Studies and projections of hydraulic conductivity of Devonian Plavinu and Daugava carbonate aquifers in Latvia

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Introduction

Carbonate aquifers show a very wide range of hydrogeological characteristics. Carbonate rock hydrogeology display two extremes: on one hand hydrogeological properties of the carbonates are governed by the pathways of the preferential groundwater flow typical in karstic regions, on the other - some carbonate aquifers behave almost like a homogeneous, isotropic, porous medium. Most lie in between these extremes, but these case variations complicate the study of carbonate aquifer properties.

In this study the results of the hydraulic conductivity in carbonate aquifers measurements, hydraulic conductivity correlation between sediments lithology and the aquifer surface depth and fractures research is presented. **Upper Devonian Frasnian stage Plavinu (Pļaviņu) (D3pl) and Daugava (D3dg) carbonate aquifers** in the Latvian part of the Baltic Artesian basin is considered. The aim of this research is to elaborate characteristic hydraulic conductivity values for each aquifer based on existing data of the pumping test results and other aquifer properties.

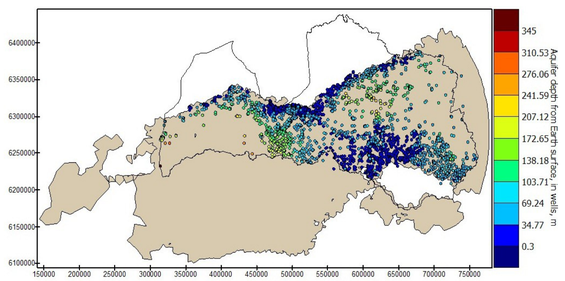

Figure 3. D3pl aquifer depth (m) from Earth surface in wells with fractred dolomites, (3824 wells)

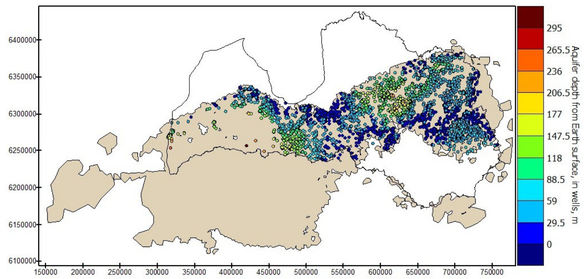

Figure 4. D3dg aquifer depth (m) from Earth surface in wells with fractured dolomites, (4066 wells)

Results

Studying average values of hydraulic conductivity, there exists a correlation between K and aquifer flat depth – Daugava aquifer (Figure 3, 4), which, in geological structure, is located above the Plavinu aquifer, has higher average K value – 32 m/day, in Plavinu aquifer – 27 m/day. Correlative study of the depth and hydraulic conductivity allowed to characterize the mean values as function of the aquifer depth for the regional groundwater flow modeling.

Calculations of hydraulic conductivity value distribution areas shows convincing connection between aquifer surface depth and K value distribution (Figure 5, 6). The connection between hydraulic conductivity and aquifer depth were calculated and analysed in two ways. In one case, a distribution of K values in connection with aquifer absolute depth was calculated (m above – below sea level) (Figure 5, 6). In second case, the hydraulic conductivity areas, connected with aquifer depth from Earth surface were estimated. Results in both cases show very similar situation.

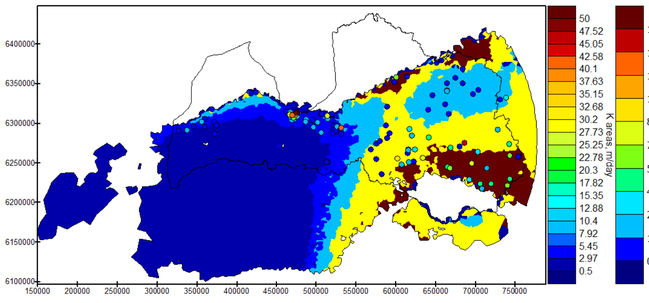

Figure 5. Calculated areas of K values (m/day) connected with aquifer depth (m above sea level) and wells with measured K (m/day) in D3pl aquifer

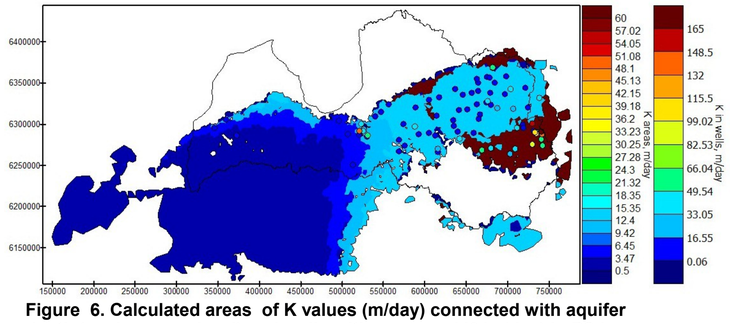

Figure 6. Calculated areas of K values (m/day) connected with aquifer depth (m above sea level) and wells with measured K (m/day) in D3dg aquifer

Input data and methods

Plavinu and Daugava carbonate aquifers mainly consist of fractured dolomite with intermediate layers of dolomitic marlstone, limestone, clays and gypsum. These aquifers are prevalent in most of the study area, except Northern and South–Eastern parts of the territory (Figure 1, 2). In geological structure Daugava aquifer lies above Plavinu aquifer. The Daugava aquifer depth (Figure 3, 4) varies between 10 - 20 or less meters in Eastern part, between 250 - 300 m in South - West part of the study area, but thickness ranges from a few meters up to 30. The surface depth of Plavinu aquifer varies from 20 - 30 m, but reaches more than 120 m in uplands of Eastern part, and exceeds 300 m in South - West part of study area (Brangulis 1998).

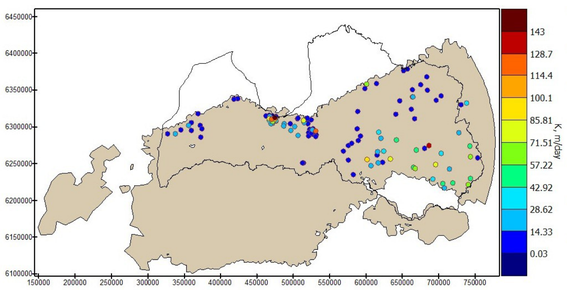

Figure 1. Prevalence area of upper Devonian Plavinu aquifer sediments and wells with measured hydraulic conductivity

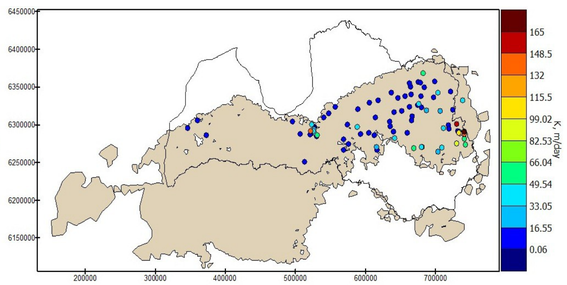

Figure 2. Prevalence area of upper Devonian Daugava aquifer sediments and wells with measured hydraulic conductivity

Pumping test results provide a wide range of hydraulic conductivity values for this study. Pumping test results were from data by the Latvian Environment, Geology and Meteorology Centre were used. In Plavinu aquifer the hydraulic conductivity varies from 0,03 – 266 m/day (131 wells), but values range from 0,06 – 735 m/day (in 96 wells) in the Daugava aquifer. To better illustrate the K value distribution, K values less than 200 m/day are shown.

Hydraulic conductivity distribution areas were plotted using hydrogeological model of Baltic Artesian Basin (BAB) (Virbulis et al in print).

Conclusions

Hydraulic conductivity values displaying carbonate aquifer filtration properties show very wide value range that is directly connected with fractures and degree of rock cavernousity. In this case that is closely related to the aquifer depth in the geological structure.

Estimation of distribution of hydraulic conductivity based on aquifer depth, in one case using aquifer absolute depth and in other depth from the surface showed very similar results for Plavinu and Daugava carbonatic aquifers.

References

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