jectively and with any desired degree of precision.

For example, if a rock (population) is "massive" then no structure is apparent and various sampling patterns will yield equivalently unbiased estimators; on the other hand if the structure is layered, orthogonal patterns, with one parallel and the other perpendicular to the layers, will yield significantly different estimators unless the parallel pattern achieves correct weighting of the layers. In layered populations, patterns perpendicular to layers (channel sampling) will yield unbiased estimators of the population mean and variance; adjusting the parallel sampling pattern to equivalence with the perpendicular supplies information on the weighting, i.e., on the variation within and between layers and hence an estimate of the number of different layers. This then leads to an objective definition of layering.

In practice, when the internal structure is initially unknown, it is necessary to use different sampling patterns to decide whether the population (rock) is structured or massive.

The achievement of random sampling in various "populations," from testing techniques to deciphering "natural" variability, indicates that this procedure is a useful tool in defining the patterned variability or "structure" of a population. It appears to be invariant to change in variate (*e.g.*, measurement or counting) or change in scale (*e.g.*, from an electron micrograph to an outcrop).

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ENERGY SOURCE OF INTRUSIVE MASSES

Textbooks of geology generally fail to discuss the motivating force of intrusive masses. Texture, composition, and shape are dealt with in detail, but the mode of emplacement is ignored. It is here postulated that the energy is almost entirely derived from the geostatic load of the overburden and that the mechanics involved in the emplacement of igneous dikes, volcanic plugs or necks, stocks, etc., is essentially the same as that involved in salt and ice piercements, and even the "frost boils" on northern roads. The mechanics of large basin downwarps is also discussed.

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MATHEMATICAL SIMULATION OF SEDIMENT ORGANISM COMMUNITY INTERACTIONS WITH AN IBM 7090 COMPUTER

An ALGOL-58 computer program has been written by the authors for IBM 7090 or 7094 computers for simulating the interactions of combined sediment-organism communities through geologic time. Although the program is based on a mathematical model applicable to various sea-floor communities, the program has been developed with carbonate sediment-organism communities in mind.

The mathematical model considers the sea floor at a given "instant" in time to consist of a large number of discrete elements arranged on a grid of arbitrary dimensions. Each grid element may be thought of as a square containing a single community and is symbolized by an integer number in a two-dimensional array. Successive "time planes" (sea-floor surfaces) are generated in which the distribution of communities for each discrete instant is printed out using various symbols to identify different communities.

The program employs feedback control loops in which the geographic distribution of communities on preceding sea-floor surfaces influences, but does not rigidly control, the geographic distribution of communities that develop subsequently. The selection of a community element occupying a particular square at a particular moment is treated as a random process influenced by conditional probabilities. The program makes extensive use of pseudo-random number generation methods for selection of individual elements.

The program is being used to study the development of Devonian coral-stromatoporoid reefs, as well as idealized modern sediment-organism communities. Adaptive learning techniques are used to adapt the model to real data. Mathematical simulation should be a powerful oil-finding tool in some regions by yielding greater insight into the behavior of reefs and other sedimentary features and providing improved means of prediction.

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DISEQUILIBRIUM PRECIPITATION OF MOLLUSCAN SKELETAL MATERIAL AND ITS IMPLICATIONS REGARDING THE USE OF TRACE ELEMENTS IN FOSSIL SHELLS AS PALEOECOLOGICAL INDICATORS

An investigation of the distribution of magnesium, iron, manganese, and strontium in the skeletal carbonate of twenty-five specimens of *Crassostrea virginica* and coexisting sea water, supplemented by a compilation and analysis of published and unpublished data on trace element distributions in other marine mollusks, indicates that molluscan skeletal material is not precipitated at equilibrium with coexisting sea water. Calculations demonstrate that the partitioning of minor elements between carbonate and sea water does not follow the Nernst distribution law. It is suggested that during shell construction the growing skeletal crystallites are either (a) at equilibrium with fluids in the depositional tissues whose composition is determined by organic processes, or (b) at complete disequilibrium with surrounding fluids. The results of this investigation explain the poor correlation observed in previous studies between skeletal chemistry and environmental factors, such as water temperature and salinity, and indicate that the trace element content of fossil skeletal material cannot be used for detailed paleoenvironmental reconstruction.

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SEDIMENTS OF THE GULF OF MAINE

The Gulf of Maine is a rectangular depression on the continental shelf about 180 miles long and 120 miles wide. Georges Bank, Browns Bank, and the Nova Scotian Shelf, all shallower than 100 meters, separate the Gulf from the Atlantic Ocean to the southeast. Glacial scouring has accentuated the highly irregular bottom topography, and numerous basins 200 to 377 meters deep are present. Large areas between shallow bedrock ridges and the large flat-floored basins are veneered by poorly sorted mixtures of clay, silt, sand, and gravel, probably derived with very little change from glacial till and outwash. These sediments contain moderate amounts of layer silicates but less than 2 per cent organic matter. The sand-size fraction contains 3 to 10 per cent rock fragments and 10 to 15 per cent dark minerals.

Post-Pleistocene reworking of poorly sorted glacial material by wave and current action near the coast and