EMSL Analytical, Inc.

200 Route 130 North, Cinnaminson, NJ 08077
Phone: (856) 858-4800

Forwarded by: Dan Golden
Date: 05/24/2023
Forwarded to: www.EarthingClay.com
1524 San Juan St.
Trinidad, CO 81082
808-280-3880

EMSL Case No.: 361501782
Sample(s) Received: 9/21/2015
Date of Reporting: 10/5/2015
Date Printed: 10/5/2015
Reported By: J. Hu
Email: hilly@goldennevalite.com

- Laboratory Report -

Clay Analysis

Conclusions:

- The sample is found to be composed of mainly montmorillonite (phyllosilicate group clay minerals), and a small amount of Bassanite (calcium sulfate mineral).

Procurement of Samples and Analytical Overview:

The sample for analysis (one, bulk) arrived at EMSL Analytical (Cinnaminson, NJ) on September 21, 2015. The package arrived in satisfactory condition with no evidence of damage to the contents. The data reported herein has been obtained using the following equipment and methodologies.

Methods & Equipment:
X-ray diffraction (XRD)
X-ray Fluorescence Spectrometry (XRF)
XRF Standardless Analysis using Rigaku ZSX Primus wavelength-dispersive X-ray fluorescence spectrometer

10/5/15. Rev1 revises report 361501782 reported on 10/5/15. Reason for revision: include estimated montmorillonite concentration per client request.

Analyzed by: Jian Hu — *Jian Hu, Ph.D.*, *Senior Materials Scientist* — October 2, 2015 — *Date*

Reviewed/Approved: Eugenia Mirica — *Eugenia Mirica, Ph.D.*, *Laboratory Manager* — October 5, 2015 — *Date*

MONTMORILLONITE TECHNICAL OVERVIEW AND HOW IT WORKS

Montmorillonite is a very soft phyllosilicate group of minerals that form when they precipitate from water solution as microscopic crystals, known as clay. It is named after Montmorillon in France where it was first discovered.

Montmorillonite, a member of the smectite group, is a 2:1 clay, meaning that it has two tetrahedral sheets of silica sandwiching a central octahedral sheet of alumina. The particles are plate-shaped with an average diameter around 1 um and a thickness of 9.6 nm; magnification of about 25,000 times, using an electron microscope, is required to "see" individual clay particles.

Montmorillonite is a subclass of smectite, a 2:1 phyllosilicate mineral characterized as having greater than 50% octahedral charge; its cation exchange capacity is due to isomorphous substitution of Mg for Al in the central alumina plane. The substitution of lower valence cations in such instances leaves the nearby oxygen atoms with a net negative charge that can attract cations.

Montmorillonite has a permanent layer charge because of the isomorphous substitution in either the octahedral sheet (typically from the substitution of low charge species such as Mg^{2+}, Fe^{2+}, or Mn^{2+} for Al^{3+}) or the tetrahedral sheet (where Al^{3+} or occasionally Fe^{3+} substitutes for Si^{4+}).

The individual crystals of montmorillonite clay are not tightly bound hence water can intervene, causing the clay to swell. The water content of montmorillonite is variable and it increases greatly in volume when it absorbs water.

Chemically, it is hydrated sodium calcium aluminum magnesium silicate hydroxide $(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2 \cdot nH_2O$. Potassium, iron, and other cations are common substitutes, and the exact ratio of cations varies with source. It often occurs intermixed with chlorite, muscovite, illite, cookeite, and kaolinite.

Montmorillonite consist of negatively charged, crystalline aluminosilicate platelets. These platelets form pseudo three-dimensional crystals consisting of regular stacks of parallel platelets held together by charge-balancing interlayer counter ions.

Cohesion of the Montmorillonite clay structure is ensured by their hydrogen-bond network that makes the octahedral layer of one platelet stick onto the adjoining tetrahedral layer of another platelet stacked over it

These layers organize themselves in a parallel fashion to form stacks with a regular Vander Waal gap between them, called interlayer or gallery

DRG

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EMSL Case No.: 361501782
Sample(s) Received: 9/21/2015
Date of Reporting: 10/5/2015
Date Printed: 10/5/2015
Reported By: J. Hu
Email: billy@goldennevalite.com

Results and Discussion:

The sample was dried at 80°C and analyzed using XRF and XRD analysis to determine the components. The results indicate that the sample is composed of mainly montmorillonite (phyllosilicate group clay minerals), and a small amount of Bassanite (calcium sulfate mineral).

Sample Identification:	1 Pink Clay	
EMSL sample number:	361501782-0001	
Chemical Compound	Result, %wt	LOD, %wt
Na2O	0.6262	0.0634
MgO	4.5332	0.0372
Al2O3	26.1148	0.024
SiO2	52.4369	0.026
P2O5	0.0283	0.0044
SO3	6.9727	0.0096
K2O	0.1937	0.0032
CaO	7.0536	0.0070
TiO2	0.1524	0.0136
MnO	0.0724	0.0044
Fe2O3	1.6712	0.0051
ZnO	0.0101	0.0020
Ga2O3	0.0072	0.0022
As2O3	0.0143	0.0018
SrO	0.0249	0.0013
Y2O3	0.0089	0.0013
ZrO2	0.0686	0.0077
Nb2O5	0.0103	0.0017

Based on the XRD and XRF results, the majority of the sample material is identified as montmorillonite. Smaller amount of Bassanite is also detected. Based on the amount of SO3 detected in the sample by XRF analysis and presuming that all the sulfur is in component of Bassanite, the amount of Bassanite calculated from stoichiometry is 13.4 wt%. Therefore, the amount of montmorillonite in the sample is approximated to be NMT 86% ± 1%.

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EMSL Case No.: 361402034
Sample(s) Received: 10/14/2014
Date of Reporting: 11/4/2014A
Date Printed: 11/4/2014
Reported By: E. Mirica
Email: billy@goldennevalite.com

Oxide Composition by X-Ray Fluorescence

WHITE

Sample Identification:	Montmorillonite Powder	
EMSL Sample Number:	361402034-0001	
Chemical Compound	Result (wt%)	LOD (wt%)
SiO_2	52.08	0.035
Al_2O_3	25.72	0.02301
CaO	8.043	0.00711
SO_3	5.690	0.008
MgO	4.08	0.03542
Fe_2O_3	1.574	0.00426
Na_2O	1.05	0.06099
TiO_2	0.15	0.01577
ZrO_2	0.082	0.00808
MnO	0.072	0.00421
Cl	0.043	0.00737
SrO	0.035	0.00138
P_2O_5	0.034	0.0042
As_2O_3	0.017	0.00192
ZnO	0.012	0.00188
Nb_2O_5	0.010	0.00177
Ga_2O_3	0.009	0.00222
Y_2O_3	0.007	0.00139
Rb_2O	0.003	0.00131

NF Monograph of purified bentonite indicates that the acceptable criteria for the ratio of the aluminum (Al) content to magnesium (Mg) content is 3.5-5.5.

The material in the sample has 13.6wt% Al and 2.46% Mg. The ratio Al:Mg = 5.5. This ratio is within the acceptance criteria for montmorillonite. Based on the XRF and XRD data, the majority of the material in the sample is identified as montmorillonite. Gypsum ($CaSO_4.2H_2O$) was also detected in the sample. Based on the amount of SO3 detected in the sample by XRF analysis and presuming that all the sulfur is component of gypsum, the amount of gypsum calculated from stoichiometry is 12.23wt%. Therefore, the amount of montmorillonite in the sample is approximated to be NMT 85% ± 1%.

Purified bentonite is a colloidal montmorillonite that has been processed to remove grit and nonswellable components.