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MEMBRANE INTERFACE EVALUATIONS FOR UNDERWATER MASS SPECTROMETERS

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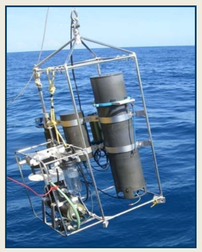
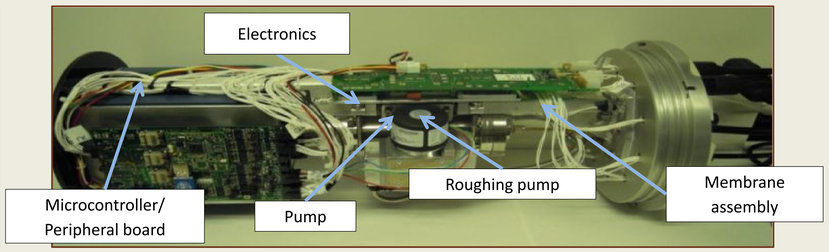
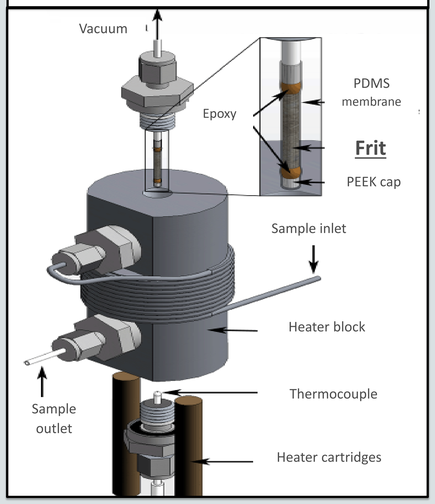
RATIONALE FOR THIS WORK

- The multifold applications of the underwater mass spectrometer (UMS) include energy exploration, ocean acidification, and ecosystem studies (1,2).
- A mechanically supported membrane interface assembly allows for deepwater UMS applications.
- The UMS membrane interface assembly consists of a polydimethyl siloxane (PDMS) capillary mechanically supported by a fabricated frit.
- The fabrication of the frit requires using a Dremel tool with a diamond-coated wheel to shape larger Hastalloy C porous frits to the specified size. This frit fabrication procedure is time-consuming and cumbersome, and the porosity of the final frits is very difficult, if not impossible, to replicate.
- We report on new porous metallic structures that facilitate the fabrication of the membrane assembly.





High Pressure Membrane Assembly
enabled the development of underwater mass spectrometry



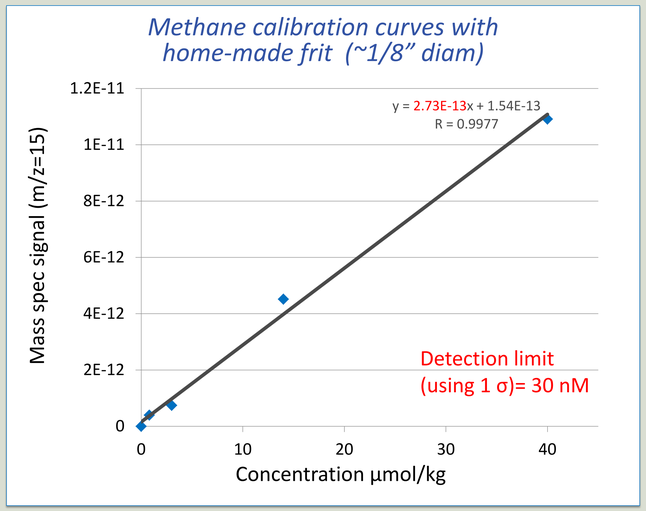
METHOD

- The Fraunhofer Institute in Dresden, Germany, used powder metallurgical processes to manufacture frits with diameters of approximately 3.0 mm (1/8”) and known porosities of 48.3 % and 32.5%
- These frits were used to fabricate new membrane interface assemblies.
- Using a custom-heated membrane probe with the new porous frits, we were able to calibrate dissolved methane concentrations to mass spectrometer responses (m/z 15) using linear least-squares fitting procedures.

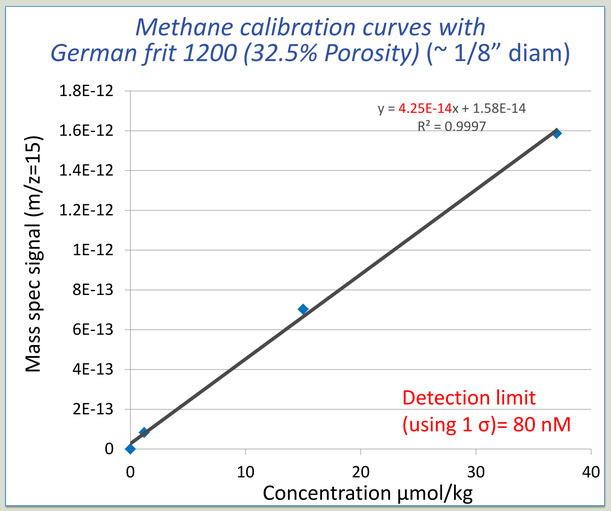
Our two research groups used metallic porous frits to mechanically support PDMS membranes, allowing the deployment of the UMSs to ocean depths of 2000 meters

RESULTS

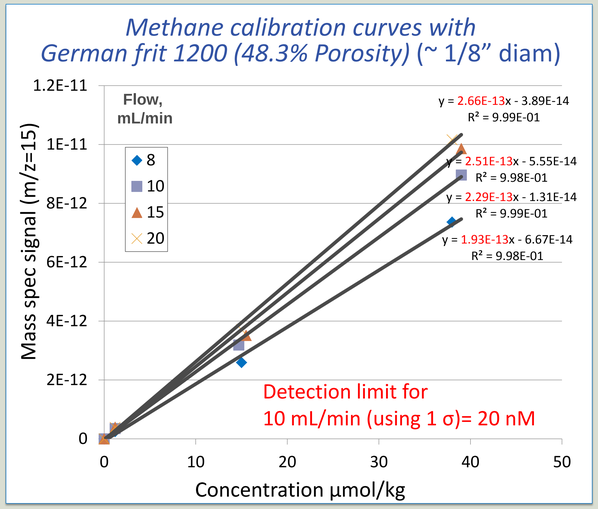
Methane calibration curves with home-made frit (~1/8” diam)



Methane calibration curves with German frit 1200 (32.5% Porosity) (~ 1/8” diam)



Methane calibration curves with German frit 1200 (48.3% Porosity) (~ 1/8” diam)



SUMMARY

- The limit of detection (methane concentration in the tens of nanomolars) and sensitivity (on the order of 10^{-1} pico-amps/nanomole of methane) were comparable with those obtained with the previously fabricated Hastalloy C frits.
- The calibration parameters for the supported membrane interface assembly depend on flow rate. We could achieve further optimization of the new frits by changing the dimensions of the channel through which the sample flows.

SELECTED REFERENCES

1. Bell, R.J., et al. (2011), *Limnol. Oceanogr.-Meth.* 9: pp. 164-175.
2. Cardenas-Valencia, A.M., et al. (2013), *Rapid Commun. in Mass Sp.* 27: pp. 635-642.