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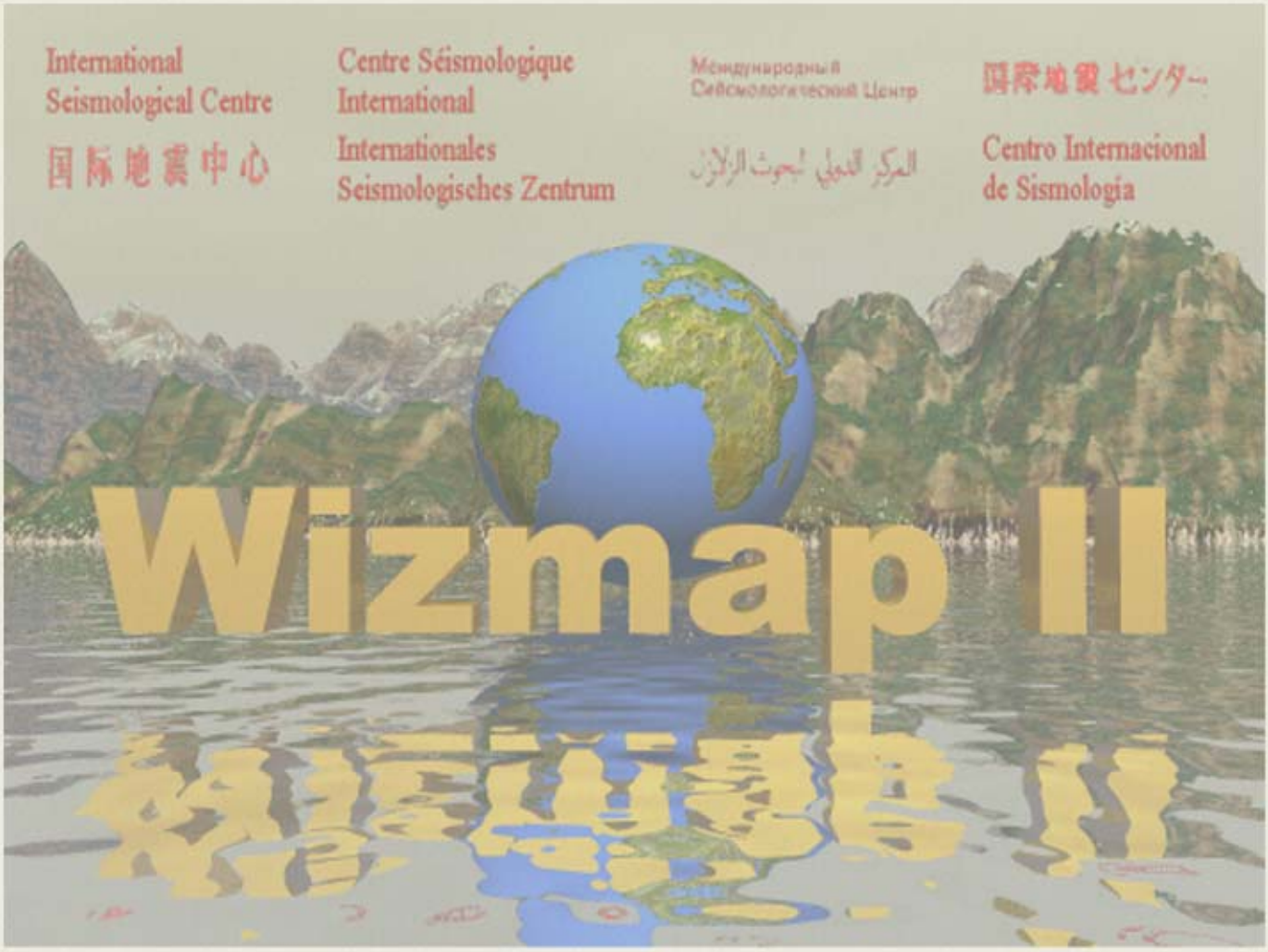
Wizmap II ISC Edition: User's Guide

RMW Musson

BGS Technical Report IR/02/078



BRITISH GEOLOGICAL SURVEY

TECHNICAL REPORT IR/02/078

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Cover image
The Wizmap II Splash screen for the ISC Edition.

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Foreword

The program Wizmap II was developed by BGS in the mid 1990s as a tool for working with earthquake catalogue data. It was decided to make the program available to the whole seismological community as a free download from the BGS website, and since then has been used throughout the world. To support the work of ISC, this special version of Wizmap has been produced, which works specifically with the ISF data format promulgated by IASPEI and used for ISC monthly data files. This manual accompanies the Wizmap software package in pdf format and is also published separately.

Acknowledgements

The coastline data supplied with Wizmap II is ultimately derived from the WDB-II data base of the US Central Intelligence Agency; this version was processed by Global Associates Ltd and supplemented with extra data from Charles Culberson, and then reformatted by myself with only minor edits. Thanks are due to Fred Pospeschil, Antonio Riveria and Paul Anderson for making this very useful data available.

Wizmap II is written mostly in Visual Basic 5 (and a little FORTRAN).

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1. Introduction to the ISC Edition

Wizmap II is a PC/Windows-based program for exploring earthquake catalogues. Its main functions are:

a) spatial display of earthquake data in the form of maps;
b) the ability to interrogate maps to identify particular events;
c) the ability to display cross-sections showing the depth of hypocentres;
d) the ability to define polygonal areas and extract earthquake statistics for those areas;
e) the ability to extract subsets of earthquake data from a catalogue, using any criteria of place, time, magnitude or depth.

This version is a special edition produced for ISC to be distributed with ISC data CDs. It is based on release 2.05a of the generally available version of the program (see www.gsrg.nmh.ac.uk/hazard/wizmap.htm). This manual is an edited version of the file Wizmap32.txt that accompanies that release. It gives general instructions on the use of Wizmap but also explains the differences and new features in the special edition.

The main differences between this version and the general version are:

a) This version is designed to work with files in ISF data format.
b) This version is able to plot world seismicity maps.
c) This version is not intended for use with intensity data files.
d) Some minor improvements and bug fixes have been included.

There are two versions of the program, distinguished as A and B. The only difference is in the number of earthquakes that can be loaded simultaneously. Version A can handle 180,000 earthquakes, but may not run so well on low specification PCs. Version B is restricted to 20,000 events at a time, which should be enough for most purposes, and runs better on PCs with less memory.

2. Introduction to Wizmap II

The original Wizmap mapping program was written in 1980. It was a mainframe-based program using FORTRAN and CALCOMP graphics for making maps of earthquake data (Musson 1980). It was capable of plotting several different types of map and a total of 36 different map projections (including one original one). However, CALCOMP ceased to be a graphics standard and Wizmap fell by the wayside. For a long time I intended updating the program for the PC but never got around to it. Then came the release of GMT (Generic Mapping Tools) by Wessel and Smith and it was clear that a new version of the old Wizmap program was superfluous - GMT is a much more powerful package.

This new release - Wizmap II - is a different sort of program altogether. If you want to make high quality hard copy maps of earthquake data then GMT is the best to use. The purpose of Wizmap II is to provide a tool with which you can interactively explore the spatial distribution of events in an earthquake catalogue, although it does also allow limited hard copy output. Wizmap II is best thought of as a mini-GIS for earthquake data. You can do many of the same things with a real GIS

like ArcView, but Wizmap II is easier to use, requires less configuration, and automatically understands concepts such as depth and magnitude.

3. Installation

Wizmap II ISC Edition is supplied as an archive file, WizmapISC.zip. Unzip this, and run the Setup.exe program. This takes care of all installation issues. The program has been tested on PCs running Windows 95, 98, NT4 and 2000.

Note for users in some countries including Germany: Before you can run Wizmap, it is necessary to set your Windows profile to recognise the full stop as the decimal point and *not* the comma. Otherwise the program will not run. I apologise for this restriction.

4. Navigation

The controls in Wizmap II are found either in the pull-down menus or the tool bar.

Changing the view is done using the leftmost three buttons on the toolbar (see Figure 1).

The Globe - This is used to specify exact co-ordinate boundaries for your map. Click on it and a form appears in which you may type the top, bottom, left and right latitude/ longitude values for the map view you want. Decimal degrees should be used. If you want to shift the map in one direction or another, but can't be bothered typing, you can click on the little up, down, left and right-pointing arrows below the map limit boxes. Each of these will shift the values in the map display boxes by half the height or width of the map, N, S, W or E respectively. Then click the "Done" button to plot the map in its new position. Whenever this form appears, it shows the current limits of the map, so if you want to fine-tune the area shown (like showing just a fraction of a degree more to the north) this is the way to do it - you can modify just the one value you want and then redisplay.

The Plus Lens - This is the zoom in tool. Click on the button, then click the left mouse button on the map to define one corner of the rectangle you want to zoom in to. As you move the mouse you will drag a rectangle across the map. Click the left mouse button a second time, and the map will be redrawn with the new boundaries. Recommended practice is that the first click defines the top left-hand corner of the new view and the second click the bottom right- hand corner. But actually it doesn't matter. It is possible to keep zooming in on successively smaller rectangles, but there is a limit of ten levels of zoom (more than sufficient) that cannot be exceeded.

The Minus Lens - This is the zoom out tool. Wizmap II ISC Edition stores a series of up to ten views, each progressively zoomed in on the last. Clicking on the zoom out tool restores you to the next largest view. If you are at the maximum view (which is set when you start the program, use the globe tool, or load a new data set) the tool has the effect of expanding the map by five degrees in every direction.

Wizmap II automatically remembers the position of the last map view you were looking at when you restart the program, and most other settings.

Whenever you load in a new data file, Wizmap II automatically switches the map co-ordinates to display the whole file. This feature can be disabled in the options menu.

At very high magnifications (map areas around 1x1 degrees or less) you may encounter distortions of symbols due to resolution problems.

Other ways of changing the map appearance:

4.1 Size

As you change the size of the Wizmap II window by dragging or maximising, the map plot changes size to match it.

4.2 Gridlines

The Gridlines menu allows you to choose how graticule lines (latitude and longitude) will be displayed. The options are either to have lines running across the map or just labels in the margin (ticks). The default is no lines. You can also specify whether the interval between lines should be 10^o, 5^o, 2^o, 1^o, 0.5^o, 0.2^o or 0.1^o. This also affects the margin labels. Default is one degree.

4.3 Projection

Nine projections are supported by Wizmap II. These are as follows:

1) Mercator - This projection is quick to execute and is good to use when you are just having a quick look at the data. It is subject to serious distortions, especially in high latitudes. A limit of 70 degrees North or South is recommended, but it will plot up to 85 degrees if you insist.

2) Gall Stereographic - an alternative cylindrical projection; like Mercator, but less subject to distortion in high latitudes.

3) Transverse Mercator - a very popular conformal projection. Not quite the same as Universal Transverse Mercator (UTM) which has standard meridians at a fixed interval. Wizmap II picks one meridian at the centre of your map.

4) Gnomonic - This is a very valuable projection for seismologists. All straight lines on the map are great circles. Thus, when you are drawing cross-section profiles and the like, what you see is what you get. However, it isn't good for displaying large areas (more than about 50 degrees across).

5) Stereographic - A conformal azimuthal projection well-known to seismologists.

6) Orthographic - Another azimuthal projection with the interesting property that it matches what you see in satellite photographs.

7) Postel Azimuthal - The property of this projection is that scale is correct from the centre of the map in all directions.

8) Lambert - A popular conformal conical projection. Warning: Do not use this projection with the World coastline file.

9) Bonne - This is an equal-area projection, so useful for work in which areas are important.

If you want to plot maps of the whole world, or most of it, only projections 1 and 2 should be used.

Note in passing: these are probably the most useful nine of the 36 projections supported by Wizmap I. Many of the latter were pseudo-cylindrical projections which are good for making display maps, but are not of any real value for an analytical tool such as Wizmap II.

Some combinations of projection and map limits give poor results. You may need to experiment to see which projection gives you the best map for your current view.

4.4 Colours

If you are printing to a greyscale printer, the default green/blue colours may come out too dark. Or you may just not like them. In the Options menu you will see two items to change the colours: one for the land, one for the sea. Clicking on either of these will bring up a standard Windows colour selector and you can pick something to your taste. Wizmap II will obligingly remember what you picked next time you run it.

5. Loading earthquake data

The standard version of Wizmap uses what I call self-parsing file format; this is a way of reading almost any line-per-event catalogue format without the need for reformatting. This method is described in Musson (1998). The ISC edition uses ISF data format for both reading and writing. For a description of this format, see the ISC web site at http://www.isc.ac.uk. ISC distributes two types of files in ISF format: bulletin files and catalogue files. The difference is that bulletin files include a phase data sub-block for each event, whereas catalogue file do not. Wizmap is designed to work with catalogue files. The ISC edition will in fact read either catalogue files or bulletin files, but it strips out the phase data and only writes catalogue files.

There are several options available in ISF format, as to whether headers, comments, etc are present or not. Wizmap should be able to cope with any ISF file, but bear in mind that if the magnitude block is missing (which is legitimate in ISF) the file will be read but nothing will be plotted. It doesn't matter if there is extraneous text before and after the ISF data in the file. A catalogue search from the ISC web site (www.isc.ac.uk) can be saved straight to a text file and loaded into Wizmap without any editing.

Wizmap expects earthquake data files to have the suffix ".isf", which is the standard ISC practice. You can load data files into Wizmap II using the "Load earthquakes" command found in the "Files" menu. In version A of the ISC edition you are restricted to 180,000 events at a time. In version B the limit is 20,000 events (but the program runs better on low-spec machines. In the standard issue of Wizmap, loading a new earthquake data file automatically clears out the previous one. This is not the case in the ISC edition. Loading a new data file causes the new data to be added to the data already being displayed. This enables you to combine different monthly files. Be careful not to load the same file twice!

You can unload the earthquake data at any time by selecting the "Clear" command from the "Files" menu.

The symbol size of earthquakes is proportional to the magnitude. Earthquakes with no magnitude aren't plotted. If you find the symbol sizes too big or two small, you can scale them using the "Symbol size" option in the "Options" menu. This brings up a dialogue in which you can enter a factor by which the standard size of symbol will be multiplied. So entering 2.0 doubles all symbols, 0.5 halves them. Further changes to symbol size are always made with respect to the original sizes.

Depth is shown by the colour of the symbol. Bright red indicates either a depth of zero or 33 km (in either case, this usually means "depth unknown but shallow"). Otherwise, very shallow events are pale pink, which darkens with depth in the crustal range (to 33 km). Below that, in intermediate depths, the colour changes gradually to blue (at 100 km). Deep events are progressively darker blue (black below 250 km).

Any ISF file is likely to have more than one set of parameters for each earthquake. If the data for an earthquake contains the “#PRIME” indicator for a particular origin, Wizmap will use this determination for plotting purposes. Otherwise, it will use the last determination in the block (because this is usually the ISC determination). If Wizmap finds the “#PRIME” indicator, it will look for a magnitude from the same agency. If it finds more than one, it will use the largest. Otherwise it will choose the largest ISC magnitude. Failing that, it will use the largest magnitude anywhere in the magnitude sub-block. This is only for plotting purposes; all the different magnitudes are preserved for reading.

6. Loading other point data

You can also load other point data (seismic stations, towns, sites, etc) from a file. This is discussed in more detail in the section on marks further on. Such data needs to be prepared in Wizmap mark format. Each point needs to be on a separate line, with an identifying name, a latitude and a longitude. Latitude and longitude must be in decimal degrees, with west and south negative. The order and position in which these appear in your file are not important, because you will indicate the position by putting a format header as the first line of the file, with letters marking out the position of the three fields.

The format header for mark files is:

UUUUUUUUUUUUUUUUUUUU	Identifying name (20 characters)
PPPPPP	Latitude
LLLLLLL	Longitude

So examples of valid files could be:

```
UUUUUUUUUUUUUUUUUUUU        PPPPPP    LLLLLLL
Site 1                       42.76      12.18
Site 2                       43.99      -0.11
```

or alternatively:

```
PPPPPPLLLLLLLUUUUUUUUUUUUUUUUUUU
 42.76  12.18Site 1
 43.00  -0.11Site 2
```

Both of these files would be read correctly.

The default file extension for files of this type is ".mrk".

Symbol size is altered in the same way as for earthquake data. Note that if you change symbol size for earthquakes, this will affect point symbols as well, and vice versa.

Note that when you load any sort of data file, Wizmap remembers which directory you got it from. If you load an earthquake data file, and then subsequently want to load another earthquake data file, Wizmap will look first in the directory you got the first one from. Even if that was some days ago. If you keep earthquake data files in one directory and point data files in another one, Wizmap will remember this and look in the right place for the different files types. I just wish that other software behaved similarly.

7. Loading coastline files

It is possible to change the coastline file displayed by Wizmap II. This is useful if you want to deal with one particular area in some detail. The default coastline file displayed by Wizmap II on starting is the file WORLD32.CST, which is a low-resolution file covering the whole world. Once you have zoomed the map to the area you want to work in, you can switch to a higher resolution file. Six are provided, one for each continent (except Antarctica). The Australia file also includes Indonesia. The option "Load coastline" in the Files menu is used to select a new coastline file. If anyone wishes help with converting their own coastline files for use with Wizmap, let me know.

Note that the coastlines provided are missing a number of islands.

WORLD32.CST does not display correctly in the Lambert projection. If you exit the program with this projection selected, the next time you run Wizmap it will load WORLD32.CST by default and you will see a blank map. Just change projection or load a new coastline and all will be well again. Certain other combinations of coastline, projection and map limits may generate unwanted artefacts. Choose a different projection or coastline file.

8. Loading files by dragging them from Windows Explorer

To save negotiating the file open dialogue, you can open a data file in Wizmap II very simply by dragging it from Windows Explorer or File Manager onto the map. The result is just as if you had opened it through the Files menu. The file dragged must have the correct file extension for it to be recognised, that is:

.isf for earthquakes
.mrk for point data (marks)
.zon for polygon files (see below)

File extensions are not case sensitive, so ".ISF" is acceptable. If you drag a whole bunch of different files at once, only the first one with a recognisable extension will be opened. However, if you drag only ISF files, they will all be opened. So if you have twelve monthly files covering January to December 1999, for instance, you can select all twelve in Windows Explorer, drag them on to the map, and you will have all the data for 1999 displayed.

9. Printing the map

To send the current map to the printer, select the print command from the Files menu, or use Ctrl+P. The map is sent to a printer you specify, with a couple of header lines. Note: no sort of scale or key is printed. A scale is unnecessary when running Wizmap II since you can retrieve the exact parameters of any event; thus a scale is superfluous. The printed maps are intended to be draft printouts, not final publication quality.

An alternative way to print is to copy the map to the clipboard, and from there paste it into a specialised graphics program like Paint Shop Pro. You can then arrange the map on the page to suit your preferences.

10. Exporting the map

If you wish to export a map produced by Wizmap II to another application, you can capture the map as a bitmap using the "Copy map to clipboard" command from the Files menu (or press Ctrl+C). You can then paste the map into another application in the usual way. Note: this sometimes fails if there is already data on the Windows clipboard. If you have problems, run the Windows Clipboard Viewer, delete the contents of the clipboard, and try again.

11. Filtering out earthquakes

If you only want to work with a subset of the data in your catalogue file, you can filter out events on date/time, magnitude or depth criteria.

Click on the filter button in the toolbar (it's the one that looks like a funnel). A form appears (see Figure 2) in which you can enter the exact date/time interval you wish to display, with options for minimum and maximum magnitude as well. Once these are selected, click the "filter on" button and they will be in force for all future Wizmap II operations until either: (a) you bring up the filter form again and change the settings, (b) you bring up the filter form again and click on the "filter off" button, (c) you bring up the filter form again and click on the rightmost button which resets the form to its default values, (d) you unload the catalogue file and reload it or load another file, (e) you quit the program and restart it.

The "Cancel" button can be used if you decide not to have a filter after all - it clears the filter form without having any effect on the data.

NB The ability to filter events on depth is very useful if you want to study the statistics of only deep events or only shallow events with the polygon tool described below.

To apply a filter to a whole file of earthquakes and save the results, after using the filter tool you can choose "Save Earthquakes" from the Files menu, which will save just the earthquakes you want to a new file. The earthquakes will be saved in ISF format with all the blocks and comments that were in the original file.

12. Animated displays of seismicity

This feature allows you to watch the earthquakes in an area as a series of "time slices"; useful for visualising any migration in the spatial distribution of seismicity e.g. in an aftershock sequence. It is activated from the filter form (see Figure 2). Bring up this form and place it on the screen so that you can see both it and the map. Set the date and time in the left-hand series of boxes to when you want the sequence to start. You have two options as to how the time slices are portrayed: you can have only the earthquakes in each interval displayed, or you can have each new interval added to the ones already plotted. In the "Advance Mode" menu select either discrete or cumulative to choose. The "Advance Margin" menu allows you to select whether the time increment should be in hours, days, months or years, and the actual value of the time increment is specified in the box labelled "Number of margin units to advance" at the bottom of the form (so you can have two-month plots, or one-year plots, or seven-day plots, or whatever).

To start the display, select the GO! option from the "Advance" menu, or (what is easier) press F2. Suppose you selected a start date of 1990 01 01 and a margin of two days. You will see that after the first press of F2, the "Finish" date is now 1990 01 03 and the only events plotted are those in this two-day interval. Press F2 again, and the end of the time window is now 1990 01 05. If you are doing a cumulative display the start date will be unchanged, but if a discrete display the start date will now be 1990 01 03. Continue pressing F2 to cycle forwards through the earthquake catalogue.

When you have finished, click the "Filter off" button. Note: it is not possible to cycle backwards.

13. Identifying earthquakes

When one looks at a map of earthquakes in any detail, the question so often arises, "which event is that one?" Wizmap II is designed to answer this sort of question.

To identify events on the map, click on the button with a question mark on it in the tool bar. Notice the button stays down (darkened) for as long as you are in event-identifying mode. Now click on any earthquake on the map. A form appears giving the basic catalogue details for the event. If more than one event occurs at exactly the same location, the data for all the events will be presented. Click on another earthquake, and the data in the form will be updated. If you click somewhere on the map where there is no earthquake, the data for the nearest event will be displayed.

Usually it is enough to see date, time and magnitude, but there are occasions when you will want to consult the full ISF data for the event. This can be done quite easily. When the form giving the details of the event or events you clicked on, the parameters appear in a little grid like an extract from a spreadsheet. Click on the row containing the earthquake you want to see the full data for. A new window appears, with the full ISF data listing, including all comments. ISF uses rather long line lengths, and by default, Wizmap truncates the lines after the depth information. To see the full line, simply resize the window by dragging the right-hand edge and the full data will be displayed.

Similarly, some large earthquakes may have quite long entries with many comment lines. This is handled as follows: if there are more than 40 lines of data, only the first 40 are shown, but a scroll bar is provided, which permits the display of the full data file.

The ISF display window must be closed before you can go back to looking at other earthquakes.

When you've finished identifying earthquakes, click on the "Finished" button on the form where the data is displayed. This removes the form and restores the button on the toolbar to its original "up" state. Clicking again on the question mark button in the toolbar has the same effect.

15. Depth profiles

Wizmap II allows you to make cross sections across areas and examine the depth distribution of earthquakes. To do this, click on the button on the toolbar that shows a saw cutting a log (yes, that's what it's meant to be). A form now appears to enable you to control where the cross section will be made. There are two ways of doing this:

(i) You can enter the values of the start point and finishing point as latitude and longitude values in the boxes provided. Then type in the required width of the section in kilometres. This width will be the distance either side of the central line within which events will be plotted (i.e. it is half the width of the whole rectangle). When you have entered exactly the values you want, press the button marked "Plot it". If you change your mind you can select the "Cancel" button and end the whole operation.

(ii) You can select the area on the map. Click the large button marked "Select with mouse". The form disappears. Now click on the map for the start point of the section. Now, as you move the mouse across the map, a purple line is dragged out showing where the line of the cross section will be. When you have it in the right place, click the mouse button again to choose the finishing point. You now find that as you move the mouse a rectangle is stretched out either side of the central line. When you are happy with the width of the rectangle, click the mouse for a third time and the cross section will be plotted.

An important thing to remember is that Wizmap draws cross-sections along great circles. If you take a large map on a cylindrical projection (e.g. Mercator) and draw a long cross-section, you won’t get the events you expected to get. This is because the actual course of the cross-section is not what it looks like on a map of this projection. If you have a serious reason for drawing cross-sections that are longer than a few hundreds of kilometres, it’s best not to use a cylindrical projection when selecting it.

The cross section appears in its own window, which can be resized as you like. The start point of the section is always on the left, and the finishing point on the right, irrespective of which is further north or west. Both are labelled on the cross section. Note that events with a depth of zero are assumed to have unknown depth and are not plotted at all. Earthquakes with no magnitude are also not plotted.

The scaling method used is controlled by two buttons on the toolbar at the top. You can have either the x and y scales the same (the "1:1"button) or you can have the section drawn to best fit the size and shape of the window ("Fit"). Clicking on either of these buttons redraws the section with the selected method. If the section you draw is much deeper than it is long, the bottom of the

section may disappear off the bottom end of the window until the form is resized or you click the "Fit" button.

When the section is first drawn, the base of the section is automatically chosen to be the depth of the deepest earthquake plus 5 km, which is shown in a small box on the toolbar. You can change the depth of the section by altering the number shown in the toolbar, and then clicking on one of the scaling buttons to redraw the section with the new base depth. This is useful if you want to zoom in on the upper layer of the crust.

Clicking on any event plotted in the cross section identifies it in exactly the same way as clicking on it in map view with the "Identify" mode selected. This is always active; you don't have to activate a tool first as you do when working in map view.

The default view is a 2D section, but you can also get a 3D view by clicking the button marked "3D". The caption on this button then changes to "2D" and clicking it again returns you to 2D viewing. When a 3D view is selected, the section is shown as a wire frame box, with depth labels along two edges. The latitude/longitude values shown at the top of the screen are still the co-ordinates of the end points of the centre line of the section. The earthquakes are plotted within the wire frame.

At the bottom of the window, you will now see a second toolbar with controls for altering the view. The principle ones are five scroll bars, as follows:

Rotate	- this changes the horizontal angle at which you view the section;
Pitch	- this changes the vertical angle at which you view the section (and you can view from underneath as well as from above);
Zoom	- zooms in or out for a closer look;
Pan left-right	- moves the whole view from side to side;
Pan up-down	- moves the whole view up and down.

On a reasonably fast PC you should be able to rotate the section smoothly to and fro, which gives a good idea of the 3D structure. Because selected sections can vary considerably in aspect ratio and size, the default view may not be the best, but by using the pan and zoom tools one can obtain a good view.

There is also an option control labelled "No stalks" and "Stalks". If you select the second option, as well as plotting the position of the hypocentres, Wizmap also displays the epicentres as projections on the surface plane, and draws a line from each hypocentre to its associated epicentre. It some situations this may help to visualise the 3Dstructure. Selecting "No stalks" removes these extra lines.

Note that you can still identify individual earthquakes by clicking on them even in 3D view.

The other buttons in the top toolbar are marked "Print", which prints the cross section on a printer, and "Finished" which closes the window. You need to close the window before you can plot a new cross section.

When you finish with the cross section, you will find the box defining the area is still shown on the map (now in black). This enables you to make further cross-sections that take the first one as a point of reference. The black outline disappears when you next resize the map. It isn't displayed at all if you entered in the values for the section manually.

If you attempt to make a cross section of an area within which there are no earthquakes with depth values, you will be informed that a cross section cannot be made.

16. Analysing polygonal zones

A powerful ability of Wizmap II is making analyses of the properties of polygons drawn on the map. To draw a polygon, select the polygon tool on the toolbar. Now left-click on the map to define the first point of the polygon. Move the mouse to the next point of the polygon you want to define and click the left mouse button at each vertex. When you have reached the last vertex, click anywhere on the map using the right mouse button and the polygon will be closed automatically.

The program assumes that you will give it sensible points for a polygon. If you make the sides cross one another, the results are unpredictable. Also, bear in mind that Wizmap analyses a polygon using great circle lines between each vertex (although they are displayed as straight lines on the map). Therefore the earthquakes actually included in a zone may not be exactly as it appears in the map, especially with projections like Mercator and vertices in high latitudes, or if zones are very large. This feature is intended for use to analyse seismicity at a regional scale, not a continental scale.

16.1 Basic statistics

Once the zone is completed, a window appears giving various details about the seismicity within the zone (see Figure 3). The first group of statistics areas follows:

i) The area of the zone. This is often useful on its own.
ii) The total number of events in the zone.
iii) The mean depth of all events that have a depth more than zero.
iv) The maximum depth reported.
v) The date of the first earthquake in the zone.
vi) The date of the last earthquake in the zone.
vii) The maximum magnitude found in the zone.

16.2 Magnitude-frequency

Below these details there is a chart showing the G/R magnitude-frequency plot. The regression line is shown in red.

To the right are shown details about the magnitude-frequency relationship. Firstly, the a and b values are shown, as in the equation

$$\log N = a + b M \qquad (1)$$

The standard deviations of both parameters are shown to the right of the values. Note: the standard deviations are calculated in the standard statistical way for linear regression. They represent the fit of equation (1) to the data, which is not quite the same as the uncertainty that the calculated values are representative of long-term seismicity.

In the analysis of ISF data files for relatively short periods of time it is highly unlikely that the activity rate determined will be anything like representative of the long-term seismicity of a zone. It is expected that anyone computing recurrence parameters for hazard purposes will use a national earthquake catalogue (which will not be in ISF format) and the standard version of Wizmap II. However, it may be very interesting to use this feature to examine fluctuations in b-values over short periods of time.

The Mmin and Mmax boxes show the magnitude of the smallest and largest earthquakes in the zone. Probably the catalogue is not complete for the smallest events and not representative of the full seismic cycle for the larger events. Therefore it is useful to change these values, with respect to where the graph "rolls off". To do this, click on the "Pick" buttons next to the Mmin and Mmax boxes. You can then pick by eye what the limits should be by clicking on the graph. The values in the box will change to reflect this. When you are happy with the limits, clicking on "redraw" will calculate the new values. Note: you cannot select Mmin larger than Mmax, or Mmax larger than the observed largest magnitude.

You have the option of calculating equation (1) either by the maximum likelihood method or by least squares. The default is maximum likelihood. The box labelled "calculation method" allows you to choose. The choice does not take effect until you click the "redraw" button.

The "step interval" box allows you to select whether the data on the graph is displayed in increments of 0.1 magnitude units (the default) or 0.2 or 0.5. The calculation of equation (1) takes the step interval into account. The choice does not take effect until you click the "redraw "button. Note that how data are plotted is different for the larger step intervals. If the step interval is 0.1, a point will be plotted for a given magnitude only if there are any earthquakes of that magnitude in the zone, although, as the data refer to cumulative frequencies, one could plot the number of earthquakes greater than 4.5 even if one didn't have any events of exactly 4.5. Similarly, the regression will only take into account the number of magnitude values for which there are actual data points. The case is different when the step interval is 0.2 or 0.5. In the former case, all magnitude values between the minimum and maximum are plotted, irrespective of whether observed magnitudes fall on the step interval or not, with the exception that a value will not be plotted if it is the same as the next highest. The table below should make things clear.

Magnitude	Data present?	Plotted at 0.1?	Plotted at 0.2?	Plotted at 0.5?
4.0	No	No	Yes	Yes
4.1	Yes	Yes	No	No
4.2	Yes	Yes	Yes	No
4.3	Yes	Yes	No	No
4.4	No	No	Yes	No
4.5	Yes	Yes	No	Yes
4.6	No	No	No	No
4.7	No	No	No	No
4.8	Yes	Yes	Yes	No
4.9	Yes	Yes	No	No
5.0	No	No	Yes	Yes
5.1	Yes	Yes	No	No
5.2	Yes	Yes	Yes	No
5.3	No	No	No	No
5.4	No	No	No	No
5.5	No	No	No	Yes
5.6	Yes	Yes	Yes	No

The data that you see plotted are the ones used to calculate the regression, subject to any further restrictions you place on minimum and maximum magnitudes. (I'm fairly sure I have seen studies

where the regression was calculated using the cumulative figures for every magnitude value, even where there were no events of exactly that value. I believe that this is not good practice.)

In zones with less than three events no analysis will be done at all. The only thing that will be reported is the area of the zone and the number of earthquakes.

The little Gutenberg-Richter graph is useful for working with but is not of publication quality. Wizmap II ISC Edition gives the possibility to export the graph points for use with Excel, Axum or some other charting tool. Select "Export G-R data" from the Actions menu and choose a file name. The data is exported as comma-separated variables (.csv), which can be read by most programs.

Clicking the button marked "Finished" concludes the analysis.

16.3 Saving zone geometry

Wizmap II remembers the zones you create and continues to plot them on the map, so that you can dovetails new zones against the old ones. You can have a maximum of 100 zones, each with up to 50 vertices. To clear all the zones off the map when you have finished with them, select the "Clear All Zones" option from the Actions menu. You can also clear just the last zone with the "Clear This Zone" option (this is useful if you make a mistake in entering the co-ordinates). Exiting the program also clears all zones, as does selecting "Clear" from the Files menu on the main screen (which clears off everything except the coastline), or "Clear zones only" in the same menu.

If you want to revisit a zone, you can do so as follows: Select the polygon tool from the toolbar. Now click once with the right mouse button somewhere inside the zone you want to go back to. The analysis of this zone (a and b values) reappears as if you last left it, except for the selected min/max limits to the calculation.

The whole set of zones can be saved to a file using the command "Write zones" from the Files menu on the main Wizmap window. The default extension is .zon.

16.4 Editing zone geometry

It may seem restrictive that one cannot delete a single zone if it isn't the last one, and one cannot drag the co-ordinates of a polygon around to improve the precision of the geometry. The philosophy behind this is that in a hazard study one will probably want quite exactly positioned zone boundaries, with greater accuracy than can be obtained easily through dragging with the mouse. The recommended way to edit zone geometry is as follows. I have found this method sufficiently easy and functional that trying to implement a dragging routine is not worthwhile.

1. Open Wizmap II, Windows File Manager/Explorer, and your favourite text editor (I prefer PFE by Alan Phillips, available at http://www.lancs.ac.uk/people/cpaap/pfe, which is powerful and free.)
2. Draw your zones in Wizmap. The points don't have to be exact.
3. Save the .zon file.
4. Open the .zon file in PFE.
5. Edit the co-ordinates by hand. If three zones meet at 45.50 5.25, then change values of (e.g.) 45.51 5.23 that resulted from mouse clicking, to the accurate value of 45.50 5.25.

6. Save the file.
7. Drag the file from Windows Explorer back into Wizmap. The modified geometry is displayed at once.
8. Continue to make fine tuning in PFE as required, and drag and drop each version into Wizmap to see how it looks.
9. Once the geometry is perfect, now do any analysis in Wizmap that you want; save the .zon file again if you want to preserve the a/b values. You only have to save from Wizmap twice, once at the very beginning of the process and once at the very end.

Note: if you delete a zone completely in PFE, you need to change the first line of the .zon file, which shows the number of zones in the file. Each zone starts with a line giving the zone identification code and the number of vertices. You will need to change the latter if you delete or add a point. A .zon file is stored in ASCII and looks like this:

```
 2
ZON1 , 4
35.76 , 23.73
35.03 , 22.73
36.83 , 20.59
37.61 , 21.48
4.306       0.081       -0.902       0.015       7.9
ZON2 , 6
38.14 , 21.47
38.14 , 22.41
37.60 , 23.00
37.99 , 23.65
38.56 , 22.57
38.58 , 21.23
3.439       0.075       -0.747       0.012       6.8
```

The first line gives the number of zones (2). The first line for each zone gives the identification code and the number of vertices. There follows a series of latitude/longitude pairs for each vertex. The last line gives a-value, standard deviation of a-value, b-value, standard deviation of b-value, and maximum magnitude.

16.5 Other actions

Selecting the option "Print Report" from the "Actions" menu prints out the information displayed on the form, together with the zone geometry and a breakdown of the events observed by magnitude (only for events with magnitude > 3). An analysis of the depth distribution is also printed. To aid identifying the printout, enter a name for the zone in the yellow box at the bottom of the window. The name will appear on the printout. The default name is "Zone X" where X is 1 for the first zone you create, 2 for the second and so on. You can change this to something more meaningful for each zone.

You can have zones within zones. You should always enter the larger zones (background zones) ahead of the smaller (contained) zones. When you create the containing zone, the program will give you information on all the earthquakes within it (obviously, since the enclosed zones haven't been entered yet). If you then create some smaller zones within the larger one, and then revisit the

containing zone (right click as above) you will get data concerning the earthquakes in this zone excluding those parts apportioned to other zones. The area reported will also exclude contained zones.

The "Actions" menu contains two options labelled: "Print earthquakes" and "Save to file". The first of these prints out a list of the earthquakes within the current zone to a printer. The second allows you to save the list of earthquakes in the zone in a file. Wizmap automatically adds a Wizmap-style header line to the file so that you can read it in again at a later date. The format used for these files is standard, and not necessarily the format of the original data file that you read in.

Since a data file saved in this way includes only the events in the zone considered to be valid according to the current operative filter, this is a useful way of compiling selections of data from a larger file that meet specific magnitude/depth/time/location constraints. For example, by putting a zone round a political boundary you could save a file containing all events in Hungarian territory of magnitude greater than 4 and depth less than 20 km since 1970.

17. Marking the map

Sometimes it's useful to be able to mark a reference point on the map while you are working. For example, you might want to mark the epicentre of an earthquake that has just occurred, or a site of interest. You can do this with the toolbar button marked with a star. Click this and you will see the button depressed (darker). Now, each time you click on the map, a little gold star will appear in the spot you clicked on. To stop adding stars, click the toolbar button a second time. Because the exact position of the mouse pointer is always reflected in terms of latitude and longitude in the tool bar, you can position your marks quite accurately. Alternatively, in the Options menu you will find an option labelled "Type in marks". If you select this, then the behaviour of the program changes. To start making marks, click on the star button as before. Now, each time you click on the map, a box will pop up asking you to type in the exact latitude/longitude for the mark. (It doesn't matter where you clicked).

The stars are persistent until (a) you select the "Clear" option from the Files menu; (b) you select the "Clear marks only" option from the Files menu, which gets rid of all the marks but leaves everything else intact; (c) you exit the program.

The maximum number of marks is 1000. You can't save them to a file, and you can't delete individual marks. (Typically you only want one or two, so this shouldn't be a problem).

However, it is possible to load marks from a file, should you wish to use this option to display miscellaneous point data such as stations in a seismic network. Each mark has a 20-character identifier, which can be read in, from the file; the format has already been described. Points can be identified in the same way as earthquakes or intensity points, but first you have to toggle the "Identify marks" entry in the Options menu. When this is checked, when you select the identify tool and click on the map, the details of the nearest mark will be displayed. If there are no marks, you won't get anything, of course.

If you enter new marks by typing, you have the option of typing in an identifier. If you enter new marks by pointing and clicking, the mark created will have an identifier of the form "* User n" where n is the ordinal number of the mark.

You can combine marks from a file with new marks, and, in fact, you can display multiple mark files, unlike earthquake files, so long as you don't overflow the 1000 mark limit.

There are two styles of mark: gold stars and silver triangles. The intention is that marks loaded from file (with proper place names or station names) will display with silver triangles, and ad hoc marks will display as gold stars. However, you can alter this if you want to use the two symbols for two different point data types. If the identifier begins with a "*" character, the mark will show as a star, otherwise a triangle. So you could show a file of stations as triangles by having the identifiers as EDU, EBL, etc, and another file of towns as stars by having the identifiers *Dundee, *Forfar, etc.

Note that all new marks made show initially as stars, even if you type in identifiers without the leading "*". When the map is next redrawn, the marks will change to the correct type.

18. Measuring distances

Often one would like to know how far two places are apart, but putting a ruler on a map is a very inaccurate way of trying to find out. Wizmap II gives you an accurate ruler. The task is accomplished through the Options menu. Select the item "Marks show distance". Now make a mark on the map, as described in the previous section. You will now find that as you move the pointer around the map, a line drags from the mark to the pointer location, and a box is displayed near the mark from which you can read the great circle distance between the mark and the pointer location, in kilometres. Note that the distance you are measuring does not actually run along the line drawn (because the line is not a great circle).

If you click on the map again, you will make a second mark and distance measuring will be terminated. If you now make a third mark, distance measuring will start again, this time with the new mark as reference point.

If there are already marks on the map, as soon as you toggle the marking button on, you will start measuring distances from the last-made mark to the pointer location.

To stop measuring distances without making a further mark on the map, click a second time on the marking button on the toolbar.

19. Plotting great circle routes

A handy function of the original Wizmap program was the ability to plot travel paths (i.e. great circle routes) from an earthquake to different stations. You can now do something like this in Wizmap II. In the Options menu, select the item "Marks show great circles". Now, whenever you start making marks on the map, great circle routes will be shown as red lines between the first mark made and any subsequent marks.

If the map already has marks made on it when you turn this option on, the routes will be displayed the next time the map is redrawn (just resize the window slightly to trigger this).

You can get rid of the great circles by selecting one of the other marking options, but again, the change won't take effect until the map is redrawn.

20. Drawing circles

Wizmap II also has the ability to plot circles of a given radius on the map. On the toolbar there is a button marked with a circle at the extreme right, which brings up a dialogue box. The default option is to type in a latitude, longitude and radius and the circle will be plotted. You can only have one circle on the map at the time, but it will persist unless either you clear the marks or plot another circle.

The second option is to estimate likely isoseismals for a notional earthquake. In this case you still type in latitude and longitude but a magnitude instead of a radius. The parameters used for estimating intensity are shown and can be edited. The default values are intended to be appropriate for general (approximate) use conditions in regimes such as the Mediterranean, for surface wave magnitude and EMS intensities (European Macroseismic Scale, EMS-98).

21. Troubleshooting

Whenever you exit Wizmap, the settings you last used (position of the window on screen, and so on) are stored in a file called WizmapISC.ini, which is in your Windows (or Winnt) directory. Some users of regular Wizmap have reported cases of Wizmap crashing on start-up and the reason appears to be invalid values being written to this file. This seems to have occurred principally when Wizmap was closed in a maximised state, and this problem should now be fixed. However, if it still occurs, the solution is just to delete WizmapISC.ini, and the program should then run.

As previously mentioned, Wizmap will not run if your PC has international settings such that a comma is used for the decimal separator.

Efforts have been made to improve the stability of this version of Wizmap, and certain actions that formerly caused the program to crash now no longer do so.

Any problems should be reported to R.Musson@bgs.ac.uk.

22. References

Musson, R.M.W., 1980. WIZMAP: A user's guide, IGS Global Seismology Unit Report No 134.

Musson, R.M.W., 1998. A self-parsing file format for earthquake catalogue and data files, Seismological Research Letters, vol 69 no 3, pp 248-250.

23. Figures

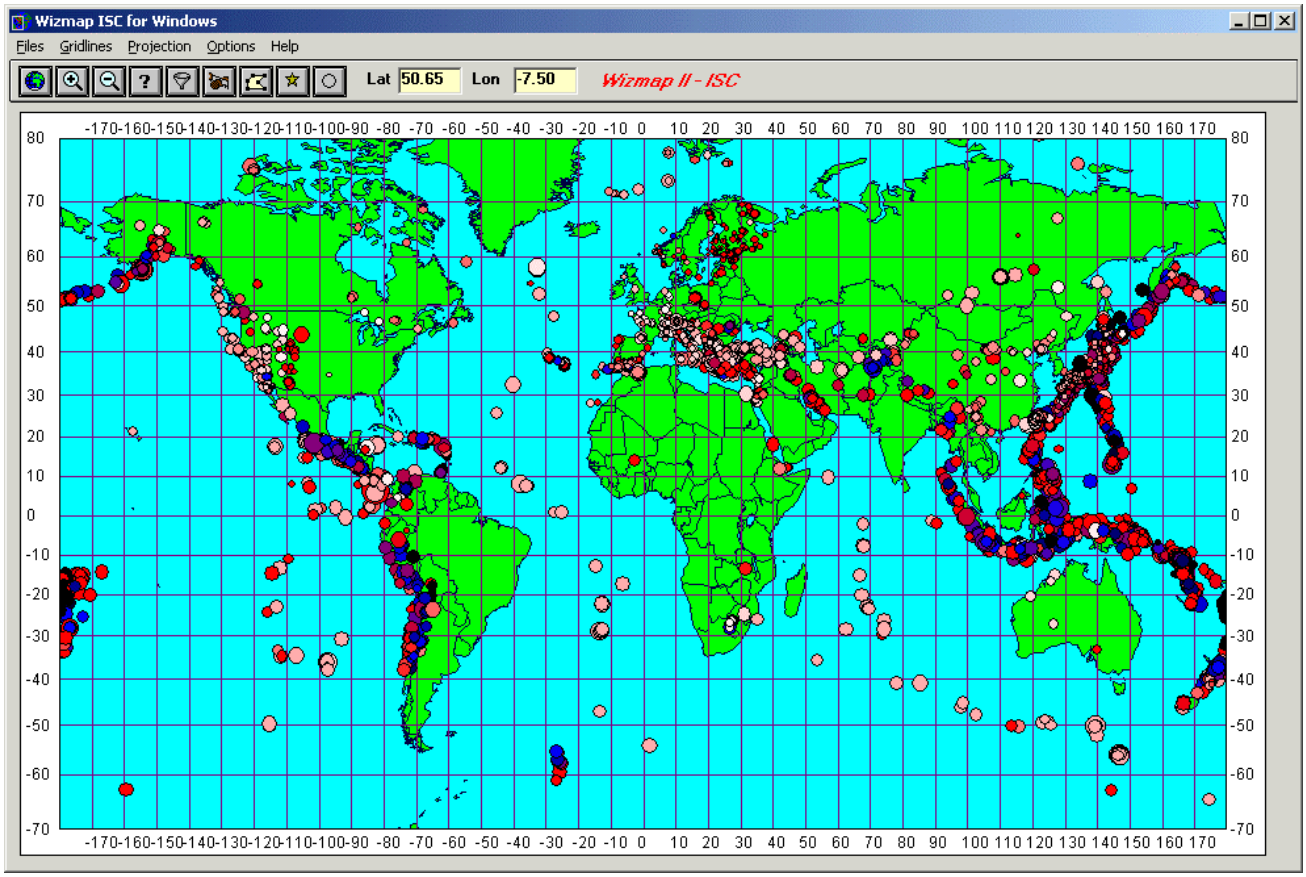

Figure 1

The Wizmap main screen, showing a complete world map of seismicity for the month of December 1999. The tool bar buttons, from left to right, have the following effects:

Globe	Set map edges
Plus	Start zooming in (click in map window to define new area)
Minus	Zoom out to previous view
Question Mark	Start identifying earthquakes (click on epicentre)
Funnel	Set filter for earthquake data
Saw	Do cross section
Polygon	Draw polygons on map
Star	Make marks on map
Circle	Draw circle on map

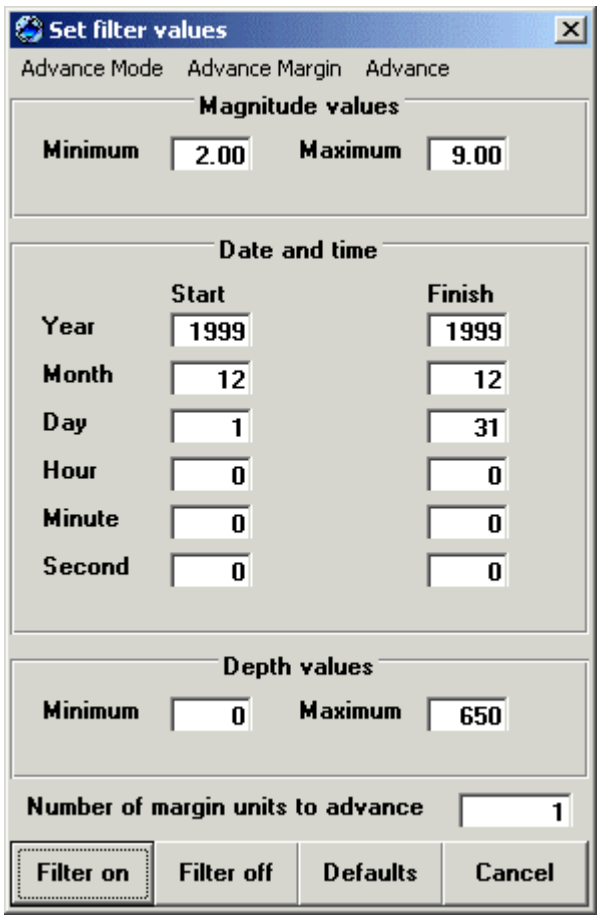

Figure 2
The filter form.

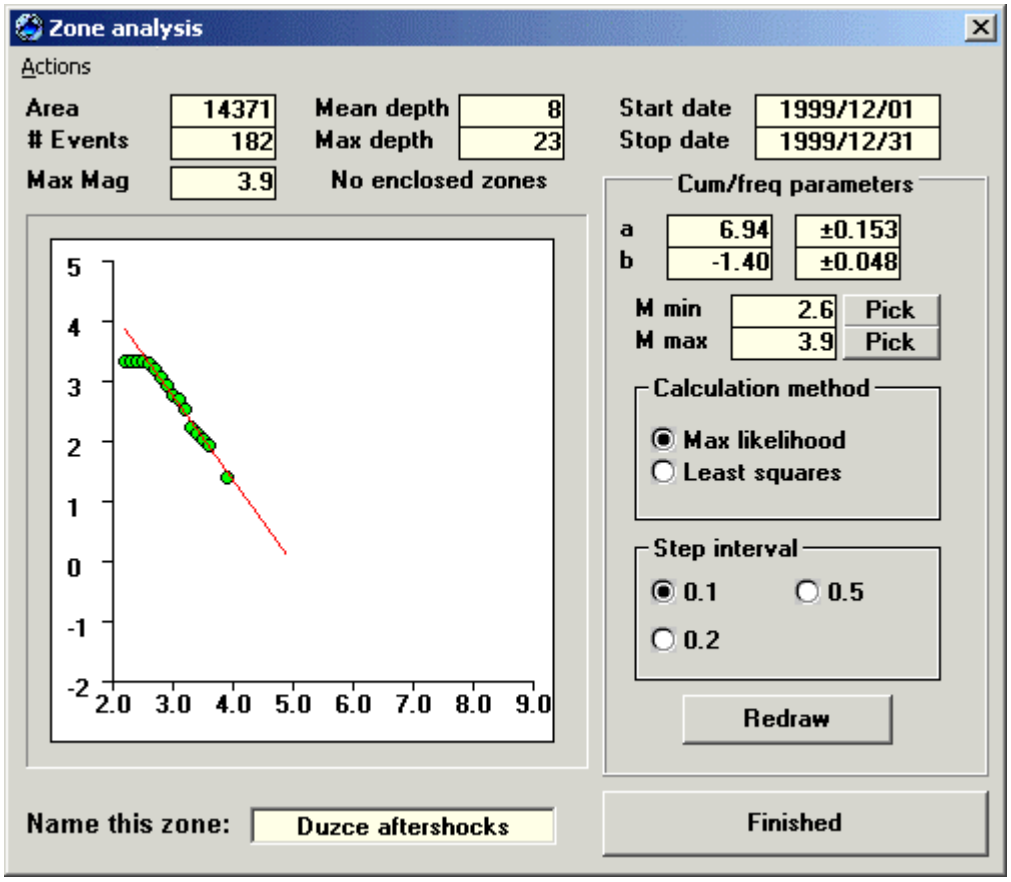

Figure 3
The zone analysis form. used in this case for examining events around Duzce, Turkey, in December 1999. Note that the minimum magnitude has been set by hand to counter incompleteness roll-off in the magnitude frequency plot below magnitude 2.6.