

Manual for CASMO – Create A Stress Map Online

1. Introduction

CASMO is a web-based HTML-form that allows the user to create own stress maps using the data of the WSM database. Requests for stress maps will be sent to our server for further processing. CASMO creates maps with the available stress orientations of any geographical region. Selections by type of stress indicator or data quality can also be made. Additional features like topography, rivers, overview maps, etc. can be added. Possible output formats are postscript, pdf or jpeg bitmap format. The requested map will be provided for download as a compressed file (*.tar). You can decompress this file with standard software such as WinZip or 7-Zip. If you intend to use the stress maps or WSM data in publications, we kindly ask you to cite our work as:

**Heidbach, Oliver; Rajabi, Mojtaba; Reiter, Karsten; Ziegler, Moritz; WSM Team (2016):
World Stress Map Database Release 2016. GFZ Data Services, doi:10.5880/WSM.2016.001.**

Last but not least, special thanks to Paul Wessel and Walter H.F. Smith for their great mapping tool GMT [Wessel and Smith, 1998] since CASMO is based to large extend on this tool. The plate boundaries shown in the maps are by courtesy of Peter Bird (Bird, 2003). The data related to his global plate boundary model are available on his ftp-site.

The following sections describe briefly the functions of the CASMO website form. Further technical details about the WSM database structure and content is presented in the WSM STR 16-01 that is available on our website.

2. Page setup

Paper Size

Possible values:

A4, A3, Letter, or Tabloid.

The paper size is not necessarily the size of your map, but constrains the map dimension (e.g. the width). The other map dimension (e.g. the length) depends on the map projection.

Paper orientation:

Possible values:

Portrait (longer side up), or Landscape (shorter side up)

Note: If you want to import the produced *.ps file into other graphics software, we recommend Portrait.

3. General map properties

Projection

Possible values:

Mercator, Lambert (azimuthal equal area), Lambert (conic conformal), or Albers (conic equal area).

For further details, please, look at the GMT website, where all projections are explained in detail.

Topography

Possible values:

Colour, Grey scale, or None.

If no topography is set, the continent fill will be grey and the ocean fill is blue (Fig. 1).

Major rivers, political boundaries, plate boundaries, gridlines

Color setting:

Major rivers: light blue; Political boundaries: pink; Plate boundaries: black; Gridlines: black.

Note: The political boundaries are not always perfectly up-to-date. The plate boundaries shown in the maps are taken from the global tectonic model of Bird [2003]. Since this is a global model the plate boundaries on regional to local stress maps is not recommended due to limited resolution of tectonic features taken from a global model.

Gridlines settings:

For longitude and latitude differences greater than 8° the number of gridlines will be 5; otherwise the number is 2.

Region to plot

Possible values:

longitude [-180.....180], latitude.[-90.....90].

You can specify the range of your map. The values represent the geographical coordinates of the map boundaries (Fig. 1). Longitudes west of the zero meridian (Greenwich) are counted negative (down to -180°), longitudes east of it positive (up to 180°). Latitudes south of the equator are counted negative (down to -90°), north of it positive (up to 90°).

Note: Be careful with very high (near 90°) or very low (near -90°) latitudes because in Mercator projection these regions appear extremely distorted.

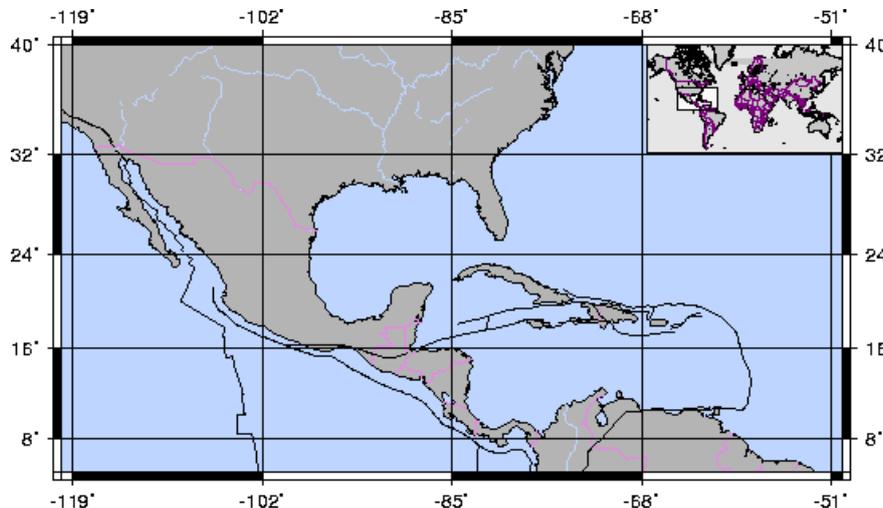


Fig.1. Map of Middle America including a global overview map.

4. Inserted overview map

Position on map

Possible values for the position of the overview map are the four corners: Upper left, Upper right, Lower left, Lower right.

Range of overview map

Longitude/Latitude values for the overview map are counted in the same way as for the main map.

5. Select stress data

Data quality

Possible categories:

A, B, C, D; and E where only the location is plotted without the S_{Hmax} orientation.

All data are quality ranked according to the quality ranking scheme developed by Zoback and Zoback [1991; 1989] and updated by Sperner et al. [2003] and Heidbach et al. [2010]. The highest quality is A, the lowest E. To indicate the different qualities the stress data have different symbol length (Fig. 2).

Tectonic stress regime

Possible stress regime categories:

TF (Thrust Faulting), TS (Thrust Faulting including a Strike-Slip component), SS (Strike-Slip), NS (Normal Faulting including a Strike-Slip component), NF (Normal Faulting), U (Unknown).

Different tectonic regimes are characterized by different symbol colours. NF and NS data is printed in red, SS data in green, and TF and TS data in blue. Data with an unknown regime is printed in black (further details).

6. Stress data type

Possible categories:

Borehole Breakout (BO); Geological Indicators (GI); Hydraulic Fracture (HF); Overcoring (OC); Borehole Slotter (BS); Drilling Induced Fractures (DIF); Focal Mechanism, Formal Inversion (FMF); Focal Mechanism, Average (FMA); and Focal Mechanism, Single (FMS), with additional data filters.

The different types of stress indicators are shown by different symbols (Fig. 2, 3).

FMS type events

Due to the uncertainty of how reliable stress is reflected by focal mechanism solution data (FMS) along plate boundaries, there are additional options to filter out subsets of FMS type data records. This data is subdivided into 7 subsets in terms of the plate boundary type located next to the individual data point using the plate boundaries from the global model of Bird [2003]. For each of these 7 subsets you can (1) exclude all events within a certain distance from the plate boundary, (2) exclude events with the corresponding regime within a certain distance from the plate boundary, or (3) exclude PBE events (possible Plate Boundary Events) as defined by the WSM team. Further information on the PBE detection reasoning and the technical procedure are presented in Heidbach et al. [2010].

Please pay attention to the following two points: (1) The regime abbreviations here are more general than in the Tectonic regime selection above: "SS" means SS, NS, and TS, while "NF" means NF and NS, and "TF" means TF and TS. (2) You deselect (exclude) data by activating a button. This way you can generate a 3-stage filter for each of the 7 subsets. For example, you select "exclude all events < distance of 100 km", "exclude SS events < 200 km" and "exclude PBE events" for the CTF subset: Then FMS data near continental transform faults will not include data flagged as PBE by the WSM team, it will not include SS, NS, and TS events within 200 km range from the transform fault, and it will not include any data within 100 km from the plate boundary. When you deselect Focal Mechanism solutions, Single (FMS) in general, all these plate boundary filters do not have any effect, as no FMS data at all will be included in the stress map.

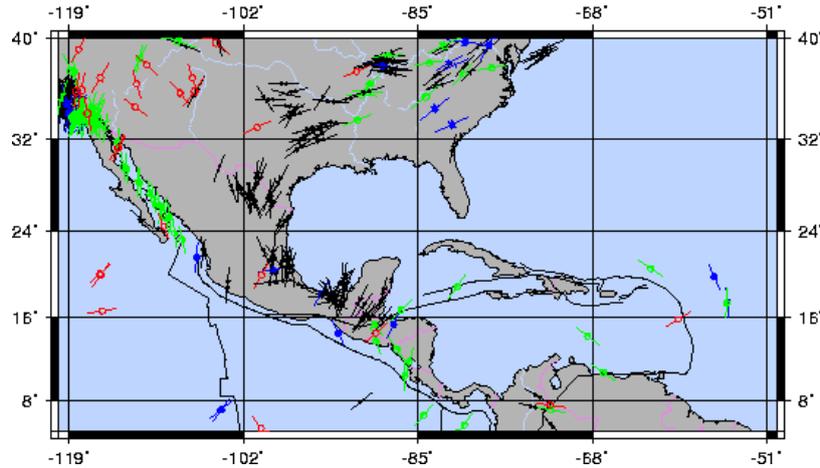


Fig. 2. Stress map of Middle America including all stress data records with A- and B-quality.

Depth interval

You can specify the depth interval from a top value to a deepest value. Depth values have to be positive. The surface has the value 0.

Symbol size

Possible values:

Default, Large, Middle, Small, Tiny, or Zero.

The relation between different symbol lengths of different data qualities will be preserved when the symbol size is changed. In Fig. 2 the symbol size was set to Default.

7. Stress map legend

It lists the plotted features (stress indicators, regimes, qualities, and depth interval) as chosen by the user, i.e. if borehole breakout data have been selected as only indicator, then only the breakout symbol will appear in the legend.

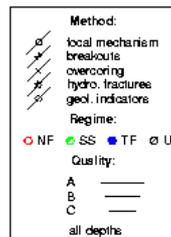


Fig. 3. Legend for a stress map with A-C quality data records from all depths from 0-40 km.

8. Add your own stress data

You can add your own stress data to the map. The file containing the data should have a format as shown in Fig. 4.

```
# longitude latitude azimuth type quality regime depth optional-text
22.3 23.4 130.3 FMS A NF 13 KaKo34
22.3 23.4 70.3 FMS A TF 31 KaKo35
22.3 23.4 98.6 BO B NF 3 KaKo36
22.3 23.4 90.3 FMS C NF 32 KaKo37
22.3 23.4 40.2 FMS C SS 23 KaKo38
```

Fig.4. File format for own stress data.

File format:

In the first line of your file you can write some comment or a headline. This line must start with the symbol "#" (Fig. 4). In the next lines your stress data are arranged in the following order: longitude, latitude, SH azimuth, type, quality, regime, depth, and optional text. Do not change this order! Due to some software peculiarities the longitude and latitude columns are exchanged compared with the WSM database.

No blanks are allowed in the beginning of each data line. All entries have to be separated by one or more blanks. Longitude, latitude, and depth have to be floating point numbers, SH azimuth an integer or floating point number. Type, quality, and regime have to be letters, but make sure that you exclusively use the abbreviations described in the WSM Scientific Technical Report 16-01 that is available on the WSM website. All columns need to be filled with information.

9. Output file format

You have the possibility to get your stress map as *.ps, *.pdf or *.jpg file. The compressed file will be provided for download in a compressed file (*.tar). You can decompress this file with standard software such as WinZip or 7-Zip.

Selected data as ASCII file

You can get the data plotted on your stress map as compressed ASCII file containing also the selection criteria for the map and some additional information (Fig. 5).

```
#####
# Creation date: Tue Sep 14 10:20:36 1999
# Data from the database of the World Stress Map project (Rel-97-1)
# Contact address: wsm@gpi.physik.uni-karlsruhe.de
#####
# Requested data:
#####
# Coordinate Range Lat: 40/50 Lon: 20/30
# Data Type: FM BO HF GI OC
# Data Quality: A B
# Tectonic Regime: IF SS TF U
# Depth Interval: 0km - 20km
# File Format:
# Latitude; Longitude; SHazimuth; Type; Quality; Regime; Depth; Site
#####
40.433;25.528;83;GFI;B;IF;0.000;AE5
40.140;24.740;92;FMS;B;SS;7.000;AE9
40.425;25.675;87;GFI;A;IF;0.000;AE13
40.430;25.693;72;GFI;B;IF;0.000;AE14
40.492;25.492;84;GFI;B;IF;0.000;AE15
40.625;24.583;84;GFI;B;IF;0.000;AE16
40.633;24.567;83;GFI;B;IF;0.000;AE17
40.008;25.383;78;GFI;A;IF;0.000;AE26
...
```

Fig.5. ASCII file containing the selection criteria and the stress data.

10. WSM newsletter subscription

If you want to receive the WSM Newsletter that will be a few times per year as a pdf-file please type in your e-mail address. The newsletter will keep you informed on our work, new database releases and software updates.

References

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- Zoback, M. L., and M. Zoback (1989), Tectonic stress field of the conterminous United States, in *Geophysical Framework of the Continental United States*, edited by L. C. Pakiser and W. D. Mooney, pp. 523-539, Geol. Soc. Am. Mem., Boulder, Colorado.