Globorotalia inflata (d'Orbigny) but also included subarctic or subtropical species. Highest foraminiferal concentrations were found in the temperate-subarctic zone, and the lowest in the central Sargasso Sea.

Bathythermograph temperatures ranged from 4.4°C. to 27.5°C. Temperature inversions occurred at nine stations SE. of Newfoundland. Within the BT range (0–274 m) temperatures fluctuated from 2.2°C. to 10.6°C. Surface salinities varied from 32.58 °/₀₀ in cold water to 37.59 °/₀₀ in warm water.

Morphological variations resulting from environmental influences were evident in some species. The maximum diameter of *Globigerina bulloides* was generally less than 0.4 mm above 14°C. Large specimens (0.6+mm) and specimens with the aperture over four chambers were abundant below 12°C. and when the salinity was less than 35.5 °/₀₀. Deeper-water samples from stations having temperature inversions contained abundant forms with a reduced final chamber, similar to *Globigerina quadrilata* Galloway and Wissler. The terminal chamber in some specimens had a secondary aperture.

Globigerina cf. *quinqueloba*, common in waters below 15°C., graded into *G. pachyderma* with decreasing temperature. Typical *G. pachyderma* was not found in surface tows. Although encountered rarely, it did appear when water temperatures were below 10°C.

Globorotalia inflata was abundant between 13.5°C. and 18°C. Only deep-water tows with temperatures about 10°C. contained small forms with thick tests, a reduced final chamber, and an aberrant aperture.

The signal morphological variation was observed from the deepest tow taken (0–1150 m), and contained forms transitional between common *Hastigerina pelagica* and large, digitate *Hastigerinella rhumbleri*.

That depth and temperature greatly influence the distribution as well as the morphology of planktonic foraminifers is evident.

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DIAGENESIS IN PELLETED LIMESTONES

The abundant pelleted limestones encountered in the geologic record are of polygenetic origin. Selected examples, biased by the author's personal field experience, are used to illustrate various textures and structures involving different pellet and matrix types.

Lithification is the most important problem. A remarkable lack of features apparently due to compaction characterizes all pellet limestones. Volume reduction by stylolitization is common, but the basic limestone fabric remains intact and essentially uncompressed. Apart from stylolitization which appears to be a late stage diagenetic effect, detectable pressure solution at points of grain contact is minor.

Calcite filling of apparent voids raises the question of what constituted a void? It is suggested that more stable crystals could grow equally as well in "voids" largely filled by metastable crystals as in fluid-filled space and the source problem is lessened. The presence of sparry or fibrous calcite is not necessarily evidence of a pre-existing void.

Drop in relative sea-level and exposure to fresh water probably promoted lithification but they were not the prime control. The course of lithification depended more on the primary distribution of carbonate minerals, particularly aragonite.

Dolomitization and silicification are only to be mentioned from the point of view of their bearing on lithification and the development of porosity.

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DIAGENESIS AND DEPOSITIONAL ENVIRONMENT OF PRE-HARROGATE DEVONIAN, BRITISH COLUMBIA*

The Middle Devonian of the Stanford Range, British Columbia, is separated into a lower, gray, light gray, and locally red-weathering sandy limestone, dolomite, and sandstone formation laterally equivalent to the Burnais gypsum and an upper fossiliferous brown limestone and dolomite, the Harrogate formation, both of which are described by Belyea and Norford (in press).

The lower formation consists predominantly of cryptograined silty to sandy limestone, dolomite, sandstone, and breccias. Beds 2 inches to 2 feet thick are separated by undulatory surfaces, locally channelled. The carbonates were probably deposited as ooze, some of the dolomite being primary or early diagenetic. Post-depositional changes include micro-brecciation, slump structures, burrowing in plastic carbonate, and desiccation cracks filled by calcite or hematite. Advancing dolomitization is marked by growth of euhedral rhombs, commonly with a nucleus of dusty material, pyrite, or spores. Increase in number and size of rhombs results in a crystalline grain growth mosaic. Pellets, bahamiths, detrital grains, and older fabrics are partly or completely destroyed in the process. Internal cavities and fractures are filled by crystalline (granular) cement and drusy growth. Quartz grains are extensively corroded by carbonate, and late tension cracks are filled by quartz and carbonate. Ostracods and charaphytes are common in some beds. This rock unit, correlative with the Burnais gypsum, is interpreted as the deposit of a shallow water, near-shore environment, periodically exposed, that received drainage from an early Paleozoic terrane of carbonates and clastics.

The overlying Harrogate is dark brown, mostly aphanitic, limestone and finely crystalline dolomite. Post-depositional effects have resulted in development of grain-growth mosaic and drusy growth. Deposition took place in deeper water than the lower unit but subject to wave or current action; lack of oxidation due to abundance of organic growth is suggested as the cause of dark color.

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DIFFERENTIATION OF LATE MISSISSIPPIAN—EARLY PENNSYLVANIAN PENTREMITES

Blastoids were virtually unknown in post-Mississippian rocks of North America until about 50 years ago when abundantly occurring specimens of *Pentremites* were described from Morrowan beds in Oklahoma and Arkansas. The early Pennsylvanian age of these beds has been generally accepted by geologists for many years; some paleontologists, however, have questioned this age assignment because of the gross resemblance of type Morrow *Pentremites* to those of the upper Mississippian Chester. Morrowan *Pentremites* can be differentiated from those of the late Mississippian by a distinctive external shape and ambulacral cross-sectional outline and, internally, by the hydrospires which have a characteristic shape, thick walls, and a nearly constant number of hydrospire folds, except for a reduced number of folds adjacent to the anus. In the field, latest Chester *Pentremites* commonly can be distinguished from those

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of early Pennsylvanian age by the outline of the ambulacral cross section alone.

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Relationship of Mineralization to Precambrian Stratigraphy in the Rocks of the Quebec-Labrador Trough

Recent work and interpretation of age determinations now indicate that the rocks of the Quebec-Labrador Trough were laid down in a depression in granitic rocks and gneisses of the Superior Province. It is possible to correlate the stratigraphy for the southern and northern parts of the Trough. The following types of ore in relation to the stratigraphy have been established: (1) iron deposits related to the Sokoman (Iron) Formation; (2) pyrite deposits in sedimentary rocks with associated copper-zinc bodies containing some gold; (3) pyrrhotite-chalcopyrite deposits in gabbros with a low-to-moderate amount of nickel and small amounts of zinc and gold; and (4) chalcocite disseminated in dolomites.

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Serandite from St. Hilaire, Quebec

Serandite from St. Hilaire, Quebec, has the following chemical composition: SiO_2 47.90, Fe_2O_3 0.08, FeO 0.86, Al_2O_3 1.20, MnO 33.8, CaO 5.56, MgO 0.03, Na_2O 6.40, K_2O 0.00, $H_2O^{-105^0 C}$ .20, $H_2O^{+105^0 C}$ 2.42, Y_2O_3 .27. Total 98.73%.

X-ray diffraction data show that this mineral is a pectolite-type mineral. The name serandite was originally given by Lacroix to the manganiferous end member of the series $Ca_2NaH(SiO_3)_3-Mn_2NaH(SiO_3)_3$. Serandite from Las Archipelago (Lacroix, 1931) contained 28.99% MnO and 10.42% CaO, whereas serandite from St. Hilaire, Quebec, is closer to the end member with 33.8% MnO and 5.56% CaO.

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Preliminary Report on Some Pennsylvanian Reefs from Northwest Ellesmere Island

Pennsylvanian reefs as thick as 2,000 feet crop out nearly 10 miles along strike at Hare Fiord, Northwest Ellesmere Island. The reef flanks slope as much as 45°. There is no interfingering between the reefs and the overlying silty limestones. Stratification within the reefs is confined to planes parallel with the reef sides.

In order of relative abundance, the reef fauna consists of crinoids, brachiopods, bryozoa, corals, gastropods, ammonites, trilobites, and fusulinids. Fenestellid bryozoans may have provided a reef framework, but no clear zonation into reef barrier and lagoon is apparent.

A fore-reef is present, characterized by reef-derived conglomerates. A strange "internal" conglomerate, not readily explained as solution-breccia, is common. Recrystallization is widespread, particularly along intrusive dike margins.

Porosity of the main reef rock is low, but the conditions leading to the formation of "internal" conglomerate may have produced porous localities in parts of the reef area other than the accessible cross section.

The reefs probably formed in a climate not only warmer but also with more sunlight hours than that at the present latitude of northern Ellesmere Island.

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Nature and Distribution of Iron Silicates in the Gunflint Iron Formation, Port Arthur

The iron silicate minerals from more than 50 specimens of the Proterozoic Gunflint Iron formation, near Port Arthur, Ontario, were identified by X-ray powder methods and microscopic techniques. There appears to be a geographical and possibly a stratigraphical distribution of the mineral species. Chamosite and chlorite characterize the lower Gunflint, which contains relatively little iron silicate; the intermediate argillite-tuff member contains a glauconite-bearing calcareous horizon, along with chamosite, chlorite, and talc; and the upper Gunflint is characterized by abundant greenalite and stilpnomelane, with minor amounts of minnesotaite and chlorite, identified optically. The ratio of stilpnomelane to greenalite appears to increase in the vicinity of the Logan Sills.

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Hydrocarbons in Non-Reservoir Rocks—Source Beds

Environmental factors in a depositional basin may control the quantity and nature of hydrocarbons initially deposited with the sediments. The hydrocarbon mixtures in sediments increase in quantity and become more like petroleum after long periods of burial and compaction, providing evidence that petroleum hydrocarbons are generated in non-reservoir rock.

Ratios of odd to even carbon numbered heavy n-paraffins in shale may in some instances be regarded as indicators of conversion of organic material to hydrocarbons. This parameter, supplemented by infrared measurements, enables the detection of petroleum-like mixtures of hydrocarbons in possible "source beds." An estimated 30 per cent of the shales in petroleum provinces contain petroliferous mixtures of hydrocarbons. There is a parallelism between amount of organic carbon, quantity of hydrocarbons, frequency of occurrence of dispersed oil in non-reservoir rock, and the occurrence of petroleum accumulations. Although the statistical nature of this parallelism provides opportunity for exceptions, it appears that both kind and quantity of hydrocarbons are important parameters for recognition of source rock.

In a number of instances similarities as well as systematic differences have been observed between hydrocarbons in oil and the corresponding fractions in the presumed source rock.

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Exploration Potential of Remote Sensing

Remote Sensing is the detection and measurement of physical quantities at a distance, and the term covers such established fields as geophysical prospecting, aerial photography, and the various military reconnaissance systems. With passing time and increased specialization, these fields tend to become parochial.

The recent symposia on Remote Sensing show that there is also a strong interdisciplinary trend, and that collective development of new techniques and the rapid dissemination of information are likely to stimulate application of the resultant systems in widely separated technical fields. Eventually Remote Sensing should be-