northward, the part below the position of zone II conodonts becomes progressively thinner, and only a thin wedge of the lower part extends into southernmost Ohio. Here this lower unit is overlain by the Dayton limestone, which underlies a shale sequence called the Alger formation in Ohio. The Alger is a northern extension of the Estill clay.

Zone I is represented in the Kankakee limestone of northern Illinois, and zone III conodonts have been obtained from the Joliet limestone of northern Illinois and the basal few inches of the Osgood formation of southern Indiana. Insufficient work in other areas of the United States precludes precise correlation. The close resemblance of the European and central Kentucky conodont faunas, together with the other known occurrences, shows the potential value of these fossils for stratigraphic work in this part of the column.

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EXPERIMENTAL CONSOLIDATION OF CARBONATE MUD†

About 200 compression and heating experiments simulating diagenesis and low-grade metamorphism have been performed on samples of $CaCO_3$ sediment obtained from the banks west of Andros Island in the Bahamas; the mud consists mainly of aragonite needles, 0.1μ by 1μ, and ovoid pellets, about 100μ across. The ranges of conditions and the precisions of the experiments were as follows: pressure P, 1–3,000 bars, $\pm 10\%$; temperature T, 25°–400° C., $\pm 10\%$; and time t, 3 hours to 2 months, $\pm 1\%$. The chemical compositions of the sea water in the mud and the vapor driven off were not determined.

Consolidation is effected by compaction of grains, recrystallization, and by increase of integranular bonding. Pressure of 30 bars causes a compaction of about 20% for a given temperature; at T = 25° C. the density increases from that of the initial mud, 1.7 g/cm^3, to a final 2.0 g/cm^3; essentially, some of the interstitial water is squeezed out. Heating at T between 100° and 200° C., under P < 30 bars, causes an apparently anomalous decrease in density because of an exchange of air for water in the void spaces, and the products remain friable.

Heating at T = 400° C. under low pressure, P < 100 bars, for t > 1 day, lithifies the mud, apparently during inversion of aragonite to calcite; electron micrographs show coalescence, increasing with time, of the original needles to rounded grains and then to a subhedral, interlocking texture; the product has a compressive strength > 100 bars. Higher pressure, P > 100 bars, causes increasing breakage of the aragonite needles.

About 30 experiments on aragonitic mud from Kapingamarangi Atoll in the Caroline Islands produced results similar to those obtained on the Bahamas mud. However, in none of 6 experiments performed on deep-sea, coccolithic, calcite ooze from near the Hawaiian Islands could the sample be lithified, even at T = 400° C., P = 1,000 bars, t = 11 days; apparently consolidation of calcite sediment requires the circulation of dissolving water.

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RELATION OF MINERALIZATION TO PRECAMBRIAN STRATIGRAPHY, BLIND RIVER AREA, ONTARIO

The study is a result of a continuing surface-mapping program that was begun in 1953, with additional data provided by the drilling and underground activities of mining companies. The Archean rocks are Keewatin greenstones intruded by Algoman granites, for which the geological age has been determined as about 2,500 million years. These granitic rocks consist of gneissic granodiorites and massive, slightly radioactive quartz monzonite. The Archean complex was eroded to a peneplain with valleys in the less resistant rock types. The Lower Huronian formations are a sequence containing a great variety of sedimentary rocks such as conglomerate, arenites, argillite, siltstone, greywacke, limestone, and quartzite. Thickness and facies changes indicate a northwesterly source, northerly overlap, and deposition in shallow water controlled by basement topography. The Lower Huronian formations unconformably overlie the Archean rocks and in turn are unconformably overlain by the Middle Huronian formations. The Middle Huronian rocks consist of the Gowganda and Lorrain formations of conglomerate, greywacke, quartzite, and arkose.

Age-dating methods give the age of the Nipissing diabase as 1,950 million years and of the granite at Cutler as 1,750 million years (Penokean orogeny). A few dikes of Keweenawan olivine diabase have been tentatively dated at 1,000 million years.

Copper mineralization is associated with the Nipissing diabase. Uranium ores in oligomictic conglomerates are post-Archean placers modified at a later date. Uranium production to the end of 1962 consisted of 44,937,871 tons of ore grading approximately 0.1% U_3O_8, valued at $944,373,250.

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EARLY AND MIDDLE PENNSYLVANIAN FUSULINIDS FROM HORQUILLA LIMESTONE, SOUTHEASTERN ARIZONA

The lower 1,000 feet of the Horquilla limestone of southeast Arizona contain abundant early and middle Pennsylvanian fusulinids. Unconformities lie at the base of the Horquilla and at the top of the zone of *Fusulina* about 1,000 feet above the base of the formation. The lowest fusulinid zones, the zones of *Millerella* and *Profusulinella*, are relatively thin and in combined thickness make up about 100 feet of strata. The overlying zone of *Fusulinella* varies from about 100 to nearly 400 feet thick and has a diverse fusulinid fauna which is divisible into three subzones. The evolution of species of *Fusulinella* from early into later fusulinid groups is remarkably complete. Above this the zone of *Fusulina* reaching 600 feet in thickness is divisible into four subzones.

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BASEMENT STUDIES IN MIDWESTERN UNITED STATES

As the midwestern United States is covered largely by Paleozoic sedimentary rocks, geologic studies of the basement complex are based primarily upon extrapolation of trends from the Laurentian shield and samples from approximately 50 basement wells in Illinois, Indiana, Ohio, and Michigan. Age determinations and lithologic studies of samples from these basement tests suggest an extension of the Grenville province from Ontario into the area of the Indiana-Ohio platform. Geophysical surveys also have revealed structural and lithologic patterns in the basement complex that can be

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