Favourability Maps



MRIA: Anosy – Build Scenarios and Ask Questions for Development and Planning Decision Support





