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Criteria of Electrical Anomalies Distinguishing for the Survey of Flooded Salt Mines
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SUMMARY
Electrical investigations are necessary for the control of negative processes on the territory of flooded salt mines but it is an ambiguous and complicated problem. Results of early conducted surveys, modeling and other additional information were used for creation of criteria to determine the most hazardous electrical anomalies.
Introduction

The salt karst process is dangerous and it is complicated for researching. Application of electrical methods allows to indicate potentially dangerous zones and to determine properties of rocks. It is an important problem for different territories. For example, Perm region which is situated in Russia near the Urals. There are some types of karst. The salt karst is one of the most dangerous because it is very quick process. There is a huge salt deposit and the city is located on the deposit territory. Electrical methods indicate a lot of low resistivity anomalies, which are associated with negative processes. A qualitative and quantitative criteria are necessary to distinguish the hazard level and nature of anomalies. It is useful for the prediction of failures and subsidence but it is an ambiguous target. This paper is devoted to the creation and analysis of possible criteria. Data of periodical electrical explorations, results of modeling and other geological and geophysical information were used for investigation.

Analysis of factors

The first factor is depth interval, which is characterized by the anomalous resistivity. Also an important aspect is the connection of this zone with the Earth’s surface. It is more dangerous. The bottom of karst anomaly is in the salt layer. It is nearly 200 m. This condition is necessary. The hazard level depends on depth of top of anomaly.

The second characteristic is shape and size. The most dangerous anomalies are isometric and quite large (200 m and more). Linear narrow anomalies are less dangerous, because there are not essential conditions for failure. Usually lateral dimension isn’t enough.

The third quality is intensity. Places of the Earth’s surface failures were connected with resistivity decreasing 2–3 times relatively ambient level. It was determined during the field data analysis.

The next factor is more informative and exact. It is the variation of electrical resistivity for some time interval (year, month, day). Monitoring is applied for this aim. Time interval depends on the territory. It is 1 year for city on the whole and some days for more dangerous areas. All variations are important both increasing and decreasing, because it reflects the condition of rocks (Andreichuk et al. 2000).

More over the wide range of additional parameters should be researched. For instance anomalies of water beds, changing of water mineralization on investigated territory (hydrogeologycal methods), peculiarities of electrical sounding curves for anomalous areas, connection with the zones of existent failures and others. Also the system of mines influences the situation and electrical anomalies.

Different electrical methods are used for the survey of geological structure and the criteria of danger. Vertical electrical sounding has maximum effective depth of exploration nearly 150 m in this conditions (Kolesnikov, 2007). Induction effect mispresents the field data of deeper investigations. The method of industrial electrical and magnetic fields allows to research the interval of depth from 50 to 230–250 m. Exact monitoring helps to indicate variations of rock’s properties. Other electrical methods can be applied for verification of some anomalies. Finally there is a complex of electrical methods for achieving this goal.

Examples

There were electrical survey one year before the failure of the Earth’s surface. It is shown on the figure 1 (a, b). The size of low resistivity anomaly was approximately 200x200 m. The failure had length nearly 150 m and width 50 m. So the square of anomaly is more than the failure 6 times. Failures on this territory have North East direction for the first time.
In other case there were two low resistivity anomalies 100x150 m and 150x200 m for depth at 180–200 m. The failure appeared between them and has size 100x100 m. It is more difficult situation but it reflects on geoelectrical sections as inclined zones of low resistivity.

Now electrical anomalies are compared with this examples and danger level can be valuated. Isometric anomaly which has size 200x250 m and differs from ambient level of resistivity 2–3 times for depth at 200 m (figure 1c) is dangerous and additional parameters must be investigated. Narrow anomalies (figure 1d) are not hazardous now but it should be controlled.

**Figure 1** Anomaly of low electrical resistivity one year before failure of the Earth’s surface (a), boundaries of the failure (b), example of isometric (c) and linear (d) anomalies.

**Conclusions**

Complex of electrical methods with other geophysical, geological, hydrogeological and geodesic explorations is needed for more exact determination of hazardous anomalies. It is more reasoned and valid way to distinguish anomalies and value danger level. However preliminary prediction can be based on results of electrical surveys.

**Acknowledgements**

The author conveys his sincere thanks to Perm State National Research University and the professor of the Geology faculty – Kolesnikov Vladimir Petrovich.

**References**
