Magma Help

(To learn how to use Help, press the F1 key)

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www.ees1.lanl.gov/Wohletz/Magma.htm

Software Use Notice

Check for periodic **updates** to this software by selecting "About/Registration" from the Help menu. Press the "Update Check..." button to take you directly to the software web page, where you can compare the current version with the one you are using. Download the update if necessary and install it after first uninstalling your version. To keep current, you may also select "Preferences" from the File menu. Check the box for a reminder to check for updates every 30 days.

INSTRUCTIONS:

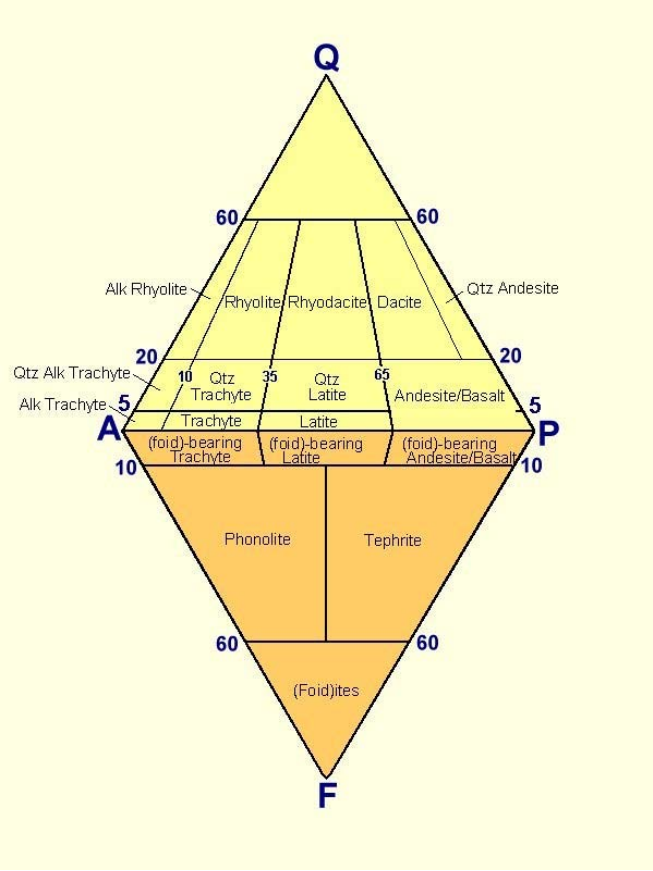
1. First enter magma compositions, pressing <Enter> after each entry. Alternatively, example compositions can be selected by choosing from those listed above the Elements frame.

2. Default values for pressure and temperature will be used if you do not enter these.

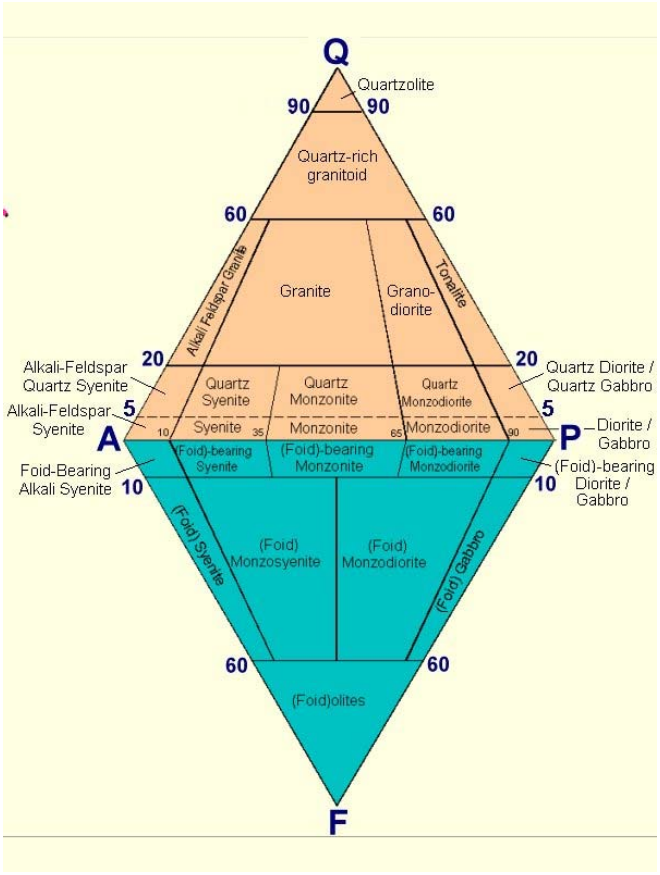
3. The effects of bubble and crystal content are activated by specifying the size and crystal content.

4. Pressing **Calculate** updates results for any changes you make and gives the IUGS volcanic rock classification based on normative QAPF mineralogy: *Le Bas, M. J. & Streckeisen, A. L. (1991)*. *The IUGS systematics of igneous rocks. Journal of the Geological Society, London **148**, 825–833*. Note that classification based on alkali-silica content (TAS) is obtained by pressing the "Plot" button (discussed below).

Normative Classification (Volcanic):



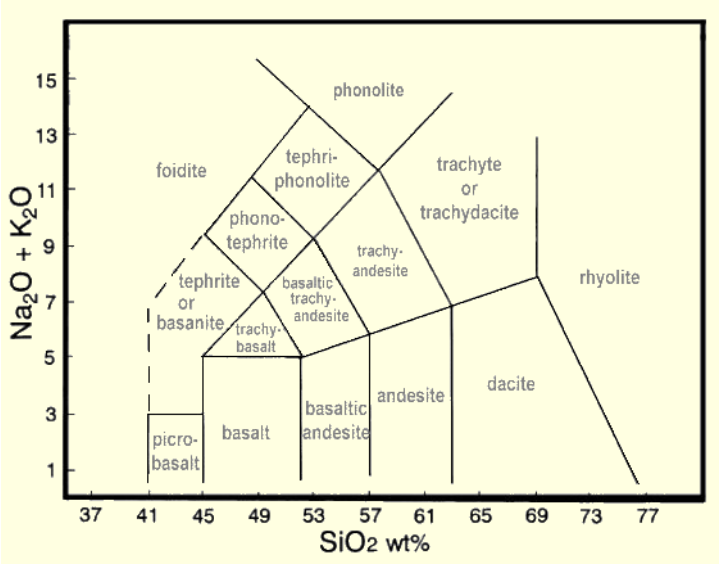
Normative Classification (Phaneritic):



5. Other buttons:
New clears all elemental information and results for a new analysis.
Open retrieves previously saved compositions and results.
Print prints a copy of the the Magma window to your default pringer
TAS Plot displays an total alkali-silica (TAS) diagram with your analyses plotted on the classification diagrams of *Le Bas & Streckheisen (1991)* and *Le Maitre et al (1989)*, or *Cox et al. (1979)*. The plot window allows clearing of specified or all analysis and printing via a print window.
Save saves the displayed results to a ascii file for later printing.
Exit ends the application.

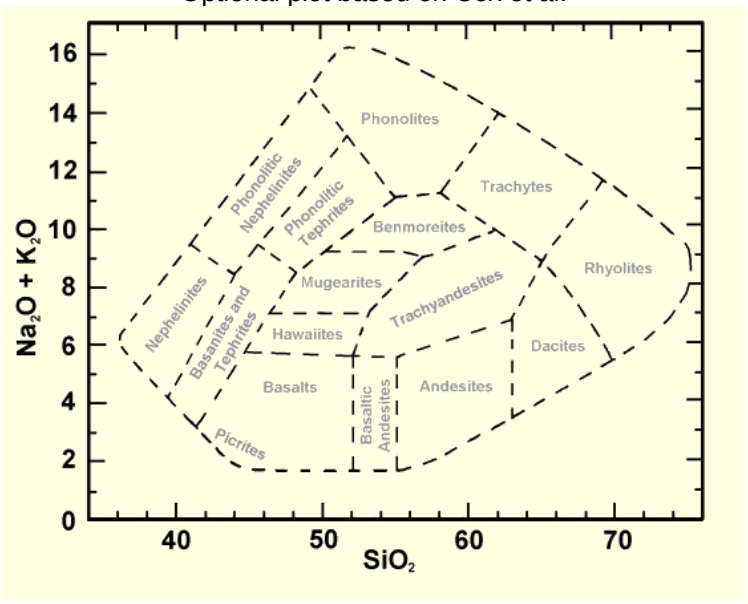
Total Alkali-Silica Classification:

Default based on LeBas and Le Maitre



Note: tephrite when OL < 10%, trachyte when Q < 20%

Optional plot based on Cox et al.



NOTES:

1. The Fe_3+/FeTot ratio depends on the oxidation state of the magma, often a function of silica content. The present version of magma will suggest a ratio to use if you have not entered a value for either Fe_2O_3 or FeO. This value ranges between 0.3 for basalts to 0.60 for rhyolites, with a value near 0.50 reasonable for all magmas.

2. The CIPW norm calculation is performed according to *Myron G. Best; Igneous and Metamorphic Petrology, Freeman, 1982, Appendix E, pp. 616-619*.

3. The Felsic mineral designation are values calculated to use for the IUGG classification tetrahedron. The distribution of Ab between K-feldspar and plagioclase for IUGS classification is somewhat complex, depending upon the overall composition of the magma. In order to make the classification as robust as possible for standard compositions, a 3rd order polynomial equation is used to determine the distribution coefficient, XPLAG, as follows.

FELD = AN - ((ORT + LC) / (AB + NE)) + (NE * (AN / (AN + AB)))
XPLAG = 0.02108 + 0.01716 * (FELD) + 0.00234 * (FELD ^ 2) - 0.00006 * (FELD ^ 3)

This method seems to provide the best overall IUGS classification for volcanic rocks that I have found. If you have a suggestion to improve the method, please let me know.

4. Densities (*Bottinga and Weil, 1972, Amer. J. Sci., 269: 169-182*) take into account normative crystal content the amount of water in the sample. Bulk density is calculated with respect to vesicles that may be present if water is excess of saturation at the calculated pressure. Particle density does not include vesicle volumes. The texture designation is dependent upon bulk density; if vesicle volumes are in excess of 0.75, the rock is arbitrarily assigned to be "Tephra."

5. The water solubility model used is a simple Henry's Law model where

$n = sP^{\beta}$

a. for basalts: s = 0.0215 and the exponent $\beta = 0.5$
b. for rhyolites: s = 0.130 and the exponent $\beta = 0.7$
c. for intermediate compositions a simple linear mixing model between these endpoint compositions is employed

6. The liquidus temperature calculation follows *Sisson and Grove (1993) Contrib. Mineral. Petrol., 113, 143 - 166*:

Tliq = 969 - 33.1 * Hx + 742.7 * AlNum - 138 * NaKNum + 125.3 * MgNum

where AlNum = ALx / (SIx + ALx), NaKNum = (Kx + NAx) / (Kx + NAx + CAx), MgNum = MGx / (MGx + F2x), and variables denoted with small x are oxide weight fractions (H is water).

7. The viscosity values are given in log units of Pa s (10 Poise). The methods for calculation are given in

Bottinga, Y. A., and Weil, D. F., 1972. The viscosity of magmatic silicate liquids: a model for calculation. Amer. J. Sci., 272: 438-473.
Shaw, H. R., 1972. Viscosities of magmatic silicate liquids: an empirical method of prediction. Amer. Jour. Sci. 272: 870-893.

Effective viscosities are calculated to estimate the effects of crystal and vesicles on viscosity. This calculation involves the Einstein-Roscoe equation from McBirney and Murase, Ann. Rev. Earth Planet. Sci. 12: 337-357, 1984.

$\eta' = \eta\ (1 - R\ \phi)^{-2.5}$ (for the Bottinga-Weil estimation)

and

$\ln \eta' = \ln \eta + \alpha\ D / [(\phi'/\phi)^{1/3} - 1] - 0.15$ (Sherman's modification for the Shaw viscosity).

where η' is th effective, viscosity, η is the liquid viscosity, ϕ is volume fraction of cystals (and vesicles), *R* is volumetric ratio of solids at maximum packing that is similar to ϕ', the concentration of crystals (and vesicles) at maximum packing, and α is a constant that varies with mean diameter, *D*. Following *McBirney and Murase (1984)*, this program assumes for a range in compositions the best fits to data are obtained using a value for $\alpha = 0.011$ and *R* (ϕ') at 1.0. Certainly there is much room for debate about these constants, so one should be careful to recognize the limitations of these estimations.

8. Option check boxes activate convenient features:
Add Water: Checking this box forces Magma to add water to make the total = 100 wt%
Auto Pressure: If a composition has a water content in excess of saturation (calculated in 5 above), the pressure will be automatically increased to minimized the excess water
Adjust FE Ratio: If Fe is present in the magma composition but is expressed as a total of FeO and

Fe_2O_3 so that one or the other is entered as zero, Magma will prompt the user with a suitable ratio to be applied.

9. Results are models and must be viewed as such!
(There are more recent models for solubility and viscosity functions that may be more appropriate for your work.)

Help: Please send email to KWare (KWare@lanl.gov) for further support.

Software by KWare: http://www-geo.lanl.gov/Wohletz/KWare.htm

Magma (Igneous rock norms, classification, and physical properties)

This Windows Help file was written by Ken Wohletz

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Disclaimer:

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