



EAGE EUROPEAN ASSOCIATION OF GEOSCIENTISTS & ENGINEERS



7-10 October 2013, Tirana, Albania

7th Congress of the Balkan Geophysical Society

POST-CONGRESS FIELDTRIP

11-12-th OCTOBER 2013

**GEOLOGICAL SETTING AND HYDROCARBON
POTENTIAL OF EXTERNAL ALBANIDES**

**TIRANA, ALBANIA,
April - May, 2013**

**G
U
I
D
E
B
O
O
K**

AUTHOR:

Engjell PRENJASI

(Faculty of Geology and Mining, Polytechnic University of Tirana)

FIGURES DIGITALIZATION:

Ana QORRI

(Faculty of Geology and Mining, Polytechnic University of Tirana)

Erald SILO

(Faculty of Geology and Mining, Polytechnic University of Tirana)

Layout:

Enkelejda Misha

CONTENTS

I. ALBANIA	
- Geographical position of Albania	4
- Climate and relief	4
- Population	5
- The Capital	5
- Getting to Albania	7
II. A REVIEW OF GEOPHYSICAL EXPLORATION AND GEOPHYSICAL INVESTIGATION IN ALBANIA	9
III. GEOLOGICAL FEATURES OF ALBANIA	11
1. Tectonic setting of the External Albanides	11
2. Hydrocarbon potential of Albania	13
IV. FIELD TRIP OBSERVATION ITINERARIES	15
1. Itinerary Tirane-Durres	16
2. Itinerary Durres Lushnje - Ardenice	17
3. Itinerary Ardenice - Kremenare	18
4. Itinerary Kremenare - Gjirokaster	20
5. Itinerary Gjirokaster - Sarande	21
6. Itinerary Sarande - Vlore	24
7. Itinerary Vlore - Tirane	28
FIGURES	
Fig. 1. Geographical position of Albania	4
Fig. 2. Field trips Map (Albania)	8
Fig. 3. Tectonic sketch of the Albanides fold-and-thrust belts	39
Fig. 4. Location of the Albanides fold-and- thrust belts	30
Fig. 5. Geoseismic profile 1-1, across the Albanides fold-and-thrust belts	30
Fig. 6. Geoseismic profile 2-2, across the Divjaka dry gas field	31
Fig. 7. Geoseismic profile 6-6, across the Povelça dry gas field	31
Fig. 8. Geoseismic profile 4-4 across the Patos-Marineza oil field	32
Fig. 9. Geological profile 7-7 across the Visoka massive hydrodynamic oil pool	32
Fig. 10. Geoseismic profile 8-8 across the Ballshi oil field	32
Fig. 11. Geological profile 9-9 across the Karbunara oil field	33
Fig. 12. Geoseismic profile 3-3 across the Dumre diapire	33
Fig. 13. Cross seismic time section 251 / 81	34
Fig.14. Geoseismic profile 13-13, across the Delvina gas condensate field	35
Fig. 15. Geologic profile 15-15 across the Dhrovjani carbonate oil prospect	35
Fig. 16. Geoseismic profile 14-14 across the Finiqi-Krane oil field	36
Fig. 17. Geological profile 12-12 across the Borshi carbonates prospects	36
Fig. 18. Geologic profile 15-15 across the Apulia-Sazani Foreland and western part of Albanides	37
Fig. 19. Geoseismic profile 10-10 across the Vlora gas condensate prospect	37
Fig. 20. Geoseismic profile 5-5, across the Apulia-Sazani Foreland and Povelça carbonate prospect	38
Fig. 21. Geoseismic profile 19 / 90 across the Povelça carbonate gas condensate prospect	38
PHOTOS	
Photo 1. Bituminous sandstone suite of Driza at the Kasnica Quarry	39
Photo 2. Macrofauna fossils in the Driza suite deposits at the Kasnica Quarry	39
Photo 3. Transgression of the Serravalian deposits on the Eocene limestone	40
Photo 4. Upper Cretaceous bioclastic limestone reservoir rocks	40
Photo 5. Upper Cretaceous-Paleocene-Eocene bioclastic limestone reservoir rocks with slam horizons	41
Photo 6. Outcrop of Liassic to Upper Cretaceous deposits in the Western slope of the Mali Gjere	41
Photo 7. Blue eye springs	42
V. REFERENCES	43

ALBANIA

GEOGRAPHICAL POSITION

In the heart of the Mediterranean, on the Adriatic and Ionian Seas, both a South-Eastern European and a Western Balkan country, Albania locates between the geographical coordinates 39° 16' latitude and 42° 39' longitudes. Its surface area is 28.748 km². It is bordered by Greece to the south-east, Montenegro to the north, Kosovo to the northeast, and the Republic of Macedonia to the east. It has a coast on the Adriatic Sea to the west and on the Ionian Sea to the southwest. It is less than 72 km (45 miles) from Italy, across the Strait of Otranto which links the Adriatic Sea to the Ionian Sea. The average altitude is 708 m above the sea level.



Fig. 1. Geographical position of Albania

CLIMATE

Like other Mediterranean countries, Albania has characteristically warm, dry summers and mild, wet winters. Local climatic variation can occur, however, from one region to another. The western part of the country, which is under the influence of warm maritime air from the Adriatic and Ionian seas, has more-moderate temperatures than the rest of Albania. The eastern part of the country, on the other hand, is mainly under the influence of continental air and is characterized by mild summers (owing to the high elevations) and cold winters.

Rainfall in Albania is abundant, but it occurs unevenly across the country and throughout the year. Average annual precipitation varies from more than 100 inches (2,500 mm) in the North Albanian Alps to less than 30 inches (760 mm) along much of the eastern border. The southwestern part of the country suffers from summer droughts.

RELIEF

Albania has a mountainous geography. About three-fourths of its territory consists of mountains and hills with elevations of more than 650 feet (200 metres) above sea level; the remainder consists of coastal and alluvial lowlands. The North Albanian Alps, an extension of the Dinaric Alps, cover the northern part of the country. With elevations approaching 8,900 feet (2,700 metres), this is the most rugged part of the country. It is heavily forested and sparsely populated.

In contrast to the Alps, the central mountain region, which extends north-south from the Drin River to the central Devolli and lower Osumi rivers, is more densely populated and has a generally less rugged terrain. In the region's easternmost portion, the imposing gypsum block of Albania's highest peak, Mount Korabi, rises to 9,030 feet (2,752 metres).

South of the central mountain region is a series of northwest-southeast-trending mountain ranges with elevations up to 8,200 feet (2,500 metres). Composed of limestone rock, the ranges are separated by wide valleys. Unlike the Alps and the central region, which are covered with dense forests, the mountains of the southern region are either bare or have a thin covering of Mediterranean shrubs, oaks, and pines. They serve essentially as pasture for livestock.

Stretching along the Adriatic coast over a distance of nearly 125 miles (200 km) and penetrating some 30 miles (50 km) into the interior are the low, fertile plains of western Albania. This is the most important agricultural and industrial region of the country and the most densely populated.

POPULATION

Albania has one of the most homogeneous populations in Europe. Based on the preliminary 2011 Census results, the total population of Albania is 2,831,741. The two main subgroups of Albanians are the Gegs (Ghegs) in the north and the Tosks in the south. The total population is composed of 1,421,810 males (50.2%) and 1,409,931 females (49.8%). 53.7% of the population lives in urban areas and 46.3% in rural areas.

THE CAPITAL

Tirana, the capital of Albania, is an ancient city with an early history enriched by the interplay of cultural forces originating in the Islamic and European Christian worlds.

There are a number of hypotheses concerning the origin of the name. One is that it is from the word 'Theranda' that Greek and Latin sources employ to refer to the area, after the term 'te ranat' used by the inhabitants, meaning 'fallen material', in reference to the composition of the terrain out of hard earth swept down by water from the nearby mountains.

It is from 'Tirkan', the name used by the sixth century Byzantine historian Prokop to refer to a castle, first built in the first century BC, on Mount Dajti, and the ruins of which are extant.

It is from 'tyros', the old Greek word for 'dairy', on the hypothesis that it was in the field there that the shepherds of surrounding areas gathered to trade dairy products.

An often-repeated explanation is that 'Tirana' was so named by Sulejman Pasha, the Turkish military leader at the time of Turkey's conquest of Persia in the 17th century, after Tehran, the capital of Persia (now Iran). Such a theory would, however, seem to be contradicted by the evidence of Tirana's name in its current form appearing in a 1418 Venetian document.

A further 'spin' on the Sulejman Pasha idea is that when he was at the location of what became the city of which he is considered to have been the founder, he came across an elderly woman who, when he asked her what she was doing, replied, 'Po tir an': 'spinning silk'.

Records of the first land registrations under the Ottomans in 1431-32 reveal that Tirana then consisted of 60 inhabited areas, with nearly 1000 houses and 7300 inhabitants.

Marin Barleti, the first to write a history of Albania (and himself of Albanian descent), tells us that in the 15th century there were 'Tirana e Madhe' and 'Tirana e Vogël' (Great and Small Tirana). Barleti, a Catholic priest and scholar, was largely responsible, through his biography of him, for creating what became the cult of Iskander Bey, the title (in Turkish) (rendered in Albanian as 'Skenderbeu', and frequently anglicized as 'Skanderbeg') given to Gjergj Kastrioti, an Albanian nobleman who, after being forcibly brought to Adrianople as a youth and given military training, distinguished himself in a number of campaigns for the Ottomans, and was promoted to the rank of general, but then returned to Albania to liberate it, and spent the next 25 years, until his death, leading a successful guerilla resistance against the forces of the Turkish empire. Skenderbeu continues to be the national hero of Albania.

The 1583 registration records inform us that at that time Tirana had 110 inhabited areas, 2900 houses and 20,000 inhabitants. When Sulejman Pasha established the city in 1614, his first constructions were a mosque, a bakery and a hamam (Turkish sauna). Two centuries later, control of the city was won by the Toptani family of Kruja. It was noted that the two oldest neighbourhoods were Mujos and Pazari, between the geographical centre and Elbasani Street, on either side of the Lana River.

The construction, by the best artisans in the country, of the mosque in the centre of Tirana, called the Mosque of Ethem Beu, was begun in 1789 by Molla Beu of Petrela (a locale in Albania). It was finished in 1821 by his son, who was also Sulejman Pasha's grand-nephew. The Clock Tower was started by Haxhi Et'hem Beu around 1821-22, and was finished with the help of the richest families of Tirana. Its installation was the work of the Tufina family. In 1928 the Albanian state bought a modern clock in Germany, and the tower was raised to a height of 35 metres. The clock was damaged during World War II, but was restored to full function in July 1946.

The Orthodox Church of Saint Prokop was built in 1780.

The Catholic Church of Saint Maria was constructed in 1865 at the expense of the Austrian-Hungarian Emperor, Franc Josef. The Tabakëve and Terzive bridges (respectively in front of the Parliament building and on Elbasani Street) date from the beginning of the 20th century. The mosque that is also the tomb of Kapllan Hysa (near the monument to Ushtari I Panjohur ('the unknown soldier')) was built in 1816.

The Library was established in 1922, with 5000 volumes.

The Fortress of Petrela, 12 kilometres from Tirana, dates from the fourth century BC. It took its current form in the 13th century, under the rule of Topiaj, and later became the property of the Kastriotis.

On 8 February, 1920 Tirana was made the temporary capital by the Congress of Lushnja, and acquired that status permanently on 31 December, 1925.

Since 1925, when they were banned in Turkey, Tirana has been the primary centre in the world of the Bektashis, an order of dervishes who take their name from Haji Bektash, a Sufi saint of the 13th and 14th

centuries. (It was the same Haji Bektash who blessed the Janissaries, the famed Ottoman fighting corps that originally comprised non-Muslim conscripts, many of them Albanians.)

The first regulatory plan of the city was compiled in 1923 by Estef Frashëri. Durrësi Street was opened in 1922, and was called Nana Mbretneshë (Mother Queen). Many houses and surrounding properties were demolished to make way for it. The existing parliamentary building was raised in 1924, and first served as a club for officers. It was there, in September 1928, that Ahmet Zogu proclaimed the monarchy.

The centre of Tirana was the project of Florestano de Fausto and Armando Brasini, well known architects of the Mussolini period in Italy. The Palace of Brigades (of the former monarch), the ministries buildings, the National Bank and the Municipality are their work.

The Dëshmoret e Kombit (National Martyrs) Boulevard was built in 1930 and given the name Zogu I Boulevard. In the communist period, the part from Skënderbej Square up to the train station was named Stalin Boulevard.

The Palace of Culture (Pallati I Kulturës), where the Theatre of Operas and Ballet and the National Library stand, was completed in 1963 on the site of the former Trade of Tirana building, with the first brick being placed by Soviet president Nikita Hrushov in 1959. The monument to Skënderbeu, raised in 1968, is the work of Odhise Paskali in collaboration with Andrea Mana and Janaq Paço. It commemorated the 500th anniversary of the death of the national hero.

The Academy of Sciences building was completed in April 1972.

The Gallery of Figurative Arts was created in 1976, and includes around 3200 works by Albanian and foreign artists.

The National Historical Museum was built in 1981.

The International Cultural Centre, formerly the Enver Hoxha Museum, popularly referred to as 'the Pyramid', was inaugurated in 1988.

In 2000 the centre of Tirana, from the central campus of Tirana University up to Skënderbej Square, was declared the place of Cultural Assembly, with special claims to state protection. In the same year the area began a process of restoration under the name 'Return to Identity'.

GETTING TO ALBANIA

Entry by air

All international air arrivals enter through Mother Theresa International Airport, located 17 km northwest of Tirana. Linkage with the city is provided through a shuttle bus service, the Tirana Rinas Express, running between Skanderbeg Square and Mother Theresa Airport. Shuttle buses depart every hour at the top of the hour, with an approximate cost of 2 Euros. Taxi service available at all times, taxi fares mounting to approximately 20 Euros.

Entry by roadways

From Montenegro

- Through Hani i Hotit and Murriqan-Sukobina. The first road links the Northern City of Shkodra and Lake Shkodra with Podgorica, while the second links Shkodra with Ulcinj Montenegro.

- Recently opened is Vermoshi, which links the region of Kelmendi in Albania with Plava and Gucia (Gusinje) in Montenegro.

From Macedonia

- Qafe Thana pass links Pogradec, Librazhd and Elbasan to Struga.
- From Tushemisht, at the South-eastern end of Lake Ohrid, leading from Pogradec to Saint Naum and Oher.
- From Billata, leading from Peshkopi to great Dibra.
- From Gorica the road leads from the northern shores of Lake Prespa to Otoshev and other parts of Macedonia.

From Kosovo

- Through Morina pass, which links Kukës, Albania, with Pristina, Kosovo
- Morina which links Tropoja with Gjakova
- Qafë Prushi, which links Kruma with Gjakova.

From Greece

- Through Kapshtica leading from Korça to Thessalonica.
- From Kakavija leading from Gjirokastra to Janina.
- At Qafe Boti Konispol is connected to Filat
- Tre Urat, connecting Permet with Konica.

Entry by Sea

- Albania can be accessed by sea through its main ports:
- Durrës*: the Italian ports of Ancona, Bari, Brindisi and Trieste
 - Vlora*: the Italian port of Brindisi
 - Shëngjin*: the Italian port of Bari
 - Saranda*: the Greek Island of Corfu



Fig. 2. Field trip Map (Albania)

II. A REVIEW OF GEOPHYSICAL EXPLORATION AND INVESTIGATION IN ALBANIA

Albania has a long history in the realm of natural resources exploration, processing and exploitation which is based upon application of many integrated geological, geophysical and geochemical methods. Pirusts, a well-known Illyrian tribe (168) BC were involved in copper processing, though the first oil discovery and exploitation began in Kuçova in 1927. Gravity and magnetic surveying and vertical electrical soundings for geophysical researches were applied by Italian companies between 1930 and 1940. In Periadriatic Depression, seismic surveys have been carried out since 1950 (Frashëri et al., 2009).

Geophysical studies in Albania gradually developed as complex methods with the application of various tools such as surveys and technological interpretation, geology and geochemistry. From 1972-1986 there was introduction of various equipment, while modern technology was applied in the area of seismic, gravity, geoelectric and magnetic surveys, as well as in radiometric studies and well logging. **Seismic Processing Center** for processing, reprocessing and interpretation of seismic data was set up in 1973. It closed down in 2005.

Geophysical exploration and research has been carried out in the oil and gas seismic and gravity enterprise in Fier (Biçoku, 2004; Frashëri et al., 2010), where 70 geophysicists engineers, four seismic teams, one gravimetric and geoelectrical team, a marine expedition and seismic geological and geoelectrical teams were involved. Consequently, about 2,500 km/year of seismic profiling with multiple coverage has been undertaken. It has also been undertaken by the oil and gas well logging enterprise at Patosi, where 30 geophysicist engineers and interpretation groups were involved. In addition electric, radioactive, sonic and gas logging was undertaken and rocks submitted to physical property analysis in the laboratory. Offshore seismic and geoelectrical surveys on the Albanian Adriatic Sea Shelf for oil and gas exploration started in 1982.

Application of geophysical methods such as seismic investigations and gravity surveys in the area of **integrated oil & gas exploration is of great importance**. The mapping illustrates the regions of possible oil and gas exploration compiled. In addition to gravity surveys, vertical electric soundings have been applied. In a few cases direct search for oil and gas reserves, electric field, radiometric and magnetic surveys were applied. Research on deep oil and gas has been carried with integrated well logging methods.

Gravity surveys at scales of 1:100,000, 1: 50,000 and 1:25,000 have been undertaken for the whole territory for oil and gas bearing rocks. Identification of the top structure **of limestone formations**, evaluation of sandstone content within onshore Neogene molasses and on the Albanian Adriatic shelf, vertical electric soundings with a depth of investigation of about 2.5 km have been applied since 1978.

Real Resistivity Section has been applied since 2005.

Seismic, gravity and electrical surveys have been of great impact for oil and gas exploration across the Ionian-Kruja tectonic nappe of the External Albanides fold-and thrust belts and across the Apulia-Sazani Foreland. In the area of geological and hydrocarbon bearing, seven **logging service** methods were applied on the rocky section penetrated by the oil exploratory, appraisal and exploitation wells. So, geophysical investigations and explorations have been carried out basing upon application of many

complex geological, geophysical and geochemical methods (Tab. 1).

Each of aforementioned method attempts to provide a general solution to describe capability restrictions of a source:

2D Seismic of multiple cover applied between 1980 and 1995 provided appropriate information on: i) thick bedded sandstone and on erosive unconformities in the premolasses, molasses and late molasses deposits from Serravallian to Pleistocene (Fig. 6, 7, 8 and 10) and, ii) top Eocene limestone along the central part and eastern flanks of the anticline structures sealed with the Oligocene flysch in some existing oil fields (Fig. 10, 16) and depicted oil prospects (Fig. 19, 21).

Tab.1. Destination targets of the methods applied in Albania

GEOPHYSICS	Methods	Destination fields			
		Oil & Gas Exploration	Mining	Engineering & Environment	Regional Surveys
Applied	Seismic reflection	++		++	++
	Electrical	+	++	++	+
	Gravity	+	+	+	++
	Magnetic		+	+	++
	Well logging	++	+	+	+
	Radiometric		+	+	+
Seismology	Earthquakes	1. Seismological Surveys Network 2. Seismological zoning of Albania			
	Engineering	1. Seismic Micro zoning and seismic risk evaluation 2. Seismic monitoring of the hydropower plant dams			
Geothermic		1. Geothermal studies 2. Geothermal energy platform and usage scenarios.			

+ *Principal method*

On the other hand, some solution capability restrictions could be met and no event is recoded when applying 2D seismic on the eroded carbonate sections, e.g., Delvina region (Fig. 14). In addition, no seismic event or very poor ones were met when investigating on anticline clay flysch diapire folds, e.g., Kalenja carbonate oil prospect (Fig. 10).

Unfortunately, both these failures took place during seismic surveys carried out by Albanian and foreign companies, as Halliburton, etc., and have brought about some deep dry exploratory wells as the Kanina-1, Shpiragu-1, etc.

Gravity method helps provide appropriate information on carbonate anticline and syncline structures sealed with the Oligocene flysch and younger deposits characterized by relevant positive and negative anomalies. Nevertheless, small **fake positive gravity anomalies** appear on the anticline flysch folds comprising thick beds of the foraminifera limestone and their misinterpretation like sourcing from top Eocene limestone has brought about several dry exploratory wells, as Kalcat-1, 2, 3, (Canaj et al., 1976), etc. Subsequently, it is the responsibility of geophysicists and geologists to find out these anomalies flysch folds sources and separate them from anomalies that generate from the hydrocarbon target of the Cretaceous-Palaeocene-Eocene carbonate rocks sequence.

Real resistivity section involved **electrical survey** which is a means to address recording of hydrocarbon target of the Cretaceous-Palaeocene-Eocene carbonate rocks sequence sealed with the Oligocene flysch. However, in some cases detecting the water table inside the karst carbonate aquifers has been impossible (Fig. 18).

A **highlight in well logging** is recording the spontaneous polarization gradient of 5 mil volt /100m in the interval 2900-3050m in that time Del-4 suspended well. Geochemical analyses are here carried out for the samples picked up from the Oligocene flysch section along the interval 2400-3050m. Consequently, both log and geochemical data become invaluable contributors to non seismic discovery of the Delvina gas condensate field by the Del-9 wildcat (Fig. 13, 15., Prenjasi, et al., 1980; 2004).

Radiometric studies and exploration, tools to address the solution of many environmental problems and measurements of natural radioactivity, were first carried out in Albania in 1958-1959. Implementing radiometric gamma spectrometric determinations of radioactive elements U, Th and K was undertaken through an international project, while a regional survey for the Geochemical Atlas of Albania (unrelated to uranium research) and regional radiometric studies according to total gamma radiation, radiometric studies and research outcomes were revealed only after 1990.

The Albanian **Seismological Network**, part of the European and Global Network through the International Central Bureau of Seismology in Strasbourg, France, was set up in 1979. The 1980s saw an increase in the number of seismological studies undertaken in Albania, meant to address engineering problems and complex seismological-engineering and geotechnical engineering micro-zoning of Albania's cities. Cooperation in the area of seismic risk with the Assembly of European Council of Seismology followed and many important projects in this area were drafted in cooperation with UNESCO. Seismological, seismological-engineering, neotectonic and geological risks maps were compiled and published under the National Programme for Research and Development framework. The seismological studies under the supervision of the Institute of Seismology and the Academy of Sciences of Albania cover the following fields: i) seismotectonic, ii) seismology and, iii) earthquake engineering. The first seismic station was established in 1968 at the Chair of Geophysics, Faculty of Geology and Mining, while the Seismological Institute was founded in 1973 by the Academy of Sciences followed by the setting up of thirteen seismological networks. *Seismic Zoning Map of Albania* (1972), *Catalogue of Earthquakes in Albania* (1975) and *Seismological Zoning of Albania* (1979) were compiled.

III. MAIN GEOLOGICAL FEATURES OF ALBANIA

III. 1. Tectonic setting of the External Albanides

Geological and geophysical data together with integrated syntheses performed on Albanides describe them as a segment of the whole Alpine chain located between Dinarides in the north and Helenides in the south (Miljush, 1973; Jacobshagen et al., 1986; Frasheri et al., 2003). Dinarides, Albanides and Helenides are folded and overthrust westward in form of tectonic nappes due to the collision between the African plate and the Euro-Asiatic one (Ricou, 1986, Fig.4). Thus the whole Albanides tectonic setting comprises partly the Apulia Foreland named Sazani zone, orogenic

fold-and-thrust nappes, Periadriatic Foredeep named Durresi Depression in its Albanides part and two intermountain or Piggy Back Depressions (Fig. 3).

The Albanides thrust-and-fold nappes are divided into Internal and External tectonic zones based on the presence of the ophiolitic rocks (Fig. 3 and 5).

The External Albanides are characterized by lack of ophiolitic rocks, as well as by presence of more regular geological models. External Albanides consist of:

Detected in few onshore seismic lines (Fig. 13 and 21) and throughout the Albania Adriatic and Ionian Offshore (Fig. 20, Prenjasi, et al 1994; Tushe et al., 1994), the **Apulia Foreland (Sazani zone)** is characterized by a restricted outcrop along the south western edge of Albanides onshore (Fig. 3 and 18). Data on outcropped sections and the drilled wells sections prove that the Apulia Foreland comprises a thick platform carbonate of the Upper Triassic to Oligocene age (Zappaterra 1990; ISGP, 1985), followed upward by the Upper Oligocene and Aquitanian flyscoides or buried by transgressive premolasse and molasse sequences of Burdigalian to Pliocene included (Fig. 19 and 20). Evaporitic deposits of considerable thickness dating between Upper Triassic and Lower Cretaceous underlie the base of carbonate section of Apulia Foreland and Ionian-Kruja tectonic nappe. Evaporitic deposits have emerged upward dissecting younger carbonate and terrigenous deposits dating up to the Plio-Quaternary showing lack of diapirism occurrence (Fig. 14, 17). So, Apulia-Sazani-Paxos Foreland (Fig. 20) is characterized by anticlines dissected by oblique or longitudinal thrust and some carbonate mounts eroded and buried somewhere under premolasse or molasse deposits characterize tectonic features of the Apulia-Sazani-Paxos Foreland (Fig. 20).

Albanides Orogeny comprises several tectonic nappes formerly called tectonic zones (ISGP 1985; Bakia, et al., 1987). Consequently, based on lithological content, age, folding and tectonic features in the External Albanides fold -and-thrust belts it's possible to make out several tectonic zones (nappes), which have their analogues in the External Dinarides and Hellenides (Zappaterra, 1990).

External Dinarides	External Albanides	External Hellenides
1. "Budva" Trough	"Krasta-Cukali" Trough	"Pindus" Trough
2. "High carst" Ridge	"Albanian Alps" Ridge	"Parnasse " Ridge
3. "Dalmatian" Ridge	"Kruja" Ridge	"Gavrovo-Tripolis" Ridge
4. "Adriatic" Trough	"Ionian" Trough	"Ionian" Trough
5. "Apulia" Foreland	"Sazani" Foreland	"Paxos" Foreland

Tectonic nappes of the External Albanides Orogeny like Hellenides (Jacobshage, 1986) overthrust westward each-other and the entire Orogeny onto the Apulia-Sazani-Paxos Foreland, to begin with the Ionian-Kruja nappe, which is the youngest one and continue in the northeastwards cross direction with the Krasta, Marly Flysch, Volcanic sedimentary-Mélange and Albanian Alps older nappes (Fig. 3, 5, 18 and 19).

Tectonic nappes of external Albanides orogeny are:

Ionian-Kruja nappe comprising the Ionian Kruja tectonic zone (Bakia et al., 1983; ISGP 1985), which represents respectively the northern continuation of the Ionian and Gavrovo Western Hellenic nappes (Jacobshagen et al., 1986). Basing on stratigraphic and geological mapping data of Albanides, both Ionian and Kruja zone represent two

different zones with gradual lithological and structural transition to each other, i.e., Kruja-Gavrovo zone does not overthrust the Ionian zone (Prenjasi et al., 1981; 2011). Consequently, the aforementioned zones represent tectonically one nappe overthrusting Apulia-Sazani-Paxos foreland, (Fig. 3, 5, 14, 18 and 19).

Consisting of three rocky sequences: i) Early flysch of Albian-Cenomanian, ii) limestone sequence of the Turonian - Campanian and, iii) Young flysch of Maastrichtian-Paleocen-Eocene, **Krasta nappe** is respectively analogue of Pindos and Budva zone in Helenides Dinarides (ISGP, 1985).

Limestone sequence of the Krasta nappe is characterized by the anticline folding associated with longitudinal and cross faults which vanish into young flysch (Prenjasi, 1982; 1983, etc). On the other hand, outcrops of the young flysch anticline folds as tectonic window under the older nappes witness the napping feature of Albanides (Fig. 3 and 5).

Marly flysch nappe is characterized by some restricted outcrops at southeast of Elbasan, north of Guri i Topit, (Prenjasi, 1983), throughout the western part of young flysch outcrop from the Okshtuni tectonic window (Fig. 5), etc. Albanides marl flysch consists mainly of medium to thick bedded marls, sandy limestone and sandstone of Tironian-Valnginian overthrusting the Krasta nappe and must be analogue of the rocks outcrop of the Olympus tectonic window in Helenides (Jacobshagen, 1986).

Depicted in figure 3 and 5, underthrusting ophiolitic rocks and overthrusting either marly flysch nappe or the Krasta nappe and comprises two successive lithological packages: i) the **lower package** consisting of some diabases, shale, cherts and thin to medium bedded pelagic limestone, which frequently pinch out into cherts and marls, and the **upper package** consisting of **mélange of sandstone**, gravels, shale and olisthostrome of neritic dolomitic limestone different in size, **volcano sedimentary-mélange nappe** could be met everywhere.

The Volcano sedimentary-mélange nappe is characterized by lack of folds and faults, whereas presence of volcanic rocks in its content may make part of the Internal Albanides. Folds and faults reported in the Albanian Geological Map at scale 1:200,000 (ISGP 1983, 2004) are not in line with the data provided by geological mapping (Prenjasi, et al., 1982; 1983, etc). Consequently, their revision is unavoidable.

Prenjasi et al., (1982; 1983; 2011) said that volcano sedimentary-mélange nappe date between Upper Triassic and Upper Jurassic-Lower Cretaceous.

Consisting of terrigenous rocks of Permian and carbonates of Triassic outcropping as a big monocline overthrusting Cukali unit, the **Albanian Alps nappe** is the analogue of Parnas zone of Helenides and High Karts zone of Dinarides (ISGP 1983; 1985).

Fig. 3 and 5 depict the **Peri-Adriatic Foredeep** consisting of Miocene to Plio-Quaternary premolasse, molasse and late molasse deposits, which cover transgressively most of the Apulia-Sazani-Paxos foreland and partly the Ionian-Kruja-Gavrovo orogeny nappe area.

Consequently, as stated by Frasheri et al., (2003), the Periadriatic foredeep deposits erect the upper tectonic stage which increases its thickness northwestward up to 6000 m.

III. 2. Hydrocarbon Potential of Albania

The limestone of the Cretaceous-Paleogene of the Apulia Foreland, the Ionian-Kruja tectonic nappe, the sandstone bodies of the Upper Miocene molasses and the Lower Pliocene late molasse deposits of Periadriatic

foredeep are mentioned for their hydrocarbon resources (Fig. 3 and 5). Sandstone bodies sealed with the clay packages of the Upper Miocene and Lower Pliocene deposits of the Peri-Adriatic Depression are rich in dry gas.

Geological section of the Ionian-Kruja tectonic nape consists of carbonate, flysch and flyschoid sequences, as well as of the premolasses deposits sequence of the Burdigalian to Tortonian included.

Carbonate section of the Mesozoic-Eocene of the Ionian zone consists of seven source rocks horizons of bituminous shale and several packages of carbonate reservoirs (Diamanti, Dule 2008). Whereas the Lower Oligocene flysch has confirmed its seal function (Plaku 1962; Prenjasi 1980; 1992).

Limestone target comprises the Cretaceous-Paleogene of the Apulia Foreland and Ionian-Kruja tectonic nappe. Basing on structural features and relationship between the reservoir rocks and seal ones within the aforementioned tectonic unites, the following types of hydrocarbon accumulation traps could be mentioned: i) **massive limestone mount buried traps** located in the Apulia-Sazani Foreland structures of the Cretaceous-Oligocene reservoir sealed with the Upper Oligocene to Burdigalian marls or clay packages (Fig. 20 and 21, Prenjasi 1997). In addition, the Miocene and Pliocene transgressive clay packages probably make the eroded carbonate mounts play the role of the seal (Tushe et al., 1994), ii) **massive limestone anticline traps** located in the Ionian zone anticline structures comprise the Cretaceous-Eocene reservoir sealed with the Lower Oligocene flysch e.g., Cakrani, Gorrishiti (Plaku et al., 1962) and in depicted prospects of Kalenja, etc (Fig. 10, Prenjasi E., et al., 1985). Some structures of the massive traps are masked by **overthrust** of big eroded anticlines associated with evaporitic diapirism through their thrust plane, as in the cases of the Delvina gas condensate field (Fig. 12, Prenjasi et al., 1980; 1994). While, some other anticline structures are masked by transgressive sequences of premolasses deposits dating between Burdigalian and Tortonian age, e.g., Ballshi field (Fig. 10) prospects of Peza (Fig. 5, Prenjasi 2001), or the transgressive mask cover may be the molasses deposits dating between Messinian to Pliocene e.g., Vlora prospect (Fig. 19), iii) **tectonic limestone screen traps** conditioned by dissection of the Cretaceous-Eocene limestone due to development of a duplex pattern faults and screened them against the Lower Oligocene flysch deposits, as it is proved in the Karbunara oil field (Fig. 11, Gjoka et al., 1985) and interpreted in the eastern part of the Borshi prospect profile (Fig. 17, Prenjasi E., et al., 1989). Also, a probable evaporitic screen entrapment may have taken place in case of the Dhrovjani prospect, which locates along the limestone footwall flank of the Mali Gjere screened by the evaporitic diapire of the Upper Triassic (Fig. 15, Prenjasi E., et al., 1986), iv) **hydrodynamic massive limestone traps** in the Cretaceous-Eocene limestone reservoir sealed with the Lower Oligocene flysch and conditioned by the underground water movement, such as in the Visoka oil field (Fig. 9, Plaku 1961; Mezini and Fili 2010) and the Fitore prospect (Prenjasi, 1992).

Sandstone target occurs in molasse sequences of the Upper Miocene and Late molasse of the Lower Pliocene from the Periadriatic Foredeep that consists of several oil and gas or gas-bearing sandstone suites, as it's occurred in the oil fields of the Patos-Marineza and Kuçova, gas fields of the Divjaka, depicted gas discovery of Durrresi (Dalipi et al., 1977) and gas prospects of Seman, etc (Tushe et al., 1994), etc. The main types of traps of oil and gas accumulation in the sandstone target bodies are: i) **anticline traps** in the sandstone beds of the Upper Miocene and Lower Pliocene, e.g., Divjak-Bllaj and Povelça gas fields (Fig. 6, 7), (Dalipi et al., 1977) and

the Durres gas discovery (Fig. 5), etc, ii) **litho-stratigraphic traps** of the sandstone beds of the Upper Miocene, e.g., palaeogeographic bay of Patos-Marinza oil field (Fig. 8), and the Kuçova one (Gjoka et al., 1985), iii) **lithologic traps** in the sandstone beds of the Upper Miocene, e.g., Kuçova oil field (Shehu et al., 1966, etc), iv) **tectonic screen traps** of the sandstone beds of the Upper Miocene, screened by evaporitic diapirism of the Upper Triassic and the Oligocene flysch, e.g., Pekisht-Murriz oil discovery (Murataj et al., 1962).

In addition to the aforementioned fields, some other fields and prospects have been discovered from 1918 to 1987. (Nikolla et al., 2012) provides information on oil and gas reserves: **Sandstone target** beds of the Upper Miocene molasse deposits of the **existing oil fields** of Marinza, Driza, Gorani, Kuçova and Pekisht, and sandstone beds of the Lower Oligocene flysch of the Drashovica small field in all have had around **342 mil tones** of original oil in place reserves. **Sandstone target** beds of the Upper Miocene molasse and the Lower Pliocene late molasse deposits in the **existing natural gas fields** of the Divjak-Ballaj, Povelç, Panaja and Frakull in all have had around **1 mild normal cubic meters** of original gas in place reserves. **Limestone target** of the Cretaceous-Paleocene-Eocene, which represent the reservoir rocks in the **existing oil fields** at Visoka, Ballsh-Hekal, Cakran-Mollaj, Karbunare, Gorisht-Kocul, Amonice, Finiq-Krane and Delvina in all have had around **100 mil tones** of original **oil and condensate** in place reserves, as well as around **13 mild cubic m** of original **associated gas** in place reserves.

Assessment of hydrocarbon potential of the prospects have been carried out via syntheses of geological and geophysical data gained by experts of General Oil Directory and Oil and Gas Institute, (1945-1990). The following data provide information on the production of oil and gas:

Around **26 mil tones** of crude oil and **120 mild normal cubic m gas in credible prospects** comprising **sandstone target** beds of the Upper Miocene molasse deposits.

Around **50 mil tones** of crude oil and **80 mild normal cubic m** of gas condensate in **credible prospects** composed of **limestone target** of the Cretaceous-Paleocene-Eocene, as well as **around 40 mil tones** of crude oil and **140 mild normal cubic m** of gas condensate in this target probable and possible prospects.

Since 1999, **upstream operations** have been run mainly by foreign companies. Data report that oil and gas production has considerably decreased (only 18 drilling wells). Consequently, further geophysical investigation by skilful geoscientists is needed. Tools and techniques need to adapt to a world of increasing scientific and technical complexity.

IV. FIELD TRIP OBSERVATION ITINERARIES

Introduction

It is fashionable to portray scientific evidence that has been collected about the way earth works. The present field trip is accessible to all geoscientists who are interested in basin analysis and hydrocarbon exploration in complicated fold-and-thrust belts, as well as in molasses deposits of Peri-Adriatic Depression.

Geological and geophysical surveys, onshore and offshore drilling well and photographs of some spectacular outcrops and outstanding

landscapes provide reliable data for making up some interesting geological-geophysical cross-sections. Consequently, everyone can make up his own view on structural models, geodynamic evolution and hydrocarbon perspective of the Outer Albanides (Fig. 3), as an integral part of the East Mediterranean Orogen thrustured onto the Apulia-Sazani-Paxos Foreland (Fig. 2, 5)

In addition, very interesting information exists on the Peri-Adriatic Depression structural model, its paleogeographic relationship with the duplex structures of the lower tectonic stage of the Kruja, and Ionia zones, as well as with the Apulia-Sazani-Paxos Foreland.

Unavoidably, particular attention has been paid to some oil and gas fields currently discovered in the Ionian zone and Peri-Adriatic depression, their facies and structural model features, as well as many oil and gas prospects. Here, further geophysical investigations are needed. So, some oil and gas condensate fields are discovered in the carbonate anticline structures sealed with Oligocene flysch of the Ionian zone. Two oil fields, dry gas fields and oil and gas prospects have been identified in the sandstone target of the molasses of Tortonian, Messinian and Lower Pliocene of the Periadriatic depression.

In the present field trip, information from the oldest source rocks horizons, reservoirs and seals of the Mesozoic section to the youngest ones of the Miocene and Pliocene molasses deposits.

1. Itinerary Tiranë-Durrës

Molasses deposits of **Preadriatic Depression** (PAD) outcrop partially along the automobilist road from Tirana to Durrës.

Tirana syncline comprises molasses deposits of sandstone, siltstone, clay, and coal beds of medium to thick bedded rhythm intercalations of Serravallian-Messinian included, that lie transgressively on Burdigalian-Langhian premolassic marl deposits along the eastern flank of the **Peza syncline** (Prenjasi et al. 2001). A well studied section of the eastern flank of the Peza syncline outcrops nearby east of Ndroqi village where the premolasses marl deposits continue with medium rhythm intercalations of clay-silt-sandstone of Serravallian and Tortonian, while above them continue successively thick bedded sandstone package of Messinian, rich in Ostrea and coal beds.

The Peza syncline premolasses and molasses deposits dating from Burdigalian to Messinian cover transgressively the **Peza buried carbonate anticline sealed by the Oligocene flysch**, which represent a good gas condensate prospect in desperate need of caring out some new seismic lines (Fig. 3 and 5).

On the west of the Peza buried anticline develops the **Synej-Shkozet syncline** filled in with the Pliocene late molasses deposits in its centre part (Prenjasi E., et al. 2001). This syncline separates the Peza anticline with the Durresi one.

Rich in dry gas, the **Durrësi anticline** consists of molasses deposits dating from Serravallian to Messinian.

Thus, in the Durrës-15 well (Dalipi., et al., 1977) some 4 million cubic meter gas per year are produced. Here more **gas pools can be discovered** and appropriate applicative geophysical methods (processing and reprocessing programs of the seismic lines) are necessary.

In the east of the Synej-Shkozet syncline, Shkëmbi i Kavajës, a real pale environment and erosion geosite consisting, outcrops. It consists of coarse

massive sandstone, full of different sedimentological and erosional forms that represent a small segment of the base of the Upper Pliocene transgression onto the Messinian clay-gypsum bearing pack. It is located in the municipality of Durrës, Albania, about 8 kilometers from the main town. It is said to be the place where, in 48 BC, during Caesar's Civil War, Caesar fought the Battle of Dyrrhachium against Pompey.

Durrës, Italian **Durazzo**, Serbian and Croatian **Drač**, is the primary seaport of Albania, lying on the Adriatic coast, west of Tiranë. Founded as Epidamnus by Greeks from Corcyra and Corinth in the 7th century BC, it was seized by the Illyrian king Glaucias in 312 Bc. It later passed to the Romans, who called it Dyrrhachium and made it the terminus of their military highway (Via Egnatia), which led past Elbasan and Lake Ohrid across the Balkan Peninsula to Thessalonica (now Thessaloníki, Greece) and the east. It thereby became the most important port of Illyricum. In the 4th century Ad it became capital of Epirus Nova (a Roman province), and an archbishopric was created there in 449. Several well-preserved fRoman arenas have been excavated in the old quarter of the city. The city is mentioned for its archeological heritage such as Bukuroshja e Durrësit (the Beauty of Durrës), Kalaja e Durrësit (Castle of Durrës), Amfiteatri (Amphitheater) etc. Durrësi was the capital of Albania from 1914 1920.

2. Itinerary Durres-Lushnje-Ardenicë

One might want to see the Divjaka-Karavasta National Park when travelling towards Fier. The Divjaka-Karavasta National Park is the largest non-coastal complex in Albania, made of four lagoons approximating 5,000 hectares of sand dunes and a river delta. It is situated in the central part of the Western Region, between Shkumbini River in the north and Seman River in the south, 40 km west of Lushnja by the Adriatic coast.

Divjaka Beach is one of the best preserved natural beauties of Albania. The sea is shallow and excellent for children and family vacations. Divjaka Beach is a stretch of roughly 15 kilometers of white sand lined by pine forest, and it is a popular seaside destination for thousands of tourists and day-trippers from south-central Albania. The sandy beach is huge (250 m wide from forest edge to water in some areas) and even in peak season, it is possible to walk further up or down and find some privacy. The region is mentioned for the **Divjak Ballaj dry gas field** met in molasses and late molasses deposits of the Upper Miocene to Lower Pliocene included (Fig. 6) in the south of Durresi gas deposit, in the same structural chain, but 1500m deeper than the Durresi gas deposit. It is richer in sandstone bodies and gas reserves. Seismic data suggest that both the Divjaka and Durrësi anticlines have inherited the structural shape of the older deposits including carbonate section of Cretaceous-Paleocene-Eocene. In other words it's possible to have carbonate gas condensate prospects under the gas deposits in Durresi (Fig. 5) and gas field of Divjaka (Prenjasi et al., 2001).

The **Karavasta Lagoon** (Albanian: Laguna e Karavastasë) is the largest lagoon in Albania and one of the largest in the Mediterranean Sea. It is separated from the Adriatic Sea by a large strip of sand (100m wide). The lagoon is part of the Divjake-Karavasta National Park. It was elected as an area of international importance, protected by the Ramsar Convention of 29 November 1995.

In addition, the area is mentioned for Divjaka old coniferous forest, which is a national park, Divjaka beach, which has a lot of sand dunes along the seaside, Colonies of Dalmatian Pelican and about two hundred other bird species, which are main clues of designated the Karavasta Lagoon as a

Ramset Site of International Importance.

Lushnja is the main town of **Myzeqeja plain**. The town was founded in late medieval times by a Turkish widow called Salushe. She built a rest stop on the road from Durrës to Berat, giving birth to the town. As of 2000, old men still called the town Salushe. In January 1920, Lushnje was a provisional capital of Albania and the place of the Congress of Lushnje. Chieftains of Albania assembled in the town and declared Tirana first a provisional and then the definitive capital of Albania. The Lushnje district is known as a main provider of agricultural products to the rest of the country. It is one of very few field districts of mountainous Albania. During the Communist Regime the town had a number of factories: among them food processing and building materials, which were closed down for one reason or another in the aftermath of the fall of Communism. Savra Field is 3 km away from Lushnje. This field is on the Lushnje-Fier road. Here the first battle between Principality of Zeta and Ottoman Empire occurred in 1385 (the Battle of Savra). In this battle Balsha II was killed. In the XV century it was named Lusnie. The Myzeqeja plain is a morphological expression of the Periadriatic Depression (PAD) epicenter filled in with molasses deposits of the Upper Miocene, late molasses of the Pliocene and Quaternary alluvial deposits.

Ardenica Abbey (church) it was in the Middle age argued by a stone in entrance dating back to the 1417, but the first building belongs at the beginning of XVIII century. Today inside the church you can admire pictures of 1743-1745 years, by Albanian artists.

The hills of **Ardenica** can be found in southern Myzeqe in a dominant position. From this position can be seen Kruja, Mount Dajt, Tomorr, the Adriatic sea, the Karavasta Lagoon and the Labëria mountains. The Ardenica hill is a view point to a wide impressionable territory as Karavasta lagoon to the northwest and the "forest" of the exploitation wells of the Patos-Marineza fields to southeast. Also it is interesting to mention that the **Ardenica -18 well**, drilled on the Ardenica hill is the deepest well in the Balkan Peninsula, but unfortunately it crossed an unexpected thrust and penetrated from the Oligocene flysch to the Upper Miocene molasses where suspended at 6700m total depth as a dry well.

3. Itinerary Ardenice-Kremenare

From Ardenica hill to Kremenara eroded carbonate anticline, we pass through Fier, Patos and Ballsh. Its the richest oil bearing region in Albania and probably in Europe because its geological setting consists of Patos-Marinza, Visoka, Ballsh-Hekal and Karbunara oil fields (Gjoka 1987). Meanwhile, at surface going down to older deposits, under the Quaternary cover of western Patosi area the following lithostratigraphic sequences (Prenjasi et al., 1984) outcrop: **Late molasses deposits of Pliocene N₂** comprising Rrogozhina and Helmesi suites that outcrop obviously at the Lalar Pass area.

The Upper Pliocene **suite of Rrogozhina N₂^r** consists of intercalations of thick bedded to massive sandstone and conglomerates with rare silty clay beds.

The Lower Pliocene **suite of Helmesi N₂^h** consists of massive clays with rare sandstone beds, rich in reddish oxides that lie almost parallel to the transgression base. Meanwhile nearby the middle level of this suite is opened the Clay Quarry used for producing drilling mud.

Ranging from oldest to youngest, the Molasses deposits of the Upper Miocene N₁³, Bubullima, Marinza, Driza, Gorani, Pollovina and Kuçova

suites together with the Pliocene late molasses form the Upper Tectonic Stage.

The Upper Miocene molasses suites outcrop Visoka village where their section begins with the transgression base named **Guret e Zes (Black Stones)** consisting of sandy lithothamnic limestone rich in numerous macrofauna fossils (Pho. 2). It lies unconformable on the premolasses deposits of Burdigalian-Langhian-Serravallian of the Ballsh syncline. Marinza, Driza and Gorani suites outcrops are saturated with bitumen and production of bituminous sands from the Driza suite (Pho. 1) continues at the open **Quarry of Kasnica**. Meanwhile the Gorani suite sandstone beds may be a good prospect. Furthermore, northwest, in the course of the Marinza and Driza suite plunging in the course of the paleogeographic bay the following oil fields are discovered: In 1927 and 1928, respectively, **Kucova and Patosi oil fields**, related to **Messinian clastic reservoirs**, were discovered by the Polish Prof. Stanislaw Zuber. Marinza, as the biggest oil field in Albania, related to Messinian-Tortonian clastics reservoirs, was discovered in 1957 (Fig. 10). Both Patos and Marinza represent the biggest oil field in Continental Europe. They consist of many sandstone bed pools of lithostratigraphic type supplied from the pale eroded surface of the big buried carbonate anticline of Visoka.

Premolasses deposits of Burdigalian-Langhian-Serravallian-Tortonian outcrop along the road segment of Visok-Greshica consisting mainly of massive marls intercalated with lithothamnic sandy limestone in the lower part and of sandy-silty-clay intercalation in the upper part. All these deposits represent the **Middle Tectonic Stage** (Dalipi et al., 1985, Prenjasi et al., 1984) that in this area form the **Ballsh syncline**, which lie transgressively on the **Lower Tectonic Stage** deposits of Cretaceous-Eocene Carbonates and the Oligocene flysch (Fig. 10, Photo. 3)

Molasses deposits of the Messinian have buried the **Visoka carbonate oil field** (Plaku 1961), while the Premolasses of the Burdigalian-Langhian-Serravallian have buried the **Ballshi carbonate oil field** (Fig. 10, Photo 3)

Reservoir rock in these fields comprises the Cretaceous-Paleocene-Eocene limestone section. Lower Oligocene flysch provides hydrocarbon accumulations sealing.

From hydrodynamic regime point of view the Ballsh field has a common drive of bottom waters, whereas in the Visoka field, the massive oil pool protection is conditioned by the flysch seal and underground water drive penetration from the molasses deposits of the Upper Miocene to the Cretaceous-Paleocene-Eocene limestone reservoir. Consequently, in the **Ballsh massive oil pool** the initial oil water contact has been almost horizontal, whereas in the **Visoka hydrodynamic oil pool** it is tilted from North West water supply source to southeast plunge of the pericline of the big buried Visoka anticline (Fig. 9)

Seismic investigations carried out in 1984 provide information regarding the top of Eocene limestone of the eastern flank of the Ballshi field anticline (Fig. 10), and the presence of the Kalenja prospect (Prenjasi, et al 1985), whereas diffraction of the seismic waves has taken place along its western hanged flank.

Carbonate and flysch deposits of the Lower Tectonic Stage outcrop obviously across the core and the eastern flank of the **Kremenara eroded anticline**. Thus, along the automobilist road of the Povla stream outcrop, the reservoir rocks intercalation of pack stone, grain stone and mudstone that have some fracture systems and intensive oil could be met (Photo. 4). The argillaceous limestone package of the Lower Cretaceous, considered as the youngest source rock horizon in the Ionian zone, lay successively

under the reservoir rocks.

Being a unique tectonic screen model where oil is trapped in the foot wall flank owing to the thrust phenomenon, the **Karbunara oil field** has developed a long the western foothill of the Kremenara eroded anticline (Fig. 11).

Ballshi surrounding fields are rich in crude petroleum and are dotted by a series of oil wells established during the communist dictatorship (**Ballsh-Hekal oil field** to the south, **Cakran-Mollaj gas condensate field** to the west and locates the **Ballshi Oil Refinery** to the east encircle the Ballshi town). Only a fraction of these wells are operating today, but the city includes a working refinery, and outputs of naphthas are significant. It was called "Glavinitsa" during Bulgarian rule, later on the city was named Ballsh after Serbian ruler Balša II. Ballsh is close to the ancient city of Byllis. The climate is Mediterranean. It is surrounded by the hills of Mallakastra. Its Latin name is Baletium. The Slavic invasions of the 6th and 7th centuries caused the decline of Byllis while Ballsh was built with materials plundered from Byllis. Here, Basilica Monument of 29x13m in has been discovered. Whereas presently

4. Itinerary Kremenare Gjirokastër

This itinerary provides information on some interesting geological structural unites as the Memaliaj syncline belt (Bakia et al., 1987, Prenjasi et al., 1984), erosional figures of Mogilia, cold water springs of Uji Ftohte, Picar and Viroi, as well as Archeological sites of Tepelena and Gjirokastra castle.

The Mogilia (tombs) area consists of some carbonate breccias fallen from the former eastern flank of the eroded anticline of Kurveleshi. Currently, they are separated from this anticline and comprise the Vjosa river erosion. Consequently, the deluvial breccias changed into small hills similar to big graves and into some funnels, due to erosion and karstic phenomena impact.

Memaliaj Coal Mine locates in the Coal Bearing Suite of Memaliaj of the premolasses deposits of Serravalian-Tortonian of the western flank of the Memaliaj Syncline Belt (Bakia et al 1987; ISGP 1987; Prenjasi et al. 1984).

From fossil natural resources point of view, the **Memaliaj syncline belt** has been target for oil exploration that unfortunately have resulted unsuccessful. Thus many dry wells as Libohova-1, Erindi-1, Nokova-1, Palokastra-1, Memaliaj-2/S, Rabije-4, Plashnik-1, Osmanzea-1, Levan Plak-1, Sqepur-6, Shpirag-1, etc, were drilled due to misinterpretation of some anticline flysch folds, thrust phenomena and fragmental poor seismic events, which confirmed the continuation syncline form of the Memaliaj Belt from south Dropull Volley to Sqepuri Pass and more northward between the eastern flank of the Visoka large buried anticline and the **Dumre Evaporitic Diapire** (Fig. 12).

Tepelena is the principal settlement in the eponymous Tepelenë District of southern Albania. It is located on the left bank of the Vjosë river, about three kilometres downstream from its union with the Drino. Its location is strategically important and there is a ruined citadel occupying a point 300 metres above the river. Ali Pasha was born at the nearby village of Beçisht. In 1847, the British writer Edward Lear visited the town and noted the devastated buildings. Another British poet and a leading figure in the Romantic Movement, at the same time the author of *Child Harold*, **Lord Byron**, visited Ali Pasha and the town in 1809.

On the way to Gjirokastra, one has the opportunity to enjoy cold water

springs, waterfalls, high old trees forest and several small beaches along the Drinos River.

Tepelena and **Picar Cold Water Springs** source from the back thrust outcrop between the eastern flank of the Kurveleshi eroded carbonate anticline and the evaporitic diapire emerged through the thrust plane. Here, the outcrop of few **amphibolites and volcanic basic rocks** in the evaporitic diapire of Picar-Kardhiq, very nearby the Picar River cold water spring is of great interest. These magmatic rocks represent a unique example throughout the external Dinarides-Albanides-Hellenides chain. While the **Viroi spring** sources from the Top Eocene limestone of the eastern flank of the Mali Gjere eroded anticline during the winter and spring periode of time, whereas it dries up during the summer and autumn time.

Gjirokastra Gjirokastër, Greek **Argyrókastron**, Italian **Argirocastro** is a town in southern Albania. Lying southeast of the Adriatic port of Vlorë, Gjirokastër overlooks the Drin River valley from the eastern slope of the long ridge of the Gjerë Mountains. The town was designated a UNESCO World Heritage site in 2005 for its well-preserved centre built by farmers during the time of the Ottoman Empire. A 13th-century citadel marks the centre of town, and several tower houses known as **kule** represent the typical architecture of the 17th century. A mosque and two churches also remain from the 18th century. Picturesque, latticed houses sprawl upon the spurs of the mountain, nestling under the shadow of the fortress built by Ali Paşa, the Turkish grand vizier, in 1811. A centre of 19th-century Albanian nationalism, the town was the site of a meeting of the Albanian League in 1880 at which a resolution was passed demanding full autonomy from Ottoman rule. In the First Balkan War (1912-13), the town was claimed by Greece, and between 1939 and 1944 it was occupied in succession by the Italians, the Greeks, and the Germans. Gjirokastër was traditionally a centre of the Bektāshīyah order of Muslims. The Albanian Communist Party leader Enver Hoxha was born there in 1908 of Muslim parents; his home was converted into a museum. Ismail Kadare, the famous Albanian writer, several times nominated for the Nobel Prize was born here. Actually, the old buildings of the city are being reconstructed conform to a historical preservation project. Here, one can visit the Museum of Renaissance, Museum of the National Liberation War and National Museum of Weapons, which has been set up in the castle. Nowadays Modern Gjirokastra has the University "Eqerem Çabej. It's an important economic center, a communication hub and a unique connection point with Greece through the Kakavi state border point. Presumably, the most aesthetic view point of Gjirokastra City is the Kuculla hill.

5. Itinerary Gjirokaster - Sarande

Travelling from Gjirokastra to Jorgucat village, along the foothill of the Mali Gjere, one passes through Dropulli region. Dropull (Albanian: Dropulli; Greek: ???p????, Dropolis) is a predominantly Greek-inhabited region in Gjirokastër District, in southern Albania. The region stretches from south of the city of Gjirokastër to the GreekAlbanian border, along the Drinos river. The region's villages are part of the Greek "minority zone" recognized by the Albanian government. Here, majorities of ethnic Greeks live. Dropull is divided into two municipalities: Dropull i Sipërm (Upper Dropull) and Dropull i Poshtëm (Lower Dropull). The villages are constructed with decorative flat stone of white, light blue, gray and dark red colors of the Eocene. On the two sides of the road from Gjirokastra to Delvina and Saranda, some geological-geomorphologic sites such as the **Vanistra cave**, or the so-called

the **Skotini Cave** 7km south of Gjirokastra, about 500m west of the national road Gjirokaster-Jorgucat, could be met. This cave is a geological site of hydrogeology, economical and historic values. It has served as water supply for the habitants of the Goranxi village since the ancient times.

Traveling further in the south, the remote south east appear the western slope of Bureto Mountain and Glina village at its foothill could be met. Here, Glina natural mineral water flows from the famous water spring Glina. Glina natural mineral water is known inside and outside of Albania for its quality, unique taste and for its useful mineral ingredients for the health, ranking as one of the highest quality waters in the world.

Mali Gjere carbonate section is the representative section of the central part of the Ionian trough. It begins nearby the Dropull village of Jorgucat, where Top Eocene limestone outcrops and continues westward across the successive older carbonates of the Paleocene and the whole Mesozoic section to the evaporitic deposits diapire of the Upper Triassic nearby west Delvina town. So, playing a giant drilling bit from Jorgucat to West Delvina town, one can make out the following lithological packages as reported by Dalipi et al., (1964) and mapped in some geological survey ones: **Bioclastic Limeston Package** dating since Upper Cretaceous-Paleocene-Eocene and consisting of almost rhythmic intercalation of thin to medium bedded of mudstone, grain stone, pack stone and wackstone where are present thin layers and lenticular cherts, as well as some seven turbidity slam horizons, **Marl Limestone Package** dating since Aptian-Albian and consisting of thin to medium bedded intercalations of marl limestone, clay and cherts where are also present bituminous schists as organic matter source rocks and the horizon of the phosphate limestone that outcrops some 500m east of the Muzina Pass and continues remarkably along the western slope of the Mali Gjere owing to dens green trees grown up on it (Fig. 13, Photo 6) , **Porcelane Limestone Package** dating since Lower Cretaceous and consisting of thin to medium bedded porcelane limestone and rare thin bedded lenticular cherts, **Upper Chert Package** dating since Malm and consisting of thin bedded intercalation of cherts, apoka and clays considered as organic matter source rocks, **Gray Limestone with Cherts** dating since Upper Doger and consisting of medium bedded gray limestone with many thin bedded and lenticular cherts, **Lower Chert Package** dating since Lower Doger, which has similar lithological content with the Upper Chert package. Its clay beds have also proved to be organic matter source rocks. Both the Lower and Upper Chert Packages are obviously remarkable due to dens green grass grown on them, **Possidonia shale Package** dating since Toarsian and consisting of massive marl shale rich in Possidonia. It is proved to be organic matter source rocks, **Crystalline Limestone Package** dating between Lower and Middle Liassic and consisting of medium to thick bedded pelagic limestone that change gradually into algal reef limestone along their north-west extant ion (Dalipi et al., 1964), **Dolomite bituminous shale Package** dating since Lower Jurassic and consisting of thin bedded intercalations of the dolomitic and bituminous shale, considered as organic matter source rock, **Dolomite Package** dating since Upper Triassic, which composes of thick bedded to massive dolomites rich in MgO that varies 17-21.8% and, **Evaporitic Rocks Diapire** of Upper Triassic age has emerged along the western thrust of the Mali Gjere Anticline. Its larger outcrop expands from the Krongji village to the west of the Delvina town as a real heterogeneous mixture of halite and sylvan salt minerals with clay, gypsum, alabaster, anhydride, rare limestone and dolomite small blocks, etc.

A considerable part of the evaporitic rocks diapire from South Peca

village to Muzina torrent area is covered transgressively by the Pleistocene lacustrine deposits of **Terra Rossa**. Meanwhile on the left slope of the Muzina torrent source some “**Blue Eye**” cold water springs along the thrust of the thick bedded crystalline limestone of the Lower and Middle Liassic onto the evaporitic diapire body of the Upper Triassic (Prenjasi et al., 1986), (Photo 9). “Blue Eyes” geotourist spot includes: a big artesian spring, some cold water springs, artificial lake, some old high oak trees, and forest on the slopes. It is a unique geoturistic spot that includes a big artesian cold water spring and some smaller cold water springs that supply the Bistrica artificial lake. The main artesian cold water spring is getting up through a natural karstic cave of about 45 meters depth, which dip east inside of the Mali Gjere underground carbonate water reservoir. On the other hand, inside the evaporate diapire develops the **Krongj-Dhroviani salt mine** where few hydrocarbon gas sources have been encountered. Along the western thrust of this diapire, onto the Oligocene Flysch deposit, in several salt exploration wells have occurred many oil shows that must have migrated from a possible tectonic screened oil pool of the **Dhrovjan carbonate prospect** at depth (Fig. 15, Prenjasi., et al., 1986) have been encountered.

The **Bistrica artificial lake** supplies the hydropower stations of the Bistrica-1 and Bistrica-2 through the underground tunnel of Krongji eroded carbonate pericline.

Presumably, the most important event of the region in question is presence of the **Delvina gas-condensate field** in the Cretaceous-Paleocene-Eocene limestone reservoir sealed with the Lower Oligocene flysch and masked with the westward thrust of the evaporitic diapire and eroded carbonates of the Mali Gjere anticline (Fig. 14, Prenjasi et al., 1986).

The Delvina gas-condensate field is a **non seismic discovery** (Prenjasi et al., 1980) in a most complicated tectonic setting throughout the Alpine Folding Chain of North and East Mediterranean regions (Fig. 13, 14). Surely the hindrance to getting seismic information are outcrops of the fractured eroded carbonates of the Mali i Gjere anticline, whereas west of the Delvina town area, where the seismic acquisition has taken place on the Oligocene flysch deposits, its time sections offer some obvious events from top Eocene limestone to possible Foreland top carbonates at 4.5 seconds (Fig. 13, after Prenjasi et al., 1998).

On the road from Bistrica village to Saranda city is possible to visit the **Mesopotami Ancient Monastery**, and the **Finiqi Ancient Archeological Village** at surface. Meanwhile at depth has taken place accumulation of the **Finiq-Krane massive oil pool** at the Cretaceous-Paleocene-Eocene carbonate reservoir sealed with the Lower Oligocene flysch and masked partly with transgressive sequence of premolasses marl deposits of the Burdigalian (Fig. 16, Prenjasi et al., 1986). The Finiq-Krane is a small oil field situated in the trend of southern plunge of the western branch of the pericline of the Fterra eroded anticline.

Finiqi - Saranda road crosses the **Vurgu syncline** filled in with flysch and flyschoid deposits of the Oligocene and Lower Miocene, and the **Kakome anticline** consisting of the Cretaceous-Paleocene-Eocene carbonate deposits.

Saranda began as the city of Onchesmas of Antiquity since the IV century BC. An early Christian monastery dedicated to 40 saints (santé quadrant) gave its name. In the center of the city there are some ancient ruins, and a large mosaic discovered under sand. Meanwhile it's possible to get more widely wonderful sights going up at the Lekuresi castle view point on the top of the hill, which locates just 3km southeast of the city center. It is situated on an open sea gulf of the Ionian Sea in the central

Mediterranean, about 14 km (8.7 mi) east of the north end of the Greek island of Corfu. It is one of the most southern harbor of Albania, an important economic and administrative center and among most attractive seaside region for summer holidays to Albanian and foreign tourists. It's open to Greece by ferryboats to the neighboring island of Corfu, as well as through onshore entering at the Boat Pass.

Ksamil Islands as integral part of the Tetranses bay (four islands in Greek) locate some 10km south of Saranda city. This bay is some 2.6km wide and enters into the land some 1.3km where the "**Ammonitico Rosso**" horizon of Toarcian outcrops as a seaside cliff at the Monastery in the north of Ksamili islands (Dalipi H., et al., 1964).

Good climate conditions, clean beaches and blue water of the sea, hilly relief with olive trees overlooking the Butrinti Lake on the east and the Ionian Sea on the west make the Ksamil area a true pearl of Albania. In other words it is a very attractive hub of domestic and international tourist's destination. Butrinti archeological site and National Park are a World Cultural Heritage protected by UNESCO that locate 18 km south of the Saranda city. It's a unique archaeological site in the whole Balkan Peninsula, with many important historical objects as the Threeangled Fortress, Ali Pasha Tepelena Castle, Kalivo and Diapor.

Butrinti town is mentioned for the first time by Hekateu in the VI century BC as part of Kaonia State of Epirus. It was turned into a roman town by Jul Cesar in the year 167 BC, but later Ali Pasha Tepelena divided again from the colony of Venetic.

The most important archeological objects of Butrinti ancient town are Amphitheater, the Tower Gate, the Lion Gate, the Nympeum, Temple above the theater, Sanctuary of Asclepius, Roman baths, the Baptistery of round shape of a diameter of 13.5m, the Hall of the multicolored mosaics of 10.15X3.70m sizes, different objects of that time every day use, etc.

Nowadays the Butrinti area is proclaimed as Native Forest Park protected by law, where grow a lot of different plants that attract a lot of birds, while some special kinds of fishes dwell in the Butrinti Lake.

6. Itinerary Sarande-Vlore (Albania Ionian Riviera)

It is called the **Ionian Riviera**. After some kilometers along the eastern foothill of Saranda and Kakome mountains, Nivica, Saint Vasil and Lukova villages could be seen. In Lukova, once can see the beautiful Ionian Riviera with its beaches of Piqeras, Borsh and Qeparo.

From tectonic zonation point of view the Kakome anticline is an integral part of the **Çika anticline belt**, which eastward has a gradual transition into the **syncline belt of Shushica** (Bakia et al., 1987, Prenjasi, 1992). But this continuity is complicated by a restricted back thrust of small amplitude some 200m west of the Nivica village where the Eocene limestone thrust eastward onto the Upper Oligocene flyschoids.

When traveling northwest from Lukova along the syncline belt of Shushica, stopping in Borsh is unavoidable for those who want to taste fresh water from the spring (Izuar), good food or coffee. The landscape of the cross fault collision between the carbonate section of the Jurassic to Eocene of the Qeparo anticline against the Lower Miocene flyschoid of the Shushica syncline belt is magnificent. This cross fault outcrops very obviously nearby south of the Borsh castle and continues eastward under the thrust of the Fterra anticline of the Kurveleshi anticline belt. Also, the Borshi cross fault continues westward under the waters of the Ionian zone and probably under the molasses deposits of the Upper Miocene that

outcrop in the western part of the Corfu island of Greece (Jacobshagen 1986; Prenjasi et al., 1994). On the other hand an anticline fold in the Middle Oligocene flysch locates some 3km north of the Borshi Castle. This fold has been called Borshi anticline prospect and is checked by the dry wells of Borsh-1, and suspended one of Borshi-2 (Fig. 17). A pattern of imbricate thrusts occurred between its eastern syncline and the thrust front of the dolomites of the Upper Triassic of the core of the Fterra anticline. Subsequently, the tectonic setting of this area offers the **Borshi carbonate oil prospect conditioned by tectonic screen** of Paleocene and Eocene limestone section against the Lower Oligocene flysch. In other words the Borshi oil prospect is a similar tectonic model to the Karbunara oil field (Fig. 11).

Çika eroded carbonate anticline lies from the Borshi cross fault to north of the old Dukati village. But firstly let enjoy the wonderful Ionian Riviera segment from Portopalermo bay to Palasa village.

Portopalermo bay is a narrow carbonate rocky one. Here, Ali Pasha Tepelena built his castle. Few underground tunnels were opened during late monist state for warship shelter. Next to Portopalermo bay appears Potam small bay with its unique beach at the delta of the Potam stream. Meanwhile the **Himara town and Himara village touristic centers**, as well as their attractive beaches locate along the central part of the Ionian Riviera from the Potam to Jala seaside touristic hub.

Himara is documented as ancient town since the State of Kaonia in the V century BC, while during the IX-X centuries, years 893- 927, Himara was an **episcopate center** included in **Bulgarian State of King Simeon**. At the end of the XIII century, King Karl of Anshuins made it pa of **Arberi Kingdom**. **Dhërmi** is a village in Himarë Municipality in the Albanian Riviera part of Coastal Albania, 10km northwest of the Himara. Thus, along the road from Himara to the Palasa village, it is the Çika anticline and its thrust front that can be made out from the distance, but westward there are a lot of tectonic gravity blocks fallen as result of the pre-Messinian and Pliocene folding and thrust events, that have masked partly each other and completely the rooting deposits lithological and structural features that develop under them. Nevertheless the gravity fallen blocks have e legible location order, as far as they have old deposits of Lower and Middle Liassic along their western tectonic front and continue successively with **Amonitico Rosso horizon of the Toarcian**, limestone with cherts and cherty package of the Jurassic up to the porcelane limestone package of the Lower Cretaceous. Also, in rare cases encounter tectonic fallen blocks of the nummulitic limestone of the Eocene.

Meanwhile, the **Gjipe torrent** has sawn a **canyon** in the fallen tectonic block of the Liassic dolomite limestone, some 2km southwest of the Vuno village nearby the Ionian coastline. Also, a very nice section of "**Terra Rossa**" **sediments** of Pleistocene cover the fallen blocks carbonate deposits of the area between the Vuno village and the Gjipe canyon (Prenjasi 1980).

Partly free of tectonic fallen block there is the Palasa region where outcrop the **anticline of Palasa** and some restricted fragments of the **Dukati syncline belt** (Fig. 18). The Palasa anticline outcrop consists of the Paleocene-Eocene limestone impacted intensively by karst phenomenon in their lower part of the section, whereas their upper part transits gradually into the Oligocene flysch of much reduced thickness. In other words the Palasa eroded carbonate anticline represents the most western eroded anticline of the Ionian zone. Its southern extension is mostly masked with the tectonic fallen blocks from the Çika eroded anticline and with the

transgressive cover of Terra Rossa deposits aged Pleistocene. Nevertheless, the Palasa anticline chain is detected nearby Jala touristic hub and probably nearby west of the Himara town (Prenjasi et al., 1980). Also the Palasa eroded anticline must continue northwest as an anticline structural chain probably sealed with the Oligocene flysch and thrust westward onto the restricted outcrops of the marl deposits of the Burdigalian of the Syncline belt of Dukati.

Qafa e Llogarasë represent a unique view point and outcrop of the tectonic collapse between the Upper Triassic dolomites of the Çika anticline that thrust westward and the shallow wackstone of the Upper Cretaceous of the Sazani zone (Apulia Foreland) eastward back thrust.

The Upper Cretaceous wackstone of the Sazani zone continue successively westward up to the Middle Oligocene limestone forming the western flank (and geo-morphological slope) of the Mali Kanalit eroded anticline, which dip south west of 50-60° angle (Sota T., et al., 1980). Meanwhile going northwest from the Llogara Pass to the New Dukat village, after an interval of some 4km covered with the slope cemented carbonate breccias of Quaternary, appears the interesting oblique thrust of the Lower Cretaceous wackstone of the western part of the core of Mali Kanalit eroded anticline onto the clay sandstone premolasses deposits of Serravallian, which belong to the syncline belt of Dukati. Following the trip westward beyond the Quaternary cover of the New Dukat and Orikum area appears a large outcrop of the Upper Cretaceous wackstone of the eastern flank of Mali Kanalit eroded anticline, which dip north-east at some 45-50° under the Vlora bay waters.

On the other hand the **Llogara Pass offers a unique touristic hub** due to natural combination of the high mountain of Çika anticline of some 2000m elevation, **Llogara Forest National Park** at some 1000m elevation, and the Ionian seaside of blue transparent water.

The Llogara National Park consists of a dense forest of pine trees green grass and medical plants populated by several kinds of animals. This park is the best Albanian candidate to enter into the **European Geo-park Net**. Furthermore a possible telpher connection between the Llogara touristic hub and Ionian seaside is a future dream project.

The small city of Orikumi lies on the southern end of the Gulf of Vlora, near a marina that can berth 650 yachts. Orikumi was one of the most important in the ancient world, cities in the ancient world; the settlers from the island of Eubea founded it during their retreat from the Trojan War. Orikum's strategic position turned it into the main port of the Illyrian Amant clan and it played an important role in the civil wars between Caesar and Pompey. During the Byzantine period, the small port of Orikum took the name "Jeriko", while during the Ottoman occupation, Orikum took the name "Pasha Liman". The most important archeological object is the antique theater of Orikum, with 400-500 seats.

Another notable local site is the Church of Marmiroi, from the early Byzantine period. Orikum is a good start point if you want to explore the peninsula of Karaburun, which encloses the western part of the Gulf of Vlora. The western shore of Karaburun is spectacular, with small gulfs and isolated beaches with deep and clear water.

The marine cave of Haxhi Alia, (a 17th century sailor from Ulqin) lies north of the peninsula. Antique writings have been found in the steep slopes close to the beach of Grame (the name derives from the Greek word Gramata).

The ruins of the antique city of Amantia stand south of the Vlora District, close to the village Piloçë. Amantia was declared an archaeological park in

2005. It was the capital city of the Illyrian Abant clan. It was founded in the fifth century B.C. and covered an area of 13 hectares. The most interesting objects for visitors are the antique stadium of Amantia, 60 m long and 12.5 m wide, and the fortifications.

Vlora is one of the largest, most populous cities in Albania. It is 130 km from the capital is 130 km and 120 km from Mother Teresa International Airport and has the second largest port in Albania. Vlora is rich with history and antiquity. This monumental city dates back to the sixth century B.C., when it was known as Aulona.

Fragments of the massive wall surrounding Aulona have been found at the center of the city, close to Sheshi i Flamurit ("Flag's Square"). In 1081, the city fell under Norman dominion. In the XIVth century it was part of the "Kingdom of Arbëria" ruled by the Balshaj, Albanian princes, until 1417 when the city was invaded by the Ottomans. In 1812, the city came under the control of Ali Pashë Tepelena, and one century later, on November 28, 1912, it became the first capital of the independent Albania, ruled by the government of Ismail Qemali.

The most interesting sights in Vlora include the Independence Museum (in the headquarters building of the first government), the History Museum, and the Ethnographic Museum. Among the religious objects in Vlora, one of the most important is the Mosque of Muradie, built in 1542 by the chief architect of the Ottoman Empire, Mimar Sinani, who was originally from the region. Also, a prominent hill above the city is home to the Bektashi tekke of Kuzum Babai. The site offers an amazing wide view of the city of Vlora, the peninsula of Karaburun, the island of Sazan and the lagoon of Narta. There are also several interesting clubs and restaurants.

The region is rich coniferous trees and an old Monastery in the northern part, as well as the Radhima and Jonufri beaches and Kanina castle in its southern part. Meanwhile several pale environmental sites rich in sedimentological forms, textures and structures, locate nearby the Zverneci beach and presence of the thick bedded lithothamnic limestone full of macro fauna characterize the lower part of the transgressive molasses deposits of the Upper Miocene. Nearby north of the Kanina Castle

From hydrocarbon potential point of view the Vlora and Povelç regions offer two carbonate gas condensate prospects conditioned by tectonic setting development of the Orogeny fold and thrust belt and the Sazani Zone or Apulia Foreland.

The **Vlora carbonate gas condensate** prospect locates at the age of Ionian Orogeny thrust onto the Sazani/Apulia foreland (Fig. 19). Its possible hydrocarbon trap cross undulation is relatively depicted by seismic works and several dry deep wells as Vlora 5, 6, 10, 11, Panaja 1-2, Zvernec-2, 3, etc, (Prenjasi E., 2011). Whereas depicting the longitudinal closure of the Vlora gas condensate prospect is a challenge of very necessary new seismic works.

The **Povelça carbonate gas condensate** prospect locates in the north western continuation of the core and the eastern flank of Mali Kanalit eroded anticline of the Sazani Zone (Apulia Foreland), that are dissected by a longitudinal westward thrust (Prenjasi E., et al., 1997). Subsequently, below the Povelça molasses dry gas field is depicted the cross closure of the Povelça carbonate gas condensate prospect (Fig. 20, 21) and remains to be recorded its longitudinal closure, i.e. the southern separating pass with the northern continuation of the Mali Kanalit anticline, which is buried under the premolasses deposits of the

Burdigalian transgression (Fig. 19).

On the other hand, sealing of the carbonate reservoir of the Povelça carbonate gas condensate prospect with terrigenous deposits of the Lower Miocene is another issue. Presumably the Foreland carbonates of this prospect are covered with older Miocene or Upper Oligocene premolasses deposits than in the Zverneci-3 well area. But do they continue successively and have sealed the carbonate reservoir or lay transgressively and have opened any hydrocarbon migration path? It's a very big question that needs further detailed investigation.

7. Itinerary Vlora - Tirana

On the way back from Vlora to Tirana it's possible to visit the ancient city of Apollonia, 12 km from Fier. It is one of the greatest archeological centers in Albania bearing numerous testimonies of the past, that flourished during the Roman times. The largest part of the town is still buried. Some 30 different parts have been discovered so far including fragments of the long and up to 6.5m high walls, a part of the temple of Artemis, Obelisk-symbol of Apollo, Fountain of Cephiso, Theatre, Odeon, Public Buildings and Dwelling Houses. Part of the existing complex is St. Mary's Monastery and the Church of the XIII-XIV-th centuries, partly reconstructed and protected as archeological museum.

Apollonia was founded by Corinthian Greeks in 558 BC and quickly grew into an important city-state, minting its own currency. This city became a great cultural centre with famous school of philosophy under the Romans rule. Julius Cezar rewarded Apollonia with title: "Free City" for supporting him against Pompey the Great during a civil war in the first century BC and sent his nephew Octavius, the future Emperor Augustus, to complete his studies there. After a series of desastres, Apollonia population moved south to Aulona (present day Vlora) and by the end of the V-th century AC, only a small village with a bishop remained in ancient Apollonia.

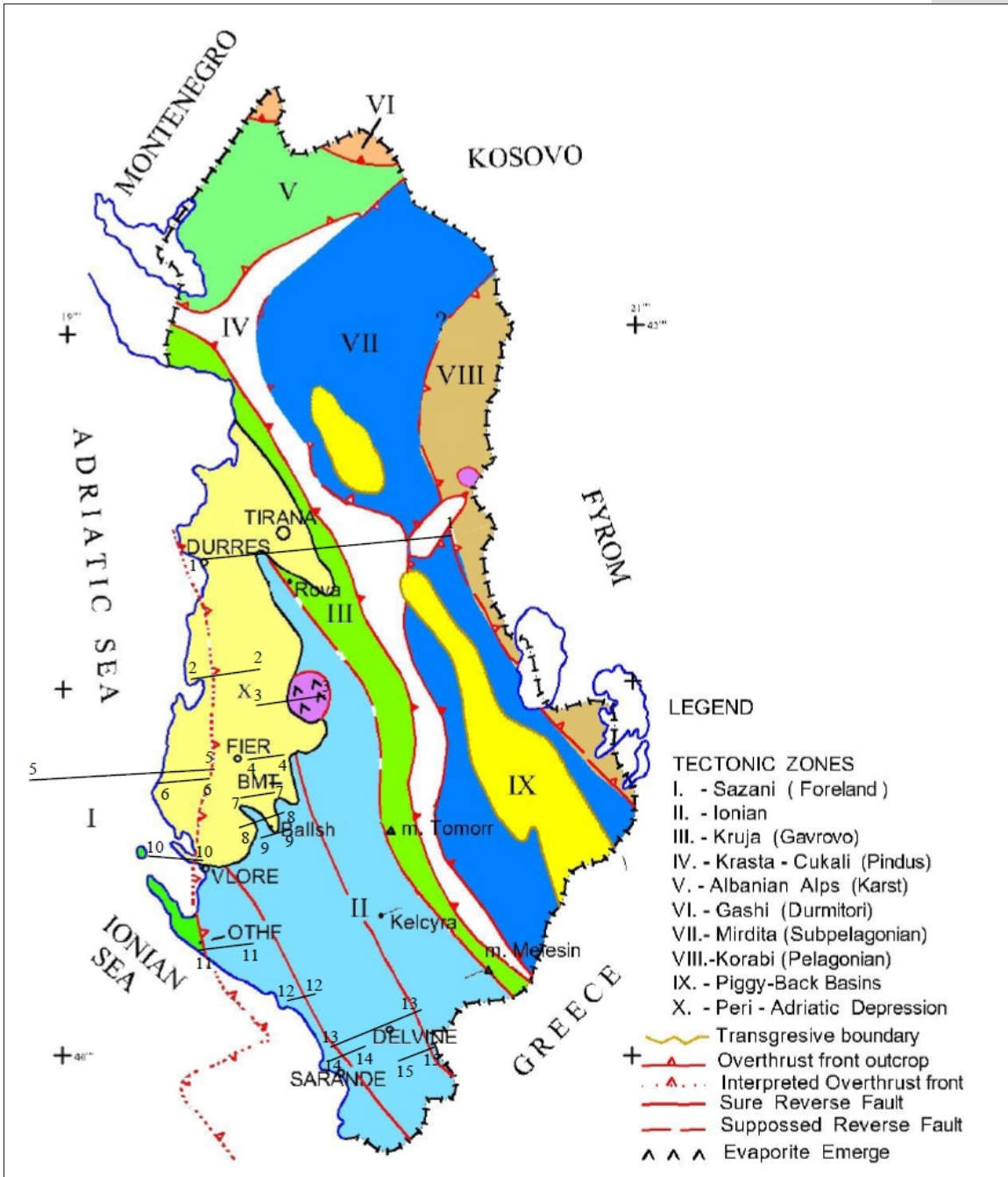


Fig. 3. Tectonic sketch of the Albanides fold-and-thrust belts.

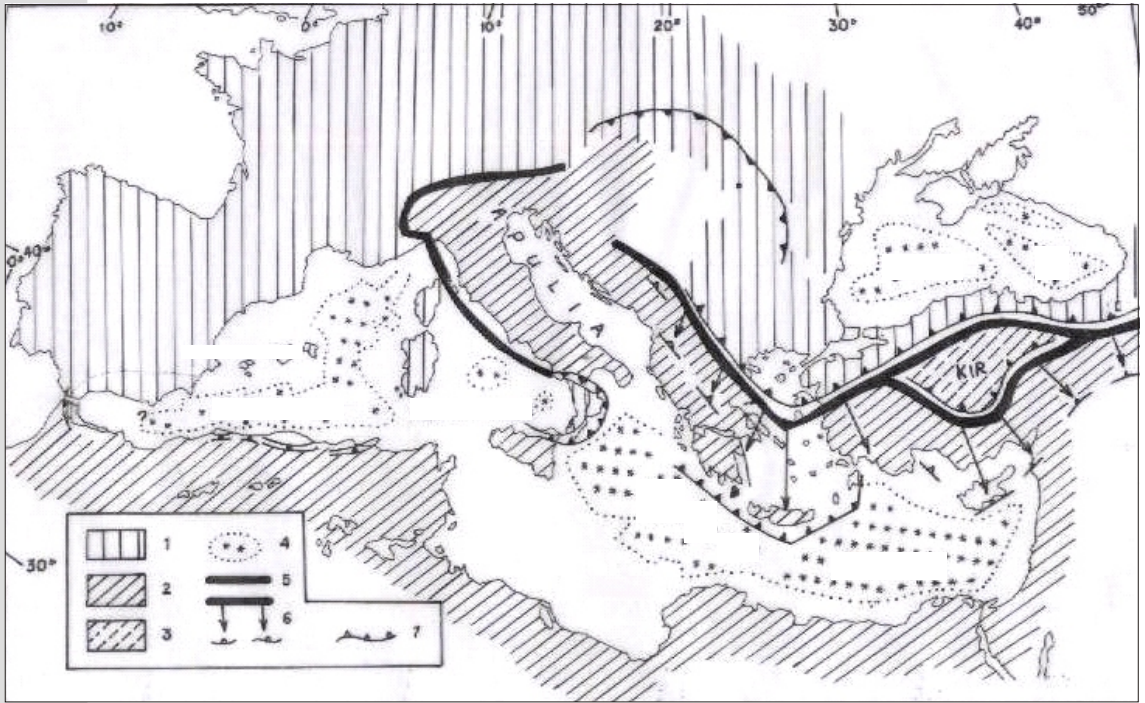


Fig. 4. Location of the Albanides fold-and- thrust belts in the framework of the African plate subduction under the Euro-Asiatic one (after Ricou E. L., *et al.*, 1986) 1. EuroAsiatic continent, 2. African continent, 3. Kishir block, 4. Present oceanic basins, 5. Boundaries of Mesozoic oceans, 6. Boundaries of Mesozoic oceans and the main ophiolitic nappes, 7. Troughs of present and past subductions.

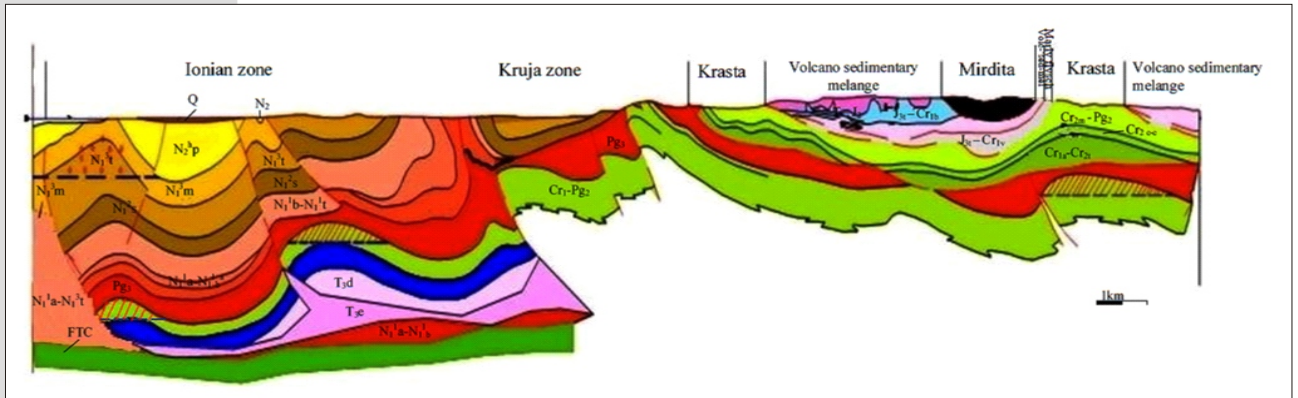


Fig. 5. Geoseismic profile 1-1, across the Albanides fold-and-thrust belts nappes, that thrust onto each other and wholly onto the Apulia-Sazani Foreland. Q -Quaternary, N_{2p} -Pliocene, N_{1m}^3 -Messinian, N_{1t}^3 -Tortonian, N_{1s}^2 -Serravallian, N_{1b}^1 - N_{1l}^1 -Burdigalian-Langhian, N_{1a}^1 - N_{1b}^1 -Aquitanian-Burdigalian, $Pg_3^{1,2,3}$ Lower + Middle + Upper Oligocene, Cr_1 - Pg_2 -Cretaceous-Eocene, Cr_{2m} - Pg_2 Maastrichtian-Eocene ("Young Flysch"), Cr_2c-c -Coniacian-Campanian, Cr_{1a} - Cr_{2t} - Aptian-Turonian ("Early Flysch"), J_{3t} - Cr_{1v} - Tithonian-Valanginian (Marly Flysch), J_{3t} - Cr_{1b} -Tithonian-Berriasian (Tectonic Mélange), T_3e - Upper Triassic evaporate rocks, T_3d -Upper Triassic dolomite rocks, FTC -Foreland (Apulia - Sazani zones) top carbonates, Supposed dry gas and gas condensate -water contacts.

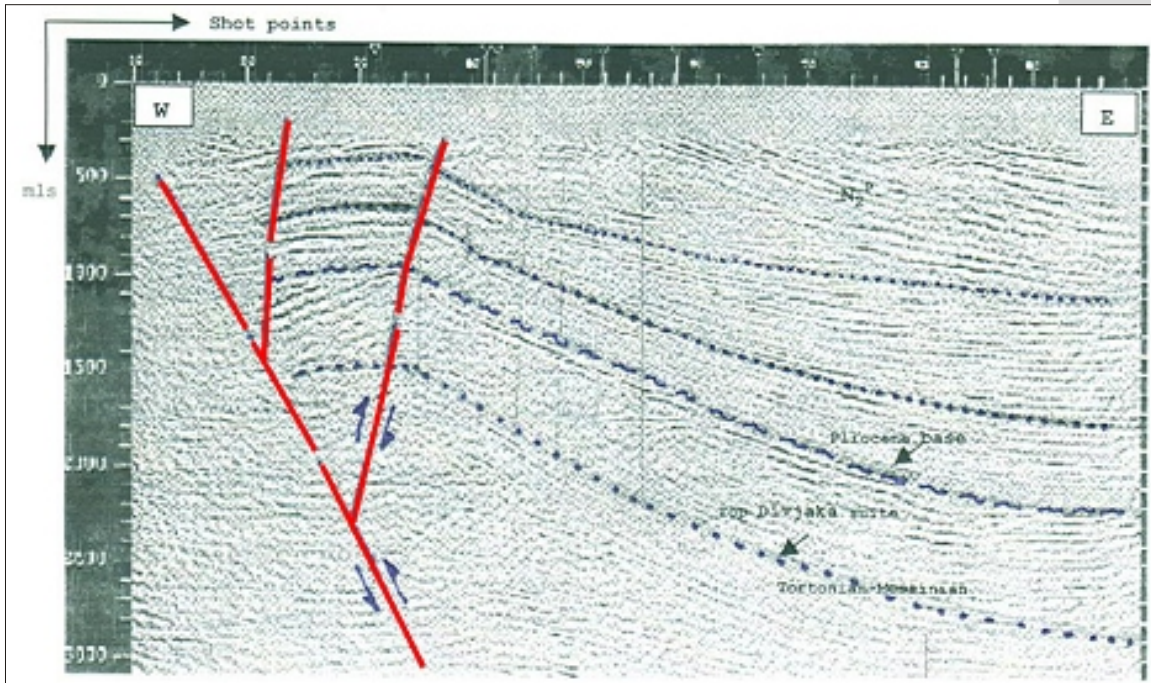


Fig. 6. Geoseismic profile 2-2, across the Divjaka dry gas field. Geological boundary (after Kurti Sh. et al.1989).

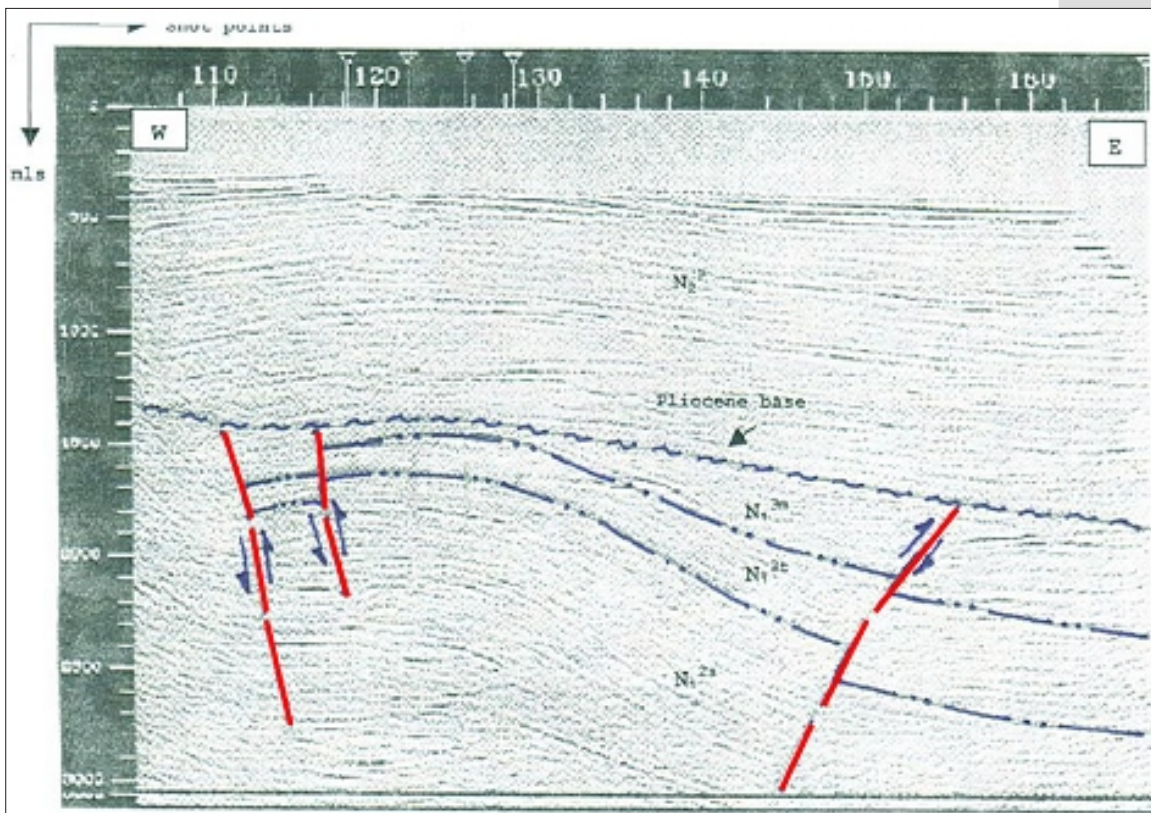


Fig. 7. Geoseismic profile 6-6 across the Povelča dry gas field. Geological boundary. N_1^{2a} Serravallian, N_1^{3m} Tortonian, N_1^{3m} Messinian, N_2^p Pliocene (after Rakipi N. et al.1994)

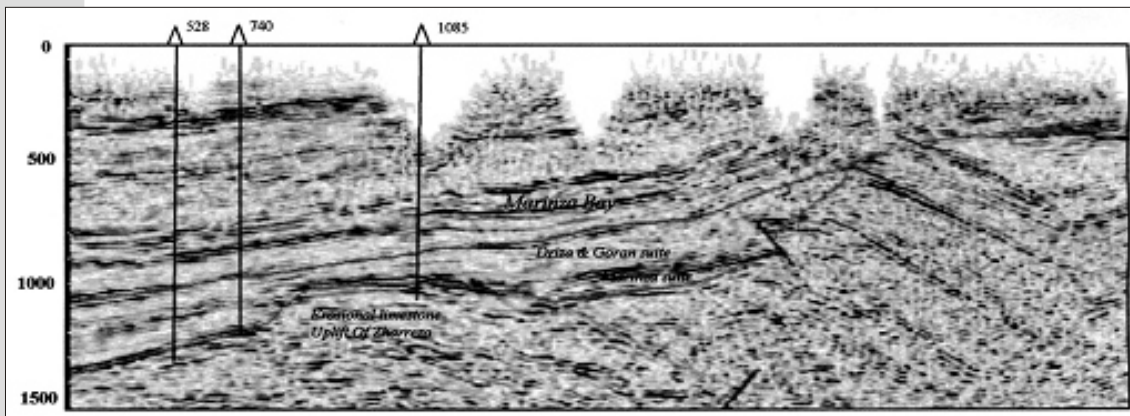


Fig. 8. Geoseismic profile 112/83 across the Patos-Marinza field.



Fig. 9. Geological profile 7-7 across the Visoka massive hydrodynamic oil pool (after Mezini A. and Fili I., 2010)

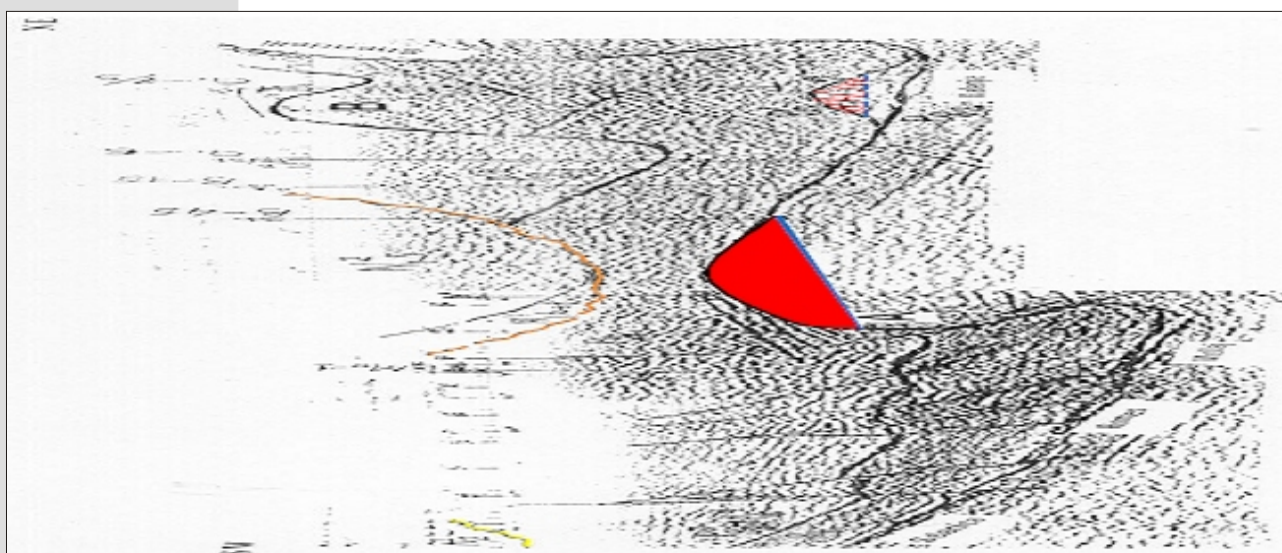


Fig. 10. Geoseismic profile 7-7 across the Ballshi oil field (A) and the Oligocene flysch anticline of the Kalenja carbonate oil prospect (B) Pg₂ -Eocene limestone, Pg₃¹⁻³ - Lower, Middle and Upper Oligocene flysch, N₁¹ -Burdigalian and Langhian, N₁² -Serravallian, N₂ -Pliocene, B-45 -Drilled well. Proved oil-water contact, - - - - - Supposed oil-water contact.

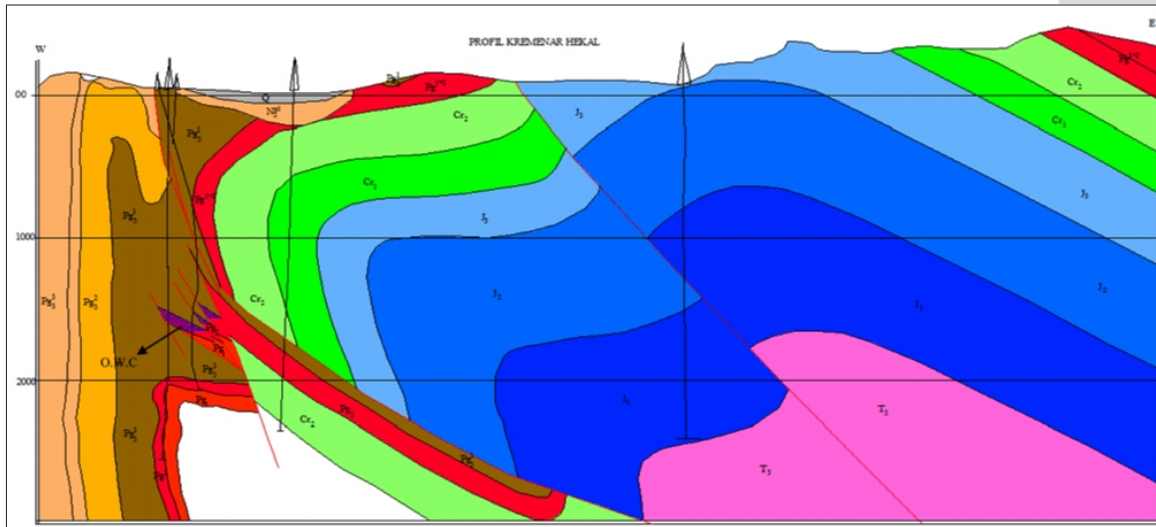


Fig. 11. Geological profile 9-9 across the Karbunara oil field situated in three tectonic screen pools. Q. - Quaternary, N_{1b} -Burdigalian, N_{1a} -Aquitanian, $Pg_{3}^{1,2,3}$ - Lower, Middle, Upper Oligocene, Pg_{1+2} - Paleocene + Eocene, $Cr_{1,2}$ - Lower, Upper Cretaceous, $J_{1,2,3}$ - Lower, Middle, Upper Jurassic, T_{3d} & T_{3e} - Upper Triassic (dolomite & evaporitic deposits), OWC Proved Oil-water contact.

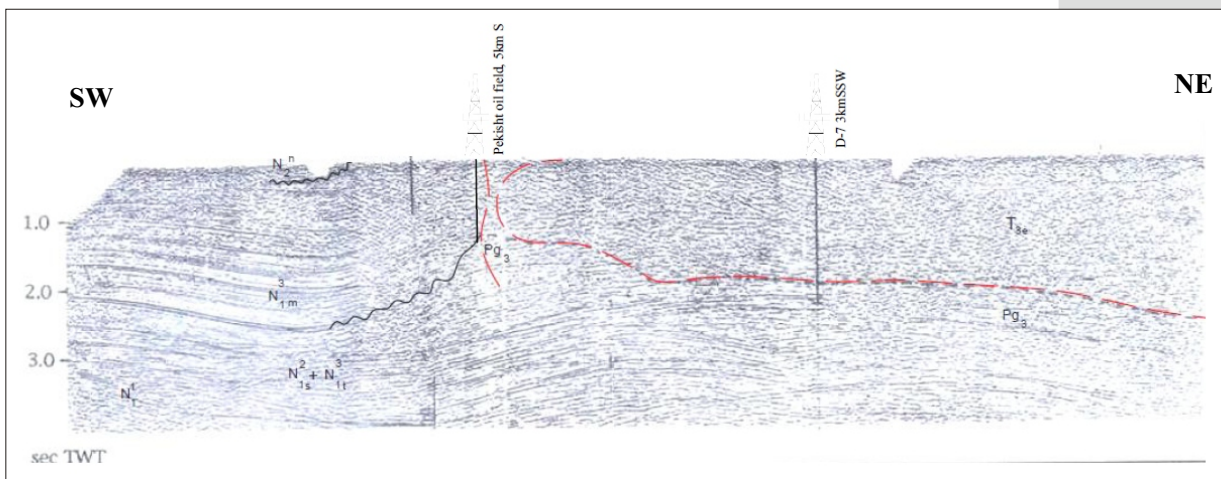


Fig. 12. Geoseismic profile 3-3 across the Dumre diapire of the Upper Triassic evaporitic rocks, as well as the Pekishti oil field in the Upper Miocene molasses deposits screened against the Oligocene flysch.

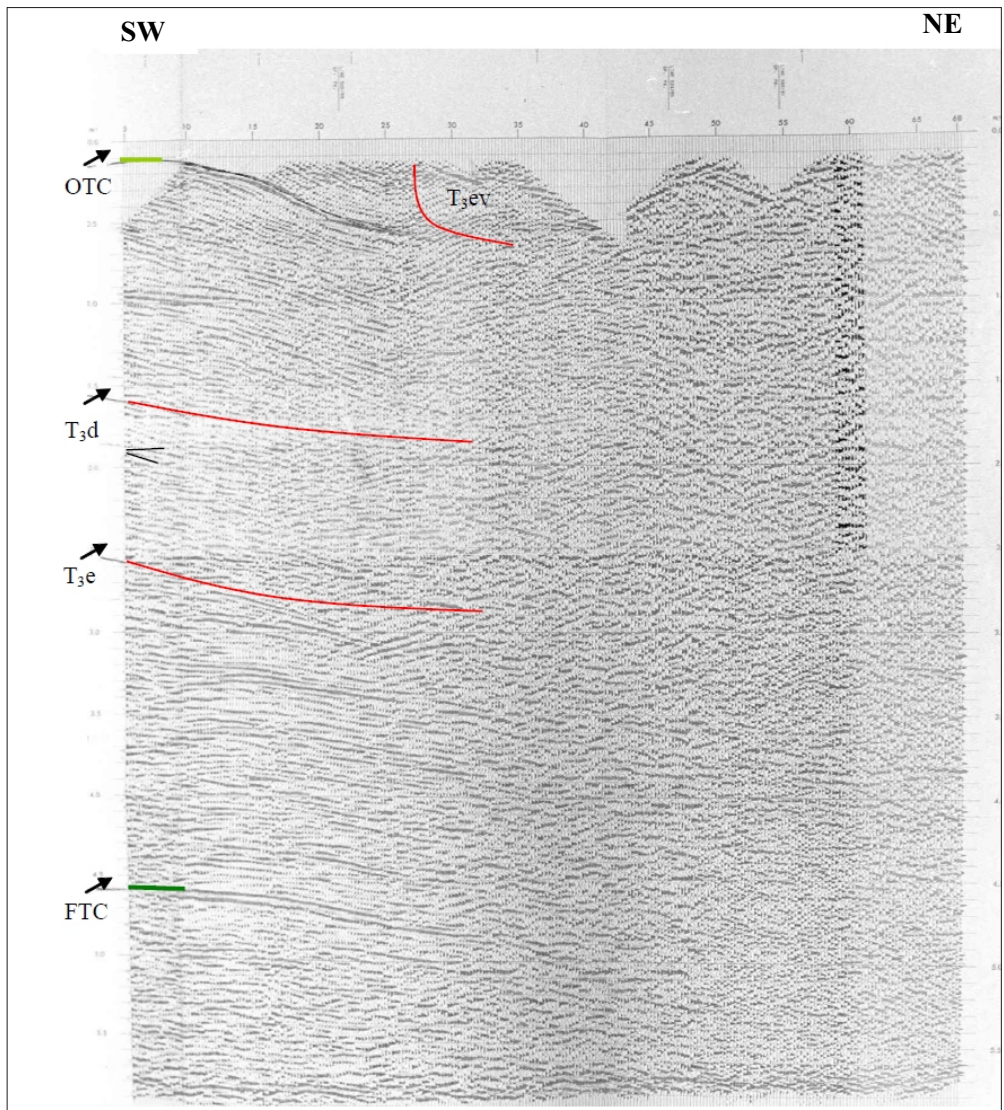


Fig. 13. Cross seismic time section 251 / 81: Geoseismic interpretation of presence of Apulia-Sazani Foreland (FTC), under the evaporitic sequence of the Albanides fold-and-thrust belts (T3 ev.). Meanwhile, there is absolutely no seismic information on the Delvina gas condensate field (right part) below the outcrop of the carbonates and evaporite diapires of the Upper Triassic of the Mali Gjere anticline.

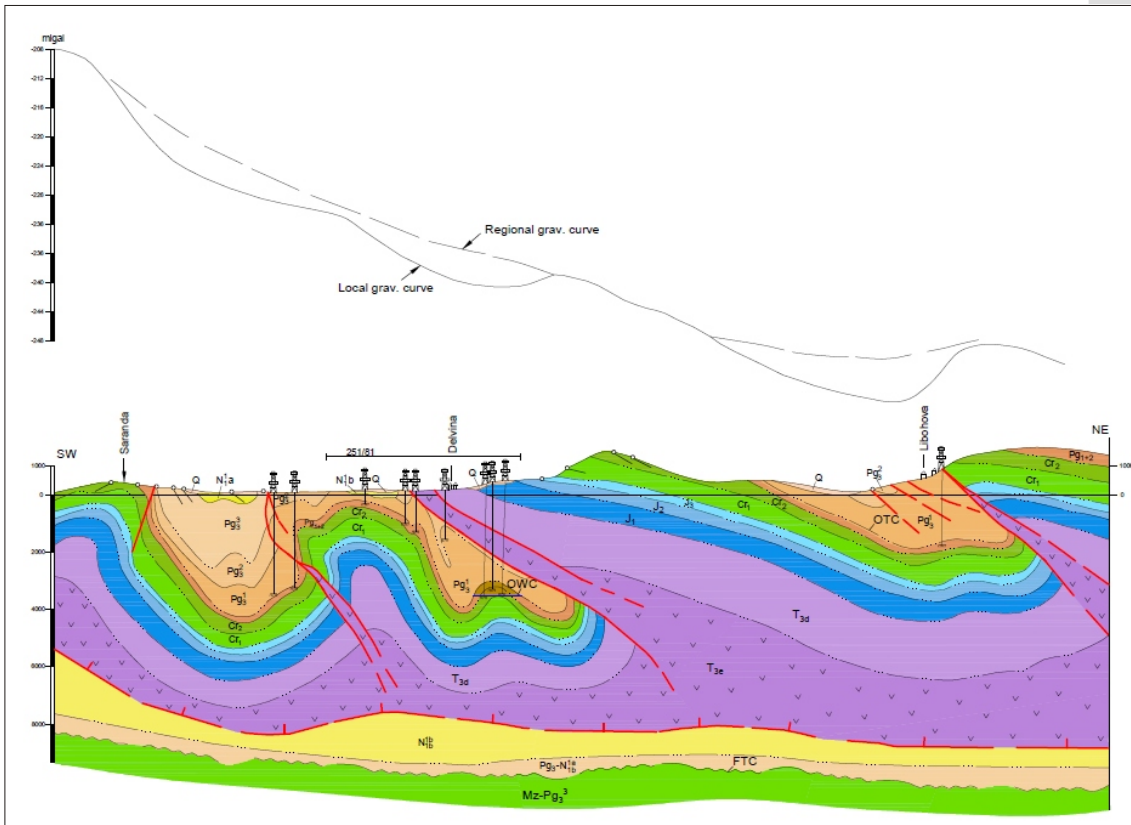


Fig. 14. Geoseismic profile 13-13, across the Delvina gas condensate field and detection of Apulian-Sazani Foreland (FTC) presence below the Albania thrust belt (OTC), Q. - Quaternary, N_{1b} -Burdigalian, N_{1a} -Aquitian, $Pg_{1,2,3}$ -Lower, Middle, Upper Oligocene, Pg_{1+2} - Paleocene and Eocene, $Cr_{1,2}$ -Lower, Upper Cretaceous, $J_{1,2,3}$ -Lower, Middle, Upper Jurassic, T_{3d} & T_{3e} -Upper Triassic (dolomite and evaporitic deposits), OWC Gas condensate-water proved contact.

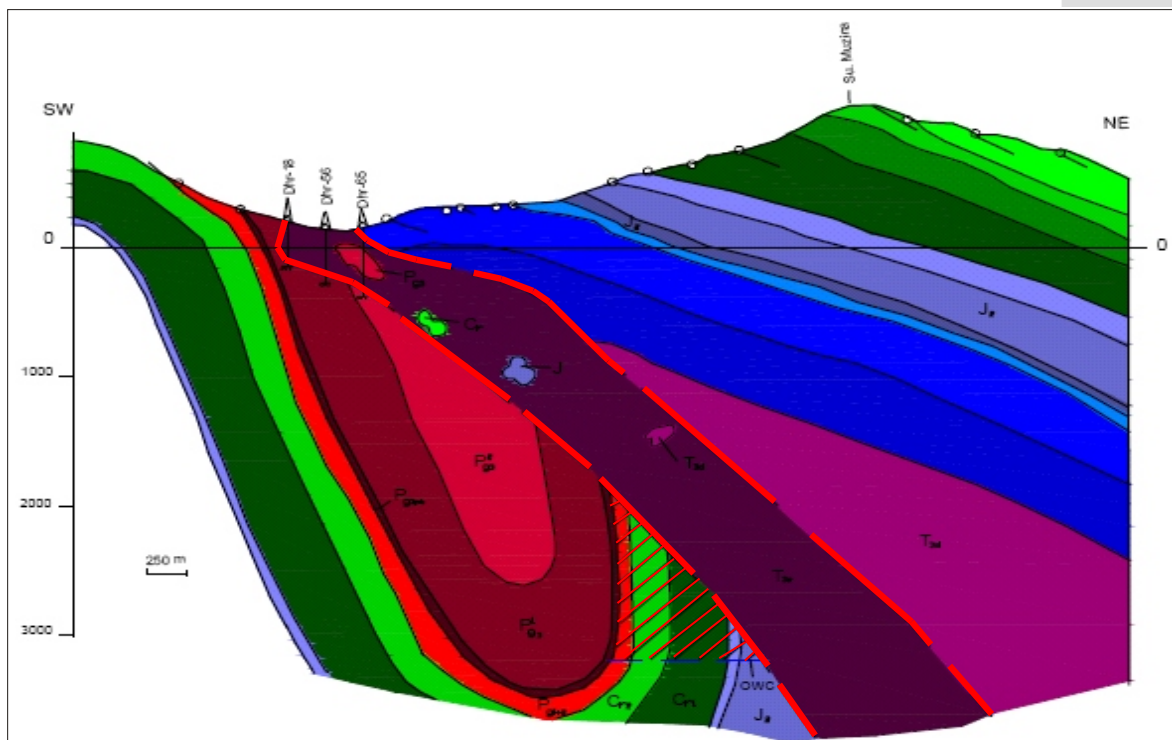


Fig. 15. Geologic profile 15-15 across the Dhrovjani carbonate oil prospect in a tectonic screen trap. $Pg_{1,2,3}$ -Lower, Middle, Upper Oligocene, Pg_1+Pg_2 -Paleocene + Eocene, $Cr_{1,2}$ -Lower, Upper Cretaceous, $J_{1,2,3}$ -Lower, Middle, Upper Jurassic, T_{3d} & T_{3e} -Upper Triassic (dolomite & evaporitic deposits), Supposed oil-water contact.

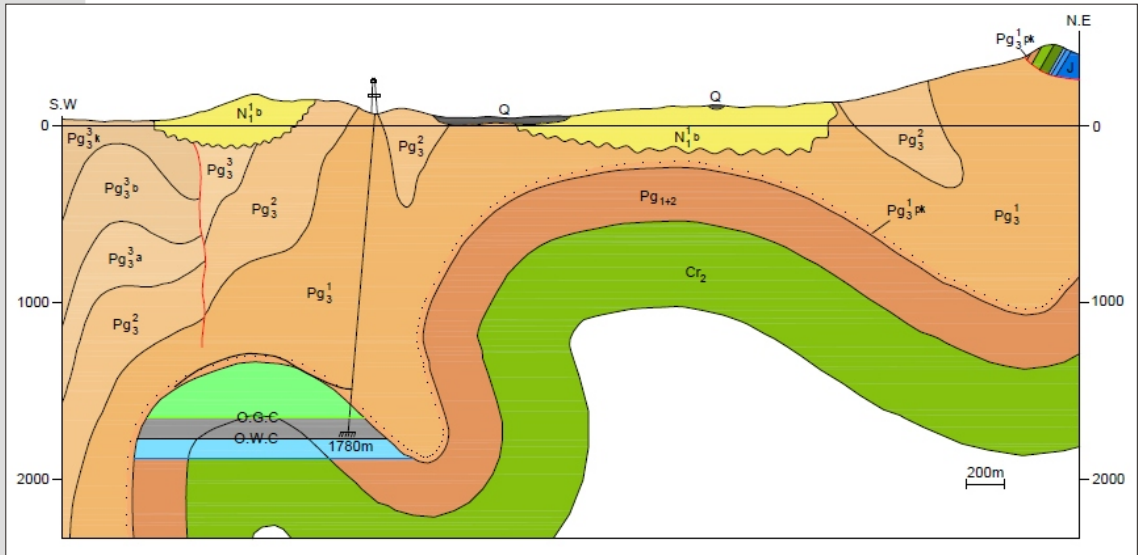


Fig.16. Geoseismic profile 14-14 across the Finiqi-Krane oil-gascondensate field. Q.- Quaternary, N_1^b Burdigalian, $Pg_3^{1,2,3}$ -Lower, Middle, Upper Oligocene, Pg_3^1 -Transition marl package, Pg_{1+2} -Paleocene and Eocene, Cr_2 Upper Cretaceous, $J_{1,2,3}$ Lower, Middle, Upper Jurassic, \sim -Top Eocene limestone seismic event, OGC -Proved oil-gas condensate contact, OWC Proved oil-water contact.

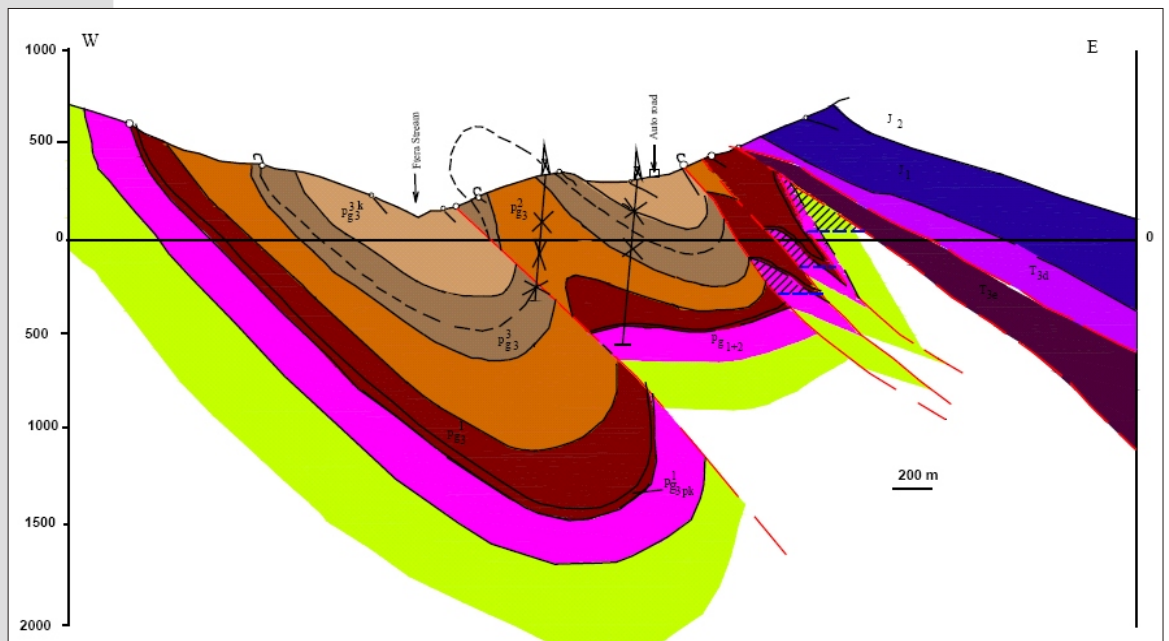


Fig.17. Geological profile 12-12 across the Borshi carbonate prospects in the eastern part of this figure and the Oligocene flysch anticline reflected merely as a terrace at the Top Eocene carbonates in the central part. $Pg_3^{1,2,3}$ -Lower, Middle, Upper Oligocene, Pg_{1+2} -Paleocene+Eocene, Cr_2 -Upper Cretaceous, $J_{1,2,3}$ - Lower, Middle, Upper Jurassic, T_{3d} & T_{3e} -Upper Triassic (dolomite & evaporitic deposits), \sim Supposed oil-water contact.

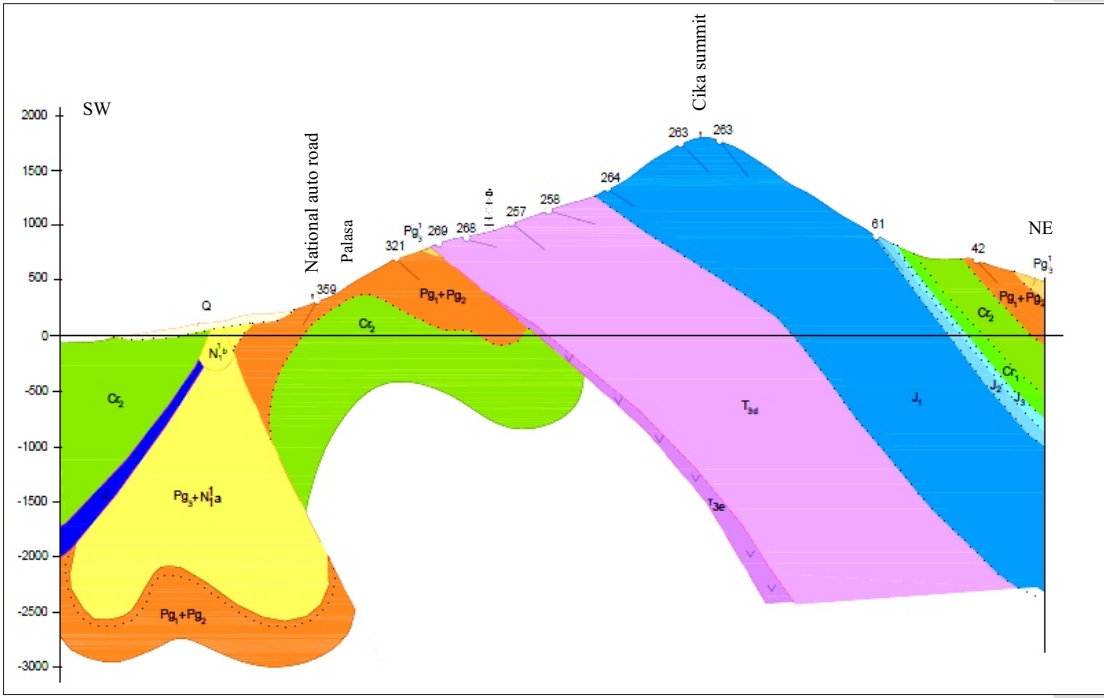


Fig.18. Geological profile across the Apulia-Sazani Foreland outcrop, syncline belt of Dukati, as well as Palasa and Çika eroded anticlines (after Prenjasi E. et al., 1980).

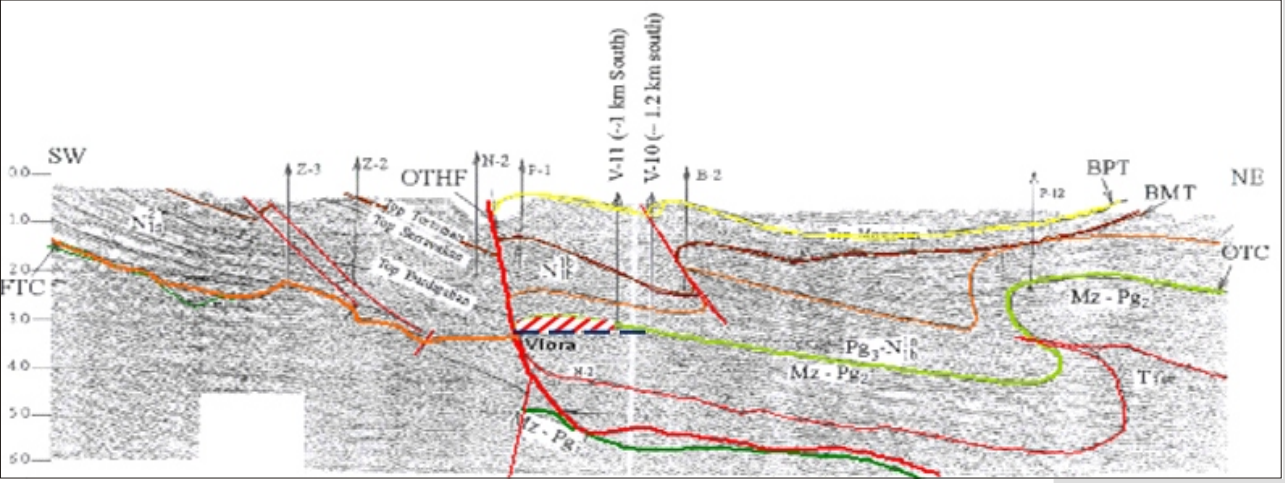


Fig. 19. Geoseismic profile 8-8 across the Vlorë gascondensate prospect situated along the edge of the Albanides fold-and-thrust belts overthrust onto the Sazani Foreland. BPT Base of Pliocene transgression, BMT Base of Messinian transgression, OTC -Orogeny top carbonates, OTHF -Orogeny thrust front, FTC - Foreland top carbonates, Mz - Pg_2 -Carbonate sequence of Albanides thrust belts, Mz- Pg_3 -Carbonate sequence of Mesozoic-Oligocene in Apulia-Sazani Foreland, $Pg_3-N_1^a$ -Oligocene to lower Burdigalian, N_1^b -Upper Burdigalian, N_1^1 -Langhian, N_1^2 -Serravallian, N_1^3 -Tortonian, N_1^m -Messinian, P-1 -Drilled well, Supposed oil-water contact.

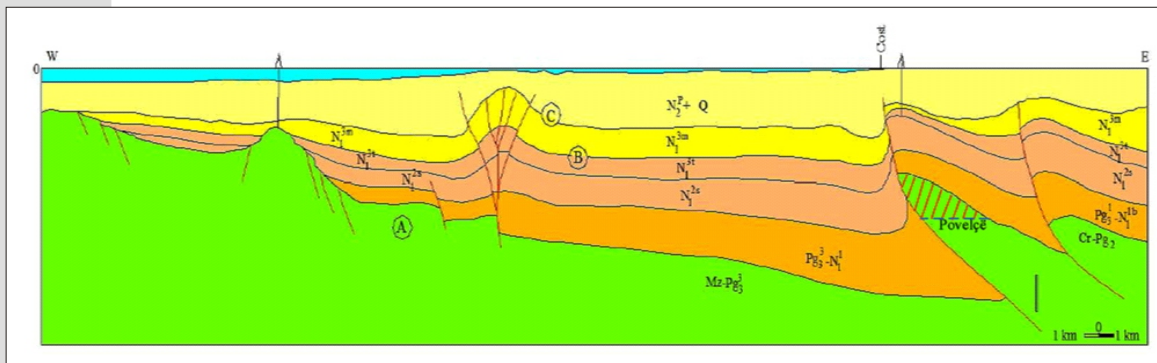


Fig. 20. Geoseismic profile 5-5, across the Apulia-Sazani Foreland (A) and the Semani carbonate gascondensate prospect. Mz - Pg₂ Carbonate sequence of the Ionian and Kruja (Gavrovo) nappes, Mz-Pg₃ Carbonate sequence of Mesozoic-Oligocene in Apulia-Sazani Foreland, Pg₃-N₁^{1a} Oligocene to Lower Burdigalian, N₁^{1b} Upper Burdigalian, N₁¹ Langhian, N₁² Serravallian, N₁³ Tortonian, N₁³ Messinian, — — Supposed gascondensate - water contact. - - - Fault and thrust in Foreland and Periadriatic basin, — — Orogeny thrust front.

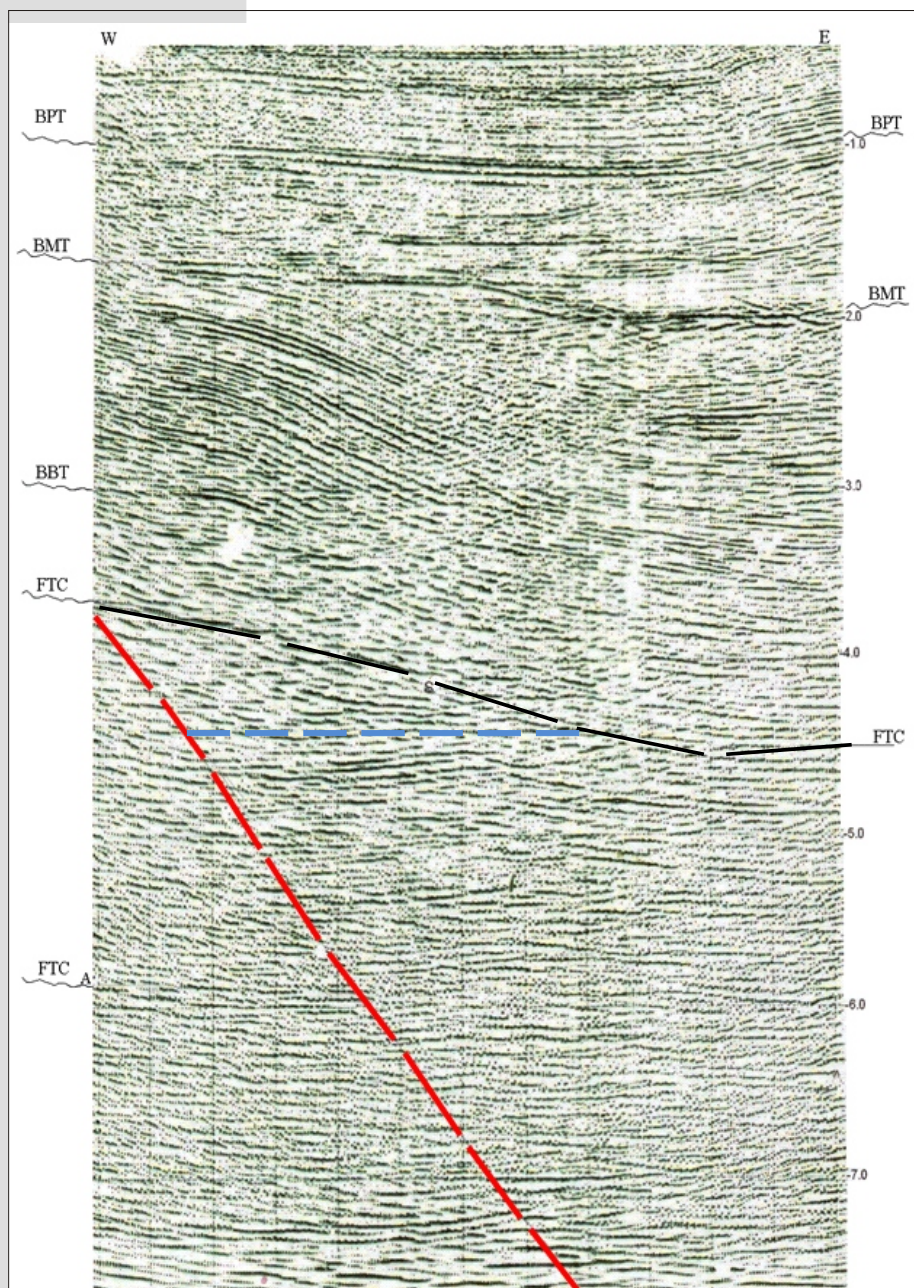


Fig. 21. Geoseismic profile 19/90 across the Povelça carbonate gascondensate prospect in the Apulia-Sazani Foreland. BPT - Base of Pliocene transgression, BMT -Base of the Upper Miocene transgression, BBT -Base of Burdigalian transgression, FTC - Foreland top carbonates, Mz-Pg₃ - Carbonate sequence of Mesozoic-Oligocene in Sazani Foreland, N₁^{1a}-N₁^{1b} -Aquitanian to lower Burdigalian, — — Supposed tectonic thrust, — — Supposed oil-water contact.



Photo 1. Bituminous sandstone of the Driza suite aged Upper Miocene at the Kasnica Quarry



Photo 2. Macrofauna fossils in the bituminous sandstone of the Driza Suite of the Upper Miocene at the Kasnica Quarry



Photo 3. Transgression of the premolasses deposits of Serravalian of the eastern flank of the Ballshi syncline onto the Eocene limestone of the Kremenara northern pericline.



Photo 4. Upper Cretaceous bioclastic carbonate reservoir rocks of the eastern flank of the Kremenara anticline impacted by some fracture systems, which are filled in with bituminous and oil shows.



Photo 5. Upper Cretaceous-Paleocene-Eocene bioclastic carbonate reservoir rocks with slump horizons of the eastern flank of the Mali Gjere anticline along the Muzina Pass to Grapsh village.

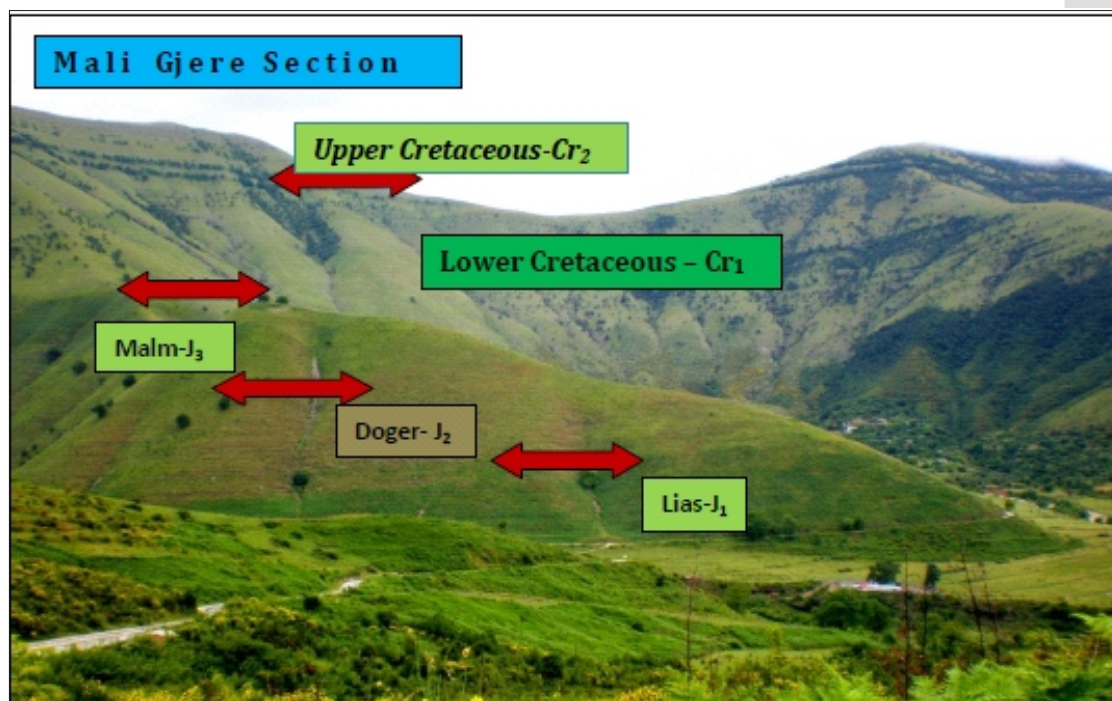


Photo 6. Outcrop of the Liassic to Upper Cretaceous carbonate, cherty and shale deposits in the Western slope of the eroded anticline of Mali Gjerë.



Photo 7. Blue eye springs sourcing along the outcrop of the thrust of the Lower and Middle Liassic pelagic limestone onto the Upper Triassic evaporitic diapire of the Mali Gjerë anticline.

REFERENCES

- Bakia H, Yzeiri D, Dalipi H, Dhimulla I. 1987**, Geological setting and the oil and gas prospects of the Kruja, Ionian, Sazani zones and circum-Adriatic Depression. (Archive of Albania Geological survey, Tirana).
- Canaj B, Mezini D, Prenjasi E., Sejдини B, Xhufi C, Stamati A, Pulija Th. 1976**. Integrated geological-geophysical synthesis of the Kalcati region. Archive of Albania Geological survey, Tirana.
- Dalipi H, Kondo A, Pejo I, Ikonomi J. 1964**, Stratigraphy of the Mesozoic of the Southern and Western Albanides. Archive of Albania Geological survey, Tirana.
- Dalipi H. 1985**. The main phases of the geologic evolution history of the External Albanides. *Nafta dhe Gazi*. N. 2. 33-54, Published by former Oil and Gas Institute, Fier, Albania.
- Dalipi H, Dhimulla I, Prifti Dh. 1977**. Accumulation condition and location constrains of the Tortonian target gas pools in the Western part of the Periadriatic Foredeep. Archive of Albania Geological survey, Tirana.
- Diamnti F, Dule A. 2008**. Source rocks horizons of the Kruja and Ionian zones (Albanides) and their geochemical evaluation. *Nafta Shqiptare*, nr. 1, 2008, Albpetrol Ltd, Patos, Albania).
- Frasheri A, Bushati S, Bare V. 2003**. Geophysical outlook on structure of the Albanides. (Journal of Natural & Technical Sciences, N. 14, 135-158, Published by Albanian Academy of Sciences.
- Frasheri A, Bushati S, Nishani P, Liço R 2009**. Albanian geophysics in years. Archive of Faculty of Geology and Mining, Tirana.
- Gjoka M, Shehu H, Prenjasi E, Dhimulla I, Xhufi C, Melonashi G, Papa N, Sylari V, Brahimi Q, Veizi V, Braho N, Kozmai S, Rapaj D. 1987**. Integrated study on connection, constrains and geological setting specifications of the region Amonice Kolonje for both tectonic stages and outline of further perspective for oil and gas exploration. Archive of Albania Geological Survey, Tirana.
- Institute of Study and Geological Projecting (ISGP), 1987, Geology of Republic of Albania and geological map at scale 1:200000. (Archive of Albania Geological survey, Tirana).
- Jacobshagen V. 1986**. *Geologie von Greichenland*. (Gebruder Borntraeger, Berlin).
- Kurti Sh, Buli K. 1999**. Geologic-geophysics and enterprise study on the Tortonian-Messinian deposits in the Divjaka gas field. Archive of Albania Geological survey, Tirane.
- Mezini A, Fili I. 2010**. Hydrodynamic conditions of the Visoka field trapping. Archive of IEC Visoka, Albania Branch.
- Miljushi I. 1973**. Geologic-tectonic structure and evolution of Outer Dinarides and Adriatic area. *AAPG Bulletin*. 57, No. 5, 913-929.
- Murataj P. 1962**. Relation about necessity of drilling an exploratory-structural well in the Murrizi region Archive of Albania Geological survey, Tirana.
- Nikolla L, Tego S, et al., 2012**, Concrete recommendations for energetic sources through geologic-geophysic studies. Re-estimation of oil and gas reserves after EU standards including the unconventional oils.
- Plaku K. 1961**. Short Report on projecting deep exploratory wells nearby the Patos-Marineza oil field. Archive of Albania Geological survey, Tirana.

- Prenjasi E, Shteto Th, Agalliu L. 1981.** Geological setting and the oil and gas prospects of the Dobrenj- Zelevizhde region. Geological survey Report, Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Ndoni J, Agalliu L. 1982.** Geological setting and the oil and gas prospects of the Elbasan-Labinot region. Geological survey Report, Archive of Albania Geological survey, Tirana.
- Prenjasi E, Ndoni J, Agalliu L. 1983.** Geological setting and the oil and gas prospects of the Shelcan-Guri Topit region. Geological survey Report, Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Çurri F, Iljazi F. 1980.** Geological setting and the oil and gas prospects of the Himara region. Geological survey Report, Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Velaj T, Bega Z. 1980.** Additional relation on integrated geologic-geophysical synthesis on the Delvina region. Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Kumati LL, Hoxha P. 1984.** Geological setting and the oil and gas prospects of the Buz-Dragot region. Geological survey Report, Archive of the Albanian Geological Survey, Tirana.
- Prenjasi E, Naço P, Nikolla L, Sinani P. 1984.** Geological revision for planschets unification of the region "Ballsh-Verbas" and "Peshkëpi-Kotë". Geological survey Report., Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Naço P, Nikolla L, Mëhillka LI, Sadikaj Y, Çela Rr, Sinani P. 1985.** Integrated geological-geophysical synthesis of the Kalenja region. Archive of Albanian Geological Survey, Tirana.
- Prenjasi E, Goxhaj D, Pollo S, Katiu V, Budo B. 1986.** Integrated geologic-geophysical synthesis of the Fitore-Karahaxh region. *Archive of Albanian Geological Survey, Tirana.*
- Prenjasi E, Spiro S, Ikonomidhi F., Shehu Sh., Pulia Th. 1986.** Integrated geological-geophysical synthesis of the Dhrovjan-Palavli region. Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Misho V, Gega N. 1989.** Integrated geologic-geophysical synthesis of the Borsh-Bolen region. Archive of Albanian Geological Survey, Tirana.
- Prenjasi E. 1992.** *Doctorate Thesis:* Tectonic setting and present spatial position of the carbonate structures sealed with the Oligocene flysch in the Ionian zone. (*National Library of Albania, Tirana*).
- Prenjasi E, Jano K. 1994.** Integrated geo seismic synthesis of the Block-5 Albania Offshore. Archive of Albanian Geological Survey, Tirana.
- Prenjasi E, Bare V, Xhelili A. 1997.** Integrated geological-geophysical synthesis on the Northern Zvërnec-Seman region. Archive of Albania Geological Survey, Tirana.
- Prenjasi E, Dhima S, Melonashi G. 1998.** Integrated geological-geophysical synthesis of the onshore Delvina Block. Archive of the Albanian Geological Survey, Tirana.
- Prenjasi E, Shehu H, Bonjaku S, Myftari S, Çobaj M. 2001.** Study on the structural and tectonic model of both tectonic stages of the Durres-Peqin region, based on integrated geological-geophysical and drilled wells data. Archive of the Geological Survey of Albania, Tirana.
- Prenjasi E, Tego S, Arapi L. 2011.** Oil and gas exploration methodology in thrust belt regions. Presentation at the Offshore Mediterranean Conference, Ravenna..
- Prenjasi E, Prifti I, Shenjatari A, Ymeri A. 2011.** Tectonic setting and

hydrocarbon potential of the Albanides fold-and-thrust belts Oral Presentation at the 60-th anniversary of the Polytechnic University of Tirana. 195

Prenjasi E, Thodhoriani S, Puka V, Arapi L. 2011. Gradual transition between the Kruja-Gavrovo and the Ionian zones. Presentation at the 4th International scientific conference on Energy and Climate Change, Athens, CD.

Ricou EL, Dercourt J, Geysant J, Grandjacquet C, Lepvrier C, Biju-Duval B. 1986. Geological constraints on the Alpine evolution of the Mediterranean Tethys. *Journal of tectonophysics*. 15 Mar.

Rakipi N, Sota T, Goxhaj M, Koçi R, Ndrio V, Fezga F. 1994. Integrated geological-geophysical synthesis on the Povelç-Seman region. Archive of the Geological Survey of Albania, Tirana.

Sota T, Gora H. 1980. Geological setting and the oilgasbearing perspective of the Karaburun region. Geological survey Report, Archive of Albania Geological Survey, Tirana.

Shehu H, Dhimulla I, Muhameti P, Starova S, Lino K. 1966. Integrated geologic-geophysical synthesis of the Q. Stalin region. Archive of Albania Geological Survey, Tirana.

Tushe I, Nazaj Sh, Prenjasi E, Seiti E. 1994. Integrated geological-geophysical synthesis on the Albanian Adriatic and Ionian Sea Offshore. Archive of the Geological Survey of Albania, Tirana.

Zappaterra E. 1990. Carbonate pale geographic sequences of the Peri-Adriatic region. *Bull. Soc. Geol. It.*, 109/5-20.