Creating the Nation's first BioPark

National Zoological Park · Smithsonian Institution · Washington, D.C. 20008-2598

Letter from the Desk of David Challinor
March 1994

This March letter was to have been written in Antarctica where I had planned to be for most of February. The streptococcus infection which has laid me low since January 9 precluded that trip, but I am recovering well and hope to return to work in the next week or so. Thus there will be no February letter.

Antarctica is turning out to be an unexpected source of new scientific knowledge as this isolated continent is more widely explored. Fossil vertebrates found there 20 years ago have helped confirm that Antarctica was part of the super continent Gonwanda and thus was joined to South America and Africa about 200 million years ago. Botanists were amazed to find lichens growing in the interstices of coarse sandstone just below the rock's surface in the dry valleys of Antarctica. How these plants survive on approximately 100 hours of sunlight each growing season is truly amazing; their rate of growth is so slow that they may be thousands of years old, perhaps the oldest continually living organisms on earth.

The discovery of meteorites on the ice surface was also unexpected. The first Antarctic meteorites were found accidentally in 1969 by a Japanese team of glaciologists. Following their discovery a search was planned for the austral (southern) summer of 1973-74. The National Science Foundation rejected this proposal for a meteorite search expedition as too far-fetched, but changed its mind when a Japanese team recovered 663 meteorite specimens in the 1974-75 season. Since 1976, U.S.-led teams have made annual expeditions during the Antarctic summer to collect meteorites (except for 1989 when damage to helicopters forced a last-minute cancellation of the season). The U.S. teams spent their first three seasons working jointly with the Japanese and afterward included members from 11 other countries. In all, nearly 15,000 meteorite fragments have been collected in Antarctica since 1969. How many individual meteorites these represent is unknown, because many meteorites explode in the atmosphere and fall as showers. An educated guess would suggest that the collections include about 1500 new meteorites. This nearly doubles the number of 2100 meteorites which were known throughout the world in 1969.

The Antarctic is such a meteoritic treasure trove because the whole central part of the continent is a huge ice field, 13 million km^2 and 3 km thick near the south pole (about the size of the United States and Mexico). Meteorites sink below the ice surface because they are heavy and their black color absorbs some heat when exposed to the weak sun. The very gradual buildup of the ice mass in the center of Antarctica causes it to flow slowly away from its greatest density down to the coast. In time most of the meteorites end up in icebergs and eventually fall to the sea bottom. However, at several places inland from the coast, there are mountain ranges which block the flow of the ice. The moving ice is thus forced upwards by these mountain barriers, exposing the buried meteorites where they can be collected.

The meteorites, having been frozen in the ice for up to a million years, are virtually free from organic contamination. When collected, they are never touched, but rather scooped into special sterile containers and kept frozen and sealed until opened under stringent laboratory conditions at NASA, Houston. From there, samples are distributed to laboratories around the world for mineralogical, chemical, and isotopic analyses. Terrestrial ages of the objects are determined by measuring several isotopes such as manganese-53, aluminum-26, and carbon-14, which are produced in the meteorites when they are bombarded by cosmic rays while hurtling through space. The meteorites are shielded from cosmic rays after entering the earth's atmosphere and each isotope they contain begins to decay at a known rate. Antarctic meteorites have terrestrial ages ranging from 1000 to a million years, whereas most meteorites found elsewhere in the world have landed within the last 200 years. By being able to determine the terrestrial ages of these bodies from space, scientists can judge whether the chemical composition of the space debris in the earth's orbit has changed over the last million years.

There are several different kinds of meteorites, although well over 96% are stony ones that have no counterpart in rocks of the Earth's crust. About 40 rare carbonaceous chondrites have been found. These black meteorites contain water, and even more intriguing, have hydrocarbon compounds which consist of amino acids. Analysis has shown that these amino acids, which are the building blocks of DNA, did not have a biological origin. This indicates that such molecules existed in the earliest nebula that coalesced to form our solar system about 4.5 billion years ago. Minute amounts of some 20 different amino acids were discovered in these special meteorites. They offer hard evidence of organic substances in the evolving solar system about a billion years before signs of the most primitive bacteria arose to start life on Earth.

One meteorite, found in January 1982, created great excitement when it was fortuitously discovered by a young geologist far from his Antarctic base camp. This specimen, about the size of an apricot, had a frothy greenish-tan crust and was quite unlike any meteorite found previously. When it was later analyzed at the Smithsonian Division of Meteorites in Washington, it was seen to bear an amazing similarity to the rocks collected on the Apollo 16 mission to the Moon. Within a few months, chemical and isotopic analyses by 17 laboratories had shown beyond doubt that it is a lunar rock. Since then 12 more lunar meteorites, from the highlands and from the maria, have been collected -- 11 in Antarctica and 1 in Australia.

How to explain the presence on earth of a lunar surface rock? Perhaps an asteroid or a similar body from space hit the Moon's surface at a low angle. Such an impact appears to be the only force powerful enough to eject surface rocks into space faster than 2.4 km/sec, the speed needed to escape the Moon's gravity. If the striking angle were low enough, rocks might have been blasted off the surface, much like a golf divot. An asteroid hitting the Moon at right angles, for example, would create a crater and the material ejected into space would be from well below the Moon's surface and would thus be quite unlike a surface rock.

Even more unusual than the lunar meteorites are nine meteorite specimens, including two from the Antarctic, that are suspected to have come from Mars. These objects are relatively young geologically and only 1.3 billion years old compared to the 4.5 billion age of all other meteorites. One of the Antarctic meteorites is similar in bulk composition to the Martian soils analyzed by the Viking landers, and it also contains pods of shocked glass that are rich in gases that are chemically and isotopically similar to those measured in the Martian atmosphere. Volcanic activity evidently occurred on Mars 1.3 billion years ago, but the mystery remains as to how they achieved sufficient velocity (5 km/sec) to escape Martian gravity. The hypothesis of their origin could be immeasurably strengthened if we ever acquire rock samples from the surface of that planet, but we will have to wait for a round trip voyage to Mars when samples could be brought back to earth.

From such small pieces of rock we have learned much about the evolution of our solar system. None of us can comprehend a million years, much less a billion. Yet here in safe storage, both in laboratories and under Antarctic ice, are bits of our primordial past when the sun and its planets were beginning to form.

In closing, I want to give special thanks to a distinguished Smithsonian scientist, Dr. Ursula Marvin, who collected meteorite samples on two expeditions to the Antarctic and on whose writings most of this letter is based.

David Challinor
(202) 673-4705