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Science of an asteroid sample return mission Hayabusa2 and water in the solar system

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An asteroid explorer Hayabusa2 launched December 2014 and now flies on the way to an asteroid 1999 JU_3. The target asteroid is a near earth asteroid and has a C-type surface reflection spectrum, a dark (low reflectance) flat spectrum without notable mineral absorptions within optical to near-infrared wavelength bands. The payload science instruments are an optical multi-band camera, a near infrared spectrometer, a thermal infrared imager, a laser range detector, an impactor (making an artificial crater), a detached camera (recording snapshots of impact ejecta), and a small lander (developed by an European team). Hayabusa2 also brings small rovers for engineering purposes. Further, it has a sampler for collecting surface material of the asteroid, designed for storing samples from at most three different places (one of which is intended to get underground material excavated from the artificial crater made by the impactor) without mixing with each other. We plan to bring back the asteroid samples to the Earth in the end of 2020.

C-type asteroids are thought to be parent bodies of carbonaceous chondrites, primitive meteorites that contain a few percent of organic matters. They are thought to be survivors or fragments of planetesimals (building blocks of planets during the formation stage) in the outer solar system. Some carbonaceous chondrites contain hydrous minerals produced by reactions of rocks with hot water, so that at least a subset of C-type asteroids had internal hydrothermal activities (hot springs!) during the formation stage of the solar system. To clarify the mineral-water-organic material reactions in planetesimals is one of the most important objectives of the Haybusa2 project.

Near earth asteroids like 1999 JU_3 are collisional fragments of parent asteroids that had belonged with the main asteroid belt (between Mars and Jupiter orbits) and brought to Earth closing orbits by planets (such as Jupiter) gravitational perturbations. Such material transport from the main asteroid belt was vital during the early stage of the solar system history and many asteroids had fallen on the surface of the early Earth. The contribution of these asteroidal material to the early Earth, especially ocean formation and prebiotic environmental evolution should be important.

Under the session keyword of ”water”, this talk will highlight on ”planetary science *from* an asteroid”, the mantra of the Hayabusa2 mission.

Keywords: solar-system exploration, asteroid, comet, hydrothermal activity, prebiotic environmental evolution, planetary science