



## CHEMICAL INVESTIGATION OF MEDICAL MUD FROM LAKE NOGOON

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ARTICLE INFO: Received: 26 Sep, 2017; Revised: 15 Dec, 2017; Accepted: 20 Dec, 2017

**Abstract:** The purpose of study was to determine chemical composition and organic matter of peloid from Nogoos Lake in Govi-Altai province by chemical and several analytical techniques. Based on these studies, it was identified that peloid belongs to silt sulphide muddy type, which is included the polymineral group. The content of macro and microelements in peloid from Nogoos was 0.0003-42.65%. Free organic matters in peloid were extracted using non-polar and polar solvents. Yield of total extract in peloid from Lake Nogoos was 1.479%.

We determined chloroform-dissoluble organic matter (DOM) in total extract's dry residue after consistently extracted by organic solvents. There were used chromatography-mass-spectrometric method and identified 83 organic compounds in peloid from Lake Nogoos, that were containing hydrocarbons derivatives 33.68%, carboxylic acid 12.95%, dialkylphthalate (DAF) 3.09%, ketone 1.01% and nitrogen-containing compound 3.96%. The IR spectrum of peloid from Lake Nogoos showed CH<sub>2</sub>, CH<sub>3</sub> alkanes group, carboxylic acid, ether (C-O) group, alkanes (CH) group absorption that free organic matter in peloid consist multiple compounds. We have developed a route for isolating and determining the composition of the organic compounds in peloids.

Lipid group contain fat-soluble vitamins include vitamins A, D, E and their derivatives, steroids and other biological activity compounds which are similar to lipid by chemical and physical characterization. These compounds have shown lot of action such as oxidation and inflammation, microbial and membrane stabilization. Furthermore, the lipid fraction of the medical mud is widely used in cosmetics [1]. In the peloid from Lake Nogoos lipid matter contained 55 organic compounds alkanes 47.73%, DAF 5.58%, carboxylic acid 0.7%, ester 0.3 %, steroids 17.24%, oxygen organic compound 0.6%, and element sulfur 2.88%, nitrogen-containing compound 2.33%, silicon-containing compound 3.74%, cyclic hydrocarbons 0.27% respectively.

**Keywords:** peloid; silt sulphide mud; humic matter; lipid; carbohydrate;

### INTRODUCTION

Peloids are natural great product and multi-component system, which consists of minerals, water, salt, free and linked organic matter and organo-mineral complex, micro and macro elements, macromolecular compounds. Peloids formed a very long period of time by chemical, physical, biological and geological

processes, and that became healthfulness [2]. The first recorded use of medical mud goes back to ancient Greek but research work of medical mud was not performed until 19<sup>th</sup> century. Nowadays, many country studied chemical composition and properties of own country's peloid. For example, Russian

scientists carried out extensive research on the chemical nature and therapeutic properties of the sapropel and peat (Bakhman and Ovsyanikova, 1965; Puntus, 1998, 2008; Shinkarenko and Milenina, 1981; Shustov, 1996). There are more than hundred lakes with medical mud in Mongolian but we have studied physicochemical properties and some

organic compound of medical mud, which is collected from 45 lakes. The main objective of this paper is to determine the chemical, physical composition of natural medical mud from Nogoos Lake and to provide some fundamental data which are useful to explain the therapeutic effects of peloid.

## MATERIAL AND METHODS

### Sampling area

*Lake Nogoos in Gobi-Altai province:* Lake Nogoos located 12 km from Gobi-Altai city. People in Gobi-Altai aimag named it stinky Lake instead of Nogoos Lake because the lake has a stinky smell [3]. The geographic coordinates of Lake Nogoos are 45°22'59" N, 96°15'48.5" E.

Methods: We used MNS 5848:2008 standard for taking and preparing samples [4]. General characteristics of peloids determined by MNS 5849:2008 [5] standard, mineral composition in peloid by X-Ray diffractometer (Rigaku, MAXimax) and chemical composition of peloid by roentgen fluorescence energy disperse MESA 500W. Yield of lipid and humic substances determined by MNS5849:2008 and MNS 5442:2005 standards [6, 7], respectively.

The yield of free organic matter in peloid was determined with the following conditions: It was washed by distilled water with the purpose of cleaning from salts, dried and sequentially extracted with hexane, chloroform, acetone, and mixture of ethanol: benzene (1:9) using Soxhlet apparatus. The compositions of organic compounds were determined by chromatomass-spectral method and infrared spectroscopy. The mass-spectra recorded on chromatomass-spectrometer LKB-2091 (HP 5971A), by using of capillary columns with phases BD 5, OV 70-280, SE-54, SE-30, length 25 and 60 m in automatically programmed temperature mode, the speed of temperature expansion was 4 grade/minute. IR spectra were recorded on spectrometer IR-20 using KBr pellets.

## RESULTS AND DISCUSSION

### 1. General characterization of peloid from Lake Nogoos

At first general characterization of peloid was performed, because it determines their classification. For the investigation of general

characteristics of peloid (Lake Nogoos) we have used MNS 5849:2008 standard (Table 1).

Table 1. General characteristics of peloid from Lake Nogoos compared With the international classification of peloid

Group	Rate for peloids [8]				Peloid from Lake Nogoos
	Peat	Sapropelic	Silt sulphide	Knoll	
General characteristics					
Color	brown, dark brown, black	gray, greenish, dark brown	dark gray	gray	dark gray
Moisture, %	60-80	80-95	40-60	20-50	35.5

Specific weight, g/cm <sup>3</sup>	1.01-1.50	1.005-1.150	1.10-1.60	-	1.55
Organic matter, % (in dry mud)	20-98	15-90	1-15	to 0.5	1.07
Hydrogen sulfide, % (in dry mud)	-	0.01-0.05	0.05-0.50	0.02	0.17
pH-test of the mud	2.8	6.6-7.5	7.0-9.7	5.0<	7.7

In the Table 1 showed that peloid of this the deposit according to international classification belongs to hydrogen sulfide muddy type.

## 2. Mineral and element composition in peloid from Lake Nogoön

We determined total content of mineral composition results have shown in Table 2 and in peloid from Lake Nogoön by X-Ray Figure1. diffractometer MAXimax tool. The mineral

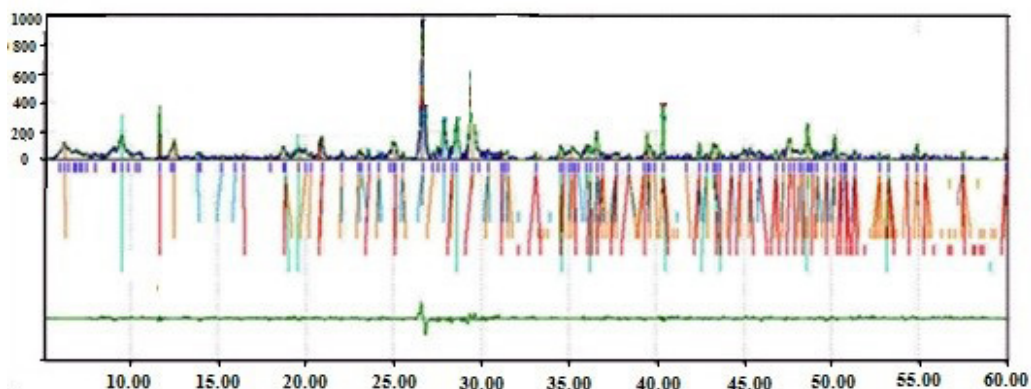


Figure.1. XRD pattern of peloid from Lake Nogoön

Table 2. Result of mineral composition in peloid from Lake Nogoön

Group	Mineral name		Mineral formula	Content, %
Silicate	Tecto-silicates	Alibite	$\text{Na}_2\text{AlSi}_4\text{O}_8$	13.1
		Quartz	$\text{SiO}_2$	22.3
	Phyllo-silicates	Talcum	$\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$	24.7
		Clinochlore	$\text{Mg}_{2.96}\text{Fe}_{1.55}\text{Fe}_{0.136}\text{Al}_{1.275}(\text{Si}_{2.622}\text{Al}_{1.376})\text{O}_{10}(\text{OH})_8$	12.2
Carbonate	Magnesium calcite		$\text{Mg}_{0.03}\text{Ca}_{0.97}\text{CO}_3$	21.8
Sulphate	Gypsum		$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	6.0

Shown this results, this peloid included the polymineral group because its contained following minerals: alibite ( $\text{Na}_2\text{AlSi}_4\text{O}_8$ ), quartz ( $\text{SiO}_2$ ), talcum ( $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ ), chlinochlore ( $\text{Mg}_{2.96}\text{Fe}_{1.55}\text{Fe}_{0.136}\text{Al}_{1.275}$ ) ( $\text{Si}_{2.622}\text{Al}_{1.376}\text{O}_{10}(\text{OH})_8$ ), magnesium calcite ( $\text{Mg}_{0.03}\text{Ca}_{0.97}\text{CO}_3$ ), gypsum ( $\text{CaSO}_4 \cdot \text{H}_2\text{O}$ ). Bedding silicate minerals developed in peloid. Thus this peloid high adsorption and ion exchange ability [9].

Elemental composition of peloid was performed by reontgen fluorescence waves disperse AXIOSmAX. We have identified 43

elements such as Al, Bi, Co, Cr, Cs, Cu, Pb, U, Ba, As, Mo, Nb. Results are showed in Table 3 and Table 4.

Table 3. Content of macro elements in peloid, %

Oxides	In the peloid from Lake nogoon	KC-6 [10]	KC-9 [10]
SiO <sub>2</sub>	43.65	41.62	33.49
Al <sub>2</sub> O <sub>3</sub>	7.3	12.82	6.24
Fe <sub>2</sub> O <sub>3</sub>	6.08	5.13	5.40
CaO	8.7	13.93	16.70
MgO	15.34	1.92	9.95
Na <sub>2</sub> O	0.85	0.84	1.36
K <sub>2</sub> O	0.71	2.93	1.03
TiO <sub>2</sub>	0.285	0.44	0.38
MnO	0.182	0.06	0.15
P <sub>2</sub> O <sub>5</sub>	0.101	0.19	0.06
SO <sub>2</sub>	0.91	=	=
LoI	14.07	19.3	24.9
Na <sub>2</sub> O/CaO	0.10	0.06	0.08

The Table 3 shows that contents of macro elements SiO<sub>2</sub>, MgO and Al<sub>2</sub>O<sub>3</sub> were 43.65%, 15.34% and 7.3%, respectively and this peloid is first sediment. A high Na<sub>2</sub>O/CaO ratio indicates the presence of swelling 2:1 clay minerals (1 < Na<sub>2</sub>O/CaO > 3), while a low ratio (Na<sub>2</sub>O/CaO < 1) is typical for non-swelling 2:1

clay minerals [11, 12].

The Na<sub>2</sub>O/CaO ratio of the mud was higher than 1.0, representing non-swelling clay minerals. And Na<sub>2</sub>O/CaO ratios in this sample were found to be above than those of Turkish peloids (KC-6 and KC-9).

Table 4. Content of elements in peloid, (%)

Elements		Clark elements of sea bottom sediment	In the peloid from Lake nogoon
Micro elements	Cu	0.0087	0.0053
	Cr	0.017	0.0998
	Co	0.0048	0.0045
	V	0.025	0.0086
	Zn	0.0105	0.0076
	Ni	0.013	0.0649
	Mo	0.0003	0.0005
Rare earth elements	Ce	0.007	0.003
	La	0.003	0.003
	Nd	0.0037	0.005
	Pr	0.0009	0.003

Heavy and hazardous	U	0.00026	0.0005
	W	-	0.0008
	Th	0.0013	0.0004
	As	-	0.0005
	Pb	0.025	0.0013
Other elements	Bi	0.00002	0.0005
	Nb	0.0018	0.0003
	Rb	0.0078	0.0021
	Sb	0.05	0.004
	Sc	0.001	0.0013
	Sm	-	0.003
	Sr	0.014	0.0283
	Ta	0.00024	0.001
	Y	0.0026	0.0012
	Ga	0.0019	0.0009
	Ge	0.00015	0.0003
	Hf	0.0004	0.0015
	Cs	0.00037	0.0015

Semi-quantitative results of Nogoos lake's peloid show that contents of some micro elements (Cu 0.0053%, Co 0.0045%, Zn 0.0076%) were less than clark elements of sea bottom sediment, other micro elements (Cr 0.0998%, Ni 0.0649%) were more than clark elements of sea bottom sediment; some rare earth elements (Pr 0.003%, Nd 0.005%) were more than clark elements of sea bottom sediment; some heavy and hazardous elements (Th 0.0004%) were less than clark elements of sea bottom sediment; some other elements

(Nb 0.0003%, Sb 0.004%, Y 0.0012%, Ga 0.0009%, Ge 0.0003%) were less than clark elements of sea bottom sediment, other elements (Sr 0.0283%, Bi 0.0005%, Hf 0.0015%) were more than clark elements of sea bottom sediment. Several accumulation of chromium and nickel have been discovered in Govi-Altai province. Values are slightly elevated for Cr, Ni concentrations in peloid from Nogoos Lake in Govi-Altai province, which is related to accumulation of chromium and nickel in the areas surrounding.

### 3. Content of organic matter in peloid from Lake Nogoos

In peloids included multiple organic matters and some biological active substances. For example; biological active substances are humic substance, lipid, and carbohydrate etc. We determined their biological activity substance's yields and which is shown on table 5.

As shown in table 5, the total organic matter yields was Lake Nogoos 1.55%. In total organic matter humic acid comprises 40%, lipid 24.94% and carbohydrate 0.90% respectively.

The free organic components isolated by extraction have shown in Table 6.

Table 5. Yield of biological active substances

Organic matter	Total organic matter, 1.55%	
	In dry mud, %	In total organic matter, %
Humic substance	0.62	40
Lipid	0.3867	24.94
carbohydrate	0.014	0.9

Table 6. Free organic components of peloid

Solvents	Lake Nogoosn	
	Extraction time, hour	Yield, % (in dry mud)
a. Hexane	7	1.0891
b. Chloroform	20	0.0805
c. Acetone	42	0.1663
d. Ethanol: Benzene /1:9/	56	0.1438
Amount	125	1.4797

Peloid extracted effectively by hexane indicates inclusion of non-polar organic compound. On the basis of determination of total carbon, confirmed that total organic matter in peloid was more than organic substances by extraction. This suggested that organic matter in peloid contain another kind of organic compound.

We determined chloroform-dissoluble matter in total extract's dry residue after consistently extraction by organic solvents by IR and chromato-mass-spectrometric methods. Mass spectrometry to identify total

83 organic compounds in peloid from Lake Nogoosn contained alkanes  $<C_{13}$  0.56%,  $C_{13}-C_{19}$  3.04%,  $C_{20}-C_{31}$  8.47%, DAF 3.09%, element sulfur 39.34%, cyclic hydrocarbons 0.67%, halogen bearing hydrocarbons 20.8%, steroids 2.32%, aromatic carbohydrates 0.14%, ketone 1.01%, nitrogen-containing compound 3.96% and silicon-containing compound 5.06% respectively.

Chloroform-dissoluble matter in total extract's dry residue after extraction by chloroform determined by infra red (IR). The results are shown in Figure 2.

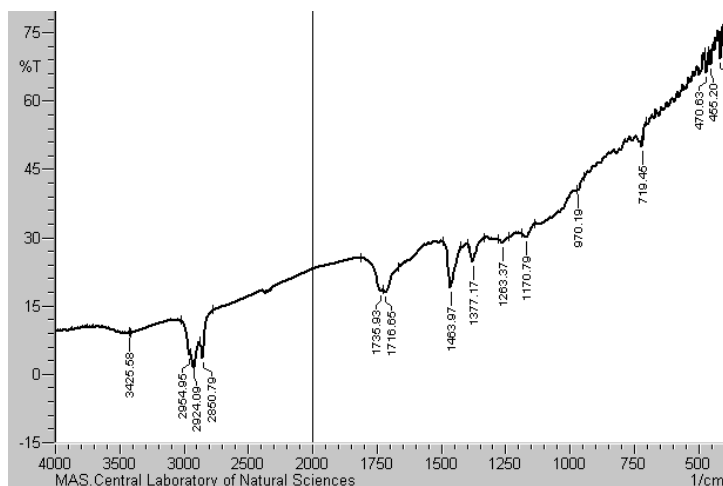


Figure 2. IR spectrum of peloid

The following adsorption spectrum in IR spectrum was identified in peloid from Lake Nagoon. The broad band at  $3448.72\text{ cm}^{-1}$  was assigned to OH and NH groups. The intense bands at  $2924.09\text{ cm}^{-1}$ - $2654.95\text{ cm}^{-1}$  were assigned CH, CH<sub>2</sub>, and CH<sub>3</sub> aliphatic. The wide bands at  $1716.6\text{ cm}^{-1}$  - $1735.9\text{ cm}^{-1}$  were assigned C=C valence variance and (CO) carbonyl groups. The band at  $1377.17\text{ cm}^{-1}$  was assigned CH<sub>3</sub>, CH<sub>2</sub> and amines C-N group. The band at  $1263.3\text{ cm}^{-1}$  was C-O group's valence variance and  $1170.7\text{ cm}^{-1}$  was assigned alcohol,

carboxylic acid, ether (C-O) group. The band at  $970.1\text{ cm}^{-1}$  was C-H deformation variance. The  $719.4$ - $719.45\text{ cm}^{-1}$  bands were assigned to carboxylic acid -C-Cl.

The lipids are a large and diverse group of naturally occurring organic compounds that are related by their solubility in nonpolar organic solvents (e.g. ether, chloroform, acetone and benzene) and general insolubility in water. The lipid fraction isolated from this peloid and extracted by mixture of ethanol: benzene (1:1).

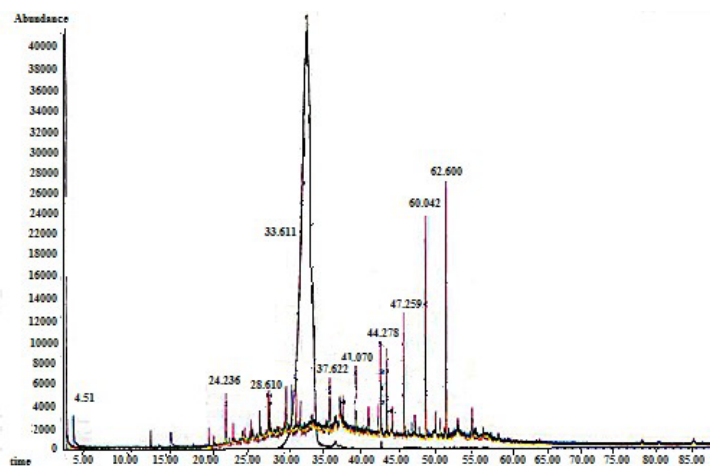


Figure.3. Chromatogram of lipid in peloid from Lake Nagoon

Table 7. Lipid matter of peloid from Lake Nagoon, %

Dry residue content	Organic matters in dry extract of lipid, %						
	Carbohydrates		Carboxylic acid and their ether		Oxygen organic compounds	Element sulfur	Other
	(C <sub>n</sub> H <sub>2n+2</sub> )	(C <sub>n</sub> H <sub>2n</sub> )	RC(O)OR <sup>1</sup> (R; R <sup>1</sup> )	C <sub>6</sub> H <sub>4</sub> (COO) <sub>2</sub> RR <sup>1</sup> (R; R <sup>1</sup> )			
0.39	1.15 (C <sub>11</sub> ) 15.91 (C <sub>14</sub> -C <sub>18</sub> ) 23.48 (C <sub>20</sub> -C <sub>24</sub> ) 7.19 (C <sub>25</sub> -C <sub>29</sub> ) 47.73	-	0.4 (C <sub>17</sub> H <sub>33</sub> ; H) 0.3 (C <sub>17</sub> H <sub>35</sub> ; C <sub>4</sub> H <sub>9</sub> )	5.58 (C <sub>4</sub> H <sub>9</sub> ; C <sub>4</sub> H <sub>9</sub> ) 5.58	0.17 0.43 0.6	2.88	0.27 <sup>1</sup> 17.24 <sup>2</sup> 2.33 <sup>3</sup> 3.47 <sup>4</sup> 0.15 42.31

Note: <sup>1</sup>- cyclic hydrocarbons, <sup>2</sup>- Steroids, <sup>3</sup>- nitrogen-containing compound, <sup>4</sup>- silicon-containing compound.

From Table 7 shows that in peloid from Lake Nogoos lipid matter contained 55 organic compounds alkanes 47.73%, DAF 5.58%, carboxylic acid 0.7%, ester 0.3 %, steroids 17.24%, oxygen organic compound 0.6%, and

element sulfur 2.88%, nitrogen-containing compound 2.33%, silicon-containing compound 3.74%, cyclic hydrocarbons 0.27% respectively.

## CONCLUSION

1. We have studied general properties and chemical composition of peloid from Nogoos Lake. Result of this analysis show Nogoos Lake's mud according to international classification belongs to silt sulphide muddy type.

2. The IR spectrum of peloid from Lake Nogoos showed  $\text{CH}_2$ ,  $\text{CH}_3$  alkanes group, carboxylic acid, ether (C-O) group, alkanes (CH) groups absorption that free organic matter in peloid consist multiple compounds.

3. The GS/MS chromatogram of dissoluble organic matter (DOM) from Lake Nogoos contained hydrocarbons and their derivatives of 33.68%, dialkylphthalate

(DAF) of 3.09%, element sulfur 39.34%, cyclic hydrocarbons 0.67%, halogen bearing hydrocarbons 20.8%, steroids 2.32%, aromatic carbohydrates 0.14%, ketone 1.01%, nitrogen-containing compound 3.96% and silicon-containing compound 5.06% respectively.

4. It was estimated that in peloid from Lake Nogoos lipid matter contained 55 organic compounds alkanes 47.73%, DAF 5.58%, carboxylic acid 0.7%, ester 0.3 %, steroids 17.24%, oxygen organic compound 0.6%, and element sulfur 2.88%, nitrogen-containing compound 2.33%, silicon-containing compound 3.74%, cyclic hydrocarbons 0.27% respectively.



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