# earth sciences

## Arctic ice and ice ages

A major theory on ice ages requires that, during the early stages of a glacial advance, the Arctic Ocean be unfrozen to provide moisture for the growth of glaciers. Past studies (SN: 8/2/69, p. 105) showed that the present Arctic ice cover has existed for 25,000 years.

Now, David L. Clark of the University of Wisconsin at Madison reports that the Arctic Ocean has been frozen since at least the middle Pliocene (4 or 5 million years ago). Since that time the major change in this ice cover has been its thickness, and even that has been relatively stable for the past 700,000 to one million years. Thicker ice allows less sunlight to enter the waters below and thus inhibits photosynthesis. Sediments from periods of thick ice cover are therefore sparse in foraminifera.

The abundances of foraminifera in cores from the Arctic indicate that for the past 3.5 million years the ice cover has never been thinner, and the Arctic Ocean has never been warmer, than they are today. This means, he explains in the December GEOLOGICAL SOCIETY OF AMERICA BULLETIN, that the ocean was frozen throughout the ice ages. He concludes that freezing of the Arctic may have been a "one time" thing, which occurred as the continents drifted to their present positions.

## How Southeast Asia got there

Most reconstructions of the pre-drift supercontinents assume that Southeast Asia has always been connected to Asia and that it was once part of Laurasia.

Evidence has been accumulating to tie Southeast Asia to Gondwanaland, and, in the Dec. 31 NATURE, M. F. Ridd of BP Petroleum Development Ltd. in Singapore concludes that it was once part of Gondwanaland and has subsequently drifted to its present position. He points out that there are similar rock groups in Thailand and India, which was once part of Gondwanaland. Using continental margins he found further that Southeast Asia fits very nicely between India and Australia, another Gondwanan continent.

Ridd suggests that, like India, Southeast Asia broke away from Gondwanaland and drifted northward to collide with Eurasia. The line of continental collision, he says, is probably the Song Ma (Black River) fault and fold belt, which runs from the Gulf of Tonkin to the eastern end of the Himalayas.

## Nonspreading crustal blocks

The Vema fracture zone, offsetting the Mid-Atlantic Ridge 300 kilometers, is a deep valley bordered on the south by a steep ridge higher than the Mid-Atlantic Ridge and older than adjacent sea floor.

This Vema ridge, say Enrico Bonatti and José Honnorez of the University of Miami, was probably formed when upper mantle material protruded into a preexisting crustal fracture. Topping the ridge are sedimentary rocks and fossils that must have accumulated when the Atlantic was much shallower and narrower.

The two researchers conclude, in the Dec. 24 SCIENCE, that sea-floor spreading in the equatorial Atlantic operates in parallel spreading belts separated at offsets such as Vema by thin nonspreading blocks. These relatively static mantle-derived bodies may indicate a stagnant mantle zone beneath the Mid-Atlantic Ridge.

# environment

## Costs and benefits of pollution control

An area of increasing controversy is the economics of pollution abatement. Conservatives in the Nixon Administration claim costs of abatement will be huge, the benefits will sometimes be small and that the nation's standard of living will deteriorate as the public pays the tab. Although many economists disagree, there have been few precise studies that clearly delineate cost-benefit ratios.

The National Wildlife Federation has just completed a detailed study of cost-benefit ratios in pollution abatement. The organization estimates that clean-up programs will yield far more benefits to the public than they will cost.

The reason, according to NWF Director Thomas Kimball: To allow pollution to continue is very expensive. Air pollution damages in the United States in 1972 will cost about $16 billion and water pollution damages, nearly $13 billion, Kimball says. The figures do not begin to measure less quantifiable costs such as those of health effects.

Kimball says that if an optimum clean-up program began now, it would cost the average consumer-taxpayer $500 by 1975, with very little tangible return. However, by 1979, the average family would recoup this loss, and, by 1980, begin realizing annual returns of $200. The benefits of air pollution abatement would begin as early as 1976, but clean water benefits would take longer and begin in about 1980.

## Where does the oil go?

A largely unsung environmental problem is disposal of waste oil from automobiles—some 500 million gallons annually.

The likelihood is strong that most of it goes into the environment, says a report in the January ENVIRONMENTAL SCIENCE AND TECHNOLOGY. Generally, most of the oil is taken from service stations by small refuse disposal entrepreneurs. Its ultimate fate is uncertain, says ES&T, but evidence so far indicates it is dumped in sewers and vacant lots or the nearest waterway.

Re-refining it and selling it as reclaimed oil is impractical—partly because of the tax advantages to oil companies using virgin oil, says ES&T. New re-refining techniques to produce diesel fuel and zero-sulfur heating oil may be part of the answer, says the magazine.

## Porous pavement

A major liability of paving over vast expanses in urban areas is the runoff problem. Precipitation, instead of soaking into the ground, runs quickly off pavement, resulting in floods, overloaded storm sewers and loss of water to subsurface reservoirs.

Edmund Thelen of the Franklin Institute Research Laboratories in Philadelphia has developed a porous asphaltic paving material that allows up to 70 inches of water an hour to flow through, reports the Jan. 10 CHEMICAL AND ENGINEERING NEWS. This is achieved by eliminating the fine particles found in ordinary paving materials; larger particles, in effect, allow the formation of pores.

Use of the material would actually reduce street costs because of the elimination of gutters and storm sewers. It may also have nonskid benefits. Laboratory tests indicate it is as durable as conventional asphalt paving.