ages of 2,670 and 3,310 years, confirming that the dolomitization is a penetemporary phenomenon related to the present sedimentary environment.

IMBRIE, JOHN, Columbia University, New York, N. Y.

SEDIMENTARY STRUCTURES IN MODERN CARBONATE SANDS OF THE BAHAMAS

Sedimentary structures of carbonate sand bottoms near Bimini, Sandy Cay, and the Berry Islands have been examined in depths ranging to 10 ft. below MLW. Box cores with a vertical face 18 in. high and 12 in. wide were impregnated in the field with epoxy resin to preserve and accentuate the structures.

Four distinct types of internal structures occur in contrasting depositional environments. *Type I*, characterized by 3–10 cm.-thick sets of cross-strata and either horizontal or curving truncation surfaces, is found in intertidal, rippled, oölite shoals. *Type II*, with 20–40 cm.-thick sets of tabular cross-strata and horizontal truncation surfaces, is found in intertidal-subtidal, unrippled, grapestone bars. *Type III*, with even, parallel laminae inclined at low angles to the horizontal, is found in the backshore and foreshore of beaches. *Type IV* is mottled, lacks stratification, and is found in unrippled level bottoms.

Bahamian field observations confirm pertinent hydrodynamic conclusions of J. R. L. Allen, H. W. Menard, and D. B. Simons. Type I is observed to form by small ripple trains induced at low flow intensities by tidal currents. Type II is judged to form by a large-scale ripple induced at high flow intensities by rare storms. According to M. M. Ball, deposits with similar structure were formed by Hurricane Donna in Florida Bay. Type III is observed to form from swash and backwash currents on beaches. Type IV reflects an environment in which organisms destroy stratification as fast as it is produced.

These four types should be considered as end-members representing hydrodynamically pure situations. Many actual sites represent alternating conditions (beach-shoal, beach-bar, etc.), as is clear from preserved structures.

IRVINE, T. N., Geological Survey of Canada, Ottawa, Ontario, Canada

SEDIMENTARY STRUCTURES IN LAYERED ULTRABASIC ROCKS*

Many igneous intrusions show layering formed by gravitational accumulation of crystals that is, both in variety and detail, remarkably similar to the bedding of sedimentary rocks. Such layering occurs in most compositional types of intrusions but especially in mafic and ultramafic bodies. The examples considered specifically are from the Duke Island ultramafic complex in the Alaskan panhandle; the rocks are composed of olivine and clinopyroxene but, where layered, look much like graded bedded turbidity current deposits. The intrusion is composite, and the layering, which has been tilted and folded, has two ages—thus, layered blocks and fragments of olivine pyroxenite are included in stratified peridotite. Over-all, stratification is developed intermittently through an original vertical thickness of 2 miles. Individual layers have been traced for 300 feet, and one continuously layered section is 1,500 feet thick and extends 1,000 feet.

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A typical layer is 2 inches to 2 feet thick and is graded from grain sizes of 2–10 mm. at its base to 0.1–1 mm. at its top; some mineralogical sorting results because the olivine crystals are generally finer and thus concentrated upward. The base of a layer is sharp; the top may terminate against the next stratum or may pass into an intervening zone of thin laminae. Some of the layers of younger age resemble graded beds of slide conglomerate, their lower part being largely olivine pyroxenite fragments.

Other layering features include: cross-layering, slump and deformation concurrent with accumulation, streamlining of layers over irregularities, load casts, general correlation between layer thickness and particle size, lateral grading, and "diagenetic" recrystallization.

The layering has undoubtedly formed because of magmatic currents during extremely unstable conditions. The currents were probably a convective type of overturn marked by the descent of dense, crystal-laden magma from the cooling roof and wells of the pluton, and it is likely that they were initiated and perpetuated by repeated slumping. The described phenomena illustrate that features of water-laid sediments can form in a vastly different environment in terms of the specific gravities of particles and transporting liquid, and the viscosity of the liquid.

JOHNSON, J. HARLAN, Colorado School of Mines, Golden, Colorado, and DANNER, W. R., University of British Columbia, Vancouver, British Columbia, Canada

PERMIAN CALCAREOUS ALGAE FROM NORTHWESTERN WASHINGTON AND SOUTHWESTERN BRITISH COLUMBIA

Limestone units of the Tethyan Permian eugeosynclinal sequences of northwestern Washington and southwestern British Columbia contain abundant specimens of calcareous algae. The limestone bodies are mostly lenticular in shape and range from a few inches to approximately 1,000 feet thick. They are interbedded with volcanic flows and breccias, tuffs, ribbon cherts, argillites, conglomerates, graywackes, and lithic sandstones which may reach a thickness of 10,000 feet or more.

Limestones of Wolfcampian age on Orcas Island, Washington, contain *Mizzia* in association with bryozoa and the fusulinids *Schwagerina* and *Pseudofusulinella*. Limestones of probable early Guadalupian age on the south side of Mount Pilchuck in Snohomish County, Washington, contain *Mizzia* and *Gyroporella* associated with the fusulinids *Cancellina* and *Schubertella*. Upper Guadalupian age limestones of San Juan Island and western Snohomish County, Washington, contain *Mizzia* and other green algae associated with fusulinids of the *Neoschwagerina-Verbeekina* zone. The youngest Permian limestone, containing the *Yabeina* fusulinid zone (Ochoan?), near Granite Falls, Washington, and near Ashcroft, British Columbia, contains *Mizzia* and several other dasyclads.

JOLLIFFE, A. W., Queen's University, Kingston, Ontario, Canada

STRATIGRAPHY OF THE STEEP ROCK GROUP, STEEP ROCK LAKE, ONTARIO, AND EVIDENCE FOR EVOLUTION OF THE PRECAMBRIAN ATMOSPHERE

Knowledge of the stratigraphy has provided the surest guide in iron ore exploration and development at Steep Rock Lake. Most and possibly all of the 33 million tons produced has come from a single stratigraphic member.