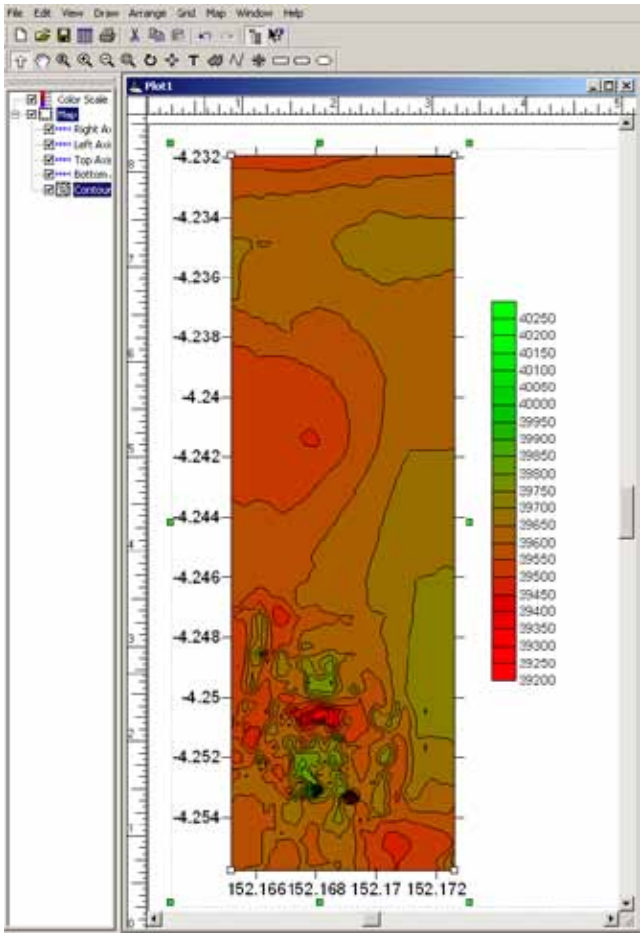
Magnetometer How to do it Manual No. 1: How to create a contour plot

Jeremy Green



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Introduction
This how to do it paper deals with how to capture magnetic field intensity data from an ELSEC 7760 and converting the magnetometer output file to a contour plot. It assumes that the data comes from the Sea Scan PC program, it is then formatted in Microsoft Excel and then converted to a contour plot in either Surfer or ArcMap.

Planning
When planning a mag survey it must be remembered that ideally the survey area should be rectangular, with sides north–south. All the contour conversion programs rely or assume that the survey area is going to be rectangular and will then attempt to try and fill any area that has not been covered in the survey, usually quite incorrectly as there is no real data for the area. So, ideally, the survey area must conform as much as possible to a rectangle. It may be that it is not possible to make the rectangle north–south, so one could process the data so that it was rotated to the north–south orientation, create the contour plot and then rotate the contour plot back to its true orientation in a GIS. This would be quite difficult, requiring complex geometric formula to rotate X Y data. So, for simplicity, work on a north–south grid.

Data capture
Operational arrangement requires the deploying of the ELSEC 7706 magnetometer and fish and a Garman Plus GPS. The software to collect the data is Sea Scan PC, usually used with a side scan sonar; so this operation may or may not be run in conjunction with the side scan fish. If side scan is being used, then the desk-top PC must be used, if it is not then it is possible to operate the system on a laptop, either a Mac (running Bootcamp), or a PC. In either case it is necessary to have two Keyspan adapters to convert the RJ11 communications to a USB connection. The Keyspan enables the USB port to become a COMS1 or COMS2 port that can then be seen by the Sea Scan PC software.

One should note that the Keyspan adapters, when plugged in, usually become COMS5 or higher, so that they need to be mapped to COMS1 and COMS2. To do this start Windows, Right Click (RC) Start button and select Explore. RC My Computer and select Properties. Select Hardware, then Device Manager, and Ports (COM & LPT). Insert the Keyspan into the USB port and note what the COM port setting it is attributed to. If it does not default to 1 to 4, you will need to map the device.

RC the device and select Port Settings. You should be able to set the device to Port to 1 or 2. It is possible that you may not have that option and the port may be 3 or 4. If it is 3 or 4 you should be able to see that in the Sea Scan PC settings, so you will be OK. Remember, the Mag has an output 9600,7,E,1 and the GPS 4800,8,N,1 (the GPS communications settings are fixed, the Mag can be changed but should never be changed). So when mapping the COMS ports, using the Port Settings its worth setting this at the same time remembering which COMS goes to which device.

Start Sea Scan PC without the Mag or the GPS connected. Ensure that the Mag and the Navigation are assigned to the right ports with the right communication protocol. Plug in the GPS and the mag. With luck the GPS should start showing navigation data in the top window and the Mag should start showing numbers on the pane above the mag trace.

Troubleshooting:

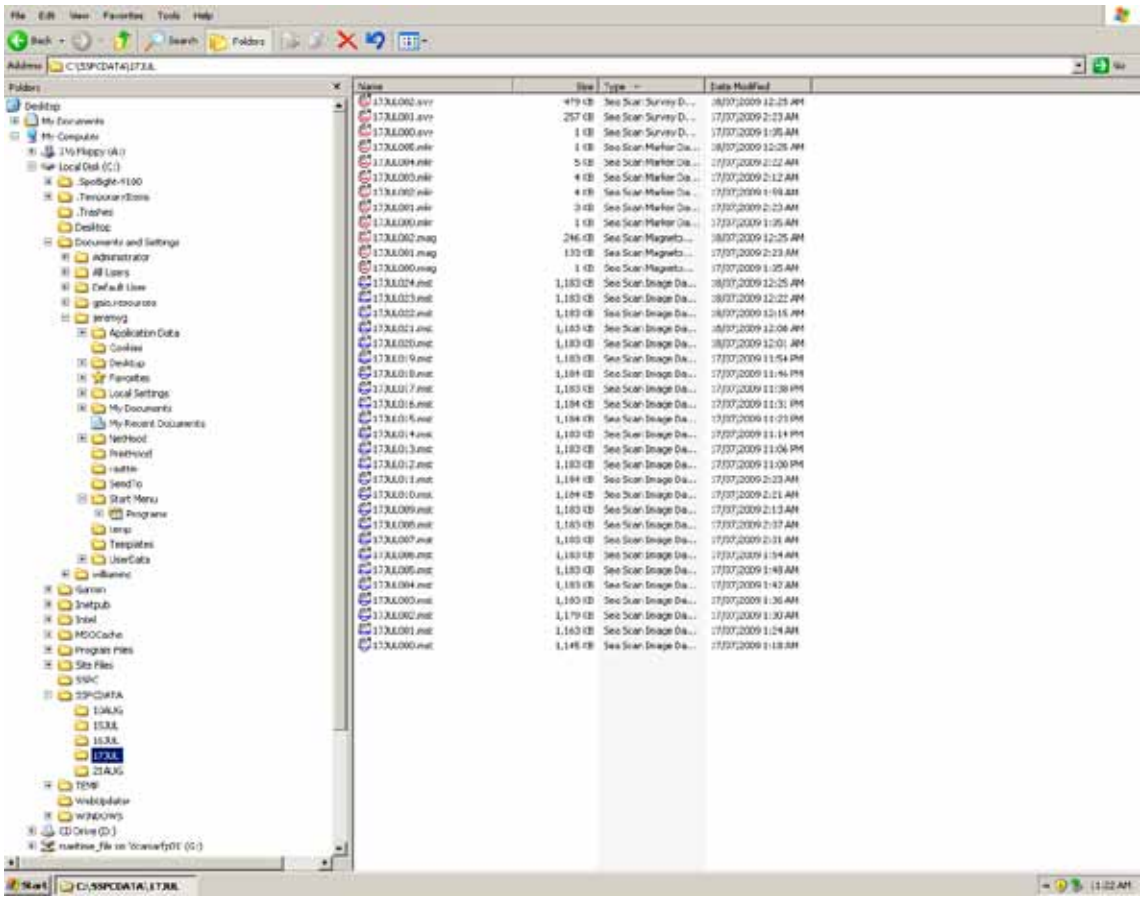
1. The mag trace on right of Sea Scan PC does not appear: In External, Magnetometer ensure that Mag is not turned off and that the ASCII button is activated.
2. Not recording mag data: In Options, Settings, Survey File Options ensure MAG Magnetometer is checked.
3. No NMEA Nav Data: In Garmin, scroll through to Settings, Interface and ensure that settings are set to NMEA/NMEA. Check that the baud rate on the Sea Scan PC is set correctly and that the correct COMS port is selected.
4. Data not coming through either on the GPS or on the Mag: In External select device (Mag or Nav) and use Test Settings. If no data then there is a problem with device or connecting cable. If garbage on screen then the protocol is incorrect and you need to check that correct baud rate, data bits, parity and stop bits are set correctly.
5. Data problem with Sea Scan PC: Close Sea Scan PC, restart computer and see if problem still occurs. If it still occurs, close Sea Scan PC, open Hyperterminal and see if, with the correct

communications settings (9600,7,E,1 or 4800,8,N,1) there is data emerging from external device. No data, then its a cable problem, something has come loose on the Mag or the GPS is set incorrectly.

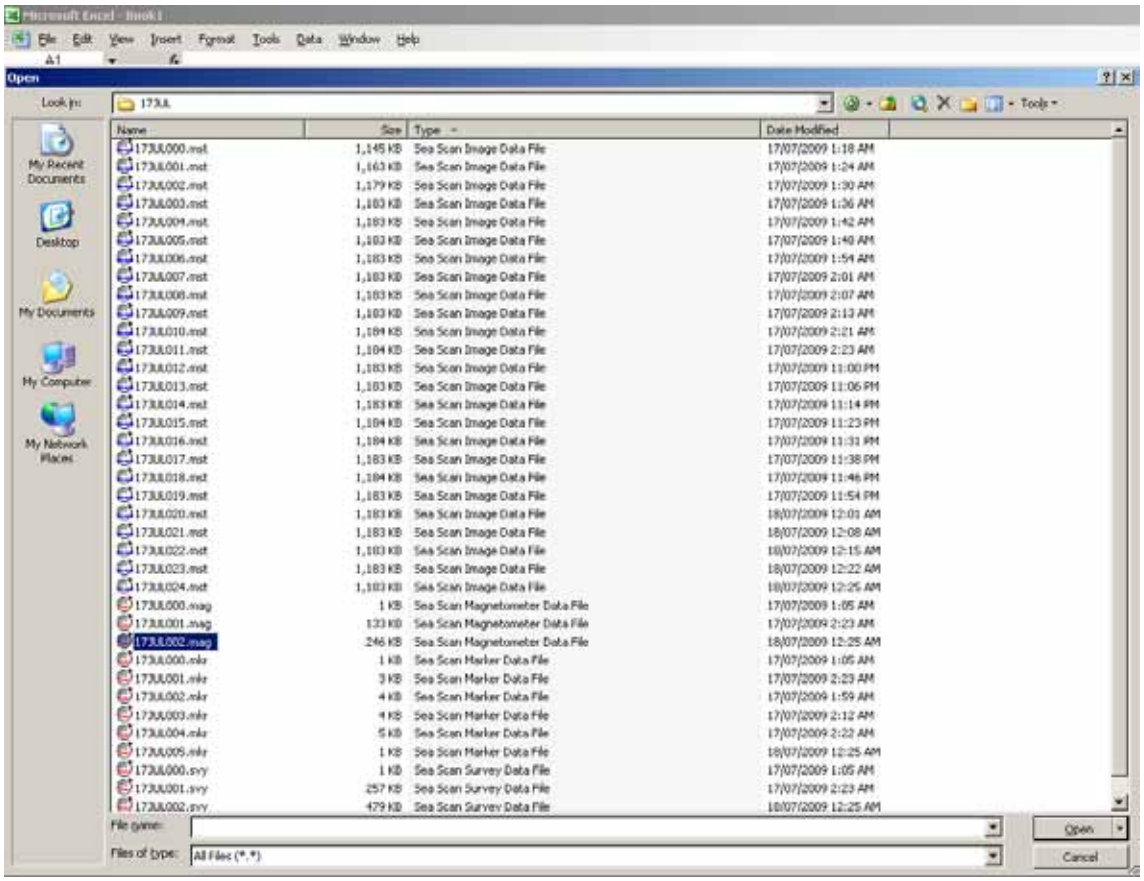
6. Mag trace not happening: The Power button (top left) must be on (red) to see the trace. If you still cannot see the trace, but numbers are appearing in the box above the trace, double click the number between the red figure and the blue figure. This centres the trace.
7. Mag trace keeps disappearing: Select a large blue trace figure and a small red trace, about 100 time the small for the big. Select the high resolution (red) to give a reasonably good trace in a quiet area (1 or 2 nT so you can see small noise variations without trace disappearing off the chart). Then when a target appears, the red will run off the scale, but the blue will show the large target. You can change the scales on the fly and keep double clicking the mag number to centre the trace.
8. Use the Plotter window to set up the grid square you want to search, use this to control the track of the vessel, but do not deviate from the planned track to investigate targets. Ensure you use reasonable search lanes, 20 metres is about the best you can achieve and ensure you have enough time to search the whole area. You can mark targets by double clicking the mag trace and this will produce M-markers on the plotter. You will need to post-process the data immediately after the end of the survey. Compare this with the visual targets.

Post-processing

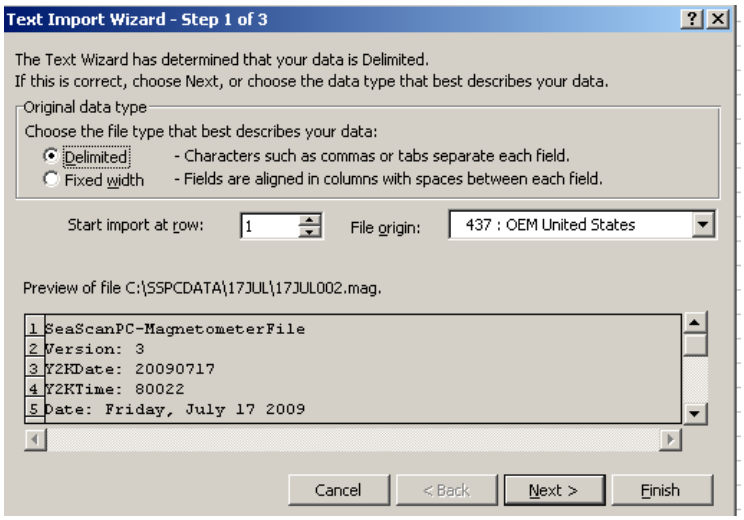
If you look in the SSPC data folder you will find that Sea Scan PC has generated a folder that is dated by day and month (ie 17JUL) of your survey (assuming you have set the clock correctly). Inside will be all the data files. Sea Scan PC saves four types of files: .mst which are the sonar files, .mkr which are the marker files where you will find the M-markers, .mag which are the magnetometer files and .svy which are the track file (the track file also has the mag data so you can use either).



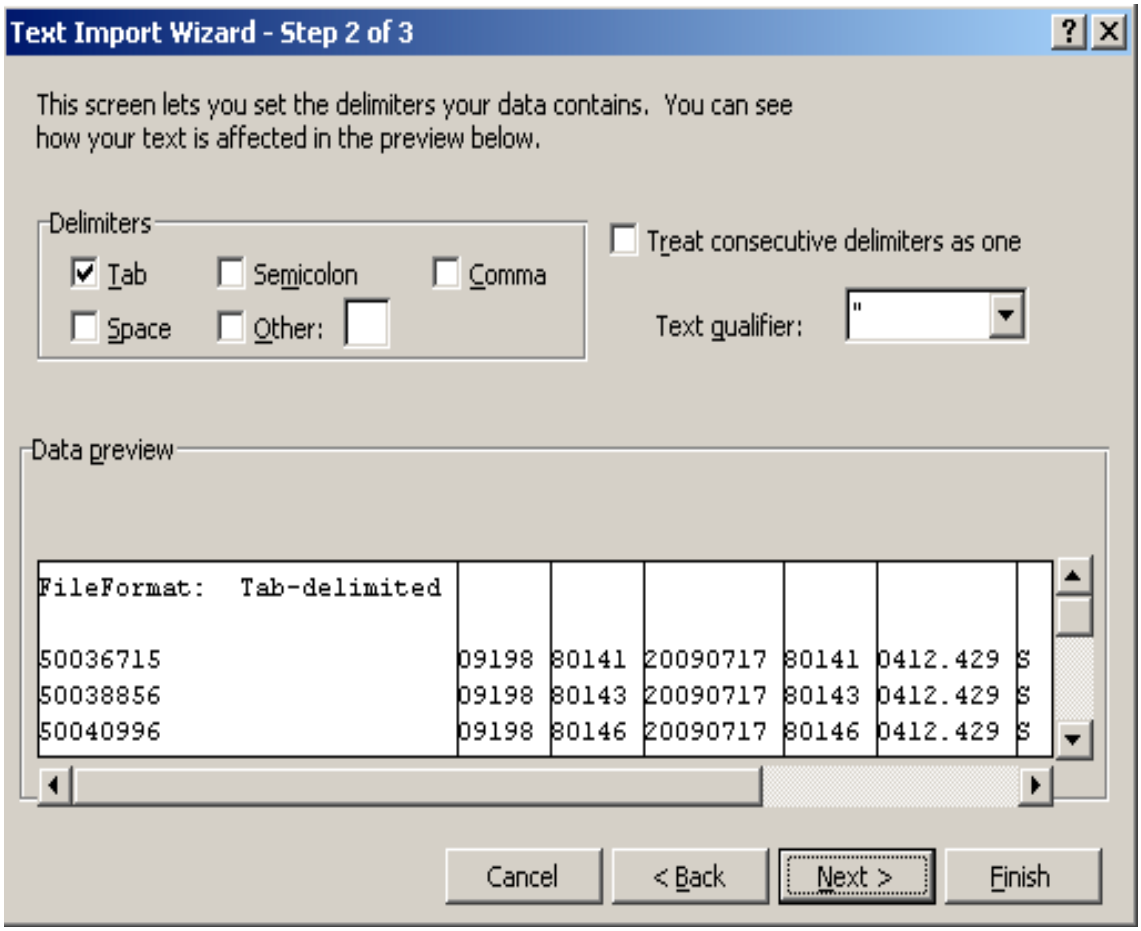
Because SSPC data files are in an odd format you need to convert them so that they can be used in other programs (ArcView, or Surfer). This requires you to open the file in Excel, so that we can manipulate the data to conform with the programs. To open the .mag file in Excel you select the following, note using the Files of Type All Files so you can see the Mag file:



Click on Open and it will start out with the first window which will look like this:



This tells you that you have a nonstandard text file. Click on Next and you will get this screen. As you can see if you scroll downward that the Tab Delimiter has recognised the field boundaries for the data.



Click on Finish and you will get the data output on a spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K
1	SeaScanPC-MagnetometerFile										
2	Version: 3										
3	Y2KDate: 20090717										
4	Y2KTime: 80022										
5	Date: Friday, July 17 2009										
6	Time: 22:13:42 (GMT)										
7	SysTime: 49918953										
8	DataMode: ACTIVE										
9											
10	TimeStamp: SysTime Julian Y2K										
11											
12											
13	FileFormat: Tab-delimited										
14											
15	50036715	9198	80141	20090717	80141	412.429	S	15210.63	E	0.00*	
16	50038856	9198	80143	20090717	80143	412.429	S	15210.63	E	40185.00*	
17	50040996	9198	80146	20090717	80146	412.429	S	15210.63	E	40611.00*	
18	50043137	9198	80148	20090717	80148	412.43	S	15210.63	E	40245.00*	
19	50045293	9198	80150	20090717	80150	412.43	S	15210.63	E	40145.00*	
20	50047434	9198	80152	20090717	80152	412.43	S	15210.63	E	39855.00*	
21	50049574	9198	80154	20090717	80154	412.43	S	15210.63	E	39928.00*	
22	50051731	9198	80156	20090717	80156	412.43	S	15210.63	E	39758.00*	
23	50053871	9198	80158	20090717	80158	412.43	S	15210.63	E	39623.00*	
24	50056012	9198	80161	20090717	80161	412.43	S	15210.62	E	40604.00*	
25	50058153	9198	80163	20090717	80163	412.43	S	15210.62	E	39901.00*	
26	50060309	9198	80165	20090717	80165	412.43	S	15210.62	E	39900.00*	

This Excel sheet shows the header data, the first 14 rows, and then the main data. You need to delete the header data and leave one blank row at top of primary data to insert field headings.

File Edit View Insert Format Tools Data Window Help

G2 =-1*(4 + (RIGHT(F2,LEN(F2)-1)/60))

	A	B	C	D	E	F	G	H	I	J	
1							LAT		LONG		MAG
2	50038856	9198	80143	20090717	80143	412.429	-4.20715	15210.63	E	40185.00*	
3	50040996	9198	80146	20090717	80146	412.429	S	15210.63	E	40611.00*	
4	50043137	9198	80148	20090717	80148	412.43	S	15210.63	E	40245.00*	
5	50045293	9198	80150	20090717	80150	412.43	S	15210.63	E	40145.00*	
6	50047434	9198	80152	20090717	80152	412.43	S	15210.63	E	39855.00*	
7	50049574	9198	80154	20090717	80154	412.43	S	15210.63	E	39928.00*	
8	50051731	9198	80156	20090717	80156	412.43	S	15210.63	E	39758.00*	

You insert the LAT, LONG and MAG data in the columns where the calculated data will appear). I have inserted in Cell G2 the calculation for decimal degrees. Note, this is for the Latitude 412.429 which is 4°12.429. You will have to make adjustments depending what the Latitude in your area is.

Microsoft Excel - 17JUL002.mag

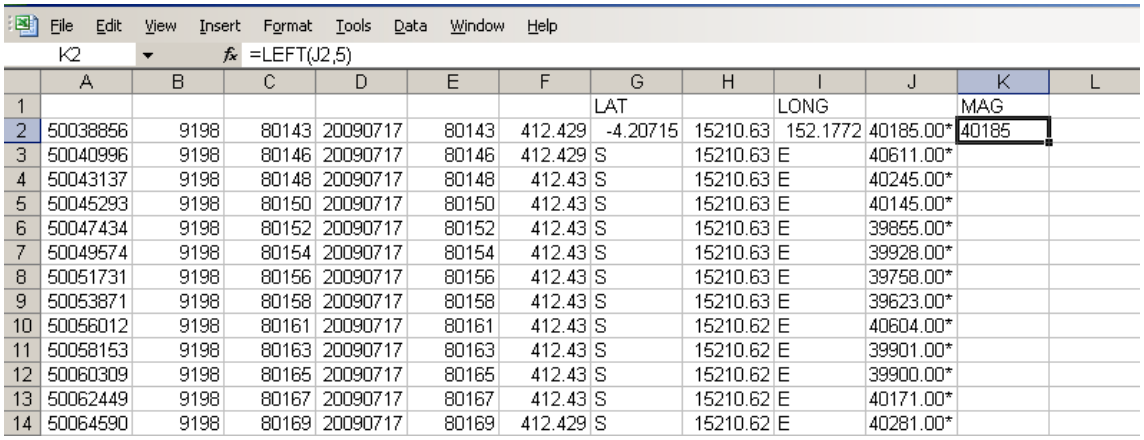
File Edit View Insert Format Tools Data Window Help

I2 =152+(RIGHT(H2,LEN(H2)-3)/60)

	A	B	C	D	E	F	G	H	I	J	K
1							LAT		LONG		MAG
2	50038856	9198	80143	20090717	80143	412.429	-4.20715	15210.63	152.1772	40185.00*	
3	50040996	9198	80146	20090717	80146	412.429	S	15210.63	E	40611.00*	
4	50043137	9198	80148	20090717	80148	412.43	S	15210.63	E	40245.00*	
5	50045293	9198	80150	20090717	80150	412.43	S	15210.63	E	40145.00*	
6	50047434	9198	80152	20090717	80152	412.43	S	15210.63	E	39855.00*	
7	50049574	9198	80154	20090717	80154	412.43	S	15210.63	E	39928.00*	

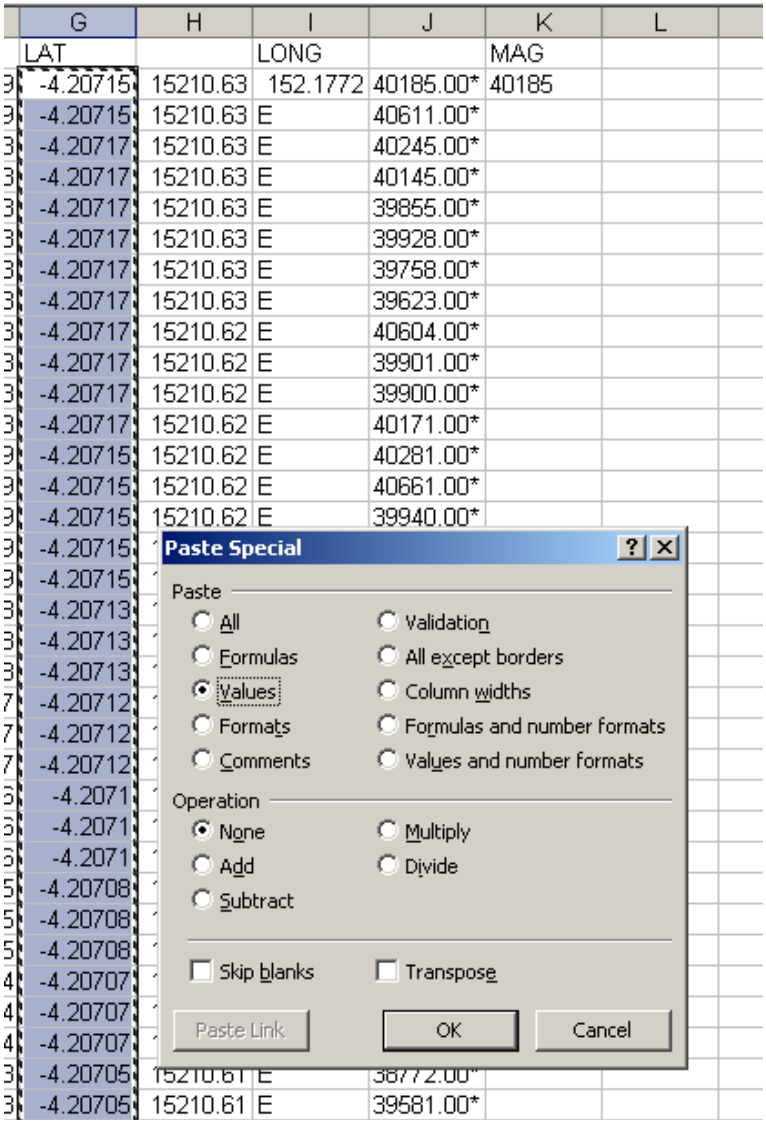
Note when creating a calculation you start the calculation with the equals sign, so it works like this: firstly, the decimal degrees is going to be negative in the southern hemisphere, so the whole

calculation, (inside the bracket) is multiplied by -1. Next the latitude in degrees is unlikely to change over the survey area so in this case the integer of latitude will be 4 (note it could be more than 9 which will change the calculation, see below). So inside the bracket we have the integer of degree and then a calculation where we want to remove the integer of degrees, giving decimal minutes and divide the that by 60 to give the calculation for what minutes are in decimal degrees, this is added to the integer degrees. The calculation works out the characters to the RIGHT for a given number. So F2 is the number we want to work on and we calculate the number of characters in F2 which is LEN(F2) and subtract 1 because we want to remove the firs digit 4. In the case where the latitude is 10 or more we would use LEN(F2)-2 to remove the two digits. Thus for latitude the calculation is -1*(RIGHT(F2,LEN(F2)-1)/60) and longitude it is 152+(RIGHT(H2,LEN(H2)-3)/60).



	A	B	C	D	E	F	G	H	I	J	K	L
1							LAT		LONG		MAG	
2	50038856	9198	80143	20090717	80143	412.429	-4.20715	15210.63	152.1772	40185.00*	40185	
3	50040996	9198	80146	20090717	80146	412.429	S	15210.63	E	40611.00*		
4	50043137	9198	80148	20090717	80148	412.43	S	15210.63	E	40245.00*		
5	50045293	9198	80150	20090717	80150	412.43	S	15210.63	E	40145.00*		
6	50047434	9198	80152	20090717	80152	412.43	S	15210.63	E	39855.00*		
7	50049574	9198	80154	20090717	80154	412.43	S	15210.63	E	39928.00*		
8	50051731	9198	80156	20090717	80156	412.43	S	15210.63	E	39758.00*		
9	50053871	9198	80158	20090717	80158	412.43	S	15210.63	E	39623.00*		
10	50056012	9198	80161	20090717	80161	412.43	S	15210.62	E	40604.00*		
11	50058153	9198	80163	20090717	80163	412.43	S	15210.62	E	39901.00*		
12	50060309	9198	80165	20090717	80165	412.43	S	15210.62	E	39900.00*		
13	50062449	9198	80167	20090717	80167	412.43	S	15210.62	E	40171.00*		
14	50064590	9198	80169	20090717	80169	412.429	S	15210.62	E	40281.00*		

For the Mag data the calculation is quite simple LEFT(J2,5) because the data is always fixed length.



Having created the formula in each of the cells, you now select each cell in turn (one at a time) and scroll down to the last cell in the column and SHIFT Click so all the cells in the column are selected, as above. You the use CONTROL D to paste values in each of cells. You then COPY all cells and the select PASTE SPECIAL and select VALUES. This then pastes the values of the calculations of the formula into the cells rather than the formula (see above). Do this for each of columns.

There is for some unknown reason a problem with the MAG data. You will see when you have done the Paste Special that the cells all have a little green triangles in the top left of the cell.

J	K
	MAG
40185.00*	40185
40611.00*	40611
40245.00*	40245
40145.00*	40145
39855.00*	39855
39928.00*	39928

This means that there is a problem with the cell because the mag donload puts an invisible character at front of data string. I will deal with this in a moment.

File Edit View Insert Format Tools Data Window Help

M8

	A	B	C	D	E	F	G	H	I	J	K
1					TIME		LAT		LONG		MAG
2	50038856	9198	80143	20090717	80143	412.429	-4.20715	15210.63	152.1772	40185.00*	40185
3	50040996	9198	80146	20090717	80146	412.429	-4.20715	15210.63	152.1772	40611.00*	40611
4	50043137	9198	80148	20090717	80148	412.43	-4.20717	15210.63	152.1772	40245.00*	40245
5	50045293	9198	80150	20090717	80150	412.43	-4.20717	15210.63	152.1772	40145.00*	40145
6	50047434	9198	80152	20090717	80152	412.43	-4.20717	15210.63	152.1772	39855.00*	39855
7	50049574	9198	80154	20090717	80154	412.43	-4.20717	15210.63	152.1771	39928.00*	39928

Firstly, get rid of the unnecessary columns. It is worth keeping the TIME (Column E) as it allows you to sort data in order that it was gathered at any point in future. So Columns A, B, C, D, F, H, J are deleted.

File Edit View Insert Format Tools Da

F9

	A	B	C	D
1	TIME	LAT	LONG	MAG
2	80143	-4.20715	152.1772	40185
3	80146	-4.20715	152.1772	40611
4	80148	-4.20717	152.1772	40245
5	80150	-4.20717	152.1772	40145
6	80152	-4.20717	152.1772	39855
7	80154	-4.20717	152.1771	39928

So the table now looks like this. Save the table with a new name Text File Tab deliminated. Reopen the table and the green triangles will have disappeared.

File Edit View Insert Format Tools Data

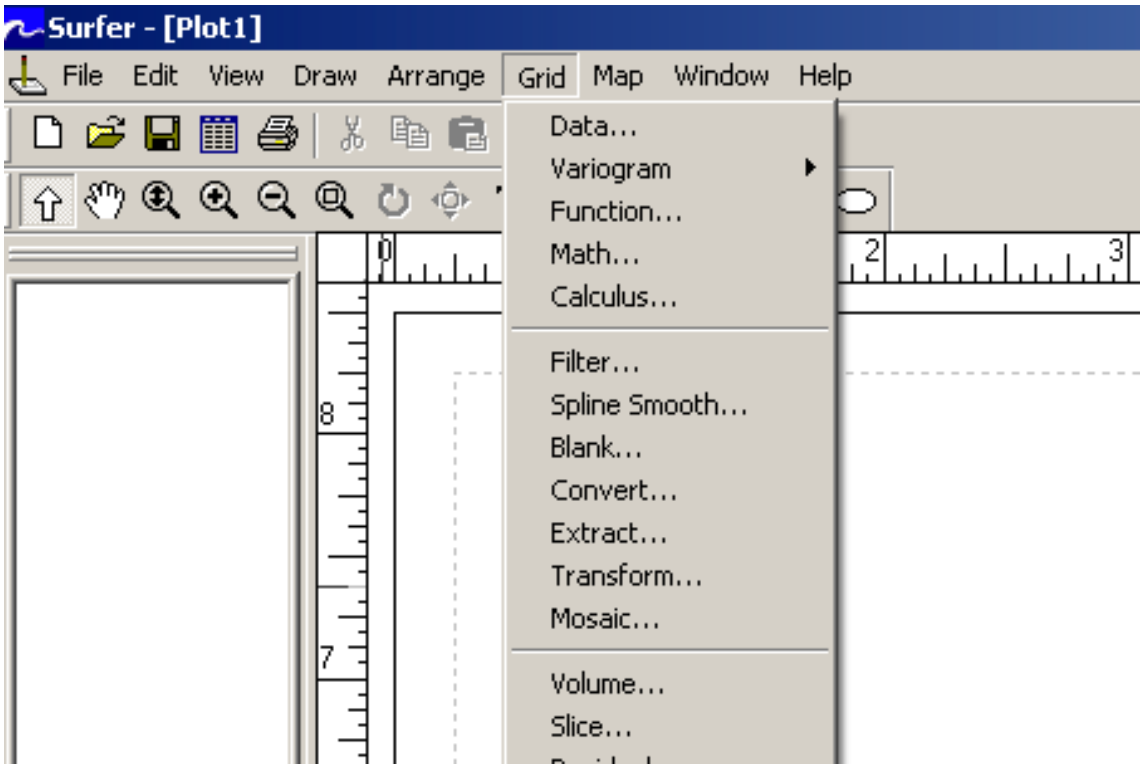
A1 fx TIME

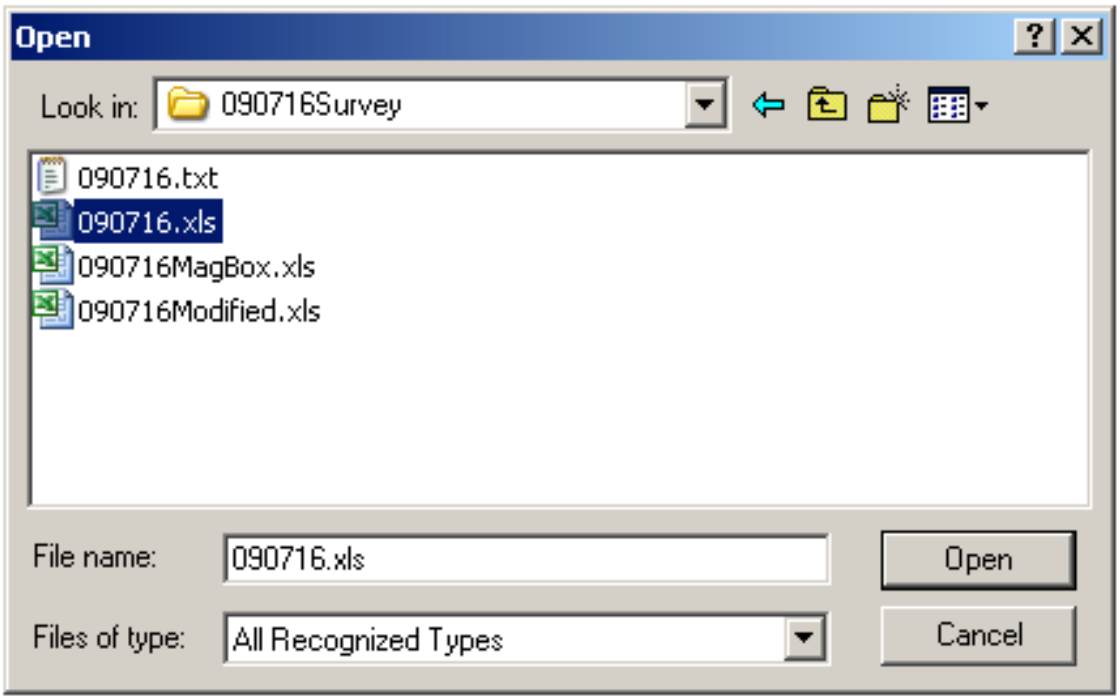
	A	B	C	D
1	TIME	LAT	LONG	MAG
2	80143	-4.20715	152.1772	40185
3	80146	-4.20715	152.1772	40611
4	80148	-4.20717	152.1772	40245
5	80150	-4.20717	152.1772	40145
6	80152	-4.20717	152.1772	39855
7	80154	-4.20717	152.1771	39928
8	80156	-4.20717	152.1771	39758
9	80158	-4.20717	152.1771	39623
10	80161	-4.20717	152.1771	40604

As shown above. You now have a decimal degree table that you could use as an XY event iem in ArcView. What we are going to do now is convert this table into a contour plot using Surfer.

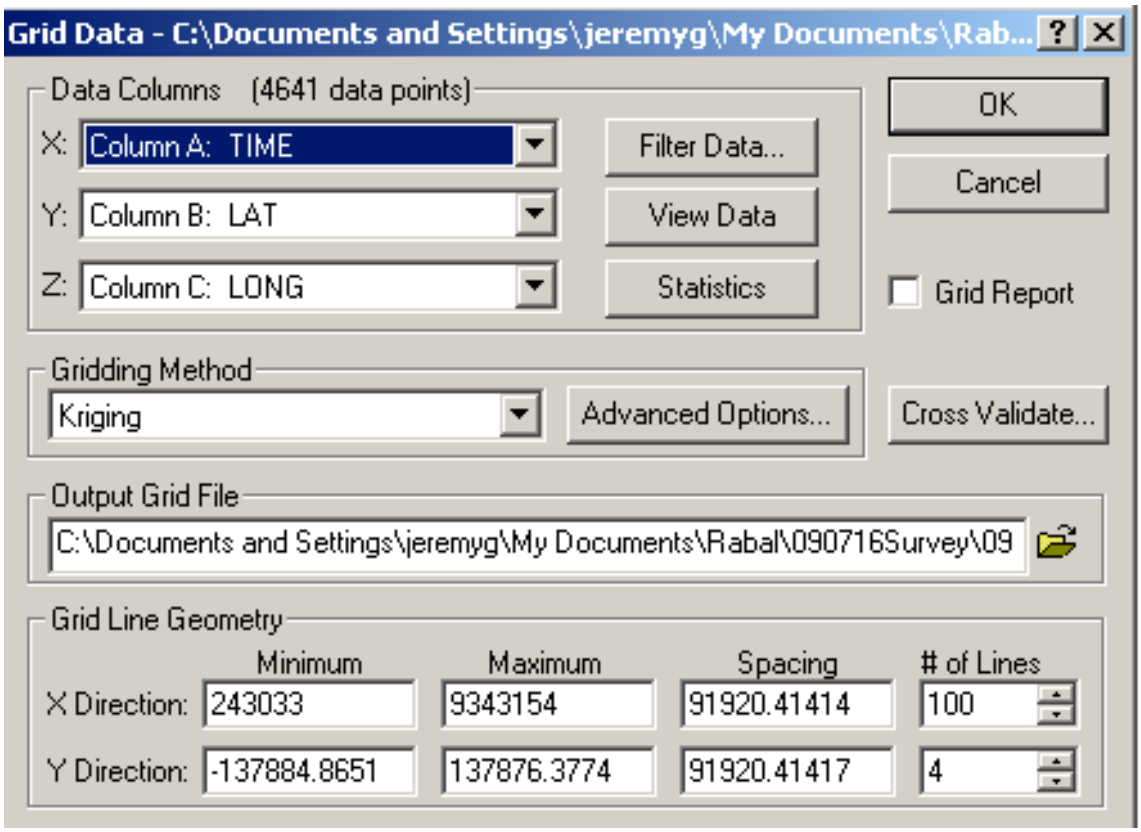
Arranging data import for Surfer

In Surfer open the file that you have saved the mag data. This can be a text file or an Excel spreadsheet, Make sure you open it in Grid/Data. and not as a file in File/Open.

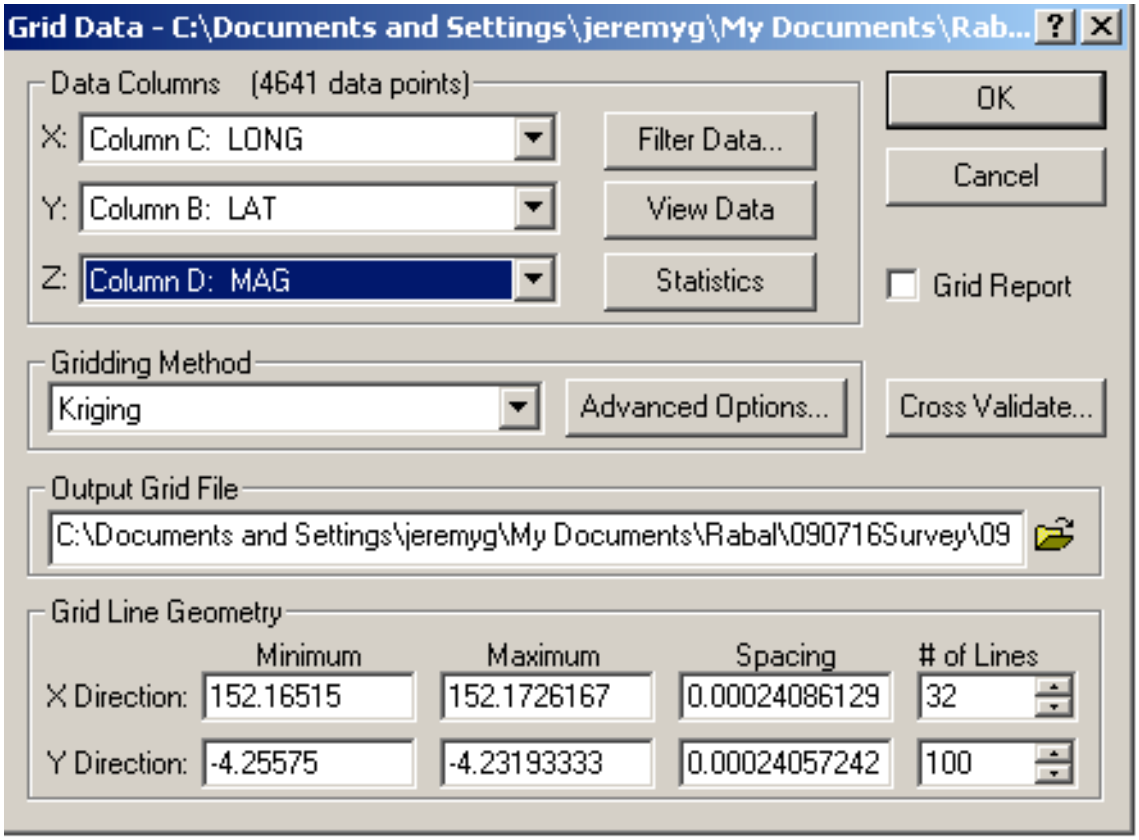




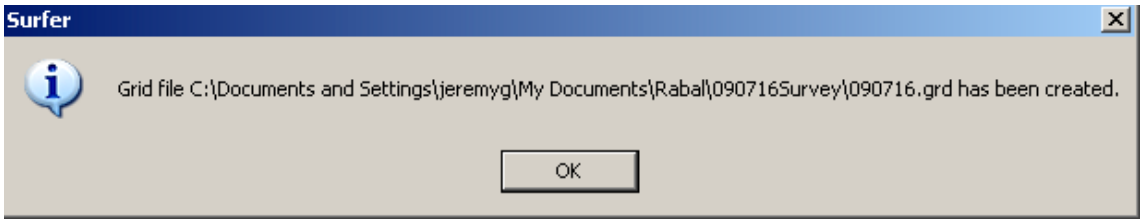
In this case we are opening 090716.xls.



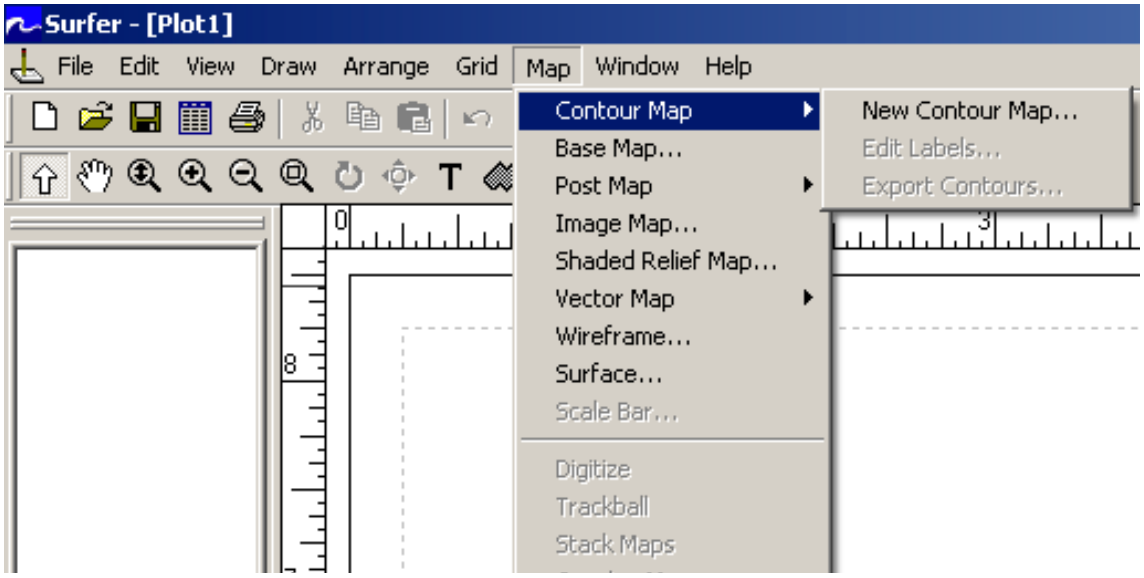
The dialog box opens with the data columns. You can see that the wrong columns have been selected, so change columns to match the X, Y and Z data.



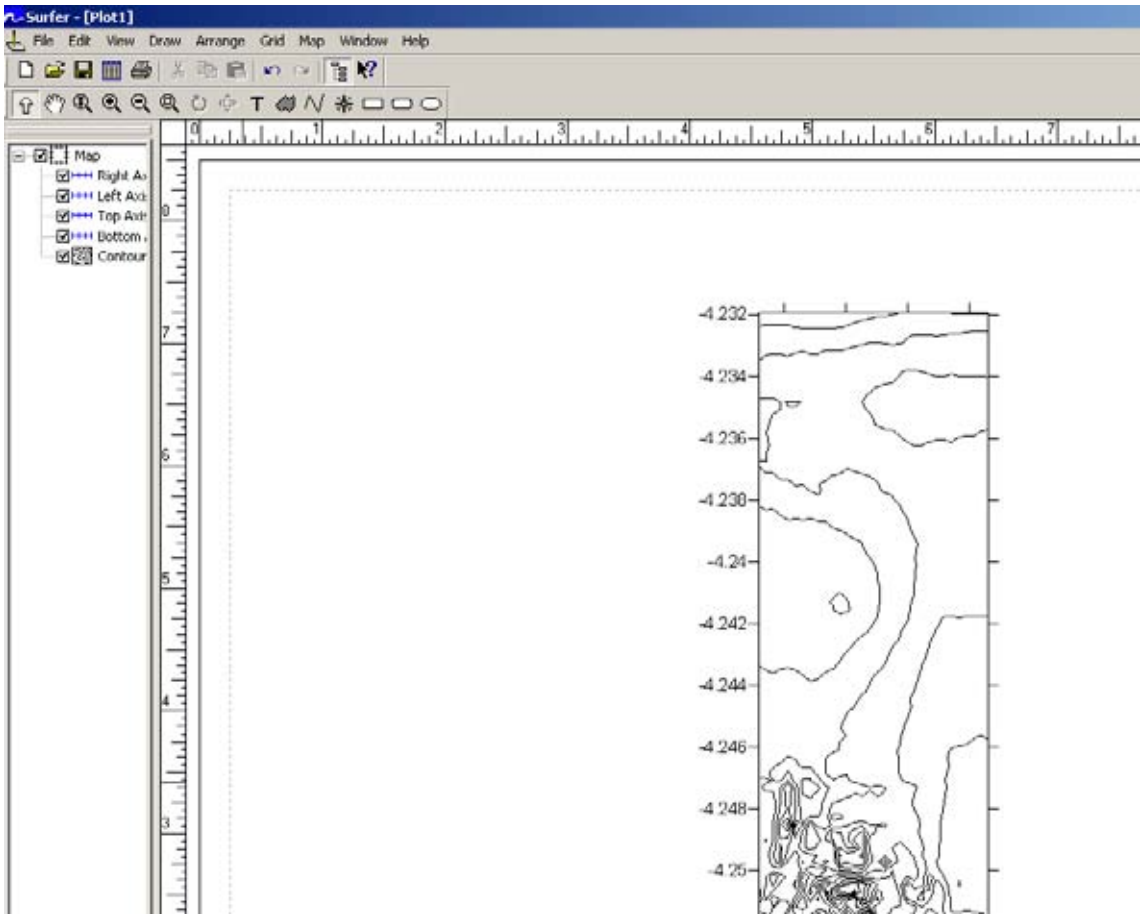
The data columns are now correctly allocated. Gridding Method should always be Kringing, but you can try other methods too.



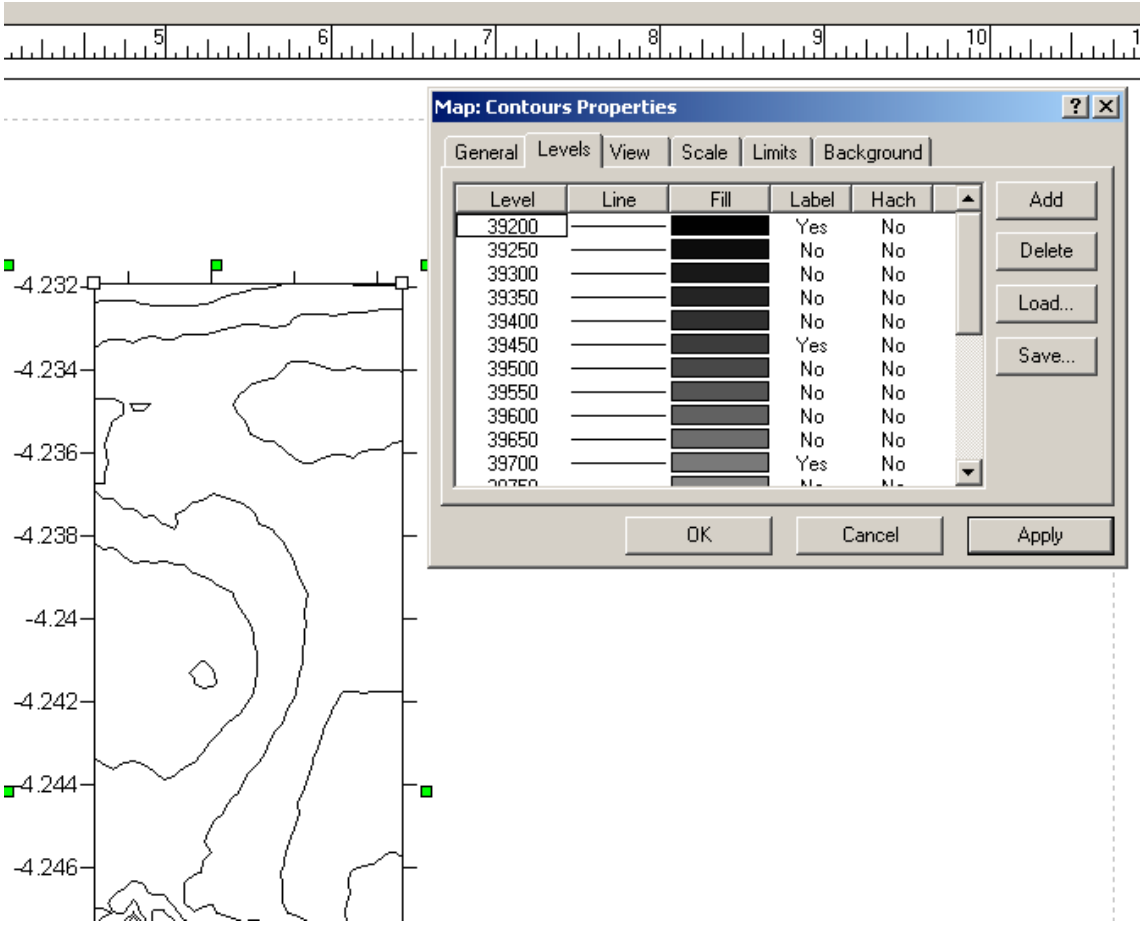
Click OK, this shows the file save dialogue.



Go to map, select contour map and open. It should give you a decent contour plan, provided everything is set OK.



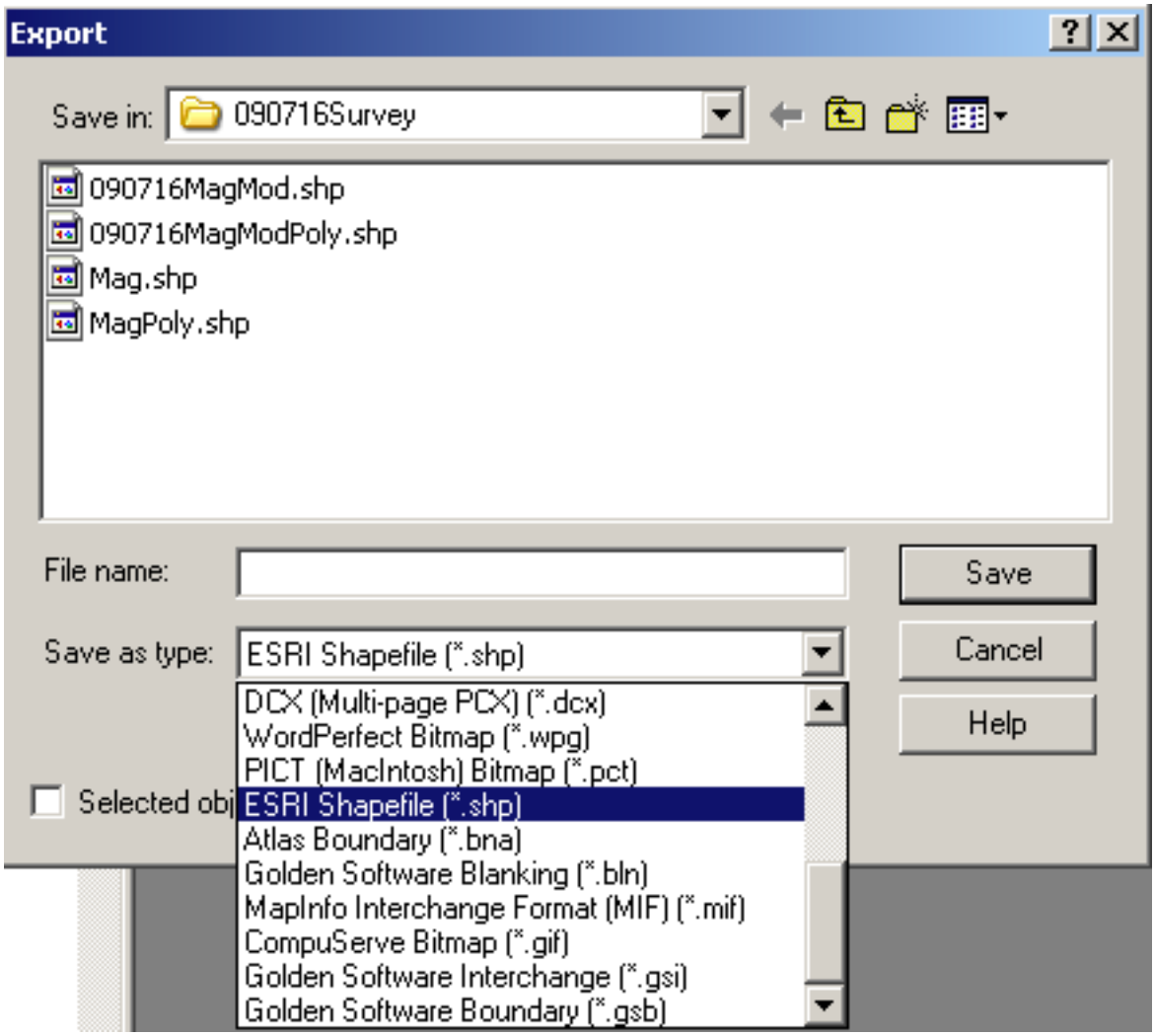
This shows the contour map produced. The only other thing you can do is make the contour fills pretty colours or adjust the contour intervals as shown in next figure.



Right click the contour map and select Properties. You can insert new Levels by selecting a particular level and then using the Add button. Its a bit tricky and you will need to play around a bit to get it right.

Exporting

If you are going to use the contour map in ArcView, then export it as a ESRI Layer file. The file will work quite simply in ArcView, there are two shape files a shape file and a polyline (eg: MAG.shp and MagPoly.shp). Use both. Also, these files do not come with the coordinate information attached, so in ArcCalalog, select the shape files and give the files the correct coordinate system (GDA94 of WGS84). Doing this will allow you to reproject the shape files into UTM.



Hope this helps.