**HALOGENS IN LUNAR SAMPLES BY THE NOBLE-GAS METHOD.** P. L. Clay¹, F. E. McDonald¹, K. H. Joy¹, R. Burgess¹, L. Ruzié², B. Joachim² and C. J. Ballentine². ¹School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Manchester, M13 9PL, UK., ²Faculty of Geo- and Atmospheric Sciences, Institute of Mineralogy and Petrography, University of Innsbruck, Innsbruck, Austria. ³ Dept. of Earth Sciences, University of Oxford, Oxford, UK. E-mail: patricia.clay@manchester.ac.uk

**Introduction:** The lunar interior has historically been thought to be depleted in volatiles, lost upon collision during a large-impact scenario between Earth and a Mars-sized body [e.g. 1,2]. Recently, SIMS studies of melt inclusions from lunar glass beads [3,4] andapatite in lunar meteorites and mare basalts [e.g. 5-7] suggest that the lunar mantle may contain water in similar abundances as the terrestrial upper mantle. Still other studies, e.g., Cl isotopes [8], show that the lunar mantle should be anhydrous. New dynamical models [9] may be moving towards reconciling a volatile-rich versus volatile-depleted lunar interior.

In this study, we have measured halogen (Cl, Br and I) element concentrations in a wide range of major lunar lithologies (see details below) to characterise the halogen budget of different lunar rock suites and investigate their source regions. This investigation is especially critical for Br and iodine where the database is particularly lacking for lunar samples.

**Sample Selection:** Nine samples were selected to represent various sample types, landing sites, and distinct sample chemistry. Two ferroan anorthosites (FAN) (15415 and 60025) represent ancient lunar highland lithologies, potentially sourced from the primary lunar crust crystallised during the lunar magma ocean. These FANs have both experienced impact shock disturbance of their isotopic systems. Dunite sample 72415 represents the product of ancient (>3.9 Ga) magmatism from the High Mg-Suite. Mare basalts, samples 12018 and 12075 (low-Ti olivine basalts) and samples 10092 (high-Ti) and 12005 (low-Ti ilmenite basalt) were chosen to represent partial melts of different regions of the lunar interior, erupted onto the lunar surface from 3.8-3.2 Ga. The picritic glass beads (picked from from lunar soils), sample 74220 ‘orange glass’ and sample 15427 ‘green glass’, access primary volcanic melt products representing melting from high-Ti and very low Ti (VLT) deep sourced (~400 km) regions of the lunar mantle.

**Methodology:** Samples were prepared as bulk whole rocks (mare basalts and FANs) and as mineral/glass separates (mare basalt olivines and soil glass beads). Whole rock samples were gently crushed in a ceramic mortar and pestle followed by sieving and hand picking of olivines. Soil samples were sieved and glass beads were extracted by size fraction (~200 μm) and selected by optical characteristics.

Halogen abundances were determined by neutron irradiation noble gas mass spectrometry (NI-NGMS). This method utilises the neutron conversion of Cl, Br, and iodine into the readily measurable noble gas proxy isotopes $^{38}$Ar$_{Cl}$, $^{80}$Kr$_{Br}$ and $^{128}$Xe$_I$ [10]. After irradiation, halogen abundances were calculated by using the neutron fluxes determined from included monitors minerals of known halogen composition. Samples were analysed on a ThermoFisher ARGUS VI™ low volume (700 cm$^3$), Nier-type, static vacuum mass spectrometer designed for multi-collection of Ar isotopes, but in this study set to optimise the measurement of Ar, Kr and Xe. Gases were released using a 55W CO$_2$ laser by CETAC with a 3 mm beam diameter and fused in a single step of 6% to 12% laser power. Gases were purified using an NP10 hot getter and transferred onto a liquid N$_2$-cooled charcoal finger for five minutes followed by warming to ~60°C to release the gases. Isotope abundances were determined by regression to the initial inlet time after 9 measurement cycles. All isotopes were corrected for extraction line blanks, which typically contributed <1% of $^{38}$Ar, $^{80}$Kr and $^{128}$Xe. Ar isotopes were corrected for mass discrimination, radioactive decay of $^{37}$Ar$_{Ca}$ and $^{39}$Ar$_{K}$ and for typical neutron-produced interference isotopes. Krypton and Xe were corrected for epi-thermal neutron production using the scapolite monitor minerals BB1 and BB2/SP and the Shallowater aubrite [10].

**Forthcoming Results:** All samples are variably affected by the presence of trapped and cosmogenically derived noble gases; correcting for these contributions complicates resolving the nuclegenic component, to an extent which is still being determined. A methodology for separating the different contributions is being developed and the full results will be presented and discussed at the meeting, in the context of understanding the halogen budget of the lunar interior.