DISTRIBUTION OF METHANE HOMOLOGS IN GAS AND OIL FIELDS[1]

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(Presented by Academician A. A. Trofimuk, June 8, 1971)

The homologs of methane (MH) are the simplest and the lightest components of natural oil-gas mixtures. In gas and oil deposits they are genetically related, if one of the, for example, butane, is present, all the lighter homologs are also present in the gas, and in some deposits their ratios follow a strict pattern [1a, b]. These distribution characteristics can be used in the search for oil and gas and in investigation of the genesis of hydrocarbons, their migration, and formation of deposits. The few available papers deal only with the distribution of methane homologs in individual deposits and regions [1 - 3]. No investigations on a broader theoretical basis, embracing whole gas and oil provinces, or of the relation of methane homologs to the composition of the other hydrocarbons in individual fields have yet been made.

We have used our own and the numerous data in the literature [4 - 10] etc. on Soviet and foreign oil and gas fields, to analyze the distribution of methane homologs in natural gas deposits where there is no oil (NG), gas field, gas-oil provinces (G), gas pools related to oil deposits (GP), gases of gas-oil deposits (GGP), and gases of oil deposits (P). Each type of deposit was treated separately and altogether over 3500 deposits were investigated.

The first step in the investigation was comparison of the patterns of distribution in different natural gas and oil-gas provinces. It was found that the maximum frequencies of occurrence of the sum of methane homologs as well as of the individual homologs in the USSR, U.S.A., and Canada are in good agreement. For example, in the natural gas deposits the sum of methane homologs ranges within narrow limits (2 to 4.5 percent). In the oil-gas deposits of the U.S.A. more than half of the samples, all of them collected and analyzed by the same method, contained 2.5 to 3.5 percent of methane homologs. In other words, the methane homolog content in each type of deposit is essentially the same everywhere, and their patterns of distribution, determined in one province, may be used in exploration for gas and oil in other, still poorly investigated provinces.

The maximum frequencies of occurrence of the sum of methane homologs in different types of deposits are different (Fig. 1). In the natural gas basins and zones (NG), the most frequently occurring Σ MH vary within narrow limits, from 1.5 to 2.0 percent in 79.1 percent of all deposits. The Σ MH most frequently encountered is 1.5 percent with 98 percent of the fields showing less than 3 percent MH. Gases from deposits of this type may contain no MH (15 percent of NG deposits), as shown by analysis with sensitivity of 0.01-0.05 percent. The gas deposits of oil and gas provinces (G) may be free of MH (12.5 percent), the most frequently occurring Σ MH being higher. A 5 percent MH content occurs in 23 percent of the deposits of this type. The gases of gas-oil deposits (GGP) always contain MH and differ in this respect from gas deposits proper. Gases from deposits of type NG contain less than 5 percent Σ MH, while gases accompanying oil (fields of types G, GGP, GP, and P) usually contain more than 5 percent Σ MH.

The C_2/C_3 ratio is the lowest in the gases of oil deposits (P) and reaches a maximum in the deposits of natural gas not associated with oil (Fig. 2). The maximum frequencies of occurrence of the highest C_2/C_3 ratio and of the highest Σ MH content are different in different types of deposits. The C_2/C_3 ratios in the gases associated with oil are similar and rather easily distinguished from the C_2/C_3 ratios in the gases not so associated. For example,

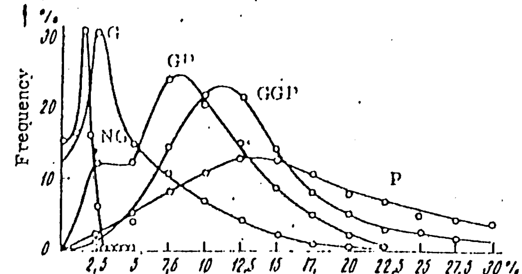

Fig. 1. Frequency distribution of the sum of methane homologs in deposits of different type.

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[1] Translated from: Zakonomernosti rasprostraneniya gomologov metana v zalezhakh gaza i nefti. Doklady Akademii Nauk SSSR, 1972, Vol. 206, No. 4, pp. 967 - 969.

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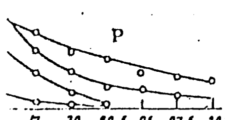

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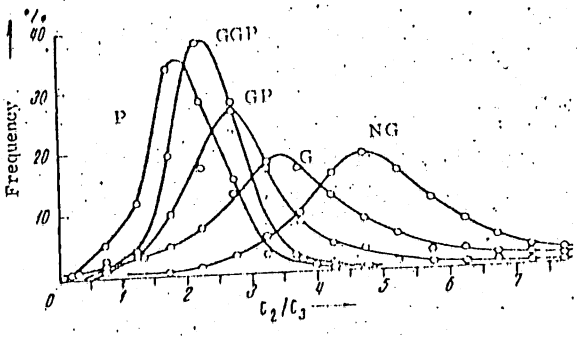

Fig. 2. Frequency distribution of C_2/C_3 ratio in deposits of different type.

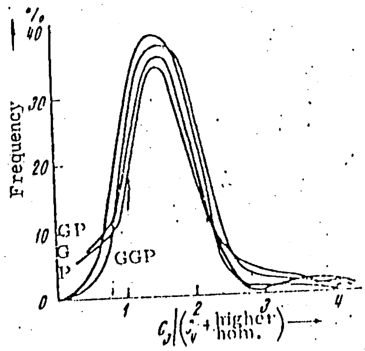

Fig. 3. Frequency distribution of $C_3/$ (C_4 + higher hom.) ratio in deposits of different type.

C_2/C_3 ratios up to 3.5 are observed in 96 percent of type P deposits, 95 percent of type G fields, and 82 percent type GGP fields. In 88 percent of the natural gas deposits (NG) this ratio is over 3.5. The gases of the gas and oil provinces are intermediate in this respect. C_2/C_3 ratios up to 4 have been found in 97 percent of type P, 96.5 percent of type G, and in 85 percent of type GGP deposits. In 80.2 percent of type NG deposits it is higher than 4.

The more complex are the homologs in the denominator of the C_2/C_3 ratio, the less useful is this ratio for distinguishing different types of deposits. The maximum frequencies of occurrences of C_{4n}/C_4 iso are close to each other, but the C_{5n}/C_5 iso and C_3(C_4 + higher hom.) are practically alike in all types of deposits, or more accurately, their variation curves are alike. This is illustrated in Fig. 3, showing frequencies of occurrence of C_3/C_4 + higher hom.) ratio. It is the ratio of the lighter hydrocarbons (methane, ethane) to the heavier ones that distinguished gases from deposits of different types. The distribution of the heavy hydrocarbons is the same in all deposits, but the contents of the methane homologues clearly distinguish between gases from natural gas deposits proper and from the deposits where oil is present[2].

The data presented here can be used in oil and gas exploration and in investigations of the genesis and deposition of hydrocarbons.

Received June 1, 1971

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[2]Methane homologs provide the best basis for distinguishing between gases from different types of deposits. It should be noted, however, that the author's calculations contain unavoidable errors arising from inexact classification of gas deposits in the literature. Thus "gas deposits proper" that have not been explored to the base may turn out to be gas-oil deposits. The presence of oil on the margins of a "gas" field is not always reported. Thus, curve GGP, Fig. 1, deviates from the normal curve below the maximum for gas deposits (NG), and this indicates that some of the deposits were not correctly classifi