INTRODUCTION

Uranium production allows for ongoing growth in the nuclear industry and Canada is currently a world leader in the production and processing of this strategic and critical resource. Current acid digestion techniques use dangerous acids including hydrofluoric acid (HF), perchloric acid (HClO4), and sulphuric acid (H2SO4). These techniques generate high-temperature gases that are difficult to analyze with existing technology. As such, alternative digestion techniques are being developed to help Canada remain a major player in the uranium industry. ColdBlock Digestion, a Canadian-based and invented technology, offers an alternative to the current problematic methods by utilizing a coldblock, a phosphoric acid matrix, and requiring significantly less digestion time.

We compared Coldblock digestion of several uranium bearing Certified Reference Materials (CRMs) obtained from CANMET Geosites, and a uranium producer to existing values that were obtained using acid leach, four acid total, and XRF fusion techniques. The values obtained using the method described by Helmeczi et al. (ie, phosphoric acid to dissolve the sample and later dilution with 2% nitric acid). These recoveries were attributed to the effectiveness of the phosphoric acid digestion as described by Helmeczi et al. These results show that the application of phosphoric acid digestion technologies, ColdBlock Digestion, can offer a safer and effective alternative. The dissolution of uranium is most commonly carried out with concentrated nitric acid (HNO3) and the resultant solution is easily processed through spectrophotometric analysis.

Digestion Technology

In order to analyze a geological sample, the solid sample must first be converted (dissolved) into a form that can be analyzed by an analytical spectrophotometry system. Several digestion techniques are available to achieve this conversion, including pressure digestion, acid digestion, and cold digestion.

Acid Digestion:

- Works by using acids to dissolve minerals and elements in a dissolution solution.

- Dissolution speed is affected by the application of heat, which flows to the test sample by conduction and convection when using hotplates or hotblocks. To achieve optimal digestion speed and microwave ovens were used to ensure the efficiency of microwave heating in combination with the acid and sample. This was found to be crucial due to the need to ensure the reaction vessel is not over heated.

ColdBlock Digestion:

- Requires the problems with the current acid digestion technologies. ColdBlock Technologies developed a new technology to establish the heated vessel, allowing the sample to be processed in the vertex vessel. The resultant solution is easily processed through spectrophotometric analysis.

Geological Sample Recovery of uranium after an inverse Aqua Regia leach digestion

Sample A 100% 104% 101%
Sample B 100% 104% 101%

Methods and Results

The certified reference materials and samples were treated using two different methods:

- Treatment Option 1:
  - 10 mL Phosphoric acid
  - 2% Nitric acid

- Treatment Option 2:
  - 10 mL Phosphoric acid
  - 0% Nitric acid

The graph illustrates the % recovery of uranium from the examined CRMs using an inverse Aqua Regia treatment. The measured values obtained using ColdBlock Digestion were compared to certified values that were obtained using 4-Acid digestion techniques, ColdBlock Technologies Inc.

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SUMMARY AND DISCUSSION

In addition to the samples of digested certified values, the geological samples were also subitted with digestion techniques based on a three-acid digestion protocol (including hydrofluoric, perchloric, and nitric acids). Results obtained using the ColdBlock Digestion techniques were comparable to the certified values obtained using 4-Acid digestion and Geostats, and a uranium producer to existing values that were obtained using total digestion techniques. The values obtained using the method described by Helmeczi et al. (ie, phosphoric acid to dissolve the sample and later dilution with 2% nitric acid). These recoveries were attributed to the effectiveness of the phosphoric acid digestion as described by Helmeczi et al. These results show that the application of phosphoric acid digestion technologies, ColdBlock Digestion, can offer a safer and effective alternative. The dissolution of uranium is most commonly carried out with concentrated nitric acid (HNO₃) and the resultant solution is easily processed through spectrophotometric analysis.

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