First results from the C1XS X-ray spectrometer on board Chandrayaan-1

I.A. CRAWFORD[1]*, B.J. KELLETT[2], M. GRANDE[3], B.J. MADDISON[2], C.J. HOWE[2], B. SWINYARD[2], K.H. JOY[1,2], P. SREEKUMAR[4], S. NARENDRANATH[4], J. HUOVELIN[5] AND THE C1XS SCIENCE TEAM[6]

[1]UCL/Birkbeck Centre for Planetary Sciences, Gower Street, London, WC1E 6BT, UK. (*correspondence: i.crawford@ucl.ac.uk)
[2]Space Science Department, Rutherford Appleton Laboratory
[3]University of Wales, Aberystwyth, UK.
[4]Indian Space Research Organisation, Bangalore, India.
[5]Observatory, University of Helsinki, Finland.
[6]See: http://www.sstd.rl.ac.uk/c1xs/CO-I.htm

The Chandrayaan-1 X-Ray Sectrometer (C1XS) is a UK-built instrument that was successfully launched on 22 October 2008 on India's first mission to the Moon [1,2]. By performing high spectral (~110 eV) and spatial (50 km) resolution measurements of the abundances of major rock-forming elements in the lunar surface, including the presently poorly constrained Mg abundance, C1XS will address important unresolved questions in lunar science [3]. An example of the capabilities of C1XS during an A-class solar flare is shown in Fig. 1. The spectrum shows that the Mg, Al and Si lines are detected and well-resolved. A compositional analysis of this spectrum, and comparison with the ground-truth from the Apollo 14 samples, will be presented.

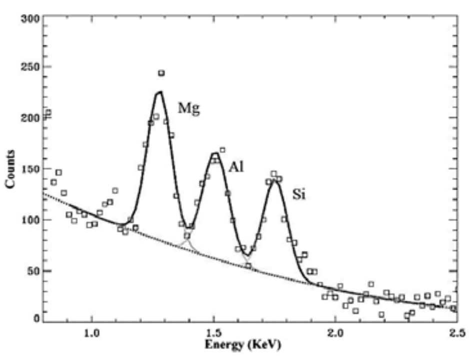

Figure 1: A spectrum obtained on 10 Jan 2009 (15:55 - 16:04 UT); corresponding to a ground track of ~50 × 750 km (including the Apollo 14 landing site at 17.5° W, 3.7° S).

[1] Grande *et al*. (in press) *Planet. Space Sci*. [2] Howe *et al*. (in press) *Planet. Space Sci*. [3] Crawford *et al*. (2008) *Planet. Space Sci* DOI: 10.1016/j.pss.2008.12.006.

Mg/Ca ocean paleo-temperatures from New Zealand foraminifera in the Eocene greenhouse world

JOHN CREECH[1]*, JOEL BAKER[1], CHRIS HOLLIS[2], HUGH MORGANS[2] AND ERICA CROUCH[2]

[1]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand (*correspondence: john.creech@gmail.com)
[2]GNS Science, P.O. Box 30368, Lower Hutt 5040, New Zealand

We have used laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) techniques to measure *in situ* element/Ca ratios of planktonic and benthic foraminifera of Early Eocene age, in order to reconstruct sea surface (SST) and bottom water (BWT) temperatures for the high-latitude South Pacific during the period 51 – 46.5 Ma, which includes the Early Eocene Climatic Optimum (EECO). The same suite of samples have been analysed for $\delta^{18}O$ and TEX_{86}, allowing comparison between independent geochemical temperature proxies and the Mg/Ca paleothermometer [1].

Thirteen species of planktonic and benthic foraminifera have been analysed from four samples from the mid-Waipara and Hampden sections, New Zealand (paleo-latitude ca. 55°S; paleo-depth ca. 1000 m). Electron microscopy shows that the preservation of these specimens is variable. However, the laser ablation technique permits multiple analyses per specimen, and yields a trace element/Ca profile through the test that makes it possible to identify and avoid zones of surficial and internal contamination resulting from diagenetic coatings, mineralisation and detrital sediment.

The species Morozovella crater, Acarinina primitiva, Cibicides spp. A, Vaginulinopsis marshalli and Bulimina subbortonica were identified as being best suited for temperature reconstructions, and used to develop inter-species Mg/Ca-temperature calibrations. Subsequently, these species were used to produce a temperature record for the EECO at ca. 200 kyr resolution. The Mg/Ca temperatures are broadly consistent with those derived from $\delta^{18}O$ and TEX_{86}, with near tropical SSTs of ca. 25-30°C and BWTs of ca. 15-19°C. A cooling event of ca. 4°C occurred ca. 48.5 – 47.5 Ma, which may coincide with the Azolla interval of [2].

These results demonstrate the ability of LA-ICP-MS to recover reliable past ocean temperatures from less than ideally preserved foraminifera, and provide important constraints on climatic conditions in the Early Eocene.

[1] Hollis *et al*. (2009) *Geology* **37**(2) 99-102. [2] Brinkhuis *et al*. (2006) *Nature* **441**, 606-609.