



Annual Conference of PhD Geology Students

Kasmetinė geologijos krypties doktorantų konferencija

19 November 2015, Vilnius

2015 m. lapkričio 19 d., Vilnius

ORGANIZED BY DEPARTMENT OF GEOLOGY AND MINERALOGY, FACULTY OF NATURAL
SCIENCES, VILNIUS UNIVERSITY

*KONFERENCIJĄ ORGANIZAVO VILNIAUS UNIVERSITETO GAMTOS MOKSLŲ FAKULTETO
GEOLOGIJOS IR MINERALOGIJOS KATEDRA*

**PALAEOCLIMATIC AND PALAEOENVIRONMENTAL RECONSTRUCTIONS
ACCORDING TO SUBFOSSIL CHIRONOMID (DIPTERA: CHIRONOMIDAE)
ANALYSIS / CHIRONOMIDŲ ANALIZĖS METODAS PALEOKLIMATO IR
PALEOAPLINKOS POKYČIAMS NUSTATYTI**

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The Late Glacial and Holocene period was characterized by several rapid and extreme shifts in climate across the North Atlantic region. The magnitude of these shifts has been recognized from sediment records using various proxies. For the past 20 years, subfossil chironomids have started to be used in paleolimnology for reconstruction of various factors such as nutrients, macrophytes, salinity, lake depth, and anoxia. Chironomid analysis is ideally suited for generating high-resolution quantitative and qualitative past temperature reconstructions (Brooks, 2006). Chironomids (also known as non-biting midges) larvae are often the most abundant insect group found in freshwaters. Their short life cycles, ability to disperse rapidly over long distances and independence from pedogenic processes enable them to respond to changing climate and environment more rapidly than terrestrial vegetation (Birks, Birks, 2008).

The first attempts on chironomid assemblage studies were carried out on Lieporiai Lake (North Lithuania) sediments, where not only Holocene but also the Lateglacial sediments are relatively well-expressed. A detailed multi-proxy analysis, e. g. pollen, plant macrofossil, radiocarbon data (^{14}C) and loss-on-ignition measurements, was used. The first results of the chironomid analysis point to the presence of Chironominae, Tanypodinae and Ortocloidiinae subfamilies in the studied sediments. Future studies trying to identify the species composition will hopefully give important information dealing with palaeoenvironmental changes.

Key words: chironomids, paleoclimate, Lieporiai Lake, Holocene, Late Glacial

References

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EVALUATION OF THE INTERDEPENDENCE OF THE COMPONENTS DETERMINED DURING COMPLEX STUDIES OF DŪKŠTELIS LAKE BOTTOM SEDIMENTS / PAGRINDINIŲ DŪKŠTELIO EŽERO DUGNO NUOSĖDŲ KOMPONENTŲ, NUSTATYTŲ KOMPLEKSINIŲ TYRIMŲ METU, TARPUSAVIO PRIKLAUSOMYBĖS VERTINIMAS

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Most Lithuanian lakes lie in the zone of the Pleistocene continental glaciation. The analysis of the bottom sediments of these lakes and further correlation of the results obtained allows reconstructing the chronology of natural and anthropogenic changes in the post-glacial environment, to access the change of palaeographical conditions in the past and to foresee possible tendencies of changes in the future. The following analyses were performed during the complex studies of Dūkštelis Lake bottom sediments: spore-pollen analysis, determination of loss on ignition of sediments (LOI), their magnetic susceptibility, absolute age (^{14}C , AMS), $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ isotope analysis, geochemical analysis with evaluation of the contents of As, Ba, Zr, Sr, Rb, Zn, Cu, Ni, Co, Fe, Mn, Cr, V, Ti, Ca, K and S. Then the evaluation of environmental and vegetal changes in the region during the recent 14 000 years was done. On the basis of the results, the analysis of inter-correlation of complex studies of vertical sections of seven borings was performed and the study of the distribution of components in the horizontal profile of lake bottom sediments was completed. The interdependence between the components (percentages of organic matter, mineral component, geochemical data, magnetic susceptibility, grain size fractions and $\delta^{18}\text{O}$, $\delta^{13}\text{C}$) was evaluated according to Spearman non-parametric correlation coefficients and their significance level. Higher contents of chemical elements, including mobile Ca and Ba and less mobile Zr, were detected in the sediments of Late Glacial and Early Holocene periods. Their accumulation is related to the amount and the variety of terrigenous material. Besides, the changes of the contents of some elements can be the indicators of the climatic events or human activity which caused these changes. Magnetic susceptibility is directly linearly related with the mineral part of the sediments and is inversely proportional to the amount of organic matter (determined by LOI method), thus, it can serve as an indicator of terrigenous material. Correlation bonds between the magnetic susceptibility and the contents of Fe, K, Mn, Rb, Sr, Zr prove that accumulation of these elements depends on terrigenous material. Further studies will be concentrated on the origin of these and other chemical elements and factors determining the changes of their contents.

Key words: lake sediments, Late Glacial and Early Holocene, complex studies, chemical elements, geochronology, correlation, linear relationship

RADIAL BASIS FUNCTION METHOD FOR MODELLING OF VERTICAL BOREHOLE HEAT EXCHANGERS | *RADIALINIŲ BAZINIŲ FUNKCIJŲ (RBF) METODAS MODELIOJANT ŠILUMOS PERDAVIMĄ VERTIKALIAIS KOLEKTORIAIS*

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The borehole heat exchangers (BHE) are used to transfer heat from/to the ground or heat could be stored in the ground for the specific needs. During the last two decades various analytical and numerical methods were developed to predict and analyse as well as to design and optimize the BHE installation and performance parameters.

In general, the heat transfer in BHE is divided into three parts: inside the BHE, around the BHE, and the interactions between BHE's including the long-time and short-time heat transfer analysis.

In this study, the radial basis function method is used for the borehole heat transfer problems. Because a much wider range of physical phenomena are modelled by the radial basis function (RBF) method, it is an efficient mesh free technique for the numerical solution of partial differential equations. The main advantage of numerical methods which use radial basis functions over traditional techniques is the meshless property of these methods. In a meshless method, a set of scattered nodes are used instead of meshing the domain of the problem.

Solving the system of linear equations usually does not lead to accurate results by the most numerical methods, because the condition number of matrix A is large. It means that the ill-conditioning of matrix A makes the numerical solution unstable. The Tikhonov regularization (TR) method is presented to solve such ill-conditioned systems. In this study, the generalized cross-validation (GCV) method was used to determine the regularization parameter ξ for the TR method that minimizes the value of the GCV function. The results of numerical experiments are presented and some comparisons are made with the well-known schemes of finite elements.

Key words: borehole heat exchangers (BHE), radial basis function (RBF), Tichonov regularization (TR), generalized cross-validation (GCV)

THE INFLUENCE OF GEOLOGICAL CONDITIONS ON THE HEAT CONDUCTIVITY OF GEOLOGICAL STRATUM | *GEOLOGINIŲ SĄLYGŲ ĮTAKA GEOLOGINĖS STORYMĖS ŠILUMINIAM LAIDUMUI*

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The research work on geological stratum thermal characteristics is important to ensure rational subsurface thermal energy extraction. The research results provide new knowledge about the thermal conductivity dependence on the geological section. These studies provide available geological information making it possible to distinguish the thermal potential of underground heat storage and production areas, and to ensure efficient utilization of geothermal resources extraction systems. The study of underground heat energy exploration was performed in twelve test sites in Lithuania. Investigations were carried out in different geological conditions. The depth of studied borehole heat exchangers is between 50 and 150 m. The prediction of the geological section was performed via drilling mud and geophysical data analysis. The geothermal heat conductivity of each geological strata was estimated by thermal response test data. Identification of the influence of the geological conditions on thermal conductivity was carried out from the comparative analysis. Geological cross-sections of the same depth and different thermal conductivity were compared with each other. Applying the principles of similarity of the geological conditions and the formula, where λ is the thermal conductivity of all section [W/mK]; λ_s is the relative thermal conductivity of sandy layers [W/mK]; λ_m is the relative thermal conductivity of clay layers [W/mK], the system of mathematical expressions of the thermal conductivity dependence from the quantity of the sandy and the clay layers in the compared geological strata was aggregated. The obtained individual thermal conductivity of the sandy layer is in a range from 2.1 to 3.08 W/mK, and that of the clay layers is from 1.54 to 1.72 W/mK in different geological conditions.

Key words: geothermal conductivity, geothermal energy, geological strata

REGULARITIES OF CARBONATE DISTRIBUTION IN THE GLACIOGENOUS DEPOSITS OF LITHUANIA | *KARBONATŲ PASISKIRSTYMO DĒSNINGUMAI GLACIGENINĖSE NUOGULOSE LIETUVOJE*

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The Pleistocene glaciogenous deposits (tills) in Lithuania contain a certain amount of carbonate material which study results are presented in this work. The vertical and lateral distribution of carbonates in the till layers as well as their composition and content variation in heterochronous glaciogenous deposits were analysed. An application of the received results of carbonate analyses for till lithostratigraphy was the main objective of the presented investigation. The carbonate analysis was carried out in the tills of more than 20 boreholes and 20 outcrops in different regions of Lithuania. The method used in this investigation allowed us not only to quantify the total content of carbonates, but also to estimate separately an amount of calcite and dolomite what is important for age determination of glaciogenous deposits.

According to the dolomite and calcite ratio, using the statistical criterion, homogeneity of till layers was tested in the vertical sections of separate boreholes, also between different boreholes. Because the number of samples collected from separate till layers is different, for proper statistical evaluation the Van der Waerden criterion was used. The results were produced using the SAS program.

A few regularities of carbonate distribution in the glaciogenous deposits of Lithuania were observed: 1) calcite and dolomite dominate among the carbonates in the tills; 2) an amount of dolomite and calcite depends on the directions of glaciers movement as well as on the variety of rocks eroded by glaciers; 3) the quantities of dolomite and calcite and their ratio are different in the heterochronous glaciogenous deposits (tills) – the Medininkai (Upper Saalian) till is the best lithostratigraphic marker because of its specific carbonate content. The received results of the presented investigation confirm that carbonate content in the till layers is a valuable criterion for the lithostratigraphic subdivision of Pleistocene sediments in Lithuania.

Key words: carbonate content, dolomite calcite ratio, glacial deposits, Lithuania, Van der Waerden criterion, lithostratigraphy