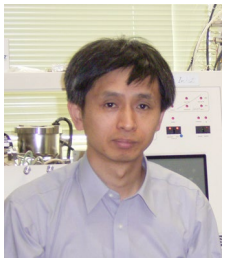
【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)



# Title of Project : Advanced Trace Organic Compound Study in Planetary Materials: Development of High Sensitivity and High Resolution

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Research Project Number : 15H05749 Researcher Number : 20198386
Research Area : Earth and Planetary Science, Cosmogeochemistry
Keyword : Planetary Materials, Trace Organic Compounds, High Sensitivity, High Resolution

## 【Purpose and Background of the Research】

Organic compounds are distributed widely in terrestrial and extraterrestrial environments, and are characterized by their various chemical structures consisting predominantly of carbon (C) with hydrogen (H), nitrogen (N), oxygen (O) and sulfur (S). Recent ultrahigh-resolution mass spectral analysis have detected tens of thousands of different mass peaks consisting of C, H, N, O, and/or S in a carbonaceous meteorite. Considering the structural and optical isomers, hundreds of thousands of organic compounds may be present in the meteorite. Currently, the organic contents identified in meteorites correspond to only approx. 1% of the total compounds present. Moreover, the quantities of planetary material obtained by sample-return missions from asteroids or ocean-drilling projects are extremely limited. In order to obtain detailed information on planetary organic compounds, the development of ultra-high sensitivity and resolution analyses is needed.

This project will study trace organic compounds of planetary materials (e.g. meteorites) using advanced chromatography and mass spectrometry with ultra-high sensitivity, resolution and separation (previously unavailable), to elucidate their history and mechanisms of formation.

## 【Research Methods】

The following advanced analyses and development will be performed over the next 5 years: 1) Clean room environment to avoid organic

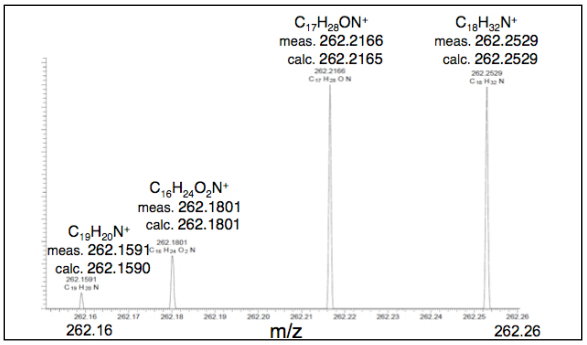


Figure 1 HRMS

contamination; 2) Detection limit (sensitivity) down to ~$10^{-18}$ mol from previous ~$10^{-15}$ mol level; 3) Ultra-high mass resolution up to ~300,000 to determine the elemental composition using exact mass (HRMS, Fig. 1); 4) Superior chromatographic separation using high-resolution column and/or 2-D columns to determine structural and optical isomers; and 5) Development of in-situ organic compound analysis of sample surface using desorption electrospray ionization.

## 【Expected Research Achievements and Scientific Significance】

The technical development will allow for the improved identification of organic compounds compared to current analysis, and will advance our studies of the formation pathways and origins of planetary materials. Furthermore, the new techniques will allow for the definitive identification of organic compounds in greatly reduced sample sizes (using ~μg of sample vs. current ~mg requirement), thereby contributing to the successful analysis for future sample-return missions (e.g. Hayabusa 2 and OSIRIS-REx). The methodology will also be applicable to various types of other rare, precious, and small samples for environmental and biochemical studies.

## 【Publications Relevant to the Project】

Y. Yamashita and H. Naraoka (2014) Two homologous series of alkylpyridines in the Murchison meteorite. *Geochem. J.*, **48**, 519-525.
H. Naraoka, et al. (2012) Preliminary organic compound analysis of microparticles returned from Asteroid 25143 Itokawa by the Hayabusa mission. *Geochem. J.*, **46**, 61-72.

## 【Term of Project】

FY2015-2019

## 【Budget Allocation】

154,800 Thousand Yen

## 【Homepage Address and Other Contact Information】

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