GL03394

6. Zaytsev, N.S. and V.V. Sazhina. Dokl. Akad. Nauk, 118, No. 1, 1958.
7. Kepezhinskas, V.V. Verkhnepaleozoyskiy vulkanizm Tokrauskogo sinklinoriya (Tsentral'nyy Kazakhstan) (Late Paleozoic Volcanism of the Tokrau Synclinorium, Central Kazakhstan), Nauka Press, 1969.
8. Kepezhinskas, V.V. and Ye.V. Devyatkin. Assotsiatsii vulkanogennykh porod MNR, ikh sostav i stratigraficheskoye polozheniye (Volcanic Rock Associations of the Mongolian People's Republic, Their Composition and Stratigraphic Position), Tr. sovmestnoy Sovetsko-Mongol'skoy n.-i. geol. ekspeditsii (Proceedings of the Joint Soviet-Mongolian Geological Research Expedition), 1972.
9. Oknova, T.M. Tr. Mongol'skoy Komissii Akad. Nauk SSSR, No. 37, fasc. 2, 1940.
10. Severov, E.A. and E.I. Tikhomirova. Dokl. Akad. Nauk, 127, No. 1, 1959.
11. Le Maitre, R.W. J. Petrol., 9, No. 2, 1968.

UNIVERSITY OF UTAH
RESEARCH INSTITUTE
EARTH SCIENCE LAB.

TEMPERATURE FIELDS OF THE PRODUCTIVE FORMATION AS RELATED TO STRUCTURAL FEATURES OF THE APSHERON PENINSULA[1]

G.P. Tamrazyan and S.T. Ovnatanov

(Presented by Academician A.V. Peyve, August 13, 1971)

Most of the known oil and gas pools in eastern Azerbaidzhan are concentrated in a three- to five-kilometer thick productive formation, the genesis of which is one of the most puzzling aspects of the Cenozoic paleogeographic history of the eastern Caucasus.

The lithology of the productive formation differs sharply (because of its predominantly silty sandy composition) from all the underlying and overlying formations, which are predominantly clayey.

The Main Caucasus Range descends southeastward across the Apsheron Peninsula and then disappears beneath the Caspian Sea. The eastern half of the peninsula is not only the most easterly land area of the Greater Caucasus but is also the most downwarped part of the entire Caucasus region. Here the bottom of the middle Pliocene oil-producing formation is depressed to depths of 4 or 5 km and more.

The uplifts in the eastern part of the Apsheron Peninsula include the Surakhany and the Karachukhur-Zykh uplifts in the west, the Mashtagi-Buzovny uplift in the north and the Kala uplift in the east. They are separated by the Bina-Gousanskaya trough, the west limb of which is complicated by the buried Gousanskoye uplift. The buried Zyrya uplift is in the southeastern part of the peninsula (Fig. 1). All these uplifts contain oil and gas; the fields confined to them have the same names.

In the eastern part of the Apsheron Peninsula the lowest members of the productive formation are the Sub-Kirmakinskaya and the Kala suites.

[1]Translated from: Temperaturnyye polya produktivnoy tolshchi v svyazi so strukturnymi osobennostyami Apsheronskogo poluostrova. Doklady Akademii Nauk SSSR, 1972, Vol. 205, No. 3, pp. 673 - 676.

The temperature at the top of the Sub-Kirmakinskaya suite is shown in Fig. 1. The temperature at the bottom of productive formation in the eastern part of the Apsheron Peninsula ranges from 40° to 65° in the northwest and from 80° to 100° in the southeast, in the zone transitional to the South Apsheron offshore area. Thus, the temperatures throughout the oil-producing formation of the Apsheron Peninsula, which lies at depths of 0 to 6 km and has colossal reserves of oil and gas, do not exceed 100°. Almost nowhere in the eastern part of the Apsheron Peninsula and, therefore, on the entire peninsula (its western part is structurally more uplifted) does the bottom of the productive formation lie at depths where the temperature is much higher than the boiling point of water.

The overall temperature distribution in basal suites of the eastern part of the Apsheron Peninsula is closely dependent on the tectonic conditions here. The temperature is lowest in zones where the depth of these suites is minimal. It is especially low in the structurally elevated zone that extends toward the Mashtagi uplift in the northwest of the peninsula and toward Artem Island in the northeast, where the Sub-Kirmakinskaya suite is exposed at the surface. The lowest temperatures were recorded in the Mashtagi-Buzovny uplift which is closest to the surface (40° to 50° in the central part and 50° to 60° on its remote limbs). The temperature at the top of the Sub-Kirmakinskaya suite increases to 60°, 70° and 60°, respectively, over the crests of the Surakhany, the Karachukhur and the Kala uplifts and reaches a peak of 80° to 90° in the deep-lying, buried Gousanskoye and Zyrya uplifts. The highest temperatures of 80 to 95° were observed in the Bina-Gousanskaya and the Dyubendy-Zyrya troughs.

Fig. 1. Tempera
kinskaya suite in
Peninsula. a to
b) 40 to 50, c) 5
f) 80 to 90, g) 90
the Sub-Kirmakin
injection of Pale

The geother
the productive
is 65 to 100 m
The temper
Pliocene seque
profile (Fig. 2
Tyurkyany-Zy
zone gradually
at increasingly
of the producti
depths of 0.4
Kala uplift to

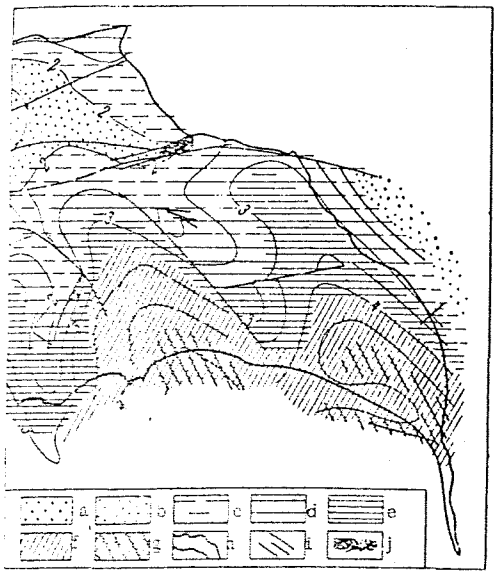

Fig. 1. Temperature at the top of the Sub-Kirmakinskaya suite in the eastern part of the Apsheron Peninsula. a to g) temperature (°C)—a) 30 to 40, b) 40 to 50, c) 50 to 60, d) 60 to 70, e) 70 to 80, f) 80 to 90, g) 90 to 100; h) contours on the top of the Sub-Kirmakinskaya suite; i) faults; j) zone of injection of Paleogene-Miocene rocks into the Buzovny fold.

The geothermal gradient in the lower part of the productive formation in the region studied is 65 to 100 m/deg.

The temperature variation throughout the Pliocene sequence is shown on the regional profile (Fig. 2). Southeastward, the Kala-Tyurkyany-Zyrya-Shakhova Spit structural zone gradually subsides, and its rock units lie at increasingly greater depths. Here, the top of the productive formation declines from depths of 0.4 or 0.5 km over the crest of the Kala uplift to 2 ot 2.5 km in the Shakhova Spit area. The bottom of the productive formation is still further depressed, from depths of 2 km over the crest of the Kala uplift to roughly 7 km near the southeast end of the Shakhova Spit[2]. This steady, directional subsidence of the bottom of the productive formation by 5 km (from depths of 2 to 7 km) occurs over a horizontal distance of only 35 to 40 km, the average gradient thus being 0.1 to 0.15 km per km of horizontal distance.

The temperature also increases in the same regional direction (southeastward), although the gradients are not so steep. The following two phenomena are the result:

1. At any given hypsometric level, the temperature decreases with regional subsidence (Table 1).

2. In any given stratigraphic suites, the temperature increases with regional subsidence much faster than it would have if a uniform increase with depth prevailed. As each suite subsides, it descends into increasingly deeper and higher-temperature zones (layers). Thus, the temperature at the bottom of the Balakhany suite, in the middle of the productive formation, increases from 50° over the crest of the Kala uplift to 70° in the Tyurkyany area (drillhole No. 1306), to 81° in the Zyrya area and to 98° under the Shakhova Spit.

The above data on the temperatures of the bottom of the productive formation and the Pliocene sequence in general in the eastern part of the Apsheron Peninsula are of great scientific interest. They can also be used in prospecting to predict the temperature in the direction of structural subsidence toward the middle of the South Caspian basin, within the newly discovered uplifts situated at structurally deeper levels in this basin. Thus, the general temperature gradient found in the zone from the Zyrya area to the Shakhova Spit (0.3° to 0.5° per km of subsidence at a depth of 4 to 6 km) may also persist farther south in the direction

[2]Hole No. 100 was drilled to a depth of 6522 m near the southeast end of the Shakhova Spit. The temperatures measured were 81° at a depth of 4.5 km and 95° at a depth of 5.75 km.

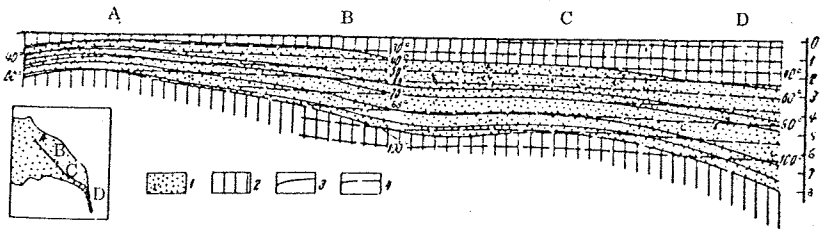

Fig. 2. Regional geothermal profile through the southeastern part of the Apsheron Peninsula. Structures (areas): A) Kala, B) Tyurkyany, C) Zyrya, D) Shakhova Spit area. 1) sandy, clayey and silty (mainly silty and sandy) productive formation; 2) predominantly clayey suites overlying or underlying the productive formation; 3) stratigraphic contacts; 4) geoisotherms.

UNIVERSITY OF UTAH LIBRARIES

Table 1

Temperature (in °C) at Different Depths in the Kala-Shakhovo More Structural Zone of the Apsheron Peninsula

Depth, km	Kala	Tyurkyan	Zyrya	Shakhovo More
1	40—47	37—39	31—33	
2	55—60	(53—57)	51—53	
3		70—73	67—70	
4		(82—86)	80—82	(74—76)
5			(92—95)	85—88
6				97—100

of regional subsidence, at least to the next uplift.

One such uplift south of the Shakhova Spit is the submarine Shakhovo More uplift, the crest of which is roughly 40 km south of the Spit. The Shakhovo More uplift is one of the largest and is oriented southeastward; various data suggest that it contains a large oil and gas pool. In the zone from the Shakhova Spit to the northern pericline of the Shakhovo More uplift, for a horizontal distance of about 20 km, the regional structural subsidence of the southeastern part of the Apsheron Peninsula continues beneath the sea; the above-mentioned temperature gradient also persists in this zone in a horizontal direction. Over a distance of 20 km in the direction of subsidence, the temperature evidently decreases by about 6° to 10°, so that in the higher part of the Shakhovo More uplift, at a depth of 5 km, the temperature should be about 75° to 85° unless, of course, the circulation along faults (which, incidentally, intersect this uplift) of hotter fluids from deeper zones has introduced substantial changes into the pattern by locally increasing the temperature.

Thus, the subsurface heat fields are closely related to structural features. The information on them, if extended to a large part of the South Caspian basin, could serve as an important criterion for estimating the oil and gas potential of new areas. Data on heat fields, especially at different hypsometric, stratigraphic and structural levels, should enable prospecting for new oil and gas pools to be carried out on a more scientific basis, assuming that the thermodynamic conditions under which oil or gas pools occur separately or together, are also taken into account.

We sincerely thank Professor Makarenko for the valuable comments and advice.

Received August 9, 1971

REFERENCES

1. Ovnatanov, S. T. and G. P. Tamrazyan. Dokl. Akad. Nauk, 135, No. 2, 403, 1960.
2. Ovnatanov, S. T. and G. P. Tamrazyan. Ibid., 190, No. 2, 421, 1970.
3. Ovnatanov, S. T. and G. P. Tamrazyan. Sov. geol., 10, 99, 1960.
4. Ovnatanov, S. T. and G. P. Tamrazyan. Ibid. No. 2, 106, 1971.
5. Tamrazyan, G. P. Dokl. Akad. Nauk, 155, No. 6, 1337, 1964.
6. Tamrazyan, G. P. Ibid., 157, No. 2, 337, 1964.
7. Ovnatanov, S. T. and G. P. Tamrazyan. Bull. Am. Assoc. Petrol. Geol., 54, No. 9, 1677, 1970.