URANIUM-RARE EARTHS OPENING

IAEA SUPPORT TO MEMBER STATES FOR SUSTAINABILIY OF NUCLEAR FUEL FOR NUCLEAR POWER PLANTS

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ABSTRACT

In January 2023, a total of 422 commercial nuclear reactors were connected to the electrical grid in 32 countries and globally an additional 57 reactors were under construction. Uranium demand is based on both the number of installed nuclear power plants as well as fuel cycle duration, enrichment level, burn-up and advanced fuel technologies.

The IAEA provides support to 175 Member States through a number of programmatic areas. To help ensure sustainability of uranium for the current and future fleet of nuclear power plants, the IAEA currently provides direct support to 52 Member States that are actively involved in development of the uranium production cycle. This includes prospecting, exploration, mine and processing facility development and finally decommissioning and remediation. To enhance support to Member States across all phases of the uranium production cycle, the IAEA published in January 2023 a Nuclear Energy Series Guidance publication titled “Milestones in the Development of National Infrastructure for the Uranium Production Cycle”. This publication can be used by Member States to assess their own status of uranium production development against each of the milestones. This publication also sets the foundation for IAEA integrated uranium production cycle review missions, which upon request from a Member State, will review a Member State’s progress in developing their national uranium production programme. The output of such missions will be a comprehensive final report outlining recommendations, suggestions and identification of areas of good practice. In addition, the results of such a review mission will form the basis for an integrated work plan, which the Member State may use a guidance in their development of national infrastructure for the uranium production cycle.

The OECD-NEA in collaboration with the IAEA is publishing the 2022 edition of “Uranium Resources, Production and Demand”, also commonly known as the “Red Book”. This government-sponsored publication, published biannually since 1965, provides an overview of global trends and developments in uranium resources, production and demand.

This presentation will provide detail on supply and demand forecasts for uranium based on the joint OECD-NEA/IAEA Uranium Resources, Production and Demand (Red Book) 2022 publication as well as provide a more detailed overview of IAEA global support to ensure a sustainable supply of uranium for nuclear power that meets social, environmental and economic requirements.

Keywords: Uranium, Mining, Supply, Demand, Sustainability, Nuclear Fuel, Nuclear Power

Talking Points…

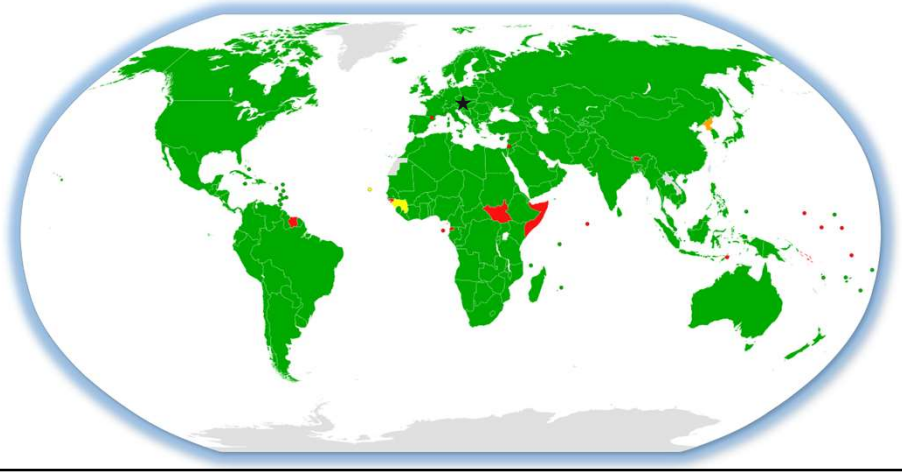
- International Atomic Energy Agency (IAEA)
- IAEA Nuclear Fuel Cycle & Materials Section (NFCMS), Uranium Production Cycle (UPC) Team
- NFCMS UPC Team support to Member States
- NFCMS UPC Team outputs
- Joint OECD-NEA / IAEA Uranium Group
- The “Red Book”… World uranium exploration, resources, and production

International Atomic Energy Agency (IAEA)

- 1953 – Eisenhower’s “Atoms for Peace” speech, UN General Assembly
- 1957 – Established as autonomous agency
  - Although established independent of UN, reports to UN General Assembly and Security Council
- Promotes the peaceful use of nuclear technology and nuclear power worldwide
- Intergovernmental forum for scientific and technical cooperation

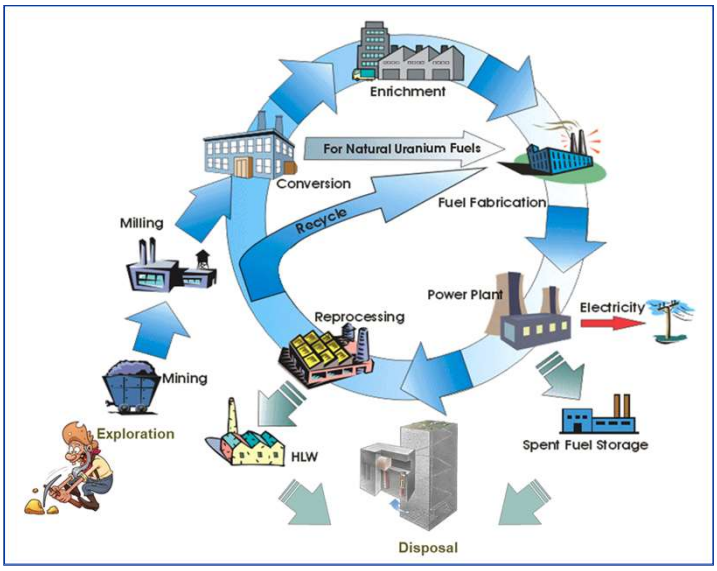
IAEA Member States… 176 As of 3 January 2023

- IAEA provides direct support to 52 Member States actively involved in the development of the uranium production cycle…

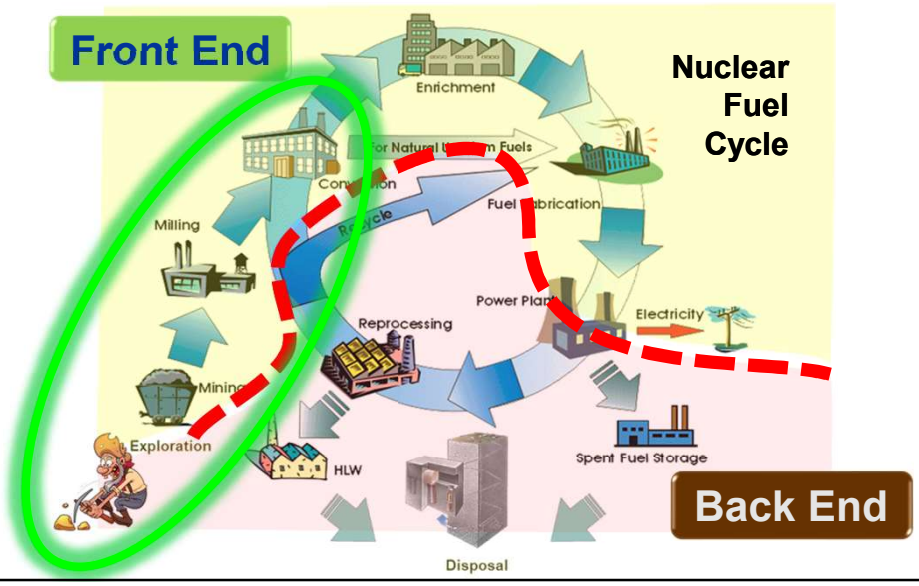


IAEA Provides Support for the Nuclear Fuel Cycle

- Prospecting and exploration
- Mine and processing facility development
- Decommissioning and remediation
- Fuel enrichment and fabrication
- Nuclear power plants
- Spent fuel management



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



IAEA NFCMS UPC Team… International Technical Cooperation Projects Support

- Technical training
- Workshops
- Expert missions
- IUPCR missions
- Fellowships
- Scientific visits
- Procurements

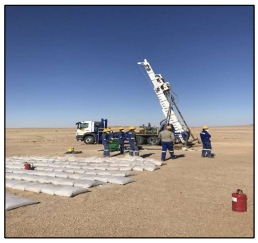
During 2016-2023, the UPC Team provided technical advice and support to 27 Inter-Regional, Regional, and National projects

Some 40-60 international experts provided training for 400-600 participants during 2018-2023…

Over 450 lectures on specific topics; Q & A sessions, discussions

IAEA NFCMS UPC Team… Development of National Infrastructure for the UPC

Development of national infrastructure to support and regulate the uranium production cycle is a significant and complex task



Uranium Exploration

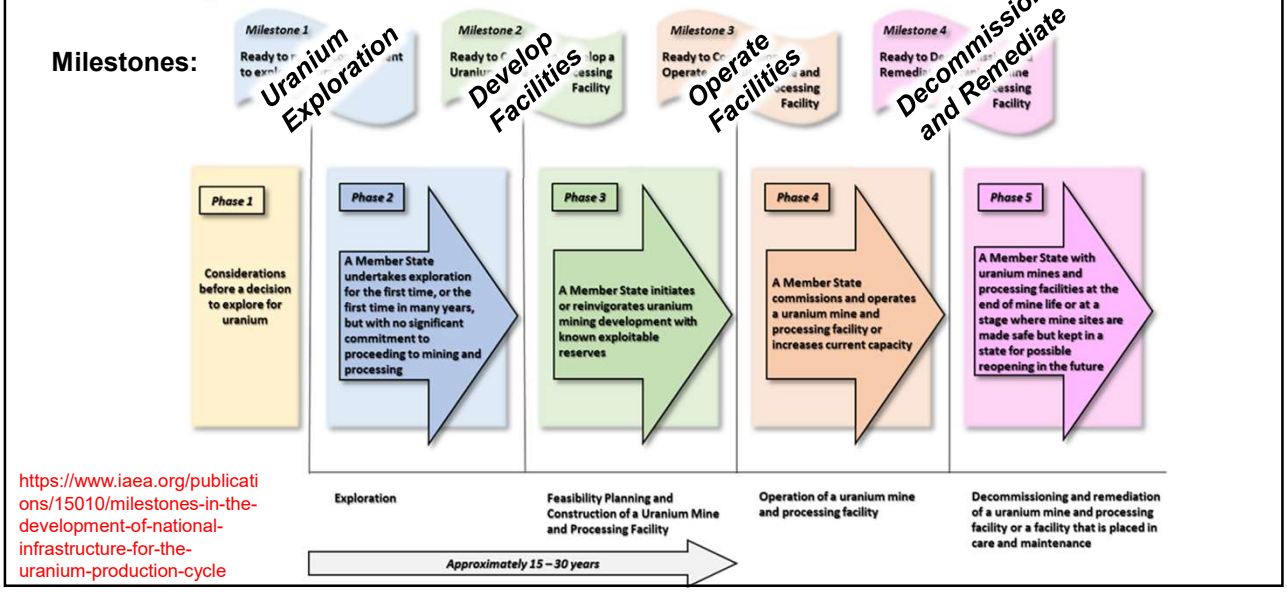
Uranium Mine and Processing Facility Construction

Uranium Mine and Processing Facility Operation

Uranium Mine and Processing Facility Decommissioning and Remediation

The IAEA has developed a Milestones approach to support Member States in developing national infrastructure in a systematic and manageable way

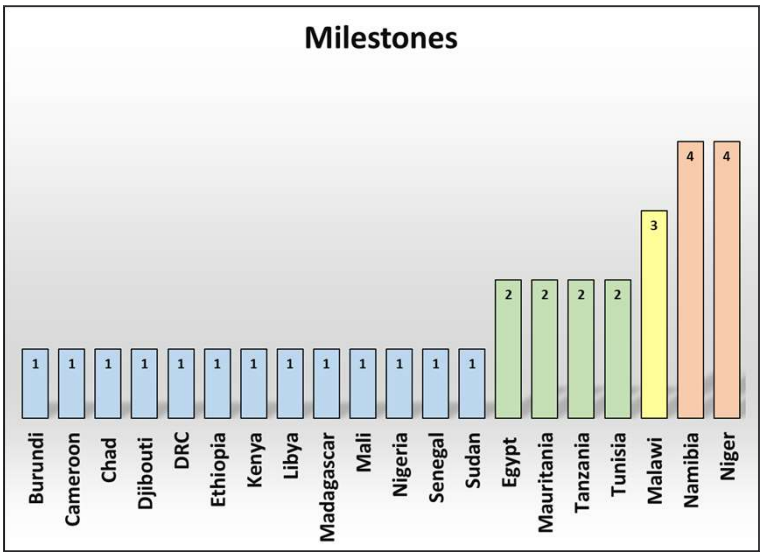
IAEA NFCMS UPC Team… Milestones Approach to Development of National Infrastructure for UPC

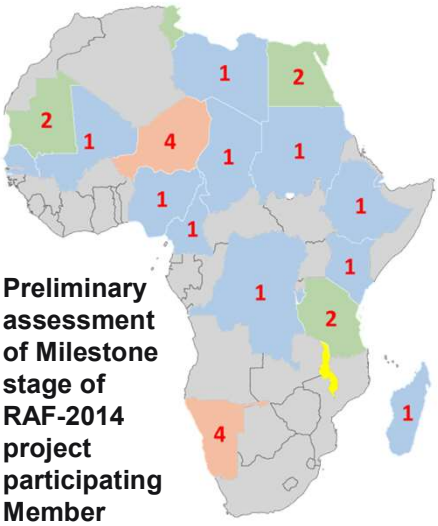


https://www.iaea.org/publications/15010/milestones-in-the-development-of-national-infrastructure-for-the-uranium-production-cycle

IAEA NFCMS UPC Team… Milestones Application

Regional Africa IAEA Technical Cooperation Project…





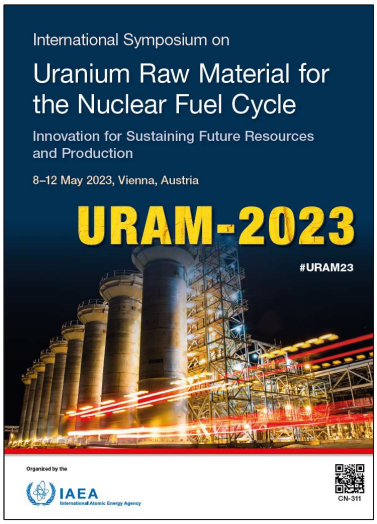
Preliminary assessment of Milestone stage of RAF-2014 project participating Member States…

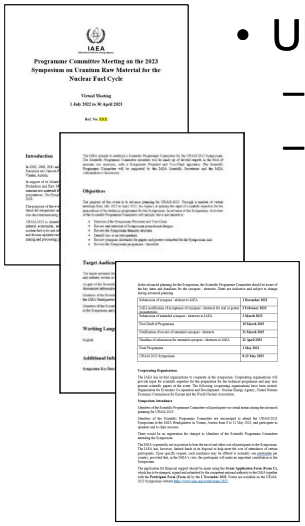
IAEA NFCMS UPC Team Outputs (Resources-Related)

- Authoritative, objective, and reliable information to support member states with characterization and evaluation of uranium resources…
  - Statistical databases
  - Geology
  - Deposit types
  - Deposit distribution
  - Undiscovered resource assessment and mineral potential
  - Best practices guides

https://nucleus.iaea.org/sites/connect/UPCpublic/SitePages/Home.aspx

Meetings… Uranium Raw Material for the Nuclear Fuel Cycle

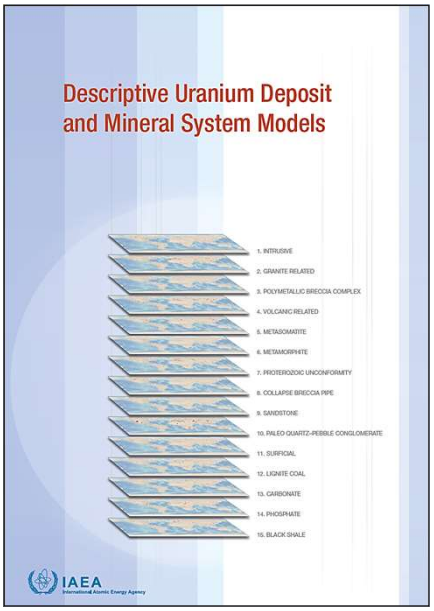


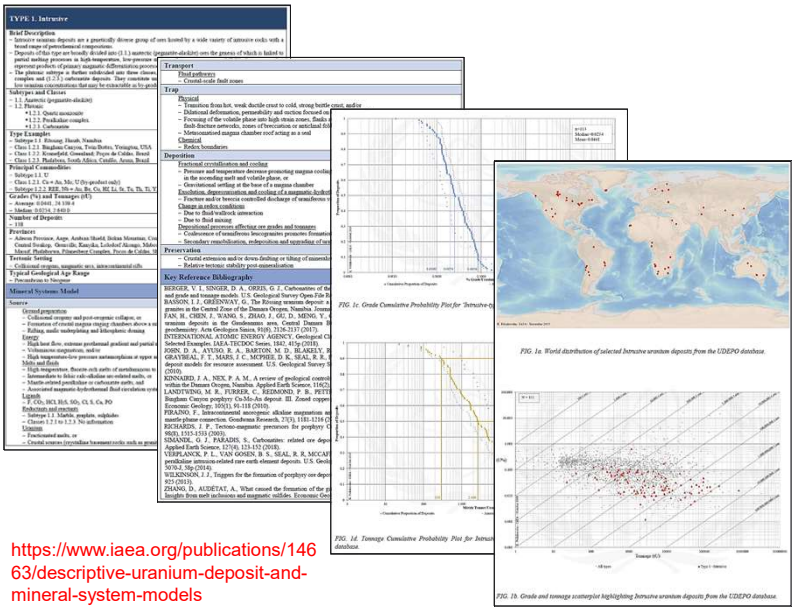


- URAM Series…
  - 2000, 2005, 2009, 2014, 2018
  - Sessions on…
    - Nuclear power and modern energy markets
    - Uranium markets
    - Uranium geology and resources
    - Advances in exploration
    - Uranium deposit evaluation
    - ISL and other U mining & processing
    - Unconventional U resources, Th
    - Health, safety and environment
    - Tailings and waste management

https://www.iaea.org/events/uram-2023

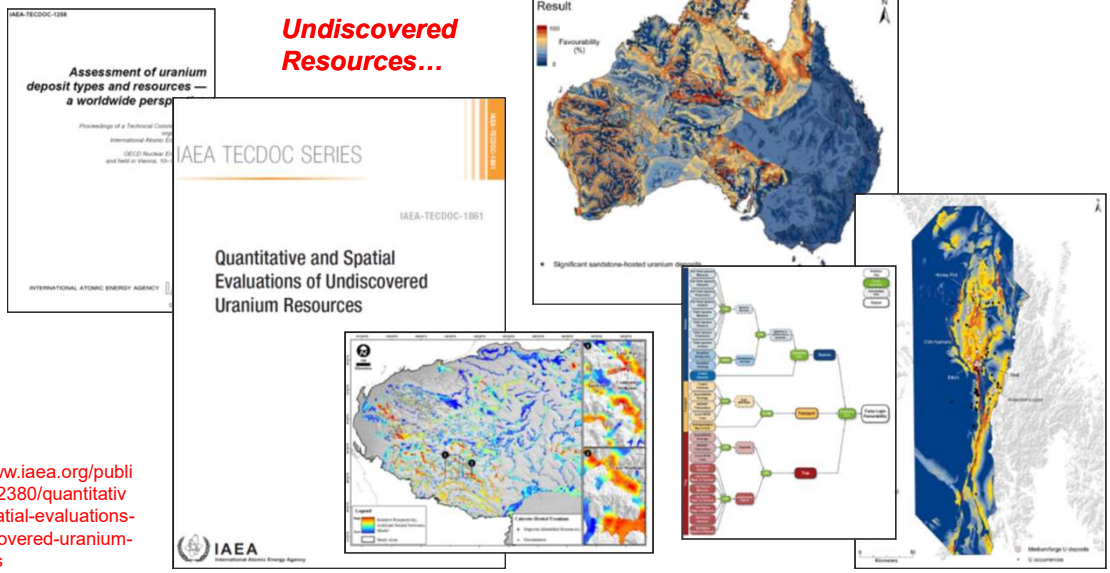
Publications… Uranium Deposit Types and Models





https://www.iaea.org/publications/14663/descriptive-uranium-deposit-and-mineral-system-models

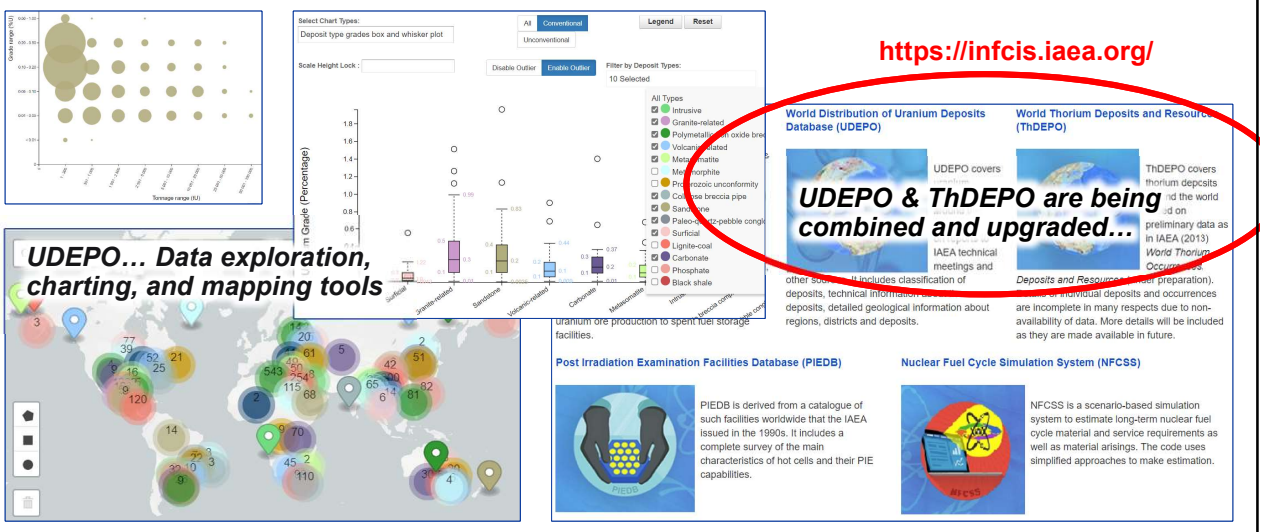
Publications… Resource Assessment & Mineral Potential



Undiscovered Resources…

https://www.iaea.org/publications/12380/quantitative-and-spatial-evaluations-of-undiscovered-uranium-resources

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



UDEPO… Data exploration, charting, and mapping tools

https://infcis.iaea.org/

UDEPO & ThDEPO are being combined and upgraded…

World Distribution of Uranium Deposits Database (UDEPO)

UDEPO covers … IAEA technical meetings and other sources. It includes classification of deposits, technical information about deposits, detailed geological information about regions, districts and deposits.

World Thorium Deposits and Resources (ThDEPO)

ThDEPO covers thorium depcsits … d on preliminary data as in IAEA (2013) *World Thorium Occurrences, Deposits and Resources* … fuel preparation). … individual deposits and occurrences are incomplete in many respects due to non-availability of data. More details will be included as they are made available in future.

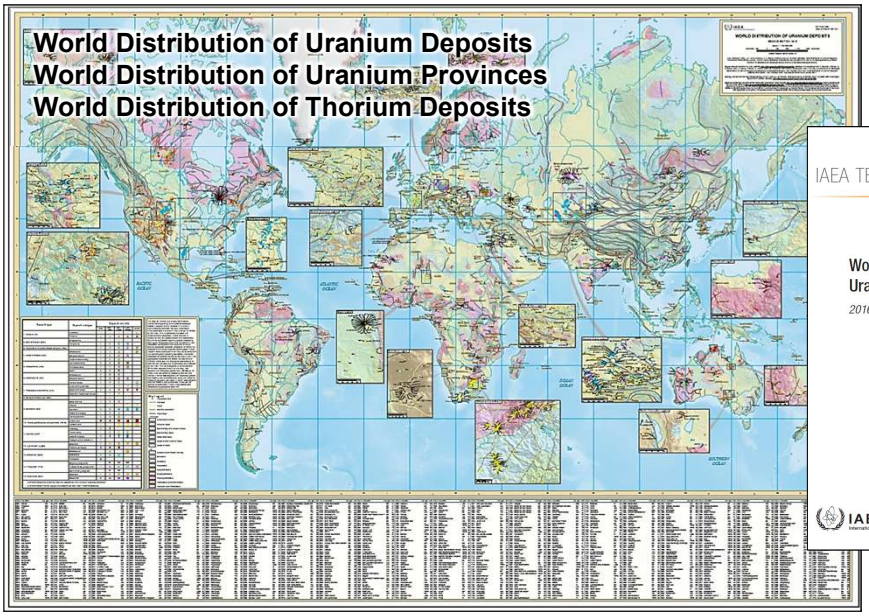
Post Irradiation Examination Facilities Database (PIEDB)

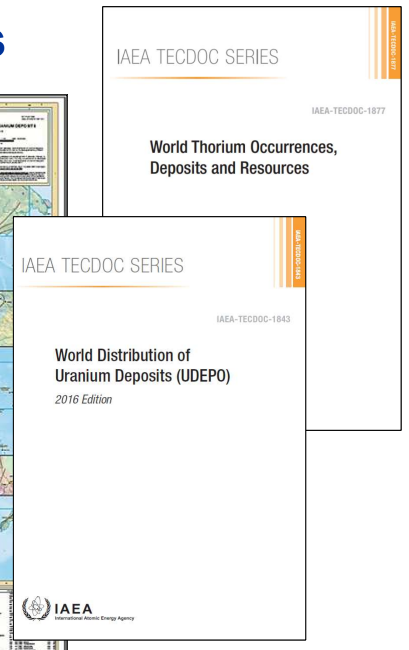
PIEDB is derived from a catalogue of such facilities worldwide that the IAEA issued in the 1990s. It includes a complete survey of the main characteristics of hot cells and their PIE capabilities.

Nuclear Fuel Cycle Simulation System (NFCSS)

NFCSS is a scenario-based simulation system to estimate long-term nuclear fuel cycle material and service requirements as well as material arisings. The code uses simplified approaches to make estimation.

Databases… Interactive PDF Maps





https://www.iaea.org/publications/12314/world-distribution-of-uranium-deposits

Joint OECD-NEA / IAEA Uranium Group

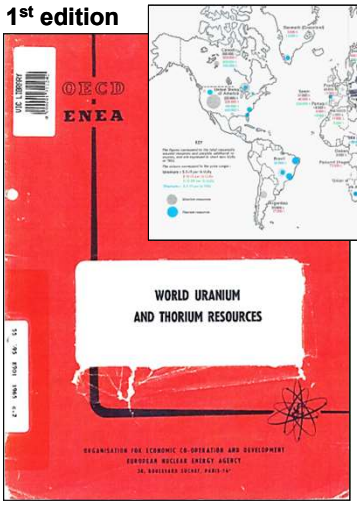
- Collaborative effort between the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD) and the International Atomic Energy Agency (IAEA)…
  - Forum for the exchange of information, analysis, and guidance on the uranium market and its role and relationship with respect to the global nuclear fuel cycle
  - Platform for dialogue and cooperation among governments, industry, and other stakeholders on issues related to the uranium market and the nuclear fuel cycle
  - Activities are based on the principles of transparency, objectivity, and impartiality

https://www.oecd-nea.org/jcms/pl_28567/the-joint-nea/iaea-group-on-uranium-ug

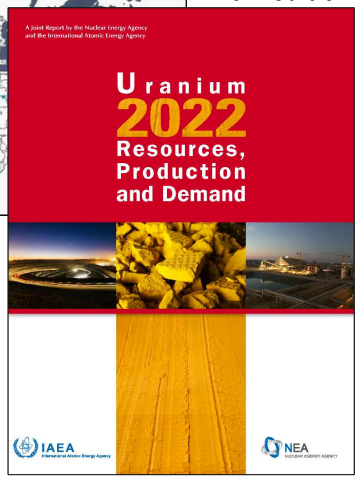
Joint OECD-NEA / IAEA Uranium Group… Red Book

- Responsible for preparation and publication of the "**Red Book**"
- Tracks world and country trends and developments in uranium resources, production & demand…
  - Derived from government information officially reported to the IAEA
  - Aims to obtain a uniform, worldwide acceptable classification of uranium resources

1st edition



29th edition

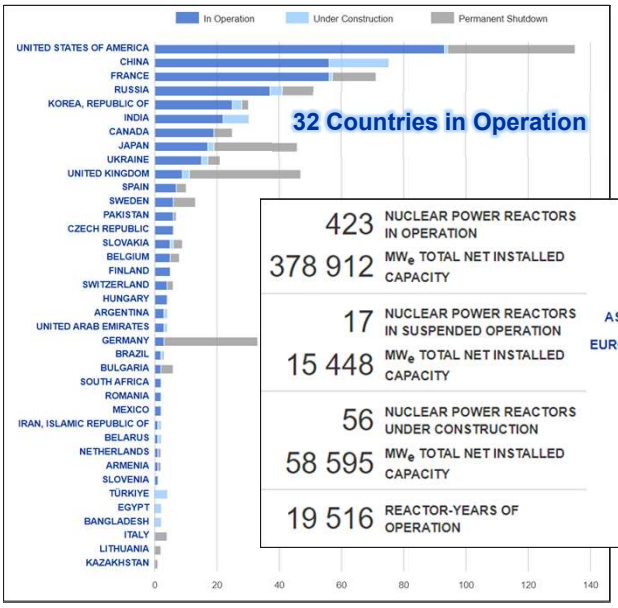


1965
OECD / ENEA

2023
OECD-NEA / IAEA

https://www.oecd-nea.org/jcms/pl_79960/uranium-2022-resources-production-and-demand

Red Book… Uranium Demand, Commercial NPPs…

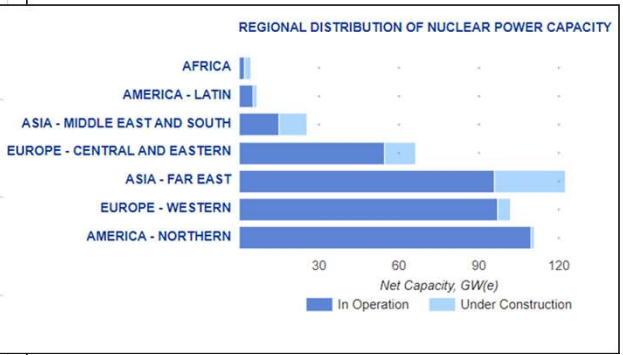


32 Countries in Operation

As of April 2023…

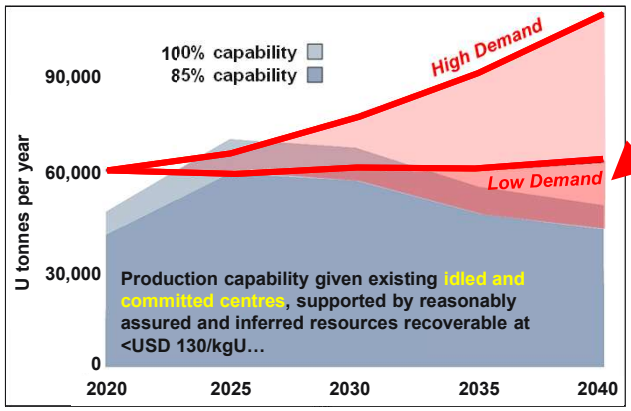
IAEA | PRIS Power Reactor Information System

423	NUCLEAR POWER REACTORS IN OPERATION
378 912	MW_e TOTAL NET INSTALLED CAPACITY
17	NUCLEAR POWER REACTORS IN SUSPENDED OPERATION
15 448	MW_e TOTAL NET INSTALLED CAPACITY
56	NUCLEAR POWER REACTORS UNDER CONSTRUCTION
58 595	MW_e TOTAL NET INSTALLED CAPACITY
19 516	REACTOR-YEARS OF OPERATION

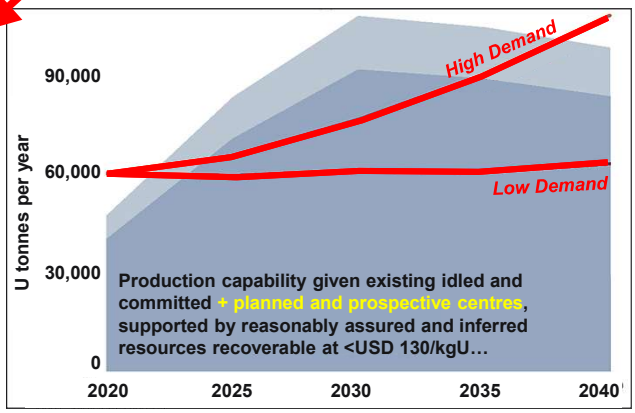


https://pris.iaea.org/pris/

Red Book… Uranium Production and Demand, Projection to 2040 (based on 2019 & 2020 data)



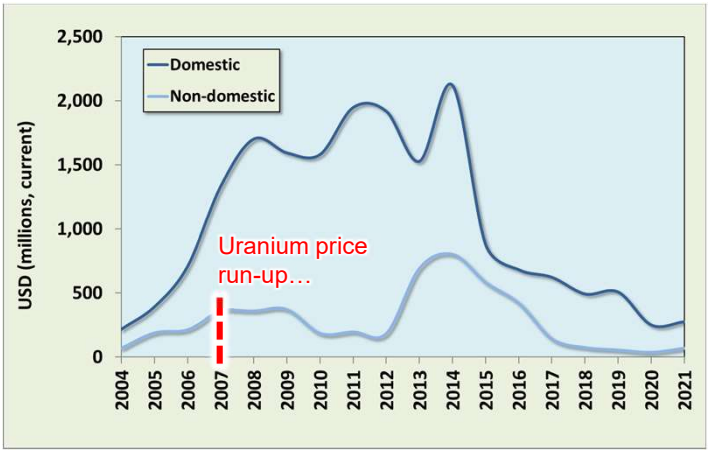
Gap between high demand and 85% capability production…



- Actual uranium production seldom, if ever, matches full production capability
- It is assumed that secondary supply will fill the gaps when requirements are greater than production

Red Book… Exploration & Mine Development Expenditures (2019 & 2020)

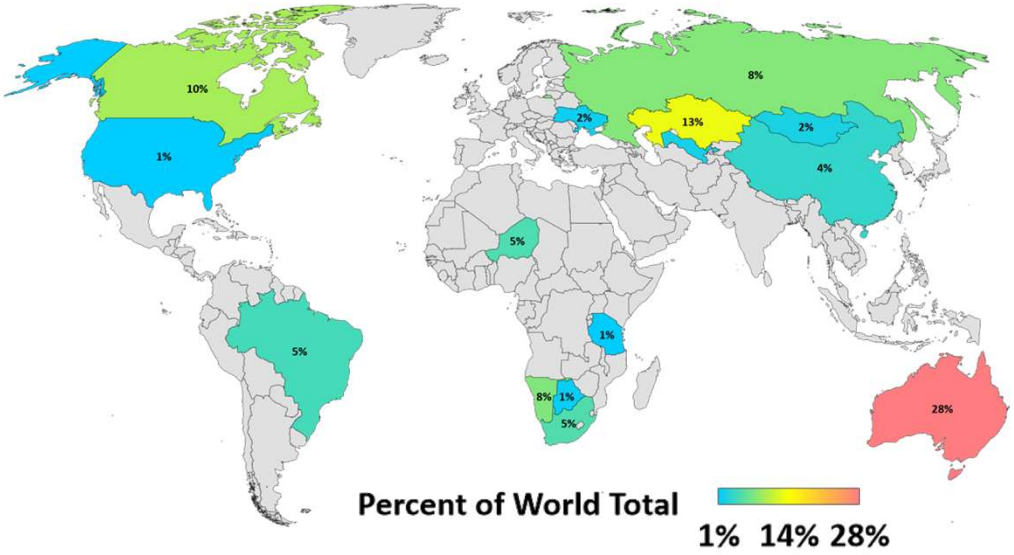
- Decreased to ~USD 250M in 2020 from ~USD 500M in 2018, and ~*USD 2B* in 2014
- Preliminary 2021 expenditures show small increase to ~USD 280M



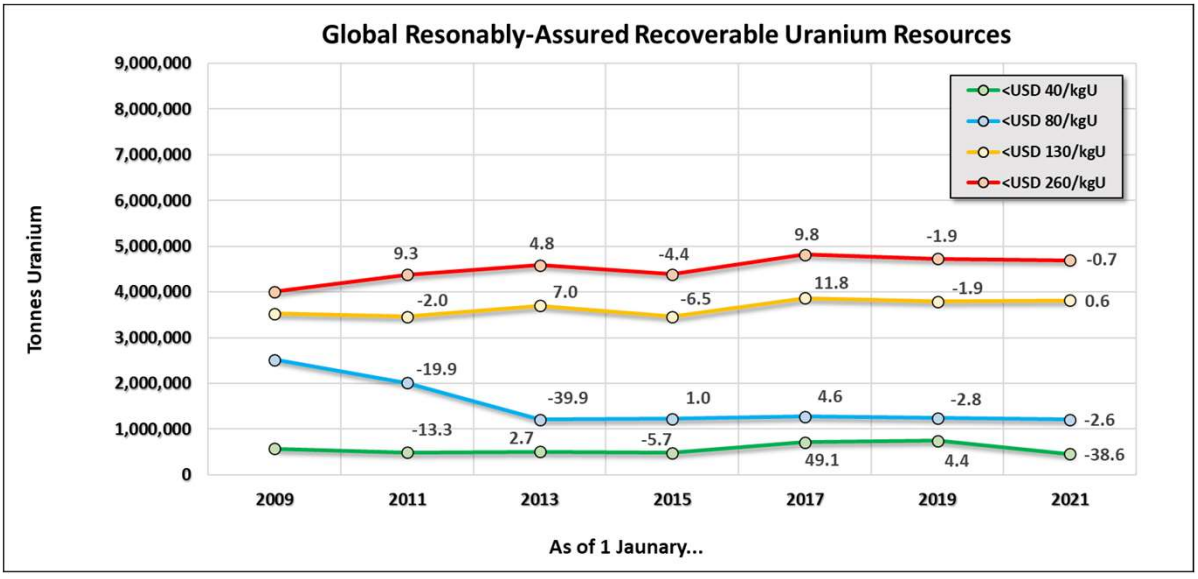
- Total expenditures continue to decrease in response to a depressed uranium market that has lasted since mid-2011

Red Book… Identified Recoverable Resources Distribution at <USD 130/kgU (2019 & 2020)

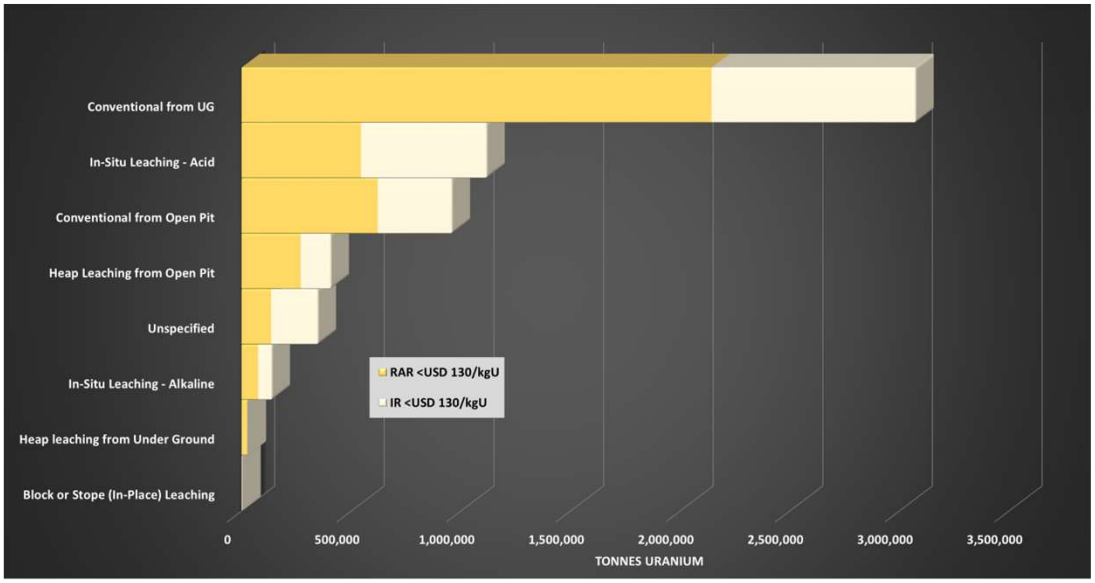
Australia	28%
Kazakhstan	13%
Canada	10%
Russia	8%
Namibia	8%
South Africa	5%
Niger	5%
Brazil	5%
China	4%
Mongolia	2%
Uzbekistan	2%
Ukraine	2%
Botswana	1%
United States	1%
Tanzania	1%



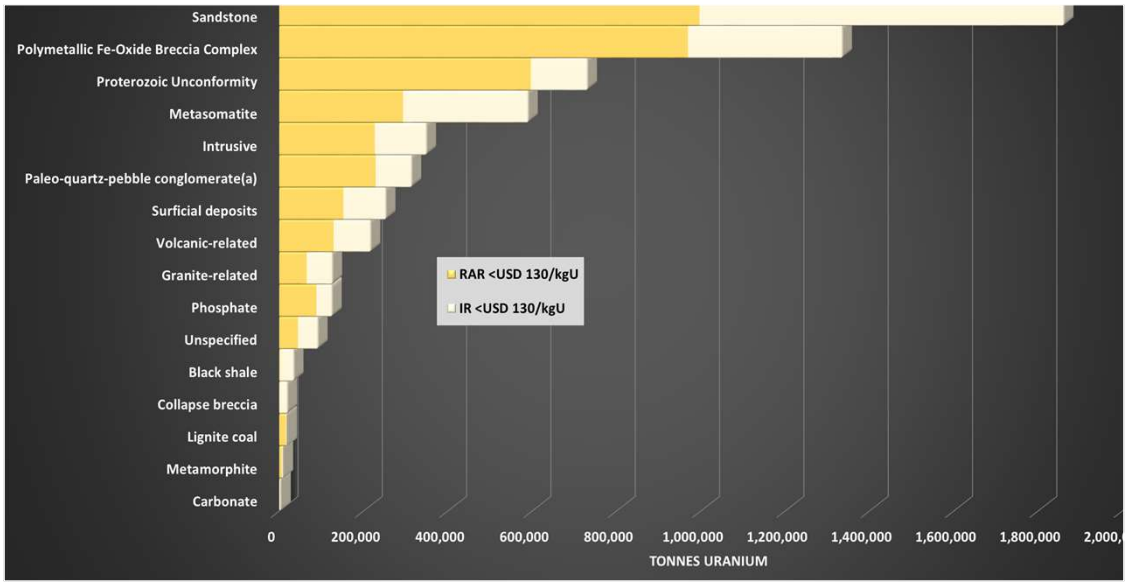
Red Book… Changes in Global Uranium Reasonably Assured Recoverable Resources



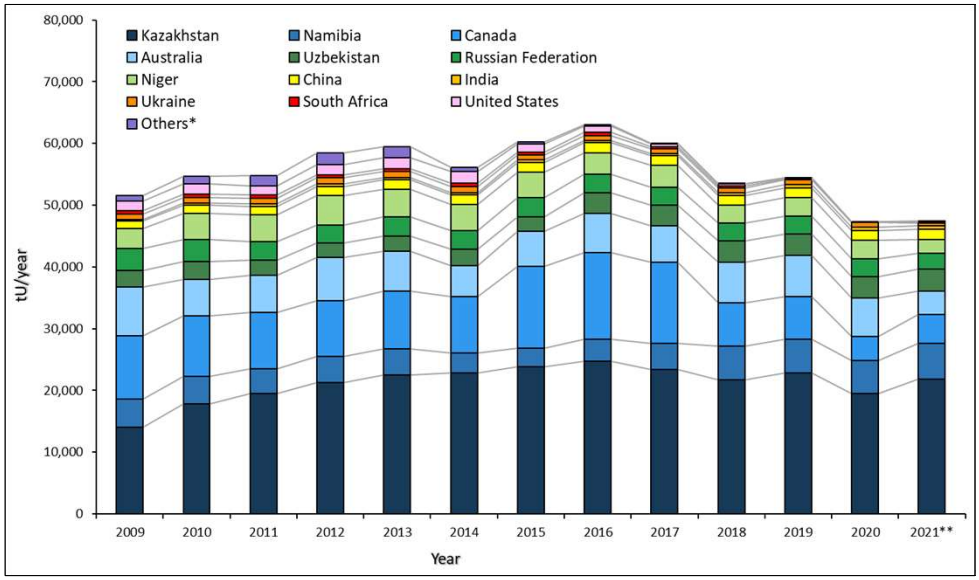
Red Book… Identified Recoverable Resources, by Processing Method, at <USD 130/kgU (2019 & 2020)



Red Book… Identified Recoverable Resources by Deposit Type, at <USD 130/kgU (2019 & 2020)

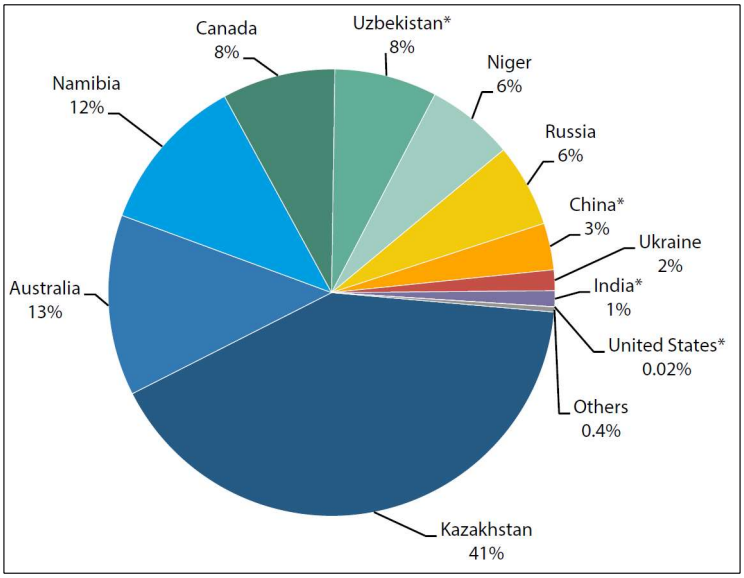


Red Book… World Total Recent Uranium Production 2009-2021 (~0.72M tU)

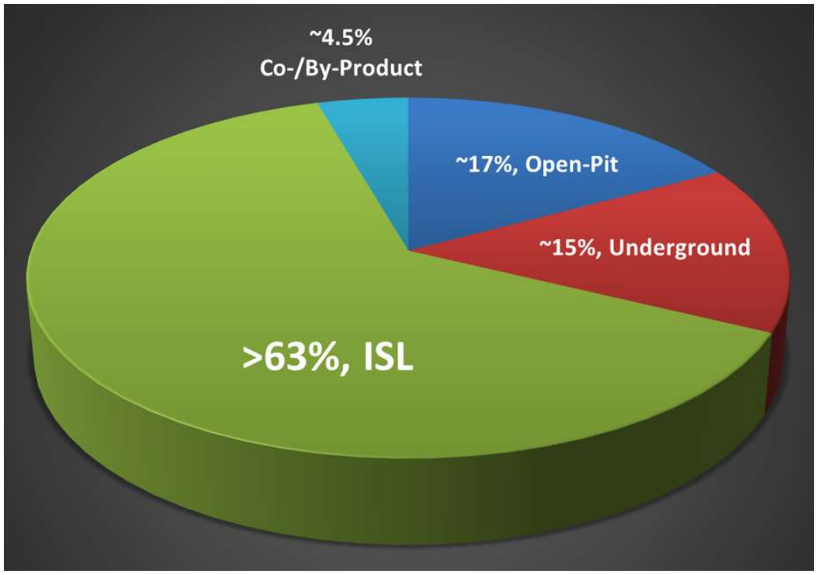


Red Book… World Uranium Production (~47,300 tU)

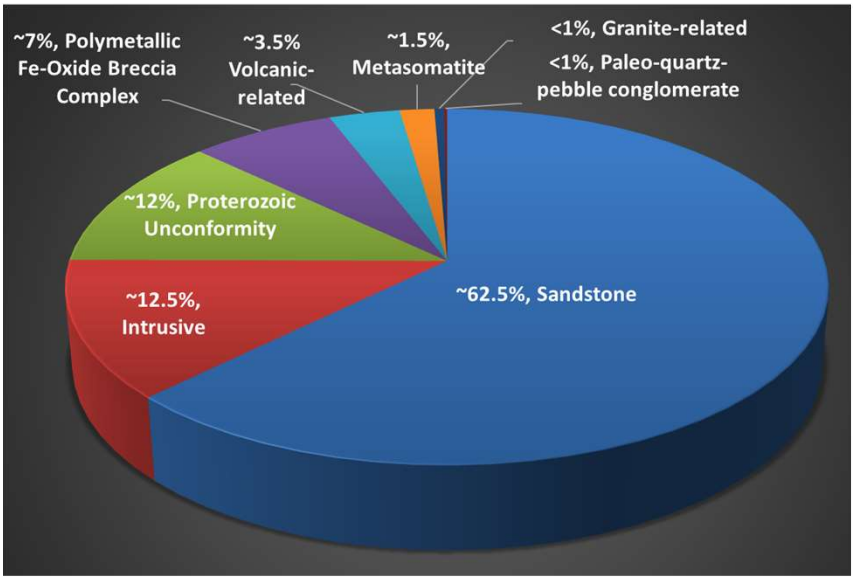
(2019 & 2020)



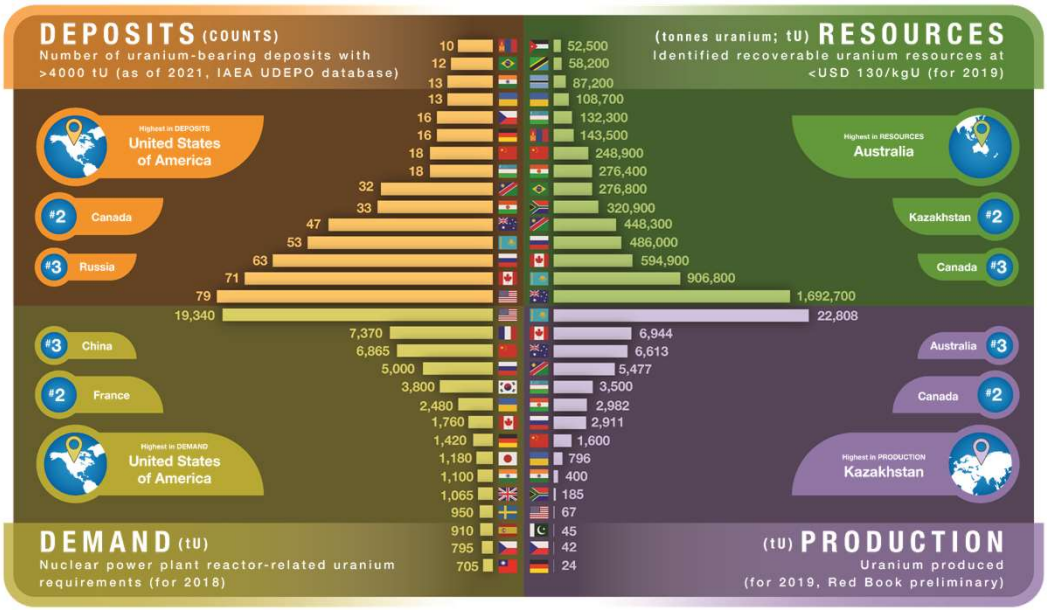
Red Book… World Uranium Production by Methods (2019 & 2020)



Red Book… World Uranium Production by Deposit Type (2019 & 2020)



Red Book & UDEPO Uranium… Who, What, Where



https://nucleus.iaea.org/sites/connect/UPCpublic/PublishingImages/Infographics/Red_Book_2020_Uranium_Depos-Res-Prod-Demd.png