

# 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 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	500
--	---	--	-----

### Very Important Note:

**The Final Version of the Report must be completed and turned in by the Deadline!**

Specific Gravity		50
HM, Color, Luster, Streak	Mineral ID Labs w/ Report	50
Mag, Rad, Organo, UV	NO retake possible.	50
Simple Chem & Flame Testing	<b>NOT group projects!</b>	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 - GROUP PROJECT -	Professional Client Report	(NO Retake once submitted) 150

## 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 will work with one to two partners in a group setting! **THIS IS A GROUP PROJECT!!!!** Your report must be TOP QUALITY since it will be mailed to a REAL client!.

## Instruction:

- Get into a Group:** Sign up in CANVAS for your group. A maximum of 3 students is allowed. Please make sure you get contact info from group members so you can collaborate. Next to phone and email, a video team (e.g. MS Teams or Zoom) might be advantageous. Then elect a group leader. The group leader will submit the final project for the whole group. Everyone in the group will receive the same grade, except “freeloaders” who will received a ZERO (details explained below).
  - NOTE: Some people might be uncomfortable working in a group. For those individuals provisions are made to sign up “single” at the group sign-up page in CANVAS.
- Labs:** The labs in this course are designed to double dip using your client sample for analysis whenever you can. At the end you will compile your lab outcomes into the final client report. While the client paper is a group project, the LABS ARE NOT A GROUP PROJECT. You will need to complete individual labs by yourself, even if they are used later in the client report! Plan your labtime well! It often takes longer than you think to complete a mineral ID lab!
- Write-up, research, pictures and project compilation:** It is best to use the templates to compile your final report. (See below) This way you will not forget anything and are assured a better grade. Therefore, Follow the template outline below to see what to included.



## GEL 3050 - Mineral ID Professional Project

**GROUP MEMBERS** Maximal 3 group members - Everyone in the group will receive the SAME grade!

Group Member 1 Name:	Activity Description	Date	Hours (Hrs:min)
Contact Info:			
Job Summary:			
<i>Should Group Member 1 receive Full Credit for the project?</i>	Group Member 2	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial
	Group Member 3	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial

Group Member 2 Name:	Activity Description	Date	Hours (Hrs:min)
Contact Info:			
Job Summary:			
<i>Should Group Member 2 receive Full Credit for the project?</i>	Group Member 1	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial
	Group Member 3	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial

Group Member 3 Name:	Activity Description	Date	Hours (Hrs:min)
Contact Info:			
Job Summary:			
<i>Should Group Member 3 receive Full Credit for the project?</i>	Group Member 1	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial
	Group Member 2	<input type="checkbox"/> Yes <input type="checkbox"/> No ____	Initial

The group leader will submit the final report for EVERYBODY in the group!



## 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 <a href="https://www.zotero.org/">https://www.zotero.org/</a>
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: <a href="https://www.gimp.org/">https://www.gimp.org/</a>

### **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 when turning in hardcopies! For online submittals, make a separate file!

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

**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
-------	----------	-----------------------------

**/30 COMPOSITION & LAYOUT - deductions according to indicated scale**

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 from labs and other reviews 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 pts - Everything present and of professional quality    25 pts - One report aspect poor or missing    20 pts - Two report aspects poor or missing  
15 pts - Three report aspect poor or missing, generally subpar quality    10 pts - Four report aspect poor or missing, generally subpar quality  
5 pts - Five or more report aspect poor or missing, generally subpar quality    0 pts - Missing

**/40 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.

**/40 RESEARCH EXECUTION & DATA - deductions according to indicated scale**

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. The data matches the conclusions in all aspects.

40 pts - Everything present and of professional quality    35 pts - One aspect poor or missing    30 pts - Two aspects poor or missing  
25 pts - Three aspects poor or missing    20 pts - Four aspects poor or missing, overall subpar quality  
15 pts - Five aspects poor or missing, overall subpar quality    10 pts - Six aspects poor or missing, overall subpar quality  
5 pts - Much poor or missing, very subpar quality    0 pts - Missing


**/40 GRAPHICS & ILLUSTRATIONS - deductions according to indicated scale**

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.

40 pts - Everything present and of professional quality    35 pts - One aspect poor or missing    30 pts - Two aspects poor or missing  
25 pts - Three aspects poor or missing    20 pts - Four aspects poor or missing, overall subpar quality  
15 pts - Five aspects poor or missing, overall subpar quality    10 pts - Six aspects poor or missing, overall subpar quality  
5 pts - Much poor or missing, very subpar quality    0 pts - Missing

Example write-up:

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

	<p style="text-align: right;">Department of Earth &amp; Atmospheric Sciences Minerals Lab; Attn: Dr. Kackstaetter Campus Box 22, P.O.Box 173362 Denver, CO 80217-3362</p>
---	---

### ASSESSMENT OF HEMIMORPHITE

John Smith

Jane Doe

11/11/2019

GEL3050 - Mineralogy & Optical Mineralogy

for  
Roger Rockhound  
123 1<sup>st</sup> 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:

<p>Last Name: Rockhound</p>	<p>First Name, MI: Roger</p>	<p>Date: 9/9/19</p>
<p>Address: 123 1<sup>st</sup> St</p>	<p>City: Quartzsite</p>	<p>State, ZIP AZ 85346</p>

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.	
<b>Requested Laboratory Tests (Check all that apply)</b> 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"/> <b>Coming soon!</b> 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.

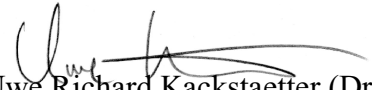
## Introduction

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



**Table of Contents**

MINERAL IDENTIFICATION RESULTS .....	<u>5</u>
RESULTS COMPARISON - ANALYTICAL vs. MINERAL DATA .....	<u>6</u>
SPECIFIC GRAVITY DETERMINATION .....	<u>7</u>
HYDROSTATIC PAN METHOD .....	<u>7</u>
PYCNOMETER METHOD .....	<u>7</u>
HARDNESS, COLOR, LUSTER, STREAK .....	<u>8</u>
MOHS HARDNESS (HM) TEST .....	<u>8</u>
COLOR TEST .....	<u>8</u>
LUSTER TEST .....	<u>9</u>
STREAK TEST .....	<u>9</u>
MAGNETISM, RADIOACTIVITY, ORGANOLEPTIC, UV .....	<u>10</u>
MAGNETISM TEST .....	<u>10</u>
RADIOACTIVITY TEST .....	<u>10</u>
ORGANOLEPTIC TEST .....	<u>11</u>
UV LIGHT EMISSION TEST .....	<u>11</u>
SIMPLE CHEMISTRY & FLAME TESTING .....	<u>13</u>
FUSIBILITY & FLAME COLOR .....	<u>13</u>
OPEN & CLOSED TUBE TEST .....	<u>13</u>
SOLUBILITY TEST .....	<u>14</u>
ION CHROMATOGRAPHY PAPER TEST .....	<u>14</u>
DRY XRF and XRD ANALYSIS .....	<u>17</u>
XRF (X-RAY FLUORESCENCE) SEMI QUANTITATIVE CHEMICAL ANALYSIS .....	<u>17</u>
XRD (X-RAY DIFFRACTION) CRYSTALLOGRAPHIC ANALYSIS with DATA INTERPRETATION .....	<u>19</u>
WET GEOCHEMICAL ANALYSIS .....	<u>20</u>
SAMPLE DIGESTION AND ANALYSIS .....	<u>20</u>
OPTICAL MINERAL IDENTIFICATION .....	<u>21</u>
GEM REFRACTOMETER ASSESSMENT .....	<u>21</u>
POLARIZED LIGHT MICROSCOPE (PLM) ASSESSMENT OF SAMPLE GRAINS .....	<u>22</u>
CITATIONS .....	<u>23</u>

**MINERAL IDENTIFICATION RESULTS**Mineral name: **Hemimorphite**Mineral group: **Sorosilicate**Chemical Formula:  **$Zn_4Si_2O_7(OH)_2 \cdot H_2O$** Locality:  
Arizona. Details unknown.

Sample submitted by:

Roger Rockhound  
123 1st St., Quartzsite, AZ 85346  
[rogerrock@gmail.com](mailto:rogerrock@gmail.com)  
202-720-5077

Picture of Client Sample. (John Smith, 2019).

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.

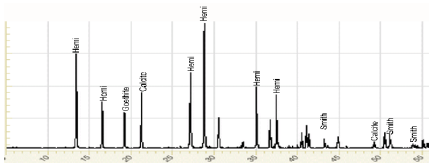
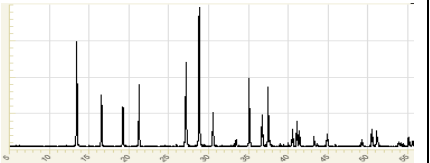
Hemimorphite ( $Zn_4Si_2O_7(OH)_2 \cdot H_2O$ ) is a zinc containing silicate minerals which is often found with other zinc bearing minerals such as sphalerite ( $ZnS$ ) or Smithonite ( $ZnCO_3$ ). It usually is an altered form of other zinc minerals because of the influence of atmospheric oxygen and 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 <sup>3</sup>	± 0.06 g/cm <sup>3</sup>	Density:	3.45 (3.4 - 3.5) g/cm <sup>3</sup>
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 <sub>3</sub> , HCl, gelatinizes		Solubility:	HNO <sub>3</sub> , gelatinizes in HCl
Ion Chromatogr.:	Zn		<b>Chemical Formula</b>	
XRF Analysis:	Si, Zn		<b>Zn<sub>4</sub>Si<sub>2</sub>O<sub>7</sub>(OH)<sub>2</sub> · H<sub>2</sub>O</b>	
Wet Geochem:	Si, Zn - minor Pb			
XRD Crystallography:			XRD Crystallography:	
<b>Optical</b>			<b>Optical</b>	
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: The hydrostatic pan method for specimen density involves the direct measurements of sample mass and the subsequent 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 cm<sup>3</sup>

Density:	3.61 g/cm <sup>3</sup>	±0.03 g/cm <sup>3</sup>		
	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. Thus establishing the mass of the liquid filled pycnometer with and without sample fragments and the mass of the fragments themselves, allows for ... 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<sub>bl</sub> = weight of liquid filled pycnometer  
etc. etc.

Density:	3.398 g/cm <sup>3</sup>	±0.090 g/cm <sup>3</sup>		
	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)
---------------------	-----	--

**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 $\mu\text{T}$	$\pm 1.66 \mu\text{T}$	7.7 %
Ferrous Magnet Reference Reading	645.29 $\mu\text{T}$	$\pm 22.55 \mu\text{T}$	8.0 %
Magnetite Mineral Reference Reading	288.12 $\mu\text{T}$	$\pm 11.68 \mu\text{T}$	8.1 %
SAMPLE	46.33 $\mu\text{T}$	$\pm 1.94 \mu\text{T}$	8.4 %
SAMPLE heat treated	49.61 $\mu\text{T}$	$\pm 2.18 \mu\text{T}$	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	$\pm 2 \text{CPS}$	12 %
SAMPLE	28 CPS	$\pm 1 \text{CPS}$	7 %

The sample is NOT radioactive.

**ORGANOLEPTIC TEST**

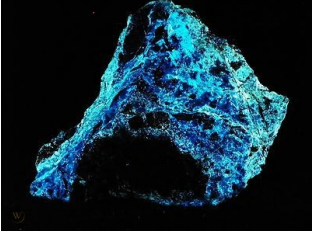
Method: Organoleptic testing uses ... etc. etc.

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 was 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		
Short Wave UV Light (254 nm) Response: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	medium light blue fluorescence	unknown	

Light blue fluorescence  
(Photo by Jane Doe, 2019)




Long Wave activated Phosphorescence Response: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	N/A		
Thermoluminescence Response: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	N/A	N/A	
Triboluminescence Response: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Descriptive Observation:		

Comments: - none -

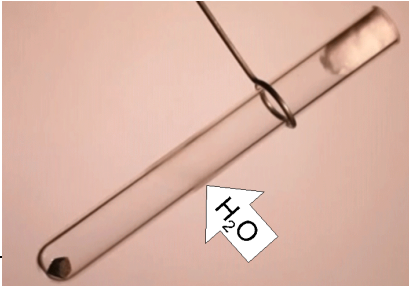
**SIMPLE CHEMISTRY & FLAME TESTING****FUSIBILITY & FLAME COLOR**

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 <sub>2</sub> 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 <sub>2</sub> SO <sub>4</sub>	not observed	not observed	not observed
1:1 HNO <sub>3</sub>	soluble	gelatinizes	none
Aqua Regia	soluble	gelatinizes	none

**ION CHROMATOGRAPHY PAPER TEST**

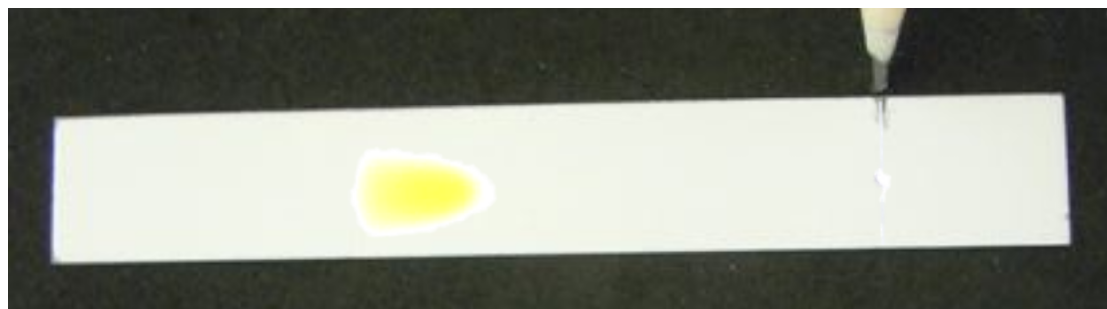
Method: A small sample powder split is digested using .... etc. etc.

**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.

NH<sub>4</sub>OH treated Chromatograph

No change with treatment

Comments: -none-

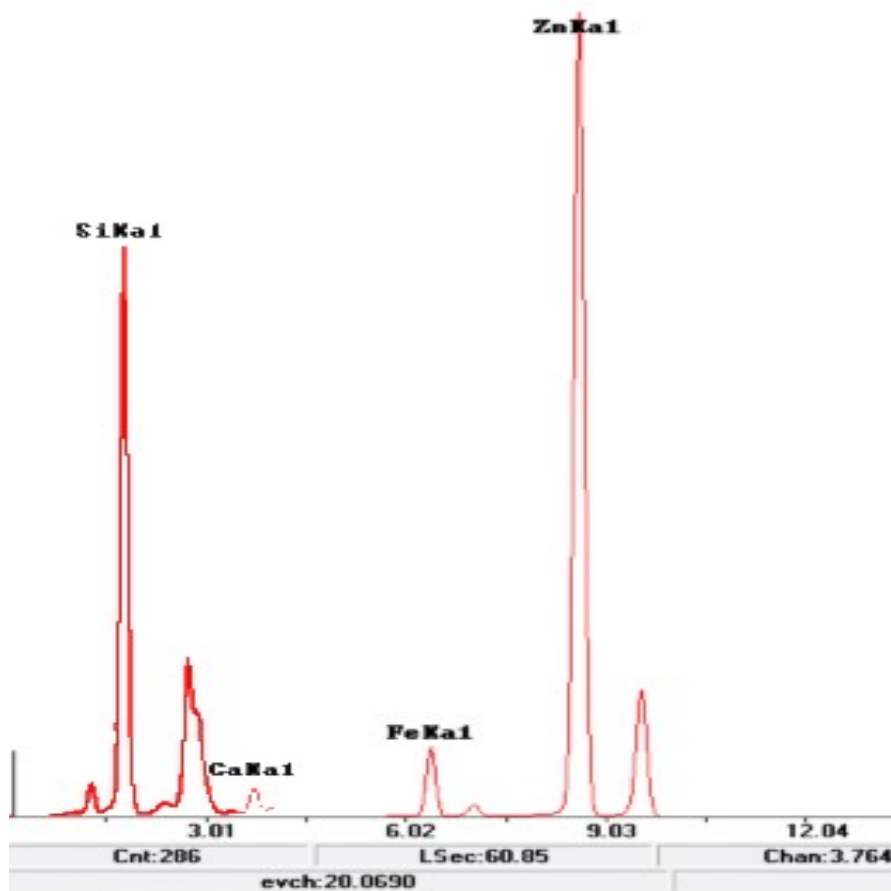
## Paper Chromatography Results

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 resultant spectra as pictured ... etc. etc.

**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.

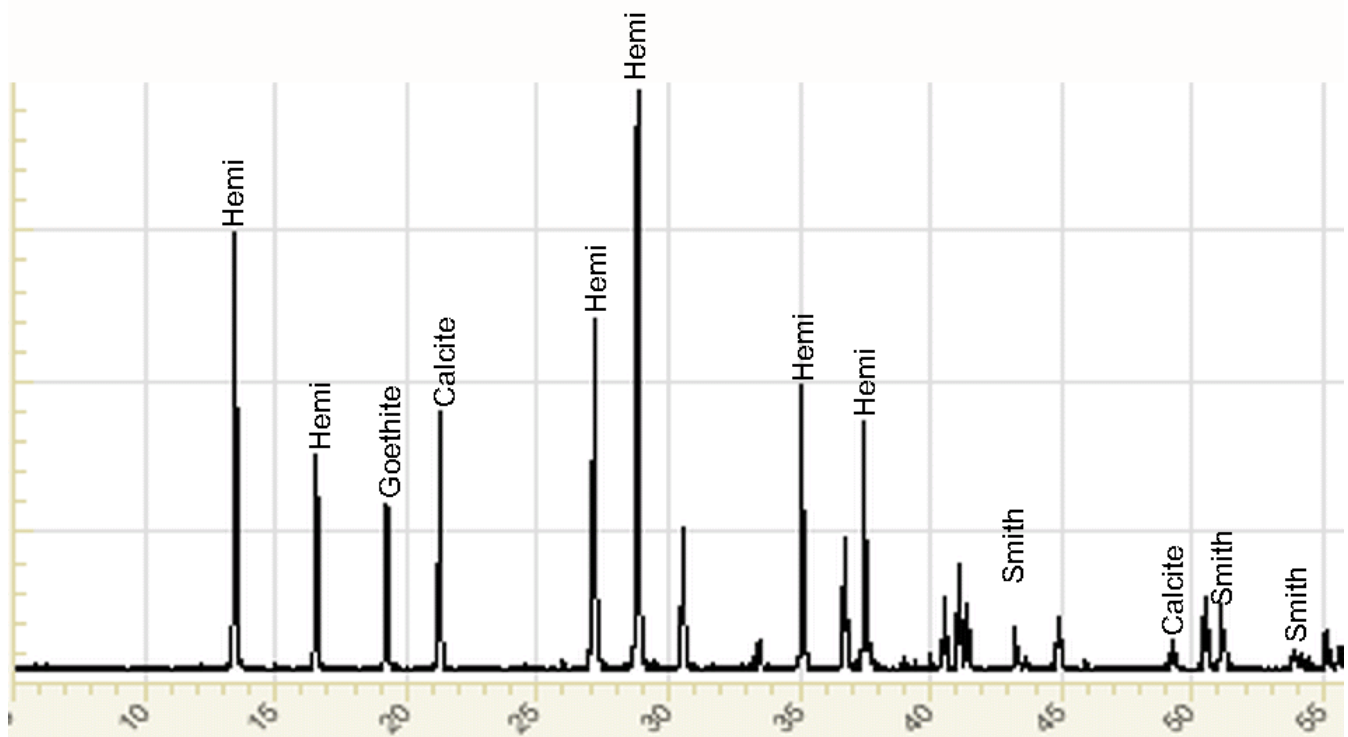
<p>N/A</p>	<p>Elements present: N/A</p> <p>Probable Element Traces: N/A</p> <p>Comments:</p>
------------	---

**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 powdered sample split (75 µm particule size) was carefully spackled into the XRD sample holder and analyzed using a Scintag 2000 X-ray Diffractometer with a Cu-Kα tube. The resulting scan determines the crystallography of the specimen powder which is like a fingerprint for mineral identification. 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 <sub>1</sub>	100	86	75

λ 1.5405 Rad: CuKα<sub>1</sub>

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 (ZnCO<sub>3</sub>), Goethite (FeO(OH)), and Calcite (CaCO<sub>3</sub>), see X-ray pattern with labeled peaks.



**WET GEOCHEMICAL ANALYSIS**

**SAMPLE DIGESTION AND ANALYSIS**

Destructive wet geochemical analysis of materials allows for a more precise resolution of chemical species present in the sample. This requires for a sample to be completely destroyed as it is dissolved (digested) either by strong acid or a flux melting process and then transferred into an aqueous solution. This digest is then analyzed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometer), which can identify ...etc. etc.

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

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

										Radioactive	
	Sb <sup>2</sup>	Se	Sn	Sr	Te <sup>2</sup>	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												

<sup>1</sup> Loss on ignition

<sup>2</sup> Volatile! Partial loss on digestion.

<sup>3</sup> Part of lithium borate flux used for digestion. Value inaccurate.

<sup>4</sup> Inaccurate! Graphite crucibles used for digestion

Zn and Si are the major elements. The lower Si value can be interpreted as interference of silicon colloids from the plasma spectrograph ....

**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 -

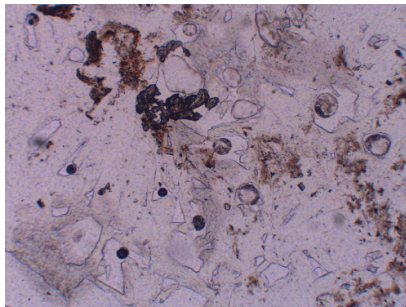
Comments: This method was not used since no even or flat crystal face of appropriate size could be found on the sample for a valid reading of the instrument.

**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 - 1<sup>st</sup> 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, 3<sup>rd</sup> 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.