Aqueous alteration of Cb-type asteroid Ryugu

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The samples from the asteroid Ryugu, which returned to Earth in the winter of 2020 [1], were stored under pure Nitrogen conditions at the Extraterrestrial Materials Curation Center of ISAS. After basic description [2-3], they were distributed to six initial analysis teams in Japan in June 2021. The initial analysis "Stone" team, which was responsible for the analysis of coarse particles (>1 mm in size), consisted of about 150 scientists from Japan and abroad, and conducted a series of analyses

We analyzed sixteen coarse Ryugu particles 1 ~ 8 mm in size: six from the 1st touch-down site and ten from the 2nd touch-down site. Individual coarse samples were cut by Xe-FIB or wire-saw to expose particular objects or textures to be exposed on the surface based on 3D structure and element distribution obtained by synchrotron X-ray CT analysis and XRF analysis, respectively. FE-SEM/EDS and FE-EPMA/WDS analysis were made on all polished sections. TEM observation of many FIB sections was made to see microstructures and to compare with carbonaceous chondrites. Many other analyses were carried out to characterize mineralogical and compositional properties and summary of the analysis procedures is described in [4].

X-ray CT analysis showed that all sixteen Ryugu particles are composed of fine-grained material, with no chondrules and CAIs larger than 100 μm in size. FE-EPMA observation showed that Ryugu samples are breccias, consisting of many small rock fragments, lithologies of different compositions, and histories. The most common lithology includes Mg-rich saponite and serpentine, dolomite, magnesite, hydroxyapatite, pyrrhotite, and magnetite as main constituents. The mineralogy of this major lithology supports the classification of Ryugu samples as CI chondrites, which experienced extensive aqueous alteration in Ryugu's parent asteroid.

Based on the obtained mineralogical properties, we performed chemical modeling of aqueous alteration of Ryugu's parent asteroid [5]. Numerical simulations [6-8] to reproduce thermal history and impact-induced destruction of the Ryugu's parent asteroid were also carried out using mineralogical and physical properties of the Ryugu samples. In the talk, I would like to explain the conditions of aqueous alteration occurred in the parent asteroid of Ryugu in order to show how the water in the asteroid changed the mineralogy and chemistry of the nebular dust.

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