reaching and significant. It is the European economic miracle. We are seeing what I would like to call the "Second European Renaissance." A dozen or more years ago, Europe suddenly shook off its traditional complacency and began planning bright new futures for everyone and every nation. They were determined to get our way of life and our material comforts for themselves. But they're not just going to take them from us. They're going to do it themselves and in their own way. They have adopted the American spirit of enterprise and have gone all out for competition. As a result, European business is booming.

This new Europe is giving us a terrific run for our money. The European nations are finding oil and gas in places where we knew it was all the time.

Why they are finding it is this . . . the new spirit of enterprise, resourcefulness, competition, ingenuity, and determination to have more for themselves and do more for themselves. In their oil industry they are using their own equipment and their own methods as much as is practical. They insist on running their own show.

All of this also applies to Japan.

Many are concerned about conditions in Latin America. These nations are also feeling restiveness and dissatisfaction with slow economic progress. Some of them are still operating by trial and error, but there are many elements down there that are beginning to understand the essentials of a sound and progressive oil industry, and the march of events and the need for oil will certainly bring improvement before too long.

The American oil industry must hump to keep ahead of this new economic rebirth. These people in other nations have just learned that nature didn't put all the oil in the U.S. and that the art of finding oil isn't an American monopoly. They are finding oil, developing their own geological theories, their own tools, their own producing methods.

Our challenge is to reduce the cost of finding oil and bringing it to the surface. And we've got to find a lot more oil. Two things are certain: The demand for petroleum is going to grow and grow, and our present surplus of crude is going to dry up rapidly. And, there are tremendous quantities of oil and gas still hidden in the rocks under these United States, waiting to be found. Finding this oil will require new approaches, much imaginative thinking, perhaps new geological theories, probably new exploration tools.

April 6, 1964

WARREN L. CALVERT, Ohio Geological Survey, now with Shell, Columbus

"Ohio's Petroleum Development and Geological Occurrence"

Ohio's first oil boom occurred from 1890 to 1905 when the Trenton Dolomite field of northwestern Ohio was the largest oil field in the world. Now, in 1964, Ohio is again the scene of another oil boom, this time the target is the Cambrian dolomite of central Ohio. Monthly production in Morrow County increased from 36,835 barrels in January, 1963, to 452,871 barrels in December, 1963.

Stratigraphically, Ohio is composed of Paleozoic sedimentary rocks resting upon Precambrian metamorphic rocks, with a cover of Pleistocene glacial drift over the northwestern two-thirds of the state. All Paleozoic systems are represented, which, in general, thicken toward the southeast. The regional structure of Ohio is dominated by the Cincinnati Arch, a northward slightly plunging axis in the western part of the state. A gentle eastward regional dip into the Appalachian basin is common, except (1) in northeastern Ohio where dip is to the south, (2) in northwestern Ohio where dip is northwestward around the Michigan basin, and (3) in southwestern Ohio where dip is northward around the Cincinnati dome.

Oil and gas has been produced in Ohio since 1860. The productive areas of the state are in general (1) the Shallow Sand Field of eastern Ohio, which produces from stratigraphic traps and local structures in rocks of Pennsylvanian, Mississippian, and Devonian age, (2) the "Clinton" (Albion) Field of east-central Ohio, which produces from stratigraphic porosity traps in Silurian dolomites and sandstones, (3) the Trenton Field of northwestern Ohio, which produces from dolomitized Ordovician limestones, and (4) the Central Cambrian Field, which is producing from stratigraphic traps in dolomites below the Knox (post-Beekmantown) unconformity. Some overlapping of producing zones occurs between various fields. The Trenton field is now practically plugged out and many older pools in the "Clinton" and Shallow Sand fields are abandoned.

Present interest is primarily focused upon the petroleum potential of rocks of the Sauk Sequence (Knox unconformity to basement complex). Formations of the Sauk Sequence are, in ascending order, (1) Mt. Simon (basal) Sandstone, (2) Shady Dolomtie, (3) Rome Formation, (4) Conasauga Shale, (5) Maynardville Dolomite, (6) Copper Ridge Dolomite, and (7) Chepultepec Dolomite. The lower four formations, Mt. Simon Sandstone to Conasauga Shale inclusive, contain

much clastic material and are placed in the Montevallo Supergroup. The upper three formations, Maynardville Dolomite to Chepultepec Dolomite inclusive, consist mainly of dolomite and comprise the Knox Dolomite Supergroup.

Sedimentation studies indicate that rocks of the Sauk Sequence were deposited in a transgressing sea which advanced from the southeast. The stratigraphic succession of Cambrian and Ordovician rocks of the Appalachian basin is clearly evident across Ohio. In northeastern Indiana, however, a transition occurs between the Appalachian basin carbonate facies and the Upper Mississippi Valley clastic facies of Wisconsin and Minnesota.

Cross sections reveal that the Sauk Sequence is truncated northward beneath the Knox unconformity. Petroleum production is related to stratigraphic traps below the unconformity. Chepultepec (Beekmantown) rocks have produced small quantities of oil and gas to the south in Kentucky. Copper Ridge (Trempealeauan) Dolomite is producing in central Ohio. Shady Dolomite is the reservoir rock of the Clearville pool in southern Ontario, and the wedge-edge of the Mt. Simon Sandstone is productive in the Gobles pool of central Ontario.

An isopach map of the Sauk Sequence shows a narrow, north-south area of thin Sauk in central and southern Ohio, over which lower beds are relatively thin or absent. This is interpreted as a Precambrian buried ridge known as the Waverly Arch. A lesser ridge may be present in eastern Ohio. In central-northern Ohio, isopach studies indicate a Precambrian platform in the vicinity of Lake Erie.

Oil accumulations of Morrow County are in stratigraphic traps of the erosional remnant type. Many are buried hills of local areal extent (100 to 300 acres), but most have high relief (100 to 200 feet) with pay sections up to 150 feet or more in thickness. Angle of west slope appears to be the critical trapping factor in remnant reservoirs. The Lower Chazy Dolomite ("Glenwood") and part of the Middle Chazy Limestone are generally missing by non-deposition. Commonly, secondary dolomitization of the Middle Chazy Limestone has occurred above the unconformity in these pinnacle type remnants, making the top of the Cambrian difficult to find.

Accumulation in the Marengo area of Bennington Township is apparently in a buried ridge of low relief, with 20 to 30 feet of overlying Lower Chazy Dolomite present. Pay thicknesses in remnants of the buried ridge type commonly range from 5 to 20 feet.

Erosional remnants are gas-solution type reservoirs with a possible moderate water drive. Porosity commonly varies from 6 to 20 percent and permeability from 1 to several hundred millidarcies. Water saturation is commonly 18 to 25 percent. Initial gas-oil ratios of 300 to 400 cubic feet per barrel increase gradually with production. Primary reserves are conservatively estimated at 140 barrels per acre foot, based upon 25 percent recovery of 560 barrels per acre foot in place.

Statigraphic traps due to truncation, sand pinch-outs, permeability barriers, and erosional remnants below the Knox unconformity may be present in all parts of Ohio. Lack of information concerning structure in the Sauk Sequence does not rule out the possibility of structural accumulations. To the present time, the great bulk of Cambrian production has been from erosional remnants in Morrow County. Extensive exploration in Ohio is expected to continue for at least several years.

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April 7, 1964

UMBERTO COLOMBO, Donegani Research Institute, Italy
"The Evolution of Petroleum"

"The idea of a 'metamorphic' evolution of petroleum arose from the consideration of differences existing in chemical structure of crude oils within each sedimentary basin, and from certain regularities, which seem to indicate a relationship between the structure of oils and such geological parameters as age and depth of their reservoirs. This concept of evolution of petroleum was strictly connected with the classical hypothesis of the origin of oil in 'source rocks,' through complex transformations of biologic matter. Recent studies on migration of hydrocarbons and on the composition of crude oils have led to a substantially new picture of origin and alteration of oil deposits. The new ideas are reviewed, with particular reference to their implications in the problem of evolution of petroleum."

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April 13, 1964

ED BARRETT, Continental, Oklahoma City
"Origin of Mobile Belts—Ouichitas Emphasized"

No one, to the present writer's knowledge, has satisfactorily explained the underlying reason for the continent-bordering mobile belts, and the following hypothesis may fall in the same category. It is thought reasonable, however, to assume that the thermal, and therefore density, differential between the sub-continental and sub-oceanic basaltic