THE CAUSES THAT LEAD TO THE TRIGERING EARTHQUAQES IN ZHARRZA AREA BY THE PETROLEUM ACTIVITY

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ABSTRACT

The seismic activity in particular regions might be connected to human's activities like the mineral extraction, liquid (petroleum, water), or solid (chrome), but even with the hydrological effects (abundant rainfall) or with the creation of the large colons of water (the case of the energy lakes, as Fierza, Koman, etc.), which might increase the tectonic movements, that exceed the average amount during an earthquake. These correlations are followed by long periods of time (57-92 years in USA) in which the earthquakes are shown after the appearance of intensive phenomena such as, abductee showers, pumping and water extraction. These results support the hydro-seismic hypothesis, which shows the role of water in the inter-plate seismicity. Analysing the seismic activity for the all studying region, we might say that in these regions, where the strain degree and seismicity degree is relatively high and even the stress is high, the conditions of the manoeuvre activity for the benefit of hydrocarbons might be another factor in the release of seismic energy through a pure tectonic process.

Keywords: Human's activities, earthquakes, the dynamic balance of the rock, the rocks strain, rock structures, seismic gaps, the collapses and the sinking.

INTRODUCTION

The aim of the study is to do the evaluation of the impact in the life of the inhabitants of the existing oil activity in the oil fields of Patos-Marrinzë and to give a proper recommendation [1]. In the studies made until now, in different sectors of oil refinery industry, there are many problems in the environmental pollution, in the air, surface waters and land (Fig.–1). But the most trouble-maker is the shock and the cracking of inhabited houses in the vast autochthonous community, long before the oil discovery, which regulates the welfare, but also makes the living possible. According to objectives undertaken by the study, it is made possible:

- the definition of the extension impact, initiated by its source;
- the selection of the most principal indicators which affect in different periods and situations;
- the definition of the causes and the impact level in the communal residential houses;
- the granting of proper recommendation in the minimization of the impacts in the environment.

MATERIALS AND METHODS

The causes that lead to the shaking of the land in Zharrëz

Cause – 1,The dynamic balance of the rocks

As previously mentioned, all the geological systems are in a dynamic balance, as our region has been without the extraction of the matrix matter as that of oil, gas, water, sand, since 1957 with the initiation of the exploitation of this source, it is calcualted the extraction of not less than 200 milion tonne or m^3 from the underground of this region. The exploitation for a long period of the sources, not maintaining the fluids balance, leads to the reduction of pressure layers (or pores) compared to the initial pressure values.

Fig- 1

In this case it is thought that there is possible a movement of geological formations around or inside the reservoir, and as a result the increase of the probability of the seismic shaking production. Such a case it is thought to have happened in the city Cleburne in the state of Texas, where in 2009 is registered seismic shaking up to 2.8 Richter scale. In this region, where the natural gas is extricated with conventional (or traditional) methods there have not been seismic shaking for 140 years, so it is thougth that the cause might be the exploitation of the gas resource and the change of effective pressure in the resource.

Cause-2, The rocks strain

The rocks where is concentrated the extraction activity and that of polluted waters pumping in our region are more connected to the ductile type of the carriage than that of cracking, beacuse they are away from the tectonic cracking zone. In these conditons, when thereon a larger strain is applied than its power. Fragile materials, as those of Pliocene age and especially those of Quaternary might be softer, as a result of the change of conditions (Fig. – 2).

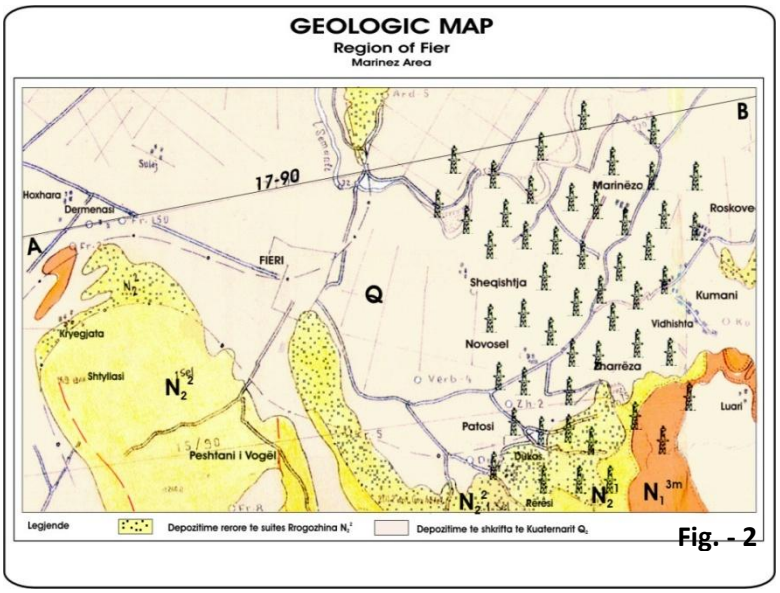

Fig. - 2

Cause – 3, The power of the rocks

Given that the rocks in the depth of the underground of the zone of Zharrëz undergoes repeated episodes, such as its pumping and pressure, eventhough of low level pressure, the accumulated strain might weaken the rock and even break it. This fracture as a result of strain of low accumulated level is called ***the fatigue of rock***.

Cause- 4, Rock structures

Given that the rocks in the depths of the underground of the zone of Zharrëz are composed ofargil and sand, as those of Messinian and of Pliocene, which are of high porosity, make possible the creation of larger porous spaces and new hydraulic cracks.

Cause-5, Dissolved rocks' gaps

Given that the rocks in the depths of the underground of the zone of Zharrëz are based on carbonaceous or limestone rocks, where the acidifying wastewater is discharged or pumped, which circulates through limestone rocks make the holes merge, making it more porous. Because rocks in the subsoil area depth Zharrez they rely on carbonate or limestone, where groundwater is pumped downloaded or acidifying which circulate through the limestone, disbanding in this way the cavities, making it more porous. Underground limestone solutions might create major gabs under the surface. These gaps weaken the retaining of the surface, leading to demolition, a well-known problem.

Cause-6, The displacement of the grains of sand

In the chapter of liquefaction we saw how the sand sediments, those undiagenised of Pliocene, [2] but especially those of Quaternary in the depths of the underground of the zone of Zharrëz (Fig. – 3), when shake because of a seismic waves or triggerd (artificial), the grains reorient themselves in a compact relationin the form of rhomboid. This result in the reduction of the porous gabs, the removal of the water parts in the pores, the compactedness of the layer and the sinking of the topsoil of the land and of ather structures on it.

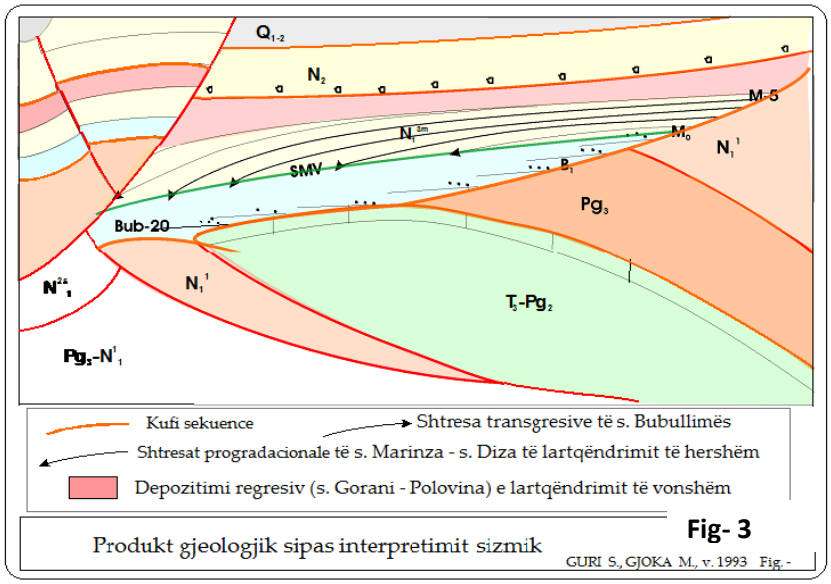

Fig- 3

Cause - 7, The moisturizing of the sand

Given that the rocks in the depths of the underground of the zone of Zharrëz, are covered by alluvial deposits on flat surfaces with cones of the spill filled with water, and of artificial fillings. In the discussion of the seismic chapter for the liquefaction, we observed, that based on geological criteria, these cases in this region are highly potentially liquefiable. Because most of the filling of sand are not dried, but are cubical packed sendiments with pores of underground water, where because of a seismic strike or wave derived from the underground turns the sendiment in a flowing/ water measure through a process called liquefaction.

Cause – 8, The flow of clays

Given that the rocks of the depths of the underground of the zone of Zharrëz, as for the Messian deposits and those of Pliocene are composed of argil, which according to their study in the diffractometry with a X ray participate and predominate the montmorillonits, and less the illites, the kaolinites, the chlorites and mixed layer minerals, whereas the other minerals are lesser. (the geologic construction) [3]. This makes these layers more sensible for bulging.These layers exert a strong pressure to the overlapped layers against the them, the land and the other structures. By the granulometric part the clay fraction prevails to the extent up to 50% (dominated heavy clay), with slopes which easily undergo the abrasion and the massive sides. Such sendiments are called "shrinking-bulging" clays. These clays are one of the geo dangers of the basis of the inhabited buildings. If the water saturated bentonites,

position themselves in a rocky slope, then the material forms a slippery surface, which reduces the friction forces and faciliates the slipping of the layers located above it. An earthquake, of an average level higher and/or lower, but frequent makes this phenomenon possible. If the slope underwent the shaking, the clay's structure would be demolished and transformed with a speed in the form of a viscose liquid, which slips down. This process is considered as a serious geo-danger which happens everywhere. Light objects (one storey) with a shallow foundation over these clays, often become distorted, because of their swelling ability (the swelling ability 1.7 up to 2.7 bars). These distortions have residual character. (Fig. – 4).

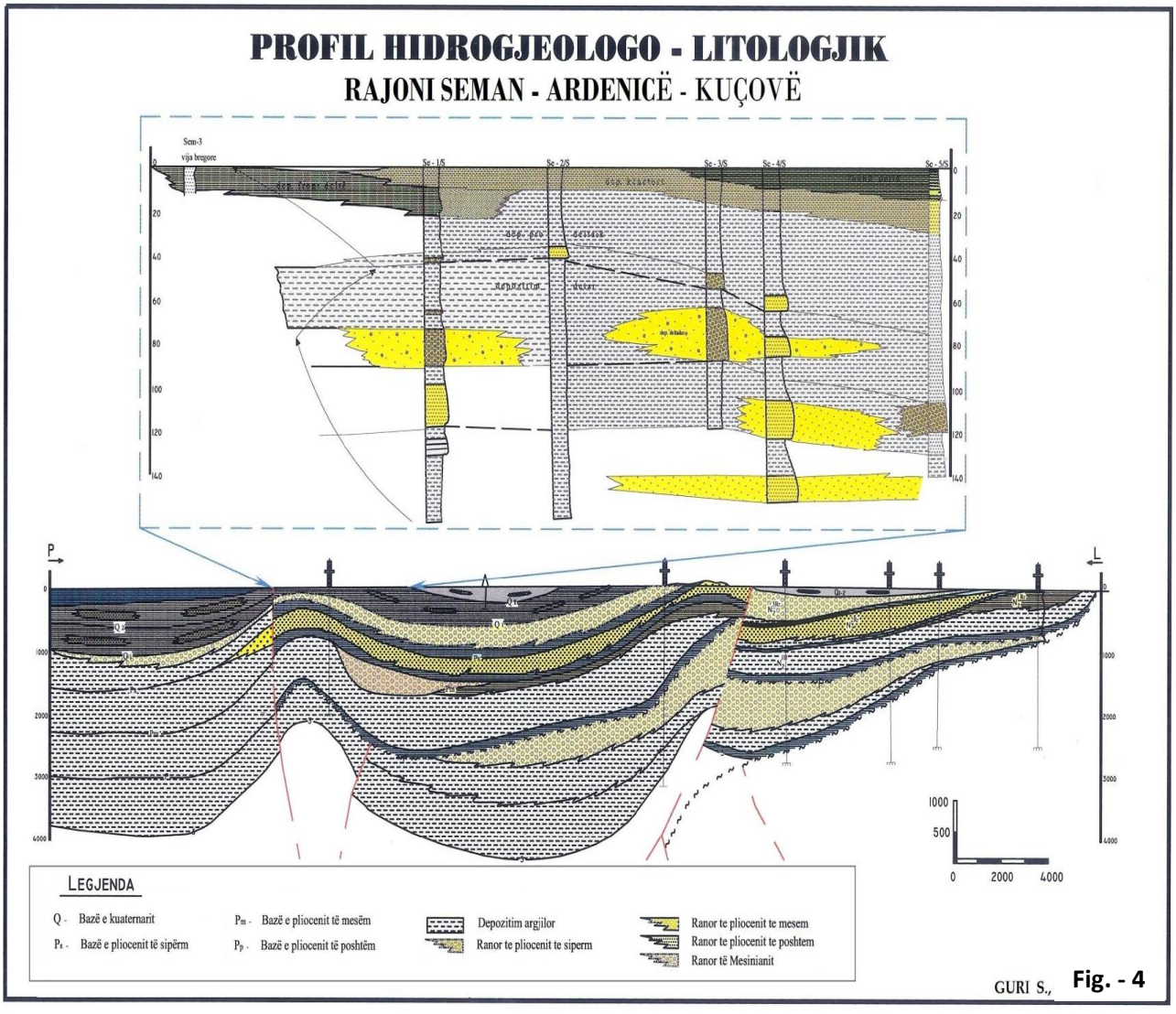

Fig. - 4

Cause- 9, The tectonic detachment in regional scale

In the tectonic detachment made to our country, our region is completely part of the Near-the-Adriatic-sea Lowland, part of external Albanides, in a tectonic compression mode. It is product of the orogenetic tectonics and expresses the renovation of old tectonic processes. [4] As a result it is accompanied by principal tectonic detachment of the up-climbing kind or secondary against-climbing kind. The close connection among the earthquakes and regions of

active detachments is identified in each of the last ones, defining even the maximal seismic potential expected. Apart from the longitudinal breaches, which accompany the neogenic structure in the west of of our region, there also exist transversal detachments in its nord where the structure of Patos-Verbas ends. In our case the Neogenic structure is located near the responsible measures of orogene, forming a triangular zone, where the principal role of detachment is exchanged, and all these kind of tectonic breaches are used as generating and releasing way for the earthquakes of every sort of level. In our case there might happen seismic shaking during the exploitation of the resources using unconventional methods, such as hydraulic crack, because:

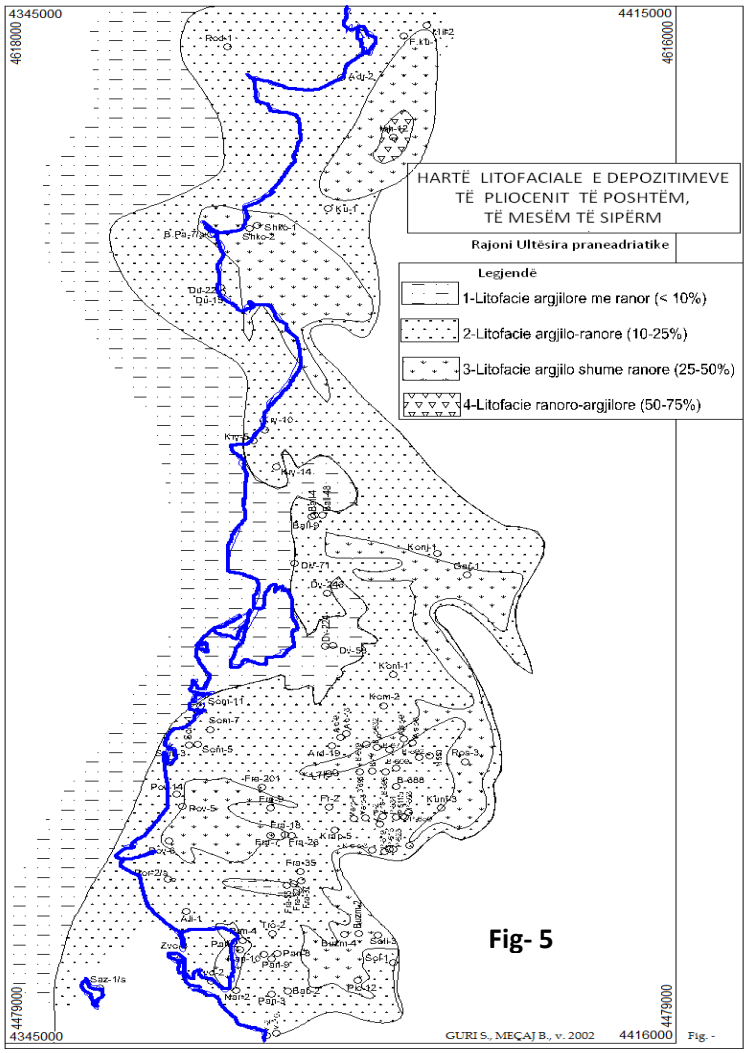

Fig- 5

1. The fluid (water, sand and chemmicals, if) which is infected with a high pressure in the limestone layer and that of sand might communicate even to the existing tectonic breaches, near or inside the layer.
2. The last movement in the breach change the balances of stress and creates the condition for these breaches to reactivate and
3. The reactivation of the breach brings slipping of the geologic formations during the breach and as a result causes the creation of seismic shaking. (Fig. – 5).

Cause – 10, The rocky slopes and the seismic activity

The steeper is a rocky slope, the bigger is its chance to slip. In the geotechnic categorization of the rocks in our region we observed that the rocks show different ground-retaining elastic behaviours, depending on the inclination of the slope, when it is under or up to 15° and/ or depending on the thickness of the sendiments of Quaternary on the fundamental rocks. Practically, in our region we have the participation of these factors, as an inclination of the slope, and the Quaternary sendiments that add more to a ground shaking.

Cause – 11, Seismic gaps

In the discussion in the seismic part, we observed that our region has undergone historical earthquakes (paleo - earthquakes), which have created seismic gaps, or damaging segments, along the big seismic events happened in the past, but not recently. These regions are the first to be the earthquakes' or the future shaking epicenters.

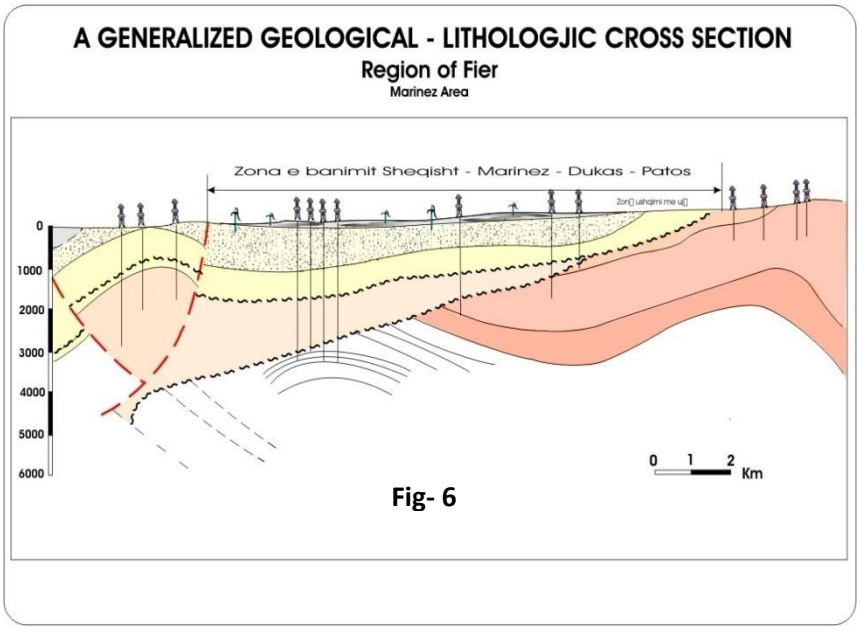

Fig- 6

Cause – 12, The rock structure
(The changes of the rocks)

Given that the rocks in the depth of the underground of the zone of Zharëz, [5] are put under pressure, the fine cracks are developed. Theses cracks increase the rock volume, a phenomenon called ***expansion***. The small crakcks in the strained rocks might produce small seismic events called ***first strikes***. These release some pressure and might be followed by a calm period, during whichthe strainings in the cracking of the building level reinitiate again. The level of straining that is created along the cracking regions might be measured by instruments called straining meters. The seismiologs use them as predictor for the seismic activity forecast. As a result, the water pumping inside the crackings as in our case might change the electric conductivity of the rocks, which might be easily measured as well. (Fig. – 6).

Cause – 13, The collapses and the sinkings

The collapses and the sinkings might be related to many factors, but what happens in our region is related to ***that caused by the extraction of the water alongside the oil***. It is known thatinthe spaces of the rocks pores in the depth of our region, on the liquids such as: water of oil, there is exerted pressure. This partly reassures a base for the mentioned layers. If, in a high scale, we remove these liquids from the underground, we lower the pressure inside the holes of the rocky material. This would allow the compaction of layers under the surface. This way the sendimentary or rocky materilas of the surface, would gradually separate in a ***sinking pond*** way. After the attraction of these liquids, because of the tension forces, the ground surface is become into pieces in structures called sinking furrows. Our sinking is strengthened by the fact that it might happen in the form of hollows, firstly inside the carbonatic rocks, that because of the water pumping there is formed the topographic phenomenon of carst. The underground water weakens the overlapped rocks against this surface, allowing the surface to sink or demolish headed to the spaces under it.

Cause- 14, The geological surface

Every building (residence, shop, or large complex) with its foundations in an unbreakable rock bed is more solid than a building constructed in an incoherent sendiment or cracked rock. Depending on this geological surface there also exists a cracking scale for the residences of Zharrëz.
(Fig. – 7).

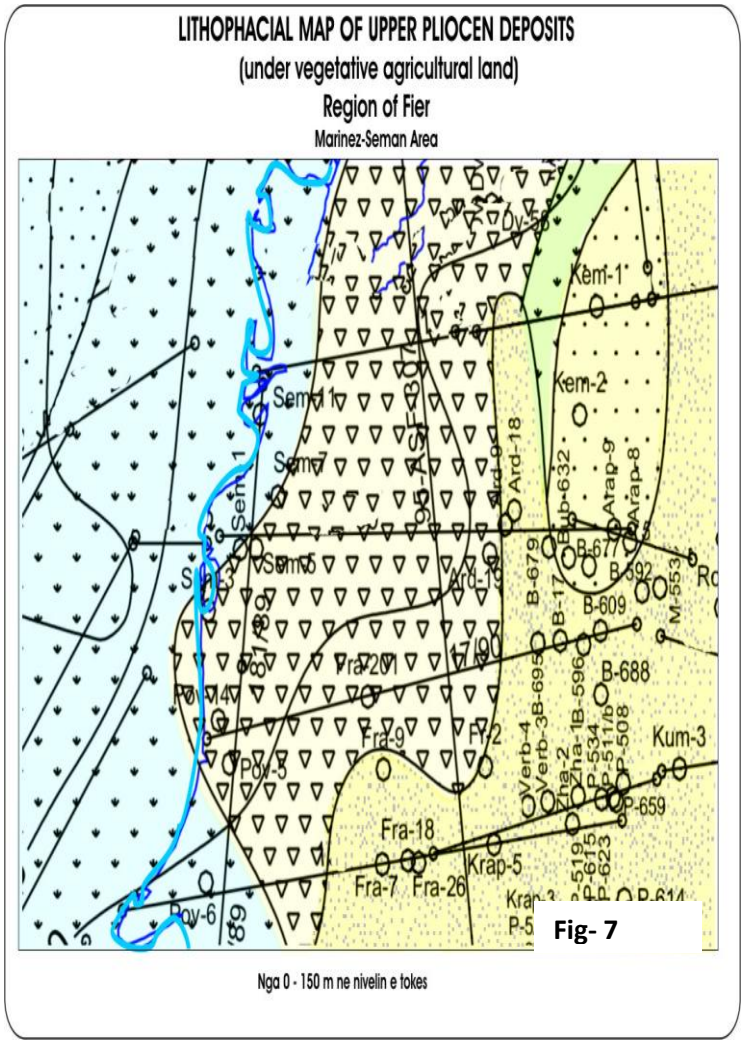

Fig- 7

The earthquakes caused as a result of extrusion and liquid pumping

Similar cases

The seismic shaking phenomenon in the oil fields resources is already well-known and accepted by scientific and environmental circles in some parts of the world. This case is mostly widespread in America during the last decade, because the exploitation of the gas and sandy compact shale is fast developping. By the monitoration of such a case in the sate of Arcansas (USA) in 2010, within 18 days are registered 85 seismic shakign with a magnitude of more than 2.5 Richter scale. Based on these measures, the State Commission of Hydrocarbons put a ban on the two wells which used this method (hydraulic cracking). Simultanously, this commission banned the activity of such drillings in a surface-ray of 1840 km around these wells. By the monitoration made within 18 days, after the banning of the wells' activity, are registered only 20 seismic shaking, that means 4 times less. The detailed monitoration in some places of the world, have shown that the local earthquakes epicenters are close to the sites of extrusion or fluid injections, and theirmagnitude had to do n a direct form with the norm of pumping. These studies show that the fluids or might bring and cause damages. The periodic injections of water might cause small earthquakes. (Fig. – 8).

RESULTS AND DISCUSSION

The cases in Albania and the case of Zharrëz

The extrusion of a particular matrix from the underground of many places of the world and our country has shown that there exist a strong connection between the seismic activity and it. The geologists think

that the yesterday hypothesis, today especially, that the water under pressure releases accumulated tension under a particular inhabited or not surface. The pumping rebalanced water pressure after the oil extrusion act to reduce the pressure on the surface of the cracked rocks, allowing those to slowly sink in the form of diving (subsidence). However, the controlled fluid injection is a potent sciantific instrument for the reduction of the tensions in

other segments. The controlled release of the earthquake energy is also problematic. Considerer a zone where the earthquake of a magnitude of 8.0 is expected every 100 years. It would be needed the production of 33,000 earthquakes approximately with a magnitude of 5.0 to release the same energy. This might need an event of 5.0 magnitudes nearly each day for 100 years. Is this the more desirable than an earthquake of 8.0 magnitude, especially if the earthquake 8.0 magnitude is predicted and the zone be evacuated? The seismic events with a magnitude of 5.0 magnitude make less damages against the well-constructed structures which are typical for the developed countries. [6]

Possible maximal Earthquakes (M_{max}) area Durrës-Fier

The values corresponding to maximum accelerations expected (PGA) in (g)

Area	Name	M_{max}	The values of maximum accelerations (PGA) in (g) for various distances hypo central(R)				
			R=10km	R=20km	R=30km	R=40km	R=50km
1	Divjakë	6.4	0.54	0.33	0.22	0.13	0.07
2	Seman	6.3	0.50	0.29	0.17	0.09	0.02

From the table No.2 it is noticed that the focal distance of up to 20 km, PGA (g) values for the four areas are ranging from 0.29-0.42 g, very favourable values for the development of liquefaction.

Map of the maximum acceleration strong ground reference (according EN 1998), 475 years return period

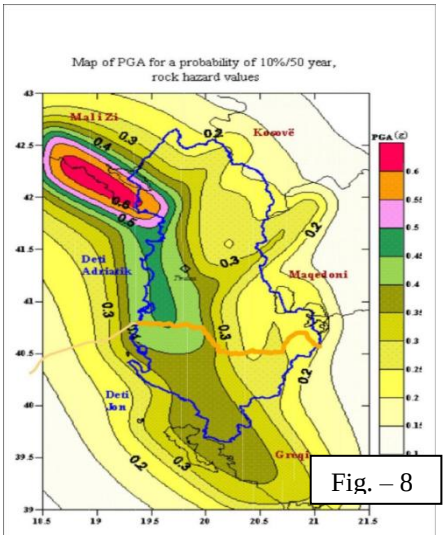

Fig. – 8

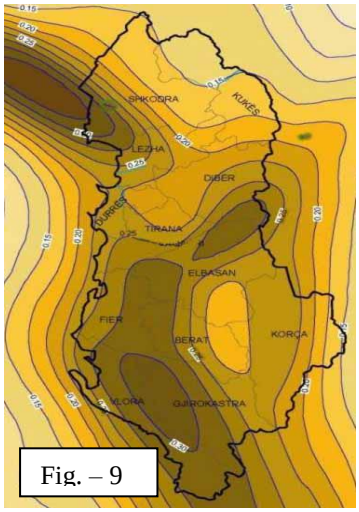

Fig. – 9

Based on the studies made by prof. Betim Muço, in Albania, the inducted seismicity started to be studied with the the constuction of four seismic stations around the zone of the future lake of Fierza at the end of 1975. The filling of the reservoir started in October 1978 and the maximum of depth was achieved in April 1981. Due to the stations located in this zone, the natural microsesmicity (before the filling of the reservoir) was studied for three years. Eventhough the ground where the reservoir was located consisted of active tectonic cracks and microcracks, the seismicity was one of the lowest in Albania. In the period before the filling, were registered 138 micro-earthquakes, while for the first three years after the filling (October 1978 – December 1981), the number of registered earthquakes was 305. From the January 1982 to December 1992, 740 earthquakes were registered around the reservoir of Fierza, with an epicenter within the zone of lake. (Fig. – 9).

Map of the maximum acceleration rocky ground reference, repetition period 475 years, edition– 2010

The earthquakes were in a depth of 2-12 km. The magnitude of these earthquakes was 3.6 Richter scale. After this there is an adaptation of the tectonic constraints with an effect in the

waters of the lake.The same happened with the filling of the reservoir of Koman, which started from the end of October 1985. As it is obvious, the filling of the reservoirs of Fierza and Koman, on the Drini river, has modified the natural stream of the release of micro-earthquakes energy.

Apart from the induced earthquakes from the big reservoir filling, the induced seismicity according to Prof B. Muço, included the earthquakes caused by the injection in the depth of fluids as well, for different purposes (waste deposits, hydrocarbons exploitation etc.), even by the exploitation of oil and gas. This phenomenon of induced sesmicity is noticed even in some of the oil fields zones in Albania. The earthquake of Ballsh, 2 March 1976 (M=4.9), depth 11 km and intensity VII-ball, which caused a lot of damages in the zone around it, attracted firstly the attention as an indeced earthquake from this exploitation. The oil fields zone of Ballsh has been exploited since 1967. (Fig. – 10).

Another earthquake which is thought to have also been induced by the oil exploitation is that of Roskovec, 16 November 1982, with M=5.7 and depth 20 km approximately. There have been 66 after-hit of this earthquake during the twenty following days. The intensity in the epicenter zone was VIII-ball and there were many damages in the rural zone. The earthquakes of Ballsh 1976 and Roskovec 1982 might be explained with the triggering mechanism connected to the isostatic imbalance, caused by the fluid extrusion from the upper crust. The readaptation of the constraints and tensions, accompanied by the restoration of imbalance, will be concentrated in the preexisting structures. (Fig. – 11).

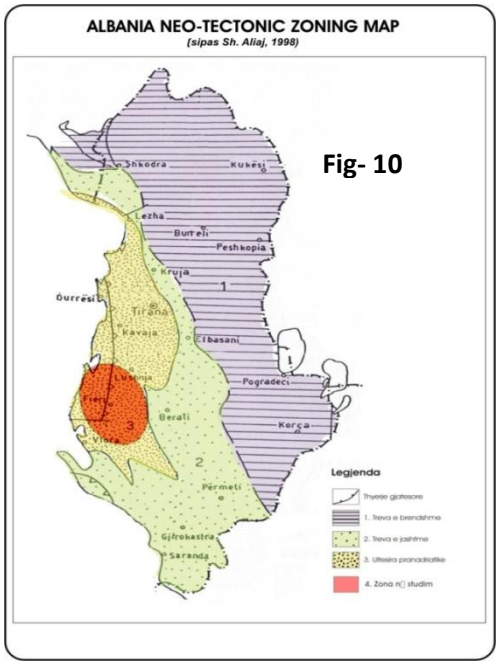

Fig- 10

An alternative explanation for the seismicity of the layers 10-20 km is that based in the high preexisting pressure of the fluids in the middle-shallow crust, which afte the massive attraction of the fluid near the surface induce sufficent changes in the hydrologic regime and may cause some migration of fluid in the depth. In this case, the existing tectonic constraint, affected by too many years of oil exploitation, causes a crust reaction and might have had located earthquakes under the exploitation zone. Like the earthquake of Ballsh, that of Reskovec as well, has happened after a period of intensive exploitation of the existing oil fields.

Another series consisting of eight earthquakes in the interval of 3.2-3.8 and hearth depth 1-27 km happened in the zone of Zharrëz, Fier, in June-September 2009. These earthquakes are connected to the oil exploitation and the injection of fluid in wells. But even the explosions made in the oil wells because of the exploitation might affect the following earthquakes. Such cases are noticed even in other times in Albania. It is to be mentioned the earthquakes of Kukësi in 1979-1981, related to the explosions made in the mine of Gjegjan.

The recent noticed earthquakes in the region of Fier, have to do with the oil exploitation in these regions.This phenomenon is not new then. With the introduction of the new techniques to increase the oil and gas production and principally of shale oil, the cracking creation, in

USA it is noticed the creation of too many earthquakes in the regions previously not known, in Texas, Ohajo, and Tennessy etc.

Earthquakes that have caused liquefaction phenomenon

Earthquake	M	Magnitude of Earthquake	Location	Phenomena observed as a result of liquefaction of sands
01.09.1959	6.4	8-9	Seman and Osumi Coast	Cracks in the ground in the district of Berati, (Çiflik and Pashalli) length several hundred meters, water fountains and sand.
18.03.1962	6.0	8	Rërës Fier Novoselë	Cracks with a length of 100m and width up to 40cm. Fountain water mixed with sand by cracks and during riverbed Gjanica and Seman.

Even though they have some characteistics different from those of natural earthquakes (as shallowness, frequency, etc.), the earthquakes induced by the human activity are not different from the normals. The natural tectonic constraints on these cracking for the effect of deformation in a large scale of the tectonic plates and microplates, adding other constraints caused by techniques used for the oil and gas exploitation. This makes more visible the earthquakes, for which many people of this regions protest. These oil and gas exploitation techniques make the change of the release of the accumulated constraints in the tectonic crackings and micro cracking, creating a new model (pattern) of the seismic situation.

The recently noticed earthquakes in the region of Fier are connected to the oil exploitation in theses regions. This phenomenon is not new. With the introduction of the new techniques to increase the oil and gas production and principally of shale oil, the cracking creation, in USA it is noticed the creation of too many earthquakes in the regions previously not known, in Texas, Ohajo, and Tennessy etc.

We think that while these shaking are shown after the application of the technologies by the actual operator company, the cause of the shaking must be related to the oil exploitation technology used in this area.

The post- concussion and the rehabilitation of ways of evacuation

The concussions are small seismic events which continue for days or weeks as followers of the principal event. The following damages in these regions produce concussions.Eventhough they are smaller in magnitude than the principal event, they might produce great damages, because they often and repetedly shake the weak structures. An important lesson from the earthquakes is the distance from the epicenter may be less important than the nature of the foundation and the method of construction. Fine structures of the building on a solid ground that might be near the epicenter respond better the earthquake even why might be further the epicenter.

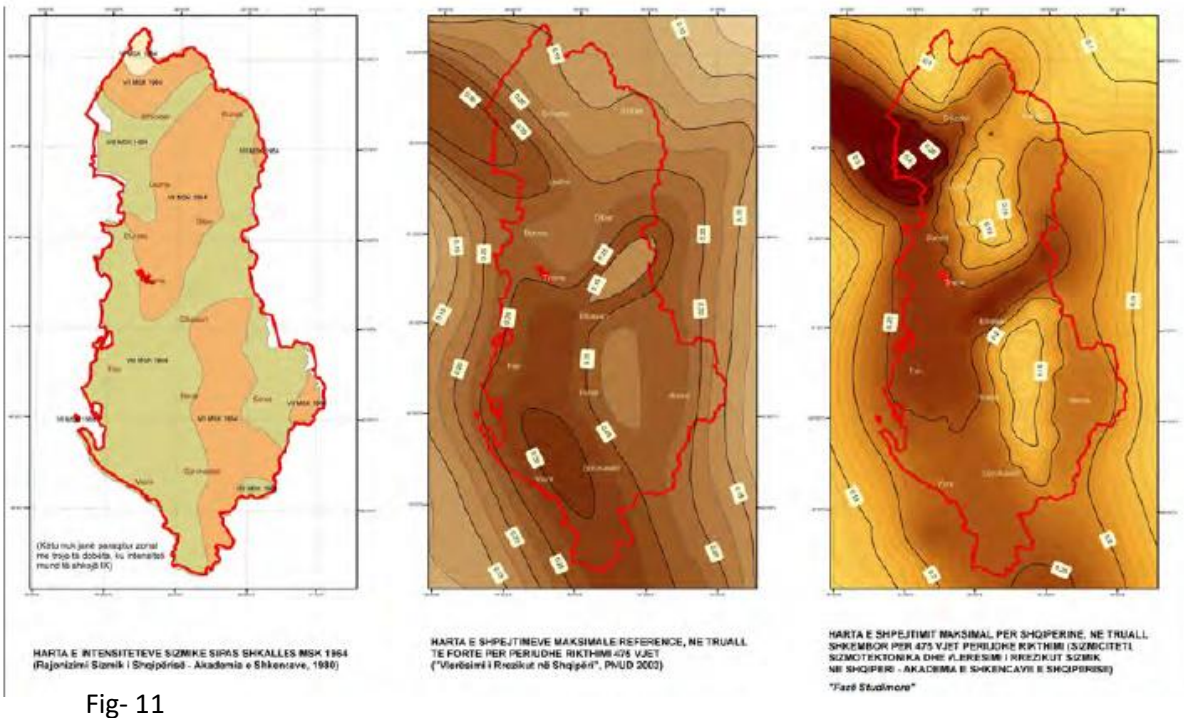

Fig- 11

The abnormal behaviours of animals

The signals taken by the animals for the pre sensitivity to the earthquakes are unknown. We know that the animals are adapted to their individual environments, and like this while some of them have similar to us sensors, others act in different levels of sensitivity. Known examples are the dog and the batts which hear sounds in further distant frequencies than us; some sort of snakes feel infrared hot waves the same way we see the light, the big eyes- owks might see in complete darkness and many other animals might feel large vibriations of ground before happening warning the humans. (Fig. – 12).

The statistics

The statistics are a very important forecasting instrument. The possibility of the occurance of a future earthquake might be calculated by the longterm experience. Just like in every effort, the bigger the registration period the bigger the forecasting level. The longest registrations or recalls come from a region that has been the most crowded for a long time, for example, the chineese registrations date up to thousands years. In a concentrated way we might say that during the period of the exploitation are used series of methods known by the literature, in the region of Marinzë there have not been recorded any disturbance concerning the ground shaking by the residents. Continuing this reasoning in our period, with the development in a fast way of the unconventional methods of the exploitation of the resources, is accepted as an side effect for the environment and the residents near, alongside, even the risque of the seismic shakings.It is possible that the seismic shaking of the zone of Marrinzë might be caused by the oil fields exploitation. A good example of the shaking caused by hydraulic crackings is a geotermic project in Bassel, Switzerland, which was banned because there were registered shaking with a 3.3-3.5 magnitude, which are stronger and are felt by the residents.

THE ENGINEERING METHODS TO RESIST THE ROCKY MOVEMENTS

The drainage of slopes

The water accumulation inside the slopes might be reduced due to some engineering techniques. The “interceptor drain” technique is realised through the digging of the upper part

of the slope. These concrete canalizations catch the water streams and take them away from the slope. The “Perforated pipe” technique is realised through the introduction of the drilled pipes in the surface of the slope, and then for the accumulation and drainage of water throught the gravity effect.Through the holes created in the rocky slope might be fast out pumped, especially in those regions considered critical.

The slope reduction

The inclination of a slope might be reduced to lower the risques of the ground sinking. If there is not enough space for that, then it is needed to dig inside the branch slope or terrace. ”The cracking” of the slope up to the terrace or scale, improves not only the rocky stability, but it also prevents the materials fall before touching the upper more protected zones of the slope, and avoids the erosion of water through the stream, channel or founts that wet the slope interruption.

The engineering methods to resist the rocky

A method to avoid the rocky slope dissolution is the protection of the slope surface from the rain and snow. All the cracked surfaces are covered by rocky layers of 8-10 cm thickness. This kind of coverage with rocky layers prevents the water entry inside the rock, which wouls create freezing spikes.

The mitigation measures

The risqué of the rocky layers movements might be reduced by the humidity control and by the angular inclination of the slope. The used engineering structures include: the coverage with “shotcrete”, the creation of protective walls, the support as well. The effects of the sinking might be reduced due to cables, wire fences, interrupted holes, rocky spills and tunnels. The best way to reduce the damages caused the rocky sinkings, would be the avoidance of the constructions in these regions.

The mitigation and recognition sinking holes

Where these holes might be formed it is predicted by the evaluation made to the lands affected by the sinking phenomenon, by the evaluation of the cracked surfaces models, and by defining where the empty spaces are located inside the rocky surface. But when such a hole is developed is not precisely known. The sinking in the surface might be discovered and controlled based in the analysis made to the surface.The crackings show that the sinking of the ground is advancing. They also show that an inevitable collaps could happen. How can the spaces underground be discovered? The drilling of the “test-holes” is a method, which requires time and money, and the holes would have to be drilled close to each-other to allow a view of the underground surface.

The penetrating ground radar

The radar antenna is placed directly on the surface and microwaving impulse which carries energy is spread to land. These waving impulses are reflected by the internal layers, where the layer with different composition reflects different characteristics.

CONCLUSSION

1. In our days, the hydrocarbons resources, which are placed under the inhabited areas, are constructed in a way that reduce the risque of the sinking of landmasses.
2. The companies that create such sources, assure compensating structures and public services.

3. If most of the structures would need support, then the expense would lead to the cancellation of the planes of their construction.
4. Such companies sign deals with the natives, to ensure them a compensation or to offer repairs in damaged cases.

REFERENCES

[1] Guri S., Ismaili J. The basin study of the Periadriatic Depression (Albania), Archive of Oil and Gas Institute, Fier, 1993
[2] AAPG Memoir 26, 36, 39, and 42. Oil and Gas Institute.
[3] Arapi M. (1994) The geological framework and the oil - gas bearing in the South Adriatic basin. Oil and Gas Institute, Fund.
[4] Guri S., Mehillka LL. The structural model of external Albanides and hydrocarbon prospects, Archive of Oil and Gas Institute, Fier 1995
[5] Mahmutaj L. The mineralogic-petrographic study of clay rocks in pre Adriatic depression, Archive of Oil and Gas Institute, Fier, 1989
[6] Skrami J., Guri S. - Some trends of the study of Quaternary loose deposits on the Durres-Vlora coastal zone. Publicize of "Universita degli Studi di Bari" (Italy),p. 185-187 Gennaio, 1999, Scientific Library of Oil & Gas Institute, Fier – Albania