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PRODUCTION AND EVALUATION STUDY FOR AN OIL WITH DISSOLVED ASSOCIATED GAS FIELD IN THE PANNONIAN DEPRESSION

1. WORK TARGETS

The work targets are:

- additional data analysis to the last study at reference date 01.01.2002 and confirmed at 01.01.2003,
- geological model update,
- resources and reserves reevaluation in order to be confirmed,
- optimum production scenario set up,
- discounted cash flow analysis.

2. RESERVOIRS PARAMETERS AND PRODUCTION STATUS

The field is located in the Pannonian Depression.

There were discovered hydrocarbon accumulations during the year 1966, through the well #50 in the Basement.

The production started in the year 1968, through the wells #51, #57 at the Basement and lower Miocene.

Lower Miocene was additionally perforated to the Basement and both are in the same hydrodynamic unit.

A representative well log and two structural maps are presented in Figure 1, Figure 2 and Figure 3, respectively.

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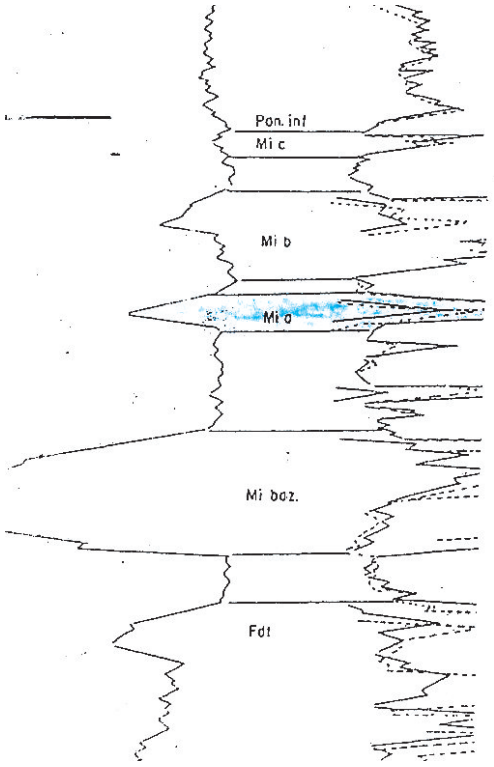

Fig. 1. Representative well log

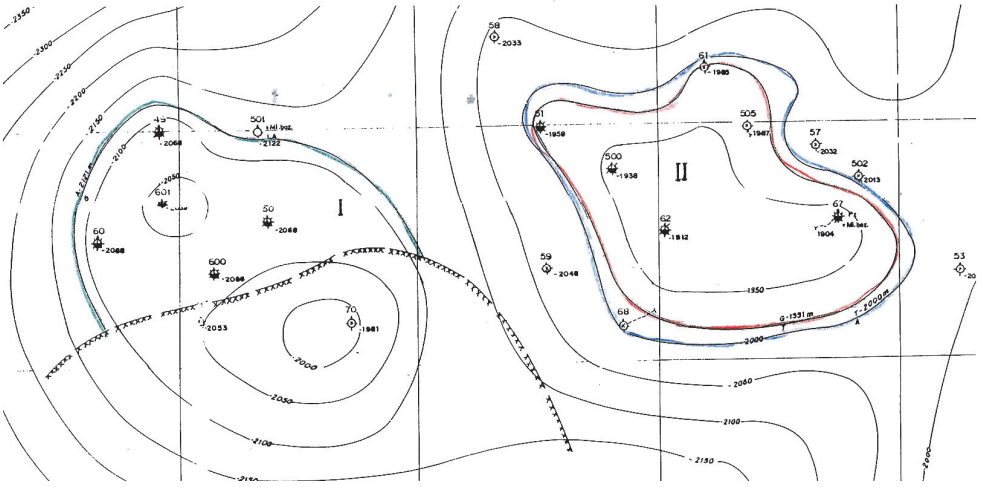

Fig. 2. Structural map – *Basement*

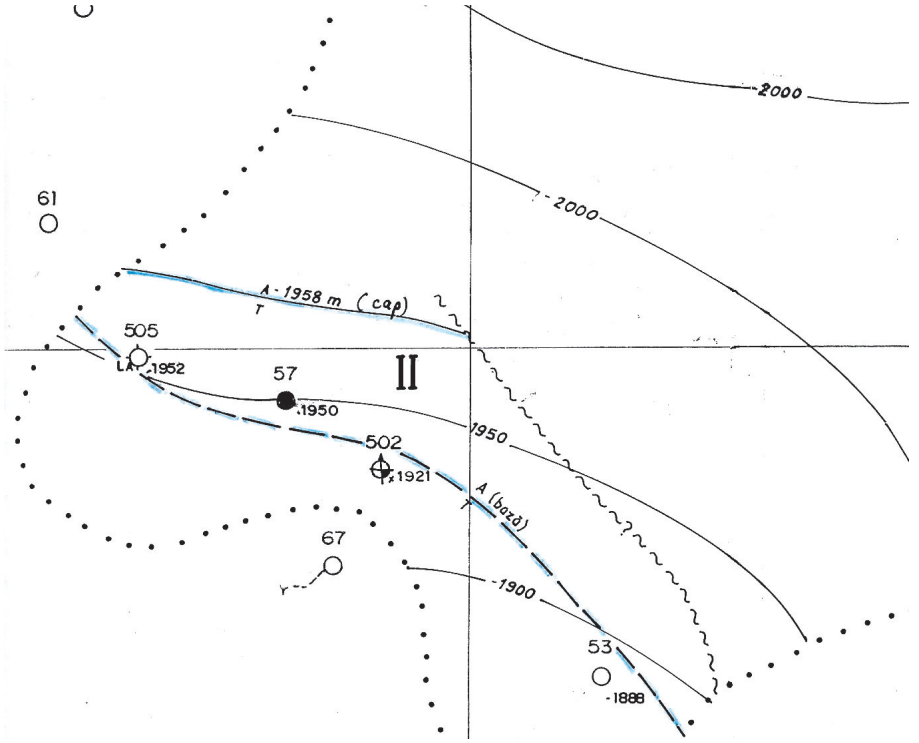

Fig. 3. Structural map – *Miocene "a"*

Miocene "b" sand has 1 free gas with condensate reservoir.

Miocene "a" sand has 1 oil reservoir with dissolved associated gas.

Basement + lower Miocene has:

- 1 oil reservoir with dissolved associated gas and gas cap (in culmination II),
- 1 free gas reservoir with condensate (in culmination I).

It is represented by two culminations: culmination I, which is saturated with free gas with condensate and culmination II, which is saturated with oil with gas cap. Basement has no production wells.

It is represented by a sedimentation area overlapping the eroded Basement or lower Miocene.

It has one oil with dissolved gas reservoir. #57 well is producing.

Production started in 1968. At January 1st, 2005 cumulative production was as following:

- 194 thousands tons of oil,
- 298 mill. scm of associated gas,
- 14 thousands tons of condensate,
- 49 mill. scm of non-associated gas.

There were drilled 25 wells; 12 wells had produced and in the present there is 1 production well.

In the year 2002 there were 4 wells in production (#50, #601, #57, #67).

In the present there is only one well in production: #57 at the Miocene "a", with the following parameters: 4.1 tons/day oil, 89% water cut and 300 scm/day associated gas.

There were performed the following workovers:

- #50 was retired from Basement at the lower Miocene, where it has produced 24 tons of condensate and 1 million scm of gas between 2002–2004, when the well was flooded and abandoned;
- #67 is piezometric (the last production was in 2004, when the well was flooded);
- #601 was retired from Basement at the lower Miocene, where from produced 70 tons of condensate and 0.85 million scm of gas between 2002–2004, when the well was flooded and abandoned;
- #49 was abandoned (the last production was in 1999, when the well was flooded);
- #62 was abandoned (the last production was in 2002, when the well was flooded);
- #505 was abandoned (the last production was in 1990, when the well was flooded);
- #600 was abandoned (the last production was in 2001, when the well was flooded).

The reservoir parameters are presented in Table I.

Table I

Main physical parameters

Formation	Basement+lower Miocene, culmination I	Basement+lower Miocene culmination II	Miocene a	Miocene b
Production starting	1969	1968	1979	1973
Production wells	–	–	57	–
Medium elevation, m	92	92	92	92
Medium depth, m	2121	2000	1954	1934
Initial pressure, atm	232	219	215	212
Actual pressure, atm			120-140	
Initial temperature, °C	125	119	117	116
Porosity, %	7.9/18	7.9/18	19.7	18
Hydrocarbon saturation, %	61/58	61/58	55	58
Absolute permeability, md	0.3/2.3	0.3/2.3	24	24
Effective permeability, md	0.1-3/24-412	0.1-3/24-412		
Saturation pressure, atm		218	215	
Oil formation volume factor at the initial pressure		1.48	1.47	
Dew point, atm	195	195		195
Initial solution ratio, scm/cm		149	147	
Gas formation volume factor at the initial pressure	0.005	0.006	0.006	0.006
Oil /condensate specific gravity, kgf/cdm	720	800/720	800	720

The reservoirs production status is presented in Table II.

Table II

Production indicators

YEAR	2002	2005
PRODUCTION WELLS	4	1
LIQUID FLOW RATE, cm/d/reservoir cm/d/well	 45 15	 48 48
OIL FLOW RATE, tons/d/reservoir tons/d/well	 2.5 2.5	 4.1 4.1
GAS FLOW RATE, Mscm/d/reservoir Mscm/d/well	 6 2	 0.3 0.3
WATER CUT, %	92	89
CUMULATIVE, OIL, Mtons GAS, MMscm	191-oil + 13-condensate 293-associated gas + 44-free gas	194-oil + 14-condensate 298-associated gas + 49-free gas
RESERVOIR PRESSURE, atm	120-140	120-140
ACTUAL RECOVERY FACTOR, % OIL ASSOCIATED GAS NON-ASSOCIATED GAS CONDENSATE	 31 61 37 31	 32 62 42 31

3. ANALYSIS AND EVALUATION METHODS

There was analyzed only 1 option for the future exploitation :

– *Option A* – production with the present well (#57) and the same operation type,

There were no proposal for reopening the Basement, due to:

– During 1973–1975 the exploitation was stopped in culmination I, because all the wells where flooded. After 1997 there were performed workovers in the wells and they produced only a few months and there were flooded again.
– The wells #600 and #601, drilled in the year 2000–2001, have produced a short period of time (8 months and 4 years, respectively) and there were flooded.
– It is considered that in culmination I the reservoir is depleted and there is no new well to be proposed to be drilled;
– In the culmination II, the wells have exploited the gas cap and the oil in the same time. The water cut grew up continuously, reaching 99% in the present. In this culmination it is considered that the reservoir is depleted and there is no new well to be proposed to be drilled;

– The Miocene “a” and “b” reservoirs are very small, because the strata are very thin and they are pinched out. The reservoir area extension is uncertain.

The production predictions were performed per well, per reservoir and per total field.

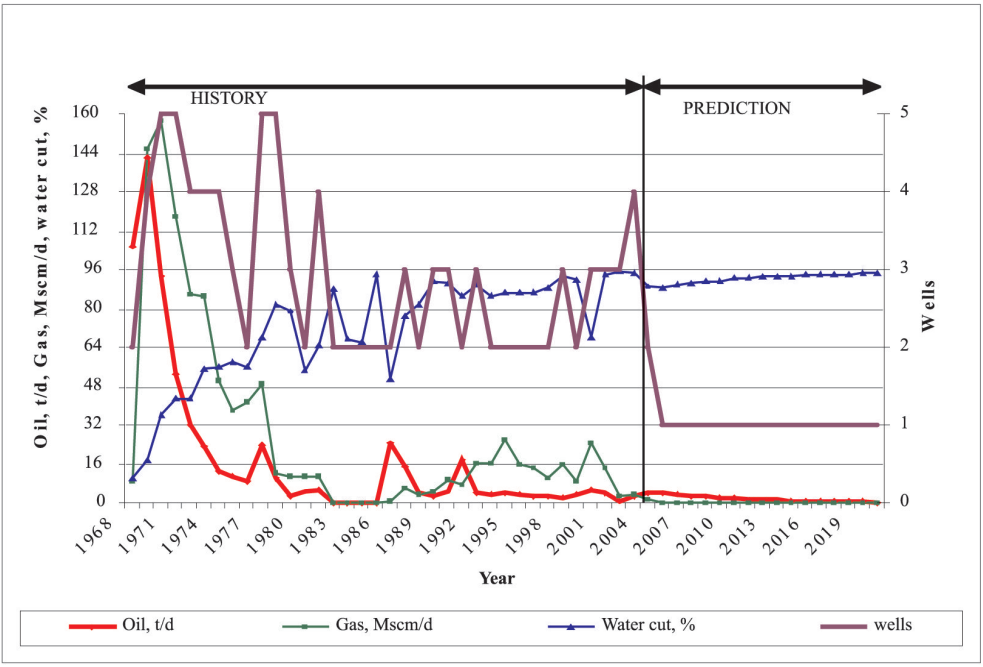

Fig. 4. Production history and production prediction

4. STUDY RESULTS

Table III

Resources and reserves differences between the present study and the last confirmation

Substance	Confirmed initial oil in place	Proposed initial oil in place	Difference	Confirmed initial reserve	Proposed initial reserve	Difference
Oil+condensate, Mtons	647	609	–38	197	202	+5
Associated gas, MMscm	471	480	+9	299	299	0
Condensate, Mtons	61	45	–16	14	14	0
Free gas, MMscm	114	118	+4	49	49	0

– The differences between resources from the last confirmation and those proposed in the study occurred because of some differences between the equations used to estimate the condensate and gas.
– The differences between reserves from the last confirmation and those proposed in the study are based on production behaviour.

5. CONCLUSIONS AND PROPOSALS

In this study it is proposed *Scenario I*:

– production with the present well (#57) and the same operation type.

The economic limit will be reached in the year 2016.
At January 1st, 2005 the reserves are:

Substance	Reserves	Developed proved reserves	Undeveloped proved reserves
Oil, thousands tons	8	8	0
Associated gas, mill. scm	0.6	0.6	0
Free gas, mill. scm	0	0	0
Condensate, thousands tons	8	8	0

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