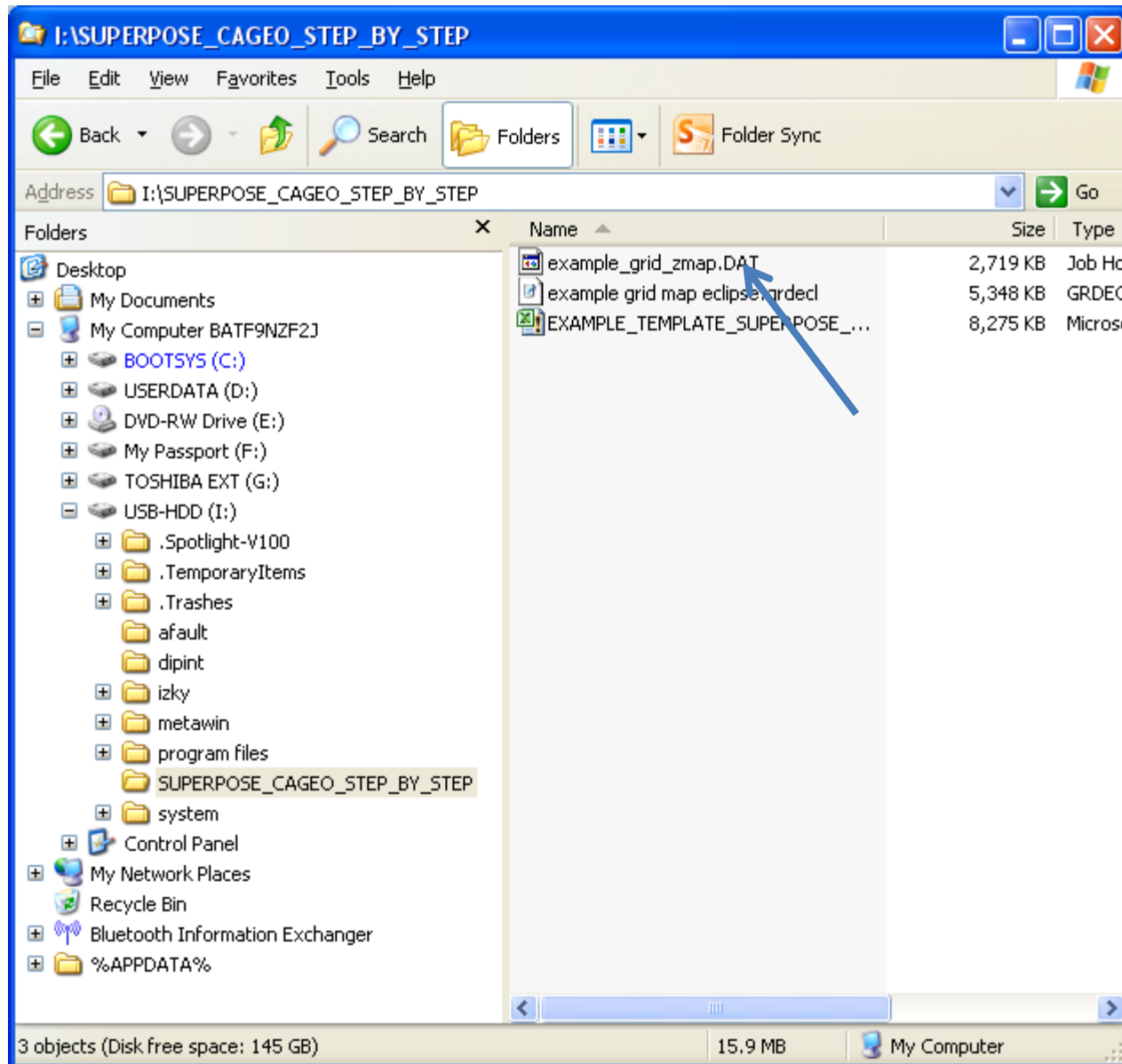


SUPERPOSE- An Excel Visual Basic Program for
Fracture Modeling Based on Stress
Superposition Method

Sait Ismail Ozkaya

STEP BY STEP QUICK RUN

IMPORTING GRID DATA IN Z MAP .DAT FORMAT



Place the grid data file in your work folder.

Make sure that the file is a text file. Otherwise open the file with pspad or wordpad programs and save as text file.

example_grid_zmap.DAT - WordPad

File Edit View Insert Format Help

```

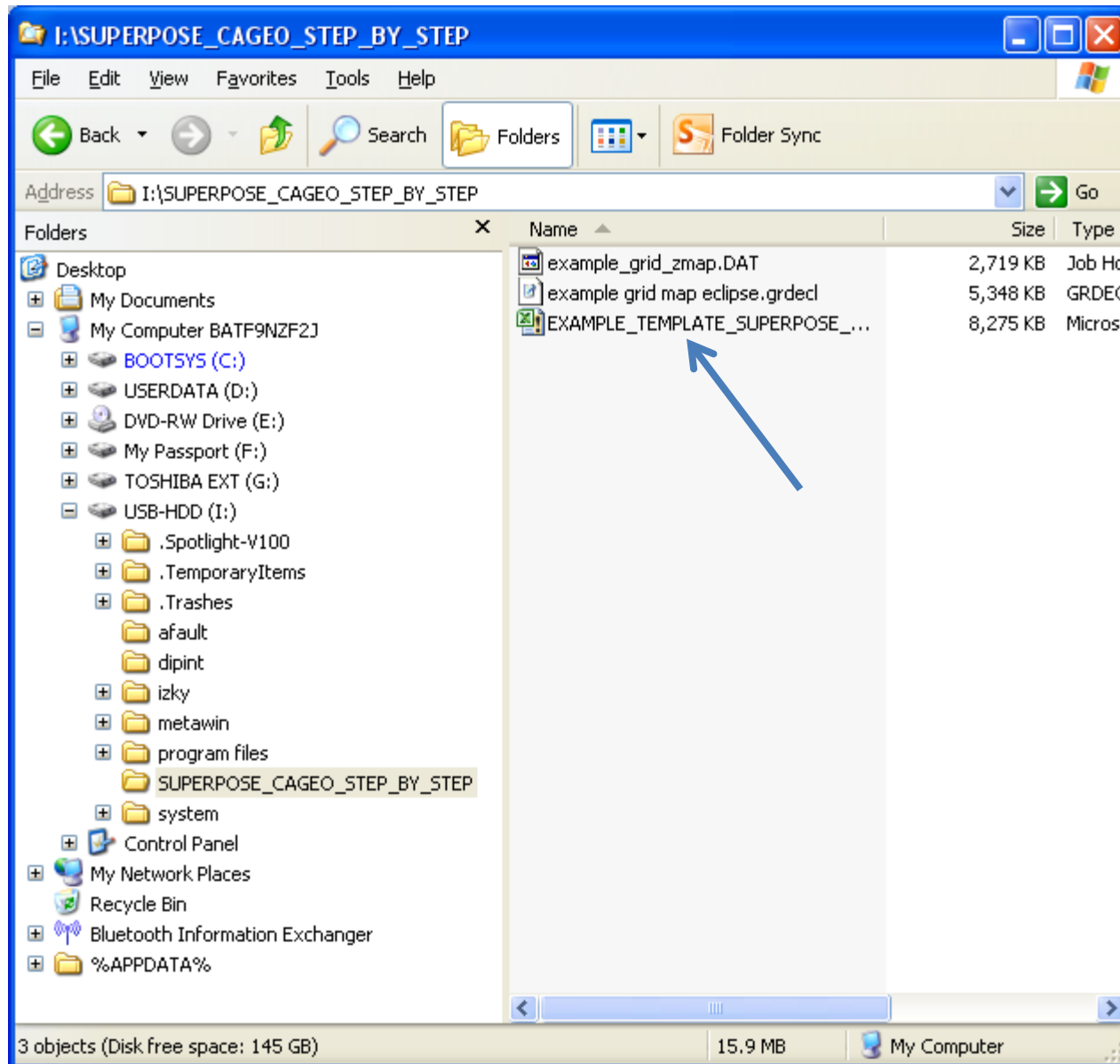
!
!   FILE NAME : SUPERPOSE STRUCTURAL DATA EXAMPLE SET 1
!   FORMATTED FILE CREATION DATE: August 2013
!   FORMATTED FILE CREATION TIME: 16:25
!
"@ZMAP_EXAMPLE           ,      GRID,      5"
"   15, 0.1000000E+31,      ,      7,      1"
"   546, 283, 233100.0 , 268350.0 , 2709800. , 2777925. "
"   36000.00 , 0.000000 , 0.000000 "
@
-2563.972 -2562.807 -2561.636 -2560.464 -2559.289
-2558.116 -2556.946 -2555.782 -2554.625 -2553.478
-2552.343 -2551.222 -2550.117 -2549.031 -2547.966
-2546.923 -2545.907 -2544.917
-2542.133 -2541.274 -2540.453
-2538.234 -2537.582 -2536.976
-2535.452 -2535.045 -2534.692
-2533.959 -2533.827 -2533.751
-2533.866 -2534.020 -2534.230
-2535.203 -2535.638 -2536.127
-2537.909 -2538.605 -2539.350
-2541.856 -2542.776 -2543.736
-2546.831 -2547.926 -2549.051
-2552.569 -2553.783 -2555.012
-2558.771 -2560.041 -2561.314
-2565.127 -2566.390 -2567.643
-2571.331 -2572.528 -2573.707
-2577.109 -2578.193 -2579.249
-2582.237 -2583.167 -2584.065
-2586.544 -2587.297 -2588.012
-2589.933 -2590.497 -2591.023
-2593.871 -2594.851 -2595.833

```

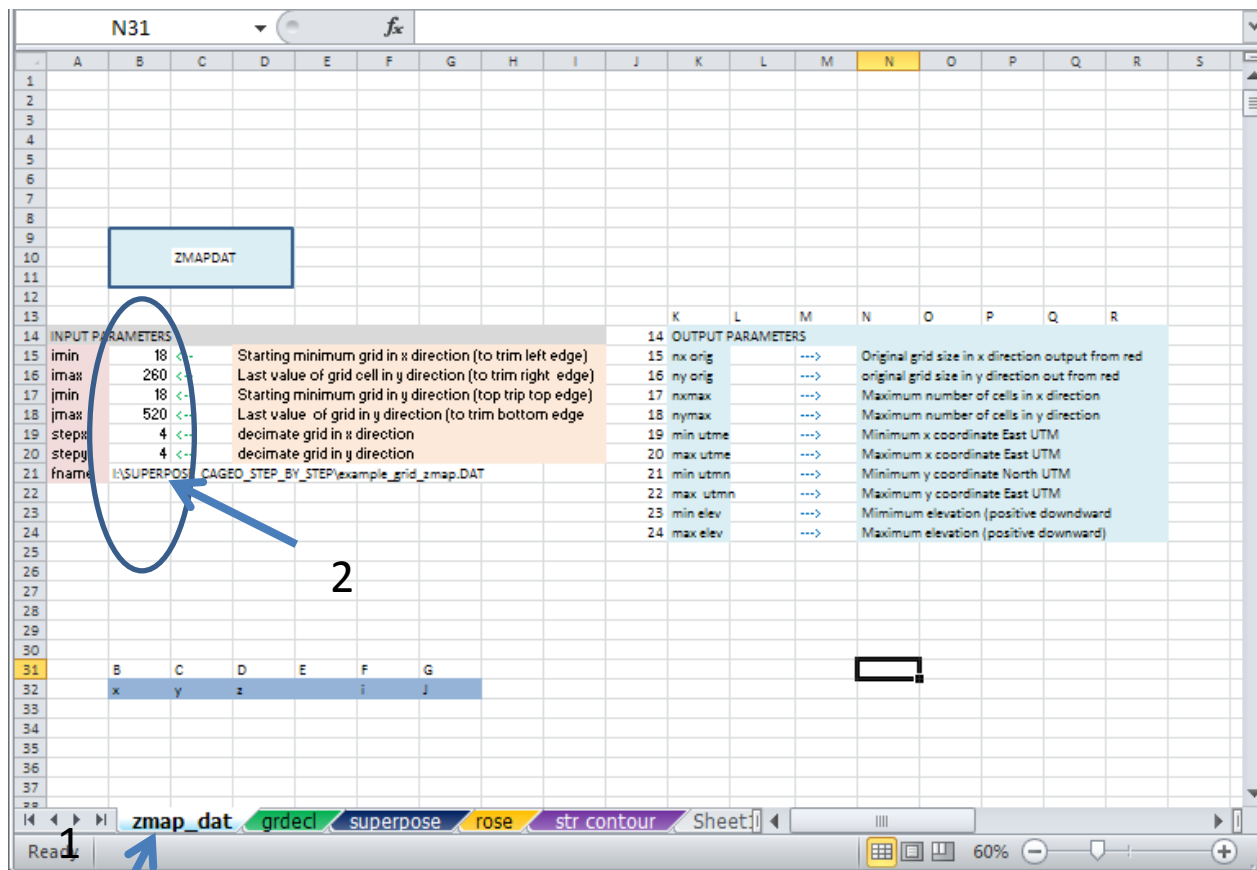
For Help, press F1

The Zmap file must have the content shown. See the User Guide for explanation.

!					
!	FILE NAME : FIELD1_STR				
!	FORMATTED FILE CREATION DATE: JUL 14 2013				
!	FORMATTED FILE CREATION TIME: 13:41				
!					
@	FIELD1_METRIC HEADER , GRID, 5				
	15, 0.1000000E+31, , 7, 1				
	546, 283, 356100.0 , 391350.0 , 2855000. , 2923125.				
	36000.00 , 0.000000 , 0.000000				
@					
	-2563.972	-2562.807	-2561.636	-2560.464	-2559.289
	-2558.116	-2556.946	-2555.782	-2554.625	-2553.478
	-2552.343	-2551.222	-2550.117	-2549.031	-2547.966
	-2546.923	-2545.907	-2544.917	-2543.957	-2543.028
	-2542.133	-2541.274	-2540.453	-2539.672	-2538.932



Open the SUPERPOSE
Excel template



Open the zmap-data tab (1). Fill in the parameters including the full path of the data import file(2).

	A	B	C	D	E	F	G	H	I
14	INPUT PARAMETERS								
15	imin	18							Starting minimum grid in x direction (to trim left edge)
16	imax	260							Last value of grid cell in y direction (to trim right edge)
17	jmin	18							Starting minimum grid in y direction (top trip top edge)
18	jmax	530							Last value of grid in y direction (to trim bottom edge)
19	stepx	4							Take every nth grid value in x direction skip n cells. n=stepx
20	stepy	4							Take every nth grid value in y direction skip n cells. n=stepy
21	fname	i:\TEST.DAT							
									Import file location and name

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G28 fx

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
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INPUT PARAMETERS

imin	18	<--	Starting minimum grid in x direction (to trim left edge)
imax	260	<--	Last value of grid cell in y direction (to trim right edge)
jmin	18	<--	Starting minimum grid in y direction (top trip top edge)
jmax	520	<--	Last value of grid in y direction (to trim bottom edge)
stepx	4	<--	decimate grid in x direction
stepy	4	<--	decimate grid in y direction
fname	H:\SUPERPOSE_CAGED_STEP_BY_STEP\example_grid_zmap.DAT		

OUTPUT PARAMETERS

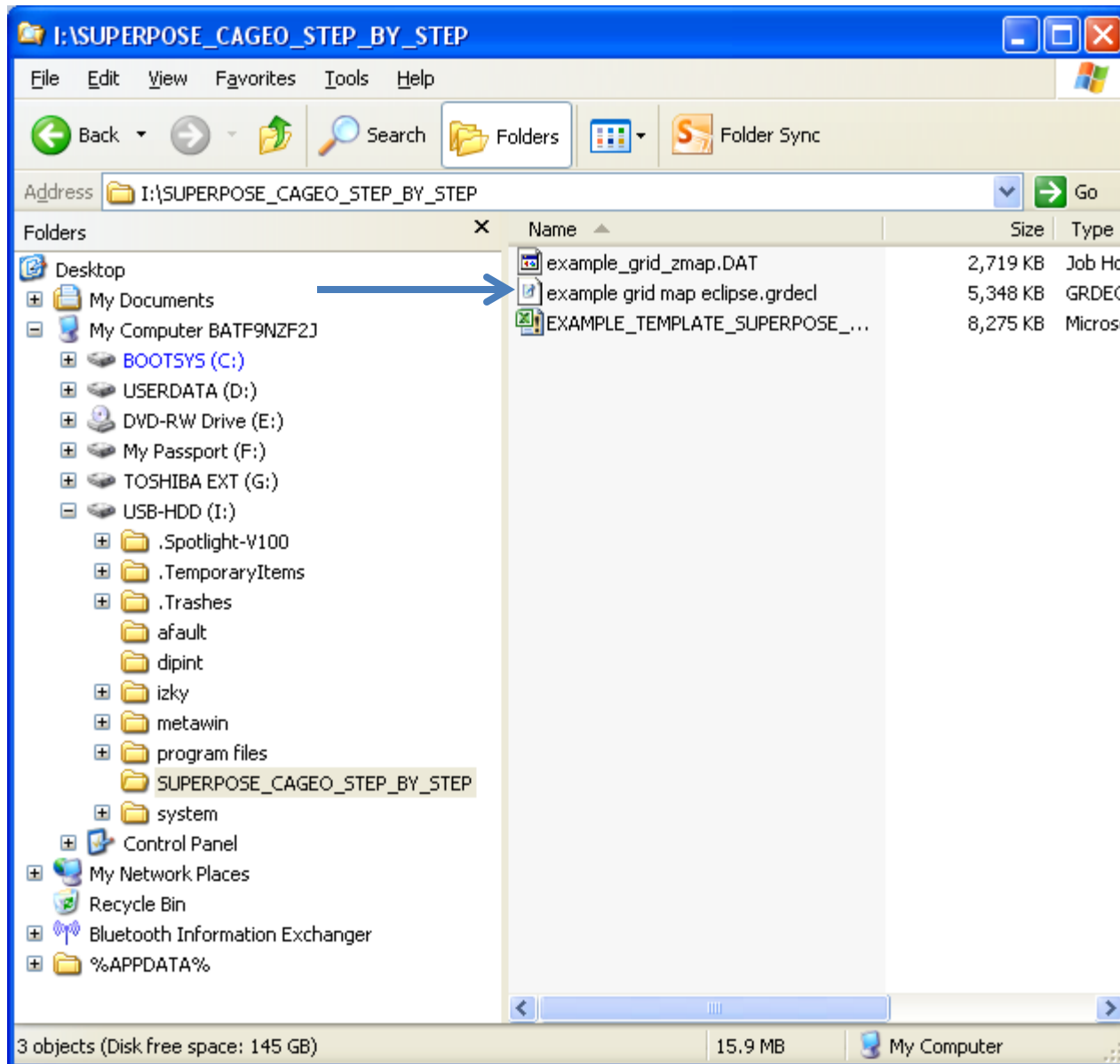
nx orig	283	-->	Original grid size in x direction output from red
ny orig	546	-->	original grid size in y direction out from red
nxmax	61	-->	Maximum number of cells in x direction
nymax	126	-->	Maximum number of cells in y direction
min utme	233100	-->	Minimum x coordinate East UTM
max utme	268350	-->	Maximum x coordinate East UTM
min utmn	2709800	-->	Minimum y coordinate North UTM
max utmn	2777925	-->	Maximum y coordinate East UTM
min elev	1706.87	-->	Minimum elevation (positive downward)
max elev	2597.14	-->	Maximum elevation (positive downward)

zmap_dat grdecl

Click on the icon (1) to run the import program. Read the imported grid data (2) and parameters (3).

	B	C	D	E	F	G
32	x	y	z		i	J
33	358100	2923125	2583.682		17	1
34	358600	2923125	2580.978		21	1
35	359100	2923125	2577.859		25	1
36	359600	2923125	2574.265		29	1
37	360100	2923125	2570.146		33	1
38					

IMPORTING GRID DATA IN ECLIPSE .GRDECL FORMAT



Place the data file in your work directory. Make sure the file is a text file. If in doubt, open it with pspad or wordpad program and save as text file.

```

example grid map eclipse.grdecl - WordPad
File Edit View Insert Format Help

----- ECLIPSE(R) Data File Generated From GOCAD
-----
----- http://hub.paradigmgeo.com
-----

SPECGRID
  150  600  1  1  F  /

GRIDUNIT
'FEET'  /

MAPUNITS
'FEET'  /

COORD
983848.42  9162398.15  8459.80
984176.50  9162398.15  8451.26
984504.58  9162398.15  8442.73
984832.67  9162398.15  8434.20
985160.75  9162398.15  8427.31
985488.84  9162398.15  8419.20
985816.92  9162398.15  8407.10
986145.00  9162398.15  8394.48
986473.09  9162398.15  8382.44
986801.17  9162398.15  8370.39
987129.26  9162398.15  8358.35
987457.34  9162398.15  8346.30
987785.42  9162398.15  8331.74
988113.51  9162398.15  8314.10
988441.58  9162398.15  8296.50

For Help, press F1

```

The format of the file must conform the example (1) with the specific key words and data (see User Guide for details).

----- Eclipse Data File Generated From GOCAD SGrid Export					
----- Name of Exported SGrid: FIELD X_Frac_SGRD					

SPECGRID					
200 304 1 1 F /					
GRIDUNIT					
'FEET' /					
MAPUNITS					
'FEET' /					
COORD					
1017060	9484908	8118.064	1017060	9484908	8123.78
1017883	9484908	8078.894	1017883	9484908	8084.532
1018705	9484908	8039.659	1018705	9484908	8045.215
1019527	9484908	8000.383	1019527	9484908	8005.856
1020349	9484908	7961.103	1020349	9484908	7966.495
1021172	9484908	7921.799	1021172	9484908	7927.108
1021994	9484908	7882.352	1021994	9484908	7887.58
.....					

EXAMPLE_TEMPLATE_SUPERPOSE_CAGEO_D_13_0489.xlsm - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View

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14 INPUT PARAMETERS

15 imin 1 <-- Starting minimum grid in x direction (to trim left edge)

16 imax 151 <-- Last value of grid cell in y direction (to trim right edge)

17 jmin 1 <-- Starting minimum grid in y direction (top trip top edge)

18 jmax 601 <-- Last value of grid in y direction (to trim bottom edge)

19 stepx 4 <-- decimate grid in x direction

20 stepy 4 <-- decimate grid in y direction

21 fname i:\example grid map eclipse.grdecl

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EXAMP

File Home Insert Page Layout

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14 INPUT PARAMETERS

	A	B	C	D	E	F	G	H	I
14	INPUT PARAMETERS								
15	imin		1		Starting minimum grid in x direction (to trim left edge)				
16	imax		101		Last value of grid cell in y direction (to trim right edge)				
17	jmin		1		Starting minimum grid in y direction (top trip top edge)				
18	jmax		305		Last value of grid in y direction (to trim bottom edge)				
19	stepx		4		Take every nth grid value in x direction skip n cells. n=stepx				
20	stepy		4		Take every nth grid value in y direction skip n cells. n=stepy				
21	fname	I:\FIELD1.GRDECL							
		Input data file location and name							

15 imin 1 <-- Starting minimum grid in x direction (to trim left edge)

16 imax 101 <-- Last value of grid cell in y direction (to trim right edge)

17 jmin 1 <-- Starting minimum grid in y direction (top trip top edge)

18 jmax 305 <-- Last value of grid in y direction (to trim bottom edge)

19 stepx 4 <-- Take every nth grid value in x direction skip n cells. n=stepx

20 stepy 4 <-- Take every nth grid value in y direction skip n cells. n=stepy

21 fname I:\FIELD1.GRDECL Input data file location and name

OUTPUT PARAMETERS

	A	B	C	D	E	F
32	x	y	z	j	i	
33	310000	2891000	2474.386	1	1	
34	311002.5	2891000	2426.544	2	1	
35	312005	2891000	2378.066	3	1	
36	313007.5	2891000	2325.422	4	1	
37	314010	2891000	2268.82	5	1	
38					
39					

3

4

1

zmap_dat grdecl superpose rose str contour

Ready

Open the grdecl tab (1). Place import parameters (2) and click on the icon to run the GRDECL import program (3). The results (data and parameters) are placed as shown (4).

DRAWING STRUCTURE CONTOUR MAP

EXAMPLE_TEMPLATE_SUPERPOSE_CAGEO_D_13_0489.xlsm - Microsoft Excel

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M28

9

10

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14 INPUT PARAMETERS

15 imin 1 Starting minimum grid in x direction (to trim left edge)

16 imax 61 Last value of grid cell in y direction (to trim right edge)

17 jmin 1 Starting minimum grid in y direction (top trip top edge)

18 jmax 126 Last value of grid in y direction (to trim bottom edge)

19 mincon 1800 minimum contour value

20 maxcon 2500 Maximum contour value

21 contint 100 Contour interval

22 null -1.00E-30

23

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41

zmap_dat grdecl superpose rose str contour Sheet1

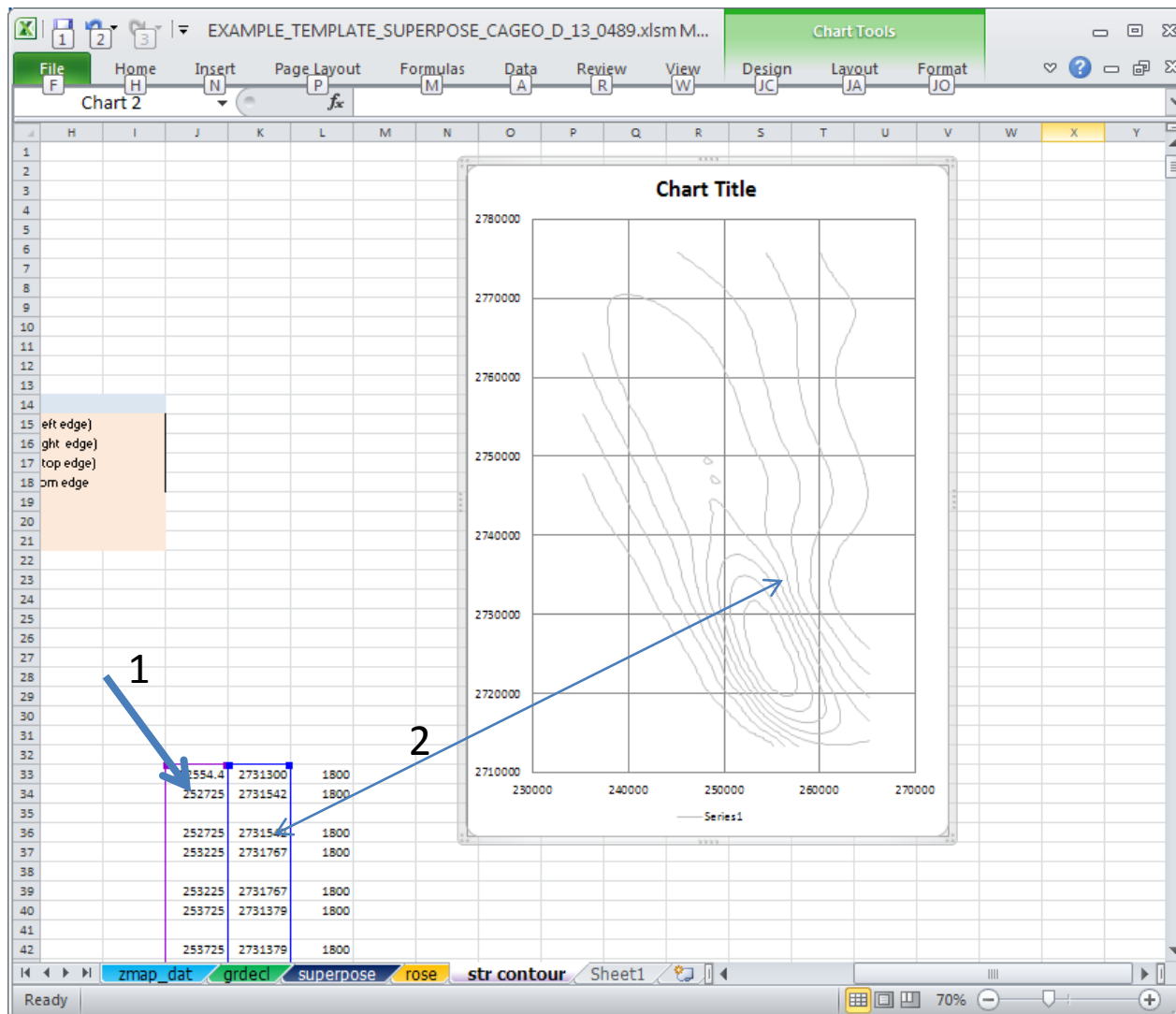
Ready 90%

2

1

x	y	z	i	j
235225	2775800	2571.55	18	18
235725	2775800	2568.46	22	18
236225	2775800	2564.99	26	18
236725	2775800	2561.1	30	18
237225	2775800	2556.74	34	18
237725	2775800	2551.85	38	18
238225	2775800	2546.41	42	18
238725	2775800	2540.42	46	18

Fill in the parameters and data (1) from either the ZMAP or GRDECL tabs. Run the contour program by clicking on the icon (2)



Select plot data (1) and plot a Excel graph (2). Adjust aspect ratio and minimum and maximum east and north UTM values.

RUNNING SUPERPOSE PROGRAM

1

2

3

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3											
4											
5											
6	nxmax	61		Original grid size in x direction output from red							
7	nymax	126		original grid size in y direction out from red							
8	nxin	61		Maximum number of x cells limit for this run							
9	nyin	126		Maximum number of y cells limit for this run							
10	xmin	235000	UTM	UTME of origin							
11	ymin	2713000	UTM	UTMN of origin							
12	zmin	1700	m	Depth to origin							
13	zmax	2597	n	Max depth							
14	nxpts	11		Number of cells in x direction							
15	nypts	11		Number of cells in y direction							
16	E	16864	Mpa	Young modulus							
17	thick	30	m	layer thickness							
18	Sxx	60	Mpa	Regional horizontal maximum stress							
19	Syy	10	MPa	Regional horizontal minimum stress							
20	alfax	30	deg	shmax angle from x (counter clockwise positive)							
21	phi	30	deg	Internal friction angle							
22	UCS	25	MPa	Unconfined compressive strength							
23	m Hoek	10		coefficient of Hoek-Brown failure envelope							
24	lendax	300		length multiplier tensile							
25	lendaxr	15		shear fractures							
26	cizlime	8		plot every kcz tensile							
27	cizlimsh	8		plot every kcz shear fracture							
28	fitregime	2		1 normal 2 strike slip 3 show both							
29	fallop	1		1 hoek-brown else Coulomb							
30											
31	min	235225	2713700	1706.87							
32		x	y	z							
33	-->	235225	2713700	2268.17509							
34		235725	2775800	2265.36597							
35		236225	2775800	2263.00098							

Ready

zmap_dat grdecl superpose rose

70%

Open the superpose tab in the Excel template(1). Fill in the input parameters and copy and paste grid data from ZMAP or GRDECL tabs (2). Click on the icon to run the SUPERPOSE program (3). See next slide for a close up of the parameters (2).

	A	B	C	D	E	F	G	H
6	nxmax	61		Original grid size in x direction output from red original grid size in y direction out from red Maximum number of x cells limit for this run Maximum number of y cells limit for this run UTME of origin UTMN of origin Depth to origin Max depth Number of cells in x direction Number of cells in y direction Young modulus Layer thickness				
7	nymax	129						
8	nxin	61						
9	nyin	129						
10	xmin	350000	UTM					
11	ymin	2850000	UTM					
12	zmin	1700	m					
13	zmax	2597	n					
14	nxpts	11						
15	nypts	11						
16	E	16864	Mpa	Vertical effective stress Regional horizontal maximum effective stress Regional horizontal minimum effective stress shmax angle from x (counter clockwise positive) Internal friction angle Unconfined compressive strength Coefficient of Hoek-Brown failure envelope Length multiplier for tensile fractures Length multiplier for shear fractures Plot every nth tensile fracture. n=cizlimex Plot every nth shear fracture. n=cizlimsh Failure option: 1 Hoek-Brown else Coulomb				
17	thick	30	m					
18	Sv	30						
19	Sxx	120	Mpa					
20	Syy	10	MPa					
21	alfax	20	deg					
22	phi	53	deg					
23	UCS	86	MPa					
24	m Hoek	20						
25	lendex	100						
26	lendshr	25						
27	cizlimex	10						
28	cizlimsh	5						
29	failop	2						

2

Close up of parameters and example values in previous slide (2).

EXAMPLE_TEMPLATE_SUPERPOSE_CAGEO_D_13_0489.xlsm - Microsoft Excel

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AT26

	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
29															
30															
31		Indices			Coordinates				Coefficients of quadratic equation						
32		i	j		utme	utmn	elev m		a x^2	b xy	c y^2	d x	e y	f	
33		6	6		237725	2773300	2242.585		1.35E-06	1.69E-06	-6.4E-07	-0.113334191	0.080378279	-1970.02	
34		7	6		238225	2773300	2240.787		1.43E-06	1.5E-06	-7.2E-07	-0.10255766	0.091278386	-2312.7	
35		8	6		238725	2773300	2239.857		1.43E-06	1.28E-06	-7.8E-07	-0.089557228	0.09885325	-2562.46	

Columns J to V :
Indices
coordinates and
coefficients of
quadratic
equations for each
window

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
22																
23																
24																
25																
26																
27																
28																
29																
30																
31		Elevations +zmin				curvature										
32		calc	actual			max	min	teta max								
33		542.3408551	542.585			3.32048E-06	-1.8934E-06	20.19005								
34		540.6940281	540.7871			3.33398E-06	-1.9163E-06	17.43733								
35																

angles are counterclockwise from x axis (positive to the east)

DATA TRANSFER FROM CURVATURE TO SUPERPOSE ROUTINE

	utme	utmn	elev	uxx	uyy	uxy	Angle uxx
			M	Mpa	Mpa		deg
33	237725	2773300	2242.584961	-3.3597961	1.915818	0	20.19005
34	238225	2773300	2240.787109	-3.3734542	1.938954	0	17.43733
35							

Columns AM to AW: Composite stress, principal
composite stress and angles

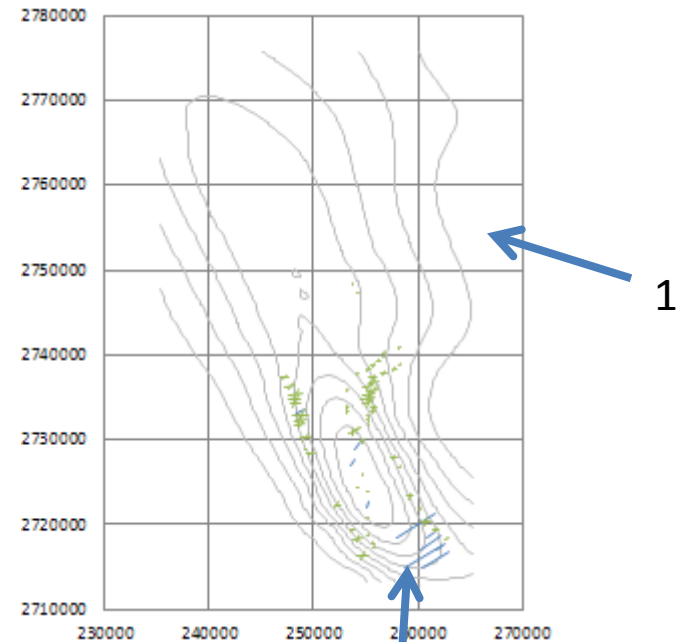
	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											

RESULTS FROM SUPERPOSE ROUTINE

	composite stress Mpa		principal composite stress		tanteta1	teta1	tanteta2	teta2
	rx	ry	rx	cy	deg	deg	deg	deg
33	56.7933525	11.762669	0.885718873	56.81077	11.74525	0	0.019661626	31.126384
34	56.8778724	11.68762725	1.127822756	56.906	11.6595	0	0.024941691	31.428759
35	57.0982607	11.5842837	1.28645701	57.13459	11.54795	0	0.028242552	31.61775
36	57.4341143	11.46071932	1.3607107	57.47435	11.42048	0	0.029571903	31.693853

The results are placed in columns J to CG.

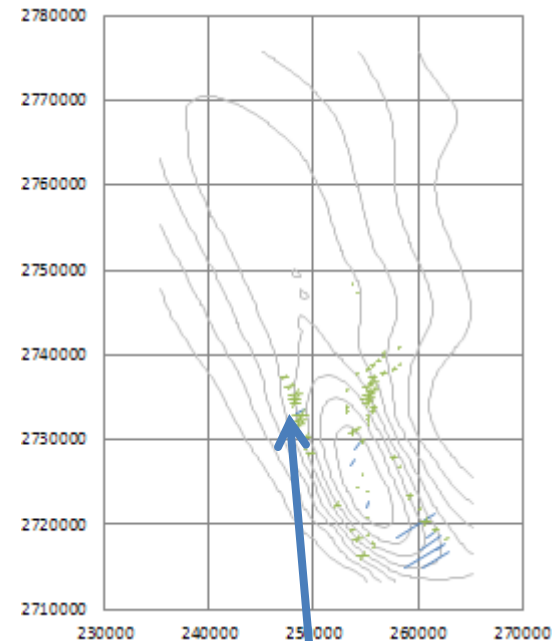
The fracture stick data for tensile fractures is placed at column BQ and BR. Copy the contour map to the SUPERPOSE tab(1). Copy and paste the data onto the contour map (2) and change color chosen for tensile fractures (blue in this example).



Columns BD to BR: Tensile fracture sticks

	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR
22															
23															
24															
25															
26	Columns BD to BR: Tensile fracture sticks														
27															
28															
29															
30	TENSILE FRACTURES					FRACTURE STICKS					EXCEL PLOT AID				
31	Length	Strike	X	Y		tip 1		tip 2			Tip 1 x	tip1 y			
32	m	deg	utme	utmn		utme	utmn	utme	utmn		Tip2 x	tip2 y			
33	862.7418	56.27857	248725	2733300		248366.2	2733061	249083.8	2733539						
34	1274.483	56.36598	249225	2731300		248694.4	2730947	249755.6	2731653						
35	749.7146	55.89773	249225	2730800		248914.6	2730590	249535.4	2731010						
36	875.9929	29.45001	253725	2730300		253509.7	2729919	253940.3	2730681						
37	880.7181	29.61821	254225	2730300		254007.4	2729917	254442.6	2730683						
38	813.001	20.05537	253725	2730800		253509.7	2730101	253940.3	2730100						

The fracture stick data for shear fractures is placed at columns CF and CG Copy and paste the data onto the contour map (1) and change color chosen for shear fractures.(green in this example.



Columns BT to CH: Shear fracture sticks

1

	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH
22															
23															
24															
25															
26															
27															
28															
29															
30	SHEAR FRACTURES					SHEAR FRACTURE STICKS STICKS						EXCEL PLOT AID			
31	Length	Strike	X	Y		tip 1		tip 2				Tip 1 x	tip 1 y		
32	m	deg	utme	utmn		utme	utmn	utme	utmn			Tip2 x	tip 2 y		
33	33.83671	89.5081	242225	2766300		242208.1	2766300	242241.9	2766300			242208.1	2766300		
34	33.83671	29.50818	242225	2766300		242216.7	2766285	242233.3	2766315			242241.9	2766300		
35	61.85426	89.13495	242225	2765800		242194.1	2765800	242255.9	2765800						
36	61.85426	29.13503	242225	2765800		242209.9	2765773	242240.1	2765827						
37	26.90363	89.19306	244225	2765800		244211.5	2765800	244238.5	2765800						
38	26.90363	29.19314	244225	2765800		244218.4	2765788	244231.6	2765812						
39	105.2603	88.88298	242225	2765300		242172.4	2765299	242277.6	2765301						