Amino acids in a meteorite

Ever since they were analyzed by the Swedish chemist Jöns Berzelius in 1834 and the German chemist Friedrich Wöhler in 1859, it has been known that the relatively rare meteorites that are called carbonaceous chondrites contain organic matter. There has been a rich history of debate since then over the nature and origin of the organic compounds. One key question always is whether they are the result of contamination from living matter on earth, or were formed naturally in space.

The latest contribution to the discussion is published this week in the Dec. 12 NATURE by Dr. Cyril Ponnamperuma and five colleagues from the Exobiology Division of the National Aeronautics and Space Administration's Ames Research Center, plus Dr. I. R. Kaplan of the University of California at Los Angeles and Dr. Carleton Moore of Arizona State University. In it they present evidence for the presence of amino acids of possible extraterrestrial origin in a meteorite that fell near Murchison, Victoria, Australia, Sept. 28, 1969. Five of the 20 most common amino acids—glycine, alanine, glutamic acid, valine and proline—were identified.

If over the course of time their finding becomes accepted—it has some difficult obstacles facing it—it would have important scientific implications. It would demonstrate that amino acids, the basic building blocks of proteins, can be and have been formed outside the earth by chemical evolution. There is already considerable evidence from radio astronomy for the chemical synthesis in interstellar space of other, less complex organic molecules (SN: 10/10, p. 299). The meteorite evidence would add tangible support to the generally accepted belief that, as apparently happened in the early stages of earth history, primordial elements elsewhere could eventually be caused to form complicated organic molecules that could evolve into reproducible living matter.

But all this hinges on whether the amino acids in the Murchison meteorite were formed outside the earth. All previous identifications of amino acids in meteorites have ultimately been attributed to terrestrial contamination. Studies in the early 1960's of the famous Orgueil meteorite, for example, showed that free amino acids were present in quantities approximately equal to the amount left in a fraction of a single human thumbprint. Studies of other meteorites have shown that the distributional patterns of amino acids found on them are similar to the patterns in human fingerprints.

Dr. Ponnamperuma and his group claim that the techniques and results of their investigations on the Murchison meteorite resolve some of the ambiguities and difficulties of previous work on the presence of organic compounds in meteorites.

"Our evidence," claims Dr. Ponnamperuma, "is so significant that it is almost incontrovertible." He points to three main clues for the extraterrestrial, nonbiological origin of the amino acids.

First, the amino acids they found had no net optical activity, meaning they were of an almost equal mixture of right- and left-handed molecule structures. Optical activity in organic compounds is generally regarded as evidence of biological, and thus of earthly, origin.

Second, the ratio of carbon 13 to carbon 12 in the hydrocarbons found along with the amino acids is far higher than found in biological material on earth.

And third, the analysis made use of both gas chromatography and mass spectrometry, in a sophisticated technique developed for analysis of the Apollo 11 lunar samples.

Still, the work is not likely to gain immediate wholehearted support. Dr. Bartholomew Nagy of the University of Arizona at Tucson, who has been analyzing carbon compounds of carbonaceous chondrites from all over the world since 1961, and who is familiar with the NASA group's work, suggests the need for healthy skepticism.

"I would be very much surprised if out of all the carbonaceous chondrites that have been studied, one would suddenly find one with [extraterrestrial] amino acids," he says. The conclusions of Dr. Ponnamperuma's group cannot be considered final, Dr. Nagy believes.

The lack of optical activity in the Murchison amino acids, for example, does not necessarily prove that they could not have been biological, and therefore earthly, originally.

"It is very difficult to confirm what is contamination and what is not," says Dr. Nagy. □

PROMETHIUM ON STARS

Action at the surface

In the interiors of stars, astrophysicists have believed for more than 30 years, are the conditions necessary for the manufacture of atomic nuclei. Here the temperature, pressure and density are sufficient to drive together neutrons, protons and light nuclei to make heavier nuclei overcoming electric forces that would keep them apart. Starlight represents the energy generated as a by-product of this process.

Now there is evidence that nucleosynthesis may also go on in the surfaces of stars, where the density, pressure and temperature are not so great. The evidence is the discovery of the element promethium in the star HR 465 by Drs. Margo F. Aller and Charles R. Cowley of the University of Michigan.

Promethium, atomic number 61, is a radioactive rare earth element with a half-life of 18 years. It is not found naturally on earth and until now was known only in fragments from nuclear fissions.

The star, which is located in the constellation Andromeda, belongs to a class called peculiar A-type stars, which are rich in rare earth elements. It is of magnitude 6.5, which is barely visible to a naked eye. The promethium was identified by the appearance of a pattern of light wavelengths that it characteristically emits. The spectrograms they used were taken at Lick Observatory in 1960 and 1961 by W. P. Bidelman, who is now at Case-Western Reserve University.

The light that is seen from a star is generated at or very near the surface. If the wavelength pattern characteristic of an element is seen in the spectrum, then that element must be near the surface of the star. Since the lifetime of promethium is so short, Drs. Aller and Cowley conclude that it must be made near the surface. If it were made in the interior it would not last long enough to get to the surface.

Formation of promethium at the surface of the star, says Dr. Aller, is evidence that tends to favor a theory of nucleosynthesis put forward about 15 years ago by Drs. Geoffrey and E. Margaret Burbidge of the University of California at San Diego, William Fowler of the California Institute of Technology and Fred Hoyle of Cambridge University. They suggested that nuclei might be made on the surfaces of stars in the neighborhood of the disturbances that on the sun are called sunspots. Sunspots have strong, changing magnetic fields. According to the theory these fields could accelerate the components of nuclei, giving them enough energy to overcome the electrical forces and to fuse. □