The Contribution of Oil Signs to the Petroleum Prospect in the Erindi Region, Albania

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Abstract

Many wells have been drilled in Albania to search oil traps in the carbonate reservoirs of the Ionian area. One of them is the Nokova-1 well, drilled in the overflow front of the Berati anticline belt. Geographically it is in Erindi region, southern Albania.

Nokova-1 well has passed flysch deposits of Oligocene (Pg3) and carbonate deposits of Eocene - Paleocene (Pg1-Pg2). To conclude in the results presented at this paper, various geological and geochemical studies have been studied.

During the drilling and testing processes, signs of oil and hydrocarbon gas have appeared, which contribute to the oil-bearing perspective of the region.

Limited quantities of crude oil were obtained during the testing process. Samples taken from this oil were determined density, from which API was calculated. Also hydrocarbon composition was performed. According to samples analysis, are determined parameters of density (0.923 gr/cm3), API (21.8) and hydrocarbon composition as follows: saturate (49.20 %), aromatics (27.9%), saturate + aromatics (77.10 %), NSO-comp (14.86%), asphalt (7.95%), saturate/aromatics (1.763441%) and NSO-comp + asphalt (22.81%).

The results of the hydrocarbon composition were correlated with those of the oil traps (carbonate reservoirs) in Albania.

From this correlation we have concluded that the crude oil taken from the Nokova-1 well is light oil, it is not biodegradable. Nokova-1 well oil correlates with oil of oil traps in Amonica, Cakrani, Mollaj, which have been interpreted as oil traps of younger geological age.

In conclusion, it can be said that the oil samples taken from the Nokova-1 well are results from the contribution of an oil trap that can be located at depth, or the result of new phases of hydrocarbon migration.

Keywords: Well, crude oil, API, component hydrocarbon saturation, hydrocarbon migration

Introduction

This study was compiled based on various geological and geochemical studies that had previously been carried out. Geochemical interpretations were performed for the first time. In terms of tectonics, there are three units such as the sub-zones of Berat, Memaliaj and Kurvelesh [1]

The geochemical parameters of the oil marks in the drilled wells in the region have been interpreted for the oil traps of the region.

In this paper are presented some achievement of oil and gas deposits exploration in the Erindi region. Geological and geochemical data provided will contribute to the further development of the region for the oil and gas exploration.

Methods, results, and discussion

a. Drilled wells

The Erind region has drawn attention as a potential region for oil and gas exploration. In this region and in the surrounding regions, are been drilled 5 wells of different depths.

There are two main purposes of the drilled wells:

- Searching for possible structures.
- Drilled wells with Structural task.

The main interest of Erindi-2 and Nokova-1 wells is in oil and gas production in the Erind region. In the flysch and carbonate section penetrated from the two wells, oil marks were meet. Those oil marks are thought to have migrated from the carbonate section through tectonic plans [2] [3].

According to the depth of drilling performed, we classify the wells as follows (from drilled well files):

•Wells that have realized the drilling depth up to H = 1500m, 2 wells.
•Wells that have realized the drilling depth H = 2000 - 3000m, 2 wells.
•Wells that have realized the drilling depth above H> 3000m, 1 well (Picar-1).

Table 1. Drilled wells in the Erind region (Drilled well files)

Wells	Geographical location			Geological section penetrated by wells
	X	Y	Z	
Erindi-2	4446243	4427251	241m	0 – 1179 m Lower Oligocene (Pg_3^1) 1179 – 1288 m Eocene (Pg_2)
Nokova-1	4448370	4429573	773m	0 – 2670m Lower Oligocene (Pg_3^1) 2670 – 2700m Eocene (Pg_2)
Libohova-1	4432301	4438835	770m	0 – 105ml Quaternare (Q) 105–400m Paleocene – Upper Cretaceous (Pg_1- Cr_2) 400–2649m Lower Oligocene (Pg_3^1) 2649–2712m Eocene (Pg_2)
Picari-10	4447041	4416985	390m	0 – 1700m Upper Triassic (T_3) 1700 – 2000m Upper Oligocene (Pg_3^2) 2000 – 2230m Upper Triassic (T_3) 2230 – 2260m Lower Oligocene (Pg_3^1) 2260 – 2330m Upper Triassic (T_3) 2330 – 2480m Lower Oligocene (Pg_3^1)
Andon Poçi-1				Perforated by foreign companies

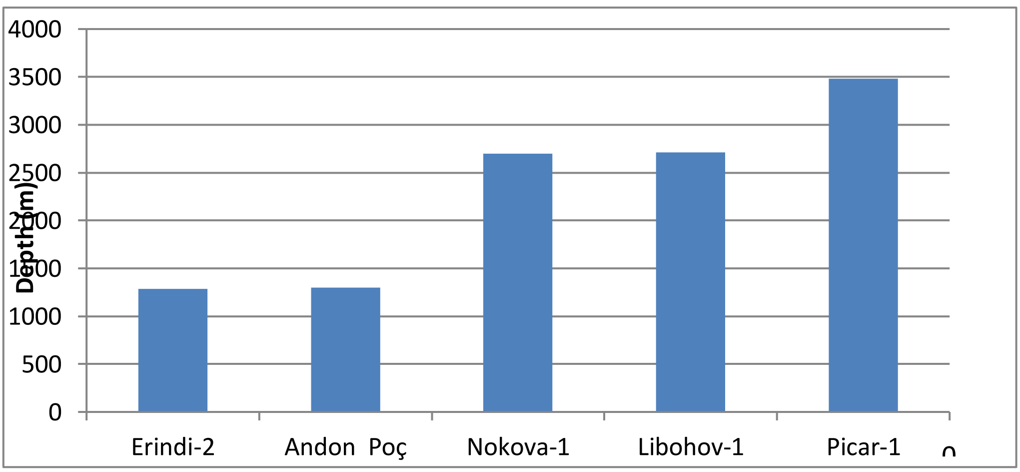

Figure 1. Depths of drilled wells in the Erind region

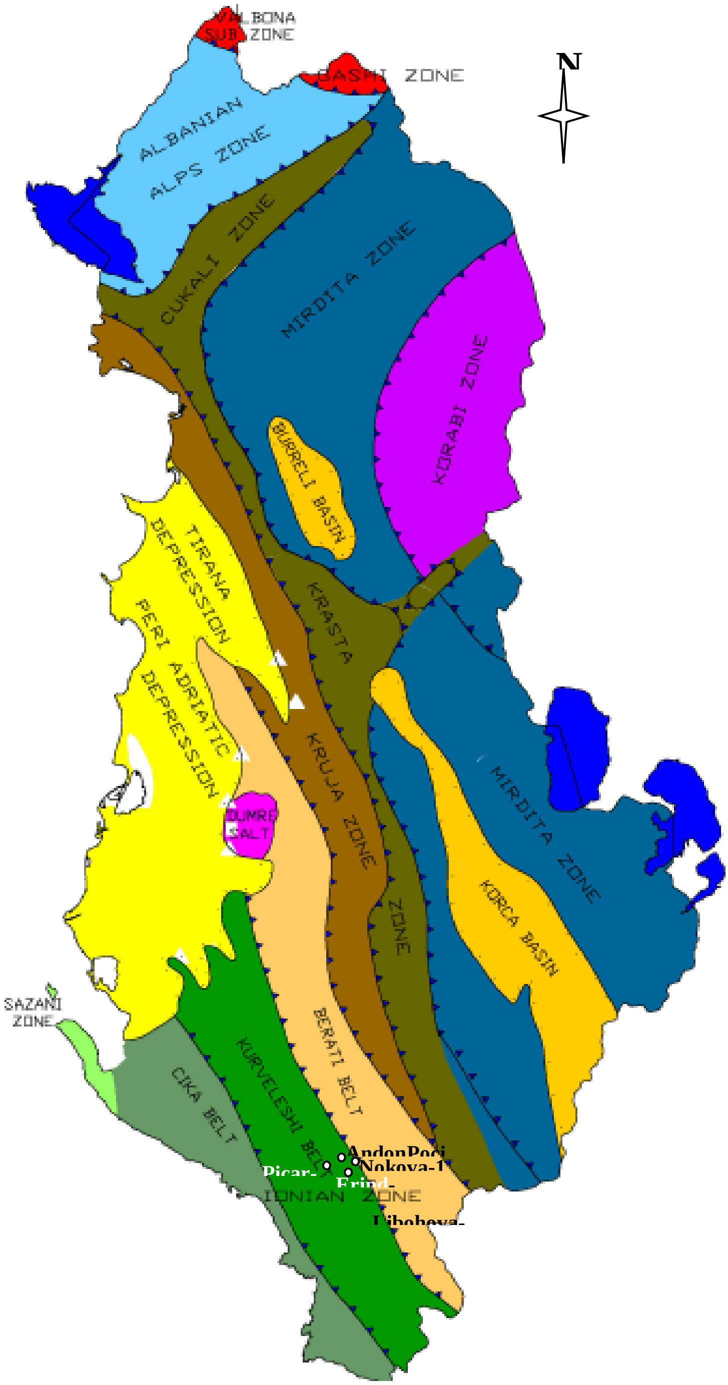

Figure 2. Position of drilled wells in the tectonic scheme of Albania

b. .Geochemical analyses

Based on the complex of geological and geophysical data, their interpretation and the conclusions reached for the tectonic and structural settings, several perspective structures have been predicted. The oil and gas prospect are also supported by the analysis of hydrocarbon signs encountered in the region.

In the Erindi region, oil marks are found in wells drilled. They also appear in the outcrops carbonate and flysch section of the structures part of the Berati anticline subzone, in the flysch section of the Lower Oligocene. Oil marks on the Lower Oligocene flysch section (Pg_3^1), are encountered on the Erind-Gjatë road [4].

In the Nokova-2 well, small amounts of oil were taken during the testing process, which was subject to the determination of density and hydrocarbon composition.

Table 2. Oil hydrocarbon composition in Nokova-1 well

Depth (metra)	**Density gr/cm³**	**API**	**Hydrocarbon composition (%)**						
			Saturate	**Aromatics**	**Satur+Arom**	**NSO-comp**	**Asphalt**	**Satur/Arom**	**NSO-comp +Asph**
2700	0,923	21,8	49,20	27,9	77,10	14,86	7,95	1,763441	22,81

Density is among the main parameters of crude oil, it is a massive parameter and easily measurable. For the interpretation effects of this parameter, is evaluated the API which is related to the density according to the following equation:
API = 141.5 / 0.923 - 131.5 = 21.8.

The API will correlate with the depth of occurrence of crude oil. In general, there is a tendency that the API of oil increases with depth. Samples analyzed from other wells and which deviate from this tendency, are showing only signs of oil.

API values are also influenced by the position of the studied sample in the oil trap. Thus, at the peak of the trap, the oils have a high API, meanwhile towards the depth (ie towards the oil-water contact) the value of the API decreases [5].

From the correlation between API and oil depth at wells, three oil groups are observed:
1. Oil in the upper part of the oil traps (Cakran, Ballsh, and Gorisht)

2. Oil near the oil-water contact (Cakran-Mollaj, Ballsh, and Amonic). This group also includes the oil taken from the Nokova-1 well (Figure 3).

3. Oils obtained in carbonate section that do not represent oil traps (Vlora-10, Kreshpan).

The type of Nokova oil is determined by the component of hydrocarbon composition. Comparing it with the oils in the carbonate section wells and oilfields, the oil type is determined. Oils in limestone deposits are divided into four types:

The condensate types include Delvina and Cakran-Mollaj condensate traps. Asphalt content is low and the amount of asphalt + resin is less than 10%.

Very lighter oils types are characteristic for the Cakran-Mollaj field. Oils of the upper part of the Gernec field and oils near water-oil contact of Delvina condensate trap. Asphalt content + resin is lower than 20% (Figure 4).

Lighter oils types are the most common type of oil in limestone oil wells.
Asphalt content varies from 18% to 38%.

Lighter oils are characteristic for the Amonice, Gernec, Cakran-Mollaj oil traps and Nokova-1 (Figure 4).

Asphalt-resin oils types are represented by oils where the asphalt-resin content is greater than 35%. Characteristic for this type are the oils of the Gorisht, Ballshi oil traps, and Vlora-11 well. Oils of this type are mainly biodegraded oils.

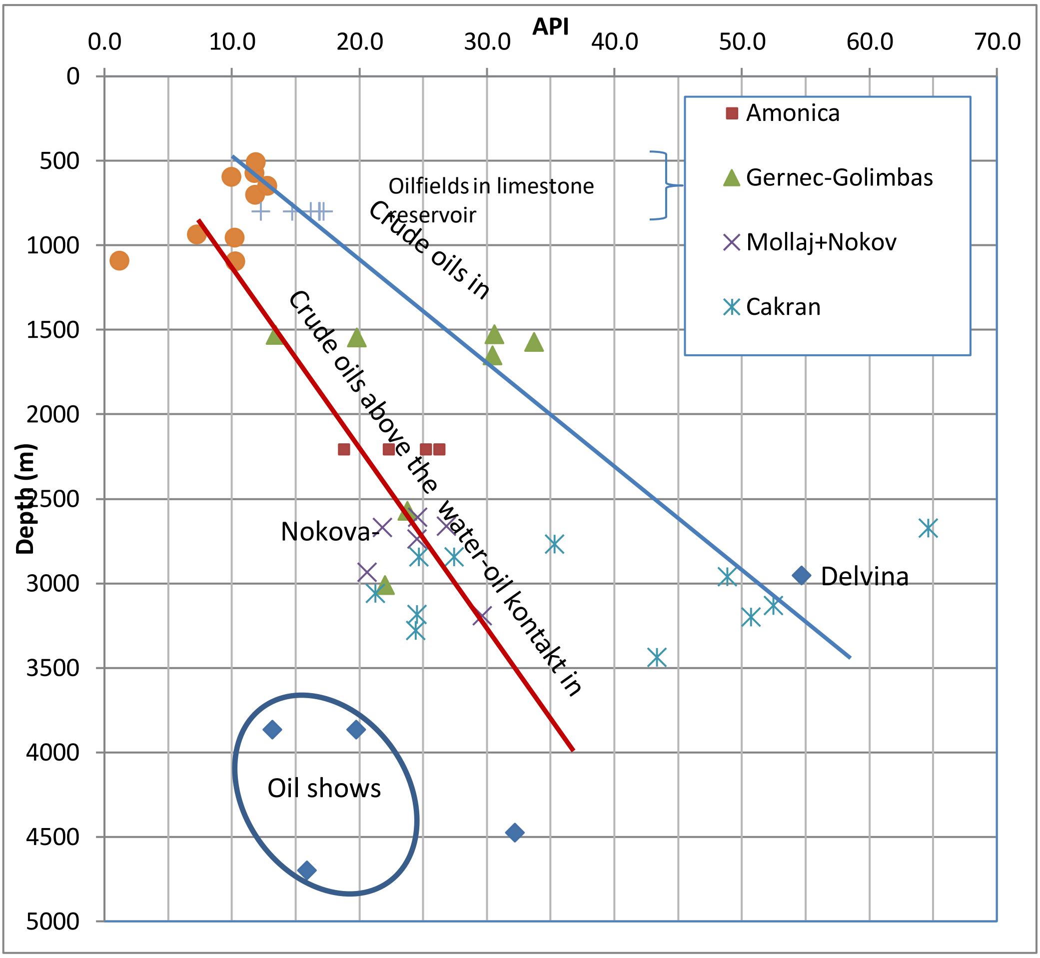

Figure 3. Positioning of the API of Nokova-1 well oil with those of other oils

The main constituents of crude oil are saturate and aromatic hydrocarbons.
Their reports are conditioned by the following factors:

a) From the properties of the organic matter of the source rocks, the organic matter of continental origin influences the increase of the aromatic hydrocarbon content.
b) From the level of maturity of source rocks, the high level of maturity reduces the content of aromatic hydrocarbons.
c) The degree of biodegradation affects the reduction of saturate hydrocarbons by increasing the aromatic hydrocarbon content. Even in an oil bed there is a tendency that by approaching the oil-water contact, the content of aromatic hydrocarbons increases.
d) The oil obtained from the Nokova-1 well has a low content of aromatic hydrocarbons (27.9%).

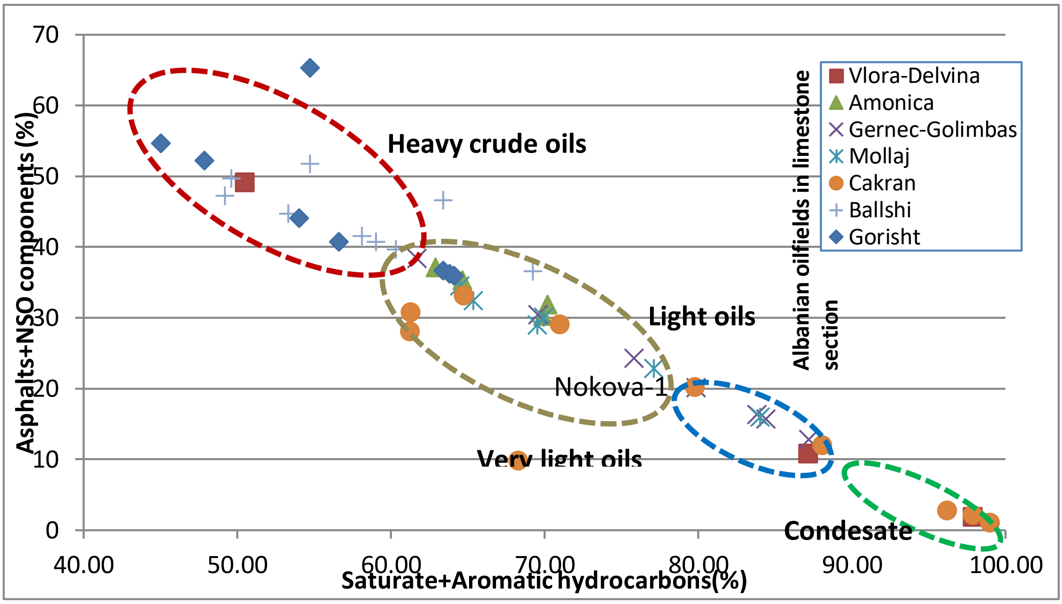

Figure 4. Classification of oils according to the component composition of oils

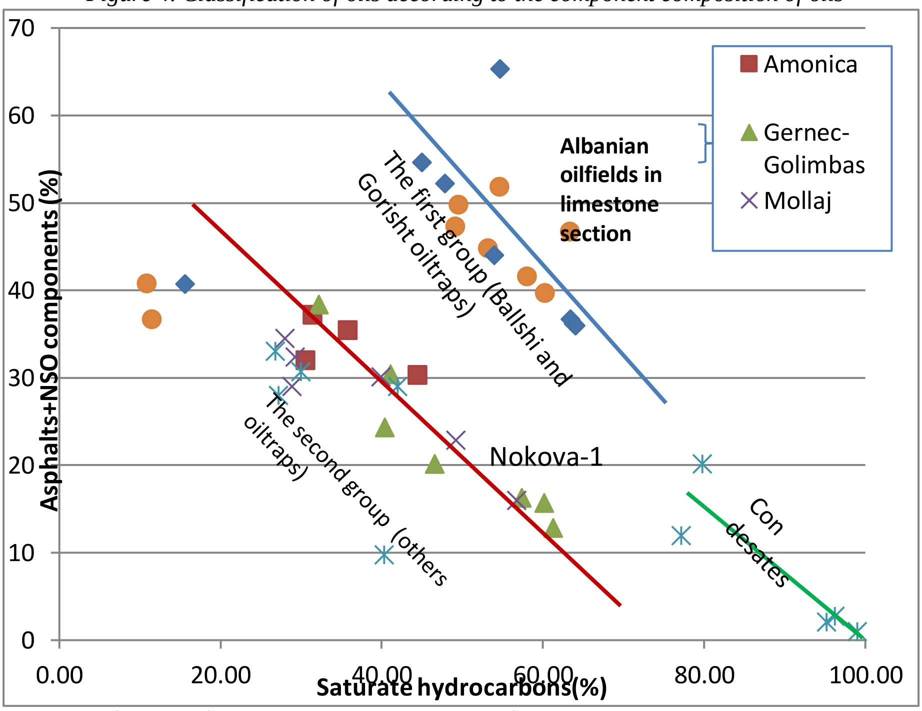

Figure 5. Classification of oils according to the content of saturate hydrocarbons and resins + Asphaltene

Based on what was discussed above, the correlation of saturate hydrocarbons with the amount of Asphaltene + Resin, shown in Figure 5, has been realized.

Three groups of oils are distinguished from the correlation:

In the first group saturate hydrocarbons fluctuate in the range 45-64%, while Resin + Asphaltene 40-65%. This group includes the crude oils of the Ballsh and Gorisht oilfields.
In the second group saturate hydrocarbons fluctuate in the range 27-62%, while Resin + Asphaltene 13-38%. This group includes oils from the Amonic, Cakran, Mollaj oilfield and Nokova-1 wells.
In the third group are included condensates from the Cakran field, where saturate hydrocarbons are more than 77%, while Asphaltene + Resin are lower than 20%.

The discussions that are taking place are mainly regarding to determination of the normal character of the crude oil received in the Nokova-1 well. For this, a triangular diagram of the hydrocarbon composition of crude oils in the Albanides has been constructed.

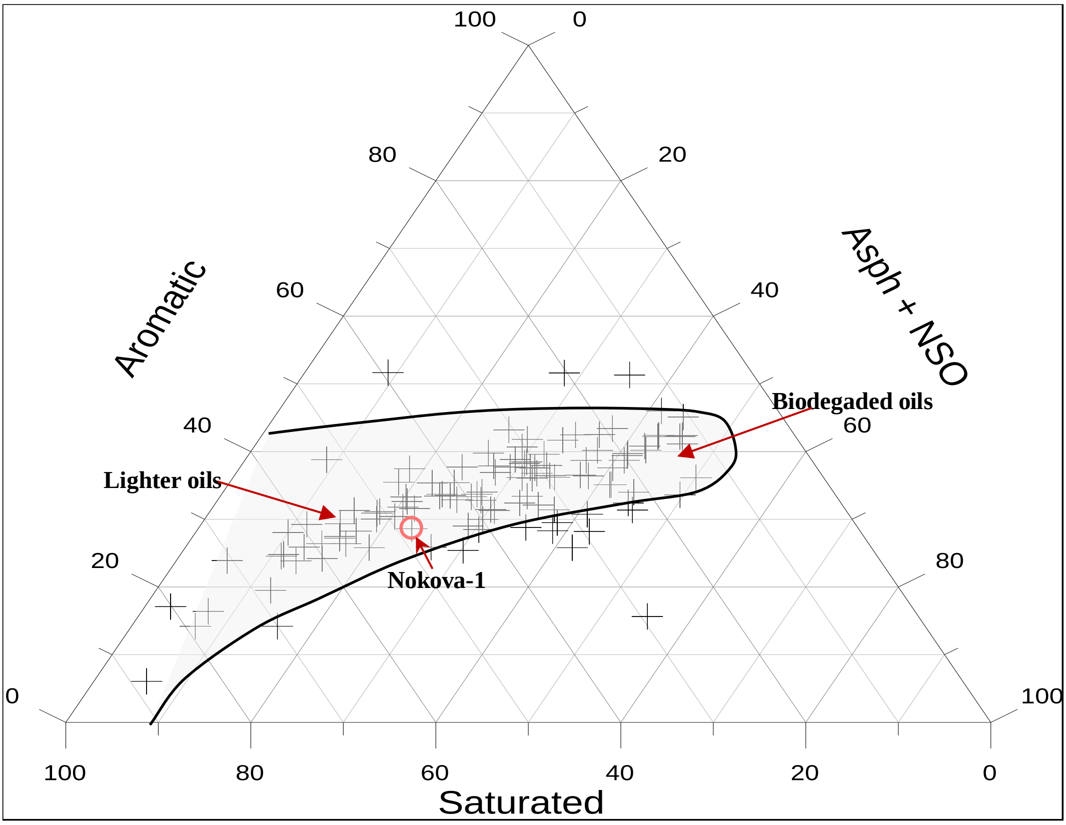

Figure 6. Triangular diagram of the hydrocarbon composition of crude oils in the Albanides

From the triangular diagrams of the hydrocarbon composition (Figure 6) it is clear that the area where crude oil is located from the Nokova-1 well is represented by lighter type one. Aromatic hydrocarbons are added as the rate of biodegradation increases, so the Saturate / Aromatic hydrocarbons ratio is carefully interpreted. Nokova-1 well oil has a ratio of 1.76. This value is of interest for petroleum exploration (Figure 7).

Based on this indicator, the crude oil from the Nokova-1 well correlates with the oils of the Mollaj-Cakran and Gernec fields. They are mainly matured oils.

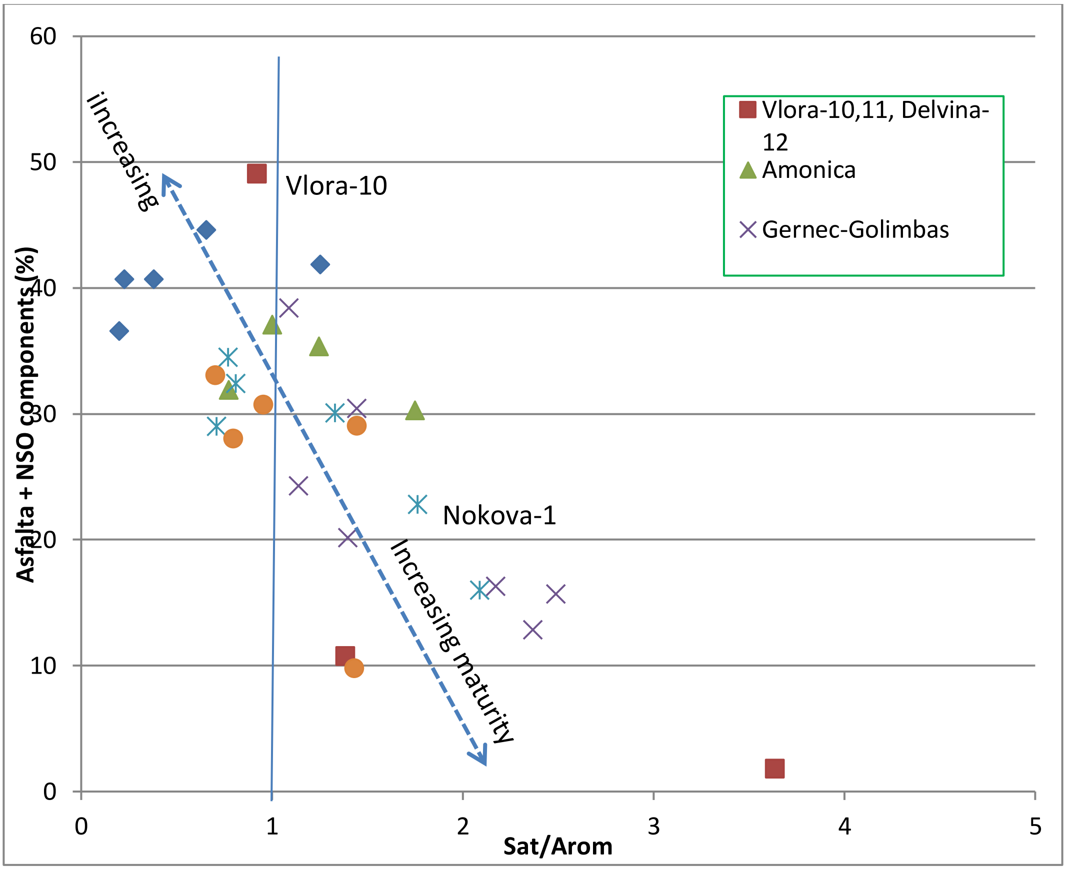

Figure 7. Dependence of the Saturate / Aromatics hydrokarbons ratio with the content of Resin + Asphaltene

c. Source rocks.

The source rocks that have generated the hydrocarbons found in the Erindi region are equivalents of those that are encountered in the carbonate section of the Ionian zone.

Source rocks have been studied by all geochemical methods. The average results of geochemical indicators where the quantity, quality and maturity of the organic matter are evaluated, are presented at Table 7.

The contribution of source rocks to hydrocarbon generation is greatest in the most submerged carbonate section sectors.

Table 7. Geochemical indicators of sourcerocks in carbonate section in the outer Albanides [6][7]

No	Zone	Age	Lithology	Sample Location	TOC (%)	HI Mg Hc/gr	T_{max}	Kerogen Type	VR/E (%)
1	Sazani	Upper Trias.	Dolomite/shale	Well	0.16-1.72	162	424	II/III	0.87
1	Ionian	Upper Trias.	Shale/Clay/limes	Outcrop	0.02-38.5	617	416	I	0.54-0.88
3		Low. Jurassic	Dolomite shale	Outcrop	0.1-52	450	434	I/II	0.55-0.75
4		Toarcian	Posidonia shale	Outcrop	0.09-3.7	588	432	I/II	0.5-0.6
5		Midd. Jurassic	Clay	Well	2	505	424	II	0.527
6			Shale	Outcrop	0.04-9.4	508	432	I	0.52
7		Upp. Jurassic	Shale	Outcrop	0.03-5.9	520	430	I	0.45-0.57
8		Low. Cretace.	Shale	Outc./Well	0.02-27	521-700	413	I/II	0.45-0.54
1	Kruja	Upper Cretac.	Dolomite/shale	Outcrop	0.18-4.2	540	427	I/II	0.3-0.4

From the studies performed it has been determined that, starting from the lower Cretaceous (Cr_1) older source rocks have entered the oil window. At this level, the migration of hydrocarbons has begun [7]

d. Hydrocarbons migration.

Primary migration (from source rocks to reservoir rocks) has been extensively addressed in many studies. The phenomenon of primary migration of hydrocarbons is carried out by meeting the following conditions [8]:

- Quality of source rocks, the maturity of the source rocks, creating reservoir conditions, reduction of geostatic pressure of source rocks.
- The quality of the source rocks and the stratified nature favour the primary migration even in the oil phase state. Source rocks are also in the main stage of hydrocarbon generation and are ready to migrate.
- The upper part of the carbonate section are the reservoir rocks. Traditionally, in studies conducted, it has been concluded that the reservoir rock features were created after the Seravalian age.

Secondary hydrocarbon migration has been extensively addressed in the literature. Here we will address some aspects related to the region.
Secondary migration occurs directly after primary migration, as reservoir rocks are formed. Hydrocarbon migration conditions are related to the following factors [8]:

- - Different stages of hydrocarbon generation.
- - Migration routes, directions and distance of migration.
- - Migration in phase-oils.
- - Trap formation time.

Hydrocarbon generation has occurred at various stages related to the immersion of source rocks.
The Erind region has been affected by this phenomenon and has been accompanied by a massive migration of hydrocarbons within the carbonate intersection and into the flysch section of the Lower Oligocene through tectonic fault plans.

Tertiary hydrocarbon migration is related to the migration of hydrocarbons from the oiltraps. Oil marks on Lower Oligocene sandstones and those on carbonate section are erosions of reservoir rocks. The possibility that the oil received in the Nokova-1 well is a contribution of an oil trap near the Nokova-1 well is not excluded, so they are the result of the third phase of migration. The oil has migrated from the oil traps through tectonic faults and is exposed in the Nokova-1 well.

Carbonate section, mainly Cr_1-Pg_2, serves as reservoir rocks, as is verified in oil traps of carbonate section on Ionian zone. Transitional packs and the lower part of the flysch section of the Lower Oligocene is serving as seal rocks [9].

Conclusions

The Erind region has drawn attention to the search for oil deposits, where 5 wells have been drilled.
Oil marks have been encountered in the geological sections passed by the wells.
The oil in the Nokova-1 well is of the light type and correlates with the oils of the Cakran-Mollaj, Amonica fields.
Erind-2 well oil is generated from mature source rocks near the deadline of the oil window.
Prospects areas for hydrocarbon exploration are the Labova - Zhaba anticline and the hydrodynamic traps located on North of the Nokova-1 well.

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