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 or absent. Large amounts of carbonaceous matter seem to enhance the development of preferred orientation, perhaps by its ability to retain large amounts of water. Specific effects of other factors on clay fabric are less well known, but one might expect the development of preferred orientation to be enhanced by decreasing concentrations of interstitial electrolytes, decreasing valence of exchangeable cations, and decreasing acidity.

The main influences on the porosity of sand are the textural characteristics of the constituent particles: size, sorting, roundness, shape, and flexibility. Well-sorted sand has greater porosity than poorly sorted sand. Angular sand has greater initial porosity and is more compressible than rounded sand of the same size. Admixtures of platy mica particles increase the porosity, compressibility, and elasticity of sand.

The influence of most of these factors—except for particle size—is inferred from laboratory experiments on simple systems. Little is known of their relative importance in complex natural sediments.

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PROCESS-RESPONSE MODEL FOR MARINE-ORGANISM COMMUNITIES

Computers can be used to mimic ancient marine-organism communities with surprising effectiveness.

In a series of special programs designed for the I.B.M. 7090/7094 computers, fossil communities and their environments have been symbolically simulated in a three-dimensional mathematical model. In constructing the model, each community was assigned specific properties which governed their response to environmental factors such as depth of water, distance from shore, substrate, turbulence, turbidity, temperature, and salinity. The environmental conditions in turn were varied by adjusting numerical data fed to the computer which regulated the model.

The properties assigned to the computer communities were finely adjusted by trial and error in order to make them "behave" more or less like their actual counterparts, adapting to changing conditions and even competing with each other. One of the most useful aspects of the program was the ability to advance the model through increments of geologic time where the responses of the communities and the long-term effect of environmental and evolutional factors could be observed in a way heretofore not possible.

Recent work with the model has dealt with environmental responses of leaf-like calcareous algae of late Paleozoic age. These algae were widespread in shallow Pennsylvanian and Early Permian seas, locally creating thickened banks or reefs. Today, some of these reefs serve as large oil reservoirs in southeastern Utah, northern Oklahoma, and West Texas. Exploration for such reservoirs will be greatly enhanced if the environmental response of the organisms that created them can be experimentally determined and this knowledge effectively used for exploration purposes.

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TURBIDITY-CURRENT EXPERIMENTS

Experiments were performed in the W. M. Keck Laboratory, California Institute of Technology, using a lucite channel 5 meters long, 50 cm. deep, and 15.4 cm. wide. Turbidity-current "surges" were produced by releasing suspensions of plastic beads from a lock at one end of the channel. The bottom of the flume was horizontal and before release of the suspension the water level was the same within the lock and the main channel; the experimental results may therefore be compared with the results obtained by Keulegan (1958) for saline surges. Experiments were performed at two depths (20 and 30 cm.), and two suspension concentrations (about 25% and 45% concentration by volume) were used. The sediment consisted of perfectly spherical plastic beads with a density of 1.52 and an average size of 0.18 mm. The results show that the shape of the head, the initial velocity, and the relation between the velocity of the head and its thickness and density are very similar to those reported for saline surges. The velocity of the head is given by the equation

$$V = C\sqrt{g'd_2}$$

where $g'=g^{\Delta}e/e$, d_2 is the thickness of the head, and C is a coefficient with a value of 0.75. In another series of experiments, with saline density currents, it was found that C varies little with increase in slope of the bottom, up to a slope of 0.04.

The velocity (u) of the water near the bottom, at a distance x in front of the head, was found to be given by the equation

$$\log_{10}\left(\frac{u}{V}\right) = -0.93\left(\frac{x}{d_2}\right).$$

Two types of graded bed were formed, depending on the concentration of the suspension used. The "normal" type of graded bed, formed by surges with low sediment concentration, shows continuous grading within the bed at nearly all percentiles. The "coarse-tail" type of graded bed, formed by high-concentration surges, shows little grading through most of the bed, except for the coarsest 2–5 per cent of the size distribution. The differences between the two types of grading can be related to the depositional mechanics, which are revealed by slow-motion movies. In low-concentration flows, the bed is deposited layer by layer. In high-concentration flows, most of the bed is deposited first as an expanded or "quick" bed which continues to shear and to be disturbed by waves which form at the interface between the bed and the flow above. As the bed comes to rest, the waves disappear and the upper surface becomes perfectly flat.

A 300-foot color movie of the experiments will be shown.

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OBSCURE BUT IMPORTANT HIATUSES IN STRATIGRAPHIC COLUMNS

The thesis is advanced that virtually all stratigraphic columns exposed on land and penetrated in wells, including those of continental-shelf areas, contain hiatuses of varied nature, the aggregate geologic-time value of which may exceed that of the rock or unconsolidated sediment in the columns. Obscurity of the hiatuses—difficulty in recognizing them—is related mainly to objective features but certainly does not exclude subjective factors. Importance is judged by the amount of continuous time represented by the gaps and by their value in indicating causes for the hiatuses as well as their significance for determining basic principles that apply to time-stratigraphic classification.