**THERMAL METAMORPHIC HISTORY OF LOW-TEMPERATURE CARBONACEOUS CHONDRITES.**

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**Introduction:** Raman spectroscopy is highly sensitive to molecular functional groups including carbon-rich structures such as aromatic moieties in meteorites. Raman spectroscopic investigation of meteoritic carbon is particularly useful as thermal metamorphic grade/history of carbonaceous chondrites can be roughly estimated through the spectral properties of polyaromatic structures in meteorites. For instance, mathematical expressions that allow estimating the peak metamorphic temperature of chondrites (mostly high-temperature chondrites) using the Raman spectral parameters of the first-order carbon peaks were previously reported [1, 2]. Recently, an expression based on the full-width half-maxima of the G band was reported and it seems to be particularly appropriate for low-temperature carbonaceous chondrites [3]. In this work, we are collecting hyperspectral Raman images and spectra for various low temperature carbonaceous chondrites such as CM2 and C2 ungrouped (C2-ung) chondrites in an effort to estimate and compare the peak thermal metamorphic temperatures experienced by these meteorites.

**Samples:** Our sample set for this investigation contains CM2 chondrites (Aguas Zarcas, Jbilet Winselwan, Murchison, Asuka (A) 12437, Asuka 12236, Asuka 12408, Asuka 12248, Yamato 980039, Northwest Africa 13711) and C2-ung (Tagish Lake, Tarda, and Queen Alexandra Range (QUE) 99038) chondrites. All meteorites were prepared in the form of polished sections with large sample surface areas for measurements.

**Technique:** Raman spectroscopic experiments were conducted using a commercial confocal Raman microspectroscopy system (WiTec alpha300R) equipped with a 600 g/mm grating, 532 nm Nd:YAG laser, and a 50× objective (NA = 0.8). The spectrograph was calibrated using a silicon wafer substrate prior to measurements. Individual Raman spectra were acquired with a 1-s integration time for 60 accumulations within 800-2000 $cm^{-1}$, while two-dimensional maps were acquired with 0.1 s integration time. The power density of the laser beam was ~0.2–0.5 $mW/\mu m^2$ on the sample surface. The collected spectra were processed using the commercial ProjectPLUSv4 (WiTec GmbH) software package. Artificial fluorescence background was removed from the spectra, which were then fitted with Lorentzian-Breit-Wigner-Fano (LBWF) spectral model to extract the D and G band parameters of aromatic hydrocarbons in the meteorites (e.g., Ferrari and Robertson, 2000; Chan et al. 2020). This method has previously used to successfully obtain the PMT values for different meteorites [e.g., 6].

**Results:** Raman spectra of all meteorites present well-developed D and G carbon bands at ~1370 and 1581 $cm^{-1}$. These carbon bands are due to disordered sp3 and graphitic-like sp2 carbon bonds, respectively [7, 8]. The full-width half-maxima (FWHM) values for the G band of Aguas Zarcas, Jbilet Winselwan, A 12236, Tarda, Tagish Lake, QUE 99038 were found to be, respectively, 97 $cm^{-1}$, 93 $cm^{-1}$, 84 $cm^{-1}$, 94 $cm^{-1}$, 90 $cm^{-1}$, and 60 $cm^{-1}$. Using the expression by [3], we found that these values roughly correspond to ~71 °C, 79 °C, 101 °C, 77 °C, 86 °C, and 195 °C. For Jbilet Winselwan, we note that we did not include the shock-heated parts into consideration for this work, which would yield much higher temperatures. Based on these results, A 12236 seems to be slightly more heated compared to other currently studied CM2 chondrites. Tarda and Tagish Lake appears to be compatible with being type 2; however, QUE 99038 presents a much higher peak metamorphic temperature. The rest of the meteorites are currently being measured as well, and their results will be presented at the meeting.

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**References:** [1] Busemann, H. et al. 2007. Meteoritics & Planetary Science, 42(7-8), pp.1387-1416. [2] Cody, G.D. et al. 2008. Earth and Planetary Science Letters, 272(1-2), pp.446-455. [3] Schmidt, J.S. and Hinrichs, R. (2020). Meteoritics & Planetary Science, 55(4), pp.800-817. [4] Ferrari, A.C. and Robertson, J. (2000). Physical review B, 61(20), p.14095. [5] Chan, Q.H. et al. 2020. Meteoritics & Planetary Science, 55(6), pp.1320-1348. [6] Yesiltas M. et al. 2021. ACS Earth and Space Chemistry, 5(12), pp.3281-3296. [7] Tuinstra, F., and Koenig, J.L. (1970). The Journal of chemical physics, 53(3), 1126-1130.92. [8] Starkey, N.A. et al. 2013. Meteoritics & Planetary Science, 48(10), 1800-1822.