U.S. Department of the Interior
Bureau of Land Management

GEOCHEMICAL ASSAY TESTING FOR THE POSSIBLE PRESENCE OF AIRBORNE CARCINOGENS AT THE PROPOSED KIRKLAND HIGH QUALITY POZZOLAN MINE, YAVAPAI COUNTY, ARIZONA

BLM Hassayampa Field Office Locatable Minerals Program, Phoenix, AZ
Dr. S. Cave. Geologist

April 2018 Draft

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ABSTRACT

This report is an explanation of geochemical assay results released by the Bureau of Land Management (BLM) Hassayampa Field Office Locatable Minerals Program to the Arizona Department of Environmental Quality (ADEQ) Air Quality Division in regards to the Kirkland Mining Company Proposed High-Quality Pozzolan Mine AZA 37212 Mining and Reclamation Plan of Operations (MRPO) submitted under 43 CFR part 3809 to the Hassayampa Field Office, BLM Arizona, in June, 2017. The Kirkland Mining Company (KMC) has proposed a high quality pozzolan mine at a pre-existing mine and quarry site in Kirkland, AZ. The proposed mine would quarry and crush Tertiary-aged rhyolite and rhyodacite volcanic tuffs exhibiting pozzolanic properties to be used as a supplement in commercial concrete production.

The proponent initially contracted multiple instances of geochemical testing of the proposed material to be mined from 2015 to 2017 at accredited laboratories for market viability studies and to test for the possible presence of any airborne carcinogens. These results found no clearly identified airborne carcinogens. However, these results contained proprietary bulk geochemical information related to market viability and are not available for the public to view. The proponent agreed to allow the BLM to take additional independent samples from both the land surface (managed by the BLM) and from drill core samples (collected and owned by the proponent) in order to perform additional spot checks of the proposed material to be mined for possible presence of airborne carcinogens as a baseline study to assist with the National Environmental Policy Act (NEPA) analysis of the proposed MRPO.

The samples were analyzed at the BLM Soils Testing Laboratory in Worland, WY and EMSL Analytical, Inc. The surface samples were collected from the historical pit areas and waste piles. The drill core samples were chosen from drill holes in the proposed 88-acre pit area in the historical mine area and extending to the north and east. These samples were collected from strata that will be mined during the life of the proposed mine. The collection of the drill core samples was observed by a representative from the ADEQ Air Quality Division.

The three known types of airborne carcinogens that could potentially found in this type of deposit based on other localities of similar composition and secondary alteration are asbestos minerals as defined by the EPA, the zeolite mineral erionite when it is in fibrous form, and crystalline silica when it has been ground small enough from crushing, sanding or blasting operations that it can be inhaled. No asbestos minerals or erionite crystals, fibrous or otherwise, were identified. Only rare to trace (less than 5 volume percent) crystalline silica was identified in the form of quartz phenocrysts in some of the tuff units, quartz as a component of trace entrained lithic clasts, and in rare, thin (less than 1 meter) volcanoclastic lenses intercalated between major tuff units that can contain some trace quartz sand. Even though the risk of respirable crystalline silica (RCS) at this proposed operation is lower than at most mining and quarry operations, it is possible to create trace, loftable RCS from the proposed mining and crushing operations. Appropriate, industry standard dust controls will need to be in place by the operator to protect workers and the public, and dust opacity will be actively monitored by the ADEQ.

1.0 Introduction

1.1 Geologic Setting

The proposed Kirkland High Quality Pozzolan Mine is located in the intermontane Skull Valley subbasin within the Transition Zone physiographic province (Trapp and Reynolds, 1995) with the Bradshaw Mountains to the east and Kirkland Peak to the west. The proposed pit area is contained within an approximately 15 million year old rhyolite to rhyodacite welded volcanic lithic tuff deposit (DeWitt, et al., 2008) that is layered and tilted slightly to the northeast. Drill Hole #514426 located approximately one mile northeast of the proposed pit has an apparent thickness of the proposed mine units of approximately 200 feet, underlain by Tertiary basaltic lavas and rhyolitic to andesite tuffs; and overlain by Tertiary basaltic lavas, rhyolitic to andesite tuffs, and Pliocene to Pleistocene sedimentary and volcanoclastic rocks (DeWitt et al., 2008).

1.2 Background

Mining claims were originally located at the mine site in 1896 by C.J. Rynearson. The mine and quarry site has had multiple owners through the decades and has been known as the Arizona Tufa Mine, the Magic Mountain Mine, the Rynearson Quarry, the Kirkland Tuff Quarry, the Maverick Mine, the Kitty Litter Mine and as the Capital Quarry. Building stone was intermittently mined at the location from the late 1800s until the 1960s, with some of the quarried stone used on the facade of the Arizona State Capitol building and to build or accent other buildings in Arizona and California. From 1979 until 1985 the tuff was crushed and sold as an adsorbent for cat litter and oil sweep applications. Kirkland Mining Company subsequently acquired the property and ascertained that the tuff had pozzolanic properties. In 2017 The BLM determined that the pozzolan was of high enough quality to be considered a locatable mineral of uncommon variety under the Common Varieties Act (30 U.S.C. § 611-615) and therefore subject to 43 CFR part 3809 regulations (i.e., the material is of high enough quality to be considered a mine, not a quarry, based on current geological data and market conditions).

2.0 Airborne Carcinogens

Airborne carcinogens are indoor or outdoor air pollution that has been evaluated in bioassays for genetic and carcinogenic effects and determined by the World Health's Organization International Agency for Research on Cancer (IARC) assessment to be potentially carcinogenic. Most dangerous airborne carcinogens are created from combustion (Lewtas, 2002). However, certain physical properties (sharp or elongated, thin minerals) of certain materials may create physical damage in lungs when inhaled that can potentially result in long-term deleterious health effects. Physical disruption of these materials, such as through demolition of buildings containing industrially applied carcinogenic material or mining of naturally occurring carcinogenic material can loft particulates into the air in concentrations or for periods of time that can be potentially harmful.

Air quality regulations include but are not limited to the following: Section 112(d) of the Federal Clean Air Act requires the Environmental Protection Agency (EPA) to regulate certain airborne toxicants. Arizona Environmental Quality Act of 1986 created the Arizona Department of Environmental Quality (ADEQ) which regulates air pollution through the Air Quality Division. Air pollution sources can be indirectly regulated in some circumstances by Federal Clean Water Act if the sources could impair waterways. In some situations there are local county and municipal regulations (for example, air quality is also regulated by Maricopa, Pima, and Pinal Counties in Arizona except for refineries, copper smelters, coal-fired power plants, and Portland cement plants). Occupational exposure is monitored by the Occupational Safety and Health Administration (OSHA) or the Mine Safety and Health Administration (MSHA).

The three most likely types of airborne carcinogens that could potentially found in this type of deposit based on other localities of similar composition and secondary alteration are the six asbestos minerals as defined by the EPA, the zeolite mineral erionite when it is in fibrous form, and crystalline silica when it has been ground small enough from crushing, sanding or blasting operations that it can be inhaled (Cave pers. comm. with EPA, ADEQ, AzGS, and USGS). Asbestos and erionite are secondary minerals and may form in volcanic ash if the deposits are exposed to certain conditions, but are not necessarily a part of any ash fall deposit, even if it may be present in a deposit with similar composition, similar geographic area, etc. Crystalline silica can be genetically a primary component of all rhyolitic to rhyodacite ash fall tuffs at least in trace amounts.

2.1 Respirable crystalline silica

Crystalline silica is a basic component of soil, sand, granite, and many other rock types. Quartz is the most common form of crystalline silica and may become respirable size particles when workers chip, cut, drill, or grind objects that contain crystalline silica. Crystalline silica has been classified as a human lung carcinogen. Additionally, breathing crystalline silica dust can cause silicosis. The respirable silica dust enters the lungs and causes the formation of scar tissue, thus reducing the lungs' ability to take in oxygen (OSHA, 2002). Crystalline silica is listed as a probable human carcinogen (IARC 1997).

Rhyolitic volcanic ash is primarily composed of non-crystalline, or amorphous, silica, not crystalline silica. Amorphous silica is similar to diatomaceous earth and is regulated as a nuisance dust. It is not listed as a carcinogen but the carcinogenity has been currently deemed as indeterminiate because of the difficulties of separating crystalline silica and non-crystalline silica in long-term scientific studies (IARC1997).

2.2 Asbestos

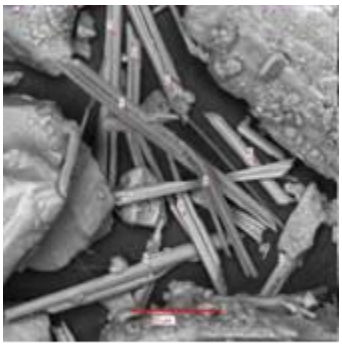
Asbestos refers to a group naturally occurring of silicate minerals that are fibrous in mineral form. They were once used extensively in construction materials because they are resistant to heat, electricity, and chemical corrosions and have good sound proofing capacity. The Asbestos Hazard Emergency Response Act (AHERA) of 1986 regulates

six asbestos specific minerals: chrysotile (white asbestos), amosite (brown asbestos), crocidolite (blue asbestos), anthophyllite, tremolite, and actinolite.

Asbestos has been classified as a known human carcinogen by the U.S. Department of Health and Human Services (HHS), the U.S. Environmental Protection Agency (EPA), and the International Agency for Research on Cancer (IARC) (EPA, 1984, IARC 2012, Agency for Toxic Substance Disease Registry retrieved 2017, National Toxicology Program 2016). According to IARC, there is sufficient evidence that asbestos causes mesothelioma, cancers of the lung, larynx, and ovary (IARC 2012). There is limited evidence that asbestos exposure is linked to increased risks of cancers of the stomach, pharynx, and colorectum (National Cancer Institute Asbestos Fact Sheet).

Asbestos is not a common alteration mineral of volcanic ash, but serpentine has been identified in the Eyjafjallajökull basaltic ash plume in Iceland in 2010 (European Assoc. of Geochemistry Goldscmidt Conference Public Release August 27th, 2013).

2.3 Erionite



Erionite (500X magnification)

Erionite is a naturally occurring zeolite mineral. It can be found in volcanic ash that has been locally altered by weathering and ground water. Erionite can form spheres or more commonly fibrous masses in the hollows of rock formations. Its color varies from white to clear and can have a green, gray or orange tint (mindat, webmineral).

Erionite is not an asbestos mineral. However, like asbestos, erionite may pose health risks to those who breathe in the fiberous form. It is classified as a known carcinogen. It appears to be associated with increased risks of fibrogenic lung disease, lung cancer and mesothelioma. Although toxic effects were documented in a study of three small villages in the Cappadocia Turkey in the 1970s, historically there have been few studies of erionite in the United States (North Dakota Department of Health Fact Sheet). Natural deposits of erionite, including fibrous forms, have been identified in the past in the western United States. Until recently, these occurrences were focused on the potential economic value and have generally been overlooked the potential hazard. In the last several years, concerns have emerged regarding the potential for environmental and occupational exposures to erionite in the United States, such as erionite-bearing gravels in western North Dakota mined and used to surface unpaved roads. As a result, there has been an increased interest in identifying locations and geologic environments across the United States where erionite occurs naturally (Van Gosen et al, 2013).

Erionite deposits in Arizona

Sheppard (1996) lists seven erionite localities in a northwest trending belt across the Transition Zone of Arizona, all in volcanic tuffs. Most are volcanic ash and pumice airfall associated with lacustrine deposits (i.e., the ash fall may have fallen onto a pre-

existing lake). This list also includes the Peeples Valley erionite-type zeolite alteration locality reported here, originally identified in Eyde and Irvin (1979).

3.0 Sample Collection Techniques

The proponent initially contracted multiple instances of geochemical testing of the proposed material to be mined from 2015 to 2017 at accredited laboratories for market viability studies and to test for the possible presence of any airborne carcinogens. These results found no clearly identified airborne carcinogens. However, these results contained proprietary bulk geochemical information related to market viability and are not available for public view. The proponent agreed to allow the BLM to take additional independent samples from both the land surface (managed by the BLM) and from drill core samples (collected and owned by the proponent) in order to perform additional spot checks of the proposed material to be mined for possible presence of airborne carcinogens to be reported in a baseline study to assist with the National Environmental Policy Act (NEPA) analysis of the proposed MRPO. The samples were analyzed at the BLM Soils Testing Laboratory in Worland, WY and to EMSL Analytical, Inc. The surface samples were collected from the historical adsorbent mine pit areas and waste piles. The drill core samples were chosen from drill holes in the proposed 88-acre pit area in extending to the north and east the historical mine area. These samples were collected from strata that will be mined during the life of the proposed mine. The collection of the drill core samples was observed by a representative from the ADEQ Air Quality Division. Appropriate chain of custody protocols were followed.

4.0 Geochemical Analysis Techniques

Please See Appendix A and B for in depth description of geochemical analysis techniques. X-ray diffraction (XRD) coupled with scanning electron microscope (SEM) was chosen as the analytical method over transmission electron microscopy (TEM). Transmission electron microscopy is very exact and can reveal if a specific needle-like crystal also has a specific composition. XRD can give a bulk composition spectrum that can detect the presence of erionite. Samples that are positive are then viewed with the SEM to see if there are fibrous or needle-like crystals present. It does not definitively reveal if those exact crystals are actually of erionite composition. If the spectrum revealed erionite present and the SEM revealed fibrous minerals present, that was considered a positive result for the presence of erionite for the purposes of this study. XRD/SEM is also more cost effective and allowed for more samples to be tested within budgetary restrictions. For certain scientific and regulatory applications TEM would be more appropriate to reduce the risk of false positive results. Asbestos testing was completed using the standard EPA Method 600.

5.0 Results

No asbestos minerals or erionite crystals, fibrous or otherwise, were identified (please see Appendix A, Appendix B). The geochemical tests do not distinguish

crystalline verses non-crystalline silica dioxide. However, inspection of field lithologic units and hand samples reveal only rare to trace (less than 5 volume percent) crystalline silica in the form of quartz phenocrysts in some of the tuff units, quartz as a component of trace entrained lithic clasts, and in rare, thin (less than 1 meter) volcanoclastic lenses intercalated between major tuff units that can contain some trace quartz sand. This is consistent with the unit descriptions of Dewitt et al., 2008.

Sheppard (1996) and Eyde and Irvin (1979) reported an erionite locality approximately seven miles from the proposed Kirkland Mine in a similar, but different, lithologic unit. One sample was collected from this site and also submitted. Results show that this site is strongly zeolite altered and the primary alteration type is erionite (please see Appendix A).

6.0 Recommendations

Even though the risk of respirable crystalline silica (RCS) at this proposed operation is significantly lower than at most mining and quarry operations, it is possible to create trace, loftable RCS from the proposed mining and crushing operations. Appropriate, industry standard dust controls will need to be in place by the operator to protect workers and the public from this minor risk, and dust opacity will be actively monitored by the ADEQ.

Multiple erionite-type zeolite alteration localities have been identified in Arizona. More work should be done geologically mapping this alteration type by state and federal geological surveys, particularly in the ubiquitous Tertiary rhyolite ash deposits found throughout the state. Road and building construction, mining, and quarrying industries in Arizona have potential to encounter erionite in naturally occurring settings. Broader implications of the hazards of erionite exposure in earth-moving activities or the use of erionite-contaminated products should be investigated and addressed in state and federal level air quality and occupational safety regulations.

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National Toxicology Program. Asbestos. In: *Report on Carcinogens. Fourteenth Edition.* U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, 2016.

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OSHA, 2002, Crystalline Silica Exposure Health Hazard Information, Occupational Safety and Health Administration U.S, Department of Labor informational fact sheet, 2 p. https://www.osha.gov/dsg/topics/silicacrystalline/

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Webmineral.com erionite online database entry http://webmineral.com/data/Erionite-Na.shtml#.WsQX4-jwaUk

Appendix A: Surface Sample Geochemical Assay Results Within Proposed Operation in Kirkland, AZ AND Sample Geochemical Assay Results Outside of Proposed Operation in Peeples Valley, AZ (Sample #8)

Samples submitted from Kirkland AZ area for erionite and asbestos mineral (EPA Method 600) testing from BLM Phoenix District Office

Contact:

Dr. Shelby Cave
Geologist | Hassayampa Field Office
Phoenix District | Bureau of Land Management
[office] 623.580.5639
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scave@blm.gov

Sample ID	Northing	Easting	Comment
BLM-PDO-SC-001	34.43599	-112.68860	Kirkland Quarry lithic rhyolite tuff, in entry pit, base of unit
BLM-PDO-SC-002	34.43617	-112.68837	Kirkland Quarry lithic rhyolite tuff in entry pit, mid-unit
BLM-PDO-SC-003	*34.43608*	*-112.68867*	*Bulk- screened Kirkland Quarry lithic rhyolite tuff and volcanoclastic material mix*
BLM-PDO-SC-004	34.43584	-112.68862	Kirkland Quarry rhyolite surge deposit at base of previous tuff
BLM-PDO-SC-005	34.43584	-112.68862	Kirkland Quarry volcanoclastic deposit underneath previous tuff
BLM-PDO-SC-006	*34.43533*	*-112.68866*	*Bulk- screened Kirkland Quarry lithic rhyolite tuff and volcanoclastic material mix*
BLM-PDO-SC-007	34.43530	-112.68768	Kirkland Quarry lithic rhyolite tuff- top of unit, on access road above entry pit
BLM-PDO-SC-008	34.32186	-112.69898	Hwy 89 roadcut, f-gr laminated rhyolite tuff, less lithics, more chalcedony, previously reported erionite locality

Italicized locations are bulk samples.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
National Minerals Testing Laboratory
C/O Wind River/Bighorn Basin District
101 S. 23rd Street
Worland, Wyoming 82401

TAKE PRIDE IN AMERICA

APR 28 2017

To: Shelby Cave, Hassayampa Field Office

From: Brent S. Bestram and Marilyn Wegweiser

Subject: X-ray Diffraction and Scanning Electron Microscope Test Results

X-ray diffraction (XRD) and a scanning electron microscope (SEM) were used to determine the mineralogical composition of eight samples with an emphasis being placed on the identification of erionite. Seven of the samples came from the Kirkland Quarry and one from a Highway 89 road cut according to information submitted with the samples. X-ray diffraction was accomplished by using a Rigaku Miniflex 600 diffractometer fitted with a copper tube. A Tescan VEGA 3 LMU scanning electron microscope was used to image the samples and look for erionite.

About 1 gram of sample is ground up in a sapphire-diamonite mortar and pestle until it has the consistency of talc. It is then packed into an aluminum sample holder and placed on the diffractometer for analysis. About 0.70 grams is needed to pack the sample holder. The parameters for the samples run are shown at the top of each scan. As seen on Scan-1 the first item given is the sample number, *PDO-SC-001*, followed by a note *KQ-sfc tuff base of unit.* Given parameters for the samples run are *3.0/56.0/0.02/2(sec), Cu(40kV,15mA, I(p)=2502*, date tested and time that the scan was finished. The sample range was run from 3° to 56° Two-Theta (2θ). Scanning took place at step of 0.02° with a dwell of 2 seconds. In other words, the sample was rotated 0.02 hundredths of a degree every 2 seconds. Cu means the diffractometer is fitted with a copper tube and operates on the voltages and amps indicated. The I(p)=2502 denotes the highest intensity peak on the scan. The date tested and scan time completion are the last two items shown. The peak line marker with the little circle on top indicates the highest intensity peak or 100% reflection for the minerals identified.

The primary mineral phases common to samples PDO-SC-001 through 007 (XRD Scans1-7) are quartz, the feldspar group (includes the plagioclases) and clay from the smectite family that is predominately montmorillonite. A secondary mineral phase present in Scans 1-7 is a mica group mineral to which no specific mineral could be named with any degree of certainty. This is possibly due to the many polymorphs in which the mica clay minerals can occur. Specific minerals within the feldspar group are difficult to identify even if they occur in significant amounts due to their triclinic or monoclinic symmetry or a mixture of the two. Furthermore, the fact that they form solid solution series and can have numerous substitutions within the crystal lattice generates complex diffraction patterns. The blue line marker on Scans 1-7 designates where erionite peaks would occur if present in the sample. No erionite occurs in Scans 1-7.

In Scans 1, 2, 4, and 6, three peaks were identified as being consistent cristobalite. Although it would not be unreasonable to expect cristobalite occurrence in a tuff, the three peak hits are not conclusive as to its presence. A zeolite, known as chabazite, was definitely identified on Scan-6 in sample PDO-SC-006. Sufficient hits identified the feldspar group mineral albite on Scan-7 in sample PDO-SC-007. Returning to Scan-1, there is a broad bulge, if one ignores the sharp peaks, starting at about 18° 2θ and ending at about 29° 2θ. This is indicative of an amorphous substance that in this case is probably volcanic glass.

Scans 1A, 2A and 4A-7A definitely show the presence of an expandable clay of the smectite family. The smectites have a strong affinity for ethylene glycol (EG) which is adsorbed by the clay at the (001) face in the interlayer position causing a fixed expansion of the unit cell in the c-axis direction. Numbers shown in parentheses on the previously mentioned scans are Miller Indices that define the orientation of a crystal face or an internal crystal plane. Each of the "A" designated samples were placed in a desiccator containing an EG atmosphere for a minimum of 24 hours and x-rayed again. In each of the scans mentioned above, the air-dried sample was enhanced by the EG and moved to the left by expansion of the (001) face. As an example, Scan-1 is the air-dried sample and Scan-1A is the EG sample. In comparing the air dried sample to the glycolated sample, it is seen that the (001) reflection has increased from 15.02 Å to 17.38 Å. The d-spacing given in angstroms (Å) is equal to 10^{-8} centimeters and is a measurement between atoms or planes of atoms. Conversely, the 2θ angle decreased from 5.880° to 5.079°.

Scan-8, which is the highway 89 road cut, is straightforward. Three mineral phases are contained in sample PDO-SC-008, clinoptilolite, erionite and quartz. A secondary mineral phase is a mica group mineral but cannot be confirmed. Scan-9 is a compilation of scans 001-007 for easy comparison. A different perspective for comparing the seven scans is provided by the two enclosed 3D scans labeled as Scans 10 and 11. All of the 3D patterns shown on both scans have had the background noise removed.

Summarizing, samples 001-007 contained no erionite using x-ray diffraction. However, SEM imaging by Marilyn Wegweiser indicated a small amount of erionite in sample PDO-SC-005 at less than 2%. Considering only 0.7 grams of sample is used for x-ray diffraction, it is quite possible the sample did not contain any erionite or there was too little for the diffractometer to recognize. Marilyn's discussion on the results of the SEM imaging are attached.

If you have any questions regarding the test results, please give Marilyn Wegweiser or me a call at the laboratory, (307) 347-4135.

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Wyoming State Office
Former CME #047 & CRME #025
WY PG-2752

PROFESSIONAL GEOLOGIST
BRENT STEVEN BESTRAM
PG-2752
WYOMING

Enclosures
11 – XRD Scans
13 – SEM Images

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
National Minerals Testing Laboratory
C/O Wind River/Bighorn Basin District
101 S. 23rd. Street
Worland, Wyoming 82401

TAKE PRIDE IN AMERICA

MAY 02 2017

To: Shelby Cave, Hassayampa Field Office

From: Brent S. Bestram

Subject: Asbestos Omission

The test results recently sent to you and dated April 28, 2017, unfortunately did not mention anything about asbestos. Judging from the literature at hand, it is my opinion that the name asbestos is a generic or nonprofessionals' term for a fibrous substance. Older names for asbestos are serpentine and chrysotile. Dana's New Mineralogy, 8th Edition (1997), identifies asbestos as clinochrysotile and provides a x-ray diffraction card numbered 00-022-1163. The JADE-9 x-ray diffraction software does not recognize asbestos as a mineral but does recognize the card number and brings up magnesium silicate hydroxide that is clinochrysotile.

The attached x-ray diffraction pattern compares clinochrysotile with sample PDO-SC-001. There is no match whatsoever. None of the eight samples you sent for analysis contains clinochrysotile.

If you have any questions regarding the above, please give me a call at the lab, (307) 347-4135.

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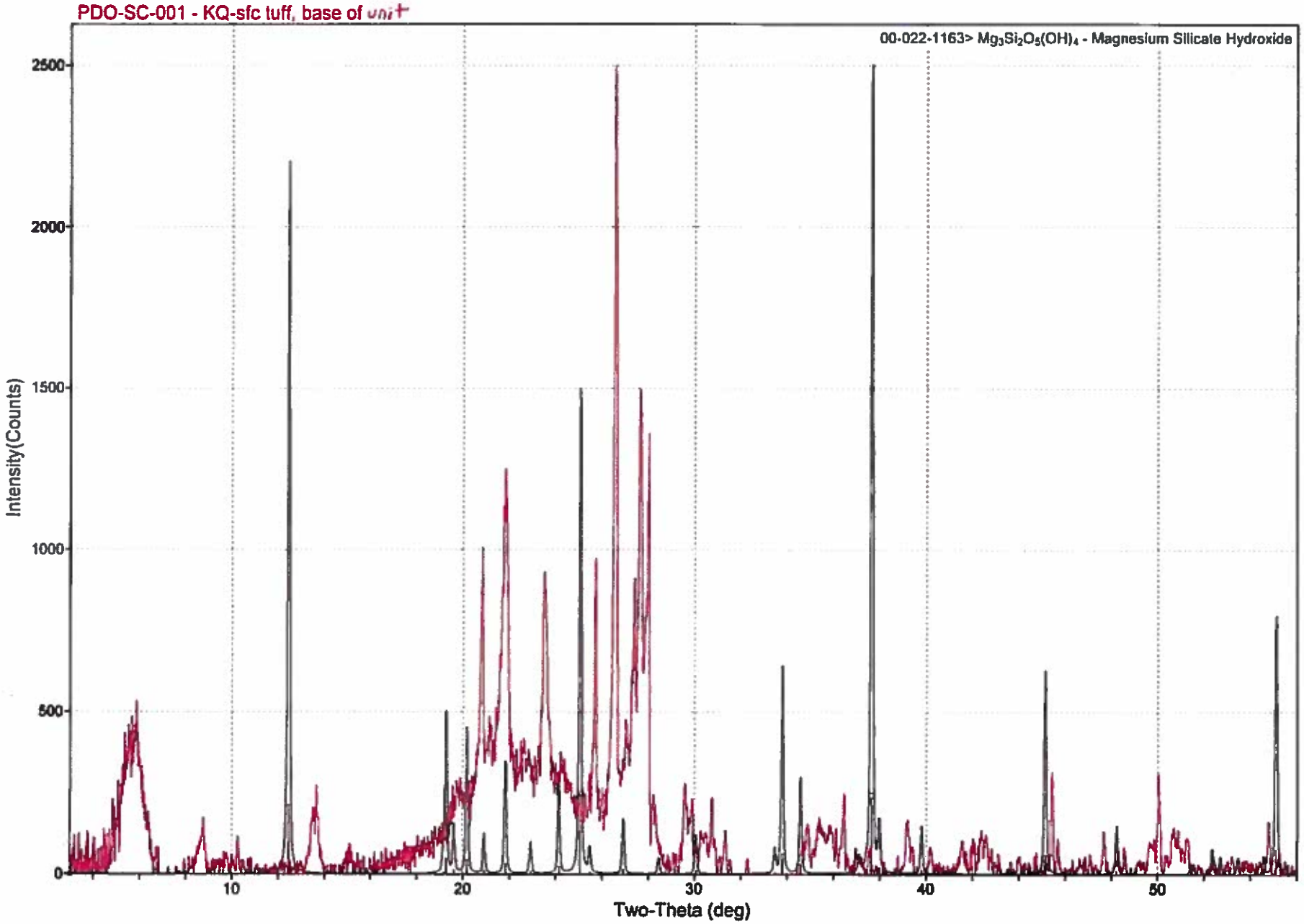
Reference

Gaines, Richard V., Skinner, Catherine W., Foord, Eugene E., Mason, Brian and Rosenzweig, Abraham, 1997, Dana's New Mineralogy, 8th ed: John Wiley & Sons, Inc., pp.1428-1430.

Enclosure
1-XRD Scan



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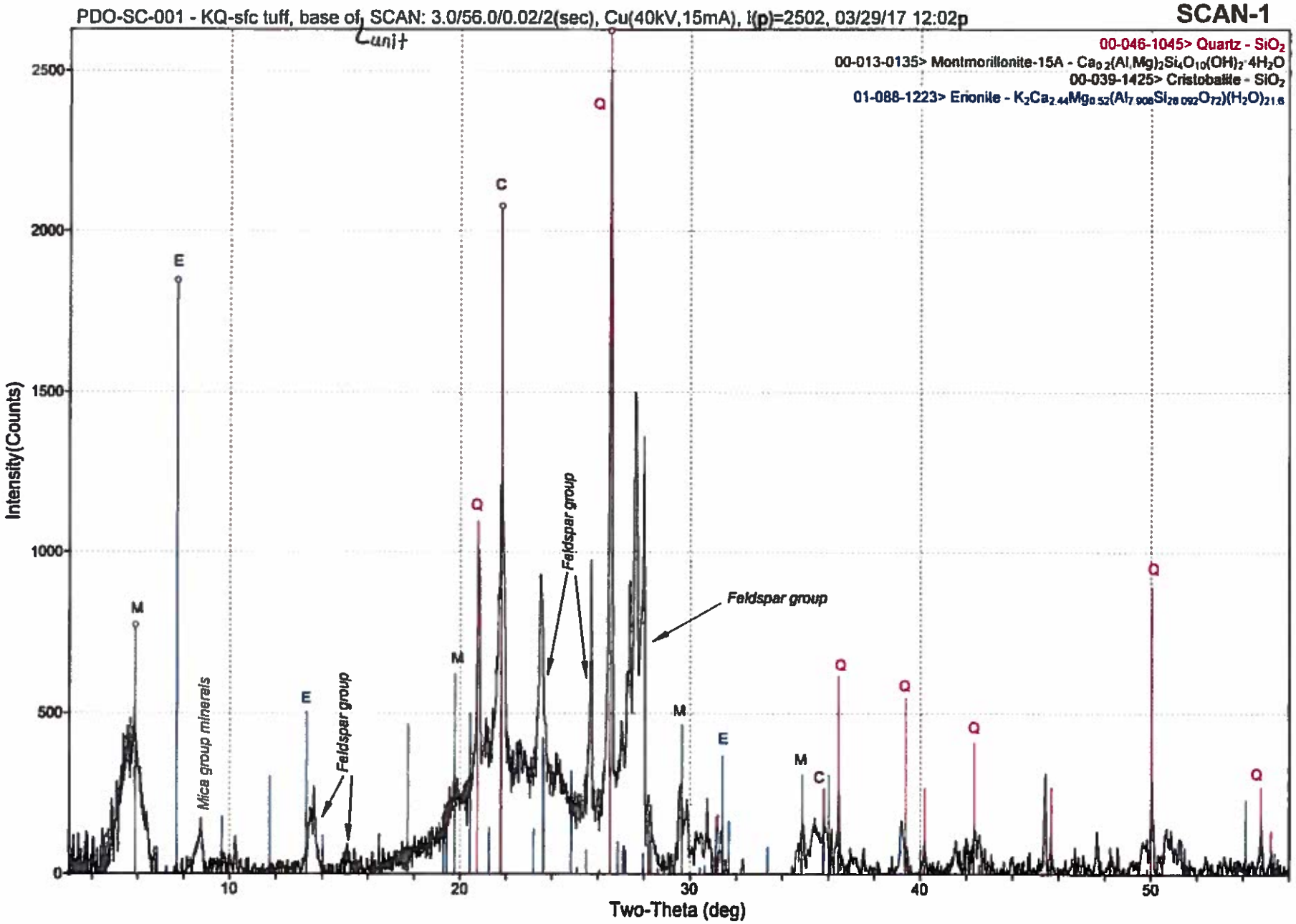

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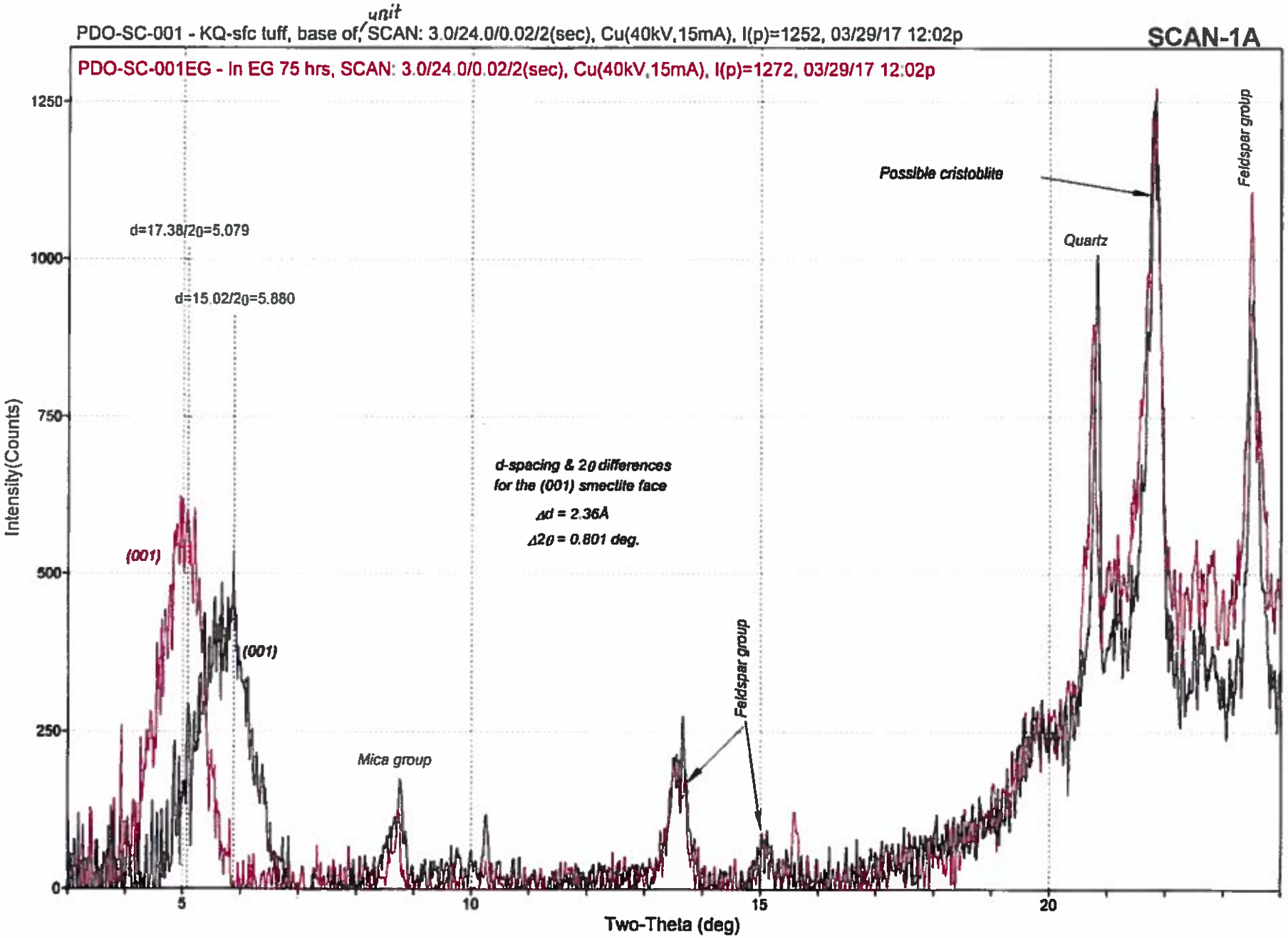

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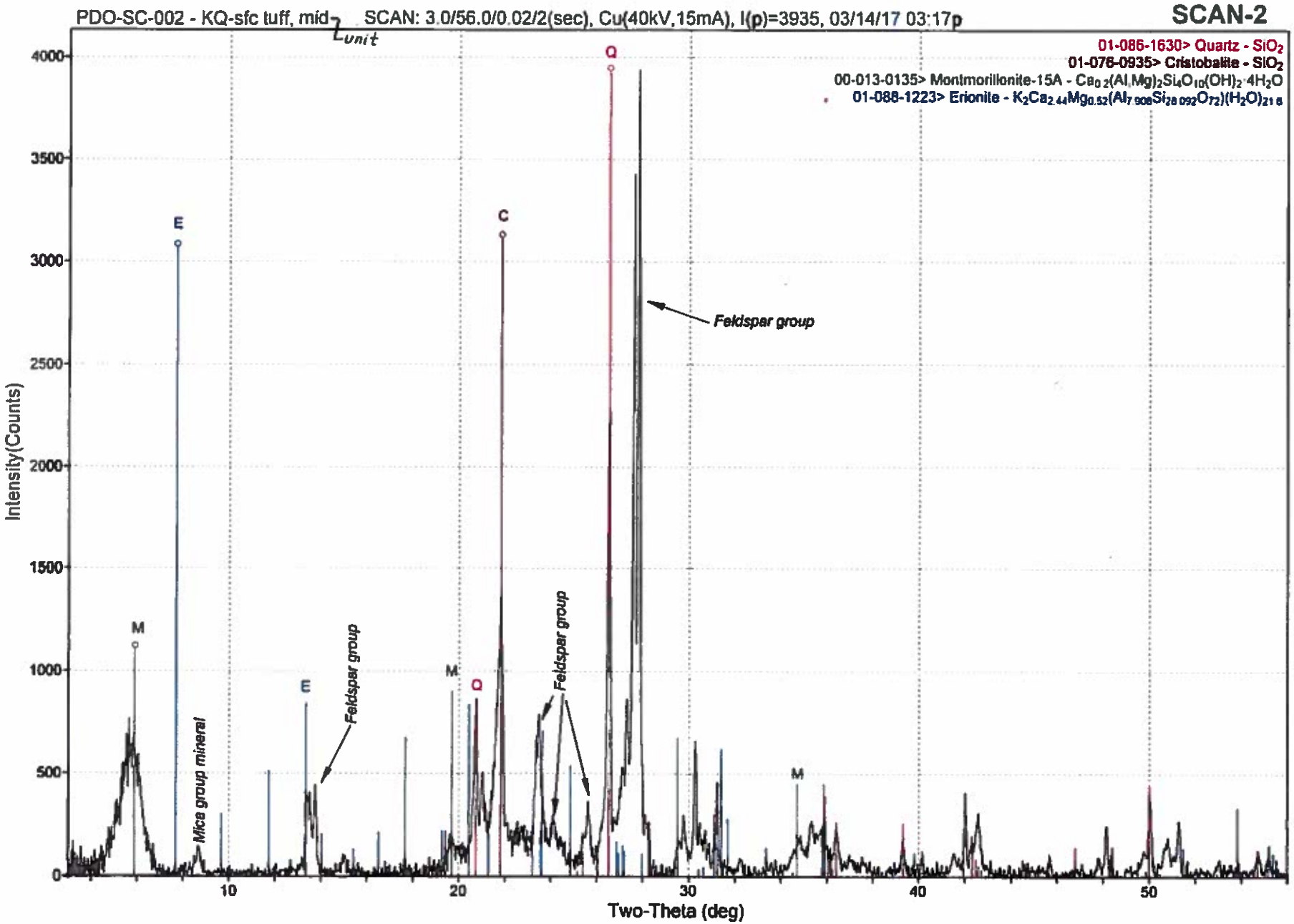

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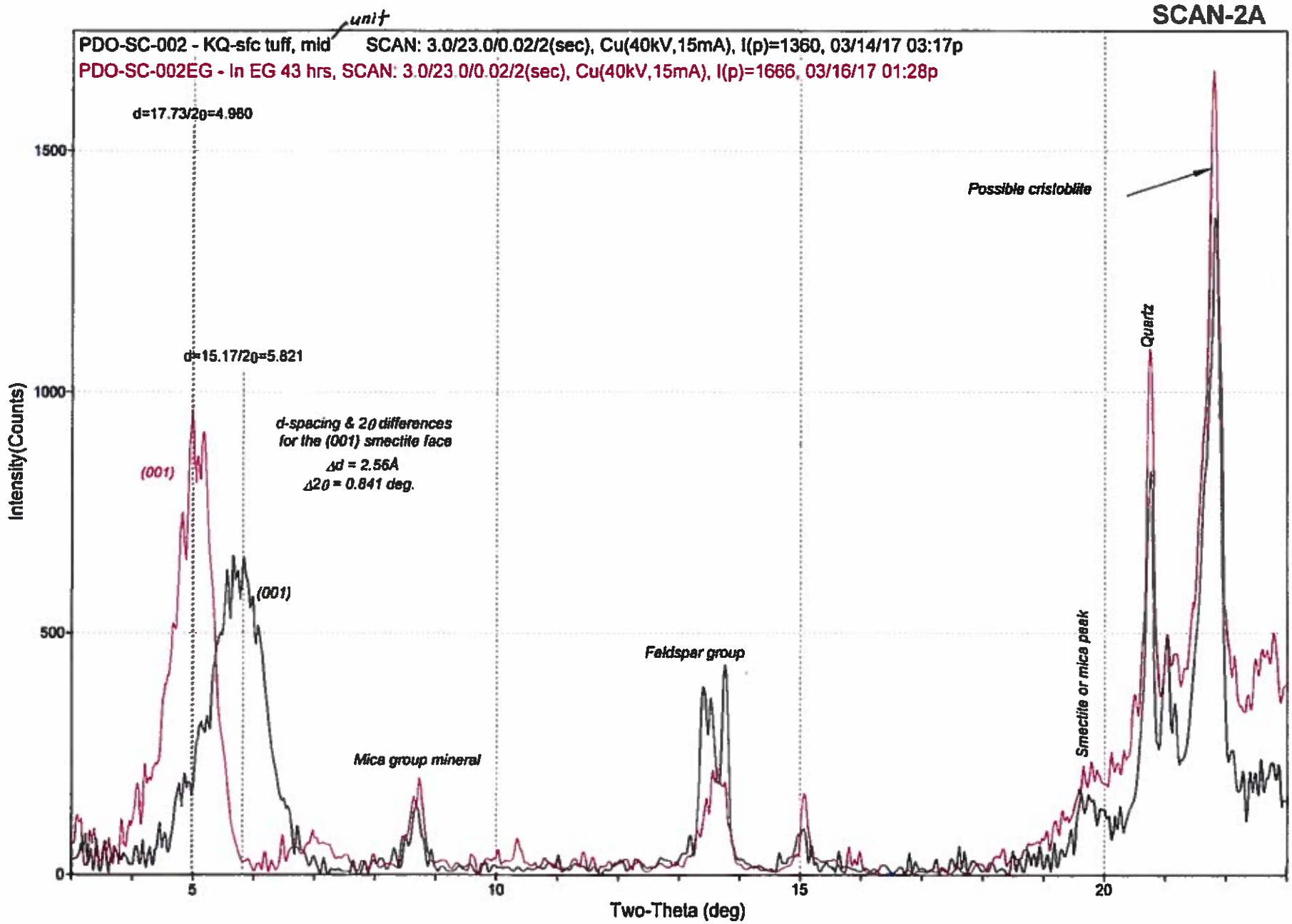

BLM

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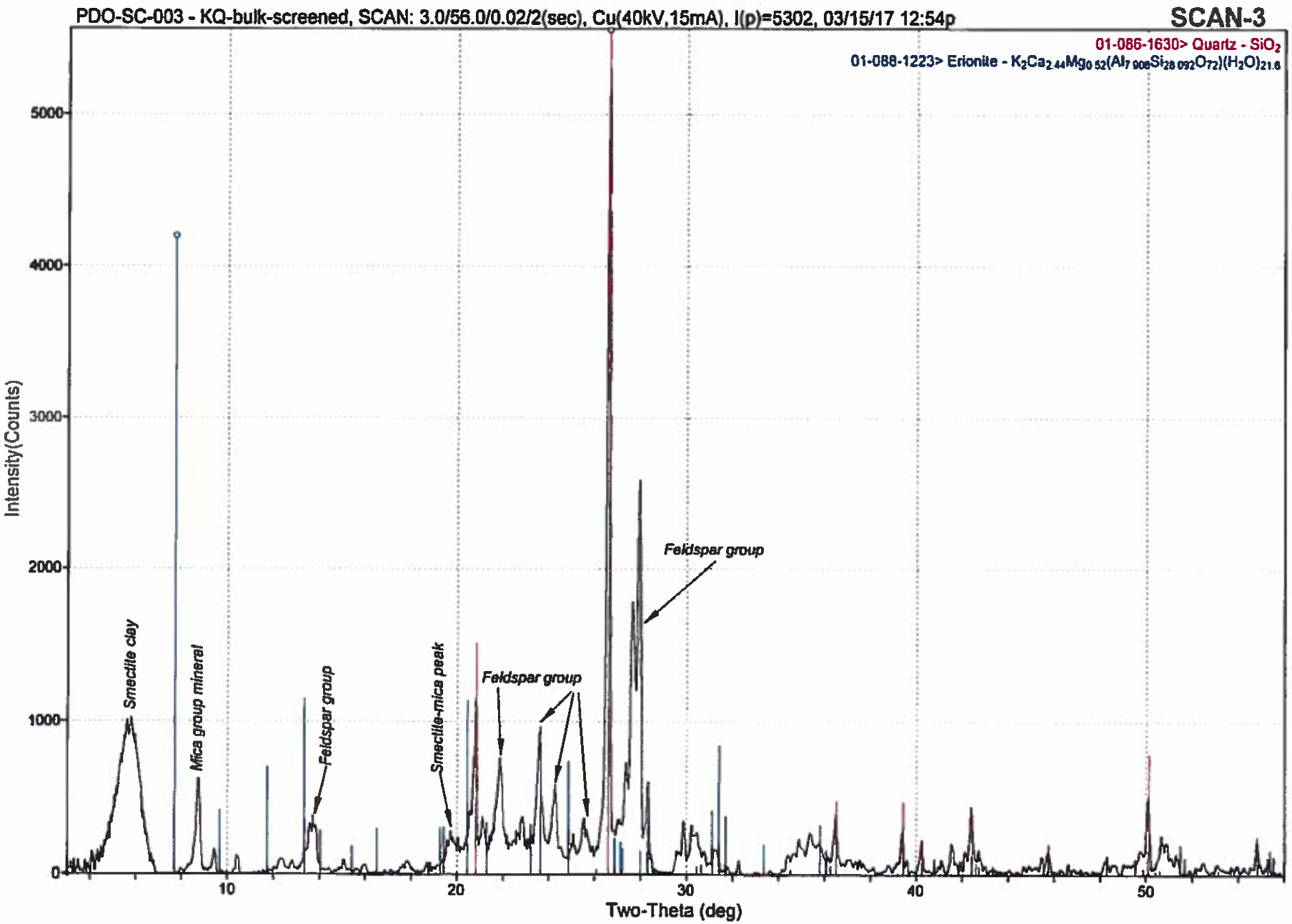

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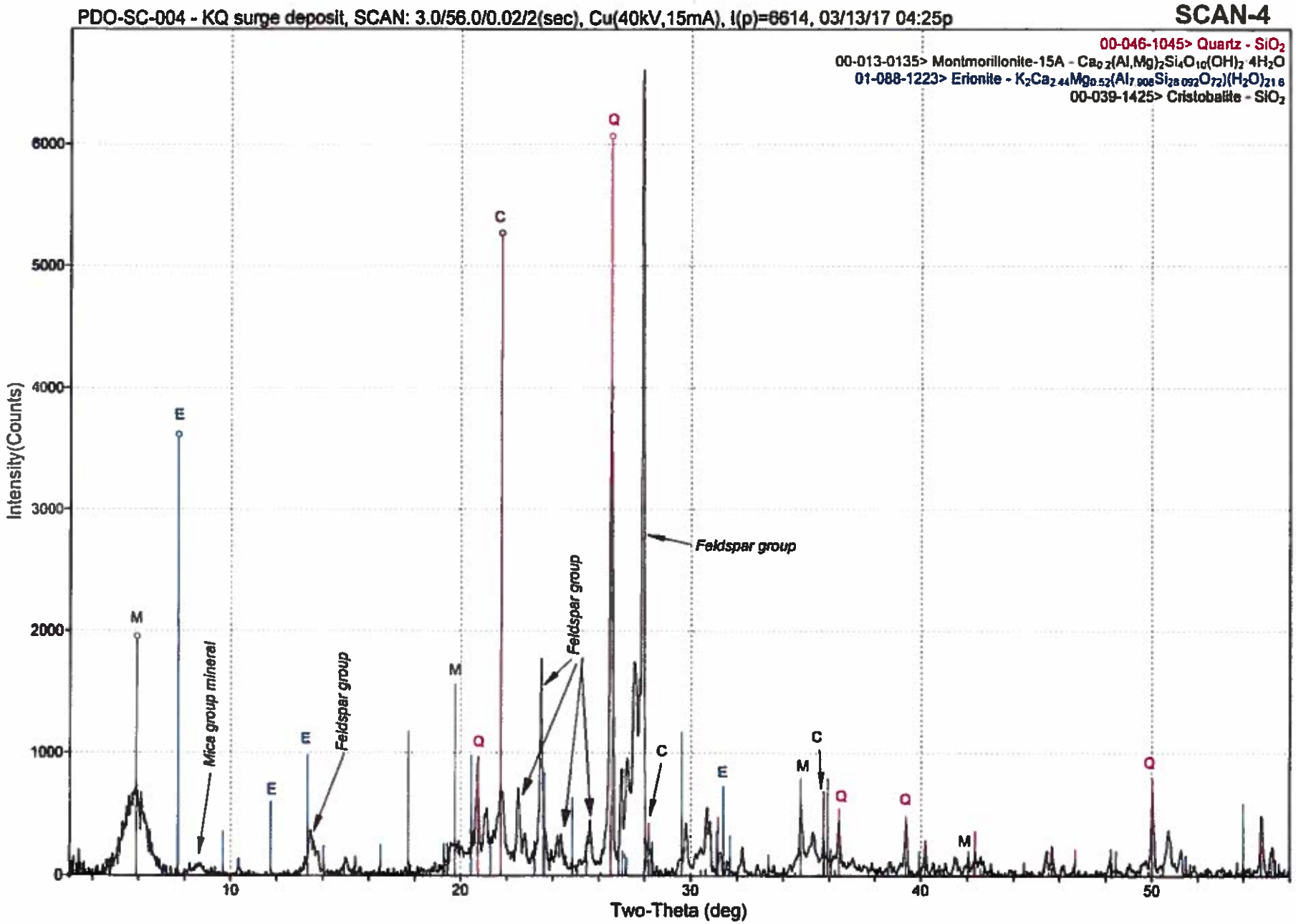

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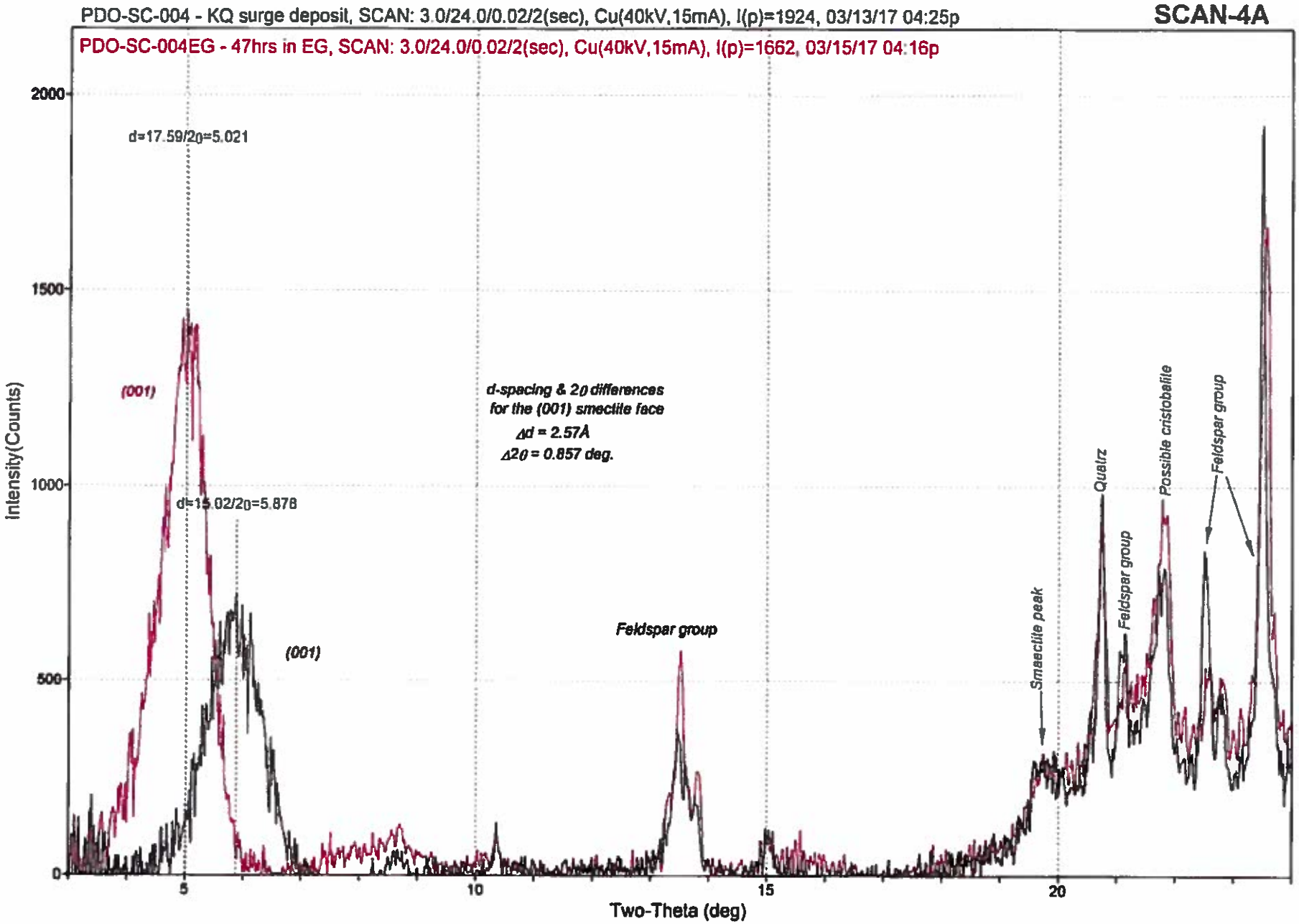

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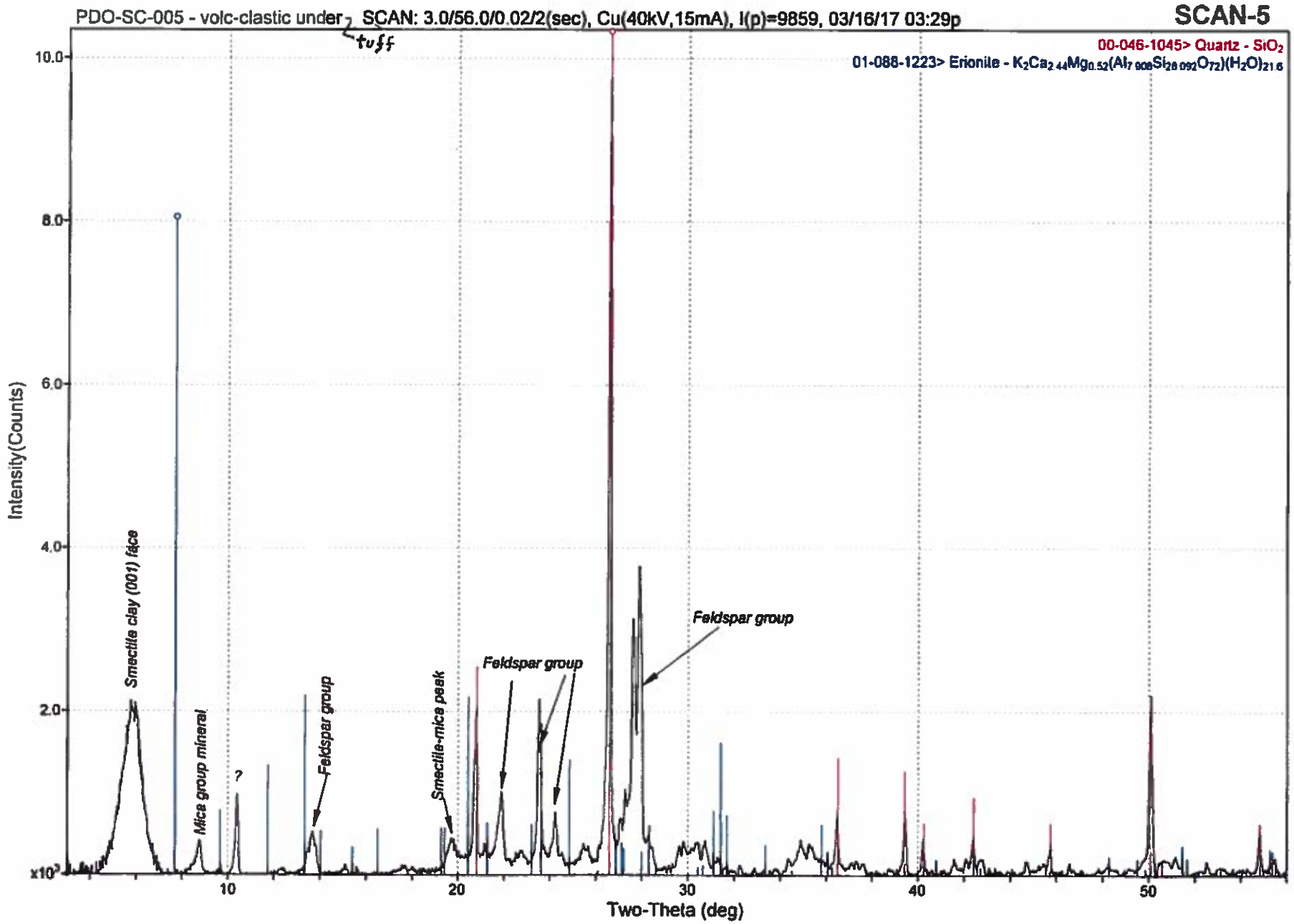

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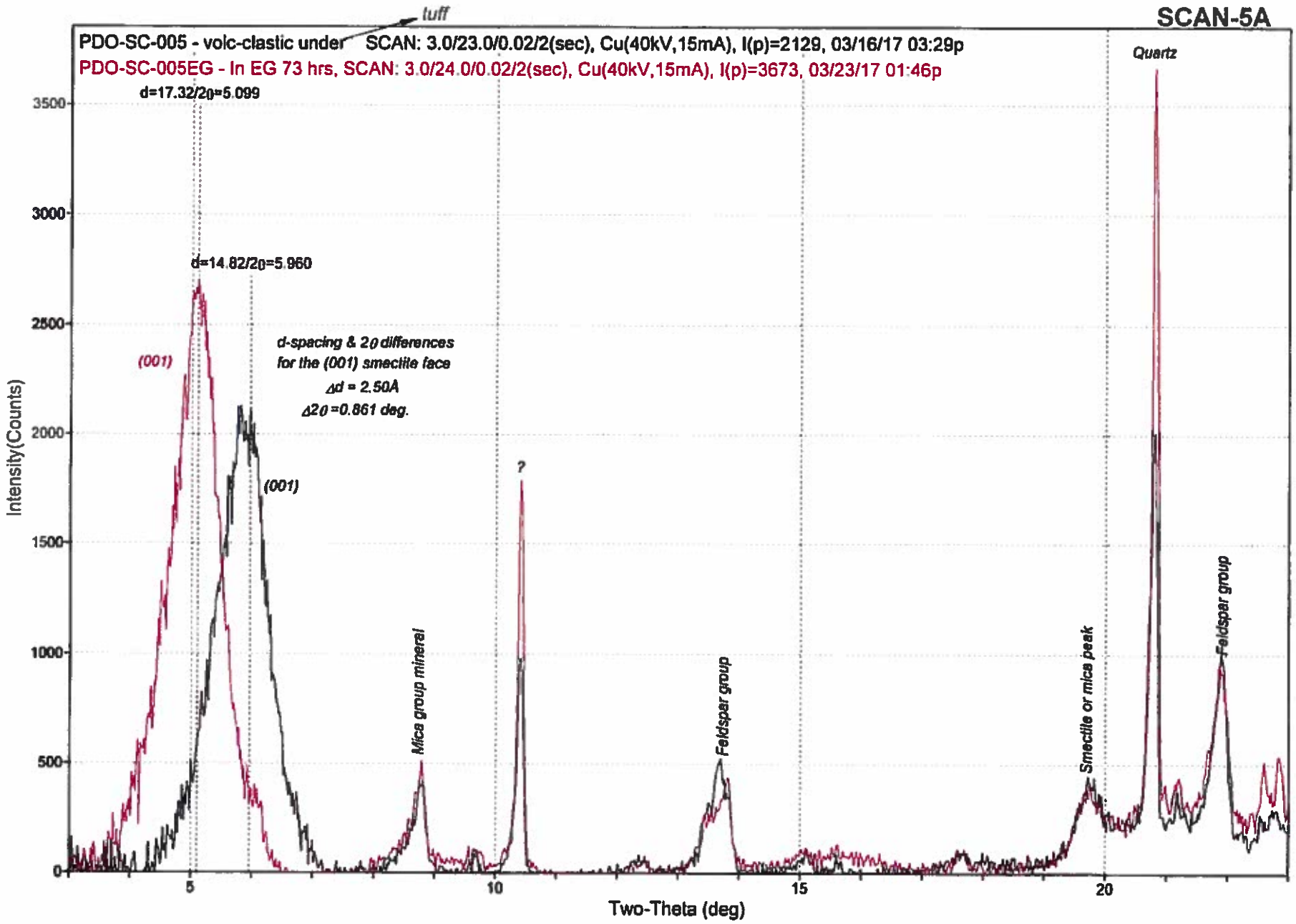

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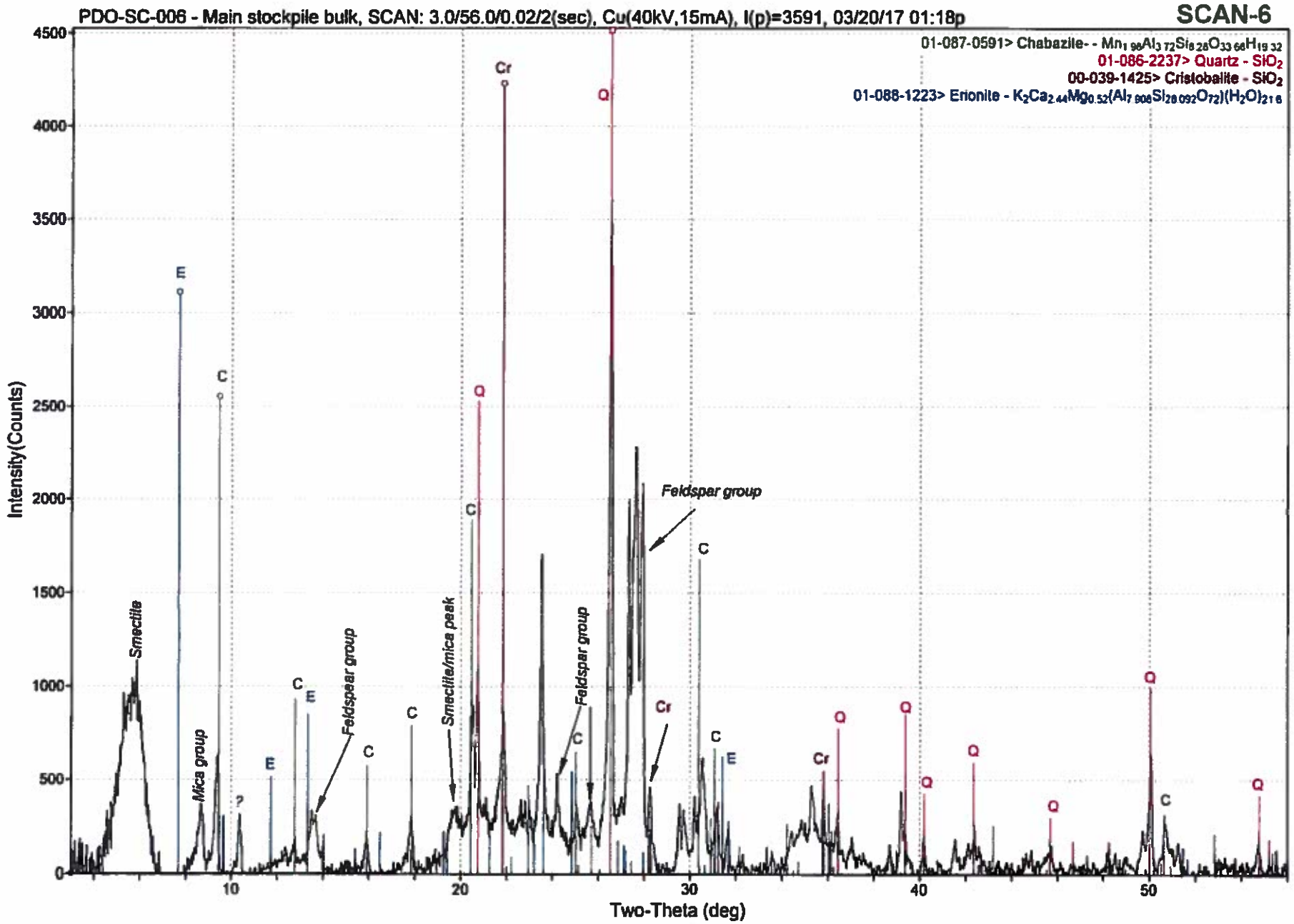

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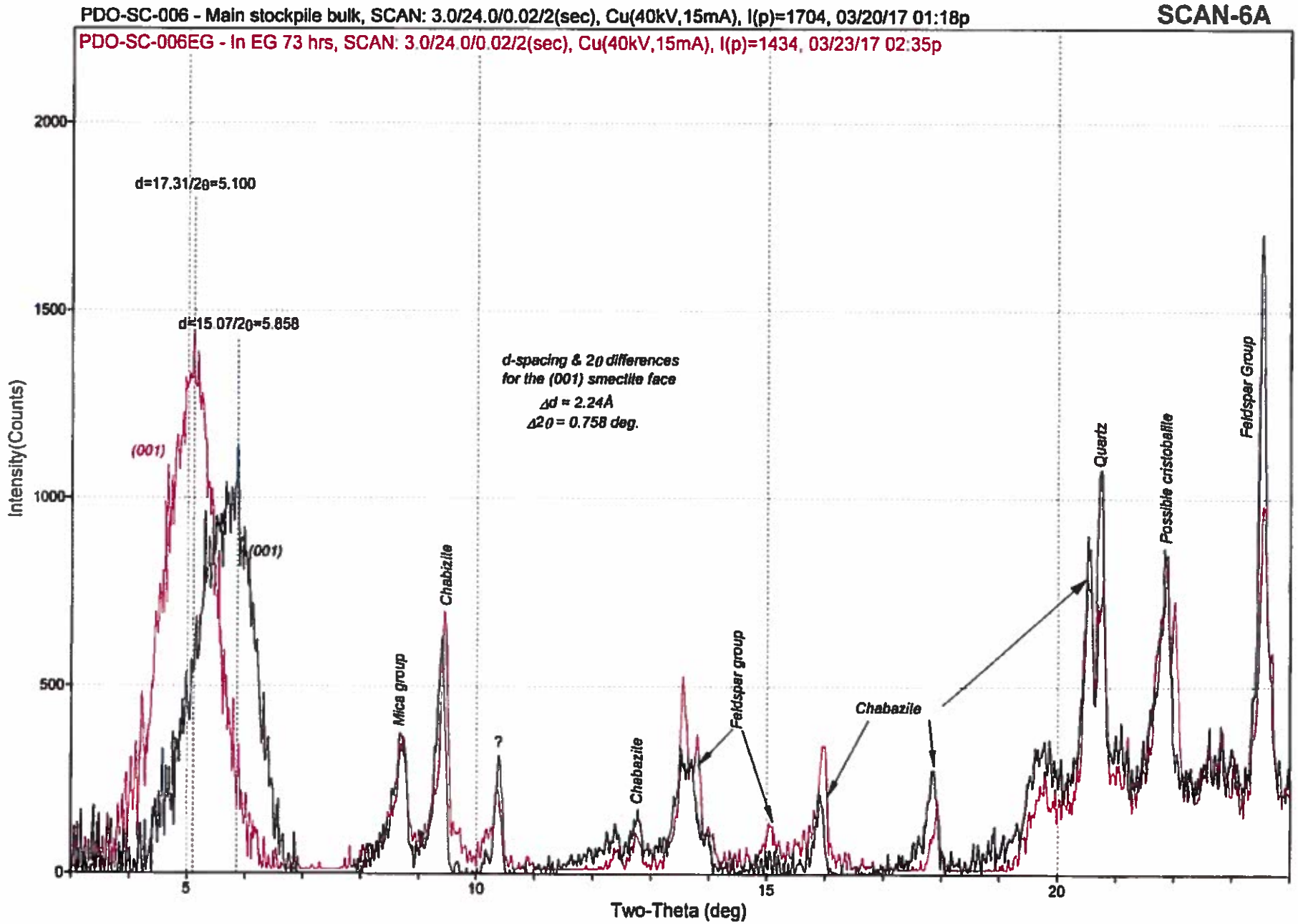
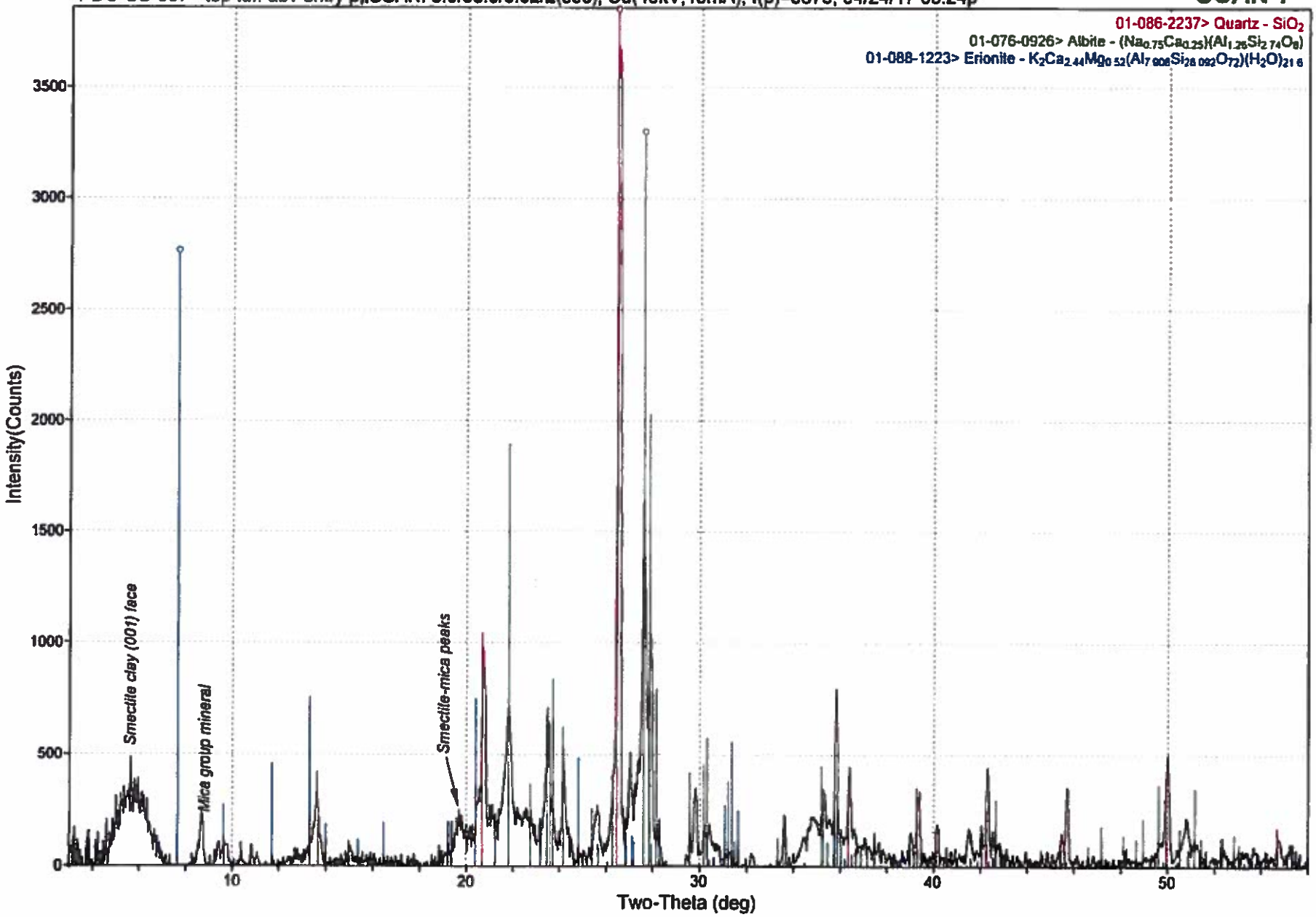


BLM

[MINIFLEX]Administrator]<c:\Windmax\Data\2016\SCave> Friday, April 21, 2017 02:16p (MDI/JADE9)

PDO-SC-007 - top tuff abv entry pitSCAN: 3.0/56.0/0.02/2(sec), Cu(40kV,15mA), I(p)=3673, 04/24/17 03:24p

SCAN-7



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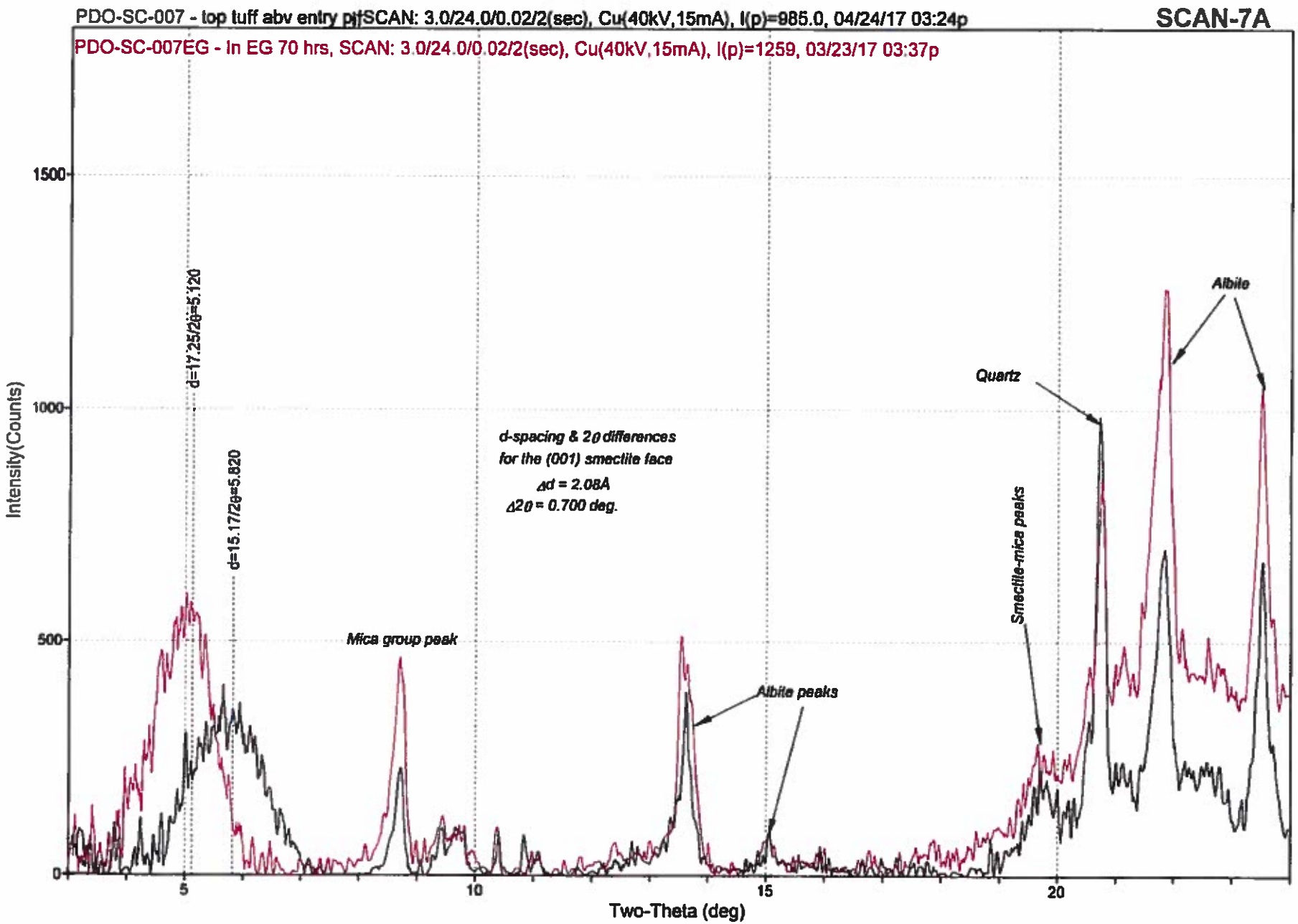

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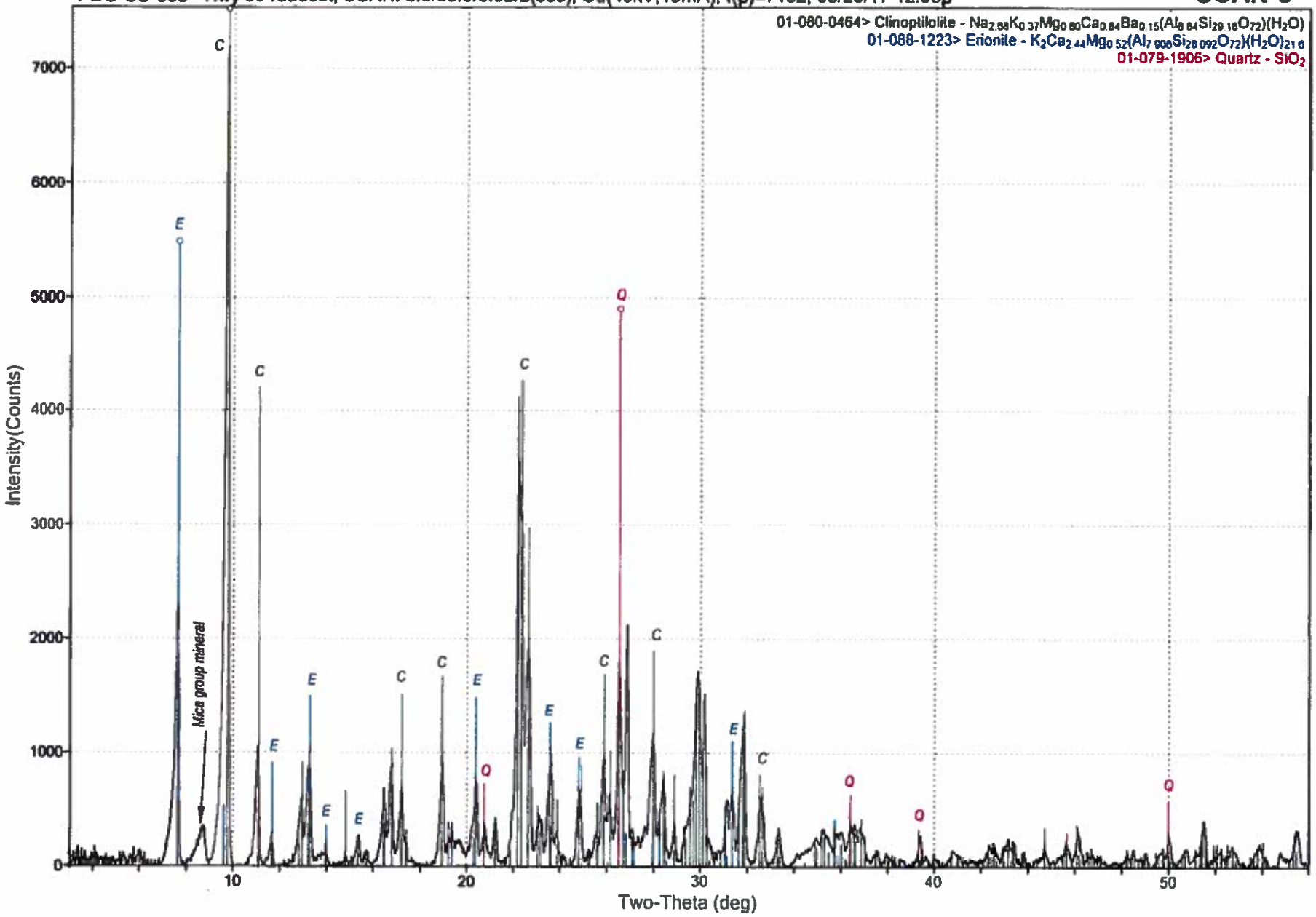
[MINIFLEX]Administrator]<c:\Windmax\Data\2016\SCave> Tuesday, April 25, 2017 04:17p (MDI/JADE9)

PDO-SC-008 - Hwy 89 roadcut, SCAN: 3.0/56.0/0.02/2(sec), Cu(40kV,15mA), I(p)=7182, 03/23/17 12:53p

SCAN-8



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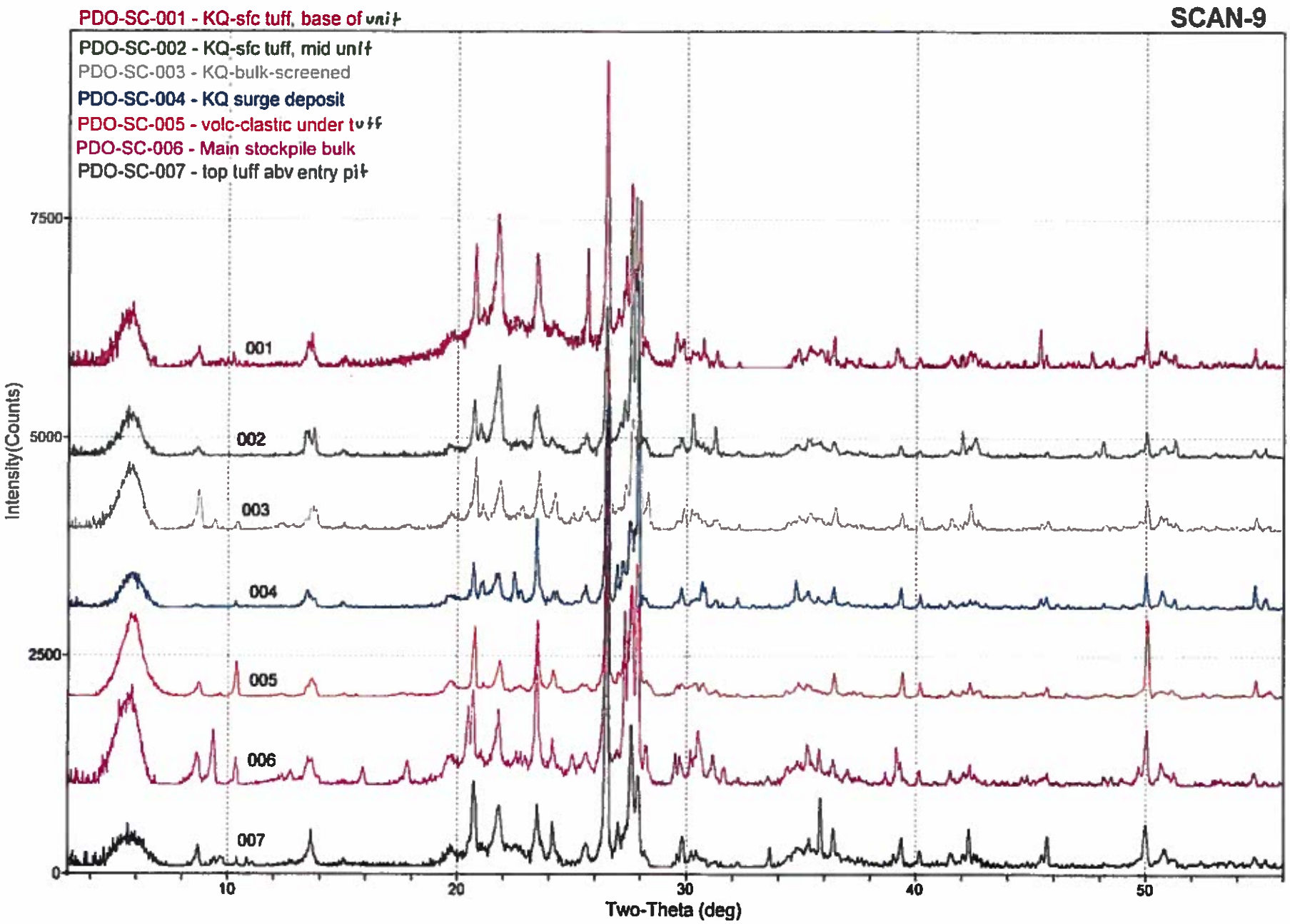
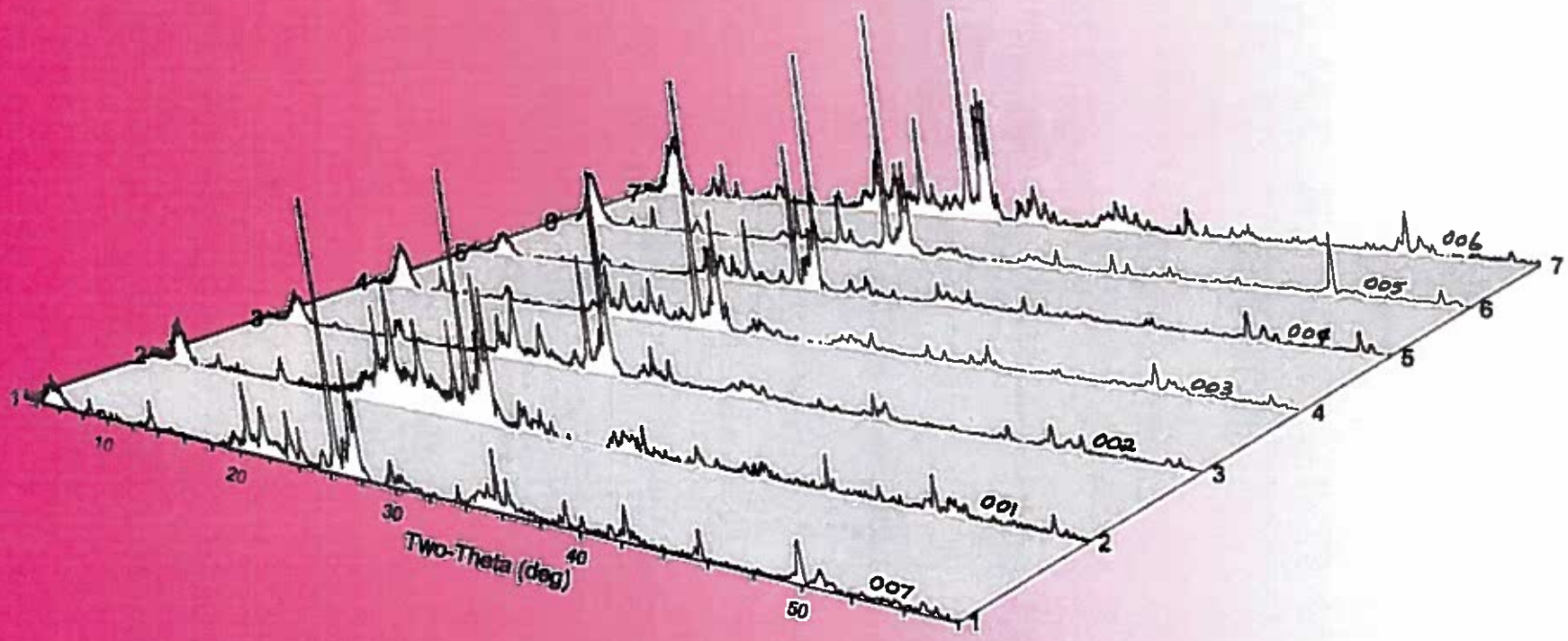


BLM

[MINIFLEX(Administrator)<c:\Windmax\Data\2016\SCave> Wednesday, April 26, 2017 12:03p (MD#JADE9)

SCAN-10

(7) PDO-SC-006 - Main stockpile bulk
(6) PDO-SC-005 - volc-clastic under tuff
(5) PDO-SC-004 - KQ surge deposit
(4) PDO-SC-003 - KQ-bulk-screened
(3) PDO-SC-002 - KQ-sfc tuff, mid unit
(2) PDO-SC-001 - KQ-sfc tuff, base of unit
(1) PDO-SC-007 - top tuff abv entry pit

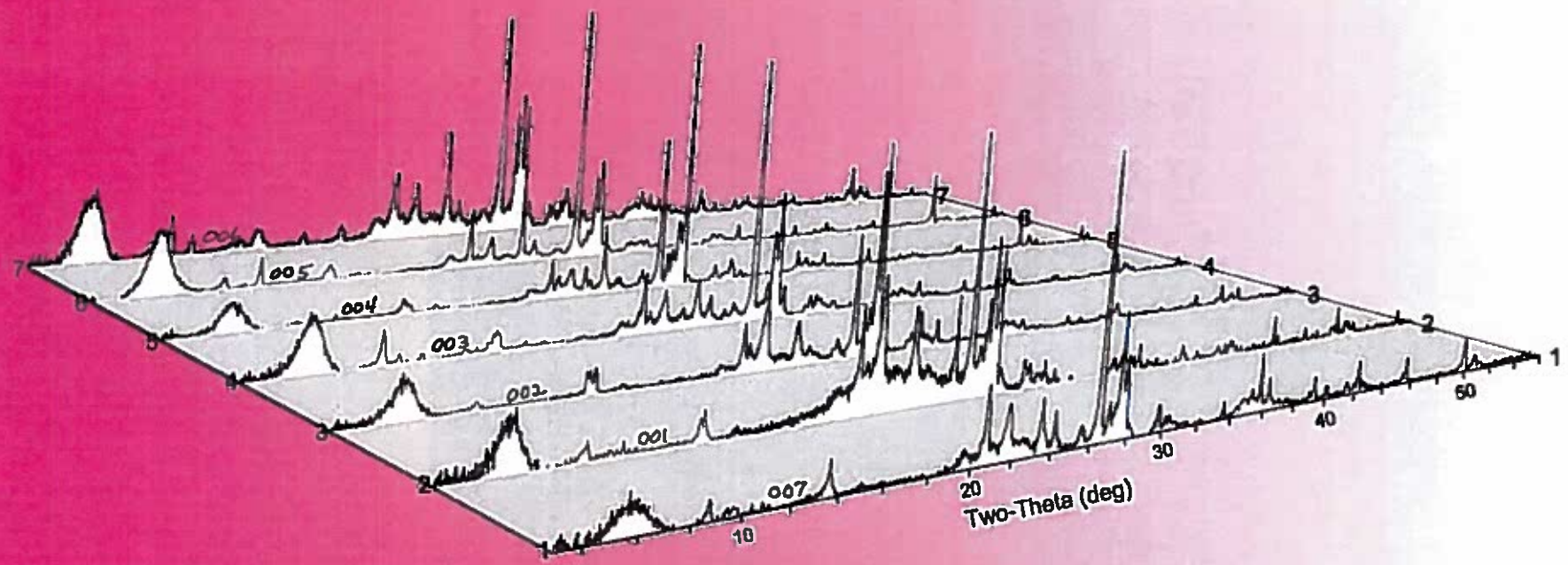


BLM

[MINIFLEX]Administrator]<c:\Windmax\Data\2016\SCave> Wednesday, April 26, 2017 12:10p (MDI/JADE9)

SCAN-11

(7) PDO-SC-006 - Main stockpile bulk
(6) PDO-SC-005 - volc-clastic under tuff
(5) PDO-SC-004 - KQ surge deposit
(4) PDO-SC-003 - KQ-bulk-screened
(3) PDO-SC-002 - KQ-sfc tuff, mid unit
(2) PDO-SC-001 - KQ-sfc tuff, base of unit
(1) PDO-SC-007 - top tuff abv entry pit



BLM

[MINIFLEX]Administrator]<c:\Windmax\Data\2016\SCave> Wednesday, April 26, 2017 12:19p (MDIJADE9)

SEM Imaging of the Subject samples

A Tescan VEGA 3 LMU SEM was used to image stub-mounted grains of the subject samples. The National Minerals Testing laboratory (NMTL) SEM has a resolution of 3.5 nm at 30 kV / 2.5 nm and has magnification capabilities of 2x – 1,000,000x. It has a maximum field of view of 24 mm at a WD of 30 mm and an accelerating voltage of 200 V to 30 kV. The probe current operates at 1 pico-Ampere (pA) to 2 micron-Ampere (μ)A and has a scan speed of 20 nanoseconds to 10 milliseconds per pixel adjustable in steps or continuously. The samples were scanned at 20.0 kV, in Back Scatter Electron (BSE) mode at a scan speed of "5", with the stub set at a "Z" of 10 mm. Working Distance (WD) changes slightly with the topography of the specimen. Working Distance (WD) is how the image is brought into focus. All stubs were viewed at a minimum of 4000x.

A quick review of the 8 samples submitted shows that Samples 001, 002, 003, 004, 006, and 007 do not display any acicular crystals indicative of erionite in any of the images created from the scans. There is evidence of clay minerals in these samples. Since erionite is the mineral of interest, these samples do not merit further discussion, as the x-ray diffraction did not indicate erionite as present, either.

Sample 005 does have acicular crystals in it, visible at the magnifications used of 4800X-5100X. The acicular crystals are indicative of erionite. The percent erionite in sample 005 is visually estimated to be <2% over all based on the visual under SEM analysis. Erionite is present in such a minute percent of the sample that it does not appear in an x-ray diffraction analysis.

Sample 008 has abundant erionite, with a visual of approximately 98% of the sample. The x-ray diffraction shows erionite and clinoptilolite.

Sample representative images with brief discussion follow.

Marilyn Wegweiser
CME #0150

BUREAU OF LAND MANAGEMENT
CERTIFIED
Marilyn D. Wegweiser
MINERAL EXAMINER
0150
U.S. DEPARTMENT OF THE INTERIOR

Image SCave 001-3: Magnification 4810X, no Erionite present.

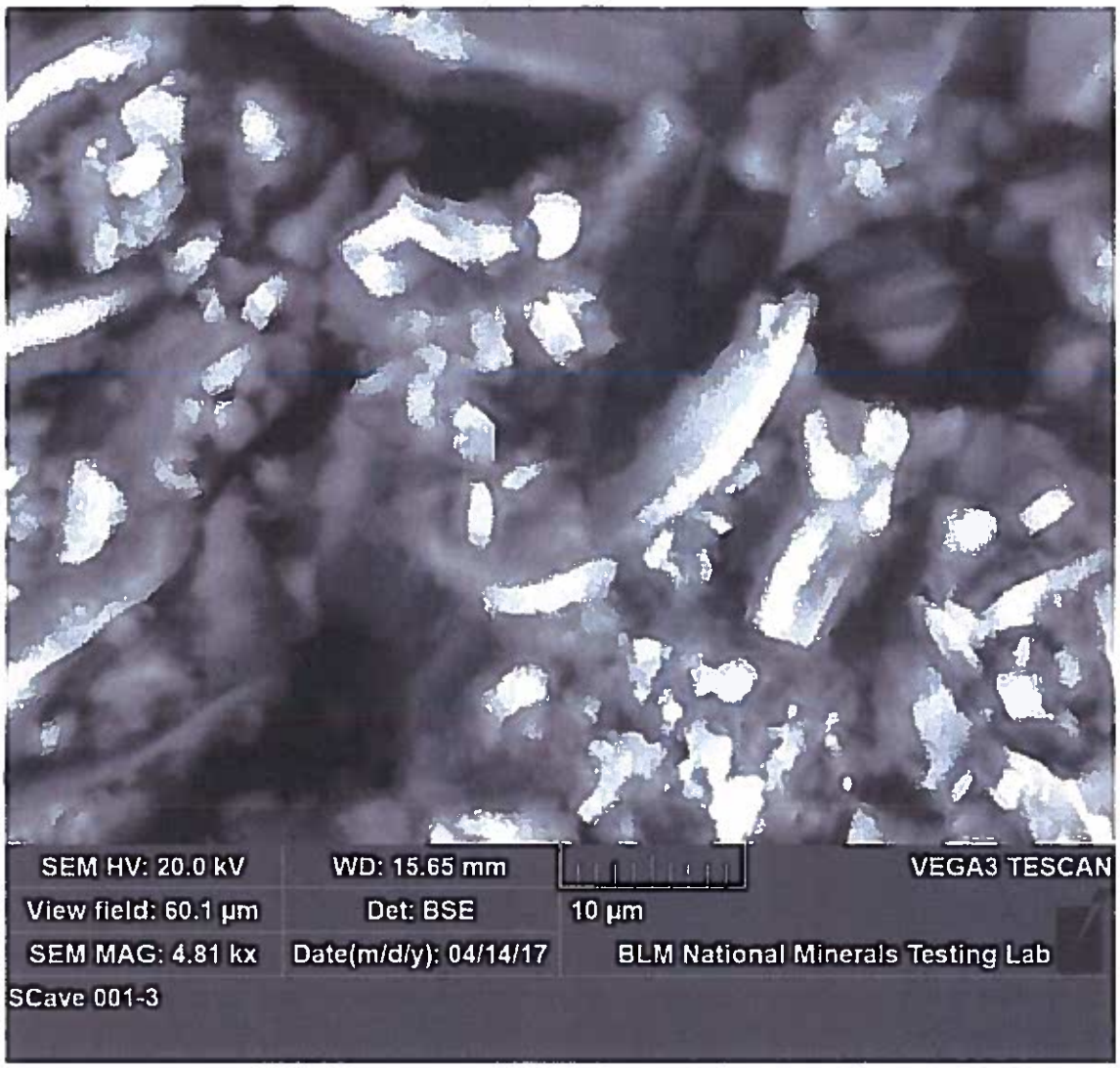


Image SCave 002-2: Magnification 4860X; no Erionite present.

Image SCave 003-1: Magnification 4840X; no Erionite present.

Image SCave 003-2: Magnification 4860X; a different perspective, note the clay particle (circled). No Erionite present.

Image SCave 004-2: Magnification 5005X; no Erionite present.

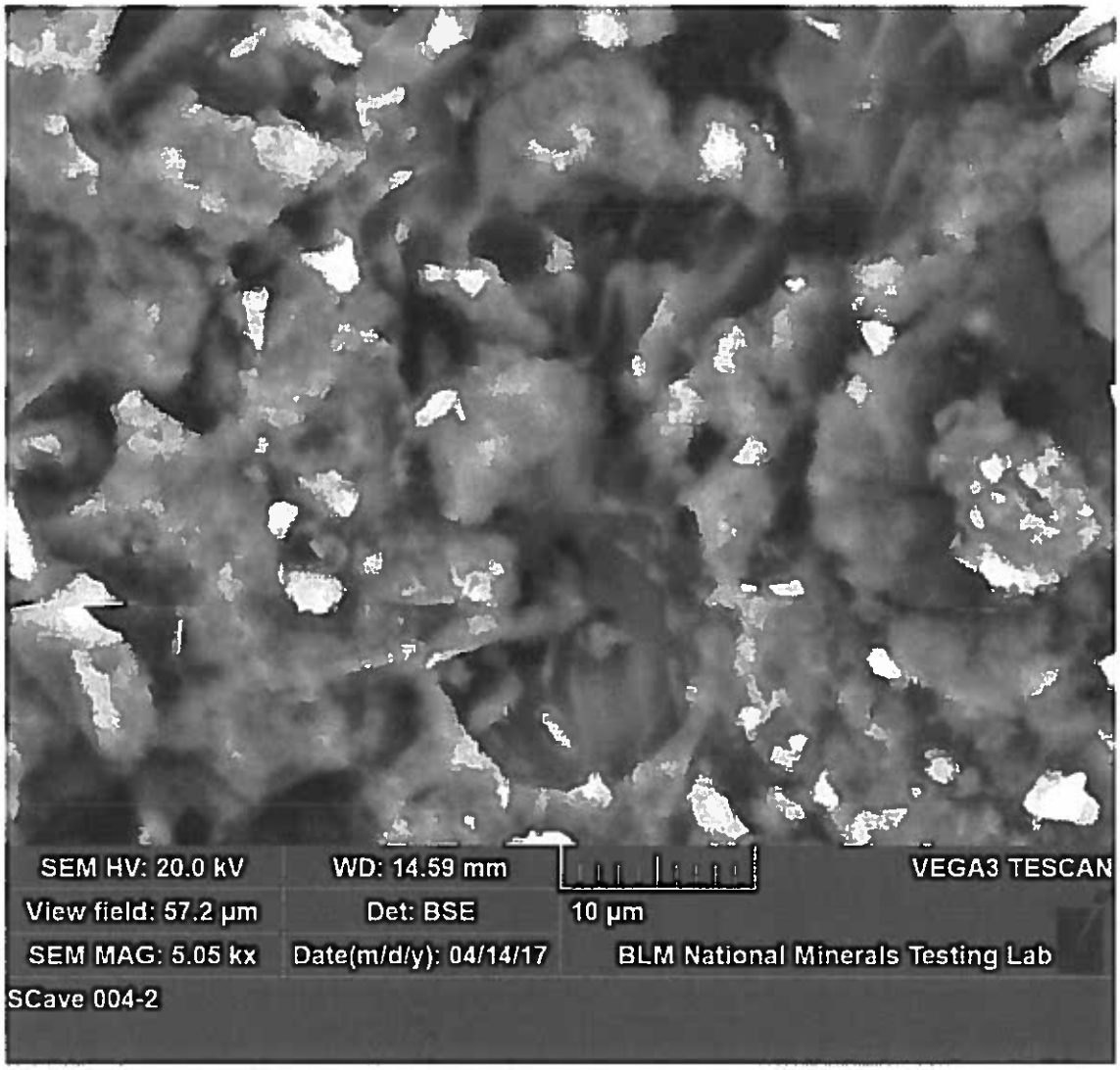


Image SCave 005-1 Magnification 4780X; about 2% Erionite present Note acicular needles (circled)

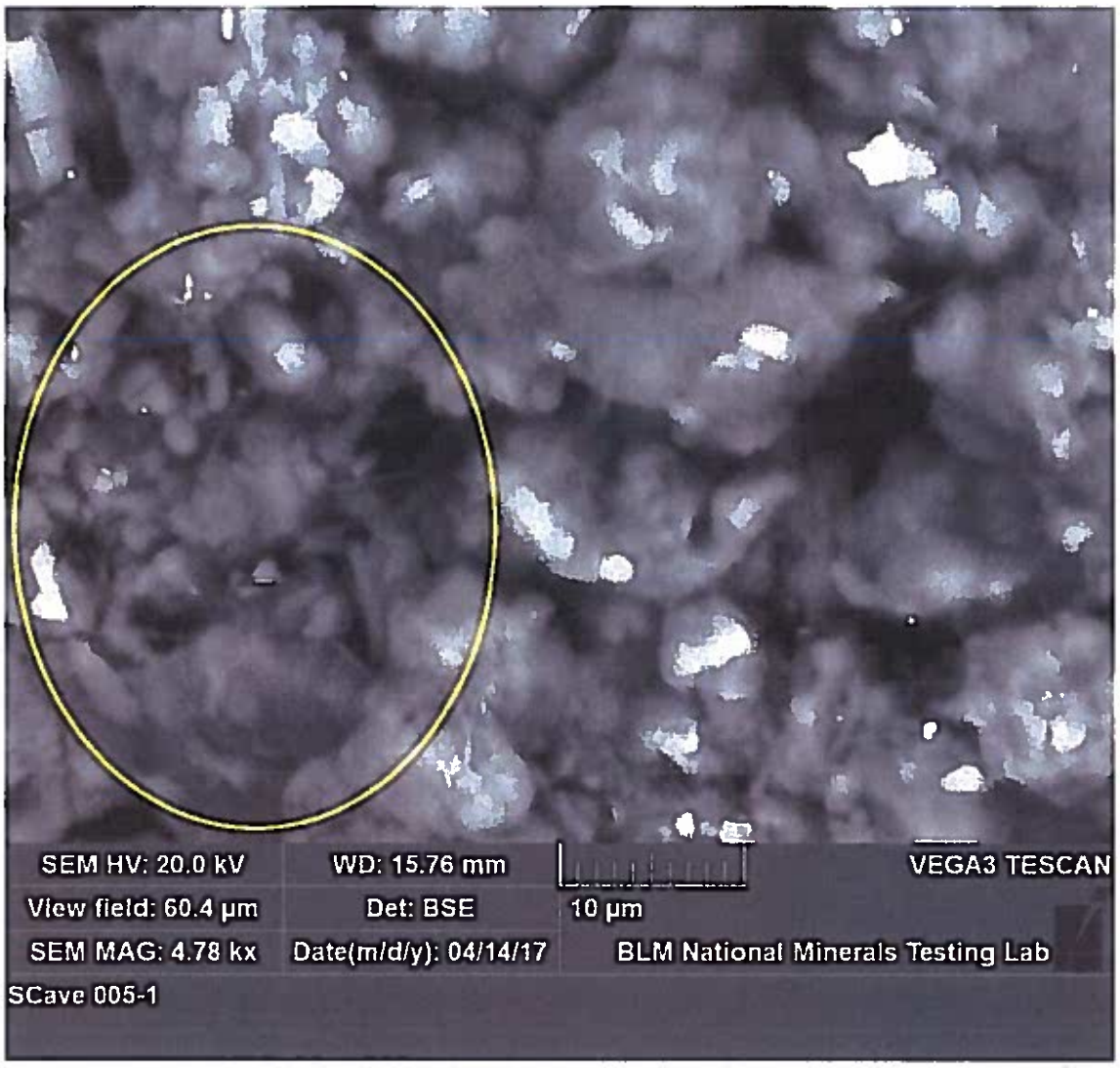


Image SCave 005-2: Magnification 4780X; less than 2% Erionite present. Note acicular needles (circled).

Image SCave 005-3: magnification 4800X; one Erionite acicular crystal present.

Image Scave 006-1: Magnification 4870X; no Erionite present

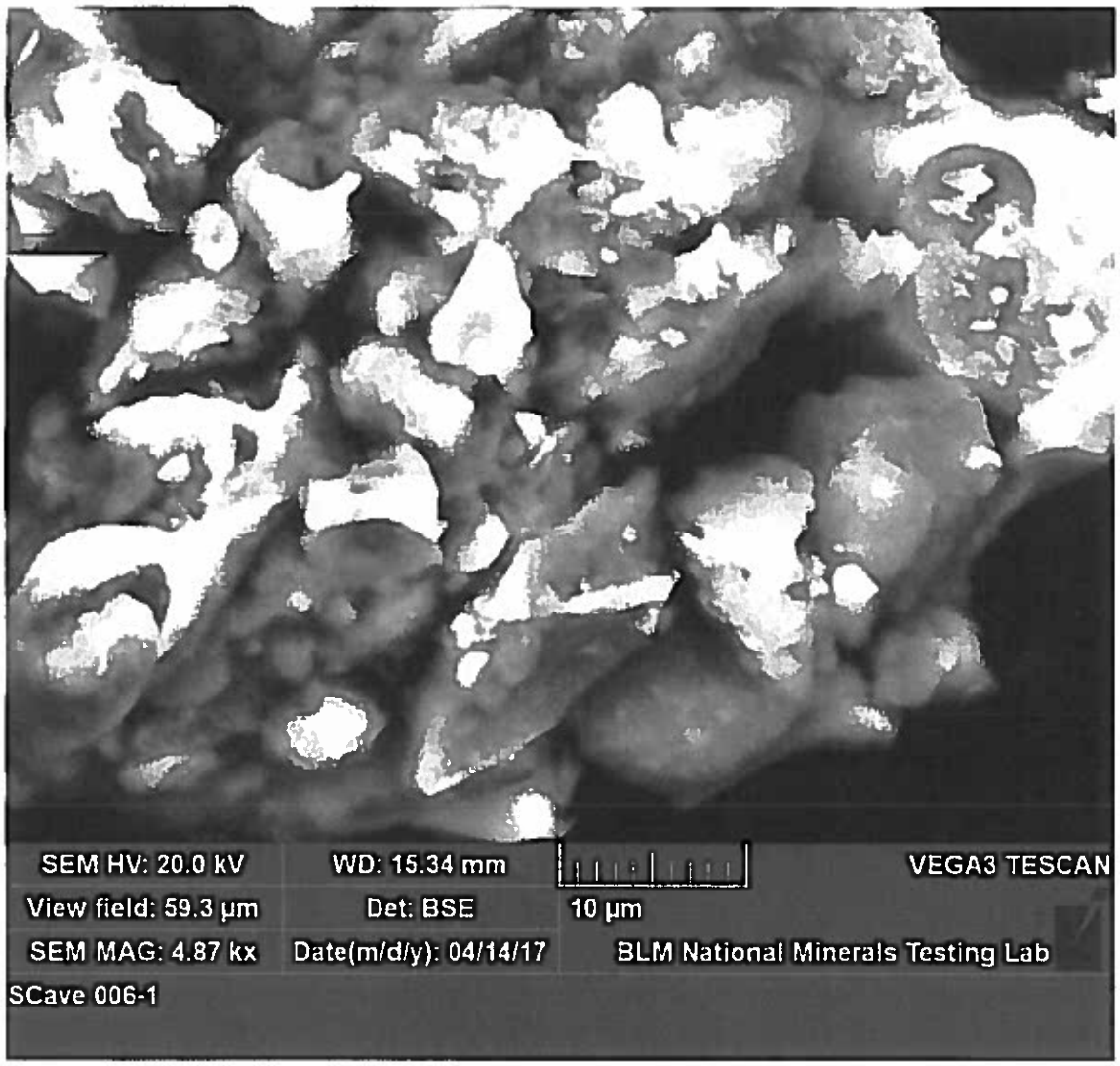


Image SCave 007-1: Magnification 4840X; no Erionite present.

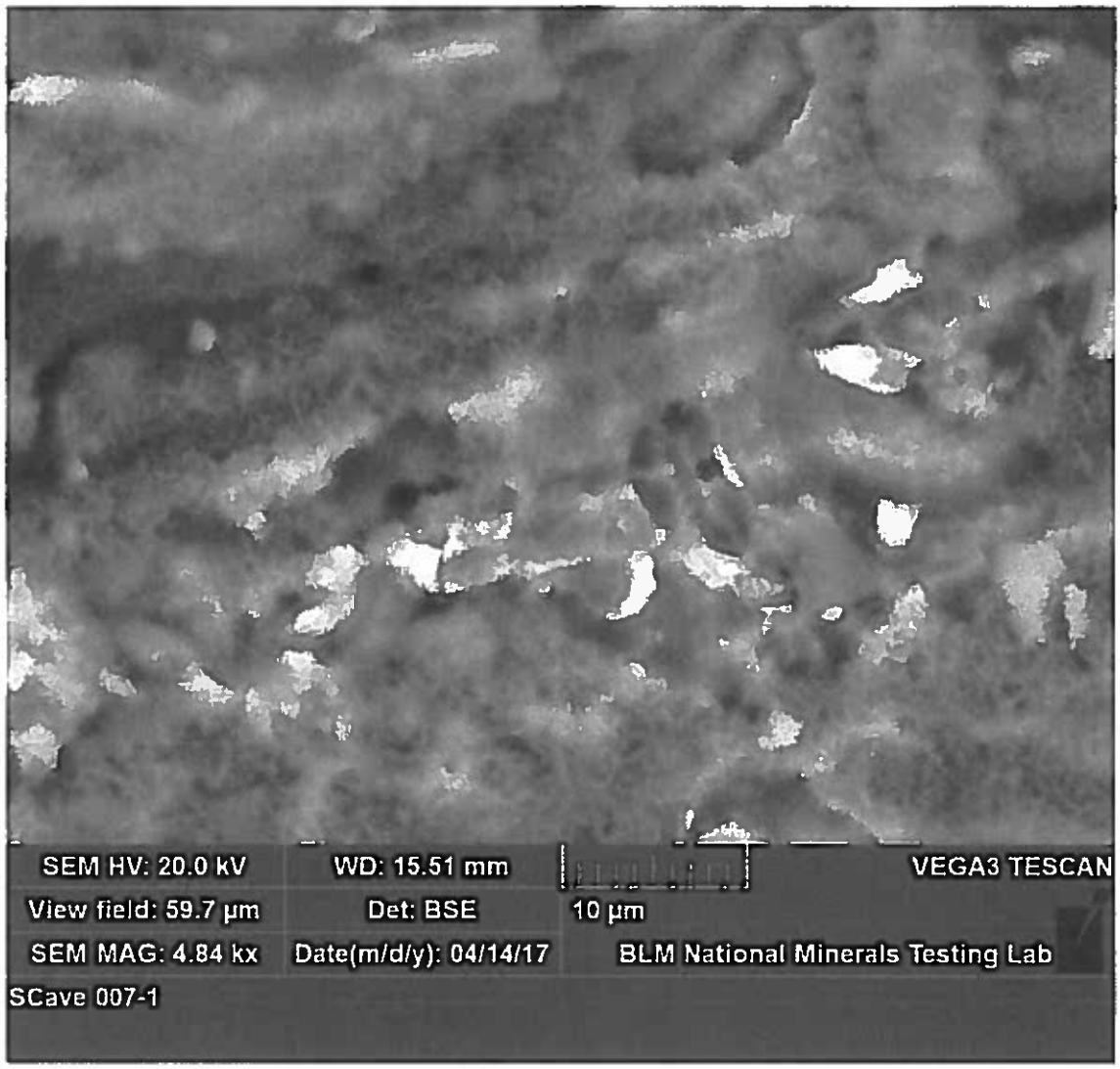


Image SCave 008-1: Magnification 4880X; abundant Erionite present.

Iamge SCave 008-2: Magnification 4840X; abundant Erionite present.

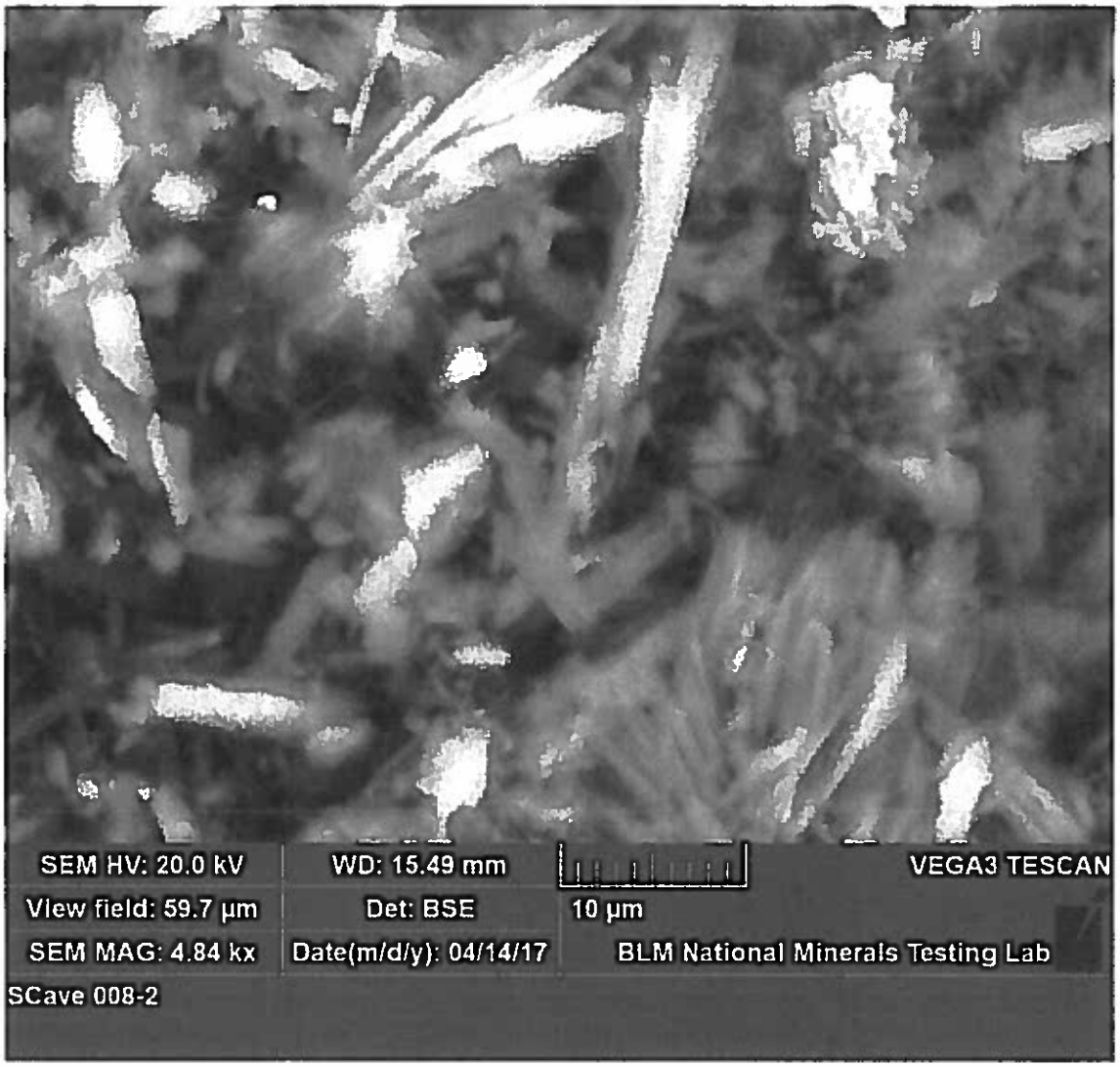
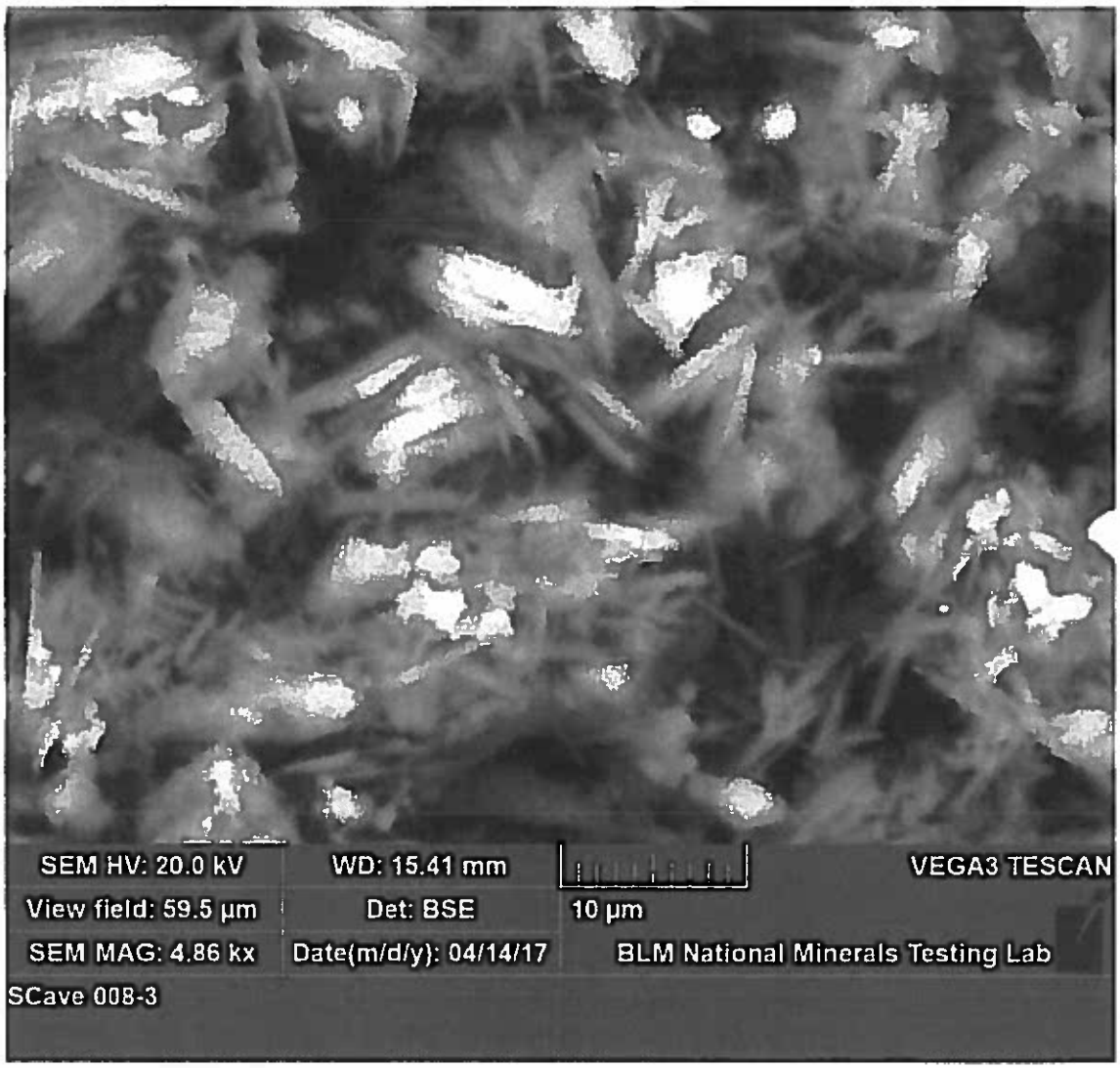


Image SCave 008-3: Magnification 4860X; abundant Erionite present.



Appendix B: Subsurface Sample Geochemical Assay Results Within Proposed Operation in Kirkland, AZ

Sample ID	DHID	Depth below collar (ft)	Date collected	Comment
BLM-PDO-SC-009	N/A		6/15/2017	Repeat of Surface Sample #5 sent to BLM National Testings Laboratory
BLM-PDO-SC-010	KMC1	48.5	6/15/2017	KMC 4 inch diametersonic drill core smaple, indurated lithic tuff, white to cream, with precambrian lithic clasts
BLM-PDO-SC-011	KMC9	41.4	6/15/2017	KMC DH hand sample, tan lithic tuff with 1-2 cm pumice
BLM-PDO-SC-012	KMC10	46.5	6/15/2017	KMC DH hand sample, same as above but more mauve and more pumice
BLM-PDO-SC-013	KMC2	33.1	6/15/2017	KMC DH hand sample, fault gouge
BLM-PDO-SC-014	KMC8	39.0	6/15/2017	KMC DH hand sample, fault gouge
BLM-PDO-SC-015	KMC8B	82.5	6/15/2017	KMC DH hand sample, pink lithic tuff
BLM-PDO-SC-016	KMC8A	86.4	6/15/2017	fault gouge with dark brown swelling clay, less lithics and pumice
BLM-PDO-SC-017	KMC7A	67.5	6/15/2017	KMC DH hand sample, pink lithic tuff
BLM-PDO-SC-018	KMC7B	73.6	6/15/2017	KMC DH hand sample, indurated, pumice rich, clay present
BLM-PDO-SC-019	KMC7C	79.0	6/15/2017	KMC DH hand sample, sandy lenses loose medium grained arkosic
BLM-PDO-SC-020	KMC4	71.5	6/15/2017	KMC DH hand sample, indurated pumice rich, ash matrix, white gray, almost clast supported
BLM-PDO-SC-021	KMC3	41.7	6/15/2017	KMC DH hand sample, indurated lithic ash fall tuff

Kirkland Mining Drill Hole Coordinates and Elevation
Capital Claims

NAD 83
3-Mar-16

Hole ID	Claim #	Drill Order	Coordinates	Elevation	Depth (ft)
KMC1	Capital 7	3	N34 26.144 W112 41.306	4097	50
KMC2	Capital 8	5	N34 26.009 W112 41.219	4044	50
KMC3	Capital 7	6	N34 26.064 W112 41.227	4111	50
KMC4	Capital 2	7	N34 26.173 W112 41.169	4147	75
KMC5	Capital 4	1	N34 25.993 W112 41.068	4054	45
KMC6	Capital 4	2	N34 25.923 W112 41.071	4049	40
KMC7	Capital 6	10	N34 26.161 W112 41.320	4081	100
KMC8	Capital 6	9	N34 26.220 W112 41.368	4040	90
KMC9	Capital 4	4	N34 25.948 W112 41.165	4110	50
KMC10	Capital 3	8	N34 26.109 W112 41.179	4124	50

Table 1

-EMSL Analytical, Inc.

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

Attn.: *Dr. Shelby Cave*
Bureau of Land Management
21605 N 7th Ave
Phoenix, AZ 85027

Phone: 623-580-5500

EMSL Order ID.: 361701940
Sample(s) Received: 9/8/2017
Date of Reporting: 9/27/2017
Date Printed: 9/27/2017
Reported By: E. Mirica
Email: scave@blm.gov

- Laboratory Report -

Material Identification/Erionite

Project: KMC AZA-37212

Conclusions:

- No Erionite was fond in the samples by powder X-ray Diffraction analysis.

Procurement of Samples and Analytical Overview:

The samples for analysis (seven, bulk) arrived at EMSL Analytical (Cinnaminson, NJ) on September 8, 2017. The package arrived in satisfactory condition with no evidence of damage to the contents. The purpose of the analysis is to determine the presence of Erionite (mineral in the zeolite group /hydrated alumino-silicates of the alkaline and alkaline-earth metals). The data reported herein has been obtained using the following equipment and methodologies.

Methods & Equipment: Rigaku Ultima-IV X-ray diffraction system with Cu X-ray tube and scintillation counter
X-ray Diffraction (XRD)

Ref: S. J. Chipera, D.L Bish, The Occurrence and Distribution of Erionite at Yucca Mountain, Nevada, DOE Contract No: W-7405-ENG-36

Analyzed by: *Eugenia Mirica, Ph.D.*
Laboratory Manager
September 27, 2017
Date

Reviewed/Approved: *Jian Hu, Ph.D.*
Senior Scientist
September 27, 2017
Date

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Figure 1: Images of the as-received samples.

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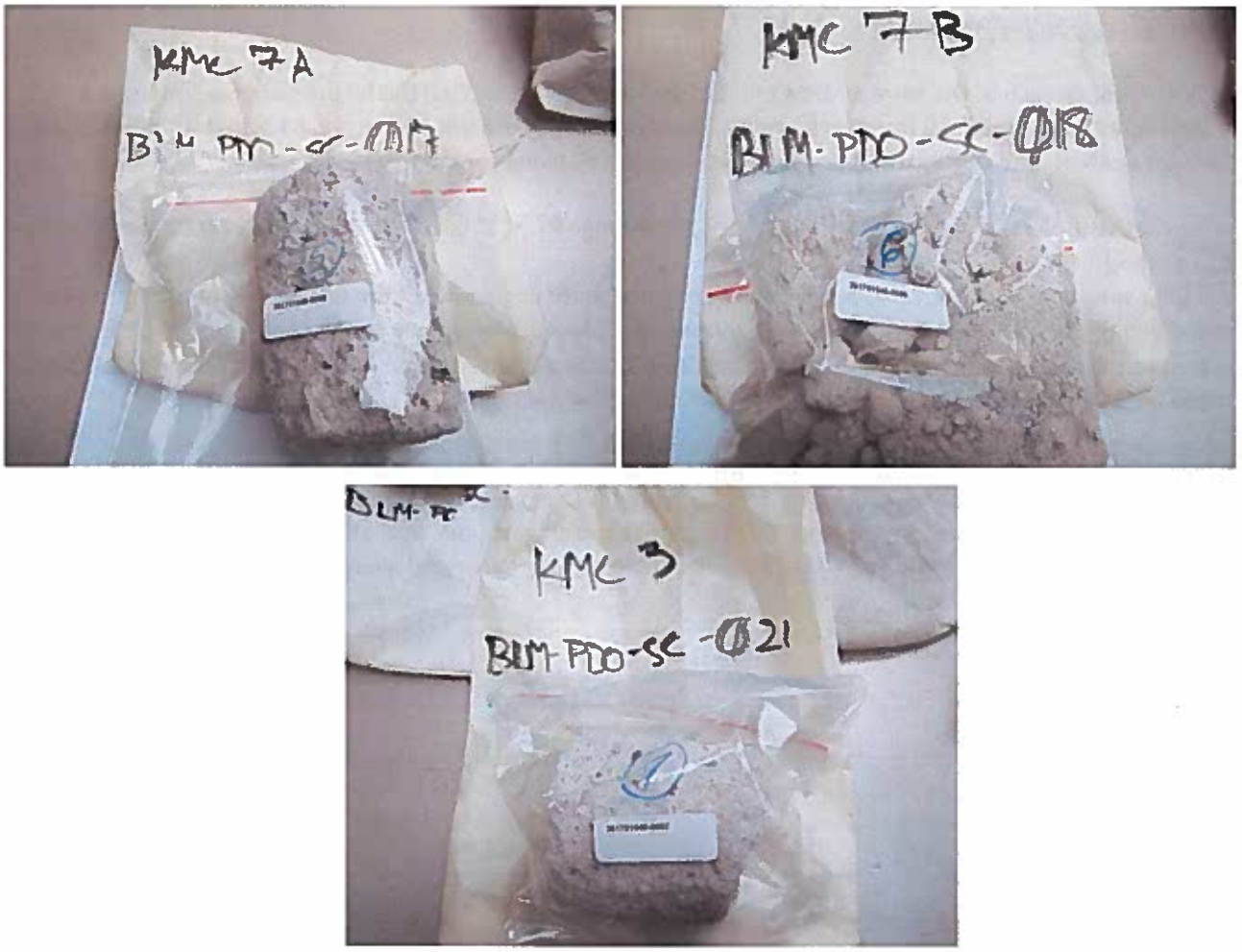

Figure 1: Images of the as-received samples (Cont'd.)

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Phone: 623-580-5500

EMSL Order ID.: 361701940
Sample(s) Received: 9/8/2017
Date of Reporting: 9/27/2017
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Reported By: E. Mirica
Email: scave@blm.gov

Background and Sample Preparation:

The full amount of each of the as-received samples (see Figure 1) was milled to 250 µm nominal size using a puck mill. An aliquot of the material from each sample was sieved using 250 µm screen and packed onto bulk sample holders for analysis. XRD patterns were obtained using the following conditions:

- A qualitative general scan was performed at 2θ angle range from 3° to 60° at a step size of 0.02° and dwell time of 1 second.
- A higher sensitivity qualitative slow scan was performed at 2θ angle range from 6.6° to 8.6° at a step size of 0.02° and dwell time of 10 seconds in order to determine the presence of the 7.641° 2θ angle Erionite peak; this peak was selected due to its location away from the 31°- 32° 2θ angle region where the main Erionite peaks reside; these peaks are typically prone to inferences with other common minerals.

The patterns were analyzed using JADE data processing software and ICDD (International Center for Diffraction Data) to verify the presence of Erionite. The conclusion regarding presence or absence of Erionite was based on the presence or absence of the main peaks for Erionite according to the available ICDD-PDF database at EMSL Analytical, Inc. (PDF # 39-1379 on Page 27). One subsample was prepared and analyzed for each submitted sample.

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Email: scave@blm.gov

Summary of Results:

Table 1. Results for the analysis based on XRD screening analysis (XRD patterns in Figures 2-22).

Sample ID	*Description*	*Analyte*	*Identification*	*Comments*
BLM-PDO-SC-010 361701940-0001	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-011 361701940-0002	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-012 361701940-0003	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-016 361701940-0004	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-017 361701940-0005	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-018 361701940-0006	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-021 361701940-0007	Consolidated rhyolithic lithic tuff	Erionite	None Detected	A

Comments:

A: The sensitivity of the screening method is estimated approximately 1% if no interference is present.

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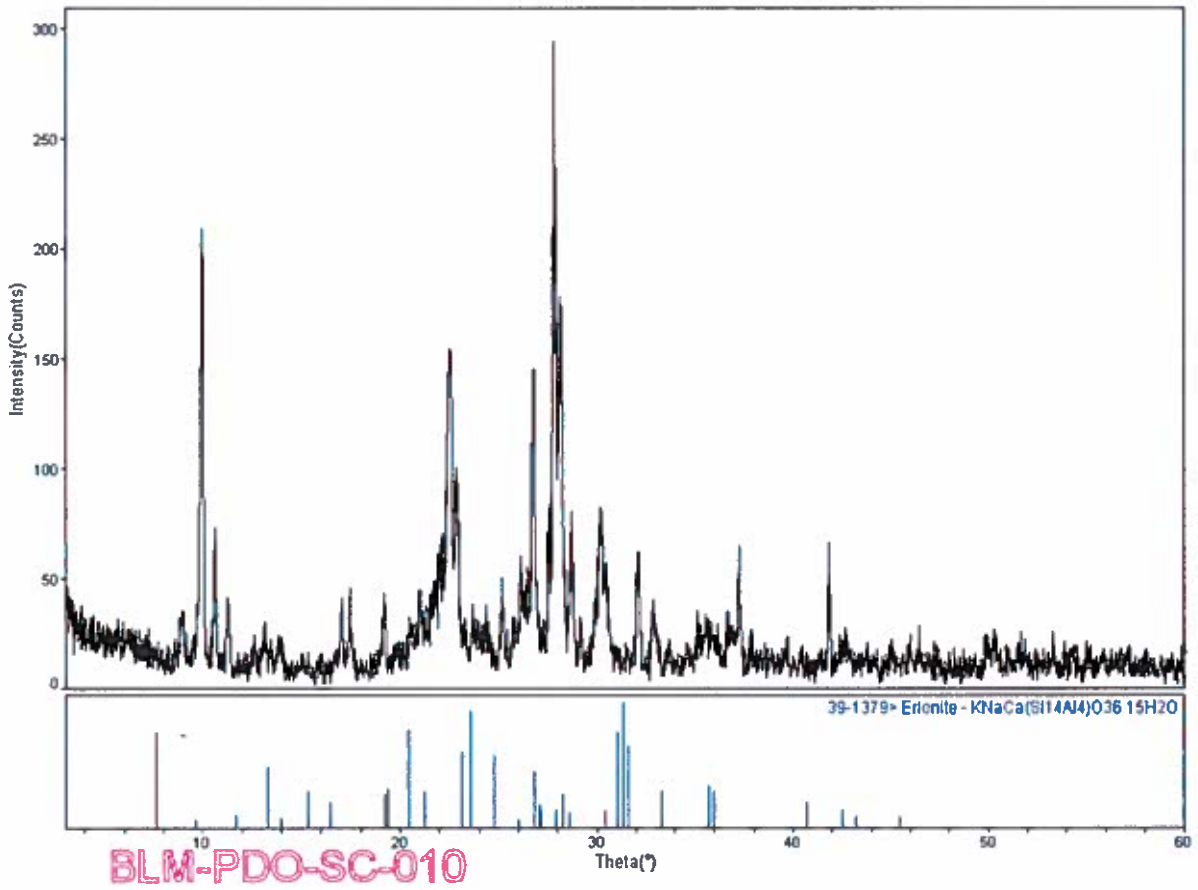

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Figure 2. General XRD pattern of material from sample BLM-PDO-SC-010 compared to the PDF # 39-1379 for Erionite. No peaks associated with Erionite were found.

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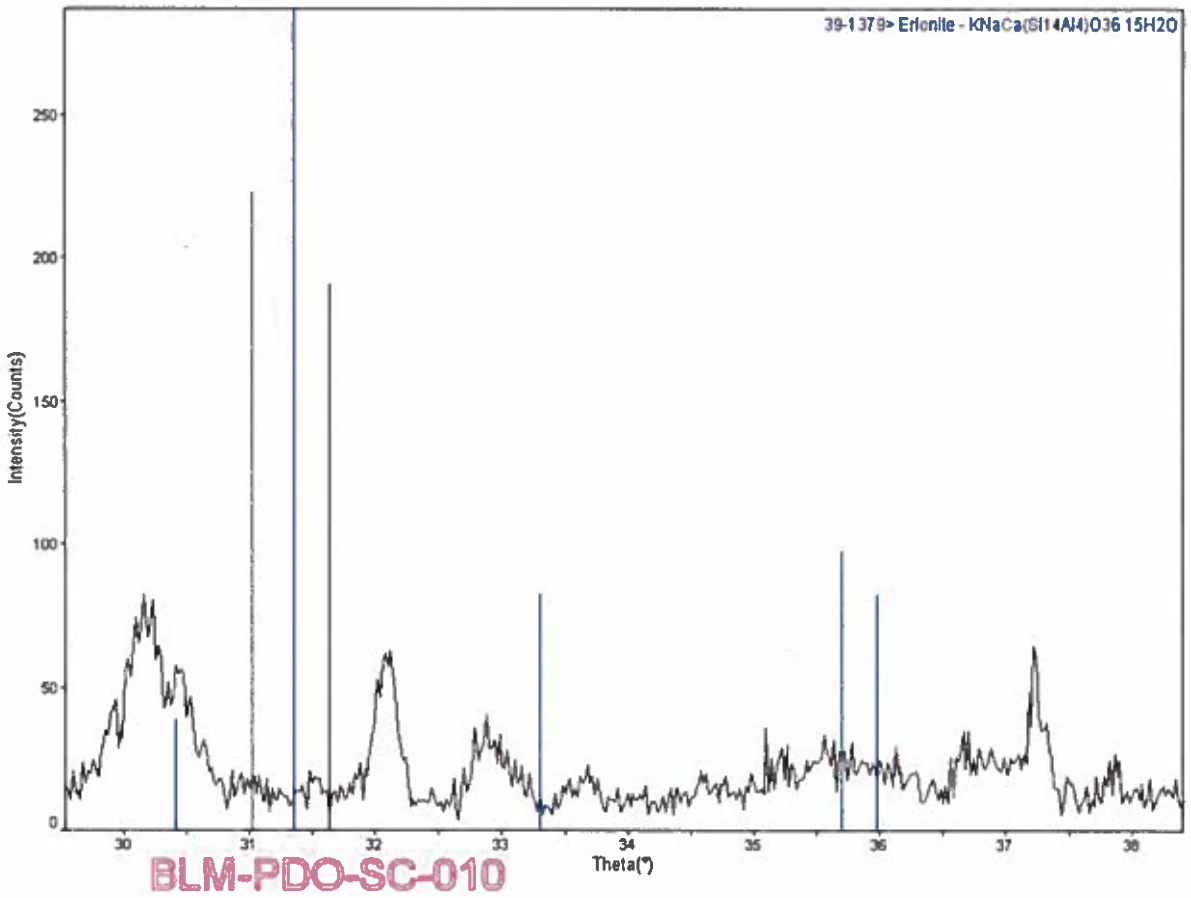

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Figure 3. Detailed XRD pattern of material from sample BLM-PDO-SC-010 in the area of the major peaks for Erionite as listed in PDF # 39-1379.

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Reported By: E. Mirica
Email: scave@blm.gov

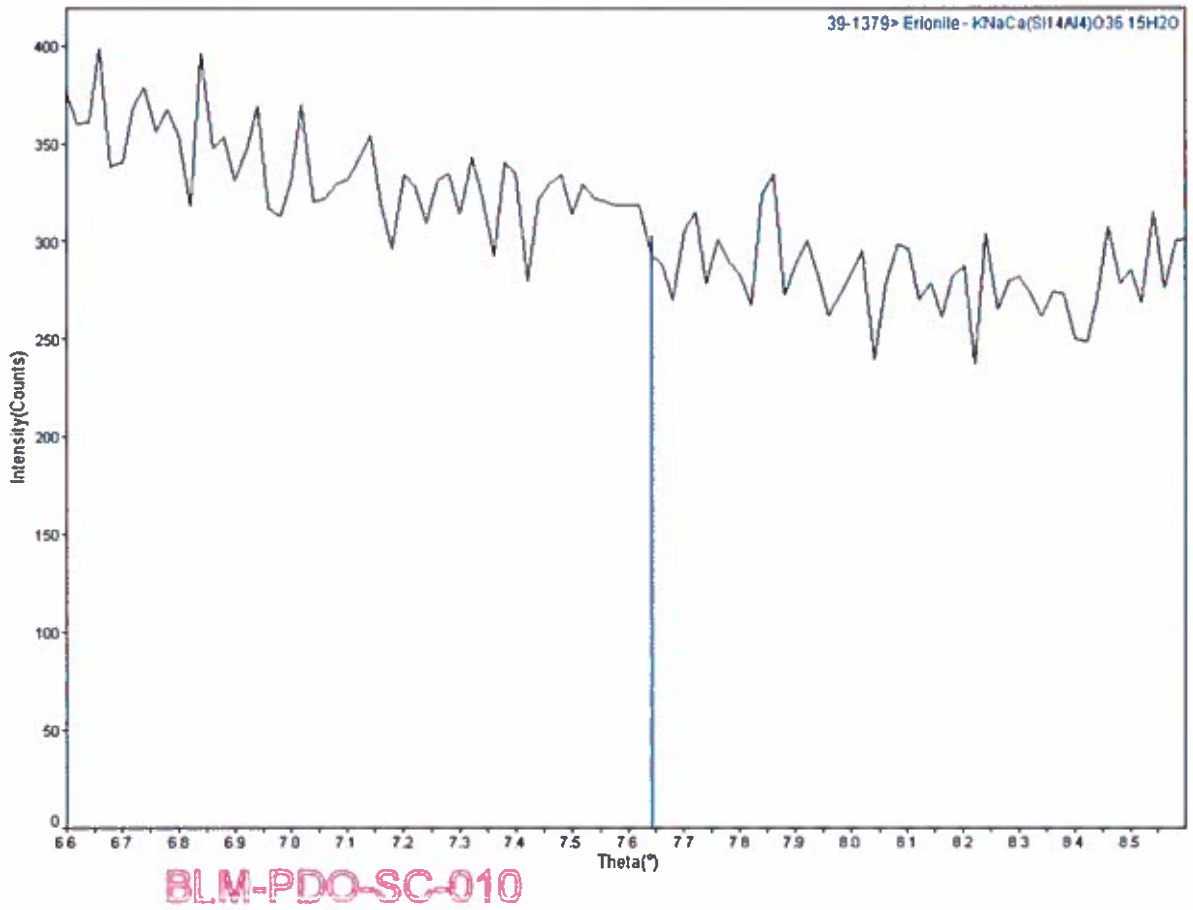

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Figure 4. XRD slow scan pattern of material from sample BLM-PDO-SC-010 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF # 39-1379.

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21605 N 7th Ave
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Phone: 623-580-5500

EMSL Order ID.: 361701940
Sample(s) Received: 9/8/2017
Date of Reporting: 9/27/2017
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Reported By: E. Mirica
Email: scave@blm.gov

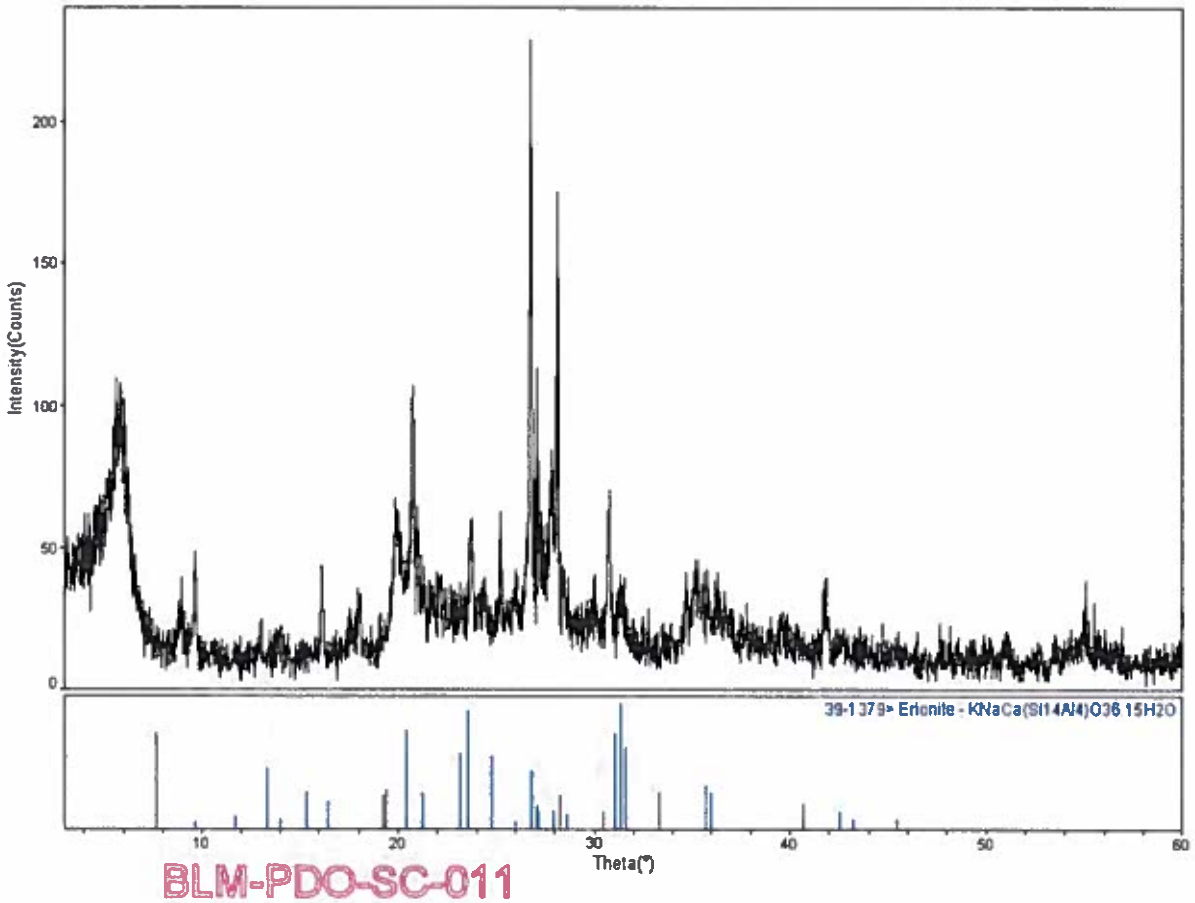

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Figure 5. General XRD pattern of material from sample BLM-PDO-SC-011 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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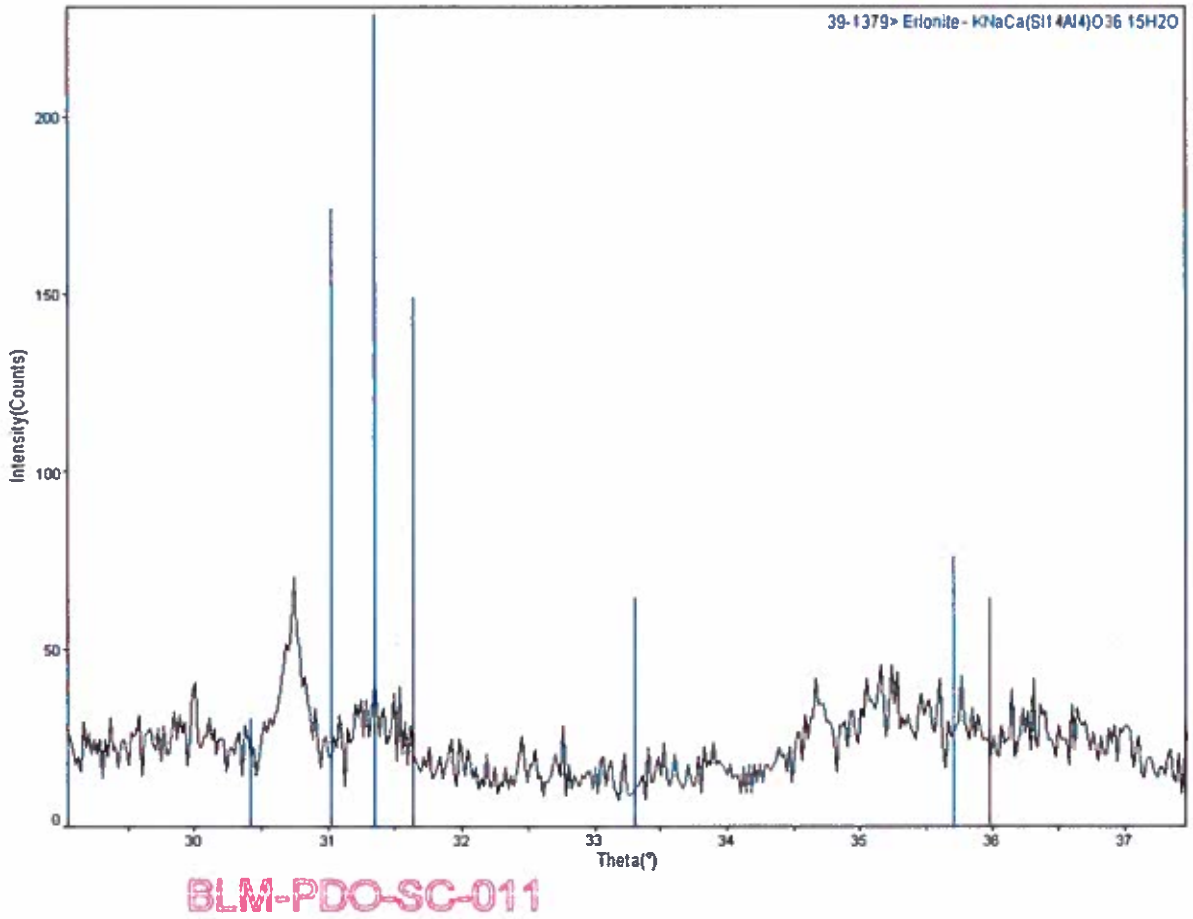

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Figure 6. Detailed XRD pattern of material from sample BLM-PDO-SC-011 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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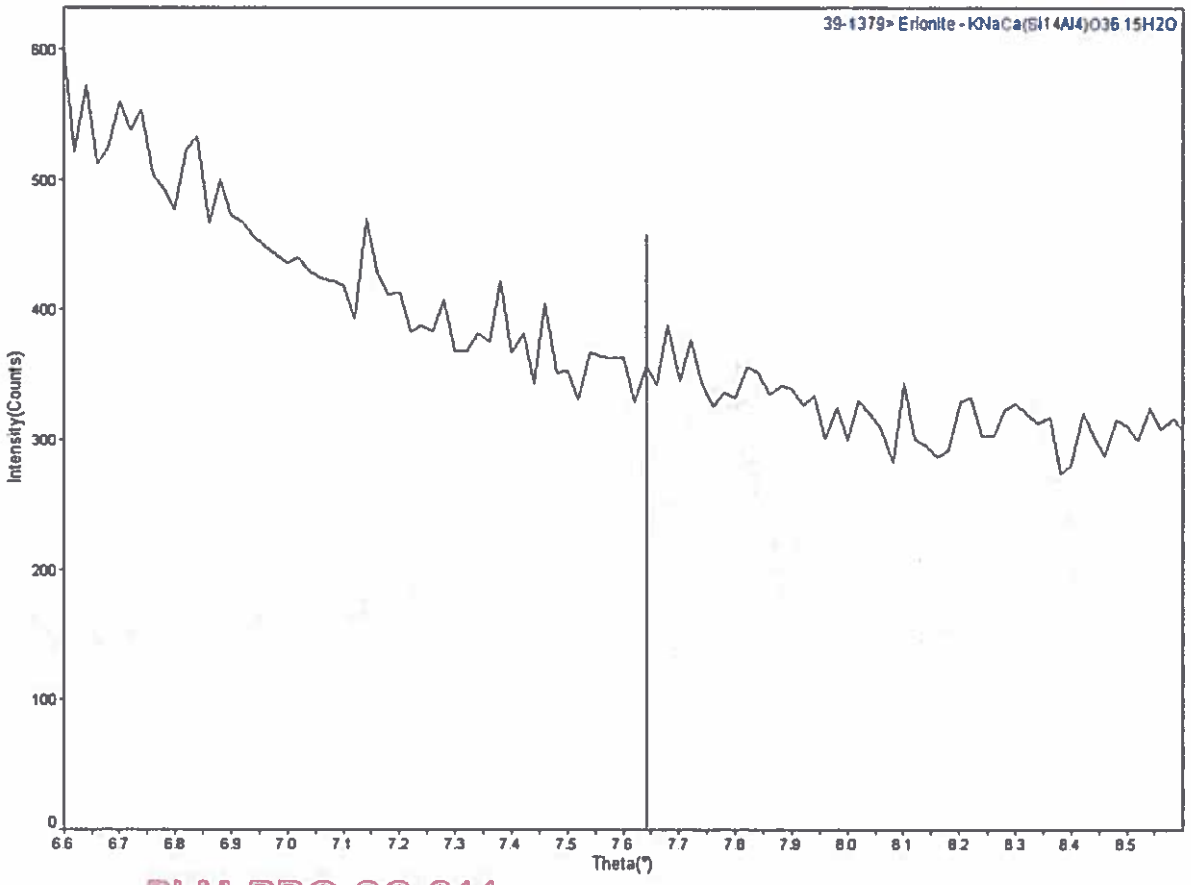

BLM-PDO-SC-011

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Figure 7. XRD slow scan pattern of material from sample BLM-PDO-SC-011 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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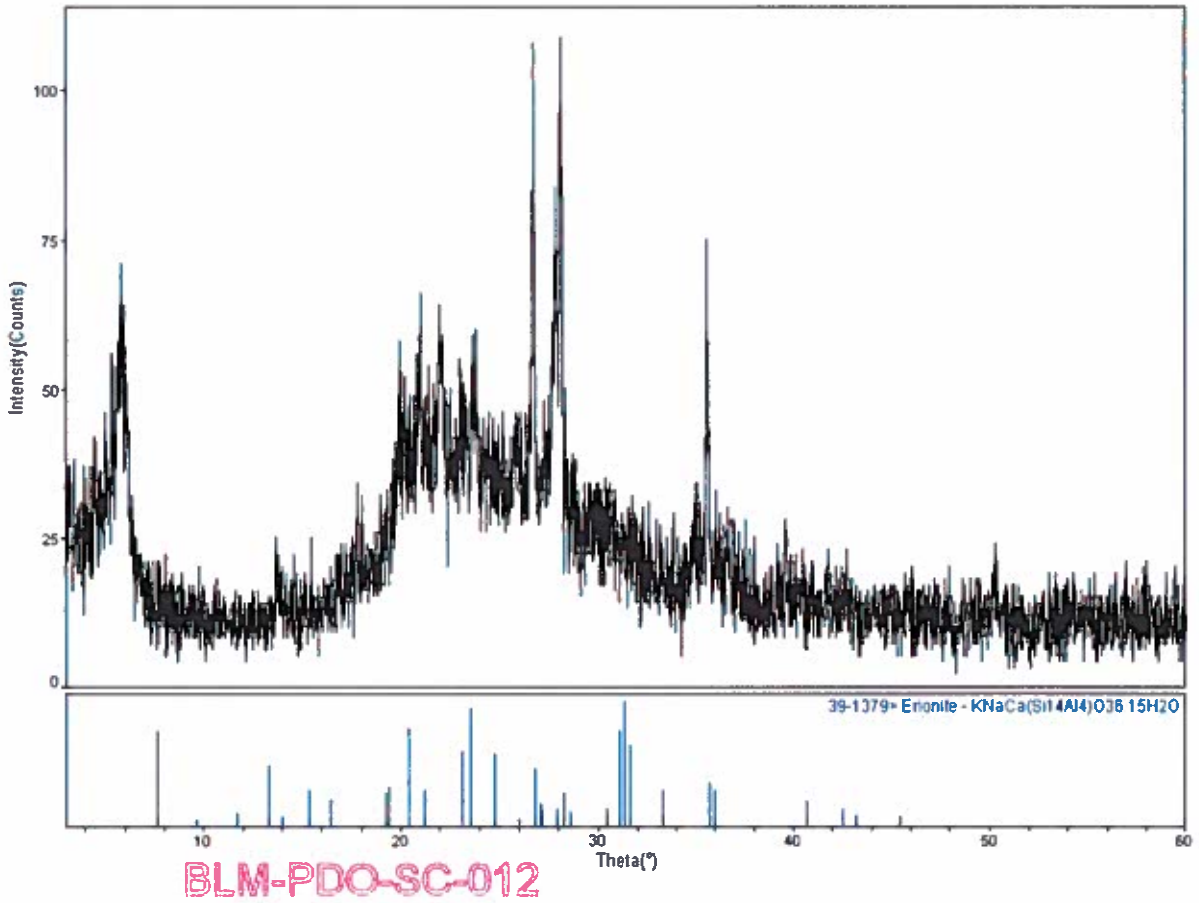

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Figure 8. General XRD pattern of material from sample BLM-PDO-SC-012 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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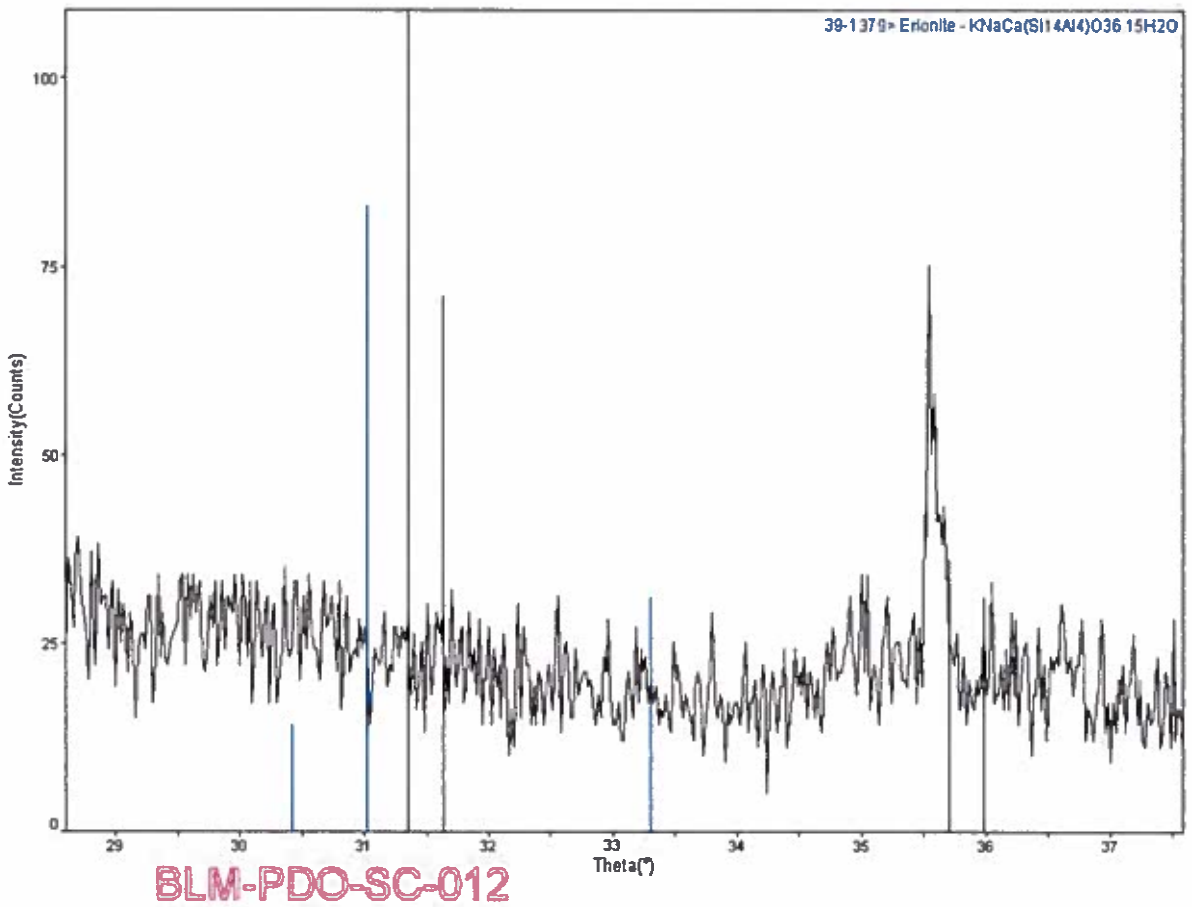

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Figure 9. Detailed XRD pattern of material from sample BLM-PDO-SC-012 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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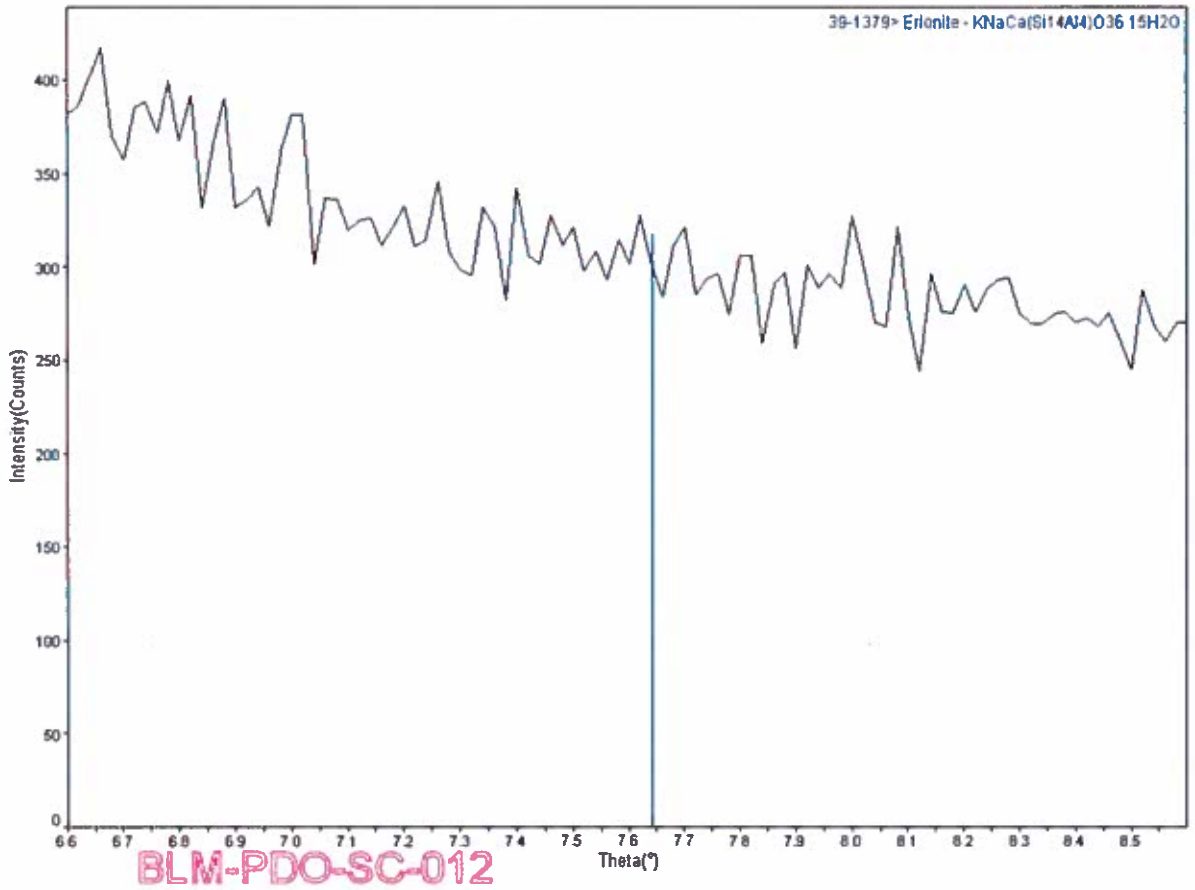

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Figure 10. XRD slow scan pattern of material from sample BLM-PDO-SC-012 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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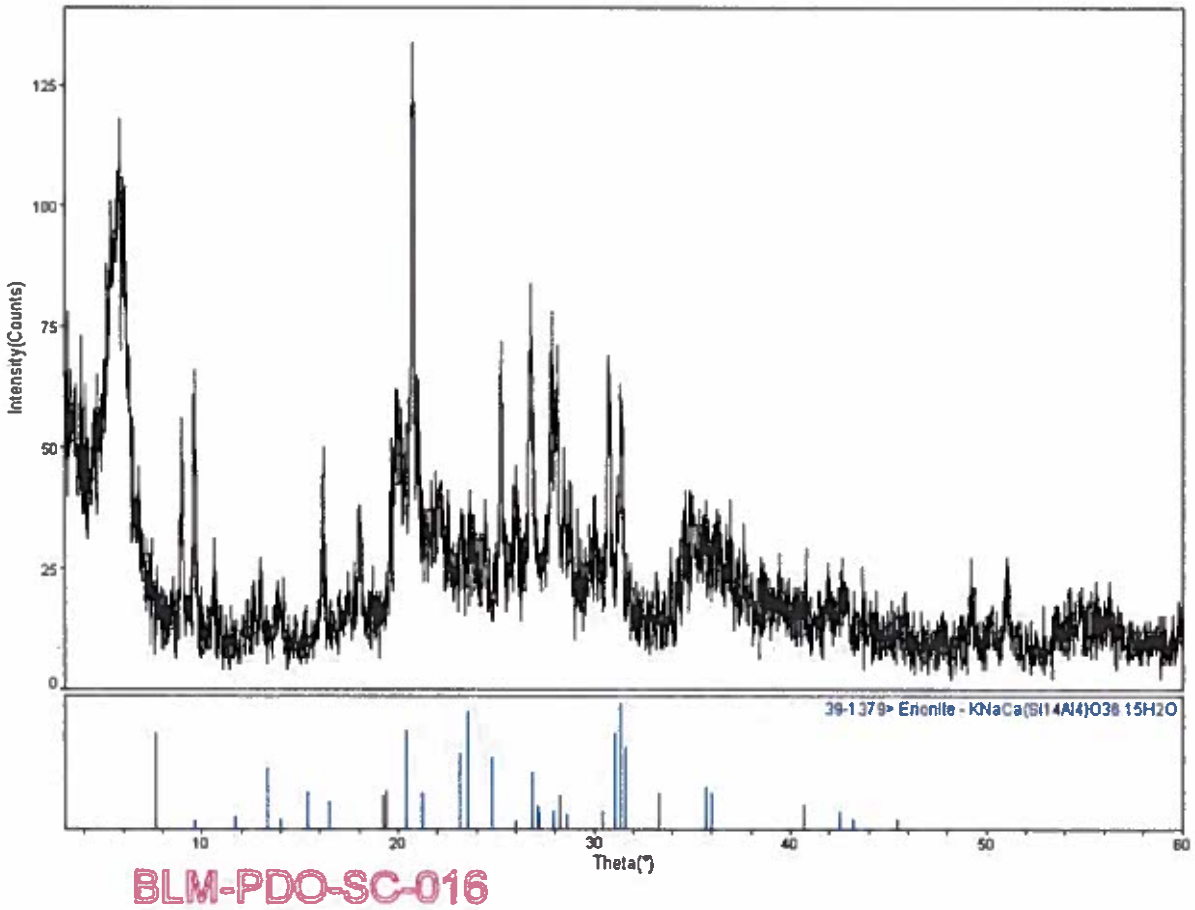

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Figure 11. General XRD pattern of material from sample BLM-PDO-SC-016 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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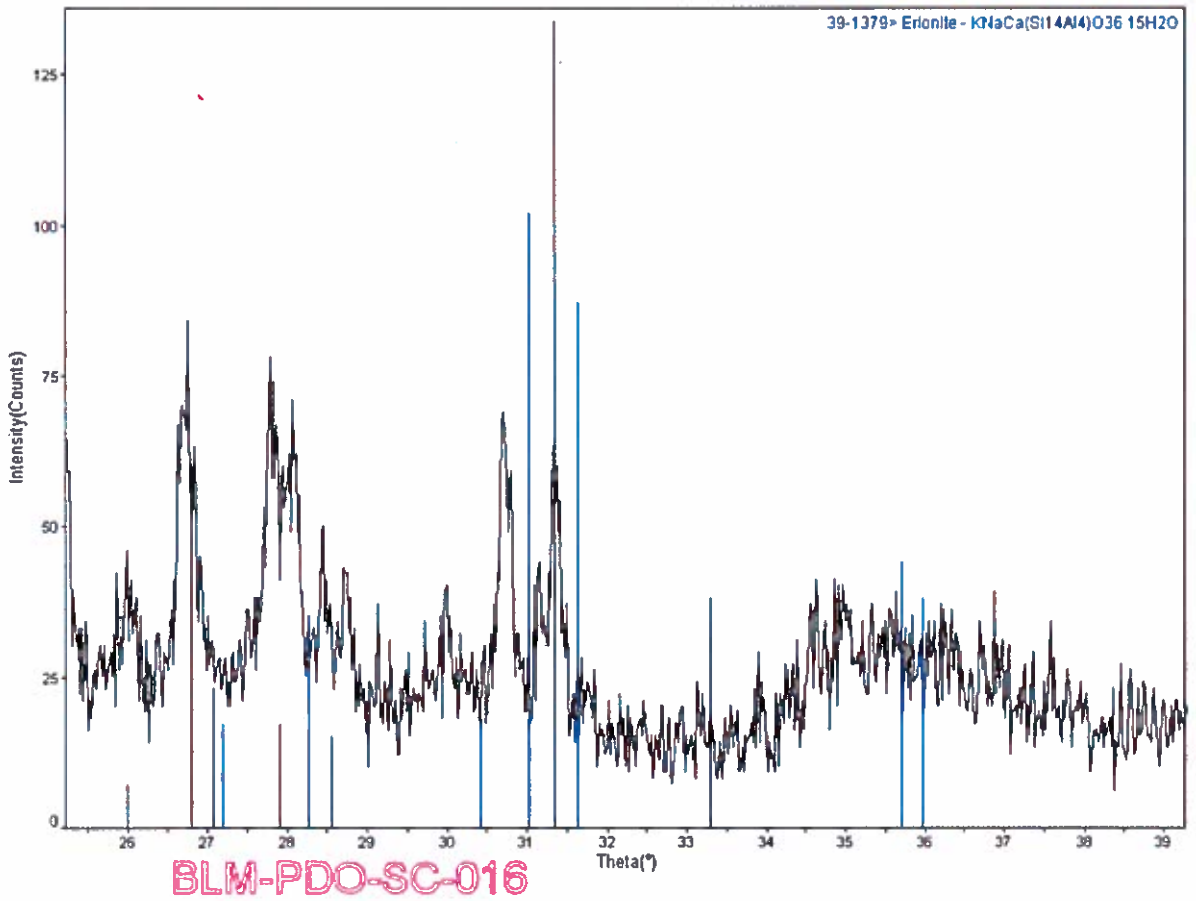

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Figure 12. Detailed XRD pattern of material from sample BLM-PDO-SC-016 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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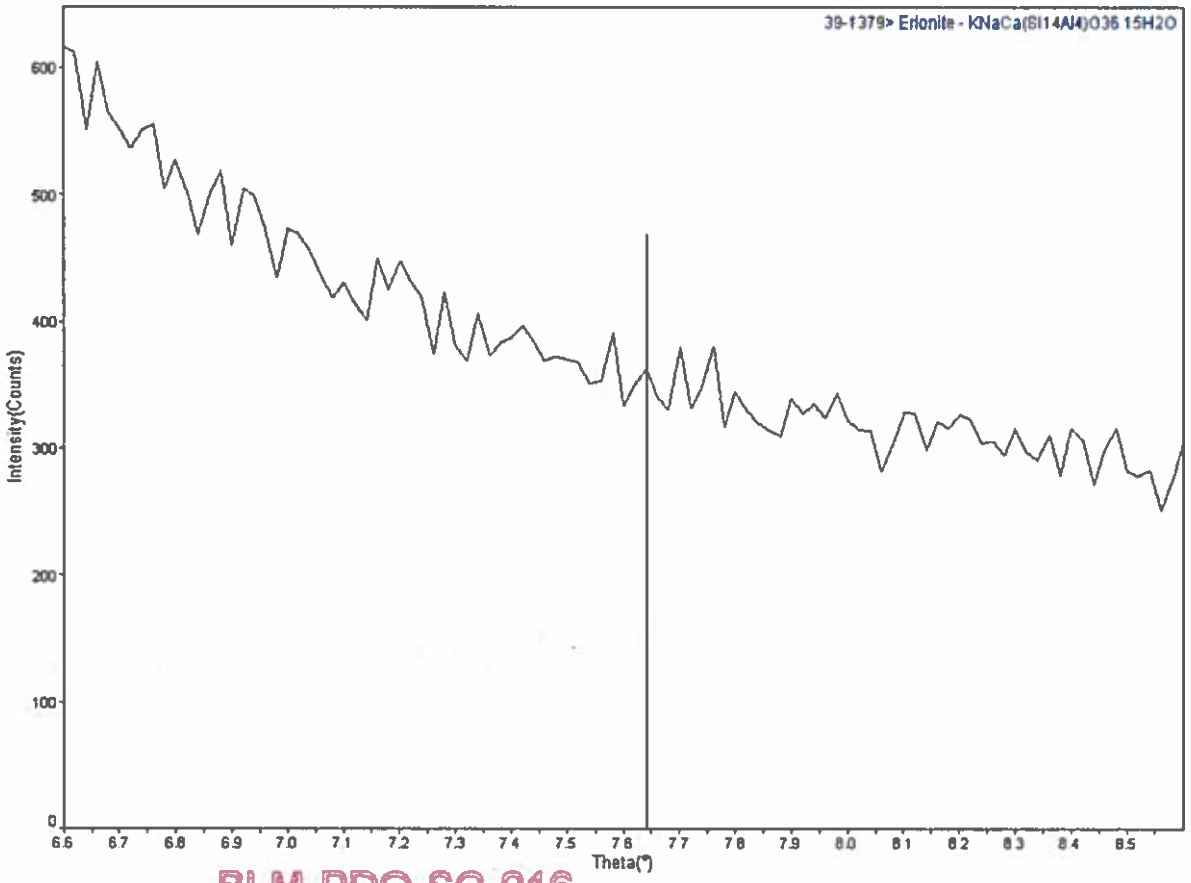

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Figure 13. XRD slow scan pattern of material from sample BLM-PDO-SC-016 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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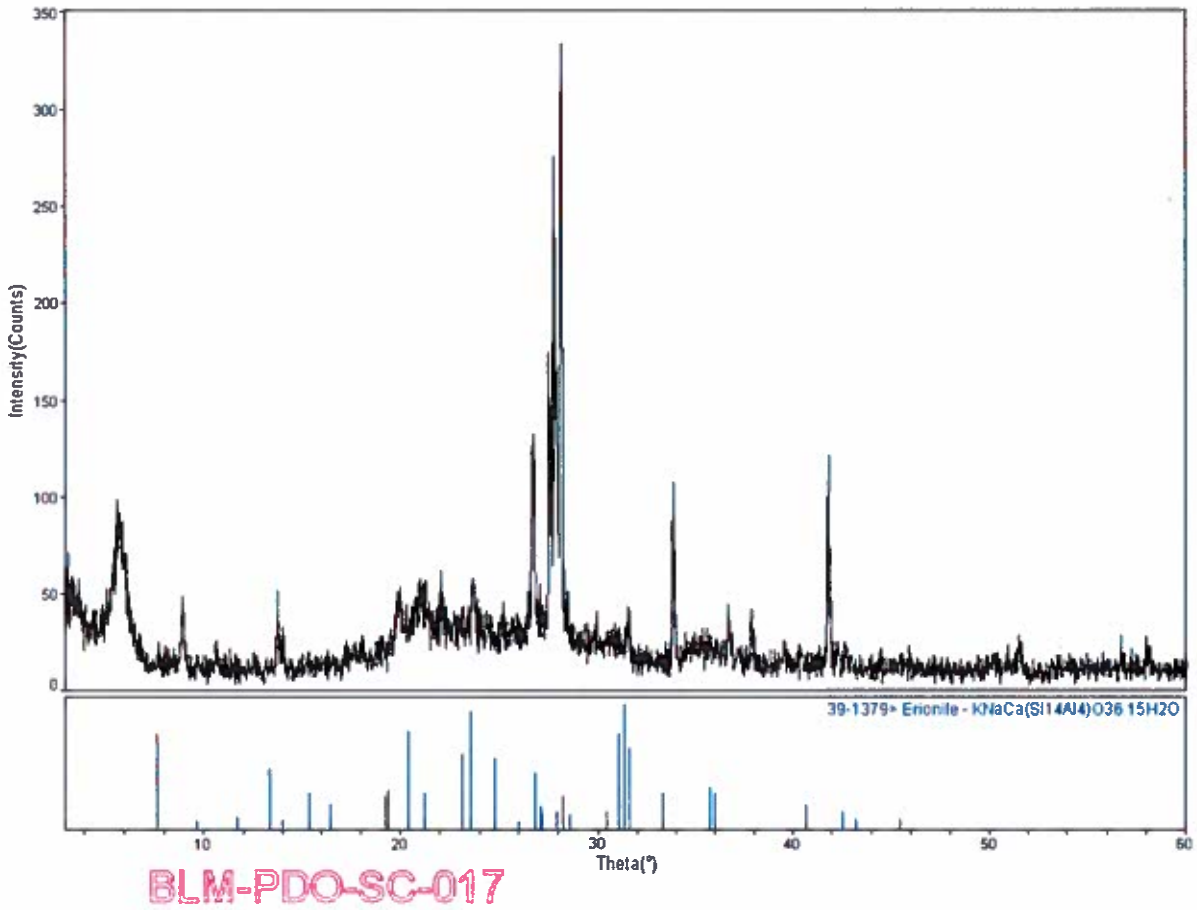

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Figure 14. General XRD pattern of material from sample BLM-PDO-SC-017 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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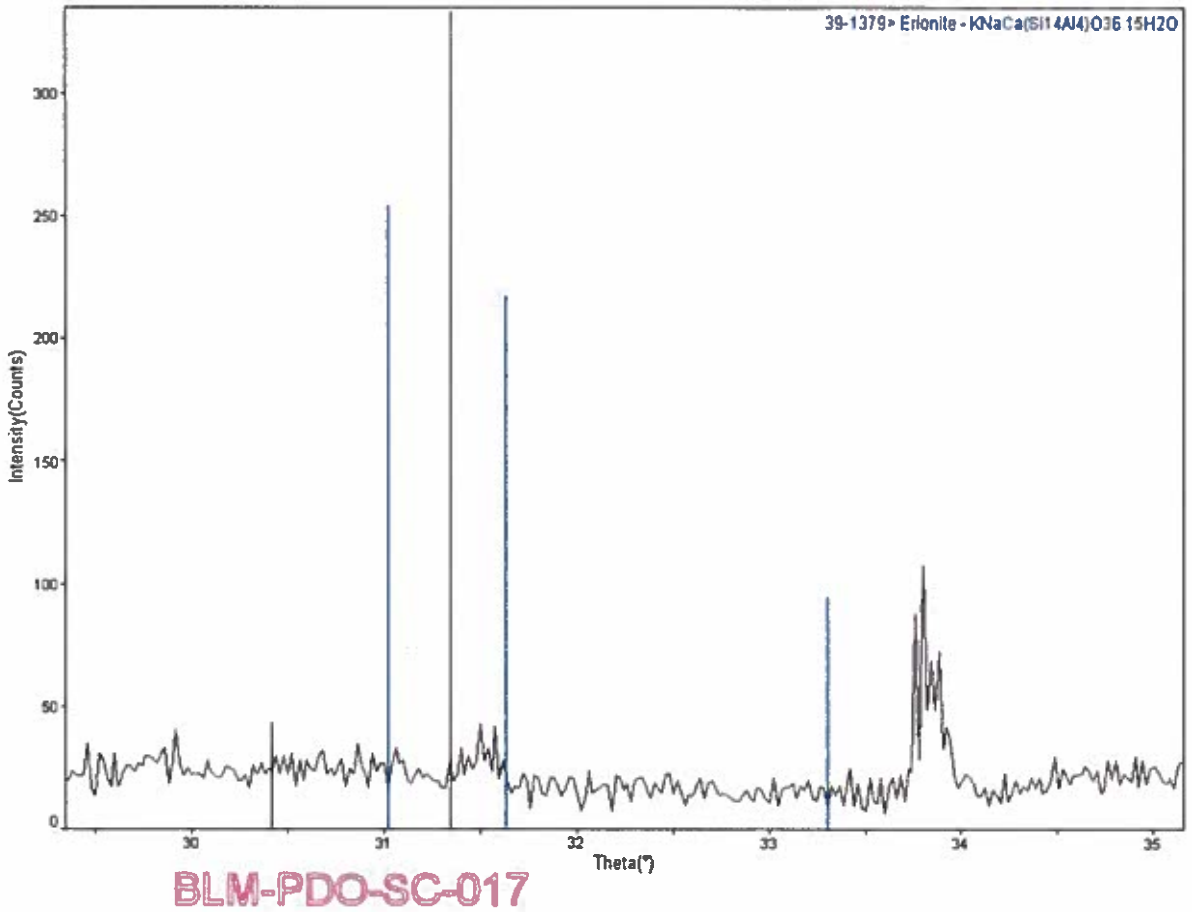

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Figure 15. Detailed XRD pattern of material from sample BLM-PDO-SC-017 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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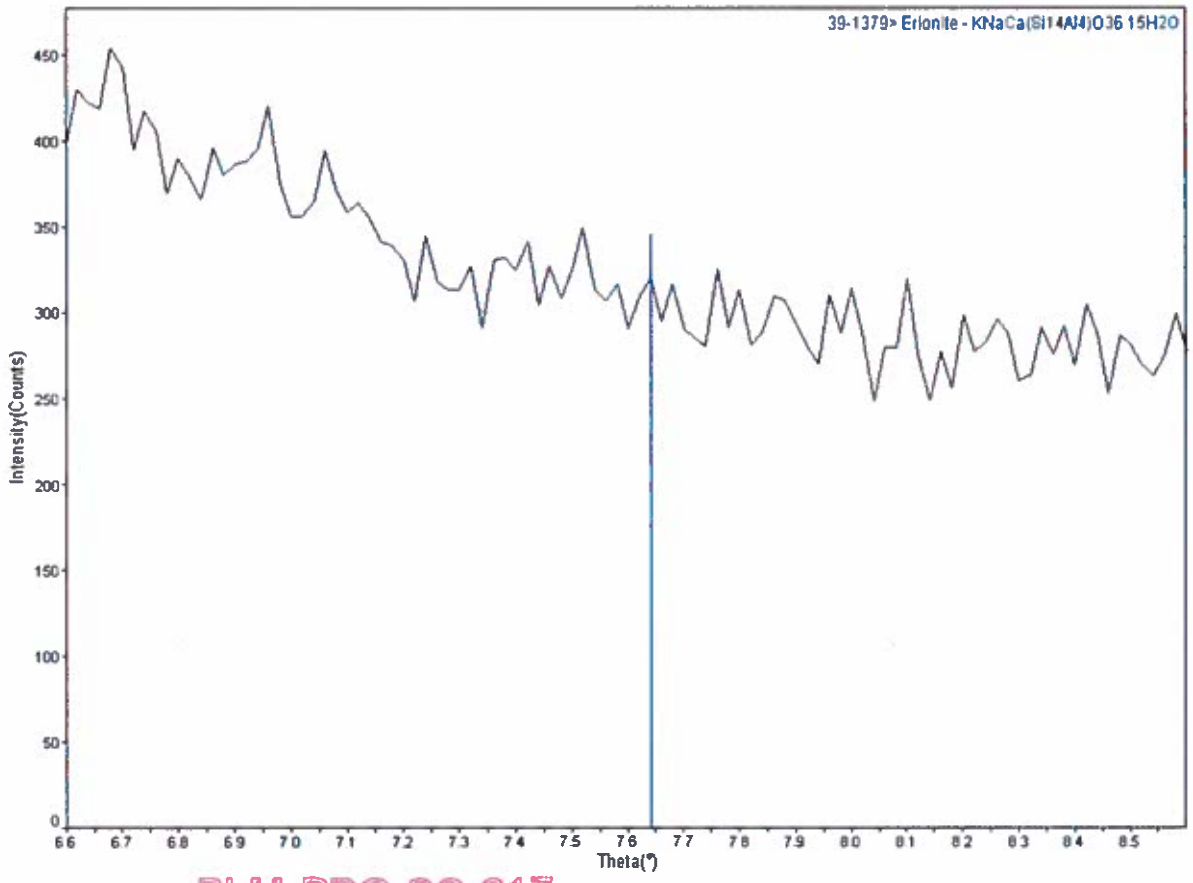

BLM-PDO-SC-017

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Figure 16. XRD slow scan pattern of material from sample BLM-PDO-SC-017 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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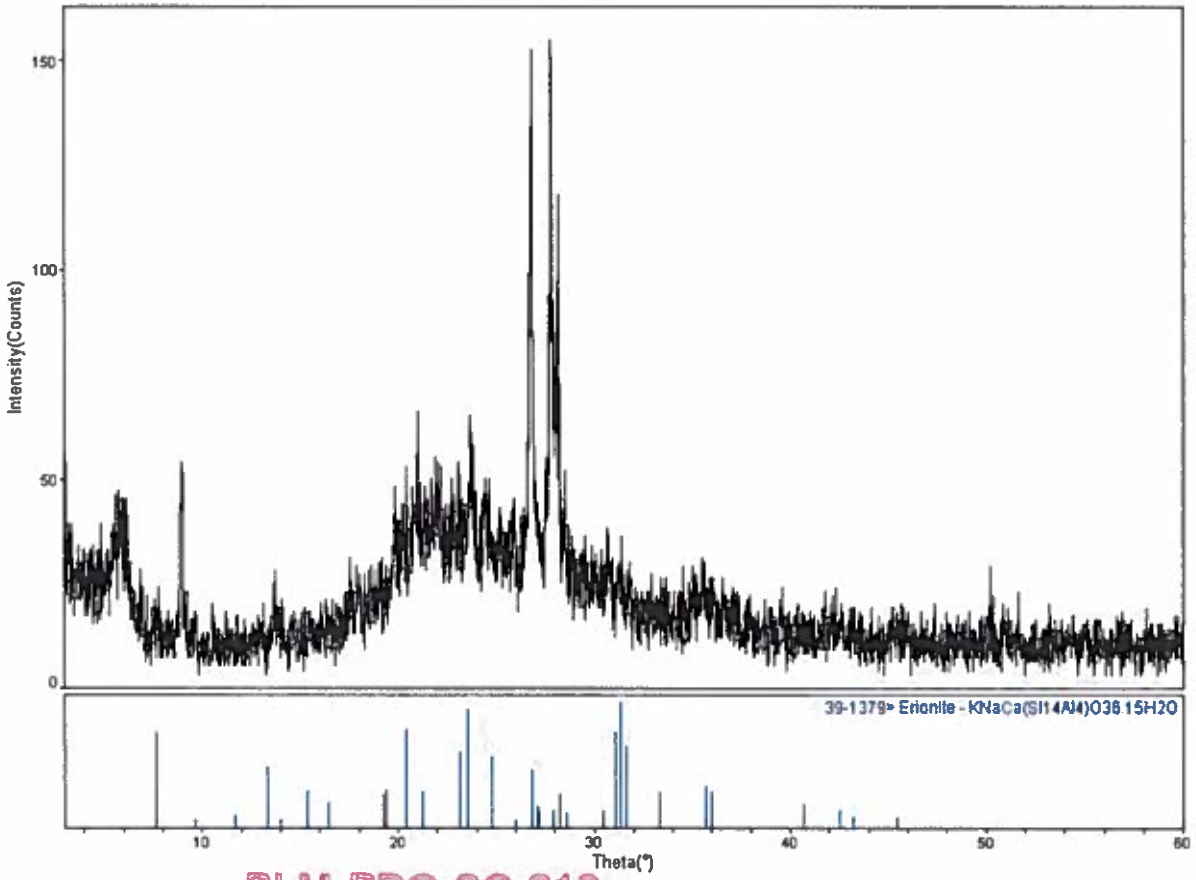

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Figure 17. General XRD pattern of material from sample BLM-PDO-SC-018 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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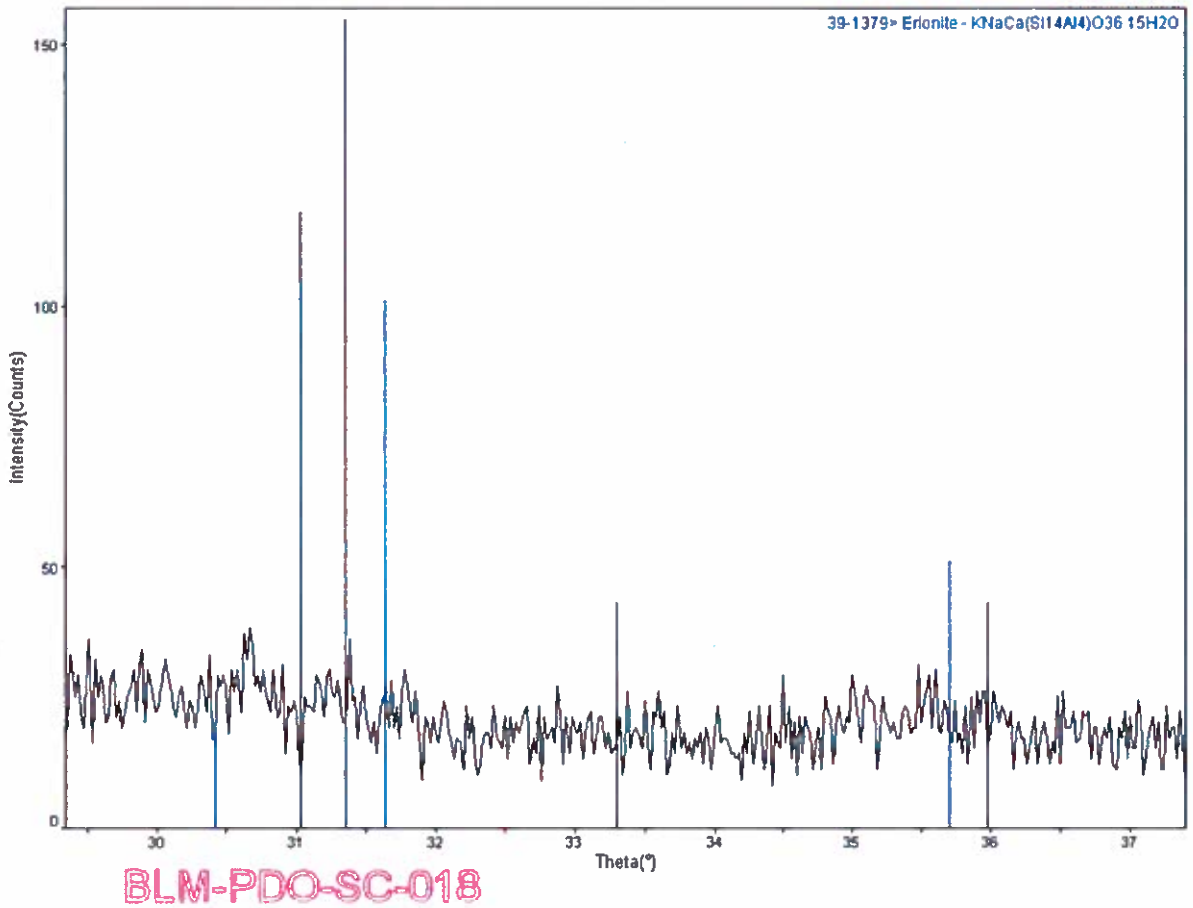

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Figure 18. Detailed XRD pattern of material from sample BLM-PDO-SC-018 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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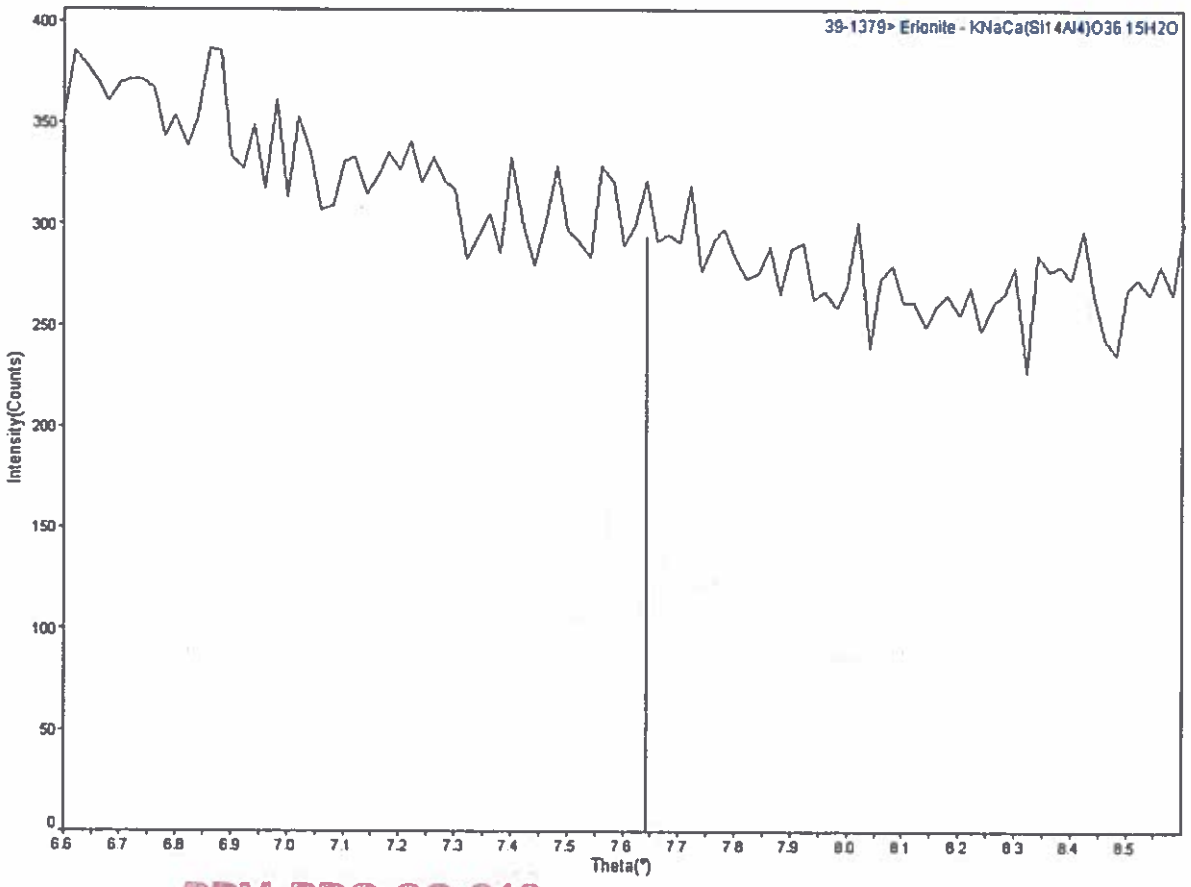

BPM-PDO-SC-018

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Figure 19. XRD slow scan pattern of material from sample BLM-PDO-SC-018 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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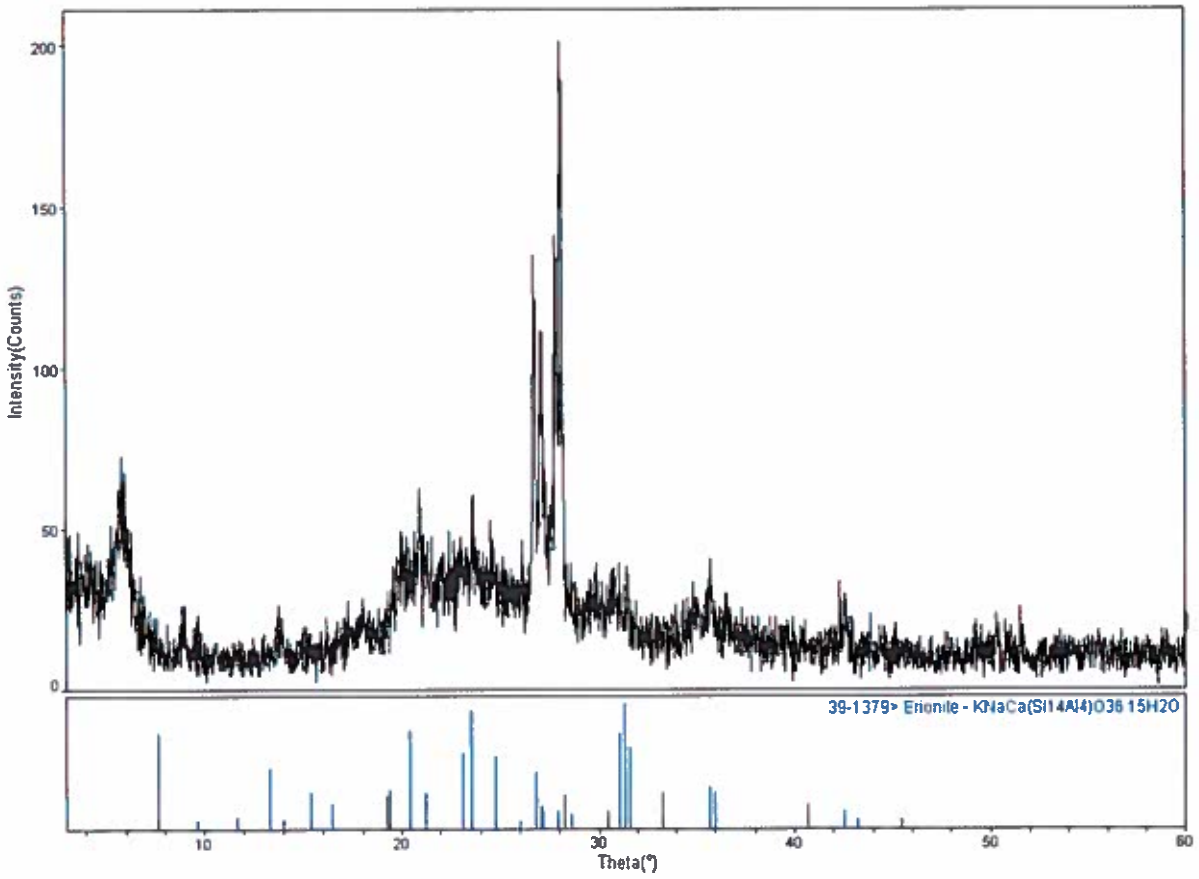

BLM-PDO-SC-021

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Figure 20. General XRD pattern of material from sample BLM-PDO-SC-021 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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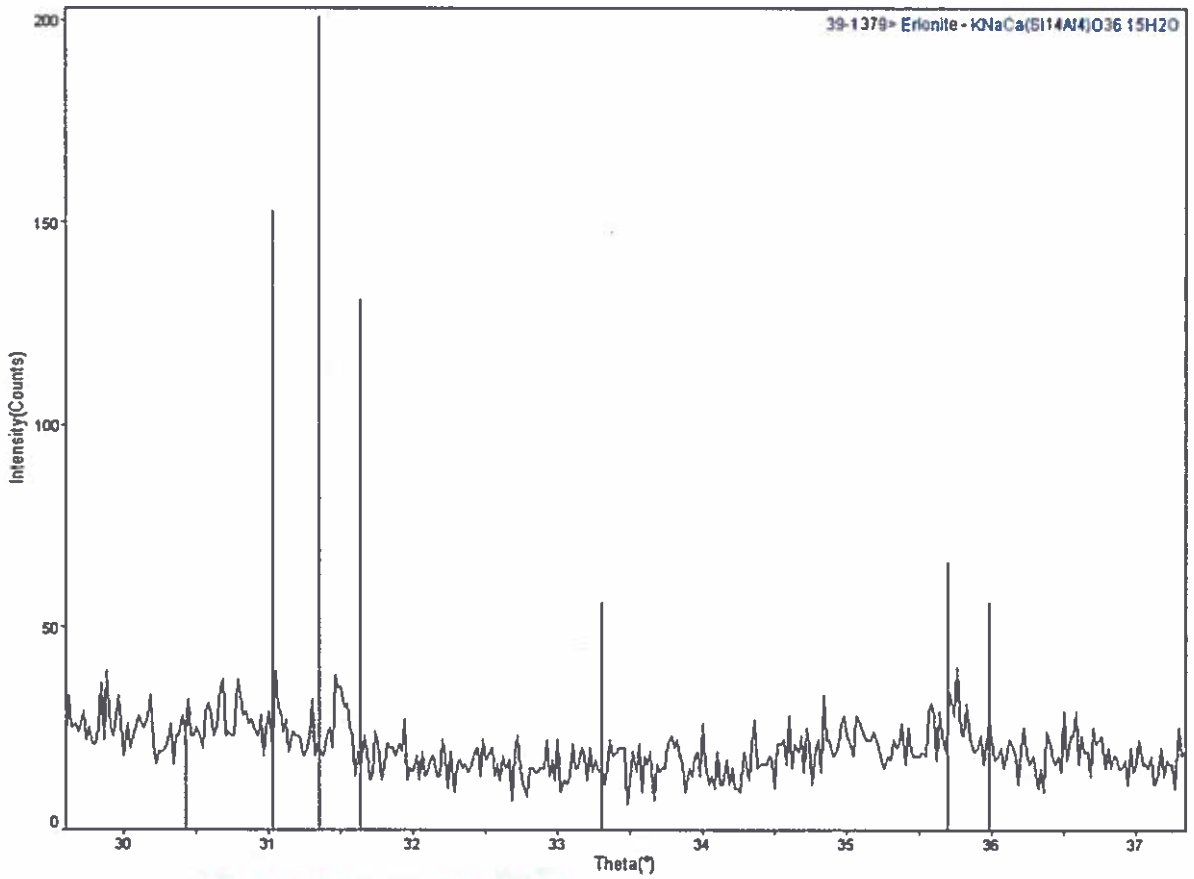

BLM-PDO-SC-021

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Figure 21. Detailed XRD pattern of material from sample BLM-PDO-SC-021 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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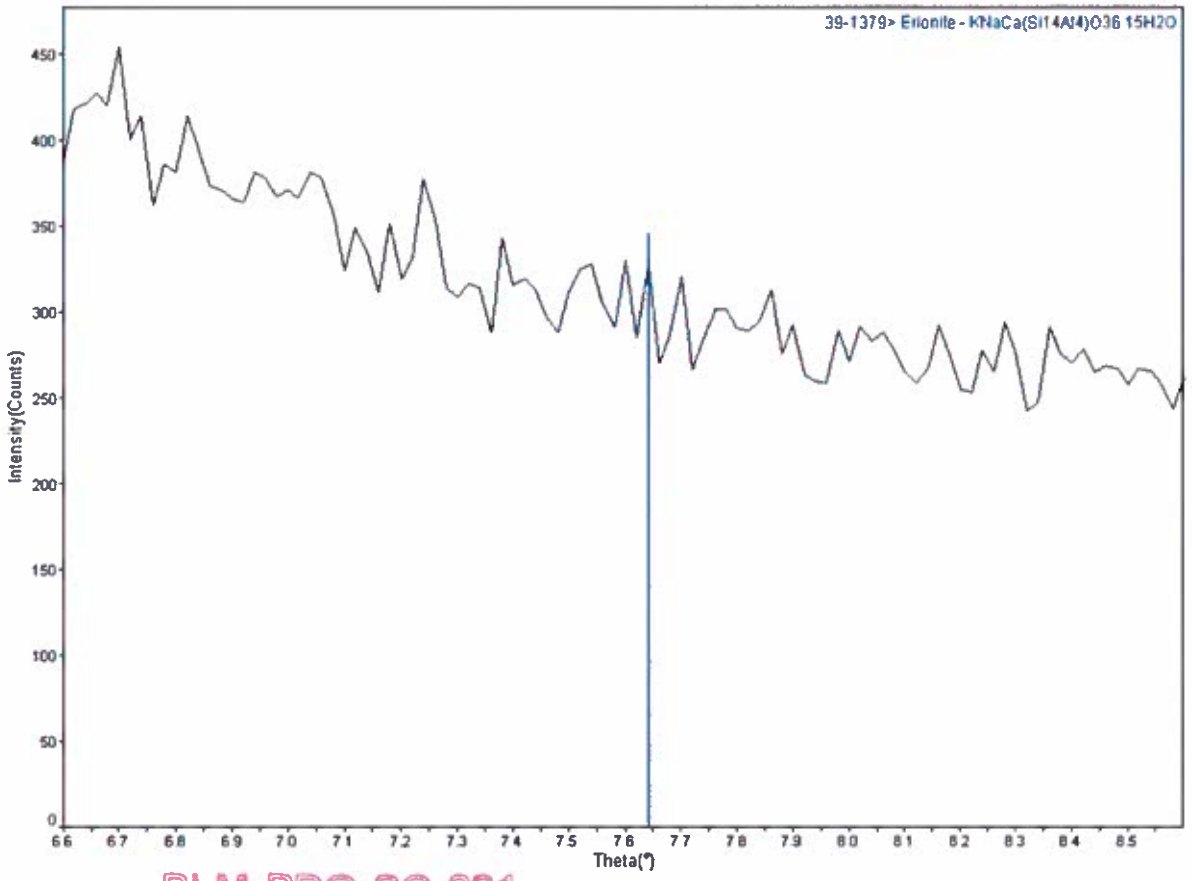

BLM-PDO-SC-021

EMSL Analytical Inc

Figure 22. XRD slow scan pattern of material from sample BLM-PDO-SC-21 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

PDF#39-1379: QM=Common(+); d=Other/Unknown; I=(Unknown)
Erionite
KNaCa(Si14Al4)O36.15H2O
Radiation=CuKa1 Lambda=1.5406 Filter=
Calibration= 2T=7.641-45.449 I/Ic(RIR)=
Ref: Level-1 PDF

Z= mp=
P.S=
Density(c)=Density(m)=Mwt= Vol=
Ref: Ibid.

Strong Lines: 2.85/X 3.77/9 4.35/8 11.56/8 2.88/8 2.83/7 3.84/6
3.59/6

2-Theta	d(Å)	I(f)	h	k	l	Theta	1/(2d)	2pi/d	n^2
7.641	11.5600	76.0				3.821	0.0433	0.5435	
9.627	9.1800	5.0				4.813	0.0545	0.6844	
11.711	7.5500	9.0				5.856	0.0662	0.8322	
13.303	6.6500	48.0				6.652	0.0752	0.9448	
14.024	6.3100	6.0				7.012	0.0792	0.9958	
15.370	5.7600	28.0				7.685	0.0868	1.0908	
16.432	5.3900	20.0				8.216	0.0928	1.1657	
19.279	4.6000	26.0				9.640	0.1087	1.3659	
19.364	4.5800	30.0				9.682	0.1092	1.3719	
20.399	4.3500	78.0				10.199	0.1149	1.4444	
21.238	4.1800	28.0				10.619	0.1196	1.5032	
23.149	3.8390	60.0				11.575	0.1302	1.6367	
23.573	3.7710	94.0				11.786	0.1326	1.6662	
24.808	3.5860	57.0				12.404	0.1394	1.7521	
26.009	3.4230	5.0				13.005	0.1461	1.8356	
26.806	3.3230	45.0				13.403	0.1505	1.8908	
27.072	3.2910	17.0				13.536	0.1519	1.9092	
27.190	3.2770	13.0				13.595	0.1526	1.9174	
27.919	3.1930	13.0				13.960	0.1566	1.9678	
28.281	3.1530	26.0				14.141	0.1586	1.9928	
28.568	3.1220	11.0				14.284	0.1602	2.0126	
30.420	2.9360	13.0				15.210	0.1703	2.1400	
31.026	2.8800	76.0				15.513	0.1736	2.1817	
31.350	2.8510	100.0				15.675	0.1754	2.2039	
31.634	2.8260	65.0				15.817	0.1769	2.2233	
33.305	2.6880	28.0				16.652	0.1860	2.3375	
35.699	2.5130	33.0				17.850	0.1990	2.5003	
35.980	2.4940	28.0				17.990	0.2005	2.5193	
40.700	2.2150	19.0				20.350	0.2257	2.8367	
42.506	2.1250	13.0				21.253	0.2353	2.9568	
43.231	2.0910	7.0				21.616	0.2391	3.0049	
45.449	1.9940	7.0				22.724	0.2508	3.1510	

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Descriptions & Definitions:

None Detected (ND) denotes the absence of analyte in the subsample analyzed. Trace levels of the analyte may be present in the sample below the limit of detection (LOD).

Limit of Detection (LOD): The minimum concentration that can be theoretically achieved for a given analytical procedure in the absence of matrix or sample processing effects. Particle analysis is limited to a single occurrence of an analyte particle in the sub-sample analyzed.

Limit of Quantitation (LOQ): The minimum concentration of an analyte that can be measured within specified limits of precision and accuracy during routine laboratory operating conditions

Concentrations for bulk samples are derived from Visual Area Estimation (VAE) unless otherwise noted. Air sample concentrations are calculated to particles per unit volume.

VAE technique estimates the relative projected area of a certain type of particulate from a mixture of particulate by comparison to data derived from analysis of calibration materials having similar texture and particulate content. Due to bi-dimensional nature of the measurements, in some cases the particle thickness could affect the results.

Important Terms, Conditions, and Limitations:

Sample Retention: Samples analyzed by EMSL will be retained for 60 days after analysis date. Storage beyond this period is available for a fee with written request prior to the initial 30 day period. Samples containing hazardous/toxic substances which require special handling may be returned to the client immediately. EMSL reserves the right to charge a sample disposal or return shipping fee.

Change Orders and Cancellation: All changes in the scope of work or turnaround time requested by the client after sample acceptance must be made in writing and confirmed in writing by EMSL. If requested changes result in a change in cost the client must accept payment responsibility. In the event work is cancelled by a client, EMSL will complete work in progress and invoice for work completed to the point of cancellation notice. EMSL is not responsible for holding times that are exceeded due to such changes.

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The data and other information contained in this report, as well as any accompanying documents, represent only the samples analyzed. They are reported upon the condition that they are not to be reproduced wholly or in part for advertising or other purposes without the written approval from the laboratory.

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Bureau of Land Management
21605 N 7th Ave
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Phone: 623-580-5500

EMSL Order ID.: 361701939
Sample(s) Received: 9/6/2017
Date of Reporting: 10/6/2017
Date Printed: 10/6/2017
Reported By: E. Mirica
Email: scave@blm.gov

- Laboratory Report -

Material Identification/Erionite

Project: KMC AZA-37212 ~~1st Submittal~~

Conclusions:

- No Erionite was fond in the samples by powder X-ray Diffraction analysis.

Procurement of Samples and Analytical Overview:

The samples for analysis (six, bulk) arrived at EMSL Analytical (Cinnaminson, NJ) on September 6, 2017. The package arrived in satisfactory condition with no evidence of damage to the contents. The purpose of the analysis is to determine the presence of Erionite (mineral in the zeolite group /hydrated alumino-silicates of the alkaline and alkaline-earth metals). The data reported herein has been obtained using the following equipment and methodologies.

Methods & Equipment: Rigaku Ultima-IV X-ray diffraction system with Cu X-ray tube and scintillation counter
X-ray Diffraction (XRD)

Ref: S. J. Chipera, D.L Bish, The Occurrence and Distribution of Erionite at Yucca Mountain, Nevada, DOE Contract No: W-7405-ENG-36

Analyzed by: *Eugenia Mirica, Ph.D.*
Laboratory Manager
October 6, 2017
Date

Reviewed/Approved: *Jian Hu, Ph.D.*
Senior Scientist
October 6, 2017
Date

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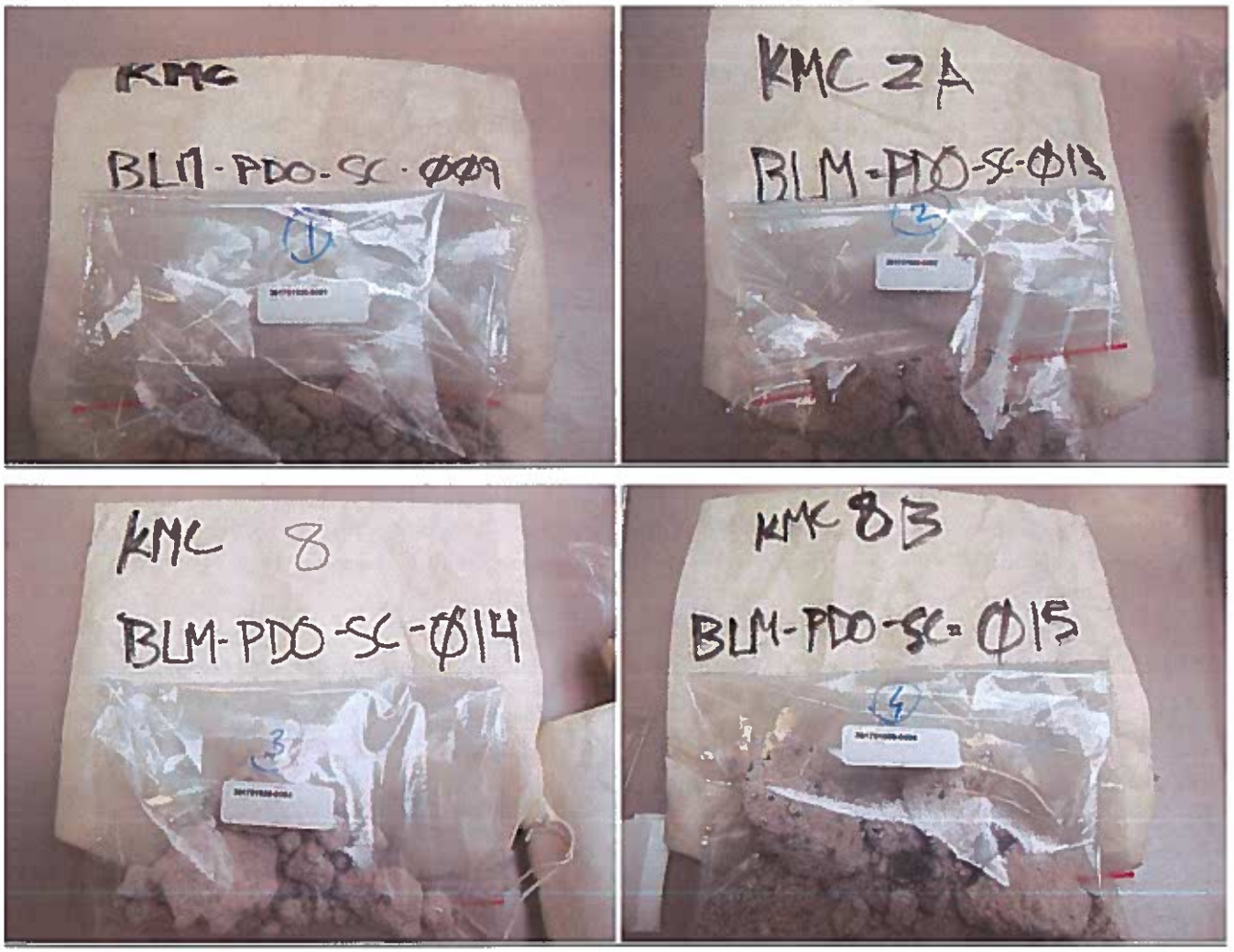

Figure 1: Images of the as-received samples.

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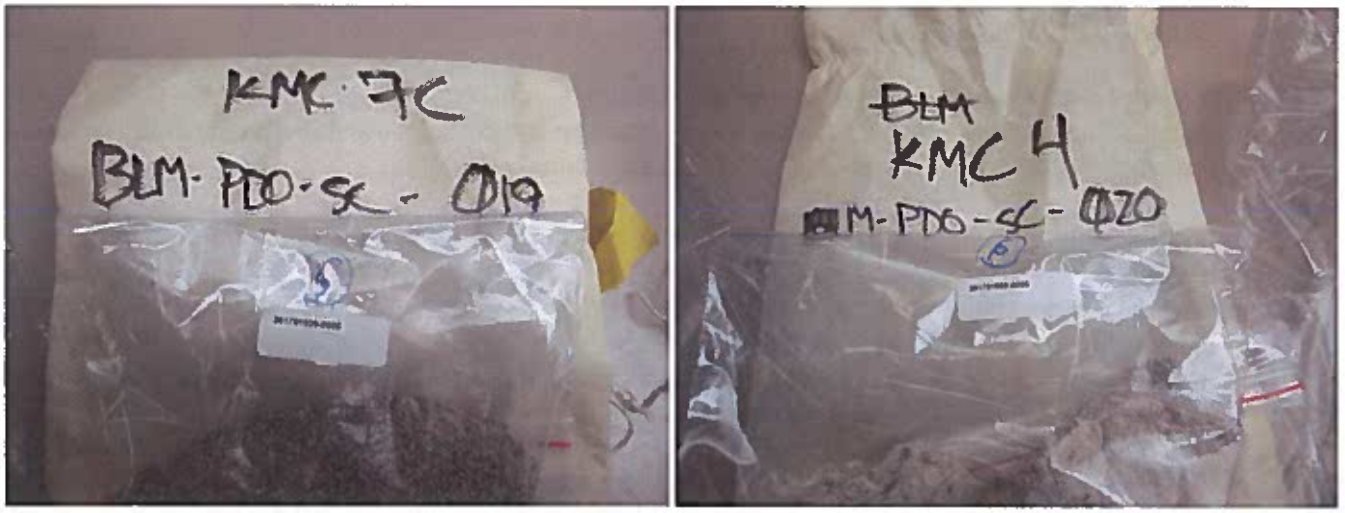

Figure 1: Images of the as-received samples (Cont'd.)

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Background and Sample Preparation:

The full amount of each of the as-received samples (see Figure 1) was milled to 250 µm nominal size using a puck mill. An aliquot of the material from each sample was sieved using 250 µm screen and packed onto bulk sample holders for analysis. XRD patterns were obtained using the following conditions:

- A qualitative general scan was performed at 2θ angle range from 3° to 60° at a step size of 0.02° and dwell time of 1 second.
- A higher sensitivity qualitative slow scan was performed at 2θ angle range from 6.6° to 8.6° at a step size of 0.02° and dwell time of 10 seconds in order to determine the presence of the 7.641° 2θ angle Erionite peak; this peak was selected due to its location away from the 31°- 32° 2θ angle region where the main Erionite peaks reside; these peaks are typically prone to inferences with other common minerals.

The patterns were analyzed using JADE data processing software and ICDD (International Center for Diffraction Data) to verify the presence of Erionite. The conclusion regarding presence or absence of Erionite was based on the presence or absence of the main peaks for Erionite according to the available ICDD-PDF database at EMSL Analytical, Inc. (PDF # 39-1379 on Page 27). One subsample was prepared and analyzed for each submitted sample.

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Summary of Results:

Table 1. Results for the analysis based on XRD screening analysis (XRD patterns in Figures 2-18).

Sample ID	*Description*	*Analyte*	*Identification*	*Comments*
BLM-PDO-SC-009 361701939-0001	Unconsolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-013 361701939-0002	Unconsolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-014 361701939-0003	Unconsolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-015 361701939-0004	Unconsolidated rhyolithic lithic tuff	Erionite	None Detected	A
BLM-PDO-SC-019 361701939-0005	Unconsolidated tuffaceous volcanoclastic sediment	Erionite	None Detected	A
BLM-PDO-SC-020 361701939-0006	Unconsolidated rhyolithic lithic tuff	Erionite	None Detected	A

Comments:

A: The sensitivity of the screening method is estimated approximately 1% if no interference is present.

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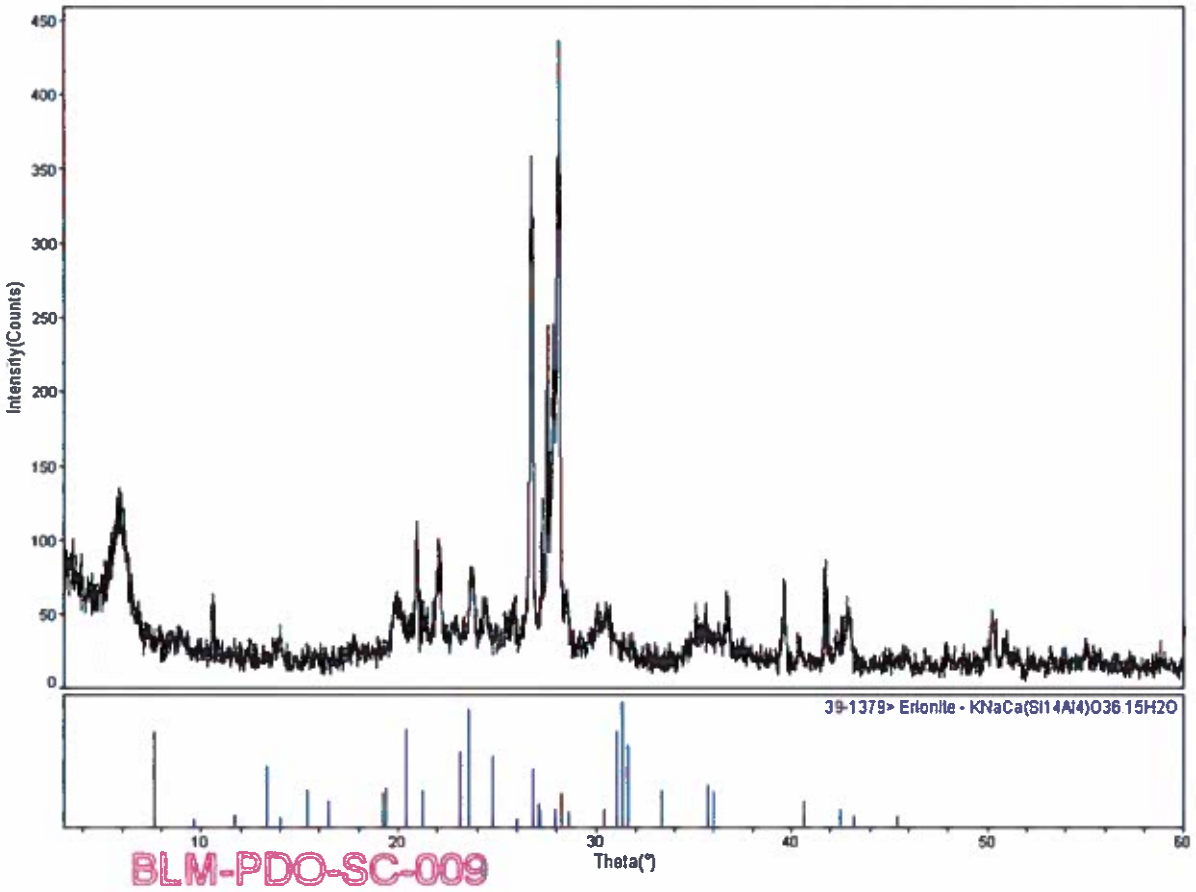

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Figure 2. General XRD pattern of material from sample BLM-PDO-SC-009 compared to the PDF # 39-1379 for Erionite. No peaks associated with Erionite were found.

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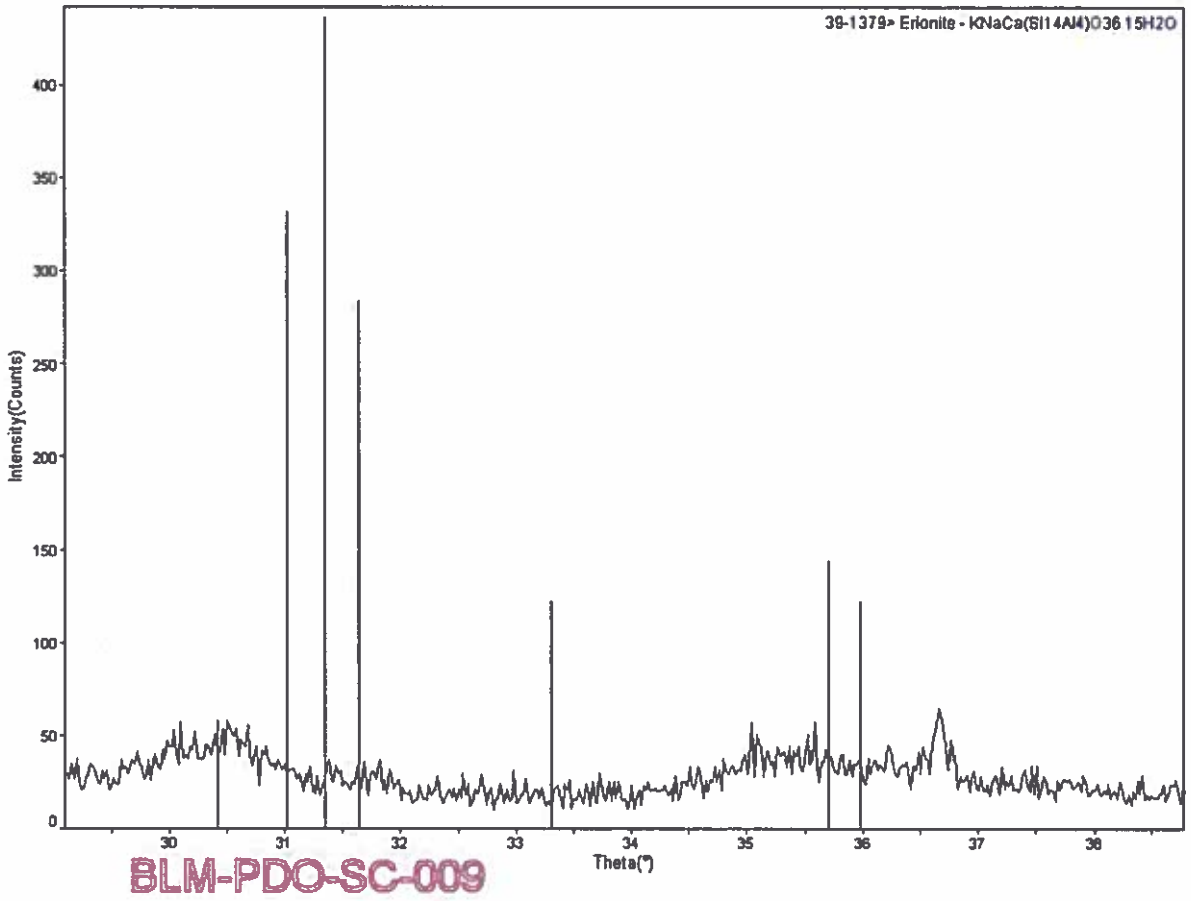

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Figure 3. Detailed XRD pattern of material from sample BLM-PDO-SC-009 in the area of the major peaks for Erionite as listed in PDF # 39-1379.

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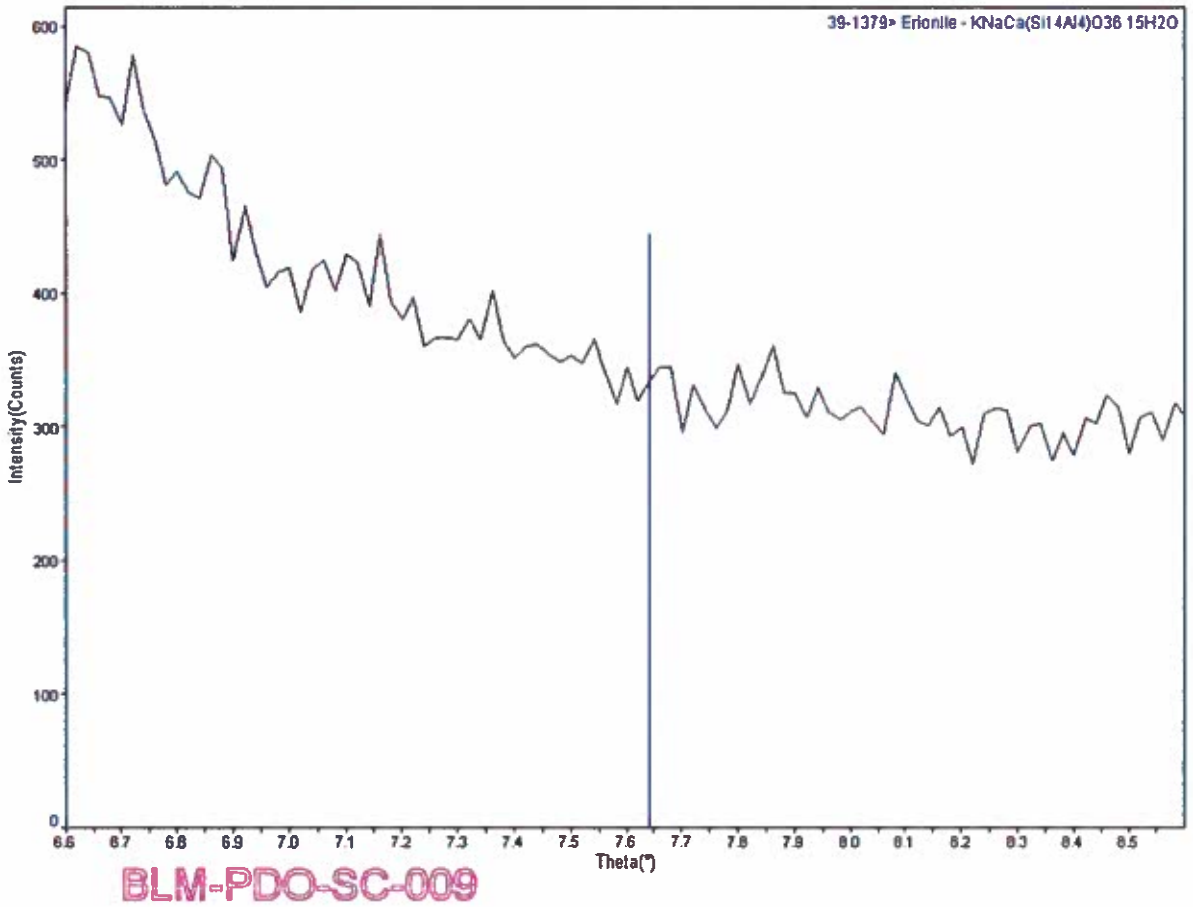

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Figure 4. XRD slow scan pattern of material from sample BLM-PDO-SC-009 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF # 39-1379.

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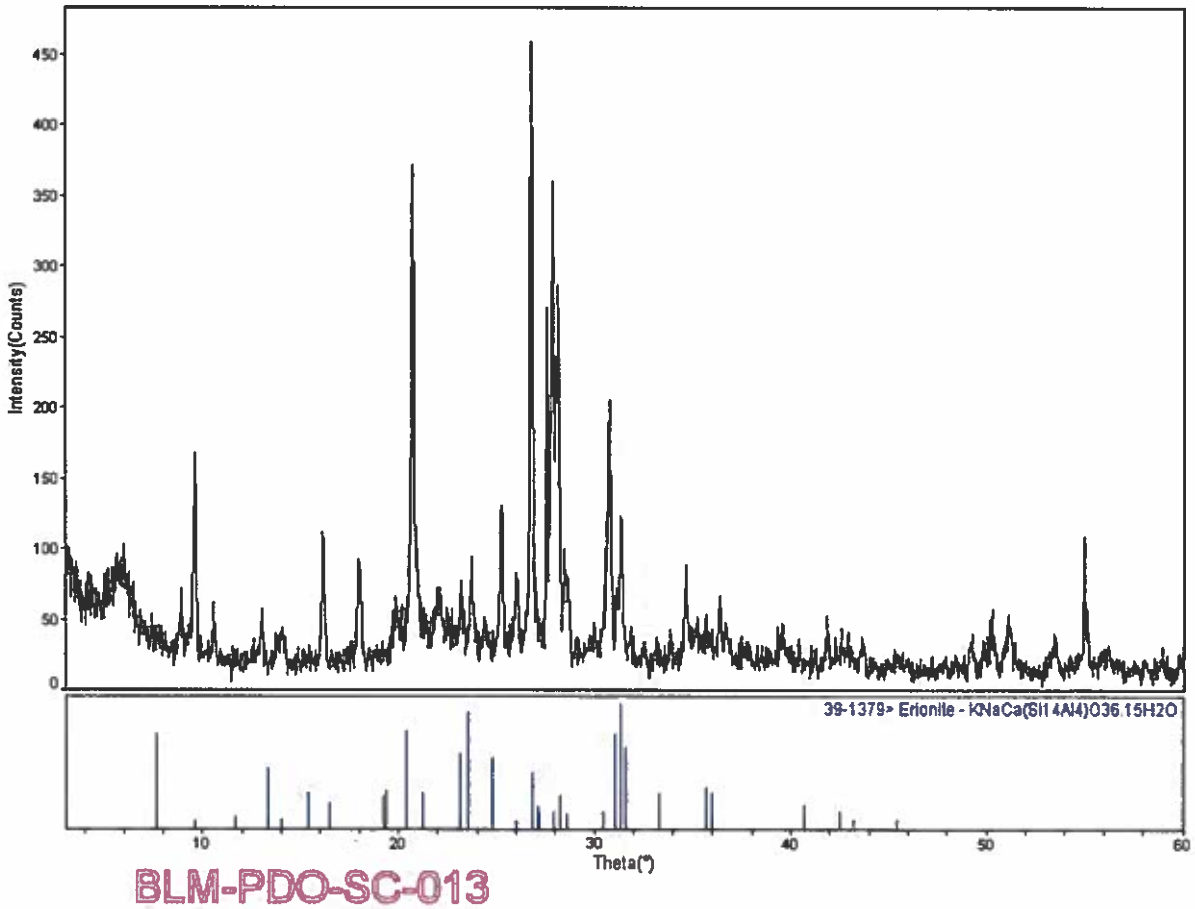

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Figure 5. General XRD pattern of material from sample BLM-PDO-SC-013 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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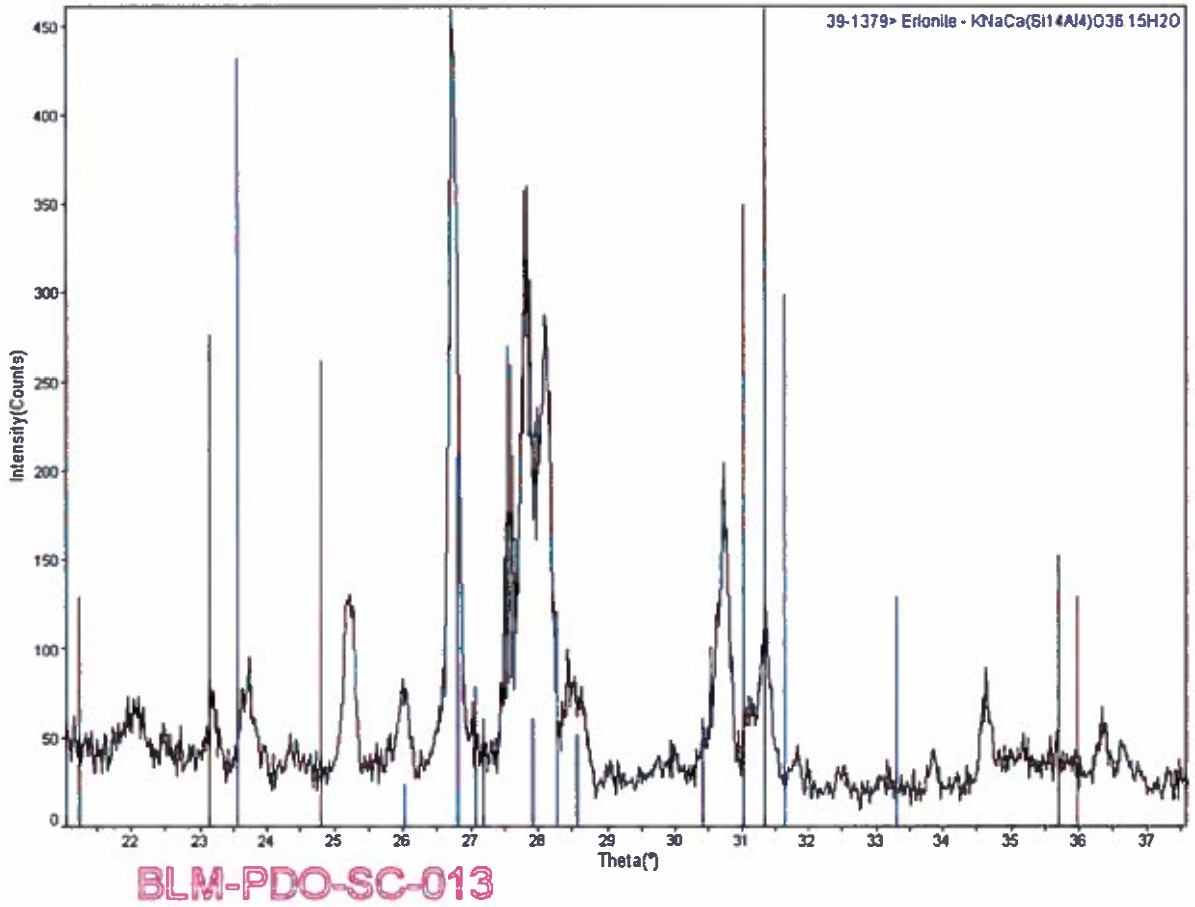

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Figure 6. Detailed XRD pattern of material from sample BLM-PDO-SC-013 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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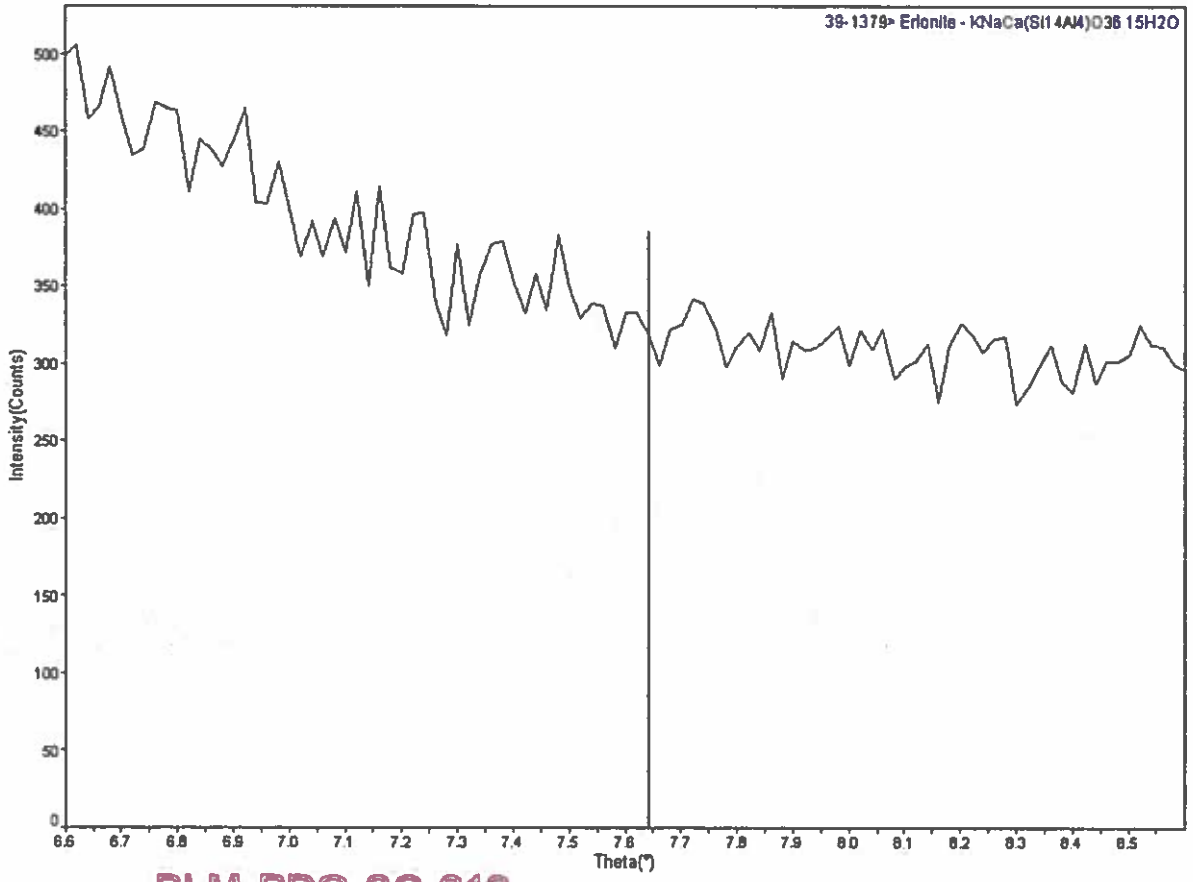

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Figure 7. XRD slow scan pattern of material from sample BLM-PDO-SC-013 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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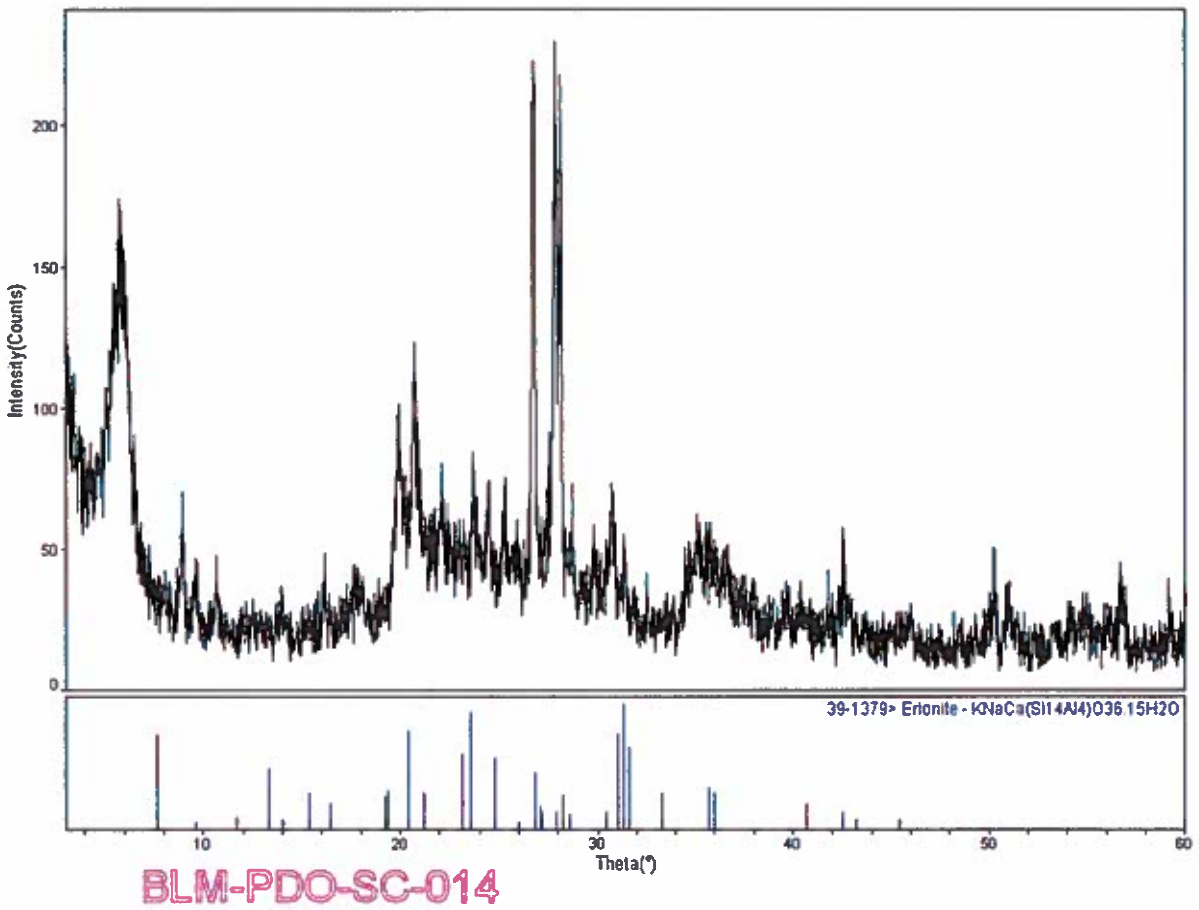

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Figure 8. General XRD pattern of material from sample BLM-PDO-SC-014 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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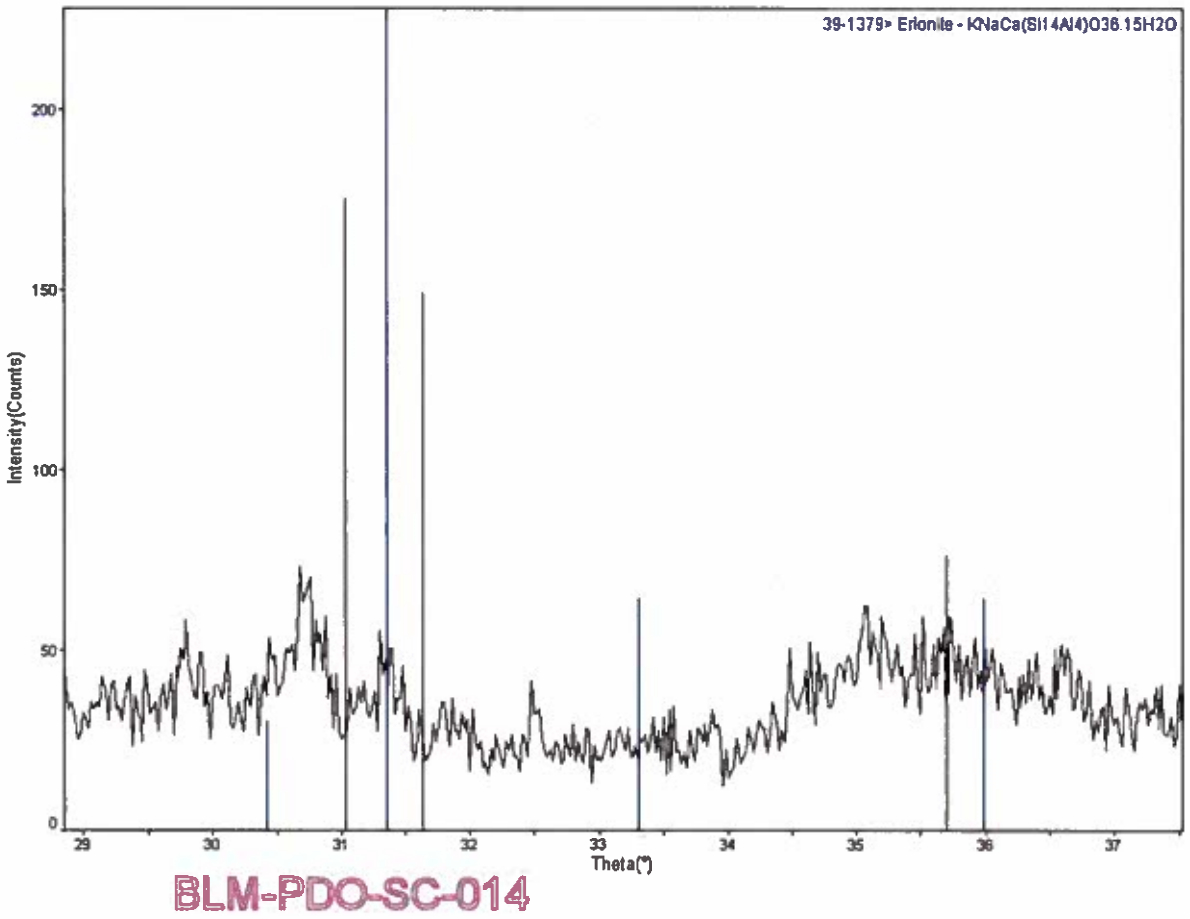

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Figure 9. Detailed XRD pattern of material from sample BLM-PDO-SC-014 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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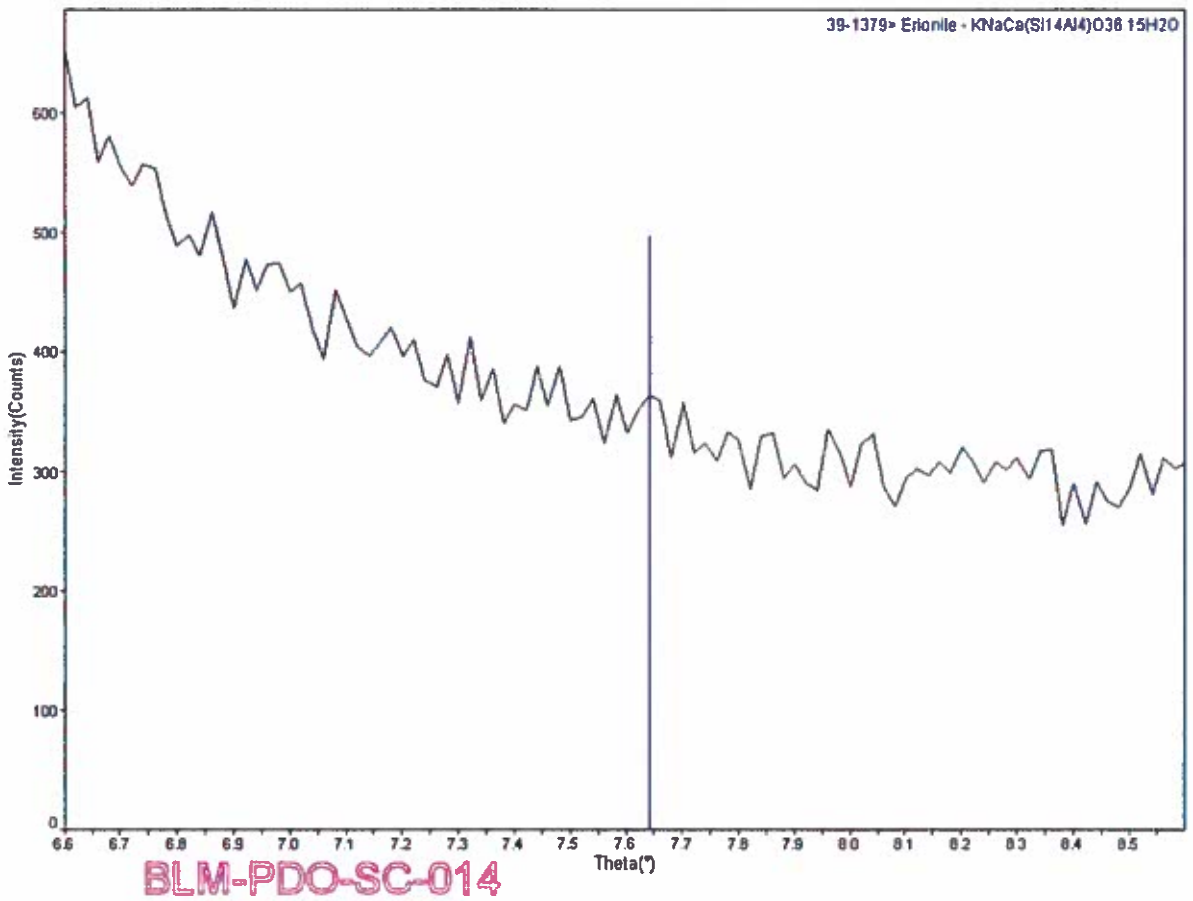

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Figure 10. XRD slow scan pattern of material from sample BLM-PDO-SC-014 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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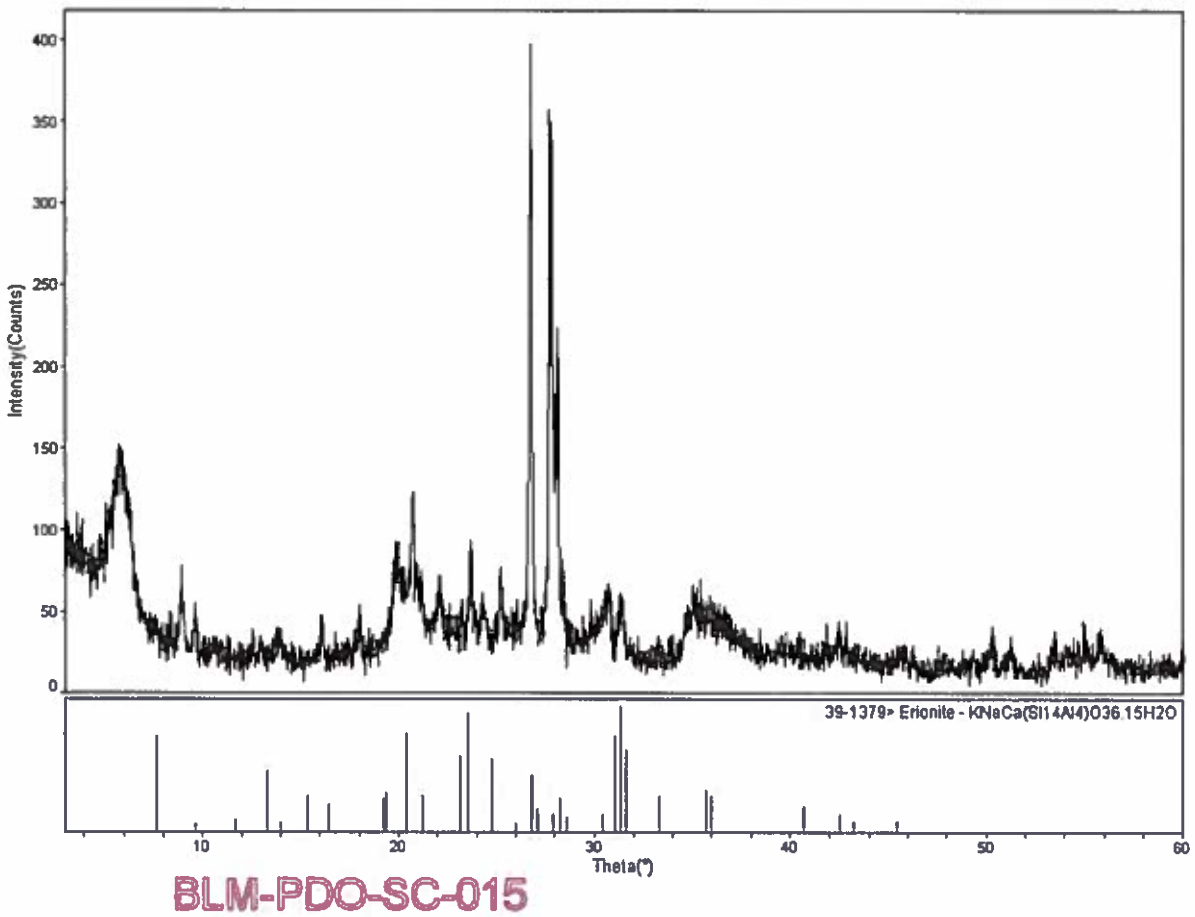

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Figure 11. General XRD pattern of material from sample BLM-PDO-SC-015 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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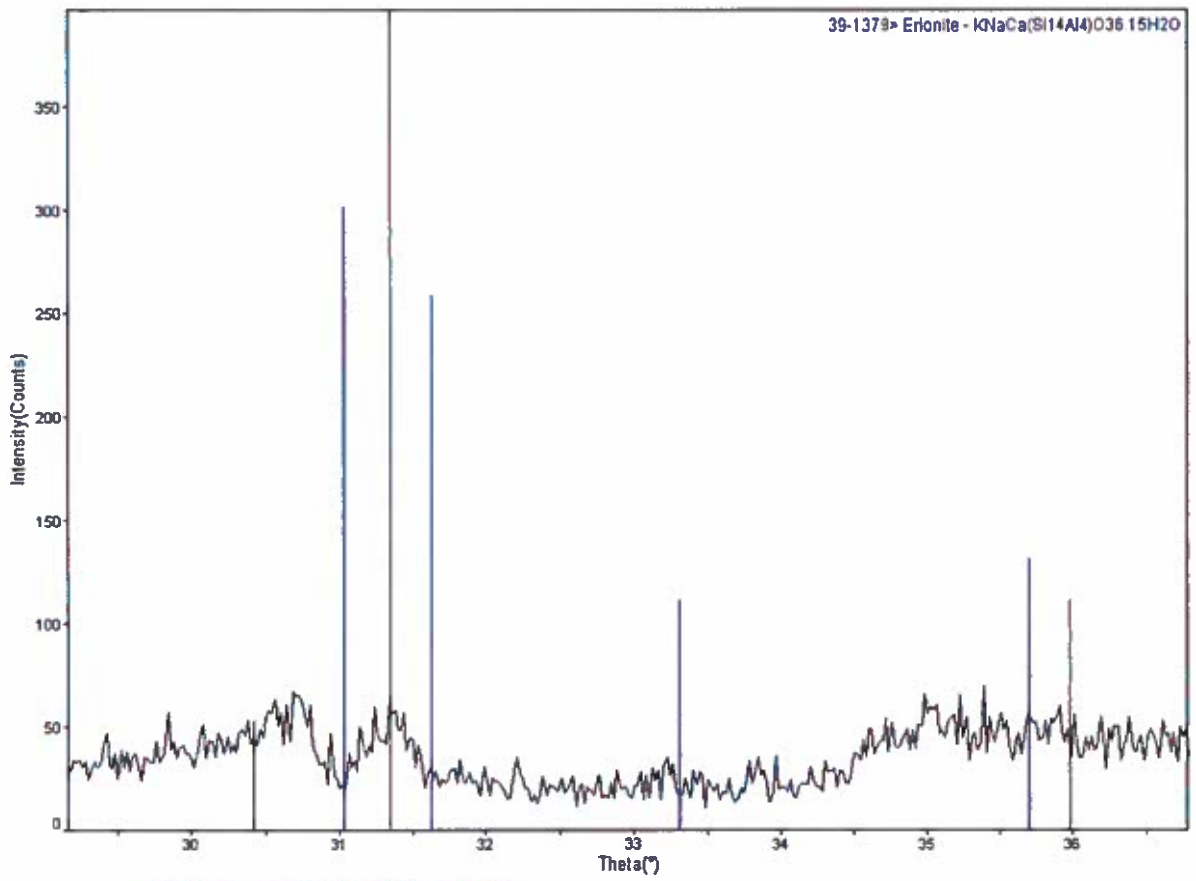

BLM-PDO-SC-015

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Figure 12. Detailed XRD pattern of material from sample BLM-PDO-SC-015 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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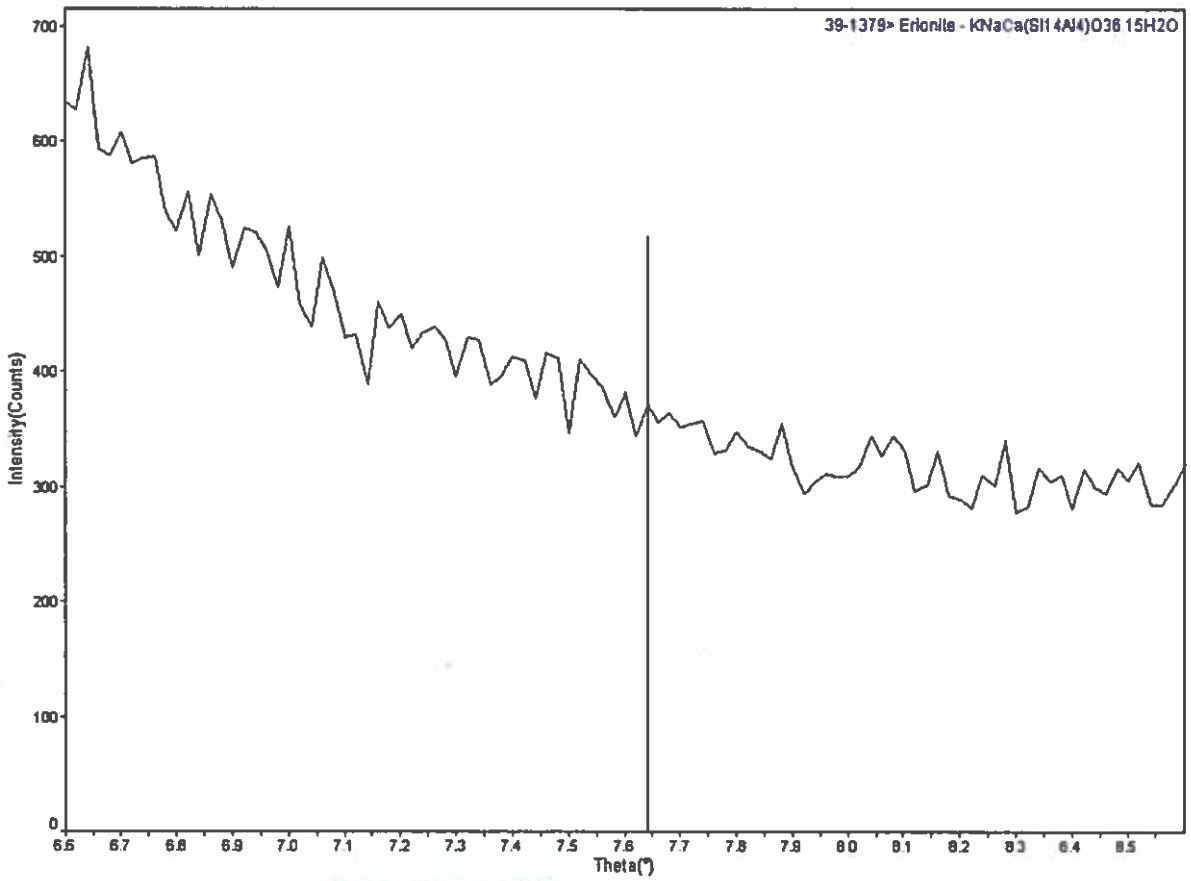

BLM-PDO-SC-015

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Figure 13. XRD slow scan pattern of material from sample BLM-PDO-SC-015 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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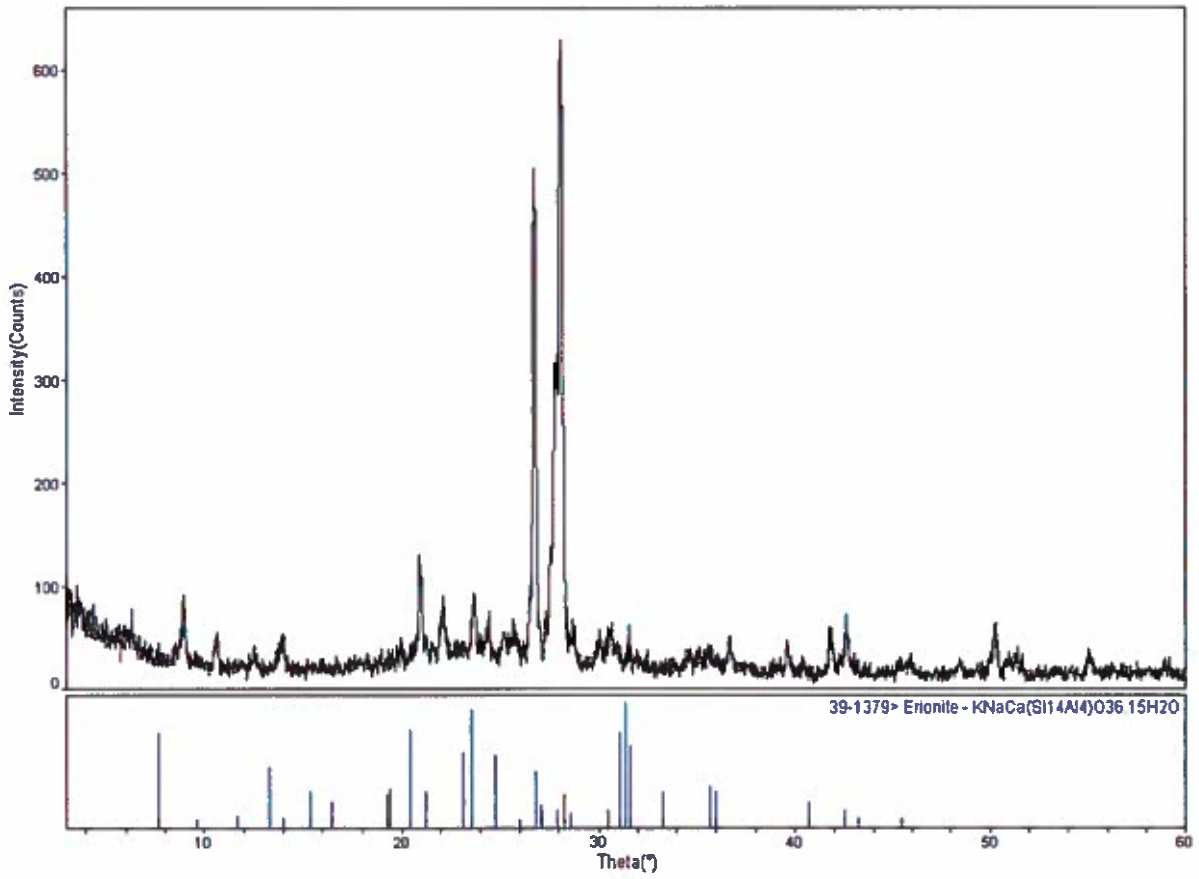

BLM-PDO-SC-019

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Figure 14. General XRD pattern of material from sample BLM-PDO-SC-019 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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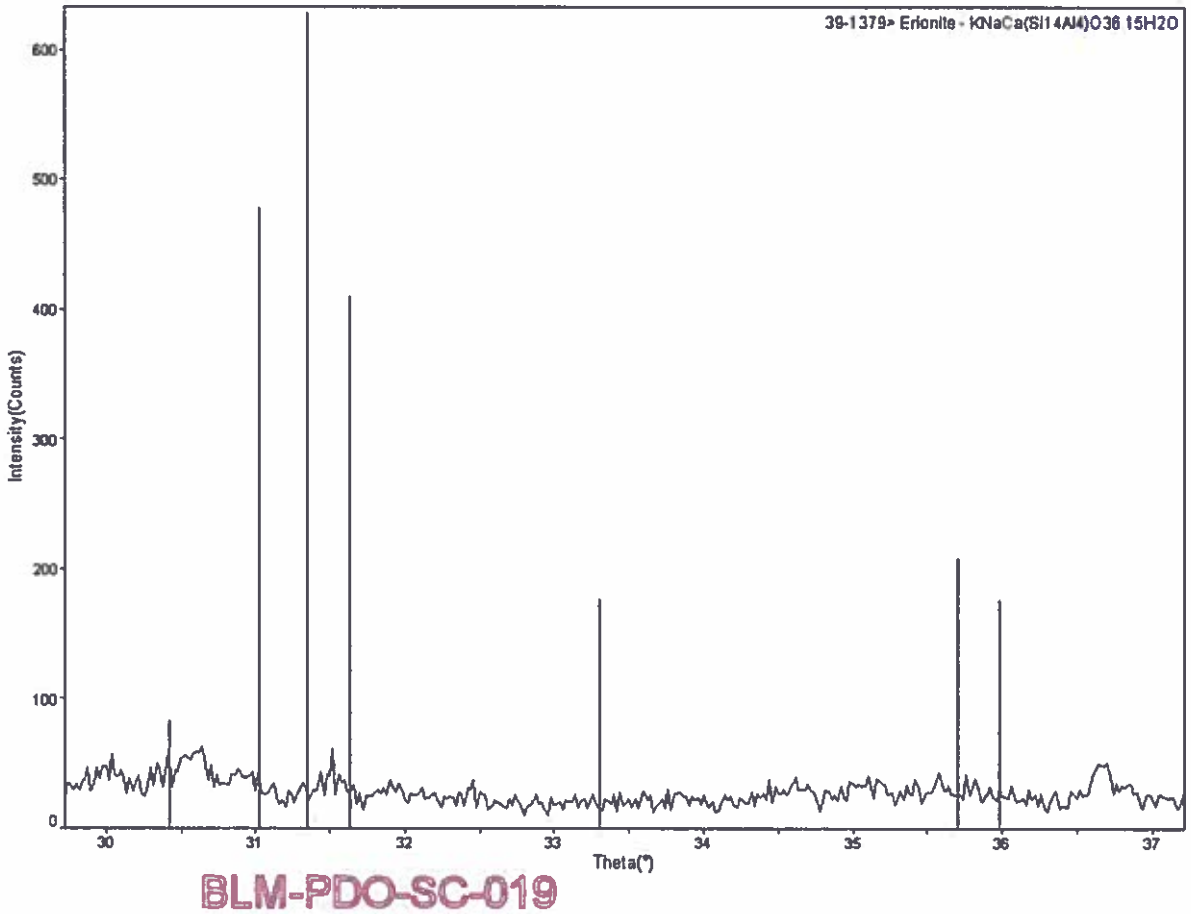

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Figure 15. Detailed XRD pattern of material from sample BLM-PDO-SC-019 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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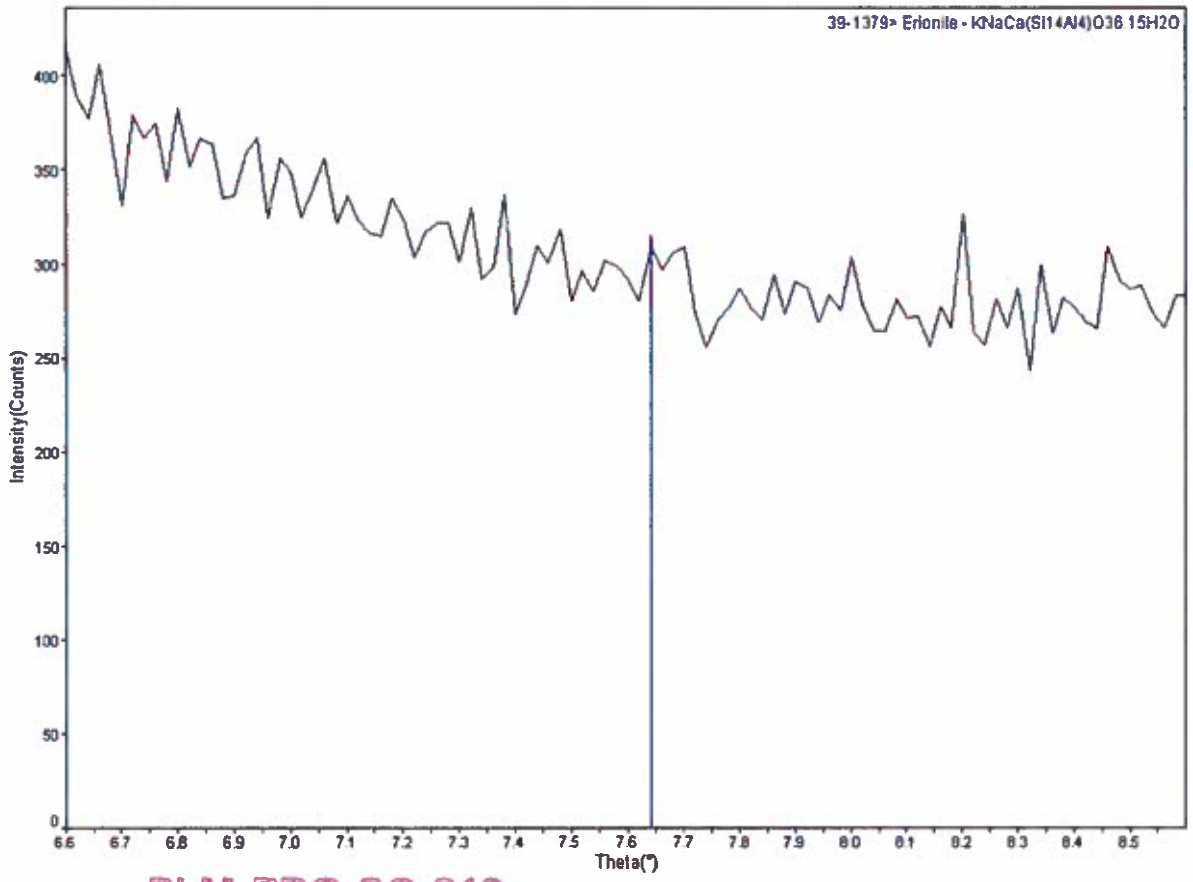

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Figure 16. XRD slow scan pattern of material from sample BLM-PDO-SC-019 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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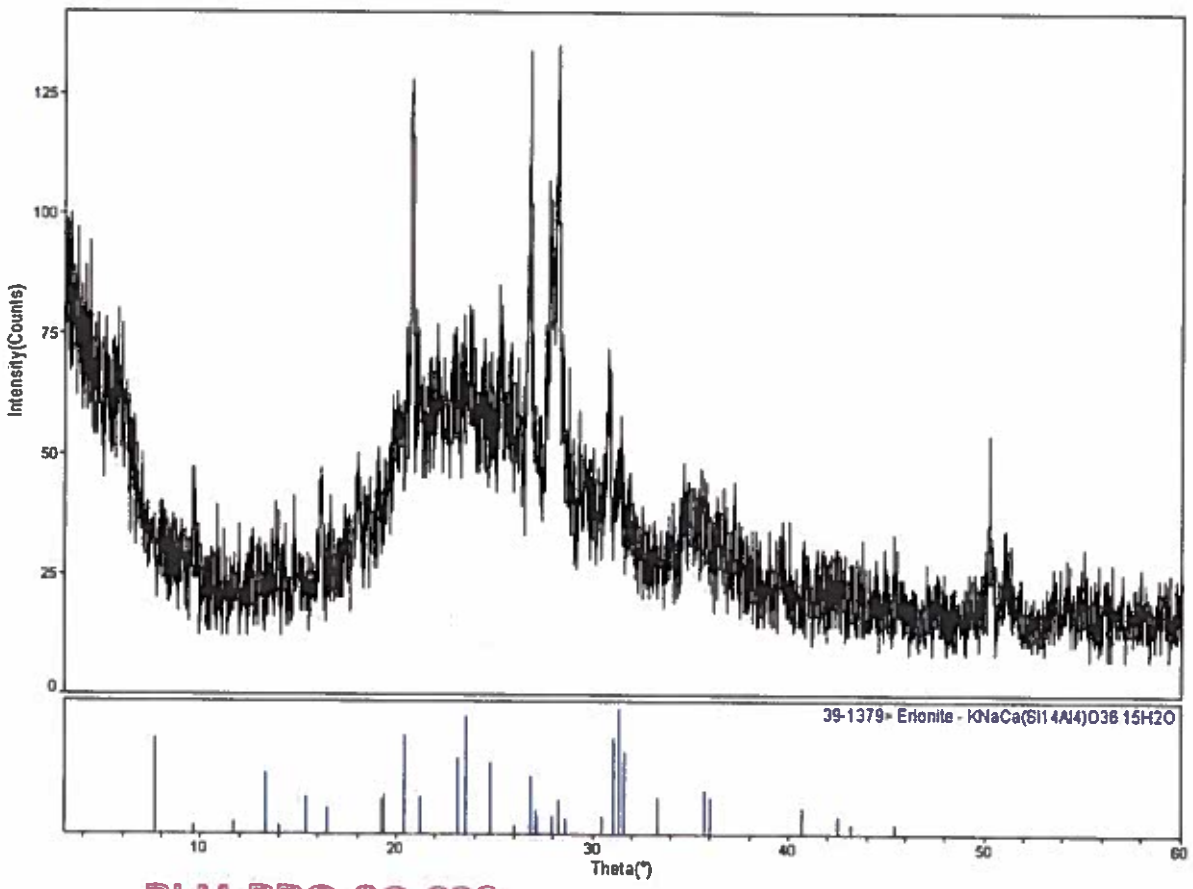

BLM-PDO-SC-020

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Figure 17. General XRD pattern of material from sample BLM-PDO-SC-020 compared to PDF# 39-1379 for Erionite. No peaks associated with Erionite were found.

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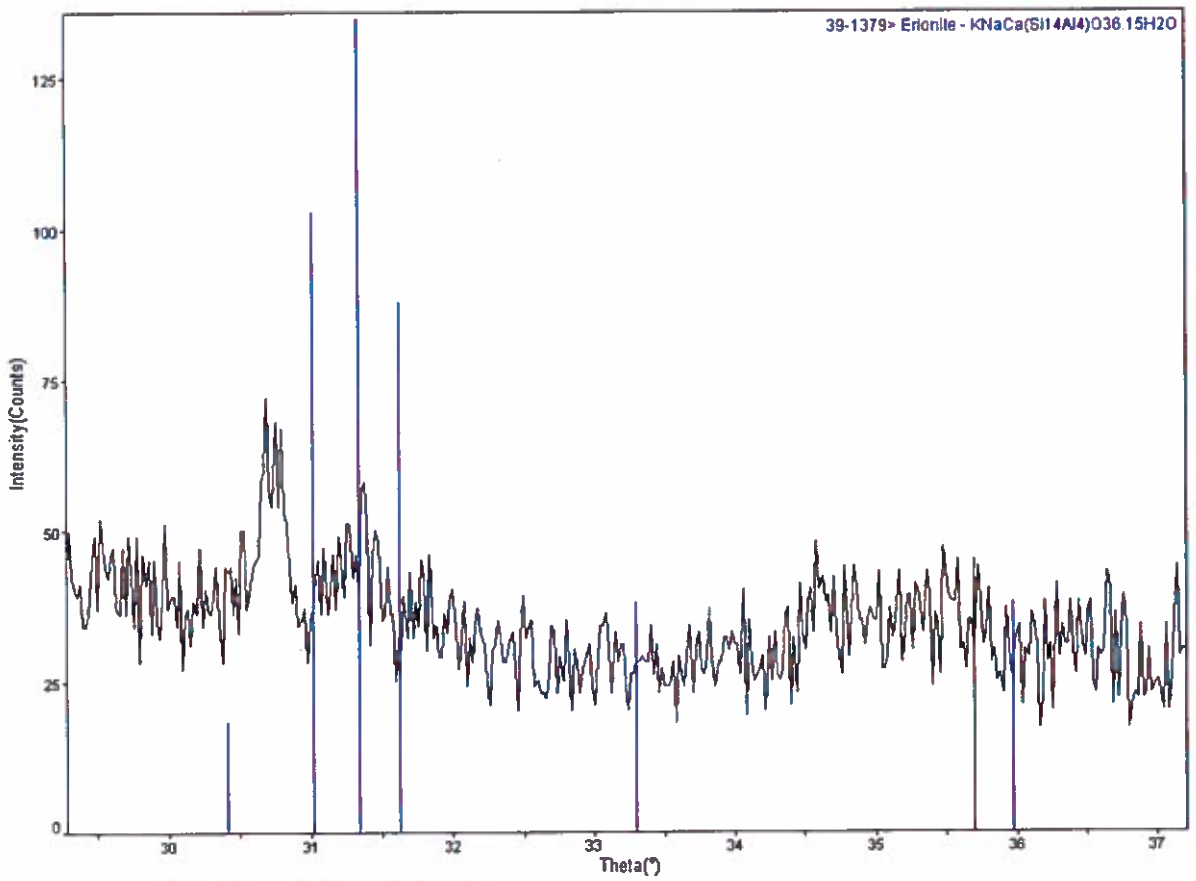

BLM-PDO-SC-020

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Figure 18. Detailed XRD pattern of material from sample BLM-PDO-SC-020 in the area of the major peaks for Erionite as listed in PDF# 39-1379.

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Attn.: *Dr. Shelby Cave*
Bureau of Land Management
21605 N 7th Ave
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Phone: 623-580-5500

EMSL Order ID.: 361701939
Sample(s) Received: 9/6/2017
Date of Reporting: 10/6/2017
Date Printed: 10/6/2017
Reported By: E. Mirica
Email: scave@blm.gov

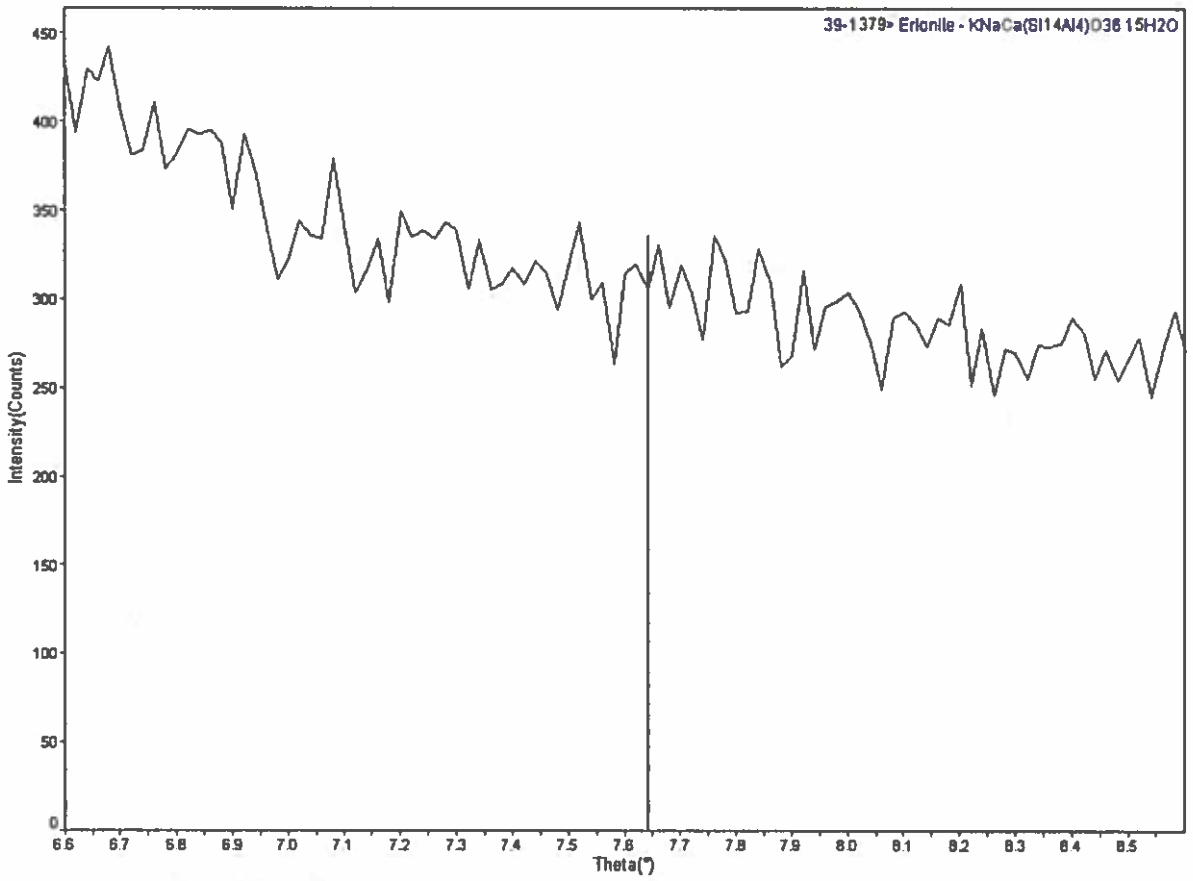

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Figure 19. XRD slow scan pattern of material from sample BLM-PDO-SC-020 in the area of 7.641° 2θ angle peak for Erionite as listed in PDF# 39-1379.

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Descriptions & Definitions:

None Detected (ND) denotes the absence of analyte in the subsample analyzed. Trace levels of the analyte may be present in the sample below the limit of detection (LOD).

Limit of Detection (LOD): The minimum concentration that can be theoretically achieved for a given analytical procedure in the absence of matrix or sample processing effects. Particle analysis is limited to a single occurrence of an analyte particle in the sub-sample analyzed.

Limit of Quantitation (LOQ): The minimum concentration of an analyte that can be measured within specified limits of precision and accuracy during routine laboratory operating conditions

Concentrations for bulk samples are derived from Visual Area Estimation (VAE) unless otherwise noted. Air sample concentrations are calculated to particles per unit volume.

VAE technique estimates the relative projected area of a certain type of particulate from a mixture of particulate by comparison to data derived from analysis of calibration materials having similar texture and particulate content. Due to bi-dimensional nature of the measurements, in some cases the particle thickness could affect the results.

Important Terms, Conditions, and Limitations:

Sample Retention: Samples analyzed by EMSL will be retained for 60 days after analysis date. Storage beyond this period is available for a fee with written request prior to the initial 30 day period. Samples containing hazardous/toxic substances which require special handling may be returned to the client immediately. EMSL reserves the right to charge a sample disposal or return shipping fee.

Change Orders and Cancellation: All changes in the scope of work or turnaround time requested by the client after sample acceptance must be made in writing and confirmed in writing by EMSL. If requested changes result in a change in cost the client must accept payment responsibility. In the event work is cancelled by a client, EMSL will complete work in progress and invoice for work completed to the point of cancellation notice. EMSL is not responsible for holding times that are exceeded due to such changes.

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Limits of Liability: In no event shall EMSL be liable for indirect, special, consequential, or incidental damages, including, but not limited to, damages for loss of profit or goodwill regardless of the negligence (either sole or concurrent) of EMSL and whether EMSL has been informed of the possibility of such damages, arising out of or in connection with EMSL's services thereunder or the delivery, use, reliance upon or interpretation of test results by client or any third party. We accept no legal responsibility for the purposes for which the client uses the test results. EMSL will not be held responsible for the improper selection of sampling devices even if we supply the device to the user. The user of the sampling device has the sole responsibility to select the proper sampler and sampling conditions to insure that a valid sample is taken for analysis. Any resampling performed will be at the sole discretion of EMSL, the cost of which shall be limited to the reasonable value of the original sample delivery group (SDG) samples. In no event shall EMSL be liable to a client or any third party, whether based upon theories of tort, contract or any other legal or equitable theory, in excess of the amount paid to EMSL by client thereunder.

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