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Calculation of subsurface rock thermal maturity, Northern Croatia

Izračun termalne zrelosti stijena u dubini, Sjeverna Hrvatska

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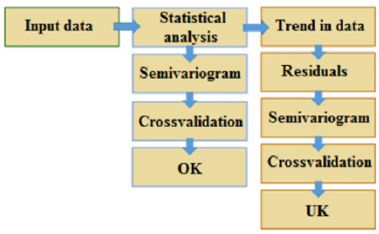
ABSTRACT

Calculation of thermal naturity of subsurface rocks is one of crucial geological and thermodinamical problem in exploration of deep geological settings. The positive results can strongly indicate: (a) mature source rocks for hydrocarbons or (b) the geothermal water and/or water steam aquifer. The successful application of entire process in exploration and exploitation can be reached if are fullfilled three neccessary conditions: (1) proper selection of mapping method that can be used for obtaining enough precise subsurface maps of rock top, bottom or thickness, (2) selection of minimum number of subsurface maps for appropriate representation of deep geological settings, (3) numerical calculation of thermal maturity using TTI value. Here application of all three procedural conditions is shown as well as it was successfully tested in the Neogene strata of the Croatian part of the Pannonian Basin System. The algorythm system can be applied for both estimation of maturity of hydrocarbon possible source rocks or evaluation of present-day temperature of potential geothermal aquifer.

I. SELECTION OF SUBSURFACE MAPPING METHODS

Mapping of large geological surfaces has become simpler and more precise with advance software development. However, the most common problem is to choose an appropriate method. There are different mapping methods, but the most accurate method is considered to be an advanced geostatistical method of estimation, a Kriging method. There are different Kriging techniques that are used depending on the mathematical properties of the input data. Selection between most commonly used Kriging technique, Ordinary Kriging (abbr. OK), and Universal Kriging (abbr. UK), a technique that is used when input data is marked with trend, is shown by a following flow chart:



Scatter plot shows positive linear trend of variable (in this case 'depth') with longitude and negative linear trend with latitude. Residuals are given by subtracting the real value of dependent variable(depth) from the estimated.

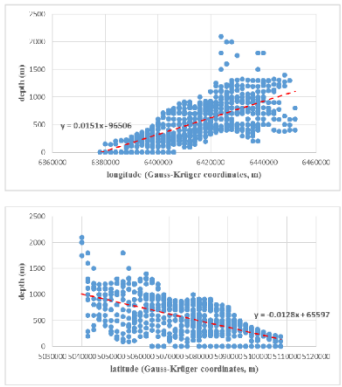


Figure 1.1: *Example of trend calculation*

Crossvalidation results: RMSE (OK) = 79,6; RMSE (UK) = 79,3.

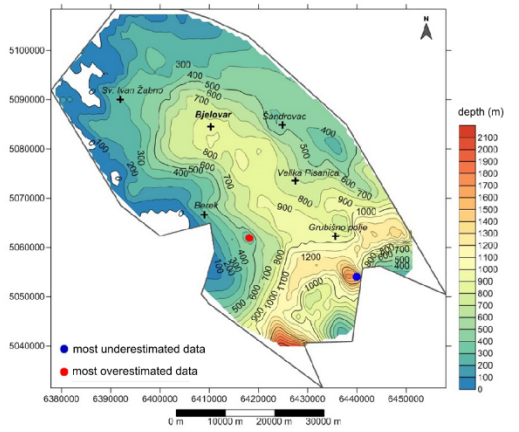


Figure 1.2: *Example of possible subsurface map*

II. SELECTION OF POSSIBLE SUBSURFACE MAPS

After selecting the most appropriate Kriging technique, two types of subsurface maps can be made (when having depth values of several e-log markers as input data):

a) depth map (that was shown before)
- shows depth values of single e-log marker
- it can indicate type of environment
- shows unconformity surfaces

b) formation thickness map
- thickness can indicate type of sedimentation
- areas of maximum sedimentation can be determined
- profiles and isochores can indicate fault zones

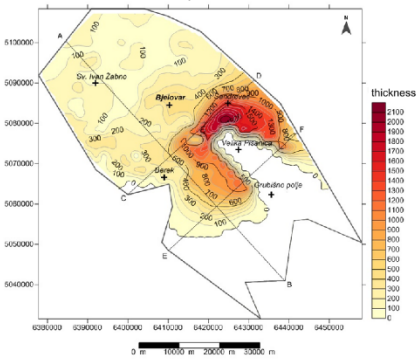


Figure 2.1: *Example of possible thickness map*

III. OWN-MADE BASIC PROGRAM FOR CALCULATION OF THERMAL MATURITY

Figure 3.1:*The program had been written in Chipmunk BASIC language, free interpeter made by Ronald H. Nicholson Jr. (http://www.nicholson.com/rhn/basic/).*

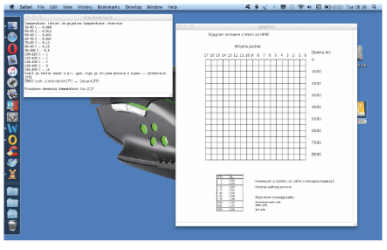


Figure 3.2:*The program outcome with inout screen (left) and graphical diagram (right)*

IV. CONCLUSION

Here are, for the first time, accompanied two compatible geological researching methods. Firstly, own-made and tested algorithm when and how apply Universal Kriging for subsurface mapping is given. Secondly, BASIC program had been programmed and listed as freeware. Using both tools it is possible appropriate, i.e. with high precision, to map any subsurface marker or border plane. Consequently, any point on such plane can be selected and accompanied with thermal (maturity) value, calculated by BASIC program. If burial history curves are available it can be done for any map's point (palinspastic approach). The computer program can be easily modified for similar applications in any geological area.

V. LITERATURE

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