

## Physical And Chemical Microbiological Analysis Of The Therapeutic Mud Of “Kossor” Deposit Of Alakol Lake

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**Abstract:** Therapeutic mud (peloids) – natural ecologic systems being formed in the b with different hydrological and hydrochemical conditions, mostly due to microbiological decomposition of plants and animals residues, distinguish with their variety of chemical composition, rich with biological and chemical active components, most of them have clearly expressed effect of pharmacodynamic action to the organism of the human. The data provided in the article about the results of the analysis on study the origin, physical and chemical, sanitary and microbiological characteristics of the therapeutic mud deposit “Kossor” on the coast of lake Alakol (Kazakhstan). In scientific researches and projects studies the sufficient information about balneological properties and sanitary and microbiological characteristics of low-mineralized sulfite-silt therapeutic muds of the system of Alakol lakes has not been received.

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### Introduction

In scientific researches and projects elaborations on study of the therapeutic muds system of Alakol lakes the issues of peloids formation development in the conditions of arid climate have not been investigated as well as the problems concerning assessment of peloids sanitary condition in respect of microbial contamination, which levels guarantee epidemic safety of peloids use in medical purposes.

In the summer period of the year 2012 the work started on physical and chemical and sanitary-microbiological analysis of the therapeutic muds of “Kossor” deposit .

The study of physical and chemical and sanitary-microbiological analysis of the therapeutic muds is closely connected with the problem of determination the level of their suitability for medical purposes. In the result of sanitary and microbiologic assessment of the therapeutic muds of “Kossor” deposit , the following items have been determined:

1. Organoleptic characteristics of the declared sample of mud (colour, smell, consistence, structure);
2. Physical and chemical characteristics of the declared sample of mud;
3. Sanitary and microbiological characteristics of the declared sample of mud;
4. Natural structure of microflora of the declared sample of mud;

It has been found out that such polluting substances as detergents, heavy metals exist in the peloid which does not exceed the established norms. The condition of the mud generating basin on these parameters can be characterized as ecologically pure.

Thereupon study of the processes of peloids generation and their value for medical and health-improving tourism development is believed to be urgent.

### Materials and methods of analysis

30 samples of peloids from different depth from 10 points with the distance 60 metres from each other were selected in 2012-2013 from “Kossor” deposit located on Aktubek peninsula in the southern coast of Alakol lake. Also 12 samples of salts were taken of the dried up saline.

Analytical work was carried out in the National scientific laboratory of JSC “Center of sciences about the Earth, metallurgy and enrichment” and biology laboratory of nitrogen fixing microorganisms of Republic State Enterprise with the right on economic activity “Institute of microbiology and virology” of Science Committee of Ministry of Education and Science of the Republic of Kazakhstan. For receiving the samples analyses the following equipment was used: "Hitachi"atomic absorption spectrometer, model 180-50 (Japan); - flame photometer PFP7 (Great Britain); - an optical issue spectrometer with

inductive-connected plasma Optima 2000 DV (USA). An electric autoclave in accordance with State Standard 9586-61, a biological microscope under State Standard 8284-78 of Leica DMLS trademark with digital video camera Leica DC 300F.

### Results and discussions.

The deposits of the therapeutic muds (peloids) are formed in the natural environment under the influence of geological, physical and chemical and biological processes. The major properties of peloids which determining their therapeutic qualities and uniting them into the group of therapeutic muds is high colloidity providing high hydrophylic property of the peloid and absence of thermal convection in it, considerable thermal capacity and heat-retaining

ability, presence of various biologically active chemical compounds by which the mud is enriched as a result of life activity of specific mud microflora.

Research of physical and chemical and microbiological characteristics of the therapeutic muds is topical and it gives its scientific validity at construction of seasonal health resorts specialising with mud treatment and medical-improving recreation development.

The basic therapeutic muds spread in dried up in the summer small estuary lakes located along coast of large lakes as Balkhash and Alakol or saline soils. Among them the deposit of therapeutic muds and brine "Kossor" located in the hole "Aktubek" in three kilometers from the southern coast of lake Alakol is the most perspective one.

Table 1. Parameters of properties and structure of the therapeutic mud of "Kossor" deposit.

Item №	Parameter	Specification (if available) from - to %	Fact was found
1	Consistence, colour, smell		Mud of black colour, the surface is quickly covered by grey film, it is smeared well, dense consistence, homogeneous structure, without smell.
2	Humidity, % H <sub>2</sub> O at 180 °C	37-70	42,9
3	Contamination by particles in diameter > 0,25 mm, %	<3	0,76
4	Contamination by mineral particles in the size 0,25 - 5,0 mm, % from natural substance	0,3 - particles in the size 0,25mm and less	No more than 3,0
5	Contamination by firm mineral spots in the size more than 5,0 mm, % from organic substance	absent	absent
6	The contamination description		Crystals of salts, plant residues
7	Resistance to shift, dynes/sm <sup>3</sup>	1500-2000	12060
8	Losses at ignition (900°C), %		12,99
9	Thermal capacity cal/g grad	Not less than 0,400	0,847
10	Volume weight, g/dm <sup>3</sup>	1,2-1,6	1,90
12	General content CO <sub>2</sub> , %		3,62
13	Hydrogen value, unit pH		6,91
14	General content H <sub>2</sub> S, %		0,14
15	Ferric sulfide of iron, % for natural mud	0,05-1,00	0,53

In this connection, in order to study the features of the nature and the opportunity for medical and health-improving tourism development of therapeutic muds deposit "Kossor" during the summer periods of the years 2012 and 2013 expedition trips were organized, when the samples of therapeutic muds and salts were taken.

At the expense of evaporation in the summer time the water level in the lake goes down on 0,5-0,8 m. However, the lakes do not dry up completely owing to underground connection with the water of lake Alakol.

The bottom and silt deposits in the lake are presented by two basic horizons: top-black silt and underlying dark grey which is bedded by grey clay

silt and sand. The depth of black silt stratum on average reaches 0,4 m, and as approaching the coast it decreases to 5 sm and is replaced by dark grey silt.

During laboratory examination the physical and chemical composition of the taken samples was determined and cameral treatment of the results of spectral analysis of the therapeutic mud (table 1) was carried out.

The Kossor peloid is plastic pasty mass of black colour with light smell of hydrogen sulphide. Humidity, i.e. the amount of water containing in 100 g native mud is 42,9 %. The amount of water with its organomineral basis determines such properties of the mud as thermal capacity, plasticity, average density. High thermal properties of the mud are

characterised by thermal capacity 0,847 cal/g grad. In the sample the exceed of norm for therapeutic muds was not revealed under the parameter of particles contamination > 0,25 mm (0,3 % at norm up to 3 %). Firm mineral spots in the size of 5,0 mm and more in

the declared sample are absent. The various metabolic processes which are performed by microorganisms in the therapeutic mud are closely connected with its physical and chemical properties [3].

Table 2 - Average ionic composition of the therapeutic mud of "Kossor" deposit

№	Ions	Factual values on tests results	Normative document for test methods
1	Mass fraction of magnesium, %	4,65	State Standard 26428-85
2	Mass fraction of calcium, g/t	4,83	State Standard 26428-85
3	Mass fraction of barium, g/t	0,016	State Standard 5382-91
4	Mass fraction of lead, %	was not found	Standard of RK ISO 11047-2008, A method
5	Mass fraction of zinc, %	was not found	Standard of RK ISO 11047-2008, A method
6	Mass fraction of copper, %	0,0027	Standard of RK ISO 11047-2008, A method
7	Mass fraction of chrome, %	0,006	Standard of RK ISO 11047-2008, A method
8	Mass fraction of ion of chloride, %	1,51	State Standard 26425-85
9	Mass fraction of carbonate-ion, %		State Standard 26424-85
10	Mass fraction of sodium, %	3,7	State Standard 26427-85
11	Mass fraction of potassium, %	0,54	State Standard 26427-85
12	Mass fraction of ion of sulfate, %	3,9	State Standard 26426-85

The degree of acidity of the environment estimated in the size pH 9,2, corresponds to alkaline reaction of the environment. muds classification the given mud can be attributed to the group of alkaline mud, pH > 9,0. On the studied physical and chemical parameters the sample of the mud of "Kossor" deposit corresponds to specifications of sulfide and silt mud. Ash content is great enough – up to 81 %, it is presented by insoluble residue: ferric oxide, aluminium, silicon, calcium and other elements [4]. In the firm phase the mud consists of the crystal skeleton (particles larger than 0,001 mm) and hydrophilic colloid complex (particles less than 0,001 mm). The crystal basis is about 44 % of dry substance.

Under the content of clay particles the mud of "Kossor" deposit can be attributed to silts of thin frame work.

On the average the concentration of H<sub>2</sub>S is 140 mg for 100 g of mud. The average ionic composition of the extract of the therapeutic mud of "Kossor" deposit is presented in table 2.

Magnesium and calcium ions, and from anions - sulfates and chlorides basically prevail in the extract. Lead and zinc in the examined sample were not

found, copper and chrome are available in insignificant concentration not exceeding MPC.

All these parameters provide activity of microbiological processes by a variety of microorganisms in the peloid. The basic sanitary-microbiological parameters characterizing the degree of faecal contamination of peloids are lactose positive colibacillus (hereinafter LPC), general microbial number (hereinafter GMN). Detection of potentially pathogenic microorganisms (blue pus bacillus - *P. aeruginosa*, staphylococcus - *S. aureus*) signals about epidemic danger of the therapeutic muds; detection faecal coliform bacteria, enterococcus confirms the presence of fresh faecal contamination [5]. The received data are presented in table 4. It is established that on sanitary-microbiological parameters the mud sample of "Kossor" deposit corresponds to the specifications approved for all muds groups. In the declared sample there are no microorganisms testifying the presence of faecal pollution (LPC), and also there are no potentially pathogenic (*S. aureus*) and pathogenic (*Pseudomonas aeruginosa*) bacteria for people. General microbial number (hereinafter GMN) of cells (33 thousand/g of mud) does not exceed the specifications (500 thousand/g of mud) (table 3).

Table 3 - Sanitary - microbiological parameters of the assessment of the mud quality of "Kossor" deposit.

Parameter	Dimension	Standard for all muds groups, coe/g of mud	Parameter
General microbial number of cells (GMN) in 1 g of natural substance	bacteria in 1 g	33000	No more than 500000
Titer of general coliform bacteria (coli titer)	g for 1 bacterium	10 and more	10 and more
Pathogenic coccal microflora (staphylococcus) in 10 g of natural substance	bacteria in 1 g	absent	absence
Pathogenic coccal microflora (streptococci) in 10 g of natural substance	bacteria in 1 g	absent	absence
pathogenic coccal microflora (enterococcus) in 10 g of natural substance	bacteria in 1 g	absent	absence
Blue pus bacillus ( <i>Pseudomonas aeruginosa</i> ) in 10 g of natural substance	bacteria in 1 g	absent	absence

At determination of natural composition of the microflora of the mud of "Kossor" deposit it was revealed that in microbial cenosis the following groups of microorganisms are presented (growth on omeal agar): bacteria - 92,3 %, ray fungus - 5,1 %; micro fungi - 2,6 % (table 4).

Table 4 - Natural composition of the microflora of "Kossor" deposit mud (bacteria, fungi, ray fungus)

Ecological and trophic groups of microorganisms	Parameter, coe/g of mud
Bacteria (total amount)	$3,6 \times 10^2$ coe/ g of mud
Ray fungus	$2,0 \times 10^1$ coe/g of mud
Microscopic fungi	$1,0 \times 10^1$ coe/g of mud

Revealed in the peloid ray fungus ( $2,0 \times 10^1$  coe/g of mud), microscopic fungi ( $1,0 \times 10^1$  coe/g of mud) relate to heterotrophic, mainly aerobic microorganisms, intensively mineralize organic substances, including such persistent as cellulose and lignin, participate in transformation of proteins and carbohydrates into organic acids, therefore acidity raises, disintegration of minerals amplifies, organomineral complexes occur. Due to ability to decompose organic substances mold fungi actively start this process and then are replaced by bacteria of mud and silt community [6]. According to some researchers, ray fungus not only participate in decomposition of organic substances, but also release the products of metabolism which in most respects determine antimicrobial properties of peloids [5; 7].

The presence of following physiological groups of bacteria was studied: bacillus, oligotrophic bacteria and ammonificators which process nitrogen compound in soil (table 5). Low level of bacillus presence and oligotrophic bacteria and high level of ammonificators presence ( $10^5$  coe/g) is noted. As a whole, microflora life ability in the mud is typical for silt sulfide muds.

Table 5 - Physiological groups of bacteria which are present in the mud of "Kossor" deposit (bacteria, fungi, ray fungus)

Physiological groups of bacteria	Parameter, coe/g of mud
Sort <i>Bacillus</i>	$4,7 \times 10^2$ coe/g of mud
Oligotrophic bacteria	$3,8 \times 10^2$ coe/g of mud
Ammonificators	$1,5 \times 10^5$ coe/g of mud

Dominating group in bacterial cenosis of the mud of "Kossor" deposit is ammonificating which participates in destruction of protein compounds with ammonia formation ( $1,5 \times 10^5$  coe/g of mud). Ammonia not only alkalizes the mud substratum creating favorable environment for the majority of microorganisms, but can be transformed by nitrobacteria to nitrites, nitrates which are acceptors of electrons of anaerobic respiration of denitrifying bacteria.

### Conclusions

On the studied physical and chemical parameters the declared sample of the mud corresponds to specifications of sulfide and silt mud, relates to group of alkaline mud (pH 9,2). It does not contain mechanical impurity, has viscous-plastic (pasty consistence), soft to the touch and colloidal homogeneous mass.

Gangrenous bacillus and pathogenic coccal microorganisms are absent. The general microbial number (GMN) is in norm. The received results demonstrate conformity of sanitary-microbiological parameters of the examined sample of the mud to standard sizes for muds applied in balneology and physiotherapy.

The natural composition of the mud microflora is presented by bacteria, ray fungus and fungi in the ratio 36:2:1. As a whole, microflora life activity in

the examined sample of the mud is typical for silt and sulfide muds.

Parameters of the mud of "Kossor" deposit correspond to standard sanitary and epidemiologic requirements of the Government of RK Resolution № 104 of January 18, 2012, that is, therapeutic muds of "Kossor" deposit are suitable for application in the medical and health improving purposes.

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