United States

Department of the Interior

U.S. Geological Survey

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Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Special Report No. 16

PETROLEUM POSSIBILITIES OF THE UMIAT AREA

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By

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ILLUSTRATION

In the vicinity of Umiat Mountain where the best exposure occurs, 176 feet of the distinctive zone F black paper shales is exposed. In Umiat Test Well No. 1 the black paper shale is 194 feet thick, and is underlain by 206 feet of additional sediments which constitute the remainder of 400 feet of zone F. The top of zone F (top of black paper shale) is horizon 7 (see fig. 4 of Report No. 3).

Zones G and H together are 2,670 feet thick. Depending on where the contact between them is placed, zone G is between 800 and 1,300 feet thick in the areas of Seabee Creek, Umiat Mountain, in the upper part of Umiat Test Well No. 1, and in shot holes 12, 27, 13, 35 and 34 of geophysical lines 1-46 and 2-46. This section consists primarily of fine-grained calcareous sandstones, shale, coal and bentonite seams.

The remainder of the total section is composed of approximately 1,370 to 1,870 feet of zone H sediments present on the flanks of the structure. These sediments are largely bentonitic and tuffaceous, fine to very fine-grained sandstones, shale, and a few coal seams.

TEST WELLS

Three tests have been made on the Umiat structure in the past. Umiat Test Well No. 1 was drilled approximately 700 to 800 feet down the west plunge of the structure (see fig. 1). Three hundred and fifty feet of zone G sediments comparable to that of the outcrop area constitute the top section of the well. The zone F section, including the black paper shales, bottoms at a depth of 750 feet. The base of E is tentatively placed at 2,100 feet. This 1,350 feet of section contains potential oil-bearing sands. Porosities in these sands vary from 5-22 percent, permeabilities have a wide range, and although generally low, recordings as high as 310 md. were made on samples ranging from depths of 1,736 feet to 1,782 feet. Thirteen hundred feet of what is now believed to be zone D sands and shale underlie the zone E section. Oil shows, oil odor, and gas are present throughout this section also. Porosity and permeability values in these sands in general approximate those above. The remainder of the well to a depth of 6,000 feet is comprised largely of zone A-C undifferentiated shales.

Umiat Test Well No. 2 was drilled on the south flank approximately 500 feet higher structurally than Test Well No. 1. Eleven hundred feet of zone E section constitute the upper part of the well. Oil shows, oil odor and gas were evident throughout almost the entire section. Permeabilities in the more favorable sands were consistently higher than those of Test Well No. 1, varying from less than 10 md. to 279 md. Porosities also were higher. The sands were predominantly very fine to fine-grained. No section

lithologically similar to the sand section underlying the zone E sequence in Test Well No. 1 is present in Test Well No. 2. Thus it is entirely possible that no zone D section is present in this test, with the possibility of an erosional break to explain its absence. However, inasmuch as the first evidence of a zone A-C type fossil (fragment of genus Cleoniceras) occurs at 2,280 feet, it is conceivable that the 1,180 feet of shale section above the position of this fossil is zone D in age. This possibility, however, is rather remote. The remainder of the well to a depth of 6,212 feet is almost entirely unfavorable zone A-C undifferentiated shales.

Umiat Core Test No. 1 was drilled approximately 150 feet higher structurally than Test Well No. 2. The entire section penetrated consisted of potential oil-bearing zone E sands intercalated with shale and siltstone. Porosities varied from 7 to 17 percent, permeabilities from 10 to 465 md. A small amount of a paraffin-base oil was produced for a short time.

STRUCTURE

The paramount feature of structural importance in the Umiat area is the closed anticline delineated on figure 1. A minimum closure of 700 feet has been mapped on the anticline with the possibility that the closure may be greater. The plunge of the structure to the east is approximately 6° but appears to be less at the western extremity. The anticline is asymmetric due to the presence of a possible steep "monoclinal flexure" a short distance north of the crestal axis. This flexure manifests itself topographically by an 8-mile ridge that extends from the vicinity of Umiat Test Well No. 1 to Umiat Mountain. Dips where measured on the surface are from 60°-90°; the alinement of structure traces near the west end of the ridge is suggestive of slight overturning 1/. In addition to the measured dips, steep to vertical bedding is further indicated by the fact that the structure traces of these basal zone G sandstones form very nearly straight lines regardless of topography.

Several explanations of this steeply dipping zone have been presented. A sharp fold such as the one described could be associated with faulting of some kind. The surface geology, which is based in part on measurements of zonal thicknesses, seemingly prohibits any major large-scale fault displacement. Small local offsets forming a shear zone are very possibly present, but a total displacement of more than 400 feet is unlikely. North of this zone of steep dips and possible shearing, the angles of dip decrease rapidly within very short distances.

1/ Whittington, C. L., personal communication Jan. 1950.

Because of the asymmetric nature of the fold, the crestal axis (highest points of the fold) and the axial plane of the structure do not coincide. The crestal plane may be very nearly vertical in attitude. The axial plane, which divides the fold as symmetrically as possible, would coincide closely with the zone of vertical dips, would dip southward, and thus could be expected to migrate southward with increasing depth. The axis delineated on figure 1 represents the crestal axis.

PETROLEUM POSSIBILITIES

In discussing the petroleum possibilities of the area, existing well conditions should be analyzed. Umiat Test Well No. 1 was drilled down the west plunge on the south flank of the structure. Although oil shows occurred in favorable-appearing zone E and zone D sands, no oil was produced. Umiat Test Well No. 2 was drilled on the south flank near the eastern plunge 500 feet higher structurally than Test Well No. 1, and although the corresponding zone E sands contained oil shows, no production was forthcoming from this test either. Umiat Core Test No. 1 was drilled 150 feet higher structurally than Test Well No. 2. A paraffin-base oil was produced for a short time from a sand at 250 feet (below collar). This sand would correspond to the favorable sand at Umiat Test Well No. 1 (1,300 feet below collar) and that at Umiat Test Well No. 2 (375 feet below collar). As this test is structurally the highest of the three, it is possible that the oil produced represents merely the marginal oil of the reservoir. If this concept is valid, another test anywhere on the south flank below the 1,000-foot contour (figure 1) would have very little chance of encountering a producing horizon in the zone E section. Owing to the fact that the favorable sands vary in porosity and permeability over the area (an indication that the control of the oil accumulation may be partly of a stratigraphic nature) the previously stated concept may not be valid. However, it is worth consideration, and if judged valid, a test on the structural high would become an attractive play.

As has been previously stated, a 1,300-foot section of zone D oil-bearing sands and shale in Umiat Test Well No. 1 may either have wedged out or been truncated entirely in the area. Unfortunately, data concerning a zone D truncation is inconclusive at this time. Should further detailing be done in the area to delimit the nature of such a wedging or truncation, then the zone D sands on the flanks may be found at a favorable location for a test.

Although the presence of a fault large enough to produce trap conditions on the north flank is considered unlikely by the writer, it cannot be ruled out entirely. If such a fault is present, a test on the north flank would be justified.

RECOMMENDATIONS

Two limitations have apparently been imposed on the drilling of the proposed test: (1) that the favorable zone E sands be encountered below the zone of permafrost (1,000 feet); and (2) that the top of the zone E sand section be encountered at a depth not exceeding 1,400 feet. The second limitation has been imposed because of the depth limitations of the available rig (2,500 feet). Figure 1 indicates that the only areas where both these conditions definitely exist are on the south flank and on the east and west plunges of the structure. A test of the zone E sands in any of these areas is not justified at this time. The first limitation is imposed on the assumption that the permafrost would act as a deterrent to production should oil be encountered. This assumption is not necessarily valid, and in any case, delimiting of any oil-bearing horizon is considered to be of primary interest. In view of the two unsuccessful test wells and one core test previously drilled on the Umiat structure, it is not considered probable that a large structurally controlled pool of oil is present in the Umiat area. However, if it is desired to explore previously untested possibilities of the Umiat anticline by means of an inexpensive cable tool hole, then the following recommendations are made:

1. That a test be located on the crestal axis approximately midway between shot point 37 and Bearpaw Creek along a line running between shot point 37 and a point halfway between shot points 9 and 10. Such a test should encounter the favorable horizon of the core test 100 to 200 feet higher structurally than in the core test. On the basis of topographic and structural maps of the area, the oil-bearing zone E sand in Umiat Core Test No. 1 would be encountered at a total depth of approximately 400 feet. Impermeable zones of shale and siltstone are judged to be sufficient in the unexposed part of the zone E sediments to act as an effective cap to the oil which may underlie it. Disregarding all other considerations, until a test is put down on the crestal high of the structure, no final evaluation of the oil possibilities of the anticline can be ascertained.

2. Although a test of the north flank may be justified, it is extremely questionable whether a location can be chosen to enable the available rig to penetrate the entire favorable zone E sand section. Drilling in the immediate vicinity of the zone of steep dips and possible shearing with the limitations imposed by the available rig would be extremely hazardous if a test of the zone E sediments is of primary interest. In effect, a test put down in this high-dip zone might conceivably penetrate nothing more interesting than several hundred feet of steeply dipping zone G section.