Changes in Hydrochemical Indicators of the Brine Water of Patos - Marinza Oil Field

Dhurata Ndreko[1], Bledi Alla[2]

[1]Polytechnic University of Tirana, Geology and Mining Faculty, Tirana; Albania

[2]Bankers Petroleum Albania Ltd

Abstract: ***The paper is focuses on the changes in the hydrochemical indicators of the brine waters at the Patos-Marinza oil field due to the production phase. The Patos - Marinza oil field is one of the largest onshore in Albania and one of the biggest in Eastern Europe. Oil reservoir are related with the sandstone formation of Messinian age. The three main oil-bearing formations in the Patos - Marinza oil field from the bottom to the top are Bubullima, Marinza and Driza. Considering that this oil field is characterized by heavy oil the secondary or tertiary recovery methods have been used for oil production. This has led to the changes in the hydrochemical indicators of brine water. Chemical analysis provides data that for the same oil-bearing layers in the Patos - Marinza field there are changes TDS and the chloride value.***

Keywords: Hydrochemical indicators, Patos – Marinza, oilfield, water

1. Introduction

In this article will be given some considerations on the changes that have occurred in the hydrochemical indicators of the brine oil waters at the Patos - Marinza oil field. The hydrochemical indicators provide the necessary information to understand the changes that occur in the brine waters in time and space. The study area is located in eastern part of the Fieri city in the south of Albania (Fig.1). The Patos - Marina oil field is the largest onshore oil field in sandstone in Albania and is also considered one of the largest in Eastern Europe. Based on the characteristics of the oil, this oil field is characterized by heavy oil [3] and this has led to the use of secondary and tertiary methods for oil production throughout the period of its exploitation [2]. The use of these methods has led to the fact that over the years the hydrochemical parameters of brine water have undergone changes, especially in those sectors in which these methods are used.

2. Geological settings

The Patos - Marinza oil field is related to the Messinian deposits which are transgressively placed on the eroded limestone of the anticlinal structure of Patos - Verbas [7] [6] (Fig.2). The Patos - Verbasi anticlinal structure is the northernmost structure of the Ionian tectonic zone (Kurvelesh subzone) and the main oil fields in Albania are concentrated in the Ionian tectonic zone. The Messinian deposites lithologically are represented by seven sandstone formations. These formation from the botton to the top are Bubullima and Guret e Zeze, Marinza, Driza, Gorani, Kucova and Polovina [5] [6].

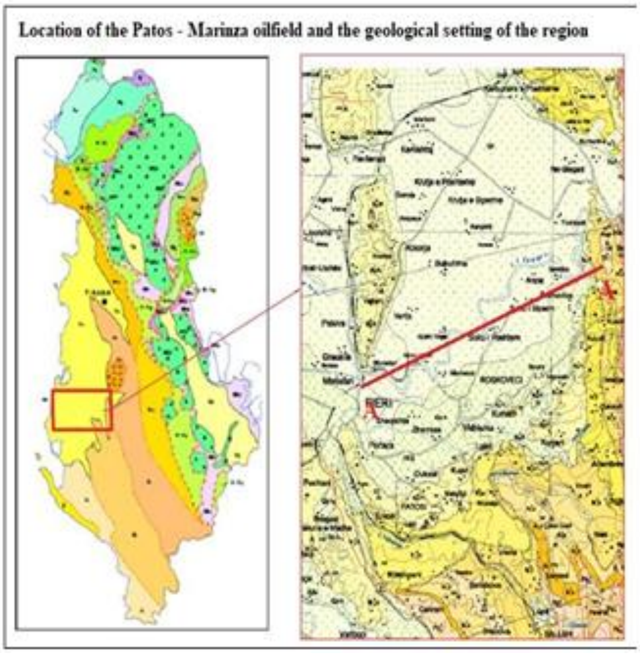

Figure 1: Location of the Patos – Marinza oilfied [14]

The main oil - bearing formations are Bubullima, Marinza and Driza.

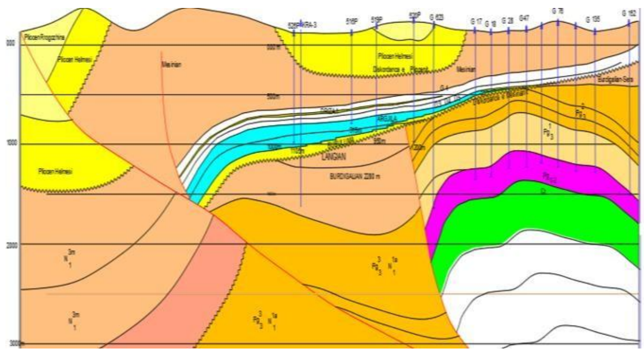

Figure 2: The geologic cross section (A - A) in the Patos – Marinza oilfied and the main oil - bearing formations [13]

The Bubullima formation is the oldest oil formation in the

Patos - Marinza oilfield [3]. The depth of this formation reaches up to 3000m. This formation is divided into 20 sublayers which are separated by a combination of claystone layers up to 10m thickness (Fig.3).

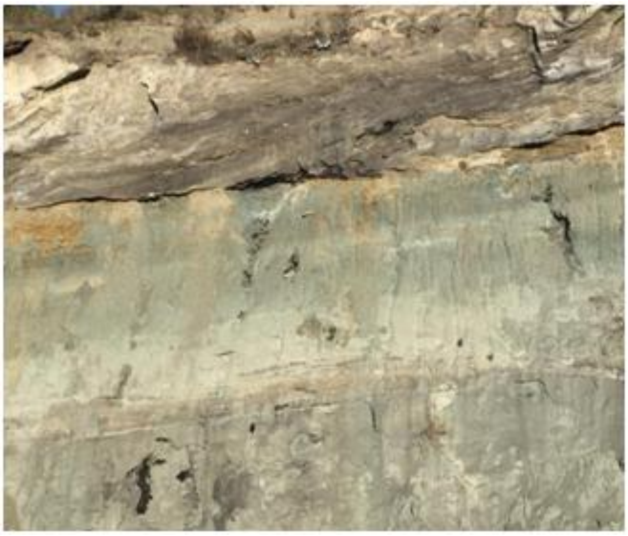

Figure 3: The combination of claystone layers with sandstone layers with oil in the Bubullima formation

In this formation are found oil - gas condensate reservoirs. The porosity and permeability decrease in depth, towards the eroded limestone as a result of the increased carbonate cement content. [7]. The Marinza Formation is divided into 8 layers with a thickness of about 120m [3]. The layers are about 15 - 20 m thick and have good accumulating properties. They are located at depths from 1200 m up to 1800m and have a range of up to 6 km. All these 8layers have oil with gas saturated and oil with gas cap reservoirs. Layers M, Mo, M1, M2 are generally grouped together and are known as "Marinza Object No. 1". This object has an area of about 8.7km2 [2]. This object is stratigraphically placed on the top "Marinza Object No. 2". The layers M3, M4 and M5 are generally known as "Marinza Object No. 2" which has an area of about 4.5 km2. The Driza Formation is divided into several sublayers placed on the top of "Marinza Object No. 1" the upper part of Marinza formation. This formation has the largest spreed in the Patos – Marinza oilfield, with an area of about 56 km2 [2] The upper part of this formation is placed transgressively over the older deposits, so the oil traps are lithological and stratigraphic types. The Driza formation is divided into 5 main layers named D5, D4, D3, D2 and D1. The D2 layers consists of two sublayers named D2 and D2 [2]. This formation is distinguished for its very good accumulating properties [3] with heavy oil in some places and on the surface it is distinguished by the presence of bitumen which also serve as a cover for oil accumulations towards the northwest direction [3].

Figure 4: Sandstone with oil of Driza formation

3. Materials and methods

The hydrochemical indicators provide the necessary information for the changes that occur in the brine waters in time and space. To see the changes in the hydrochemical indicators of the brine waters in the Patos - Marinza oil field as a result of exploitation for a long period, were studied this indicator in the first years of oil exploration. For this period were determined the genetic types [13] [1] of the brine waters of the main oil-bearing Bubullima, Marinza and Driza. Also have been studied genetic types of water for the carbonate deposits. The data collected in at the beginning of exploitation are compared with the chemical analyzes obtained in recent years in the oil wells. This is made to see how the hydrochemical indicators have changed, especially the changes that have occurred in the chlorides. Also it has been carefully studied the secondary and tertiary methods used in recent years for the oil extraction of the Patos – Marinza oil field, especially polymer injections. These methods have brought changes to the water parameters.

4. Results and Discussion

According to the [13] genetic coefficients and classification [1] the water related with oil reservoir are mainly Cl - Ca and Cl - Mg type. Chemical analyzes during the first period of oil extraction in the carbonate deposits [12] of the antichnial structure of Patos - Verbas shows high TDS values with very high values of chloride in the water sample. Also chemical analyzes for the Bubullima formation show hight TDS and chloride values and Cl – Ca water type (Fig.5).

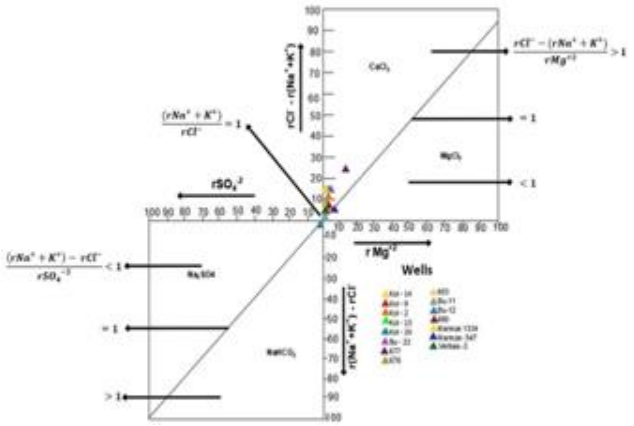

Figure 5: The graph with genetic water type of carbonate deposites

For the oil production object "Marinza No. 1" it is seen that this object have lower values of TDS from 10 – 25 gr/l and waters of type HCO_3 – Na [10]. From north to south and southeast direction of this formation the TDS increases from 16 - 20 gr/l in the north to 40 – 50 gr/l in the south [4] [8]. In this direction the water type pass from HCO_3 - Na to Cl - Mg and Cl – Ca [9]. This shows the development of metamorphism processes according to the primary stages in the sedimentation environment [1]. In the verticality within the Marinza formation are seen same areas where the TDS and the other hydrochemical properties decreases passing to the older layers. The phenomenon of hydrochemical inversion observed [11] must be related to the secondary condensation processes during migration in the gas condensate system.

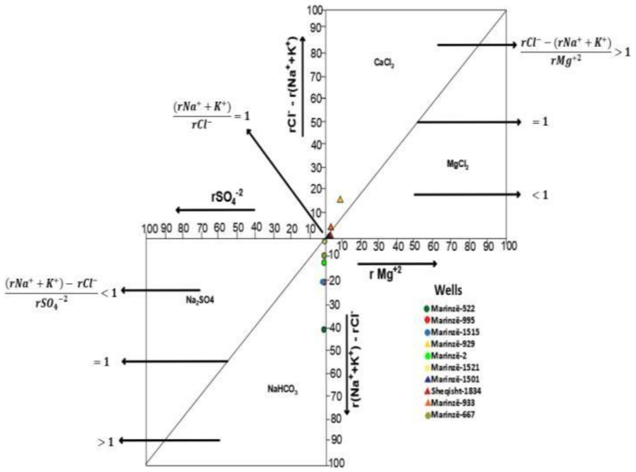

Figure 6: The genetic water type Marinza Objekt No. 1

In the Marinza Object No. 2 the chemical analysis shows different values of TDS from high 40 – 50 gr/l to lower values with water type from Cl - Ca to Cl – Mg (Fig.6) [11] [9]. These characteristics testify for water of the early sedimentation origin metamorphosed during diagenesis [11]. They are primary waters without the influence of the later stages of geological development, and which speak of the lack of communication with the "Marinza Object No. 1".

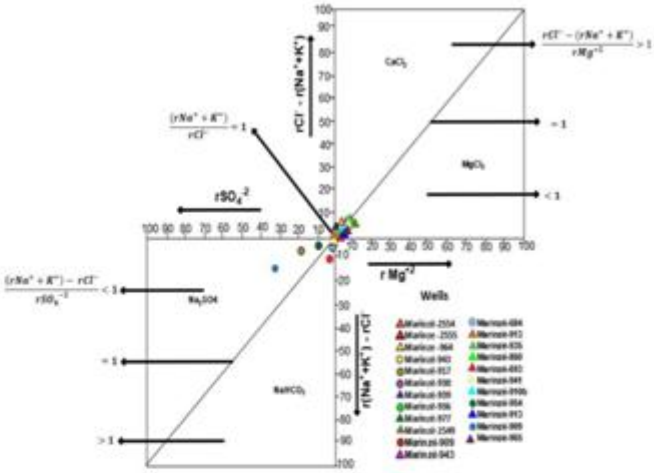

Figure 7: The genetic water type Marinza Objekt No. 2

During the period of exploitation in the Marinza formation are noticed that chloride values are reduced as a result of the water injection methods (Tab.1 & Fig 8.9). The injected water have lower values of chlorides, this has brought changes in the hydrochemical parameters of the water (Table 1).

Table 1: Chloride values measured in different years for Marinza Formation

Well	Year	Chloride ppm
860	1974	28400
	2013	17547
913	1977	21832
	2013	20915
	2015	14357
935	1974	26270
	2012	29110
	2020	9748
936	1974	15974
	2013	19497
	2019	9020
965	1979	26447
	2007	7100
	2020	4697
979	1984	27157
	2013	18965
	2016	17512

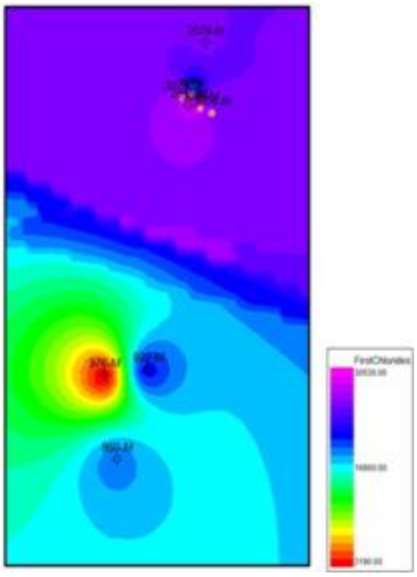

Figure 7: Clorides (mg/l) values for the time periode from 2007 -2014 Marinza formation

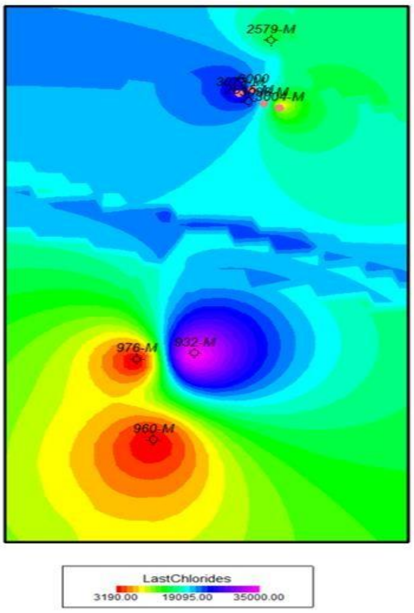

Figure 8: Clorides (mg/l) values for the time periode from 2015 -2021 Marinza formation

In the figures 7 and 8 is clearly show the changes in the chlorides values as a result of polymer injection in this formation in Marinza formation at different times of oil exploitation phase. Driza formation has different values of TDS that varies from 1 gr/l up to 10gr /l. In some areas in the northern part of Patosi village the Driza formation especially in sublayers D_4 and D_5 the chemical analysis show that the high values of TDS of 30 - 55.7gr/l [9]. Different of the rest of the Driza formation. These changes come as a result of lithological - facial changes and in this region this layer has different hydrodynamic systems and consequently water has primary origin from sedimentation phase. [7]

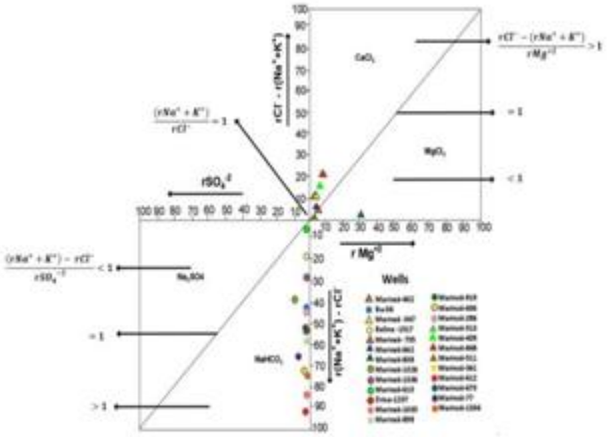

Figure 9: The genetic water type of Driza formation

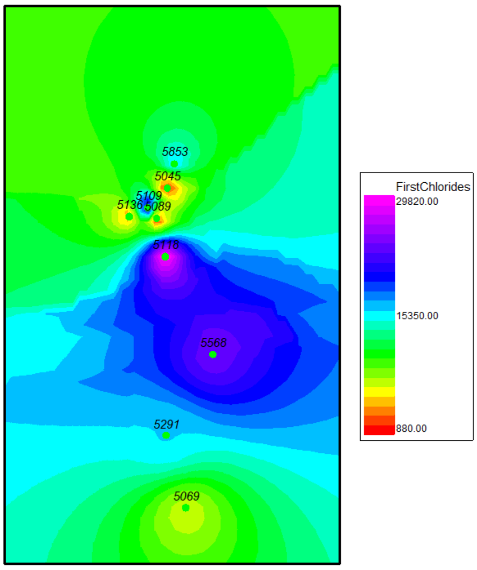

Figure 10: Clorides (mg/l) values for the time time periode from 2010 -2013 Driza formation

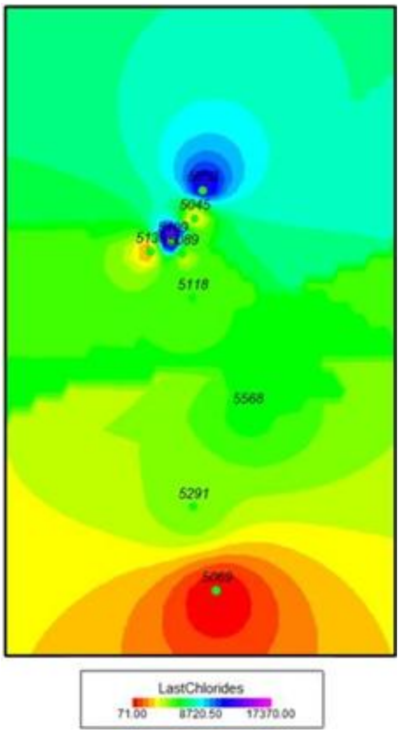

Figure 11: Clorides (mg/l) values for the time periode from 2020 -2021 Driza formation

In the figures 10 and 11 is clearly show the changes in the chlorides values as a result of the injection of the polymer in Driza formation at different times of oil exploitation phase. Also in Driza formation have been observed changes in chloride values during the period of exploitation. These changes have been seen especially in those regions where in the Driza formation was injected water with lower chloride values (Table. 2).

Table 2: Chloride values measured in different years for Driza formation

Well	Year	Chloride ppm
898	1984	16330
5045	2010	1952
	2018	1450
1207	1978	77.1
5069	2012	284
	2013	71
439	1980	30743
5568	2016	23574
	2020	4608

5. Conclusions

1) Hydrochemical indicators and the genetic types of water of the three main formations indicate different hydrochemical systems associated with different sedimentation environments of these main formations.
2) The comparison of the hydrochemical indicators for the main oil-bearing formations of the Patos – Marinza oil field shows that this hydrochemical indicators of the waters have changed as a result of the oil exploitation methods.
3) These changes are noticed especially in the decrease of the values of the chlorides especially in the Marinza and Driza formations and in those regions where secondary and tertiary methods for oil extraction have been used.
4) Also it is seen in some cases that the chlorides values are increased in same ares that in the first stage of oil exploitation the chloride values were lower. This happen as a result of the collapse of the columns of the drilled wells in the deeper formations and the water comes from the depths with high values of chlorides.
5) Changes may also occur as a result of the movement of the oil - water contact from north to south of the the Patos – Marinza oil field.

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Author Profile

Dhurata NDREKO Ph.D candidate completed the Geology Engineering from Polytechnic University of Tirana, Geology and Mining Faculty in 2009.

Bledi ALLA completed the Geology Engineering from Polytechnic University of Tirana, Geology and Mining Faculty in 2009.