The Hydrocarbon Potential of Albania*

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Introduction

The recent drilling in search of hydrocarbons performed by Royal Dutch Shell and Petromanas Albania in Molisht-Shpirag area near Berat in Albania has led to renewed interest in this rich hydrocarbon area. Albania is located in the western part of the Balkan Peninsula at the eastern coasts of Adriatic and Ionian seas. Albania has common borders with Montenegro, Kosovo, Macedonia and Greece. It is characterized by a Mediterranean climate consisting of hot and dry summers with long days of sunshine, followed by mild and wet winters. The country is a parliamentary republic with a population of 3.01 million people, area of 28,748 km^2 with the capital in Tirana.

Hydrocarbon Occurrence

Albania was established as a hydrocarbon-bearing province as early as Roman times, when heavy oil and asphalts of Selenica mine were used as fuel for lamps. In 1918 the oil was discovered in the Oligocene flysch in Drashovica. In 1927 and 1928, respectively, the Kucova and Patosi oil fields, related to Messinian clastic reservoirs, were discovered. Marinza, the biggest oil field in Albania, is related to Messinian-Tortonian clastic reservoirs. Visoka, the first oil field related to carbonate reservoirs (discovered in 1963), was followed by other discoveries such as Gorishti, Ballshi, Finiq-Krane, Cakran-Mollaj, Amonica, and Delvina. The first gas discovery in 1963 in the Tortonian sandstone layers of Divjaka led to further discoveries, such as Frakulla, Ballaj, Povelca, Panaja, and Durres. The A4-1X well drilled in 1993 by AGIP and Chevron (Adriatiku-4 offshore) proved oil- (condensate) and gas-bearing in Messinian clastic reservoir. The first light oil discovery onshore Albania was made by Oxy in 2001 (Shpiragu discovery) after the drilling and testing of Shpiragu-1 well in the Sqepuri structure located in the Block 2 area.

Due to the intensive development of oil and gas fields production increased dramatically, reaching a peak for oil, at 2.25 million tons, in 1974 and gas, 940 million Nm^3, in 1982. In the 1980s crude oil production decreased to 1.4 million tons and it continued to decrease to 1.1 million tons in 1990. Albania saw a drastic fall of oil production during the first half of 1990s, reaching the bottom in 2000 with 0.32 million tons. Since 2000, however, there has been a gradual increase in oil production.

Geological Framework

Situated in the western part of the Balkan Peninsula, Albania includes portions of the petroliferous Durres and Ionian sedimentary provinces. As an element of the southern branch of the Alpine folded belt and the Apulian plate, this area has experienced Mezosoic rifting and the Cenozoic collision of the European and African plates (Figure 1). Part of the southeast Adriatic region, the territory of Albania is characterized by the progressive advancement from north to south of overthrusting of the more external parts of the Dinaride-Hellenide (locally called Albanides) chains onto the Apulian-Adriatic foreland. The Adria plate or the Apulian-Adriatic foreland is composed of Permo-Triassic clastics and evaporites, Mesozoic carbonates overlaid by Tertiary carbonates and clastics. In Italy it is characterized by the gentle folding and by systems of normal faults. The Apulian-Adriatic foreland extends eastwards to Albania and may represent a rather deep prospective area offshore Albania. Albania is a part of the Mediterranean Alpine Folded Belt and fits in the Dinaric-Hellenic range between Dinarides in the north and Hellenides in the south (Figure 2).

The geological structure of the Albanides comprises two major units: the Internal Albanides in the eastern part and the External Albanides in the west. Deformation of the Internal Albanides took place by the end of the Jurassic and the beginning of the Cretaceous, whereas for the External Albanides this started during the late Eocene and lasted into the Pliocene. During the Neogene large volumes of clastics were transported into the foredeep situated on the eastern margin of the Apulian plate.

The Internal Albanides are characterized by a developed magnetism and by the intensive tectonics which has led to the overthrust and tectonic nappes. The Internal Albanides are further subdivided from east to west into the Korabi, Mirdita, Gashi, Albanian Alp, and Krasta-Cukali zones. The two post-orogenic sedimentary (intermontane) basins, Burreli Basin and Korca Basin, overlie trangressively the Mirdita zone and partially the Krasta-Cukali zone (Figure 3).

The External Albanides, despite being characterized by the lack of magmatism and by more regular structures than the Internal Albanides, are highly affected by a considerable thrusting of the tectonic zones and/or structural belts westwards. The External Albanides comprise the Krasta, Kruja, Ionian and Sazani zones and are characterized by successive folds thrusted westerly over the Adriatic (Apulian) foreland (Figure 4). The main thrusting phase that affected the Kruja zone took place during middle / late Oligocene and for the Ionian zone, during the middle Miocene. In the central western part of Albania the overlying Peri-Adriatic Depression masks the Ionian and partly Kruja tectonic zones. The Peri-Adriatic Depression westwards offshore is unified with the South Adriatic Basin, which overlies the Pre-Apulian (Sazani zone) and Apulian platform. The uplifted foreland Sazani zone is located in the southwestern part of Albania and outcrops in Karaburun Peninsula and Sazani Island. The Ionian zone is a major oil and gas province in Albania. It crops out in the central southwestern parts of the country and extends south onshore towards the western part of Greece. In the central western part, the Ionian zone is overlain by the post-tectonic Durres Basin.

Tectonic Styles in Albanides

The tectonic zones and their respective structural belts in Albanides have a general NW-SE orientation and thrust over one another from east to southwest direction. Except for the over thrusting in the southwest direction, some differential horizontal displacement occurred in Albanides, causing local rotation of the mountain fronts and the formation of mountain arcs. The Triassic evaporites formed the main slip planes for the overthrusting. Locally the thick Triassic evaporites not only played the role as slip planes, but also pierced as salt domes into flysch and/or molasses and in places reached the surface, as is seen in the Dumrea salt dome.

The mountain fronts and fold belts, especially in the External Albanides, comprise the main features of a thrust system, including drag faults, back-thrusting and triangle zones. Thrusting of tectonic zones and their structural belts or individual structures on one another westwards represent one of the main tectonic features in Albanides. Both the Shkoder-Peje lineament and Vloree-Elbasan lineament permeate the Albanides structure, respectively, in the north and in the central part with a SW-NE trending.

Stratigraphy

Sediments ranging in age from Paleozoic to Quaternary are encountered in Albanides. The Paleozoic metamorphic rocks consisting of terrigenous, effusive and rare carbonate rocks are encountered in the Internal Albanides (Korabi zone). The evaporitic formations, consisting of Permain-Triassic salts and anhydrites, are mainly encountered in the Korabi and Ionian tectonic zones. The ophiolitic formations, consisting of plutogenic and volcanic facies, belong to the Middle to Upper Jurassic and are widespread in the Internal Albanides, especially in the Mirdita tectonic zone.

The carbonate formations, widespread in both External and Internal Albanides, are represented by a variety of limestones and dolomites. The carbonate formations in the External Albanides (Ionian zone) are of Late Triassic – Eocene age and are pelagic in origin. These units vary in thickness between 2100 – 2850 m. The flysch formation, the so-called "Early flysch" (Upper Jurassic – Lower Cretaceous), is encountered in Krasta-Cukali and Mirdita zones; while the "Young flysch" (Maastrichtian - Eocene) was found in Krasta-Cukali and Albanian Alps. In Kruja and Ionian tectonic zones, the flysch formation belongs to the Oligocene age, and its thickness varies between 1000-3000 m, thinning westward.

The Pre-molasse formation, which consists of marls, marl clays, sandstone, and lithotamnic organogenic limestone and belongs to the Acquitanian-Burdigalian-early Serravalian, is encountered in the External Albanides, especially in the western part of the Ionian zone and Sazani zone. The thickness of Pre-molasse formation varies from 850 m in the east up to 2500 m in the west. The middle Serravalian-Quaternary molassic formation consists of a considerable number of sand-clay megasequences, conglomerates, clastic limestone and clayey gypsum. It is widespread in the Peri-Adriatic Depression and westward offshore in the South Adriatic Basin.

Oil and Gas Plays

Recoverable oil reserves are present in Neogene clastic reservoirs in the Durres Basin with further reserves in the Mezosoic-Paleogene carbonate reservoirs in the underlying Ionian zone succession. Most of the gas is produced in the Durres Basin and only one gas field (Delvina) is located in the Ionian zone. By contrast, most of the oilfields produce from reservoirs in the Ionian zone, and only two have been found in the Durres Basin (Kucova and Patos-Marinza). Eight oilfields are located along the general trend of the Vlora-Elbasan lineament near the southeastern margin of the Durres Basin. All of these fields are believed to produce from structural traps on the hanging wall of thrusts.

In the Ionian zone, source rocks which have been identified comprise Triassic – Liassic carbonates and shales of Middle Jurassic, Upper Jurassic, and Cretaceous age. Reservoir rocks in both oil and gas fields mainly consist of Cretaceous-Eocene carbonates with <10% primary porosity. Sediment thicknesses are sufficient for source rock maturation and hydrocarbon generation. Porosity is improved by fracture development, and oil is produced from interconnected fracture systems. Upper Cretaceous – Eocene reservoirs are fractured with predominantly vuggy porosity (Figure 5). Many of the traps formed when the Oligocene flysch formation became superposed to carbonates. Oil accumulations are sealed by Triassic evaporites whereas the seal for gas is provided by Oligocene shales which lie structurally below the evaporite sheet. The structural style comprising stacked carbonate successions with intervening evaporites is important if the carbonate reservoir rocks are sealed efficiently. Thin-skinned thrusting along evaporitic decollements resulting in stacked carbonate sequences has clearly been demonstrated on seismic profiles and in well data. During mid-Tertiary compression the Ionian zone was subdivided by internal thrusting into at least three sub-basins which have been mapped by Albanian geologists. Triassic evaporites (e.g., the Dumrea Evaporite) are present in the hangingwalls of the thrusts which separate the basins.

Most of the Albanian gas fields are located along the southeastern margin of the Durres Basin along the Vlora-Elbasan lineament. This ancient lineament probably acted as a wrench fault during Tertiary thrusting, creating particularly favourable trap structures and causing brecciation of the carbonate reservoir rocks. Formation of the Durres Basin was controlled by synchronous activity on the Vlora-Elbasan lineament and internal thrusting in the Ionian zone. The thickest sediments in this basin accumulated in the southeast close to both the Vlora-Elbasan fault and the internal Ionian thrust. Source rocks (late Miocene) have produced mostly gas, which has accumulated in coarse-grained siliciclastic reservoir rocks, with sealing and trapping achieved by internal faulting and unconformities. Tortonian shales have been identified as source rocks while Tortonian-Messinian sandstones form the reservoirs. Most of the reservoirs are sealed by Messinian evaporates, but hydrocarbons are in some cases trapped by biodegraded oil, forming a tar mat.

The underexplored Eocene-Mesozoic, basinal and platform-slope carbonate subthrust traps are key plays in southern part of External Albanides. The Mesozoic platform carbonate inverted subthrusts and buried hills are new key plays in northern part of External Albanides. The play is partly a model driven because of lack of 2D regional seismic data. The untapped hydrocarbon potential in Durresi Basin (off-onshore) can likely only be realized through the acquisition of 3D seismic data. No commercial oil or gas accumulations have yet been discovered in the Oligocene-Miocene turbidites in the Apulian-Pindos foreland basin, which overlies the rocks of the Ionian and Kruja-Gavrovo zones, although their sedimentary thickness is between 2 and 6.5 km.

Patos Marinza, an oil field discovered in 1928, is the biggest oil producing field in Albania and the biggest onshore oil field in Europe (Figure 6). The Patos Marinza oil field is located 10 km east of the city of Fier in south-central Albania. Estimates of the original oil in-place volumes range from 2 0 Bbbl to 7.5 Bbbl. Patos Marinza has only heavy oil and is in production since the 1930s. In the fourth quarter of 2013, it was producing 19,303 bopd. Enhanced oil recovery technologies (polymer flooding and thermal methods) are extensively applied at this field.

Oil and Gas Potential

Based on the geological studies carried out by Albpetrol (Albanian state company) and those performed in the recent years by foreign companies, it appears that Albania, in spite of the existing oil and gas fields, still has good potential and is a promising area for further exploration both onshore and offshore. Potential discoveries could be found under the existing oil discoveries in the deeper levels.

The probable structures, linked to Triassic salt diapirism, must be taken into consideration for further exploration in the onshore areas, close to the region where salt diapirism is present. Onshore, thrusting westwards especially in the External Albanides is associated with the masking of the separate anticline structures or anticline chains which have potential for new oil and gas discoveries. In the cases where thrusting westwards is associated with the backthrust tectonic faults, synclines of triangular type are formed; these are not easily identified but generally hide potential trapping structures for oil and gas accumulations.

Oil potential offshore is related to the possible Ionian carbonate structures and morphological highs of Apulian platform. In the appropriate offshore conditions, there are possibilities for new potential oil accumulations both in the clastic section, as it was the case in A4-1X well and in the platform carbonate reservoirs. Gas potential is related to the Miocene-Pliocene folded structures, as identified from the old seismic and confirmed by recent 3D seismic.

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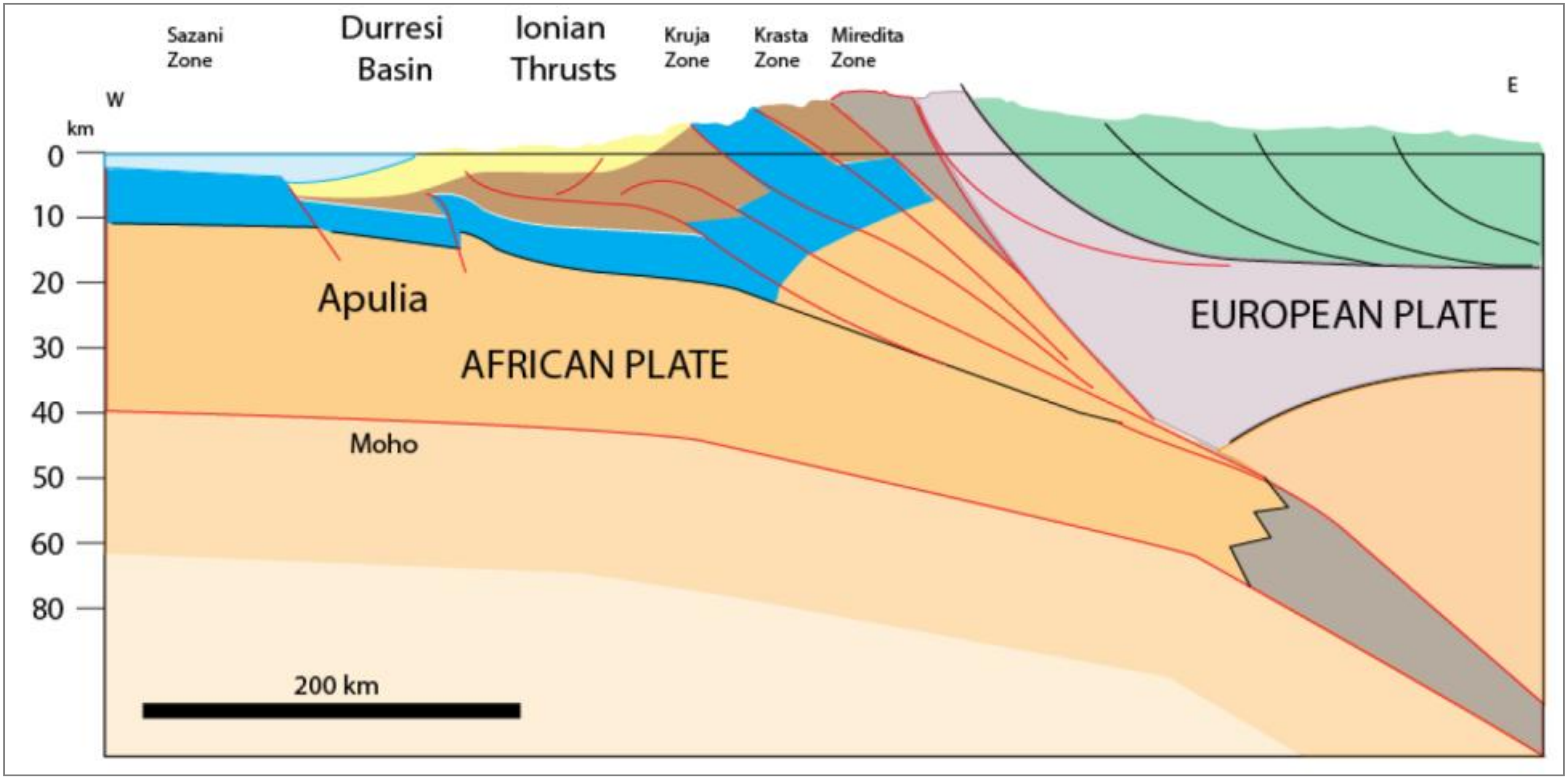

Figure 1. Albanian foreland fold and thrust belt system (Barbulushi, 2013).

Figure 2. Regional setting of Albania (NANR, 2009).

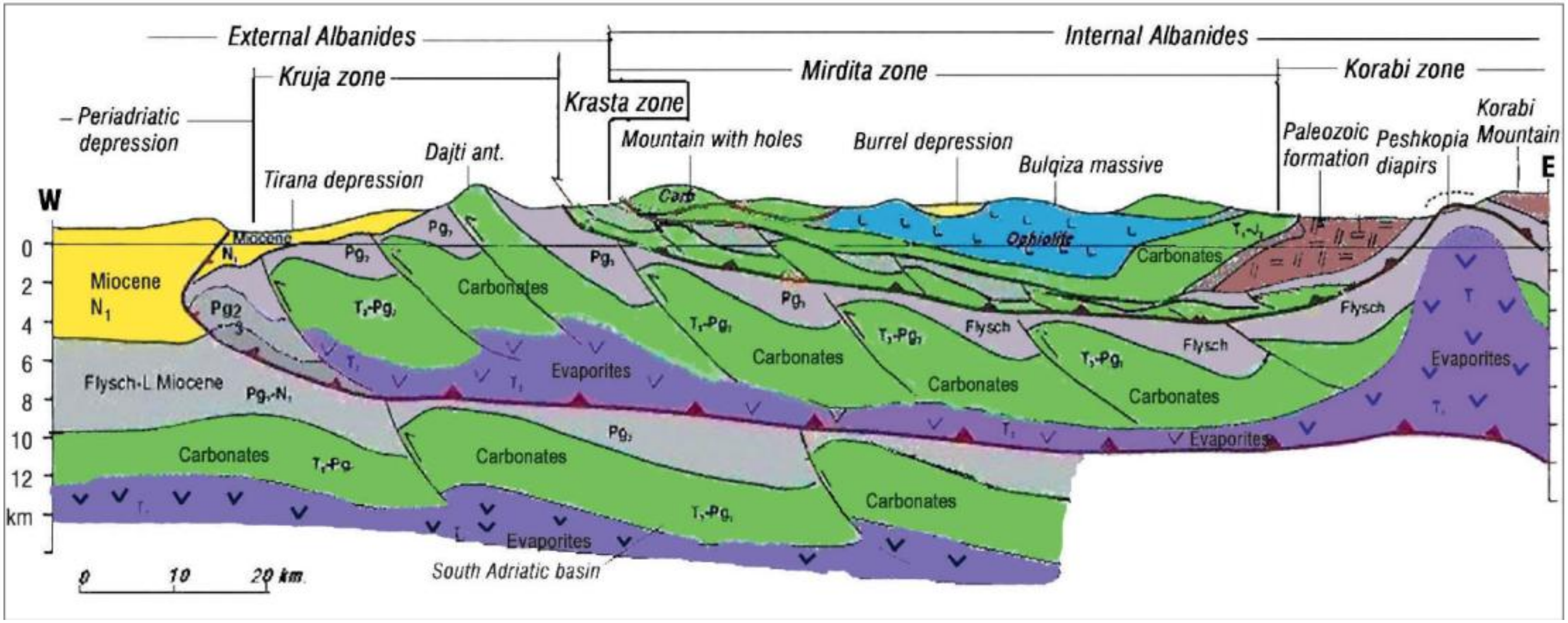

Figure 3. Schematic geological cross-section through the Albanides and South Adriatic Basin (Velaj, 2012).

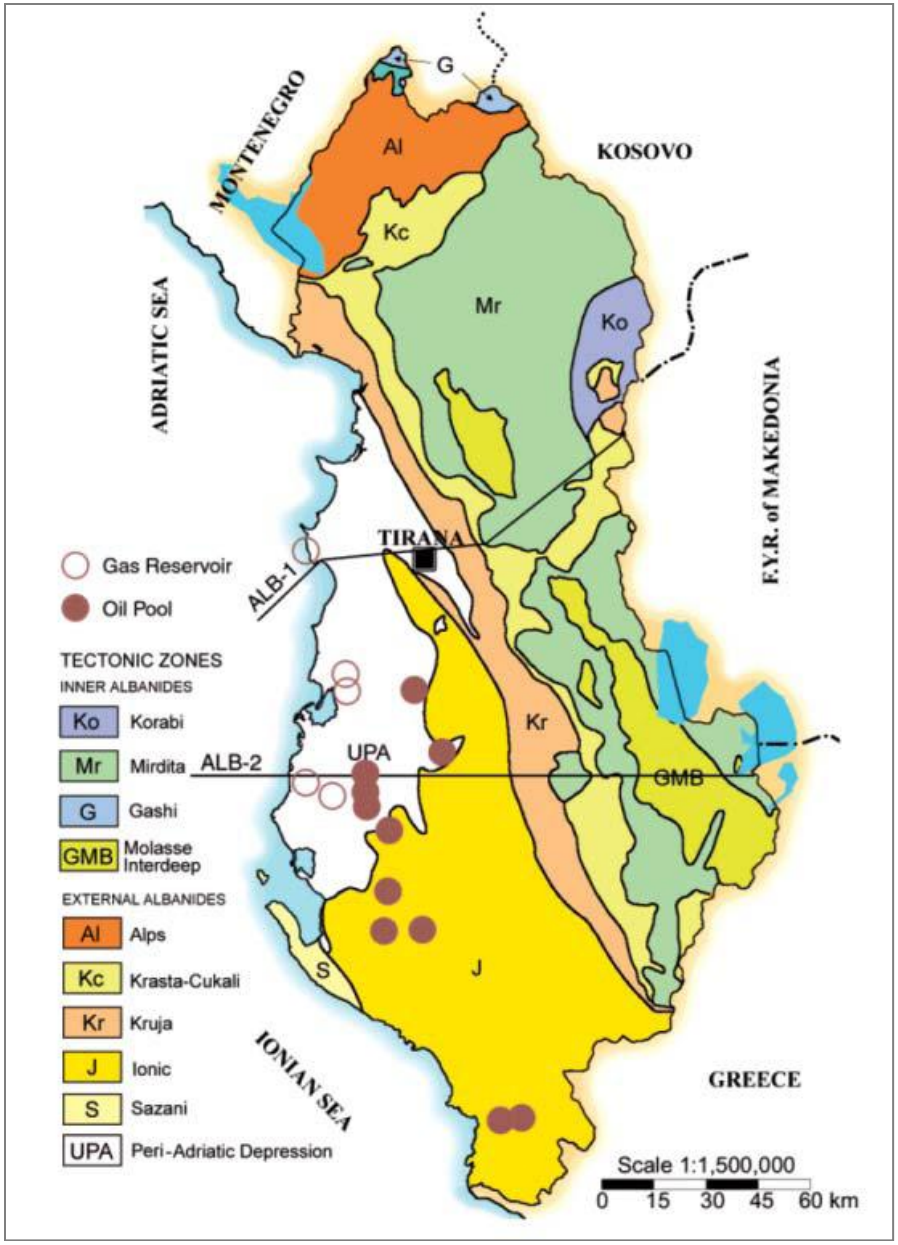

Figure 4. Schematic tectonic map of Albania and its oil and gas fields (Frasheri, 2005).

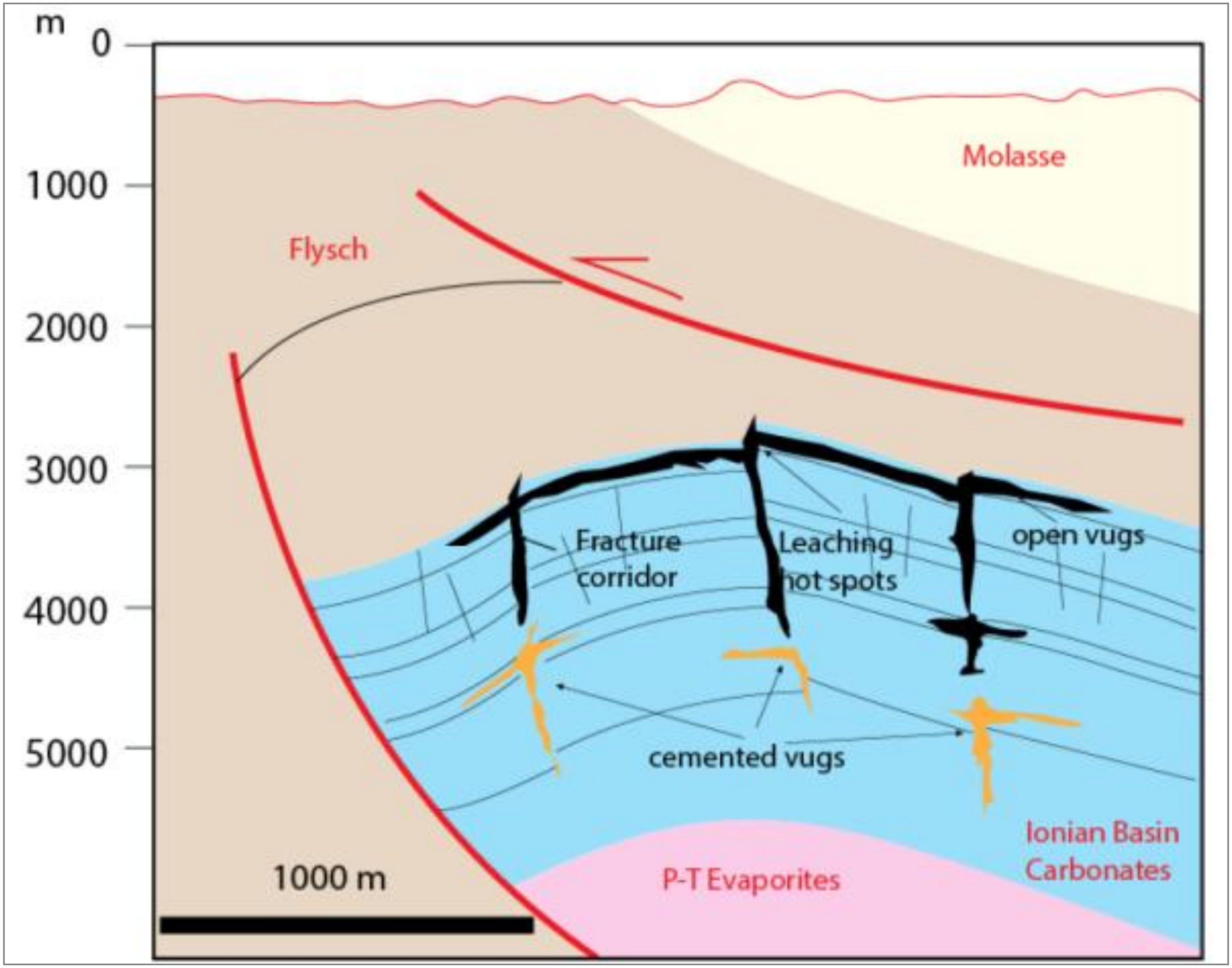

Figure 5. Fractured Upper Cretaceous – Eocene reservoirs with predominantly vuggy porosity (Barbullushi, 2013).

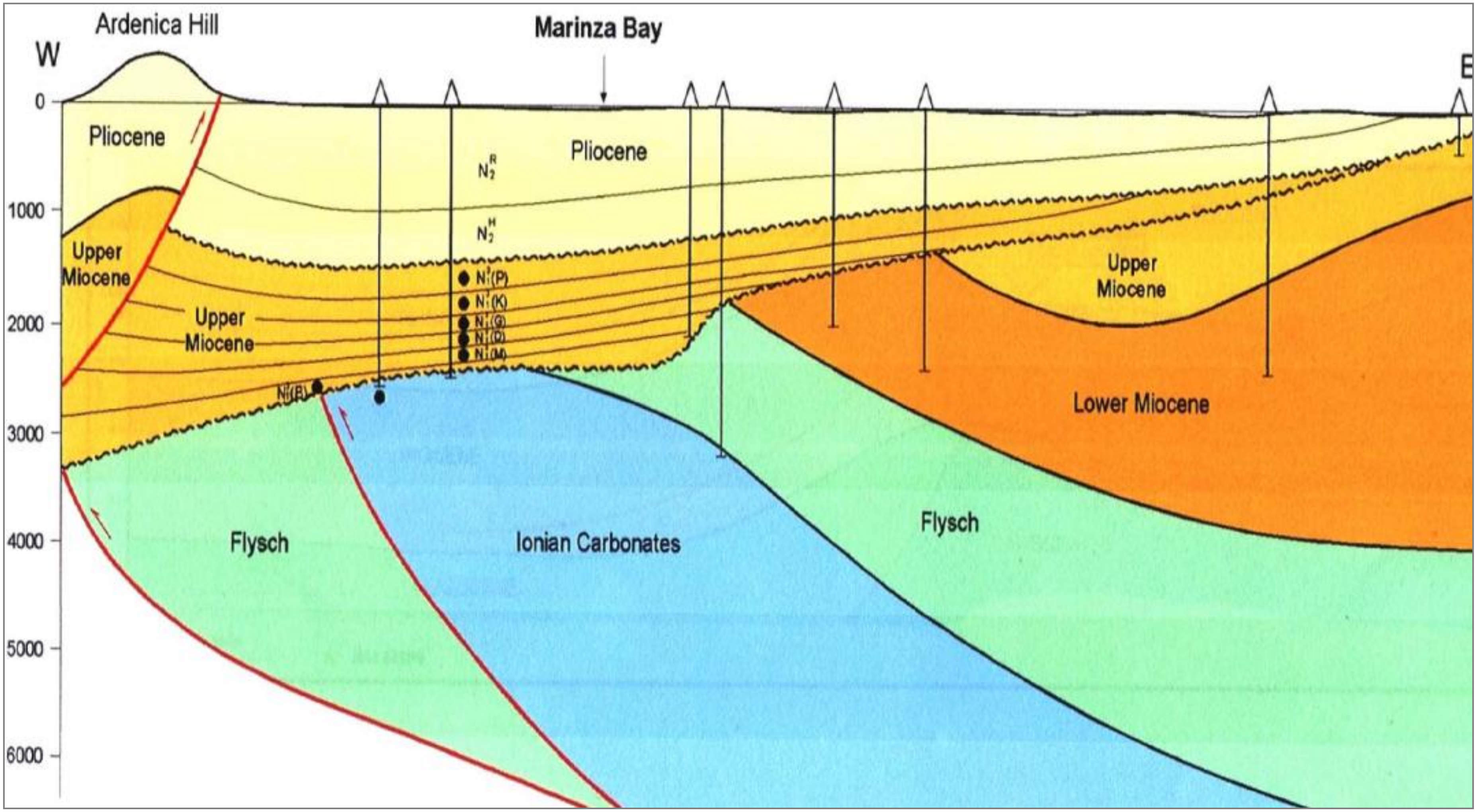

Figure 6. Patos Marinza oil field (NANR, 2009).