

however, is the danger of injection at all. Presumably little harm is likely to result from pure replacement of water; but there is proven danger in injecting fluids where there were none before, however attractive or suitable the geological structure. The series of earthquakes which some years ago struck Denver as a result of underground waste disposal are still fresh in many minds. But even dams are not free from that problem as experience in India, France and Rhodesia has shown.

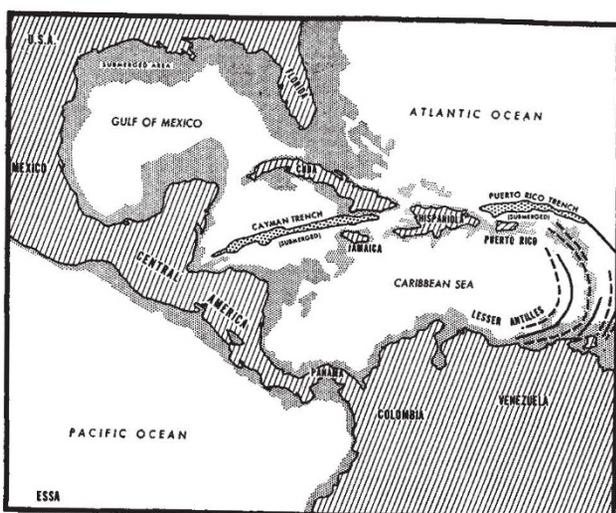
## TECTONICS

### A Caribbean Plate?

from our Geomagnetism Correspondent

ALTHOUGH the principal features of plate tectonics are now widely accepted, many details remain to be settled. This week, the US Coast and Geodetic Survey ship *Discoverer*, with its electronic sonar equipment, is being used to probe the bottom and sub-bottom of the Caribbean around Barbados to trace the extension of structural features found during previous studies and, hopefully, to gather evidence which will finally settle the question of whether the Caribbean is a separate crustal plate or is an extension of the South American continental landmass.

If the Caribbean forms a separate crustal plate, as some scientists apparently believe, there would have to be large faults along its northern and southern boundaries. The southern fault, for example, would presumably lie between the southern end of the Lesser Antilles and Venezuela. The *Discoverer*, however, made eighteen crossings over the supposed fault trace during 1968 and 1969 and found no evidence that such a fault actually exists. The data obtained so far thus support the conclusion that the Antilles double island arc system is an offshore extension of



This week's investigations by the US Coast and Geodetic Survey ship *Discoverer* will centre around the Antilles double island arc system, an island arc comprising both an inner volcanic belt and an outer sedimentary belt. Part of this double island arc system rises above the water and forms the islands of Guadeloupe, Dominica, Martinique, St Lucia, St Vincent, Barbados, Grenada and Tobago. Barbados and Tobago are part of the outer sedimentary belt; the other islands are part of the inner volcanic belt. The islands, or elevated portions of the belts, are shown as broken lines; the submerged portions as solid lines.

South America. The present traverses should confirm this interpretation.

## MICROELECTRONICS

### High Hopes for New Device

by our Solid State Physics Correspondents

A NEW type of semiconductor device has been constructed at Bell Telephone Laboratories which promises to be of major importance in the design of computers and communications systems. It is based on an idea revealed earlier this year called charge coupling which enables a series of metal-oxide-semiconductor (MOS) elements to be linked together in a way that removes for the first time the need for separate capacitors between elements.

It is this use of the MOS element as its own capacitor for storing charge that is particularly important, both from the point of view of performance and of cost. M. F. Tompsett, G. F. Amelio and G. E. Smith (*Appl. Phys. Lett.*, **17**, 111; 1970) have fabricated an eight bit shift register based on this concept, and have achieved transfer efficiencies of greater than 98 per cent for times of less than 100 ns, comparable with those for existing shift registers. They accomplished this with a design which, they say, was chosen for ease of construction rather than high performance.

The special feature of charge coupled devices lies in the way that charges are stored and passed along the device. The structure used by Tompsett *et al.* consisted of a row of MOS capacitors on a substrate of *n*-type silicon with a *p-n* junction at either end. Application of a potential to one of the capacitors creates a region depleted in electrons under the capacitor, and by varying the potential along the array the holes thus formed can be transferred to neighbouring capacitors. The key to the efficiency of this process is the generation and maintenance of a depletion region under the electrodes.

The construction of these devices hinges on the production of highly perfect oxide surfaces and silicon substrates. Although the team at Bell Telephone Laboratories seem to have overcome the major hurdle the exact way in which the performance of the array depends on different parameters in the system is still not clear. Tompsett *et al.* have found, however, that the transfer efficiency depends quite sensitively on the depth and shape of the voltage drops of the transfer pulses, and that greater efficiency is induced if the surface potential of the silicon is lowered during charge transfer.

The first experiments have demonstrated the use of the eight bit shift register as a 48  $\mu$ s delay line and as a display for an image optically focused on to the device. The most exciting possibility for these devices lies naturally in their use as shift registers and for logic operations in computers. Shift registers, after all, perform the meat of a computer calculation and are involved in the process of time sharing. Storage periods of only a few microseconds are adequate here. But the successful demonstration of the line-imaging capability of the device, in which the spatial form of an image is translated into a train of electrical pulses, must raise hopes for the optical possibilities of the system, and elevate once again the question of when a solid state replacement for the cathode ray tube will eventually be produced.