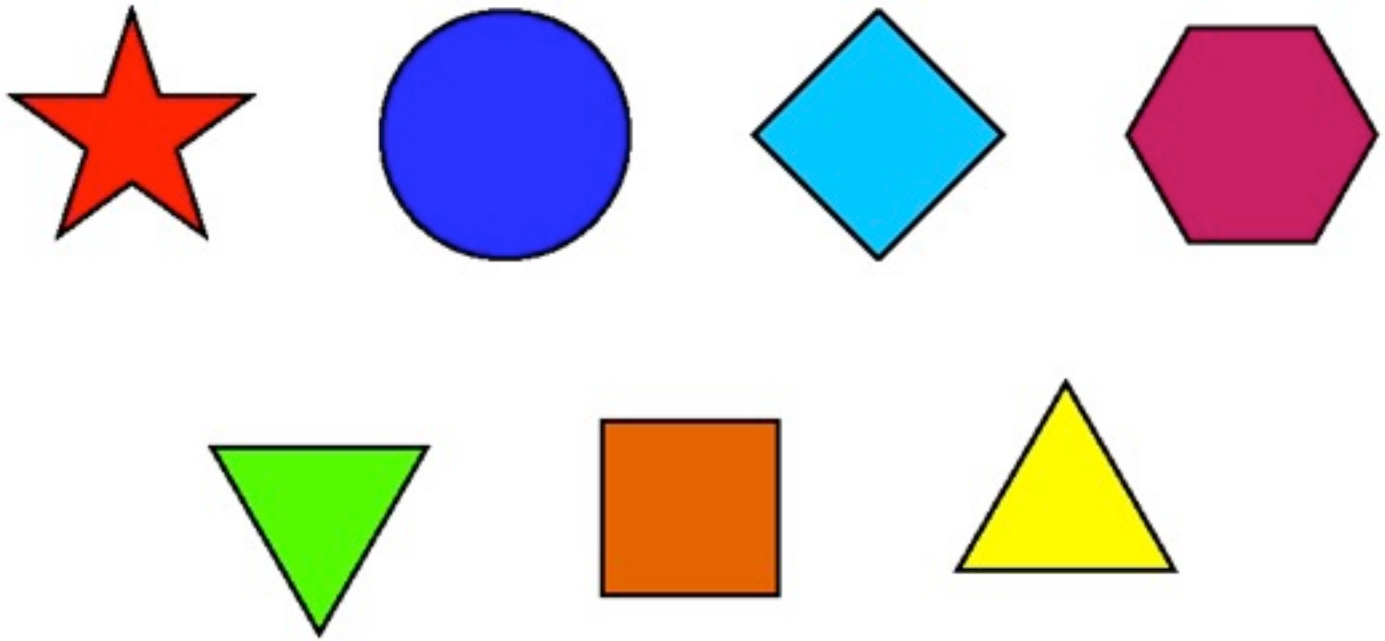
Plotting Lines and Symbols

- psxy can be used to plot;
  - lines
  - closed polygons
  - standard geometric symbols (circle, square, etc.)
  - Custom designed symbols
- Polygons and most symbols may be
  - filled with paint of chosen colour
  - filled with B/W or colour pattern

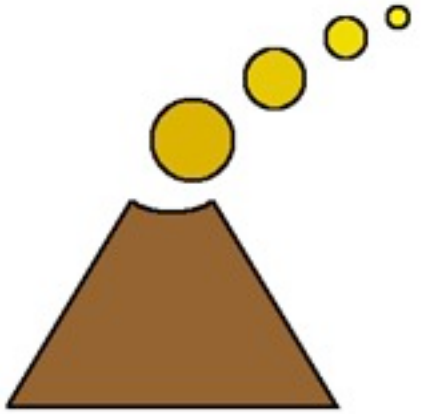
GMT Symbols and Patterns

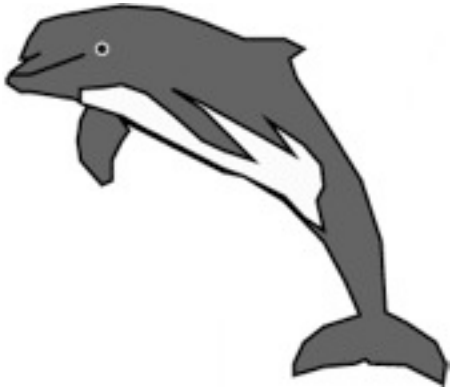
- Standard Geometrical shapes



GMT Symbols and Patterns

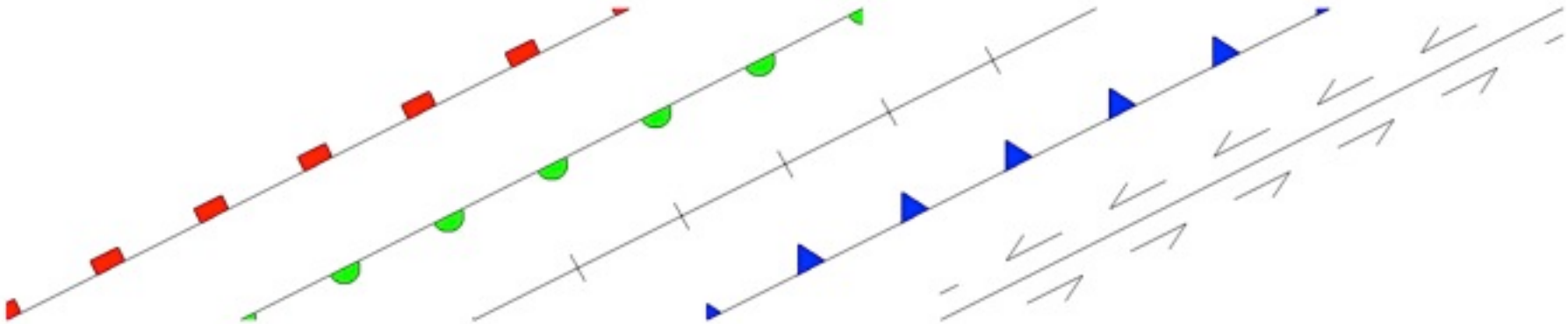
- User Defined Symbols





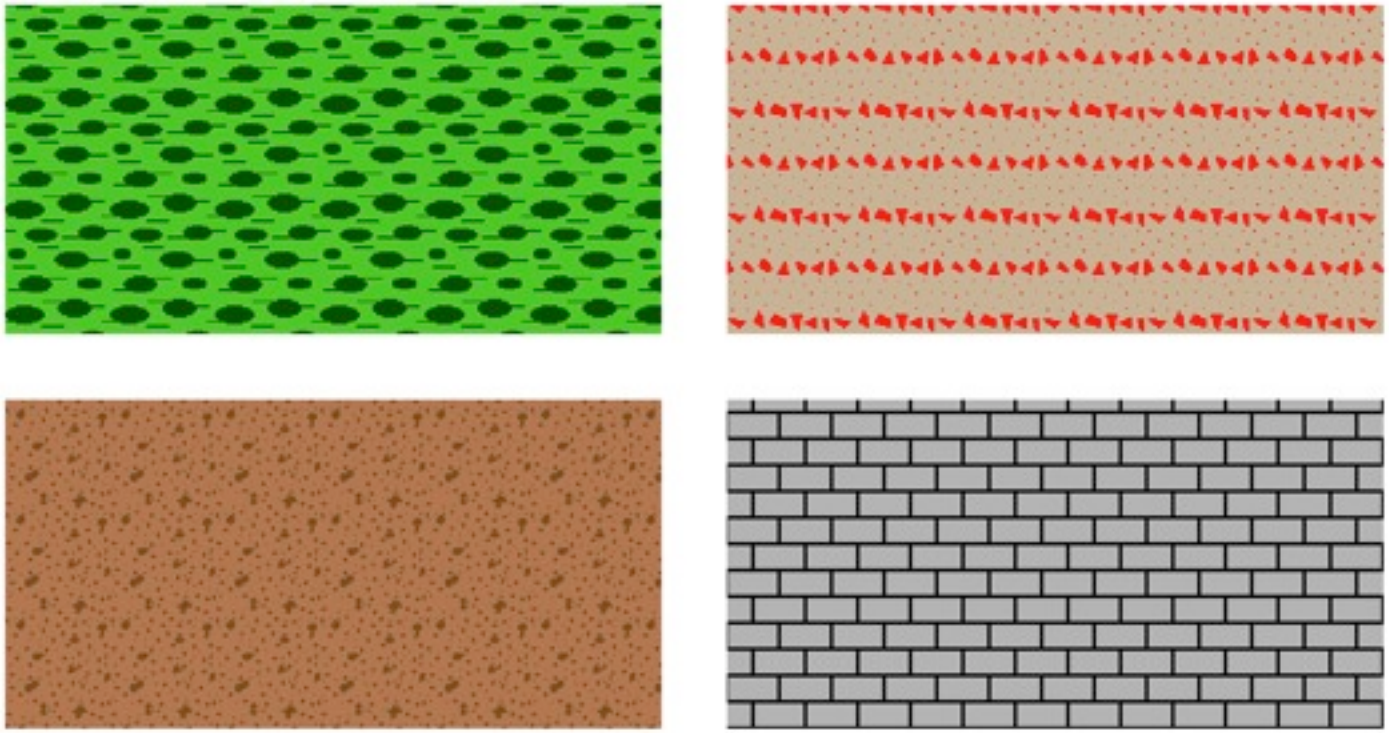
GMT Symbols and Patterns

- Faults, Fronts and other demarcations



GMT Symbols and Patterns

- Pattern Fill



Common psxy options

Option	Purpose
–A	Suppress great circle line interpolation
–Ccpt	Set symbol color from z-values and cpt file
–E[**x**|**X**][**y**|**Y**][cap][/pen]	Draw error bars with specified attributes
–Gfill	Set color for symbol or fill for polygons
–L	Explicitly close polygons
–M[flag]	Multiple segment file; headers start with flag
–N	Do Not clip symbols at map borders
–S[symbol][size]	Selects one of several symbol
–Wpen	Set pen for line or symbol outline

Controlling psxy

- Lines:
  - **–W**pen, optionally **–L** for closure
- Polygons:
  - **–G**fill (implies **–L**)
  - Optionally **–W**pen for polygon outline
- Symbols:
  - **–S**[symbol][size]
  - If not specified, symbol and/or size must be given in the data file(s)
  - Select **–G**fill and/or **–W**pen for outline
  - Optionally add error bars with **–E**[x|X][y|Y]

psxy –S: Available symbols

Code	Symbol	Code	Symbol	Code	Symbol
–	x-dash (–)	**g**	octagon	**r**	rectangle
a	star	**h**	hexagon	**s**	square
b	bar	**i**	invtriangle	**t**	triangle
c	circle	**k**	kustom	**v**	vector
d	diamond	**l**	letter	**w**	wedge
e	ellipse	**n**	pentagon	**x**	cross (x)
f	front	**p**	point	**y**	y-dash (|)

(a, c, d, g, h, i, n, s, t, x) fits inside circle of given diameter

(A, C, D, G, H, I, N, S, T, X) has area equal to circle of given diameter

Specifying colours

- Color names: Give standard X11 names such as red, green, violet, pink, lemonchiffon.
- RGB system: Give r/g/b where each integer indicates intensity of light from 0 to 255. If r = g = b we have gray and only r needs to be specified.
- E.g. red = 255/000/000
- E.g. yellow = 255/255/000
- E.g. pink = 200/000/080

psxy exercise

- Copy over the file called data.txt
- Use psxy to plot data as transparent circles of size 0.6 cm.

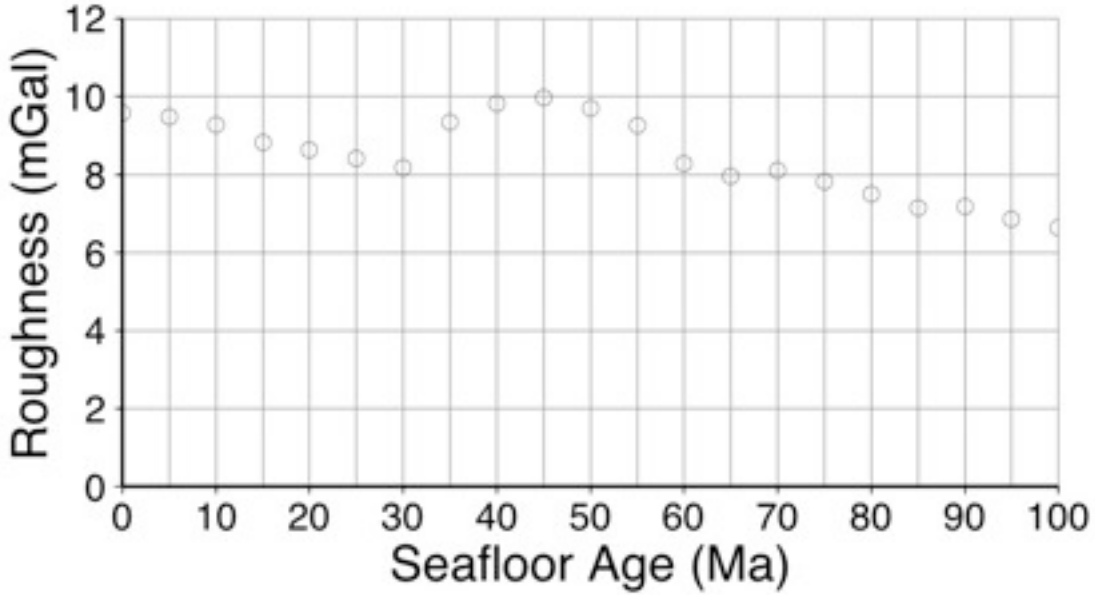
```
psxy data.txt -R0/6/0/6 -JX12 -B2g1 -Sc0.6 -P > ex11.ps
ps2raster ex11.ps
```

- Now try using the -G option to fill the circles (e.g. -Ggreen or -G0/255/0)
  - `psxy data.txt -R0/6/0/6 -JX12 -B2g1 -Sc0.6 -P -Ggreen > ex11.ps`
- Now give them back an outline (e.g. -Wthin)
  - `psxy data.txt -R0/6/0/6 -JX12 -B2g1 -Sc0.6 -P -Ggreen -Wthin > ex11.ps`

Exercise: Use psxy to plot point data

- Copy over the file testpoints.txt
- Have a look at it using Notepad++
- Use minmax to determine the range of the data (to fill the ? in the psxy command)
- Now use the following GMT command and options to plot this data.
  - minmax testpoints.txt
  - psxy testpoints.txt -JX12/6 -R0/?/0/? -Ba10g5:"Seafloor Age (Ma)":/a2g2:"Roughness (mGal)":SW -Sc0.2 > testpoints_1.ps
- To see the figure you made type
  - ps2raster testpoints_1.ps

- -JX12/6 - We are plotting non-geographic data (i.e. these are not latitudes and longitudes) so we need to use -JX. 12/6 sets the width=12cm, and height=6cm.
- -R0/100/0/12 - Sets the region of the plot from 0 to 100 for the x-axis and 0 to 12 for the y-axis
- -Ba10g5:"Seafloor Age (Ma)":/a2g2:"Roughness (mGal)":SW - For the x-axis, sets the annotation interval to 10 and grid interval to 5. For the y-axis, sets the annotation and grid interval to 2. WS specifies that only the west and south axes of the plot will be plotted and labelled.
- -Sc0.2c - This option tells GMT how to treat the data points that are in the file testpoints.txt. 'c' specifies a circle, and 0.2c specifies the size of the circles.



Exercise: Use psxy to plot point data cont…

- Plot as solid purple stars
- Give your stars a thick (1.5p), dashed green outline (-W.....)
- Plot as line data (no symbols)
- Plot as filled polygon using your favorite color (use -L, -W and -G but no -S)
- Plot solid line with inverted triangles (0.6 cm) (hint: look at -Sf .....)

psxy data file format

General format with [optional] columns:

x y [z] [size] [σ_x] [σ_y] [symbol]

- Supply size if you want individual sizes*
- Supply error info for x and/or y:
  - **–Ex** needs σ_x (plain error bar)
  - **–EX** needs x_{min} $x_{25\%}$ $x_{75\%}$ x_{max} (box-whisker)
- Supply z and a cpt file (**–C**) to assign colors based on z

*size is direction length for vectors, direction major- minor-axis for ellipses, and width height for rectangles

psxy exercise – Specifying errors etc in the input file

- 1) Use the file testpoints_sizes.txt to plot different symbols for different points. (Hint: remove size from the command line e.g. -Sa rather than -Sa0.5)
- 4) Use the file testpoints_errors.txt and the -E option with to plot error bars || to the y-axis

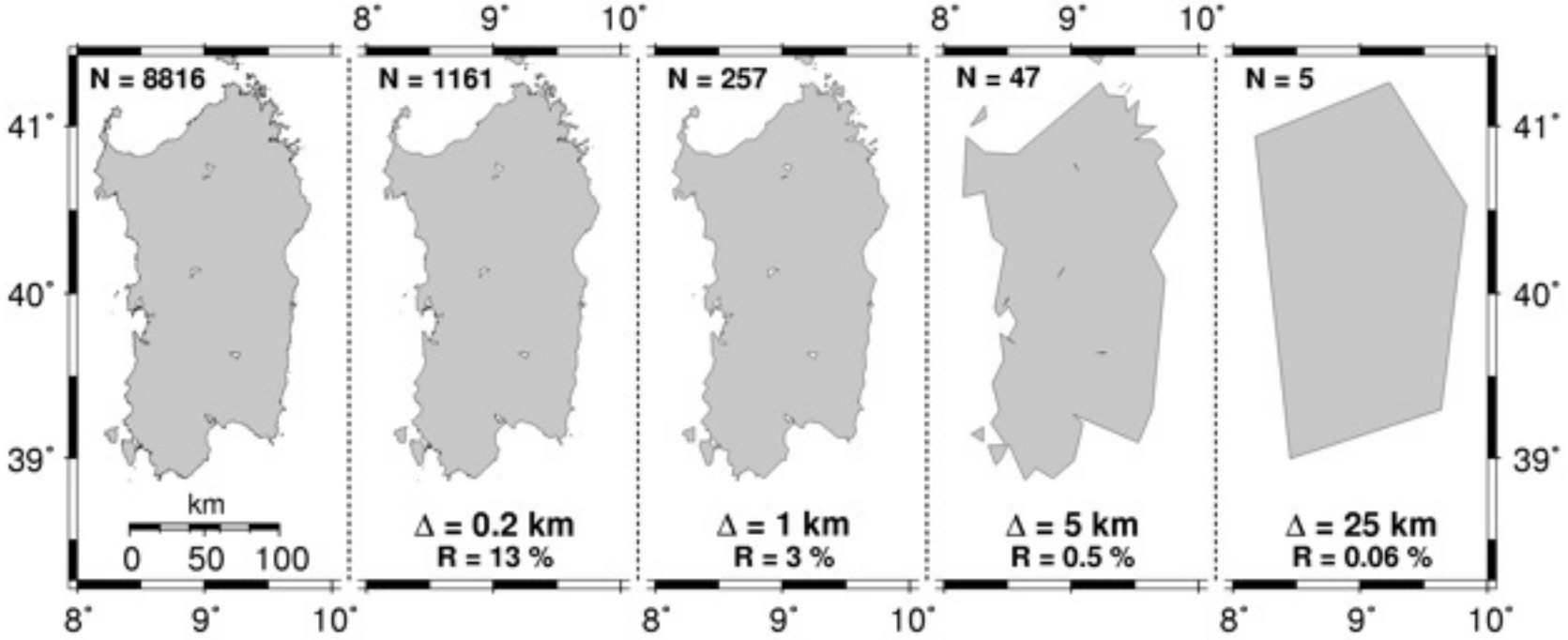
Plotting basic maps with pscoast

- Takes –R, –J, and –B for basic setup
- One or more additional options required:

Option	Purpose
–A	Exclude small features or those of high hierarchical levels
–D	Select data resolution (full, high, intermediate, low, crude)
–G	Color of dry areas [no paint]
–I	Draw rivers (append category and pen)
–L	Plot map scale
–N	Draw political boundaries (append category and pen)
–S	Color of wet areas [no paint]
–W	Draw coastline (append pen)

The 5 Coastline Resolutions

- full, high, intermediate, low [Default], crude
- About 20% reduction in detail per level



Exercise: pscoast

Make a Mercator map of Australia. Plot green land with blue oceans.

- Try another coastline resolution
- Draw the coastline with a white pen
- Change annotation appearance with **PLOT_DEGREE_FORMAT**
- pscoast -JM12 -R90/150/-40/0 -Ggreen -Sblue -P -Ba10f10 -Df > Australia.ps
- --PLOT_DEGREE_FORMAT=dddF > Australia.ps
  - --MEASURE_UNIT=cm

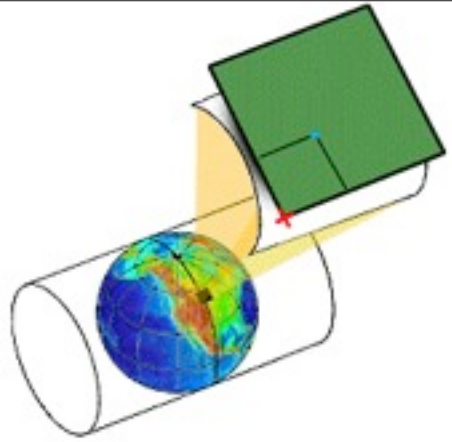
UTM Projection

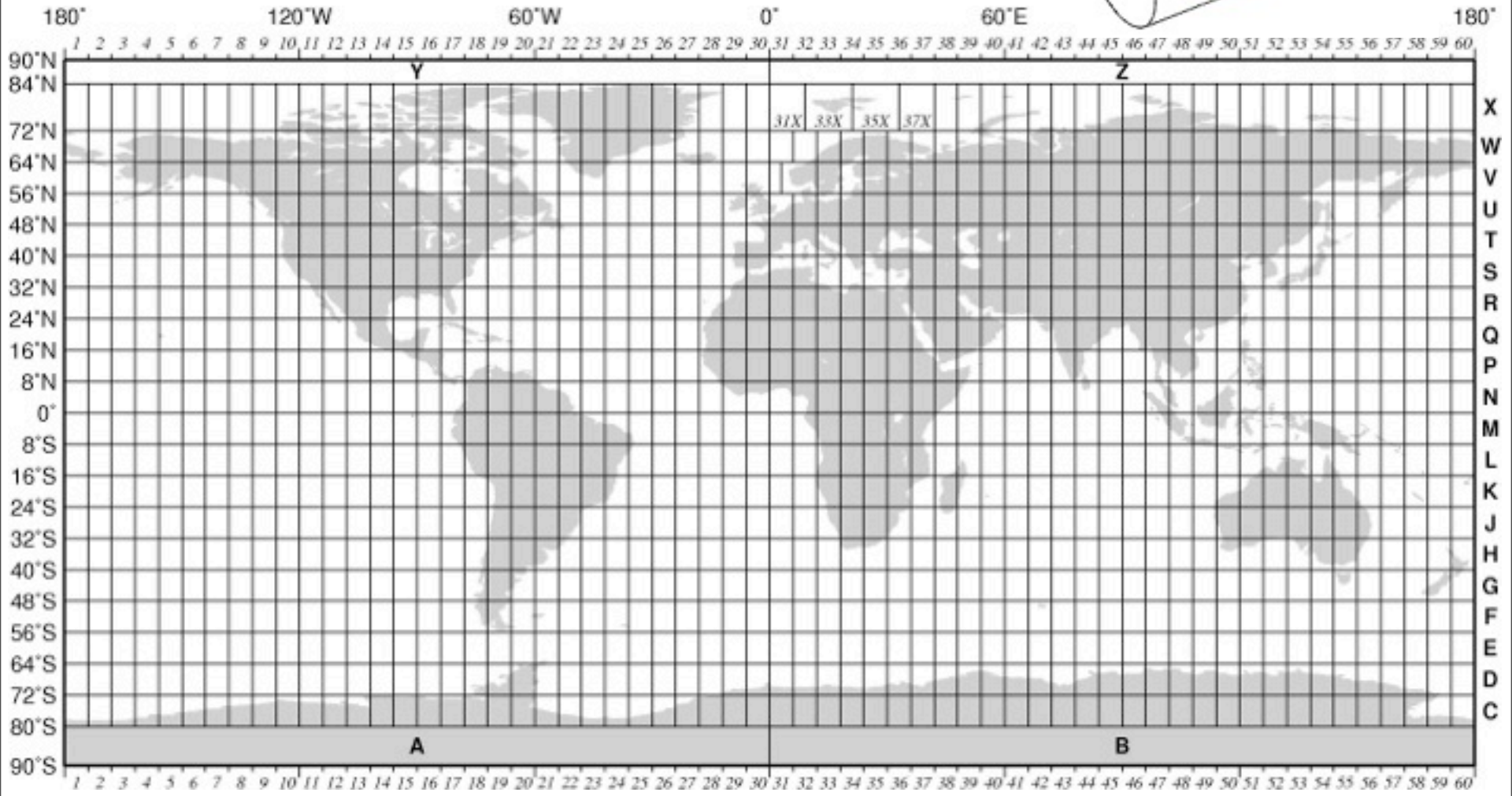
- Conformal and Cylindrical projection
- Syntax: -JUzone/width or -Juzone/scale
  - Height calculated automatically
  - Zone is a 6°wide longitude strip starting at 180°W
    - E.g., zone 1 is 180°W to 174°W, centered on 177°W
    - zone is usually provided, if not, compute from the central meridian as

$$zone = \frac{(lon - 180 + 360)\%360}{6} + 1$$

  - Some special zones are different (see map)
  - scale can be
    - plot units per degree or 1:xxxxxxx

UTM Zones A–B,1–60,Y–Z





UTM Zones – Australia

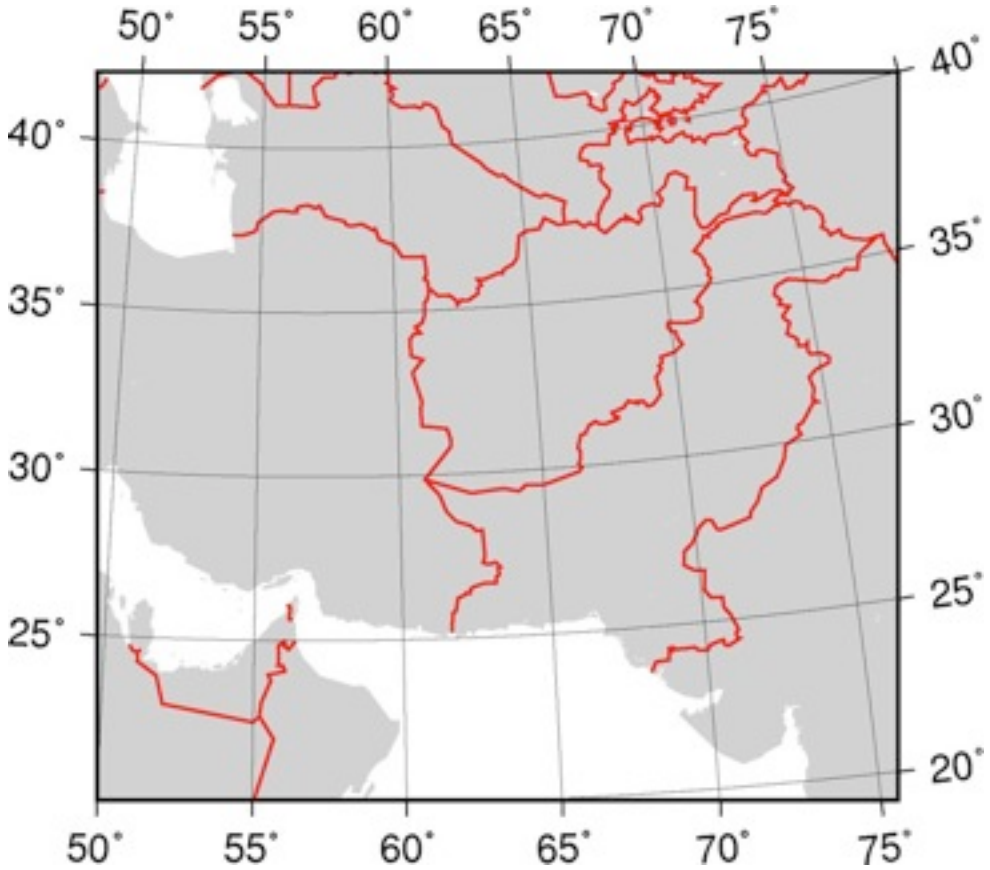
Exercise: UTM Afghanistan

- Task: Make a UTM map of Afghanistan, using UTM zone 40. Plot shaded land with political borders.

- Use lower left and upper right setup instead of w/e/s/n

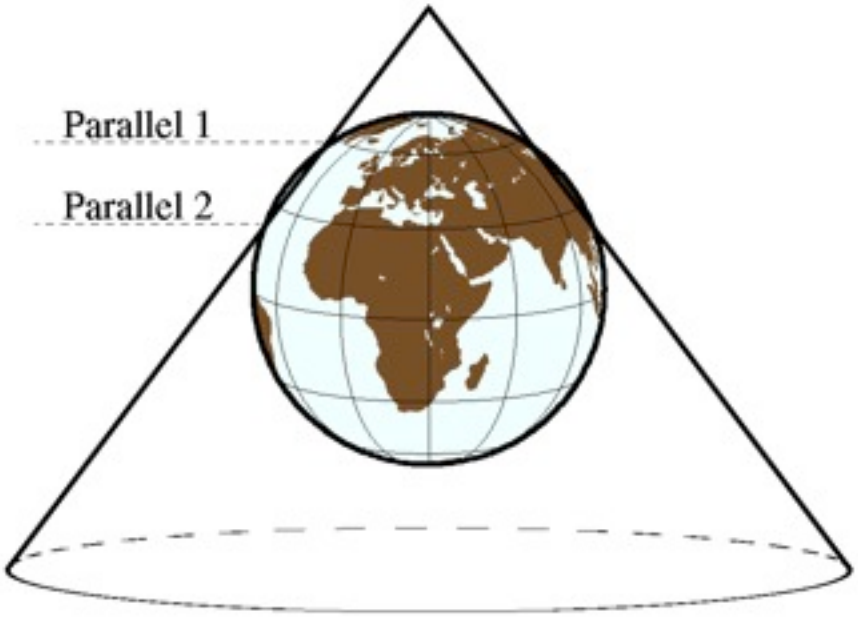
Exercise: UTM Afghanistan

- pscoast -R50E/20N/80E/40Nr -JU40/10 -B5g5 -G200 -N1/1p,red -P > afghan.ps



Conical Projections

- Cone defined by two standard parallels
- Cone unrolled to yield flat sheet
- Conformal, equal area, or equal distance



Conical Map Projections

- Syntax:
  - **–JΔ**$lon_0/lat_0/slat_1/slat_2/width$
  - **–J**$\delta lon_0/lat_0/slat_1/slat_2/scale$
  - scale can be
    - plot units per degree
    - 1:xxxxx
- Conical Map Projections include;
  - **B** (or **b**): Albers Equal-Area
  - **D** (or **d**): Equidistant
  - **L** (or **a**): Lambert Conformal

Exercise: Conical Map of the US

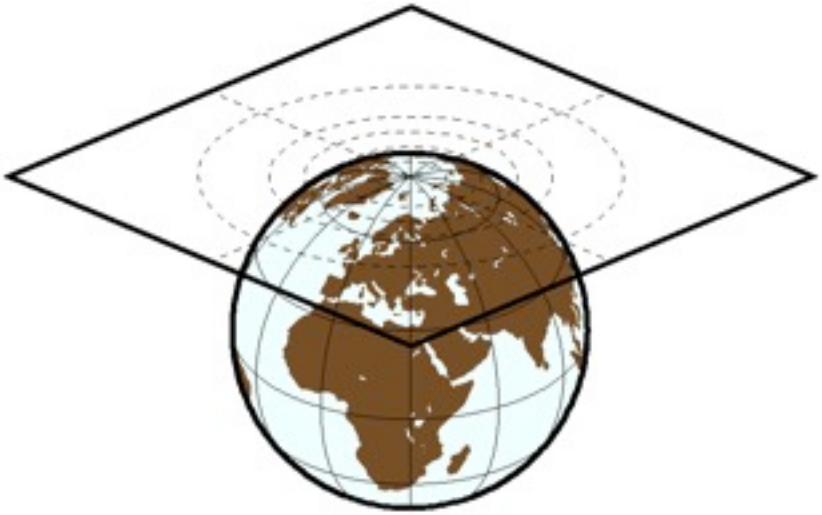
- Make a map of continental US, with 33N and 45N as parallels. Paint land, and draw national and state borders
- pscoast -R230/300/25/50 -JB265/35/33/45/10 -B10g10 -Gdarkbrown -Lf295/28/33/500k -P > conical_us.ps

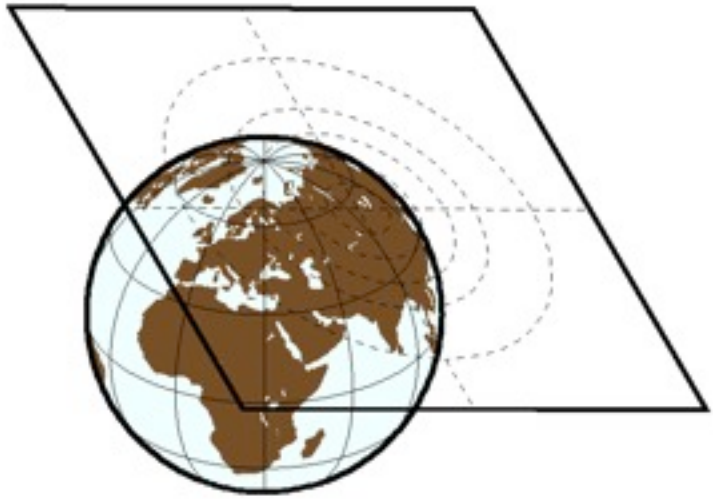
Exercise: Conical Map of the US

- Make a map of continental US, with 33N and 45N as parallels. Paint land, and draw national and state borders
- Draw grid crosses every 10 degrees
- Use rectangular region
- Add map scale with -L
- Now plot 3 maps which will show each of the 3 conic projections in GMT, applied to the continental US (complete with political borders and scale)

Azimuthal projections

- Plane is tangent to point of origin
- Coordinates projected onto plane
- Conformal, equal area, equal distance, other



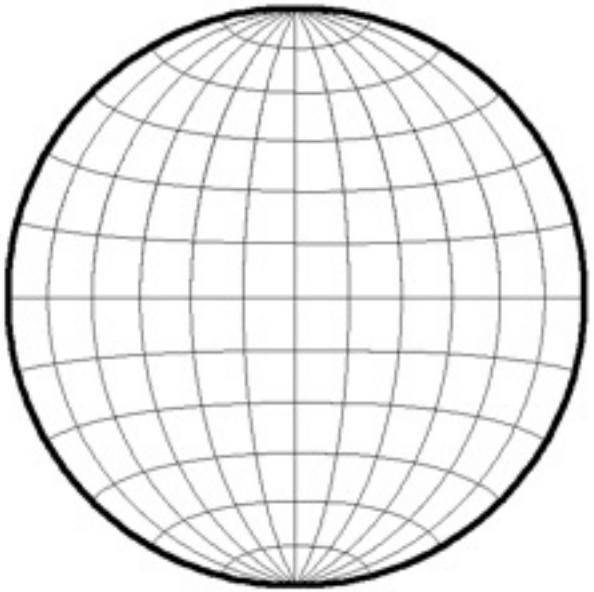


Azimuthal Map Projections

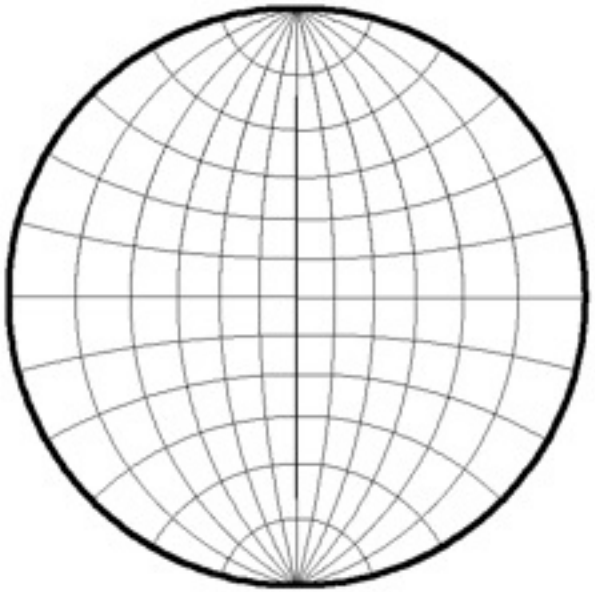
- Syntax:
  - **–JA**lon_0/lat_0/width
  - **–J**δlon_0/lat_0/scale
  - scale can be
    - plot units per degree
    - 1:xxxxx
    - lat_s/1:xxxxx
    - radius/lat
- Azimuthal Map Projections include;
  - **A** (or **a**): Lambert Equal-Area
  - **E** (or **e**): Equidistant
  - **G** (or **g**): Orthographic
  - **S** (or **s**): Stereographic Conformal
  - **F** (or **f**): Gnomonic (takes lat_h/scale)

Schmidt and Wulff

- $lon_0 = lat_0 = 0$ gives stereo-nets
- Schmidt is equal-area (**–JA**)
- Wulff is equal-angle (**–JS**)



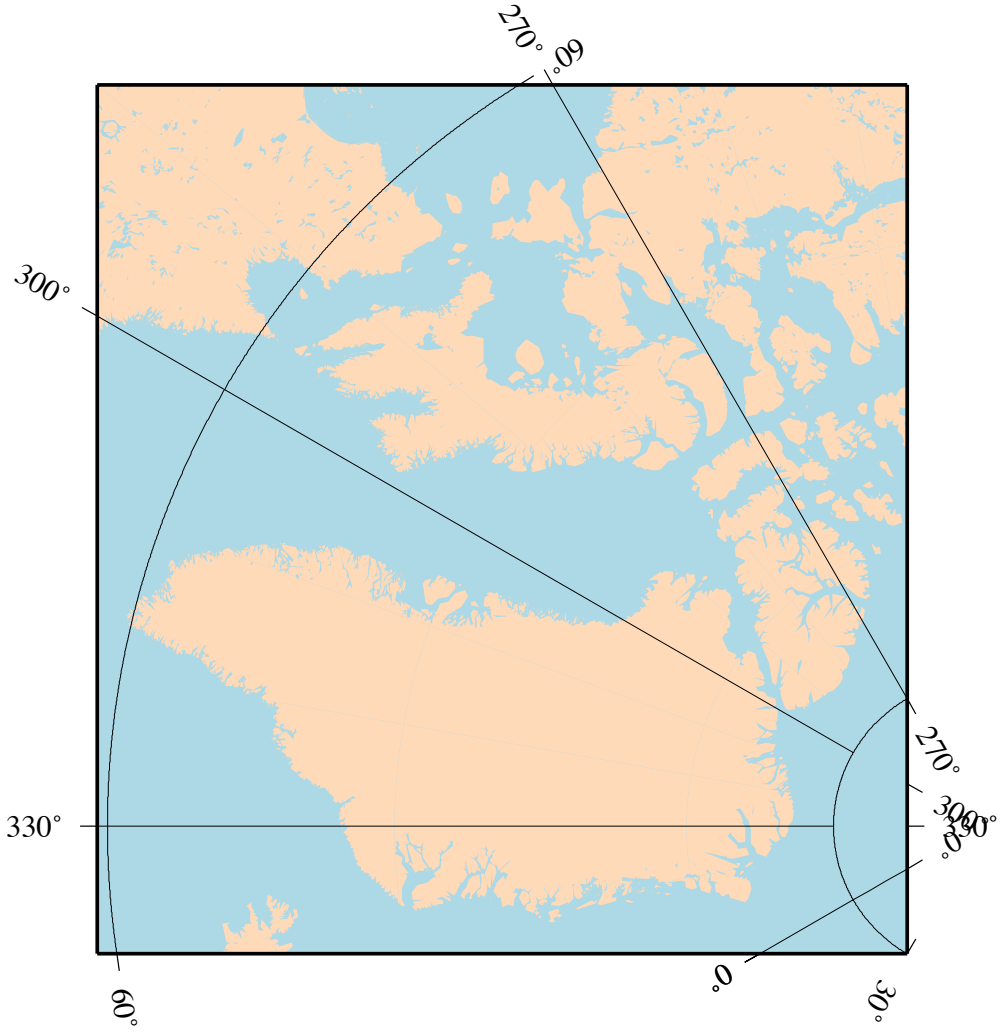
SCHMIDT



WULFF

Exercise: Azimuthal Greenland – Equal-Area and Orthographic

- Task: Plot two maps on separate pages:
  - 1) Showing Baffin Island and Greenland using an equal-area azimuthal projection with rectangular borders
  - 2) Showing global setting of Greenland and Baffin Island using an orthographic view


270°
60°
300°
330°
270°
300°
330°
0°
30°
60°

Answers

- pscoast -R70W/50N/30E/85Nr -JA30W/90N/10 -Gpeachpuff -Slightblue -B30g30 -P › greenland1.ps

- pscoast -Rg -JG20W/50/4 -Gpeachpuff -Slightblue -P -B30g30 › greenland2.ps

Thematic (Global) Map Projections

- Most have the syntax:
  - **–JΔ**lon$_0$/width
  - **–J**δlon$_0$/scale
  - scale can be
    - plot units per degree
    - 1:xxxxx
- Thematic Map Projections include;
  - **H** (or **h**): Hammer [E]
  - **R** (or **r**): Robinson (National Geographic Society)
  - **I** (or **i**): Sinusoidal [E]

Exercise: Hammer, Robinson and Sinusoidal

- Task: Plot 3 global maps centered on the Americas
  - Use Hammer, Robinson, and Sinusoidal
  - You choose colors and pens
  - Use crude coastlines and -A10000