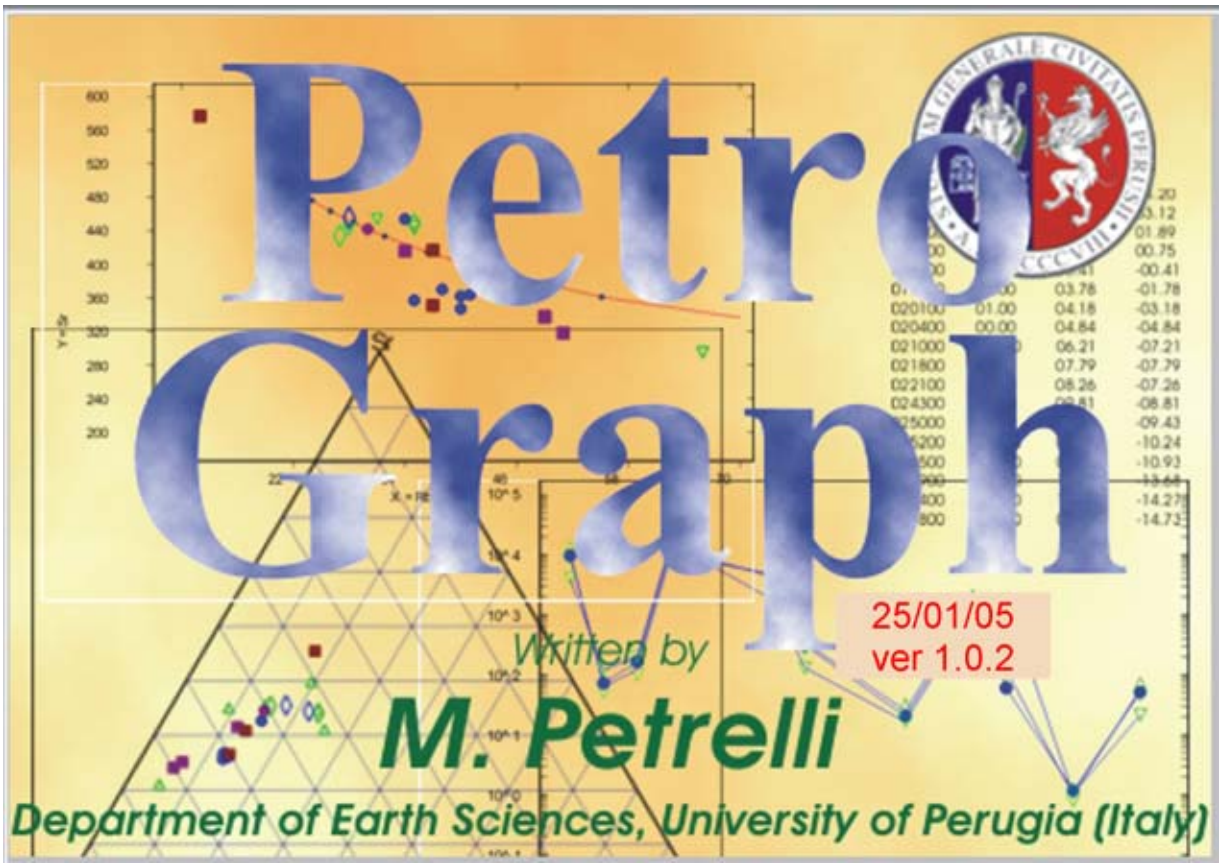
Petro
Graph
25/01/05
ver 1.0.2
Written by
M. Petrelli
Department of Earth Sciences, University of Perugia (Italy)

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MAIN FEATURES

1 Introduction

Petrograph (see Figure 1 for a screen shot) is a program specifically developed to help the user to visualize, elaborate and in particular to model geochemical data. The source code is written in MS Visual Basic 6.0® and it runs under Windows 98/2000/XP® platforms.

The software is able to plot data on several different diagrams, including a large number of classification and 'petro-tectonic' plots. Petrograph gives the opportunity to manage large geochemical datasets in a single program without the need of passing from one software to the other as usually happens in petrologic data handling. Along with these basic functions, Petrograph comes with wide choice of modelling capabilities from major element mass balance calculations to the most common trace element and isotope models. Results and graphs can be exported as vector graphics in publication quality form or they can be copied and pasted within the most common graphics programs for further modifications. All these features makes of Petrograph one of the most complete software presently available for igneous petrology research.

Petrograph can be downloaded from the following URL:

http://www.unipg.it/~maurip/SOFTWARE.htm

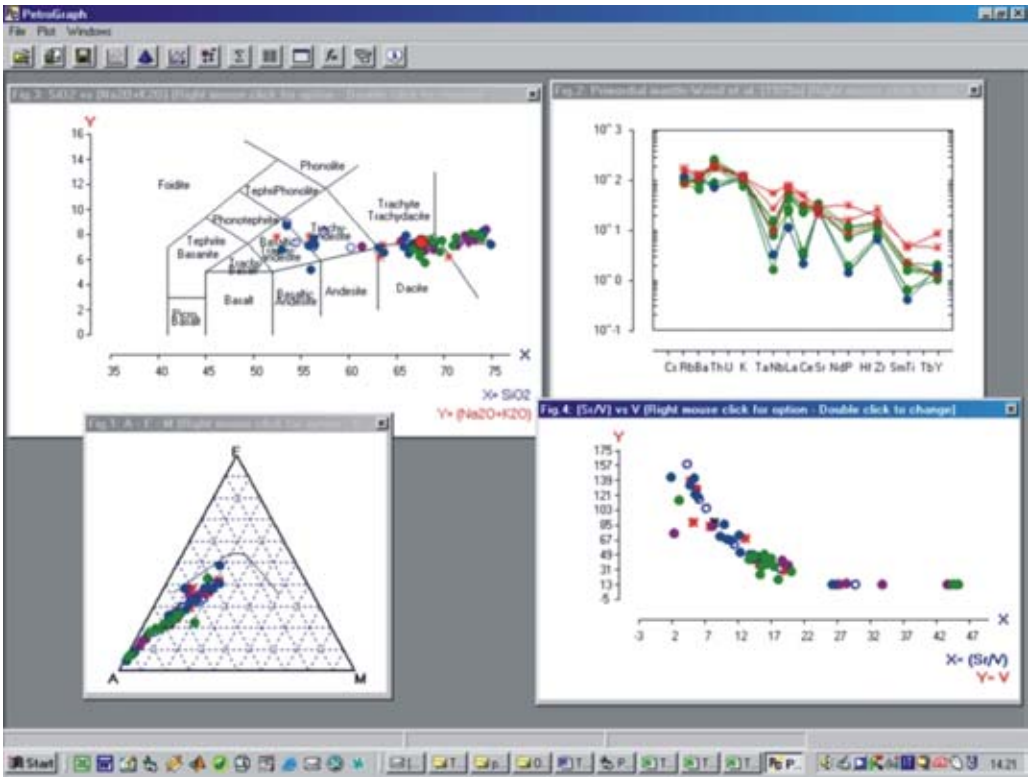


Figure 1

2 Open, Import, and Save files

2.1 Open .peg Files

The option “open” allows to open “.peg” files previously saved using Petrograph. To open a .peg file, select the option “Open” from the “file” menu or click the button  in the control bar.

2.2 Import Excel Files

To open a .xls file, select the option “import – file Excel (.xls) from the “file” menu or click the button  in the control bar. Before importing an Excel worksheet, ensure that data are correctly arranged. Data can be easily arranged in the Excel worksheet following these rules (Figure 2):

- the first column must contain the sample name;

- a number between 0 and 12 must be placed in the second and the third column. These numbers correspond to the symbol and the colour used to plot the sample, respectively;
- the fourth column must contain the number zero (0) or one (1); if Petrograph encounters 0, it will not display the sample in diagrams;
- the first row must contain the name of analysed elements, isotope, etc…
- if some data are not available, the symbol "-" must be used;
- the syntax for the isotope ratio must be as follow: "wheight of the isotope"+"Element"+"/"+ "wheight of the isotope"+"Element" (for example the ratio between the isotope 87 and 86 of Strontium (Sr) must be written as 87Sr/86Sr.

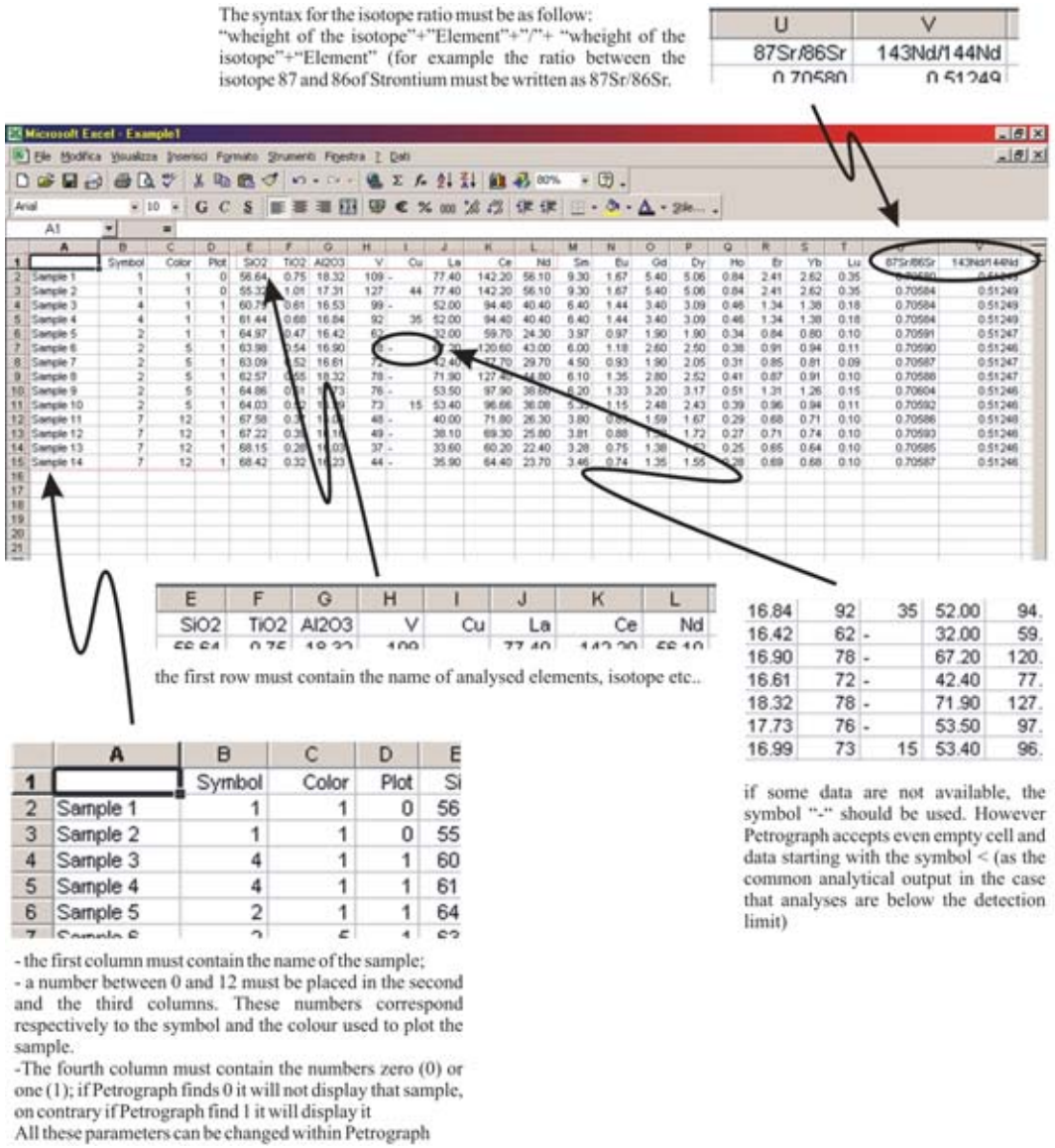


Figure 2

2.3 Import Igpetwin Files

Igpetwin is a widely diffused program to plot and manage geochemical data. This program saves data files using the .roc extension; Petrograph is able to recognize the structure of .roc files and imports these files without any further arrangement. To import a .roc file, select the option “import – file IgpetWin (.roc) from the “file” menu or click the button  in the control bar.

2.4 Save File

This option allows to save the data. Petrograph saves files using the .peg extension. To save a file, select the option “save” from the “file” menu or click the  button in the control bar.

3 Plots & Diagrams

3.1 Generals

Petrograph performs three type of diagrams: Binary, Triangular and Spider diagrams; it can also perform a large number of classification and discriminating diagrams.

3.2 Binary Plot

Plot a graph in y vs. x coordinates.

To perform a binary plot, open the “binary plot windows” (Figure 3) selecting the option “binary plot” from the “Plot” menu or clicking the button  in the control bar.

Elements for the x and the y axes can be selected using the buttons  and the diagram can be created by clicking on the button “Plot (Spacebar)”.

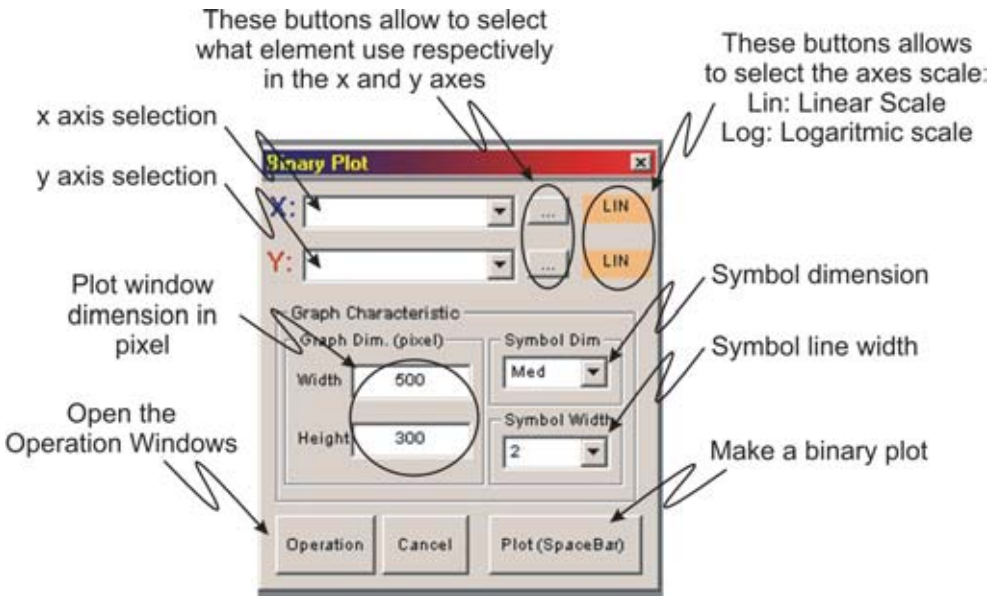


Figure 3

3.3 Triangular Plot

Plot a triangular plot.

To perform a triangular plot, open the "triangular plot window" (Figure 4) selecting the option "triangular plot" from the Plot Menu or clicking the button  in the control bar.

Elements for the A, B and the C corners can be selected using the buttons  and the plot can be created with a click in the button "Plot (Spacebar)".

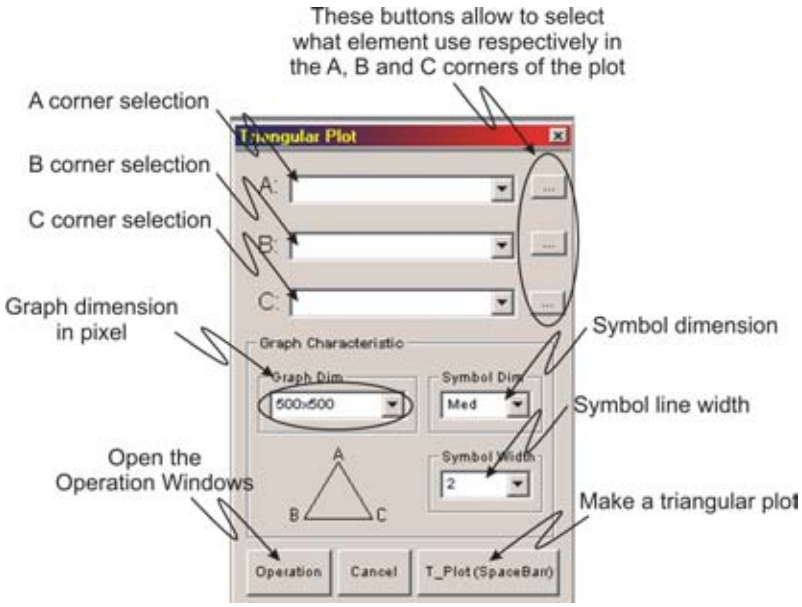


Figure 4

3.4 Spiders

3.4.1 REE Spiders

Plot a spider of Rare Earth Elements (REE, Figure 5).

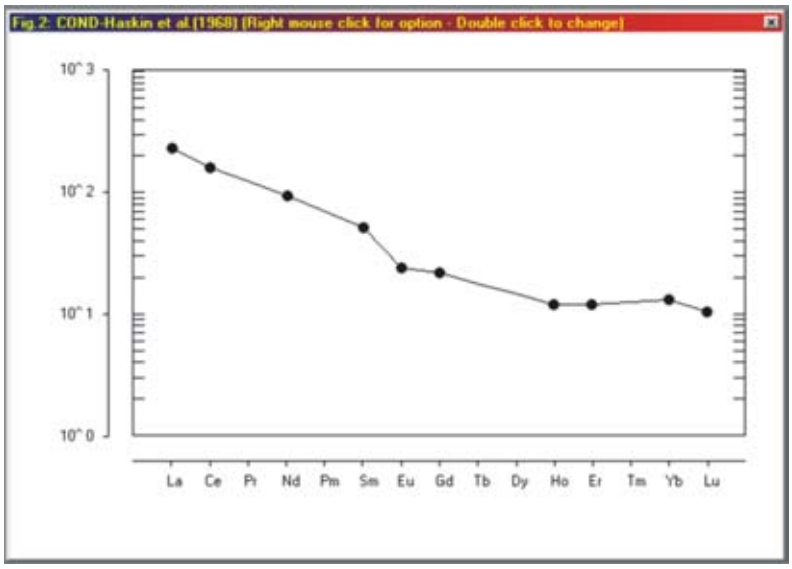


Figure 5

To perform a REE spider plot, open the "REE spider window" (Figure 6) by selecting the option "Spider - REE" from the "Plot" menu or clicking the button  in the control bar. It is possible to plot a maximum number of 50 samples contemporaneously by selecting them using the button  . Several option are available to customize a spider diagram. Among these, the possibility to change values the normalizations (see Table 1) by selecting the preferred values in the relative cascade box; selected normalization values will appear on the right side of the window. To create the diagram, click the button "Plot (spacebar)".

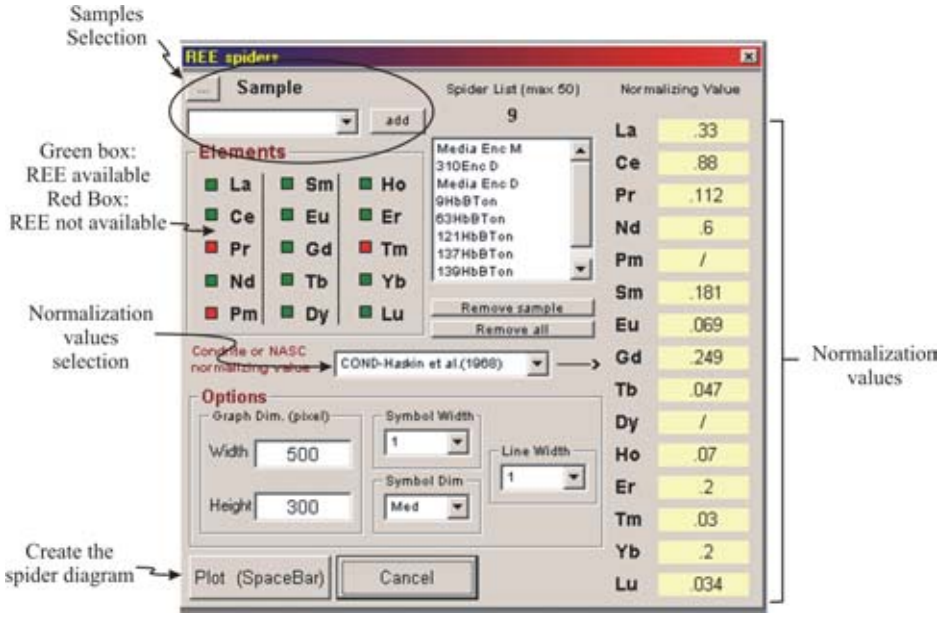


Figure 6

3.4.2 Other Spiders

Plot a spider diagram.

To perform this type of diagram, open the "Other spider window" by selecting the option "Spider - Other" from the "Plot" menu or clicking the button  in the control bar. Figure 7 explains the features of the "Other spider window".

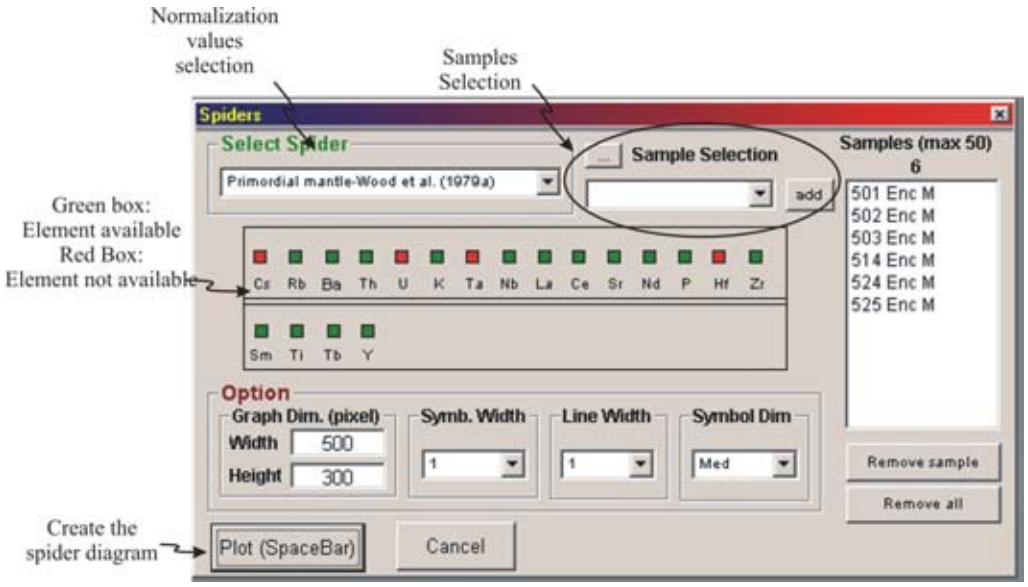


Figure 7

Several normalization for the Primordial Mantle, Condrite, MORB and crust can be selected (see Table 1) and it is also possible to import a personal normalization file. Personal normalization are text files formatted as described in (Figure 8).

REE Spiders
- Chondrite - Haskin et al.(1968)
- Chondrite - Masuda et al.(1973)
- Chondrite - Nakamura (1974)
- Chondrite - Boynton (1984)
- Chondrite - Sun & McDonough (1989)
- NASC - Haskin & Frey(1966)
- NASC - Haskin & Haskin(1966)
Other Spiders
- Primordial mantle - Wood et al. (1979a)
- Primordial mantle - McDonough et al. (1992)
- Primordial mantle - Taylor & McLennan (1985)
- Condrite - Wood et al. (1979b)
- MORB - Bevins et al. (1984)
- Upper cont. Crust - Taylor & McLennan (1981)
- Lower cont.crust - Weaver & Tarney (1984)
- Average cont crust - Weaver & Tarney (1984)
- Average N-type MORB - Saunders & Tarney (1984);Sun (1980)
- Average OIB - Sun (1980)
- Custom Spider (allows to generate personal normalization file)

Table 1

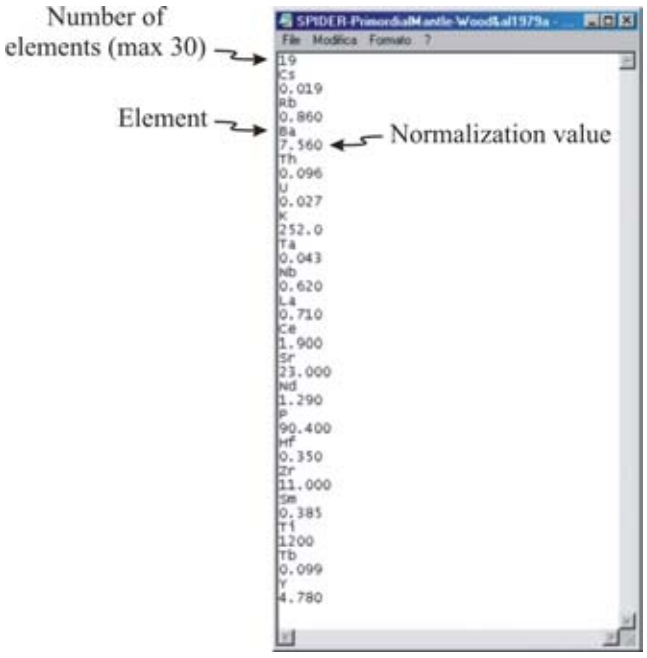


Figure 8

3.5 Classification and Discriminant Diagrams

Petrograph performs a large number of classification and discriminating diagrams (see Table 2). To plot one of these diagrams, select the option “diagram” from the “plot” menu or click the button  in the control bar. A list of diagrams, divided by categories, will appear. Now select the diagram of interest to plot it.

General Classification Diagrams
Binary
[Q'(F')-ANOR] - volcanic - after Streckeisen & LeMaitre, 1979
[K_2O-SiO_2] - after Peccerillo and Taylor, 1976
[K_2O-SiO_2] - after Middlemost, 1975
[TAS Alkalies-Silica] - volcanic - after LeBas et al., 1986
[TAS Alkalies-Silica] - volcanic - after Cox et al., 1979
[TAS Alkalies-Silica] - plutonic - after Cox et al., 1979
[SiO_2-K_2O Andesite Types] - after Gill, 1981
[SiO_2-F/M] - after Miyashiro, 1974
Triangular
AFM - after Kuno,1968
AFM - after Irvine & Baragar, 1971
Diagrams for Basalts
Binary
[Ti-Zr] - after Pearce & Cann,1973
Triangular
[Ti-Zr-Y] - after Pearce & Cann, 1973
[Ti-Zr-Sr] - afterPearce & Cann, 1973
[Nb-Zr-Y] - after Meschede, 1986
[Th-Hf-Ta] - after Wood, 1980
Diagrams for Granites
Binary
[Nb-Y] - after Pearce et al., 1984
[Ta-Yb] - after Pearce et al., 1984
[Rb-(Y+Nb)] - after Pearce et al., 1984
[Rb-(Yb+Ta)] - after Pearce et al., 1984

Table 2

3.6 Double click on graph

By double Click on a diagram the user can change some attributes of a graph. The nature of possible changes is function of the selected graph. For example a double click on the binary plot open the windows displayed in Figure 9. This window allows to adjust the maximum, the minimum and the step interval for the axes; it also permits to change plotted elements and it allows to change the dimension of the window in which the graph is displayed.

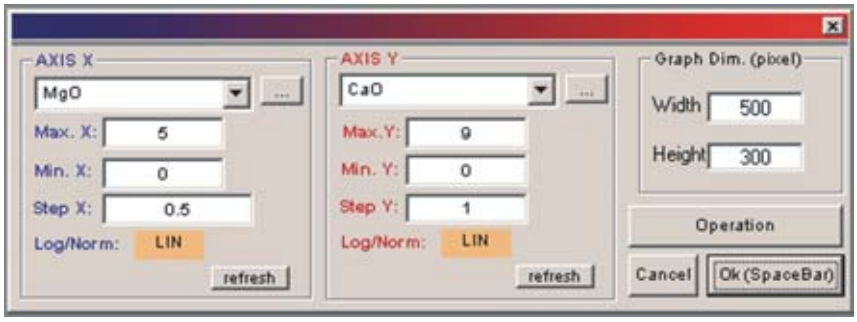


Figure 9

3.7 Right click on graph

By right click on a graph a cascade menu containing some possible actions appears (Figure 10). For example, it is possible to copy the diagram in the clipboard, to insert a trace element model, to change the shape of the symbols and their colours etc…

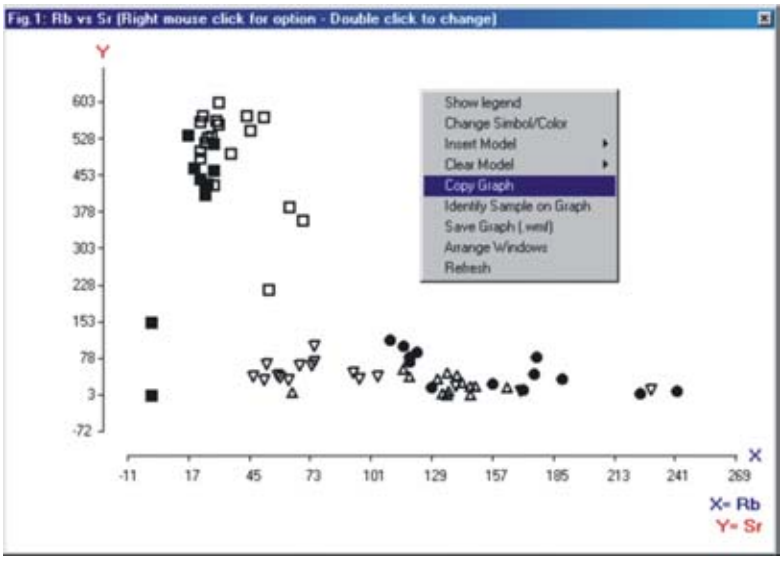


Figure 10

3.8 Export plots & diagrams

To export a graph, the user can copy it in the clipboard and successively paste it in another application or he/she can save it as Windows Metafile image (.wmf). To copy the diagram, click the right button on the selected plot and click on “Copy Graph” from the cascade menu (Figure 10). To save the diagram, proceed as for the “Copy Graph” option but select “Save Graph (.wfm)” from the cascade menu (Figure 10).

4 Geochemical Models

4.1 Generals

One of the principal features of Petrograph is the possibility to perform geochemical models for major, trace elements and isotopes.

4.2 Major Elements Models

Major elements are modelled by using the mass balance algorithm by Stormer and Nichols (1978). To start a mass balance calculation, open the “Mass Balance Window” by selecting the option “Mass Balance” from the “Windows” menu or clicking the button  in the control bar. Figure 11 explains the main features of the “Mass Balance Window”.

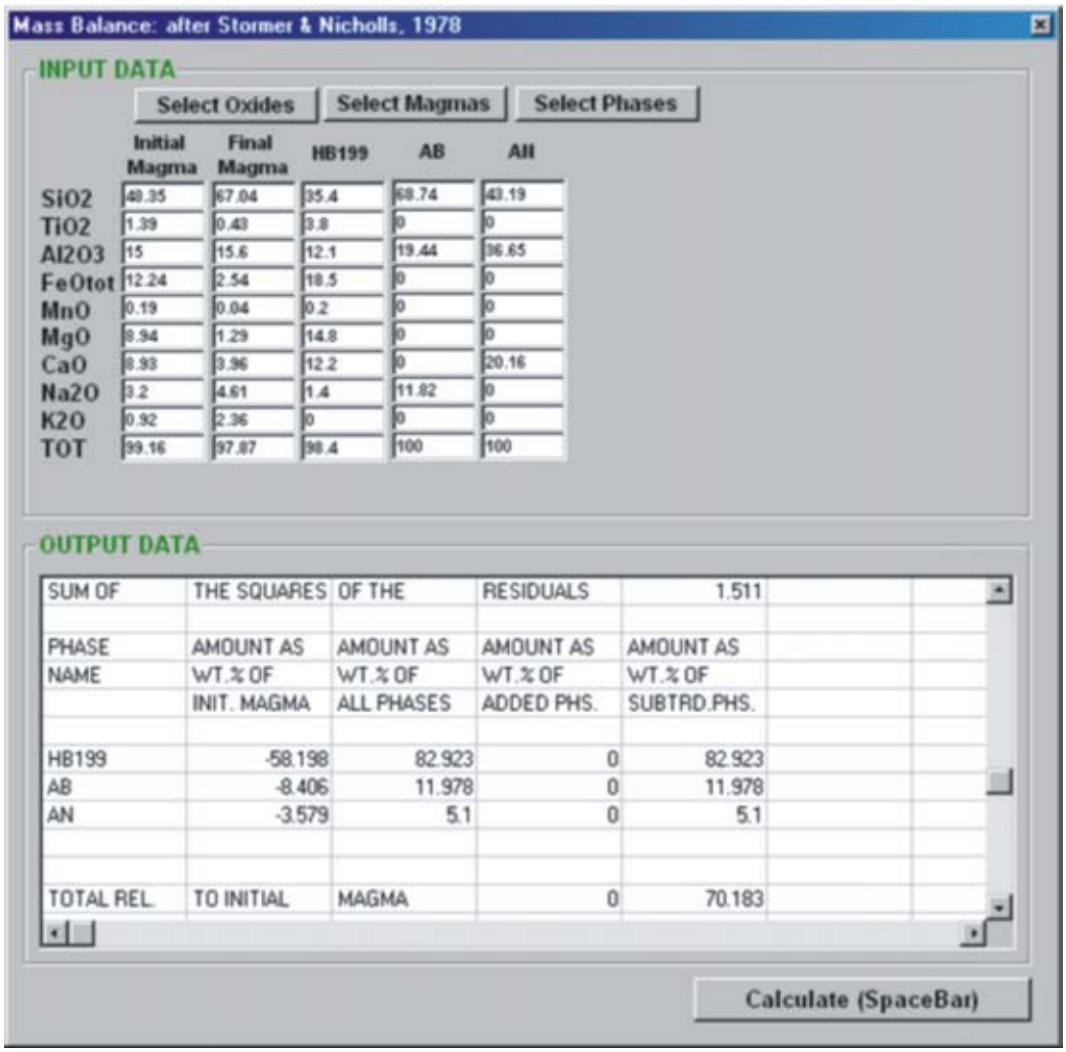


Figure 11

The mass balance algorithm involves a least-squares solution to a set of linear mass-balance equations (one for each oxide) and the calculations are performed on data consisting of chemical analyses of igneous rock, assumed to represent the composition of “magmas”, and chemical composition of minerals or other rocks, assumed to represent “phases” added or subtracted from one “magma” to derive a second “magma”. As described by Stormer and Nicholls (1978), this computation can be used to test fractional crystallization (by subtraction of analysed phenocrysts or cumulate minerals as “phases”), assimilation (by addition of country rock as “phase”), fractional melting (by subtraction of residual minerals or refractory residual rock “phases” from an assumed parental rock “magma”), and magma mixing (by adding a third magma, entered as a “phase” to the

first “magma” to derive a second “magma”). Mass balance computations are performed in a user friendly environment (Figure 11) by selecting “magmas” and “phases” among the samples belonging to the geochemical dataset and the output is reported in the same way of the original program of Stormer and Nichols (1978; see the Examples section for more details about the mass balance computation).

4.2 Trace Elements Models

Trace element models are very useful to quantitatively discriminate among different geochemical processes mostly because they are dilute and their behaviour depends primarily on the element-matrix interaction and very little on the element-element interaction. This implies that geochemical processes for trace element can be modelled using simple equations. Several trace elements models are implemented in Petrograph and they are divided in three main sections: (i) models related to the crystallization process (Table 3), (ii) models related to the melting process (Table 4a) and finally (iii) one model for the mixing process (Table 4b).

Trace elements models are performed by Petrograph directly on binary plots. To develop a trace element model, select “Insert Model” from the cascade window generated by a right click on the diagram (Figure 10). Melting and Crystallization models can be performed by selecting the option “Models Generator” whereas for the mixing process select “Mixing” (see the Examples section for more detail on the trace element models development).

Model (Reference)	Sigle	Equation	Parameters
Equilibrium Crystallization (Wood & Fraser, 1976)	EC	$C_L = \frac{C_O}{[D + F(1-D)]}$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element D = bulk partition coefficient F = fraction of melt remaining
Fractional Crystallization (Neuman et al., 1957)	FC	$C_L = C_O F^{(D-1)}$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element D = bulk partition coefficient F = fraction of melt remaining
Assimilation plus Fractional Crystallization (DePaolo, 1981)	AFC	$C_L = C_O\left[f' + \frac{r}{(r-1+D)} \cdot \frac{C_A}{C_O} \cdot (1-f')\right]$ $f' = F^{-(r-1+D)/(r-1)}$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element C_A = concentration of trace element in the assimilated wallrock D = bulk partition coefficient F = fraction of melt remaining r = ratio of the assimilation rate to the fractional crystallization rate
In Situ Crystallization (Langmuir, 1989)	In Situ C	$C_L = C_O (M_L / M_O)^{\{f/(D-1)\}\{D(1-f)+f\}}$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element M_0 = initial mass of the magma chambers D = bulk partition coefficient M_L = mass of the liquid f = fraction of magma allocated to the solidification zone which is returned to the magma chambers
Zone Refining (Richter, 1986)	ZR	$C_L = C_O\left[\frac{1}{D} - \left(\frac{1}{D} - 1\right)e^{-nD}\right]$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element D = bulk partition coefficient n = number of equivalent rock volumes that have reacted with the liquid

Table 3

a) Melting Models (Reference)	Sigle	Equation	Parameters
Batch Melting (Wood and Fraser, 1976)	BM	$C_L = \frac{C_O}{[D_{RS} + F(1 - D_{RS})]}$	C_L = concentration of trace element in the melt C_O = trace element concentration of the unmelted source D_{RS} = bulk partition coefficient of the residual solid F = fraction of melt produced
non Modal Batch Melting (Wood and Fraser, 1976)	nMBM	$C_L = \frac{C_O}{[D_O + F(1 - P)]}$ $P = p_1K_1 + p_2K_2 + ... + p_nK_n$	C_L = concentration of trace element in the melt C_O = initial concentration of trace element D_O = bulk partition coefficient p = normative weigth fraction of minerals in the melt K = mineral / melt partition coefficient F = fraction of melt produced
Fractional Melting (Wood and Fraser, 1976)	FM	$C_L = \frac{C_O}{D_O}(1 - F)^{(1/D_O - 1)}$	C_L = concentration of trace element in the melt C_O = trace element concentration of the unmelted source D_0 = bulk partition coefficient of the original solid F = fraction of melt produced

b) Mixing Model (Reference)	Sigle	Equation	Parameters
Mixing (Langmuir et al., 1977)	Mix	$Ax + Bxy + Cy + D$ $A = a_2b_1y_2 - a_1b_2y_1$ $B = a_1b_2 - a_2b_1$ $C = a_2b_1x_1 - a_1b_2x_2$ $D = a_1x_2y_1 - a_2x_1y_2$	*See Langmuir aet al., 1977 for detail*

Table 4

4.3 Isotope Models

Regarding Isotopes, Petrograph can model the process of Mixing (Langmuir et al, 1978) and the process of Assimilation plus Fractional Crystallization (AFC; De Paolo, 1981). To develop a model for isotopes, select “Insert Model” from the cascade windows generated by a right click on the diagram (Figure 9). AFC model can be performed by selecting the option “Isotopic AFC” while for the mixing process select the “Mixing” option as for trace elements mixing.

5 Additional Features

5.1 Partition Coefficient Database

A partition coefficient database can be opened by selecting the option “Partition Coefficient DB” from the “Windows” menu. As result, the “Partition Coefficients Windows” will appear (Figure 12); the partition coefficients relative to an Element will be displayed by clicking on it. Data for the partition coefficient database are from Earth Reference Data and Models web site (EARTHREF; www.earthref.org).

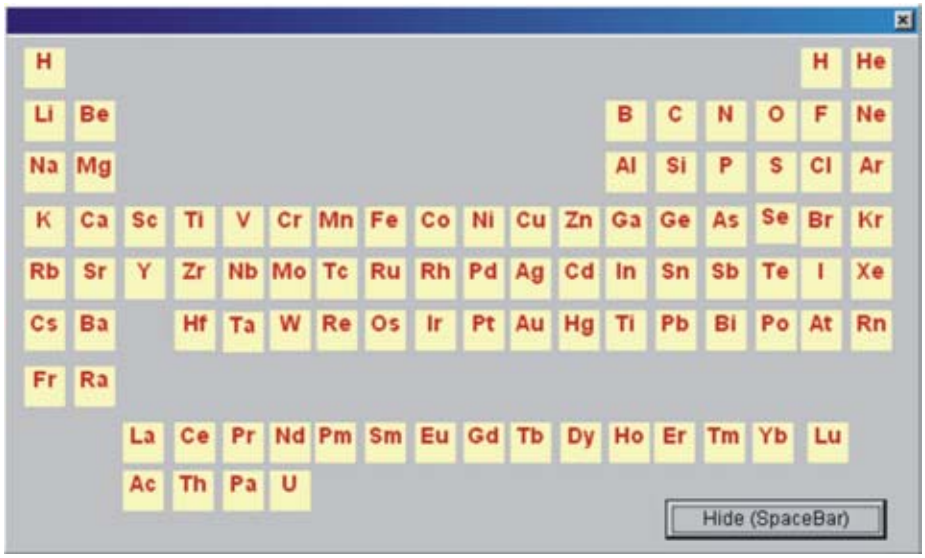


Figure 12

5.2 Operations and Filters

The elaboration of variables stored in the original dataset can be performed by Petrograph using two principal types of operation: (i) mathematical operations and (ii) determination of geochemical parameters and indexes (Figure 13).

Mathematical operation are the sum, subtraction, multiplication, division, the elevation to an exponent, and the square root. These operations allow the user to generate new variables that can be plotted and/or further elaborated.

Geochemical parameters and indexes that can be determined by using Petrograph are: CIPW, Larsen Index, Solidification Index, Total Iron (FeOTot) and Fe/Mg Ratio; weight per cent value can be converted in molar value and Eu anomalies can be also calculated.

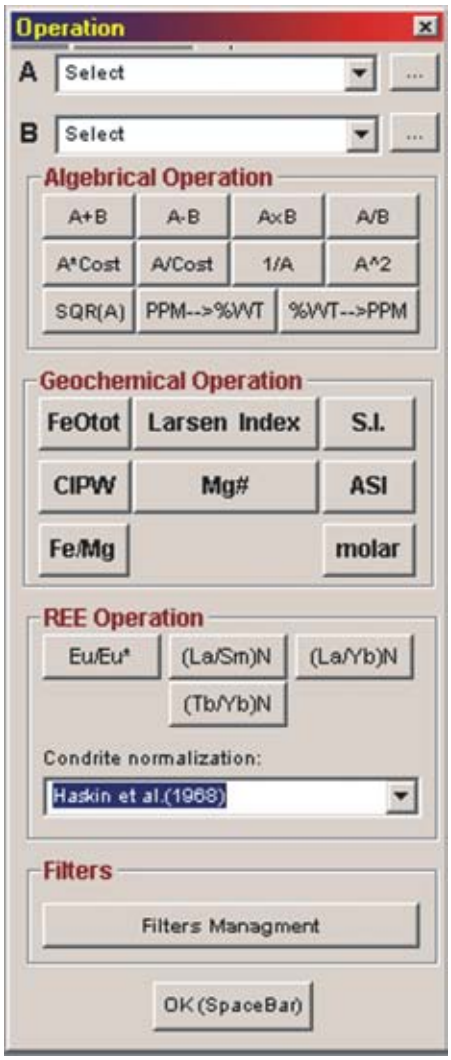


Figure 13

To perform one of the above operations, select the “Operation” option from the “Windows” menu or click the button  in the control bar.

Regarding the CIPW Norm calculation note that Petrograph do not perform any adjustment for Fe molecular ratio (see Cox et al., 1979 and Best, 2003 for detail) and as benchmark for the computation the program computes the difference between the sum of the weight percentages of the oxides in the original analysis and the sum of the normative minerals. This value should be within (+/-0.2) the error due to the rounding operations.

The equations utilized for the computation of geochemical indexes are reported in the following table:

Parameter	Equation
Total Iron as FeO (FeO_{tot})	$FeO_{tot} = FeO + 0.9 \cdot Fe_2O_3$
Larsen Index	$LarsenIndex = (1/3) \cdot SiO_2 + K_2O - MgO - CaO - FeO_{tot}$
Solidification Index (S.I.)	$S.I. = 100 \cdot \frac{MgO}{Na_2O + K_2O + FeO_{tot} + MgO}$
Magnesium Number (Mg#)	$Mg\# = 100 \cdot \frac{Mg}{Mg + Fe^{2+}}$
Alumina Saturation Index (ASI)	$ASI = molar\left(\frac{Al_2O_3}{Na_2O + K_2O + CaO}\right)$
Fe-Mg molecular ratio (Fe/Mg)	$Fe/Mg = \frac{FeO_{tot}}{MgO}$
Molar conversion	$MolarConversion = \frac{oxide\_wt\%}{MolecularWeight}$

Additional features of Petrograph are the filter options; filters are useful when the user works with a large database containing heterogeneous analysis and he/she wants to plot only samples having peculiar characteristics. For example he/she can introduce a filter that allow the program to plot only that samples with a content of SiO_2 less then 50% wt. Petrograph will exclude automatically form the diagrams all the samples with a content of SiO_2 higher than 50% wt.

EXAMPLES

1 Import file and make a plot

In this example an Excel file will be imported and then a binary plot will be developed. Before importing an Excel file the user have to be sure that the spreadsheet is arranged in the correct way. To arrange correctly on Excel worksheet refer to paragraph 2.2 in the Main Features Section. The file Gede2001.xls (see the examples folder) can be used as an example and it can be imported with no changes.

To import the Gede2001.xls, select the "Import – file Excel (.XLS)" option from the file menu (Figure 14).

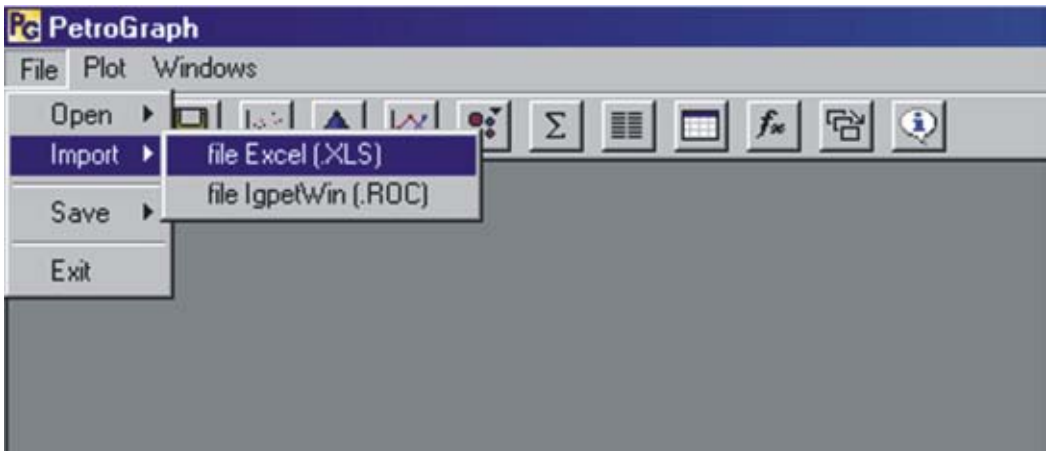
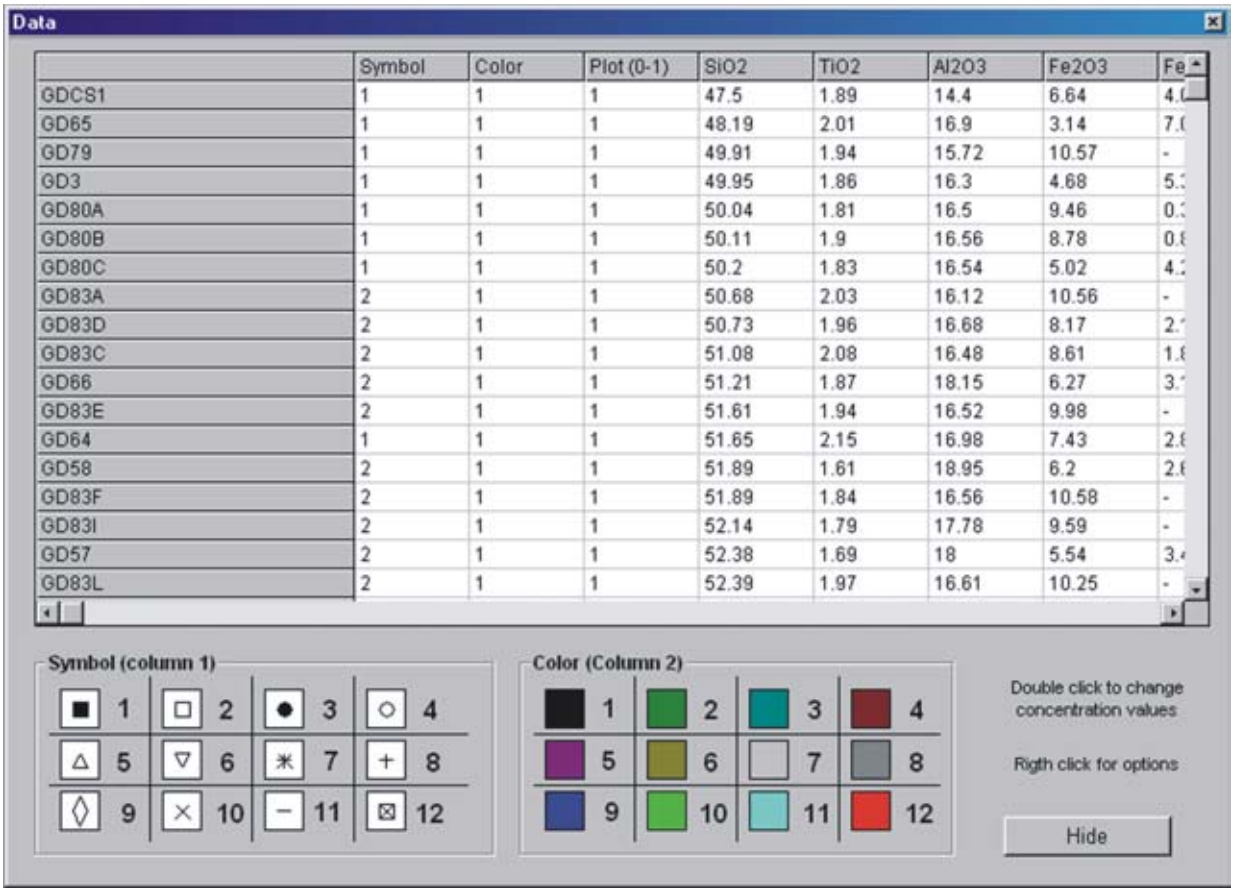


Figure 14

Once the file is loaded, the "Data Table" will appear (Figure 15). Within the "Data Table" it is possible to change the symbol of each sample by selecting the relative cell in column "Symbol" and clicking the selected symbol lower part of the table. To change the colour of the sample proceed as before but act on the "Colour" column.



	Symbol	Color	Plot (0-1)	SiO2	TiO2	Al2O3	Fe2O3	Fe
GDCS1	1	1	1	47.5	1.89	14.4	6.64	4.
GD65	1	1	1	48.19	2.01	16.9	3.14	7.
GD79	1	1	1	49.91	1.94	15.72	10.57	-
GD3	1	1	1	49.95	1.86	16.3	4.68	5.
GD80A	1	1	1	50.04	1.81	16.5	9.46	0.
GD80B	1	1	1	50.11	1.9	16.56	8.78	0.
GD80C	1	1	1	50.2	1.83	16.54	5.02	4.
GD83A	2	1	1	50.68	2.03	16.12	10.56	-
GD83D	2	1	1	50.73	1.96	16.68	8.17	2.
GD83C	2	1	1	51.08	2.08	16.48	8.61	1.
GD66	2	1	1	51.21	1.87	18.15	6.27	3.
GD83E	2	1	1	51.61	1.94	16.52	9.98	-
GD64	1	1	1	51.65	2.15	16.98	7.43	2.
GD58	2	1	1	51.89	1.61	18.95	6.2	2.
GD83F	2	1	1	51.89	1.84	16.56	10.58	-
GD83I	2	1	1	52.14	1.79	17.78	9.59	-
GD57	2	1	1	52.38	1.69	18	5.54	3.
GD83L	2	1	1	52.39	1.97	16.61	10.25	-

Figure 15

To make a binary plot, select the option “Binary plot” from the “Plot” menu (Figure 16) and the “Binary Plot Windows” will appear (Figure 17).

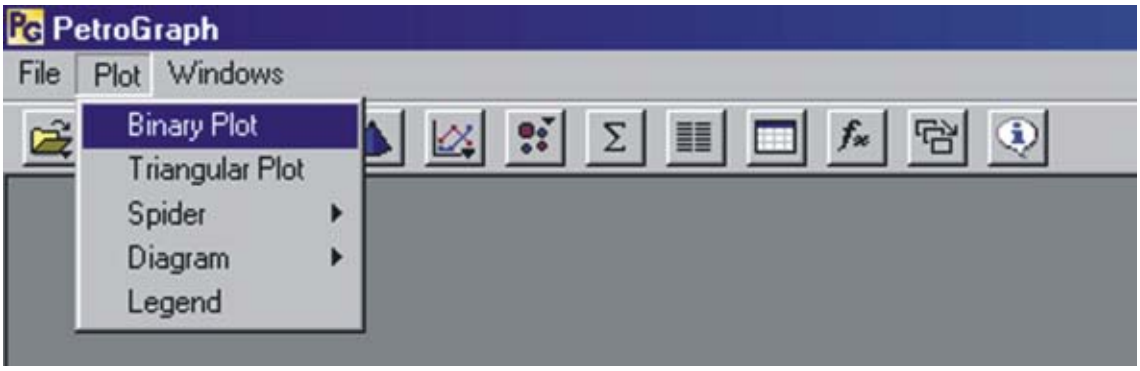


Figure 16

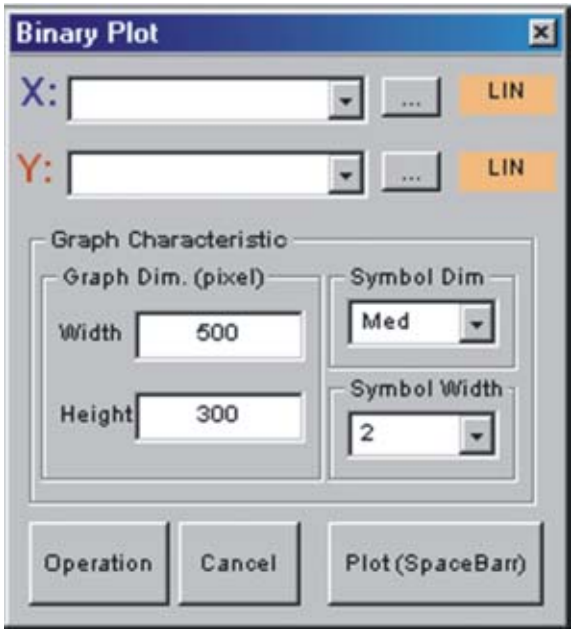


Figure 17

Select the elements to be plotted by clicking the buttons ... and then create the diagram by clicking the “Plot(spacebar)” button. For example, selecting “Rb” for the x axis and “Sr” for the y axis the plot displayed in Figure 18 will be generated.

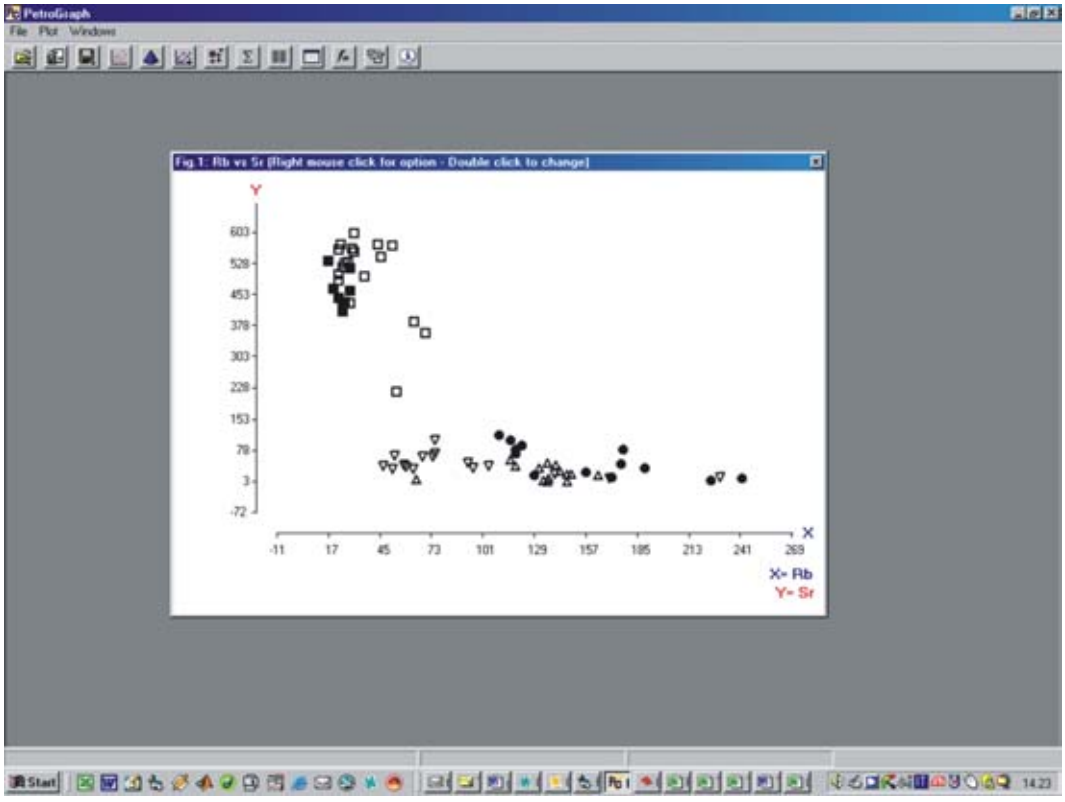


Figure 18

To adjust the x and y axes properties, make a double click on the graph and the windows displayed in Figure 19 will appear.

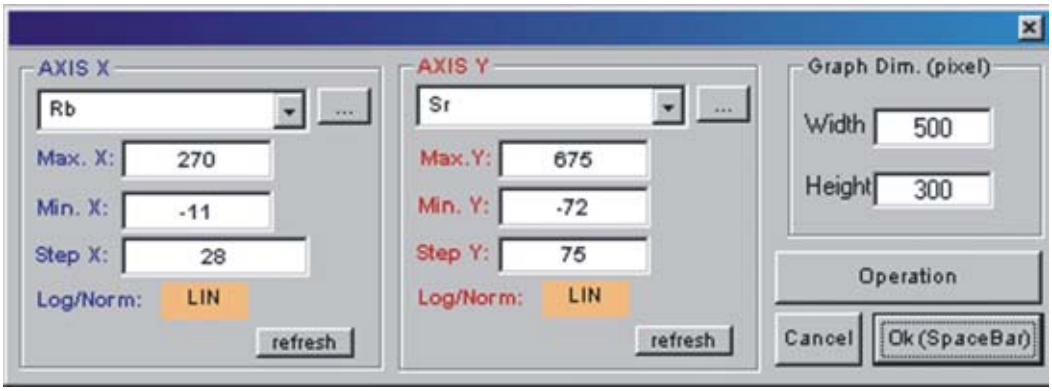


Figure 19

Replacing the minimum value for Rb and Sr with 0 and putting in the step interval 20 and 50 for Rb and Sr respectively a more readable diagram can be genetated (Figure 20)

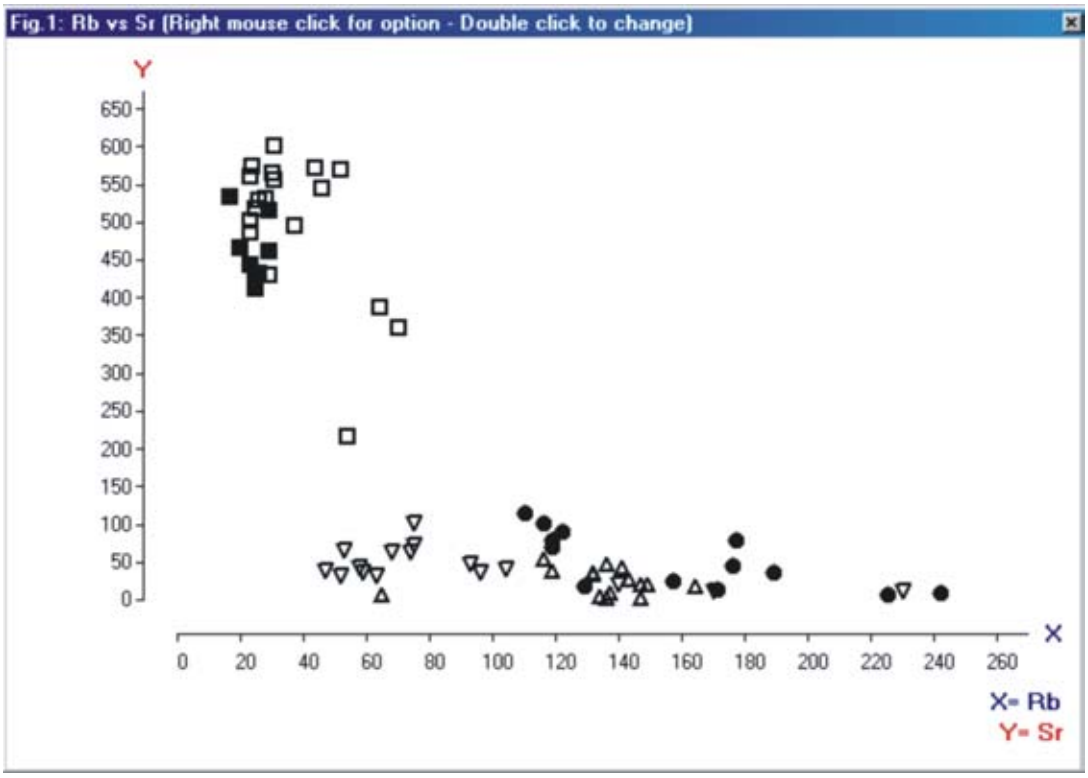


Figure 20

2 Make a REE spider

To make a REE spider select the “Spider – REE” option from the “Plot” menu (Figure 21).

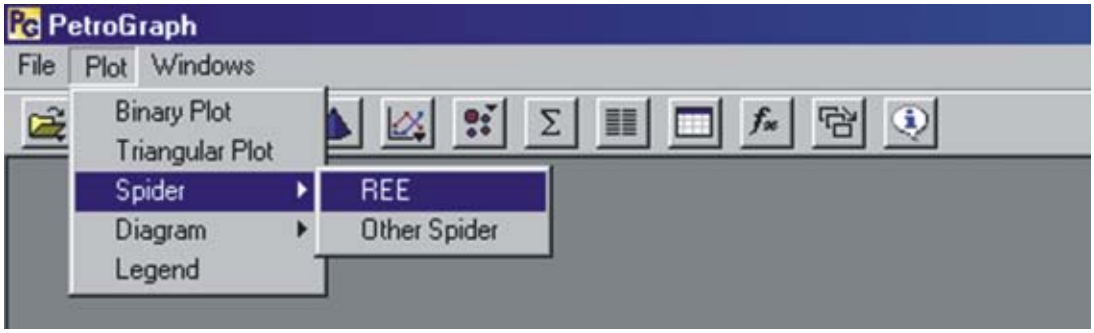


Figure 21

The “REE spider window” (Figure 22) will appear. This window allows to select the samples (max 50) to be plotted by clicking the button ... Only samples with Eu analysed can be selected.

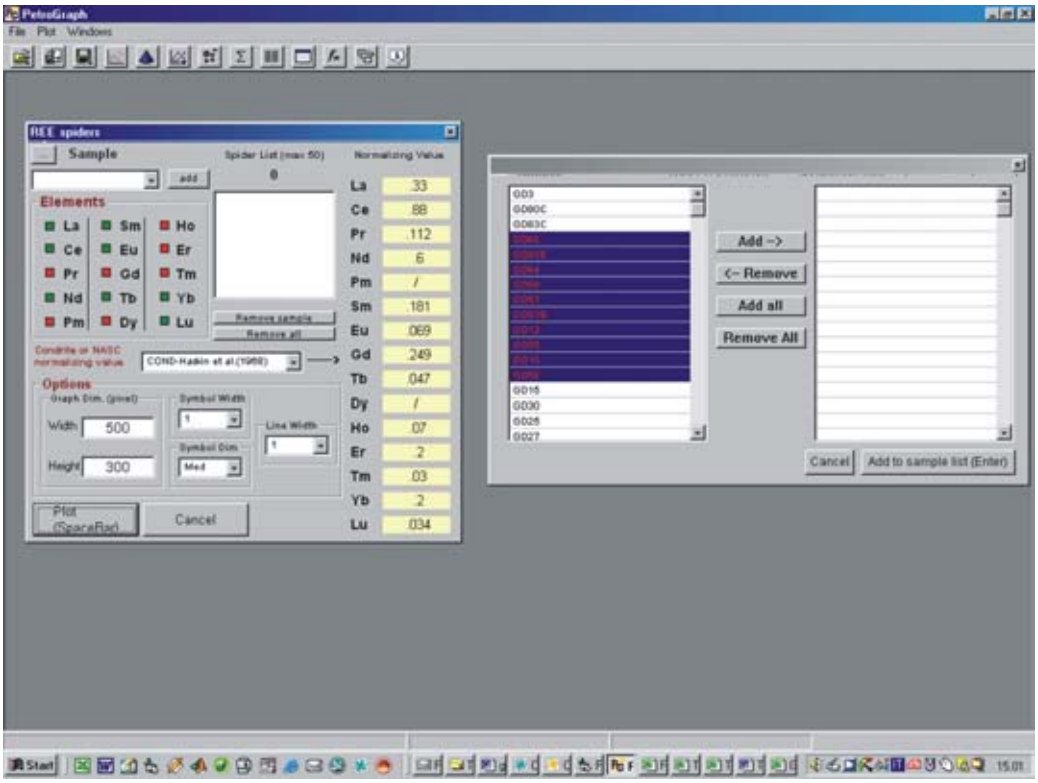


Figure 22

To generate the diagram (Figure 23) click the button “Plot(spacebar)” in the “REE spider Windows”.

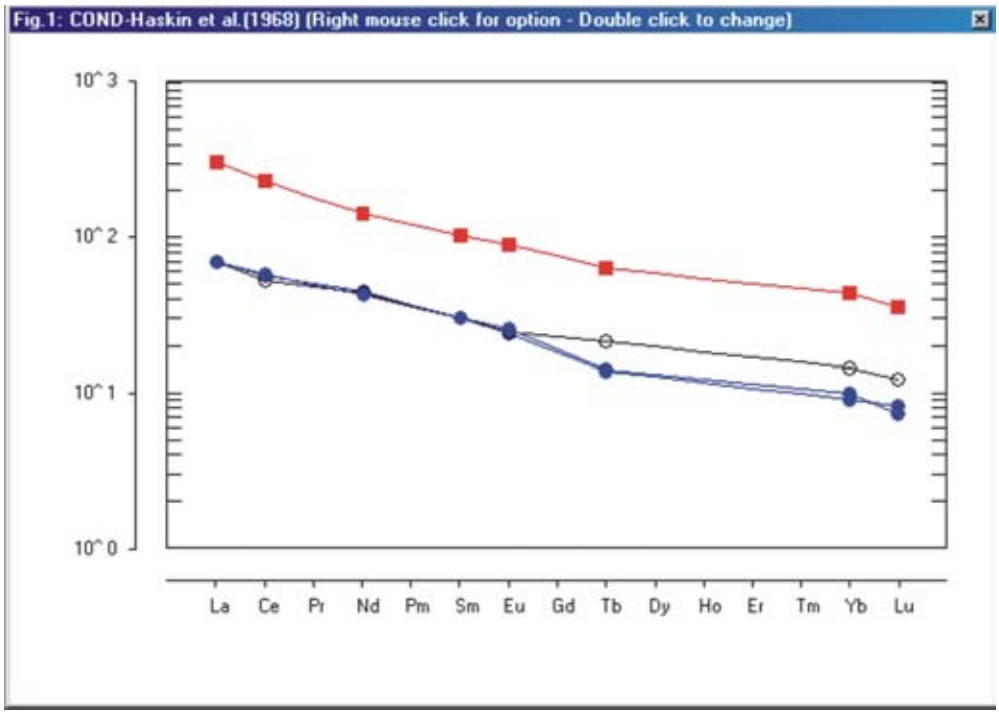


Figure 23

3 Make a Model for Major Elements

In this paragraph we show an example for the Mass Balance computation. In particular we reproduce the original example proposed by Stormer and Nichols in their paper published on Computer and Geosciences on 1978. The StormerNichols1978.xls file is stored in the example folders and it can be imported as described in the first example. To perform a Mass Balance computation select the “Mass Balance” option from the “Windows” menu (Figure 24) or click the button Σ from the control bar; as result, a blank “Mass Balance windows” will appear (Figure 25).

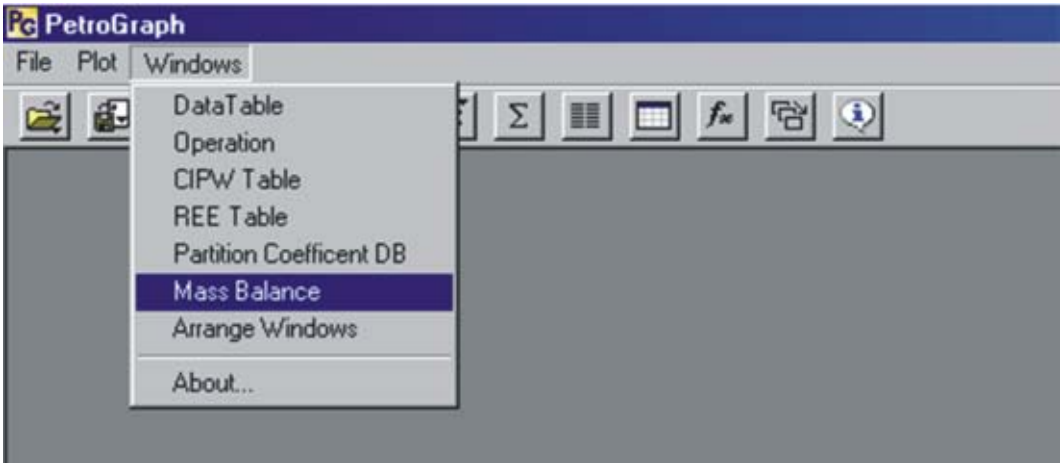


Figure 24

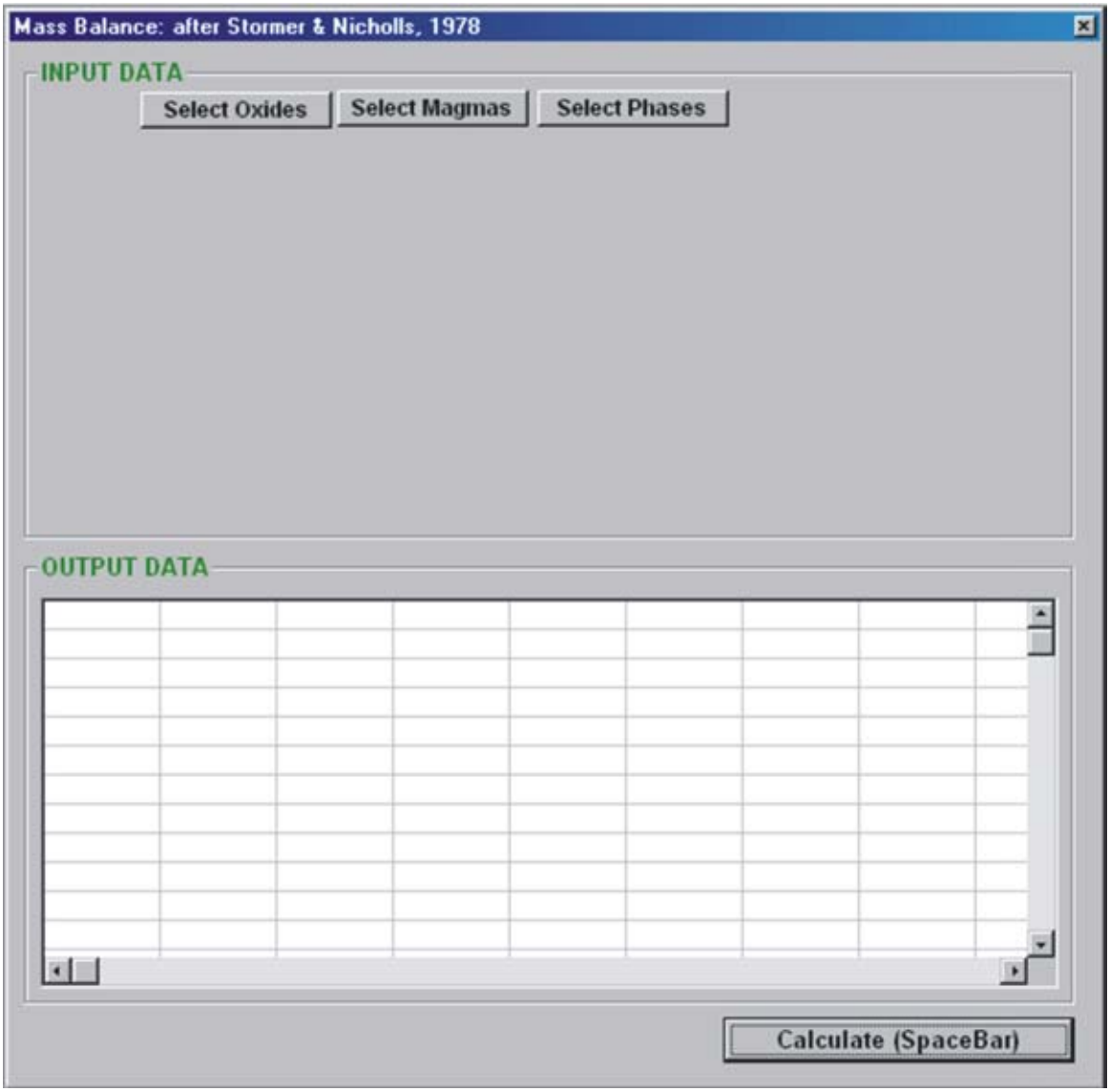


Figure 25

Now select oxides that will be utilized for the computation by clicking on the button with label “select oxides” in the “Mass Balace Window”; the windows displayed in Figure 25 will appear.

Figure 26

By observing oxides present in the imported database we see that P2O5 is lacking and therefore we unselect it. Selected oxides appear as green while the unselected oxides are red. In practice, to activate an unselect an oxide, click on it an it will change from red to green. To continue click on “OK (SpBar)”. Now selected oxides will appear in the “Mass Balance windows” (Figure 27).

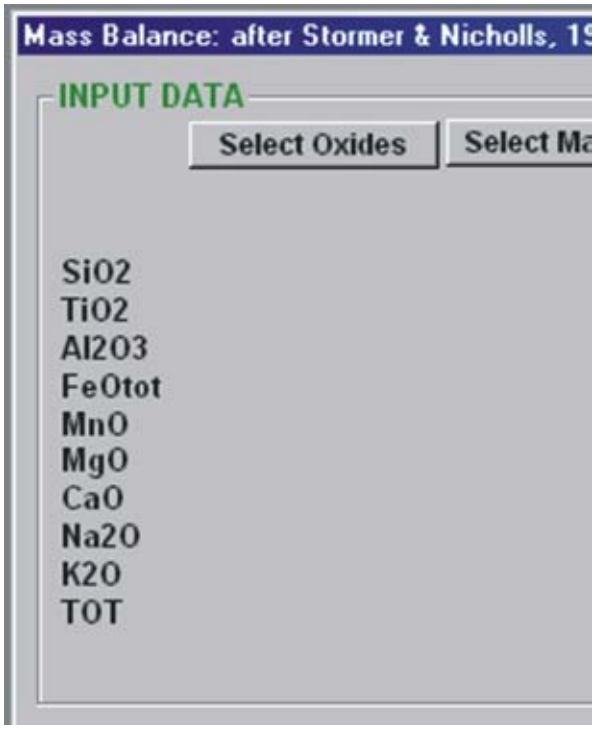


Figure 27

The initial and the final magma can be selected (Figure 28) by clicking the button with the label “Select Magmas” in the “Mass Balance Window”.

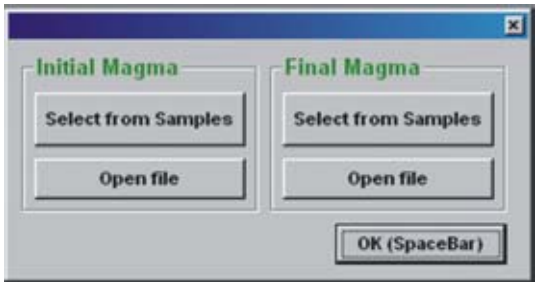


Figure 28

Clicking on “Select from Samples” a list for the available samples will appear and the choice can be performed by clicking on the selected sample. To repeat the example of Stormer and Nichols (1978), select the sample “RCB-153” as initial Magma, “RMD-277” as final magma and click the button “OK (Spacebar)”. The initial an the final magma analyses will appear on the “Mass Balance Windows” (Figure 29).

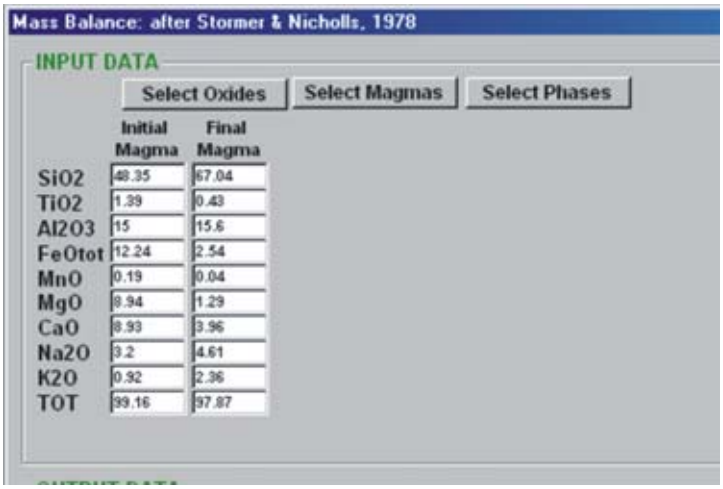


Figure 29

Now it is necessary to select the phases that will be subtracted from the initial magma to reach the final magma. To do it, click the button “Select Phases” and the window displayed in Figure 30 will appear.

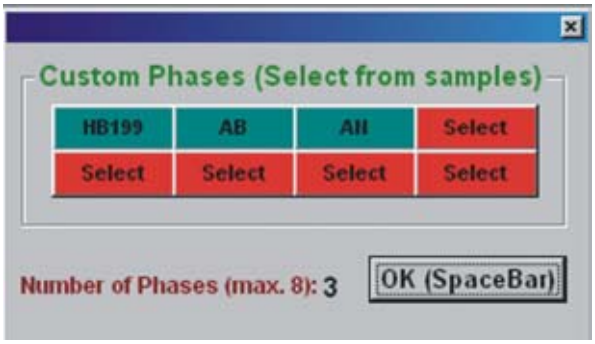


Figure 30

To select a phase click on a red button, when all the phases of interest are activated click on the button “OK (Spacebar). In this case we select the Amphibole “HB199” plus Albite (AB) and Anortite (AN) phases as Stormer and Nicholls did in their original paper. Now all the element required to perform the Mass Balance are ready; to start the computation click on the button “Calculate (Spacebar)”. Results (Figure 31) will be displayed on the lower part of the “Mass Balance Window” in the same way of the original paper by Stormer and Nichols. Results can be also copied in the clipboard and successively pasted in another application like, such as, MS Excel (Figure 32).

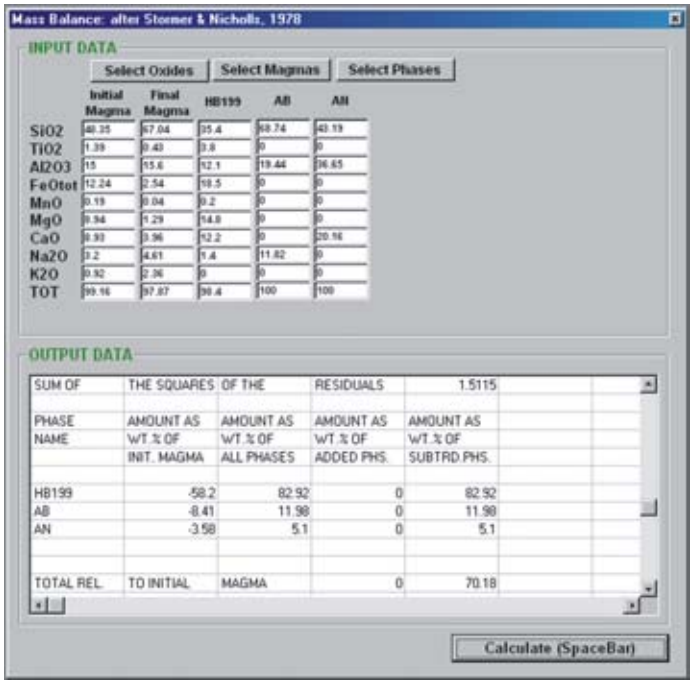


Figure 31

RECAL. ANALYSES (WT.%) TO 100%

OXIDE	INIT	FINAL	HB199	AB	AN
SiO2	48.75958	68.49903	35.98	68.74	43.19
TiO2	1.401775	0.4393583	3.86	0	0
Al2O3	15.12707	15.93951	12.3	19.44	36.65
FeOtot	12.34369	2.595279	18.8	0	0
MnO	0.1916095	4.09E-02	0.2	0	0
MgO	9.015732	1.318075	15.04	0	0
CaO	9.005648	4.046184	12.4	0	20.16
Na2O	3.227108	4.71033	1.42	11.82	0
K2O	0.9277935	2.411362	0	0	0
TOT	100	100	100	100	100

RESULTS

OXIDE	BULK COMP. OR ADDED OR SUBTR.MATL.	OBS.DIFF. BETWEEN MAGMAS	CALC.DIFF. BETWEEN MAGMAS	OBS.-CALC. RESIDUALS
SiO2	40.268	19.739	19.813	-0.074
TiO2	3.202	-0.962	-1.939	0.977
Al2O3	14.394	0.812	1.085	-0.272
FeOtot	15.59	-9.748	-9.12	-0.628
MnO	0.169	-0.151	-0.09	-0.061
MgO	12.472	-7.698	-7.828	0.131
CaO	11.309	-4.959	-5.097	0.138
Na2O	2.596	1.483	1.484	-0.001
K2O	0	1.484	1.692	-0.209
			TOTAL	0

SUM OF THE SQUARES OF THE RESIDUALS 1.5115

PHASE NAME	AMOUNT AS WT.% OF INIT. MAGMA	AMOUNT AS WT.% OF ALL PHASES	AMOUNT AS WT.% OF ADDED PHS.	AMOUNT AS WT.% OF SUBTRD.PHS.
HB199	-58.2	82.92	0	82.92
AB	-8.41	11.98	0	11.98
AN	-3.58	5.1	0	5.1

TOTAL REL. TO INITIAL MAGMA 0 70.18

Figure 32

4 Make a Trace Elements model

Trace elements models can be performed by Petrograph directly on binary diagrams. In this example we develop a Fractional Crystallization model for an incompatible element against a compatible one (see Peccerillo et al., 2003 for details). We first create a binary plot on the file Gede2001.xls as described in the first example. In particular we set in the x axis a compatible element like Vanadium (V) while in the y axis we set an incompatible element like Zirconium (Zr).

To develop a trace element model, click the right button on the diagram and select the option "Insert Model – Models Generator" from the cascade menu (Figure 33).

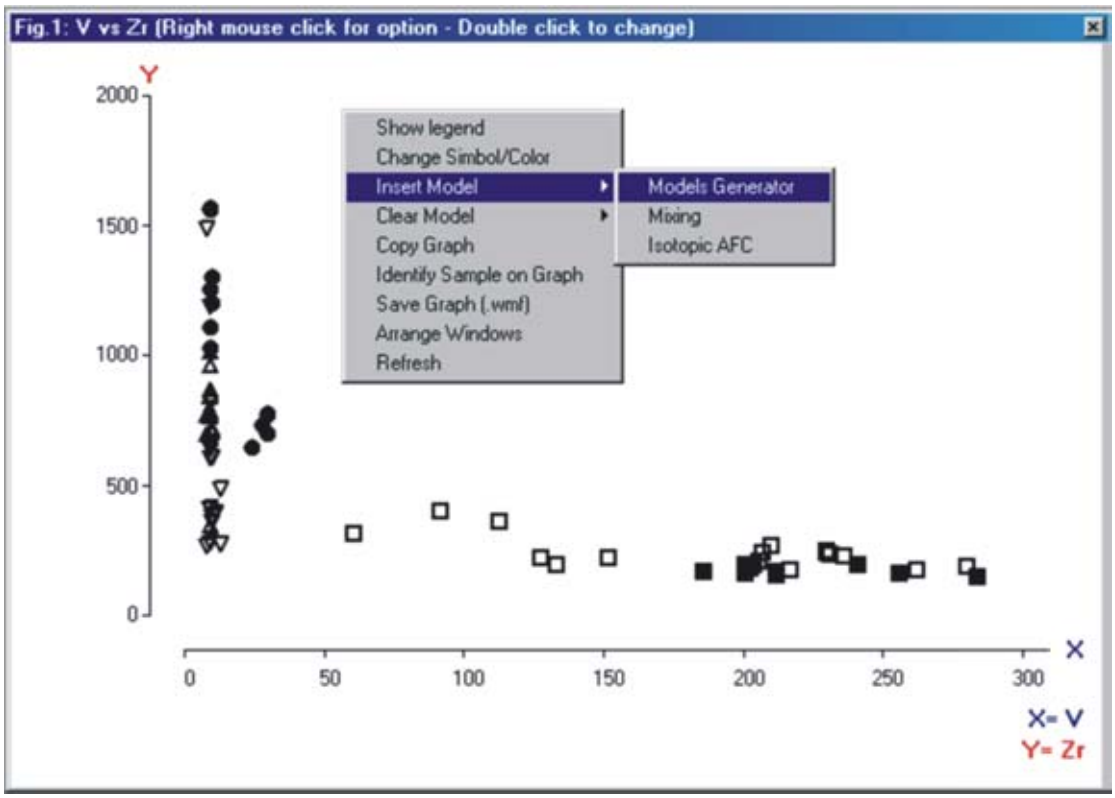


Figure 33

The "Model Generator Windows" will appear (Figure 34)

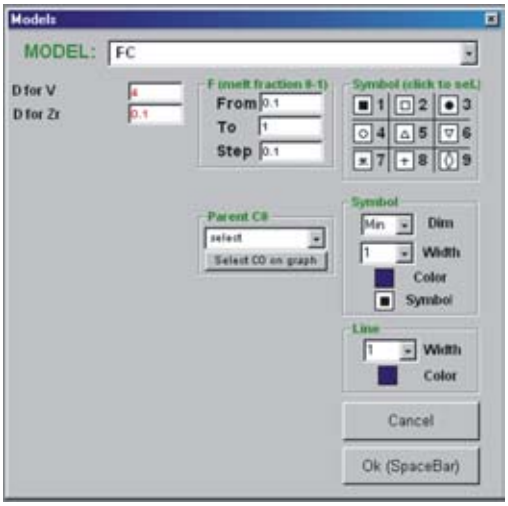


Figure 34

Select the “FC” model from the Cascade list in the upper part of the window, insert values for the bulk partition coefficient for V (D_V=4) and Zr (D_{Zr}=0.1) and select GD65 as “Parent magma” (CO). It is possible to select the “Parent” magma in two ways: (i) by selecting it from the cascade list with the label “Parent CO” or (ii) by clicking the “Select CO on graph” button and selecting the parent magma directly on the graph with a click on a sample. For this example we select the sample “GD65” as parent magma. To plot the model (Figure 35) on the graph click the “OK (Spacebar)” button.

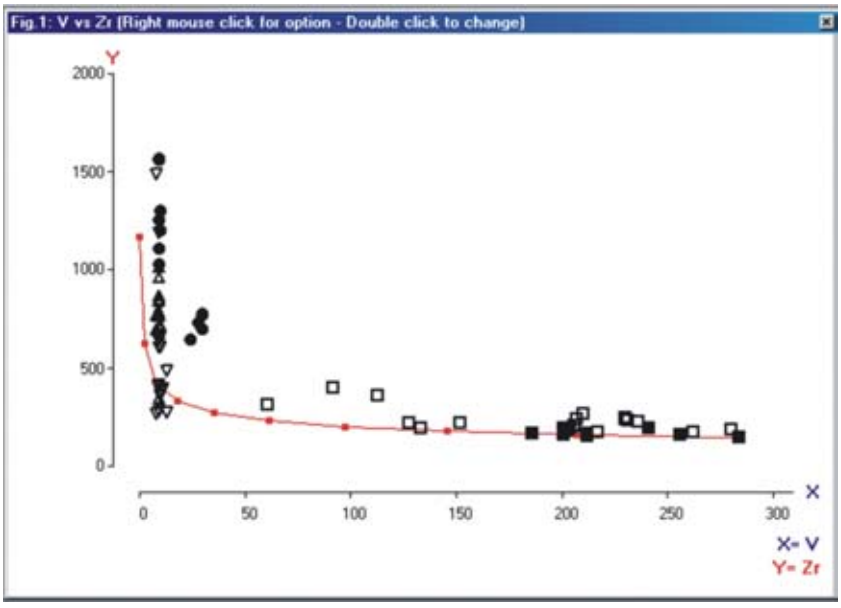


Figure 35

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CREDITS

Petrograph is developed within the Petrography Section of Earth Sciences Department - Perugia University (Italy) by Maurizio Petrelli under the supervision of the PetroPg group.

Address:

UNIVERSITA' DEGLI STUDI DI PERUGIA

DIPARTIMENTO DI SCIENZE DELLA TERRA

Piazza dell'Università – 06100 PERUGIA (ITALY)

PetroPg group:

Name	Position	e-mail	www
Giampiero Poli	Full professor	polig@unipg.it	www.unipg.it\~polig\
Angelo Peccerillo	Full professor	pecceang@unipg.it	www.unipg.it\~pecceang\
Diego Perugini	PhD	diegop@unipg.it	www.unipg.it\~diegop\
Maurizio Petrelli	PhD Student	maurip@unipg.it	www.unipg.it\~maurip\
Carmelita Donati	Assistant	denz@unipg.it	www.unipg.it\~denz\
Danilo Chiocchini	Technician	denz@unipg.it	www.unipg.it\~denz\
Enzo Pagana	Technician	denz@unipg.it	www.unipg.it\~denz\
Fabio Lazzari	Technician	denz@unipg.it	www.unipg.it\~denz\