FORMATION PETROLEUM BIOMARKERS
FROM ARCHAEA THERMOPLASMA SP. BIOMASS

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Prokaryotes insufficient attention is paid in the formation of petroleum biomarkers. We have previously shown that from the bacteria biomass Arthrobacter sp. RV and Pseudomonas aeruginosa RM formed petroleum biomarkers (references 1-3). Moreover, only n-alkanes and some oxygenates formation is observed in the soluble portion of these bacteria. Cyclic biomarkers generated in the thermolysis (low temperature pyrolysis) products of the insoluble portion. It is interesting to note that the distribution of steranes C_{27}-C_{29} resembles that in the oils of marine origin.

The present communication is devoted research of the distribution of petroleum biomarkers in soluble portion and the products of thermolysis insoluble portion archaea Thermoplasma sp.

Termophilic, acidophilic archaea Thermoplasma sp. was grown in a mineral-organic medium of the following composition, g/L: NH4Cl – 0.33; KCl – 0.33; MgCl2:6H2O – 0.7; CaCl2:2H2O – 0.44; KH2PO4 – 0.33; microelements, 1 ml; vitamins, 1 ml; yeast extract, 0.5; sucrose, 2.0; glycine, 0.7; distilled water; pH 3.0. The strain was cultured under aerobic conditions at 60 °C for 48-72h.

The lyophilic biomass Thermoplasma sp. under was extracted with chloroform in an ultrasonic bath for 20-25h at room temperature until complete disappearance of the soluble part. The insoluble portion of the archaea was subjected to thermolysis at 340 °C for 5h in a sealed glass ampoule. The soluble part of Thermoplasma sp. and products of thermolysis were analyzed by gas chromatography-mass spectrometry. Additionally, native biomass of Thermoplasma sp. was investigated by pyrolysis Rock-Eval.

Unlike the bacteria biomass Arthrobacter sp. RV and Pseudomonas aeruginosa RM we identified aliphatic and cyclic high molecular biomarkers - steranes and terpanes in the soluble portion of the biomass of Thermoplasma sp. Similarly, their formation is observed in the products of thermolysis insoluble portion of Thermoplasma sp. However, the relative content of some hydrocarbons are different from those in the soluble portion. We showed some hydrocarbon ratio in soluble and insoluble products of the thermolysis of Thermoplasma sp. (Fig.1). It is easy to notice that in the thermolysis products among alkanes relative concentrations of regular isoprenanes pristane and phytane prevail significantly compared with n-alkanes C_{17} and C_{18}, respectively. Similarly in thermolysis products occurs slight relief of the hydrocarbon composition (the value of n-C_{15}/n-C_{25} in thermolysis products higher than soluble part of Thermoplasma sp. 0.02 vs. 0.45). It is interesting to note that the ratio of pristane/phytane vary narrow range 0.64-0.82 (Fig.1a). This value is observed in the oils of marine origin.

The relative distribution of steranes C_{27}-C_{29} is also reminds of the oil of marine origin. But in the thermolysis products is observed higher relative content of cholestane (C_{27}). With regard to maturity coefficients, K_{1mat} and K_{2mat} have not reached an equilibrium state, indicating that mature low organic matter. Interestingly, in the thermolysis products values of
K₁mat and K₂mat lower than that in the soluble fraction (0.36 vs. 0.45 and 0.55 vs. 0.69, respectively). The low value of the ratio diasteranes to regular (0.14-0.21) resembles oil generated in carbonate strata (Fig.1b).

Among terpanes value of ratio Ts/(Ts+Tm), M₃₀/G₃₀ closer vary within 0.37-0.48 and 0.16-0.17, respectively, indicating a lower degree of maturity of organic matter. However, in thermolysis products significant relatively high content of tetra- (tetra/tri) and pentacyclo (tri/penta) is observed (0.8 vs. 0.37 and 0.46 vs. 0.06, respectively) (Fig.1c).

The above findings are fully consistent with pyrolysis data Rock-Eval. So the maximum pyrolysis temperature Tmax = 410 °C (low degree of maturity), IH = 454 mgHC/gTOC (marine organic matter).

![Figure 1](image.png)

**Figure 1** Comparative characteristics of alkanes (a), steranes (b) and terpanes (c) of the soluble part and the products of thermolysis of insoluble part of portion *Thermoplasma* sp. (St – sterane, K₁mat = αS/(αS+αR), K₂mat = αββ/(αββ+αR), Dia/Reg – the ratio diasteranes to regular, G₂₉/G₃₀ - the ratio adiantane to hopane, M₃₀/G₃₀ - the ratio moretane to hopane).

**References**