

Primordial aqueous alteration signatures in the carbonaceous asteroids Bennu and Ryugu: Insight from keto–enol tautomerism.

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The samples of carbonaceous asteroid (101955) Bennu collected by the OSIRIS-REx spacecraft contain primordial chemical information, including light elements (e.g., C, N, H, O, S) and their isotopic compositions [1]. Pristine soluble organic matter (SOM) [2] and distinct mineralogical signatures [3] are of high scientific value, as previously described for samples from carbonaceous asteroid (162173) Ryugu [e.g., 4-6]. One of the key issues in investigating these two carbonaceous asteroids is the interaction among water, organics, and minerals. Therefore, we searched for molecular signatures to estimate the degree of aqueous alteration in Bennu. We focus on hydrophilic organic molecules to study keto-enol tautomerism of underivatized dicarboxylic acids (e.g., HOOC-R-COOH; R-alkyl chains of carbon). The analysis of these underivatized dicarboxylic acids in Ryugu samples indicated that malonic acid (HOOC-CH₂-COOH, as normalized by mole%) was particularly sensitive to molecular tautomerism in the presence of water (i.e., time and physicochemical factors) [4]. We applied our analytical protocol developed for Ryugu [4,5] to Bennu samples. Specifically, we analyzed a homogenized aggregate (OREX-800107-106) [7] and a mottled sample (OREX-800023-100) [8,9], along with CI chondrite reference samples, to evaluate the molecular diversity of soluble organic matter. The visualization scheme of mass defect (MD = exact mass – nominal mass) was applied using high-resolution mass spectrometry (HRMS) [after 10]. In this presentation, we compare the aqueous alteration signatures in soluble organic molecules from samples of the two carbonaceous asteroids and the CI chondrites.

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References: [1] Lauretta and Connolly et al. (2024) Meteoritics & Planet. Sci. 59, 2453–2486. [2] Glavin et al. (2025) Nat. Astron. 9, 199–210. [3] McCoy et al. (2025) Nature 637, 1072-1077. [4] Naraoka et al. (2023) Science 379, eabn9033. [5] Takano et al. (2024) Nat. Commun. 15, 5708. [6]