Mg-PHOSPHATE FROM ASTEROID RYUGU: AN ORIGINAL H_2O-RICH PHASE.

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Introduction: During initial mineralogy and petrology analyses of the Ryugu samples, an Mg-phosphate phase was observed [1]. Presented here is a further nanomineralogy investigation of this phosphate in section C0040-01. A field-emission analytical scanning electron microscope (SEM), electron back-scatter diffraction (EBSD) and electron probe microanalyzer (EPMA) were used to characterize its composition and structure and associated phases.

Occurrence, Chemistry, and Crystallography: The Mg-phosphate occurs as subhedral-irregular grains, ~10-100 μm in size, loosely clustered in one region in section C0040-01 (Fig. 1a). There are abundant openings at micron to nano-scales on the polished surface of this phosphate (Fig. 1b), probably caused by dehydration process. Section C0040-01 consists of mainly secondary phyllosilicates (saponite and serpentine), dolomite, Fe-Mn-bearing magnesite, pyrrhotite, magnetite, this Mg-phosphate, and minor hydroxylapatite, pentlandite, plus trace ilmenite and sphalerite. The section also contains minor primary forsterite, kamacite, enstatite, and spinel.

The chemical composition of this Mg-phosphate determined by low-voltage EPMA (10 kV and 10 nA, 5-10 μm defocused beam, n=8) is (wt%): MgO 26.34, P_2O_5 47.48, Na_2O 1.74, FeO 0.44, Cl 0.20, total 76.2, showing atomic ratio of Mg/P = ~1, which gives rise to a possible formula of $Mg_2P_2O_7 \cdot 4(H_2O)$ or $Mg(PO_3OH) \cdot 1{\sim}2(H_2O)$. EBSD analysis reveals that the present Mg-phosphate is amorphous – its structure was damaged due to dehydration.

Origin and Significance: The Mg-phosphate and hydroxylapatite are only phosphates identified so far in Ryugu. Day-time temperature of Ryugu is ~80 °C [2]. Regolith particles are heated at this temperature. The Mg-phosphate dehydration might have occurred at this temperature. The Mg-phosphate was also dehydrated under vacuum conditions on the surface of asteroid Ryugu where the samples were collected, not under vacuum in SEM or EPMA in our labs. Its original phase was H_2O-rich, apparently formed on the Ryugu parent body via aqueous alteration. The original Mg-phosphate would likely be a new mineral and the most H_2O-rich phase from Ryugu.

References: [1] Nakamura T. et al. (2022) *LPS XXVII*, Abstract #1423. [2] Shimaki Y. et al. (2020) *Icarus*, 348, 113835.

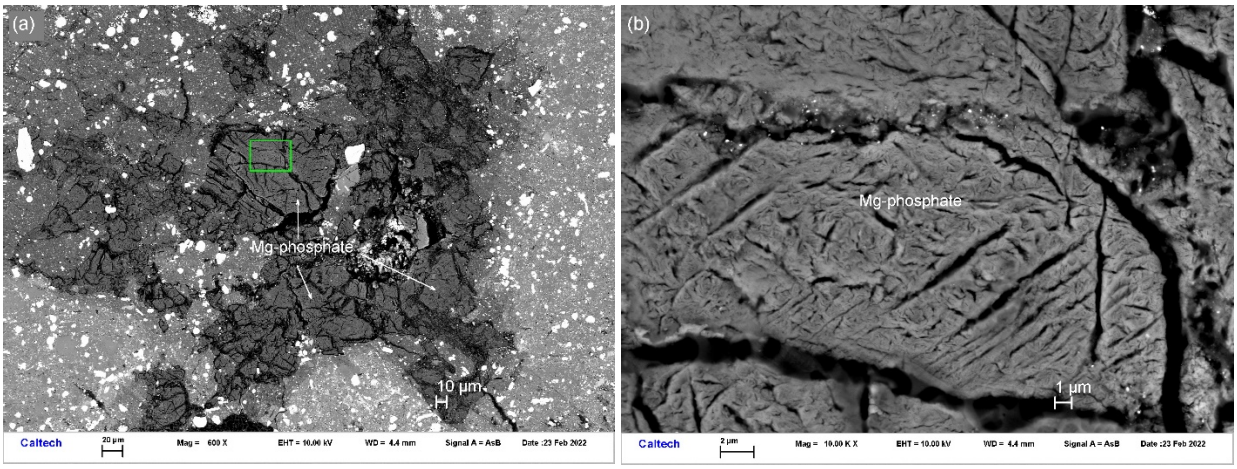

Fig. 1. Back-scatter electron images showing Mg-phosphate in Ryugu section C0040-01.