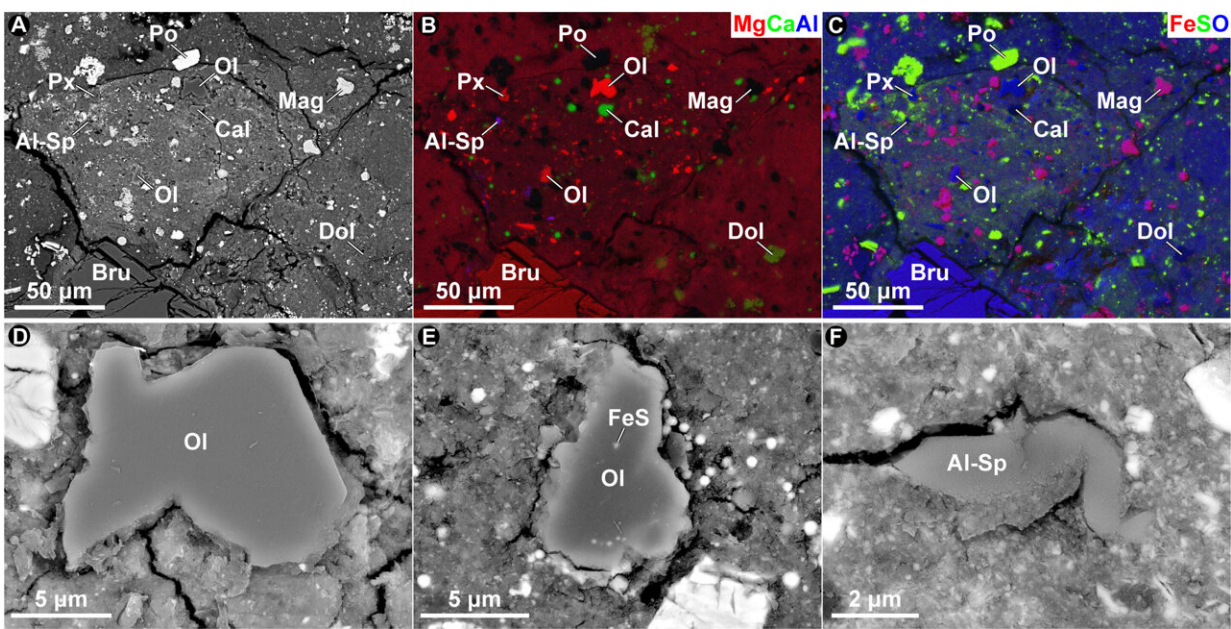


Isotopic signatures in Ryugu suggest it formed close to comets along with some unique minerals

December 19 2022, by Bob Yirka



Occurrences of anhydrous primary minerals in Ryugu sample. (A) BSE image of primary mineral-rich clast. (B) Combined x-ray elemental map of (A) using Mg $K\alpha$, Ca $K\alpha$, and Al $K\alpha$ lines assigned for RGB color channels. (C) Combined x-ray elemental map of (A) using Fe $K\alpha$, S $K\alpha$, and O $K\alpha$ lines assigned for RGB color channels. BSE images of (D) and (E) olivine and (F) Mg-Al spinel. The olivine grains (D and E) are located in the clast shown in (A) to (C). Their O isotopic compositions ($\Delta^{17}\text{O}$) are (D) -24‰ , (E) -4‰ , and (F) -23‰ , respectively. Al-Sp, Mg-Al spinel; Bru, breunnerite; Cal, calcite; Dol, dolomite; FeS, Fe-sulfide; Mag, magnetite; Ol, olivine; Po, pyrrhotite; Px, low-Ca pyroxene. Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.ade2067

An international team of researchers studying material from the asteroid Ryugu returned to Earth by the Hayabusa-2 Japanese space probe has found evidence that the asteroid formed in an outer part of the solar system, near where comets tend to form.

In their paper published in the journal *Science Advances*, they also note that some of the material found in Ryugu appears to have come from materials that were pulled from the inner parts of the solar system to the outer parts.

Two years ago, [dust samples](#) collected from the asteroid Ryugu were returned to Earth courtesy of the Japanese spacecraft Hayabusa2. Since that time, various research groups have been studying the samples to learn more about asteroids and the formation of planetary bodies in the solar system.

In this new effort, the researchers focused their attention on minerals found in the dust samples. They found evidence of amino acids along with [carbonate minerals](#)—materials that tend to form in low-temperature, watery environments. Such evidence strongly suggests that the asteroid was formed in an outer part of the solar system.

The researchers also found many similarities between Ryugu and Ivuna—a carbonaceous chondrite meteor found many years ago in Tanzania—the copper and zinc isotopes were very much alike.

Some material in the Ryugu dust could not have formed in the outer solar system—minerals such as spinel, olivine and perovskite, which all form at high temperatures. The researchers found that the ratios of isotopes of oxygen 16 in some cases were rich, but in other cases, were poor. And they also found that some of the isotopic ratios were similar

to those found by researchers studying samples brought back from the Wild 2 comet.

Taken together, the researchers suggest the [mineral](#) evidence indicates that Ryugu formed in a part of the outer solar system near where most comets form. During its formation, some materials that originated in the inner solar system made their way to the outer solar system and collided with the newly forming asteroid, adding to its makeup.

More information: Noriyuki Kawasaki et al, Oxygen isotopes of anhydrous primary minerals show kinship between asteroid Ryugu and comet 81P/Wild2, *Science Advances* (2022). [DOI: 10.1126/sciadv.ade2067](#)

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