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Analytical Instrumentation for *in-situ* Biogeochemical Research

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In order to fully understand biogeochemical reactions that affect any environment, the utilization of in-situ analytical tools are key to understanding the chemistry of these complex systems. Bringing analytical instruments into the field that have been traditionally left in the lab, will offer a clearer picture of biogeochemical reactions in real time. Traditionally samples are taken from the field and later analyzed in a lab where the context of the sample may have been compromised.

This SBIR Phase II project is focused on building a new type of electrochemical device that is capable of collecting data from any environment on Earth. These new systems are voltammetric in nature and will allow the determination of the standard biogeochemicals in-situ including and not limited to, oxygen, sulfide, iron, iron sulfide, and manganese directly on one sensor in real time in about 3-5 seconds. These new instruments are capable of analyzing any ion in the environment including mercury to heavy metals from acid mine drainage down to the parts per trillion level. Several versions of this instrument are being developed for particular applications that have specific needs. A hand-held unit is being developed to quickly ascertain a particular site of interest that will allow the user to make a judgment on deploying the long-term unit for monitoring diurnal cycling of pertinent biogeochemical over time. The main deployable unit will be used to collect data over time and allow that data to be gathered and transmitted directly to a cloud server system. What makes these systems unique are the low power electronics and the new electrode systems that can be deployed for many months to years with little user servicing. We are currently going to deploy some of these new systems at the Crested Butte area in Colorado with Kenneth Williams and in Oak Ridge Tennessee with Scott Brooks.

Other devices that are produced by Analytical Instrument Systems, Inc. (AIS) include a DLK-MO-1 micro-observatory that allows data collection from a wide assortment of sensors that can be obtained commercially, an in-situ combination electrochemical analyzer and an HPLC (AIS ISEA-HPLC) instrument that allows for the determination of all the standard biogeochemical analytes, anions and organics. These systems use an embedded web server and can be addressed through standard Ethernet with any web browser. One of these instruments is being used to analyze red tide in Florida at Mote Marine Institute.

In summary AIS has had direct experience of analyzing some of the most extreme environments on Earth. From hydrothermal vents on the ocean floor at 9N EPR aboard the Alvin DSV to geysers in Yellowstone and Iceland to acid mine drainage from the most naturally polluted river on Earth, the Rio Tinto in Spain.