Underwater Mass Spectrometry: Developments and Deployments

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The Chemical Sensors group at SRI St. Petersburg is developing and operating underwater mass spectrometers (UMS) for chemical monitoring and profiling of our oceans, coastal regions, harbors, and internal waterways. We have developed a method to calibrate underwater mass spectrometers to make quantitative measurements of dissolved gases and volatile organic compounds (VOCs) to depths of 2000 meters. Our UMS instrument operates moored, tethered, remotely, or autonomously, allowing users to customize deployments to suit a wide variety of situations. Recent field operations, which have varied widely, included (1) depth profiling of methane hydrate fields to determine the fate of methane released from hydrates, (2) pore water sampling to quantify dissolved gas concentrations as a function of depth in the sediment, and (3) chemical surveying with the UMS on a remotely operated vehicle to provide real-time measurements of dissolved gas and VOC concentrations.

We have designed and constructed a deep-water, positive-displacement syringe pumping system which provides significantly improved sample flow rate stability compared with that of constant force pumps, such as piston pumps. The syringe pump system also allows for the introduction of reagents into the sample flow stream to induce chemical reactions that convert non-volatile and/or polar compounds into volatile non-polar species, which are then detectable with a membrane introduction mass spectrometer MIMS system. We have also designed and constructed a programmable sediment probe that interfaces with the underwater MIMS system. The probe, which was integrated with the modular programmable syringe pumping system, can be extended into the sediment for pore water sampling, or retracted for direct sampling of the water column above the sediment. Water is drawn through a thin porous filter in the probe tip, and is then analyzed by the MIMS system.

Details about system developments and data from recent deployments will be presented.