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December 8, 2010

David C. Harris
Kentucky Geological Survey
228 Mining and Mineral Resources Bldg.
University of Kentucky
Lexington KY 40506-0107
(859) 323-0545
dcharris@uky.edu

Subject: X-ray Diffraction Analysis
K/T File No.: Z10341

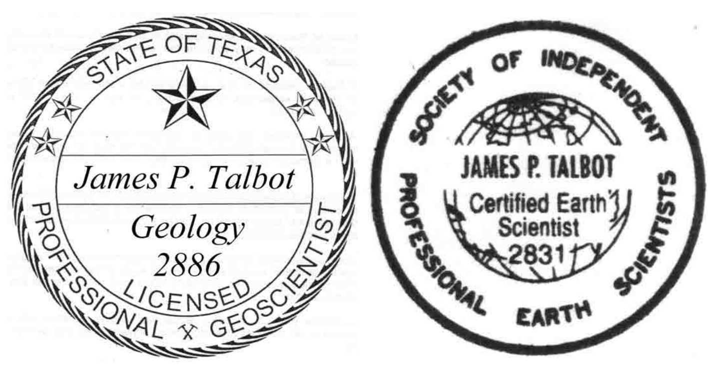
Dear Dave,

This report presents the results of bulk (whole rock) and clay fraction (<4 micron) X-ray diffraction (XRD) analysis performed on 10 samples. This analysis is performed to provide mineralogy of the samples.

Enclosed find the tabular XRD data (weight percentage), the X-ray diffraction traces and a detailed description of sample preparation and analytical procedures. For your convenience, I have sent a copy of this report via e-mail.

Unused portions of the samples will be returned upon request. If you have any questions concerning these results or if you need anything else please contact me at (940) 597-9076. Thank you for using K/T GeoServices to perform your X-ray diffraction analyses and I look forward to working with you again in the future.

Sincerely,



James P. Talbot, P.G.

X-ray Diffraction Data (Weight Percent)

XRD#	Well Name	Depth	Quartz	K-Feldspar	Plagioclase	Calcite	Mg-Calcite	Ankerite	Fe-Dolomite	Pyrite	Gypsum	Total Phyllosilicates	R3 M-L I/S 15S*	Illite&Mica	Kaolinite	Chlorite	TOTAL
DH101	Ashland #1	6273	22.9	10.9	5.5	1.5	0.0	0.0	1.1	0.5	0.0	57.6	20.5	23.7	2.5	10.9	100.0
DH102	Ashland #1	6278	17.1	11.9	4.1	1.0	0.0	0.0	1.4	1.8	0.0	62.7	23.8	24.3	2.7	11.9	100.0
DH103	Ashland #1	6290	23.3	8.8	4.2	5.5	0.0	5.4	0.0	1.0	0.0	51.8	16.1	21.1	2.5	12.1	100.0
DH104	Ashland #1	6284	23.5	9.8	4.7	2.3	0.0	5.9	0.0	0.9	0.0	52.9	16.3	23.2	2.4	11.0	100.0
DH105	Exxon #1 Smith	11141.9	22.1	12.0	14.8	2.8	0.0	0.0	7.1	2.6	0.9	37.7	11.9	17.5	1.8	6.5	100.0
DH106	Exxon #1 Smith	11155.9	16.2	8.8	8.9	16.6	4.2	0.0	11.3	2.4	0.9	30.7	9.1	13.0	1.9	6.7	100.0
DH107	Exxon #1 Smith	11167.3	14.9	5.2	5.3	24.7	14.8	2.4	0.0	2.6	1.4	28.7	8.6	12.3	1.9	5.9	100.0
DH108	Exxon #1 Smith	11178.3	17.3	7.0	9.0	12.9	9.4	6.2	0.0	1.8	1.3	35.1	10.5	16.1	2.0	6.5	100.0
DH109	Exxon #1 Smith	11191.0	19.2	7.4	6.9	13.4	6.4	5.8	0.0	3.0	0.8	37.1	11.3	17.5	1.9	6.4	100.0
DH110	Exxon #1 Smith	11197.3	21.1	6.9	11.2	12.5	5.2	8.4	0.0	2.2	1.1	31.4	7.2	9.5	2.6	12.1	100.0

*R3 M-L I/S 15S - Ordered Mixed-Layer Illite/Smectite with 15% Smectite Layers

Ashland #1 Williams, Johnson Co., KY, Permit 67549
Exxon #1 Smith, Wayne County, WV, API 4709901572

See page 3 for mineral definitions.
See page 4 for a discussion of X-ray diffraction terminology and limitations.
Sample preparation and analytical procedures are on page 5.
X-ray diffraction traces are on pages 6 – 27.

Mineral Definitions

Phyllosilicate (Clay) Minerals

Mixed-Layer Illite/Smectite

A clay mineral group containing interlayered or interstratified Illite and Smectite. The mixed-layer clay type is identified by the minerals involved (Illite and Smectite in this case), the type of order or stacking along the Z axis (R3 ordered in this case), and the proportions of the minerals involved (85% Illite and 15% Smectite in this case).

Illite & Mica

Illite & Mica (muscovite) are common non-expanding (non-swelling) minerals. Illite is the fine-grained clay mineral analogue to muscovite. Illite and Mica are hydrated silicates containing potassium, silica and alumina.

Kaolinite

Kaolinite is a common non-expanding (non-swelling) clay mineral. It is a hydrous aluminum silicate with the general formula $Al_2(Si_2O_5)(OH)_4$.

Chlorite

Chlorite is a common non-expanding (non-swelling) clay mineral. It is a hydrous aluminum silicate that often contains iron.

Rock Forming (nonclay) Minerals

Quartz

Quartz (SiO_2) is the most common rock-forming mineral.

K-Feldspar

K-Feldspar ($KAlSi_3O_8$) is a potassium bearing feldspar and can be Orthoclase, Microcline or Sanidine.

Plagioclase

Plagioclase is a mineral series ranging in composition from Albite ($NaAlSi_3O_8$) to Anorthite ($CaAl_2Si_2O_8$) and is one of the most common rock forming mineral groups.

Calcite

Calcite is a common hexagonal carbonate mineral with the formula $CaCO_3$.

Mg-Calcite

Mg-Calcite is a carbonate mineral with the general formula $(Mg,Ca)CO_3$.

Fe Dolomite

Fe-Dolomite is a dolomite that contains Fe and has the general formula $(Fe,Mg)Ca(CO_3)_2$.

Pyrite

Pyrite (FeS_2) is an iron sulfide and is also known as fool's gold.

Reference for general mineral definitions: Dictionary of Geological Terms, American Geological Institute, 1976, Anchor Press/Doubleday, Garden City, New York.

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Whole Rock and Clay Fraction XRD
Discussion of Terminology and Limitations

Weight percentage data from X-ray diffraction methods are considered semi-quantitative. There are many factors affecting the results.

XRD methods can quantify crystalline material only. Organic non-crystalline material in large concentrations can be detected but not quantified. Therefore, any organic and/or non-crystalline material is not included in the accompanying results.

Detection limits for XRD are on the order of one to five weight percent. The detection limits differ for each mineral species.

Mineral standards used to determine calibration factors are often different from the actual minerals analyzed. Minerals such as feldspars that undergo solid solution are especially problematic. Clay minerals are problematic for this same reason. Clay minerals also have a wide range of crystallinities (poorly crystallized to well crystallized) which may compound this problem.

With this method the data always sums to 100%. This means that the percentages reported for each mineral are dependent upon the percentages reported for the other minerals. If one mineral is underestimated the others will be overestimated. Also, if one or more minerals are present but not detected then the percentages of the minerals that are detected will be overestimated.

Any or all of the above factors may affect the estimated weight percentages.

Data are formatted as weight percent, but are actually calculated as weight fractions. Therefore, slight rounding errors may be observed in the formatted data.

For this analytical method, the clay fraction is defined as the <4 micron ESD (Equivalent Spherical Diameter) fraction of the sample. Clay fraction does not mean clay minerals (phyllosilicates) only, it is a size term and as such this size fraction can and almost always does include non-clay minerals (quartz, plagioclase, etc.). This size fraction is used because it typically contains abundant clay minerals.

Whole Rock and Clay Fraction XRD
Sample Preparation and Analytical Procedures

Sample Preparation

Samples submitted for whole rock and clay mineral XRD analyses are cleaned of obvious contaminants and disaggregated in a mortar and pestle. A split of each sample is then transferred to distilled water and pulverized using a McCrone micronizing mill. The resultant powder is dried, disaggregated, and packed into a metal sample holder to produce random whole-rock mounts. A separate split of each sample is dispersed in distilled water using a sonic probe. The suspensions are then size fractionated with a centrifuge to isolate clay-size (<4 micron equivalent spherical diameter) materials for a separate clay mount. The suspensions are then vacuum deposited on nylon membrane filters to produce oriented clay mineral mounts. The clay mineral mounts are attached to glass slides and exposed to ethylene glycol vapor for approximately 12 hours.

Analytical Procedures

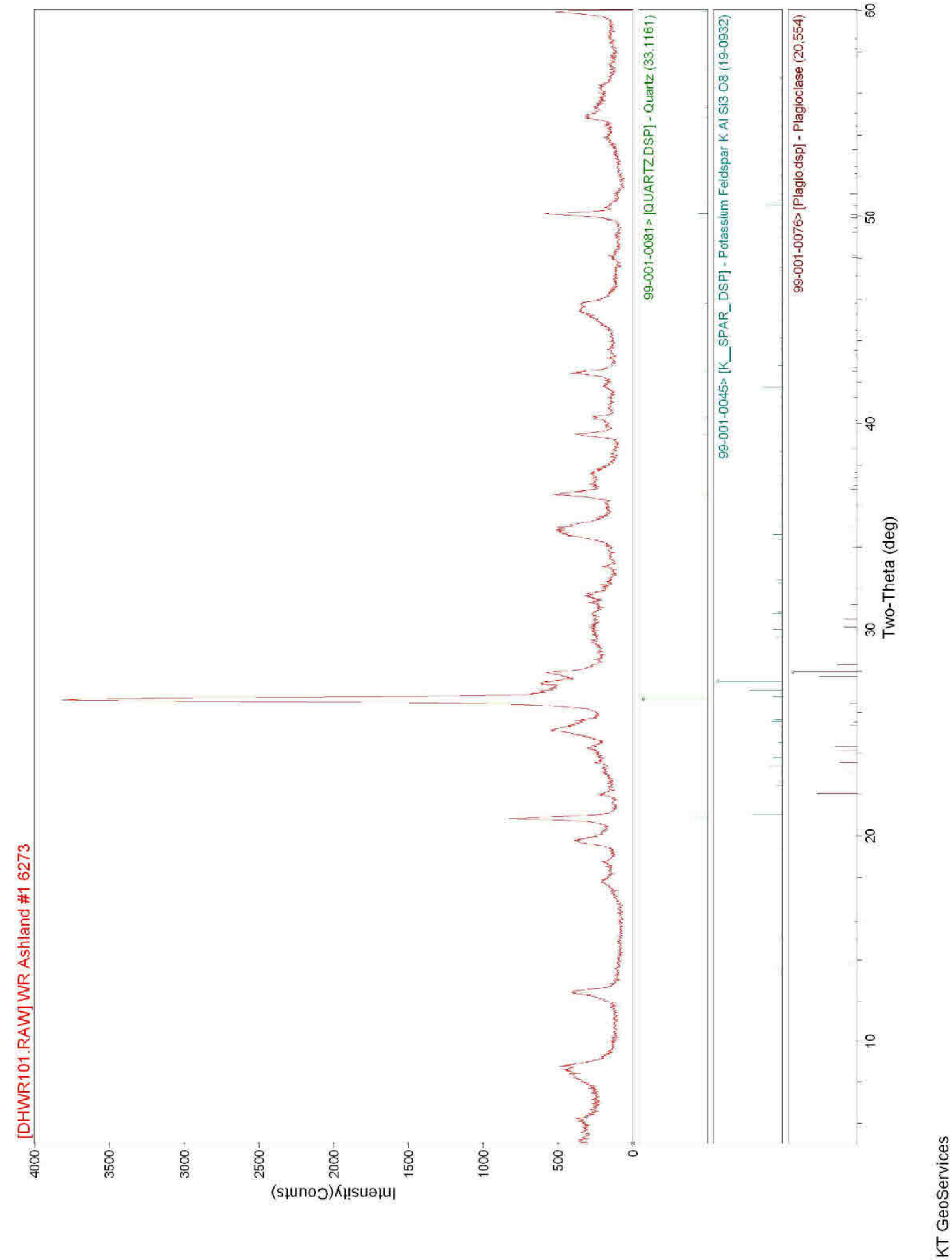
X-ray Diffraction (XRD) analyses of the samples are performed using a Siemens D500 automated powder diffractometer equipped with a copper X-ray source (40kV, 30mA) and a scintillation X-ray detector. The whole rock samples are analyzed over an angular range of five to sixty degrees two theta at a scan rate of one degree per minute. The glycol solvated oriented clay mounts are analyzed over an angular range of two to thirty six degrees two theta at a scan rate of one degree per minute.

Semiquantitative determinations of whole-rock mineral amounts are done utilizing integrated peak areas (derived from peak-decomposition / profile-fitting methods) and empirical reference intensity ratio (RIR) factors determined specifically for the diffractometer used in data collection. The total phyllosilicate (clay and mica) abundance of the samples are determined on the whole-rock XRD patterns using combined {00l} and {hkl} clay mineral reflections and suitable empirical RIR factors.

XRD patterns from glycol-solvated clay-fraction samples are analyzed using techniques similar to those described above. The relative amounts of phyllosilicate minerals are determined from the patterns using profile-fitted integrated peak intensities and combined empirical and calculated RIR factors. Determinations of mixed-layer clay ordering and expandability are done by comparing experimental diffraction data from the glycol-solvated clay mounts with simulated one dimensional diffraction profiles generated using the program NEWMOD written by R. C. Reynolds.

Bulk (Whole-Rock)
X-ray Diffraction Traces

K/T GeoServices Report Z10341
December 8, 2010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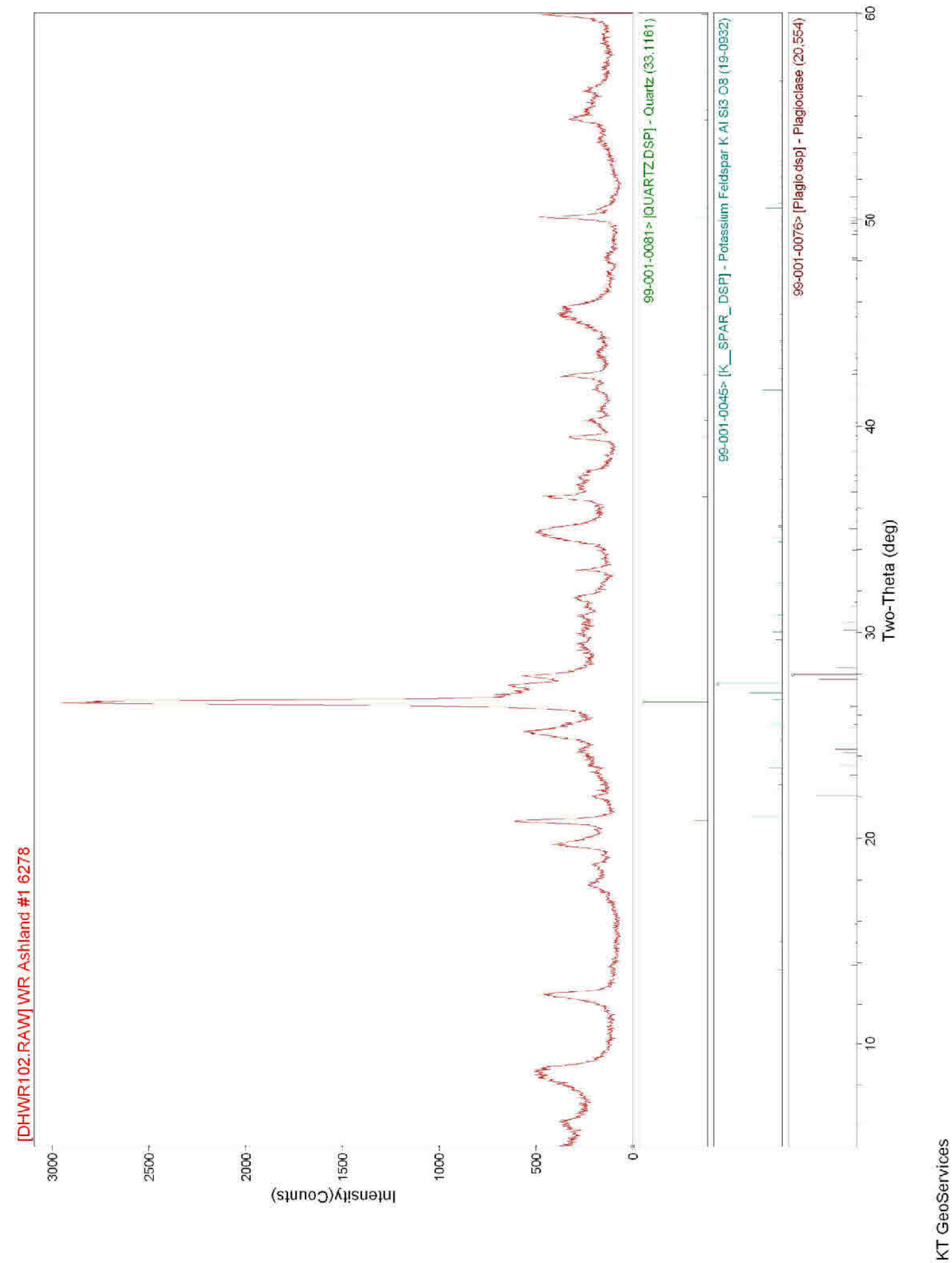
KT GeoServices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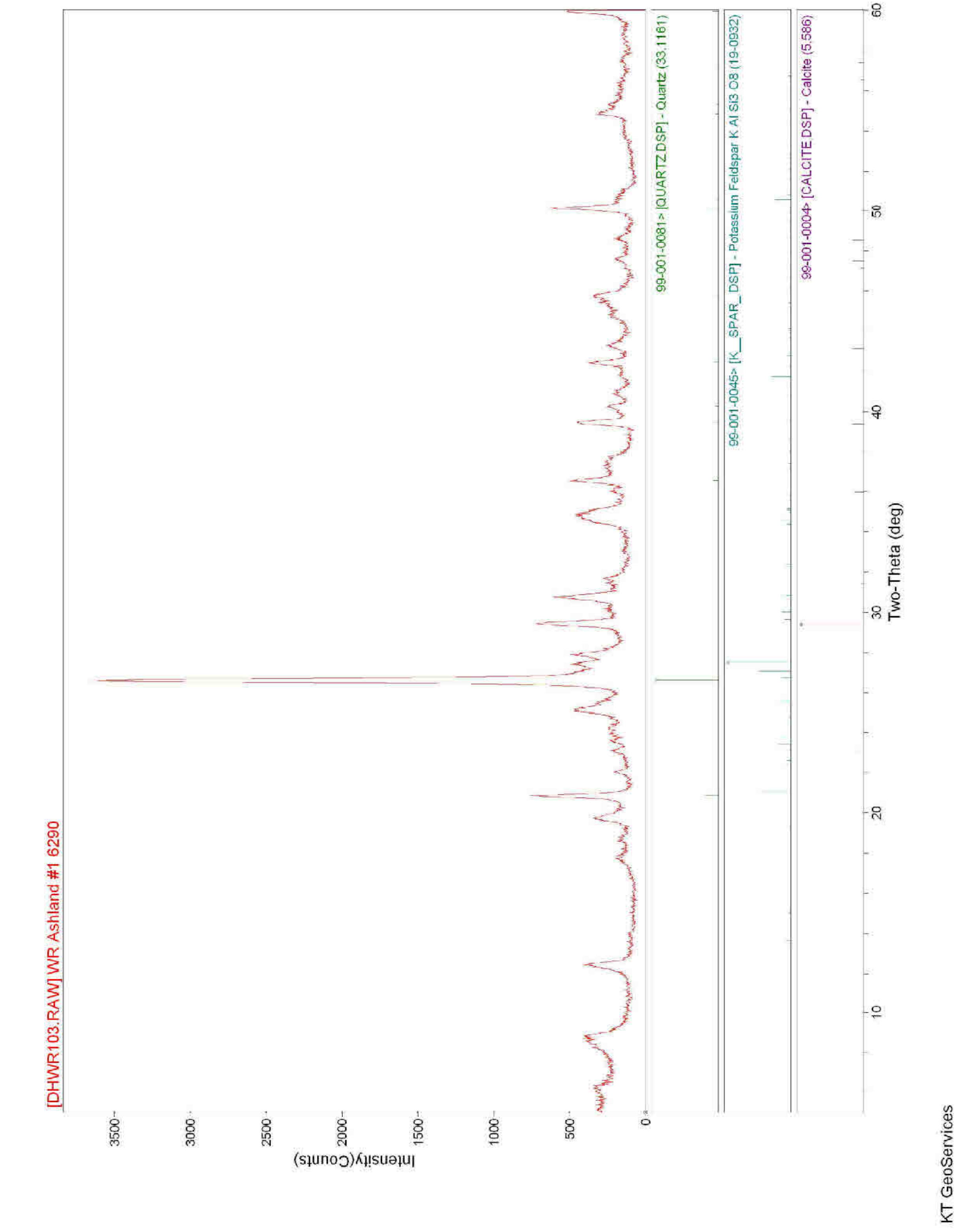
Two-Theta (deg)
KT GeoServices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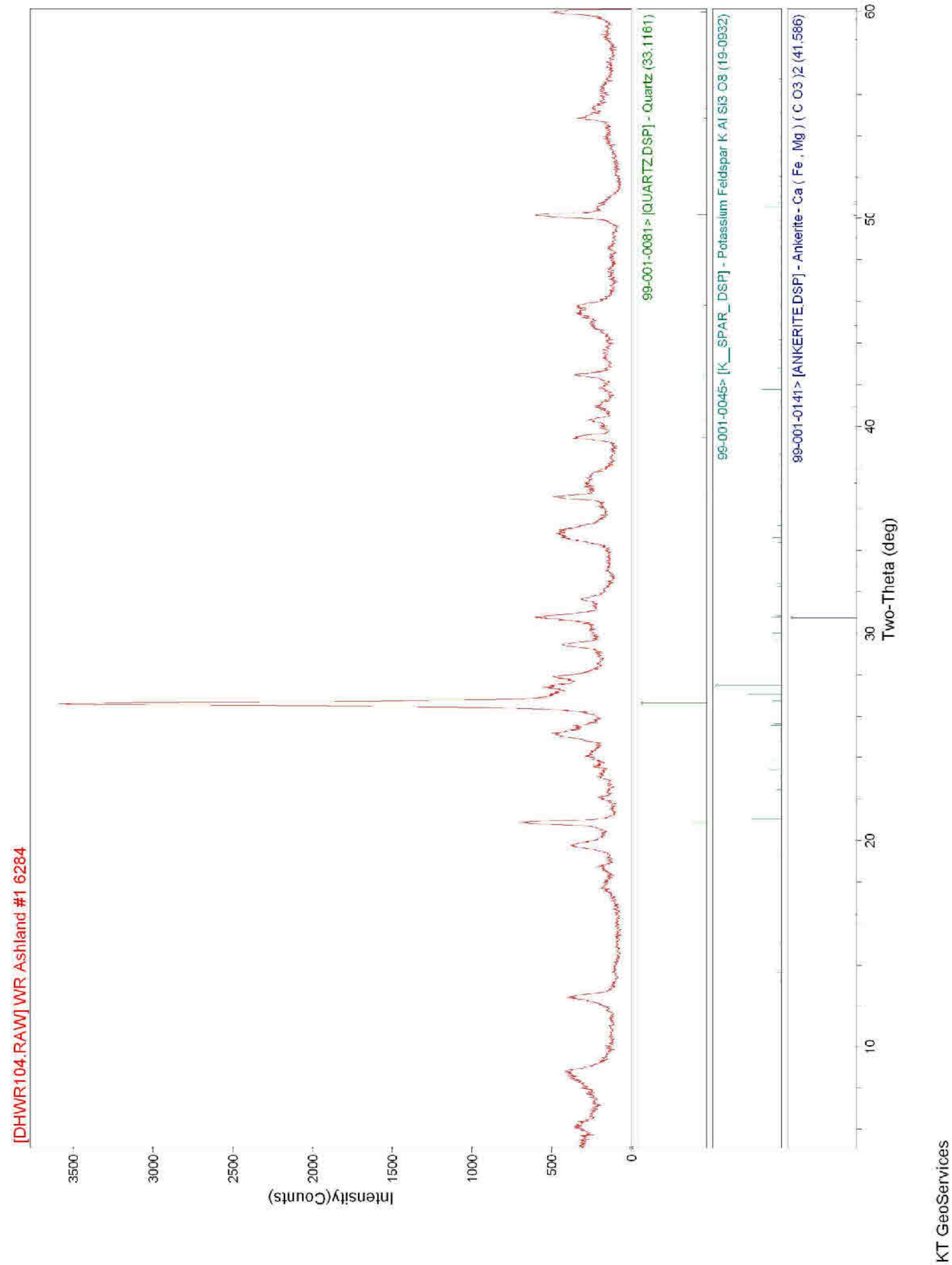
KT GeoServices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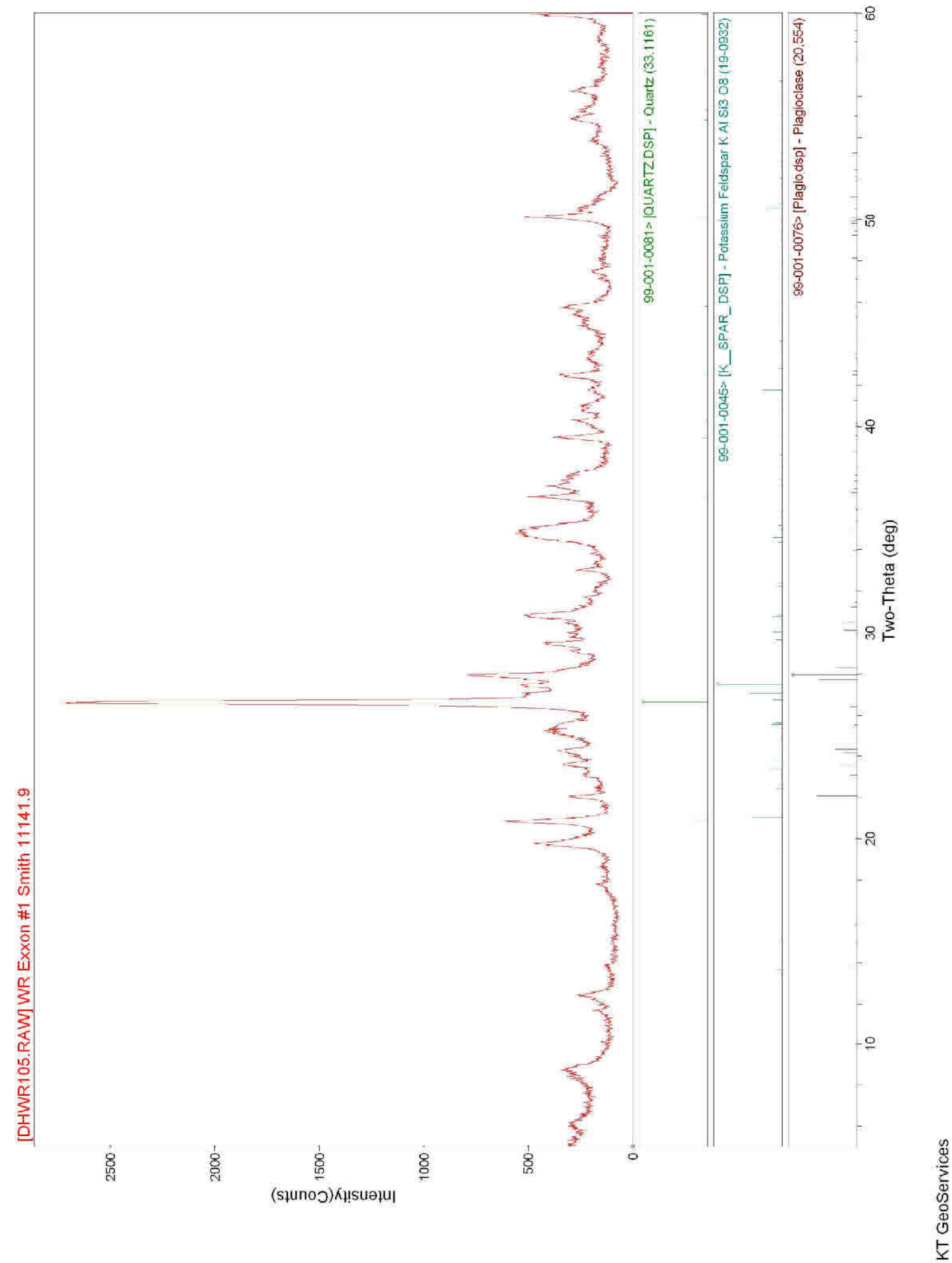
KT GeoServices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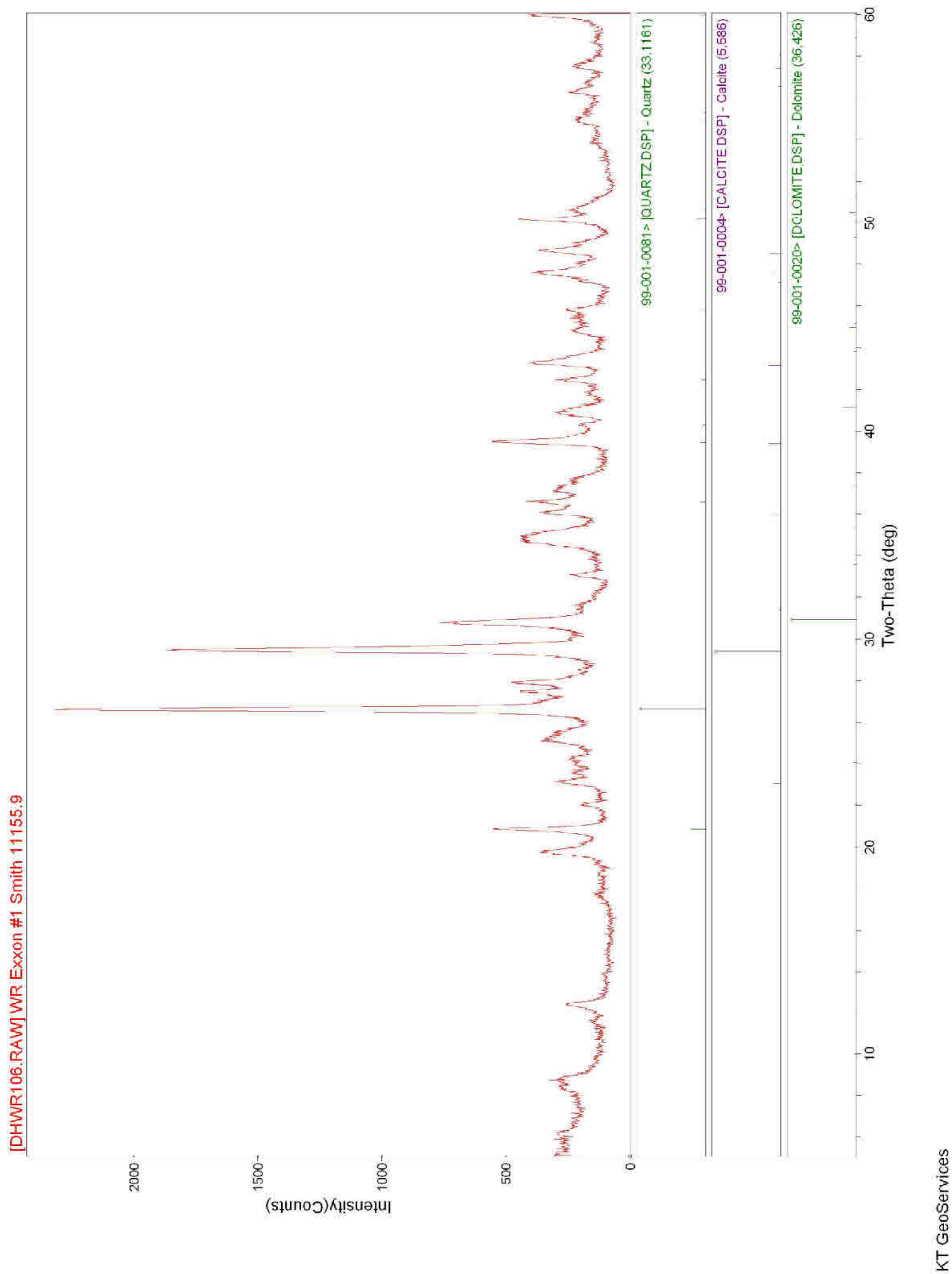
Two-Theta (deg)
KT GeoServices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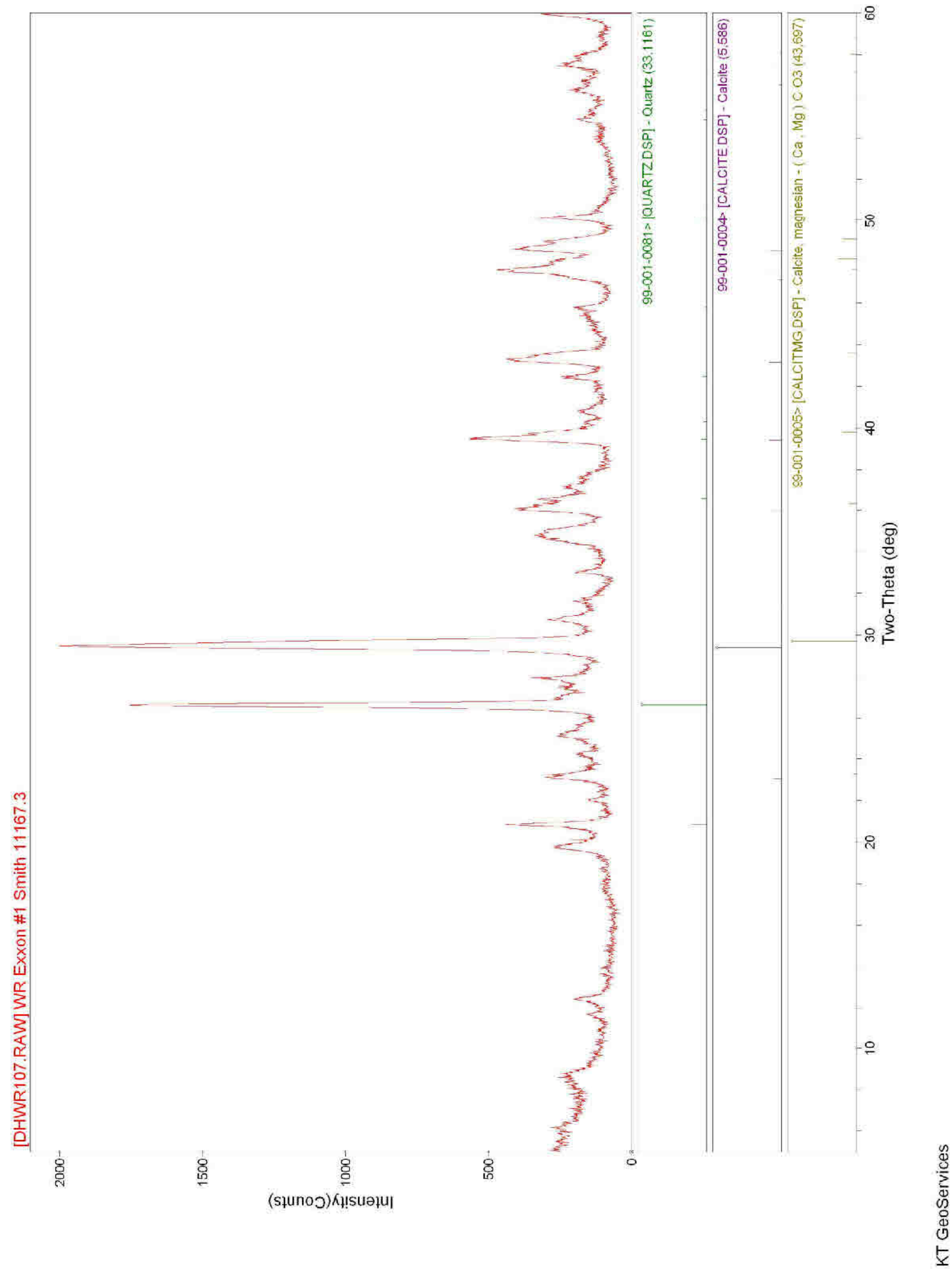
KT GeoServices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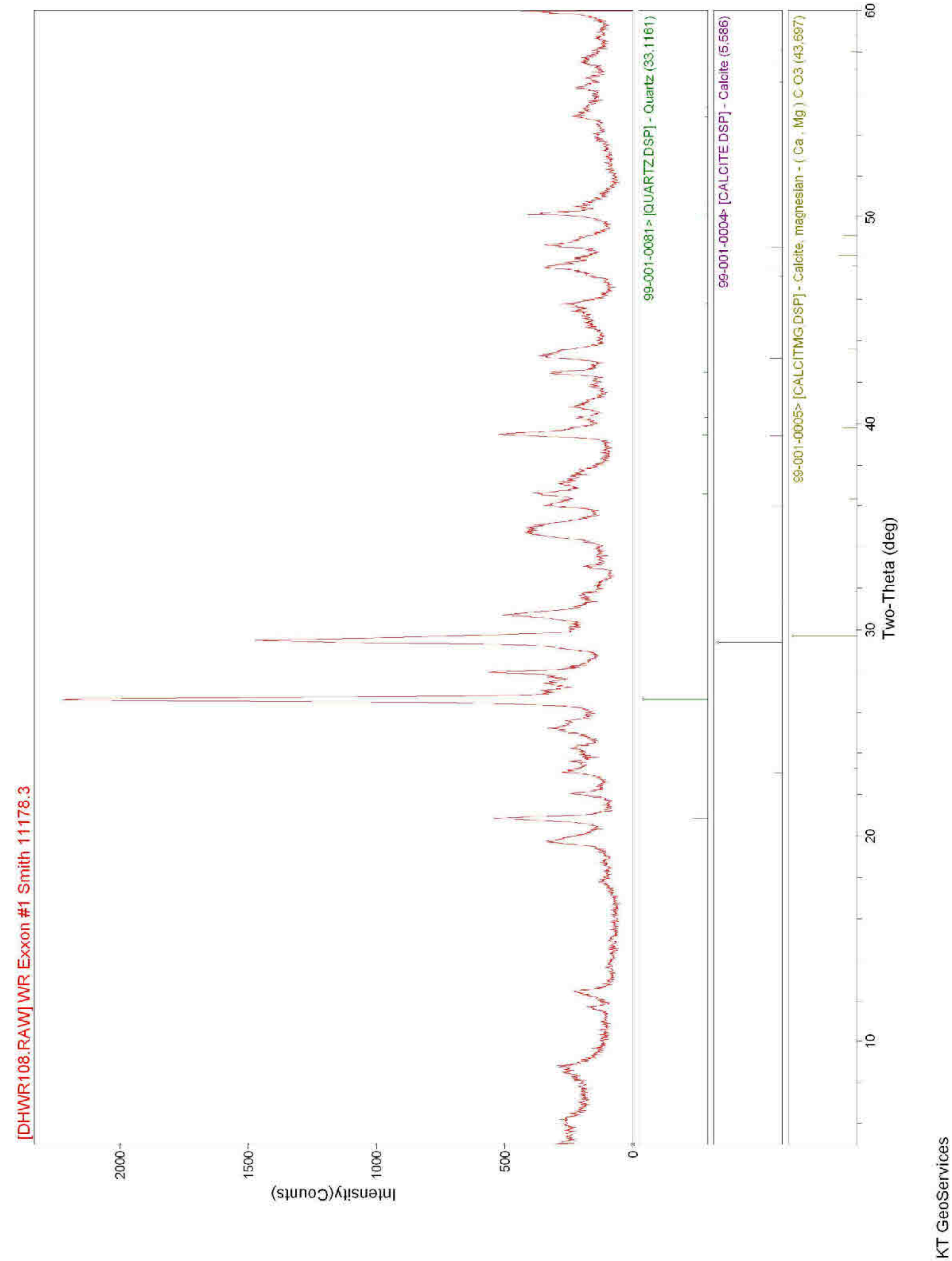
KT GeoServices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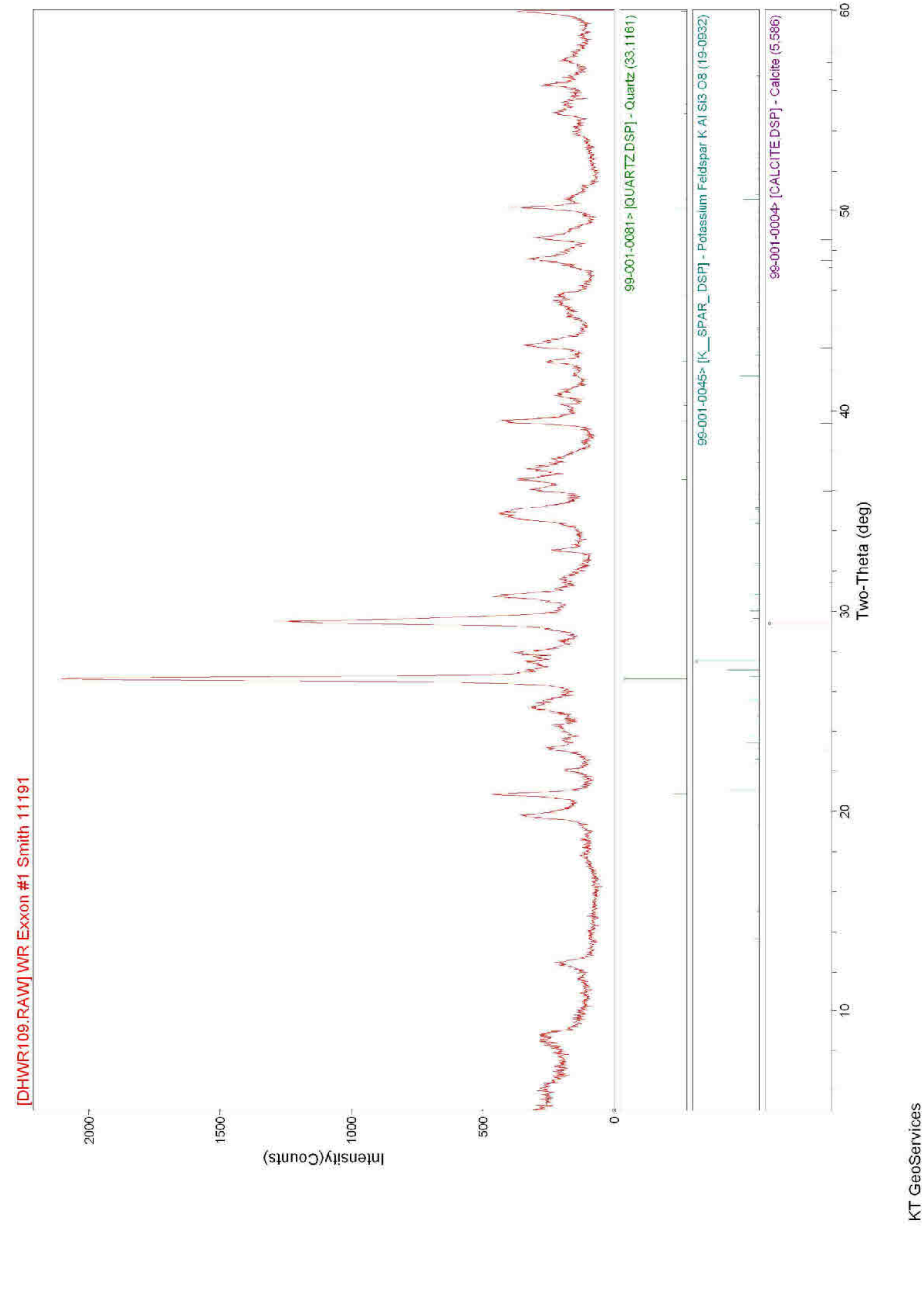
Two-Theta (deg)
KT GeoServices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Intensity(Counts)
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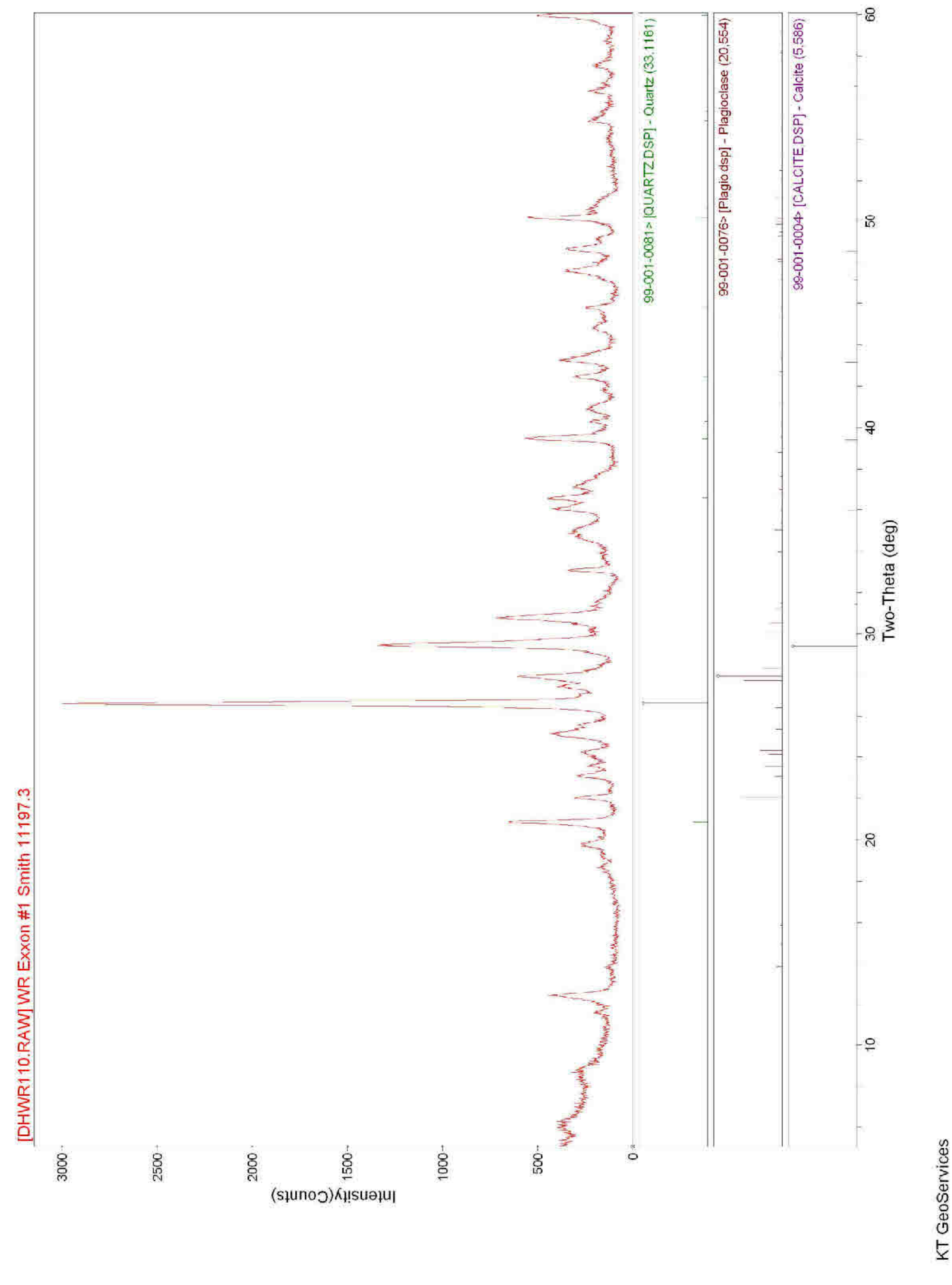
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Two-Theta (deg)
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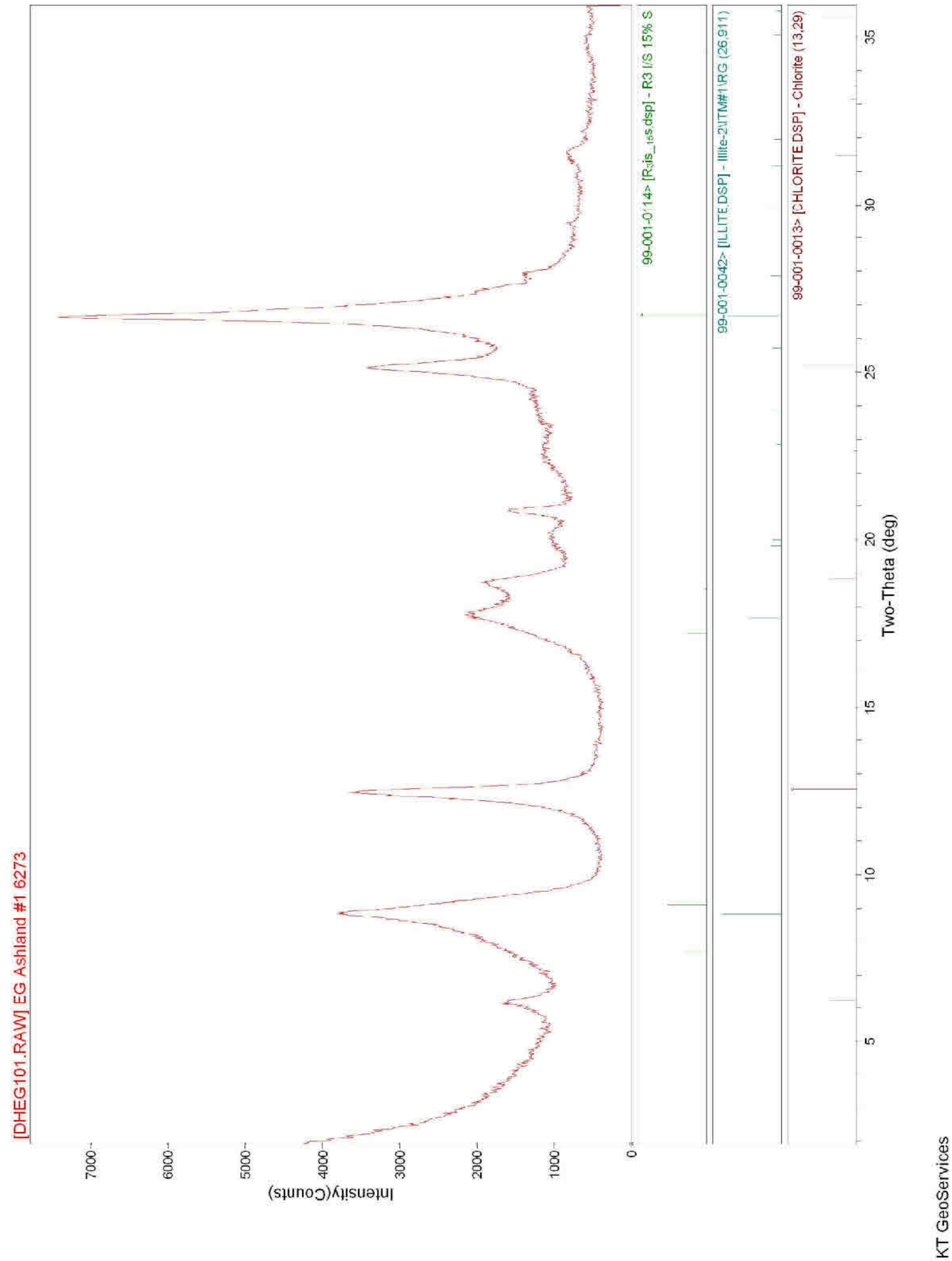
Ethylene Glycol Solvated
Clay Fraction (<4 micron)
X-ray Diffraction Traces

K/T GeoServices Report Z10341
December 8, 2010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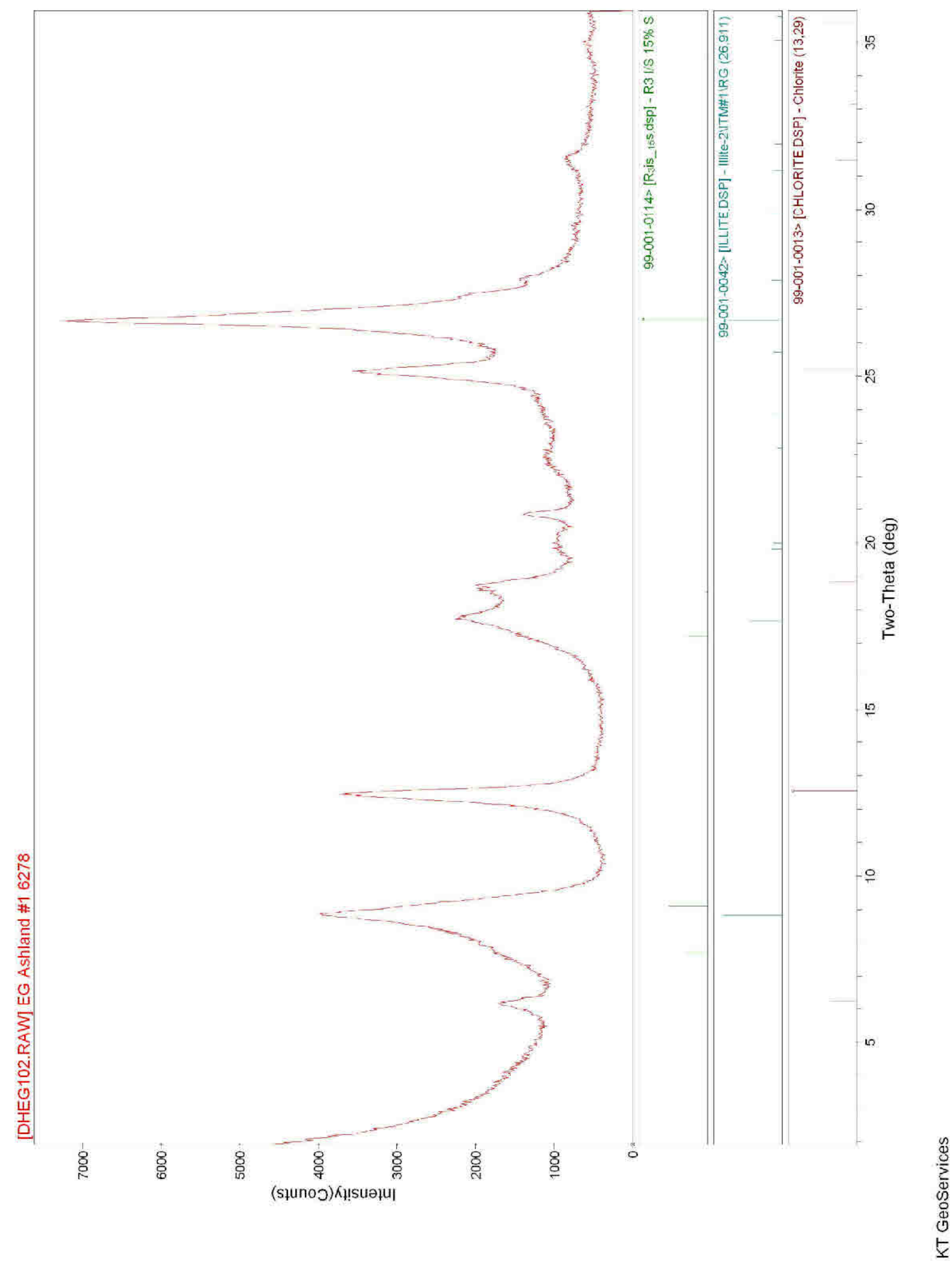
KT GeoServices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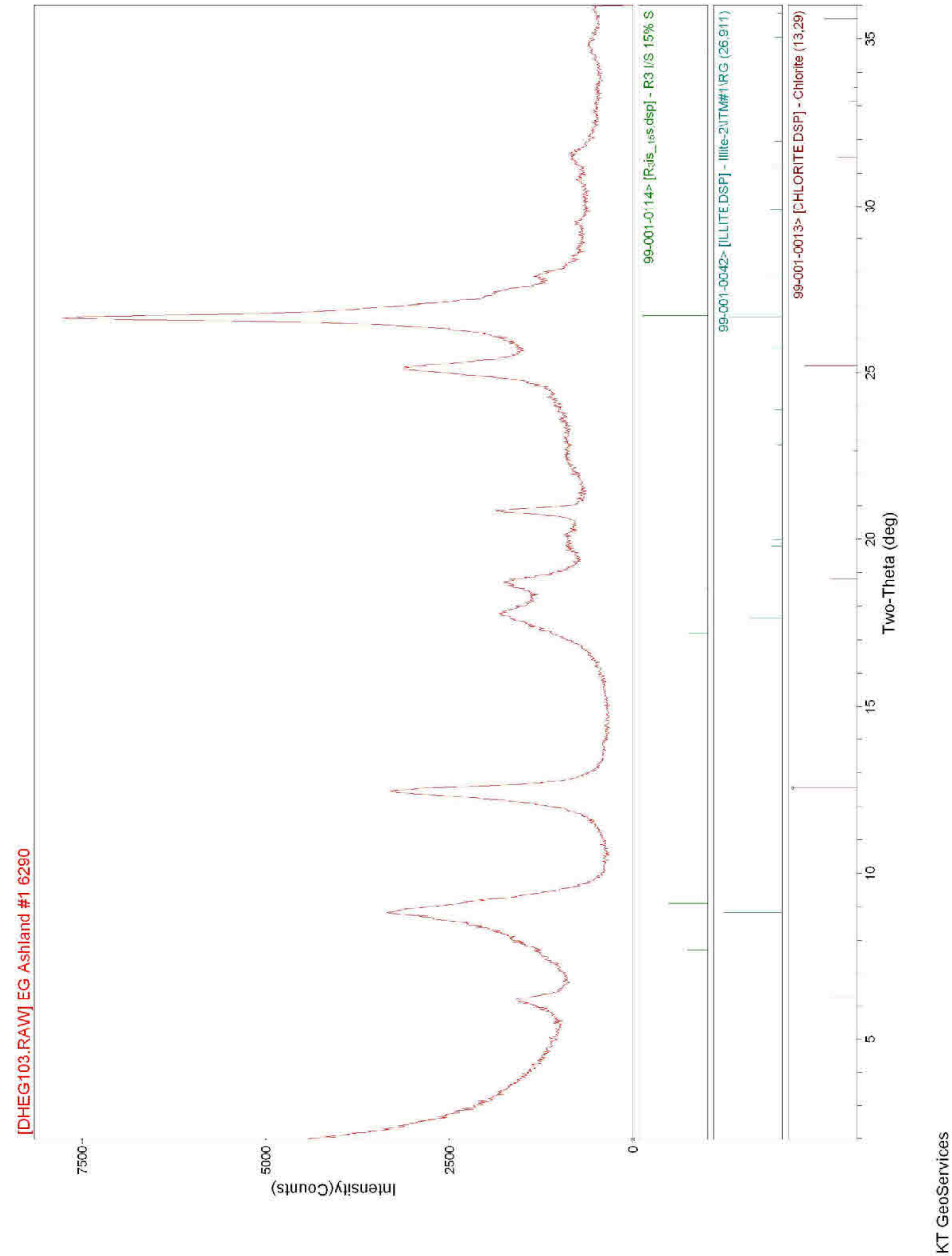
Two-Theta (deg)
KT GeoServices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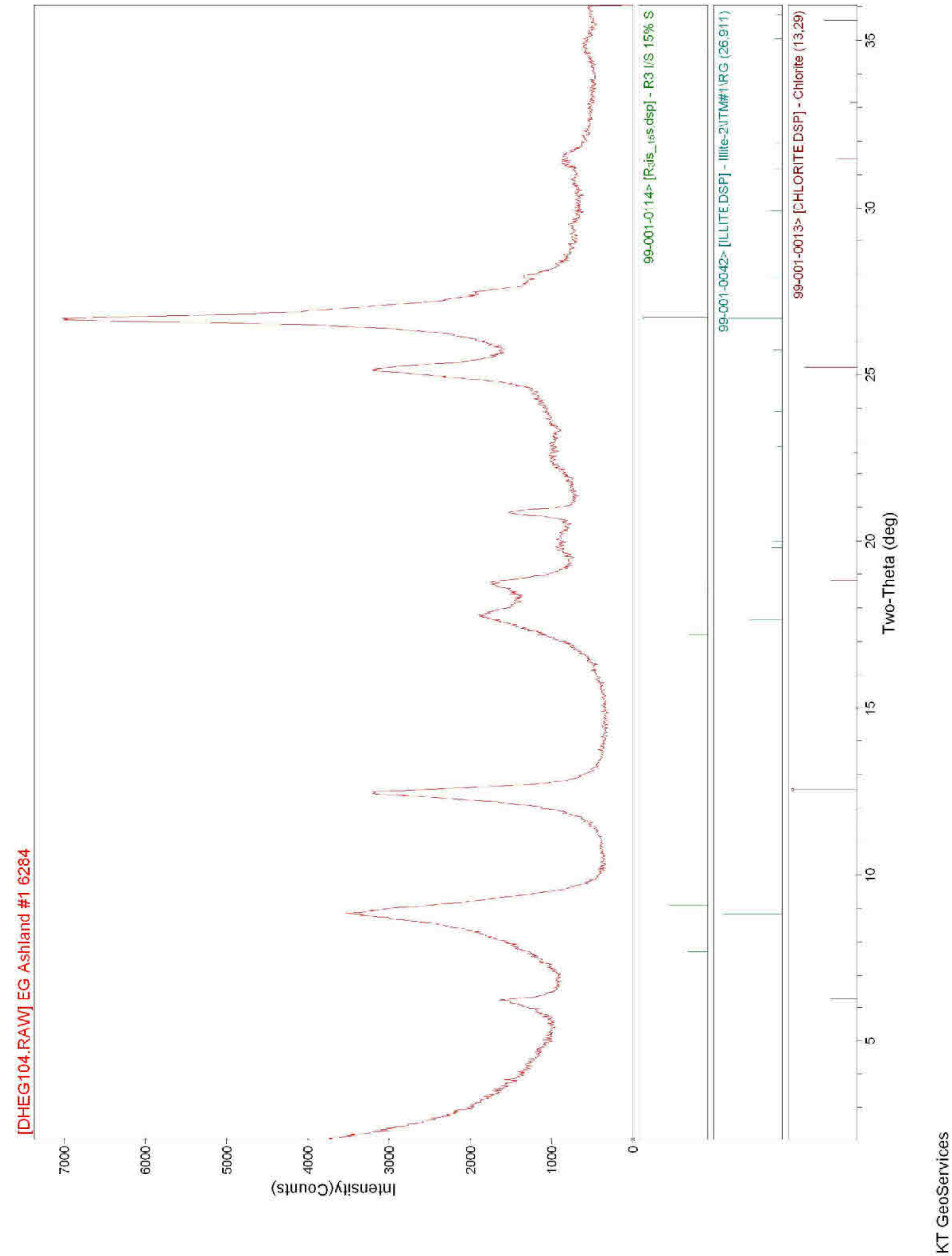
Two-Theta (deg)
KT GeoServices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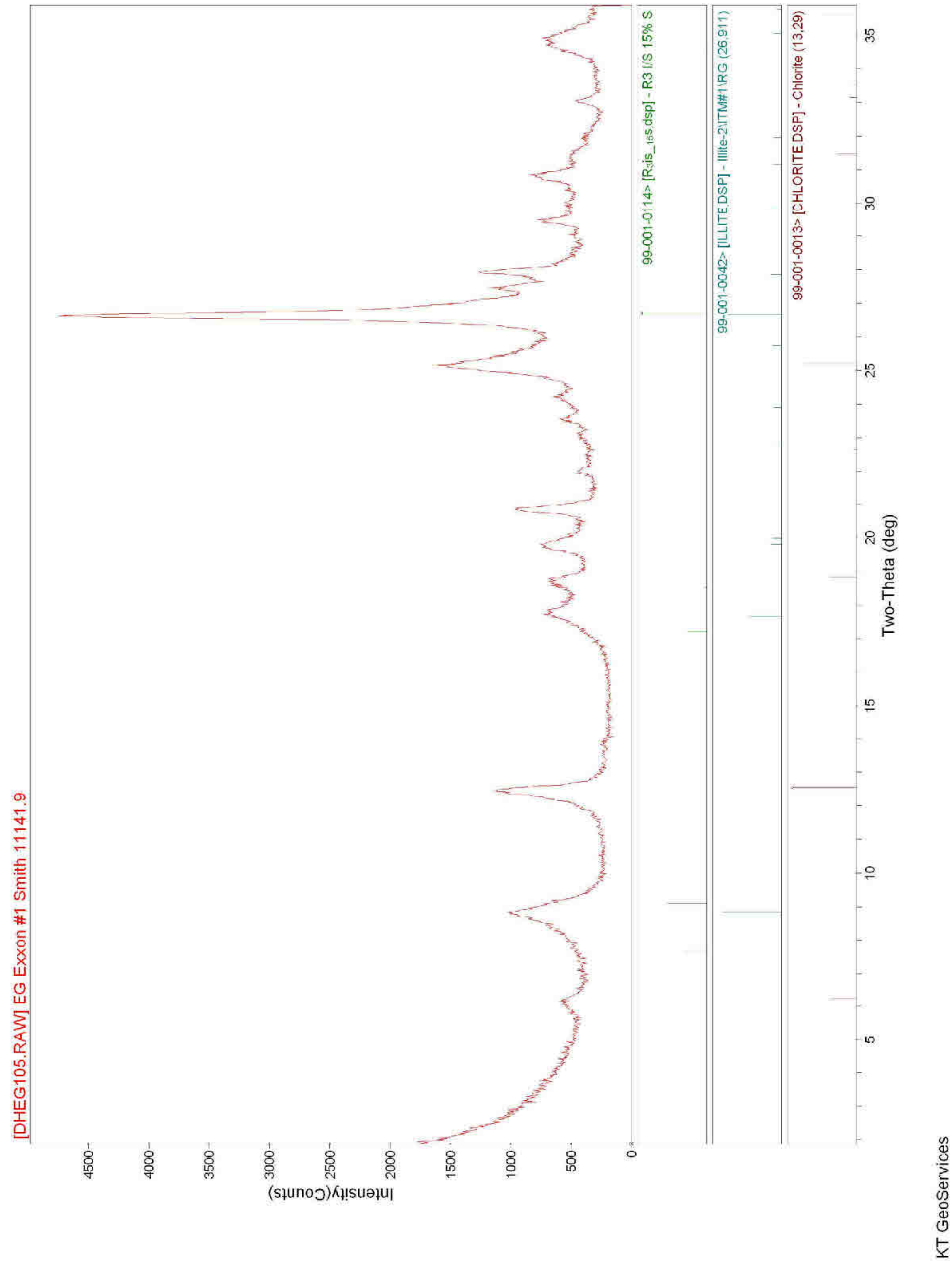
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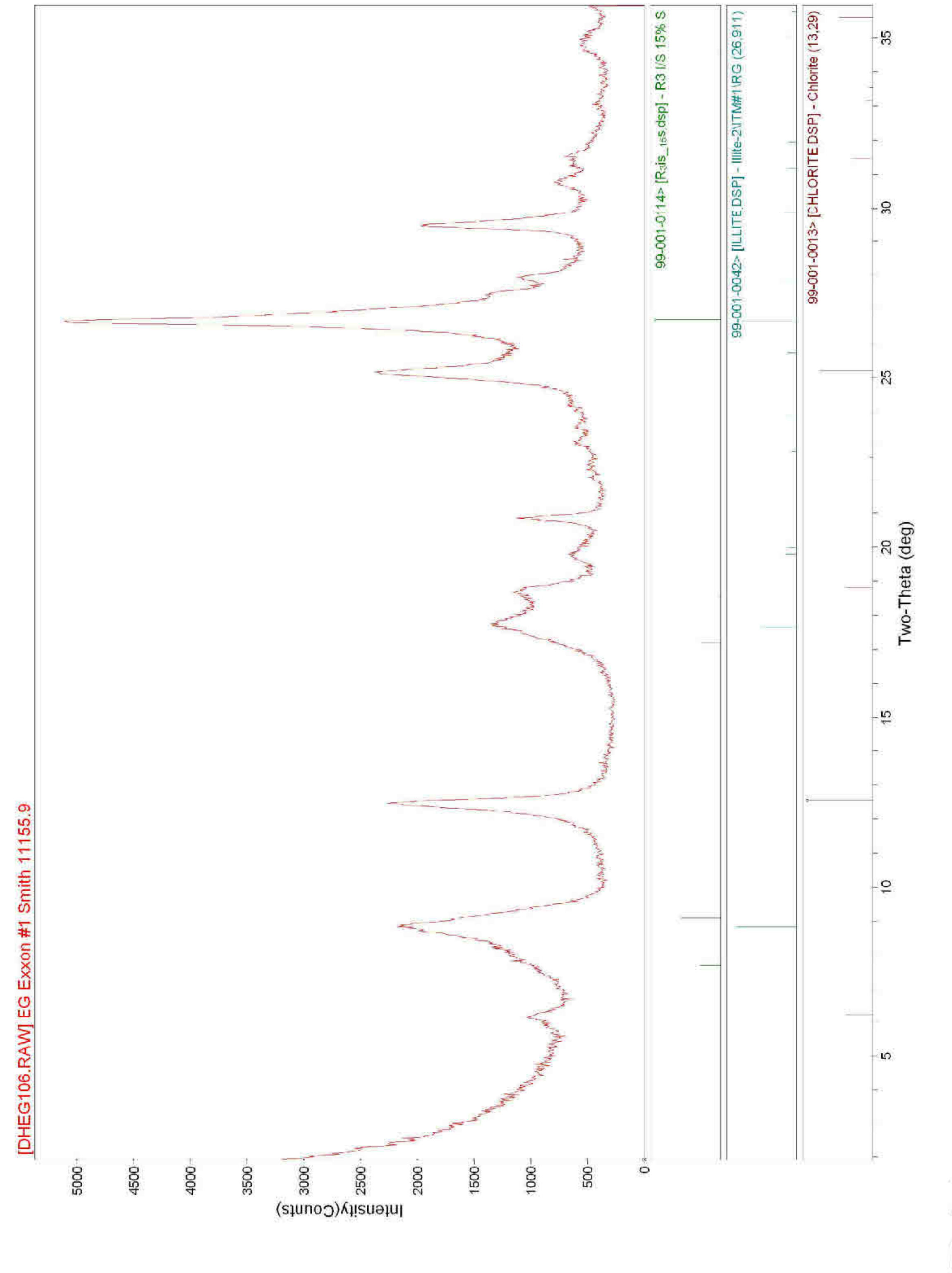
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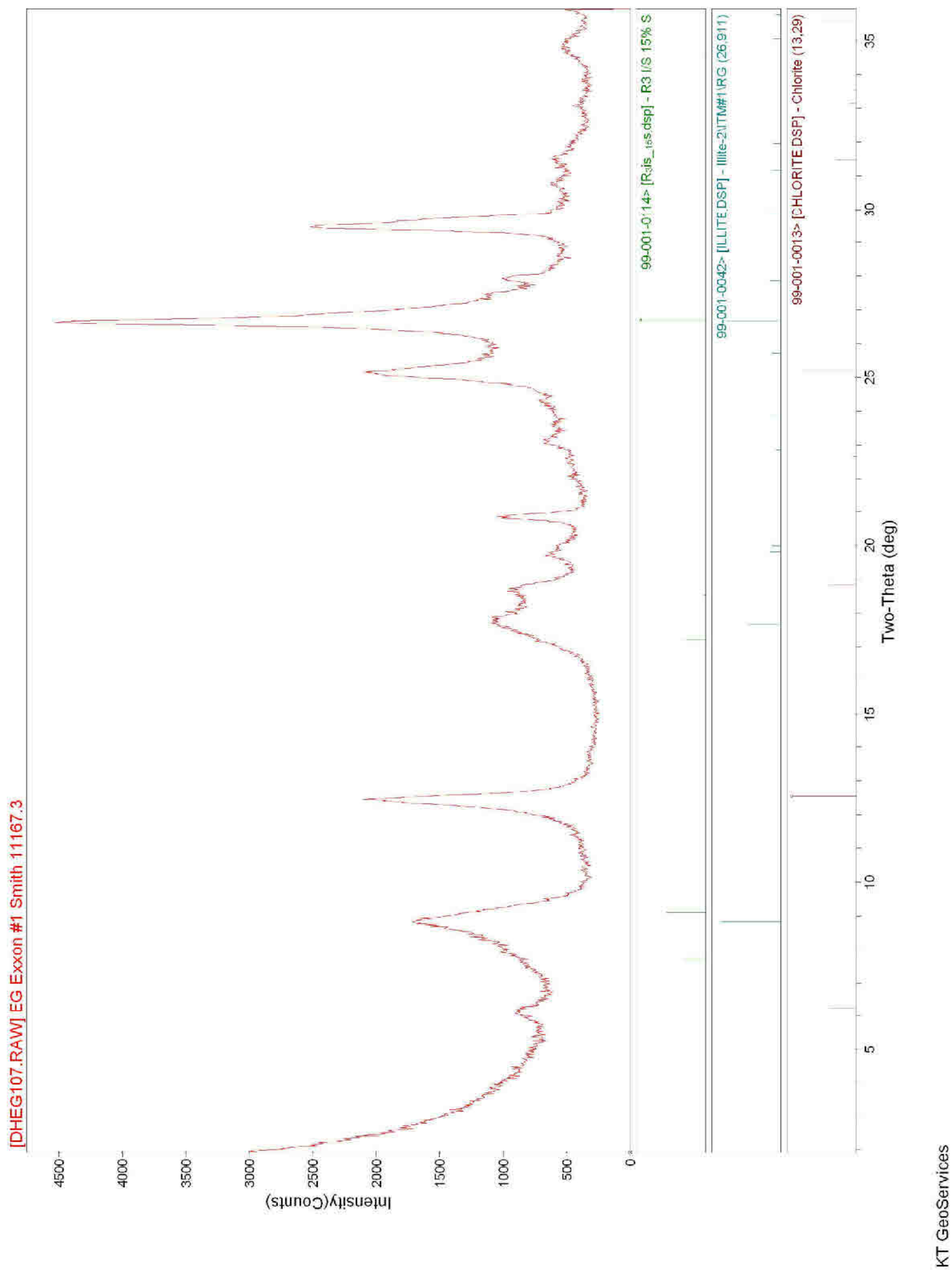

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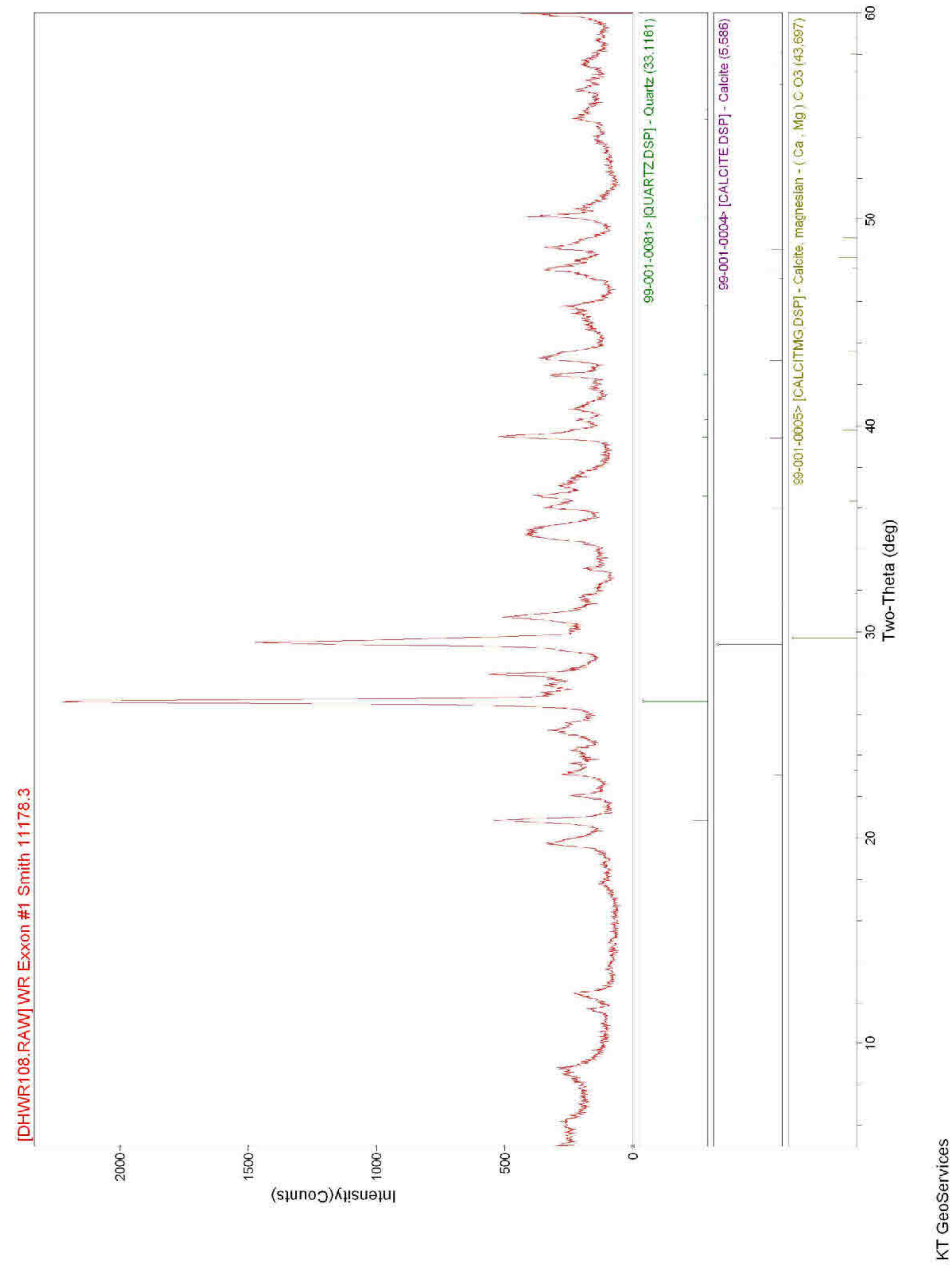
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99-001-0004> [CALCITE.DSP] - Calcite (5.586)
99-001-0005> [CALCITMG.DSP] - Calcite, magnesian - (Ca , Mg) C O3 (43.697)
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Two-Theta (deg)
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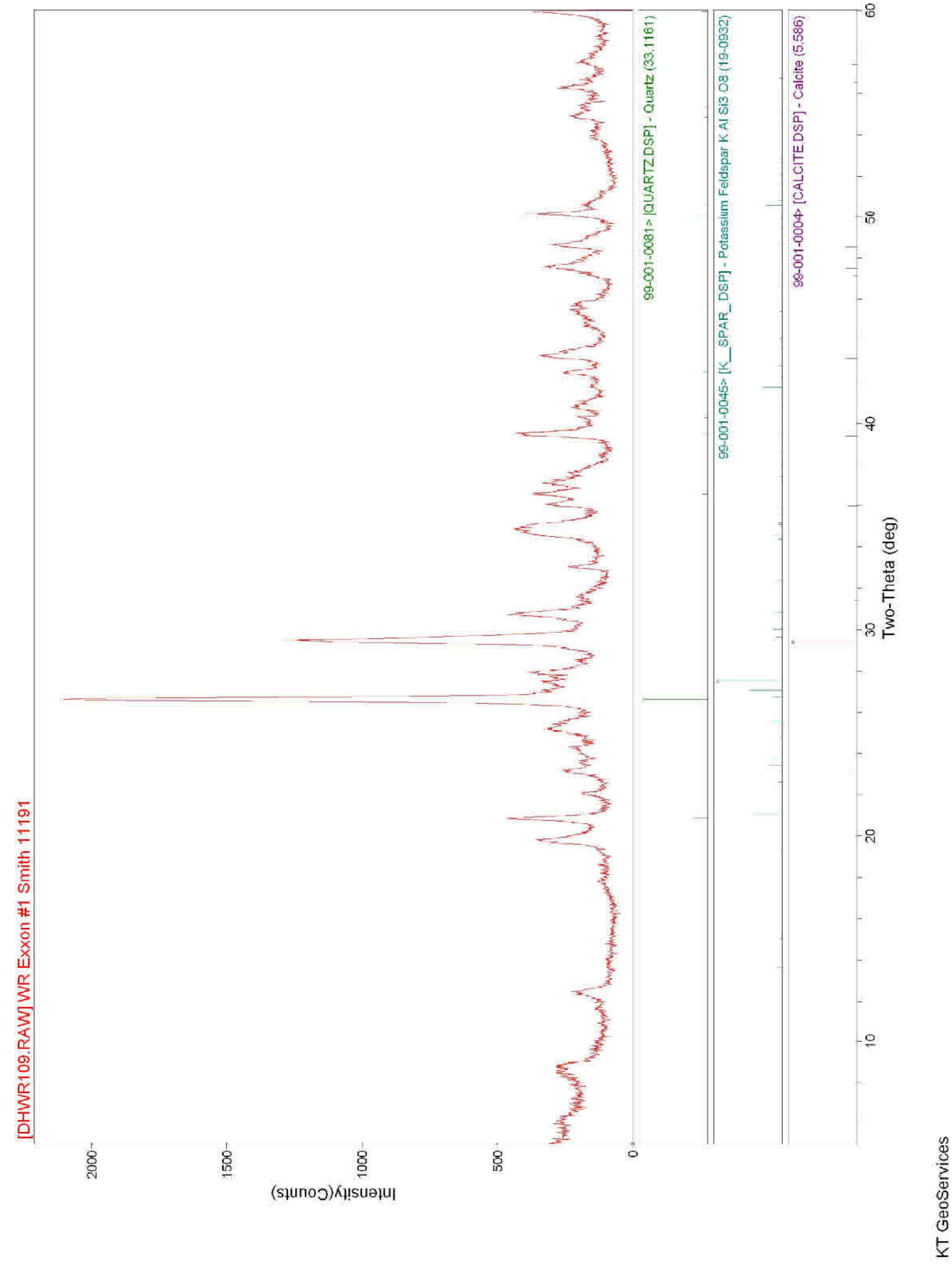
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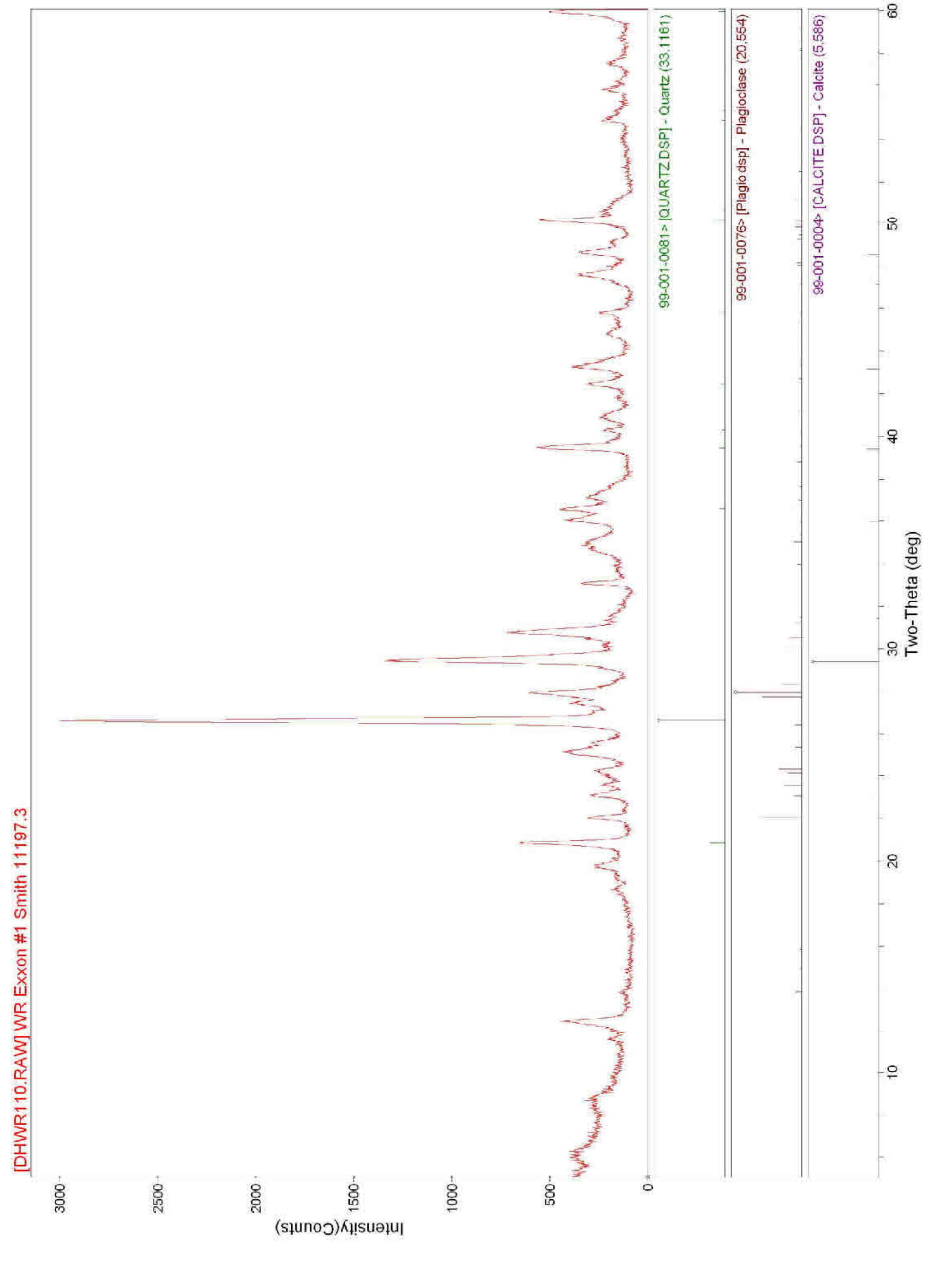
Two-Theta (deg)
KT GeoServices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99-001-0004> [CALCITE.DSP] - Calcite (5.586)
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Two-Theta (deg)
KT GeoServices