TASMANIA DEVELOPMENT AND RESOURCES

MINERAL RESOURCES TASMANIA

REPORT 1993/35

STRESS: a computer program for the calculation of the regional stress tensor from faults and their striations

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Introduction

This program is derived from the work of Etchecopar *et al.* (1981) and was prepared by Dr R. F. Berry, University of Tasmania. It involves material in the public domain. The program runs on the hard-disc (C-drive) in MS-DOS on the IBM computer in the old Regional Geological Survey Branch tea area.

In order to interpret your results, background reading in fault-striation analysis literature is necessary (see *Journal of Structural Geology* back to 1981).

List of Commands

ENTDD

enters data under a named file

BB [filename]

brings up data for viewing after entry

COPY [filename] STRIA

copies your data to the working file STRIA for editing purposes, leaving your entered file data unedited but saved

Ctrl-Z

exits to allow the calculation whilst saving the data in the working file STRIA

Ctrl-D

is an editor which will delete a line in your working file

Ctrl-U

is an editor which will undelete the previously deleted line in your working file

Alt-Z

aborts the editing done in your working file

STRESS

tells the program to calculate the regional stress tensor from the edited data in file STRIA

BR

allows you to browse through the calculation and view the results

PR

will print the data and results

METAWNDO

is the entry to allow you to view the equal area stereo-nets of poles to faults, faults as great circles, striations and M-planes. No print facility is available under PR or the key "print page" as this requires a dot-matrix printer at present. This can be remedied by Dr R. Berry if required.

STEREO

is the command to view the above stereo-nets

COPY [filename] + [filename] [newfilename]

allows you to combine files. The combined files will need editing to form a coherent file using the editor BB [filename]

Using the program

This section gives the commands in order to run the program.

You will start in WINDOWS. Set the cursor to FILE. Click EXIT WINDOWS and then OK to exit WINDOWS and go to MS-DOS.

If the prompt "U:\" appears type C: and ENTER. You are now in C drive.

When the "C:\" prompt appears type CD STRESS and ENTER. You are now in the STRESS directory. You will see the prompt "C:\STRESS>"

To view the STRESS directory type DIR/W and you will get the wide format display of the STRESS directory. Other formats are available; see the MS-DOS manual.

To create a file and input data, type ENTDD on prompt "C:\STRESS>" and ENTER. The prompt "ENTER FILE NAME:" appears.

Type in your filename adding .STR. You are allowed four letters e.g. BOBS.STR. DO NOT type any spaces into the filename or you will cause havoc which is very hard to retrieve.

The prompt "ENTER dip direction" appears. Type in dip direction and ENTER.

The prompt "ENTER DIP 0-90" appears. Type in dip; if dip is 0 use 1°, if dip is 90° use 89° to avoid a mathematical problem that I believe has been cured but may not be. ENTER.

The prompt "ENTER PITCHLIN0-90" appears. Type in the amount of pitch of the striation. If you have measured the plunge, type zero and enter.

The prompt "PITCHENDNSEW" appears. If you have measured the pitch, this prompt asks for the pitch direction; type in N or S or E or W. Otherwise leave blank and hit ENTER key.

If you have not measured the pitch, hit ENTER and then the prompt "ENTER AZIM STR-360" appears. Give the azimuth of the striation and enter.

The prompt "ENTER SENSE NRDS" appears. Give the slip sense on the fault: N-normal, R-reverse, D-dextral, S-sinistral, or X if you don't know, and enter. These entries must be as CAPITALS; lower case entries create problems.

The next prompt repeats the above so you can enter the next striation measurement.

When you have put in all your data type 450 and ENTER on the prompt "ENTER dip direction".

The prompt "ANOTHER Y/N:" appears. Type N and ENTER to close the session; type Y if you want to create another file to add more data from a different locality.

On command N and ENTER, the screen will read "Stop-Program terminated" followed by the prompt "C:\STRESS>". This is where you move to edit mode; if you get the following commands mixed up you stand to lose your file.

On prompt "C:\STRESS>" type "COPY [filename] STRIA, and ENTER; this copies your data file to the working file STRIA, saving your data file, obliterating all previous material in STRIA, and allows you to manipulate your data an a file separate from that in which it is stored.

The file BOBS.STR has been created to allow you to see the layout once you have copied your data to STRIA. To see BOBS.STR in STRIA type COPY BOBS.STR STRIA. Do not type a space in BOBS.STR or you will cause problems.

The screen will read:

C:\STRESS> COPY BOBS.STR STRIA

1 file(s) copied

C:\STRESS>

To view your working file with your data in STRIA for the purposes of editing type BB STRIA on prompt "C:\STRESS>"

This displays through Blackbeard your file data e.g.

1

BOBS.STR

(a) 10 89 E 0 100 X 1

(b) 450

(c) 1 100 357

(d) 340 08

line (a) represents a group of lines containing the data you have entered, the dip the strike, the dip direction, the zero pitch, the azimuth of plunge, the sense of slip and the datum number (in this case 1)

line (b) displays the termination number 450

line (c) displays an option number between 1 and 7 for the purposes of calculation, the percentage (100) of the stria to be used for the calculation, and a random number (357) (*note:* when I copied this an extra 100 appeared; this should be deleted using the cursor and the delete button or the calculation won't run).

line (d) contains the azimuth of a principal stress tensor 340 and its plunge 08; this is arbitrary for starting the calculation.

Note: Letters (a), (b), (c) and (d) do not appear on the screen.

To edit the data, use the cursor; the data may be changed, new lines added, slip senses assigned, and line numbers altered using the cursor, the appropriate keys, and the delete button, or the delete line command Ctrl D.

To set the parameters for the calculation go to lines (c) and (d). It is easiest to use the option "2" to set a possible principal maximum stress $\sigma 1$. To set the percentage of striations to be used from the incoherent mess you are bound to have typed in go to the column 100; a useful start is to type 060 as this will allow screening of multi-generational fault movements.

Note that if line (c) should read 1 100 100 357, use the delete button to delete one of the 100's and one of the extra remaining spaces left in its former position.

To assign a value to your guessed at σ_1 change 340 08 to the numbers of your choice.

When the editing is complete press Ctrl-Z; Alt-Z will abort your editing. The prompt "C:\STRESS>" appears. You are now set for the calculation; to do this, type command STRESS and enter.

This is where the file BOBS.STR crashes as the data are too few for the calculation. I have left the file VTC1.STR in the directory for you to view what the results look like. So use the command"COPY VTC1.STR STRIA" to copy VTC1.STR to STRIA and then Ctrl-Z followed by command STRESS, and this will show you what to expect.

After typing command STRESS the screen reads "Stop-Program terminated" – this means the machine is doing the calculation which is complex and takes time; or you may get an error message giving the line number. If the latter, either you have typed in the wrong type of data, your editing has not produced a picture the computer recognises (e.g. numbers or letters in the wrong columns, the termination number 450 may be absent etc., or you do not have enough data for the statistics used. If the latter, things like "REAL divide by zero" etc. appear on the screens). If confused phone R. F. Berry on 20 2101 and explain your problem; he is sure to offer advice.

Below "Stop-Program terminated" is the prompt "C:\STRESS>". Type "BR" and enter. You will see your data displayed and by using the page-up or page-down button, or the cursor, you can see the rest

of the results. The program, using the editor BB STRIA, allows you to massage your data to produce a coherent, if meaningless picture, if you so want. You can cull your data to pick out multiple fault movements, and I can generally see my way to getting three sets out of 100-150 striation measurements; you need here to refer back to your field observations to see if this is realistic.

To print your results after BR, hit the Esc key. On the prompt "C:\STRESS>" type PR and enter. The screen will read

C:\STRESS>
C:\STRESS>TYPE FAULT.LP>LPT1
C:\STRESS>

The prompt "C:\STRESS>" awaits your next command.

To get out of STRESS type CD .. on the prompt "C:\STRESS>" and ENTER. This produces prompt "C:\>".

To get out of DOS and into WINDOWS type WIN and ENTER.

Sample data files

There are three sample data files available in the STRESS directory: BOBS.STR is there to explain the layout of the data on the screen and is too short to yield results; UBUT.STR is a concocted reverse fault system with some strike-slip surfaces added and this is used below to explain some of the workings of the calculation; VTC1.STR is a data file from northern Vietnam where multiple faulting has occurred

File UBUT.STR. Copy UBUT.STR to STRIA. There are 17 data entries, principally reverse faults. σ_1 is set, using option 2, to a plunge of 16° to 156°. This yields a stress ratio R=0.00 ($R=\sigma_1-\sigma_2/\sigma_2-\sigma_3$) which means the result is unstable. Under INDICE DES VALEURS DANS CETTE GAMME (see Appendix B for the print-out of the UBUT.STR calculation) no striation yields a result closer than 0.9 radians to the user-created value of 16° to 156° for σ_1; 16° to 156° is not the correct answer.

Below this section is the heading;

UBUT.STR
NO. READINGS USED

That is, the machine has redone the calculation and has come up with 7.9° to 045.9°. This yields a stable stress ratio of R=0.55, and under INDICE DES VALEURS DANS CETTE GAMME all seventeen striations lie within 0.3 radians of this ideal solution; the maximum number lie between 0 and 0.1 radians away, the nextmost lie between 0.1 and 0.2 radians away and two lie between 0.2 and 0.3 radians away. This is an excellent result.

Using the STRIA file, you may add extra striations to the data and you may change σ_1 to see what happens; do not change the existing seventeen striations within UBUT.STR as these have been created to give you a sound and simple result.

File VTC1.STR. These are real data from a number of localities in northern Vietnam; sinistral strike-slip and thrusting has occurred here since the Cretaceous. One Vietnamese worker, using a different and as yet unpublished computer analysis, has found three directions for σ_1 from local data-sets. Again COPY VTC1.STR STRIA before you attempt to cull the data. Using σ_1 set to a plunge of 14° to 010° for VTC1.STR, and the minimisation percent to 040, I got R=0.60 indicating a stable system for about 10 or 11 striations out of the 28 in the file. The remainder form a population which does not fit this stress system. Using BB STRIA you can cull the ones that do fit (striations 26, 21, 11, 24, 12, 4, 10, 27, 18, 2 and perhaps 5) and change σ_1 until you get a coherent result with the remaining striations. When I did this I got R=0.14, which means uncertainty as to which is σ_2 and which is σ_3, and a cluster of results with σ_1 having a shallow north-west plunge. A low or high R value is not particularly good. Further cleaning of the data could resolve things more clearly and this is where you need to refer to your field notes to find out what outlying data could be affecting the results.

Building a file from other files

You may want to combine files to look at a larger amount of data at one time. First determine a new file name. Then on the prompt "C:\STRESS>" type the command BB [newfilename]. This brings up Blackbeard and a statement that the file does not exist, but do you want to create one? Answer "Y" and type in the new file name and ENTER. This leaves you with a blank screen, so press Ctrl-Z to exit and you return to the prompt "C:\STRESS>". You now type COPY [filename] + [filename] + [filename] [newfilename] and ENTER. This places your data in the new file; you will now type BB [newfilename] and use Ctrl-D and the cursor to clean up the file into a workable format. This file will be permanent.

If you want to do the same thing but only temporarily for the purpose of looking at possible combinations of data, on the prompt "C:\STRESS>" type COPY [filename] + [filename] + [filename] STRIA. This puts your files in STRIA where they can be edited for working. If you decide you want to preserve the data within STRIA you must:

(1) create a new filename by the method given in the second paragraph in this section; and

(2) on the prompt "C:\STRESS>" type COPY STRIA [newfilename].

To edit your data file you can use either (1) BB STRIA which you can use to clean up the file to a computer-recognisable format (this preserves the old data in old file format under the new file name) or (2) BB [newfilename] in which the new file can be edited permanently, losing the reference to the old files.

Backing up your data

All your files are on drive C. You should back up your data entries on either drive A or B. To copy your files from drive C to drive A from the STRESS directory type COPY [filename] A:

To go from C drive to A drive type A: then DIR to view the A directory. It is not worth working in A drive as the calculation is too slow.

To delete files

Type DEL [filename] on the prompt "C:\STRESS>". If you mistakenly type a space within the filename (e.g. BOBS. STR instead of BOBS.STR the DEL

command will not work and nor will any other for this file.

Reference

ETCHECOPAR, A; VASSEUR, G.; DAIGNIÈRES, M. 1981: An inverse problem in microtectonics for the determination of stress tensors from fault striation analysis. *J. struct. Geol.* 3: 51-65.

Appendix A

Files in STRESS directory on 20 August 1993

BB.CFG; METAWNDO.EXE; FAULT.LP; BROWSE.COM; STEREO.EXE; BB.EXE; STRESS.EXE; STRIA; BR.BAT; MARKERS.FNT; PR.BAT; ENTDD.EXE; SYSTEM08.FNT; BOBS.STR; VTC1.STR; UBUT.STR.

STRIA is your working file; it is empty until you copy data into it from another file. Any copied file will overwrite previous files copied into STRIA. Do not delete STRIA.

BOBS.STR, UBUT.STR and VTC1.STR are data files; all data files should have the extension .STR so you know what is what; you may experiment with these two files or any other data files you put in.

If you experiment or delete any files other than the three .STR files above, or your own data files, you will damage the program.

[23 August 1993]