AMINO ACID CHEMISTRY AS A LINK BETWEEN SMALL SOLAR SYSTEM BODIES AND CARBONACEOUS CHONDRITES

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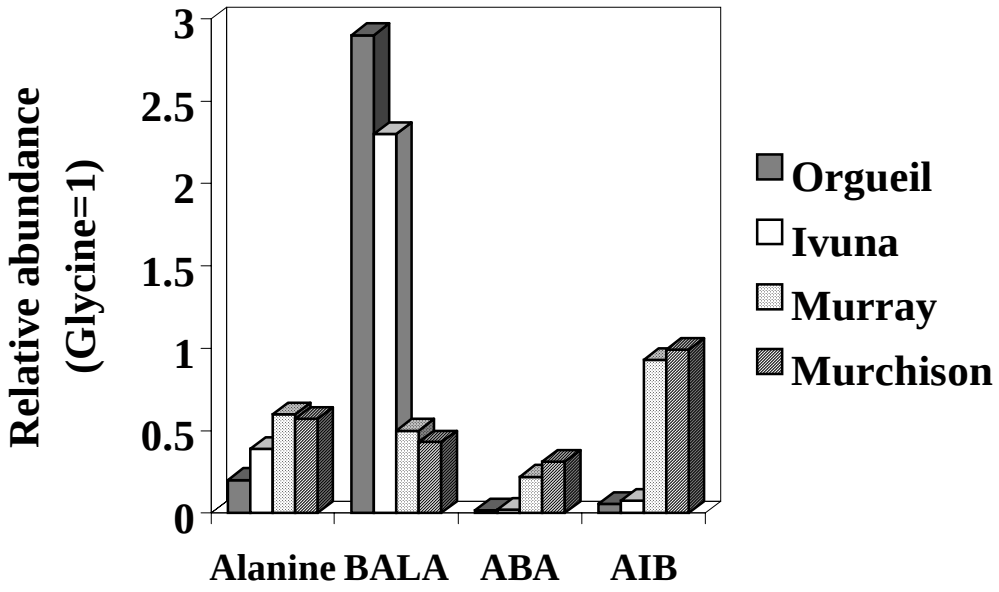
Establishing chemical links between meteorites and small solar system bodies, such as comets and asteroids, provides a tool for investigating the processes that occurred during the formation of the solar system (1-3). Carbonaceous meteorites are of particular interest, since they may have seeded the early Earth with a variety of prebiotic organic compounds including amino acids, purines and pyrimidines, which are thought to be necessary for the origin of life (4). Here we report the results of high-performance liquid chromatography (HPLC) based amino acid analyses of the acid-hydrolyzed hot water extracts from pristine interior pieces of the CI carbonaceous chondrites Orgueil and Ivuna and the CM meteorites Murchison and Murray.

We found that the CI meteorites Orgueil and Ivuna contained high abundances of β-alanine and glycine, while only traces of other amino acids like alanine, α-amino-*n*-butryic acid (ABA) and α-aminoisobutyric acid (AIB) were detected in these meteorites (Fig. 1). Carbon isotopic measurements of b-alanine and glycine in Orgueil by gas chromatography combustion-isotope ratio mass spectrometry (5) clearly indicate an extraterrestrial origin of these amino acids. The amino acid composition of Orgueil and Ivuna was strikingly different from the CM chondrites Murchison and Murray. The most notable difference was the high relative abundance of β-alanine in Orgueil and Ivuna compared to Murchison and Murray (Fig. 1). Furthermore, AIB, which is one of the most abundant amino acids found in Murchison and Murray (6,7), was present in only trace amounts in Orgueil and Ivuna.

Our amino acid data strongly suggest that the CI meteorites Orgueil and Ivuna came from a different type of parent body than the CM meteorites Murchison and Murray, possibly from an extinct comet. It is generally thought that carbonaceous meteorites are fragments of larger asteroidal bodies delivered via near Earth objects (NEO). Orbital and dynamic studies suggest that both fragments of main belt asteroids and comets replenish the NEO population, therefore extinct comets may contribute up to half of all NEO's (8). A comparison of an amino acid analysis of a returned NEO sample to CI and CM carbonaceous chondrites would help establish a link between small solar system bodies and meteorites.

Based on our amino acid measurements of CI and CM chondrites, amino acid chemistry can be included as an additional set of criteria to constrain the nature of meteorite parent bodies.

Fig. 1. Comparison of amino acid abundances (relative to glycine) in the CI carbonaceous meteorites Orgueil and Ivuna, and the CM meteorites Murchison and Murray. Abbreviations: BALA: β-alanine; ABA: α-amino-*n*-butyric acid; AIB: α-aminoisobutyric acid.



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