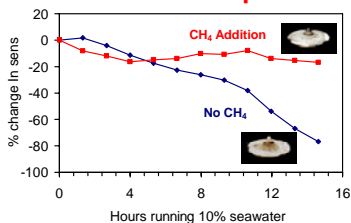


Diluted Seawater

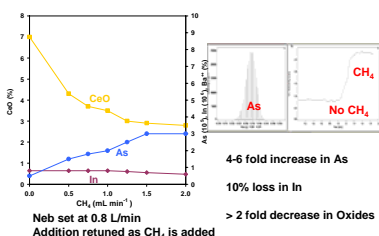
Abstract

A rapid high throughput method is developed for the determination of potential tracer elements (P, V, Mn, As, Mo, Ba and U) of the exchange history of seawater collected from ballast tanks of cargo ships. Here we demonstrate long term precision $< \pm 10\%$ (2-SD) and accuracy within the certified (2-SD) values for NASS-5 (n=170, 15 different analytical dates).

Reduced Cone Deposition



CH₄ Plasma Addition



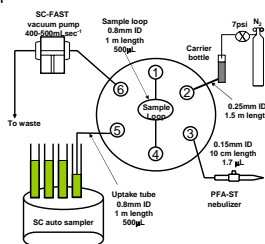
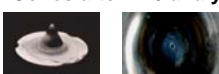
SC-Fast Sample introduction with ELEMENT-XR



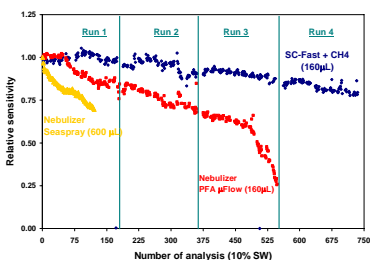
CH₄ SC-Fast

- 10 sec uptake
- 2 min analysis
- 2min 10 sec/sample
- 120 samples in 7.25 hrs
- uFlow (160µL)
- PFA spray Chamber
- 1500W
- Tuned on 10% SW

Cones after 740 analyses



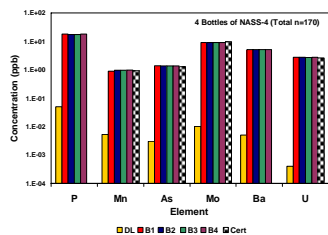
Stability and Sample Throughput



Conclusion

By employing direct flow injection and methane addition to minimize cone deposition, the method is capable of >700 continuous determinations of 10-fold diluted seawater samples by HR-ICP-MS in less than 30 hrs. Our determined value of 9.04 ppb Mo is more oceanographically consistent and in better agreement with other studies than the 9.6 certified value and likely represents a more accurate value for NASS-5. We also suggest values of 17.6 ppb for P and 5.14 ppb for Ba, two elements that are uncertified and have no listed informative values.

DLs Precision and Accuracy

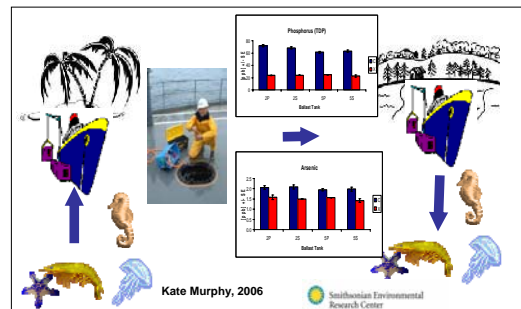


NASS-5

Element	Avg	n	2-std	RSD	Cert
P	17.6	4	0.78	4.4	
Mn	0.94	4	0.08	8.8	0.919
As	1.36	4	0.03	2.0	1.27
Mo	9.04	4	0.10	1.1	9.6
Ba	5.14	4	0.06	1.3	
U	2.73	4	0.05	1.8	2.6

Application to Ballast Seawater and Invasive Species

- Important to trace water from Ports
- Identify open ocean SW in ballast tanks.
- Murphy, et al. identified P, Mn, Mo, Ba, and U as potential tracers.



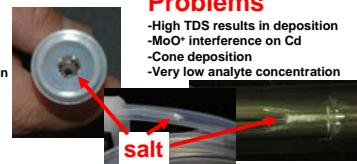
Undiluted Seawater (preliminary)

Goals

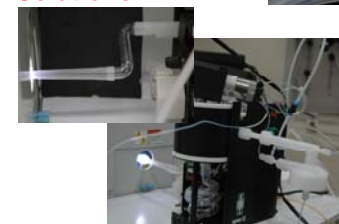
- No sample prep
- Blank reduction
- Oxide reduction
- Reduced cone deposition
- High TDS tolerance

Problems

- High TDS results in deposition
- MoO⁴ interference on Cd
- Cone deposition
- Very low analyte concentration

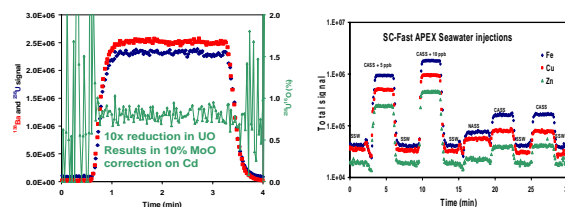


Solutions

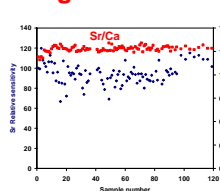


- Gradual reduction in ID of flow path
- Use APEX to reduce oxides
- Use SC-Fast to inject samples
- Add cyclonic spray chamber
- Inject undiluted SW at 10µLmin⁻¹
- Add CH₄

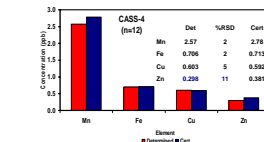
APEX Sensitivity Oxides and Stability



Long term Stability



Precision and Accuracy



Acknowledgements

ESI, Dan Wiederin for loan of APEX, Fast system and developmental support
Michele LaVigne for laboratory assistance