Uranium Mineralisation & FPXRF

Utilization of Innov-X Systems Field Portable XRF & XRD Analyzers for the determination of U & Th Mineralization, Mineralogy & Associated Pathfinder Elements.

INNOV-X SYSTEMS

Introduction & Background:

The use of Field Portable X-Ray Fluorescence (FPXRF) & X-Ray Diffraction (FPXRD) within the Mining & Mineral Exploration Industry is fast becoming an established method for conducting real-time geochemical investigations in the field, with the significant benefit of receiving a determination at the actual sample location. Customized analyzer configuration and flexibility across the element calibration suite from Mg (z=12) to U (z=92), provides versatility to the Uranium Explorer or Miner looking for ppm level Uranium & Thorium as well as accompanying geochemical pathfinder signature elements.

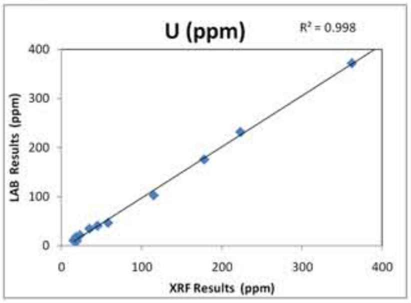
Uranium Deposit Types & Associated Pathfinders Element Suites

Uranium's average crustal abundance is around 2 to 4 parts per million, or about 40 times as abundant as silver. The average concentration of uranium in soil ranges from 0.7 to 11 parts per million and up to 15 parts per million in farmland soil due to use of phosphate fertilizers. Uranium is more plentiful than antimony, tin, cadmium, mercury or silver and it is about as abundant as arsenic or molybdenum. Significant concentrations of uranium occur in enriched, metamorphic sediments as well as in phosphate & lignite deposits and monazite enriched mineral sands. It is recovered commercially from sources with as little as 0.1% uranium content. Thorium is also commonly associated with many styles of uranium mineralization and is found in small amounts in most rocks and soils, where it generally is about four times more abundant than uranium and about as common as lead. Soil commonly contains an average of around 12 parts per million (ppm) of thorium. The main Uranium deposit types are summarized in the table below from ioGlobal along with their commonly associated geochemical pathfinder element suites.

Typical FPXRF LOD's for U-Th & Associated Pathfinders

Element	LOD* (ppm)
U	**3**
Th	**5**
Ni	8
Fe	10
Co	9
Cu	6
Ti	15
V	12
Pb	3
Mo	2
Ag	14
As	3
Se	1

** In typical soil matrix over 120sec test*



Uranium Chemistry & the Need for XRD (Terra™ XRD)

There is over 130 naturally occurring Uranium minerals know to date. Uranium has many oxidation states, but only U^{4+}(Uranous) and U^{6+}(Uranyl) are important geologically. U^{4+} (Uranous) is insoluble and forms primary minerals such us Uraninite (the most common uranium-ore), Coffinite and Brannerite. U^{6+}(Uranyl) is significantly more soluble than U^{4+} and forms numerous complexes and minerals such as vandates (Carnotite), phosphates (Tobernite), silicates (Uranophane) and arsenates. As such, the need for mineralogical determination is a critical part of exploring for Uranium mineralization and understanding complex uranium geochemistry. The recent addition of the Terra ™ Portable X-Ray Diffractometer (XRD) to the Innov-X range of field solutions presents the opportunity for true field-based mineralogical investigation. The setup requires only a very small sample (typically only 15mg) with minimal sample preparation (pulverize to 150um) and can derive results in as little as 60 seconds. Bundled with industry standard phase matching software, a semi-quantitative report can be produced directly whilst still standing over the sample location in real time.

Innov-X Terra ™ Portable XRD

High Grade Uraninite Ore

Summary Geochemical Signatures

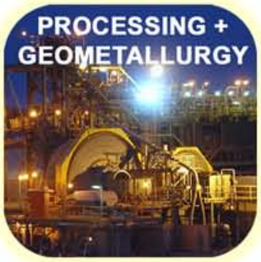
io global

Deposit Type	Geochemical Signatures
Unconformity-related	Ni, Pb, Co, As, B, Mo
Sandstone	Mo, Se, Ti, S, Fe
Breccia Complex (IOCG)	Fe, Cu, Au, Ag, Ba, F & REE
Quartz-Pebble Conglomerate	Ti, Au, Ag, REE, Fe, S, PGE, Ni, Co
Calcretes (Surficial)	V
Phosphorite	P, F

Other Uranium Deposit Types Include: *Vein, Instrusive, Volcanic & Caldera-related, Metasomatic, Collapsed Breccia Pipe, Lignite & Black Shales*

Table Source: ioGlobal Geochemistry Workshop - Oct 2008

APPLICATION BRIEF



APPLICATION BRIEF

Uranium Exploration Methodologies & the Use of FPXRF:

FPXRF performance on Uranium & Thorium is typically 5-10ppm dependant on the matrix materials. This renders the technique useful as both an exploration tool and for grade control applications within a producing mine. Several techniques are generally used in various phases of exploration for Uranium. These include: Gamma Ray Spectrometers, Scintillometers, Geiger Counters, Radon / Alpha Track Etch Cups, Isotopes , Hydro-geochemistry & Conventional Geochemistry (soils, rocks…etc) + FPXRF "Instant" Real-Time Geochemistry. FPXRF can be used in tandem with conventional surface and sub-surface geochemistry and is useful for determining background level abundance and establishing baseline orientation surveys. FPXRF can also be used side-by-side with Gamma & Geiger counters to help verify and hone targets in the field real-time, as well as monitor instrument calibration and performance. The ability to easily gather higher density sampling due to relative ease and low cost versus conventional transport logistics and commercial laboratory turnaround times, renders FPXRF very useful in the field, especially when used as a pre-screening tool and as a means to select the "best" and most representative sample to submit for detailed lab analysis.

Why Use FPXRF?

The aspect of "True Portability" with the latest generation of XRF's essentially enables the ability to bring a "miniaturized version of the laboratory" into the field, with obvious limitations of course! Innov-X Systems is clear and transparent about these limitations: (1) Higher LOD's than lab-based techniques (2) Lower precision than lab-based techniques (higher +/- values but no compromise on accuracy above LOD's (3) Less repeatable results. FPXRF should not to be seen as a replacement for the Laboratory and should be used in conjunction with laboratory and industry standard reporting protocols such as determined by the ASX (JORC CODE) & the TSX (43-101). The main advantage of FPXRF lies in the ability to generate, dynamic, real-time, spatially registered geochemical data sets, rapidly. The Geoscientist can now immediately postulate the elemental characteristics of the observed regolith or lithology dynamically, making informed decisions whilst still in the field, at the exact location of the sample of interest. Instant and interactive approaches to exploration project management, target delineation and associated vectoring towards mineralization are now possible. This results in significantly reduced timeframes with less time intensive reiterations, such as the excavating samples & sending them to the Lab with the associated "normal" lengthy turnaround times and lags. FPXRF can be thought of as being a "Pre-Screening" tool used to select the "best" and most "appropriate" sample to submit to the Laboratory for comprehensive and more detailed analysis. Additionally, the ability to refine your sampling program in the field real-time means that you can easily increase sample density & resolution instantaneously. These field based efficiency gains are advancing project time-frames and assisting companies to better utilize their time in the field and maximize the use of the exploration budget.

LOD's: The 1 Million Dollar Question!...

The determination of the analytical Limit Of Detection (LOD's) depends on many aspects, often not directly related to the instrumentation of choice. Some of these influences include (influencial factor denoted in brackets):

- The energy of excitation or X-Ray source (instrument) Note: this is not all about obtaining the maximum voltage (or keV). It is reliant on the process of fine-tuning both the X-Ray voltage and current to maximize the received count rate and therefore analytical precision (instrument)
- The Atomic Number and associated response of element(s) being analyzed (sample)
- Concentration of Elements present (sample)
- Relative Density & Matrix Composition (sample)
- Sample size, Granularity & Surface Geometry (sample & user)
- Length of test run (user)
- The Quality of the Instrument Calibration & QC Samples used to "Tweak" the instrument (user & instrument)

"AS SUCH, THE SAMPLE IS THE MOST INFUENCIAL FACTOR WITH REGARDS TO DETERMINING LOD's WHEN USING FPXRF"

Our Mission at Innov-X is to "Take XRF out of the lab and into the real world, to help our customers make real-time decisions. Innov-X provides XRF solutions in-line, at line and on-the-move with the industry's best customer support: wherever and whenever needed…"

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www.innovx.com

For More Information - Email : mininginfo@innovx.com

Innov-X Systems, Inc. 100 Sylvan Road, Suite 500 Woburn, MA 01801 USA T. 1-781-938-5005 F. 1-781-938-0128 info@innovx.com