Performance of L2140-*i* Analyzer (Picarro, Inc.) for $\delta^{18}O$ and δD analyses of freshwater, plant extracted waters and methanol or ethanol-water mixtures

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Introduction

Isotope-ratio infrared spectroscopy (IRIS) represents a cheaper alternative to isotope-ratio mass spectroscopy (IRMS) for stable isotope analyses of waters and could significantly enhance the application of stable isotopic data of waters in a variety of disciplines. However, the presence of organic contaminants in liquid samples causes spectral interferences and erroneous measurements.

We assessed the performance of a new commercially available IRIS instrument (L2140-*i*, Picarro, Inc., Santa Clara, CA) designed with improved spectroscopy and on-line module for oxidation of organic compounds (Micro-Combustion Module, or MCM) in order to overcome the problems as mentioned above.

Materials and methods

We compared isotope data obtained by L2140-*i* to IRMS data for different types of samples: freshwaters (n = 65), plant-extracted waters (n = 10), and methanol (n = 8, at 0, 0.3, 0.7 and 1% MeOH) or ethanol-water mixtures (n = 12, at 0, 0.3, 0.7, 1, 1.5 and 2% EtOH). MCM cartridge lifetime was assessed analyzing the same batches of samples with new and used (up to 500 samples) cartridges. Carryover effects were evaluated on a sub-set of samples analyzed with a new MCM cartridge and based on the last 3 injections of a total of 6 and 12 injections. Freshwater samples were also analyzed without on-line MCM.

Precision and accuracy

Precision and accuracy of our lab water standard with on-line MCM improved and were similar to what was obtained without on-line MCM when septa were changed every ≤ 200 samples. On average, $\delta^{18}O$ matched the IRMS reference value, but δD was approximately 1 ‰ more depleted than the IRMS reference value.

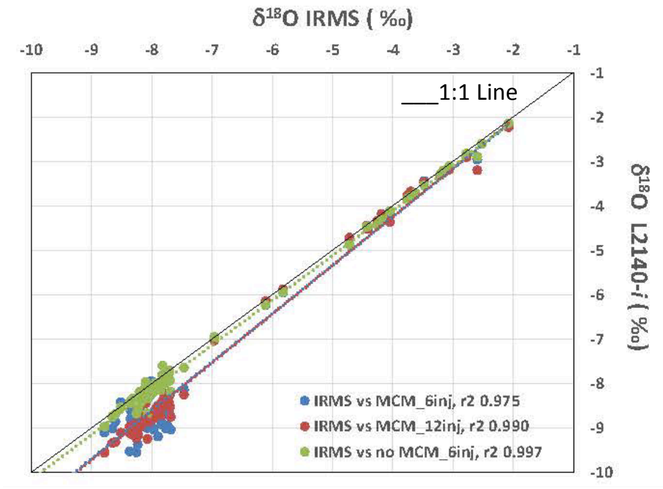
Mode of analysis	n		$\delta^{18}O$ (‰)	δD (‰)
MCM, overall	63	Average	-5.06	-37.22
		SD	± 0.28	± 1.89
MCM, septa < 200 samples	18	Average	-4.99	-36.65
		SD	± 0.13	± 0.52
no MCM, septa < 200 samples	22	Average	-4.99	-36.58
		SD	± 0.11	± 0.55
		IRMS Reference values*	-4.77	-35.50

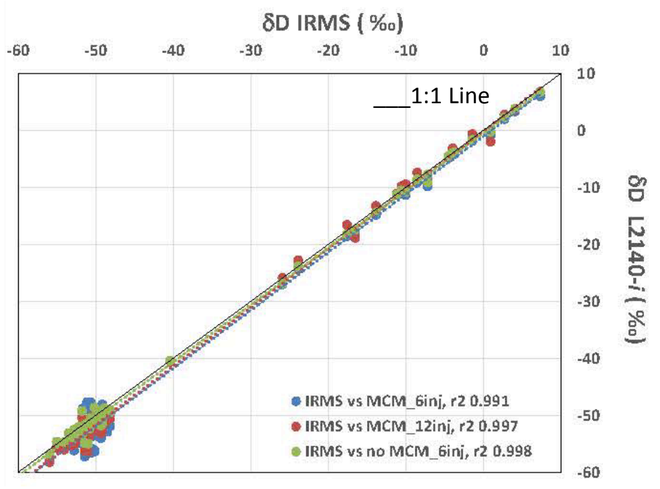
*calibrated against IAEA water standards

Conclusions

- **Changing septa at ≤ 200 samples helped improve L2140-*i* precision (based on quality control data).**
- **Accuracy and precision of L2140-*i* data were better for $\delta^{18}O$ compared to δD, but were influenced by sample type.**
- **L2140-*i* represents a good alternative to IRMS for freshwater samples, especially if used without on-line MCM.**
- **MCM proved unable to completely eliminate the organic interferences in plant-extracted waters or alcohol-water mixtures leading to unsystematic δD discrepancy between IRIS and IRMS measurements even while using a new cartridge.**
- **We are currently testing the effect of adding activated carbon to the samples and/or filtering them.**

Freshwater samples

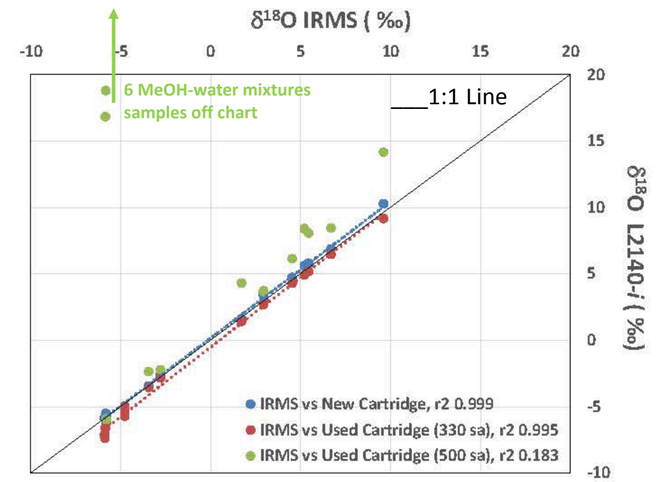


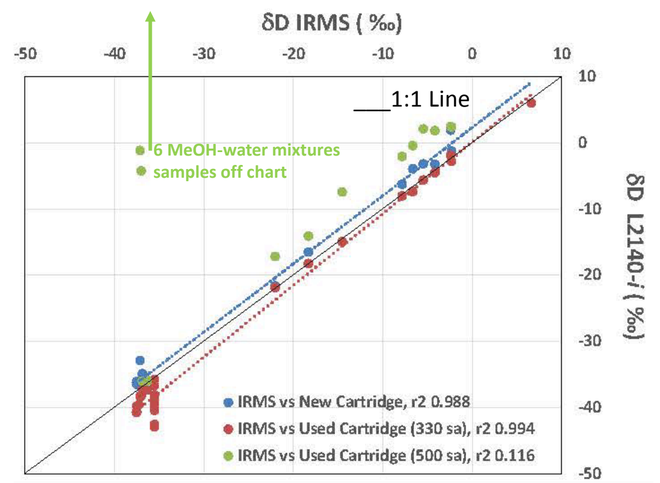


- $\delta^{18}O$ measurements of freshwater samples with on-line MCM and 6 or 12 injections were comparable, while data from 6 injections without MCM were more similar to the IRMS data and had smaller standard deviations than data obtained from 6 injections with on-line MCM.
- More accurate δD measurements of freshwater samples were attained without MCM.
- Freshwater data were not affected by the number of samples previously run on the cartridge for up to 500 samples.

Mode of analysis	IRMS - L2140-*i* Difference		
		$\delta^{18}O$ (‰)	δD (‰)
MCM 6 inj	Average	0.50	1.67
	SD	± 0.43	± 2.10
MCM 12 inj	Average	0.50	1.32
	SD	± 0.21	± 1.41
no MCM 6 inj	Average	0.13	0.55
	SD	± 0.13	± 0.93

Plant-extracted waters and methanol or ethanol-water mixtures





- Laser measurements of plant extracts and alcohol-water mixtures were affected by the number of samples already run on the MCM cartridge and the nature of the sample. Best results were obtained by using a new cartridge; acceptable cartridge lifetime is for ≤ 300 samples.
- However, even using a new cartridge, δD data were less consistent than $\delta^{18}O$ data with the IRMS data, with the discrepancies unsystematic and sample dependent.
- Screening data for organic contamination running the ChemCorrect software was unreliable due to missed identification of problematic samples (high discrepancy between the IRMS data and the L2140-*i*) and erroneous identification of non-problematic samples.

Mode of analysis	IRMS - L2140-*i* Difference		
		$\delta^{18}O$ (‰)	δD (‰)
New Cartridge	Average	0.18	1.48
	SD	± 0.21	± 1.53
Used Cartridge (330 sa)	Average	-0.04	0.94
	SD	± 0.88	± 2.83
Used Cartridge (500 sa) (only plant extracted waters)	Average	1.95	5.95
	SD	± 1.28	± 1.35
Used Cartridge (500 sa) (includes MeOH-water mixtures)	Average	22.66	35.38
	SD	± 36.39	± 53.20