rial sizes, suspended-sediment concentrations and sizes from depth-integrated samples, stream flow, and water temperatures. Twenty-four computations of total sediment discharge were made at several unconfined sections, and the ratios of computed total sediment discharge to measured sediment discharge at the contracted section ranged from 0.56 to 1.87 and averaged 0.97. If two of the computations based on data of questionable accuracy are disregarded, the range in ratios becomes 0.66 to 1.46. The size distributions of the computed and of the measured sediment discharges agreed reasonably well.

The major advantages of this modified procedure include applicability to a single section rather than to a reach of channel requiring measurements at several sections, use of measured velocity instead of water-surface slope, use of depth-integrated sediment samples, and apparently fair accuracy for computing both total sediment discharge and approximate size distribution of the sediment. Because of these advantages, this modified procedure is being studied further to increase its accuracy, to simplify the required computations, and to define its limitations.

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The Geology of Glacier National Park and Vicinity in Montana

Field work for the U.S. Geological Survey in and near Glacier National Park, Montana, was conducted from 1948 through 1951, and Richard Rezak's work on the stromatolites (algal deposits) there continued through 1953. The results of these field studies, supplemented extensively by use of hitherto unpublished data, mainly those gathered by parties of the Geological Survey under the leadership of M. R. Campbell from 1911 through 1914, are summarized here.

The rocks of the region range in age from pre-Cambrian to Recent. The thickest units belong to the Belt series (pre-Cambrian), and these were given special attention. The Belt series as a whole comprises rather fine-grained argillaceous, sandy, and calcareous (largely magnesian) rocks with subordinate amounts of conglomerate. This series has been sufficiently metamorphosed so that it now consists largely of argillite, quartzite, and comparable rocks. The lower part of the series is mainly somber-colored; the upper part, reddish purple and green. Available evidence favors the concept of deposition in shallow marine water, but some investigators have regarded the series as of lacustrine origin.

In the Glacier National Park region, magnesian limestone is abundant. The limestone contains stromatolites at numerous horizons, suggesting that much of the limestone was laid down in extremely shallow water. High in the series basaltic flows of submarine origin (Purcell basalt) are interbedded with the sedimentary rocks. Sills and dikes related to the flows are conspicuous, although thin, features in the cliffs of the Park. Cupriferous deposits associated with the intrusive rocks were prospected about 50 yr ago with unencouraging results.

In Montana as a whole, most of the Belt series is included by the present writer in the Ravalli, Piegan, and Missoula groups, in ascending order, with a few units such as the Prichard formation not included in these groups. The maximum thickness may be near 45,000 ft, part of which is missing in Glacier National Park.

In the Glacier National Park region, the Ravalli group is regarded as comprising the Altyn limestone, Appekunny argillite, and Grinnell argillite. The base of the Altyn limestone is not exposed. This formation is the oldest unit present and, since it has no counterpart elsewhere in the state, may prove to be of pre-Ravalli age.

As mapped during the present investigation, the sole component of the Piegan group in the Park region is the Siyeh limestone, a thick magnesian limestone, perhaps largely of algal origin. The Siyeh is itself expected to be subdivided into smaller map units when refined mapping is done.

The reddish argillaceous beds formerly included in the Siyeh by some workers are now regarded as belonging to the basal part of the uppermost group of the series, the Missoula group. This latter group has been extensively eroded in the Park. It includes red-purple and green argillaceous rocks with numerous beds of magnesian limestone, plus the Purcell basalt already referred to. Only a few of the formations comprising the group in northern Montana have been named. Within the Park limits (with minor exceptions), only remnants of Tertiary and later beds remain above the Belt series, but nearby numerous and varied formations of Paleozoic and Mesozoic ages are widespread.

Through much of geologic time, crustal activity in the region of Glacier National Park was confined to broad warping. Near the beginning of the Tertiary period, conditions changed drastically. Thrust and normal faults of the first magnitude, preceded and accompanied by folds and minor fractures, resulted from a series of violent movements that may not have entirely ceased even yet. The master structure produced is the Lewis overthrust. This thrust is thought to have originated deep in the crust and moved many miles in a direction somewhat north of east over a mass of relatively incompetent rocks that were intricately folded and broken to depths thousands of feet below present sea level. If the thrust plane emerged at the surface, it was far to the east of the present Park.

Erosion during and after the major deformation culminated in a mature surface (the Blackfoot surface) near the end of the Tertiary period. Subsequently, several stages of mountain glaciation, with an intermediate stage in which rejuvenated stream erosion cut deep gorges, have together modified and, over large

areas, obliterated the Blackfoot surface. The result is the spectacular topography of the present day.

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Stromatolite Classification in the Belt Series

One of the results of recent studies of stromatolites in the Belt series of northwestern Montana is a new classification of these algaloid structures, based on (i) mode of growth, (ii) gross form of the colony, and (iii) nature and orientation of the laminae. It is believed that this scheme for classification may be extended to include Paleozoic and younger stromatolites in a consistent pattern of form-genera and form-species.

Mode of growth is the basis of "generic" distinction in the classification here proposed. Three distinct types of growth have been recognized. The first is characteristic of *Cryptozoon* Hall. These forms begin their growth from a point on the substratum and grow upward by addition of convex upward laminae that increase in area as the stromatolite develops. The second type is exhibited by *Collenia* Walcott. The species begin as incrustations on a surface of the substratum. Growth is upward by addition of convex- or concave-upward laminae that do not increase greatly in surface area. The third type is displayed by *Conophyton* Maslov. Here the structure is sheetlike and in the form of a cone attached to the substratum by its apex. Growth is upward by addition of conical laminae.

Gross form of the colony is considered of primary importance in determining "species." The basic forms are cylindroidal, depressed spheroidal, and turbinate. Combinations of these forms are regarded as distinct species. For example, in one common species from the Belt series (*Collenia willisii* Fenton and Fenton) the lower part consists of varying numbers of expanding cylindroids, whereas the upper part is dome-shaped and covers the lower cylindroids so as to give the entire structure the form of a depressed spheroid.

Nature of the laminae is an important, although difficult, criterion to use in distinguishing species. Attempts have been made to measure the number of laminae per unit distance on several species. Such measurements have not been useful in studies of the stromatolites of the Belt series, because parts of the algal colonies that formed the laminae have been destroyed or obscured during the long interval since pre-Cambrian time. Recrystallization has largely or entirely erased the laminae in some colonies. Weathering may cause several laminae to become fused, simulating one prominent lamina. Varying amounts of silt and clay deposited as the colony was growing would affect apparent thickness and frequency of the laminae. Microscopic measurement of laminae might be used to differentiate species, but studies based on such measurements have not been encouraging.

Ordinarily the shape of the laminae is reflected in the gross form of the colony. For example, in *Collenia symmetrica* Fenton and Fenton the laminae occur as domelike sheets superimposed one upon the other. The gross form of the colony is a dome or depressed spheroid. An exception to the rule is *Cryptozoon occidentale* Dawson, which has a turbinate form. In vertical cross section, it has a fan-shaped appearance; but the laminae in the younger portion of the colony are dome-shaped, becoming flattened as the colony increases in size. The flattened laminae are abruptly downcurved along their margins, and each one is but slightly larger than the one below, giving rise to the fan-shaped cross section. Laminae may be either smooth or crenulate. The degree of smoothness is consistent within each species.

Size of colony has been used by some authors as a specific characteristic, but in my experience form and laminae remain constant in each species, regardless of size. Specimens of *Collenia symmetrica,* for instance, range from a few inches to about 20 ft in diameter.

The detailed results of the investigations noted, including paleoecologic and stratigraphic applications, are currently being processed for publication as a comprehensive summary of the stromatolites of the Belt series.

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A New Method for the Production of Autoradiographs

By using a light-tight cover over the automatic-staining machine (Autotechnicon), found in many histological laboratories, and successive solutions of silver and halogen salts, we have succeeded in impregnating and coating histological sections with sensitive silver halide.

Personnel who have no training in autoradiographic technique have been able to turn out 10–20 sections with the "Emulsion" as an integral part of the slide in as short a time as 20 min. After the required exposure time (to allow the radioisotope to act on the silver halide), the slides are allowed to continue through the developing, fixing, and staining solutions within the machine, and a finished and stained autoradiograph, ready for the coverslip, is obtained.

This method and technique are simple and automatic, require very little special training of personnel, and can turn out many autoradiographs in a short time. Thus, it is in marked contrast to the conventional methods now in use, which are delicate, difficult, highly specialized, and time consuming.

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