Advanced noble gas analytical systems control using embedded real-time process hardware and software

HOURIGAN, JEREMY K. [1], GROVE, MARTY[2]

[1]Earth and Planetary Sciences, UC Santa Cruz, 1156 High Street, Santa Cruz, CA, 95064, hourigan@ucsc.edu
[2]Geological Sciences Department, 450 Serra Mall Bldg. 320 Stanford, CA 94305, mjgrove@stanford.edu

The challenge of interfacing large commercially available systems, such as mass spectrometers, with custom-designed hardware that permits specialized process control and measurements represents an impediment to analytical innovation. We have developed two complementary noble gas extraction systems at Stanford and UC Santa Cruz leveraging the National Instruments Compact RIO (cRIO) platform. NI cRIO systems comprise a controller that runs a Linux real-time operating system (OS), and a chassis that can be populated with a diverse array of input-output modules to suit specific sensing, communication, and control needs. Implemented with LabVIEW software, the control code runs entirely within the Linux OS allowing full determinism of time-critical processes (e.g. PID control) and cuts the cord to web-connected, vulnerable desktop computers. NI cRIO controllers are ideally suited for tight integration of multiple front-end systems with mass spectrometry including: (1) laser heating systems with real-time machine vision analysis, stage motion, and temperature monitoring with embedded PID laser feedback; (2) complex multi-stage vacuum systems with valve and pressure monitoring networks augmented by temperature-controlled gettering and cryogenic systems for gas purification; and (3) full-featured mass spectrometer control for seamless interaction with the "front end" equipment. Feedback between the laser heating schedules and mass spectrometer signals allow dynamic optimization of noble gas diffusion experiments. Recent development of continuous ramp heating analytical methodologies [1,2] for (U-Th)/He thermochronology illustrates the utility of a powerful, yet flexible, mass spectrometry control system. We are actively developing similar ramp-heating extraction protocols for $^{40}Ar/^{39}Ar$ thermochronology [3]. We will demonstrate the design and functionality of the Stanford and UCSC control systems with a focus on innovative coupled heating and mass spectrometry optimization.

[1] Idleman *et al*. (2018) *Chem. Geol.* ***476***, 223-232. [2] McDannell *et al*. (2018) *Geoch. et Cosmoch. Acta* ***223***, 90-106. [3] Grove et al., this volume.

This abstract is too long to be accepted for publication. Please revise it so that it fits into the column on one page.