INFRARED SPECTROSCOPIC EVIDENCE OF BENZONITRILE IN CARBONACEOUS-CHONDRITE MATERIAL FROM THE KAPOETA METEORITE.

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Introduction: Kapoeta is a howardite meteorite characterized as a gas-rich polymict breccia with a light-dark structure. It contains mm-sized dark inclusions that are described as carbonaceous chondrite (CC) materials [1]; these are believed to have been incorporated into the HED (howardite-eucrite-diogenite) parent body by carbonaceous meteorites impactors at a later stage of its formation. Previous spectroscopic work on the Kapoeta CC material indicates the presence of nanodiamonds with IR spectral features that resemble those observed in IR absorption spectra of hydrocarbon dust in dense interstellar clouds, aldehyde and nitrile functional groups [2]. Aromatic molecules, including nitriles, are ubiquitous in the interstellar medium (ISM) and are believed to be the carriers of the IR emission spectra of the ISM in the 3–20 μm region, commonly known as the unidentified infrared (UIR) bands [3]. Recently, the aromatic molecule benzonitrile (C_7H_5N) was detected in the ISM using radio spectroscopy [4]. Here, we report the finding of benzonitrile in CC material from the Kapoeta meteorite by Fourier-transform infrared (FTIR) spectroscopy.

Experimental: The same KB-pellet sample used in [2] was used in this study. Transmission micro-FTIR spectra on selected areas in the KBr pellet (spot size is ∼50 μm) were acquired with a Bruker Hyperion 2000 IR microscope equipped with a liquid-nitrogen-cooled mercury cadmium telluride (MCT) detector, at the Department of Earth Sciences, University of Manitoba, Canada. Spectra over the range of 4000–650 cm^{-1} were obtained by averaging 100 scans with a resolution of 4 cm^{-1}.

Results and Discussion: In a previous Micro-FTIR study, a weak nitrile band at 2237 cm^{-1} was detected in FTIR spectrum of the diamond-enriched region in the KBr-pellet of the Kapoeta CC material, and is due to C≡N stretching vibrations in an aromatic nitrile [2]. Micro-FTIR spectra collected from a small region (~ 100 μm in size), which appears orange in transmitted light, are radically different from those of the diamond-enriched region. In these spectra, the intensity of the C≡N stretch band at 2237 cm^{-1} is significantly enhanced compared to that observed in [2], and its observation along with the following bands: 3080, 3060 and 3027 cm^{-1} (aromatic C–H stretches); 1602, 1494 and 1453 cm^{-1} (aromatic C=C stretches); 763 and 703 cm^{-1} (aromatic C–H bends), clearly indicates the presence of benzonitrile in the Kapoeta CC material. In addition, the spectra also show the presence of strong bands at 2922 and 2870 cm^{-1} that may be assigned to CH_3 groups bonded to benzene rings [5], a broad band at ~ 3330 cm^{-1} due to NH_2 stretches, a C=O stretch band at ~ 1730 cm^{-1}, and bands in the 1400–800 cm^{-1} region that are mainly due to C–O and C–N stretches. This is the first IR spectroscopic evidence for the presence of benzonitrile in meteorites. Benzonitrile is a possible precursor of the more complex polycyclic aromatic hydrocarbons (PAHs) that make up ~ 10% of carbon budget in the ISM [6]. In meteorites, it's a common pyrolysis product of meteoritic organic matter [7], and may have been derived from nebular processes early in the history of the solar system. Further work, including TEM and isotopic composition, is needed to better address the issue of the origin of benzonitrile and the associated hydrocarbons in the Kapoeta CC material.

References: [1] Zolensky M. E. et al. 1996. *Meteoritics & Planetary Science* 31: 518. [2] Abdu Y.A. et al. 2018. *The Astrophysical Journal Letters* 856, L9 (7 pp). [3] Allamandola L. J. et al. 1985. *The Astrophysical Journal Letters* 290, L25. [4] McGuire B. A. et al. 2018. Science 359, 202. [5] Smith, B. C. 1999, Infrared Spectral Interpretation: A Systematic Approach (Boca Raton, FL: CRC Press), p. 244. [6] J. E. Chiar, J. E. et al. 2013. *Astrophysical Journal* 770, 78. [7] Sephton M. A. 2012. *Mass Spectrometry Reviews* 31, 560.