**DUAL ISOTOPIC COMPOSITION OF METHANE IN CARBONACEOUS CHONDRITES.**
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**Introduction:** The study of organic matter in meteorites can uncover processes and starting materials important in the evolution of the early solar system. Methane is a fundamental building block in the synthesis of organic compounds. Depletion of $^{13}C$ content with carbon number in C1 to C6 hydrocarbons extracted from the Murchison meteorite [1] implies that longer chain meteoritic hydrocarbon were synthesized from methane. Whereas the carbon isotope composition of methane points to the mechanisms of its formation or destruction, the deuterium content strongly reflects its origin. Highly deuterium enriched organic species found in meteorites are thought to be pre-solar, originating in ion-molecule reactions in molecular clouds [2]

The presence of methane in a meteorite may indicate the presence of trapped material that has survived relatively unaltered since parent body formation; volatile species would have been easily lost during processing. As such, methane content may be seen as sensitive indicator of parent body alteration.

Here we investigate the presence and dual isotopic composition of methane in several meteorites, starting with two carbonaceous chondrites: Murchison (CM2) and Orgueil (CI), which have undergone different levels of parent body processing.

**Experimental:** For samples of each of the meteorites, Murchison (106.7 mg) and Orgueil (352.5 mg), the volatile component was extracted from two chips using freeze/thaw cycling in 0.5 ml distilled RO water. The chips and water were outgassed in an evacuated 3 ml Pyrex vessel before dropping the chips into the water to commence disaggregation. The process was assisted by brief periods of sonication during each thaw cycle.

The headspace gases were transferred to a high vacuum inlet to be dried and purified using a combination of cryogenic trapping and gettering (SAES St172) to separate out $CO_2$ and to remove $N_2$, CO and non-methane hydrocarbons. Methane was then analyzed in a static mass spectrometer for its combined isotopic composition [3]. The minimum sample size for isotope ratio measurements was 0.1 nmol, however the detection limit is ten times lower before background and isobaric interference may mask a methane signal.

**Results:** The Murchison chips were found to contain 18 nmol $g^{-1}$ methane. Assuming the $\delta^{13}C$ of methane to be +9.2 ‰ (VPDB) [1], a deuterium enrichment of at least +450 ‰ (VSMOW) was calculated from the measured combined isotopic composition.

Any methane contained in the chips of Orgueil was masked by isobaric interference, which sets an upper limit of 0.5 nmol $CH_4$ $g^{-1}$ for the sample, much lower than the value of 13.5 nmol $g^{-1}$ previously proposed [4].

**Discussion:** The presence of methane in Murchison and its highly enriched deuterium content suggests that some pre-solar organic material may have been retained in this meteorite. Orgueil appears not to contain any methane. It is possible that methane was lost during the extensive parent body processing experienced by Orgueil. In an analogous fashion to our freeze-thaw procedure, aqueous alteration may have degraded the sites in Orgueil at which methane is trapped and, hence, liberated this volatile molecule from the meteorite.

The abundance of methane in meteorites may be a valuable indicator of the level of parent body processing. Measuring the dual isotopic composition of methane verifies its pre-solar origin. A combination of these two steps enables the primitive nature of a meteorite's organic assemblage to be assessed. Such methods may be useful in the identification of the closest example of the progenitor of chondritic organic matter

**References:** [1] Yuen G. et al. (1984) *Nature* 307, 252-254. [2] Sandford, S.A. (1996) *Meteorit. Planet. Sci.* 31: 449-476. [3] Morse A. D. et al. (1996) *Rapid Commun. Mass Spectrom*. 10, 1743-1746. [4] Belsky T and Kaplan I.R. (1970) *GCA* 34, 257-278.

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