SCIENCE NEWS OF THE WEEK

Mars and the Absent Organic Molecules

It's possible that somewhere in the vastness of the universe dwell life forms that earthlings would barely even define as such, let alone recognize: the energy beings of Epsilon Eridani, perhaps, or the lithomorphs of Barnard's star system. Project Viking's pioneering search for extraterrestrial life, however, is largely confined to seeking living things that meet the criteria of "life as we know it," one of which is a basis in organic chemistry. The first Viking lander has so far failed to detect any organic molecules in the Martian surface material, but last week the auditorium at Jet Propulsion Laboratory in Pasadena was packed with reporters, scientists and others waiting to hear the result of the first test from lander 2. There is more water in the atmosphere over lander 2's more northerly site, and the selected sample was taken from a crusty area nicknamed "Bonneville," thought to offer a possibly greater chance for organics to have formed and survived (SN: 9/25/76, p. 196).

The initial results were disappointing, although, despite such newspaper headlines as "Viking finds no life," not conclusive. Four tests were scheduled for the Bonneville sampler in lander 2's organic chemistry instrument, called a gas chromatograph/mass spectrometer (GCMS), involving heating the sample to 200°C, 350° and twice to 500° in hopes of vaporizing increasingly large organic molecules and driving them off for detection by the spectrometer. The 200° run showed nothing, according to GCMS team leader Klaus Biemann of the Massachusetts Institute of Technology, except for traces of several organic solvents used in cleaning the instrument on earth.

Three analyses at higher temperatures remained to be carried out, but Biemann acknowledged that in the few terrestrial soils that had been tried out on earth, "there was never a case where there was nothing at 200° and then a reasonable amount at 500°." Such a result, he said, would require one of two scenarios. Either the smaller, relatively more volatile molecules would have to have evaporated very slowly over the passing billions of years, or they could be absent because they were long ago polymerized together into larger, more heat-stable molecules that would only appear in the GCMS at higher temperatures. The latter, says Biemann, is quite unlikely, however, since the shrinking supply of small molecules would probably stop the process before they were all used up.

A day later came the 350° run. The only additional compound detected was dichloromethane, but that too was believed to be a trace of terrestrial cleaning fluid. One change was a 10-fold increase in the amount of released benzene, although the amount was still less than the cleanliness specification when the GCMS was built. If benzene is all that ever appears, however, said Biemann, "I would be very suspicious about that being indigenous to the soil, because it is hard to conceive of a process that could perform on Mars [that] could produce only benzene and nothing else."

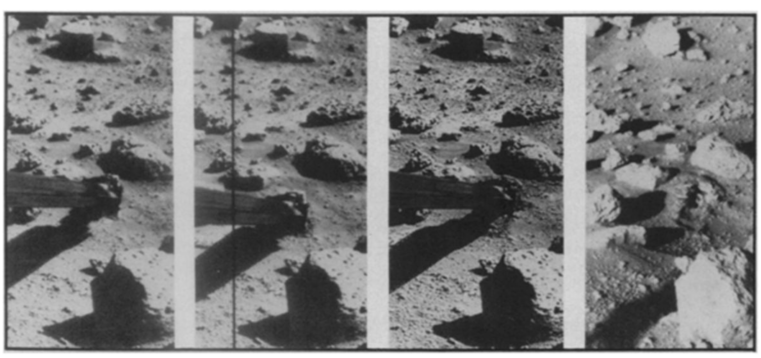
The two high-temperature analyses were to take place late this week and early next, with another series of tests to be run later on a sample taken from beneath a rock, where it would presumably have been protected from solar ultraviolet radiation. But even if they all come up empty-handed, some researchers believe that Mars may still harbor organics somewhere. The solar wind, for example, has produced detectable amounts of methane on the moon, although the Martian atmosphere and possible magnetic field (SN: 10/2/76, p. 212) could have short-circuited that process. A class of meteorites known as carbonaceous chondrites may well have dumped various organics onto the surface, although entry heating, impact forces and UV bombardment could have considerably reduced the surviving crop.

Organics or no, Viking's biologists are still faced with the problem of explaining the disconcertingly biologic-seeming results of their own instruments, with a fascinating answer in the offing either way. "I think," says Viking's Science Analysis and Mission Planning director, B. Gentry Lee, "it is fair to say that the preponderance of scientific opinion is that most of what we have seen can be more easily explained by chemistry. However, it is by no means that clean-cut. . . . Both the biological and chemical hypotheses have some difficult questions they have to answer in order to be consistent with all the data." There's a strong case for highly active oxidants in the soil, for example, but that leaves the problem of an apparent reduction process in the two landers' pyrolytic-release experiments. Some of the proposals to explain that one have been pretty exotic, says one Viking scientist, such as the possibility of energetic hydrogen ions created by cosmic-ray bombardment. The same process would presumably create energetic oxygen ions as well, with the obvious result of water unless, say, the ions were "matrix-locked" in some tight structural lattice that would keep the hydrogen and oxygen apart, simultaneously preserving the hydrogen's reducing potential. It's just an idea, one of many that might otherwise never have seen the light of day but for the public fishbowl in which Viking's scientists have been obliged to work. But the biologists in particular are trying to leave no stone unturned (the motto also of the rock-rolling team, SN: 9/25/76, p. 196) to unravel their puzzle.

One source of help is a group of researchers at the NASA Ames Research Center, nearly 400 miles north of JPL in Mountain View, Calif., who have been trying to duplicate the responses of the biology instruments in a laboratory. A key goal is to match the gas release and intake patterns of the Viking gas-exchange experiment, in part because it measures a wider range of phenomena than do the other two instruments in the package. Using a variety of terrestrial test soils such as volcanic ash, salt-containing basalt and magnetite, the Ames team is exposing various batches to peroxides, superoxides, ultraviolet radiation, water, controlled temperature profiles and other influences, and measuring the responses with a detector similar to Viking's.

The task is formidable. Virtually everything is an unknown, from the photocatalytic effects that may have modified the Martian soil to the kind of glass used in the labware. In addition, the researchers must contend with the vast number of possible tests that result from permuting their long list of variables. But far more work is necessary. The seemingly obvious option of manufacturing a test soil modeled on Viking's inorganic analysis may not be so obvious after all, points out Priestley Toulmin III of the U.S. Geological Survey, since a mere list of elemental abundances leaves out what may be critical mineralogical information.

If indeed there is neither life nor organic material on Mars, that knowledge itself will be valuable, points out GCMS team



NASA/Viking 2

Lander scoop gathering sample from "Bonneville" spot for organic analysis.

member John Oro of the University of Houston, perhaps tightening the known constraints on planets where life as we know it can form. Gravity, he says, will have to be sufficient to retain the volatile elements; atmospheres may be required to possess enough ozone to keep out ultraviolet radiation, and there may have to be a temperature range—perhaps 0 to 100°C—that is both cool enough to retain water but warm enough to allow the proper chemical reaction rates as pre-life compounds try to get a foothold. "It may sound defeatist," says one Viking team member, "but the lack of life on Mars would have its interesting side too." □

Earth's hot past: Delay to evolution?

The farther we go back in time, the more fragmentary is our record of past temperatures on earth. For the oldest geological periods the record is practically nonexistent. But now isotopic analysis of 66 samples of chert from the western and central United States and abroad has added valuable new data to the record, showing that 3 billion years ago the earth was apparently much warmer than it is today, the average temperature perhaps as high as 160°F. The new data indicate that by 1.2 billion years ago, the climatic temperature had declined to 90°F.

The new evidence was obtained at the California Institute of Technology by geochemists Samuel Epstein and L. Paul Knauth. Knauth, then a graduate student, is now on the faculty of Louisiana State University. The findings are reported in the current GEOCHIMICA ET COSMOCHIMICA ACTA, the journal of the Geochemical Society and the Meteoritical Society, and in an announcement from Caltech.

Epstein believes the hot ancient temperatures may help explain why advanced forms of life did not evolve on earth until about the latest eon of the planet's existence. "If our estimated ancient temperatures are even nearly correct," he says, "these temperatures may have been a reason why multicelled organisms did not appear on earth until about one billion years ago. The earth may simply have been too hot for sophisticated life to have evolved."

It wouldn't have been too warm for bacteria, however, which have been around for at least 3.3 billion years, or the primitive blue-green algae, which followed bacteria on earth.

The Epstein-Knauth data also contain a temperature record of the earth's most recent one billion years. They indicate that the annual temperatures dropped from about 93° to 68°F during the Paleozoic era (600 to 225 million years ago), then climbed to 95° to 104° in the Triassic (225 to 190 million years ago), and declined through the Mesozoic and Cenozoic to values of about 63°. The figures for more recent times correspond to trends, if not actual degrees, shown in previous calculations based on paleontological and other data. The cause of the hot temperatures in earlier times is not known. One suggestion is that the sun was hotter then.

The findings are based on measurements of the relative abundances in the chert of isotopes of oxygen and of hydrogen. The isotopic ratios vary according to the temperature of the atmosphere at the time the cherts are formed.

The samples were taken from 11 states, plus southeastern Canada, South Africa and England. The readings turned out to be consistent for geological periods, no matter how far apart the samples were located.

Epstein points out that there are uncertainties in any paleoclimatological method as one goes back in time and says that the results have to be considered tentative.

"However," he says, "of all the possible interpretations, only those involving changes with time of climatic temperatures come close to accounting fully for the observations." □

Element 107: U.S. group skeptical

Among scientists interested in the discovery or synthesis of new chemical elements the name of Academician Georgi Flerov is often heard. Flerov and his colleagues in the Joint Institute for Nuclear Studies at Dubna in Russia have specialized in this sort of work for years, and they have outstanding claims to the discovery of several of the elements with atomic numbers greater than 100. Their latest claim is to element 107 and appears in the Russian language express journal Pis'ma v Redaktsyu ZhETPh, vol. 23 p. 206. (This will eventually be translated into English as JETP Letters.) Flerov and colleagues say they have made a nucleus with 107 protons and 154 neutrons.

Counterclaims to the synthesis of elements 104, 105 and 106 have been entered by an American group that has specialized in synthesizing new elements for decades and has been led by Glenn T. Seaborg and Albert Ghiorso of the Lawrence Berkeley Laboratory. No one, at the moment, makes a counterclaim to discovery of element 107, but Seaborg is extremely skeptical of Flerov's claim. "There isn't sufficient information to assign an atomic number," he told SCIENCE NEWS.

Seaborg's objection is to Flerov's use of spontaneous fission of the supposed new nucleus as evidence for its existence and characteristics. Flerov's experiment began with the bombardment of bismuth nuclei with chromium nuclei in the hope that they would fuse to form the new element. At first a spontaneously dividing nucleus with a lifetime of 5 seconds was found. This is much longer than theory would expect for the lifetime of 107. Pushing down the response time of the experiment, Flerov's group then found a spontaneously dividing nucleus of about 2 milliseconds lifetime, which comes much closer to the theoretically expected duration of element 107. Further checks led them to conclude that the 2-millisecond nucleus was 107, while the 5-second activity is attributed to nuclei of element 105 produced by alpha decay of element 107.

Seaborg says that this spontaneous fission evidence puts the present claim in the same category as Flerov's claims to several previous heavy elements, that is, highly doubtful. In fact, because of the number of recent claims to discovery of heavy elements (114, 115, 116, 124 and 126) from various sources and the expectation that the spread of heavy-ion accelerators will lead to many more, Seaborg and other persons prominent in the specialty published a manifesto in the Sept. 24 SCIENCE, in which they call for the establishment of criteria that a claim to a new element must satisfy before being admitted for consideration. Other signatories are Bernard G. Harvey of LBL, Günter Herrmann of the University of Mainz, Richard W. Hoff of the Lawrence Livermore Laboratory, Darleane C. Hoffman of the Los Alamos Scientific Laboratory, Earl K. Hyde of LBL, Joseph J. Katz of Argonne National Laboratory, O. Lewin Keller Jr. of Oak Ridge National Laboratory and Marc Lefort of the Institut Physique Nucléaire at Orsay, France.

The main point of their argument is that "detection of a spontaneous fission activity and measurement of its half-life cannot per se establish that an element with a new atomic number has been produced." Chemical tests establishing the candidate's position in the periodic table would be ideal. But this group realizes that chemical procedures with small samples are difficult and so says that if the new element is observed by spontaneous fission or alpha decay or both, "The chemical identification can be confined to separation from all known elements with atomic number greater than lead." Other acceptable evidence would be observation of characteristic X-rays emitted in connection with the decay of the new element or the placement of the new element in an alpha-particle decay chain with previously known decay products. As a final shot, the manifesto points out that heavy-ion bombardment experiments produce two new kinds of short-lived states, compound nuclei and nuclear molecular systems. These are not really new elements, and to guard against claiming them as such, they urge that composite nuclear systems lasting less than 10^{-14} seconds should not be considered new elements. □