

Note to instructors

When I put this together, I thought that students would be able to do this on their own. Most cannot.

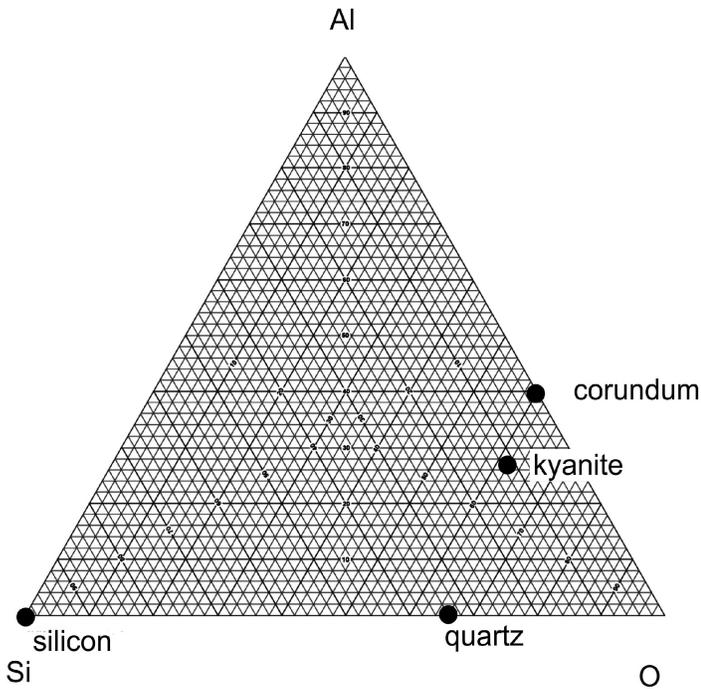
I tried it as homework once and few completed it.

When I use it in class, some really struggle, even when working with their peers in groups.

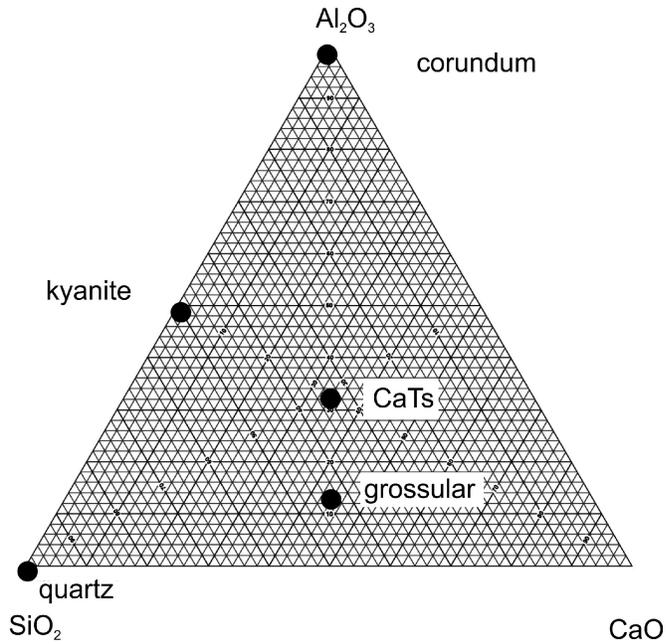
If you can make the read the part in the textbook about triangular diagrams before they come to class, it helps. But, still, there is something inherently difficult - at least for my students.

So, you may want to do a few worked examples before you turn them loose.

Triangular Diagrams - Answers



1. On the diagram above, plot the following (mostly mineral) compositions:
- silicon
 - quartz
 - corundum
 - kyanite



2. On the diagram above, plot the following (mostly mineral) compositions:
- silicon DOES NOT PLOT
 - quartz
 - corundum
 - kyanite
 - grossular, $\text{Ca}_3\text{Al}_2\text{Si}_3\text{O}_{12}$
 - CaTs, $\text{CaAl}_2\text{SiO}_6$

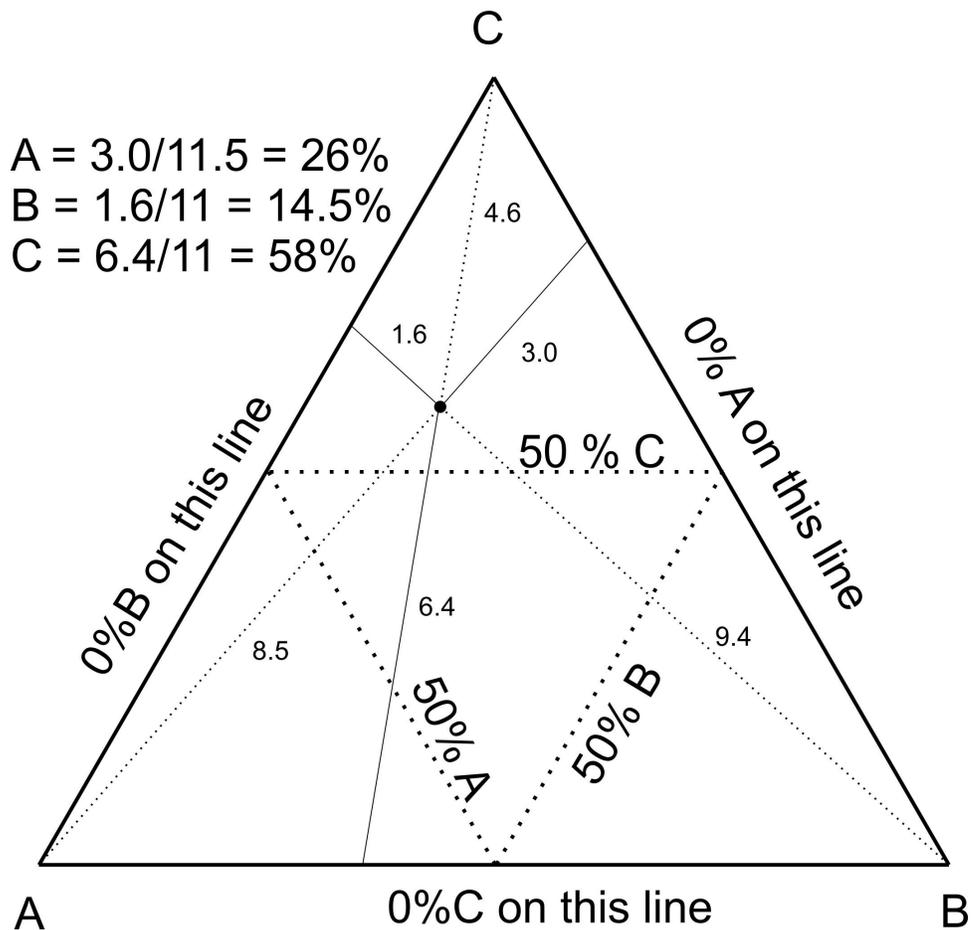
The Lever Rule

Sometimes you won't have all those % lines on your diagram. You can draw them in, or use the lever rule.

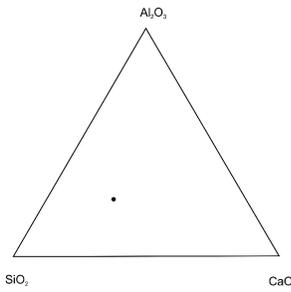
3. Where on the diagram do compositions plot that contain 0% A? 0%B? 0%C?
ON OUT SIDE LINES OF DIAGRAMS OPPOSITE THE A, B, AND C CORNERS - shown below.

4. Where on the diagram do compositions plot that contain 50% A? 50%B? 50%C?
ON DOTTED LINES LABELED BELOW.

5. What %A, %B, and %C are represented by the black dot? (Figure out real number values.)
USE RULER, AND MEASURE, AND APPLY LEVER RULE AS SHOWN BELOW.



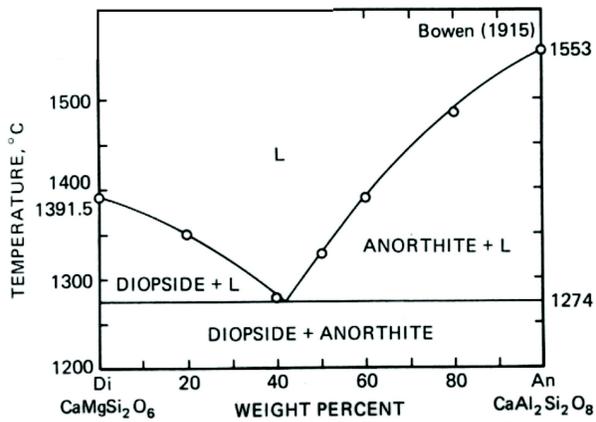
4. What mineral (name it!) is plotted on this diagram? (You may wish to use a ruler.)

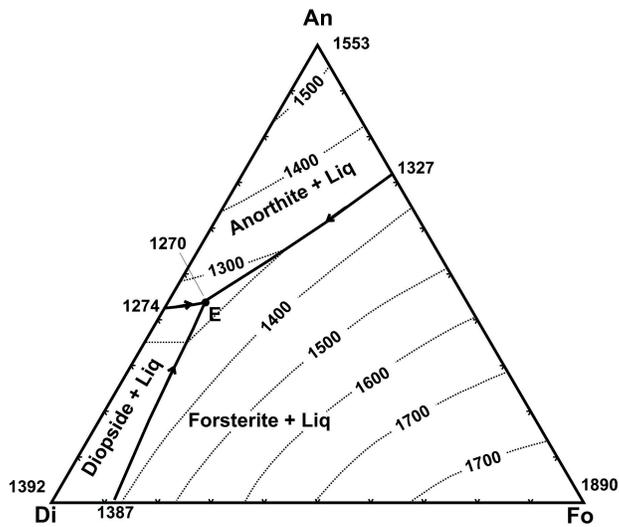


USE THE LEVER RULE OF JUST EYE-BALL THIS. IT IS 50% SiO_2 , 25% CaO , AND 25% Al_2O_3 , MAKING IT ANORTHITE = $\text{CaAl}_2\text{Si}_2\text{O}_8$.

5. What is a eutectic? YOU KNOW THIS ONE.

On this binary diagram (below), where is the binary Di-An eutectic? AT THE LOW POINT IN THE CENTER.

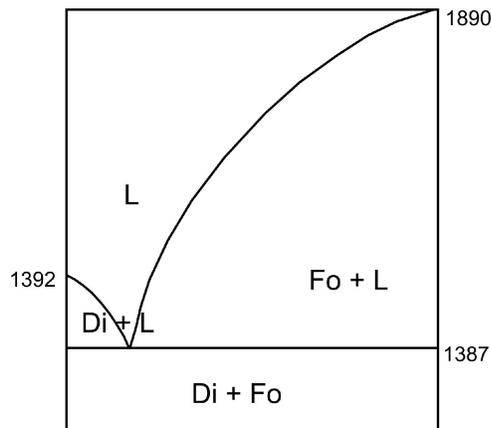




6. On the ternary diagram above where is the binary Di-An eutectic?
 WHERE THE TEMPERATURE LABEL IS 1274 on the outside of the triangle.

7. On the ternary diagram above, where is the ternary Di-An-Fo eutectic?
 AT POINT E WHERE THE TEMPERATURE LABEL IS 1270

8. Using the ternary diagram on the previous page as a reference, sketch the Di-An binary phase diagram as best you can to scale with temperatures of end members and any eutectic (if present) labeled).



9. Consider the diagram shown.

If a magma (of any composition) cools, what is the lowest temperature it can reach before it is all solidified?

1270

If a rock composed of a mix of Di, An, and Fo is heated, at what temperature will it begin to melt?

1270

If a rock contains some amounts of Di, An, and Fo, what is the highest temperature it can reach without being completely melted?

1890

10. Triangular diagrams describe melting/crystallization in model chemical systems that approximate real rocks. What kind of rocks (name some; e.g., diorite) does the diagram on the previous page best describe? You may wish to look at the IUGS classification scheme - be sure to look at the correct diagram.

OLIVINE GABBRO/NORITE IS A GOOD GENERAL TERM, BUT PARTS OF THE DIAGRAM APPLY TO GABBRO, TROCTOLITE, ETC.

11. Consider a rock containing Di, An, and Fo that has overall composition A, shown below. What %s Di, An, and Fo does this rock contain?

56% FO, 31% AN, 12% DI

12. Consider a plutonic rock with composition A. What name would an igneous petrologist give to such a rock? (Consult the IUGS classification scheme.)

olivine gabbro/norite

13. If a magma of composition A cools to 1640°, it will begin to crystallize forsterite. What happens after that? Describe what happens and at what temperatures.

FORSTERITE CRYSTALLIZES UNTIL T REACHES ABOUT 1310
THEN FO AND AN CRYSTALLIZE UNTIL THE EUTECTIC AT 1270
THEN FO-AN-DI CRYSTALLIZE UNTIL DONE

MELT COMPOSITION MOVES AWAY FROM FO TO AN-FO COTECTIC AND FOLLOWS COTECTIC TO EUTECTIC

14. If magma A crystallizes completely, what will be present after it is all solid?

56% FO, 31% AN, 12% DI

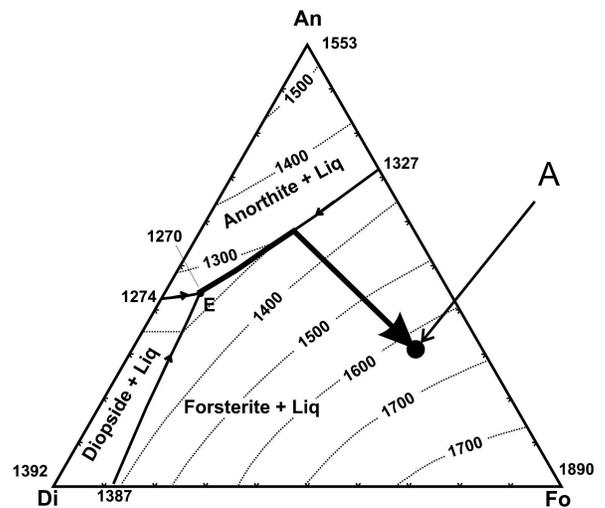
15. A rock of composition A is heated. At what temperature will melting begin? 1270

Which mineral will melt first? ALL WILL MELT TOGETHER BUT DIOPSIDE WILL BE GONE FIRST

What will be the composition of the first drop of melt? THE EUTECTIC COMPOSITION.

Will all minerals in this rock melt at the same time? TO START WITH, YES. LATER, NO.

16. Describe in general terms how melting proceeds until the rock is entirely molten. Use arrows on the diagram to show how the magma composition changes during melting.



ALL THREE MINERALS WILL MELT TOGETHER AT THE BEGINNING, STARTING AT 1270°. THE FIRST MELT WILL HAVE THE EUTECTIC COMPOSITION.

DIOPSIDE WILL RUN OUT FIRST, AND MELT WILL FOLLOW COTECTIC UP AND TO THE RIGHT OF THE EUTECTIC UNTIL ANORTHITE IS GONE. THEN MELT COMPOSITION WILL LEAVE THE COTECTIC (ONLY FORSTERITE IS LEFT TO MELT) AND EVENTUALLY REACH POINT A.

ALL WILL BE MELTED AT 1640°

17. Suppose melt A cools and crystallizes. At what temperature will it be approximately 50% solidified? SLIGHTLY AFTER IT REACHES THE COTECTIC, PERHAPS AT T = 1300 OR SO

18. The melt will change composition until it reaches the eutectic. What % melt will be present just when the composition reaches the eutectic?

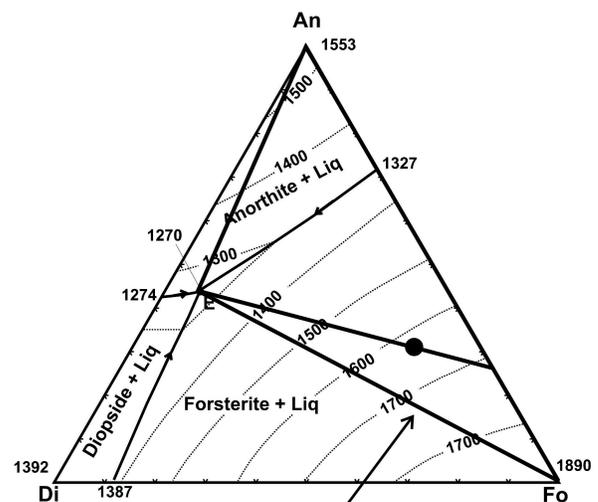
LEVER RULE SAYS ABOUT $1.9/6.6 \text{ CM} = 28.8\%$

What minerals will be present just before melt composition reaches the eutectic? FO+AN

Just after the melt composition reaches the eutectic, what minerals will be present? FO+AN+DI

19. Suppose the melt reaches the eutectic and then the remaining melt squirts off (is separated from the crystals). What rock (name it) will that melt produce when IT crystallizes?

IT WILL PRODUCE A BASALT OR GABBRO AND LEAVE BEHIND AN UM ROCK SUCH AS TROCTOLITE.



Apply lever rule to this triangle. %E comes out to about 28.8%.A