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International Atomic Energy Agency
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Case Study - Non Conventional Uranium Extraction

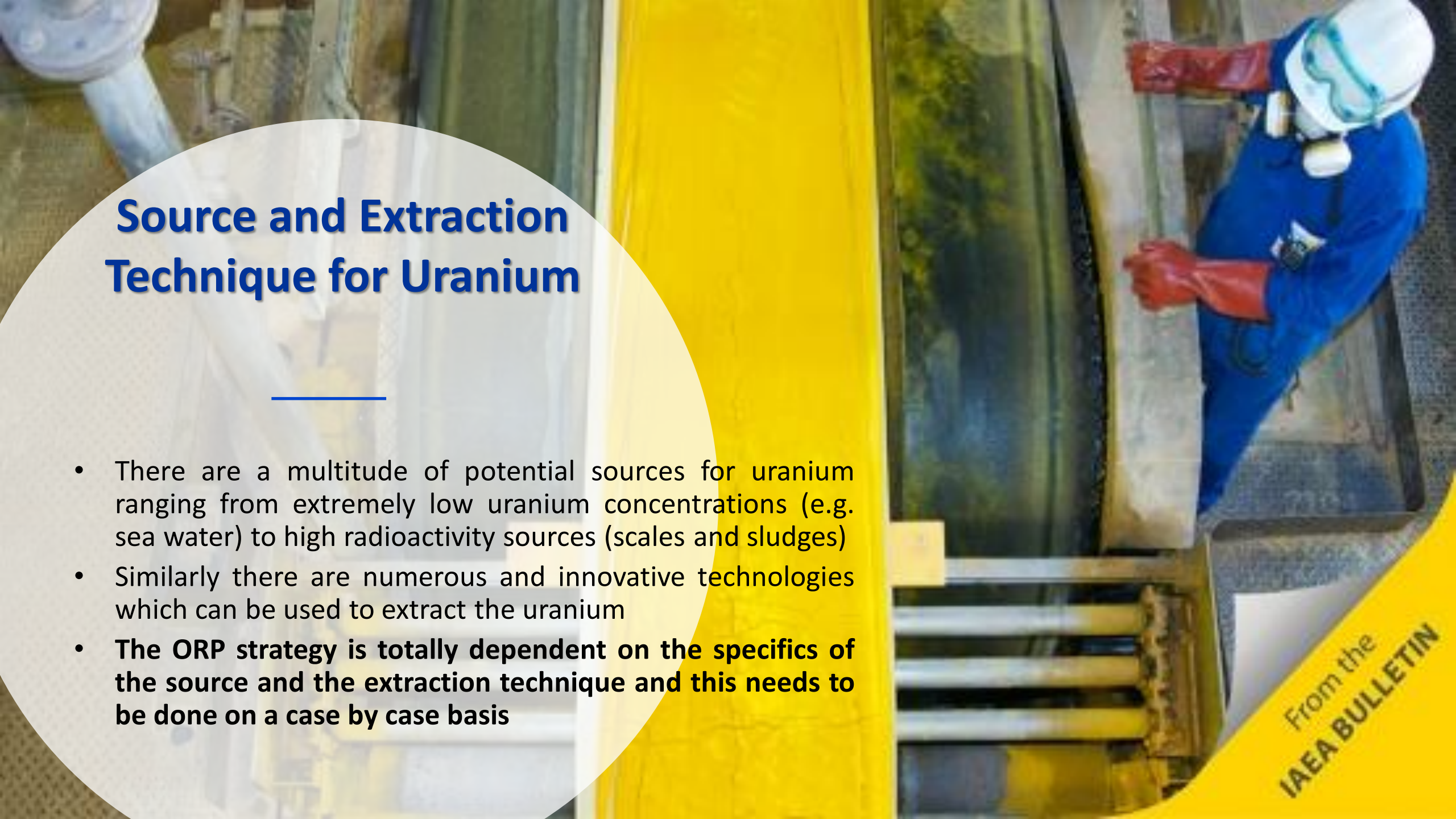
Training Package on Occupational Radiation Protection in Uranium Mining and Processing Industry

What is Non-conventional Uranium Extraction?

- **Uranium is present in many materials and as such can be extracted if technological and economically feasible**
  - Vanadium, molybdenum, copper, nickel, cobalt, arsenic, gold, the rare earths and yttrium may be locally associated with uranium ores.
  - All of these elements, except for gold, are co-extracted with various degrees of recovery during leaching.
  - Most of the time the concentration of these elements is too low to permit economical separation and recovery, but high enough to affect the purity of the yellow cake.
  - Special separation steps must be included in the processing operations to ensure the required yellow cake purity.
- **Historically non-conventional extraction** includes
  - Copper mines in South Africa, Australia and Zambia;
  - Gold mines in South Africa (from 1952 to the present);
  - Nickel mine in Finland;
  - Phosphate mines (e.g. Iran, Jordan, the United States of America, Egypt);
  - Vanadium mines in the United States of America;
  - Silver mines (e.g. the United States of America and Czech Republic);
  - The treatment of water containing uranium (Canada, Germany, Hungary and France).
  - Other potential sources such as rare earth concentrates, sea water, old tailings structures, etc.

Source and Extraction Technique for Uranium

- There are a multitude of potential sources for uranium ranging from extremely low uranium concentrations (e.g. sea water) to high radioactivity sources (scales and sludges)
- Similarly there are numerous and innovative technologies which can be used to extract the uranium
- **The ORP strategy is totally dependent on the specifics of the source and the extraction technique and this needs to be done on a case by case basis**

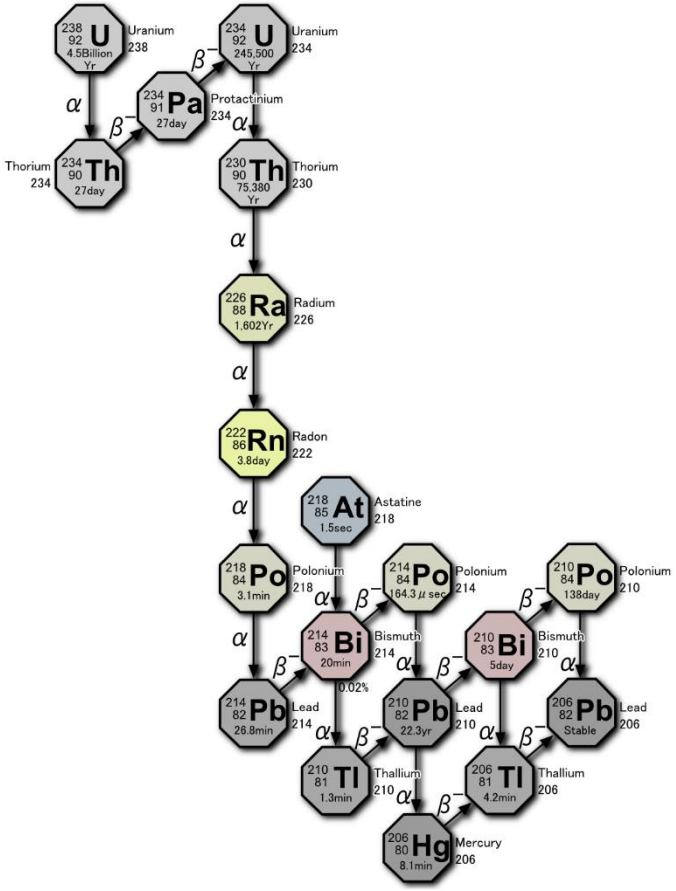


Potential Radiation Protection Areas of concern

- The build-up of **any scales which may contain ^{226}Ra** and hence pose a gamma risk
- **Any confined spaces or areas** of restricted or recirculating ventilation for radon progeny exposure
- Areas where **ground water** is degassed and hence releases contained radon
- Release of **^{210}Po and to a lesser extent ^{210}Pb if the material is heated or smelted and fume is emitted** and hence an inhalation hazard
- The final production of uranium is ALWAYS a potential exposure area

General Rule

- If non-conventional uranium extraction is to be considered, it is important to **determine where all the critical radionuclides go**
- A radionuclide mass and activity balance of the process can form the foundation of a Radiation Protection Program
- It is the unknowns which may give rise to high exposures
- General OH&S approaches will assist in managing the radiation exposure



Key Messages

- Uranium can occur in association with other minerals such as gold and copper and is often mined as a by-product of these materials.
- There are multiple potential sources of uranium and multiple technologies for extraction
- Knowing the chemical and physical properties of ALL the radionuclides is vital to determining the appropriate level of radiation protection
- A radionuclide balance of the process is a good means of providing the input to programs
- It is the unknowns which will cause the high exposures

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Thank you!