GEOPHYSICAL SCIENCES

From our reporters at the spring meeting of the American Geophysical Union in Washington

New ozone model: Earlier life on land

Conditions may have been right for life's big move from the sea to land several hundred million years earlier than previously estimated. New calculations indicate earlier formation of the ozone screen necessary to shield plants and animals from damaging ultraviolet radiation, report Joel S. Levine of NASA Langley Research Center, Paul B. Hays of the University of Michigan and James C. G. Walker of the National Astronomy and Ionosphere Center. Unlike previous studies, their model considers the role of nitrogen and hydrogen compounds in the atmosphere, the vertical movement of gases and the effect of oxygen in absorbing radiation.

During evolution, the level of molecular oxygen (O_2) has increased to more than one million times its original level, predominantly due to photosynthesis by plants. The early low levels of oxygen permitted solar radiation to penetrate deeply into the atmosphere and to dissociate oxygen molecules, initiating ozone formation. The new calculations indicate that ozone levels increased along with oxygen, reaching a peak when oxygen was at 10 percent its present level, about 420 million years ago. The critical amount of ozone required to shield life on land had been reached a few hundred million years earlier.

As the accumulating oxygen limited penetration of ultraviolet light, ozone formed more slowly. Other chemical reactions that destroy ozone continued. Levine reports that the total amount of ozone has now decreased more than 20 percent from when oxygen was at 10 percent its present level. The researchers predict that if atmospheric oxygen levels should increase in the future, the total amount of ozone would decrease further.

Earth-based ions in Van Allen belts

The "belts" of trapped radiation around the earth, named Van Allen belts after James A. Van Allen of the University of Iowa, have commonly been thought to consist primarily of charged particles from the solar wind. Now a group of researchers has reported the discovery that the belts also include a substantial contribution from earth's own atmosphere.

The finding comes from data provided by an ion mass spectrometer aboard a military satellite known as S3-3. The instrument has detected hydrogen ions (H^+), helium ions (He^+ and He^{++}) and oxygen ions (O^+) streaming upward along the earth's magnetic field lines, according to Richard G. Johnson, Richard D. Sharp and Edward G. Shelley of Lockheed Missiles and Space Co.'s Palo Alto Laboratories in California. The key clue among these is the oxygen, says Johnson, since it is by far the most rare in the solar wind. The hydrogen ions (protons) are about 1,000 times more numerous than the charged oxygen atoms in the sun's outpourings, and even the less common helium ions are abundant enough to leave room for ambiguity.

The oxygen alone, however, is sufficient to prove the point, Johnson maintains. The significance of the discovery, he says, lies not in the nature of the ions themselves but in their terrestrial origin, which could necessitate rethinking some ideas about the way trapped radiation belts are formed.

The discovery could also make itself felt in studies of the radiation belts of other planets. Jupiter's belts are well-known—they nearly blitzed the Pioneer 10 and 11 spacecraft—and similar phenomena are suspected for Saturn, Uranus and Neptune, based on inferences from those planets' reported nonthermal radio emissions.

The spectrometer, said by Johnson to be one of the first ever orbited capable of studying ions with more than thermal energy ranges, was developed for the Office of Naval Research.

Refining a cooler moon

In March of 1976, Stephen J. Keihm and Marcus G. Langseth of the Lamont-Doherty Geological Observatory made major news among scientists studying earth's moon with their report that the lunar heat flow was barely half the previously estimated amount. This was important in part because it eased one of the principal discrepancies between the earth and the moon. In view of the possibly cooler estimates for the "total moon," implications of high uranium content from Apollo surface samples were taken to mean that heat-producing radionuclides must be concentrated close to the surface, leaving a corresponding depletion at greater depths. Now Keihm and Langseth have put some numbers to their new view of the moon.

"Consistency with the heat flow, geochemical and magnetics data," they report, "requires a 300-600-kilometer layer depleted in heat sources which have migrated upward into the lunar crust." Such a heat-source distribution, combined with inferences from seismic data regarding the degree of melting in the interior, suggests that the temperature increases rapidly from the surface to a depth of about 300 kilometers. Temperatures reach 700° to 800°K at the base of a crust about 60 kilometers thick and 1,100° to 1,150°K about 300 kilometers down. Below that depth, the researchers report, the temperature variations with depth are probably much smaller.

Global temperature changes

Climate variation has become such a crucial subject of scientific concern that it is essential to have accurate and up-to-date data on what's happening to the climate. The global variation in temperature during the period 1958 to 1976 has now been determined using a sample of 63 radiosonde stations evenly spaced over the earth's surface. J. K. Angell and J. Korshover of the National Oceanic and Atmospheric Administration's Air Resources Laboratory report the findings.

The results confirm other reports that the often-noted post-World War II cooling trend bottomed-out a decade ago in the Northern Hemisphere and actually reversed in the Southern Hemisphere. In the global average, there was a highly significant cooling of 0.6°C between 1959 and 1965, with the decrease somewhat greater in the Northern than Southern Hemispheres. Since 1965 there has been a 0.2°C warming in the Southern Hemisphere but little temperature change in the Northern Hemisphere.

The NOAA analysts say the data base has been set up so it is very easy to update each year, and they plan to do so.

Bulges in the crust of North America

A large area of southwestern Montana, Yellowstone National Park and the Snake River Plain has been found to have gradually bulged upward prior to an earthquake at Hebgen Lake, Mont., in 1959. Robert Reilinger, G. P. Citron and L. D. Brown of Cornell University analyzed and cross-checked the data from five survey lines, run at different times across the study area. The analysis was carried out over a much larger area than that studied intensively after the earthquake. They show that an area of approximately 8,000 square kilometers surrounding the earthquake had risen 15 to 20 centimeters since about 1923.

Reilinger and his co-workers suggest that the doming preceded the earthquake for a considerable time (hundreds to thousands of years or more), causing tensional stresses in the upper crust. When these stresses exceeded some critical value, the ground faulted and collapsed, causing the 1959 earthquake

and some 22 feet of vertical movement along the Hegben fault. The doming of the area continued at least 5 years after the quake.

Evidence indicates that intrusion of magma upward into the crust is the most likely cause of the observed uplift. This suggestion is supported by the proximity of the doming region to the thermally active Yellowstone region.

The weekend goes extraterrestrial

There is preliminary evidence that man's terrestrial activities may be affecting a region of space thousands of miles away. Several independent experiments by Stanford engineers have measured slight changes in the earth's ionosphere and magnetosphere that occur only during weekends. The ionosphere is the electrically charged layer of the upper atmosphere, off which radio signals bounce in long-distance communications and beyond which is the magnetosphere, an extensive region of space that envelopes the earth and contains its magnetic field. Interpreting the results, Chung Gun Park expresses the experimenters' consensus conclusion that "there is no known weekly cycle in nature. It has to be a manmade effect."

Antony C. Fraser-Smith, who conducted the first such Stanford experiment, has detected a slight overall weekend increase of the earth's magnetic field. Some of his data are derived from records that go back over a century, and he finds the effect persisting from the present until about 80 years ago. Although each of the other two experiments has detected disturbances in other aspects of the spatial regions, each of them corroborate the weekend behavior.

The engineers involved suggest that the weekend effect is caused in part by the complex of power lines that crisscross the United States. They base the hypothesis on some theoretical work done 20 years ago by Stanford professor Robert A. Helliwell. According to it, a small amount of radiation that leaks from the earth's surface into space can there provoke a disturbance about one million times greater than itself. This enormous amplification factor makes plausible the idea that man's piddlings on earth could precipitate an effect thousands of miles removed in space. Furthermore, Fraser-Smith speculates, the appearance of the weekend effect seems to roughly coincide with the emergence of power lines in the United States, about 80 years ago.

Sea quartz maps land wind

In an unusual addition to the study of earth's climatic evolution, a researcher is using quartz crystals to probe the winds of the past. The crystals were embedded in a 3-meter core sample of the Atlantic Ocean floor, taken from just north of the Cape Verde Islands about 1,600 kilometers west of Africa. Their presence in varying sizes reflects changes in the winds that carried them there from the land.

"The stronger the wind," says J. Paul Dauphin of the University of Rhode Island, "the larger the grain size which that wind can carry. . . . You can see the grain size vary as you measure down the core length." Pure quartz is particularly useful, he says, since it avoids the difficulties of making the same calculations from "bulk, carbonate-free material," which is likely to include a range of densities.

Dauphin reports that his results also correlate well with oxygen-isotope data from the same sample. As the earth cools, heading for a glacial period, the winds intensify, he says, reducing in strength as the world warms up. The quartz-dust concentrations, reflecting changes in the region's dominant northeast trade winds, match the oxygen-isotope inferences back through at least two glacial cycles.

BIOLOGY

Mosquito love spreads human virus

Viruses take various routes from one disease-causing infection to the next. The La Crosse virus, which causes encephalitis in almost 100 children each year, is transmitted by mosquitoes in the midwestern and eastern United States. The mosquitoes often obtain the virus from infected chipmunks and squirrels. The virus may also pass from female mosquitoes to their eggs and thus to the next mosquito generation. The most recent discovery of Wayne H. Thompson and Barry J. Beaty at the University of Wisconsin is the first case of venereal transmission of a virus by mosquitoes—mating spreads La Crosse virus.

In the laboratory, Thompson and Beaty induced "limited contact" mating of mosquitoes to prevent viral spread by other routes, such as through the saliva. La Crosse virus was detected with a chemical probe, a specially constructed antibody that fluoresces when it binds the virus. The researchers found that sex glands of infected male mosquitoes and the extruded semen both contain large amounts of virus. After mating with an infected male, all previously uninfected females have virus in the lower reproductive tract. In 5 percent, virus spreads to other organs such as nerves, ovaries and salivary glands.

The La Crosse virus has been detected in about a third of the eggs laid by an infected female. Thompson is now collecting mosquito eggs from the field to determine the virus's natural prevalence. Transmission through eggs is the main way the La Crosse virus population survives the winter, Thompson explains. "The infection seems to have no effect on the mosquitoes' ability to survive and mate," he reports.

Peptide found to cool cold rats

Bombesin, a 14-amino-acid peptide chain originally isolated from the skin of frogs, is powerful in a new role. A tiny amount of the peptide, when injected into the brain, lowers the body temperature of rats exposed to cold, Marvin Brown, Jean Rivier and Wylie Vale report in the May 27 SCIENCE. They find, however, that bombesin does not cool animals kept at room temperature. The researchers explain the peptide probably decreases a rat's ability to produce heat or increases its heat loss.

Although bombesin has never been isolated from a mammalian brain, the Salk Institute researchers have indications that the peptide is relevant to normal function. Antibodies made to bind that peptide react in pig and rat brains with a material that either is or resembles bombesin. The investigators are now exploring the interactions of bombesin with hormones known to coordinately control body temperature and determining whether bombesin will prevent fever. They suggest the peptide may be valuable in reducing body temperature for surgery.

Antibiotic action: An outside job?

A spoonful of gelatinous beads may help future medicines go down. Researchers at the University of Illinois report that antibiotics tethered to 0.1 millimeter spheres can still interfere with the growth of certain bacteria. The drugs used, polymixin B and EM 49, are known to inhibit respiration in bacteria. But when the antibiotics are bound to the beads, which are 100 times larger than the bacteria, they are unable to reach the bacterial inner membrane where respiration occurs. David C. LaPorte, Ken S. Rosenthal and Dan R. Storm propose in the April 19 issue of BIOCHEMISTRY that these antibiotics act indirectly by perturbing the structure of the bacteria's outer membranes. Attachment of antibiotics to large polymers, such as these beads, will be a useful tool for studying drug interactions with cell surfaces and may have clinical value for permanently sterilizing cotton bandages or reducing drug side effects.