

the North Atlantic), ice-rafting will probably be due to icebergs, because they will melt later, and be transported further than coastal ice because of larger size and smaller ratio of volume to surface.

It is difficult to discriminate between material transported by icebergs, and coastal winter ice; both will be transported by the same systems of wind and current. The presence of many contemporaneous shallow-water organisms (foraminifera and molluscs) in ice-rafted deep-water sediments (4) may be an indication of transport by coastal ice, since the possibilities of picking up unconsolidated sediments with organisms in them is considerably higher in a normal littoral situation than in the calving front of a glacier.

An alternative model to that suggested by Herman and Hopkins (1) could be that their unit III was formed when the climate was cold enough for the formation of coastal winter ice, but that the real glaciation started only at the time of unit II.

During a period of general cooling, there may be a time lag between the stage when coastal winter ice is formed and the onset of a glaciation. The length of this time lag depends on the rate of temperature change, the topography on land, and the precipitation and wind systems. In those parts of the North Atlantic where the coastal areas were obliquely uplifted during the Neogene (5), the early accumulation of ice on land probably took place on the landward side of the water divide. It may have taken considerable time after the onset of the glaciation before appreciable amounts of glacial ice were drained into the ocean and could give ice-rafted sediments.

Generally speaking, the first occurrence of ice-rafting indicates cooling to a level where coastal winter ice is formed. The dating of the onset of glaciation is better made on the consequent eustatic drop in sea level.

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Observations in the nearshore zone of the Chukchi and Beaufort seas confirm that sand and gravel can be lifted from the beach by adfrozen sea ice [for example, see (1)], but gravel from beach sources can be readily recognized in cores and bottom samples by its high degree of rounding (2). Grounded pressure ridges are also known to lift coarse material from relict sand and gravel patches on the continental shelves of the Bering and Beaufort seas. An area of relict Pleistocene gravel on the floor of northern Bering Sea near Nome (3), for example, is surrounded by a halo about a kilometer wide in which bottom muds contain an outward-diminishing admixture of pebbles (2), evidently translocated by grounded pressure ridges. Near the stamukhi zone in Beaufort Sea (4), floating remnants of once-grounded pressure ridges have yielded mixtures of mud and erratic boulders with attached epifauna, material evidently scraped up from submerged outcrops of Flaxman Formation (5). Sand and gravel lifted by grounded pressure ridges, however, appears unlikely to be transported any great distance before melting returns it to the sea floor.

In contrast, ice islands derived from ice shelves off northern Ellesmere Island contain abundant coarse detritus on their upper surfaces and presumably in their interiors (6), and some of these ice islands reach and become grounded on the Beaufort Sea shelf. Striated glacial erratics of a different suite of lithologies are found in the late Pleistocene Flaxman Formation of the Beaufort Sea coast (5). The Flaxman Formation erratics consist partly of rock types that could reach the Arctic Ocean only by glacial transport from their inland outcrop areas in northern Canada and northern Greenland. Similar erratics are found at Skull Cliff (7) in beds that appear to be at least as

old as early Pleistocene and equivalent in age to unit II of Herman and Hopkins (8). Scanning microscope studies of surface textures of quartz grains confirm that some of the coarse debris of unit I (Pliocene) has also undergone glacial handling (9). These are the reasons why we are inclined to believe that glacial icebergs are the major source of coarse erratic material in all three of the zones recognized within Arctic Basin deep-sea cores.

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## Interstellar Chemistry: Polycyanoacetylene Formation

We disagree with one of the conclusions reached by Hayatsu *et al.* (1) regarding the origin of interstellar carbynes and cyanopolyacetylenes. They found evidence for carbyne fragments in the Allende meteorite in the form  $-(C\equiv C)_n$  and  $-(C\equiv C)_n-CN$  and, in the laboratory, showed that such carbynes can form metastably at low temperatures from CO and H<sub>2</sub> by a catalytic reaction on chromite. They concluded that this process in the solar nebula formed carbynes on the

Allende meteorite. They went on to suggest, however, that the polycyanoacetylenes that have been detected in a few interstellar clouds are produced by fragmentation of polymerized cyanoacetylenes formed on grains, rather than built up stepwise by gas phase ion-molecule reactions.

To the contrary, it was shown by Langer *et al.* (2) that the simplest polycyanoacetylene, HC<sub>3</sub>N, is produced by gas phase ion-molecule reactions, rather

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