Oxidized organic aerosol components in Cabauw, Netherlands, during the May 2008 EUCAARI IOP: NMR spectroscopic characterization and factor analysis

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Outside urban areas, oxidized organic aerosols (OOA) dominate the composition of the organic atmospheric particulate matter. In the frame of the EUCAARI (European integrated project on Aerosol Cloud Climate Air Quality Interactions) project, the submicron aerosol chemical composition in Cabauw, Netherlands, was characterized by means of proton-Nuclear Magnetic Resonance (^{1}H-NMR) spectroscopy with aim of organic aerosol characterization and source apportionment. The analysis was applied to water-soluble organic aerosols (WSOA), which is a proxy for OOA.

A set of 25 PM1 filter samples, collected in a period of prolonged stable anticyclonic conditions and of accumulation of pollutants, were analysed by ^{1}H-NMR spectroscopy and the resulting collection of spectra was processed using a suite of chemometric techniques, including PCA, cluster analysis and factor analysis (PMF, NMF, MCR) aiming to identify recurrent spectral profiles, to quantify their relative contributions and so to identify different prevalent sources.

Factor analysis identified three factors with characteristic spectral profile: (a) OOA associated to metanesulphonic acid (MSA), (b) humic-like substances (HULIS) and (c) other complex OOA enriched in aliphatic acids. The analysis of metadata (meteorological variables, concentrations of nitrate, sulfate, ammonium, potassium, black carbon, and air masses origin), shows that the MSA-containing OOA factor is associated to northerly marine air masses, the HULIS are carried by polluted continental air masses, whereas the aliphatic-rich OOA have no clear dependence on wind direction.

The comparison of these results with those of Positive Matrix Factorization (PMF) applied to a parallel AMS dataset showed a good agreement between NMR 'HULIS'-factor and one type of AMS 'LV-OOA' (a-type).

Volatile loss via outgassing of the lunar magma ocean

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Among the most striking observations made of the Apollo samples is the depletion of trace elements in lunar materials [1] including moderately volatile elements (i.e. potassium) that condense from the solar nebula at relatively high temperature (T > 1000 K). While initially thought to be a feature of the degassing of lunar magmas into vacuum, the depletion of volatile elements in lunar samples has since been established as a feature of interior reservoirs [2] and therefore potentially diagnostic of the processes of lunar formation. While this observation is generally thought to be consistent with the high energy events associated with a giant impact, no quantitative scenario has been put forward to explain it. In particular, the settings and processes relevant to the volatile loss episode(s) have not been identified, and the isotopic signatures expected for the various scenarios have not been developed.

The energy released in the Moon-forming giant impact is sufficient to melt and partially vaporize both the Earth and the impactor. The timescale to eliminate this heat by radiation is ~10^3 years [3]. Hence, the Earth-Moon system is expected to be in a melt-vapor state for the first thousand years after the giant impact. Moreover, the Moon-forming material may revaporize during the process of lunar accretion from a disk if the process is sufficiently rapid [4]. Previous work has shown that silicate vapors are gravitationally bound to the gravity field of the Earth, even at the high temperatures encountered after a giant impact [5]. We have investigated the conditions necessary for the efficient outgassing of the lunar magma ocean and hydrodynamic escape of the resulting transient atmosphere from the weak lunar gravity field. We will present predictions for isotopic signatures that can test and constrain such a scenairo experimentally.

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