

**MARTIAN ORIGIN CALCITE IN DHOFAR 019.**

T. Nakazato<sup>1</sup>, M. Kayama<sup>1</sup>, H. Nishido<sup>1</sup>, K. Ninagawa<sup>2</sup>, A. Gucsik<sup>3</sup>, and Sz. Bérczi<sup>4</sup>. <sup>1</sup>Research Institute of Natural Sciences, Okayama University of Science 1-1 Ridaicho, Okayama, 700-005, Japan, E-mail: nakazato@rins.ous.ac.jp, <sup>2</sup>Department of Applied Physics, Okayama University of Science 1-1 Ridaicho, Okayama, 700-005, Japan, <sup>3</sup>Max Planck Institute for Chemistry, Department of Geochemistry, Mainz, Germany, <sup>4</sup>Eötvös University, Institute of Physics, Dept. G. Physics, Cosmic Materials Space R. Group, H-1117 Budapest, Hungary.

**Introduction:** Dhofar 019 found in Oman is classified as an olivine bearing basaltic shergottite. It consists of subhedral grain of pyroxene (pigeonite and augite), olivine, and feldspar mostly converted to maskelynite and minor phases, with terrestrial secondary phases. Calcite occurs in it as a small grain coexisted with merrillite and olivine, and interstitial filling in olivine crack. Although carbonates have been recognized in several Martian meteorites such as ALH84001 [1], most of the minerals have been interpreted as a weathering product after the fall on the Earth. The calcite in Dhofar 019 meteorite has been referred to as a secondary mineral [2], whereas it has not been investigated in detail. In this study, cathodoluminescence (CL) and Raman spectroscopy clarify the calcite formation as Martian origin in Dhofar 019.

**Samples and methods:** Two polished thin sections of Dhofar019 meteorite were employed for CL and Raman measurements. Color CL images were obtained by Luminoscope ELM-3R (Nuclide) at accelerating voltage of 15 kV and beam current of 0.5 mA. The CL spectral measurements were carried out using a cathodoluminescence scanning microscopy (SEM-CL), SEM (JEOL: JSM-5400) combined with a grating monochromator (OXFORD: MonoCL2), in the range from 300 to 800 nm at accelerating voltage of 15 kV and beam current of 1.0 nA. The Laser Raman spectroscopy are carried out using a NRS-2100 (JASCO\_CO.) with an Ar laser of 514.5nm wave length. The sample excitation and Raman scatter collection was performed using a 100 X optical lens on the Raman microscope.

**Results and discussion:** The calcite has a dull orange emission with homogeneous feature in color CL images. CL spectra of the calcite have two broad peaks at around 420nm related to defect center and at around 620 nm assigned to Mn<sup>2+</sup> impurity center. CL of terrestrial calcite generally has a pronounced red to orange emission due to Mn<sup>2+</sup> activator without blue emission. This fact indicates that the calcite in Dhofar has a high density of the defect in its lattice, suggesting different genetic condition from terrestrial calcite. The calcite in Dhofar 019 gives very weak Raman peaks at around 142 cm<sup>-1</sup>, 264 cm<sup>-1</sup> and 1085 cm<sup>-1</sup>, whereas Raman spectra of terrestrial calcite exhibit pronounced peaks at around 154 cm<sup>-1</sup>, 281 cm<sup>-1</sup> and 1089 cm<sup>-1</sup> with unambiguous peak shift by comparison with the calcite in Dhofar 019. Shock pressure of this meteorite has been estimated at approximately 40 GPa on the basis of formation condition of the observed shocked plagioclase. These facts imply that the calcite in Dhofar 019 is Martian origin.

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**References:**

[1] McKay, D. et al. 1996. *Science*, 273:924-930. [2] <http://curator.jsc.nasa.gov/atmet/mmc/index.cfm>