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Dust from collisions: mid-infrared absorbance spectroscopy of Martian meteorites

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DUST FROM COLLISIONS: MID-INFRARED ABSORBANCE SPECTROSCOPY OF MARTIAN METEORITES. A. Morlok¹, M. Anand² and M. M. Grady³ ¹Department of Earth and Planetary Sciences, Faculty of Science, Kobe University, Nada, Kobe 657-8501, Japan <morlok70@kobe-u.ac.jp> ²Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK <M.Anand@open.ac.uk > ³Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK <M.M.Grady@open.ac.uk>.

Introduction: There is growing evidence from astronomical observations that dust is produced in later stages of circumstellar disks by collisional cascades of material after the collisions of larger bodies or planetesimals [e.g. 1, 2]. Material from such larger bodies probably underwent significant changes before other processes such as aqueous alteration, thermal metamorphism, or differentiation.

For the interpretation of astronomical infrared spectra of such dust from circumstellar disks, a comparison with spectra of material from meteorites which have been affected by similar alteration processes could be useful.

As part of a study of infrared spectroscopy of planetary materials, we obtained spectra of materials from differentiated bodies – achondrites, but also terrestrial rocks and martian meteorites – for the comparison with astronomical spectra of dust materials.

Here we present transmission/absorbance spectra of a comprehensive series of martian meteorites. While there have been several infrared studies of martian material in the past, they usually were in the near-infrared range [e.g. 3] or technically different reflectance/thermal emission studies for planetary remote sensing [e.g. 4]. Transmission/absorbance studies needed for comparison with dust spectra so far have been rare [5].

Techniques: Material was taken from larger powdered representative samples of martian meteorites. We mixed 2mg of powdered sample with 300mg of powdered KBr. The mixture was grinded in an agate mortar, and afterwards pressed in an evacuated pellet press into a pellet at 10tons/cm². To avoid water bands due to absorbed water, the pellets were dried in an oven at 100°C for three days.

Of each pellet, a spectra was obtained from 2.5 to 30 μm , with a spectral resolution of 4cm⁻¹. In Figures 1a and 1b we concentrate on the the important region from 8-13 μm , where the characteristic Si-O bands are located. All results are in relative absorbance (A) and normalized to the same height.

Abbreviations used for meteorites: SaU 005 = Sayh al Uhaymir 005, DaG 476 = Dar al Gani 476, Y-

000593 = Yamato 000593, MIL 03346 = Miller Range 03346.

Results:

Shergottites (Fig.1a). This group shows the biggest diversity. Shergotty and Zagami look similar to the Nakhrites with strong bands at 9.4 and 10.4 μm (pyroxenes). The third strong feature (olivine), however is slightly shifted to ~11.3 μm . There is also weak band/shoulder at 10.7-10.8 μm . A second group of three spectra has a dominating band at 11.3 μm (olivine), while the other three features in this range (9.5-9.6, 10.4 and 10.6-10.7 μm) are relatively weak pyroxene bands. Los Angeles 001 forms a third grouplet, with a very strong band at 9.6 μm , and only weak features/shoulders at 10.3 and ~11.3 μm .

Chassignites (Fig.1a). The infrared spectra of Chassigny confirms the dunitic composition of this group, the spectra shows typical olivine bands at 10.3, 11.4 and 12 μm .

Nakhrites (Fig.1b). All five Nakhrite samples are very similar. They show strong bands at 9.4, ~10.3 (pyroxene) and at 11.4 μm , a olivine band of variable strength.

Discussion: Generally, the infrared spectra clearly show the major bulk mineral components in these meteorites. The dunitic Chassignites have basically a typical olivine spectra. Nakhrites (clinopyroxenites) are dominated by pyroxene, the varying relative intensity of the 11.3 μm band possibly is an indicator of the variable olivine content. Here the probably most fractionated member of this group, MIL 00346 [6] is the endmember with the weakest 11.4 μm feature, while this feature is strongest in Layayette . The Shergottites are divided into a group with strong olivine features (olivine-phyric shergottites) and a pyroxene rich group of Zagami and Shergotty (basaltic shergottites), The basaltic shergottite Los Angeles 001 shows a significantly different spectra, probably reflecting its high degree of differentiation [7].

References: [1] Telesco et al. (2005) *Nature*, 433, 133-136. van Boekel R. et al. (2005) *A&A.*, 437, 189-208. [2] Okamoto et al. (2004) *Nature*, 431, 660-663. [3] Gaffey M. J. (1976) *JGR.*, 81, 905-920. [4] Hamilton V. E. et al. (1997) *JGR.*, 102 E11, 25593-25604. [5] Sandford A. (1984) *Icarus*, 60, 115-126 [6] Anand M. et al. (2005) LPS XXXVI Abstract #1639 [7] Warren et al. (2000) MAPS 35 Supp.A166

Fig.1a: Shergottites and Chassignites. All spectra in relative absorbance (A). Abbreviations see Text.

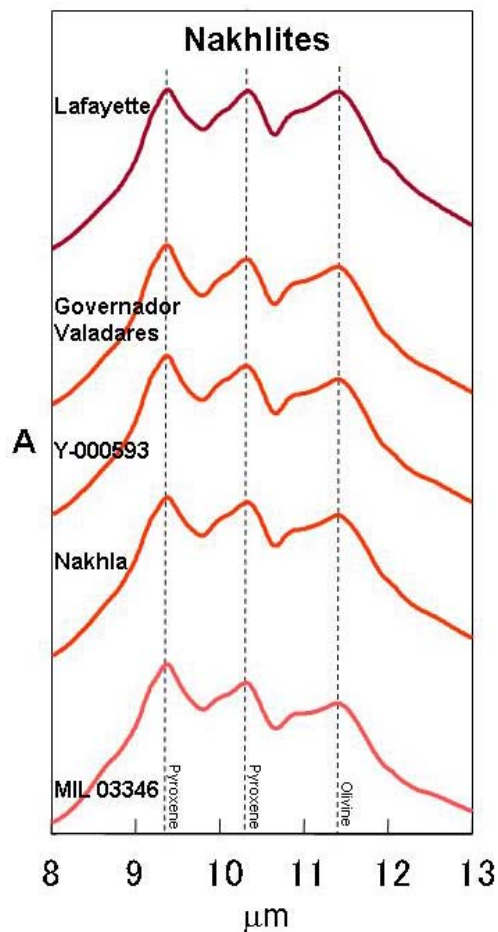
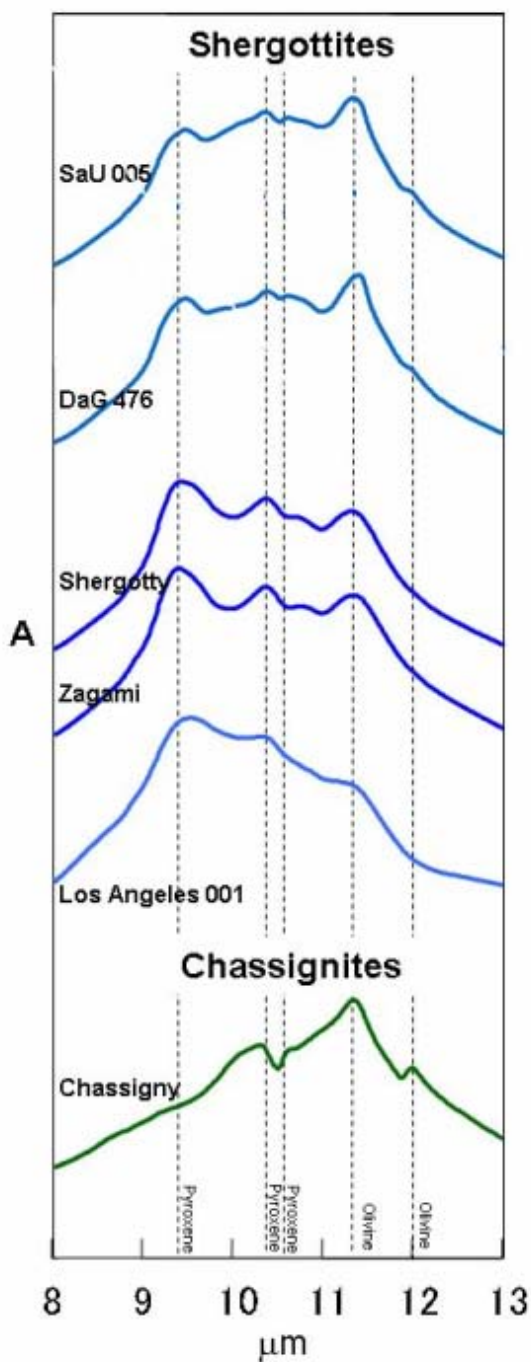


Fig.1b: Nakhrites. All spectra in relative absorbance (A). Abbreviations see Text.