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BASEMENT ROCKS AND STRUCTURAL EVOLUTION OF SOUTHERN OKLAHOMA

Basement rocks in the 17,000-square-mile region of southern Oklahoma crop out in the Wichita and Arbuckle Mountains and have been studied in subsurface samples from 175 wells. The rocks are divided into two contrasting provinces, each completely different from the other in age and petrologic character. Each province has played a different role in guiding the stratigraphic and structural evolution of overlying Paleozoic strata.

The older or Eastern Arbuckle Province consists dominantly of Precambrian massive granites isotopically dated at 1,050–1,350 million years. They are part of an extensive continental craton, on which the Paleozoic sediments are thin and have been only slightly disturbed, chiefly by gentle folding and block-faulting.

Basement rocks of the younger or Wichita Province are sediments, flows, and intrusive igneous rocks of probable Early and Middle Cambrian age. The sediments and flows consist of graywacke, bedded chert, spilitic basalt, and rhyolite. As shown by drilling and supporting seismic data, these framework rocks accumulated to a thickness of about 20,000 feet within an elongate downwarp upon the craton. Overlying strata of Paleozoic age are 40,000 feet thick. The 60,000-foot sequence in this trough, here called the southern Oklahoma geosyncline, was strongly folded and faulted in Pennsylvanian time, the structural grain and some of the major faults having been established during the time of formation of the basement rocks.

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BASEMENT CONTROL OF KEWEENAWAN AND CAMBRIAN SEDIMENTATION IN THE LAKE SUPERIOR REGION

A study of Keweenawan and Cambrian sediments in the Lake Superior region indicates that major structural trends in the basement rocks exerted a prolonged and profound influence upon sedimentation and development of post-depositional structural features. The major structural elements trend east-west throughout most of northern Michigan, northeast throughout Minnesota and western Ontario, and north-south to east-west near the eastern shore of Lake Superior. Paleocurrent directions show that the depositional strike and outline of the Precambrian Keweenaw sedimentary basin were essentially parallel with these structural trends. Source areas were located near the margins of the present Lake Superior. Subsidence of the basin permitted great thickness of lava and clastic sediment to accumulate with little or no variation in the regional slope. Structural contours and isopach lines of the Keweenawan sequence are parallel with paleoslope contours of the Keweenaw basin, indicating that subsidence parallel with basement structural trends was a controlling factor for dispersal patterns and sediment accumulation. Basement control of sedimentation continued throughout most of Cambrian time.

Post-depositional structural features such as the Lake Superior syncline and the Keweenaw fault as well as the present Lake Superior basin also parallel basement structural trends.

It is concluded that resurgent tectonics have been active in the Lake Superior region since pre-Keweenawan time and have exerted a significant effect upon the area up to the present.

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GEOCHEMISTRY'S ROLE IN OIL EXPLORATION

This introductory paper keynotes the symposium on "Geochemistry in Petroleum Exploration," the first A.A.P.G. symposium ever to be devoted exclusively to the subject of geochemistry. The purpose is to acquaint petroleum geologists with this rapidly growing field and to alert them to the potential which geochemical methods may have in the search for oil.

The science of geochemistry which deals broadly with chemical processes in the earth has been developing vigorously over the past two decades along organic and biochemical as well as physical and inorganic lines. With the advent of new and highly sensitive analytical techniques, it is now possible to probe the complex chemical changes that occur during the accumulation, compaction, and subsequent lithification of sediments, and in particular to trace the course of bituminization of the organic plant and animal debris that accumulates with the finer grained minerals.

Out of this work are emerging numerous relationships which reflect in a sensitive manner the source materials and natural history of petroleum genesis. The evaluation of these relationships as practical criteria in petroleum exploration requires that they be assessed critically in basin-wide studies by closely cooperating geologists and geochemists. Some types of exploration problems appear to be amenable to geochemical analysis.

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USE OF FACTOR ANALYSIS IN RECOGNIZING FACIES BOUNDARIES

One of the vexing problems of geology is recognizing boundaries between facies that intergrade. For example, if a shale facies grades laterally into sandstone, where do you draw the line between the two facies? No matter where the boundary is placed, it is partly subjective and depends on what you consider to be important criteria—color, lithological proportions, thickness of beds, kinds of fossils, and so on. Factor analysis, a statistical technique, can help in determining facies boundaries by objectively establishing where major changes occur, once the criteria have been decided.

As an experiment, a thin, continuous limestone unit within the Lower Permian Americus limestone was sampled at 27 localities along a 250-mile-long outcrop belt in Kansas and Oklahoma. The problem was to interpret variations along the outcrop belt and to decide where facies changes occur. Specimens from each of the localities were point-counted and were also analyzed chemically. As a result, 14 different constituents (percentages of bryozoans, fusulinids, crinoids, shells, intraclasts, visibly crystalline calcite, microcrystalline calcite, silica, magnesia, the R_2O_3 group, manganese, titanium, strontium, and vanadium) were quantitatively determined, and permitted comparisons between each of the 27 localities in terms of each of the 14 constituents. Factor analysis brought about a great simplification by showing that two basic variables, or factors, were sufficient to mark where major changes occur and where boundaries between four different facies should be placed. Thus, 2 factors substituted for 14 constituents.