Estimation of formation mechanism and morphological condition in calcite concretion

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Iron oxide concretions were discovered on Meridiani plain by Mars explorer opportunity. The concretion found on Mars is called blueberry, it is spherical and the composition is mainly iron oxide. Concretions similar to them are found on the Navajo sandstone stratum in the United States of Utah , and is Gobi Desert, Mongolia. They are called Fe-oxide concretion. Both Fe-oxide concretion and blueberry have a spherical shell structure of iron oxide. [1] performed field work and analyzed element maps to investigate the mechanism of formation of Fe-oxide concretion of Utah and Gobi. As a result, [1] showed the formation mechanism of spherical Fe-oxide concretion as follows. In an eolian layer spherical calcite concretions were formed as a precursor. Second, acidic groundwater containing iron ions flows into it and reacts with $CaCO_3$ and iron precipitates in a spherical shell shape. Furthermore, [1] indicated that the iron contraction of Mars is a similar mechanism. However, the formation mechanism of spherical calcite concretion as a precursor is not known. If we can clarify the formation mechanism, we can restrict the ancient environment of Earth and Mars.

In this study, we focused on calcite concretion produced in an eolian layer. Calcite concretion of the eolian layer is produced in three forms, spherical, plate-like, fish egg (globular gathering state). It is aimed to clarify the forming mechanism and the forming conditions in indoor experiments. We will report the current experiment status. $CaCO_3$ is precipitated by evaporation in Utah's sand. In order to increase the solubility of the $CaCO_3$ aqueous solution, CO_2 is blown into the solvent. $Ca(HCO_3)_2$ is made in the solvent. By evaporating it $CaCO_3$ is precipitated in the layer of sand to generate a concretion. Then $Ca(HCO_3)_2$ is made in the solvent. It evaporates to precipitate $CaCO_3$ in the layer of sand.Utah's sand has an average particle diameter of 150 μm (Kawakami 2015). The minimum size of calcite concretion and Fe-oxide concretion discovered on Earth is several mm in diameter [2] and experiments are conducted with the aim of creating the size. $CaCO_3$ concentration and evaporation rate are changed as parameters. X-ray CT is used to analyze $CaCO_3$ in the experimental layer. In order to investigate whether $CaCO_3$ and sand can be distinguished from X-ray CT images, a experiment was conducted when $CaCO_3$ precipitated in the sand layer. The simulated sample was prepared by mixing sand from Navajo sandstone and a few mg of $CaCO_3$. As a result of the X-ray CT experiment, it was confirmed that a $CaCO_3$ having a size of 0.50 mm can be discriminated at a resolution of 0.019mm/pixel. It was also found that $CaCO_3$ and sand are close in density, so it can not be determined that $CaCO_3$ is not sufficiently larger than the average particle diameter of sand 150μm.

In the future, we will analyze the samples prepared in the experiment and try experiments under various conditions by adding experimental parameters as well as $CaCO_3$ concentration, evaporation rate and sand filling rate. Then we will clarify the formation mechanism and the morphological condition of calcite concretion in the eolian layer.

[1] Yoshida et al.(2018) Science Advances Vol.4, no.12;[2]Sally Latham Potter.2009 Chracteization of navajo sandstone hydrous ferric oxide concretions

Keywords: Spherical calcite concretion

