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New consortium study to determine the solar system composition using Ryugu samples

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The Hayabusa 2 spacecraft sampled ~5.4 g of asteroidal materials from Cb-type asteroid Ryugu [1]. Initial analysis of Ryugu materials revealed a mineralogical, chemical, and isotopic kinship to the CI chondrites [2-3]. The pristine nature of Ryugu makes the returned samples ideal to constrain the solar system composition. Here, we propose to establish a new consortium to estimate solar elemental and isotopic abundances based on analyses of Ryugu samples. The present study summarizes the elemental abundances in bulk Ryugu samples published to date, evaluates the compositional variability, and compares the results to those of CI chondrites. The ultimate goal of the consortium is to determine the reference values for bulk Ryugu material, which will be used by multi-disciplinary communities including earth and planetary sciences, astronomy, physics, and chemistry.

Figure 1 presents the CI-normalized abundances of 18 selected elements in Ryugu samples reported by [2-3]. The results obtained by the two studies are generally in good agreement with each other, whereas some elements (e.g., P, Ca, Mn, REEs) show large relative dispersion compared to the other elements, which most likely stems from the presence of aqueously formed secondary minerals (e.g., carbonates, phosphates) in Ryugu. Therefore, estimating solar composition using currently available Ryugu data is challenging due to the nugget effect of carbonates and phosphates, and possibly other accessory minerals. We estimated that for 1 g of Ryugu sample homogenized, the dispersion (2SD) of the bulk Mn/Cr and Rb/Sr ratios will be better than ~±5%. The first step is to produce a homogenous powder from a large sample (i.e., the Ryugu Reference Powder), which will be analyzed by several teams of the consortium to obtain the abundances of all analyzable elements. This approach is important to constrain the "cosmic" composition, and test if previous estimates based on CI chondrites stored in museums for decades to centuries are reliable. The consortium solicitation will be announced later by JAXA.

References: [1] Tachibana S. et al. (2022) *Science, 375,* 1011–1016. [2] Yokoyama T. et al. (2022) *Science,* eabn7850. [3] Nakamura E. et al. (2022) *Proc. Jap. Acad. B, 98,* 227–282.

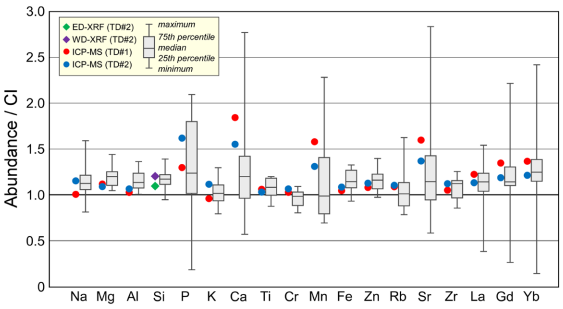

Figure 1 CI-normalized elemental abundances in bulk Ryugu samples. Diamonds (XRF) and circles (ICP-MS) are those obtained using ~25 mg of powdered Ryugu samples (Yokoyama et al., 2022). Boxplots were created from the ICP-MS data of 16 individual Ryugu grains with digested masses of 0.2-3 mg except for Si that was measured by electron probe (Nakamura E. et al., 2022). CI data are from Lodders (2021).