Raman Spectroscopy of organic matter in Bennu particles.

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Introduction:

In September 2023, approximately 120 g of material from asteroid Bennu was successfully returned to Earth by the OSIRIS-REx spacecraft [e.g., 1]. Samples returned from asteroid Bennu exhibit mineralogical similarities to Ryugu particles and CI chondrites, however, differences in the characteristics of organic matter have been reported [1–3]. Our previous studies of Ryugu particles demonstrated that Raman spectroscopy is an effective tool for assessing the thermal primitiveness of organic matter in returned asteroid materials [4–6]. The results indicate that Ryugu particles did not experience long-duration thermal metamorphism. In addition, the high fluorescence intensity of Ryugu organic matter, comparable to that of CI chondrites, reflects its primitive chemical composition [6]. To better characterize the organic matter in particles returned from asteroid Bennu, we conducted Raman spectroscopic analyses of Bennu particles.

Results and Discussion:

Raman point analyses were performed on three intact grains of Bennu samples (ORX10059, ORX10060, and ORX20007). In addition, the residues after water and solvent extraction (ORX10028 and ORX20015), the residues after HCl treatment (ORX10028 and ORX20015), and the insoluble organic matter (IOM) residues after HF/HCl treatment (ORX10037, ORX10041, ORX20014, and ORX20018) [7] were examined.

The Raman spectra of Bennu particles exhibit broad D and G bands, indicating the presence of disordered polyaromatic carbonaceous matter. They also exhibit systematically higher fluorescence intensities than type 2 and type 3 carbonaceous chondrites, consistent with the presence of thermally immature organic matter and minimal parent-body thermal metamorphism. Among the intact particles, the fluorescence intensity decreases in the order ORX10059 > ORX10060 > ORX20007. Our collaborative studies have shown that ORX20007 is characterized by relatively lower abundances of organic matter (OM) and phyllosilicates compared with other particles [7], as well as partial enrichment in ammonium salt [8]. These characteristics are likely to contribute to the low fluorescence intensity of this particle.

The Raman parameters of Bennu particles in this study are characterized by small I_D/I_G ratios and large full-width at half maximum of D band. Although some variability is observed both among the three Bennu particles and within individual particles, the Raman parameters of Bennu overlap with those of CI and CM chondrites and are clearly separated from thermally metamorphosed type 3 chondrites such as Allende, and also appear to be distinguishable from the heated CM chondrite Jbilet Winselwan.

In this study, we also analyzed extracted residues obtained using different extraction methods. A decrease in fluorescence intensity was observed depending on the extraction method. In contrast, no systematic variation in Raman parameters related to the extraction method was observed, and we found no clear difference in Raman parameter values between the residues and the intact grains.

The Raman characteristics of Bennu particles suggest that the organic matter in Bennu was not subjected to high-temperature, long-duration radiogenic heating. Accordingly, the overall Raman signatures of organic matter in the Bennu particles are most similar to those of CI chondrites, providing constraints on the low-temperature environment on asteroid Bennu and demonstrating the utility of Raman spectroscopy

for investigating parent-body processes in returned asteroid materials.

References: [1] Lauretta D. et al. (2024) *MAPS 59*, 2543–2486. [2] Glavin et al. (2025) *Nat Astron* 9, 199–210 [3] Cody et al. (2026) *GCA 413*, 33–47. [4] Yabuta et al. (2023) *Science* 379, eabn9057. [5] Bonal et al. (2023) *Icarus*, 408, 115826. [6] Komatsu et al. (2024) *MAPS 59*, 2166–2185. [7] Yabuta et al. (2026) *LPSC* no.1809 [8] Kebukawa et al. (2026) *LPSC.* no.1385.

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