Surface analysis of Mercury with a mass-spectrometer

Conference or Workshop Item

SURFACE ANALYSIS OF MERCURY WITH A MASS-SPECTROMETER. J. A. Whitby, H. Busemann, U. Rohner, W. Benz, P. Wurz. Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland.

Introduction: The European Space Agency BepiColombo mission to Mercury will include a lander, the Mercury Surface Element (MSE). Although the final configuration of instruments is still to be decided, we are developing a mass spectrometer suitable for use on this lander, or in other missions where low mass and low power consumption are a priority. Advantages of a mass-spectrometer over other analytical instruments include sensitivity to almost all elements, high dynamic range, spatially resolved measurements (with an appropriate sampling technique) and the potential to determine isotopic compositions.

The instrument: Using experience gained during the construction of the RTOF [1] instrument for the Rosetta mission we have built a miniature reflectron time-of-flight mass analyser with ~10cm dimensions and a benchmark instrument mass of 150g (plus electronics and wiring harness). Sample introduction and ionization will be by means of a pulsed laser. Early tests of the analyser alone show good agreement with ion-optical simulations – mass resolution is $M/\Delta M$ ~300 at half-height and can be increased to ~1000 with additional energy filtering. We will present results obtained with the laser ablation source at the meeting.

Application: In a similar device [2] elemental ratios have been measured with an uncertainty of ~10%, and isotopic ratios to better than 30‰. We anticipate collecting 10^4 spectra per second of operation, each of ~10^5 detected ions and so for many isotopic ratios of interest, the uncertainty will be dominated not by counting statistics but by the stability of matrix and instrumental mass fractionation effects. A limiting factor in practice will be the dynamic range of the instrument, determined in large part by the background observed in a flight optimised instrument. Fig. 1 shows a simulated mass spectrum for enstatite, a plausible component of the Hermean regolith [3]. Oxygen isotopes are cleanly resolved with no expected interferences and in principle isotopic ratios could be determined with a precision (if not accuracy) of the order of 1 per mil.

References:

[1] H. Balsiger et al. (998) *Adv. Space. Res., 21,* 1527. [2] W. B. Brinckerhoff et al. (2000) *Rev. Sci. Instrum., 71,* 536. [3] L. V. Ksanfomaliti (2001) *Solar System Res., 35*, 339.

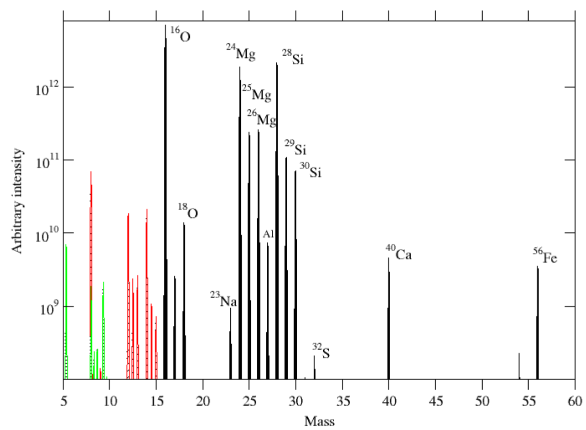

FIG. 1: Simulated mass spectrum of enstatite