Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10504

Cr and Ti isotope systematics of Ryugu samples

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The Hayabusa2 mission conducted two sampling sequences on the C-type asteroid Ryugu, and brought 5.4 g of the asteroidal materials back to Earth. Analyses of the returned samples in the primary curation phase and subsequent initial analyses revealed that Ryugu samples possess a similarity to CI chondrites [1-2]. Here, we report results on the isotopic compositions of Cr and Ti obtained from the Ryugu samples. Figure 1 shows the ε^{50}Ti and ε^{54}Cr values for two bulk Ryugu samples (A0106-A0107 and C0108 from the first and second touchdown, respectively) and various meteorites. Previous studies have revealed a dichotomy in ε^{50}Ti and ε^{54}Cr values between non-carbonaceous (NC) and carbonaceous (CC) meteorites [3]. The Ryugu data plot close to the CI chondrite value in the CC meteorites region, but also overlap with the compositions of CBs and Tagish Lake (Fig. 1). However, the metal-rich nature of CBs rejects their possible kinship with Ryugu. The observation suggests that 1) the source materials of Ryugu are related to those of the CIs and/or Tagish Lake, and 2) such materials were supplied to asteroids orbiting the outer part of the current asteroid belt. Figure 2 shows the ε^{53}Cr and ^{55}Mn/^{52}Cr data for the bulk Ryugu samples and some chondrites. The suprachondritic Mn/Cr ratio and ε^{53}Cr value for Ryugu A0106-A0107 could be caused by the enrichment of the sample in aqueously formed carbonates with high Mn/Cr ratios [2]. The regression line in Fig. 2 yields a slope of $(^{53}Mn/^{55}Mn)_0 = (3.6\pm0.7)\times10^{-6}$, corresponding to the age of 4563.9±1.0 Ma. However, as discussed in [4], this age may be averaging the effects of multiple fractionation events because carbonaceous chondrites consist of mechanical mixtures of CAIs, chondrules, metals, and matrix that may have formed at different times in the early Solar System and experienced aqueous activity at different times.

This research was conducted by the teamwork of the Hayabusa2-initial-analysis chemistry team and the Hayabusa2-initial-analysis core.

References: [1] Tachibana et al. (2022) *Science*, in review. [2] Yokoyama et al. *Science,* in review. [3] Kleine et al. (2020) *Space Sci. Rev.,* 216, 55. [4] Zhu et al. (2021) *GCA,* 301, 158.

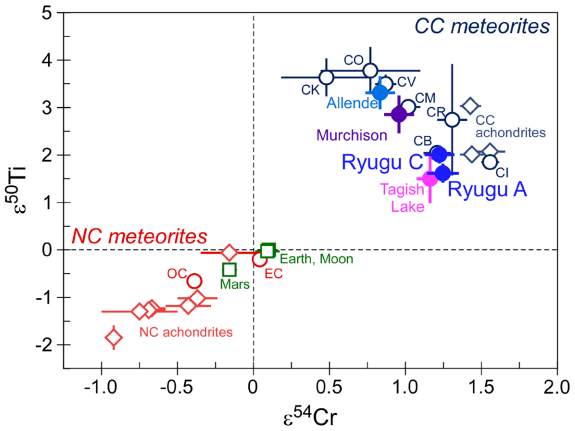

Fig. 1 ^{50}Ti-^{54}Cr isotope systematics of Ryugu and meteorites. Open symbols are literature data [3].

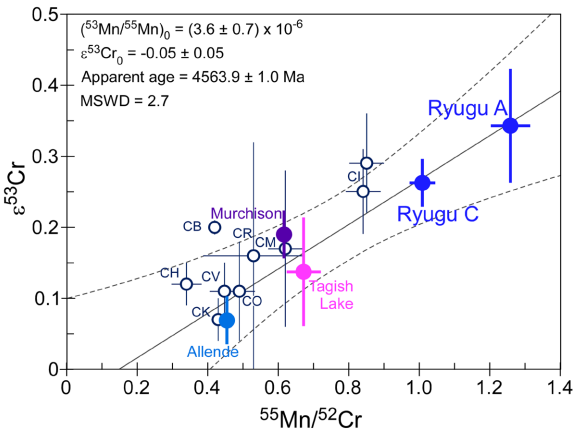

Fig. 2 ^{53}Mn-^{53}Cr isotope systematics of Ryugu and meteorites. Open symbols are literature data [4].