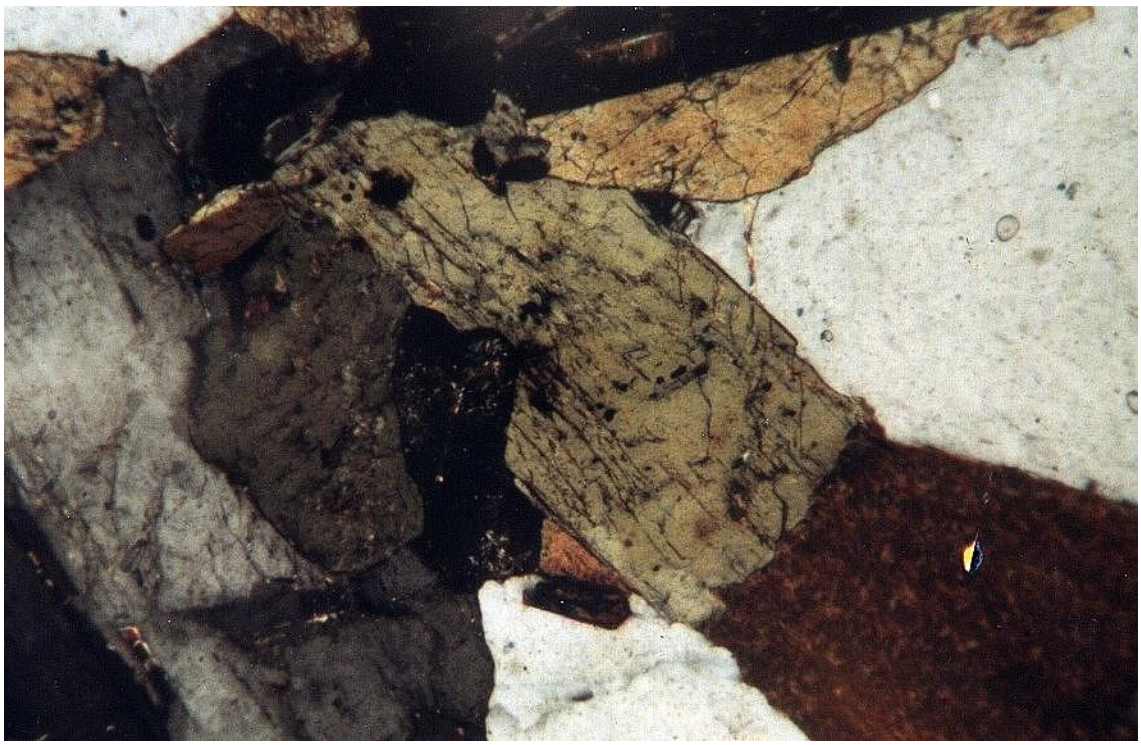
WINROCK



MinServ

By Rob Kanen BSc(Hons)

Kanen, Rob.
WinRock.

Bibliography.
ISBN 0 9756723 8 X.

1. WinRock (Computer file). 2. Rocks - Analysis - Computer programs - Handbooks, manuals, etc. I. Mineral Services (Vic.). II. Title.

552.06028553

TABLE OF CONTENTS

License Agreement

THIS IS A SINGLE COPY SOFTWARE LICENSE granted by **MinServ (Mineral Services)**, (the "Company"). The Software is licensed to you as the end user. It is not sold.

1. The Software enclosed in this package is copyrighted material. Once you have paid the required single copy license fee, you may use the Software for as long as you like provided you do not violate the copyright and if you follow these simple rules:

(a) You may use the Software on any computer for which it is designed so long as not more than one (1) person uses it at any one time. You must pay for additional copies of the Software if more than one (1) person will be using it at the same time on one (1) or more computers.

(b) The Software is copy protected. You may make no more than one (1) copy of the Software for backup purposes, and all such copies, together with the originals, must be kept in your possession or control. You may only transfer the Software to another user if you transfer the originals and all copies retaining no copies for yourself.

(c) You may not make any changes or modifications to the Software, and you may not decompile, disassemble, or otherwise reverse engineer the Software. You may not rent or lease it to others. You may not use it on a computer network unless only one (1) person can use it at a time.

(d) If this copy of the Software is an update to an earlier version of the Software, it is provided to you on an exchange basis. The acceptance of an updated copy of the Software shall result in the voluntary termination of your earlier License and of all rights to use or transfer the earlier version of the Software to another.

2. Use of this Software for business solicitations and/or mailings of any kind may be contrary to the laws of Australia or other governments, or the rules and regulations of certain governing bodies, and the Company disclaims any liability for any improper use or misuse of the Software.

3. In no case shall the Company's liability exceed the price paid for the product and for the license fee to use the Software.

4. This License constitutes the entire agreement and understanding between the parties and supersedes any prior agreement or understanding whether oral or written, relating to the subject of this License. This License may only be modified by a written agreement signed by the Company.

Introduction

About WinRock

WinRock is a petrology/geochemistry and classification program for Windows. WinRock plots IUGS igneous classification diagrams, including QAPF diagrams, plus sandstone, general purpose ternary and XY diagrams. Each diagram contains separate Labeled fields corresponding to individual rock types with rock names listed in separate tables. There are optional tick marks, labels, titles, fonts and fields, plus a choice of symbols and colors. Data can be marked and Labeled using the drawing tools. There is a built in spreadsheet with multiple document interface and clipboard support. .

WinRock Features

Built in Spreadsheet

WinRock has an inbuilt spreadsheet for entering and editing data. The spreadsheet reads and writes tab delimited ASCII files, compatible with most spreadsheets and text editors. A number of other popular formats including excel, csv, pdf and html are also supported.

Standard Classification Diagrams

A set of standard rock classification diagrams are included: carbonatite, charnockite, melilite volcanic, melilite plutonic, QAPF general plutonic, QAPF general volcanic, PlagPxOl, PlagPxHbl, PlagOpxCPx, OlOPxCPx, OlPxHbl, general sandstone, Arenites and Wackes.

A number of geochemical classification diagrams, including, TAS plutonic and volcanic, Jensen Cation and tectonic classification plots are available.

CIPW Norms

CIPW normative minerals for normal rocks can be calculated. Alkali norm for alkaline rocks and carbonatites can be calculated.

Petrology Plots

Petrology diagrams, including harker, ternary and spider plot diagrams are included

Other Plots

A number of other plots, XY, Log, Ternary, Diamond and Bar Charts in 2D and 3D are included

Diagram Manipulation

Many options are available for plotting data. A choice of symbols, labels and diagram title is available to customize the diagram

Printing

Print diagrams with all labels, titles, etc on any windows printer. Format the diagrams for printing, including, size, margins, quality etc.

Getting Started

For both 32 and 64 bit CPU's. WinRock requires a minimum system configuration for effective results. The system requirements are:

Windows 2000, XP, Vista, Windows 7
Net Framework version (V8.0 or higher) requires Net Framework 4.0 or higher.
Devices supported by Windows
Printer supported by Windows.

For automatic installation, proceed as follows:

1. Start Windows and place CD into CD Drive
2. Go to the Run Option on the Start Menu and Click on Browse
3. Open (CDROM)D:
4. Install Net Framework 4

5. Install WinRock
6. After Setup has concluded, you will get a [App] Setup was Completed Successfully message.
7. Go to the WinRock Menu and right click on WinRock. Select Properties and Run As Administrator.
8. To Start WinRock, go to the WinRock Menu and click on WinRock. Enter your registration details in the Registration Window.

Installation will now proceed. The user will be notified when installation is complete. A new Start Menu Item containing WinRock and WinRock HELP is created. Click on WinRock to start the program.

Tutorial

Introduction

WinRock has a standard Windows interface, reducing the number of new procedures to learn. Before starting the exercise, WinRock must be installed on the user's hard drive and opened ready to use. See Getting Started in the Introduction for information on how to install WinRock. A sample data file called comrie.rok is provided for use with the tutorial exercise. If help is required, pull down the Help menu and select Contents.

Getting To Know WinRock

To load the comrie.rok data file, click the Open toolbar button or select Open from the File menu. The Open common Dialog box will pop up. Select comrie.rok in the winrock/data directory.

Hint:

Use the toolbar as a short cut to access some options.

Before proceeding with a plot, select a rock group from the Modal Menu. The user should set the correct rock group. Pull down the Modal Menu and select General Plutonic QAP. The selected rock group is displayed in the bottom left hand corner of the spreadsheet.

Plotting Data

Pull down the Options Menu and select Plot Classification. Select a QAP diagram and click the Plot button. A ternary diagram of QAP will appear on a new form. When finished, click the OK button and you will be returned to the Spreadsheet window.

Entering Data

WinRock has its own built in spreadsheet but you may find it easier to use a spreadsheet or text editor you are familiar with to enter your data. Select New from the File menu to start new data files. Pull down the Modal Menu and select general plutonic QAP. The appropriate column headings are placed in the spreadsheet. Data is entered in each cell by simply typing the value and pressing <enter>. Use the scroll bars, arrow, page up and page down keys to navigate through the spreadsheet. To edit a cell, press <enter> for the cell you want to edit and use the backspace/delete/insert keys to edit the text. When finished editing press <enter> the new value will appear in the spreadsheet. Whole rows can be inserted and deleted using the Insert Row and Delete Row toolbar buttons. Blank lines are not permitted between data. **Column headings are used for reading column data. Be sure a column heading exists for each column of data in the spreadsheet, beginning with column 1 and ending with the last column of data.**

Enter the following data:

Sample #	Quartz	Al Felds	Plag
134223	25	20	55
134225	12	36	52
134226	7	56	37
134227	47	21	32

To edit a cell, go back to Row 2, Col 1 and press <enter>. Type 134224 to replace 134223 and press <enter>.

When you have finished using the program, select Exit from the File menu.

Hint:

Use the mouse to navigate through the spreadsheet. Click a cell to change the current cell or click on the scroll bars to display out of view data. To begin editing a cell, double click the mouse or type a character.

Analyzing a Geochem File

Open one of the data files containing whole rock chemical analyses from the winrock/data directory i.e. basalt.rok or trace.rok. The data file contains a standard set of whole rock analyses. Compositional variation diagrams and classification diagrams can be plotted to determine genetic and compositional information about the samples. Open the GeoChem Menu and click on Total Analyses incl. H2O. Various petrological indices are calculated and displayed in the spreadsheet. The mafic and felsic indices and solidification index are calculated. Plotting Total Alkali and Oxides vs SiO2 i.e. Na2O+K2O vs SiO2 may give information about genetically similar magmas. Select the Geochem Menu and click on CIPW Norm wt%. A CIPW normative mineral assemblage with petrological indices is calculated. The norms can be plotted on standard classification diagrams i.e. PlagPxOl to classify the rocks. In addition, the AMF and QML indices can be plotted on Ternary diagrams to give genetic and compositional information. Select the Geochem Menu and Chemical Classification. Select Classify Volcanic Rocks from the Options Window and click on calculate. Data will automatically be classified and rocknames will be placed in the spreadsheet.

The procedure for plotting a TAS diagram is as follows:

1. Load the Geochem Data into the spreadsheet or type in the data
- Use Add Whole Rock Headings or Convert… from Geochem Menu for correct columns.
2. Define the columns containing the X and Y data
- TAS Diagrams Automatically Assign the appropriate columns using the current spreadsheet, provided the data is in WinRock Whole Rock Chemistry Format.
3. Select Plot Classification from the Plot Menu
4. Select TAS-Volcanic in the Diagram List
- Accept all default values
5. Click on Plot
6. The TAS Diagram should be displayed

The procedure for plotting a QAP diagram is as follows:

1. Load Data into the spreadsheet or type in the data
- Use Add Modal Headings QAP from Modal Menu for correct columns.
2. Define the columns containing the X ,Y and Z data
Use Define Columns in the Options Menu
- Set X value to the column containing Q
-This is Column 5 for the default comrie.rok file supplied
-Set Y Column to the column containing A

-This is Column 6 for the default comrie.rok file supplied.
-Set Z Column to the column containing P
-This is Column 7 for the default comrie.rok file supplied.
3. Select Plot Classification from the Plot Menu
4. Select QAP-Plutonic in the Diagram List
- Accept all default values
5. Click on Plot
6. The QAP Diagram should be displayed

WinRock Menu System

Introduction

When WinRock is started the first screen displayed contains a spreadsheet and menu system. The menu system provides access to all the features of WinRock. Standard Windows menu items; such as, File, Edit and Help are included. Other menu items provide access to the specialized features of WinRock.

File Menu

The File Menu provides many standard file management options.

New Command

Starts a new spreadsheet

Close Command

Closes the current spreadsheet.

Open Command

Provides access to the Open common dialog box. Opens a new file. Select the directory and file and click OK. Clicking the Open toolbar button can also open a file.

Save Command

Saves a file to disk. The default filename is the current filename. The same result is obtained by clicking the Save toolbar button.

Save As Command

Saves a file to disk in a directory and filename specified by the user. A Save As Dialog box pops up for the user to enter filename and directory path information.

Save As Command

Saves a file to disk in a directory and filename specified by the user. A Save As Dialog box pops up for the user to enter filename and directory path information.

Import Command

Imports a text file. Select the type of file to import:
Space Delimited
Comma Delimited
Tab Delimited
Semi Colon Delimited
Fixed Width

Specify the number of lines to skip at the beginning of the file to avoid importation of file headings into the spreadsheet.

Page Setup Command

Specifies printer settings available to the user. Use this option to set various spreadsheet formatting items.

Print Preview

Preview the spreadsheet to be printed fully formatted.

Print Command

Print the spreadsheet

Exit Command

Quits the application.

Edit Menu

The Edit Menu provides access to several standard commands for editing the spreadsheet.

Undo Command

Undo's the previous editing action in the spreadsheet.

Copy Command

Copies selected text in the spreadsheet to the clipboard without deleting. Highlight the text to be copied by dragging the mouse or holding down the shift key and clicking cells. Highlighted text must be contiguous. Select Copy to copy the selected text to the clipboard. Use Paste to paste text from the clipboard to the spreadsheet. Use Cut to remove highlighted text from the spreadsheet to the clipboard.

Cut Command

Copies selected text from the spreadsheet to the clipboard and clears the highlighted area in the spreadsheet. Highlight text to be cut by dragging the mouse or holding down the shift key and clicking cells. Select Cut from the edit menu to transfer selected text to the clipboard. Use Paste to retrieve cut text from the clipboard. Use Copy when you want to copy text to the clipboard without deleting the highlighted text.

Paste Command

Retrieves text from the clipboard and pastes it into selected cells. Highlight cells that are to receive the incoming text by dragging the mouse or holding down the shift key and clicking cells. Highlighted cells must be contiguous. Select Paste from the Edit menu to transfer text from the clipboard to the spreadsheet.. Any text that already exists in the highlighted cells will be replaced. If the number of selected cells are fewer than will hold the clipboard text, the rightmost text from the clipboard will be truncated to fit the selected cells. If the number of cells selected exceed the length of the clipboard text, the remaining cells will be cleared. Use Copy and Cut to send text to the clipboard.

Sort Menu

The Sort Menu allows the user to sort data in the spreadsheet. A new window opens asking for the column number to sort. Click on Sort to sort the spreadsheet.

Search Menu

The Search Menu allows the user to find and replace user specified text.

Find Command

Finds a user specified search text in the spreadsheet. A pop up Search/Replace Dialog box prompts the user for the search text. Enter the exact search text and click OK to proceed with the search.

Find Next Command

Repeats a search using the previous specified search text.

Replace Command

Provides access to the search/replace Dialog box for searching and replacing spreadsheet text. Select from:

Replace All - replace all occurrences of the search text with the specified replace text.

Replace - replaces contents of the current cell with the specified replace text.

Modal Menu

This menu selects the type of modal diagram to be plotted and automatically places the appropriate column headings into the spreadsheet. WinRock uses standard classification diagrams and tables. See Literature References for publications dealing with rock classification. Modal mineralogy headings for entering mineral modes will automatically be placed into the spreadsheet by clicking on the appropriate rockgroup. Rocks can also be classified by calculation using the Calc Modal Classification Command. The correct rockgroup must be selected and data entered properly for the calculation to work correctly.

Select from some of the following classification diagrams:

Carbonatites - CaO/MgO/FeO+Fe2O3+MnO chemical classification of carbonatites.
Charnockites - Quartz/Alkali Feldspar/Plagioclase charnockites.
Melilite Plutonic - Melilite/Olivine/Clinopyroxene melilite plutonic rocks.

Melilite Volcanic - Melilite/Olivine/Clinopyroxene melilite volcanic rocks
General Plutonic QAPF- Quartz/Alkali Feldspar/Plagioclase/Foids plutonic rocks.
General Plutonic QAP - Quartz/Alkali Feldspar/Plagioclase plutonic rocks.
General Plutonic FAP - Foid/Alkali Feldspar/Plagioclase plutonic rocks.
Mafic PlagPxOl - Plagioclase/Pyroxene/Olivine mafic rocks.
Mafic PlagOpxCPx - Plagioclase/Orthopyroxene/Clinopyroxene mafic rocks
Mafic Plag/Px/Hbl - Plagioclase/Pyroxene/Hornblende mafic rocks
Ultramafic Ol/OPx/CPx - Olivine/Orthopyroxene/Clinopyroxene ultramafic rocks.
Ultramafic Ol/Px/Hbl - Olivine/Pyroxene/Hornblende ultramafic rocks.
Volcanic QAPF - Quartz/Alkali Feldspar/Plagioclase/Foids volcanic rocks
Volcanic QAP - Quartz/Alkali Feldspar/Plagioclase volcanic rocks.
Volcanic FAP - Foids/Alkali Feldspar/Plagioclase volcanic rocks.
General Sandstones - Quartz/Clay/Feldspar general sandstones.
Sandstones Arenites - Quartz/Feldspar/Rock Fragments for sandstones <15% clay.
Sandstones Wackes - Quartz/Feldspar/Rock Fragments for sandstones >15% clay.

Calc Modal Classification

Automatically classifies rocks using modal mineralogy and places the rocknames into the spreadsheet. Select a rockgroup from the Modal Menu and click on Modal Classification to classify the rocks. This option is only available for felsic, mafic and ultramafic plutonic, volcanic and charnockite rockgroups and sandstones.

Add Headings

Adds mineral headings into the spreadsheet for plotting classification diagrams. For ternary classification diagrams, each mineral corresponds to the X, Y or Z axis. Enter mineral data under the appropriate heading to plot your diagram. Before plotting, ensure the spreadsheet columns are assigned to the correct axes using the Define Columns Command in the Options Menu.

Modal Headings

Automatically places mineral headings into the spreadsheet for entering modal compositions.

Reports

Automatically loads a petrographic report template for routine petrographic analyses. The reports can be used "as is" or customized to the users requirements. Reports can be saved or cut and pasted into

spreadsheet applications for further formatting. Reports are also supplied already formatted in Excel '97 format. They are located in the winrock/templates directory.

Report Templates Supplied:
Igneous Rocks
Pyroclastic Rocks
Metamorphic Rocks
Sedimentary Rocks
Limestones
Ore Minerals

GeoChem Menu

Total Analyses Command

Calculates Totals for chemical analyses. Several Indices are also calculated:

Silica Grade – Acid, Intermediate, Basic, Ultrabasic.
Acid >= 63%
Intermediate >=52% And <63%
Basic >= 45% And <52%
Ultrabasic >= 35% And < 45%

Na2O+K2O - Total Alkali

FeOt - Total Iron. Calculates Fe2O3/1.11134 + FeO and places it into the FeOt column.

Mg Ratio or Mg# - Atomic (Mg/Mg+Fe) * 100

Solidification Index (Kuno, 1959)) -
100 * (MgO/(MgO+Fe2O3+FeO+Na2O+K2O))

Felsic Index - ((Na2O+K2O)/(Na2O+K2O+CaO)) * 100

Mafic Index - ((FeO+Fe2O3)/FeO+Fe2O3+MgO)) * 100

CMAS (Cox, Bell and Pankhurst (1979) -

C = (CaO - 3.33 * P2O3 + 2 * Na2O + 2 * K2O) * 56.08
M = (Fe2O3 + MnO + NiO + MgO - TiO2) * 40.31
A = (Al2O3 + Cr2O3 + Fe2O3 + Na2O + K2O + TiO2) * 101.96
S = (SiO2 - 2 * Na2O - 2 * K2O) * 60.09
All in mol proportions of major oxides
Recalculated as %

Totals can be calculated with or w/o H2O and CO2 and with or w/o LOI (Loss on Ignition)

Recalc to a New Sum

Recalculates major element whole rock chemistry to a new user defined total

Convert

Selecting Convert from the Geochem Menu will start the spreadsheet conversion routine. The current spreadsheet will be converted to WinRock whole rock spreadsheet format for use with WinRock's Geochem functions. The spreadsheet conversion matches the column headings in your imported file to WinRock whole rock headings to perform the conversion. As most geochem files use standard whole rock chemistry and trace element abbreviations, conversion is usually not a problem

Add Headings Command

Adds chemical analysis or multi element headings into the spreadsheet

Each element is assigned to a specific column. For the calculations to work correctly, these columns must be used “as is”, in their pre-defined format. The format has changed in V8.7 upwards, with some additional trace elements added. Do not change the whole rock geochemistry headings. To convert your file to Winrock format, select Convert… from th3e Geochem Menu. For multi element geochemistry, the text in the column headings can be changed to suit your analysis, but there must be the same number of columns for the calculations (Totals) to work correctly.

The geochem columns are defined in the following format:
Col1: Sample #
Col2: Rockname
Col3: Symbol
Col4: Color
Col5: SiO2

Col6: TiO2
Col7: Al2O3
Col8: Fe2O3
Col9: FeO
Col10: MnO
Col11: MgO
Col12: CaO
Col13: Na2O
Col14: K2O
Col15: P2O5
Col16: H2O+
Col17: H2O-
Co18: CO2
Co19: Other
Col20: ZrO2
Co21: Cr2O3
Col22: V2O3
Co23: NiO
Col24: CoO
Co25: BaO
Co26: SrO
Co27: Rb2O
Col28: F
Col 29: Cl
Col30: S
Col31: Total

For multi element geochemistry, the columns have the following format:

Col1: Sample #
Col2: Rockname
Col3: Symbol
Col4: Color
Col5: Au
Col6: Ag
Col7: As
Col8: Cr

Col9: Cu
Col10: Fe
Col11: Hg
Col12: Mn
Col13: Mo
Col14: Ni
Col15: Pb
Col16: Pt
Col17: Sb
Co18: Sn
Col19: Ti
Co20: U
Col21: V
Co22: Zn
Col23: Zr
Col25: Total
Co26: LOI

Chemical Classification

Classifies rocks by calculating whole rock chemistry and normative minerals and places the rocknames into the spreadsheet. Only available for plutonic and volcanic rocks. Select a Classification Scheme to classify the rocks. The calculation uses the Classic CIPW norm. Normative mineral percentages are calculated into volume % (approximating the mode) by dividing the weight% norm by the mineral density and recalculating to 100%.

Enter the iron ratio for norms if required. Select Use Standard Values if a TAS classification is calculated. This option uses standard Fe2O3 ratios for specific rocktypes, as listed under the Set Fe Ratio heading.

The spreadsheet can be slow to read large files. If this is the case, better performance can be obtained by deleting unused columns (setting columns to empty). For example, when performing a chemical classification on a whole rock chemistry file, it is possible to delete all trace element columns (trace elements are not required in the calculation) before the operation to improve performance.

CIPW Norm (Classic) Command

Calculates CIPW normative minerals for normal igneous rocks in wt%, mole% or volume%. Calculations performed in wt% sum to the water free total of the original analysis in wt%, equivalent to the original

CIPW Norm; whereas, mol% sums to 100, following the method of Barth-Niggli's Molecular Norm (Catanorm). For volume%, normative mineral percentages are calculated into volume % (approximating the mode) by dividing the weight% norm by the mineral density and recalculating to 100%. If Adjust Fe Ratio is selected, the CIPW Fe is proportioned according to this formula:
FE = Fe2O3 / 1.1113 + FeO: Fe2O3 = FE * FR * 1.1113: FeO = FE * (1 - FR)
Where:
FE = Total Fe
FR = Fe Ratio

See chemical classification for classifying volcanic rocks using norms and Fe Ratio's of Le Bas and Middlemost (1989). If Adjust FeRatio is not selected, the CIPW Fe uses the Whole Rock Analysis Fe2O3 and FeO in wt%

The following compositional factors are also calculated:
1. AMF - the ratio Na_2O + K_2O/MgO/FeOt (Irvine and Baragar, 1971)
2. QML - the ratio silica(Q)/mafic(M)/leucocratic(L) components (Johanssen, 1938)
3. Quartz/Albite/Orthoclase ratio if >70% felsic minerals are present
4. Differentiation Index of Thornton and Tuttle(1960)
DI= normative q + or + ab + ne + ks + lc
Larsen Index (Larsen, 1938 and Cox et al., 1979)
1/3SiO2 + K2O - FeO + MgO + CaO
Alkalinity Ratio (Wright, 1969)
(Al2O3 + CaO + Na2O + K2O)/(Al2O3 + CaO - Na2O - K2O)
If SiO2>50% and 1.0-K2O/Na2O<2.5 Then
(Al2O3 + CaO + 2Na2O)/(Al2O3 + CaO - 2Na2O)
CMAS (Cox, Bell and Pankhurst (1979) -
C = (CaO - 3.33 * P2O3 + 2 * Na2O + 2 * K2O) * 56.08
M = (Fe2O3 + MnO + NiO + MgO - TiO2) * 40.31
A = (Al2O3 + Cr2O3 + Fe2O3 + Na2O + K2O + TiO2) * 101.96
S = (SiO2 - 2 * Na2O - 2 * K2O) * 60.09
All in mol proportions of major oxides
Recalculated as %

Normative mineral abbreviations:
Q -quartz
ap -apatite
or - orthoclase
ab -albite

an -anorthite
ne -nepheline
lc - leucite
kp - kaliophillite
hl - halite
ac - acmite
il - ilmenite
mt - magnetite
hm - hematite
tn - sphene
ru - rutile
ns - Na metasilicate
ks - K metasilicate
cs - dicalcsilicate
wo - wollastonite
ol - olivine
di - diopside
hy - hypersthene
pf - perovskite
c - corundum

CIPW Norm (IUGS) Command

Calculates the IUGS CIPW normative minerals in wt% or volume%. Wt% sums to the original analysis total in wt%. For volume%, normative mineral percentages are calculated into volume % (approximating the mode) by dividing the weight% norm by the mineral density and recalculating to 100%.
FE = Fe2O3 / 1.1113 + FeO: Fe2O3 = FE * FR * 1.1113: FeO = FE * (1 - FR)
Where:
FE = Total Fe
FR = Fe Ratio

See chemical classification for classifying volcanic rocks using norms and Fe Ratio's of Le Bas and Middlemost (1989). If Adjust FeRatio is not selected, the CIPW Fe uses the Whole Rock Analysis Fe2O3 and FeO in wt%

The following compositional factors are also calculated:
1. AMF - the ratio Na_2O + K_2O/MgO/FeOt (Irvine and Baragar, 1971)
2. QML - the ratio silica(Q)/mafic(M)/leucocratic(L) components (Johanssen, 1938)

3. Quartz/Albite/Orthoclase ratio if >70% felsic minerals are present
4. Differentiation Index of Thornton and Tuttle(1960)
DI= normative q + or + ab + ne + ks + lc
Larsen Index (Larsen, 1938 and Cox et al., 1979)
1/3SiO2 + K2O - FeO + MgO + CaO
Alkalinity Ratio (Wright, 1969)
(Al2O3 + CaO + Na2O + K2O)/(Al2O3 + CaO - Na2O - K2O)
If SiO2>50% and 1.0-K2O/Na2O<2.5 Then
(Al2O3 + CaO + 2Na2O)/(Al2O3 + CaO - 2Na2O)
CMAS (Cox, Bell and Pankhurst (1979) -
C = (CaO - 3.33 * P2O3 + 2 * Na2O + 2 * K2O) * 56.08
M = (Fe2O3 + MnO + NiO + MgO - TiO2) * 40.31
A = (Al2O3 + Cr2O3 + Fe2O3 + Na2O + K2O + TiO2) * 101.96
S = (SiO2 - 2 * Na2O - 2 * K2O) * 60.09
All in mol proportions of major oxides
Recalculated as %

Normative mineral abbreviations:
Q - quartz
C - corundum
Z - zircon
or - orthoclase
ab - albite
an - anorthite
ne - nepheline
lc - leucite
kp - kaliophillite
hl - halite
nc - sodium carbonate
ac - acmite
ns - Na metasilicate
ks - K metasilicate
di - diopside
hy -hypersthene
wo - wollastonite
ol - olivine
cs - dicalcsilicate
cm - chromite

hm - hematite
mt - magnetite
il - ilmenite
tn - sphene
pf - perovskite
ru - rutile
ap - apatite
hap - hydroxyapatite
fr - fluorite
pr - pyrite
cc - calcite
mag - Magnesite
sid - Siderite
H2O+
H2O-
Other
fsd - Final silica deficiency
P2O5+ - Excess P2O5
CO2+ - Excess CO2
Cr2O3+ - Excess Cr2O3
F+ - Excess F
Cl+ - Excess Cl
S+ - Excess S
Mg/Fe - 100MgO/MgO+FeO
SiUnd - Silica Undersaturation

Alkali-Carb Norm Command

Calculates normative minerals for strongly alkaline and carbonatite rocks in wt% or mole%. Suitable for nephelinites, ijolites and carbonatites. The norm is derived from the alkali norm of Le Bas (1973). Originally presented by McBirney et al. (1993). Calculations performed in wt% sum to the water free total of the original analysis in wt%; whereas, mol% sums to 100. The additional chemical components CO2, Cl, F, S, SO3, CR2O3 and ZRO2 are used in this calculation if available. If Adjust Fe Ratio is selected, the CIPW Fe is proportioned according to this formula:

FE = Fe2O3 / 1.1113 + FeO: Fe2O3 = FE * FR * 1.1113:FeO = FE * (1 - FR)

Where:

FE = Total Fe
FR = Fe Ratio

The Fe Ratio calculation used here follows that of Middlemost (1989). If Adjust FeRatio is not selected, the CIPW Fe uses the Whole Rock Analysis Fe2O3 and FeO in wt%

Normative mineral abbreviations:
Q - quartz
ap - apatite
or - orthoclase
ab - albite
an - anorthite
ak - akermanite
mel - melanite
nc - sodium carbonate
kc - potassium carbonate
ma - magnesite
ba - baddeleyite
ge - gehlenite
cn - carnegieite
ne - nepheline
ka - kalsilite
lc - leucite
kp - kaliophyllite
hl - halite
th - thenardite
cc - calcite
ac - acmite
il - ilmenite
mt - magnetite
hm - hematite
tn - sphene
ru - rutile
zn - zircon
fl - fluorite
cm - chromite
ns - Na metasilicate
ks - K metasilicate

wo - wollastonite
ol - olivine
di - diopside
hy -hypersthene
pf - perovskite
c - corundum
pr - pyrite

Adjust Fe Ratio Command

The ratio Fe3+/Total Fe. The Fe Ratio can be redefined using the Adjust Fe Ratio command. The Fe Ratio is used for calculating CIPW norms. See chemical classification for classifying volcanic rocks using norms and Fe Ratio's of Le Bas and Middlemost (1989). Use the following values for some common compositions:
Foidite 0.1 to 0.4
Picrite 0.15 to 2
Komatiite 0.15 to 2
Miemechite 0.15 to 2
Boninite 0.35 to 4
Picrobasalt 0.15
Basanite 0.2
Basalts 0.2
Basaltic Andesites 0.3
Andesites 0.35
Dacites 0.4
Tephrite 0.3
Phono-Tephrite 0.35
Tephri-Phonolite 0.4
Trachybasalt 0.3
Basaltic Trachyandesite 0.35
Trachyandesite 0.4
Rhyolites 0.5
Phonolite 0.5
Trachyte 0.5

FE = Fe2O3 / 1.1113 + FeO: Fe2O3 = FE * FR * 1.1113:FeO = FE * (1 - FR)

Where:

FE = Total Fe
FR = Fe Ratio

If Adjust FeRatio is not selected, the CIPW Fe uses the Whole Rock Analysis Fe2O3 and FeO in wt%

Metamorphic Indices Command

Totals the chemical analyses and calculates Eskola's Metamorphic Indices ACF and A'KF

1. ACF - the ratio $Na_2O + K_2O$/CaO/FeO+MgO+MnO

Calculated as Follows:
A=Al2O3+Fe2O3-(Na2O+K2O)
C=CaO
F=FeO+MgO+MnO

1. A'KF - the ratio $Na_2O + K_2O$+CaO/K2O/FeO+MgO+MnO

Calculated as Follows:
A=Al2O3+Fe2O3-(Na2O+K2O+CaO)
K=K2O
F=FeO+MgO+MnO

Options Menu

The File Menu provides many standard file management options.

Define Columns Command

Defines which columns contain the XYZ data. A Dialog box prompts the user for columns containing Sample #, Rockname, Symbol, Color, X Value, Y Value and Z Value. When the default data file format is used, these correspond to columns 1, 2, 3, 4, 5, 6 and 7 respectively. If a file using a different format is imported, new values can be entered. For example, a file containing only XYZ data is imported. X Value, Y Value and Z Value will be set to columns 1, 2 and 3 respectively. In this example, Sample #, Symbol and Color can be left blank or assigned to empty columns. Whole Rock Chemistry use the predefined WinRock whole rock chemistry spreadsheet format for some diagrams requiring calculations. These diagrams are TAS-Volcanic, TAS-Plutonic, Tectonic Classification Diagrams and Spider Diagrams.

Add XY Headings

This command selects a general XY diagram and places the appropriate column headings in to the current spreadsheet. Axes titles can be specified in the Options Window by selecting Set XY Options.

Add Ternary Headings

This command selects a general ternary diagram and places the appropriate column headings in to the current spreadsheet. Axes titles can be specified in the Options Window by selecting Set Ternary Options.

Add Diamond Headings

This command selects a diamond diagram and places the appropriate column headings in to the current spreadsheet. Axes titles can be specified in the Options Window by selecting Set Ternary Options.

Normalize Command

Normalizes data in a specified column to a new user specified sum.

Format Command

Automatically formats numeric data in the spreadsheet. Specify the number of decimal points and click on format to format data. Formatting only occurs in columns 5 to end.

Statistics Command

Calculates the maximum, minimum, median, mean and standard deviation of a group of samples. Enter the spreadsheet column number containing the data to be analyzed. Click on calculate to calculate statistics.

Colors Command

Provides access to the Colors Dialog box for selecting the symbol colors. Enter a color code in the spreadsheet under the color column.

Symbols Command

This command opens the Symbol window to view available symbols. Enter a symbol code in the spreadsheet under the symbol column.

Auto Symbols Command

Automatically assigns a symbol to each data point when a diagram is plotted.

Assign Symbols Command

Automatically calculates a different symbol for each data point and places the symbol codes into the spreadsheet under the Symbol column heading.

Convert to Coord Command

Converts modal mineralogy to XYZ coordinates as used by ternary diagrams.

Tables Menu

Displays standard rock classification and petrographic tables. The tables can be printed or displayed on screen. They are useful to assist identifying groups of rocks and determining properties.

Tables:
Conglomerates
Dynamometamorphic
Lamprophyres
Limestones
Meteorites
Mudstones
Phosphorites
Pyroclastics
Ultramafics
Volcaniclastics

Petrographic Charts
Sedimentary grain size

Igneous and metamorphic grainsize
Roundness
Volume
Birefringence

Plot Menu

Bar Chart Plot Command

Plots bar charts using data in the current spreadsheet. The Bar Chart Options Window pops up for selecting plotting options.

Classification Plot Command

Plots classification diagrams using data in the current spreadsheet. The Classification Options Window pops up for selecting plotting options.

Discrimination Plot Command

Plots discrimination graphs using data in the current spreadsheet. The Discrimination Options Window pops up for selecting plotting options.

Log Plot Command

Plots Log-Log and Log-Linear graphs using data in the current spreadsheet. The Options Window pops up for selecting log plotting options.

Spider Plot Command

Plots spider diagrams using data in the current spreadsheet. The Spider Plot Options Window pops up for selecting plotting options.

Ternary Plot Command

Plots ternary and diamond graphs using data in the current spreadsheet. The Options Window pops up for selecting plotting options.

XY Plot Command

Plots XY graphs using data in the current spreadsheet. The Options Window pops up for selecting XY plotting options.

The Spreadsheet

Introduction

A spreadsheet is a form consisting of rows and columns of data and is the best method for displaying and manipulating data in row and column format. The custom spreadsheet supplied with WinRock is used for entering and editing data. Once the data is correctly entered, data can be sorted, calculated and plotted.

File Formats

The built in spreadsheet saves data files in tab delimited ASCII format, the default format for Winrock. This format is used by Microsoft Excel and is compatible with most spreadsheets. To import a data file created with another application, save the file in tab delimited format (in Excel, these files have a .txt extension), start WinRock and open the data file. WinRock will automatically load the file into the spreadsheet. To export a data file created with WinRock, use any of the following methods:

1. Select tab delimited ASCII format in the other application. These files usually have a .txt extension. Open the file.
2. In Excel, the file created with WinRock can simply be opened directly.
3. Winrock also opens and saves Excel files

Winrock also reads and writes Microsoft Excel (xls) and CSV files.

The built in spreadsheet requires data to be in a specific format for plotting and calculating. The first row in the spreadsheet is reserved for column headings. Any data placed in the first row will not be included in subsequent calculations. Imported data files will be displayed intact with all headings and data; however, to use WinRock's features it is necessary to correctly define which columns contain sample #, symbol, color, X, Y and Z values. Additional data can be entered via the keyboard or using the clipboard.

The spreadsheet can be slow to read large files. If this is the case, better performance can be obtained by deleting unused columns (setting columns to empty). For example, when performing a chemical

classification on a whole rock chemistry file, it is possible to delete all trace element columns (trace elements are not required in the calculation) before the operation to improve performance.

For geochemical data, each element is assigned to a specific column. For the calculations to work correctly, these columns must be used as is, in their pre-defined format. Do not change the whole rock geochemistry headings.

The geochem columns are defined in the following format:
Col1: Sample #
Col2: Rockname
Col3: Symbol
Col4: Color
Col5: SiO2
Col6: TiO2
Col7: Al2O3
Col8: Fe2O3
Col9: FeO
Col10: MnO
Col11: MgO
Col12: CaO
Col13: Na2O
Col14: K2O
Col15: P2O5
Col16: H2O+
Col17: H2O-
Co18: CO2
Co19: Other
Col20: ZrO2
Co21: Cr2O3
Col22: V2O3
Co23: NiO
Col24: CoO
Co25: BaO
Co26: SrO
Co27: Rb2O
Col28: F
Col 29: Cl
Col30: S
Col31: Total

For multi element geochemistry, the columns have the following format:
Col1: Sample #
Col2: Rockname
Col3: Symbol
Col4: Color
Col5: Au
Col6: Ag
Col7: As
Col8: Cr
Col9: Cu
Col10: Fe
Col11: Hg
Col12: Mn
Col13: Mo
Col14: Ni
Col15: Pb
Col16: Pt
Col17: Sb
Co18: Sn
Col19: Ti
Co20: U
Col21: V
Co22: Zn
Col23: Zr
Col25: Total
Co26: LOI

Diagrams can also be exported to pdf files using the pdf printer driver supplied. Select the dopdf printer in the printer settings to print a pdf file.

Entering Data

Data is entered in each cell by simply typing the value and pressing <enter>. Use the scroll bars, arrow, page up and page down keys to navigate through the spreadsheet. Use the scroll bars when moving around the spreadsheet. To edit a cell, press <enter> for the cell you want to edit and use the

backspace/delete/insert keys to edit the text. When finished editing press <enter> the new value will appear in the spreadsheet. Whole rows can be inserted and deleted using the Insert Row and Delete Row toolbar buttons. Blank lines are not permitted between data.

Sorting Data

To sort data, pull down the Edit menu and select Sort. The Sort Menu allows the user to sort data in the spreadsheet. A new window opens asking for the column number to sort. Click on Sort to sort the spreadsheet.

Converting Data to XYZ

If data has been entered as modal mineralogy, clicking on the convert to XYZ option in the Options Menu will convert the data to XYZ coordinates. It is not necessary to convert data as conversion automatically takes place when a diagram is plotted.

Printing Data

Pulling down the File menu and selecting Print prints data. A Print Dialog box will pop up with several options. Select OK to print the data. A simple listing of current data will be printed.

Hint:

Be sure the correct printer is selected as the default printer. Use the options button in the Print Dialog box to select the correct printer

The Diagrams

Introduction

WinRock will plot standard rock classification diagrams in addition to general-purpose xy, ternary, diamond, log-log and log-linear graphs. Many options are available to customize the diagrams. Publication quality diagrams can be produced on a laser printer.

Before plotting data, several options must be set to control the type and appearance of the diagram. To access the Options window, pull down the Plot menu and select the diagrams to be plotted.

Bar Chart Options Window

Select Plot Bar Chart from the Plot menu to plot a bar chart. A bar chart displays sample numbers on the x-axis and a variable, such as Cu, Au, As etc on the Y axis. Bar charts have the same drawing/editing tools as the other graphs. In the options window, specify the Y coordinate from the whole rock chemistry or multi-element chemistry drop down list. Alternatively, specify a column containing data to plot. Choose from a standard bar graph or line graph.

Graph titles and labels can also be entered.

Classification Plot Options Window

The Classification Options window has many user definable settings to control the diagram. For ternary plots (eg. QAP), data in the defined columns for top, left and right values are used. The default columns are columns 5, 6 and 7. For diamond plots (eg. QAPF), the defined column for the bottom apex is also used. The default column is column 8. For diamond plots, column 5 (top) and column 8 (bottom) data cannot be co-existing. Set column 5 (top apex) data to empty (zero) for each entry in column 8 (bottom apex).

Geochemical plots do not require user defined columns for plotting data. Geochemical data in the spreadsheet is already in a pre-defined format; therefore, when a diagram is selected, data for that

diagram is obtained directly from the spreadsheet and the necessary calculations are performed automatically before plotting the diagram.

Diagram Type

This option determines the type of diagram to be plotted. Select from the list of diagram types.

Plutonic Rocks
Barker, 1979 – An/Ab/Or, granites
IUGS Carbonatites - CaO/MgO/FeO+Fe2O3+MnO carbonatites. Contains > 50% primary carbonates.
IUGS Charnockites - Quartz/Alkali Feldspar/Plagioclase charnockites. Contains >5% hypersthene
IUGS Melilite Plutonic - Melilite/Olivine/Clinopyroxene melilite plutonic rocks. Contains > 10% melilite and <10% feldspathoids.
IUGS General Plutonic QAPF - Quartz/Alkali Feldspar/Plagioclase/Foids plutonic rocks. Contains 0-90% mafic minerals.
IUGS General Plutonic QAP - Quartz/Alkali Feldspar/Plagioclase plutonic rocks. Contains 0-90% mafic minerals.
IUGS General Plutonic FAP - Foid/Alkali Feldspar/Plagioclase plutonic rocks. Contains 0-90% mafic minerals.
Plutonic TAS - K2O+Na2O vs SiO2 chemical classification for plutonic rocks. Middlemost, 1994
IUGS Mafic PlagPxOl - Plagioclase/Pyroxene/Olivine mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Mafic PlagOpxCPx - Plagioclase/Orthopyroxene/Clinopyroxene mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Mafic Plag/Px/Hbl - Plagioclase/Pyroxene/Hornblende mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Ultramafic Ol/OPx/CPx - Olivine/Orthopyroxene/Clinopyroxene ultramafic rocks. Contains >90% mafic minerals.
IUGS Ultramafic Ol/Px/Hbl - Olivine/Pyroxene/Hornblende ultramafic rocks. Contains >90% mafic minerals.

Volcanic Rocks
AFM Volcanic - K2O+Na2O/FeOt/MgO chemical classification for volcanic rocks. Irvin and Baragar, 1971
IUGS Carbonatites - CaO/MgO/FeO+Fe2O3+MnO carbonatites. Contains > 50% primary carbonates.
IUGS Melilite Volcanic - Melilite/Olivine/Clino-Pyroxene melilite volcanic rocks. Contains > 10% melilite and <10% feldspathoids.
IUGS Volcanic QAPF - Quartz/Alkali Feldspar/Plagioclase/Foids volcanic rocks. Contains 0-90% mafic minerals.

IUGS Volcanic QAP - Quartz/Alkali Feldspar/Plagioclase volcanic rocks. Contains 0-90% mafic minerals.
IUGS Volcanic FAP - Foids/Alkali Feldspar/Plagioclase volcanic rocks. Contains 0-90% mafic minerals.
IUGS Volcanic TAS - K2O+Na2O vs SiO2 chemical classification for volcanic rocks. Le Bas, 1986
IUGS Volcanic TAS - K2O+Na2O vs SiO2 chemical classification for volcanic rocks. Middlemost, 1994
Jensen Cation - Fet+Ti/Al/Mg chemical classification for volcanic rocks. Jensen, 1976, Modified by Rollinson, 1993
Winchester and Floyd, 1977– Zr/TiO2 * 0.0001 vs SiO2, volcanic rocks
Winchester and Floyd , 1977 – Nb/Y vs Zr/TiO2 * 0.0001, volcanic rocks

Sandstones
General Sandstones - Quartz/Clay/Feldspar general sandstones. Selley, 1984
General Sandstones - Quartz/Feldspar/Rock Fragments general sandstones. Pettijohn, 1975
Sandstones Arenites - Quartz/Feldspar/Rock Fragments for sandstones <15% clay. Pettijohn, 1975
Sandstones Wackes - Quartz/Feldspar/Rock Fragments for sandstones >15% and <75% clay. Pettijohn, 1975

Metamorphic Rocks
Metamorphic - ACF - the ratio $Na_2O + K_2O$/CaO/FeO+MgO+MnO
Metamorphic - A'KF - the ratio $Na_2O + K_2O$+CaO/K2O/FeO+MgO+MnO

Tectonic Classification Granites
Batchelor and Bowden, 1985 - R1=4*Si-11*(Na + K)-2*(Fe + Ti) vs R2=6*Ca+2*Mg+Al in millications, granites
Harris et al, 1986 – Rb/10,Hf,Ta*3, granites
Pearce et al, 1984 - Y+Nb vs Rb, granites
Pearce et al, 1984 - Y vs Nb, granites
Pearce et al, 1984 - Ta+Yb vs Rb, granites
Pearce et al, 1984 - Yb vs Ta, granites

Tectonic Classification Basalts
Pearce and Cann, 1973 - Zr vs Ti , basalts
Pearce and Cann, 1973 - Ti/100,Zr,Y*3, basalts
Pearce et al., 1977 - FeT, MgO, Al2O3, for rocks with SiO2 greater than 51 percent and less than 56 percent, basalts
Meschede, 1986 – 2*Nb,Zr/4,Y, basalts
Mullen, 1983 - TiO2, 10xMnO 10xP2O5, with SiO2 greater than 45 percent and less than 54 percent, basalts

Set Labels

This option determines which labels appear on the diagram. Select from:

1.none - no labels appear on the diagram

2.sample # - sample #'s as shown on the spreadsheet

Labels will be printed with the diagram.

Axes

Specify your own axes titles here.

Symbol Definitions

If you want symbol descriptions printed with the diagram, enter the descriptions here.

Discrimination Plot Options Window

The Discrimination Plot Options Window sets options for Discrimination plots. Discrimination plots use data from the spreadsheet in the Winrock geochemical data format. Do not change columns for the whole rock or trace element data.

Graph and Scale Type

Select standard XY Plot or XY Line Plot to plot points connected by lines. Auto Scale or Manual Scale can be selected.

Set Scale

When Manual Scale is selected enter maximum and minimum values for the X and Y axes here.

Set Titles

Enter diagram, x-axis and y-axis titles here.

X and Y Axes

Sets the X and Y Axes for Discrimination Plots. Uses data in the current spreadsheet. Data must be in the pre-defined format for whole chemistry and multi-element chemistry. Load one of the sample whole rock chemistry data files or select Add Whole Rock Headings from the Geochem Menu to view the pre-defined format. Select the elements from the pre-defined lists for X and Y Axes. For example, if SiO2 is selected as X Axes and K2O is selected as Y Axes, the graph will be plotted as a SiO2 vs K2O plot.

Log Plot Options Window

The Log Plot Options Window sets options for Log-Log and Log-Linear Plots. For log plots, data in the defined columns for x and y values are used. The default columns are columns 5, and 6. These columns can be changed, if necessary, using the Define Columns command.

Scale

Select the scale of the X and Y axes here.

Scale Type

Select log-log or log-linear type plots

Titles

Enter titles for the graph and x and y axes here.

Pie Chart Options Window

For pie charts, it is possible to define labels and a chart title in the options window. Set the columns containing sample name and percentage. There are no color and symbol settings for pie charts, the built in color library is used instead. Additional options can be set in the Pie Chart Window.

Set Labels

This option determines which labels appear on the diagram. Select from:

1.none - no labels appear on the diagram

2. sample name - sample names as shown on the spreadsheet

Labels will be printed with the diagram.

Title

Customize the chart title.

Spider Plot Options Window

The Spider Plot Options Window initializes the settings for Spider Plots. Spider plots use data from the spreadsheet in the Winrock geochemical data format. Do not change columns for the whole rock or trace element data.

Normalize

Select the type of normalization to be applied to the trace element chemistry. For example, select MORB to apply the MORB norm of Pearce (1983).

Some of the Norms Available:

MORB Pearce (1983)
Sr,K,Rb,Ba,Th,Ta,Nb,Ce,P,Zr,Hf,Sm,Ti,Y,Yb

REE Chondrite Boyden (1984)
La,Ce,Pr,Nd,Pm,Sm,Eu,Gd,Tb,Dy,Ho,Er,Tm,Yb,Lu

ORG (Pearce et al.1984)
K2O,Rb,Ba,Th,Ta,Nb,Ce,Hf,Zr,Sm,Y,Yb

Primitive Mantle (Sun & McDonough 1989)
Cs,Rb,Ba,Th,U,Nb,K,La,Ce,Pb,Pr,Sr,P,Nd,Zr,Sm,Eu,Ti,Dy,Y,Yb,Lu

Additional norms are available in norm definition files in the winrock\spider folder.

Select Elements

Select elements to plot on the Spider Diagram from the list of elements. Multiple selections can be made. When a norm is selected, the elements are automatically assigned and no selection is necessary.

Use File Norm

A norm definition file can be used to plot spider diagrams. You can create your own definition file or use one of the supplied files. The supplied definition files are in the winrock\spider folder. Norm definition files can be opened and edited within WinRock. They should be saved as plain text files (tab delim ASCII, csv) or WinRock (*.rok) files. Norm definition files are plain text files in the following format:

Title
Element1
Value1
Element2
Value2
Element3
Value3
etc. to End

The first line is reserved for a title. The second line contains the first element in the norm. The third line contains the normalization factor for that element. This elements continue to the end of the file.
for example:

Spider Plot Norm MORB
Rb
2.0
Sr
120
Ba
20
etc. to End

If a norm definition file is plotted, specify the correct scale to plot the Spider diagram correctly.

Scale

Spider diagrams use log scales on the y-axis because of the large range of values in trace elements. You can select the scale here. When a norm is selected, the scale is automatically assigned and no selection is necessary.

Symbols

If you want symbol descriptions printed with the diagram, enter the descriptions here.

Titles

Enter the titles to appear on the diagram

Ternary Plot Options Window

The Ternary/Diamond Options window has many user definable settings to control the diagram. For ternary plots, data in the defined columns for top, left and right values are used. The default columns are columns 5, 6 and 7. For diamond plots, the defined column for the bottom apex is also used. The default column is column 8. For diamond plots, column 5 (top) and column 8 (bottom) data cannot be co-existing. Set column 5 (top apex) data to empty (zero) for each entry in column 8 (bottom apex).

Axes Titles

Specify the axes titles for plots here.

Diagram Type

This option determines the type of diagram to be plotted. Select from the list of diagram types.

Set Labels

This option determines which labels appear on the diagram. Select from:

1.none - no labels appear on the diagram

2.sample # - sample #'s as shown on the spreadsheet

Labels will be printed with the diagram.

Symbol Definitions

If you want symbol descriptions printed with the diagram, enter the descriptions here.

XY Plot Options Window

The XY Setup Window sets options for XY plots. For XY plots, data in the defined columns for x and y values are used. The default columns are columns 5, and 6. These columns can be changed, if necessary, using the Define Columns command.

Graph and Scale Type

Select standard XY Plot or XY Line Plot to plot points connected by lines. Auto Scale or Manual Scale can be selected.

Set Scale

When Manual Scale is selected enter maximum and minimum values for the X and Y axes here.

Set Titles

Enter diagram, x-axis and y-axis titles here.

Plot Window

The Plot window displays the diagram and sends output to the printer or disk.

Axes Color

To change the default color of the diagram, select this command. A Colors Dialog box will pop up. Select a color and click OK.

Box Draw

To draw a box, select box draw. Position the pointer where the box is to begin and drag the cursor by holding down the left mouse button. Release the left mouse button when you have positioned the box correctly.

Copy Diagram Command

Copies the current diagram to the clipboard for pasting into other applications.

Data Information Display

Displays a data value for each point on the graph. Click on the point to display the data. To enable, check the Data Information Display Menu, followed by the selector toolbar (arrow icon).

Delete All

Deletes all drawing and text actions and redraws the plot

Ellipse Draw

To draw an ellipse, select ellipse draw. Position the mouse pointer where the ellipse is to begin and drag the cursor by holding down the left mouse button. Release the left mouse button when you have positioned the box correctly.

Fields

If this command is checked, all fields and field labels are displayed and printed with the diagram.

Field Labels

This option determines whether field labels are displayed on screen and printed with the diagram. When Field Labels is checked all field labels are displayed and printed with the diagram.

Add Text

To add text select, Add Text. Position the cursor where you would like to add text and click the left mouse button. Type the text to be Added. Press F2 to finish editing text. Double click on existing text to start editing. To delete text, clear the text box, press enter and F2 or Escape.

Legends

Displays several different types of Legends on screen. Select sample #, rock name, standard symbols, or classification legend. The legend can be printed and saved.

Line Draw

To draw a line, select Line Draw. Position the cursor where you would like the line to begin and drag the line by holding down the left mouse button and moving the mouse. Release the left mouse button when the line is positioned correctly.

Print Diagram

Prints the current diagram. Also previews the diagram in its fully formatted state and allows further control of margins, quality etc. If Field Labels and Symbol Legends are enabled in the Options Menu, these will be printed.

Save Diagram As Command

This command saves the current diagram in a user-specified directory and filename. A pop up Dialog box appears which prompts the user for directory path and filename information. The diagram can be exported to many different bitmap and vector file formats. Some of these include bmp, jpeg, pdf and svg.

Scroll Axes

Activates scrolling of the X and Y axes. Right click the mouse, with the pointer over the axis and drag the axis scale.

Symbol Legends

Displays the selected symbol legend on screen. To add symbol descriptions, type the description next to the desired symbol. The symbol legend can be printed and saved.

Tick Marks

If this command is checked, tick marks are displayed and printed with the diagram.

Undo

Undo the previous drawing action.

Zoom

When zoom is selected true, hold down the right mouse key and drag the pointer from top left to bottom right to zoom the chart. Drag in the opposite direction to undo the zoom.

Geolbases

Geolbases is a set of geological databases to help retrieval of mineralogical and petrological data. Each database has its own unique graphical user interface so they can be used individually without having to change tables and report layouts. The databases can be accessed from the database menu in WinRock or from the Windows Start Menu.

GeolBases Features

Querying

The databases use standard SQL query language to search records, however the SQL language is hidden behind a simplified Search interface so that no previous knowledge of SQL is required. The search engine keyword and substring searches are based on whatever text is input by the user.

Printing and Clipboard Support

Each database has printing and clipboard support. Search results can be printed tables and information from the databases can be copied to the clipboard for use in other applications.

Getting Started

Geolbases requires a minimum system configuration. The system requirements are:

Windows 2000, XP , Vista, Windows 7, Server 2008
Requires Net Framework 4.0 or higher
Access 20010 Database Engine Runtime
Mouse
Printer supported by Windows

For automatic installation, proceed as follows:

1. Start Windows
2. Select My Computer

3. Open (CDDrive)D:
4. Install Net Framework 4
5. Install Access 2010 Database Engine
6. Install Geolbases

Net Framework 4 and Access 2010 Database Engine are included on the CD or can be downloaded from Microsoft.

Editing Databases

This has changed in V.2. Now, Microsoft Access is required to edit the access database files directly.

The WinRock Database

The WinRock Database for Windows is a petrographic database of igneous, metamorphic and sedimentary rocks. Each rocktype contains a petrographic summary consisting of Rock Name, Group, Family, Texture, Structure, Composition, Occurrence and Comments. The descriptions have been standardized using the usual petrographic terms. Searches can be carried out on individual or multiple fields using partial or complete key words. The composition field can be searched with up to three minerals simultaneously.

Using The WinRock Database

Click on The WinRock Database menu item or icon to start the program. The WinRock Database Window is displayed with a scrollable list of rock names and their descriptions. Records can be printed or copied to the clipboard.

To start a query click on the Query command button. The Search Window is displayed with a list of searchable fields. Enter search terms in the appropriate fields. The database has been standardized using the usual petrographic terms. These terms are listed under the appropriate fields in the Search Window. It is recommended that searches are made using these terms; however, descriptions are not limited to these terms and any keyword can be used. Click on Search to start a search. A list of matches is displayed in The WinRock Database Window. Search results can be printed or copied to the clipboard. To list the entire database click on the Refresh command button.

A set of sample images are included with the database. Further images can be added by using Microsoft Access to link to the image name. Place the Image File in the Images Folder with other images.

Bookmarks can be entered using the database ID property. Enable editing and enter a unique number/label into the ID field. This label is searchable with the Query/Search option. Useful for indexing samples or as simple reference bookmarks.

List of Search Terms

Group

Igneous
Metamorphic
Sedimentary

Structure

Massive - No structure
Foliated - Planar alignment of platy minerals
Schistose - Discontinuous planar alignment of minerals
Flow - Changing alignment of minerals in a flow pattern
Banded - With bands of different composition or color
Bedded/Laminated - Divided into separate layers

Texture

Crystalline - All crystalline textures, with a grain size > 0.2mm (e.g. Granite, Gneiss)
Microcrystalline - Crystalline textures with a grain size < 0.2mm and > 0.01mm (e.g. Hornfels)
Cryptocrystalline - Crystalline textures with a grain size < 0.01mm (e.g. Agate)
Amorphous - Non crystalline, glassy (e.g. Obsidian)
Porphyritic - Large crystals (phenocrysts) in a fine-grained ground mass (e.g. Basalt)
Recrystallized - Textures produced by partial recrystallization (e.g. Meta-Basalt)
Inequigranular - Fine to macro - sized grains (e.g. Kimberlite)
Fragmental - Composed of mineral and/or rock fragments (e.g. pyroclastics)
Biogenic- Textures produced by organisms (e.g. Limestone - Boundstone)
Organic-Textures produced by organic material (e.g. coal)
Clastic - Textures produced by mechanically accumulated grains cemented together (e.g. Sandstone)
Chemical - Textures produced by chemical precipitation (e.g. Anhydrite)

Occurrence

Plutonic - A general term for any large scale intrusive rocks
Volcanic - Extrusive and associated intrusive rocks
Regional Metamorphic - Metamorphic rocks occurring over large areas

Contact Metamorphic - Adjacent to intrusions
Fault/Shear Zone - Planar zones of brittle and/or ductile deformation
Basin - Sedimentary rocks in a sedimentary basin.

MinServ Mineral Database

The MinServ Mineral Database is a reference database of over 3700 minerals. Mineral Name, Formula and Crystal System index each mineral. Nearly all registered mineral names are listed but group terms such as feldspar and apatite are not listed. The database can be searched for key words and substrings and the results printed and copied to the clipboard.

Using The Mineral Database

The Mineral Database has all entries listed in a table. Minerals can be scrolled up and down through the table. To find a specific property, it is a simple matter of entering a search term and selecting the field to be searched to find a specific mineral. The results can be printed or copied to the clipboard for use with other applications.

Bookmarks can be entered using the database ID property. Enable editing and enter a unique number/label into the ID field. This label is searchable with the Query/Search option. Useful for indexing samples or as simple reference bookmarks.

Mineral Properties Included

Mineral Name - The International Mineralogical Organization recognized mineral name

Formula - Enter part or whole formula i.e. Cu for formula containing copper

Crystal System - Enter crystal system
Isometric or cubic
Hexagonal or trigonal
Tetragonal
Orthorhombic
Monoclinic
Triclinic

MinServ Rock Forming Minerals Database

The MinServ Rock Forming Minerals Database is a reference database of all rock forming and accessory minerals. The database is divided into two sections: 1. Physical properties, listing all physical properties and 2. Optical properties, listing all optical properties visible with a polarizing microscope.

Using The Database

The Rock Forming Minerals Database is based around a standard mineral description report displayed as a form with a scrollable list of mineral names linked to each mineral property. Properties for each mineral are displayed as the names are selected from a scrollable list. Clicking on the Query button can search all properties. It is a simple matter of entering a search term and selecting the field to be searched to find a specific mineral. The results can be printed or copied to the clipboard for use with other applications.

A set of sample images are included with the database. Further images can be added by using Microsoft Access to link to the image name. Place the Image File in the Images Folder with other images.

Bookmarks can be entered using the database ID property. Enable editing and enter a unique number/label into the ID field. This label is searchable with the Query/Search option. Useful for indexing samples or as simple reference bookmarks.

Recommended Search Terms:

Formula - Enter part or whole formula i.e. Cu for formula containing copper

Crystal System - Enter crystal system
Isometric or cubic
Hexagonal or trigonal
Tetragonal
Orthorhombic
Monoclinic
Triclinic

Group - Enter mineral group name
Quartz
Pyroxene
Feldspar
Garnet
Serpentine
Clay
Mica
Brittle Mica
Bauxite
Oxide
Amphibole
Feldspathoid
Zeolite
Silliminite
Calcite
Barite
Humite
Tourmaline
Epidote
Chlorite

Specific Gravity - the relative weight of a mineral as compared to water

Hardness - hardness of a mineral according to Moh's Hardness Scale

1 - Soft, i.e. Talc
2 - Copper
3 - Calcite
4 - Fluorite
5 - Medium i.e. Apatite
6 - Feldspar
7 - Glass or Quartz
8 - Topaz
9 - Corundum
10 - Hardest natural occurring mineral, Diamond

Streak - Color of a minerals powder when crushed. Determined by rubbing a mineral on a porcelain plate.
White - most common, feldspar, calcite, garnet
Black - magnetite, uraninite
Green - hornblende, vesuvianite

Color - Natural color of a mineral
Black - Mica, Uraninite, Hematite
White - Plagioclase
Pink - Orthoclase
Green - Chlorite, Olivine

Opacity - The transparency of a mineral
Opaque - Does not transmit light
Translucent - Partially transmits light
Transparent - Fully transmits light

Luster - Appearance of a minerals surface
Pearly - Smooth, shiny, white surface, talc, calcite
Vitreous - Glass like, most transparent minerals are vitreous, quartz, garnet
Dull - Does not shine, talc, kaolinite
Adamantine - Brilliant shining surface, diamond
Soapy - Soapy feel, talc, chlorite
Greasy - Greasy feel, topaz, olivine
Silky - Like silk, antigorite, anthophyllite
Waxy - Wax like surface, quartz, serpentine,
Satin - Satin like surface, kaolinite
Submetallic - Shiny, opaque, metallic like surface, mica

Metallic - Shiny, metallic surface, pyrite
Splintery - In splinters, chlorite

Habit - A minerals external form
Cubic - In cubes, pyrite, halite garnet
Polyhedrons/Octohedrons - Garnet, fluorite
Rhombohedral - Rhomb shaped, calcite, chiastolite
Prismatic - Rectangular, square outlines, very common, hornblende, epidote, augite, zircon, sphene
Hexagonal - Hexagonal or triangular outlines, tourmaline, beryl, topaz
Tabular - Thick, flat prismatic outlines, feldspar, biotite, chlorite, epidote, olivine
Columnar - Thin columns, often in aggregates, tourmaline, actinolite/tremolite, hornblende, diopside
Flakes/Plates/Scales - Mostly the fine, microcrystalline varieties. Mica, clay minerals, chlorite, sericite
Fibrous - In fibers, actinolite/tremolite, talc, serpentine, nephrite
Acicular - Fine, needle like crystals, tourmaline, rutile, mimetite (apatite)
Radiating - Outwardly radiating from a center, zeolite, tourmaline, gypsum
Spherulitic - A radiating acicular mass of crystals forming a circular shaped pattern. Common pattern in devitrified volcanic glass
Short - Short
Long - Long

Occurrence - The mode of occurrence and/or formation of a mineral
Veins - hydrothermal veins, quartz, calcite veins
Pegmatites - V.coarse grained veins of granites, feldspars, tourmaline, micas
Vesicular/Amygdaloidal - Cavities in volcanic rocks
Evaporites - Within sedimentary evaporite basins
Metamorphic (Contact) - Along contact zones of recrystallized rocks, hornfels, skarn
Metamorphic (Regional) - Metamorphic rocks occurring over a large area, gneiss
Igneous - Generally some form of magmatic intrusion, granite, gabbro
Sedimentary - Derived from pre-existing rocks and often laid down in layers, sandstone, shale
Sedimentary Limestones - Deposited in ocean basins due reef building or accumulation of carbonate grains (detrital or precipitation), limestone

Optical Mineralogy Database
Most of these properties are only discernable with a polarizing microscope, as used by geologists.

Relief - The visibility of a mineral in plane polarized light. Usually compared to adjacent minerals or the cementing material used in the slide, such as balsam.

Birefringence - The interference color observable under crossed polars. Refer to a birefringence table to determine values

2V - The angle of the optical axis in biaxial minerals. Measured in an oriented crystal with a Bertrand Lens under crossed polars and high power.

Optical Sign - Most minerals are either uniaxial, with a single optic axis or biaxial, with two optic axes i.e. quartz, calcite, tourmaline are uniaxial, olivine, augite, hornblende, feldspar are biaxial.

Refractive Index - The degree to which a crystal bends light, as it passes through a crystal. The RI varies according to the optical axes. Uniaxial minerals have two directions of RI: 1. Along the ordinary ray; and 2. Along the extraordinary ray.. Biaxial minerals have three directions of RI: 1. Nalpha, 2. Nbeta and 3. Ngamma.

Pleochroism - The variation in color as a mineral is rotated under plane polarized light. I.e. hornblende, biotite are strongly pleochroic

Extinction Angle - The type of extinction when a mineral is rotated under crossed polarized light.
Parallel - Parallel to cleavage or crystal outlines
Oblique - At an angle to cleavage or crystal outlines
Symmetrical - Symmetrical to crystal shape or cleavage, i.e. hornblende, hypersthene, dolomite

Cleavage - Cleavage outlines in thin section are often distinctive of a mineral.
Amphibole Cleavage - Two at 56" and 124" in cross section
Pyroxene Cleavage - Two at 83" and 97" in cross section
Mica Cleavage - Perfect in one direction
Chlorite Cleavage - Perfect in one direction
Cubic Cleavage - Halite, galena
Cleavage/Foliation Masses/Aggregates - Aggregates of planar minerals, such as chlorite and mica in one direction, parallel to cleavage.

Twinning - Twinned crystals are often observed in thin section and are distinctive of certain minerals
Polysynthetic Twinning Albite Law - Plagioclase feldspars almost always exhibit this. Used to determine Albite/Anorthite content
Simple Twinning, Amphibole - Hornblende often is twinned with two crystals sharing a common twin plane
Simple Twinning, Carlsbad - Very common in K-feldspars

Penetration Twinning - Where two crystals penetrate each other through the center, andalusite, staurolite, cordierite

MinServ Economic Database

The MinServ Commodity Database contains data on economic minerals and their uses. It has over 70 commodities and 200 economic minerals covering all major ore and industrial mineral commodities.

Using The Commodity Database

The Commodity Database has all entries indexed by commodity and displayed report style. Each mineral is listed in a scrollable table and linked to their respective physical properties. As a mineral is selected in the list, all physical properties for that mineral are displayed on the report form. A separate query form allows querying of all fields by keyword or substring. To perform a query, click on query and enter the search terms under the field to be searched. Leave fields not searched blank. Click on Search to perform the Search. A list of matches is shown in the main window. Scroll through the minerals to see each record that matches the query.

Bookmarks can be entered using the database ID property. Enable editing and enter a unique number/label into the ID field. This label is searchable with the Query/Search option. Useful for indexing samples or as simple reference bookmarks.

A set of sample images are included with the database. Further images can be added by using Microsoft Access to link to the image name. Place the Image File in the Images Folder with other images.

Recommended Search Terms:

Commodity - Enter a commodity
Aluminum
Feldspar
Garnet
Lithium
Uranium
Copper
Lead
Zinc
Nickel
Iron
Phosphate
Gold

Silver
Etc.

Formula - Enter part or whole formula i.e. Cu for formula containing copper

Crystal System - Enter crystal system
Isometric or cubic
Hexagonal or trigonal
Tetragonal
Orthorhombic
Monoclinic
Triclinic

Group - Enter mineral group name
Quartz
Pyroxene
Feldspar
Garnet
Serpentine
Clay
Mica
Brittle Mica
Bauxite
Oxide
Amphibole
Feldspathoid
Zeolite
Silliminite
Calcite
Barite
Humite
Tourmaline
Epidote
Chlorite

Specific Gravity - the relative weight of a mineral as compared to water

Hardness - hardness of a mineral according to Moh's Hardness Scale

1 - Soft, i.e. Talc
2 - Copper
3 - Calcite
4 - Fluorite
5 - Medium i.e. Apatite
6 - Feldspar
7 - Glass or Quartz
8 - Topaz
9 - Corundum
10 - Hardest natural occurring mineral, Diamond

Streak - Color of a minerals powder when crushed. Determined by rubbing a mineral on a porcelain plate.
White - most common, feldspar, calcite, garnet
Black - magnetite, uraninite
Green - hornblende, vesuvianite

Color - Natural color of a mineral
Black - Mica, Uraninite, Hematite
White - Plagioclase
Pink - Orthoclase
Green - Chlorite, Olivine

Opacity - The transparency of a mineral
Opaque - Does not transmit light
Translucent - Partially transmits light
Transparent - Fully transmits light

Luster - Appearance of a minerals surface
Pearly - Smooth, shiny, white surface, talc, calcite
Vitreous - Glass like, most transparent minerals are vitreous, quartz, garnet
Dull - Does not shine, talc, kaolinite
Adamantine - Brilliant shining surface, diamond
Soapy - Soapy feel, talc, chlorite
Greasy - Greasy feel, topaz, olivine
Silky - Like silk, antigorite, anthophyllite
Waxy - Wax like surface, quartz, serpentine,
Satin - Satin like surface, kaolinite

Submetallic - Shiny, opaque, metallic like surface, mica
Metallic - Shiny, metallic surface, pyrite
Splintery - In splinters, chlorite

Habit - A minerals external form
Cubic In cubes, pyrite, halite garnet
Polyhedrons/Octohedrons - Garnet, fluorite
Rhombohedral - Rhomb shaped, calcite, chiastolite
Prismatic - Rectangular, square outlines, very common, hornblende, epidote, augite, zircon, sphene
Hexagonal - Hexagonal or triangular outlines, tourmaline, beryl, topaz
Tabular - Thick, flat prismatic outlines, feldspar, biotite, chlorite, epidote, olivine
Columnar - Thin columns, often in aggregates, tourmaline, actinolite/tremolite, hornblende, diopside
Flakes/Plates/Scales - Mostly the fine, microcrystalline varieties. Mica, clay minerals, chlorite, sericite
Fibrous - In fibers, actinolite/tremolite, talc, serpentine, nephrite
Acicular - Fine, needle like crystals, tourmaline, rutile, mimetite (apatite)
Radiating - Outwardly radiating from a center, zeolite, tourmaline, gypsum
Spherulitic - A radiating acicular mass of crystals forming a circular shaped pattern. Common pattern in devitrified volcanic glass
Short - Short
Long - Long

Uses - The main uses for and applications for this commodity
Lithium - Greases, ceramics, production of aluminum
Garnet - Abrasives
Feldspar - Manufacture of porcelain
Lead - Pipes, batteries, radiation shielding
Copper - Alloyed for bronzes, brasses, electrical
Nickel - Steel making

Model - The mode of occurrence and/or formation of an economic mineral
Veins - hydrothermal veins, quartz, calcite veins
Pegmatites - V.coarse grained veins of granites, feldspars, tourmaline, micas
Vesicular/Amygdaloidal - Cavities in volcanic rocks
Evaporites - Within sedimentary evaporite basins
Metamorphic (Contact) - Along contact zones of recrystallized rocks, hornfels, skarn
Metamorphic (Regional) - Metamorphic rocks occurring over a large area, gneiss
Igneous - Generally some form of magmatic intrusion, granite, gabbro
Sedimentary - Derived from pre-existing rocks and often laid down in layers, sandstone, shale

Sedimentary Limestones - Deposited in ocean basins due reef building or accumulation of carbonate grains (detrital or precipitation), limestone
Replacement - Hydrothermal replacement deposits

MinServ XRD Minerals Database

The MinServ XRD Minerals Database contains XRD data on all minerals. Over 3800 minerals with mineral name and three strongest d-spacings are listed.

Using The XRD Database

The XRD Database has all entries indexed by mineral name and d-spacing and is displayed in tabular format. The table can be browsed using scroll bars. To perform a query, enter the search terms in the search option boxes. Mineral name and d-spacing can be searched and d-spacing search limits can be entered or selected.

Important: Search limits must be entered for d-spacing searches. In most cases, a narrow search pattern will give the most accurate results. If the XRD peaks are uncertain, perform a wider search, by specifying a wider d-spacing range.

Click on Search to perform the search. A list of matches is shown in the main window. Scroll through the minerals to see each record that matches the query. The results may be printed. The database can be sorted according to mineral name or d-spacing from the Edit Menu and all data can be printed.

Backing Up and Editing Databases

The Mineral Databases are editable. The databases are edited using Microsoft Access. It is highly recommended, the databases are backed up periodically. The easiest way to do this is to copy the database files to a backup folder of your choice using Windows Explorer or My Computer File Manager.

Important: Blank and null entries are not allowed in the database. If no entry is desired under a specific property then enter "Empty" for that specific property. Default values for all properties are "Empty".

Software Support

Technical support for WinRock is provided through the pdf manual and online help. Updates for WinRock can be obtained directly for free using the builtin internet connection. Downloads are also available at http://www.geologynet.com/download.htm. Further technical support is available directly from Mineral Services; however, the software must be registered to receive support.

email: support@geologynet.com
http://www.geologynet.com

Classification Diagrams

Plutonic Rocks
Barker, 1979 – An/Ab/Or, granites
IUGS Carbonatites - CaO/MgO/FeO+Fe2O3+MnO carbonatites. Contains >50% primary carbonates.
IUGS Charnockites - Quartz/Alkali Feldspar/Plagioclase Charnockites. Contains >5% hypersthene.
IUGS Melilite Plutonic - Melilite/Olivine/Clinopyroxene melilite plutonic rocks. Contains > 10% melilite and <10% feldspathoids.
IUGS General Plutonic QAP - Quartz/Alkali Feldspar/Plagioclase plutonic rocks. Contains 0-90% mafic minerals.
IUGS General Plutonic QAPF - Quartz/Alkali Feldspar/Plagioclase/Foids plutonic rocks. Contains 0-90% mafic minerals.
IUGS General Plutonic FAP - Foid/Alkali Feldspar/Plagioclase plutonic rocks. Contains 0-90% mafic minerals.
Plutonic TAS – K2O+Na2O vs SiO2 chemical classification for plutonic rocks. Middlemost, 1994
IUGS Mafic PlagPxOl - Plagioclase/Pyroxene/Olivine mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Mafic PlagOpxCPx - Plagioclase/Orthopyroxene/Clinopyroxene mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Mafic Plag/Px/Hbl - Plagioclase/Pyroxene/Hornblende mafic rocks. Rocks falling into the gabbroic field of QAP diagram.
IUGS Ultramafic Ol/OPx/CPx - Olivine/Orthopyroxene/Clinopyroxene ultramafic rocks. Contains >90% mafic minerals.
IUGS Ultramafic Ol/Px/Hbl - Olivine/Pyroxene/Hornblende ultramafic rocks. Contains >90% mafic minerals.

Volcanic Rocks
AFM Volcanic - K2O+Na2O/FeOt/MgO chemical classification for volcanic rocks. Irvin and Baragar, 1971
IUGS Carbonatites - CaO/MgO/FeO+Fe2O3+MnO carbonatites. Contains > 50% primary carbonates.
IUGS Melilite Volcanic - Melilite/Olivine/Clino-Pyroxene melilite volcanic rocks. Contains > 10% melilite and <10% feldspathoids
IUGS Volcanic QAPF - Quartz/Alkali Feldspar/Plagioclase/Foids volcanic rocks. Contains 0-90% mafic minerals.
IUGS Volcanic QAP - Quartz/Alkali Feldspar/Plagioclase volcanic rocks. Contains 0-90% mafic minerals.

IUGS Volcanic FAP - Foids/Alkali Feldspar/Plagioclase volcanic rocks. Contains 0-90% mafic minerals.
IUGS Volcanic TAS - K2O+Na2O vs SiO2 chemical classification for volcanic rocks. Le Bas, 1986
IUGS Volcanic TAS - K2O+Na2O vs SiO2 chemical classification for volcanic rocks. Middlemost, 1994
Jensen Cation - Fet+Ti/Al/Mg chemical classification for volcanic rocks. Jensen, 1976, modified by Rollinson, 1993
Winchester and Floyd, 1977 - Zr/TiO2 * 0.0001-SiO2, volcanic rocks
Winchester and Floyd, 1977 – Nb/Y-Zr/TiO2 * 0.0001, volcanic rocks

Metamorphic Rocks
Metamorphic - ACF - the ratio Na_2O + K_2O/CaO/FeO+MgO+MnO
Metamorphic - A'KF - the ratio Na_2O + K_2O+CaO/K2O/FeO+MgO+MnO

Sandstones
General Sandstones - Quartz/Clay/Feldspar general sandstones. Selley, 1984
Sandstones Arenites - Quartz/Feldspar/Rock Fragments for sandstones <15% clay. Pettijohn, 1975
Sandstones Wackes - Quartz/Feldspar/Rock Fragments for sandstones >15% and <75% clay. Pettijohn, 1975

Tectonic Classification Granites
Batchelor and Bowden, 1985 - R1=4*Si-11*(Na + K)-2*(Fe + Ti) vs R2=6*Ca+2*Mg+Al in millications, granites
Harris et al, 1986 – Rb/10,Hf,Ta*3, granites
Pearce et al, 1984 - Y(ppm)+Nb(ppm) vs Rb(ppm), granites
Pearce et al, 1984 – Y(ppm) vs Nb(ppm), granites
Pearce et al, 1984 - Ta(ppm)+Yb(ppm) vs Rb(ppm), granites
Pearce et al, 1984 - Yb(ppm) vs Ta(ppm), granites

Tectonic Classification Basalts
Pearce and Cann, 1973 - Zr(ppm) vs Ti(ppm) , basalts
Pearce and Cann, 1973 – Ti(ppm)/100,Zr(ppm),Y(ppm)*3, basalts
Pearce et al., 1977 - FeT, MgO, Al2O3, for rocks with SiO2 greater than 51 percent and less than 56 percent, basalts
Meschede, 1986 – 2*Nb,Zr/4,Y, basalts
Mullen, 1983 - TiO2, 10xMnO 10xP2O5, with SiO2 greater than 45 percent and less than 54 percent, basalts

Definitions
Mafic minerals = amphibole + pyroxene + olivine + mica + opaque minerals + epidote + allanite + garnet + melilite + monticellite + primary carbonate + accessory minerals.

Abbreviations used in the Rockname Table:
M = mafic minerals
An = anorthite
Mel = melilite

TAS Classification
Q = Normative quartz
Ol = Normative olivine

Spider Norms
MORB, Pearce, 1983
MORB, Pearce, 1996
EMORB, Sun and McDonough, 1989
NMORB, Sun and McDonough, 1989
REE Chondrite, Boynton, 1984
REE Chondrite, Nakamura, 1974
REE Primitive Mantle, McDonough and Sun, 1995
Chondrites, Thompson, 1982
Chondrites, Sun et al, 1980
PGE Chondrite, Jochum, 1996
PGE Primitive Mantle, McDonough and Sun, 1995
HSE Chondrite, Jochum, 1996
HSE Primitive Mantle, Becker, 2006
Primitive Mantle, Sun and McDonough, 1989
Primitive Mantle, McDonough and Sun, 1995
Primordial Mantle, Wood et al, 1979
OIB, Sun and McDonough, 1989
Lower Crust, Weaver and Tarney, 1984
Average Crust, Weaver and Tarney, 1984
Upper Crust, Taylor and McLennan, 1985
Upper Continental Crust, Taylor and McLennan, 1995
Bulk Continental Crust, Taylor and McLennan, 1995
Lower Continental Crust, Taylor and McLennan, 1995
ORG, Pearce et al., 1984

References

Rock Classification and Petrology:

Boynton, W.V., 1984, " Cosmochemistry of the rare earth elements: meteorite studies ". In: Henderson, P. (ed), "Rare Earth Element Geochemistry ". Elsevier, Amsterdam, pp. 63-114
Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1979, "The Interpretation of Igneous Rocks"Allen and Unwin, London, 450p. - Norm calculations and indices.

Harris, N.B.W., Pearce, J.A., and Tindle, A.G., 1986, "Geochemical Characteristics of Collision-Zone Magmatism" *in* Coward, M.P., and Ries, A.C., eds., "Collision Tectonics". Geological Society of America Special Publication 19, 415p.

Irvine, T.N. and Baragar,, W.R.A., "A Guide to the Chemical Classification of the Common Volcanic rocks". Canadian J. of Earth Sci., V.8, pp.523-548.

Janousek, V., Farrow, C., Erban, G., Smid, J., 1999-2006, "Geochemical Data Toolkit". Software, http://www.gla.ac.uk/gcdkit.

Johanssen, A., 1938, " A Descriptive Petrography of the Igneous Rocks". Univ. of Chicago Press, USA.

Le Maitre, R.W.(ed), 1989, "A Classification of Igneous Rocks and Glossary of Terms". Blackwell Scientific Publications, Oxford, UK. - Igneous plots and systematics.

McBirney, A, 1993, "Igneous Petrology". Jones and Bartlett. - Norm calculations and indices.

Meschede, M., 1986, "A Method of Discriminating Between Different Types of Mid-Ocean Ridge Basalts and Continental Tholeiites with the Nb-Zr-Y Diagram". Chem. Geol., V.56, pp 207-218.

Midddlemost, E.A.K., 1989, "Iron Oxidation Ratios, Norms and the Classification of Volcanic Rocks". Chem. Geology, V.77, pp19-26.

Middlemost, E.A.K., 1994, "Naming materials in the magma/igneous rock system". Earth Sci Rev, V.37, pp. 215-224

Mullen, E. D., 1983" MnO/TiO2/P2O5: a minor element discriminant for basaltic rocks of oceanic environments and its implications for petrogenesis". Earth Planet Sci Letters, V62, pp53-62

Pearce, J.A., 1983, "Role of sub-continental lithosphere in magma genesis at active continental margins. Continental Basalts and Mantle Xenoliths". Shiva, Nantwich, pp. 230-249

Pearce, J.A. & Cann, J.R., 1973," Tectonic setting of basic volcanic rocks determined using trace element analyses". Earth Planet Sci Letters, V19, pp 290-300

Petrelli M., Poli G., Perugini D. & Peccerillo A., 2005, " Petrograph: a New Software to Visualize, Model, and Present Geochemical Data in Igneous Petrology", Geochem. Geophys. Geosyst , Vol. 6.

Rollinson, H.R., 1993, "Using Geochemical Data", Longman, 352p.

Sun S S, McDonough, W.F., 1989," Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes". In: Saunders, A.D. and Norry, M. (eds) , "Magmatism in Ocean Basins". Geological Society of London Special Publication V42, pp. 313-345

Pettijohn, E.J., 1975, "Sedimentary Rocks ". Harper and Row. - Arenites and Wackes.

Selley, R.C, 1981, "An Introduction to Sedimentology ". Academic Press Inc, London. - Sandstone plots

Verma, S.P., Torres-Alvarado, I.S., Sotelo-Rodriguez, Z.T., 2002, " SINCLAS: Standard Igneous Norm and Volcanic Rock Classification System", Computers and Geosciences, V28, pp711-715.

Weaver, B. L. and Tarney, J., 1984 "Empirical approach to estimating the composition of the continental crust". Nature V310, pp 575-577

Winchester, J.A., and Floyd, P.A., 1977, “Geochemical Discrimination of Different Magma Series and their Differentiation Products Using Immobile Elements”. Chemical Geology, v. 20, p. 325-343.

Rock and Mineral Databases and Nomenclature:

Bayliss, P., Berry, L.G., Mrose, M.E., Sabina, A.P., Smith, D.K. (eds), 1983, "Mineral Powder Diffraction File". JCPDS, ICDD, 1005p.

Craig, J.R., Vaughan, D,J., 1981, " Ore Microscopy and Ore Petrography", John Wiley and Sons, New York, 406p.

Dana, J.D., "Manual of Mineralogy".

Deer, W.A., Howie, R.A. and Zussman, J, 1980, "An Introduction to the Rock Forming Minerals". Longman, London. 528p.

Finn, D. and Newall, G., “Michel-Levy Chart”. University of Liverpool.

Kerr, P.F., 1977, "Optical Mineralogy", McGraw-Hill, 492p.

Le Maitre, R.W.(ed), 1989, “A Classification of Igneous Rocks and Glossary of Terms”. Blackwell Scientific Publications, Oxford, UK. - Igneous plots and systematics.

Mutschler, F.E., Rougon, D.J., Lavin, O.P., Hughes, R.D., 1981, "Petros - A Data Bank of Major Element Chemical Analyses of Igneous Rocks for Research and Teaching (Version 6.1)". NOAA-National Geophysical and Solar-Terrestrial Data Center.

Myashiro, A.,1973. "Metamorphism and Metamorphic Belts". Allen and Unwin, London,492p.
Nichols, M.C., Nickel, E.H., 1991, "Mineral Reference Manual", Chapman and Hall, New York, 250p.

U.S. Geological Survey, 1999, "Public Review Draft – Digital Cartographic Standard for Geologic Map Symbolization", Open-File Report 99-430.

Wills, B.A., 1992, "Mineral Processing Technology". Pergamon, Oxford, 855p.