Uranium

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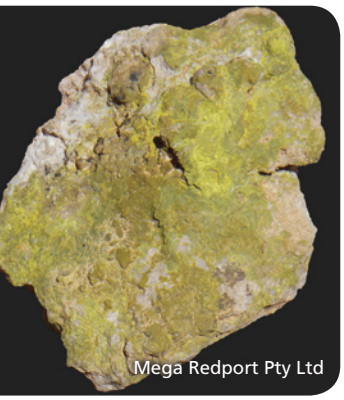

Uranium is a metallic, radioactive element which has some affinities with REE, Th, Y, Zr Mo, Ba and Ca. It occurs in a variety of primary and secondary minerals such as oxides (uraninite, pitchblende), titanates (davidite, brannerite, absite), niobates (euxenite, fergusonite, samarskite), phosphates (torbernite, autunite, saleeite), vanadates (carnotite), silicates (coffinite, uranophane, sklodowskite), as well as carbonates, sulphates, selenites, tellurites, hydroxides, halides, arsenates, molybdates and nitrates.

Uranium is found in a variety of igneous and sedimentary settings with U deposits classified into many categories based on either the geological setting of the mineralisation, or the fomation precesses.

Most exploration programs exploit the radioactive properties of U with radiometric surveys the first step in a U exploration program. However, be aware of the limitation of such surveys: shallow cover will mask the signal and the signal will only be indicative of the amount of U if secular equilibrium has been achieved and is maintained.

Geochemical Analyses

There is no substitute for good geochemistry. Consider the relative mobility of associated elements: U is very mobile in oxidising surface conditions, whereas Th remains largely immobile; Ra may precipitate in anhydrite and give a strong radiometric signal, but the U will have dispersed. Changes in redox conditions and the scavenging properties of Fe and Mn oxides affect the distribution of U.

Geochemical methods should be used in conjunction with radiometric surveys for U exploration. Orientation surveys are always a good idea to establish the best sample medium and the range of elements to be analysed.

Stream sediment, soil, rock chip and drill core samples can all be analysed by standard geochemical methods. Surficial type U deposits, where carnotite is the dominant U mineral, are amenable to partial acid digest methods such as aqua regia. A four acid digest will give a more complete digestion, but for refractory minerals such as davidite, often found in intrusive style U deposits, a fusion is needed to completely dissolve the sample. All the solutions generated from these acid digestions and fusions can be analysed for U by ICP-MS along with a range of other elements by ICP-MS and ICP-OES. Solid techniques for U analysis include XRF, INAA and DNC. Uranium and some other elements can be done by XRF using either pressed powder pellets or fused discs. The nuclear methods, INAA and DNC give total U, but these methods are not readily available, commercially in Australia.

Have you considered something different?
Sampling groundwater, vegetation, or doing partial extractions on soils for enhanced anomaly definition compared with conventional soil geochemistry?

OHS Protocols

While the additional radiation exposure to people working with naturally occurring radioactive materials (NORM) is usually only about the same as background levels, sensible measures should be taken to reduce any potential risks and protect workers. Unlike some other workplace hazards, radiation is easy to measure and there is a long history of management and control. Most jurisdictions have regulations that govern workplace practices, exposure to ionizing radiation and transportation of radioactive materials. Working in well ventilated areas, reducing dust and paying particular attention to hygiene, are the best ways to reduce the main risks of inhalation and ingestion of alpha emitters. Direct irradiation from gamma radiation from NORM is very low and again can be easily managed by increasing the distance and reducing the time spent near such materials. Shielding can also be used, but this is usually unnecessary when dealing with NORM.

Radioactive decay is measured in Becquerels (Bq) where the activity is the number of disintegrations per second. The dose, or potential damage to the human body, is measured in Sieverts (Sv). Each jurisdiction has regulations on both the activity concentration (Bq/g) and total activity for radioactive material to be classed as exempt. These limits may not be uniform and may differ from the International Atomic Energy Agency (IAEA) limits which should be adopted more widely in future. Therefore, when working with reasonably large volumes of NORM it is likely that they will not be classed as exempt under most jurisdictions, so the appropriate handling and storage protocols will need to be used.

Sample Size

To comply with antidumping requirements, all unused radioactive material must be returned to the company/country of origin. Therefore it is sensible to send appropriate size samples to the closest laboratory to reduce transport, storage and handling issues. To reduce the dust generated during manual sample preparation, it is preferable to limit the sample sizes to less than 3kg, to avoid the need to riffle split larger samples. Where possible, samples should be crushed and pulverised using robotic preparation facilities. When submitting samples for analysis, please provide as much information about your samples as possible.

For the accurate low level quantification of uranium and thorium, ICP-MS is the preferred technique. Ore grade uranium samples can be accurately quantified using XRF techniques, taking advantage of the excellent precision and accuracy of fusion XRF.

Uranium Exploration Packages

U Four Acid Exploration ICP-OES & MS Package

Element	Range ppm	Element	Range ppm	Element	Range ppm
As	0.5 - 1%	K	20 - 10%	Se	0.5 - 1%
Bi	0.01 - 1%	La	0.01 - 5000	Th	0.01 - 5000
Ca	50 - 40%	Mo	0.1 - 1%	U	0.01 - 1%
Co	0.1 - 1%	Ni	1 - 2%	V	1 - 1%
Cu	1 - 2%	Pb	0.5 - 1%		
Fe	100 - 50%	S	50 - 15%		
U exploration package		4 acid digest / ICP-OES & ICP-MS			4A/OM47

Uranium Ore Grade Packages

U Four Acid Ore Grade ICP-OES & MS Package

Element	Range ppm	Element	Range ppm	Element	Range ppm
As	10 - 20%	K	200 - 20%	Se	10 - 2%
Bi	0.1 - 10%	La	0.5 - 2%	Th	0.5 - 1%
Ca	100 - 50%	Mo	1 - 10%	U	0.5 - 30%
Co	10 - 20%	Ni	10 - 70%	V	20 - 5%
Cu	10 - 70%	Pb	10 - 70%		
Fe	100 - 70%	S	100 - 60%		
U ore grade package		4 acid digest / ICP-OES & ICP-MS			4AH/OM47

U Lithium Borate Ore Grade ICP-OES & MS Package

Element	Range ppm	Element	Range ppm	Element	Range ppm
Ca	100 - 70%	La	0.2 - 20%	Th	0.1 - 2%
Co	0.5 - 10%	Mo	1 - 1%	U	0.1 - 30%
Cu	20 - 10%	Ni	20 - 10%	V	10 - 5%
Fe	100 - 75%	Pb	5 - 10%		
K	100 - 20%	S	100 - 30%		
U ore grade package		Lithium borate / ICP-OES & ICP-MS			FB6/OM20

U Nickel Crucible Fusion ICP-MS Package

Element	Range ppm
U	0.1 - 60%
U	Sodium peroxide fusion / ICP-MS	FP6/MS45

U Ore Grade XRF Package

Element	Range %
	0.002 - 10%
U	Li borate fusion / XRF	FB1/XRF45

Intertek

15 Davison Street,
Maddington,
Western Australia

Richard Holdsworth

T: + 61 8 9251 8100
F: +61 8 9251 8110
E richard.holdsworth@intertek.com

For more information please visit www.intertek.com or contact us at richard.holdsworth@intertek.com, or call us +61 8 9251 8100.

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