



X-ray Diffraction Analysis of Thirty Samples

W.O. # A16-10795
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Client: ALSet Energy Corp.

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Methods

Thirty samples were submitted for quantitative X-ray diffraction analysis including clay speciation. The quantitative XRD analysis was performed on a pulverized bulk sample. A portion of each pulverized sample was mixed with corundum and packed into a standard holder. Corundum was added as an internal standard, to determine the amount of poorly crystalline and X-ray amorphous material. For clay speciation analysis, a portion of each sample was dispersed in distilled water and clay minerals in the $< 2 \mu\text{m}$ size fraction separated by gravity settling of particles in suspension. Oriented slides of the $< 2 \mu\text{m}$ size fraction were prepared by placing a portion of the suspension onto a glass slide. In order to identify expandable clay minerals, the oriented slides were analyzed air-dry and after treatment with ethylene glycol.

The X-ray diffraction analysis was performed on a Panalytical X'Pert Pro diffractometer equipped with Cu X-ray source and an X'Celerator detector and operating at the following conditions: 40 kV and 40 mA; range 5-70 deg 2θ for random specimens and 3 – 35 deg 2θ for oriented specimens; step size 0.017 deg 2θ ; time per step 50.165 sec; fixed divergence slit, angle 0.5° and 0.25° ; sample rotation 1 rev/sec. The X'Pert HighScore plus software along with the PDF4/Minerals ICDD database were used for mineral identification. The quantities of the crystalline mineral phases were determined using Rietveld method. The Rietveld method is based on the calculation of the full diffraction pattern from crystal structure information. The amount of poorly crystalline minerals such as smectite could not be calculated by the Rietveld refinement. Instead, the amounts of the crystalline minerals were recalculated based on a known percent of corundum and the remainder to 100 % was considered poorly crystalline and X-ray amorphous material. The relative proportions of the clay minerals in the $< 2 \mu\text{m}$ size fraction were calculated using ratios of their basal-peak areas.

Results

The minerals identified in the bulk samples are illite, quartz, K feldspar, plagioclase, analcime, calcite, dolomite, gaylussite, trona and halite. Dolomite includes Fe dolomite. A trace amount of chlorite was detected in sample 13951.

The clay minerals identified in the $< 2 \mu\text{m}$ size fraction are illite, smectite and chlorite. Smectite was identified on the basis of the peak at 17 \AA in the diffraction patterns of the glycolated specimens. Presence of a poorly crystalline smectite-like mineral in samples 612644, 612622, 612709, 612660, 612702 and 612710 was inferred as a result of the broad reflection at about $13\text{-}14 \text{ \AA}$, which shifted to about $17\text{-}18 \text{ \AA}$ upon glycolation.

The mineral abundances in the bulk samples are in Table 1 and the relative proportions of the clay minerals in the $< 2 \mu\text{m}$ size fraction are in Table 2. The diffraction patterns are in Appendix 1 and Appendix 2.

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Table 1. Mineral abundances in bulk samples (wt %)

| Client ID | ActLabs ID | Illite | Quartz | K feldspar | Plagioclase | Analcime | Calcite | Dolomite | Gaylussite | Trona | Halite | Amorphous and smectite |
|-----------|--------------|--------|--------|------------|-------------|----------|---------|----------|------------|-------|--------|------------------------|
| 1039 | A16-10795-1 | 46.6 | 2.5 | 1.0 | 2.3 | 6.2 | 11.6 | n.d. | n.d. | n.d. | 6.1 | 23.7 |
| 26761 | A16-10795-2 | 45.2 | 5.1 | 3.9 | 1.9 | 7.0 | 10.7 | n.d. | n.d. | n.d. | 4.4 | 21.7 |
| 26935 | A16-10795-3 | 51.4 | 2.2 | 5.2 | 1.9 | 6.2 | 12.4 | n.d. | n.d. | n.d. | 1.6 | 19.1 |
| 12552 | A16-10795-4 | 53.3 | 1.5 | 4.7 | 1.2 | 5.4 | 9.4 | n.d. | n.d. | n.d. | 2.6 | 22.0 |
| 26851 | A16-10795-5 | 53.2 | 3.4 | 4.7 | 1.7 | 6.4 | 9.4 | n.d. | n.d. | n.d. | 2.8 | 18.4 |
| 13597 | A16-10795-6 | 29.3 | 19.3 | 3.2 | 6.2 | 4.6 | 10.1 | n.d. | n.d. | n.d. | n.d. | 27.4 |
| 13697 | A16-10795-7 | 23.2 | 16.3 | 6.2 | 6.6 | 2.1 | 11.4 | n.d. | n.d. | n.d. | n.d. | 34.2 |
| 13995 | A16-10795-8 | 50.9 | 2.7 | 4.6 | 1.8 | 13.1 | 8.8 | n.d. | n.d. | n.d. | 3.6 | 14.6 |
| 13951 | A16-10795-9 | 47.9 | 2.1 | 5.8 | 4.0 | 10.6 | 11.2 | n.d. | n.d. | n.d. | n.d. | 18.5 |
| 13632 | A16-10795-10 | 39.1 | 21.6 | 3.3 | 5.7 | 9.6 | 10.5 | n.d. | n.d. | n.d. | n.d. | 10.2 |
| 612644 | A16-10795-11 | 12.9 | n.d. | 3.6 | n.d. | n.d. | 15.8 | 11.8 | 7.7 | n.d. | 1.5 | 46.7 |
| 612622 | A16-10795-12 | trace | 0.7 | 2.0 | n.d. | n.d. | 9.0 | 11.4 | 22.3 | n.d. | 2.7 | 51.8 |
| 612696 | A16-10795-13 | 8.0 | n.d. | 6.5 | n.d. | n.d. | 34.3 | 3.8 | n.d. | n.d. | 1.3 | 46.0 |
| 612635 | A16-10795-14 | 10.0 | 4.3 | 5.3 | n.d. | n.d. | 28.9 | 10.1 | n.d. | n.d. | 2.3 | 39.1 |
| 612709 | A16-10795-15 | 8.0 | n.d. | 6.4 | n.d. | n.d. | 24.2 | 5.9 | n.d. | n.d. | 1.3 | 54.2 |
| 612660 | A16-10795-16 | 11.0 | 0.5 | n.d. | n.d. | n.d. | 19.9 | 10.0 | n.d. | 5.9 | 0.9 | 51.8 |
| 612702 | A16-10795-17 | 7.0 | n.d. | 4.7 | n.d. | n.d. | 33.5 | 5.7 | n.d. | n.d. | 1.0 | 48.0 |
| 612650 | A16-10795-18 | 8.0 | n.d. | 3.2 | n.d. | n.d. | 29.8 | 7.2 | n.d. | n.d. | 0.6 | 51.2 |
| 612710 | A16-10795-19 | 7.0 | n.d. | 3.0 | n.d. | n.d. | 19.2 | 7.2 | n.d. | n.d. | 1.2 | 62.4 |
| 612687 | A16-10795-20 | 4.0 | 7.5 | 3.8 | n.d. | n.d. | 37.6 | 4.6 | n.d. | n.d. | 1.2 | 41.3 |
| 820767 | A16-10795-21 | 37.6 | 1.8 | 17.7 | 1.7 | n.d. | 8.0 | n.d. | n.d. | n.d. | 0.3 | 32.8 |
| 820777 | A16-10795-22 | 20.2 | n.d. | 13.3 | n.d. | n.d. | 10.3 | 9.9 | n.d. | n.d. | 0.7 | 45.6 |
| 10560 | A16-10795-23 | 24.5 | 0.6 | 14.7 | n.d. | n.d. | 11.4 | 10.6 | n.d. | n.d. | 2.3 | 36.0 |
| 10596 | A16-10795-24 | 11.0 | 9.7 | 8.3 | 7.1 | n.d. | 17.8 | 3.6 | n.d. | n.d. | 0.9 | 41.6 |

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| Client ID | ActLabs ID | Illite | Quartz | K feldspar | Plagioclase | Analcime | Calcite | Dolomite | Gaylussite | Trona | Halite | Amorphous and smectite |
|-----------|--------------|--------|--------|------------|-------------|----------|---------|----------|------------|-------|--------|------------------------|
| 820762 | A16-10795-25 | 24.2 | 7.8 | 17 | 10.8 | n.d. | 12.2 | n.d. | n.d. | n.d. | 1.2 | 26.8 |
| 820797 | A16-10795-26 | 14 | n.d. | 6.4 | 4.7 | n.d. | 37.2 | n.d. | n.d. | n.d. | n.d. | 37.7 |
| 10556 | A16-10795-27 | 48.7 | 3.5 | 14.9 | 7.9 | n.d. | 5.9 | n.d. | n.d. | n.d. | 0.8 | 18.4 |
| 10562 | A16-10795-28 | 6.0 | 1.0 | 7.3 | 8.5 | n.d. | 38.5 | n.d. | n.d. | n.d. | n.d. | 38.7 |
| 10383 | A16-10795-29 | 42.6 | 3.4 | 3.9 | 4.7 | n.d. | 7.9 | 16.0 | n.d. | n.d. | 0.3 | 21.3 |
| 820792 | A16-10795-30 | 18.2 | 17 | 16.8 | 21.4 | n.d. | 8.3 | n.d. | n.d. | n.d. | 0.8 | 17.6 |

Table 2. Relative proportions of clay minerals in the < 2 μ m size fraction

| Client ID | ActLabs ID | Illite | Smectite | Chlorite |
|-----------|--------------|--------|----------|----------|
| 1039 | A16-10795-1 | 100 | n.d. | n.d. |
| 26761 | A16-10795-2 | 100 | n.d. | n.d. |
| 26935 | A16-10795-3 | 98 | n.d. | 2 |
| 12552 | A16-10795-4 | 100 | n.d. | n.d. |
| 26851 | A16-10795-5 | 100 | n.d. | n.d. |
| 13597 | A16-10795-6 | 100 | n.d. | n.d. |
| 13697 | A16-10795-7 | 100 | n.d. | n.d. |
| 13995 | A16-10795-8 | 100 | n.d. | n.d. |
| 13951 | A16-10795-9 | 96 | n.d. | 4 |
| 13632 | A16-10795-10 | 100 | n.d. | n.d. |
| 612644 | A16-10795-11 | Y | Y | n.d. |
| 612622 | A16-10795-12 | trace | trace | n.d. |
| 612696 | A16-10795-13 | Y | n.d. | n.d. |
| 612635 | A16-10795-14 | 22 | 78 | n.d. |
| 612709 | A16-10795-15 | Y | Y | n.d. |
| 612660 | A16-10795-16 | Y | Y | n.d. |
| 612702 | A16-10795-17 | Y | Y | n.d. |
| 612650 | A16-10795-18 | 20 | 80 | n.d. |
| 612710 | A16-10795-19 | trace | trace | n.d. |
| 612687 | A16-10795-20 | 20 | 80 | n.d. |
| 820767 | A16-10795-21 | 100 | n.d. | n.d. |
| 820777 | A16-10795-22 | 60 | 40 | n.d. |
| 10560 | A16-10795-23 | 60 | 40 | n.d. |
| 10596 | A16-10795-24 | 30 | 70 | n.d. |
| 820762 | A16-10795-25 | 60 | 40 | n.d. |
| 820797 | A16-10795-26 | 35 | 65 | n.d. |
| 10556 | A16-10795-27 | 92 | 8 | n.d. |
| 10562 | A16-10795-28 | 5 | 95 | n.d. |
| 10383 | A16-10795-29 | 86 | 14 | n.d. |
| 820792 | A16-10795-30 | 95 | 5 | n.d. |

Note: n.d. = not detected; Y = present; the relative proportions of smectite and illite were not calculated for samples containing poorly crystalline smectite-like mineral.

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