Geophysical Research Abstracts
Vol. 20, EGU2018-13231, 2018
EGU General Assembly 2018

Scientific performance of the Gas Chromatograph Neutral Gas Mass Spectrometer for the Luna-Resurs Mission

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Analyzing chemical composition of the lunar surface imparts knowledge about origin and evolution the Moon. Among the scientific instruments selected for investigation onboard the Russian Luna-Resurs mission the gas-chromatograph mass spectrometer complex will investigate volatiles including water in the lunar soil and exosphere in situ. Since available lunar samples originate from a restricted area near the equator, Luna-Resurs landing near the lunar South Pole provides access to lunar soil of a very different area, and being near the pole lots of volatiles are expected to be frozen in to soil.

We developed a compact time-of-flight mass spectrometer (the neutral gas mass spectrometer, NGMS) that is coupled with a gas chromatograph (GC) to investigate volatile fraction of lunar regolith. The NGMS instrument is capable to record the continuous GC outflow allowing for highly sensitive measurements of chemical compositions as recently demonstrated. The NGMS instrument has mass resolution of up to $m/\Delta m = 1200$. The GC system has two chromatographic columns, one for optimised hydrocarbons and one for noble gases. It chemically pre-separates molecules based on their retention in the column in time, mitigating interferences at close mass-to-charge ratio in the mass spectrum and allowing for improvement of chemical separation and identification of complex chemical mixtures.

Calibration measurements with noble gas mixtures (and CHON) indicate that the NGMS instrument is capable to detect even trace quantities of species at 10^{-16} mbar partial pressure when assuming the low ambient gas pressure of the lunar atmosphere of the order of 10^{-10} mbar. The dynamic range and mass resolution of the coupled GC-NGMS allows analysis of isotopic, elemental, and molecular with their structure, composition at once.