

GEOCHEMISTRY

Carbon-14, Atomic Age Sleuth

Carbon-14 is the atomic sleuth tracing man's past and uncovering information about the earth and its atmosphere that may help foretell his future.

See Front Cover

► CARBON-14, the Sherlock Holmes of the atoms that has dated man's past, now is revealing the secrets of the earth from the depths of the oceans to the atmosphere.

The sleuthing talent of this element was discovered by Dr. Willard F. Libby, Nobelist at the University of California, Los Angeles, more than ten years ago.

Dr. Libby, then at the University of Chicago, discovered that carbon-14, a comparatively scarce isotope of natural carbon, is radioactive. This carbon isotope, with a half-life of about 5,600 years, is found in both plants and animals and after their death disintegrates at a steady rate. In other words, a body or fossil 5,600 years old would be half as radioactive as a currently living organism.

Tests using radiocarbon for dating were made by Dr. Libby and his collaborator E. C. Anderson on ancient artifacts of known age. The results were found to be remarkably accurate.

Carbon-14 also has been used for geological research. Radiocarbon dating has established the chronology of such geological events as the advances of the ice ages and the period of time between them and whether they occurred simultaneously in various scattered areas of the world.

Ice Age glacier advances are estimated by radiocarbon dating of stumps and fragments of trees destroyed by advancing glaciers such as the Tumbling Glacier in Mt. Robson, Canada, shown on the front cover of this week's SCIENCE NEWS LETTER.

Measures Water Sources

Available water supplies in arid zones also can be measured by radiocarbon dating of underground water to determine its age. This recent use of carbon-14 tracing is profoundly important to those who live in hot, dry climates. Water whose carbon-14 measure shows it to be young in age means adequate water. Such youth indicates that the underground reservoir is being adequately replenished by rainfall.

Aged or "fossil" water means a dwindling water supply and offers a sharp warning to inhabitants dependent upon it either to look for other water sources or begin organized water rationing.

Too little water is a danger to man's survival, too much also poses a threat. The rate at which the oceans now are rising on coastlines will give some indication of land that may be lost to man in the longer future. This may be revealed by a current study on the rate at which ocean waters submerged coastal forests some 4,000 years ago.

Radiocarbon measurements of ancient tree stumps and fragments still rooted in land now exposed by high tide in various coastal areas have been made by Prof. Charles J. Lyon, a Dartmouth College botanist.

His results show that it took 320 years for the ocean to rise one foot on New Hampshire's coastline at Odiorne Point, in contrast to only 51 years at Fort Lawrence and 62 years at Grand Pre. The last two in Nova Scotia are referred to as "drowned forest" sites.

According to Prof. Lyons, the ocean now is rising at about this same rate in these areas. For lifetime planning for the present generation, the study of ocean levels may not be important; but it will be vital to future generations.

Oceans' Mixing Rate Found

In oceanography, radiocarbon techniques have yielded the answer to the great question of the mixing rate of the oceans. Studies have shown that the Pacific mixes less rapidly than the Atlantic. In the Pacific, the turnover time between waters at the surface and those at great depths is between 1,500 and 2,000 years; in the Atlantic, it is about 750 to 1,000 years.

Radiocarbon dating also can measure the deep ocean currents. It has disclosed evidence for velocities and directions of the deep ocean currents in the Pacific that correspond to a requirement of some hundreds of years for the passage northward along the bottom.

In meteorology, carbon-14 tracing has shown for the first time clear and incontrovertible evidence of the world-wide circulation of elements and material in the atmosphere. This has had important biological implications by making it possible for scientists to determine the distribution and concentration of radioactive fallout from bomb tests. Thus the levels of strontium-90 and other harmful radiation from atomic testing now can be estimated with considerable accuracy.

The best dating techniques today require something like the discipline of surgery, Dr. Libby has said. "Cleanliness, care, seriousness, and practice" must be adopted by adequately trained personnel in order to assure obtaining radiocarbon dates that are consistent.

New techniques for radiocarbon dating are under development. With their advance and the subsequent increase in accuracy, new uses for carbon-14 in scientific research undoubtedly will develop. But its major use and greatest value undoubtedly will continue to be in revealing more of man's history, and thereby perhaps shedding new light on his future.

Written records of antiquity have been found in Egypt, in Asia Minor and in limited areas of Central America. But most ancient men did not write. Yet through the use of chemistry, scientists have been able to establish that people living 10,000 and more years ago had intelligence and capabilities that rival those of modern man.

The handiwork of the ancient Indians in North America, their basketry and skillfully made arrowheads, give evidence of their ability and skill. Among the most beautiful basketry of ancient man are the 300 pairs of sandals found in Fort Rock Cave in Oregon woven from grass rope, neatly stacked as those in a modern shoe store today. These sandals, 9,000 years old, are among the several thousand items traced back to their chronological origins by radiocarbon dating.

Radiocarbon dates also have established the existence of clashes between cultures of people who did not write or leave records. For example, the Neanderthal man and the Cro-Magnon man appear to have come on the world scene at the same time; but they did not remain together. The Cro-Magnon man survived the Neanderthal man, but how and why his survival occurred still is not known.

By radiocarbon dating, interesting and important details about ancient people have been discovered. An example of this was the successful correlation of the Babylonian calendar from the time of King Hammurabi with our own calendar, which Dr. Libby described in the journal *Science*.

The calendar of the Babylonians is a good one, but there appeared to be some conflict with the calendar in use today concerning the identification of a particular eclipse.

Dating Method Tested

Carbon-14 measurements were made on a portion of a house, about 4,000 years old, that was precisely dated by the Babylonian calendar. These provided a serious test of the limit of sensitivity and accuracy of the radiocarbon dating method. The sample of wood used for the testing came from a beam which bore a clear and legible date according to the Hammurabian Babylonian calendar.

The beam was divided into three equal portions, carefully measured over a period of three months, and the results then coordinated to get an answer as to which of the two most likely correlations of the Christian and Babylonian calendars was correct. The younger of the two possible calendars was strongly favored; the odds against the other being correct were about nine to one.

Radiocarbon techniques by pinpointing past events in time may make it possible to drive back history into prehistoric periods now only guessed at and to more clearly describe the development of modern man.

To roll back the pages of history faster,

Dr. Libby and his associates at UCLA are working on a portable radiocarbon dater which will allow specialists to work in the field with archaeologists and geologists.

This will make it possible to excavate and utilize sites which now are little more than dark spots in some remote area, even though the dates obtained on the sites would not be as accurate as those which

would be obtained in the laboratory.

The main advantage of the portable dater for archaeologists would be its use as a guide for digging. But its successful development, as Dr. Libby has pointed out, will permit "radiocarbon daters to go out and share, at least vicariously, in the great thrill of an archaeological dig."

• Science News Letter, 80:122 August 19, 1961

PHYSIOLOGY

Body's Master "Timer"

► THE HYPOTHALAMUS, a part of the forebrain containing vital nervous centers, functions as "the master timing signal generator" of the human body.

Dr. John Erskine Malcolm of the Postgraduate Medical School, London, reports nerve cells in the hypothalamus receive a pulse beat that starts in a circuit connecting arteries in the neck and brain, and is independent of the pulse from the heart. The pulse from this arterial circuit, called the circle of Willis, excites the hypothalamus cells and causes them to generate electrical impulses which are used by the brain as timing signals.

The hypothalamus, Dr. Malcolm contends, is therefore the timing device or "co-ordinating mechanism" that prevents interference between the pulse waves produced by the heart and those produced by the Willis circle.

He compares the action of the hypothalamus to that of a master timing signal generator used with radar equipment to enable the transmitter to take synchronized signals from both the generator and the receiver.

Signals or impulses travel from the hypothalamus to the heart by way of the involuntary nervous system. It now appears, Dr. Malcolm says, that the signals from the heart to the hypothalamus are actually heart sounds, conducted by the bones of the chest and spinal column.

The Willis circle is probably "the most important site in the body" at which these self-starting electrical vibrations occur, he states. A dilated portion of the internal neck artery apparently monitors blood pressure to assure "stable operating conditions" for the pulse-producing arterial circuit, Dr. Malcolm reports in *Nature*, 191:606, 1961.

• Science News Letter, 80:123 August 19, 1961

MATHEMATICS

Unified System Urged

► MATHEMATICS should be taught as a unified whole. Its "dead, useless, outmoded or unimportant parts" should be abandoned and replaced by a system that merges specific subjects to allow a smooth, gradual transition from basic principles to advanced work.

Drastic revisions in present teaching methods are needed to close the gap between secondary schools, which are 50 years behind the times, and universities, which have kept up with modern research and new programs in mathematics.

The conclusions were reached by mathematicians and educators from 18 nations that attended an international seminar. Their report has been issued by the Organization for European Economic Cooperation, Paris, sponsors of the 1959 meeting at Royaumont, France. It was written by Dr. Howard F. Fehr, head of the mathematics teaching department at Columbia University Teachers College in New York.

The new program would blend geometry and algebra as related subjects, taught from a fundamentally algebraic approach. The differences between the two would gradually disappear.

This would mean changing or replacing Euclid's traditional principles of geometry, taught for centuries. The theory is that all the Euclidean essentials can be learned "intuitively," at ages 11 to 13, by drawing,

measuring, making models and investigating all useful facts.

From 13 to 15, the pupil would study deductive geometry — but not with the time-honored Euclidean triangles. Synthetic geometry would be replaced by a basic mathematics system using vectors, or real numbers. From the age of 15 on, geometry's established principles would be merged with algebra to promote a "gradual departure from physical reality to formal geometric abstraction and structure" by the time the student is ready for college.

Algebra itself would have much of its presently taught material weeded out. The solving of unnecessarily complicated problems is one of the factors that tends to clutter up the subject, the report said.

Trigonometry would not be taught as a separate subject, but as a part of the geometry-algebra mixture and later as a part of analysis.

Two new fields would be introduced at the high school level. They are elementary probability and statistical inference, which contribute to the "scientific method" basic to many modern fields.

New textbooks would, of course, be needed. Most of the countries also reported a need for more and better qualified teachers. Some are considering putting retired mathematics teachers back into service, or hiring retired scientists and engineers with

teaching qualifications.

The countries represented were Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, Turkey, the United Kingdom and Yugoslavia, all organization members, and the United States, which sent four "guest experts."

• Science News Letter, 80:123 August 19, 1961

PHARMACOLOGY

Anti-Cancer Chemical Gets Clinical Trials

► A NEW CHEMICAL COMPOUND that slows up three types of mouse tumor is undergoing preliminary trials on humans, four scientists of Lederle Laboratories, Pearl River, N. Y., report.

Three kinds of cancer respond to oral doses of the drug, which is also effective by injection. The types are sarcoma 180, a common type of cancer, 6C3HED lymphosarcoma, a lymph gland tumor, and C3H mammary adenocarcinoma, a cancer attacking the breast glands.

The drug significantly prolonged the survival time of mice that had had transplants of mammary adenocarcinoma, but it was ineffective against "spontaneous" mammary adenocarcinomas.

Previously reported anti-tumor chemicals or "alkylating agents" act as bone marrow depressants, and the new Lederle chemical also diminishes the activity of bone marrow.

The chemical name of the experimental drug now being tried out clinically is N-(acrylamidomethyl)-3-bromopropionamide. Detailed results of evaluation studies of this and other anti-tumor chemicals will be published soon.

Drs. A. S. Tomcufcik, S. D. Willson, A. W. Vogel and A. Sloboda of Lederle Laboratories report in *Nature*, 191:611, 1961.

• Science News Letter, 80:123 August 19, 1961

GEOPHYSICS

Scientists Search for Nuclear Test Sites

► UNITED STATES Geological Survey scientists have been scouring the countryside searching for possible test sites for nuclear explosions. These sites would be used for peaceful or military testing purposes if and when nuclear testing is resumed.

Selection of the proper testing area is very important, Geological Survey scientist V. E. McElvey said. Contamination of surface or underground waters from a nuclear explosion is but one of the many possible hazards, he said.

Two of the sites already recommended to the Atomic Energy Commission are near the towns of Hattiesburg, Miss., and Carlsbad, N.M. Both locations contain thick underground salt layers that would be used to confine a nuclear explosion.

The Carlsbad site was chosen to explore the peaceful uses of the atom.

• Science News Letter, 80:123 August 19, 1961