System Setup and Parameter Optimization for a Desolvating Nebulizer Unit with Multicollector Inductively Coupled Plasma Mass Spectrometry for Stable and Radiogenic Isotope Ratio Measurements

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Abstract

Multicollector ICP-MS instruments are widely used in geochemistry for high precision isotope ratio measurements. Signal enhancement and / or interference reduction (ex. oxides and hydrides) is often necessary for useful measurement of low abundant isotopes and mass-limited samples.

This work will describe the setup and optimization of a new desolvating nebulizer accessory for multicollector ICP-MS. Important accessory benefits include inert wetted components for HF-containing samples, heated inert spray chamber and membrane desolvator for optimum sample transport efficiency, and mass flow controllers with computer software for Ar sweep and N_2 addition gases.

The nebulizer accessory is applied with multicollector ICP-MS for uranium-thorium dating, as is commonly used for cave and coral calcite and aragonite samples.

Instrumentation - I

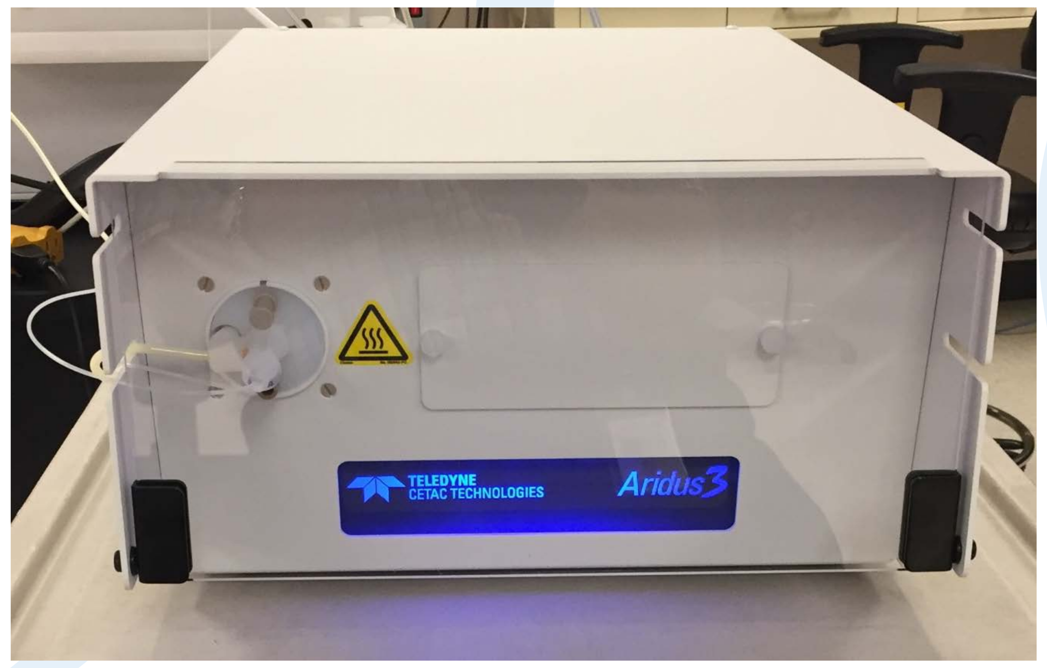

Figure 1. Aridus3 Desolvating Nebulizer

Figure 2. Removable Membrane Oven Module

Instrumentation - II

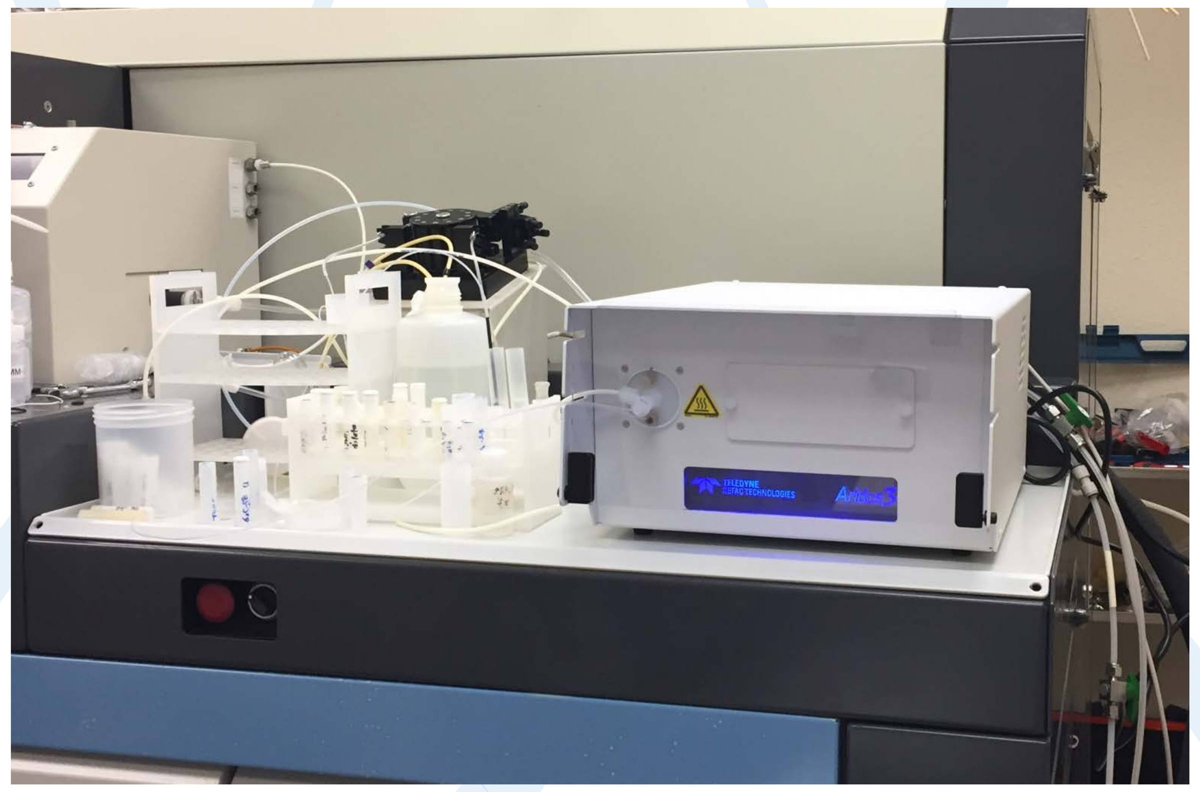

Figure 3. ThermoFisher Neptune MC-ICP-MS & Teledyne CETAC Aridus 3 Desolvating Nebulizer

Table 1. Operating Conditions

Thermo Neptune MC-ICP-MS Conditions:	
ICP Power	1200 W
Coolant Gas	15.00 L/min
Auxiliary Gas	1.30 L/min
Sample Gas	0.75 L/min
Interface	Jet Type*
Extraction	-2000 V
Focus	-642.0 V
X-Defl.	7.61 V
Y-Defl.	0.02 V
Shape	193.00 V
Rot Quad 1	0.01 V
Source Offset	-10.00 V

Teledyne CETAC Aridus3 Conditions:	
PFA Nebulizer	C-Flow 100
Uptake Rate	99 µL/min

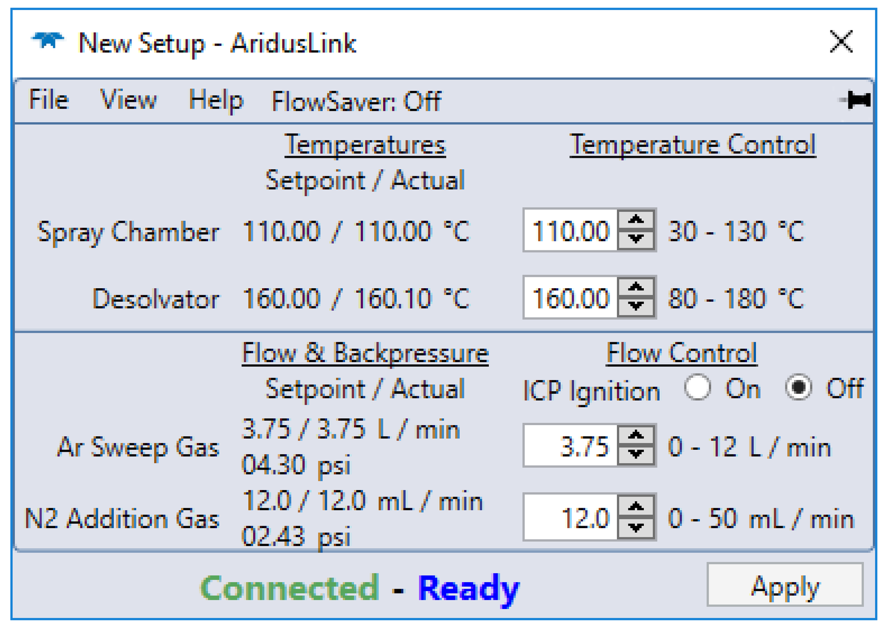

Figure 4. AridusLink Software Control Screen

Sample Type & Results

Sample BC9-88mm was drilled to screen this sample for its age. Using the Neptune MC-ICP-MS with the Aridus 3, the results are given below.

Note that 8 cycles were run per block with an integration time of 20 seconds per cycle.

Figure 5. Stalagmite BC9, Carlsbad Cavern, New Mexico USA

130 mg calcite powder
$^{238}U = 0.5205 \pm 0.0005$ ppm
$^{232}Th = 0.00320 \pm 0.00004$ ppm
$^{230}Th/^{232}Th = 18.6 \pm 0.3$*
$^{230}Th/^{238}U = 0.0374 \pm 0.0003$*
$\delta^{234}U_{measured} = 1554 \pm 3$ ‰
$\delta^{234}U_{initial} = 1561 \pm 3$ ‰
Age uncorrected = 1608 ± 14 yr B2k
Age corrected = 1210 ± 120 yr B2k

* = activity ratio, and ‰ = permil
Yr BP = years before 2000CE
Sample collected by V. Polyak by federal permit granted by Carlsbad Cavern National Park.

Summary & Notes

Sample BC9-88mm was dated with a Thermo Neptune multicollector ICP-MS. A CETAC Aridus3 desolvating nebulizer system was used to enhance the signal by 4x above that signal produced from a quartz spray chamber having an equivalent nebulizer feeding into the spray chamber. This enhancement of signal allows for the use of smaller sample sizes and spike/sample ratios, and also reduces run time.

Note that the Neptune MC-ICP-MS was equipped with Jet sample and X interface skimmer cones but not with the high performance interface vacuum pump.

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