Change of continuum in asteroid reflectance spectra by space weathering

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Although asteroids are believed to be the main source of meteorites, many asteroids, especially the S asteroids, show characteristic slope in their reflectance spectra called continuum, and do not match with any meteorites. As the probably cause, space weathering is proposed where micrometeorite impacts onto asteroidal regoliths cause heating and thus reduction of the regolith particles, changing their chemical/mineral composition and/or structure. Recent space weathering simulation using a pulse laser irradiation onto mineral powder samples successfully reproduce asteroid continuum trend to a reasonable extent. We are comparing such a continuum trend with those of some asteroids to evaluate its validity.

Asteroids are believed to be the main source of meteorites, and therefore comparison of reflectance spectra of asteroids and meteorites is generally supposed to provide information on where each meteorite came from and mineral composition of asteroidal regoliths.

However, many asteroids, especially the S asteroids, show characteristic slope in their reflectance spectra called continuum, and do not match with any meteorites. Also, although many asteroids show characteristic absorption bands of silicates which are also seen in meteorites, their band strengths seem to be reduced.

As the probably cause of such discrepancy of reflectance spectra between asteroids and meteorites, space weathering was proposed similar to that seen in lunar regoliths. Lunar regolith particles formed microscopic iron particles inside and on the surface of their minerals. It was pointed out that characteristic red slope of reflectance spectra of lunar regoliths was consistent with theoretically-derived optical effect of such microscopic iron particles. The main cause of formation of such microscopic iron particles is believed to be micrometeorite impacts.

Micrometeorite impacts onto asteroidal regoliths could cause heating and thus reduction of the regolith particles, changing their chemical/mineral composition and/or structure to some leser extents than the same process to lunar regoliths.

Attempts to reproduce such space weathering effect have been made at NASA Johnson Space Cente for a long time. One revolutional way was develped by Moroz et al. In Russia who used laser irradiation and grinding of mineral and meteorite samples. The results were mainly production of olivine or glass due to partial melting and recrystallization. The implication was that pyroxene and other minerals could change into olivine by space weathering, altering the apparent composition of asteroids toward olivine-rich side.

Recent space weathering simulation performed by Yamada et al. using a pulse laser irradiation onto mineral powder samples successfully reproduce asteroid continuum trend to a reasonable extent without causing any significant mineral change. Such a process could preserve major mineral composition of asteroid bed rock even on their regolith surface and still produce characteristic red continuum slope. We are analyzing the change of continuum in reflectance spectra of these laser-irradiated minerals and attempting to use such trend in comparing reflectance spectra of asteroids and meteorites. The main focus of this study is the relationship between the S asteroids and ordinary chondrites.