velocity zones? Much of the Taurus–Littrow site area is apparently covered by a dark mantling material, and presumably at some depth this gives way to the subfloor material represented by the velocity of 0.25 km s^{-1}. Because of the lack of resolution in the upper 20 m, Kovach and Watkins have been unable to discover whether this boundary is sharp or gradational; but whether or not there is a well-defined interface, the change from mantling material to subfloor must clearly take place in the upper 20 m.

Geological examination of the subfloor material itself (for example, where it is exposed in crater walls) shows it to be a medium-grained vesicular basalt with textural variations implying the presence of individual flows. Kovach and Watkins interpret both the 0.25 km s^{-1} material and the 1.2 km s^{-1} material as basalt flows; and certainly these velocities fall within the range of terrestrial basalts. On the other hand, the abrupt change from one velocity to the other implies a major change in the formation or evolution of the subfloor basalts. One possibility is that the lower velocity flow or flows are fractured or brecciated, and, again, there is a terrestrial precedent for this. In any event, the combined thickness of 1,173 m appears to account for all the subfloor basalts at the Taurus–Littrow site.

Finally, as only to be expected, the nature of the underlying 4+ km s^{-1} material is more difficult to define. The most likely candidate seems to be the coherent breccia which dominates in the surrounding highland massif. Insofar as this breccia appears to be similar to that obtained at the Apennine front by Apollo 15 and in the Descartes region by Apollo 16, support for its underlying the basalt comes from laboratory studies in which Todd *et al.* (*Geochim. Cosmochim. Acta*, **3**, 2577; 1972) measured comparable velocities.

SEMICONDUCTORS

CCD Prospects

from a Correspondent

CHARGE coupled devices (CCDs) have attracted much attention since their development at Bell Telephone Laboratories in 1970, because of their potential as fast semiconductor memories and imaging devices with high packing densities and low power consumption, and the fact that, at least in concept, they are simple to fabricate. The importance now attached to these devices by the electronics industry was reflected by the attendance at an Institute of Physics meeting at Imperial College, London, on June 11. It is somewhat unfair to say that all participants were interested solely in charge coupled devices as the meeting was officially titled "Charge Transfer Devices" and three out of the eight contributions discussed MOS and bipolar bucket brigade devices which offer advantages in some particular applications, such as correlators and filters. Existing bipolar devices operate at clock rates of more than 10 MHz and have storage times longer than 10 ms.

In a CCD minority carriers, which are stored at the surface of a semiconductor in potential wells, can be transported along that surface by means of suitable potentials applied to an array of closely spaced metal electrodes separated from the semiconductor by an insulating layer.

After the introductory papers on both CCDs (Mr D. J. Burt (GEC)) and bucket brigade devices (Mr P. W. Rivers-Latham (Plessey)) there was a series of contributions from GEC which described the fabrication and performance of different CCDs for both shift registers and imaging devices. These ranged from two-phase two-level electrode and implanted barrier devices, with potential packing densities of 10^5 bits per package for serial memory applications, through 100 element three-phase single level electrode devices for analogue delay lines with maximum delays of 4 ms and 10 kHz bandwidths at low frequencies (or 25 μs delays and 1 to 2 MHz bandwidth at 4 MHz clock rates) to optical imaging devices with up to 100×50 element area imaging arrays plus a 100×49 element information store and a 100 element linear readout, all on the same chip.

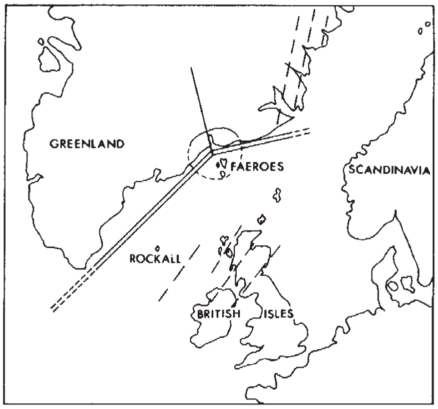
The picture painted was an optimistic one of the future of CCDs but it was clear that there are problems in obtaining sufficiently high charge transfer efficiencies to make more than 100 element linear arrays without the use of on-chip charge regenerators. Figures quoted for charge loss per transfer ranged from $3\times 10^{-3}\%$ to $3\times 10^{-2}\%$ with the use of "fat zeroes", although it was clear in subsequent contributions from the Royal Radar Establishment and the University of Southampton that more work is required on both the

Early Effects of Icelandic Plume

GILLULY (*Bull. geol. Soc. Am.*, **82**, 2383; 1971) recently concluded that it is difficult to relate the large volume of plateau basalt lavas in East Greenland to "any mechanism of plate tectonics". In *Nature Physical Science* next Monday (July 9), however, Brooks apparently overcomes this difficulty by proposing that the East Greenland flood basalts are the result of what some people would now regard as the most fundamental of all plate tectonic mechanisms—the mantle plume. In particular, he suggests that the basalts, and associated doming and rifting, represent the early stages of the activity of the supposed Icelandic mantle plume, thus following Gass (*Phil. Trans. R. Soc.*, **A267**, 369; 1970) who first applied the basic idea to crustal doming in the Red Sea and East African regions.

The particular dome investigated by Brooks lies in the Kangerdlugssuaq area of East Greenland and probably formed just after, or partly during, the basalt production which marked the advent of the Icelandic plume. In plan, the dome is now roughly elliptical in shape with a long axis of several hundred kilometres, and lies along the Greenland coast (see map). But according to Brooks's interpretation, it would originally have been more circular, extending out into what is now ocean and including the Faeroes in their pre-drift position. During its early history, the dome was then subject to Y-shaped rifting, the two rift arms lying along the East Greenland coast being active and thus giving rise to lithospheric spreading and the creation of new ocean floor. The third arm, striking inland, was inactive.

The inactive arm, now represented by a wide fjord, has some of the characteristics of continental rift valleys. The magmatic rocks along it, for example, become progressively more alkaline away from the triple junction. By contrast, the two spreading rifts are characterized by "plume-type tholeiites". In addition, the coastal flanks of the present dome are associated with an intense dyke swarm within which the basement gneisses are present only as very thin sections. A dyke swarm of this density is reminiscent of the type of dyke production responsible for the creation of oceanic lithosphere and suggests parallels with the Troodos (Cyprus) sheeted diabase complex, also thought to represent the result of ancient ocean floor spreading. Brooks thus believes that the coastal area around Kangerdlugssuaq preserves another segment of old ocean floor.



The pre-drift configuration of the NE Atlantic showing the extent of the dome postulated by Brooks and the triple junction formed by dome rifting.