field and laboratory data are separated from local fluctuations by using two smoothing formulas. A 21-term formula which loses ten observations at each end of the series is used to accentuate the long-period trends, and a 5-term formula losing only two observations at each end is used for the short-period changes. The IBM 7090 has been programmed to compute simultaneously both smoothed curves for 11 variables from a continuous series containing up to 500 units.

The smoothed curves for several lithologic characteristics including thickness, and percentages of calcite, dolomite, micrite, and sparite, are compared with curves based on the condition, size, orientation, and relative abundance of several fossil species. The influx of new species and the decline of others can be related to physical changes in the rock, which are the result of differences in the depositional environment.

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CALCITE ARAGONITE PROBLEM

The fundamental stability relations of calcite and aragonite are considered in the light of: (a) calorimetric data, (b) solubility measurements, (c) direct studies of phase changes. New data of Crawford and Fyfe suggest slightly lower pressures for aragonite formation than have been formerly proposed. The difference in free energies of calcite and aragonite are small, and the effect on stability of grain size, non-hydrostatic stress, and impurities are evaluated and may be as large as ΔG°.

Consideration of precipitation reactions involving nucleation and growth indicates that there need be no direct relationship between fundamental stability and the order of appearance of possible phases. Ostwald's law of stages implies an inverse correlation. Data on the effects of temperature and solution composition indicate that the form of calcium carbonate precipitated may frequently reflect favorable kinetics of aragonite nucleation enhanced by calcite growth inhibition.

A basic problem in carbonate sedimentation involves the rate at which metastable aragonite undergoes transformation to calcite. Data on this reaction in the dry state are compared with similar processes in nitrates. It is suggested from study of single crystals that the dry process is essentially zero order, but a combination of structure and habit sensitivity may lead to other apparent rate laws. Nucleation normally takes place in the prism zone and proceeds via a linear boundary migration parallel to the c axis. A lack of reactivity of (001) also appears in aqueous reactions. In general, dry rates must be of no significance at the temperatures normally encountered in diagenesis unless deformation is extensive.

In aqueous solution the problem is more complex. The rate is a function of volume, pH, P_{CO_2}, salt catalysis (general) and salt inhibition (specific), and organic protection as in some fossil aragonite, and aggregate fabric (as in fossils). It is suggested that the formation of calcite from aragonite in aqueous solutions involves homogeneous nucleation and that this is the slow rate step and is controlled by some function involving Ca^{++} and/or HCO_3^- activities. Specific inhibition appears to involve inhibition of growth and several explanations are possible, but the size of the inhibiting cation appears to be critical.

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STROMATOPOROIDEA OF THE DEVONIAN SOURIS RIVER FORMATION FROM THE SUBSURFACE OF SASKATCHEWAN

The Souris River formation is a Devonian subsurface formation, presently tilted southwestward, which is encountered in southern and central Saskatchewan in wells drilled for oil, potash, and helium at depths ranging from a maximum of 6,142 feet below sea-level near the international boundary to a minimum of 821 feet below sea-level near the Souris River subcrop edge in central Saskatchewan.

Stromatoporoids were recovered from cores 2–4 inches in diameter in fragmental dolomitic limestone of the lower Souris River formation. The wells are widely spaced over a belt more than 250 miles long in southern Saskatchewan.

The stromatoporoid faunas are represented by *Atelodictyon* and *Stictostroma* of the family Clathrodictyidae; *Actinostroma* and *Trupetostroma* of the Actinostromatidae; *Amphipora*, *Idiostroma*, and *Stachyodes* of the Idiostromatidae; and *Ferestromatopora*, *Stromatopora*, *Parallelopora*, and *Synthetostroma* of the Stromatoporidae. The faunas most closely resemble those described from the lower Upper Devonian Moberly member of the Waterways formation of northeastern Alberta. Members of the family Idiostromatidae are the most common in numbers of specimens if not bulk. The Stromatoporidae is the second most important family. *Trupetostroma* stands out among the Actinostromatidae.

Most of the stromatoporoid coenostea are whole, especially the massive forms. Thin bands of matrix material around most specimens are dark brown organic lutitic limestone. The hemispherical coenostea appear to have been rolled around and show no preferred orientation. These coenostea may have been transported a short distance and deposited outside of their normal habitat. The elongate coenostea of members of the Idiostromatidae are oriented parallel with bedding surfaces and show a slight but inconclusive suggestion of polarity. The lithologic character of the described matrix material is common in association with *Amphipora* and *Stachyodes* wherever they are found. These genera are likely not oriented in their position of growth. The absence of any suggestion of a base of attachment in *Amphipora* is puzzling.

The internal preservation of the stromatoporoid coenostea is good considering the nature of the over-all lithologic character of the stratigraphic unit. Gallery spaces are mostly infiltrated by calcium carbonate.

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PRINCIPLES AND LIMITATIONS OF PRECAMBRIAN STRATIGRAPHY

Detailed studies of the Precambrian basement complex, initiated mainly for economic reasons, have now shown that the record is in part decipherable; that considered as a whole, it is indeed complex; and that it represents a large part of the history of the earth. However, the geological histories of many individual parts are no more complicated than those of areas of comparable size in younger mountain-built belts.

The processes affecting the outer crust in Precambrian time differed but little from those now active. Differences in proportions of rocks of different types that make up the record of the Precambrian, in contrast

to those of later time, can be accounted for in part by gradual changes in the compositions of the atmosphere and oceans and in part by the depth of erosion.

Methods of study used in younger rock groups are all useful in the Precambrian, but extreme metamorphism over wide areas, more abundant igneous intrusive masses, and a dearth of fossils useful in correlation make the interpretation of the record less certain.

Methods of classification and naming recommended by the American Commission on Stratigraphic Nomenclature are now being adopted by Precambrian geologists, some of whom have assisted in their formulation. This should lead to clearer understanding and better communication.

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DISTRIBUTION OF THE REEF-BUILDING COMMUNITY IN FLORIDA AND THE BAHAMAS

Luxuriant growths of reef-building corals and associated biota are characteristic of easterly facing margins of the Florida and Bahamas platforms. Along the eastern margins the reef community is most luxuriant and continuous seaward of islands; it is absent or poorly developed where islands are absent. The reef community is absent along almost all the western margins of the platforms and its few occurrences seaward of islands or shoals are small, discontinuous, and without the variety and vitality of the eastern examples.

The reef community favors the eastern margins because wave agitation and circulation of oceanic water that promotes its growth is more intense there than on the western margins. The western margins are unfavorable because water from the platform interiors, warmer and saltier than normal, is moved westward across them by the prevailing easterly winds.

The most luxuriant growths of the reef community are seaward of islands because the islands protect these areas from unfavorable currents. The islands prevent the existence of the normal cross-platform currents that produce bottom-sediment movement (oölitic sands) unfavorable for the reef community. The islands shield areas seaward of them from tidal runoff of platform-interior water that is inimical to the growth of the reef community.

Can these "principles" be applied to ancient reefs?

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SOME MINERALS FROM THE OKA ALKALINE COMPLEX, OKA, QUEBEC

The carbonate rocks of the Oka complex contain abnormally high amounts of Zr, Nb, Ce, La, Nd, Sr, Ba, P, Mn, Ti, Na, K, F, S, and Cr, and give rise to an impressive array of unusual and rare minerals. Sixty-five minerals have been so far identified from the alkaline rocks and carbonatite at Oka.

As in most alkaline complexes the paucity of silica is reflected in the low silica type of minerals they contain, by the presence of oxide minerals of iron, titanium, phosphorus, and niobium, and undersaturated silicate rocks. Substitution of elements in some of the minerals is inferred from their chemical composition, and probably accounts for their anomalous optical properties. The constituent minerals of the silicate rocks are commonly characterized by high alkali, alumina, manganese, and low silica content, with in some cases unusually high substitution of alumina for silicon. In the oxide minerals niobium commonly substitutes for titanium.

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RELATIONSHIP OF MINERALIZATION TO STRATIGRAPHY IN THE PRECAMBRIAN VOLCANIC-SEDIMENTARY COMPLEX, MICHIPICOTEN AREA, ONTARIO

The Michipicoten group of older volcanic and sedimentary rocks comprises flows and pyroclastic rocks of andesite-rhyolite association together with conformable zones of clastic sediments and banded iron formation. Later intrusive rocks consist of dacite, granite, and diabase.

The typical volcanic cycle progressed from (1) widespread and prolonged extrusion of andesite-basalt flows, through (2) violent ejection of rhyolite-dacite pyroclastics, to (3) extensive hot-spring and fumarolic activity. Banded iron formations are considered to represent chemical products of this last stage. Development of the Michipicoten group is viewed as a continuous process which, once initiated, proceeded through explosive, erosional, chemical, and intrusive phases to produce a complex family group of which the members, although each possesses unique characteristics, are related by common volcanic heritage.

Iron, gold, and base metal deposits occur within, or marginal to, the principal acid volcanic zones. In general, mineralized centers coincide with what may be reasonably interpreted as centers of maximum explosive volcanic discharge. In this manner, siderite-pyrite members of banded iron formation overlie coarse acid pyroclastic zones; gold and base metal deposits occur within, or marginal to, nearby porphyry intrusive stocks. Acid extrusive rocks, porphyry intrusions, and mineral deposits are considered to have a common, sub-volcanic derivation and to owe their present stratigraphic association to common generative volcanic processes.

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MILLERITE AT STRATHCONA MINE, SUDBURY DISTRICT

Millerite occurs in relative abundance with chalcopyrite, pentlandite, violarite, pyrrhotite, and sparse pyrite in discontinuous stringers and disseminations along fractures and joints in leucocratic and amphibolitic footwall gneisses near the norite contact more than 3,000 feet below the present surface. Some roughly equidimensional masses up to 8–10 centimeters in size show splendent crystal faces and excellent cleavages barred by polysynthetic twinning. Gangue minerals include sodic and potassic feldspar, quartz, amphibole, epidote, garnet, and biotite. Partial chemical analysis on hand-picked cleavage fragments of millerite gave 62.0% Ni, 0.04% Cu, 0.33% Co, and 1.44% Fe. The x-ray powder diffraction pattern gave $a_0 = 9.622 \pm 0.006$Å and $c. = 3.150 \pm 0.005$Å. Primary origin by crystallization from a hot sulphur-rich iron-poor fluid is proposed from the environmental evidence available.

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AN ALGORITHMIC PROGRAM FOR THE ANALYSIS OF DETRITAL RESERVOIR ROCKS

The objectives of this program are essentially fourfold: (1) the data gathering process leads to a quantita-