

**GEL4050 Igneous and Metamorphic Petrology**  
**VOLCANIC IGNEOUS NORM CALCULATION & ROCK ID LAB**

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*Note: Anything marked in gray is filled in by the instructor. All other fields, checks, and write-ups to be completed by you!*

Name:

Course section ID

**Grading Rubric**

**/10 COMPOSITION & LAYOUT - one or multiple point deduction per infraction**

The appearance is neat and orderly. The lab is typed and graphics and data are electronically prepared and analyzed. Subscripts and superscripts are appropriately used and equations are explained. The lab is complete with all fields populated, if any. Graphics and data are placed in a coherent form. Proper formatted citations are included.

**/15 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 is used. Scientific notations / abbreviations as well as subscripts and superscripts are appropriately formatted.

**/15 EXECUTION & DATA COLLECTION - one or multiple point deduction per infraction**

Appropriate procedural execution of the lab is evident from the writing and data. Procedural detail is adequately mentioned. Data table is present (copied). Explanations and inferences are logically drawn and supported by evidence.

**/10 GRAPHICS & ILLUSTRATIONS (QAPF & TAS: 5pts ea.) - one or multiple point deduction per infraction**

Lab results are plotted as 1 QAPF and 1 TAS diagram. 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.

The following assignment was modified from *Calculating of a CIPW norm from a bulk chemical analysis* (2013) Kurt Hollocher, Geology Department, Union College NY, and *Calculation of CIPW Norm* (2008), G. Mattioli, Dept. of Geosciences, Univ. of Arkansas.

**Materials:**

- Whole Rock Analytical Results     Calculator     Normative Calculation Instruction  
 Normative Igneous Calculator and Plotter Software: [MAGMA](#) and/or [GCDkit](#)     Volcanic QAPF Diagram

**Introduction:**

Normative mineralogy calculations from bulk geochemical analysis were first developed in the 1930s by W. Cross, J.P. Iddings, L.V. Pirsson, and H.S. Washington. Using the letters of their last name the method is called the CIPW normative calculation of igneous rocks. A norm is essentially a set of idealized mineral-like components that are calculated from a whole rock chemical analysis based on the predictable geochemistry of the Bowen's Reaction Series.

Volcanic igneous rock classification is especially difficult because of their aphanitic or porphyritic textures. You can not tell the mineral assemblage from a hand sample. Here, normative calculations are an essential tool to identify and classify a volcanic rock. The calculated normative minerals are a representation of actual minerals present. Certain mineralogical rules are assumed and observed in the calculation process as, for example, mutually exclusive mineral assemblages listed in table 1:

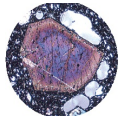


Table 1 - Observed and normative exclusive mineral assemblages

Mutually exclusive mineralogy observed	Mutually exclusive mineralogy assumed in calculation
quartz and Mg-rich olivine	quartz and olivine of any composition
quartz and nepheline	quartz and nepheline
Al-silicates and augite	corundum and diopside
orthopyroxene and nepheline	orthopyroxene and nepheline

Table 2 summarizes the mutually INCLUSIVE mineral pairs commonly used in normative assessments:

Table 2 - Normative INCLUSIVE mineral assemblages

Mineral Assemblages	Igneous Rock Interpretation
quartz, corundum, orthopyroxene	silica-saturated, peraluminous, subalkaline
quartz, diopside, orthopyroxene	Silica-saturated, subaluminous, subalkaline
olivine, diopside, orthopyroxene	silica-undersaturated, subaluminous, subalkaline
olivine, diopside, nepheline	silica-undersaturated, subaluminous, peralkaline

Using these generalizations it is possible to calculate mineralogies. With the advent of computer technology these normative calculation procedures are no longer needed to be done by hand. While you are NOT required to calculate the mineralogies by “hand”, it is still important for you to know HOW these calculations operate.

**The Data and Your Assignment:**

The whole rock analysis of two volcanic igneous rock from the same area yield the following results:

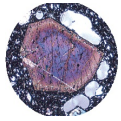
	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	LOI	TOTAL
Sample 1	66 %	0.5 %	15 %	4.3 %	2.5 %	4.5 %	4.0 %	3.0 %	0.2 %	100 %
Sample 2	58 %	1.8 %	18 %	6.7 %	3.9 %	2.6 %	2.1 %	2.4 %	4.3 %	99.8 %

It will be your job during this lab to classify the volcanic igneous rocks and compile results. Use both [MAGMA](#) and [GCDkit](#) software to give you a greater variety of interpretative tools & plots.

From the resulting calculated mineralogies you can now classify the rocks using the IUGS QAPF diagram for volcanics. This diagram is part of the GCDkit package. In addition, plot your results on a geochemical TAS diagram, which is part of both, MAGMA and GCDkit. The attached graphs are given for reference..

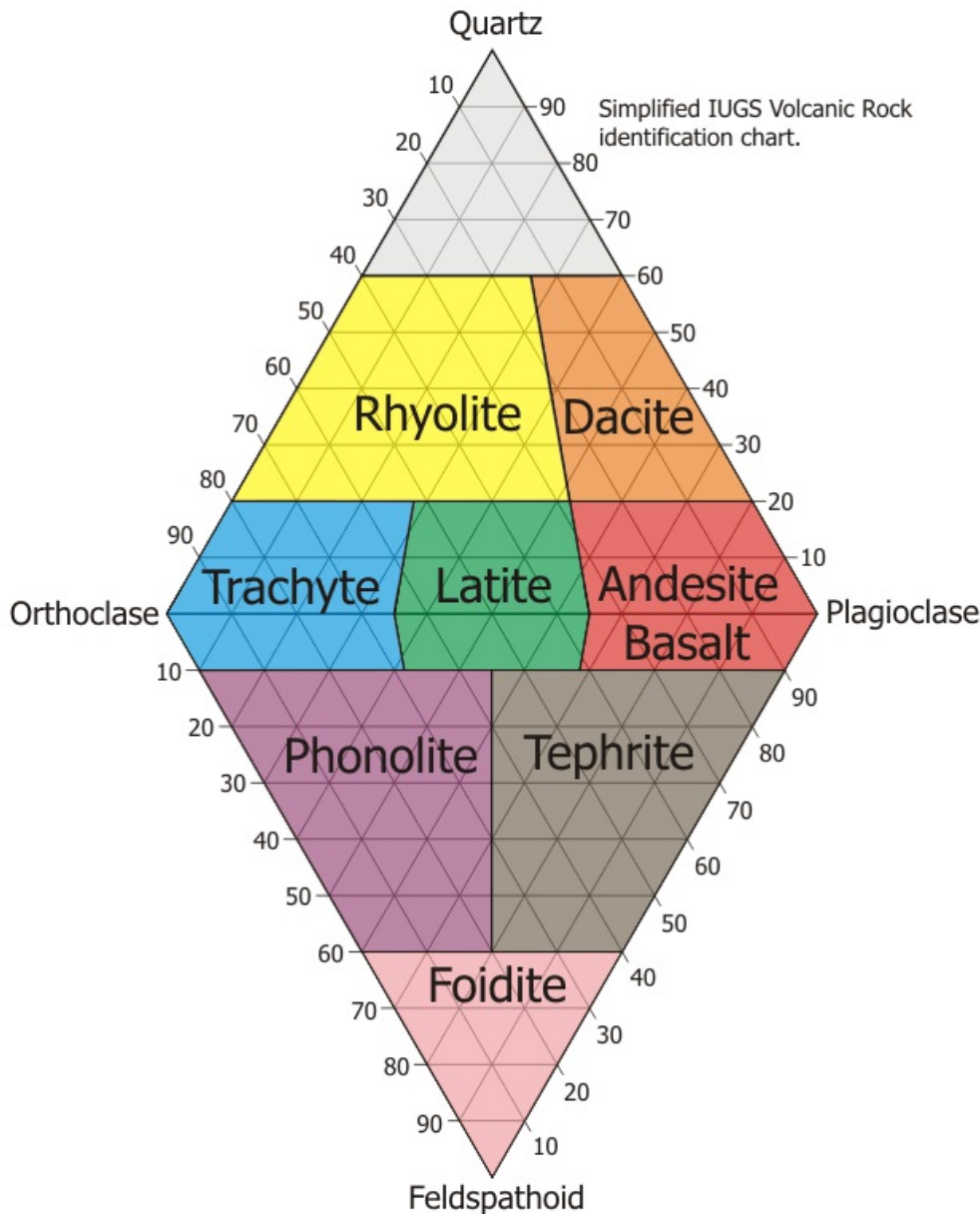
**Rock Classification**

- Start with the IUGS QAPF diagram for volcanics.
  - From the mineral percentages of your CIPW norm calculation, recalculate QAP or APF to 100 and allot the endmembers.
  - Plot on diagram (see below)

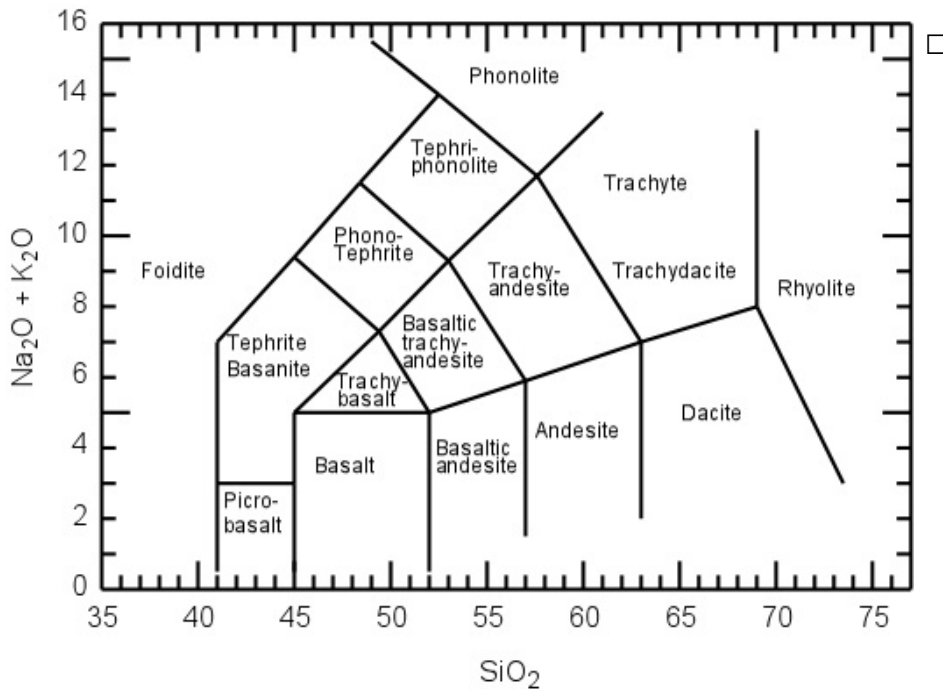
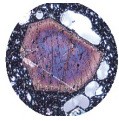


# VOLCANIC IGNEOUS NORM CALCULATION & ROCK ID LAB

- Complete the TAS diagram for Volcanic Rock Identification based on plotting  $\text{SiO}_2$  weight percent against the sum of  $\text{Na}_2\text{O} + \text{K}_2\text{O}$  weight percent. Use the diagram below to plot your result.
- How does your QAPF and TAS plots compare? Where do you see advantages and disadvantages in using the TAS plot versus the QAPF plot.



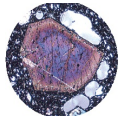
- Plot your results on the pictured QAPF diagram for volcanics to determine extrusive igneous rock type.



Complete the pictured TAS plot by plotting  $\text{SiO}_2$  weight percent against the sum of  $\text{Na}_2\text{O} + \text{K}_2\text{O}$  weight percent.

**Write-Up** should contain the following:

- Title page
- Summary explanation of CIPW norms
- A “table” showing the analytical data and the mineral results - *Your table needs a title and table caption*
- An electronically prepared **volcanic** (not plutonic) QAPF diagram showing your sample - *Your graph needs a title and caption*
- An electronically prepared **volcanic** (not plutonic) TAS diagram showing your sample - *Your graph needs a title and caption*
- A write-up answering the above questions and concluding the identity of the rock with descriptors (e.g. peraluminous or silica-poor, etc.)
- Explain how these two extrusive igneous rocks could be related



### GRADING and NOTATIONS



**ALL ANSWERS MUST BE TYPED USING A WORD PROCESSOR!** This includes chemical formulas, equations, tables and special characters. Become intimately familiar with these functions in your preferred word processor. Where graphics are indicated insert the proper graphic or picture. Be familiar with placing and sizing visuals into a written document. Attach your completed document(s) to this sheet!

**LAB PROCEDURE:** You may work with a partner for collecting data and running the lab experiments. However, this is NOT a group project. Each individual in the group is responsible for his/her own lab write-up, which includes OWN pictures, data tables, graphics, etc.! Do **NOT** copy and share except for RAW data!!!



### For ALL assignments use a citation's database:

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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>
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*Note: You may use a different citations database, if desired. But you MUST use a citations database!*

NOTE: After downloading and installing ZOTERO, take an hour or two to become familiar with the operation of the software. One of your first tasks will be to set the citation style to the United States Geologies Survey (USGS) format in ZOTERO. The USGS citation system will be required for this course and your final product.

**Loading the USGS citation format into ZOTERO:** 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.

### General Writing Instruction Summary:

- Use professional language, which means AVOID first person expressions such as "I", "we", "our". Use normal prose, active voice and third party language. Do NOT use informal wording, contractions, jargon, slang terms, or superlatives. Exclude similes/metaphors (and humor!)
- Use present tense to report well accepted facts, e.g. 'Pyrite is a sulfide mineral'. Use past tense to describe specific results, e.g. 'When acid was applied, the specimen effervesced'
- Be quantitative wherever relevant (stats, numbers etc.).

Subscript & Superscript      Use appropriate subscript and superscript, especially when it comes to chemical formulas and mathematical units..

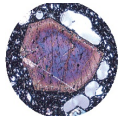
Acceptable examples:  $2.9 \text{ g/cm}^3$ ,  $\text{H}_2\text{O}$ ,  $\text{PO}_4^{3-}$ ,  $a_g=9.8\text{m/s}^2$

Unacceptable examples:  $2.9 \text{ g/cm}3$ ,  $\text{H}2\text{O}$ ,  $\text{PO}4 \text{ } 3-$ ,  $a_g=9.8\text{m/s}^2$

- Use precise concrete language, no ambiguity e.g. 'correlated'  $\neq$  'related'. Use simple language – no unnecessary "frills" (distractions). Pay attention to sentence structure and grammar

### **COMPILING TABLES, FIGURES and EQUATIONS**

GRAPHICS are the heart of any report. Nothing is more true than in science that a picture is worth a thousand words. Always compile graphics first and then write your text focusing on your graphic. In order to create good graphics and photographs, follow the instructions below.



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### **Cameras and Photos:**

Cell phones with a 7.2MP camera are usually ok. When taking pictures, lighting and background is 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:**

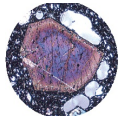
You should be able to modify, enhance, annotate or overlay graphics. Minimum resolution is 300dpi. Make sure graphics are crisp, clear and any label is easily readable. All graphics should have a caption stating the author and/or citation. Preferably use lossless graphic formats, such as .tif or .bmp. 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.



COMPOSITION, LAYOUT, WRITING & GRAMMAR SUMMARY

Language

The following list is an example of common faults in language usage and attribution.

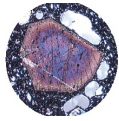
Errors / Mistakes / Faults	Examples with margin <i>Fault Counts &amp; Codes</i>
Spelling: incl. capitalization errors & spacing	The mineral <u>florite</u> has a <u>mohs</u> hardness of four.   Nicolas Steno <u>_</u> was trained in the classical texts on science.
Grammar: incl. punctuation, superfluous words, transpositions	Isometric crystals are also isotropic <u>Here</u> light propagates at the same speed.    Rocks are composed of many <u>many</u> minerals mixed. )
Style: incl. paragraph, repetitive expressions / words, erroneous expression / words, sub- or superscription, unprofessional style, word insertion	<i>Para.</i> ... in the geologic sciences. ¶ Near the end of the 19 <sup>th</sup> a new theory ...    <i>rep</i> ... is a <u>light</u> colored mineral. These <u>light</u> colored minerals are often <u>light</u> ...   Stalactites hang from the <u>sealing?</u> of a limestone cave.   <i>sup</i> The density of quartz is 2.65 g/cm <sup>3</sup> .    I <u>was</u> investigating the outcrop with <u>my</u> group.   Sodium sulfate forms a chalky, <u>incoherent</u> precipitate. <i>amorphous?</i> ^
Sentence: incl. grammar, run-on, strings of nouns	The density of gold is greater <u>then?</u> the density of silver.   Pyrite has a symmetrical crystal <u>structure</u> , <u>it</u> is cubic.    <u>Skarn mineral zonation?</u> is apparent in the sample.

Content

Errors in content are spelled out. Severe infractions may count for multiple errors.

Errors / Mistakes / Faults	Examples with margin <i>Fault Counter &amp; Codes</i>
Unclear / erroneous statements	<i>unclear, units?</i> <u>Mohs hardness of the mineral in question is 16.5.</u>
False / nonsense	<i>Nonsense</i> <del>Glaciation cause severe metamorphism of the region</del>





TABLES, FIGURES & EQUATIONS SUMMARY

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**Tables**

Each table must be sufficiently complete that it could stand on its own, separate from text.

**Only HORIZONTAL lines are allowed in tables. Do NOT use any VERTICAL lines.**

DO consecutively number and caption tables and refer to them accordingly within your text. Captions go ABOVE the table.

DO provide a short description of your table within the caption.

DO place your tables appropriately, closest to their mention in the text.

DO make sure tables are legible and reproduce well. Print can be smaller than text, with an 8pt size minimum.

DO appropriately label columns. Do NOT forget units for numeric values.

AVOID splitting tables across pages.

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**Figures**

Each figure must be sufficiently complete that it could stand on its own, separate from text.

DO number and caption figures consecutively and refer to them accordingly within your text. Captions go BELOW the figure.

DO provide a short description of your figure within the caption.

DO place your figures appropriately, closest to their mention in the text.

DO use appropriate citations for figures that are NOT your own. If you use a figure that has been modified by you, the phrase “modified after....” is most appropriate. Photos should show the name of the photographer.

DO make sure figures are legible and reproduce well. Print can be smaller than text, with an 8pt size minimum. Use a minimum resolution of 300dpi. This is a common publication standard.

AVOID cluttering of figures with too much detail. Simplify if necessary.

AVOID moire patterns in photos, a nuisance in copied or scanned pictures. Most scanners come with a moire pattern removal tool.

**GRAPHS**

**Understand graphs: Bar graphs and/or line graphs are used when plotting nominal vs. ratio or interval data. Scatter plot graphs are used when plotting numeric vs. numeric data.**

DO make sure that the graph axis are appropriately labeled and scaled. Axis should have titles as well as scalar units.

DO use electronic means to generated graphs. Hand drawn graphs are no longer acceptable.

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**Equations & Computations**

- Equations should contain explanation of symbols used.
- A reader should be able to follow where your values or numbers come from. Indicate accordingly.

WRITE DOWN UNITS!!!!

Show equations used before indicating any computation

Acceptable Example:  $F = m \times a = 0.034kg \times 9.8m/s^2 = 0.33kgm/s^2$

where  $m$  is mass of the object in kg as determined with a triple beam balance and  $a$  is the gravitational acceleration.  $F$  indicates force expressed in  $kgm/s^2$  or  $N$  (Newtons).

Unacceptable example: The answer is 0.33. This is obtained by multiplying gravity by 0.034.

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