more of oceanic sediments in tropical and temperate zones. These planktonic algal remains have a long geologic record, as well as a high degree of evolutionary plasticity, and have been used, with some success, as stratigraphic tools. To date, however, no attempt has been made to determine their ecologic usefulness.

During investigation of the Coccolithophoridae in the Atlantic and Antarctic Oceans, the writers found several temperature-dependent species. To test the usefulness of these forms, their contemporary, postglacial and Wisconsin-glacial distribution in the North Atlantic was examined. Twelve cores, representing a range of conditions from present subarctic to tropical, were chosen from those described by Ericson, Ewing, and Wollin as representing an unbroken sequence of sediments ranging from Recent through Wisconsin in age.

The colder-water fauna is defined by the presence of *Coccolithus pelagicus* and large numbers of *Coccolithus huxleyi, Gephyrocapsa oceanica,* and *Coccolithus leptoporus.* The warmer-water fauna is typified by *Umbellosphaera tenuis, Umbellosphaera irregularis* (erroneously called *Discoaster murrayi* by some workers), and in lower concentrations, *Coccolithus annulus* and *Discolithus antillarum.* In addition, the faunal diversity increases in such a way that non-placolith coccoliths constitute an increasingly significant percentage of the fauna as the temperature increases. It is from these forms that more sophisticated ecologic inferences will be drawn.

Comparison of Recent with glacial sediments indicates a faunal shift of about 10° latitude. During the Wisconsin, the *C. pelagicus* fauna occurred as far south as 25° North latitude, whereas today it is restricted to areas north of 35° North latitude.

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Silica-Bicarbonate Balance in Oceans and Early Diagenesis

If present stream discharge and dissolved load are assumed to be representative of the geologic past, and if the volume of the oceans has remained essentially constant, many problems arise concerning the disposal of the constituents brought into the oceans by streams. Two of these problems relate to silica and bicarbonate.

The amount of dissolved silica delivered to the oceans in 10^9 years, if precipitated chemically or biochemically as SiO_2, would produce a much greater volume of sediment than is observed in the geologic column. The bicarbonate ion transported to the oceans either must be recycled through the atmosphere as CO_2, or removed in calcareous sediments. Yet the precipitation of carbonate minerals, with concomitant loss of CO_2 to the atmosphere, leaves about 40 per cent of the HCO_3^- unaccounted for.

These two problems can be solved by assuming that a small but significant fraction of the suspended load of streams consists of weathered aluminosilicates, probably poorly crystalline, that react with silica and bicarbonate prior to deposition, by reactions of the type: Al-silicate + SiO_2 + HCO_3^- + cations = cation-Al-silicate + CO_2 + H_2O.

Reactions of this type can be considered "reverse weathering," and are representative of chemical changes commonly considered to take place *after* deposition.

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Habitat of Oil in Carbonate Rocks

The Kemnitz field in Lea County, New Mexico, is a typical example of stratigraphic entrapment of oil in a carbonate reservoir rock. To understand the reason for entrapment of oil in fields such as Kemnitz, one should analyze geological factors in terms of depositional environment, diagenetic history, and structural history.

Environments favorable to deposition of reservoir-type carbonate formations include reefs, bioherms, oölite bars, and porous skeletal calcarenites. Production of organic material in such environments (with the exception of oölite bars) is prolific; however, under normal conditions most of the organic soft parts are destroyed by bacteria and scavengers, so that only skeletal parts are preserved.

Hydrocarbons are found in cyclic carbonates which were deposited on unstable shelves which were subject to recurrent sea-level fluctuations and periodic influxes of terrigenous clastic sediments. A reef bank or oölite bar can be covered by transgression of basin sediments, suffocated by regressive evaporites, or smothered by influx of terrigenous clastic sediments. Biogenic carbonates which are overlain by evaporites, black sapropelic shale, or basin sediments reflect an early diagenetic history which was favorable for the preservation of animal and plant remains. Early diagenesis is also important in dolomitization and modification of primary porosity of limestone.

Petrologic studies of the Kemnitz reef indicate that this stratigraphic trap is caused by a barrier reef crossing a plunging structural nose. The lower Wolfcamp (Permian) is slightly transgressive and the reef top is covered by basin sediments. Thus this reef retained its porosity and organic source material.

In the North Anderson Ranch field, Lea County, New Mexico, the upper Cisco (Pennsylvanian) is a reef-type porous carbonate but is non-productive because of unfavorable diagenetic history. The younger lower Wolfcamp also is of reefoid nature and occupies a position along the flank of the structure lower than the porous Cisco reef at the crest. The Wolfcamp had a favorable early diagenetic history and therefore contains commercial accumulations of oil.

Elusive stratigraphic traps in carbonate rocks can be explored effectively only after thorough subsurface and structural analyses are supplemented with studies of the environment and diagenetic history of prospective carbonate beds.

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Distribution of Interstitial Salts in Drill Cores from Atlantic Ocean Floor off Florida

Interstitial water from five Paleocene to Recent core series, taken on the J.O.I.D.E.S. offshore drilling project, has been analyzed for chloride and major cations. The cores were obtained at depths to 300 meters below the sea bottom on the continental shelf, the Florida-Hatteras slope, and the Blake plateau.

Samples from several holes show a marked downward increase in chloride concentrations, with maximum Cl^- greater than 26 ‰, equivalent to a salinity greater than 47 ‰. It appears that forces

tending to concentrate brines in deeper parts of many older sedimentary basins may operate at depths of only a few hundred feet in young sediments. The downward increases in salinity can not be accounted for easily by such mechanisms as molecular filtration. However, a combination of pressure-induced diffusion and migration induced by the geothermal gradient (Soret effect) tends to pump salts downward and appears to be a promising explanation for the increase in salt content with depth.

Total water content in the cores is uneven, partly because of irregular carbonate cementation. The cementation may be related partly to changes in ionic composition noted in the interstitial waters.

Fresh waters have been detected in marine strata under the Atlantic Ocean as far as 60 miles from shore. The water-bearing zones are believed to be extensions of land aquifers and may discharge in the slope regions.

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COMPUTERS SIMPLIFY LOG APPLICATIONS

Modern exploration methods generate large quantities of information about each well drilled. Much of the data obtained are pertinent for subsurface studies. However, in order for the petroleum geologist to take full advantage of the information, he must correlate and consolidate the various data from seismic studies, drilling, sampling coring, wireline logging, *etc.* It is here that electronic computation offers the greatest potential for geologic studies.

Various forms of computers are now used for automatic well-site processing of data from electric well logs. Simple forms of computers apply automatic corrections for borehole and environmental effects. Others convert the basic measurements to a more convenient form. For example, density values and neutron log counting rates each may be converted, during the logging operations, to equivalent limestone-porosity values. Such field-recorded logs of porosity simplify well-site interpretations of lithology and formation-fluid content.

More sophisticated recorder-computers are used at the well-site to record logs on tape and to merge and compute data from separately recorded surveys. The logs thus produced enable a rapid and thorough reconnaissance of all formations logged.

The tapes of digital log values offer several important advantages over the customary optical records. For example, information on magnetic tapes may be transmitted rapidly via telephone and microwave circuits. In addition, the taped logs provide a rapid input for office-based, high-speed, electronic computers.

The speed and flexibility of general purpose computers permit even more complex correlations and applications of well data. Such computers offer a wide variety of combinations of information and, at the same time, enable presentation of results in forms best suited for application. In addition, information from sources other than electric logs may be incorporated.

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LUNAR STRATIGRAPHY AND SEDIMENTATION—POST-RANGER VIEW

The completion of the preliminary geologic mapping of the equatorial belt of the Moon allows a first look at the history of a large piece of the lunar crust. Twenty-eight quadrangles at a scale of 1:1 million, amounting to 3 million square miles, have been mapped, and a compilation at a scale of 1:5 million has been made. Field studies of terrestrial impact and volcanic craters are underway, and laboratory studies of crater formation by hypervelocity impact and impact metamorphism of the rocks are continuing.

The Moon is studied by examination of telescopic and spacecraft photography, by visual telescopic observations, by photometry, by polarization, and by infrared, radar, and microwave radiation.

The geologic development of a large linear basin, first worked out in the Imbrium region on the basis of smaller-crater morphology and deposits, has been amplified and extended. A similar sequence of events is indicated by the deposits around other lunar basins. A preliminary attempt can be made to interrelate the basinal histories. Several areas are blanketed by complex volcanic deposits of several types and several ages. The interlayered volcanic and ejecta deposits are offset by at least four episodes of faulting. The processes affecting the original constructional topography have been worked out in lowland areas and are being applied to the more complex uplands. Sedimentation, erosion, isostatic adjustment, and tectonic deformation gradually obliterate lunar craters. Sediments are formed by impact and volcanic processes, and both may cover large areas.

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FACTORS INFLUENCING EARLY STAGES OF COMPACTION OF CLAYS AND SANDS—REVIEW

Variations in the water content and fabric of clay, and the porosity of sand during compaction under pressures of 0–100 kg./cm.^{2} reflect the influence of sediment texture and composition, and are not related uniquely to increases in overburden load.

The porosity and water content of sand, silt, and clay under these pressures are inversely related to particle size. This relation commonly is strong enough to obscure the expected decrease in porosity with increasing depth of burial.

Variations in the water content of saturated clay reflect the physico-chemical influences on the sorption of water on the surfaces of clay minerals. Water content and surface area per unit mass in the common clay minerals increase in the order kaolinite-illite-montmorillonite. In montmorillonite, at pressures less than 50 kg./cm.^{2}, the water content changes with the exchangeable cation—Na-montmorillonite holds more water than montmorillonite whose exchange positions are filled with Ca, Mg, K, or Al. Increasing concentrations of interstitial electrolyte tend to increase the water content of most clay at a given pressure less than 50 kg./cm.^{2}, presumably by increasing the tendency of the clay particles to form open-work flocculated aggregates that resist compaction. The main exception to this is in very fine-grained clay saturated with Na electrolytes in concentrations less than 0.3 molar.

Most of the development of preferred orientation in clay compacted under pressures of 0-100 kg./cm.^{2} takes place very early—at pressures near 1 kg./cm.^{2} The most critical factor for this development may be the amount of water held by the clay. If enough water is present, the particles may slip past one another into preferred positions; if not, preferred orientation may be either poorly developed