

GEL 3050 - Mineral ID Professional Project

Name: _____

Section: _____

Overview:

The Department of Earth & Atmospheric Sciences Mineral Laboratory at the Metropolitan State University of Denver offers free non-destructive & certain destructive mineral identification services as part of their geoscientist training program in GEL3050. One or more of these samples will be assigned to you as a student in Mineralogy & Optical Mineralogy. Your responsibility will be to analyze the unknown mineral under the supervision of the instructing professor according to the clients specification. In the end you will be required to present the client(s) with a full analytical report. Your work must meet a minimum standard of quality and professionalism. You also will need to return non-destructive tested specimens if requested (Client should have provided SASE or they will pick-up their samples personally from you at the Earth Science laboratories at MSU Denver). For detailed grading see attached Grading Rubric.

This client project consists of a series of labs and a final report. The following is a short overview. All combined it will make up over ½ of your grade.

Project Grading Overview

MINERAL ID CLIENT PROJECT w/ specific labs	Mineral identification project for actual clients. Students will analyze a sample and compile a professional client report.	For details exact details see the project rubric	470
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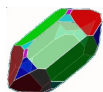
Very Important Note:

The Final Version of the Report must be completed and turned in by the Deadline, or you will receive an F for the course!

Specific Gravity		50
HM, Color, Luster, Streak		50
Mag, Rad, Organo, UV	Mineral ID Labs w/ Report	50
Simple Chem & Flame Testing	NO retake possible.	50
Optical Mineral ID	However, feedback from labs	50
Wet Geochem Analysis	invaluable for the client report	50
Dry XRF & XRD Analysis		50
FINAL PROJECT Report	Professional Client Report (Retake possible if submitted by deadline)	200

Professionalism:

Since this project requires professional interaction with individuals and businesses in the community, high standards are expected. In order to assure a professional criterion of the outcome, you are assigned a partner. You may work together in collecting data, however, the write-up of the report must be uniquely yours. **THIS IS NOT A GROUP PROJECT!!!!** The best of the reports will be chosen to be mailed to the client.



GEL 3050 - Mineral ID Professional Project

Basic background and preparation:

Here is a list of software applications necessary to work through the labs and the final report.

Product	Description	Download
MS Word or equivalent Word Processor	A word processor capable of generating quality reports with pictures, graphs and tables.	Office 365 with Word available to students through the University
MS Excel or equivalent Spreadsheet	A programmable spreadsheet capable of manipulating data incl. programming and able to generate graphs.	Office 365 with Excel available to students through the University
Zotero citations database	Zotero is a citations database that incorporates itself into Word and your Browser.	Free open source software available at https://www.zotero.org/
Graphics Editor: Windows Paint editor or equivalent	A graphics editor to create graphics or to modify or enhance external pictures / graphics.	Windows paint or GIMP: https://www.gimp.org/

Word:

Be familiar with formatting text, using subscripts and superscripts, inserting and editing equations, and inserting and captioning graphics. Understand the wrapping format for inserted graphics, so text flows meaningfully around your insertions.

Camera:

A cell phones with a 7.2MP camera are usually ok. When taking pictures, lighting and background is the key. This means dark objects should be photographed with light or white backgrounds (sheet of paper) and visa versa for light objects. Having adequate lighting will also help to get sharp, crisp, in focus pictures. Blurry and out of focus pictures are not acceptable.

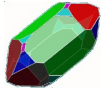
Graphics:

You should be able to modify, enhance, annotate or overlay graphics. Minimum resolution is 300dpi. Make sure graphics are crisp, clear and any label is easily readable. All graphics should have a caption stating the author and/or citation. Preferably use lossless graphic formats, such as .tif or .bmp. Unfortunately .jpg is NOT lossless and will degrade a little every time you open and save it again in order to manipulate picture contents.

Graphics Editor Software: You will need a graphics editor and learn how to use it. Windows comes with its default Windows Paint editor. It is found in the Windows Accessories Folder. For a more advanced option with many more professional features you may try GIMP: <https://www.gimp.org/> This is a FREE, open source image editor working across all computing platforms (Windows, Apple, Linux, etc.). The software comes with ample documentation and examples on how to manipulate any picture or graphic.

Screen Capture Software: A screen capture or snipping software is advantageous in order to only grab the part of a graphic from the screen that is important or necessary. Windows 10 comes with a default snipping tools, such as “Snip & Sketch” found in its own folder or “Snipping Tool” found in the Windows Accessories Folder. Note: When snapping a picture, make sure it is large enough on the screen to capture enough pixels to have adequate resolution for the final product.

NOTE: Compiling acceptable and good looking graphics and photographs is very involved and can not be rushed. These are often the heart of any report and should be compiled BEFORE writing. Last minute thrown together graphics will without doubt lower your grade on the client report significantly.



GEL 3050 - Mineral ID Professional Project

Citations:

Should be compiled and tracked using Zotero (<https://www.zotero.org/>). As citation style use the United States Geologies Survey (USGS) format. Your report should have a minimum of 5 credible citations. Do NOT forget to cite inserted maps and photos.

Loading the USGS citation format: Once Zotero Standalone is installed, click on "Preferences" under the Edit tab. Once there click on "Cite" and go to the "Styles" tab. Click on the "Get additional styles..." below the Styles Manger Box. When the Zotero Styles Repository Window opens, click on the "geology" button within the "Fields" section. A list of geology journals should now appear. Scroll down to the U.S.Geological Survey and click on it. The U.S.G.S style will now be part of your Zotero system and you can set your citations to be formatted accordingly in Zotero.

Compiling the Final Report:

The final report should be worthy of the effort expended. You are dealing with real clients that will receive a copy of your report. Therefore, a folder and neatness are absolutely essential and you will be graded on appearance as well as content. The labs that are graded and returned to you serve as your data that now will need to be compiled into the final report. It will NOT be necessary nor prudent to copy all the lab text into the final report. Just state methods, data and observations according to the template. You may copy and reuse the writing of significant phrases. Any graph or picture, however, associated with your lab, including error assessment should make it into your final report.

Please do NOT incorporate grading or tracking sheets into your report, but paperclip loosely to your work!

Upon acceptance of your report email a final, cleaned-up version of your work to the instructor at kackstae@msudenver.edu. **Failing to do so will result in a 25% deduction of your report grade.**

Tracking Sheet:

You are also required to keep a tracking sheet that will be turned in with your report. However, this sheet is for internal use only and will NOT be given to the client. Download the tracking sheet from <http://college.earthscienceeducation.net/MIN/MIN PROFESSIONAL PROJECT TRACKING.pdf>.



GEL 3050 - Mineral ID Professional Project

PROJECT GRADING

Name:	Section:
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GRADING:

DRAFT DOCUMENT - To be turned in by the draft/redo deadline-

It should include your completed narrative and your figure placement. You will be graded as outlined below:

Name:	Section:	Draft Grade: /50
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/10 **COMPOSITION & LAYOUT** - one or multiple point deduction per infraction

The appearance of the draft paper is neat and orderly. The draft document is typed and graphics and data are electronically prepared and analyzed. Subscripts and superscripts are appropriately used and equations are explained. The draft is complete with all appropriate pages populated. Graphics and data are placed in a coherent form. Proper formatted citations are included. The conclusion is appropriate for the client and his/her analytical request. The project template was used.

/10 **WRITING & GRAMMAR** - one point deduction per infraction

Spelling and grammar are correct. Word repetition and use of first person language is avoided. Statements are factually correct. Appropriate and complete language becoming to a client report is used.

/10 **EXECUTION & DATA COLLECTION** - one or multiple point deduction per infraction

Appropriate procedural execution of all analytical procedures is evident from the writing and data. Procedural detail is adequately mentioned. One or multiple controls are used and described to identify the integrity of the data. Any inconsistencies are mentioned and explained.

/10 **GRAPHICS & ILLUSTRATIONS** - one or multiple point deduction per infraction

Graphical representations of the client sample and analytical results were appropriate and as outlined in the example. All illustrations must be electronically prepared. Pictures should be clear, of high quality, and with neutral background. Graphs should have a title with appropriate axis and unit labels. Citation of source must be included. Graphics need to meet minimum resolution (300 DPI) requirements.

/10 **CONTROL, ACCURACY & PRECISION** - one or multiple point deduction per infraction

A control to establish accuracy and precision must be used as indicated. For numerical data collection, precision must be calculated and presented. If applicable, an explanation should be given why accuracy was not established.

FINAL REPORT -To be turned in by the deadline-

You will be graded on your complete document, including figures, layout, grammar, spelling, content, concept, format, presentation, expression, design, citation, etc. For each infraction you will lose at least one point. (Be aware that repeat mistakes will count MORE THAN ONCE!)

Name:	Section:	Final Report Grade: /150
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/30 COMPOSITION & LAYOUT - one or multiple point deduction per infraction

The FINAL REPORT is neat, orderly, and professional. The document is typed and graphics and data are electronically prepared and analyzed. Subscripts and superscripts are appropriately used and equations are explained. The report is complete with all appropriate pages populated. Editing suggestions were incorporated. Graphics and data are placed in a coherent form. Proper formatted citations are included. The conclusion is appropriate for the client and his/her analytical request. The project template was used.

/30 WRITING & GRAMMAR - one or multiple point deduction per infraction

Spelling and grammar are correct. Word repetition and use of first person language is avoided. Statements are factually correct. Appropriate and complete language becoming to a professional client report is used.

/30 EXECUTION & DATA COLLECTION - one or multiple point deduction per infraction

Appropriate procedural execution of all analytical procedures is evident from the writing and data. Procedural detail is adequately mentioned. One or multiple controls are used and described to identify the integrity of the data. Any inconsistencies are mentioned and explained.

/30 GRAPHICS & ILLUSTRATIONS - one or multiple point deduction per infraction


Graphical representations of the client sample and analytical results are appropriate and as outlined in the example. All illustrations are electronically prepared. Pictures are clear, of high quality, and with neutral background. Graphs have a title with appropriate axis and unit labels. Citation of source is included. Graphics have a minimum resolution of 300 DPI.

/30 CONTROL, ACCURACY & PRECISION - one or multiple point deduction per infraction

A control to establish accuracy and precision is used as indicated. For numerical data collection, precision was calculated and presented. If applicable, an explanation was given why accuracy was not established.

Example write-up:

- not all fields are populated, but you will get the general idea how your final report should look like -

 <p>METROPOLITAN STATE UNIVERSITY™ OF DENVER</p>	<p>Department of Earth & Atmospheric Sciences Minerals Lab; Attn: Dr. Kackstaetter Campus Box 22, P.O.Box 173362 Denver, CO 80217-3362</p>
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ASSESSMENT OF HEMIMORPHITE

John Smith

Jane Doe

11/11/2019

GEL3050 - Mineralogy & Optical Mineralogy

for

**Roger Rockhound
123 1st St., Quartzsite, AZ 85346
rogerrock@gmail.com**

Disclaimer: While every care has been taken to correctly identify the submitted specimen, information contained in this report is to be considered “AS-IS” and NO WARRANTY for its correctness is given or implied. Neither Metropolitan State College of Denver, the Department of Earth & Atmospheric Science nor its affiliates, professors and students shall be liable for any loss or damage to submitted mineral samples nor for any damages, including but not limited to injuries, loss of property or profits, or incidental, consequential, exemplary, special or other damages that may result from use of reported analytical results.

CLIENT INFORMATION:

Last Name: Rockhound	First Name, MI: Roger	Date: 9/9/19
Address: 123 1 st St	City: Quartzsite	State, ZIP AZ 85346
Phone: 202-720-5077	Email: rogerrock@gmail.com	

MINERAL SAMPLE INFORMATION & ANALYTICAL REQUEST:

Short Mineral Description: White and bluish white crystals on brown rock	
Where found (approx. location o.k.): Exact location unknown, but sample was found in Arizona.	
Requested Laboratory Tests (Check all that apply) Suggestion: For destructive sample testing, please submit additional secondary sample chips of same material <input checked="" type="checkbox"/> BASIC MINERAL IDENTIFICATION incl. XRF - NON DESTRUCTIVE <input checked="" type="checkbox"/> ADD'L WET CHEMICAL QUALITATIVE ANALYSIS (ICP-MS / AAS / Chromatographic) - DESTRUCTIVE <input checked="" type="checkbox"/> OPTICAL TESTS: <input type="checkbox"/> Grain Mount - DESTRUCTIVE; <input type="checkbox"/> Refractometer -limited to suitable samples (NON DESTR.) <input checked="" type="checkbox"/> X-RAY DIFFRACTION ANALYSIS - DESTRUCTIVE <input type="checkbox"/> Coming soon! SCANNING ELECTRON MICROSCOPY - NON DESTRUCTIVE	
Comments: <input type="checkbox"/> Please Return Sample: <input type="checkbox"/> SASE included or <input type="checkbox"/> Will pick up. <input type="checkbox"/> Discard sample after analysis: <input checked="" type="checkbox"/> Just mail report or <input type="checkbox"/> Will pick up report	Voluntary Suggested Donation: <input type="checkbox"/> \$60 <input type="checkbox"/> \$30 <input checked="" type="checkbox"/> \$15 <input type="checkbox"/> \$8 (Make Checks payable to MSU Denver Earth Science Foundation)

By submitting the mineral sample for analysis I agree to following terms and condition: Neither Metropolitan State University of Denver, the Department of Earth & Atmospheric Science nor its affiliates, professors and students shall be liable for any loss or damage to submitted mineral samples nor for any damages, including but not limited to injuries, loss of property or profits, or incidental, consequential, exemplary, special or other damages that may result from use of reported analytical results.

Introduction

Thank you for choosing the mineral analytical services at the mineral laboratories of the Earth and Atmospheric Sciences Department at the Metropolitan State University of Denver. Your request has aided in the training of future geoscience professionals, endowing them with valuable skills and knowledge in mineral assessment and identification.

The final outcome of our investigation is summarized below followed by the results for each specific analytical procedure as indicated in the Table of Contents. We hope that this report will be helpful to you, further your endeavors and satisfy your curiosity.

Please let us know if we can be of future service which could include larger projects involving an undergraduate researcher. Feel free to contact us if you have any questions.

Sincerely



Prof. Dr.rer.nat. Uwe Richard Kackstaetter (Dr.K)
Full Professor of Geology - Specializing in Applied Geology and Mineralogy
Department of Earth & Atmospheric Sciences
Metropolitan State University of Denver
Office: SI2025 (303) 615-0789 kackstae@msudenver.edu

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MINERAL IDENTIFICATION RESULTSMineral name: **Hemimorphite**Mineral group: **Sorosilicate**Chemical Formula: **$Zn_4Si_2O_7(OH)_2 \cdot H_2O$** 

Picture of Client Sample (John Smith, 2019)

Locality:
Arizona. Details unknown.

Sample submitted by:

Roger Rockhound
123 1st St., Quartzsite, AZ 85346
rogerrock@gmail.com
202-720-5077

To the best of our abilities it was determined that the unknown mineral in question is most likely hemimorphite. Because of the results from our sophisticated XRD analysis coupled with the ICP instrumental chemical assessments and feedback obtained from all other tests, we are confident that your mineral is hemimorphite.

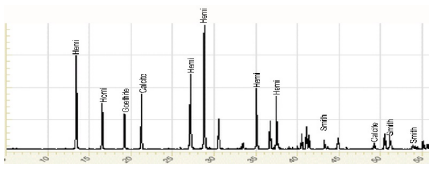
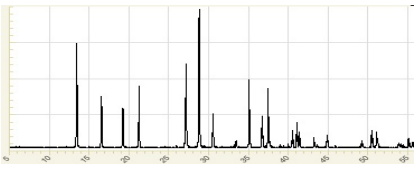
Hemimorphite ($Zn_4Si_2O_7(OH)_2 \cdot H_2O$) is a zinc containing silicate minerals which is often found with other zinc bearing minerals such as sphalerite (ZnS) or Smithonite ($ZnCO_3$). It usually is an altered form of other zinc minerals because of the influence of atmospheric oxygen and water. It occurs close to or within zinc bearing mineral deposits.

The mineral will often make beautiful radiating patterns from bladed crystals. It may also occur as botryoidal or bubbly looking green-blue masses. Hemimorphite can be a semi-precious gemstone when transparent. However, this form is rare and typically only small stones of less than 3 carats are found. The most sought after form of hemimorphite is a transparent, gem quality blue to blue-green botryoidal crust that looks like smithonite. However, smithonite will effervesce (fizz) with acid, such as strong vinegar, while hemimorphite will not.

Hemimorphite is named after its unusual crystal structure when crystals are visible. Crystals are terminated differently at each end. While one termination is rather blunt, the opposite end is terminated like the point of a pyramid, hence hemimorphite (Hemi = half, morph = shape). Only a few other minerals show hemimorphic character such as tourmaline. The mineral is also strongly pyroelectric, which means it generates electrical charges with changing temperatures.

Occurrence: Found in the oxidation zone of zinc-bearing ore deposits. Veins and beds in stratified calcareous rocks common. Usually found with smithsonite, sphalerite, galena, cerussite, anglesite, calcite, aurichalcite, rosasite, hydrozincite, and chrysocolla.

RESULTS COMPARISON - ANALYTICAL vs. MINERAL DATA

Analytical Results Summary			Mineral Data	
			Likely Mineral:	Hemimorphite
Density (Avg):	3.50 g/cm ³	± 0.06 g/cm ³	Density:	3.45 (3.4 - 3.5) g/cm ³
Mohs Hardness:	~ 5		Mohs Hardness:	4.5 - 5
Color (fresh):	bluish white	5B 9/1 Munsell	Color:	brown, white, clear, yellow, green
Luster (fresh):	vitreous to silky		Luster:	vitreous - glassy
Streak:	white	N9 Munsell	Streak:	white
Magnetism:	none	46.33 μT	Magnetism:	none
Radioactivity:	none	28 cps	Radioactivity:	none
Organoleptic:	no taste or odor		Organoleptic:	no taste or odor
UV Light (LW):	none		UV Light (LW):	faint yellow possible
UV Light (SW):	light blue		UV Light (SW):	bluish or blue possible
Fusibility:	# 6		Fusibility:	# 6
Solubility:	Aqua Regia, HNO ₃ , HCl, gelatinizes		Solubility:	HNO ₃ , gelatinizes in HCl
Ion Chromatogr.:	Zn		Chemical Formula	
XRF Analysis:	Si, Zn		Zn₄Si₂O₇(OH)₂ · H₂O	
Wet Geochem:	Si, Zn - minor Pb			
XRD Crystallography:			XRD Crystallography:	
Optical			Optical	
Cleavage:	some good cleavage parallel to c-axis		Cleavage:	perfect {110, 101}, good {001}
Color:	no color or pleochroism		Color:	no color or pleochroism
Relief:	moderate		Relief:	moderate in epoxy
RI:	1.615 - 1.630		RI:	1.614 - 1.636
Optics:	Anisotropic biaxial positive		Optics:	Anisotropic biaxial positive

SPECIFIC GRAVITY DETERMINATION**HYDROSTATIC PAN METHOD**

Method: Specific gravity of the sample is assessed by measuring the dry weight of the specimen and the etc. etc. ...

Equation / Calculation:

$$SG\left(\frac{g}{cm^3}\right) = \frac{m(g)}{V(cm^3)}$$

where:

m = mass of sample in g

V = volume of sample in cm³

Density:	3.61 g/cm ³	±0.03 g/cm ³		
	Precision Error:	1.50 %	Precision:	98.5 %
	Accuracy Error:	2.34 %	Accuracy:	97.7 %

PYCNOMETER METHOD

Method: A pycnometer is a calibrated glass vessel with an exact liquid volume capacity. The weight of the liquid filled pycnometer is ... etc.etc.

Equation / Calculation:

$$SG\left(\frac{g}{cm^3}\right) = \frac{m}{W_{bl} + m - W} \times SG_l$$

where:

m = mass of sample in g

W_{bl} = weight of liquid filled pycnometer

etc. etc.

Density:	3.398 g/cm ³	±0.090 g/cm ³		
	Precision Error:	5.29 %	Precision:	94.7 %
	Accuracy Error:	6.32 %	Accuracy:	93.7 %

Comments: -none-

HARDNESS, COLOR, LUSTER, STREAK

MOHS HARDNESS (HM) TEST

Method: Mohs hardness is a test of scratch resistance against ... etc.etc.etc.

Mohs Hardness (HM):	~ 5	Comments: Sample scratched copper (HM=3) and fluorite (MH=4), but did not scratch glass (HM=5.5)
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COLOR TEST

Method: A subjective comparative color test using the Munsell ... etc. etc.

Overall Color Assessment:		<input type="checkbox"/> Idiochromatic	<input checked="" type="checkbox"/> Allochromatic	<input type="checkbox"/> Pseudochromatic
FRESH SURFACE	Munsell Color Code: 5B 9/1	Descriptive Color: Bluish white		
WEATHERED SURFACE	Munsell Color Code: 5B 7/1	Descriptive Color: Light bluish grey		

Comments: - none -

LUSTER TEST

Method: A subjective luster observation ... etc. etc.

Overall Luster Assessment:

Metallic Non-Metallic

Descriptive Luster: Vitreous to silky luster on fresh surfaces

STREAK TEST

Method: The color of the mineral powder on a white and dark streak plate was assessed. This test is ... etc. etc.

Streak Color
Fresh Surface:

Munsell Color Code:
N9

Descriptive Color:
White

Streak Color
Weathered Surface:

Munsell Color Code:
N9

Descriptive Color:
White

Overall Streak Color Assessment: Streak is white for weathered and fresh surfaces

Possible Minerals: N/A

Comments: - none -

MAGNETISM, RADIOACTIVITY, ORGANOLEPTIC, UV**MAGNETISM TEST**

Method: Magnetic field strength of the client sample was established using the magnetometer sensor of a Samsung SM-N900T smartphone in conjunction with the Physics Toolbox Sensor Suite Pro - Magnetometer App (Version 1.9.4.1). The magnetic field strength of the mineral specimen was measured at a distance of 3 cm and compared to background and magnetic standards consisting of ... etc. etc.

	Magnetic Field Strength	± Precision	% Precision Error
Non-Magnetic Background Reference Reading	43.25 μT	± 1.66 μT	7.7 %
Ferrous Magnet Reference Reading	645.29 μT	± 22.55 μT	8.0 %
Magnetite Mineral Reference Reading	288.12 μT	± 11.68 μT	8.1 %
SAMPLE	46.33 μT	± 1.94 μT	8.4 %
SAMPLE heat treated	49.61 μT	± 2.18 μT	8.8 %

The sample does NOT show a significant magnetic response. It is non-magnetic.

RADIOACTIVITY TEST

Method: Gamma radiation emission from the sample was measured using ... etc. etc.

	Gamma Emission	± Precision	% Precision Error
Background Reference Reading	33 CPS	± 2 CPS	12 %
SAMPLE	28 CPS	± 1 CPS	7 %

The sample is NOT radioactive.

ORGANOLEPTIC TEST

Method: Organoleptic testing uses ... etc. etc.

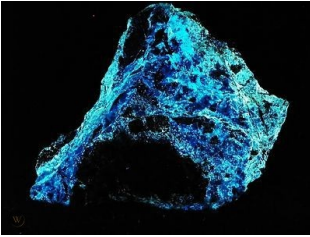
TEST	DESCRIPTIVE OBSERVATION
TASTE	none
SMELL unmoistened	none
SMELL moistened	none
SMELL slightly heated	none

Comments: No smell, taste or odor detected

UV LIGHT EMISSION TEST

Method: The sample is exposed to both long wave (364 nm) and short wave (254 nm) UV (ultra violet) light in sequence in a darkened room and the fluorescent response of specimen is observed. Furthermore, phosphorescence ... etc. etc.


TEST	Observation	Possible Activators	Photo
Long Wave UV Light (365 nm) Response: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	N/A	N/A	
Long Wave activated Phosphorescence Response: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	N/A		

<p>Short Wave UV Light (254 nm) Response: <input checked="" type="checkbox"/>Yes <input type="checkbox"/>No</p>	<p>medium light blue fluorescence</p>	<p>unknown</p>	 <p>Light blue fluorescence (Photo by Jane Doe, 2019)</p>
<p>Long Wave activated Phosphoresence Response: <input type="checkbox"/>Yes <input checked="" type="checkbox"/>No</p>	<p>N/A</p>		
<p>Thermoluminescence Response: <input type="checkbox"/>Yes <input checked="" type="checkbox"/>No</p>	<p>N/A</p>	<p>N/A</p>	
<p>Triboluminescence Response: <input type="checkbox"/>Yes <input checked="" type="checkbox"/>No</p>	<p>Descriptive Observation:</p>		

Comments: - none -

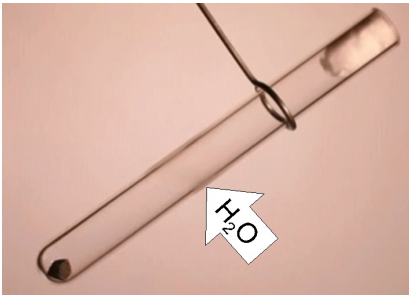
SIMPLE CHEMISTRY & FLAME TESTING**FUSIBILITY & FLAME COLOR**

Method: Fusibility or ease of melting was tested using a micro-torch with hottest flame temperature estimated at 2,200°F (1,200°C). The sample was held with tongs and brought incrementally toward the hottest part of the flame. Melting behavior and flame color was observed at each increment. Etc. Etc.

Fusibility: decrepitates, rounds thin edges	 Fusibility #: 6	Comments: - none -
Flame Color:	non-indicative, yellow	Possible Elements: Na contamination!
Flame Color w/ blue filter:	very slight green	Possible Elements: Ca traces

OPEN & CLOSED TUBE TEST

Method: A sample fragment is placed into a closed tube (small test tube) and slowly heated with a ... etc. etc.

Open Tube Test:	Descriptive Observation & Interpretation: - no observation -	N/A
Closed Tube Test:	Descriptive Observation & Interpretation: Some water vapor condensate detected. Possible OH group or H ₂ O in the sample chemistry.	

SOLUBILITY TEST

Method: A dry powder streak of the sample is subjected to water and various acids without mixing or overlapping the individual liquids. Reaction and solubility are carefully observed using a ... etc. etc.

Test Solution	Solubility	Reaction	Odors
Water	none	none	none
1:5 HCl	not noticeable	minute gelatinization	none
1:1 HCl	slightly soluble	some gelatinization	none
1:1 H ₂ SO ₄	not observed	not observed	not observed
1:1 HNO ₃	soluble	gelatinizes	none
Aqua Regia	soluble	gelatinizes	none

ION CHROMATOGRAPHY PAPER TEST

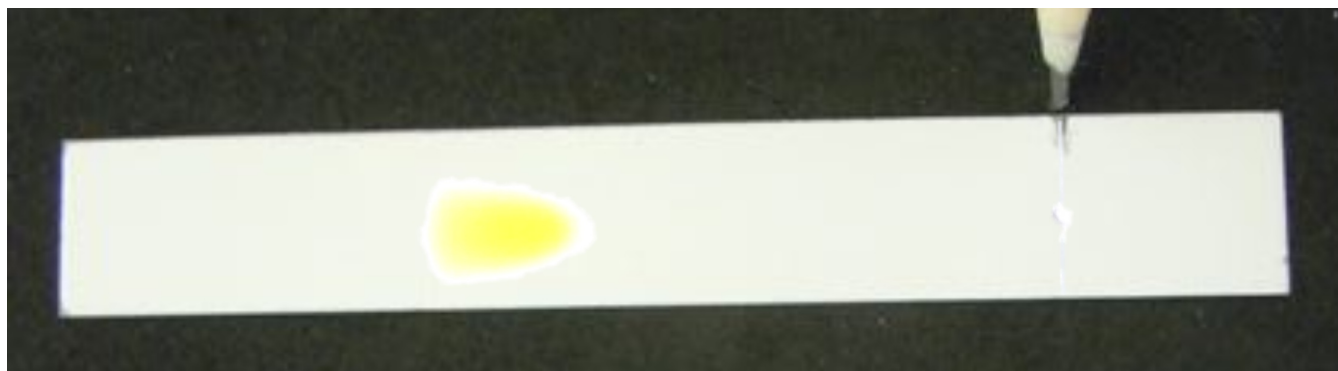
Method: A small sample powder split is digested using etc. etc.

Untreated Chromatograph

No visible ion spots

Comments: No chromatographic spot is seen on the raw chromatographic strip.

8-Hydroxyquinoline treated Chromatograph



Comments: After treatment with 8-hydroxyquinoline spray a yellowish ion spot develops toward the top of the chromatograph.

Treated Chromatogram under UV light



Comments: A greenish fluorescence of the same ion spot is observed under LW UV light.

NH₄OH treated Chromatograph

No change with treatment

Comments: -none-

Paper Chromatography Results

Probable Detected Ions with corrected R_f		R_f Correction Factor: 0.740
Zn; R_f 0.93		
Interpretation: The calculated R_f value, which is the ratio of the spot distance to the chromatographic fluid advancement, is 0.93. Observations are a close match to Zn.		

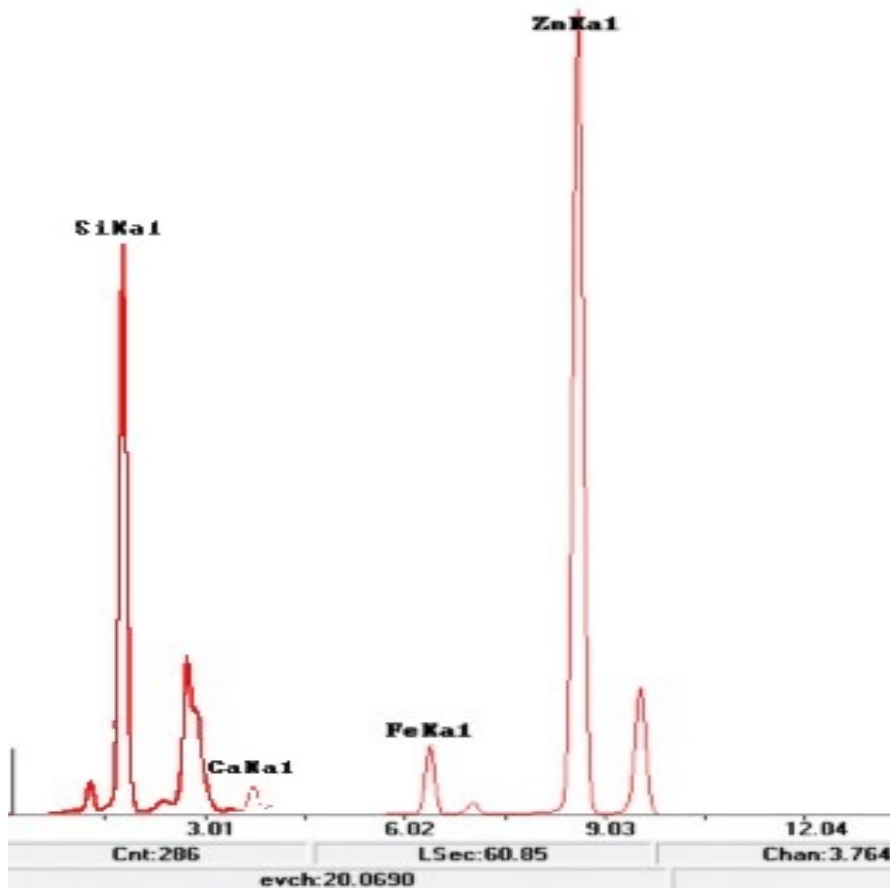
DRY XRF and XRD ANALYSIS

XRF (X-RAY FLUORESCENCE) SEMI QUANTITATIVE CHEMICAL ANALYSIS

Non-destructive XRF (x-ray fluorescence) measurements help qualify elemental composition. This test is effective for trace elements with an atomic number of Fe (iron) and greater. Estimates for other elements, such as Si, Ca, Mg can also be obtained if the concentrations are sufficiently high.

Method: The fluorescent X-ray spectra was determined using a Bruker Tracer IV portable XRF system and the associated S1PXRF software (Version 3.8.3.0). The sample was placed ...

Low Energy XRF Spectra - 15.00kV



Elements present:

Si, Zn

Probable Element Traces:

Ca, Fe with very minor Mg

Comments:

Only the low energy XRF 15kV spectra was established. Resolution of chemical elements was sufficient.

Zn and Si are identified as major elements contained in the mineral and must be present in its chemical formula.

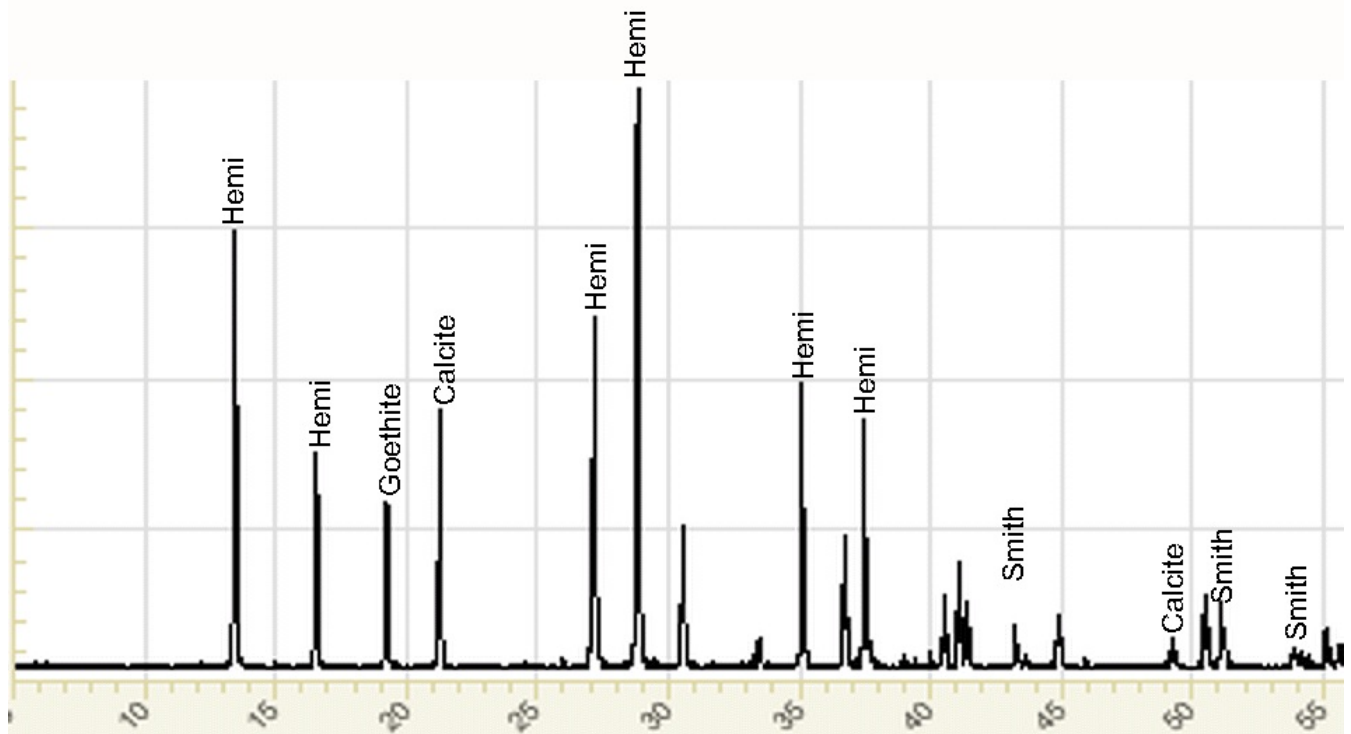
N/A	Elements present: N/A Probable Element Traces: N/A Comments:
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XRD (X-RAY DIFFRACTION) CRYSTALLOGRAPHIC ANALYSIS with DATA INTERPRETATION

The X-ray diffractometer (XRD) identifies unique crystal structures of minerals by assessing the internal crystal lattice spacings. Because lattices and unit cell dimensions in a crystal are unique for specific minerals, a XRD pattern acts like a fingerprint when identifying an unknown sample. Mineral mixtures or phases can also be assessed, especially when some of the sample mineralogy is known. This method is destructive and requires a small amount of finely powdered sample.

Method: A sample split was powdered to 75 μm particale size and an acetone based slurry of the powder was carefully spackled into the XRD sample holder. The sample was then placed into a Scintag 2000 X-ray Diffractometer with a Cu-K α tube and scanned for crystallographically induced X-ray peaks between 10° and 55° 2-theta angles. The resulting spectrum was then ... etc.etc.

XRD Analysis:



X-ray Pattern

Major Peaks and d-spacing:

2 θ	28.7°	13.4°	27.1°
d Å	3.10	6.60	3.28
I/I ₁	100	86	75

λ 1.5405 Rad: CuKα₁

XRD pattern interpretation / comments:

X-ray diffraction unambiguously identifies the unknown mineral as Hemimorphite. The pattern also indicates certain impurities present in the sample such as possible Smithonite (ZnCO₃), Goethite (FeO(OH)), and Calcite (CaCO₃), see X-ray pattern with labeled peaks.

WET GEOCHEMICAL ANALYSIS

SAMPLE DIGESTION AND ANALYSIS

Digestive Method: A small sample split was powdered to 200 mesh and 0.215grams of the powder were subjected to 3mL of concentrated 90°C Aqua Regia for 90 minutes. This digest was filtered and diluted 1:100 in order to be analyzed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometer). Aqua Regia leaches are near total for most base metals, partial for Mn, Fe, Sr, Ca, P, La, Cr, Mg, Ba, Ti, B, W and limited for Na, K, Si and Al.

Analytical Method: Using a ... etc. etc.

	SiO ₂	Al ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	Fe ₂ O ₃	MnO	TiO ₂	P ₃ O ₄	Cr ₂ O ₃	LOI ¹
%	28.5		0.042					1.3				

	As ²	B ³	Ba	Be	C ⁴	Co	Cu	Li ³	Mo	Ni	Pb	Rb	S
ppm							17.6				1320		

										Radioactive	
	Sb ²	Se	Sn	Sr	Te ²	V	W	Zn	Zr	Th	U
ppm								38.2%			30.5

	Precious Metals			Rare Earth and others									
	Ag	Au	Pt	Ce	Dy	Er	Eu	Ga	Gd	Ge	Hf	Ho	Ir
ppm													

	Rare Earth and others											
	La	Lu	Nb	Nd	Pr	Sc	Sm	Ta	Tb	Tm	Y	Yb
ppm												

¹ Loss on ignition

² Volatile! Partial loss on digestion.

³ Part of lithium borate flux used for digestion. Value inaccurate.

⁴ Inaccurate! Graphite crucibles used for digestion

Zn and Si are the major elements. The lower Si value can be interpreted as partial leaching of silicon from the sample due to the Aqua Regia process.

OPTICAL MINERAL IDENTIFICATION**GEM REFRACTOMETER ASSESSMENT**

Method: A gem refractometer uses the critical angle of a monochromatic light beam to determine the Index of Refraction. A flat (polished) crystal face or cut is placed on the hemi-cylinder window of the instrument where light ... etc. etc.

Sample IR or IR Range	Sample Birefringence	Sample Optic Axis	Sample Optic sign
N/A	N/A	N/A	N/A

Result Interpretation: - see below -

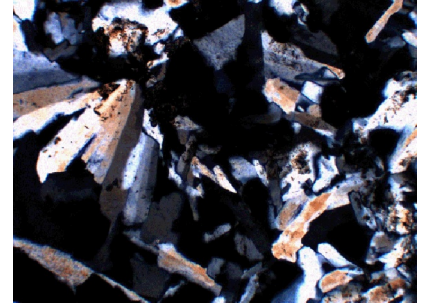
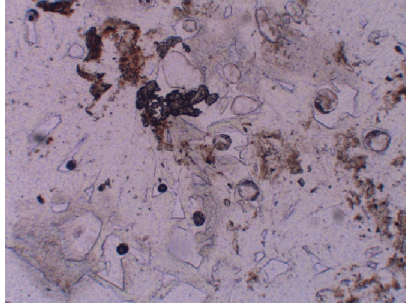
Comments: This method was not used since no even or flat crystal face of appropriate size could be found on the sample for a valid reading of the instrument.

POLARIZED LIGHT MICROSCOPE (PLM) ASSESSMENT OF SAMPLE GRAINS

Method: A few translucent, small (75 μm) sized grains were investigated with the PLM to determine the optical characteristics of the mineral. Observations under plain polarized (PPL) included etc. etc.

Observations in Plain Polarized Light (PPL)

Observations in Crossed Polarized Light (XPL)



Cleavage: good cleavage parallel to c-axis

Isotropic Anisotropic

Color: none

Highest Birefringence Color / Order:
 δ 0.015 - 1st order reds to blues
 (difficult to determine in grain mounts)

Pleochroism: none

Extinction & Angles:
 Parallel extinction, slightly undulose

Relief: moderate

Estimated IR or IR-Range: 1.615 - 1.630

Interference Figure Assessment:
 UNIAXIAL Positive BIAXIAL Positive - estimated
 Negative Negative
 2V Angle: ~45°

Result Interpretation: The optical test results are very indicative of Hemimorphite. Some inclusions present. Probably other Zinc minerals, such as Smithonite. Crystals grow in slightly radiating patterns

Comments: The refractory index and resulting birefringence show the greatest deviations. This is most likely due to a more selective crystal orientation during the investigation.

CITATIONS

Perkins, D. (2011). Mineralogy, 3rd ed., Pearson/Prentice Hall

Kackstaetter, U.R.(2011). Mineralogy Optical Mineralogy e-Manual, preliminary edition CD, Earthscience Education LLC

Tasa, D., Dyar, M.D., and Gunter, M.E. (2008). Mineralogy and Optical Mineralogy. Mineralogical Society of America

etc. etc.