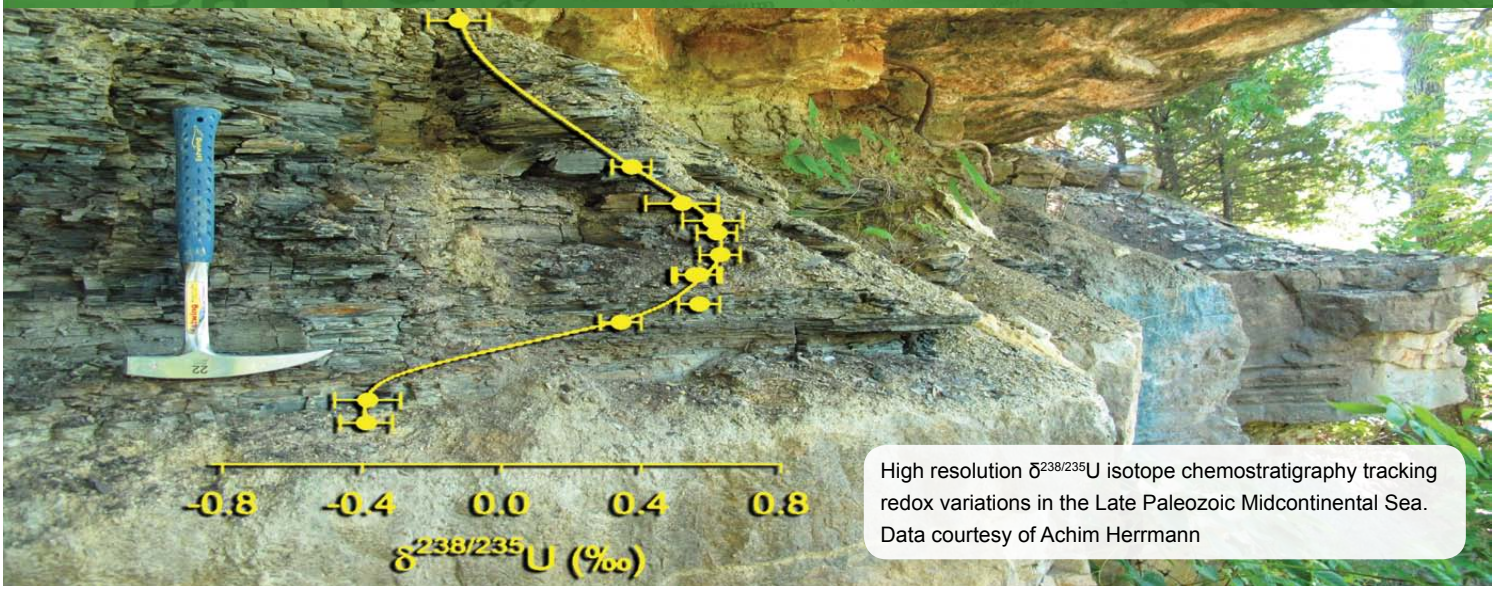
Elemental Scientific

prepFAST-MC: Uranium Isotopes



High resolution $\delta^{238/235}U$ isotope chemostratigraphy tracking redox variations in the Late Paleozoic Midcontinental Sea. Data courtesy of Achim Herrmann

High-resoluton isotope ratio stratigraphy requires the routine analysis of large numbers of samples. To reduce interferences and minimize matrix effects, extensive purification procedures are used to isolate elements from their natural matrix. Current purification protocols require manually feeding gravity-driven separation columns, a process that is both costly and time consuming. This laboratory bottleneck is eliminated with the prep*FAST*-MC™, an automated, low-pressure ion exchange chromatography system that can process from 1 to 60 samples in unattended operation. The syringe-driven system automatically isolates elements of interest and collects up to 3 discrete fractions at user-defined intervals (time, volume and flow rate). The combination of maximizing sample throughput and minimizing costs associated with personnel and consumables provides an opportunity to greatly expand research horizons in fields where large isotopic data sets are required, including archeology, geochemistry, climate/environmental science, biomedical sciences and food authentication.

Features:

- Flexible hardware can be adapted for other isotopic systems (Pb, Nd, Th, Sr, etc.)
- All-fluoropolymer flow paths
- Fully-automated software
- Compact footprint (SC-4 DX Autosampler with ULPA enclosure)
- High capacity (sixty 15 mL samples)
- Up to 3 fractions collected per sample
- Syringe load and elute
- Column flow rates up to 5 mL/min
- Single column for multiple samples
- Two 6-port and one stream selection valve
- Configured inline or offline
- Low carryover

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In collaboration with:

ASU School of Earth & Space Exploration
ARIZONA STATE UNIVERSITY

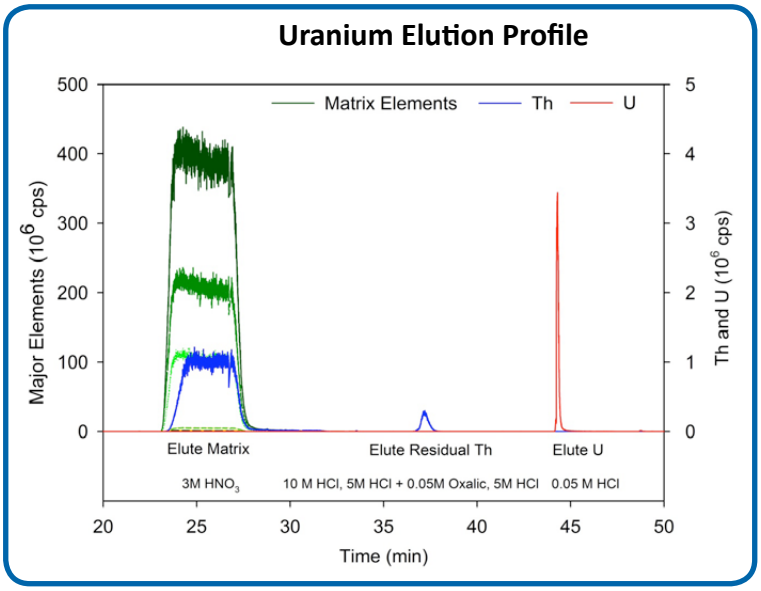


Figure 1. Fully-automated chromatographic separation of uranium (red) from all other matrix elements in BCR-2 (Columbia River Basalt) using the prep*FAST*-MC system. Elution profile was collected online in realtime using a Thermo XSERIES ICP-MS. Data courtesy of Stephen Romaniello and Gwyneth Gordon (Arizona State University).

Stephen Romaniello, Gwyneth W. Gordon, Achim Herrmann and Ariel D. Anbar

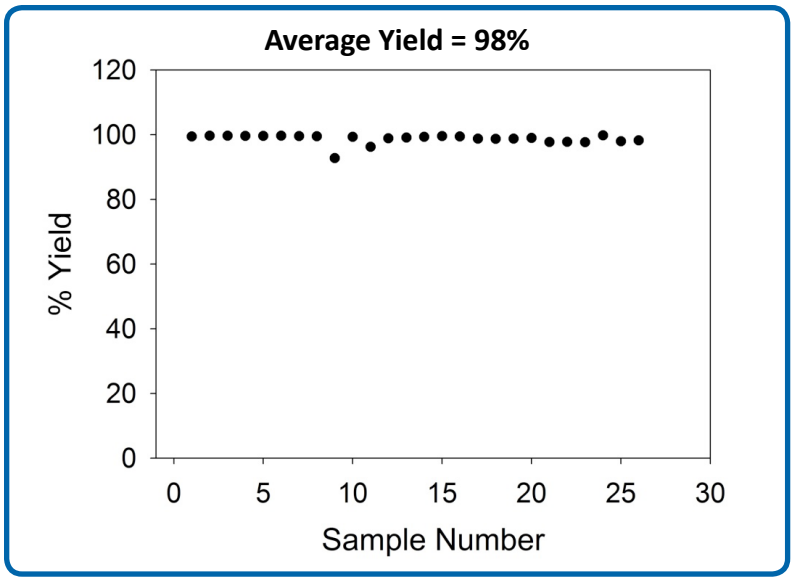


Figure 2. Uranium recovery for 26 consecutive samples with fully-automated cleaning and reuse of the separation column. The average yield was 98% and the minimum yield was 92%. Data courtesy of Stephen Romaniello and Gwyneth Gordon (Arizona State University).

prep*FAST*-MC System
Note: ULPA enclosure not shown

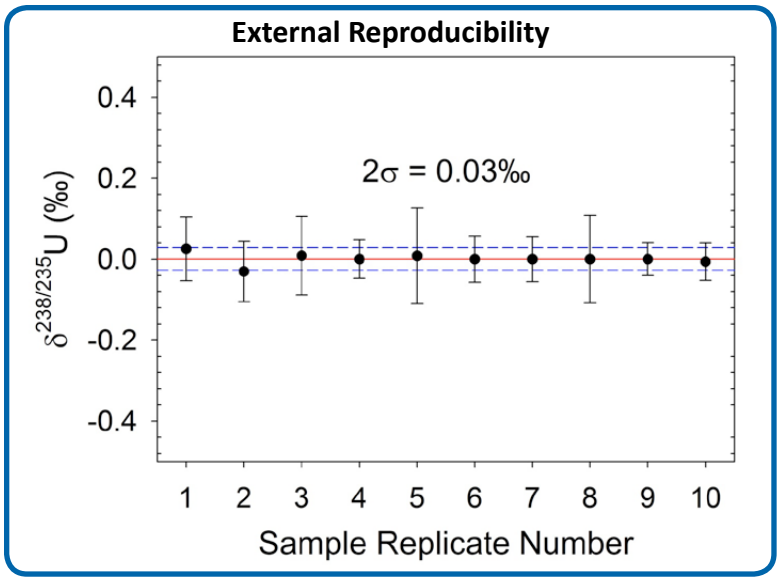


Figure 3. External reproducibility of $\delta^{238/235}U$ for 10 aliquots CRM145 independently processed through chemistry over a 1 week period interspersed with natural samples using the prep*FAST*-MC. Errors bars indicate the 2σ precision of replicate measurements on a single sample aliquot (n≥3). Blue dashed lines indicate the 2σ precision for the means of all sample aliquots. Data collected using a Thermo Neptune MC-ICP-MS and courtesy of Stephen Romaniello and Gwyneth Gordon (Arizona State University).

Table 1. Typical Uranium chemistry steps illustrated in Figure 4.

Step	Acid	Purpose
Clean Resin	0.05 M HCl	Strip any uranium
	3M HNO_3	Condition resin
Load Sample/Major Element Elution*	3M HNO_3	Load sample
	3M HNO_3	Elute matrix
Elute Matrix	10M HCl	Switch resin to Cl form
	5M HCl+0.05 M Oxalic	Strip any thorium
	5M HCl	Get rid of oxalic acid
Elute Sample	0.05 M HCl	Elute uranium

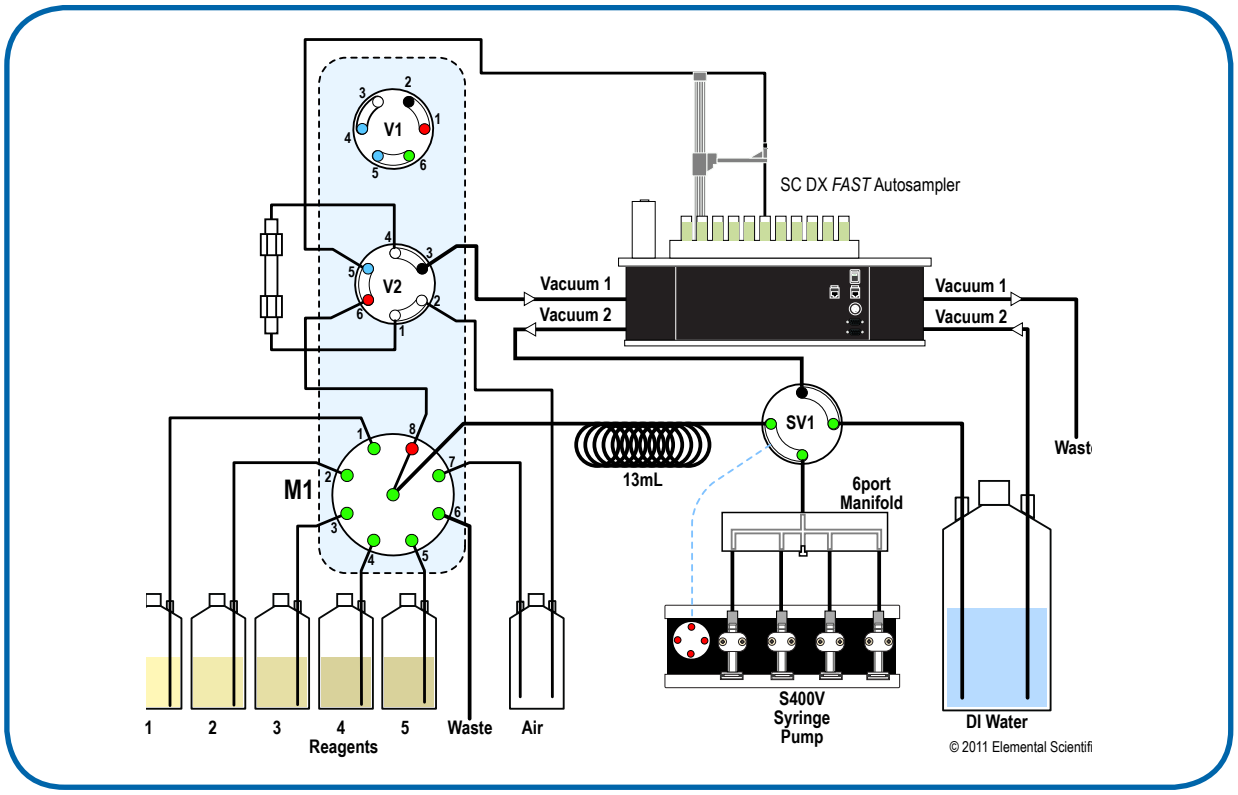


Figure 4. Schematic of offline system configured for single column chemistry. Second valve can potentially be utilized for dual column applications.

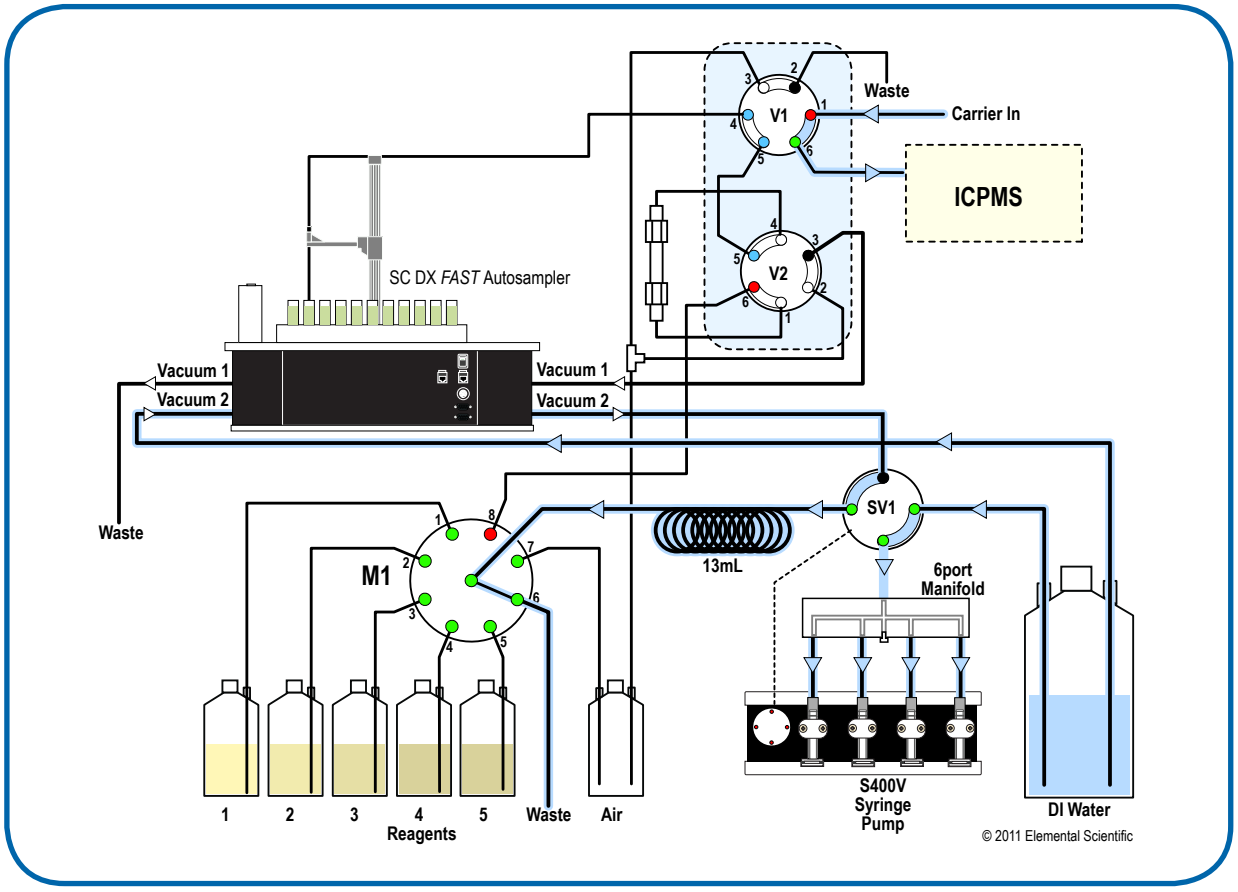
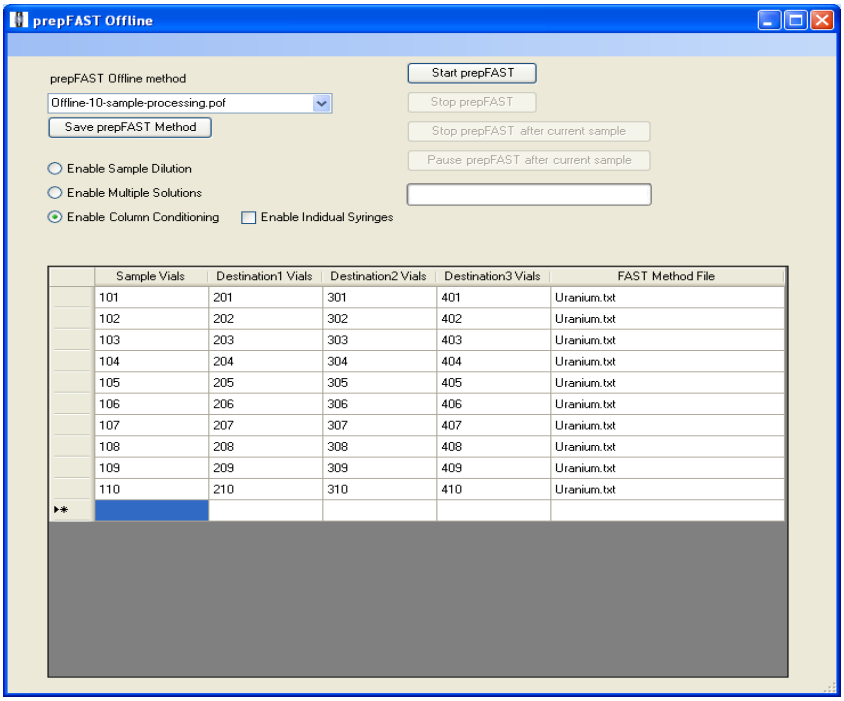


Figure 5. Schematic of inline system configured for single column chemistry connected to ICP-MS.

Benefits:

- Flexible hardware can be adapted for other isotopic systems (Pb, Nd, Th, Sr, etc.)
- Software automation greatly improves efficiency and reproducibility
- Easily fits in any lab and can replace dedicated HEPA hood procedures
- Accurate (±0.2%) and precise (±0.2%) syringe control ensures exact volumes and flow rates for very reproducible fraction collection
- High, consistent yield for more than 25 samples on one column
- Process samples and collect various fractions in a single run
- Reduce resin consumption
- Couple inline system with ICP-MS to monitor signals in real time
- Adjust or develop new chemistries efficiently and quickly
- Program offline to process samples overnight
- External reproducibility 2σ < 0.03‰ ($\delta^{238/235}U$)
- High throughput eliminates the sample prep bottleneck associated with all high precision isotopic analysis
- Potential to automate complex chemistries utilizing 8 different reagents and 2 columns



Sample Vials	Destination1 Vials	Destination2 Vials	Destination3 Vials	FAST Method File
101	201	301	401	Uranium.txt
102	202	302	402	Uranium.txt
103	203	303	403	Uranium.txt
104	204	304	404	Uranium.txt
105	205	305	405	Uranium.txt
106	206	306	406	Uranium.txt
107	207	307	407	Uranium.txt
108	208	308	408	Uranium.txt
109	209	309	409	Uranium.txt
110	210	310	410	Uranium.txt

Figure 6. In the prep*FAST* offline software, user selects rack/vial locations for Sample and Destination 1, 2 and 3, as well as the prep*FAST* method for sample processing. Then simply click on start prep*FAST* to run samples.

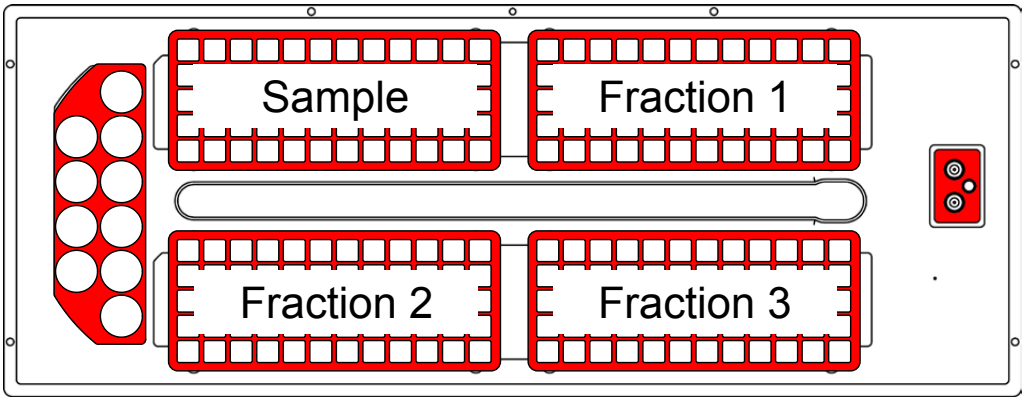


Figure 6. SC-4 DX top view with locations for Sample, Fraction 1, Fraction 2, and Fraction 3. Vial sizes, styles and rack configurations are flexible.

'AUTOMATED SAMPLE PURIFICATION: RADIOGENIC AND NON-TRADITIONAL METAL ISOTOPES IN THE 21ST CENTURY',

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