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AUI GEOLOGIE

Lithostratigraphical characterization of the exploited aquifers from the Faraoani well field (Bacău County)

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Abstract

This paper deals with the analysis and the correlation of the geophysical logs registered in the 11 wells belonging to the Faraoani well field (Bacau County, Romania), in order to distinguish and to characterize the aquifers opened in the wells.

Keywords: well field, aquifer, geophysical log.

Introduction

The Faraoani well field is situated in the eastern part of Romania, in Bacău County, at about 18 km from Bacău Municipality (Fig. 1).

From a physio-geographical point of view, this area belongs to the major relief unit of Moldavian Plateau, Siret valley subunit (Ielenicz et al., 2005; Ielenicz and Săndulache, 2008), which favored the circulation and the accumulation of drinking water (Fig. 2). Moreover, the existence of the landforms created by Siret River in its middle and inferior sectors led to the development of the phreatic aquifer at small depths, ranging between 2 and 2.5 m, and of some medium and deep aquifers, characterized by great thicknesses and significant debits. In this context, the placement of the Faraoani well field on the Siret River terrace was based on the existence of the mentioned aquifers (Fig. 3).

Geological settings

According to Simionescu (1977), the Sarmatian thicknesses are estimated at 650–700 m for the Chersonian deposits, and 200 m for the Basarabian ones. Lithologically, the Sarmatian is composed of clays, silts and sands with thin intercalations of sandstone, oolitic limestone (oosparite), biosparite and arenitic limestone. Toward the west, between the platform and the Carpathian Molasse, the Sarmatian deposits accumulated in a deltaic facies, being composed of gravels and sands (Ionesi, 1994).

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In the Siret Valley, toward which the main watercourses in the area are directed, Pleistocene and Holocene alluvial accumulations composed of sands, gravels and loess are deposited.

Methods and technics

The wells from the Faraoani well field were drilled using boring rigs in dry system up to a depth of 6 m, and then the drillings continued in hydraulic regime, with reverse circulation, up to the final depth. The lithology of the penetrated strata was established based on the analysis of sieve samples. The wells were equipped with a single extracting casing. Behind this casing, a filtering gravel bed was introduced, functioning as a reverse filter. The sealing of the well at the upper part of the casing was made using a clay plug and a cement coating.

After the drilling, but before the pipe string was introduced, geophysical investigation operations were carried out in the boreholes. These investigations correlated with the lithology of the sieve samples led to the set-up for the placement intervals of the water filters.

The main geophysical investigations performed here were the standard electrical logging and the natural gamma ray logging.

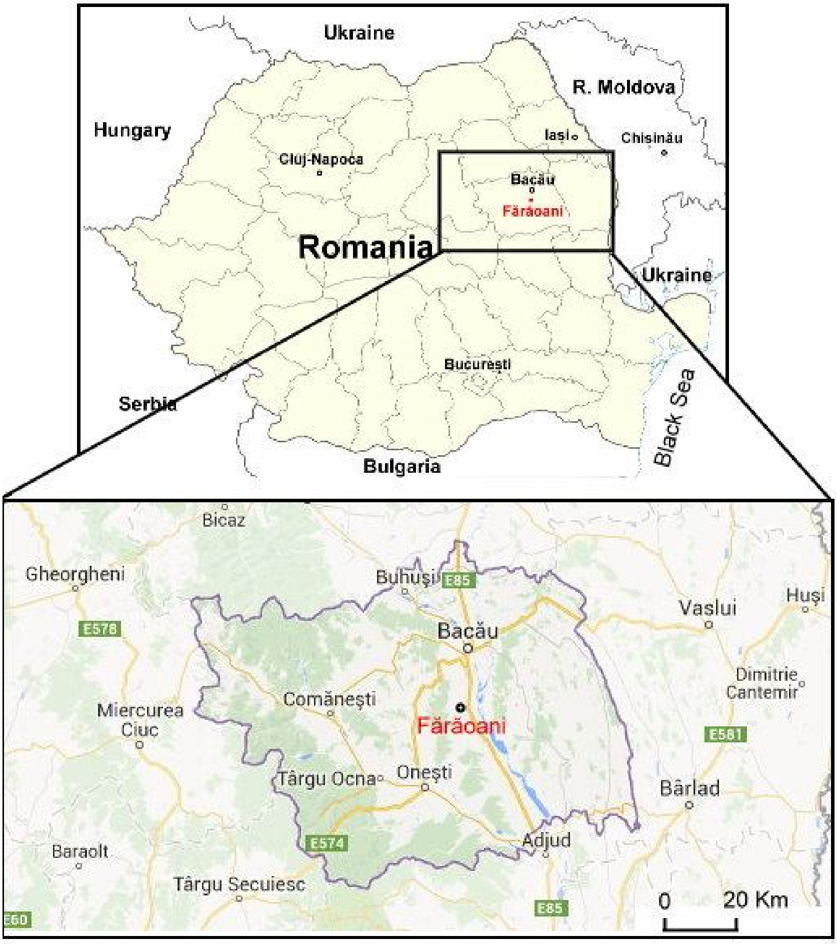

Fig. 1 Location of the Faraoani village.

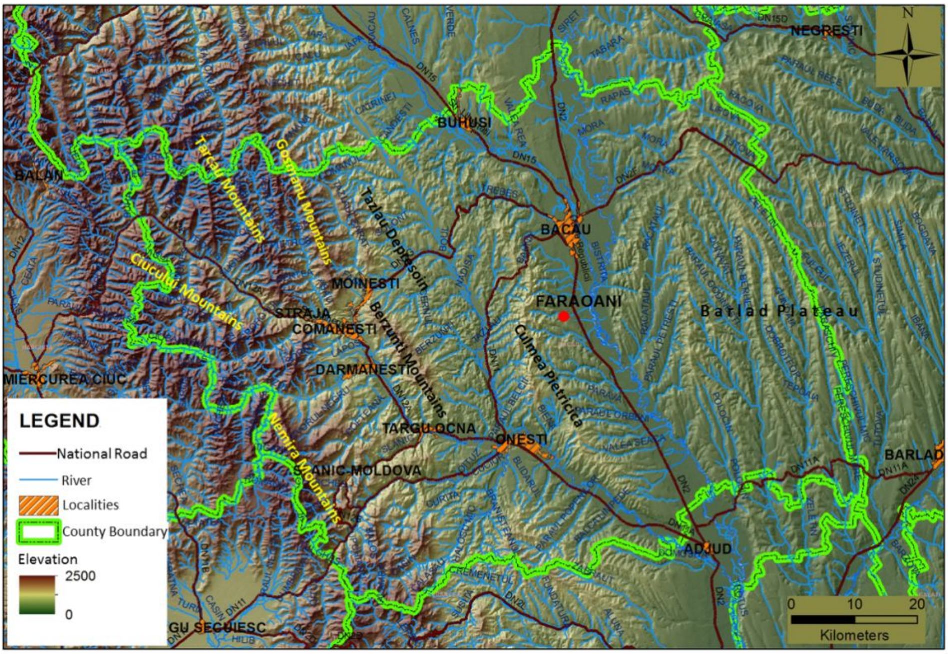

Fig. 2 Faraoani village territorial framing on the physical map of Bacău County.

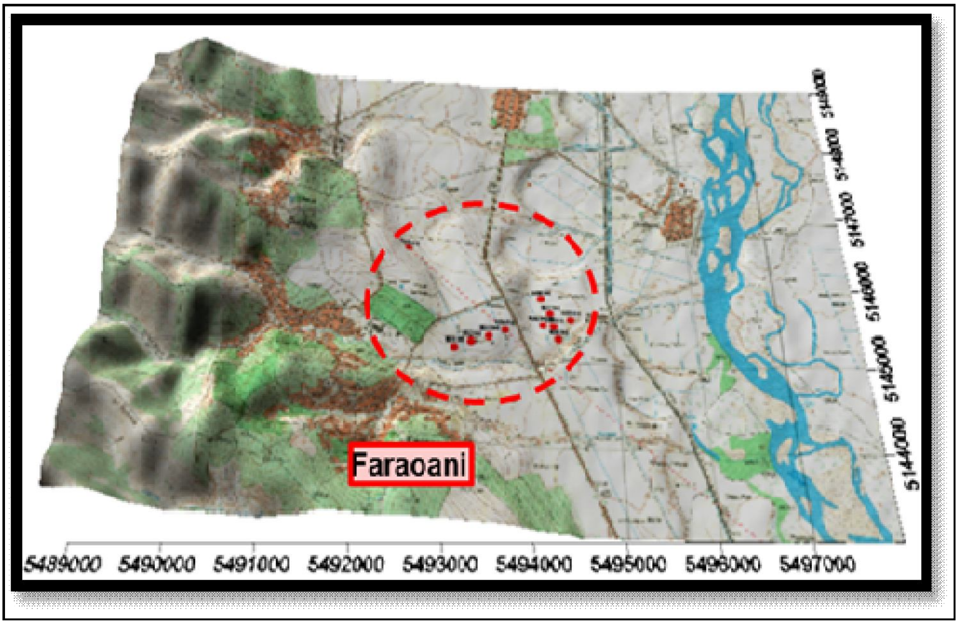

Fig. 3 3D topographical map of the Faraoani well field (after the topographical map 1:25000, L-35-54-D-d sheet, plotted using Surfer software).

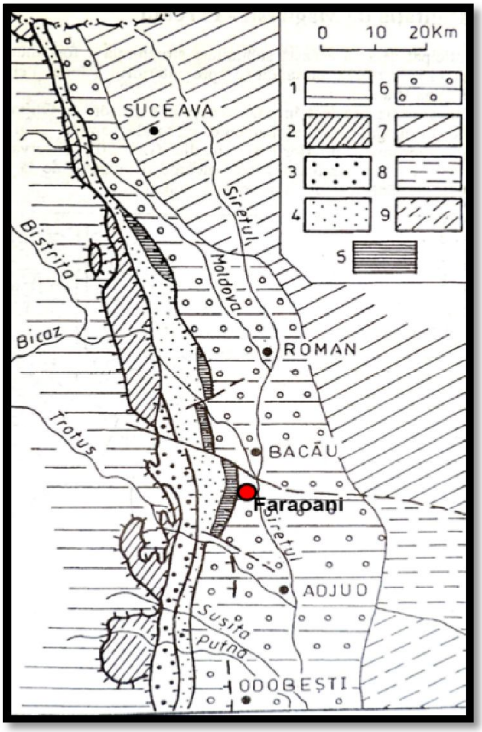

Fig. 4 Structural map of the northern sector of the Eastern Carpathians' molasse and its bordering units (after Săndulescu et al., 1980, 1995 fide Grasu et al., 1999). 1-Tarcău Nappe; 2-Vrancea Nappe. Pericarpathic Nappe: 3-Măgirești-Perchiu Digitation; 4-Pietricica Digitation; 5-Valea Mare Digitation; 6-Foredeep s. str.; 7-Moldavian Platform; 8-Scythian Platform; 9-North-Dobrogean Promonthory.

The clay line that connects the most electropositive points and the sand line that links the most electronegative points were plotted analyzing the spontaneous potential curve of the electrical logging (Fig. 5). Using these reference lines, the porous-permeable strata with sands and gravels were sorted out from the impermeable ones with clays and/or marls (Sglimbea et al., 1979; Babskow and Mălureanu, 1995).

In order to establish the strata thicknesses, a center line was drawn between the clays' line and the sands' line that divides the spontaneous potential curve in two areas: the right-side area represents the porous strata (sands) and the left-side area the impermeable strata (clays and marls). The amplitude difference between the PS peaks from the upper and lower part of the curve, measured on the center line, indicates the thickness of the porous-permeable stratum.

At the same time, in order to establish the lithological type, the natural gamma ray curve (NGA) was also used, which has high values (80–90 API units) transiting argillaceous strata, due to the content of radioactive elements these strata have, and small values (25–40 API units) transiting areas with sands and sandstones.

The resistivity curves indicate water presence through their high values, when they transit porous-permeable strata. Because these two curves (gradient and potential) have approximately the same amplitude, it denotes that there is fresh water.

In a similar manner, the aquiferous structures and their thicknesses were established and their corresponding hydrostatic level was plotted for the other wells (Fig. 6).

The data obtained from the logs interpretation also contributed in establishing some correlations between different types of aquifers opened by the executed wells. The most relevant correlations were carried out using two cross-cutting profiles, as shown below:

● Along the alignment that crosses the wells 101H, 102H, 103H, 104H, 106H, 106H bis and 109H, having a WSW-ENE setting, porous-permeable aquiferous structures made of sandy gravel and sand were identified at depths that correspond to shallow and deep aquifers, which are continuous in wells 101H, 102H, 103H and 104H. In wells 106H, 106H bis and 109H, the presence of a sandy gravel and sand stratum can be observed within the depth interval that corresponds to shallow aquifers, that is specific to the phreatic, and in well 106H, the occurrence of some aquifers is signaled at great depths in sandy strata (Fig. 7).

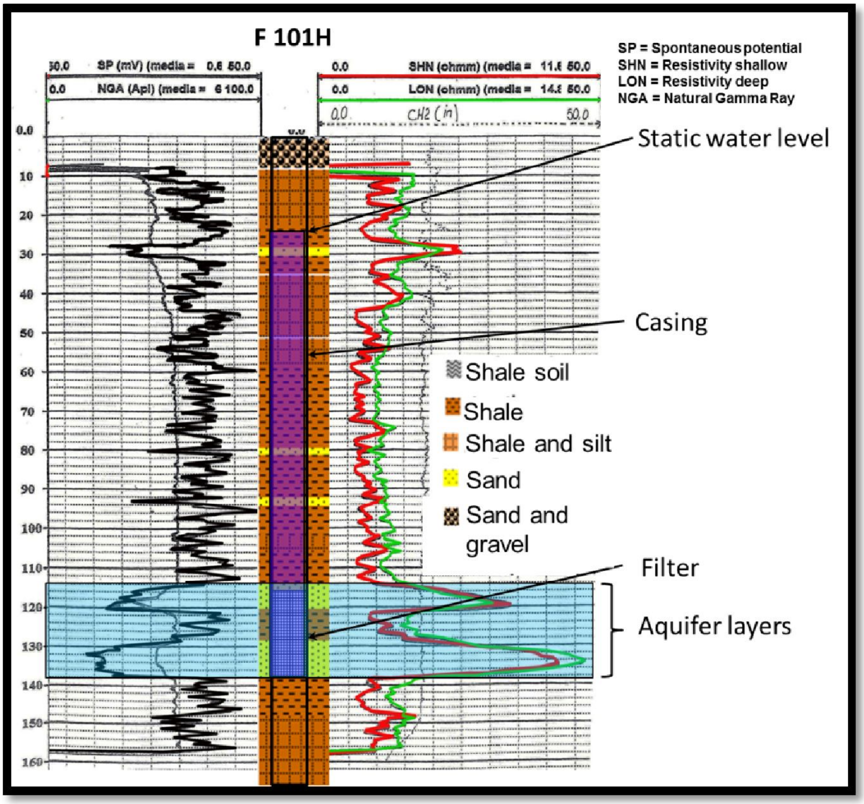

Fig. 5 The geophysical log and the lithological column of Well 101H.

● Along the alignment that crosses the wells 110H, 108H, 107H, 106H and 105H, having a WNW-ESE setting, continuities of the sand and sandy gravel aquifers can be observed only in wells 108H, 107H, 106H and 105H. In case of well 110H, a continuity of the aquiferous structures towards the other wells from the alignment cannot be established due to the great distance between this well and the other wells within the capture zone (Fig. 8).

Taking into account all of the above, one can observe that the interpretation of the logs obtained for the wells from the Faraoani has a great importance in assessing the thickness of the natural reservoirs and the depth intervals at which they were intercepted and in establishing some correlations between the identified aquifers.

At the same time, a discontinuity of the intercepted aquifers can be observed, which is characteristic to the Siret River alluvial meadow and terrace area and to the irregular manner of alluvial transport and accumulation in process of geological time.

Conclusions

Based on the analysis of the geophysical loggings from the wells drilled in the Faraoani, in conjunction with the sieve samples taken during the well drilling, the following were established:

● The lithological successions, the depths and thicknesses of the intercepted strata;

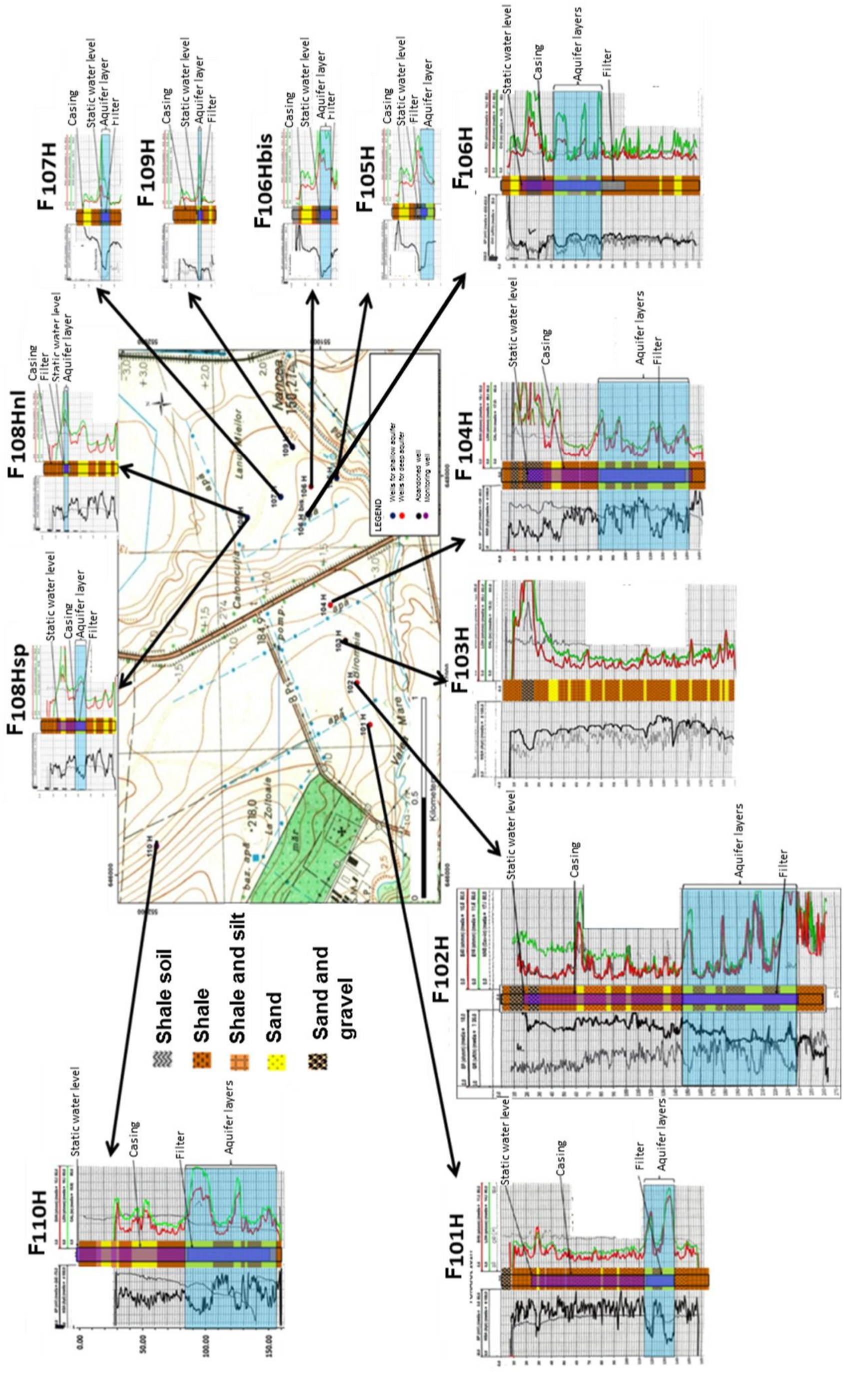

Fig. 6 The distribution of the hydrogeological wells from the Faraoani well field with their geophysical logs, lithological columns, confinement of the aquifers, position of the filters and hydrostatic level.

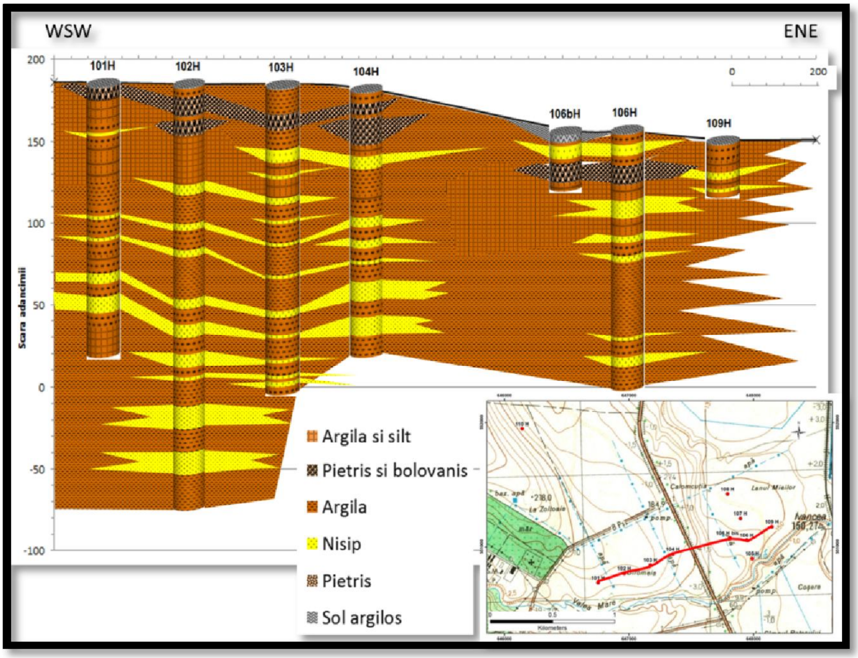

Fig. 7 The display of the aquiferous structures from the WSW-ENE alignment.

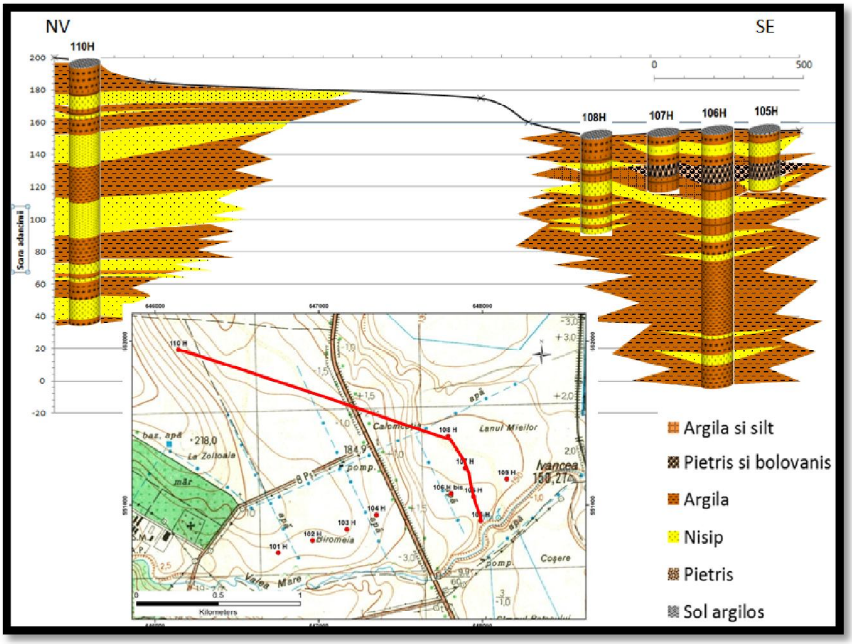

Fig. 8 The display of the aquiferous structures from the NV-SE alignment.

●The presence of the porous-permeable strata and of the aquifers;

●The correlation of these strata and aquifers between the wells;

●The spotting of three types of aquifers based on their depths:

●A surface phreatic aquifer in wells 105H, 106H bis, 107H, 108H and 109H;

●A medium depth aquifer in wells 106H and 108H;

●A great depth aquifer in wells 101H, 102H and 104H;

●The assessment of the optimum depth at which the filters that connect the aquifers with the drilled wells were locked fixed.

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