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Dependence of Karst Processes on Physico-Chemical Properties of Salts

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ABSTRACT: In the article, the karst process depends on the physico-chemical properties of salt and its specific features, the nature of salt karst and the influence of a complex interdependent complex of naturally determined nature on the scale of development and activation, operational control over exogenous geological processes, ensuring a reliable forecast of their development and environmental - the issues of reducing the negative impact on the environment are drawn up.

KEYWORD: Karst process, physicochemical properties of salt, nature of salt karst, exogenous geological process, operational control, reliable forecasting, environment, negative impact.

INTRODUCTION. Salts in the earth's crust are mainly associated with its sedimentary part, they are found either in the form of minerals with a crystalline structure, or aqueous solutions on all continents of the Earth without exception and under water (Mexico and Persian Gulfs, Caspian Sea). They can make up significant masses of specific rocks (haloliths) or be in a dispersed (solid or liquid) state. Most halogenated rocks (with the exception of gypsum-anhydrite) are composed of halite and some other salts. They almost always contain carbonate-clay material and calcium sulfate (anhydrite or gypsum). According to the predominant mineral content, they are called halite rock (rock salt, NaCl), sylvinite rock (sylvinite KCl), carnalite rock (KClMgCl26H2O), langbeinite rock (K2SO42MgSO4), kainite-langbeinite rock, polyhalite-halite rock, and so on..

LITERATURE ANALYSIS AND METHODOLOGY. The main factor in the sharp activation of the salt karst was the industrial man-made intervention in the geological environment of the distribution of salt deposits. The most important works at that time include the works of H. Korotkevich, S. Korenevskyi, V. Zakharov, T. Frolova, V. Lipnytskyi, and R. Apse [1, 2]. In the written works, attempts were made to clarify the nature of the occurrence of certain negative situations in the Precarpathian and Transcarpathian salt mines and to connect them with the local features of the geological and hydrogeological structure.

DISCUSSION. The most important physical properties of salts and salt rocks are their generally high solubility, plasticity and hygroscopicity. The solubility of most salts in water increases to varying degrees with increasing temperature, although there are also inverse ratios (mirabilite - Na2SO4 10H2O). The limit concentration of table salt in water at a temperature of 10 C0 is 357.2 g/dm 3, gypsum - 2.05 g/dm 3,

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limestone -0.013 g/dm 3. If we take the solubility of carbonates as 1, then the ratio of these values will be 10,000:160:1[1].

It is believed that the vast majority of salts in nature are products of halogenation - evaporite formations formed in shallow sea basins during the evaporation of natural waters in arid climates. Depending on the composition of these waters, the nature of the physical and chemical processes of salt formation, sedimentation conditions, and other factors, different salts appear simultaneously or sequentially. When the concentration of salts in the oil of the salt-bearing basin reaches a value approximately twice that of the oceanic one (conditionally 70 g/l), dolomite begins to fall out of it.

When the concentration increases from 2-4 to 12 times, gypsum precipitates. Crystallization of NaCl begins after the evaporation of 93% of seawater. At further concentration, sylvine precipitates, followed by epsomite (MgSO47H2O), then carnallite (KClMgCl26H2O), or kainite (KClMgSO43H2O). Bischofite (MgCl26H2O) precipitates last. In a conditionally stable thermobarogeochemical closed system, the release of salts from seawater takes place in the following order [3]:

gypsum, anhydrite;

halite in association with gypsum, anhydrite and polyhalite;

kieserite with halite, kainite, polyhalite, etc.;

carnalite with halite, kieserite, etc.;

bischofite with carnalite, halite and other easily soluble salts.

After deposition, salts undergo diagenetic recrystallization, during which local new formations occur, for example, the appearance of astrakhanite (Na2SO4MgSO44H2O) due to the dehydration of epsomite and mirabilite. During further metamorphism in an environment of increased temperature and pressure, salts are dehydrated, forming at the same time mineral paragenesis that is not characteristic of surface conditions (for example: halite - carnalite - sylvin - langbeinite). During the leaching of salt deposits of polymineral composition, which after their sedimentation were affected by complex processes of diagenesis and catagenesis, chemical transformation and dehydration of minerals, the transition of salts into solution takes place in an order close to the reverse when they fall out of seawater. It is also, like sedimentation, a rather complex process that has its own specific features and depends on the total concentration and ratio of salts in brines, as well as the pressure and temperature of the environment. It is these properties of salts that explain the presence of the most water-permeable types of sediments precisely above the occurrence of polymineralic potassium-magnesium salts.

The most important physical properties of salts and salt rocks are their generally high solubility, plasticity, hygroscopicity, and low specific gravity of deposits. The high plasticity and density of salts with their relatively small specific gravity causes a wide manifestation of plastic deformations in the earth's crust (salt tectonics - halokinesis), and their high solubility and hygroscopicity contribute to the natural development of underground leaching processes - karst. Although under natural conditions (due to the peculiarities of physical properties) the active development of salt karst is a relatively rare phenomenon, there are still entire karst regions with a characteristic karst relief: the Caspian Salt Dome Province, Tajikistan, Southern Iran (the longest of those studied in salt cave in the world - "3 N", more than 6.5 km long (Fig. 3.14) [2, 4]. Given the characteristic features of the structure of the Precarpathian region and the location of salt-bearing sediments close to the surface, which are in direct contact with the zone of active water exchange, processes karstization of salt-bearing rocks cannot but occur and continues in its natural state.

The dissolution of salt deposits is evidenced by the presence of a layer of gypsum-clay cap rocks, a kind of "caprock" - a zone of weathering of native sediments. However, the rates of natural karst formation are

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relatively small. This is due to several reasons. One of the main ones, however paradoxical it may seem at first glance, is the high solubility of salts. It is this characteristic of salt rocks that is the reason why there are no natural karst caves among salt-bearing strata (in the conditions of Precarpathia), as in limestone or gypsum deposits.

The extremely high solubility of salts (the limiting concentration of rock salt brines at a temperature of 10°C is 357.2 g/dm 3) is the reason that, under certain hydrogeological conditions, the surface of native saltbearing sediments (the surface of the "salt mirror") can become practically absolute a water-resistant horizon, a characteristic geochemical barrier, due to a much higher specific gravity of saturated brines in relation to surface fresh waters. Saturated salt solutions can have a specific gravity exceeding 1.2 g/ml.

Hydrogeological observations conducted in different years at the potassium salt deposit show that the hypergenic altered root deposits of the Vorotyshchensk world within the "salt mirror" are the most permeable. Among various types of hypergenically altered rocks, the rocks represented by terrigenous varieties cemented by polymineralic potassium salts are characterized by the highest filtration properties [3, 5]. This can be explained as follows. According to the physico-chemical properties, polymineral salts are the first to hydrate and dissolve, which were the last to crystallize from mother solutions, and more stable, in the form of a cementing element, so far bind clay inclusions and hold the skeleton and structure of the rock. During the processes of underground leaching of salts in the "salt mirror" zone, cavernous voids are formed due to heterogeneous dissolution of minerals in rocks that still retain their general structure; grains of kainite and other more soluble salt minerals dissolve first, and kieserite, langbeinite, and polyhalite last [1, 5].

Such cavernousness, with a relatively immobile skeleton of soils in the zone of saturated brines, leads to a certain increase in their porosity, which creates conditions for an increase in water permeability of sediments. In monomineral halite deposits, hydration and dissolution of salt occurs more uniformly throughout the volume of the altered rock due to a more homogeneous (?) environment. The flow of physico-chemical processes of a homogeneous medium forms corresponding uniform physical and mechanical properties in its volume, which accordingly increases its overall uniform consistency and plasticity throughout the volume of the altered rock and leads to simultaneous with leaching, relatively higher shrinkage of sediments, a decrease in the formed karst porosity and filtration indicators of soils. In this case, they are more similar in physical and mechanical properties to clays than to salts. The properties of the dispersed medium of clays are mainly based on the mechanical (structural) connections between particles, while in salts, crystallization (chemical) connections are dominant, which affects the properties of the substance itself. Although at the first stage of karst, the cavernousness and filtration properties of clay-halite deposits also naturally increase a little [4], they are still inferior in terms of their indicators to the corresponding indicators above potassic layers of polymineral composition.

Staged leaching of salts, when kainite, which can be up to 20% of the content of water-soluble salts, is leached first, forms an unstable porous medium at the first stage of karstification, the framework of which is composed of insoluble residue, held together by halite-polyhalite langbeinite-anhydrite cement. Such an environment, peculiar water channels, is a fairly permeable morphological geological element for saturated brines existing in the plane of the "salt mirror". When hydrogeological regimes change and aggressive surface water enters such channels, the processes of natural or man-made karst formation can be accelerated by many orders of magnitude, forming dangerous exogenous geological manifestations in the layers of sediments or on the earth's surface.

During the further slow passage of natural leaching, the subsequent dissolution of minerals more resistant to dissolution takes place, which bind finely dispersed particles of undissolved residue and, in the final version, form classic overlying deposits of GHSH, composed mainly of plastered and varying degrees of salinity, practically impermeable tugoplastic clay deposits of undissolved residue.

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CLEAR CONCLUSIONS AND PRACTICAL SUGGESTIONS. A comparative analysis of visual graphic images and obtained results shows that: - leaching processes do not lose their intensity for a certain time even after stopping the circulation of raw water; - during the formation of visible karst voids, new hidden volumes (micro-cavities) are formed in the environment containing salts, the chemical and mineral composition of salts changes, hydration of minerals takes place, which in the future, under favorable conditions, facilitates and accelerates the processes of salt dissociation; - due to the formation of a complex spatial system of geochemical barriers, there is a redistribution of chemical components between the brine environment of karst cavities and the host rocks (brine-salt) due to the development of diffusion processes, which to a large extent penetrate deep into salt-bearing sediments.

In such a state of affairs, conditions should arise for the movement of the solvent precisely in the directions favorable for the natural dissolution of salt deposits, forming deeply penetrating zones of loosening of deposits and hydration of minerals. Such circumstances form a favorable environment for a sharp intensification of salt leaching processes in altered sediments after the resumption of solvent circulation in the leaching chamber.

Taking into account the specifics of the development of physico-chemical processes of underground salt dissolution makes it possible to more fully formulate the directions and methods of monitoring work in the territories in the zone of influence of flooded underground mining in salt-bearing deposits, as well as safer, predictable and effective exploitation of future and existing salt deposits, for example , by the method of underground leaching of salts.

In addition to physical and chemical properties, the nature, features and scale of development and activation of salt karst is affected by a complex complex of interrelated factors of a naturally determined nature, without a comprehensive analysis of which it is impossible to reliably assess the condition of the research object, to carry out operational control over the detected dangerous exogenous geological processes , provide a reliable forecast of their development and reduce the negative impact on the environment.

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