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PALEOCURRENTS IN THE TRIASSIC OF NORTHEASTERN BRITISH COLUMBIA, CANADA

Triassic strata of the Rocky Mountain Foothills in northeastern British Columbia consist predominately of fine-grained clastics in the lower part, medium- to coarse-grained in the middle and lower upper parts, and fine-grained in the uppermost part. Some bioclastic carbonates and evaporites also occur in the middle and upper parts. Triassic rocks rest disconformably upon upper Paleozoic chert, and are overlain disconformably by Jurassic shales in the southern part of the area and lower Cretaceous shales in the north. This, together with an unconformity, bevelling progressively older beds northeasterly indicates uplift in the northeast. Seventy sections were measured to establish the stratigraphic facies relations and history of sedimentation. This work was augmented by textural studies on hand specimens from certain sections and by observations on bedding thicknesses. Generally, lower Triassic beds are thinner and finer-grained than middle and upper parts except for the youngest beds. Also, as sediments are coarser in the east than west, the following history of easterly transgression, followed by westerly regression and again followed by easterly transgression, was established.

Paleocurrents based on the observations on 2,500 current structures such as planar cross-bedding, festoon bedding, current and wave ripple marks, and flow markings indicated that the probable direction of sedimentary transport was toward the west and southwest. Triassic sediments deposited during a regressive phase underwent textural changes expressed as decrease in grain size and gross lithological aspect from coarse in the east to fine in the west; at a given section younger beds are generally coarser than older beds, and axes of maximum thickness for successively younger formations occur successively westerly from those of older formations. These observations implied an apparent migration of depositional sites in the direction of sedimentary transport during the regressive phase of sedimentation. Such apparent migratory behavior of depositional sites in a direction away from the source area, and coinciding with the direction of sedimentary transport, was a response to increased erosion and consequent sedimentation arising from uplift in the northeast. It appears that paleoslope attitude was the dominant regional control of the resulting sedimentary trends.

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CARBONATE PETROGRAPHY OF BLAINE FORMATION (PERMIAN), NORTH CENTRAL TEXAS

The Blaine formation is a part of the Pease River group (Upper Guadalupian) and consists of alternating gypsum and anhydrite, carbonate, and fine clastic beds. Carbonates occurring within the Blaine are relatively pure dolomites, closely associated with evaporite deposits.

Petrography, staining methods, chemical analysis, Ca/Mg ratios, X-ray, differential thermal analysis, and stratigraphy were used to interpret the mode of formation and deposition, the sedimentary environments, and the secondary alteration of the Blaine carbonates. The dolomites are predomintly very finely crystalline and are associated with various allochemical elements typical of what has been termed "evaporitic dolomite."

Origin of the carbonate is interpreted to be dolomitization (penecontemporaneous?) of aragonite or calcite allochemical and orthochemical sediments. The homogeneous character, lateral persistency, uniform thickness, and paleogeography suggest deposition in a large lagoon which was probably hypersaline and surrounded by low, arid to semi-arid landmasses. Deposition of carbonate and evaporite sediments occurred similar to configurations noted by Scruton (1953) and Briggs (1958): carbonates and sulphates around the margin and chlorides and sulphates in the center of the basin.

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PYROCHLORE FROM OKA, PROVINCE OF QUEBEC, CANADA

Five varieties of pyrochlore have been identified at Oka.

1. A metamict variety containing uranium and thorium; bright red color, fine-grained, associated with ijolitic rocks. $a_0 = 10.43 \pm 0.05$ Å.
2. A cerian variety; chocolate-brown, coarse-grained, euhedral (octahedra and dodecahedra), associated soda pyroxene marble. $G = 4.38$, $a_0 = 10.393 \pm .001$ Å.
3. A thorian variety; brownish red, in calcite-forsterite rock. $a_0 = 10.428 \pm .005$ Å.
4. A zirconian variety; reddish brown to black, occurrence in carbonatite. $a_0 = 10.395 \pm .001$ Å.
5. A fifth variety is known to be high in Nb_2O_5; the complete chemical composition is not available but the Nb_2O_5 content is greater than 60%.

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MINERALOGY OF THE MOUNT PLEASANT TIN DEPOSIT IN NEW BRUNSWICK

The Mount Pleasant tin deposit in New Brunswick is mineralogically complex and contains a wide variety of minerals. The tin-bearing minerals are cassiterite and stannite. Cassiterite is the chief tin mineral, and it occurs in sulphide veins, wall-rock and in a kaolin body containing fluorite. The cassiterite in the sulphide veins and wall-rock is present as small grains, whereas that in the fluorite-bearing kaolin body is present as relatively large grains in massive fluorite. Stannite has been found only in sulphide veins where it occurs as grains, veinlets and minute inclusions in sphalerite, and occasionally as borders around cassiterite.

Sphalerite is the most abundant ore mineral. It is black and contains minute exsolution bodies of chalcopyrite and stannite. Analyses of sphalerite concentrates give Fe 8.2–14.3%, Cu 1.3–5.5%, Sn 0.15–0.40%, In 0.03–0.30%, Cd 0.12–0.19%, and Mn 0.06–0.08%.

Sphalerite geothermometry indicates that the depositional temperatures of the sphalerite fall between 335° C. and 700° C., and arsenopyrite geothermometry gives depositional temperature up to 500° C.

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SILURIAN STRATIGRAPHIC AND STRUCTURAL HISTORY IN INDIANA FROM THE CINCINNATI ARCH TO THE MICHIGAN BASIN*

Silurian rocks in northern Indiana early inspired

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understanding of fossil reefs, ideas on genesis of the Cincinnati arch, and demonstration of the great stratigraphic-paleontologic principles. We have learned only recently, however, that the formations, thickening northward and all exposed, are, in ascending order, the Brassfield limestone, Osgood-Laurel section (so-called), Waldron shale, Louisville limestone, Missisinewa shale, Liston Creek limestone, unnamed rocks, and equivalents of lower Salina rocks of Michigan. Rocks below the Waldron (Llandovery in age) are coextensive with most of the undifferentiated Niagaran and lower rocks in southernmost Michigan and with the Cedarville dolomite and lower rocks in western Ohio. Waldron and higher Niagaran rocks (Wenlock and Ludlow) mostly terminate northward in a reef bank crossing the northern quarter of Indiana. The type Huntington dolomite is a reefy facies of Missisinewa and higher Niagaran rocks, although "Huntington" has been applied throughout the Niagaran. The Salina equivalents partly abut against the bank and partly overlie and extend in two tongues south of the bank, partly complement in thickness the reef-bearing formations, and lie from north to south on *lower* to upper Niagaran rocks.

We postulate southward Silurian expansion of the Michigan basin prototype and consider that lower and middle Silurian sediments were deposited in the subsiding basin in southernmost Michigan and northernmost Indiana and on a relatively stable shallow-water shelf at the south. During late Niagaran and then early Cayugan time, the basin margin became better defined by southward shelf-edge sharpening that resulted from continued relatively greater subsidence northward and extensive fringing bank growth. Bank growth resulted in near-restriction of sea-to-basin circulation to two inlets corresponding to present structural sags in Cass and Jasper Counties. Post-Silurian events helping to define the present basin and the flanking Cincinnati arch include interruption and renewal of basin subsidence; probable inlet closing and deposition of lower-middle Devonian evaporite-bearing sediments, whose southern boundary marks approximately the southern margin of the Michigan basin; and differential subsidence of the Illinois basin, which imparted the southwesterly dip to part of the Silurian shelf area.

We conclude, not entirely facetiously, with the question: Is part of the Cayugan in Michigan and Indiana Niagaran in age, or is part of the Niagaran Cayugan?

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Evolution of Chazyan (Ordovician) Reefs of Eastern United States and Canada

Chazyan (lower middle Ordovician) reefs from the Virginias, Vermont and New York, and Quebec show changes in organic composition through time. In the evolution of reef communities, these Chazyan reefs represent assemblages or organisms which are transitional in taxonomic composition and ecologic setting between pre-Chazyan and Silurian reefs.

Early Chazyan trepostome (*Batostoma*) and cyclostome (*Cheiloporella*) bryozoans built linearly aligned reefs up to 10 feet high in shallow, agitated waters. The reef matrix of carbonate mud and skeletal debris differs markedly from the cross-bedded, mud-free skeletal carbonates adjacent to the reefs.

Middle Chazyan reefs shown an evolution of reef assemblages from a laminar stromatoporoid (*Cystostroma*)—algal (*Anthracoporella*) composition to an assemblage with a higher percentage of tabulate corals (*Billingsaria*), sponges (*Zittelella*), and a different stromatoporoid (*Pseudostylodictyon*). At the top of the Middle Chazyan, three separate assemblages (stromatolite-calcareous alga-nautiloid, trepostome and cyclostome bryozoans, and stromatoporoid-sponge-coral) are all in close lateral contact with each other and appear to have been contemporaneous. In the Upper Chazyan, the trepostome bryozoans replace the stromatoporoids of the early assemblages and combine with the alga (*Anthracoporella*) to form a different assemblage. This succession of assemblages takes place with no apparent change in habitat.

The Lower Chazyan bryozoan reefs contain more detrital quartz and have more pronounced cross-bedding in adjacent sediments than the younger Chazyan reefs, indicating that the bryozoans existed in more agitated conditions closer to land than the later assemblages. However, close proximity of oölitic and oncolitic carbonates, dislodged and tumbled corals and stromatoporoids, erosional channels and margins cut into the reefs, and the presence of blue, green, and red algae suggest that the Middle and Upper Chazyan reefs also developed in shallow water.

A spectrum of textures in the non-reef sediments, mudstones through well washed grainstones, represents most stages from restricted to open circulation, high energy conditions in their environments of deposition.

The sequence of diagenetic events that affected the limestones is: formation of rim cement in grainstones before and concomitant with pore-filling drusy cementation, dolomitization, lithification of carbonate mud, and finally grain growth in the aragonite skeletons and carbonate mud.

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Age and Stratigraphic Significance for Lyellian Correlation of the Vigo Formation and Fauna, Luzon, Philippines

The late R. E. Dickerson, in 1921, put forward the theory that tropical Tertiary molluscan faunas evolve much more slowly than do faunas from temperate regions; hence, that the percentage of Recent species in later Tertiary tropical faunas is considerably higher than in contemporaneous faunas from temperate regions. This theory, derived from analysis of a tropical fauna of inferred Miocene age from the Philippine Islands, has been frequently cited but has never been critically evaluated.

Studies of Philippine and Indonesian later Tertiary molluscan and foraminiferal faunas collected since Dickerson's time, and accurately placed stratigraphically, indicate that the Philippine molluscan faunas Dickerson believed to be of Miocene age are more probably later Pliocene in age, with a percentage of extinct species differing not very greatly from the percentages established by Lyell and Deshayes for contemporary faunas in Europe. The theory that tropical molluscan faunas evolve at a markedly different rate than those of temperate regions is therefore without basis and is probably erroneous.

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Diagenesis of Recent Marine Carbonate Sediments

The diagenesis of carbonate sediments can be ascribed conveniently and naturally to pene-depositional and post-depositional processes. Pene-depositional effects