RAMAN TEMPERATURE CONSTRAINS OF VOLATILE-RICH CLASTS IN POLYMICT UREILITES, POLYMICT EUCRITES, AND HOWARDITES.

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Introduction: An intriguing aspect of the Solar System is the origin and timing of volatile element incorporation into Earth and other terrestrial planets. The incorporation of comets, Kuiper Belt objects, and water-bearing asteroids alone cannot explain the volatile inventory of Earth [1-4]. Volatile-rich clasts in brecciated meteorites may be a missing component. So far, two groups of these clasts can be identified that resemble CM- and CI-like chondrites but are not properly characterized and classified yet (e.g. [5-10]). This study focuses on the origin, formation processes, and incorporation of these clasts into the host rock, applying a Raman-based thermometry to the organic matter, which is embedded into the matrix of the volatile-rich clasts.

Methods: Extensive studies and progressive work on carbonaceous materials in terrestrial metasediments led to the development of a Raman geothermometer that is applicable in the temperature range of 165-655^{0}C [11-14]. To apply this method to carbonaceous chondrites aqueously altered at low temperatures (<100 ^{0}C) this method was further calibrated based on work by [14] and can now be potentially applied to materials, which have experienced peak temperatures as low as 20-30 ^{0}C. Using peak analysis of Raman spectra has some important advantages: It is a quick, non-destructive *in-situ* technique with a high spatial resolution. [10-14].

For this study, over 4000 Raman spectra were obtained from 30 different clasts in four polymict eucrites (*NWA7229, NWA7234, NWA6301, NWA8431*), five polymict ureilites (*DaG976, DaG999, DaG1000, DaG319, NWA4304*), and a howardite (*NWA776*). Five different carbonaceous chondrites (*Tagish Lake, C2ung; Orgueil, CI1; Murray, CM2; Kainsaz, CO3.2; Allende, CV3*) were analyzed for comparison. Similar to [14], a linear background from 1000-1800 cm^{-1} was substracted from the spectra. An automated MatLab script was used to fit low temperature amorphous carbon spectra with a pseudovoigt function to characterize the spectra. Data, for which peak fit analyses yielded a coefficient of determination (R^2) lower than 0.993 was discarded, and parameters that deviated more than 2σ from the mean were excluded [14,15]. The full width half maximum (FWHM) of the D1-band was then used to calculate temperatures for the different clasts and chondrites after [15]. Electron microprobe was used to analyse the mineral composition and the fine grained matrix of the clast.

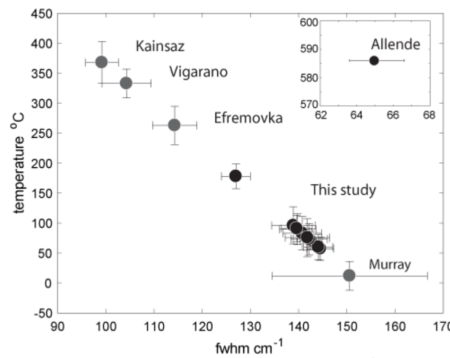

Fig.1: FWHM vs temperature plot of the CM-, CI-like clasts from this study (black) and data obtained by [15] (grey).

Results and Discussion: First results on polymict eucrites show that different clasts can be distinguished via their specific Raman spectra and corresponding temperatures (Fig.1). All but one clast in the polymict eucrites range from 60 to 90 ^{0}C. No significant temperature difference between the CI- or CM-like clasts has been detected yet, but one texturally distinct clast from *NWA8431* yields a considerately higher temperature of ~178^{0}C. Further electron microprobe analyses will clarify, whether this difference in temperature is also displayed in the mineral and/or matrix composition. The observation of different temperatures for different clasts shows that the Raman technique is capable of detecting temperature differences in the fine-grained heterogeneous matrix of these volatile-rich clasts and, thus, can be used to constrain the experienced peak temperatures, discuss the origin of the peak temperature, and formation processes of the volatile-rich clasts .

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