**Petroleum Geoscience, UK,**
**Vol. 11, 2005, pp 347-352.**

# GEOTHERMAL REGIME AND HYDROCARBON GENERATION IN THE ALBANIDES

Alfred FRASHËRI

Faculty of Geology and Mining, Polytechnic University of Tirana, ALBANIA

E-mail: alfi@inima.al

**Abstract**

The geothermal regime of the Albanides is described in this paper. Following a summary of the geological structure of the Albanides and of the oil and gas reservoirs in Albania, the parameters controlling the distribution of the present-day geothermal field are analyzed in detail: temperatures, geothermal gradient, heat flow density in the centre of Albanian Sedimentary Basin. The palaeo-thermal regime of the External Albanides is analyzed for the Upper Triassic-Eocene carbonates and the Middle–Upper Miocene and Pliocene molasse. The burial and thermal history of the External Albanides and the implications for hydrocarbon generation are analyzed.

**Key words**: Geothermal history, geothermal gradient, palaeo-geothermal regime, hydrcarbon generation.

## 1. Introduction

Geothermal studies have been carried out in Albania over the past 90 years, in the framework of Geothermal Atlas of Albania, the European Geothermal Atlas and the Atlas of the Geothermal Resources in Europe.

These studies were based on the temperature logs in the 137 deep oil and gas wells and in 50 shallow boreholes, and the following maps were prepared: Temperature Maps at 100, 500, 1000, 2000, 3000 metres depths, Average Geothermal Gradient Map, Heat Flow Density Map, and Geothermal Resources Thematic Map. Geothermal models have been developed, based on regional geological-geophysical profiles. Temperature distributions down to 50 km depth, based on these models have presented in two regional profiles: **Albanid-1** and **Albanid–2**, which run from Falco (Italian Adriatic Shelf) to the NE and SE of Albania (far location, see Fig. 1). The results of these modelling studies have been used in the interpretation of the Heat Flow Density Map of Albania. Thermal water springs and deep wells have been investigated, and geothermal potential of the reservoirs has been evaluated.

## 2. Geological setting of the Albanides

The Albanides represents the assemblage of the geological structures in the territory of Albania and, together with the Dinarides to the north and, the Hellenides to the south form the southern branch of the Mediterranean Alpine Belt. The Albanides are formed by two major palaeogeographic domains: the Internal Albanides in the eastern part and the External Albanides in the western part of Albania. The Internal Albanides are characterized by the presence of the immense and intensively tectonised ophiolitic belt, which is displaced from east to west as an overthrust nappe (Frashëri et al. 1996). The External Albanides developed on the western passive margin and continental shelf of the Adriatic plate. The External Albanides are affected only by the later palaeotectonic stages, and are characterized by regular overthrust structural belts. Geological and geophysical regional studies, based on facial-structural criteria, have distinguished a number tectonic zones (Fig. 1):

***Internal Albanides:*** Korabi, Mirdita, and Gashi tectonic zones,

***External Albanides*** Albanian Alps, Krasta-Cukali, Kruja, Ionian, and Sazani tectonic zones, and Peri Adriatic Depression.

Oil pools and gas reservoirs are located in the Ionian and Peri Adriatic Depression (Foto et al. 1998, Foto 2000, Misha et al. 1999).

**The Ionian** zone (Io) occurs the southwestern part of Albania and developed in a deep pelagic environment the upper Triassic. The Permian- Triassic evaporites are the oldest rocks in this zone. Overlying are thick deposits formed by Upper Triassic- lower Jurassic dolomitic limestones and Jurassic-Cretaceous-Palaeogene pelagic cherty limestones. The limestones are overlain by Palaeogenic flysch, an Aquitanian flyschoidal formation and a thin section of Burdigalian-Langhian (and partially of Serravalian-Tortonian), age which mainly fill the synclinal belts. The Burdigalian deposits unconformably overlay the anticline belts. Three tectonic blocks, representing the structural belts, are present in the Ionian zone:

**a) The Berati anticline belt,** in the eastern margin of the zone.

**b) Kurveleshi anticline belt,** in the central part of the zone.

**c) Çika anticline belt,** which represents the western edge of the Ionian zone.

Structures are fractured by longitudinal tectonic faults on their western flanks, with thrusting of 5-10 km horizontal displacement. Two main tectonic styles are distinguished in the Ionian zone: duplex tectonic and imbricate tectonic styles. Regional reflection seismic lines through the Ionian zone clearly show that during the overthrusting structuration of the Ionian zone, formations from upper Oligocene to Langhian were extended over underlying limestones of southern Adriatic basin and Sazani Zone.

**Peri-Adriatic Depression.** The overlying Peri-Adriatic Depression covers the Ionian, Sazani and part of the Kruja tectonic zones. This is a foredeep filled with middle Miocene and Pliocene molasse, which are mainly covered by Quaternary deposits. From south-east to north-west, the thickness of the molasse increases, reaching 5000 m. Serravalian and

Tortonian sandstone-clay deposits were trangressively extended over the older units, including the Eocene limestone.

The Albanian sedimentary basin extends in the Adriatic shelf with detrial and carbonate formations.

## 3. Oil pools and gas reservoir in Albania

There are 11 main oil and gas reservoirs are located in the Ionian zone and in the Peri Adriatic Depression (Fig. 1). Reservoirs are formed by carbonates and by sandstones of the molasse formation (Çuri 1993, Misha et al. 1999, Sazhdanaku et al. 1999).

Oil pools in carbonate reservoirs are located in the Kurveleshi anticline belt of Ionian tectonic zone. There are three types of carbonate reservoirs: Upper Cretaceous- Palaeocene-Eocene; Jurassic- Palaeocene- Eocene; and one of Upper Triassic- Palaeogene. The traps are generally of anticline type, sometimes partly eroded and covered by flysch or Neogene Molasse.

Oil pools in sandstone reservoirs occur in the Tortonian-Messinian molasse section that transgressed over the older formations up to Palaeogene limestones in the Peri Adriatic Depression. The Tortonian- Messinian molasse comprises by marine shale, submarine fans, and deltaic coastal sand and shale interbeds with coastal, bay, lagoon and delta deposits forming the Tortonian- Messinian reservoirs. These reservoirs can be oil and gas-condensate-bearing, oil-gas-bearing and oil-bearing. The hydrocarbons have been generated at depth in the carbonates.

In the oil pools, different types of hydrocarbons are present: condensates, highly paraffinic oil, paraffinic oil and asphaltic resinous oils. In the Kurveleshi Belt fields, aromatic-intermediate oils unsaturated with gas, and aromatic bitumens with high sulfur content have filled the reservoirs. Paraffinic- naphthenic petroleum occur in the Çika Belt. The wet and very wet associated gases have a high content of $H_2S$ and $CO_2$ and are very

acidic. Stable carbon Isotopic ratios ( $\delta^{13}C$ ) range from 37.4 up to 52.3%, which suggests the presence of at least two petroleum generation phases.

The Peri Adriatic Depression is the main gas production play in Albania ( Dulaj & Gjini 1997). Biogenic gas reservoirs are located in the Miocene-Pliocene molasses, in which comprise massive shales, prodelta clays and submarine fans. The trap types are stratigraphic, and structural-lithological, formed during the Pliocene and post Pliocene tectonism.

The Upper Triassic to the Upper Cretaceous carbonate of Ionian, Kruja and Krasta-Cukali tectonic zones contain several rich to very rich source-rock intervals. The main interval are (Çuri 1993, Dulaj & Basha 1998):

- Bituminous Upper Triassic dolomitic schist, with T.O.C about 4.96% and vitrinite reflectance Ro=0.7-0.87%.
- Bituminous clay-dolomitic schists at the Upper Triassic-Lower Jurassic boundary, very rich with T.O.C up to 29.1%, and vitrinite reflectance R0 reaching 0.65%.
- Bituminous schist of Cretaceous, with T.O.C= 1- 27.1 % and vitrinite reflectance Ro=0.41= 0.446%.

For the all sources rock levels, the concentrated kerogen is predominately of Type I, and the dispersed kerogen of Type II.

The dispersed kerogen type in the Miocene-Pliocene molasses is predominately Type III-a and Type III-b, and has generated gas. T.O.C. has a low value, below 0.4%, and the vitrinite reflectance Ro=0.3- 0.5% even below 6000 m.

The great thickness of the sedimentary series, the occurrence of good quality source-rocks at several stratigraphic levels, the suitable relationship between source-rocks and reservoir/seal pairs and the structuration of the External Albanides provide excellent conditions for entrapment and preservation of major hydrocarbon accumulations at shallow and at greater depths.

The migration phases of hydrocarbons were during the Burdigalian, Tortonian and Pliocene are distinguished.

## 4. Geothermy of the External Albanides

**The temperature:** The geothermal field in the External Albanides is characterized by a relatively low temperature (Fig. 2, 3, Tab.1) (Čermak, Krešl, Kučerova et al. 1996, Frashëri 1993, 2001, Frashëri et al. 1999). In the central part of the Peri-Adriatic Depression the temperature at 100 metres depth varies from 8 to 20°C and at 6.000 metres depth increases to 105,8°C. According to the geothermal modelling, the temperature is 262,3$^{o}$C at a depth 18.000 m, where the top of the crystalline basement is predicted. The isotherms follow the structural configuration of the Albanides. The observed geothermal field, with relatively low temperatures, is characteristic of sedimentary basins with a great thickness of sediments.

**The geothermal gradient:** The External Albanides are characterized by low geothermal gradients. In the Peri-Adriatic Depression, the gradient varies from 1,61-2,13 $^{o}$C/100m. According to the modelling results, the gradient decreases below 15 km to a maximum of 0,9 $^{o}$C/100m. This change of the gradient coincides with the top of the Jurassic carbonate section. All structural and lithological variations in the Ionic zone and Peri-Adriatic Depression are reflected in the distribution of the geothermal field. The higher gradients occur in the anticlinal molasse structures in the centre of the Peri-Adriatic Depression, with the higher value of about 2,13 $^{o}$C/100m in the Pliocene clay section in the centre of Peri-Adriatic Depression. Increasing sand content decreases the geothermal gradient and the gradient also decreases (by 10-29%) in the limestone core of anticlines in Ionic zone. The lowest values of 0,7-1,1 $^{o}$C/100m are observed in the deep synclinal belts. Over-pressure in the molasse of the Albanian Sedimentary Basin also has a great influence on the values of geothermal gradient. Local variations of the temperature and the geothermal gradient are

observed in a small distances of 7-8 km. For example, at a depth of 3000m the temperature may vary up to 8-9°C over these distances. Even in a vertical direction, the geothermal gradient values can change from 1,05 to 1,75 $^{o}$C/ˆ00m.

**The Heat Flow Density:** Heat Flow Density of the Albanian Sedimentary Basin ranges 25,2-41,4 mW/m$^2$, which represent an HFU = 0,60-0,98 (Fig.4, Tab. 1). Heat flow density has its highest value of 42 mW.m$^{-2}$ in the centre of Peri-Adriatic Depression. The 30 mW$^{-2}$ value isotherms open towards the Adriatic Sea Shelf.

In Table 2 the thermal regime of the oil pools and gas reservoirs in Albania are summarized.

**The Palaeotemperature regime:** The parameters of the present-day geothermal regime, seismic data, amount of removed sediments, tectonic subsidence analysis and geodynamics considerations have been used to calculate the palaeo geothermal model. This model was calibrated by measured vitrinite reflectance. Palaeotemperatures were estimated using Nemchenco N. methode (Nemchenco 2002).

The burial and thermal history of the of Upper Triassic- Jurassic-Cretaceous-Palaeocene and Eocene carbonate section, the Lowe Oligocene flysch section, and Middle-Upper Miocene and Pliocene molasse is presented in Table 3 in particular the thermal regime for the main carbonate source rocks, with kerogen of Type I concentrated and Type II dispersed kerogen.

Modelling results indicate that maximum temperatures of 105,3 $^{o}$C occurred during Upper Triassic-Lower Oligocene with palaeogeothermal gradient ranges of 1,28-2,10 $^{o}$C/100 meters and a heat flow density of 38,5 mW/m$^2$. Maximum temperature in the main Cretaous carbonate source rocks was 54,5 $^{o}$C. In these conditions, the organic matter would have been thermally mature, entering the oil window. The Upper Triassic to Lower Oligocene section of the Albanian Sedimentary Basin would thus entered the first phase of the hydrocarbon generation, with condensate, oil and gas. Later, during the Middle-Upper Oligocene and

Miocene, the carbonate section was located at greater depth, with maximum temperatures up to 250$^{o}$C. This geothermal regime created the thermal conditions for methane generation, thus consideration opening up new possibilities for the discovering of methane reservoirs at the depth of the Albanian Sedimentary Basin.

Maximum temperatures up to 122,8$^{o}$C, with a geothermal gradient 1,67 $^{o}$C/100 m and Heat Flow Density ranges of 39,8-41,2 mW/m$^2$ during the Middle and Upper Miocene, created the thermal conditions for maturation of the organic material in the molasse formations, and also in the Pliocene section, where the maximum temperature is 64,9$^{o}$C, geothermal gradient up to 2,13 $^{o}$C/100 m, and Heat Flow Density 41,4 mW/m$^2$. However, the general interpretation of the Albanian petroleum geologists is that in molasse formations the gas was generated biogenically from Typr III organic matter. The oil of molasse section is correlated with the carbonate source rocks is thought to have migrated through the eroded tops of the limestone anticlines.

The thermal regime in the Middle-Upper Miocene, with the temperatures up to 122,8$^{o}$C and Heat Flow Density 41,2 mW/m$^2$, creates the possibility that the complete molasses section was in the oil window and oil have been generated from organic material within it. This interpretation could open new possibilities for discovery oil pools in the Miocene molasses in suitable traps, which do not have direct contact with eroded limestone anticlines.

## 5. Conclusions

1. The Albanian Sedimentary Basin represents a major and deep geological structure with a relatively low Heat Flow Density at the present-day, equal with maximum 0.98 HFU. Temperatures range from 20.7$^{o}$C at the top of the Pliocene section to 262,3$^{o}$C, at the top of the crystalline basement. Geothermal gradients range between 0,9-2,13 $^{o}$C/100 m.

2. During the sedimentation of the Upper Triassic-Eocene carbonate, the temperature ranged between 34,6-105,3$^{o}$C, and consequently the organic matter become thermally mature, and able to generate hydrocarbons. This was the first phase of hydrocarbon generation. With increasing of the basin subsidence, the temperature of the carbonates was raised to 250$^{o}$C, and with suitable conditions for methane generation. This represents the second phase of the hydrocarbon generation.

3. During the sedimentation of the Middle-Upper Miocene age, the molasse formations reached a temperature of 122,8$^{o}$C and a Heat Flow Density 41,2 mW/m$^{2}$, which has created the possibility for the molasses section to enter the oil window, and oil may have generated from organic matter. This interpretation could open new possibilities for discovery of oil pools in suitable traps in the Miocene molasses of the Albania Sedimentary Basin, onshore and offshore. The biogenic gas generation in the Middle-Upper Miocene and Pliocene molasse represents the third phase of the hydrocarbon generation in Albanides.

## 6. References

-Çermak, V., Kresl, M., Kucerova, L., Safanda, J., Frashëri, A., Kapedani, N., Lico, R. & Cano, D. 1996. Heat flow in Albania. *Geothermics*, .**25**, No.1, 91-102.

-Çuri, F., 1993. Oil Generation and Accumulation in the Albanides Ionian Basin. Generation, Accumulation and Production of Europe'' *Hydrocharbons III*, A.M.Spenser (Ed), Special Publication of the European Association of Petroleum Geoscientists No. **3**. Springer-Verlag Berlin Heidelberg, 281-293.

-Dulaj, A. & Gjini, M. 1997; Generation, migration and accumulation of the natural gas in the Peri Adriatic Depression, Albania. Paper D043, presented at the 59th EAGE Conference and Technical Exhibition, Geneva, 26-30 May.

-Dulaj, A. & Basha, M. 1998. Genetic Relations of Hydrocarbons in the central Part of Kurveleshi Belt and Northern Part of the Çika Belt, Albania. Paper 4-21, presented at the 60th EAGE Conference and Technical Exhibition, Leipzig, 8-12 June.

-Foto, G., Hyseni, A. & Foto M. 1998. Some Characteristics of Oil & Gas Bearing Formations in

Albania. Paper presented at the 8th International Congress, Patras, May 1998, *Bulletin of the Geological Survey of Greece,* **XXXII/3**, 334-352.

-Foto, Gj. 2000 Carbonate reservoirs in Ionian zone and their natural characteristics. Paper presented at the 8th Congress of Geosciences in Albania "Position of the Albanides in Alpine Mediterranean Folded System", Tirana , 8-10 November.

-Frashëri, A., Nishani, P., Bushati, S. and Hyseni, A., 1996. Relationship between tectonic zones of the Albanides, based on results of geophysical studies. *Peri-Tethys Memoir **2**: Structure and Prospects of Alpine Basins and Forelands. Mém.* Mus. Natn. Hist. Nat., 170, 485-511, Paris.

-Frashëri, A. 1993. Geothermics of Albanides. *Studia Geophysica et Geodaetica*, **3**, 293-301. Akademije Ved Ceske Republic.

-Frashëri, A., Liço, R., Kapedani, N., 1999. An outlook on the influence of geological structures in geothermal regime in Albania. *Albanian Journal of Natural & Technical Sciences*, **VI**, 129-139. Academy of Sciences of Albania, Tirana.

-Frashëri, A., 2001. Temperature signals from the Albanides depth. *Bulletin of Geological Sciences.* 57-66, Geological Survey of Albania, Tirana.

-Misha, V., Bandilli, L., Bare, V. and Xhufi, C., 1999. The structire modeling and extending of the prospect targets for oil and gas in Albania territory, estimation of their prognoses".

Paper presented at the Workshop "National Program for Research and Development: Geology, Exploration and Processing of the minerals". Ministry of Public Economy and Privatization. December, Tirana.

-Nemchenko N. N., 2002. *Selected Works on Oil and Gas Geology*. Ministry of Natural Resources of the Russian Federation, Russian Academy of Natural Sciences. Moscow OAO "VNIIOENG".

-Sazhdanaku, F., Gjoka, M., Kamberi, Th. and Gjini, A. 1999. Geological setting of sandstone reservoirs in Kreshpan – Patos – Marinëz - Kononjë and Kuçova – Arrës – Rasë - Pekisht regions based on existing geological-geophysical field data and re-evaluation of gas and oil reserves. Paper presented at the Workshop "National Program for Research and Development: Geology, Exploration and Processing of the minerals". Ministry of Public Economy and Privatization. December, Tirana.

## LIST OF CAPTIONS

Fig. 1. Schematic Tectonic Map of Albania and oil and gas reservoirs

Fig. 2. Geological-geophysical regional profile of the Albanides (Adriatic Shelf-Durres-Tirana-Peshkopi).

1- Miocene -Pliocene Molasses; 2- Paleogene-Lower Neogene Flysch and Flyschoidal Formation; 3- Mesozoic-Eocene Carbonate Formation; 4- Ultrabasic Rocks; 5- Salt; 6- Upper Crust; 7- Lower Crust; 8- MOHO Discontinuity; 9- Overthrust tectonics; 10- Crustal Fractures; 11- Density; 12- Temperature; 13- Deep Wells; 14- Bouguer Anomaly; 15- Magnetic Anomaly; 16- Heat Flow Density.

Fig. 3. Present-days temperature regime in the centre of the Albanian Sedimentary Basin.

Fig. 4. Heat Density Map of Albania.

Tab. 1

**Present – day geothermal regime of the Albanian Sedimentary Basin**

| Age | Temperature ($^oC$) | Geothermal Gradient ($^oC$/100m) | Heat Flow Density | | Note |
|---|---|---|---|---|---|
| | | | ($mW/m^2$) | HFU | |
| Pliocene ($N_2^{Krogozhina\ section}$) | 20.7-37.1 | 1.61 | 41.4 | 0.98 | After Ko-10 data |
| Pliocene ($N_2^{Helmesi\ section}$) | 37.1-64.9 | 2.13 | 41.3 | 0.98 | After Ko-10 data |
| Upper Miocene ($N_1^3$) | 64.9-122.8 | 1.67 | 41.2 | 0.98 | After Ko-10 and A-18 data |
| Middle Miocene ($N_1^2$) | 122.8-143.7 | 1.61 | 39.8 | 0.95 | After calculated data |
| Lower Miocene ($N_1^1$) | 143.7-175.1 | 1.43 | 36.4 | 0.87 | |
| Oligocene ($Pg_{3)}$ | 175.1-216.3 | 1.29 | 34.3 | 0.81 | |
| Paleocene-Eocene ($Pg_{1-2)}$ | 216.3-222.6 | 1.26 | 30.6 | 0.73 | |
| Cretaceous (Cr) | 222.6-235.1 | 1.14 | 23.7 | 0.56 | |
| Jurassic (J) | 235.1-247.8 | 0.98 | 24.6 | 0.59 | |
| Upper Triasic ($T_3$) | 247.8-256.8 | 0.90 | 25.2 | 0.60 | |
| Lower-Middle Triasic ($T_{1-2}$) | 256.8-262.3 | 1.00 | 33.3 | 0.79 | |
| Crystal Basement | 262.3 | | | | |

Table 2

**Thermal regime of the oil pools and gas reservoirs in Albania**

| Reservoir | | Thermal regime | | | Average depth (m) | Fluid |
|---|---|---|---|---|---|---|
| Lithology and age | Location | Temperature ($^oC$) | Gradient ($^oC$/100m) | Heat flow density ($mW/m^2$) | | |
| Limestone $Pg_{1-2}$-$T_3$ | Gorisht | 37.0-55.0 | 1.86 | 48.0 | 1 300 | Oil and gas |
| | Ballsh | 28.4-49.4 | 1.59 | 41.0 | 1 500 | |
| | Finiq | 31.3-40.2 | 1.39 | 35.9 | 1 750 | |
| | Amonica | 42.8-54.6 | 1.53 | 39.5 | 2 450 | |
| | Cakran | 49.9-71.2 | 1.54 | 39.7 | 3 100 | Condensate-Oil |
| | Delvina | 30.8-41.3 | 1.17 | 30.2 | 3 100 | |
| Sandstone Upper & Middle Miocene | Marinza | 33.4-37.8 | 1.72 | 36.0 | 1 100 | Oil and gas |
| | Kuçova | 19.6-34.6 | 1.67 | 32.0 | 750 | |
| | | | | | | |
| Sandstone Upper Miocene | Divjaka | 21.0-78.6 | 1.95 | 48.2 | 1 900 | Mixed biogenic gas |
| Sandstone Pliocene | Ballaj | 23.4-47.9 | 2.18 | 43.0 | 1 000 | Very dry, biogenic gas |

Table 3

**Burial and thermal history in the Albanides- implication for hydrocarbon generation**

| Litho-logy and age | Palaeothermal regime | | | | Buried rate m/Ma | Geochemical data | | | Hydrocarbon generation phase |
|---|---|---|---|---|---|---|---|---|---|
| | Tempe-rature, $^oC$ | Gradient $^oC$/100m | Heat Flow Density $mW/m^2$ | Tempe-rature rate $^oC$/Ma | | Kerogen type | Vitrinite reflectance Ro (%) | Geo-thermo metre ($^oC$) | |
| Molasse Pliocene | 28.83-48.57 | 1.85 | 41.8 | 3.96 | 350 | III | <0.5 | <50 | III[rd] Biogenic Gas |
| Molasses Middle-Upper Miocene | 48.57-70.70 | 1.8 | 45.6 | 2.59 | 300 | | | | |
| Carbonate $Pg_{1-2}$-$T_3$ And Flysch $Pg_3^1$ | 34.6-105.3 | 1.28-2.10 | 38.5 | 0.62 | 30 | I and II | 0.41-0.87 | 43-104 | I[st] Oil, condensate and gas, II[nd] Methane phase at temperatu-res higher than 200$^o$C during the Neogene sedimenta-tion. |
| **Main carbonate source rocks with kerogen Concentrated of I[st] type and dispersed of II[nd] type** | | | | | | | | | |
| $Cr_2$-$Cr_1$ | 54.5 | 1.82 | 37.9 | | | I | 0.41-0.446 | 43 | |
| $J_1$-$T_3$ | 92.5 | 1.80 | 34.4 | | | I | 0.65 | 76 | |
| $T_3$ | 97.8 | 1.50 | 28.6 | | | I | 0.7-0.87 | 85-104 | |

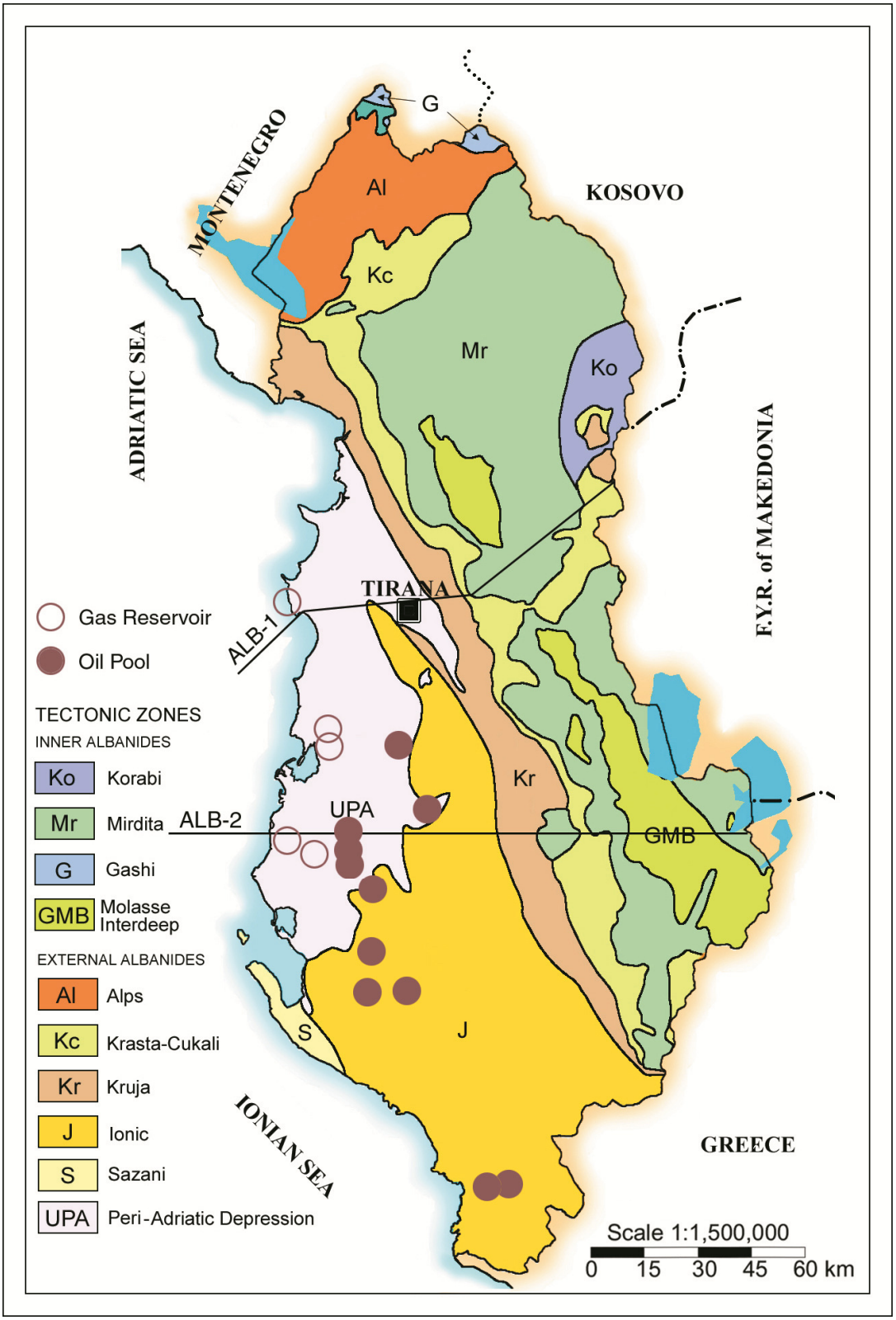


Fig. 1. Schematic Tectonic Map of Albania and oil and gas reservoirs

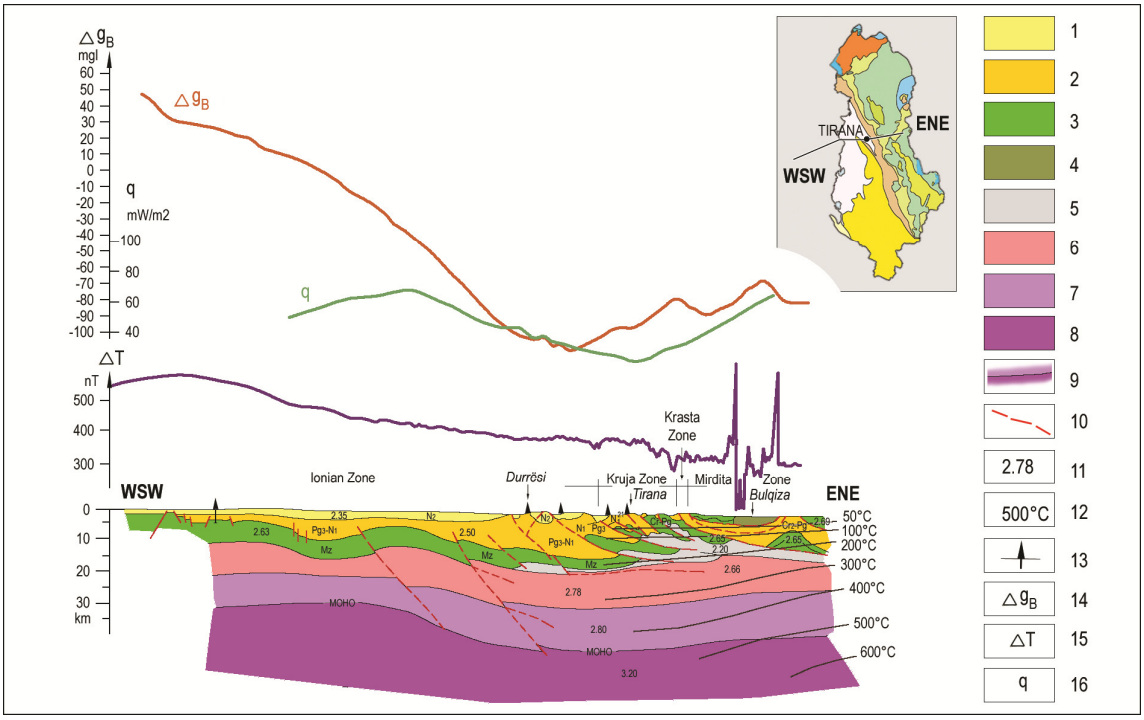


Fig. 2. Geological-geophysical regional profile of the Albanides (Adriatic Shelf-Durres-Tirana-Peshkopi).

1- Miocene -Pliocene Molasses; 2- Paleogene-Lower Neogene Flysch and Flyschoidal Formation; 3- Mesozoic-Eocene Carbonate Formation; 4- Ultrabasic Rocks; 5- Salt; 6- Upper Crust; 7- Lower Crust; 8- MOHO Discontinuity; 9- Overthrust tectonics; 10- Crustal Fractures; 11- Density; 12- Temperature; 13- Deep Wells; 14- Bouguer Anomaly; 15- Magnetic Anomaly; 16- Heat Flow Density.

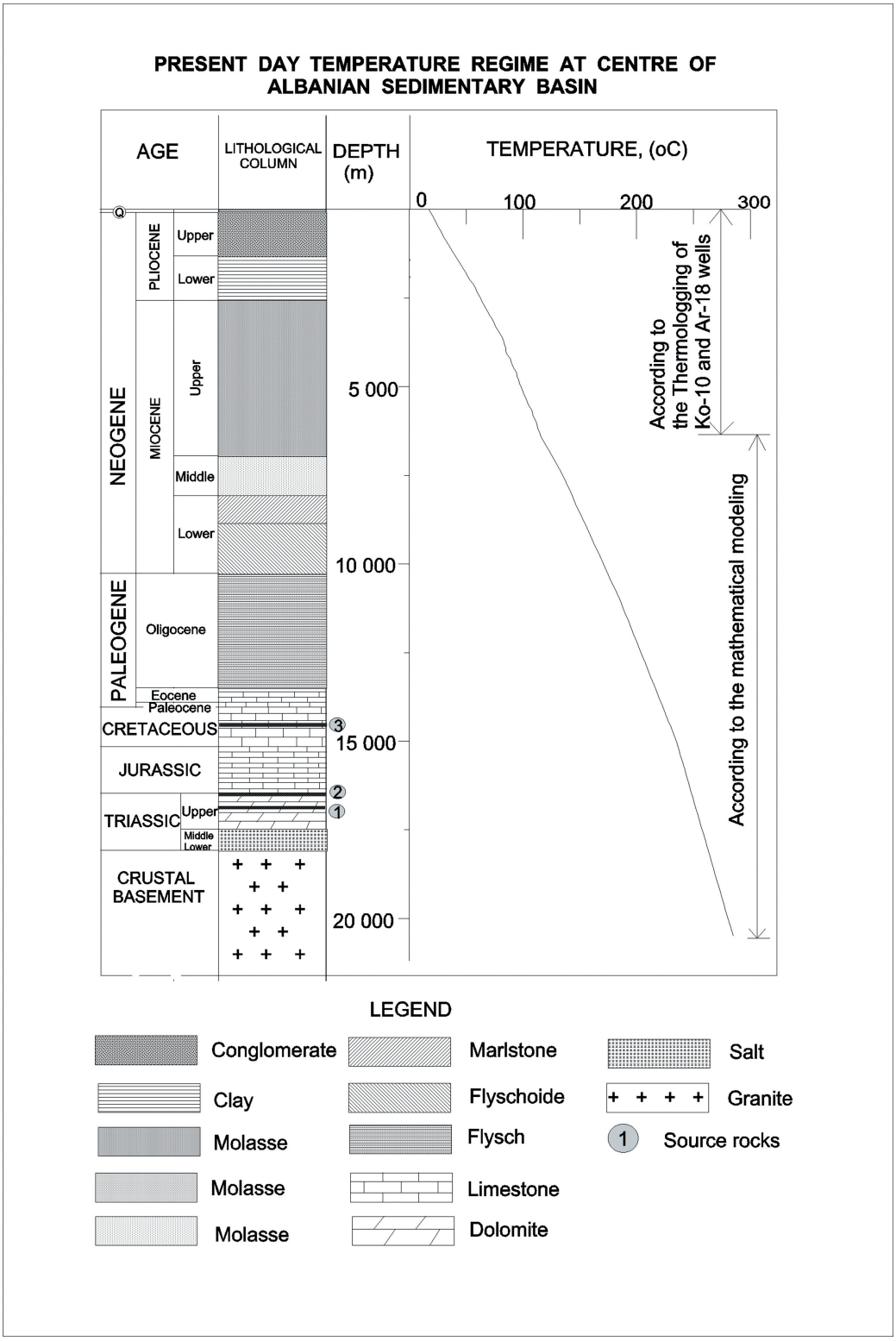


Fig. 3. Present-days temperature regime in the centre of the Albanian Sedimentary Basin.

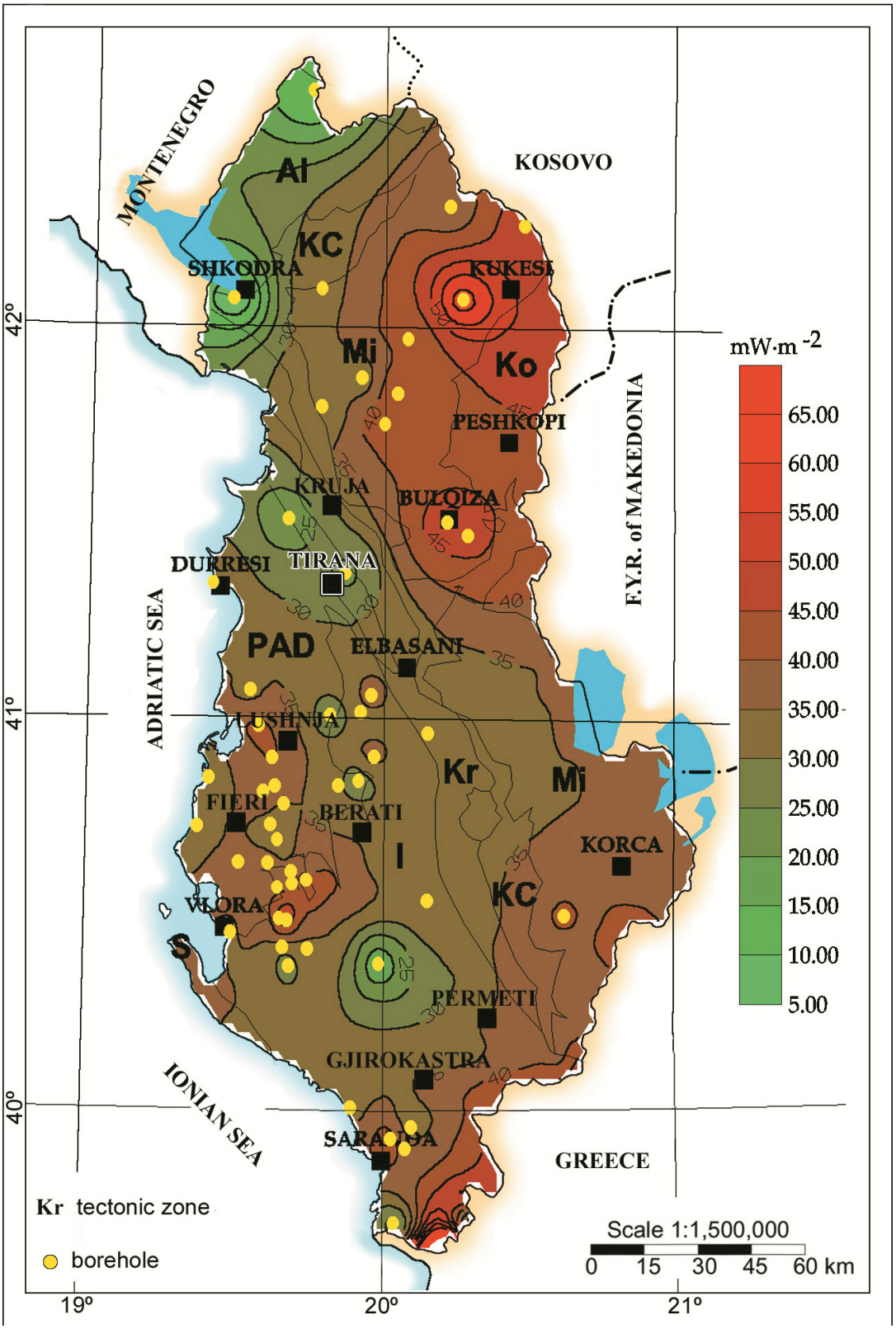


Fig. 4. Heat Density Map of Albania.