Miles Industrial Mineral Research
1244 Columbine Street
Denver, CO 80206
Tel: (303) 355-5568 Fax: (303) 355-0422
w_miles@hotmail.com

August 31, 2007

Edward D. Harrington, BSc.(Geol), Pgeo.
VP, Exploration
Reliance Geological Services Inc.
3476 Dartmoor Place
Vancouver, B.C.
Canada V5S 4G2
Tel: 604-437-9538; 604-984-3663
Fax: 425-984-9440
e_harrington@shaw.ca

Re: Bentonite from Midas, Nevada

Dear Mr. Harrington:

As we discussed by phone, the bentonite from Midas, Nevada has been evaluated for mineral composition by x-ray diffraction analysis. When XRD confirmed that it is predominantly montmorillonite, viscosity and physical properties were determined using American Petroleum Institute (API) procedures. The results are reported in this letter.

1. X-Ray Diffraction Analysis

A Philips Norelco x-ray diffractometer (XRD) with step-scanning mode was used for evaluation of this sample. All XRD scans were run at 0.03º increments for 2 seconds per channel in order to provide precision and accuracy.

The bulk sample provided by Reliance Geological was air dried to about 15% moisture, ground, sifted to less than 200 mesh (<75 micrometers), and then back-loaded into a sample mount to produce a randomly oriented powder for qualitative and quantitative XRD analysis of all mineral components. External standards for montmorillonite, quartz, opal, calcite and feldspars were used for quantification of these minerals in this sample. The quantitative XRD analysis of the bentonite sample is listed in Table 1. A copy of the randomly oriented x-ray pattern is enclosed.

The diffraction region from 4 to 16° 2theta of this bentonite powder pattern was expanded in order to clearly show contributions from sodium and calcium, respectively. Preliminary identification of dominant sodium or calcium exchange cations associated with montmorillonite was carried out because the peak position, peak shape and peak width of the (0,0,1) montmorillonite layer spacing is affected by these respective cations. When sodium is the dominant montmorillonite cation, the (0,0,1) peak is centered at about 12 Angstroms, with divalent calcium and magnesium cations shifting the peak to 14-15 Angstroms. The dominant cation associated with this montmorillonite is calcium.

After preliminary identification of clay minerals, this sample was slurried in distilled water and coated on a glass slide. As the slurry dries, dispersed clay platelets orient parallel to the glass slide, enhancing the (0,0,x) clay layer spacing peaks. The oriented film of this sample was evaluated by x-ray diffraction analysis to determine layer spacing for montmorillonite (smectite), illite/mica and kaolin minerals. After exposure of the oriented film for each sample to ethylene glycol vapor at 50ºC, clay layer peaks of expandable smectites shift to 5º 2theta (17Å) from 6º (14-15Å) for calcium montmorillonite or from 7º 2theta (12-13Å) for sodium montmorillonite. This layer expansion confirms the presence of expandable (montmorillonite) in this sample. Kaolin, illite and other clay minerals do not expand with exposure to ethylene glycol. To illustrate the shift in layer spacing, the ethylene glycol pattern overlays the oriented film pattern for this sample. Other clay layer spacings in these oriented patterns assigned as (0,0,2) and (0,0,3) also shift to larger Angstrom values with exposure to ethylene glycol vapor. This pattern is enclosed with the mailed report.

2. American Petroleum Institute Drilling Fluid Properties:

In API 13A, test methods and criteria for evaluation of bentonite for drill fluid use are provided. However, acceptable bentonite performance in API evaluations indicates that other industrial uses are possible. The bentonite from Midas, Nevada was evaluated using the API methods and specifications for Section 9 Bentonite, Section 10 Untreated Bentonite, and Section 11 OCMA Bentonite.

The bulk sample provided by Reliance Geological was initially evaluated for Section 9 Bentonite, API 13A Section 10 Untreated Bentonite, and API 13A Section 11 OCMA Bentonite. Table 2 contains the minimum requirements for these three API grades of bentonite.

API requirements for maximum allowable 75 micrometer grit were met for the Midas Nevada bentonite. The initial viscosity test results for Midas calcium bentonite did not meet acceptance for drilling fluids uses. Another slurry containing addition of 0.8% sodium carbonate significantly improved viscosity, gel strengths and fluid loss at 100 psi; however, the viscosity characteristics were inadequate for API requirements. Another slurry was prepared using 1.3% sodium carbonate additive. After 24-hour hydration, this slurry surpassed the minimum viscosity and other requirements for API 13A section 11 OCMA Bentonite. Addition of polymers to Midas bentonite could possibly allow the criteria for API 13A section 9 bentonite to be met.

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In summary, if the sample you provided is representative of the deposit, this bentonite has possible uses for absorbents, animal feed, ceramics, fillers & extenders, foundry sand binders, iron ore pelletizing and sealants. However, additional testing will be required to confirm these possible markets.

Table 1

X-Ray Diffraction Analysis of Bentonite from near Midas, Nevada

Calcium montmorillonite	~93%
Opal (amorphous silica hydrate)	1.2%
Quartz	4.4%
Calcite	0.8%

Table 2

American Petroleum Institute Drilling Fluid Properties

Property:	API Section 9 Bentonite	API Section 10 Bentonite Untreated	API Section 11 Bentonite OCMA	Midas, NV Bentonite 0% Na2CO3	Midas NV Bentonite 0.8% Na2CO3	Midas NV Bentonite 1.3% Na2CO3
% Moisture	<13%		<13.0%	12.7%	12.7%	12.7%
200 mesh grit	<4.0%		<2.5%	1.4%	1.4%	1.4%
Viscosity Characteristics:						
Fann 600	>30		>30	10.5	18.5	53
Fann 300				8	15	49
Gel Strengths				7 - 8	8 – 9	39 - 50
AV				5.25	9.25	26.5
PV		>10.0		2.5	3.5	4
YP				5.5	11.5	45
YP/PV	<3.0	<1.5	<6.0	2.2	3.3	11.25
FL	<15.0	<12.5	<16.0	39.8	13.8	14.5