Zinc, copper and calcium isotopic composition of Ryugu's samples

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Initial analyses of Ryugu's samples show a close composition to CI carbonaceous chondrite (CC) group [1]. Some isotopic signatures (Ti, Cr) of Ryugu overlap, however, with other CC groups. Zn and Cu are moderately volatile elements (MVE) with variable isotopic compositions across the different chondrites and could be used to further test the Ryugu/CI connection. Furthermore, Ryugu has an apparent excess of over 50% Ca compared to CI chondrites that may be related to a heterogeneous distribution of carbonates [1,2]. Given that calcium in carbonates can be isotopically fractionated during aqueous alteration and carbonate precipitation it could be a useful tool for investigating the origin of the Ca excesses in the Ryugu samples. In addition, Ca exhibits large isotopic variations among bulk CC and Ca stable isotopes could be used to further test the Ryugu/CI connection.

Here we will present the stable isotopic composition of Zn, Cu, [3] and Ca [4] from two Ryugu sampling sites. We show that Ryugu and CI have identical Zn and Cu isotopic compositions, demonstrating their common genetic heritage and ruling out any affinity with other CC. Since Ryugu's pristine samples match the solar elemental composition for many elements, their Zn and Cu isotopic compositions likely represent the best estimates of the proto-solar composition. Earth's mass-independent Zn isotopic composition is intermediate between Ryugu/CC and NC chondrites, suggesting a major contribution of Ryugu-like material to Earth's budgets of MVE. We also show that both Ryugu samples have similar Ca isotopic composition that falls within the range defined by CIs, notwithstanding their higher Ca contents. This similarity indicates that the Ca isotopic composition and the Ca budget of CIs and Ryugu samples are dominated by carbonates and consistent with a major event involving precipitation of carbonates in the Ryugu samples that has been dated to have occurred ~5Ma after Solar System formation.

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References

[1] Yokoyama, T. *et al. Science* (2022). [2] Nakamura, T. et al. *Science (*2022).[3] Paquet et al. *Nature Astronomy* (2022). [4]