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NICKEL ISOTOPIC COMPOSITION OF RYUGU SAMPLES RETURNED BY THE HAYABUSA2 MISSION

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Nucleosynthetic isotope anomalies in meteorites show that the solar protoplanetary disk can be subdivided into the non-carbonaceous (NC) and carbonaceous (CC) reservoirs, which likely represent the inner and outer solar system. The return of samples from the Cb-type asteroid Ryugu by JAXA's Hayabusa2 mission provides a new opportunity to assess genetic links among materials from the CC reservoir, because Ryugu appears to be closely related to CI chondrites [1,2]. In particular, Ryugu and CI chondrites share the same nucleosynthetic Fe isotope signatures, which are distinct from those of all other carbonaceous chondrites [3]. Nickel isotopes hold considerable promise to further investigate the genetic link between Ryugu and CI chondrites, because CI chondrites display the largest μ^{62}Ni and μ^{64}Ni anomalies among carbonaceous chondrites (μ^{i}Ni is the parts per million-deviation from terrestrial standard values) and are characterized by distinct μ^{60}Ni values compared to all other CC materials. We analyzed four Ryugu samples (A0106, A0106–A0107, C0107, C0108) together with a comprehensive set of carbonaceous chondrites. The new Ni isotopic data for CM, CO, CV, and CR chondrites agree well with those reported in previous studies and reveal that these chondrites are characterized by negative μ^{60}Ni and positive μ^{62}Ni and μ^{64}Ni values. The ungrouped carbonaceous chondrites Tagish Lake (TL) and Tarda, for which no Ni isotopic data have been reported previously, also show similar Ni isotopic signatures. By contrast, the Ryugu samples, like CI chondrites, have larger μ^{60}Ni, μ^{62}Ni, and μ^{64}Ni values compared to all other carbonaceous chondrites. Thus, like for Fe isotopes [3], the Ni isotope results reveal a distinct genetic heritage of Ryugu/CI chondrites from other carbonaceous chondrites, indicating they derive from a different region of the solar protoplanetary disk, which is likely located further away from the sun. The implications of these findings for the origin of isotopic variations among carbonaceous chondrites will be presented at the conference.

This research was conducted in collaboration with the Hayabusa2 initial analysis chemistry team and the Hayabusa2 initial analysis core.

References: [1] Yada et al. 2022., Nat. Astron. 6:214–220. [2] Yokoyama et al. 2022., Science abn7850. [3] Hopp et al., 2022. Science Adv. 8:8141.