GEOLOGICAL AND HYDROGEOLOGICAL CONSIDERATIONS ON THE QUATERNARY DEPOSITS FROM CRIŞUL ALB BASIN, BETWEEN VÂRŞAND AND SEBIŞ (CLIMHYDEX PROJECT)

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ABSTRACT. – Geological and hydrogeological considerations on the Quaternary deposits from Crişul Alb basin between Vârşand and Sebiş (CLIMHYDEX PROJECT). CLIMHYDEX project - "Extreme climate and the impact associated to the hydrological events from Romania" – is a Complex Project of Exploratory Research, supported by the Executive Agency for Higher Education, Research, Development and Innovation Funding. The overall objective of the project is to improve the knowledge on the quantification of the climate change impact on the hydrological and hydrogeological regime in extreme conditions, at river basin scale. The project runs in two pilot basins, Crişul Alb river basin and Bârlad basin. In the paper are presented geological and hydrogeological considerations on the Quaternary deposits from Crişul Alb basin, the sector between Vârşand and Sebiş. This data is based on the elaboration and interpretation of the hydrogeological cross-sections executed through the wells of the hydrogeological first order stations Vârşand, Chişineu Criş, Zărand, Ineu and Bocsig, and also on the hydrogeological mapping made in the area, in October 2012. The results will stand at the base of a future conceptual model for the elaboration of the groundwater flow mathematical model.

Keywords: Quaternary deposits, shallow aquifer, alluvial fan of Crişul Alb, piezometric map.

1. INTRODUCTION

Within the CLIMHYDEX project - "Extreme climate and the impact associated to the hydrological events from Romania", Complex Project of Exploratory Research supported by the Executive Unit for Funding Higher Education, Research, Development and Innovation, the *National Institute of Hydrology and Water Management* is one of the main partners. The purpose of the activities within the project is to improve the knowledge on the quantification of the climate change impact on the hydrological and hydrogeological regime in

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extreme conditions, at river basin scale. The project runs in two pilot river basins: Crişul Alb river basin and Bârlad river basin. In the current paper there are presented aspects on shallow groundwater from the plain area of Crişul Alb basin. In what concerns groundwater, the objective of the activities within the project are the establishment in the pilot area of the relations between groundwater and surface waters and also the evolution of these relations during climate changes.

The paper presents the results of a first stage from the research of shallow groundwater from the study area, respectively detailing knowledge in terms of lithology and hydrogeology of the Quaternary deposits in which is located the shallow aquifer from the study area, based on the elaboration and interpretation of the hydrogeological cross-sections executed through hydrogeological observation wells in the area and based on hydrogeological mapping made in October 2012.

The study area is situated in Crişurilor Plain, between the localities Sebiş, at East and Vârşand, at West. Towards North, the limit of the study area is situated at the limit with the Crişul Negru river basin, and in the southern part, at the limit with the of Mureş river basin (Fig. 1).

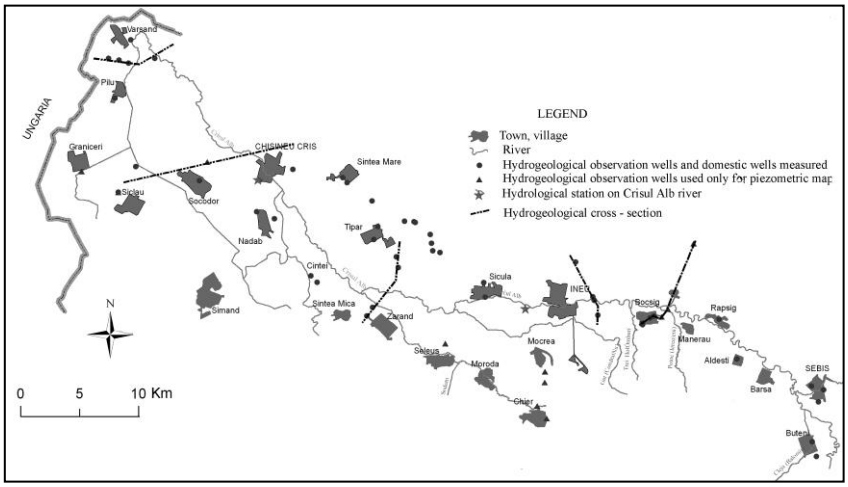


Fig. 1. ***Crişul Alb river basin between Vârşand and Sebiş -overview***

2. GENERAL GEOMORPHOLOGICAL AND GEOLOGICAL CONSIDERATIONS

Crişul Alb river basin is situated in the contact area of four mountain massifs from Western Carpathians, the main water course, Crişul Alb, covering a length of 234 km, passing through a series of tectonic depressions before reaching the Tisa Plain. The lower course of the river, located in Crişurilor Plain has a length of about 100 km and a general orientation from ESE to WNW (Coteţ, 1973).

The natural setting of the relief from Crişul Alb river basin is consistent with the geological formations. Thus, in the East there are the oldest formations belonging to the crystalline foundation and the sedimentary layer, with a structural

and tectonic variety, that also make the most complex relief steps: mountains, hills and depressions, and in the western part there is a plain area consisting of Pannonian and Quaternary detritic deposits, characterized through a large morphological uniformity (Coteț, 1957).

The plain area of the Crişul Alb river basin overlaps the Pannonian Depression. The foundation, composed of crystalline schist, is covered by Cretaceous sedimentary deposits, over which it is disposed the Neogene fill specific to the depression. The deposits of the filling belong to the Badenian, Sarmatian and Pannonian, being composed of marls, clays, conglomerates and sands. The quaternary consists of fluvial-lacustrine deposits, gravel, sand, clay, red clay, loess, loess deposits and eolian sand.

3. LITHOLOGICAL AND HYDROGEOLOGICAL CONSIDERATIONS REGARDING THE QUATERNARY DEPOSITS

The study area overlaps the development area of Crişul Alb alluvial fan, one of the most important hydrostructure in the area.

Generally, the alluvial deposits of the Crişul Alb fan consist of sands, sands with gravels, sands with gravels and boulders, alternating with levels of clays, sandy clays (Cineti, 1990). The age of these deposits is Upper Pleistocene – Lower Holocene.

This hydrostructure is in direct hydraulic connection with the aquifer located in the alluvial fan of Mureş river, developed in the southern area, and also with the aquifer from the alluvial fan of Crişul Negru river, developed in the northern part (Cineti, 1990),(NIHWM Archive).

For detailing knowledge from lithological and hydrogeological point of view of the Quaternary deposits from the study area that encloses the shallow aquifer, there were elaborated five hydrogeological cross-sections through observation hydrogeological wells (NIHWM Archive) in the area of the localities (from East to West) Bocsig, Ineu, Zărand, Chişineu Criş and Vârşand. The knowledge in depth of the lithological succession of Quaternary deposits is given by the depths of the observation wells, which is between 15.0 – 23.0 m at Bocsig, 15.6 – 52.0 m at Ineu, 12.5 – 30.0 m at Zărand, 17.0 – 21.0 m at Chişineu Criş and 10.0 – 30.0 m at Vârşand. Apart from Bocsig profile, where they were also intercepted the terrace deposits on the left bank of the Crişul Alb, in the other sections there were intercepted deposits of the floodplain and of the lower plain.

Generally, the wells intercepted an alternation of porous permeable deposits, whose granulometry varies both vertically and horizontally, with clay levels with relatively large extension in space. Within the porous permeable deposits appear as intercalations clay levels with lenticular aspect.

At Bocsig (Fig. 2), in the proximal area of development of the Crişul Alb alluvial fan, over an alternation of clays, sandy clays, silty sands, there are sands with gravels, locally with intercalations of sands and intercalations of gravels and

sands with boulders, and completely subordinated, argillaceous sands. Vertically, the granulometry of the deposits increases, the deposits consisting of sands with gravels and boulders, under the lenticular intercalations of clays and sands with gravels. At the upper part of the detritic deposits, there are developing clays, sandy clays, with argillaceous sands intercalations.

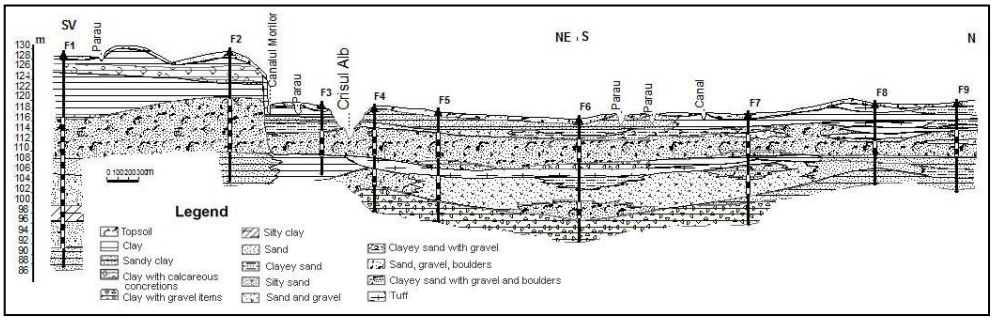


Fig. 2. ***Hydrogeological cross-section in the Bocsig area***

In the terrace on the left bank of the Crişul Alb, the alluvial deposits consist of sands with gravels and boulders. Over these, there are clays, and clays with calcareous concretions, with a thickness of 8.5 to 11.0 m.

Characteristic for Bocsig area, north of Crişul Alb, are some thin intercalations of greenish rhyolitic tuffs with lenticular development. The oldest intercalation was intercepted in the F4 (between 10.0 – 12.0 m), F5 (between 11.0 – 12.5 m), F6 (between 9.5 – 12.5 m) and F7 (between 9.0 – 10.0 m). In the F8 well there were intercepted three horizons of tuffs at the depths of 0.5 – 1.85 m, 3.8 – 4.3 m and 5.7 – 6.9 m.

Toward West, ***at Ineu*** (Fig. 3), the thickness of the alluvial deposits of the Crişul Alb fan increases significantly, the observation wells from this area intercepting their upper part. From lithological point of view, they are made of sands with gravels and boulders, which towards the marginal zone, to the southeast, turn to sands with gravels.

Subordinated, there are thin intercalations of clays, silty clays, whose thickness increases towards the marginal zone.

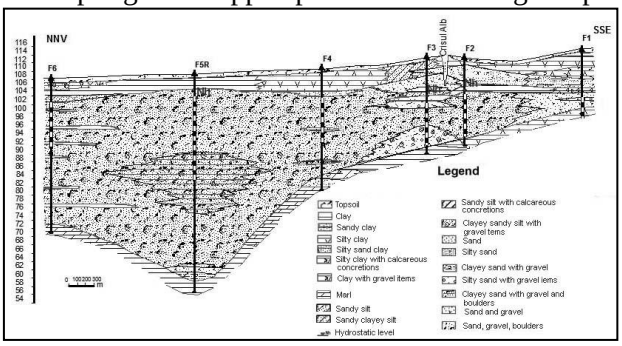


Fig. 3. ***Hydrogeological cross-section in the Ineu area***

The maximum thickness of the porous permeable deposits, intercepted by the observation wells is of 45.5 m (F5 R Ineu well). At the upper part of the porous permeable deposits are developed loessoid deposits consisting of clays, silty clays,

sandy silts, silty sands. The granulometry and thickness of porous permeable deposits have a tendency to decrease towards west, while increasing the weight and thickness of the argillaceous deposits.

Thus, ***at Zărand*** (Fig. 4), the porous permeable deposits are represented by sands with gravels, with local lenticular aspect, totally subordinated intercalations of argillaceous sands. These alternate with levels of argillaceous deposits, the aquifer quartered in these deposits having a multilayer character. The loessoid deposits (with a maximum thickness of 16.5 m in F1 Zărand well) developed at the upper part of the lithological succession in the Zărand area, are represented by clays, sandy clays, silty clays, clays with calcareous concretions, sandy clay silts.

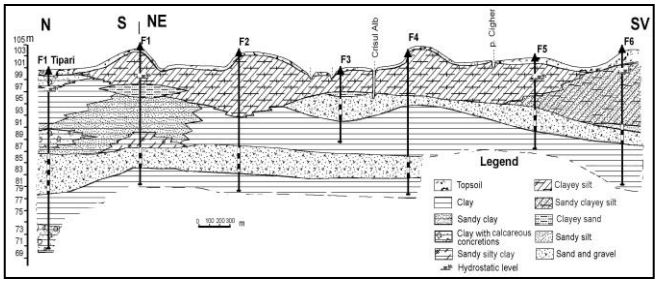


Fig.4. ***Hydrogeological cross-section in the Zărand area***

At West of Zărand, in the Chişineu Criş area (Fig. 5), the porous permeable deposits intercepted by the observation wells are better developed, forming a continuous horizon consisting of sands with gravels, with an intercalation of sands with gravels and boulders to the SW and towards NE, the coarse sands deposits turn to argillaceous sands with lenticular intercalations of clays.

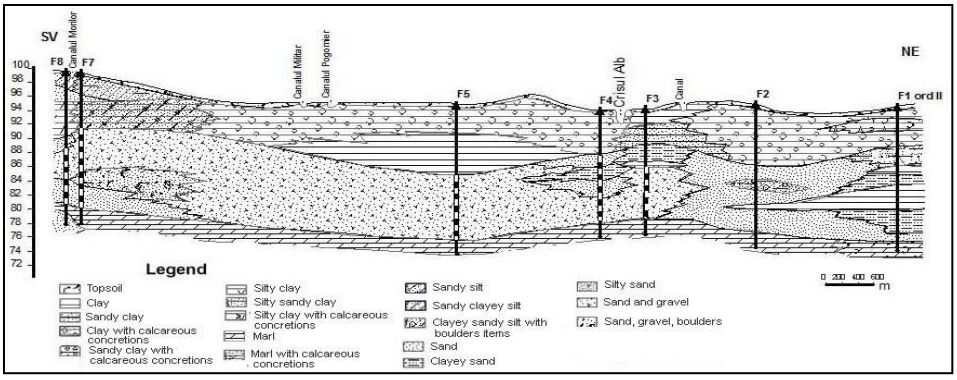


Fig. 5. ***Hydrogeological cross-section in the Chişineu Criş area***

The loessoid deposits consist of clays, sandy clays, silty sandy clays, clays with calcareous concretions. In the western part of the study area, at Vârşand (Figure 6), the porous permeable deposits have a low weight, predominantly silty clay deposits. The granulometry of the deposits decreases, the porous permeable deposits being represented through sands, completely subordinated with intercalations of sands with gravels.

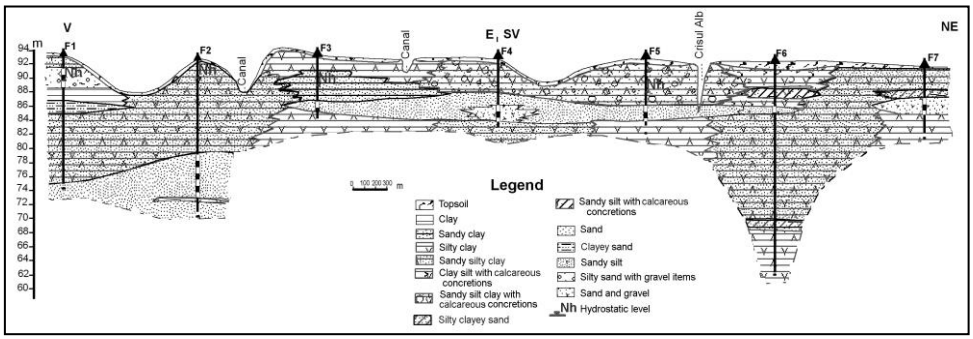


Fig. 6. ***Hydrogeological cross-section in the Vârşand area***

Towards NE there is an intercalation of sands with gravels, which may belong to the alluvial fan of the Crişul Negru. The loessoid deposits consist of clays, sandy clays, silty clays, sandy clays, silty sands with calcareous concretions, subordinated silty sands and argillaceous sands.

From hydrogeological point of view, the shallow aquifer from the study area is located in the porous permeable horizons from the upper part of the Crişul Alb alluvial fan and in the floodplain deposits. The hydrostatic level of the groundwater is generally free, but can be ascension when at the upper part of the aquifers horizons are developed argillaceous deposits (Vârşand, Chişineu Criş).

At the experimental pumping made at the execution of the observation wells from the study area (NIHWM Archive) there were obtained discharges 1.2 – 10.0 l/s for drawdowns of 0.91 to 8.75 m at Bocsig, 3.0 to 10.8 l/s for drawdowns of 0.36 to 3.25 m at Ineu, 1.25 to 8.5 l/s for drawdowns of 1.0 - 5.0 m at Zărand, from 0.37 to 8.0 l/s for drawdowns of 0.65 to 5.0 m at Chişineu Criş and 1.43 to 3.3 l/s for drawdowns of 0.7 to 5 m at Vârşand. Hydraulic conductivity is between 9.3 to 34.0 m/day at Bocsig, from 14.5 to 24 m day at Ineu, 10.6 to 16.35 m/day at Zărand, from 3.0 to 38.4 m/day at Chişineu Criş and 10.6 to 16.35 m/day at Vârşand.

It is observed a great variability of the discharges obtained from the shallow aquifer and also of the value of the hydraulic conductivity, due to the facies and granulometry variation of the porous permeable deposits.

In October 2012 there was made a measurements campaign for the shallow aquifer hydrostatic level from the study area, in 18 observation wells and 48 domestic fountains.

Based on these and on the data from the hydrological stations Ineu and Chişineu Criş on the absolute height of the Crişul Alb water surface, there was elaborated the piezometric map of the shallow aquifer in the study area (Fig. 7).

It is observed that the general flow direction of the shallow groundwater is ESE – WNW, with its local change near Crişul Alb, towards it, the shallow aquifer being drained by the river (the shallow aquifer recharge the river).

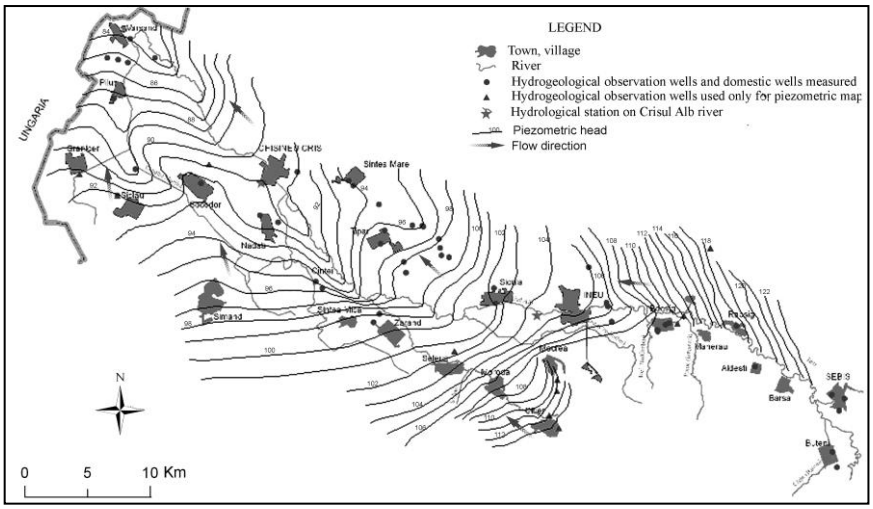


Fig. 7. ***Piezometric map of the shallow aquifer***

During flash – flood periods, the flow direction of the groundwater changes, from the river toward the shallow aquifer (the river recharge the aquifer). The recharge of the shallow aquifer from the study area is mainly made from precipitations, to which it is added the supply from the hydrographic network and from the area of the river Mureş alluvial fan, which has a hydraulic connection with the alluvial fan of Crişul Alb.

From the analysis of the evolution of processed and measured levels for 2012, also using the measurements made in the field campaign, it is established a clear tendency of increase of ***the monthly average hydrostatic levels*** in the first 4 months of the year, then a decrease until September, followed by an increase until the end of the year (Fig. 8).

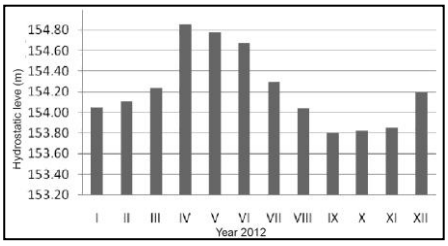
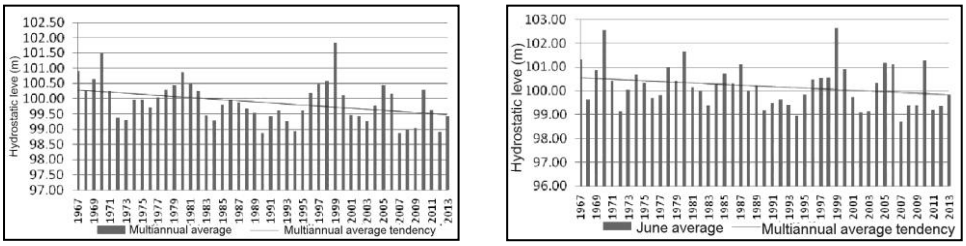


Fig. 8. ***The evolution of the monthly average hydrostatic levels in F3 Zărand well in the year 2012***

For the observation wells in which there is a continuous series of data since their execution until present (NIHWM Archive) there were drawn up variation graphics of the multiannual average of the hydrostatic level (Fig. 9a), variation graphics of the average hydrostatic level corresponding to each month of the year (Fig. 9b). Generally, there was established a decreasing multiannual average tendency of the hydrostatic level for the majority of the analyzed wells, and also a clear increasing tendency of the hydrostatic levels in the first four months of the year, and then a sudden change until September, followed by a slight increase until the end of the year.



a ***b***

Fig. 9. ***The evolution of the average hydrostatic level in F3 Zărand well***

4. CONCLUSIONS

Within CLIMHYDEX Project - *"Extreme climate and the impact associated to the hydrological events from Romania*", there was made in the plain area of the Crişul Alb pilot basin, the detailing knowledge from lithological and hydrogeological point of view of the Quaternary deposits in which is located the shallow aquifer.

The shallow aquifer is located in the porous permeable intercalations of the upper part of Crişul Alb alluvial fan and in the floodplain deposits (sands, gravels, boulders). These deposits are characterized through a variation of lithological and granulometric facies both vertically and horizontally. The general flow direction of the groundwater is ESE – WNW, with local change near Crişul Alb, towards it, the aquifer being drained by the river (the shallow aquifer recharge the river). During flash – floods periods, the flow direction of the groundwater changes, from the river towards the shallow aquifer (the river recharge the aquifer).

Based on the analysis of the hydrostatic levels evolution, it was established a decreasing multiannual average tendency of the hydrostatic level for the majority of the analyzed wells, and also a clear increasing tendency of the hydrostatic levels in the first four months of the year, and then a sudden change until September, followed by a slight increase until the end of the year. The obtained results are the base of the conceptual model for the elaboration of the mathematical model of the shallow aquifer groundwater flow in the study area.

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