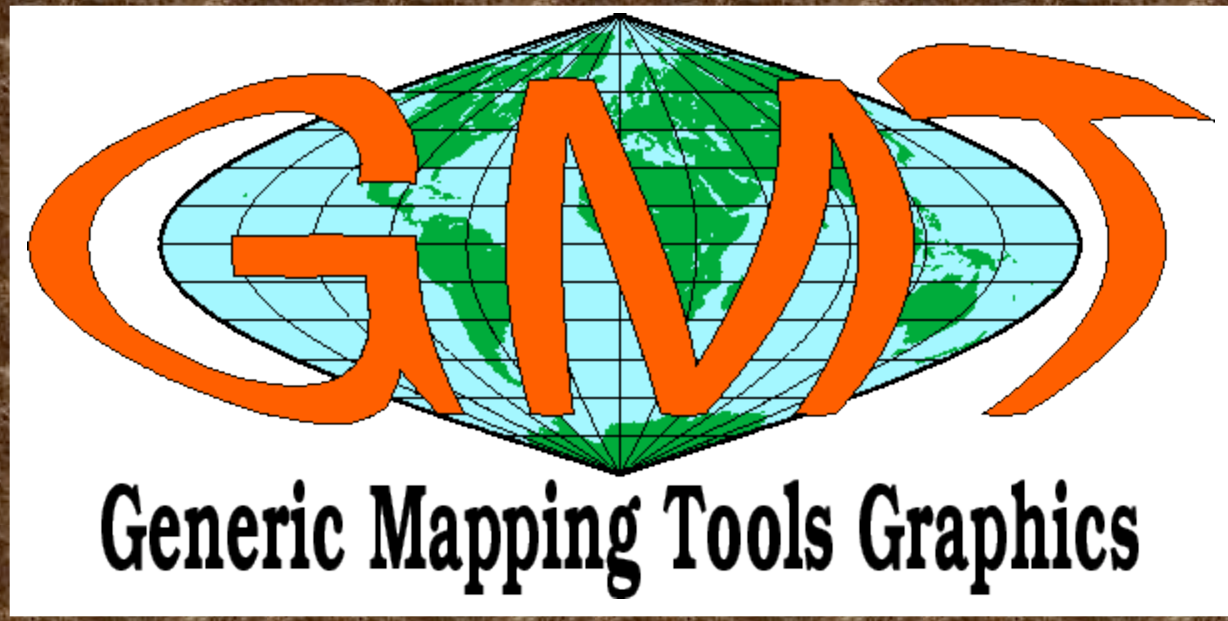


Advanced maps - topography, focal mechanisms

GENERIC MAPPING TOOLS (GMT)

Creating a map

gmtset: change individual GMT default parameters

(grdimage: plot topography)

pscoast: Plot coastlines, filled continents, rivers, political borders (, map border).

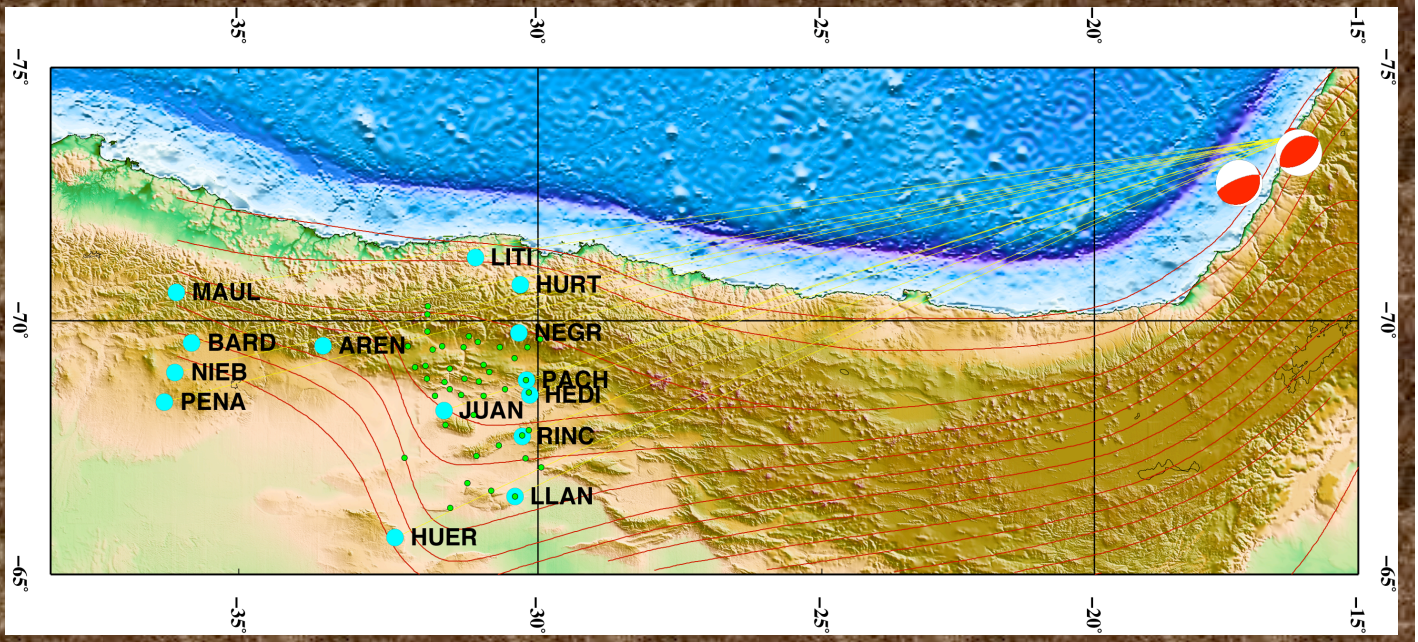
psxy: Plot symbols, polygons, and lines in 2-D

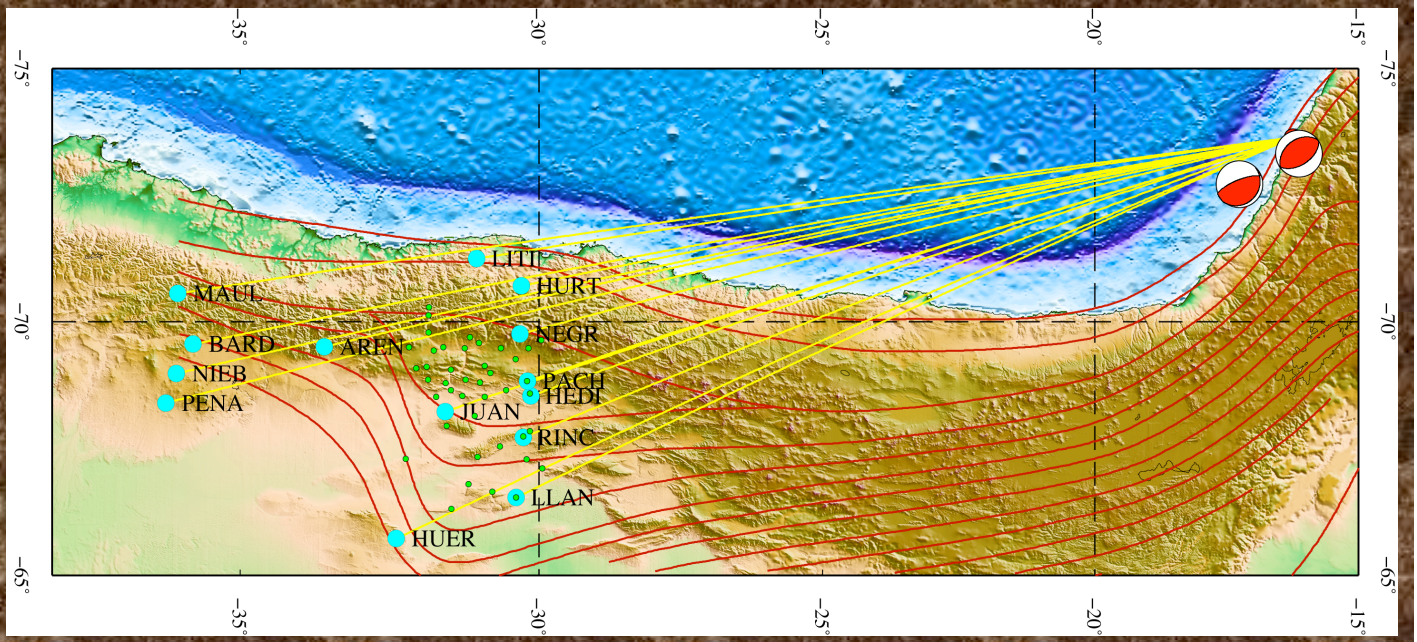
pstext: Plot text strings

psmeca: Plot focal mechanisms

psvelo: plot gps velocity vectors

Before edit with Illustrator





After edit with Illustrator

Setup

```
#!/bin/bash

ROOT=$HOME/unixside
GEODATA=$ROOT/geolfigs
SAMDATA=$ROOT/geolfigs
VBSE=-V

REGION=-75/-65/-38/-15
PROJ=-Jm0.9
```

```
WHITE=255
DKGRAY=64
LTGRAY=192
VLTGRAY=225
EXTGRAY=250
GRAY=128
BLACK=0
BLACKP1=1
BLACKP2=2
BLACKP3=3
BLACKP4=4
WHITEM1=254
WHITEM2=253

RED=255/0/0
RED1=254/0/0
DKRED=196/0/0
BLUE=0/0/255
GREEN=0/255/0
LTGREEN=192/255/192
DKGREEN=0/196/0
YELLOW=255/255/0
ORANGE=255/192/0
MAGENTA=255/0/255
DKMAGENTA=181/0/223
CYAN=0/255/255
LTCYAN=196/255/255
LTBLUE=192/192/255
VLTBLUE=225/255/255
VLTBLUE=240/250/255
LTRED=255/225/225
PINK=255/225/255
BROWN=160/64/32
LTBROWN=224/128/96
REDBROWN=255/96/64
VLTBROWN=229/225/209
MUDBLUE=193/213/232
```

```
MOREPS=-K
CONTINUEPS="-K -O"
ENDPS=-O
PORTRAIT=-P
OUTFILE=$0.ps
```

Get Bathymetry

```
GRDRASTERREGION=$REGION
DATASET=10
DATAGRID=-I2m/2m
grdraster $DATASET -G${ROOTNAME}_2mtopo.grd $DATAGRID -R
$GRDRASTERREGION $VBSE
```

Get Topography

```
DATASET=9
DATAGRID=-I30c/30c
grdraster $DATASET -G${ROOTNAME}_topo.grd $DATAGRID -R
$GRDRASTERREGION $VBSE
```

Illuminate topography

```
BATHILLUM=270
TOPOILLUM=315
NORM=-Nt
grdgradient ${ROOTNAME}_topo.grd -A$TOPOILLUM -G$
{ROOTNAME}_topo.intns $NORM $VBSE
INTNSFILE=${ROOTNAME}_topobath
```

Resample (up/interpolate) bathymetry

```
grdsample ${ROOTNAME}_2mtopo.grd -G${ROOTNAME}_30stopo.grd
$DATAGRID -F -R$GRDRASTERREGION $VBSE
```

Illuminate bathymetry

```
grdgradient ${ROOTNAME}_30stopo.grd -A$BATHILLUM -G$
{ROOTNAME}_30stopo.intns $NORM $VBSE
```

Combine bathymetry and topo data sets. Have to do for both color topo and shading.

```
grdmath $VBSE ${ROOTNAME}_topo.grd ${ROOTNAME}_30stopo.grd AND
= ${ROOTNAME}_topobath.grd
grdmath $VBSE ${ROOTNAME}_topo.intns ${ROOTNAME}_30stopo.intns
AND = ${ROOTNAME}_topobath.intns
```

(see grdmath man page

```
   Name     #args   Returns
   ----------------------
    . . .
   AND   2 1    NaN if A and B == NaN, B if A == NaN, else A.
   . . .
```

Select color table, some more setup, render shaded color topo. This call has all the setup info (projection, offset, orientation, etc.)

```
CPTFILE=$ROOT/dem/GMT_globe.cpt
XOFFSET=4.8
YOFFSET=3.6
grdimage $INTNSFILE.grd -I$INTNSFILE.intns -C$CPTFILE -R
$REGION $PROJ $MOREPS -X$XOFFSET -Y$YOFFSET $PORTRAIT $VBSE >
$OUTFILE
```

Draw coastline

```
pscoast -R$REGION $PROJ -B5g10 -W1 $CONTINUEPS -Dh $VBSE >>
$OUTFILE
```

Draw Wadati-Benioff zone contour lines

```
LINE=-W2./$DKRED
WBZFILE=${ROOTNAME}.WBZ
\rm $WBZFILE
touch $WBZFILE
cat $SAMDATA/0836_25km_bend_notrench.gmt >> $WBZFILE
cat $SAMDATA/575.gmt >> $WBZFILE
nawk 'BEGIN {print "$"} !/\$/ { print $2, $1}' $SAMDATA/
sj-100-km-well-defined.gmt >> $WBZFILE
nawk '{ print $1, $2}' $SAMDATA/0836_100km_extn.gmt >>
$WBZFILE
psxy -R$REGION $PROJ -M$ $CONTINUEPS $LINE $WBZFILE $VBSE >>
$OUTFILE
```

Draw lines from earthquake to stations

```
sac <$MACRO | nawk -f sachdr.nawk > $0.tmp

EQLAT=-16.26
EQLON=-73.64
psxy -R$REGION $PROJ -M$ -L -W1/$YELLOW $CONTINUEPS $VBSE
<<END>> $OUTFILE
`nawk '{print '$EQLON','$EQLAT'}{print $1,$2}{print "$"}'
$0.tmp`
END
```

Plot stations

```
psxy -R$REGION $PROJ -Sc0.3 -G$CYAN -L -W.1/0 $CONTINUEPS
$0.tmp $VBSE >> $OUTFILE
```

Could also have done with

```
#sac <$MACRO | nawk -f sachdr.nawk | psxy -R$REGION $PROJ -
Sc0.1 -G$CYAN -L -W.1/0 $CONTUNUEPS $VBSE >> $OUTFILE
#psxy -R$REGION $PROJ -Sc0.3 -G$CYAN -L -W.1/0 $CONTUNUEPS
$VBSE <<END>> $OUTFILE
#`sac <$MACRO | nawk -f sachdr.nawk`
#END
```

Plot earthquake

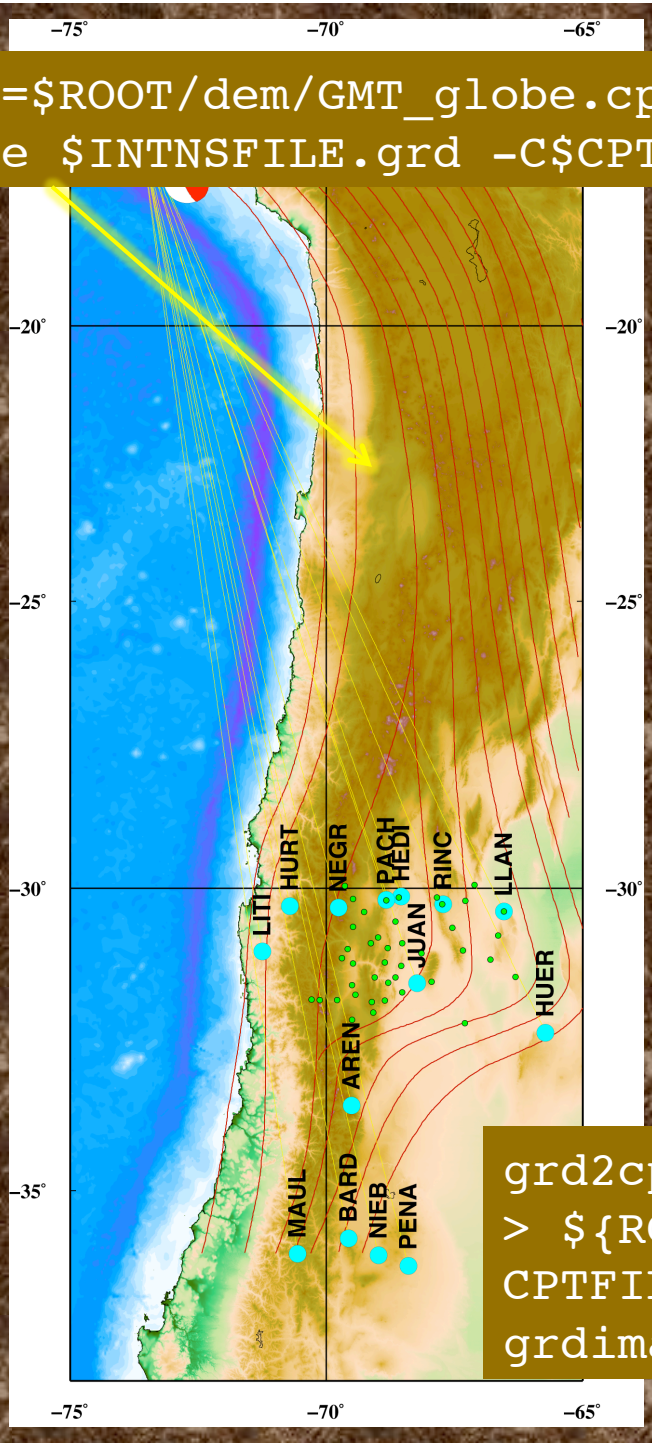
```
echo $EQLON $EQLAT | psxy -R$REGION $PROJ -Sc0.3 -G$RED -L -W.
1/0 $CONTINUEPS $VBSE >> $OUTFILE
```

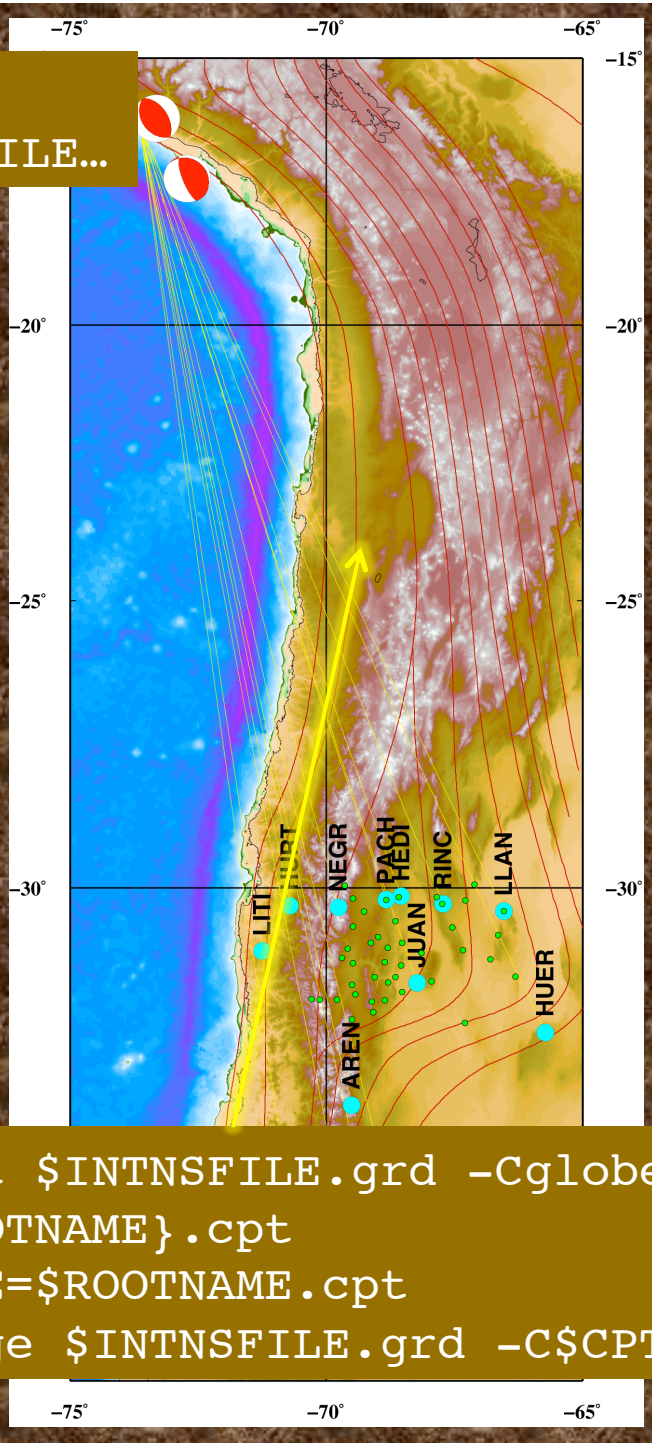
Plot focal mechanism

```
MECASIZE=.5
psmeca -R$REGION $PROJ -Sd$MECASIZE/0/0 -G$RED $ENDPS -L -
W0.5/$BLACK $VBSE << END >> $OUTFILE
`nawk '{print $1, $2, $3, $4, $5, $6, $7, $8, $9, $10}'
eq.cmt`
`nawk '{print $1, $2, $3, $4, $5, $6, $7, $8, $9, $10}'
eq.usgsmt`
```

Topo to color, no shading

```
CPTFILE=$ROOT/dem/GMT_globe.cpt
grdimage $INTNSFILE.grd -C$CPTFILE…
```



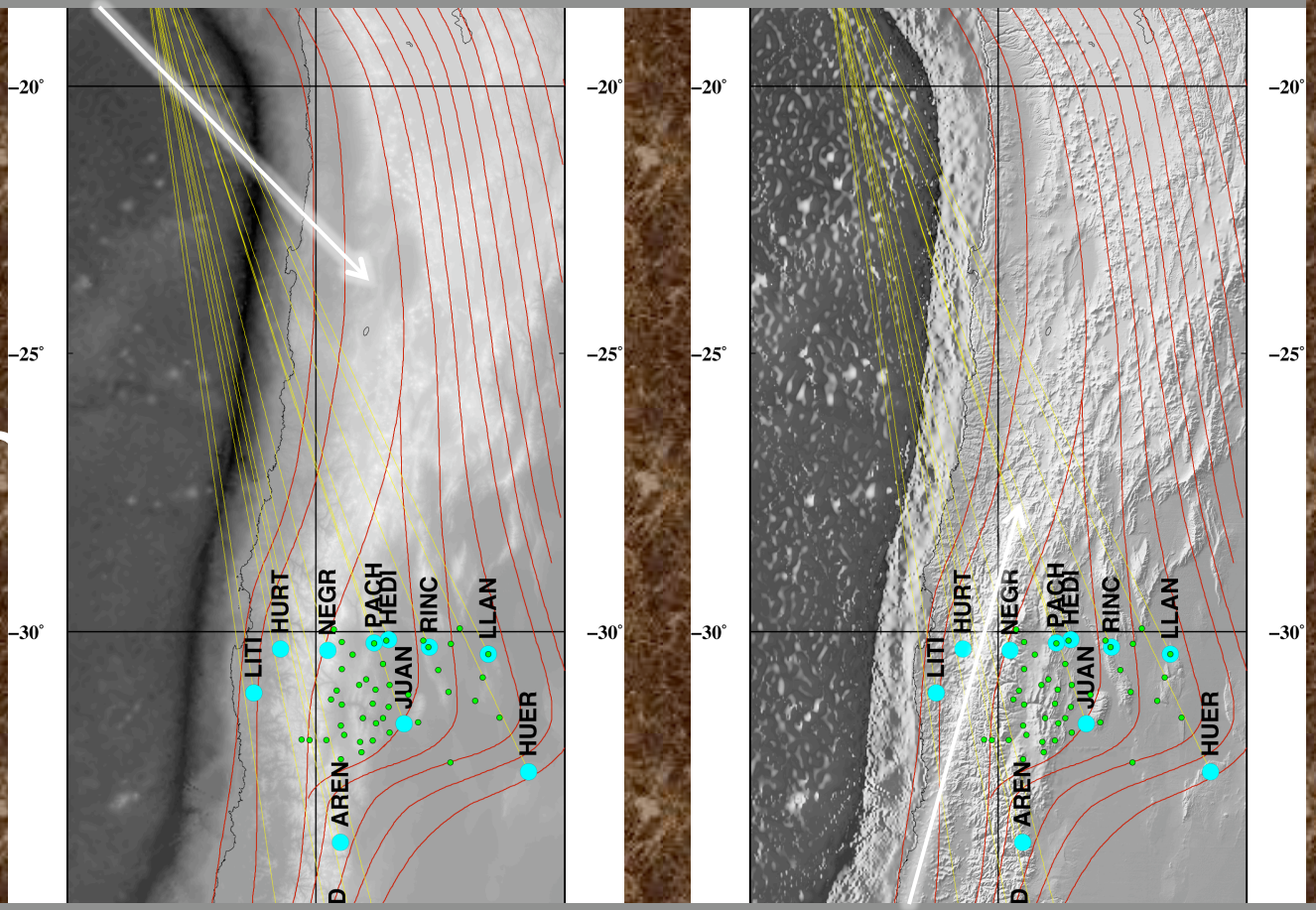


Topo to color (color rescaled for wider range), no shading

```
grd2cpt $INTNSFILE.grd -Cglobe -E128
> ${ROOTNAME}.cpt
CPTFILE=$ROOTNAME.cpt
grdimage $INTNSFILE.grd -C$CPTFILE…
```

```
rd2cpt $INTNSFILE.grd -Cgray -E128 > ${ROOTNAME}.cpt
CPTFILE=$ROOTNAME.cpt
#topo to graysacel plus shading
grdimage $INTNSFILE.grd -C$CPTFILE…
```

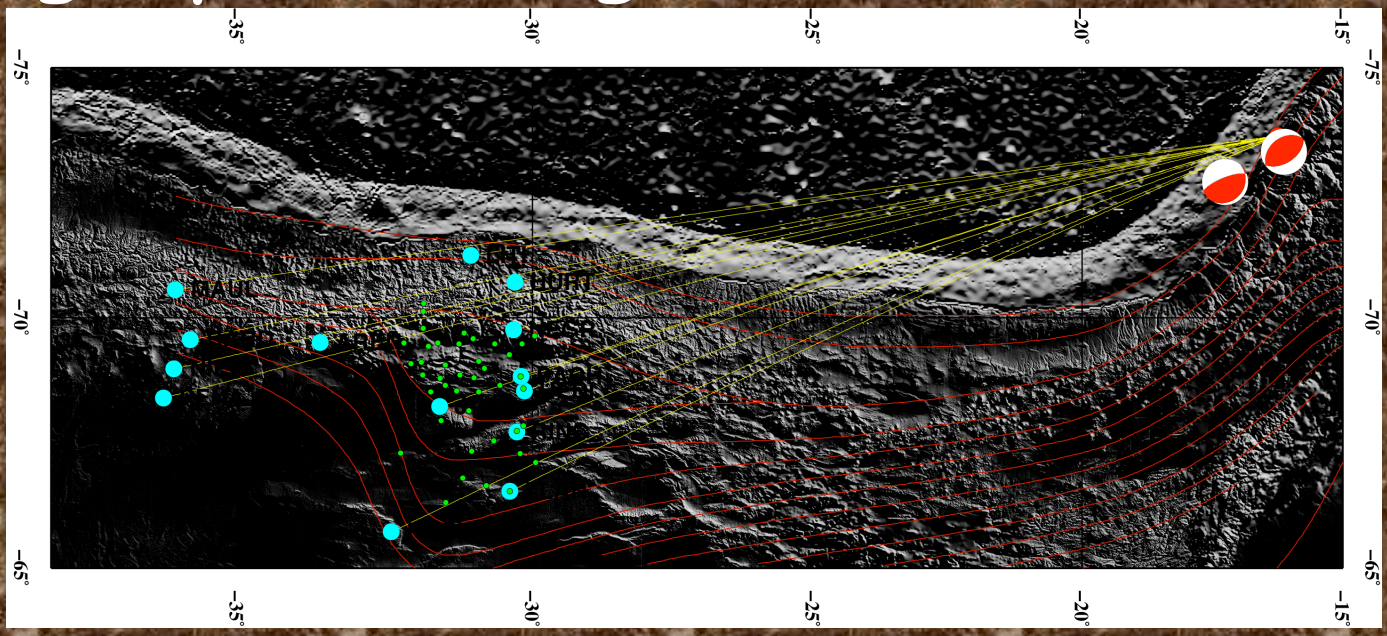
Topo to grayscale, no shading

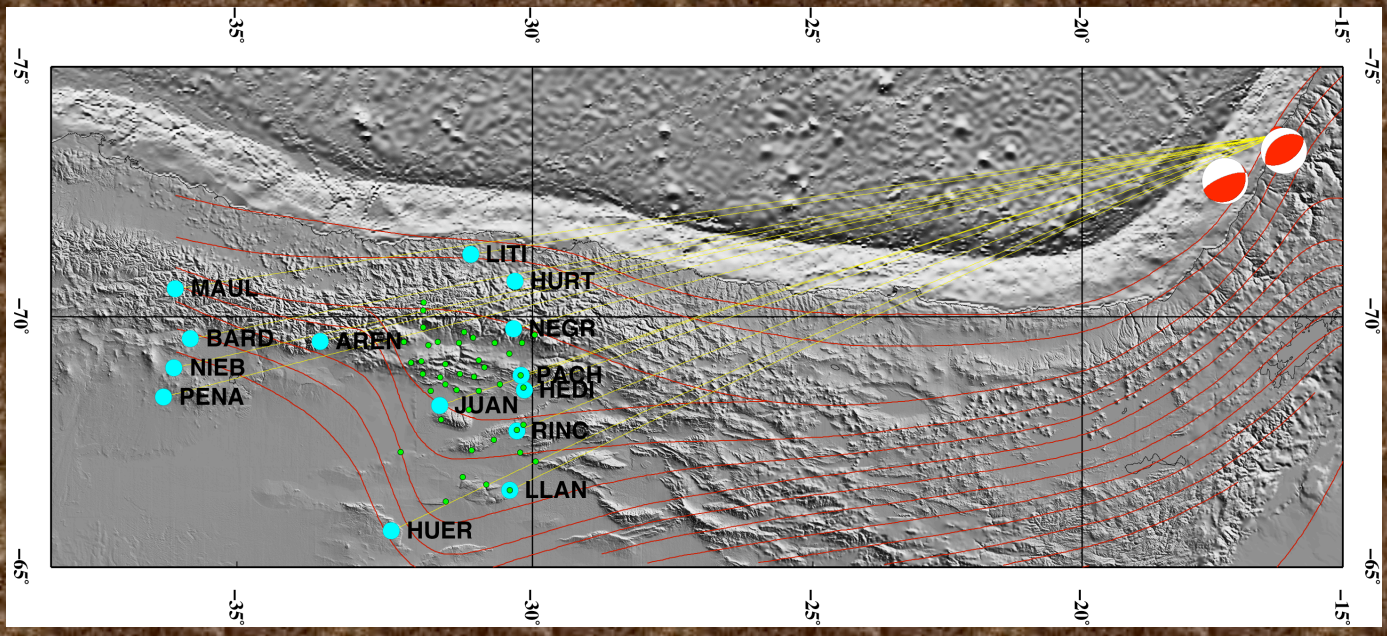


Topo to grayscale, with shading

```
rd2cpt $INTNSFILE.grd -Cgray -E128 > ${ROOTNAME}.cpt
CPTFILE=$ROOTNAME.cpt
#topo to graysacel plus shading
grdimage $INTNSFILE.grd -I$INTNSFILE.intns -C$CPTFILE…
```

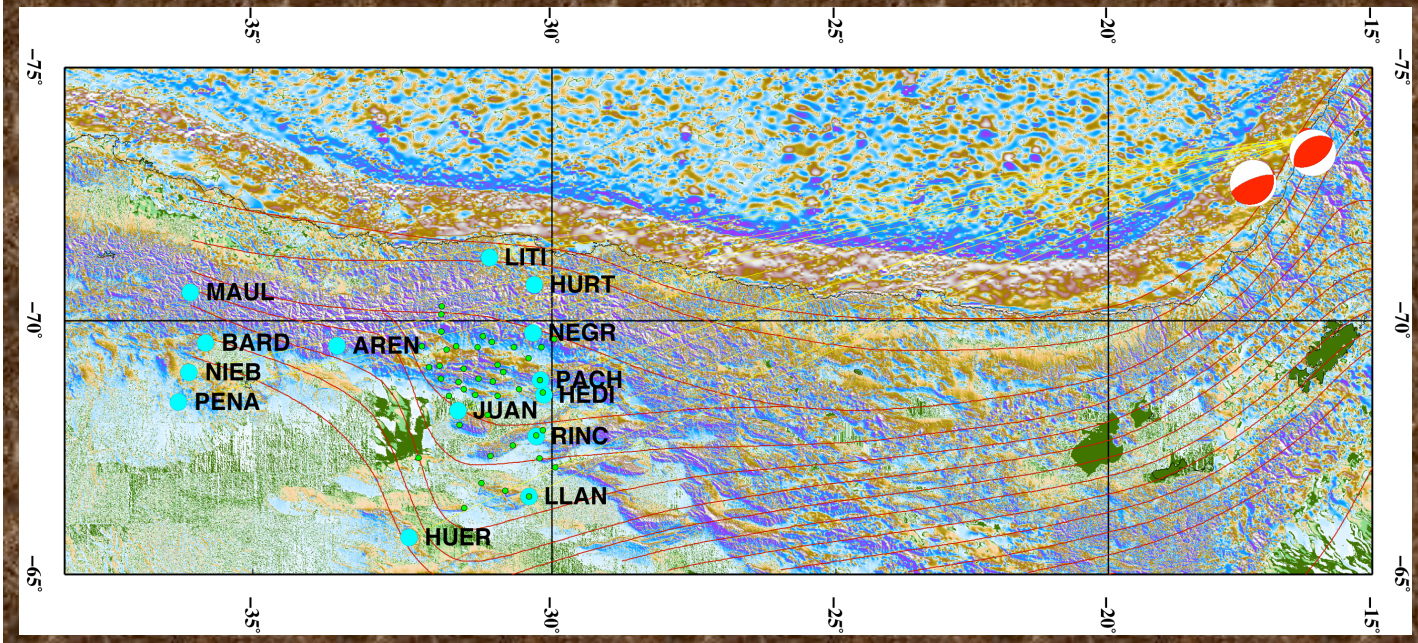
Shading (intensity) to grayscale, high contrast





Shading (intensity) to grayscale, low contrast

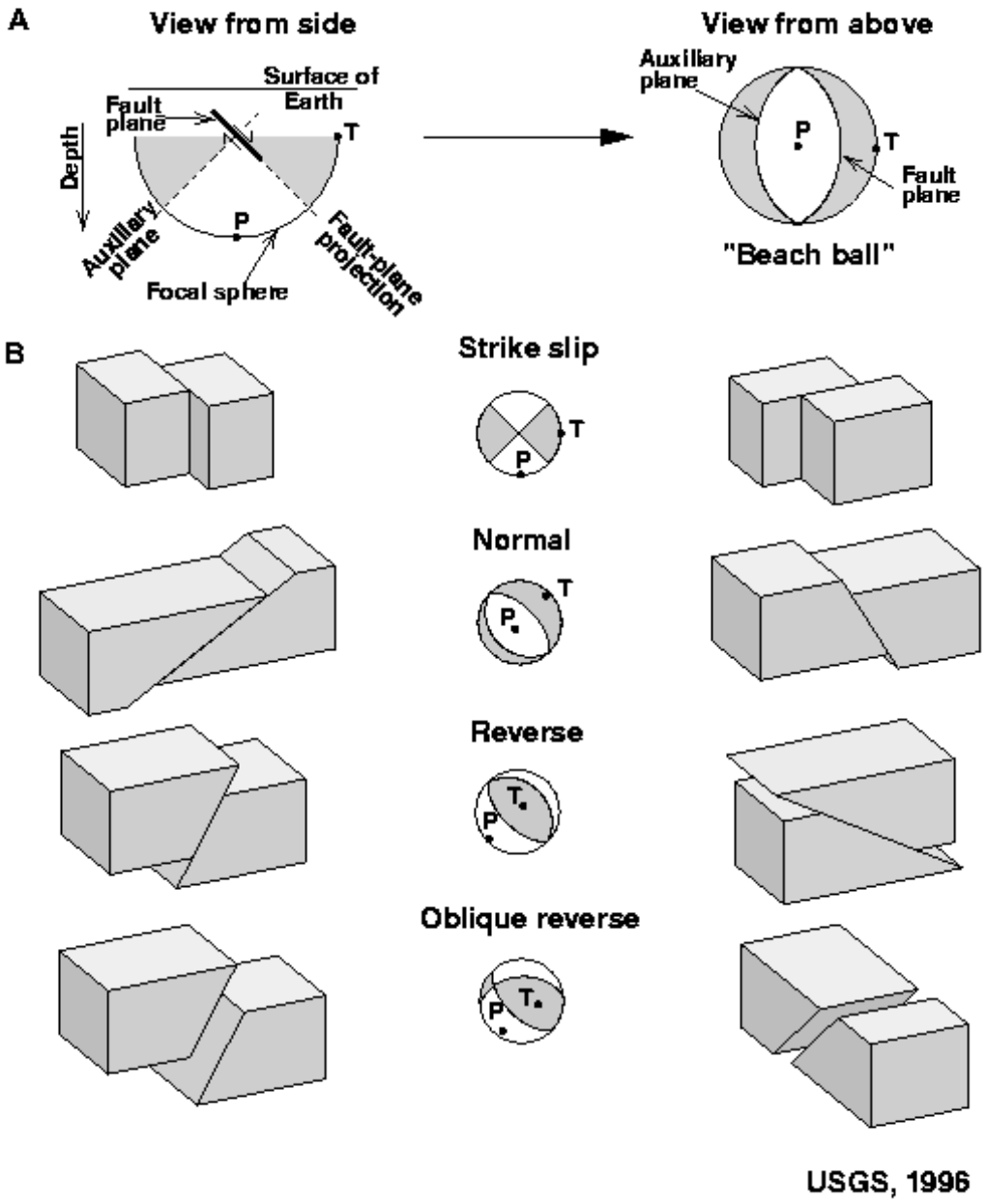
Shading (intensity) to color



```
grdgradient
grdgradient 4.3.1 - Compute directional gradients from grid files

usage: grdgradient <infile> -G<outfile> [-A<azim>[/<azim2>]] [-D[a][o][n]]
[-E[s|p]<azim>/<elev[ambient/diffuse/specular/shine]>]
[-L<flag>] [-M] [-N[t_or_e][<amp>[/<sigma>[/<offset>]]]] [-S<slopefile>] [-V]

    <infile> is name of input grid file

    OPTIONS:
    -A sets azimuth (0-360 CW from North (+y)) for directional derivatives
      -A<azim>/<azim2> will compute two directions and save the one larger in
magnitude.
    -D finds the direction of grad z.
       Append c to get cartesian angle (0-360 CCW from East (+x)) [Default:
azimuth]
       Append o to get bidirectional orientations [0-180] rather than directions
[0-360]
       Append n to add 90 degrees to the values from c or o
    -E Compute Lambertian radiance appropriate to use with grdimage/grdview.
       -E<azim/elev> sets azimuth and elevation of light vector.
       -E<azim/elev/ambient/diffuse/specular/shine> sets azim, elev and
        other parameters that control the reflectance properties of the surface.
        Default values are: 0.55/0.6/0.4/10
        Specify '=' to get the default value (e.g. -E60/30/=/0.5)
       Append s to use a simpler Lambertian algorithm (note that with this form
       you only have to provide the azimuth and elevation parameters)
       Append p to use the Peucker picewise linear aproximation (simpler but
faster algorithm)
       Note that in this case the azimuth and elevation are hardwired to 315 and
45 degrees
```

```
        This means that even if you provide other values they will be ignored.
    -G output file for results from -A or -D
    -L sets boundary conditions.  <flag> can be either
       g for geographic boundary conditions
       or one or both of
       x for periodic boundary conditions on x
       y for periodic boundary conditions on y
       [Default:  Natural conditions]
    -M to use map units.  In this case, dx,dy of grid
       will be converted from degrees lon,lat into meters (Flat-earth
approximation).
       Default computes gradient in units of data/grid_distance.
    -N will normalize gradients so that max |grad| = <amp> [1.0]
      -Nt will make atan transform, then scale to <amp> [1.0]
      -Ne will make exp  transform, then scale to <amp> [1.0]
      -Nt<amp>/<sigma>[/<offset>] or -Ne<amp>/<sigma>[/<offset>] sets sigma
         (and offset) for transform. [sigma, offset estimated from data]
    -S output file for |grad z|; requires -D
    -V Run in verbose mode [OFF].
```

Schematic diagram of a focal mechanism



USGS, 1996