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火星隕石の多様性と火星探査によって得られたリモートセンシングデータとの関係
Diversity of Martian meteorites and its relationship to the remote sensing data as obtained by Mars exploration

三河内 岳 [1*]
Takashi Mikouchi[1*]

[1] 東大・理・地球惑星科学
[1]Dept. Earth & Planet. Sci., U. of Tokyo

Recent recoveries of many hot and cold desert meteorites have drastically increased the number of Martian meteorites. We only had 10 samples in early 1990s, but now we have more than 50 unpaired samples. At the same time, the accumulation of remote sensing data by Mars mission has been considerably increasing for the past 15 years. Therefore, now is a good time to compare Martian meteorites and remote sensing data to construct the better view of the red planet.

In spite of the increase of recovered Martian meteorites, classic grouping as "SNC" (shergottite-nakhlite-chassignite) meteorites is still alive probably because many samples were transported to the earth by the same ejec-tion event. Except for ALH84001, all other samples can be grouped as either of "SNC" with young crystallization ages (170-1300 Ma). Therefore, these samples probably originated from Tharsis or Elysium regions. It is still unex-plained why ALH84001 is the only old sample possibly originating from the southern hemisphere. All Martian meteorites are igneous rocks, and no sedimentary rocks have been found yet, although both orbiters and rovers have found the wide distribution of sedimentary rocks. One of the explanations is that these altered rocks can not be ejected into the space because of fragile nature of the rock.

Shergottite is still the largest group of Martian meteorites that are generally divided into three subgroups (basaltic, lherzolitic, and olivine-phyric) based on petrology and mineralogy. In recent years, geochemical studies have shown that shergottites can be divided into another three subgroups (enriched, depleted, and intermediate) based on distinct trace element and isotopic compositions, which is completely independent from petrological subgrouping. Their redox states are closely related to these geochemical characteristics, and interpreted to reflect the heterogeneity of the mantle reservoirs [e.g., 1]. These reservoirs formed about 4.5 Ga in a global magma ocean and kept separated because of the absence of active plate tectonics since the reservoirs formed. The second largest group is nakhlite that now consists of 8 samples. Because all nakhlites show similar mineralogy and ages, they probably originated from the same igneous body on Mars with possible layering by accumulation of crystallizing minerals. Each nakhlite is modeled to fit the location from near the surface to the depth of this igneous body. Nakhlites show minor evidence for secondary aqueous alteration that is related to the burial depth as inferred from igneous accumulation. There are a few alteration phases, but the presence of jarosite is important because it is one of the major alteration products on the surface as discovered by Mars Exploration Rover. Two chassignites are dunite rocks that have identical ages to nakhlites. The second chassignite shows black appearance because of the presence of Fe-rich nano-particles in olivine formed by shock metamorphism. ALH84001 is the only old Martian meteorite and the presence of possible biogenic magnetite is still under dispute.

Thus, Martian meteorites are important sources to deduce differentiation history of the planet. However, caution should be taken when we discuss a global view of the planet because of their young formation ages [2]. In fact, the chemical composition of the surface obtained by orbiters showed that the majority is tholeiitic basalts and Martian meteorites have distinct chemical compositions. Obviously Martian meteorites do not represent old crustal chemistry although they record that the planet's interior preserves distinctive regions that formed at 4.5 Ga.

References: [1] Borg L. E. et al. (2003) GCA 67, 3519-3536. [2] McSween H. Y. Jr. (2009) Science 324, 736-739.

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