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TIORCO Inc., 2013, X-Ray Diffraction Analysis of cuttings samples from the Trading Bay Unit M-31B well.

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PROJECT: X-RAY DIFFRACTION ANALYSIS OF TEN ROCK FRAGMENT SAMPLES

ANALYST: RICHARD F. WENDLANDT
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OBJECTIVE

Ten samples originating from TIORCO were delivered to R. Wendlandt during mid-May 2013 for XRD mineralogical characterization. The 10 samples were rock fragments up to ~1 cm in size of unspecified origin, possibly cuttings. The following report describes analytical methodology and interpretation of mineralogy for these samples.

ANALYTICAL METHODS

All samples were ground to a fine powder in a tungsten carbide ball mill. The powdered material was subsequently analyzed using a Scintag XDS-2000 Θ-Θ diffractometer. Instrumental conditions were 40 KV accelerating potential, 40 mA filament current, and 0.5 and 0.3 receiving slits.

Continuous diffraction scans of randomly oriented bulk materials were obtained at a scan rate of 1.0 degree/minute over the range of 4º-60º 2Θ. Diffraction patterns are identified by the sample name, e.g., **1-31B 9970-10000.ni**. Oriented preparations of the clay-size fraction (< 4um grain size) of each sample were then prepared by gravitative settling and removal of larger size particles. These preparations were analyzed from 2º-40º 2Θ using the same instrumental parameters and a scan rate of 0.8 degrees/minute. Diffraction patterns of the clay-size fraction are designated by the sample name modified with "CL", e.g., **1-31B 9970-10000-CL.ni**. Because the presence of a smectite group mineral was a possible interpretation, all 10 samples were ethylene glycol solvated and reanalyzed from 2º-30º 2Θ (designated on the diffraction scans by the sample name modified with "GLY", e.g., **1-31B 9970-10000-GLY.ni**) at the same instrumental conditions and a scan rate of 1.0 degree/minute.

Ethylene glycol solvation enables identification of the presence of smectite group minerals by causing a shift of the (001) basal reflection to lower 2-theta (i.e., 5.2º, which corresponds to a basal spacing of ~17 Angstroms) relative to the air-dried sample. Detailed discussion of these methods is provided in Moore and Reynolds, 1997. Non-clay minerals were identified using the JCPDS data base. Mineral identification by XRD is possible if minerals are present in abundances greater than approximately 1-2 %. The actual limit of resolution varies with mineral type.

Diffraction scans for each sample are presented in a stacked format, showing all of the results for multiple scans on a sample. For convenience, the 10 rock fragment samples were numbered from 1 to 10 in order of increasing depth. Whole rock scans are also presented in stacked format to illustrate the extremely quartz-rich and clay-poor nature of these samples. Results are presented in the table that follows.

DATA

The mineralogy of the 10 samples is summarized below.

Sample	Mineral Assemblage
1-M31B 9970-10000	Quartz, plagioclase feldspar (minor), illite, kaolinite, chlorite (minor), calcite (trace?), smectite (trace)
2-M31B 10000-10030	Quartz, plagioclase feldspar (minor), K-feldspar (minor), illite (minor), chlorite (trace), kaolinite, calcite
3-M31B 10090-10120	Quartz, K-feldspar, plagioclase feldspar, kaolinite, illite (trace), chlorite(?), calcite (minor)
4-M31B 10210-10240	Quartz, plagioclase feldspar, calcite, kaolinite, illite (minor)
5-M31B 10330-10360	Quartz, K-feldspar, plagioclase feldspar, calcite, kaolinite, illite (minor), chlorite (trace)
6-M31B 10450-10480	Quartz, plagioclase feldspar, K-feldspar, calcite (minor), illite, kaolinite, chlorite
7-M31B 10540-10570	Quartz, plagioclase feldspar, K-feldspar (?), kaolinite, chlorite (trace), illite (minor), calcite (trace), smectite (trace)
8-M31B 10720-10750	Quartz, plagioclase feldspar, K-feldspar (minor), kaolinite, illite (minor), chlorite (trace), calcite (?)
9-M31B 11140-11170	Quartz, plagioclase feldspar, K-feldspar (minor), calcite (major), kaolinite, illite (minor), chlorite (trace?)
10-M31B 11350-11380	Quartz, plagioclase feldspar, K-feldspar, calcite (major), kaolinite, illite chlorite, smectite (trace)

DISCUSSION

The 10 rock fragment samples are extremely quartz-rich, with lesser amounts of feldspars, variable calcite contents, and minor overall clay mineral contents. Trace amounts of smectite are interpreted to be present in the ethylene glycol solvated scans of the clay size fractions for samples 1, 7, and 10.

REFERENCE

Moore, D.M. and Reynolds, R.C. (1997) ***X-ray Diffraction and the Identification and Analysis of Clay Minerals.*** 2nd Ed., Oxford University Press, 378 pp.