Developments in Noble Gas mass spectrometry

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Recent advances in ion optics and electronic design have added features to the new range of Noble Gas mass spectrometers from Thermo Fisher Scientific that will enable the scientific community to resolve a number of existing analytical limitations.

The first development relates to detector technology. Because instrument transmission and ion source efficiency can be very high, detector noise can be the limiting factor for ultra-small sample analysis. Faraday cup detectors are the detectors of choice for high accuracy and high precision isotope ratio measurements because of their unmatched stability and linearity and because of the electronic cross calibration network available to precisely and accurately cross calibrate the multiple Faraday detector channels against each other.

Today, most IOMS systems are equipped with current amplifiers using a 10^{11} Ohm resistor coupled to the feedback loop of a high stability and temperature-stabilized operational amplifier.

In this paper we will describe our latest investigations in Faraday cup measurements utilising 10^{12} & 10^{13} resistors for signal intensities in the range of 1 pA to 1 fA.

The second development relates to a new beam deflection technology added to the new ARGUS VI mass spectrometer that enables a fixed collector array to be given some of the properties of a mechanically adjustable array. This enables multi-dynamic multi-collector measurements to be taken utilising a fixed array thus enabling the end user to perform vital detector cross-calibrations “in run”.

Lastly we will describe early results on a new high resolution platform and the capabilities of this platform to finally deal with certain isotopic interferences in both the Argon and Neon spectra.

Martian surface geochemistry from MGS TES: Evidence of global-scale dissolution of olivine from basalts

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Previous studies of MGS TES-derived major element oxides have found relatively high SiO_2 abundances, interpreted as being due to the presence of high-silica weathering phases in basaltic materials [e.g., 1]. Our derivation of major element chemistry from TES is not substantially different than that obtained in previous studies. However, we have applied new and different approaches to analyzing the data in terms of primary and secondary compositions and draw additional conclusions for the weathering history of the Martian surface.

The molar proportions of Al_2O_3, $CaO+Na_2O+K_2O$, and $FeO+MgO$ can be indicative of weathering trends and the global TES data plot along a line that is consistent with the trend measured in Gusev crater. In Gusev, this trend is attributed to olivine dissolution at low water-to-rock ratios [e.g., 2]. On this diagram, however, the same trend also could reflect primary igneous variation, for which there is evidence on Mars [e.g., 3]; we are in the process of examining trends on regional scales to distinguish between these in TES data.

To evaluate primary igneous trends, we excluded all likely weathering phases and recalculated the bulk oxides. As a result, SiO_2 is reduced relative to prior studies, and overlaps the basaltic field on a total alkalis vs. silica classification diagram to a greater degree than shown previously. On a plot of FeO^*/MgO vs. SiO_2, however, our data still largely plot in the calc-alkaline field. This suggests that the igneous phases represent: 1) a non-tholeiitic composition, 2) weathering of a tholeiitic composition that enriches the residual material in relatively higher SiO_2 phases, and/or 3) a weathered tholeiitic composition depleted in FeO relative to MgO. In the absence of evidence for abundant calc-alkaline compositions on Mars, we suggest that olivine dissolution could produce both 2 and 3 above, offering a plausible explanation for the observed trends. We are recalculating compositions with added olivine to constrain how much olivine could have been removed to produce the observed compositions.

[1] McSween *et al*. (2009) *Science*, **324**, 736-739. [2] Hurowitz *et al*. (2006) *JGR*, **111** (E02S19). [3] Rogers and Christensen (2007) *JGR*, **112** (E01003).