week or two would disillusion him. A few sects, including the Roman Catholic, do conditionally permit the accommodation of evolutionary fact to official dogma. Even in those sects many pastors and most laymen nevertheless reject evolution on superstitious grounds, and it is well known that other sects forbid acceptance of this and some other facts established scientifically.

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Meetings

Program for Collecting Meteorites

The urgent need for a scientific program for collecting meteorites was a key topic at the 22nd meeting of the Meteoritical Society. Attended by 50 members and guests, the meeting was held at the Harvard College Observatory, Cambridge, Mass., 10 and 11 September 1959, under the auspices of the Smithsonian Institution. A symposium was conducted on the ages of meteorites and on the effects of the bombardment of meteorites by cosmic rays. During the regular sessions, participants read technical papers on the spectra of meteor trails, electron-probe microanalysis, meteorite craters, micrometeorites, cosmic dust, and tektites. Of particular importance was a conference held to discuss the critical shortage of meteoritic materials for research purposes and to outline a cooperative program to improve the situation.

A scientist working alone can do fruitful research on meteorites if he has suitable and adequate specimens. However, the efficient collection and proper distribution of meteorite samples requires the cooperative efforts of many people.

The amount of meteoritic material available in the United States is rapidly diminishing as specimens from private and institutional collections and the meagre supply from new falls are rapidly being used up in research. Meanwhile, our need for such material is growing rapidly. At present, researchers receive samples from only about one new fall a year, an amount far less than that required for the many investigations now being carried on. As a consequence, some important research cannot be undertaken, and some investigations presently under way are starved for material.

Importance of Meteoritic Research

Results important both to astrophysics and to our national space program have been obtained from the study of the chemical, metallurgical, and mineral composition of meteorites and from measurements of the amounts of radioactive and stable isotopes produced in meteorites by cosmic rays. These results have contributed significantly to our knowledge of cosmic rays in the far regions of the solar system; the frequency of collisions among asteroids, comets, and cosmic dust; the history of the temperature and pressure to which meteorites have been subjected; the abundances of the chemical elements; the ages of meteorites; and the time lapse between the formation of the elements and the formation of the meteorites.

Measurements of the abundances of long-lived radioactive isotopes in meteorites tell us the average of the cosmic-ray intensity in the same region of space at different times; measurements of the abundances of short-lived radioactive isotopes tell us the intensity of cosmic rays in different regions of space. Recently, the amounts of tritium (half-life, 12.4 years), argon-37 (half-life, 34 days), argon-39 (half-life, 260 years), and chlorine-36 (half-life, 3.1×10^5 years) produced in meteorites by cosmic-ray bombardment have been measured in a few samples. The ratio of argon-39 to chlorine-36 indicates, when integrated over these long half-life times, that the intensity of cosmic rays is constant. However, the ratios of argon-37 to argon-39 and of tritium to argon-39 indicate, when integrated over these short half-life times, that the intensity is not always constant.

These measurements have given us information about the intensity of cosmic rays in the regions between the planets, just as in recent years rockets have provided us with data on the intensity in the region between the earth and the moon.

The amounts of the stable isotopes helium-3, helium-4, neon-20, neon-21, neon-22, argon-36, and argon-38 have also been measured in several specimens. The abundances of these isotopes in some meteorites can easily be explained by the action of cosmic rays; in others, they remain a mystery.

The length of time during which the meteorites were exposed to cosmic-ray bombardment can be derived from this study of the radioactive and stable isotopes. In some meteorites, the exposure time was as short as 10^7 years, while in others it was as long as 2×10^9 years. These data can best be explained by our assuming that collisions between interplanetary bodies have occurred at different times. However, a systematic investigation of this problem will require the experimental use of many more meteorite samples than are now available.

Metallurgical studies of iron meteorites, and studies of the diffusion of the noble gases in stony meteorites, have provided us with valuable information about the history of the pressure and temperature of these bodies. The metallurgical evidence indicates that the iron meteorites cooled very slowly under high pressures until they reached a temperature of approximately 300°C; they remained at this temperature for at least 50 million years and then became cold. On the other hand, the studies of the diffusion of the noble gases in stony meteorites indicate that these were colder than -150°C and under low pressures for almost all of their 4.5×10^9-year history. Further work is needed, however, to establish the validity, consistency, and significance of these observations.

The abundances of the nonvolatile elements in the universe are assumed to be the same as their abundances in chondritic meteorites. We therefore base our theories of the origin of these elements on a study of the chemical composition of chondrites. However, many of the measurements of these abundances which are still used as basic data were made decades ago; we should repeat them, using current laboratory techniques. We need also to investigate further the question of which elements have relatively the same abundances in all chondrites and which have not.

Perhaps even more important than the measurements of the time that a meteorite was exposed to cosmic rays are determinations of the time when it solidified, or its radiogenic age. This time is calculated from the relative amounts of a primordial parent isotope and of the stable daughter isotope. Stony meteorites have much higher concentrations of the isotopes useful for this measurement than do iron meteorites. Consequently, the radiogenic ages of the former have been measured by many investigators by several different methods; 4.5×10^9 years is the maximum value that has been obtained. Recently, the radiogenic age of several iron meteorites has been determined; the value was 10^{10} years, much higher than that for stony meteorites. This work should be repeated and extended.

The presence of isotope xenon-129 was very recently discovered in a meteorite, although a previous investigation had failed to reveal it in a sample of a different meteorite. The amount of this isotope indicates the time between the formation of the elements and the solidification of the meteorite; the value derived for this one sample was 3×10^8.

These and other investigations emphasize the critical need for an abundant supply of meteorite specimens for research purposes. Furthermore, a point often overlooked is the value of a "surplus" of samples. At present, we have so little meteoritic material to work with that every gram must be used only in a carefully planned way. A surplus would allow researchers a greater freedom in their experiments, a freedom which could lead to results that at present we cannot in any way foresee but that might be of great scientific importance.

Haphazard Collecting

The collecting of meteorites in the United States is very haphazard. No effort is made to obtain material from some reported falls; for other falls, collectors compete for the material. There is no cooperative plan for searching for finds. No extensive and continuing survey of the night sky is maintained to record the transits of meteors and determine the possibility of falls. While a few scientists and organizations have been fairly successful in obtaining specimens, there is no over-all program, and there is no well-established and generally accepted procedure.

When a meteorite falls, the owner of the property on which it lands becomes the legal owner of the material. However, he is often uncertain whether it actually is a meteorite, and he seldom knows its scientific and market value. He may take a sample to the curator of a museum or to a faculty member of a local college or university. On the other hand, he may display it on the mantelpiece or store it away, give it away, or throw it away.

If considerable noise was associated with the fall, or if there was some property damage, the event may make the local newspaper and even, though rarely, a metropolitan paper. Frequently, as a consequence of this publicity the owner then asks an exorbitant price for the specimen. A few collectors will investigate such stories and attempt to obtain the meteorite; the others will not.

The personality of the successful collector is also an important factor. Some collectors readily sell or donate samples to scientists and museums; others refuse to part with any.

During the past 40 years, H. H. Nininger has been the most successful and most enlightened collector in the United States and has contributed much of the material now being used in research. Nininger is planning to retire soon.

The U.S. National Museum, the American Museum of Natural History, and the Harvard Geological Museum have also donated many samples to research. However, these museums are not at present in a position to devote much time to collecting new falls; they acquire most of their specimens through bequest or purchase from the estates of private collectors.

The result of this haphazard situation is that we obtain for research only about one new fall a year, whereas we could, through a cooperative, scientific program, acquire materials from perhaps five new falls per year. Furthermore, specimens usually do not arrive at the laboratories soon enough and in good enough condition to be of maximum value to science. For example, if we are to measure the argon-37 in a sample, we must be able to work with the sample in the laboratory within a month or two of its fall; this is seldom possible under present circumstances.

The Proposed Program

The conference at the meeting suggested three methods that would result in more efficient collecting of meteorites. First, a central agency should investigate all reported falls, actively search for meteorites, quickly purchase specimens at reasonable prices, inform interested scientists of the availability of new material, distribute samples for research, and keep accurate records. A clipping service should be used to ensure that all falls reported in the newspapers are made known to the agency. And the active support of meteorite collectors should be enlisted.

Second, amateur astronomer groups, science clubs, and the general public should be alerted to the need for specimens and urged to report to the agency any bright meteors they observe. Ideally, the report should include the time of observation, the estimated magnitude of the meteor, the position at the beginning and at the end of the meteor trail relative to familiar landmarks and to background stars, and the presence or absence of any noise associated with the passage of the meteor.

Third, a network of meteor cameras should be built to photograph continuously and automatically the night sky over a large area of the United States. A realistic plan would be to have between ten and 20 wide-angle cameras stationed 100 to 200 miles apart. Periodically, the film in each camera would be processed and new film would be inserted. When the photographs show that a meteor larger than a certain size (perhaps 1 kilogram) has fallen, a search party would attempt to find the meteorite. From the photographs, the area containing the specimen would be known to within approximately 0.1 square mile.

By this means, two fields of knowledge now separated could be joined. For, associated with each collected specimen would be photographs giving its precise transit through the atmosphere, and from these data its precise orbit in space and its interactions with the atmosphere could be determined. What we thus learn from a study of the meteor trail would be correlated with what we learn from the specimen in the laboratory.

The Smithsonian Institution has agreed to serve as the central agency for this program. The Moonwatch volunteer satellite observing teams have been alerted to report falls. Any information concerning recent meteorite falls should be sent to Dr. F. L. Whipple, Director, Smithsonian Institution Astrophysical Observatory, Cambridge 38, Mass., or to Dr. E. P. Henderson, Curator of Mineralogy and Petrology, U.S. National Museum, Washington 25, D.C.

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Forthcoming Events

July

11–12. Response of Materials to High Velocity Deformation conf., Estes Park, Colo. (AIME, 29 W. 39 St., New York 18)

11–15. British Dental Assoc., annual, Edinburgh, Scotland. (Secretary, British Dental Assoc., 13 Hill St., Berkeley Sq., London, W.1, England)

11–15. Royal Medico-Physiological Assoc., annual, London, England. (A. B. Monro, 11 Chandos St., Cavendish Sq., London, W.1)