SCIENCE

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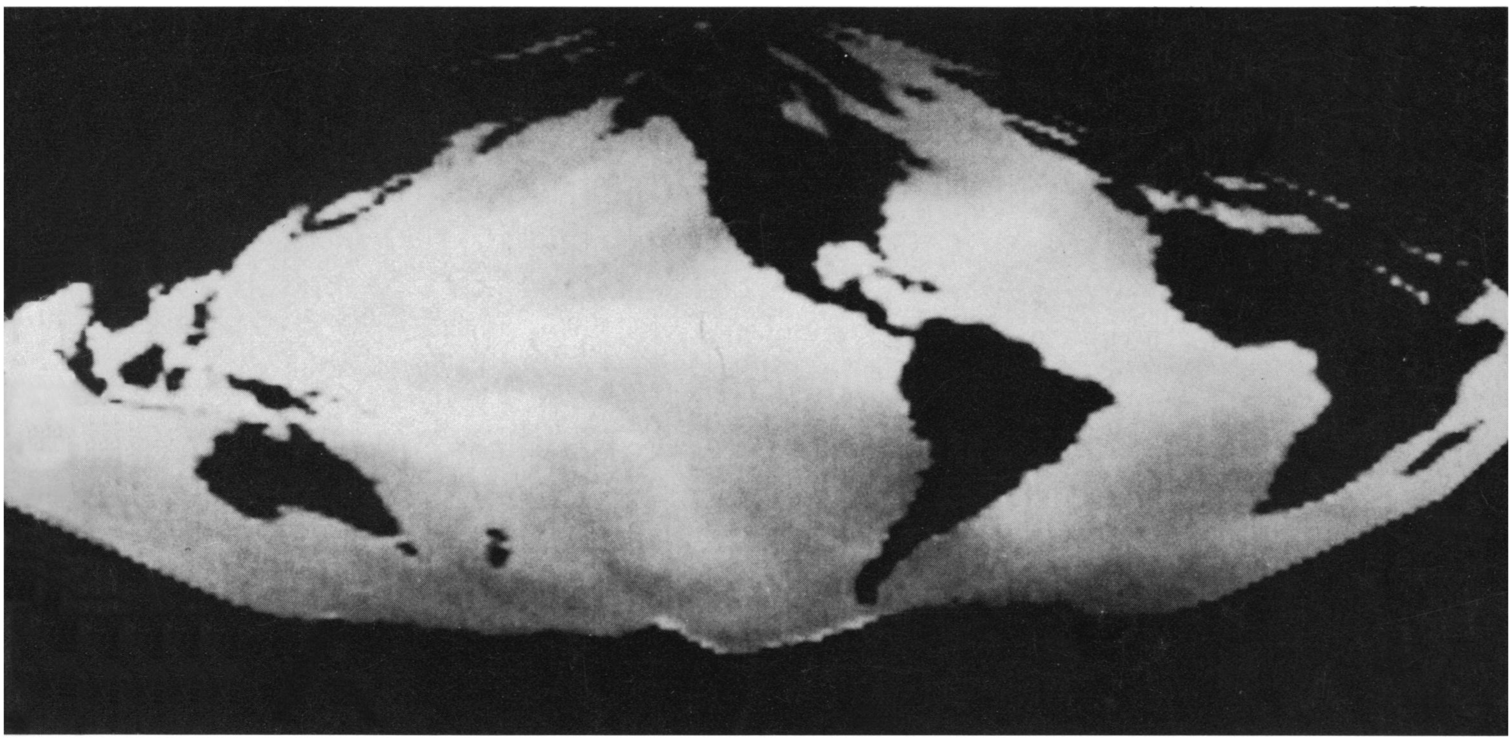
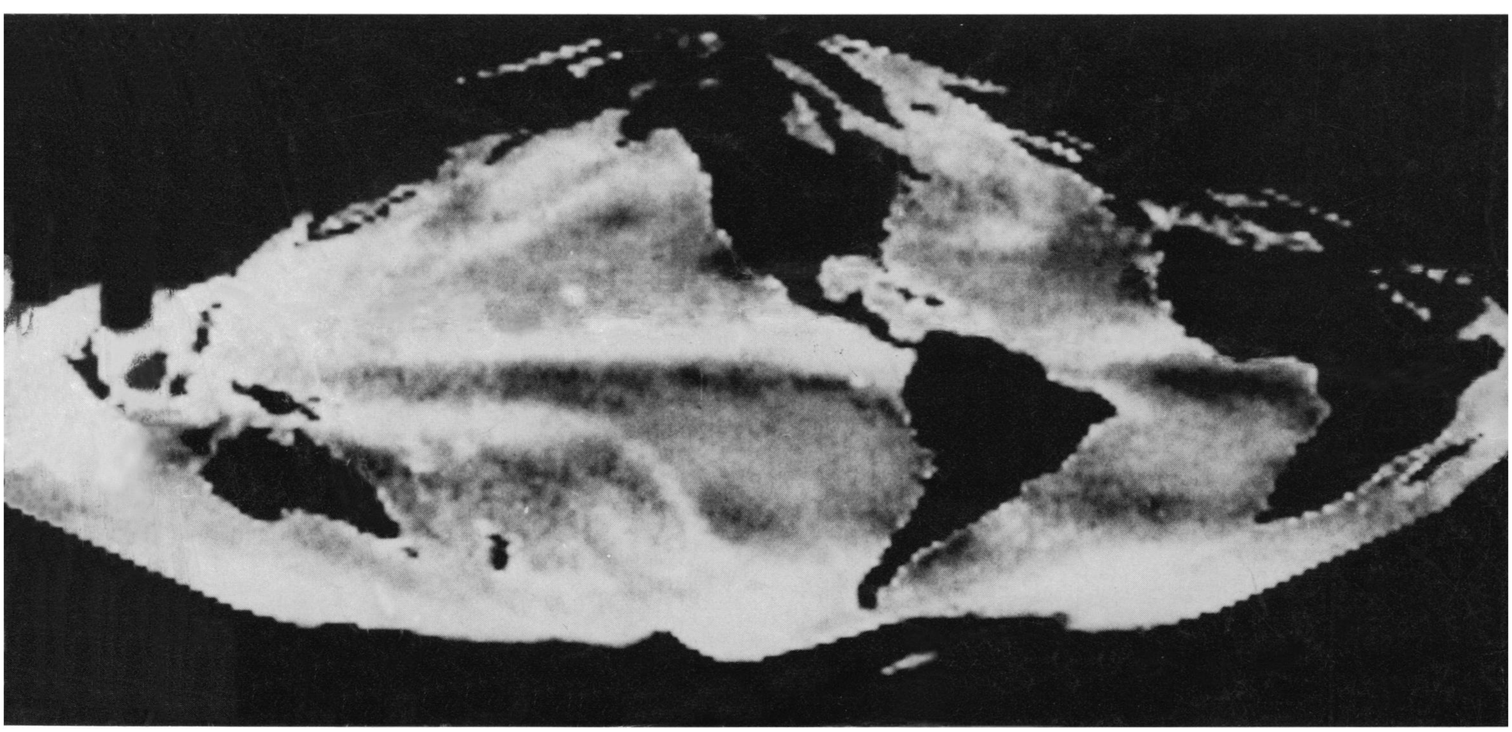
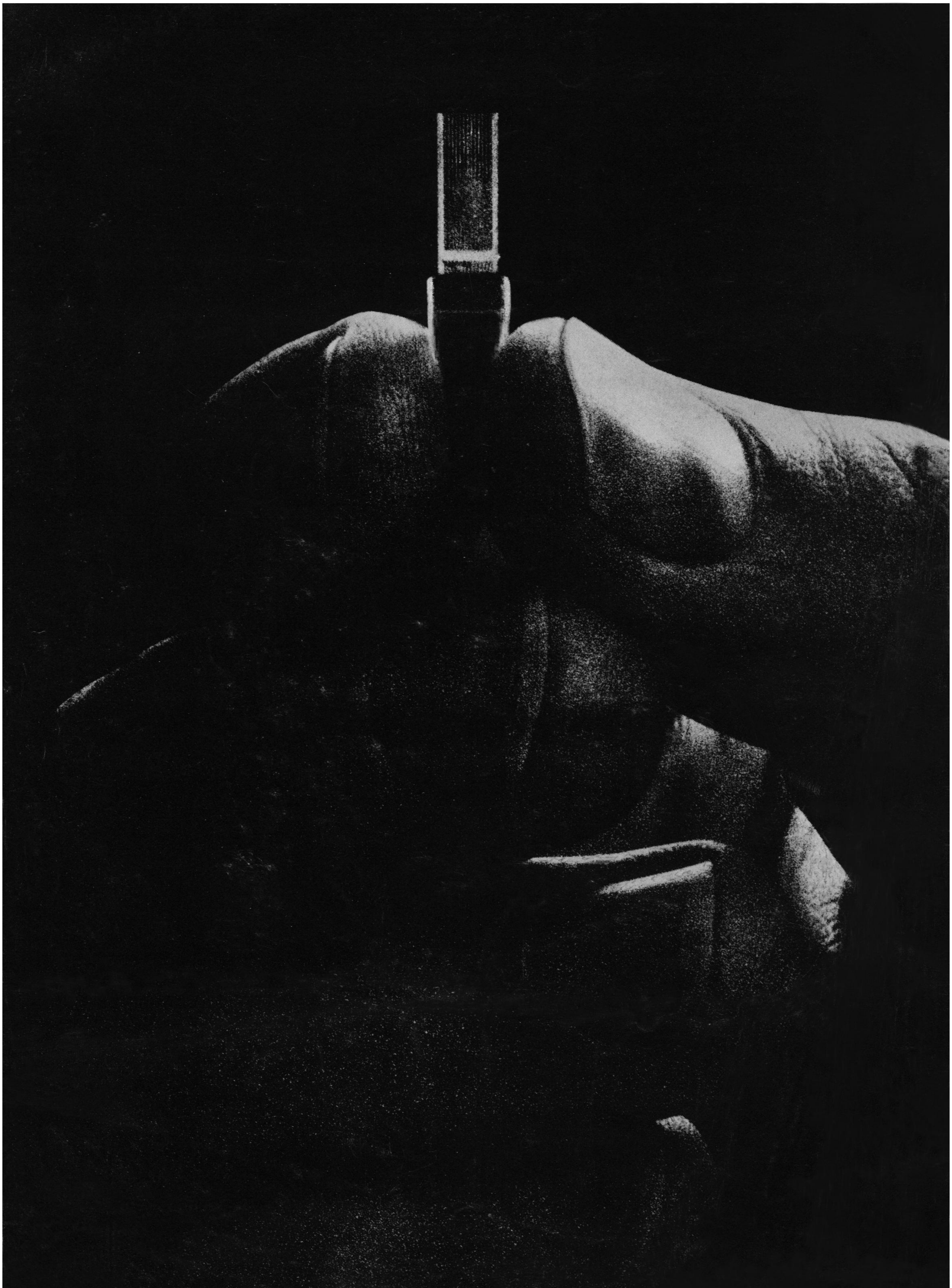
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE







The Chicago Connection.

With it, the phone system of tomorrow is in Chicago today.

A while ago, we told you lightwave communications was just around the corner. Today, it's in the streets of Chicago.

For the first time, the human voice, business data and even video signals are being carried by lightwaves traveling over hair-thin glass fibers. Instead of electric current traveling over copper wire.

But without that little link you see on the opposite page, lightwave communications for such a wide range of services might still be an experiment in a lab. And without Western Electric technology, the link might still be a design on a blueprint.

The link is an outgrowth of an idea from the people at Bell Labs. While they were putting the major components of the lightwave system together, they had to find a way to splice the glass fibers and get the light across the splice.

A Simple Idea

The idea they came up with was deceptively simple. A coupling device made up of tiny grooved chips, smaller than the tip of your finger, that would guide the ends of the hair-thin fibers and butt them up in perfect alignment.

There was only one hitch. Making one chip was easy. But there was no machinery that could mass produce all the identical chips that would be needed for a lightwave system like the one in Chicago.

Making Ideas Reality

That's where Western Electric comes in. Turning ideas into technological innovations is nothing new at Western Electric.

Over the years, Western Electric has piled up an impressive list of innovations that have become manufacturing standards.

It was the first company in the world to manufacture the transistor.

It was the first to put the laser to work as a useful production tool.

And it is the company that went beyond conventional machining techniques to make the chips for Chicago's lightwave system.

Each chip is pure silicon crystal. Its internal structure (a criss-cross arrangement of intersecting planes) provides a built-in blueprint for regularly spaced grooves. And because the crystal's diagonal planes etch faster than its perpendicular planes, uniform grooves can be chemically cut into the chip.

By combining the science of chemistry and the art of lithography, Western Electric's Engineering Research Center developed a way to etch 12 ultra-precise, perfectly shaped, identical V-grooves on each chip. With each groove no wider than a hair and separated only by a hair's breadth from its neighbors.

And, more importantly, they were able to reproduce these chips so that each one was a perfect double of the other.

Teamwork is the Key

The telecommunications revolution beginning in Chicago is another good example of how Western Electric and Bell Labs help put new technology into practical use for the Bell telephone companies, quickly and economically.

Their close relationship is an important reason why your telephone system is the most efficient and reliable communications system in the world. And it's a basic reason why innovations in technology are a common occurrence in the Bell System.

Western Electric

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COVER

Average of water vapor (top) and atmospheric liquid water (bottom) estimates over ocean obtained from passive microwave spectrum observations of the Nimbus 6 satellite near 1-centimeter wavelength on 15 through 29 August 1975. Drier air masses are darker. See page 991. [Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts]

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Casio's amazing ST-1, the world's most powerful stopwatch gives you the flexibility to time every sport 100 hours with .005% accuracy.

Standard: Times single events. Successive presses of Start/Stop (S/S) button record times for successive trials. *Total* key displays cumulative time for all trials. *Comp* mode can then be used to calculate average time.

Net or Time Out: Ideal for ballgames with timeouts. Press S/S to commence timeout. First counter freezes cumulative game time. Press *Total* key to show second counter with elapsed time since timeout started. Press S/S again to restart game and unfreeze gametime counter.

Lap-1: *Split/Cumulative* mode times athlete at each lap. S/S freezes display for recording total elapsed time. Press S/S again to unlatch display.

Lap-2: *Taylor/Interval* mode recordes athlete's time for each lap. S/S button freezes display with latest laptime while resetting clock for next lap. Press again to unlatch display and watch current lap. *Total* key displays cumulative time to last lap. For auto races, S/S gives time between successive cars, while *Total* key gives time behind leader.

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Runner wins 20-km marathon in 1 hour 35 min, 8.7 sec.

Shown Actual Size (calculator cover removed).

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And For The Executive Desk

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Energy and Climate

Whenever the weather in a region departs from norms for a few weeks or more, anxious queries arise. Is the world's climate changing? When leading meteorologists are questioned they usually equivocate. At one time considerable optimism was voiced that new insights would be gained soon from modeling calculations. In the past decade much time on some of the most powerful computers has been devoted to such calculations. But success has been elusive. The best performance on weather seems to be in short-range prediction—that is, the next day or two. Even then surprises occur. In predicting weather, meteorologists can take as a point of departure current conditions, but in attempting to estimate climatic change there is little guidance. Some cyclical patterns related to the 11-year sunspot activity have been noted, and a 2- to 3-year cycle also seems to persist.

Meteorologists still hold out global modeling as the best hope for achieving climate prediction. However, optimism has been replaced by a sober realization that the problem is enormously complex. In a recent report* Verner E. Suomi listed 27 variables that must be monitored to obtain data needed for studies of climate dynamics. These include total solar flux, cloudiness, surface albedo, sea and surface temperature, thickness of polar ice sheets, water vapor, CO_2, and tropospheric aerosols. Human activity has been changing at least three of the variables—albedo, aerosols, and CO_2. The report emphasizes potential effects of increasing and long-term use of fossil fuels.

One fact about CO_2 that is known with certainty is that the concentration in the atmosphere is increasing. Charles Keeling has been conducting precise measurements of atmospheric CO_2 since 1957. In two decades the concentration at the south pole has increased from 314 to 331 parts per million. It is estimated that since the beginning of the industrial revolution the change has been about 13 percent. Roger Revelle has analyzed cogent factors. Part of the increase is due to deforestation. About half of the CO_2 that has been produced remains in the atmosphere, and the rest has been absorbed in the ocean or removed by increased photosynthesis.

What are the likely future trends? For the remainder of this century the clearing of land will continue and the use of fossil fuel will increase. As a result, by the year 2000 the CO_2 concentration will exceed preindustrial levels by about 25 percent. Ultimately, other forms of energy such as solar may come to play a more substantial role. However, humanity's appetite for energy use seems insatiable.

What will be the climatic consequences of increased CO_2? S. Manabe and R. T. Wetherald have calculated that a doubling of CO_2 would lead to an average global increase in temperature of 2.5°C. Their model was necessarily oversimplified, but it seems plausible on the basis of a greenhouse effect. However, a few scientists can be found who privately suggest that because of complex feedback phenomena the net effect of increased CO_2 might be global cooling.

The most likely trend appears to be warming, with effects considerably greater in the polar regions than at mid-latitudes. In the polar regions CO_2 can have a relatively large greenhouse effect. Changes in global circulation would also contribute to the increase.

Humanity is in the process of conducting a great global experiment. If unpleasant effects are encountered they cannot be quickly reversed. Although a comprehensive understanding of what is going on may be difficult to attain, prudence requires at least a determined and sustained effort.

Congress is considering bills aimed at improving climate monitoring, augmenting climate research, improving services related to the climate, and identifying the domestic and international impacts of changes in the climate. Such legislation should be enacted.—PHILIP H. ABELSON

**Energy and Climate* (prepublication version, National Research Council, Washington, D.C., July 1977).

Deadline for Nominations: 15 September 1977
AAAS–Newcomb Cleveland Prize: Contest Year Is Nearly Over

The deadline for nominations of papers for the AAAS–Newcomb Cleveland Prize is fast approaching. Readers are invited to nominate papers published in the Reports section of *Science* from 3 September 1976 to 26 August 1977. The prize of $5000 and a bronze medal is now given annually to the author of an outstanding paper that is a first-time publication of the author's own research.

Nominations must be typed and the following information provided: the title of the paper, issue in which it was published, author's name, and a brief statement of justification for nomination. Nominations should be submitted to AAAS–Newcomb Cleveland Prize, AAAS, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Final selection will rest with a panel of distinguished scientists appointed by the Board of Directors.

The award will be presented at a session of the annual meeting at which the winner will be invited to present a scientific paper reviewing the field related to the prizewinning research. The review paper will subsequently be published in *Science*. In cases of multiple authorship, the prize will be divided equally between or among the authors; the senior author will be invited to speak at the annual meeting.

Reports

The Oldest Macroborers: Lower Cambrian of Labrador

Abstract. *We have discovered numerous borings of* Trypanites *penetrating skeletons and synsedimentary cemented limestones in archaeocyathid reefs of the Forteau formation in southern Labrador. These are, to date, the oldest known macroborings. The discovery of these structures extends the record of large endolithic organisms 100 million years from the Lower Ordovician to the Lower Cambrian. This immediately postdates the appearance of metazoans with hard parts and confirms that endoliths have played a role in reef formation since the early Cambrian.*

The Forteau formation is a sequence of shales, limestones, and minor sandstones about 120 m thick that outcrops, mainly in shoreline section, in southern Labrador and in western Newfoundland (Fig. 1) (*1*). These Cambrian sediments are the upper part of a sandstone (Bradore formation) to shale to limestone (Forteau formation) sequence that unconformably overlies Precambrian granites and granite gneisses of Grenville age. The middle part of the Forteau formation contains a series of archaeocyathid reefs, specifically a lower patch-reef complex and an upper reef-mound/oolite-shoal complex (*2*).

The lower, 20-m-thick patch-reef complex is best developed in Labrador and grades eastward into black, potassium-rich shales. The complex consists of individual patch reefs or groups of patch reefs and associated calcarenites separated by subtidal, calcarenite-shale rhythmites. Reefs (Fig. 2A), which may attain a stratigraphic thickness of 20 m, are made up of numerous overlapping small mounds. Each mound is a jumble of sticklike and vaselike archaeocyathids along with coelobitic algae and foraminifers (?) set in a matrix of red lime mudstone which was deposited as internal sediment. The tops of shelter cavities are commonly roofed with synsedimentary cement.

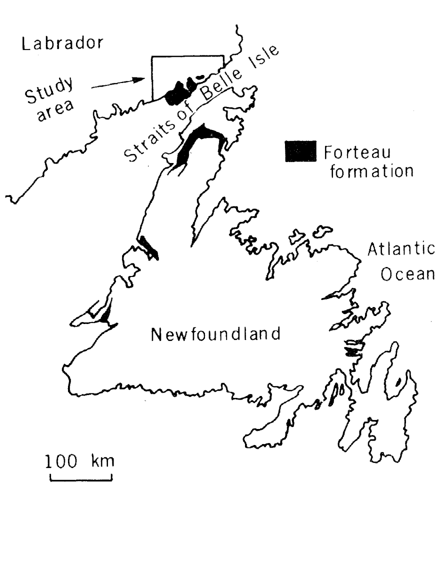

Fig. 1. Map of Newfoundland and southern Labrador, showing the distribution of Forteau formation outcrop, and the study area on the north shore of the Straits of Belle Isle.

The upper, 15-m-thick archaeocyathid-mound/oolite-shoal complex, a series of irregularly distributed mounds, surrounded by, or intercalated with, oolitic lime grainstones, can be traced some 75 km eastward from Labrador across the Great Northern Peninsula of Newfoundland. Each mound comprises upright robust to delicate archaeocyathids, in a matrix of skeletal lime grainstone to calcareous siltstone.

On the basis of trilobites the Forteau formation is assigned a late Lower Cambrian age, mainly in the *Bonnia-Olenellus* zone (*3*). This is confirmed by the archaeocyathid fauna, particularly the forms *Archaeocyathus* and *Cambrocyathus* which are characteristic of the uppermost Lower Cambrian Lena or Elanka stage as defined on the Siberian Platform (*4*).

The shape of the individual mounds that make up the archaeocyathid reefs is not wholly constructive, but also appears to be partly a function of erosion. In cross section skeletal lime sands are seen to directly overlie truncated archaeocyathid skeletons and argillaceous lime mud, clearly indicating that the mound surface was hard and subsequently eroded before deposition of the overlying skeletal sand. Where outcrop permits, the overlying lime sands can be stripped away, or erosion has removed overlying mounds to reveal a mound surface composed of many upright and top-