SOLUBLE ORGANIC MATTER (SOM) STUDY OF THE HAYABUSA2-RETURNED SAMPLES: THE FIRST REHEARSAL ANALYSIS. H. Naraoka[1], Y. Takano[2], J. P. Dworkin[3] and SOM analysis team, [1]Research Center for Planetary Trace Organic Compounds, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan (naraoka@geo.kyushu-u.ac.jp), [2]Japan Agency for Marine-Earth Science Technology (JAMSTEC), 2-15 Natsushima, Yokosuka 237-0061, Japan (takano@jamstec.go.jp), [3]NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, U.S.A. (jason.p.dworkin@nasa.gov).

Introduction: Asteroid 162173 Ryugu is a carbonaceous asteroid possessing primitive surface materials with low abundance hydrous minerals [1]. The Hayabusa2 spacecraft twice performed touch and go sampling of the surface materials of Ryugu, which will be delivered to Earth in late 2020. Because the asteroid surface appears composed of materials similar to that of carbonaceous chondrites, the returned materials are expected to yield water- and organic-soluble organic matter (SOM). The occurrence of SOM in Ryugu will provide clues to the formation pathways of organic compounds as well as prebiotic molecules with respect to origins of life in the solar system. We have organized a 27-member international team for the initial SOM analysis for the Hayabusa2-returned samples. The first rehearsal analysis is conducted using comparatively large amounts of organic rich and poor carbonaceous chondrites (~50 mg) followed by a <10 mg rehearsal next year of the same meteorites and blanks, since the sampling amount is expected to be ~100 mg [2]. The comprehensive SOM analyses have been developed using high-sensitive and high-resolution analytical methods [3], because meteoritic SOM usually occurs as a complex mixture consisting of various types of organic compounds with very small concentrations at each compound.

Samples and Methods: Two CM carbonaceous chondrites (Murchison and Yamato793321), 500°C air baked serpentine blank, and procedural blanks were used to evaluate various analytical techniques for comparison with the results by previous studies. The Murchison meteorite's rich SOM distribution has been extensively studied on the SOM distribution, while the Y793321 meteorite is thermally altered and SOM depleted. The powdered samples were extracted sequentially with non-polar (hexane) to polar (H_2O) solvents in an ISO5 clean bench set inside of an ISO6 clean room to avoid contamination. The solvent extracts were delivered to the team for the molecular and isotopic analyses as follows: 1) High-Resolution Mass Spectroscopy (HRMS) using electrospray ionization (ESI) by Fourier Transform-Ion Cyclotron Resonance/MS (FT-ICR/MS) [4], 2) HRMS with nano-liquid chromatography (nanoLC) by nanoESI with Orbitrap MS [3], 3) Chiral amino acid analysis using ultrahigh-performance LC (UHPLC) with fluorescence detection (FD) coupled with HRMS [5, 6]. 4) Compound-specific isotope analysis using gas chromatography (GC)/Orbitrap MS [7] and GC/Combustion/ isotope ratio MS (GC/C/IRMS), 5) *In situ* organic compound analysis using desorption electrospray ionization (DESI) equipped with Orbitrap HRMS [8]. 6) Spatial resolution imaging of organic compounds using Time of Flight-Secondary Ion MS (ToF-SIMS) [8], and 7) Bulk stable isotopic compositions of C and N using nano-elemental analysis/IRMS [10, 11].

Results and Discussion: The FT-ICR/MS analysis of Murchison revealed significantly diverse molecular compositions with the homologous series, being consistent with the previous studies [4]. The various structural isomers were identified using nanoLC/nano ESI/Orbitrap MS, in which the CHN compounds (positive) and sulfur-containing compounds (negative) were predominant in the dichloromethane and methanol extracts of Murchison, being similar results as the previous study [12]. The 3D-HPLC/FD analysis clarified some chiral amino acid distribution of the Murchison meteorite, in which non-proteinogenic amino acids were present as racemic mixtures. The heterogeneous distribution of the CHN compounds was revealed by DESI/Orbitrap MS, which is consistent with previous studies [3, 8]. Unsurprisingly, Y793321 meteorite yielded much less SOM using these analytical methods.

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