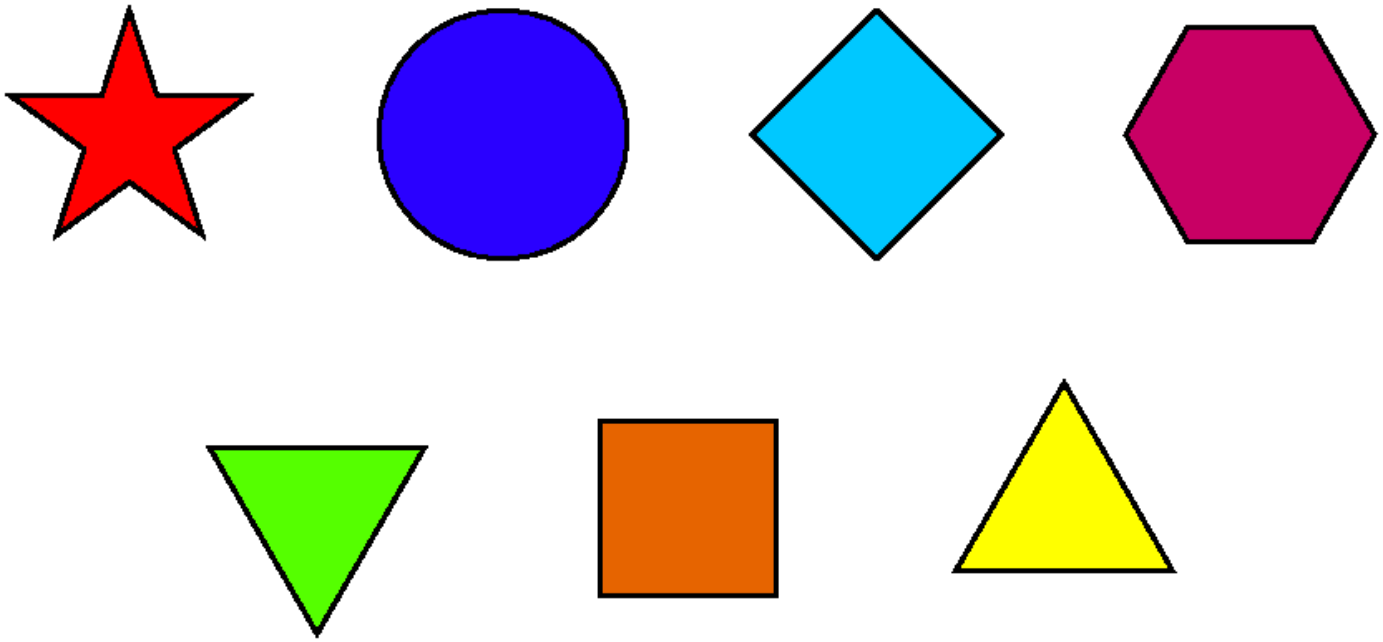
Plotting Lines and Symbols

- 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

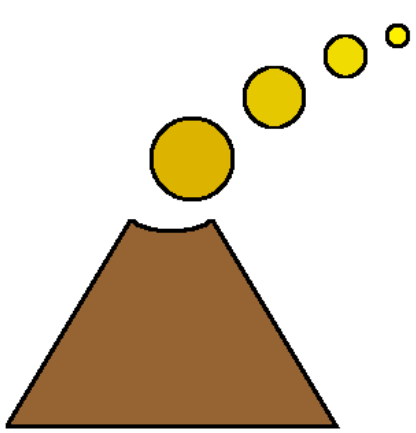
GMT Symbols and Patterns

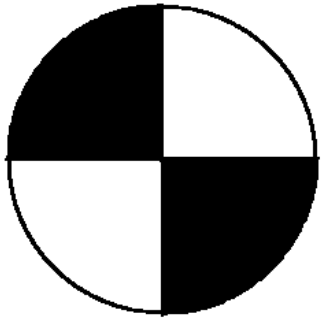
- Standard Geometrical shapes

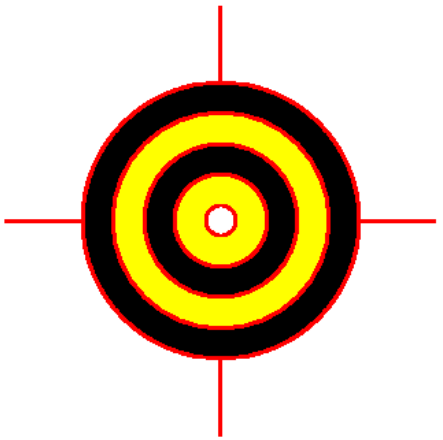


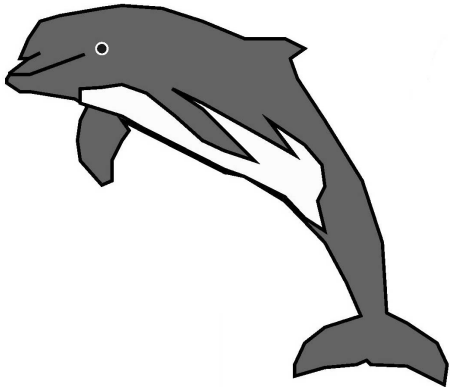
GMT Symbols and Patterns

- User Defined Symbols



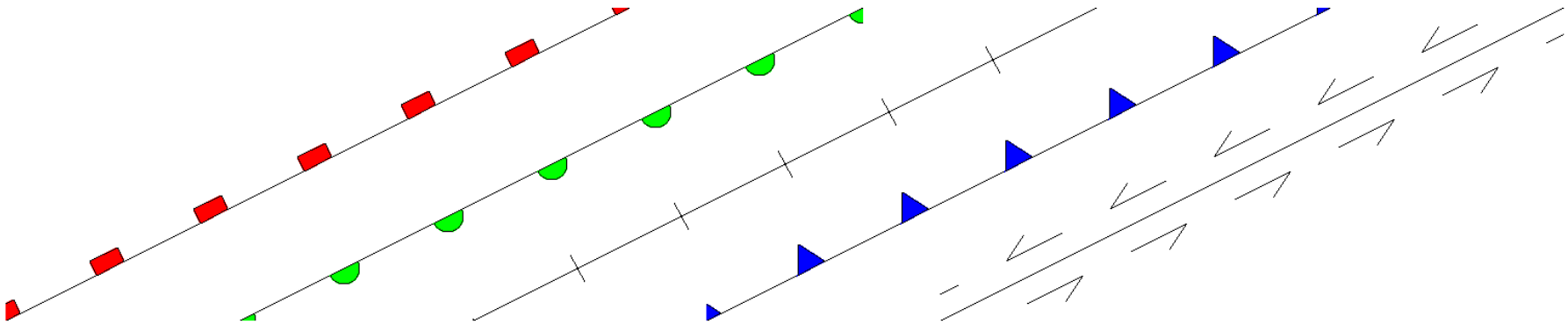






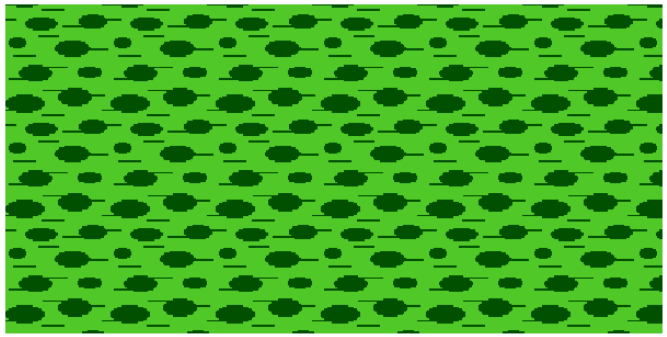
GMT Symbols and Patterns

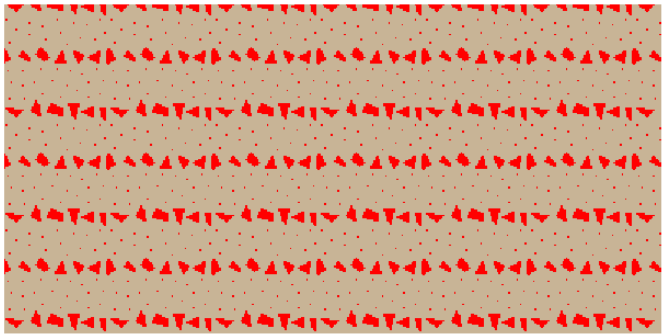
- Faults, Fronts and other demarcations

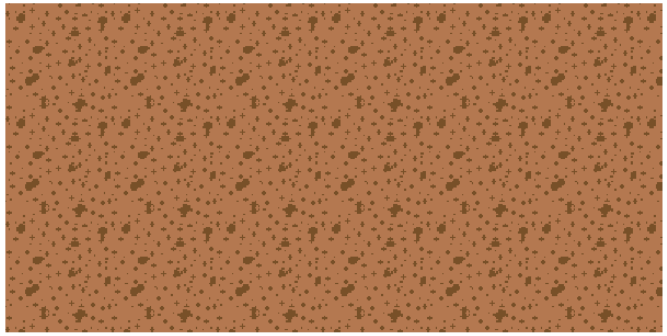


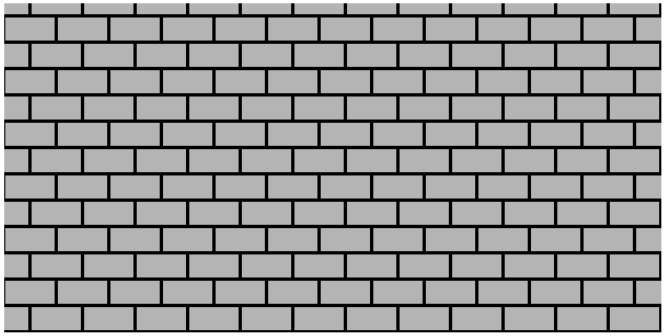
GMT Symbols and Patterns

- Pattern Fill

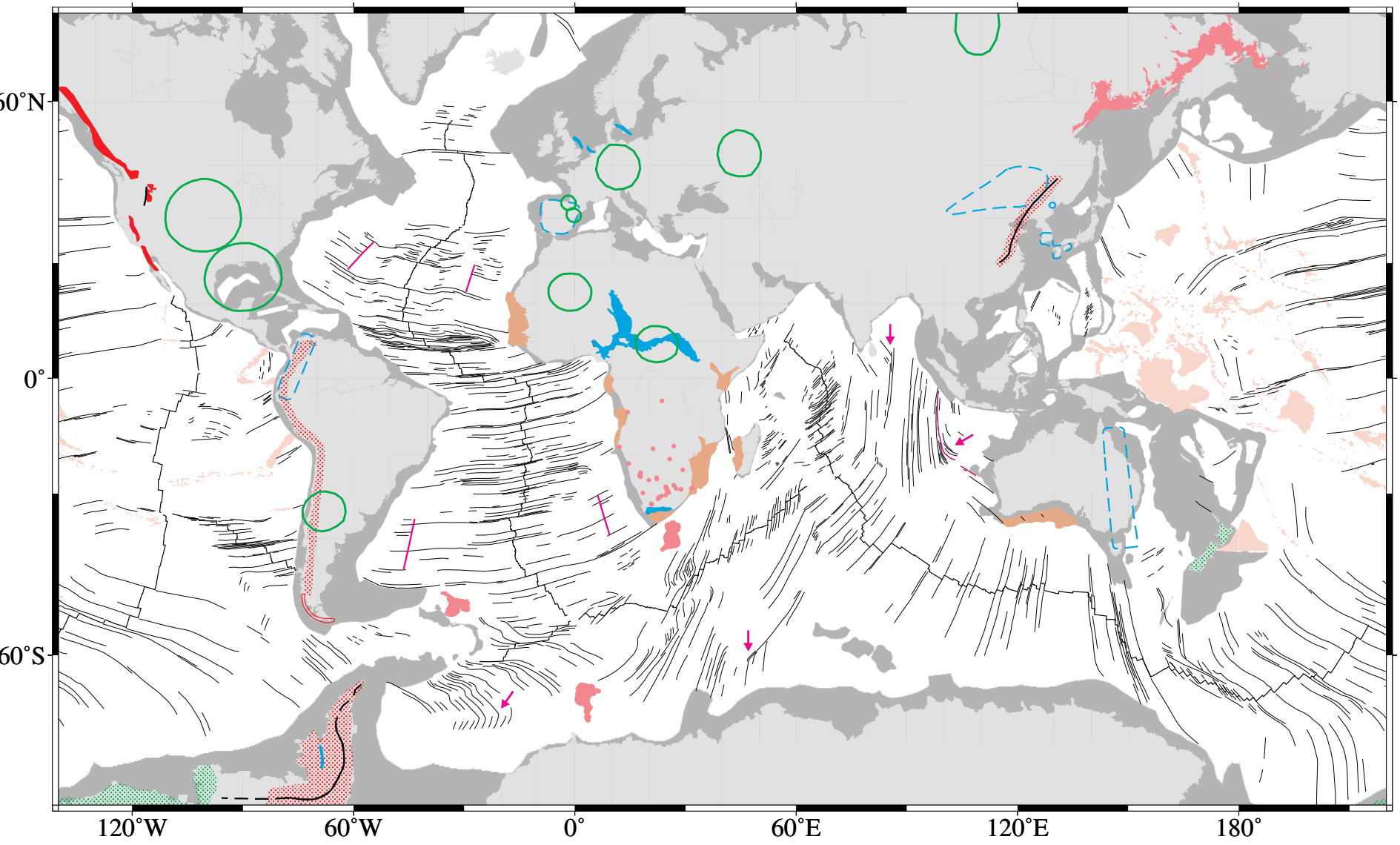




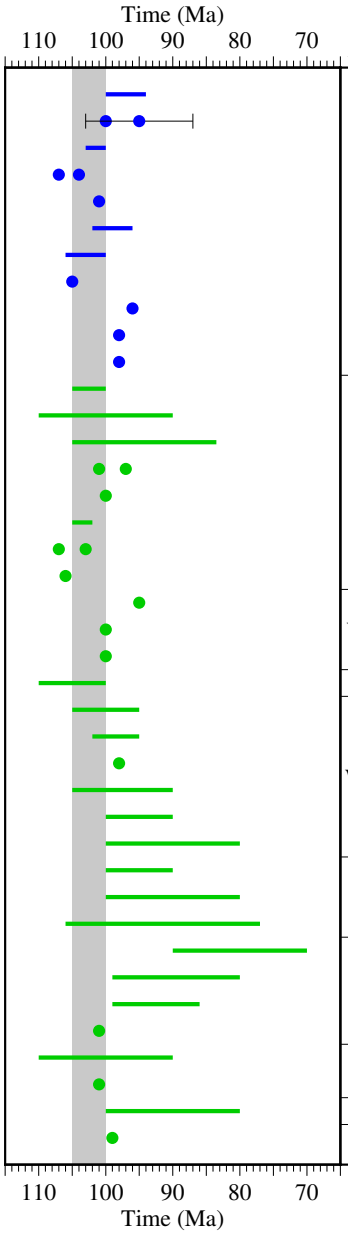




Example…



Example…



Area	Observation
OB	Bouvet plume eruption.
	Change in absolute Pacific plate motion*.
	Pacific FZ bends form.
	Wharton Basin FZ bends form.
	Spreading rate increase in the Central Atlantic.
	Spreading rate increase in the South Atlantic.
	Equatorial Atlantic separation.
	Weddell Sea FZ bends form.
	Southwest Indian Ridge FZ bends form.
	Enderby Basin and Bay of Bengal FZ bends form.
	India–Madagascar separation.
EG	Subduction is replaced by strike–slip motion along eastern Gondwanaland.
	Uplift and denudation in eastern Australia.
	Accelerated subsidence at southern Australian margin.
	A–type magmatic events in New Zealand.
	Major angular unconformity forms in New Zealand.
	A–type magmatism begins in Marie Byrd Land.
	Antarctic Peninsula compressional episodes (Palmer Land Event).
	Alexander Island uplift.
WSA	Rocas Verdes Basin closure.
	Andean compressional regime initiates.
	Deformation event in the northern Andes.
C	Caribbean subduction polarity reversal.
WNA	Increase in compressional stress at the Peninsular Ranges Batholith.
	Changes in faulting patterns at the Sierra Nevada Batholith.
	Idaho Batholith magmatism commences.
	Main phase of deformation at the Western Idaho shear zone.
	Thrusting at the Coast Mountains Batholith.
	High flux magmatism at the Coast Mountains Batholith.
EA	Transpression at the Tan–Lu fault zone.
	Uplift in eastern Asia: Japan, Korean Peninsula, eastern China, Mongolia.
	Okhotsk–Chukotka volcanic belt forms.
A	Pulse of alkaline magmatism in southern Africa.
	Exhumation of southern Cape region of South Africa.
	Rapid tectonic subsidence in marginal African basins.
	Folding events in the West and Central African Rift System.
WE	Uplift and exhumation in the North Sea region.
	Regional unconformity in Iberia.
NT	Magmatic pulse and possible MOR subduction event in southern Eurasia.
G	Global distribution of unconformities.

psxy +
pstext +
psbasemap

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 (|)

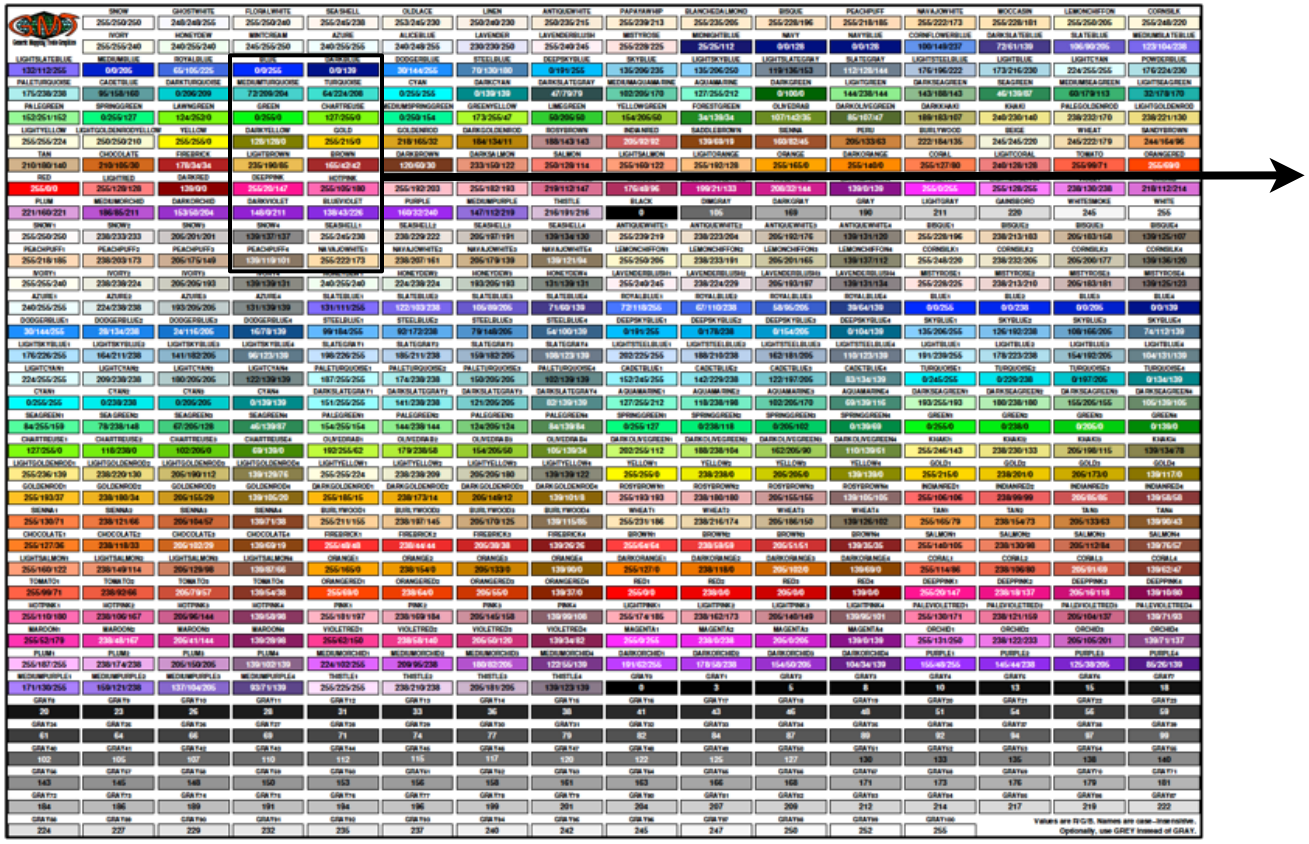
(a, c, d, g, h, i, n, s, t, x) fits inside circle of given diameter

(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

Appendix H



BLUE	DARKBLUE
0/0/255	0/0/139
MEDIUMTURQUOISE	**TURQUOISE**
72/209/204	64/224/208
GREEN	**CHARTREUSE**
0/255/0	127/255/0
DARKYELLOW	**GOLD**
128/128/0	255/215/0
LIGHTBROWN	**BROWN**
235/190/85	165/42/42
DEEPPINK	**HOTPINK**
255/20/147	255/105/180
DARKVIOLET	**BLUEVIOLET**
148/0/211	138/43/226
SNOW4	**SEASHELL1**
139/137/137	255/245/238
PEACHPUFF4	**NAVAJOWHITE1**
139/119/101	255/222/173

psxy exercise 4

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

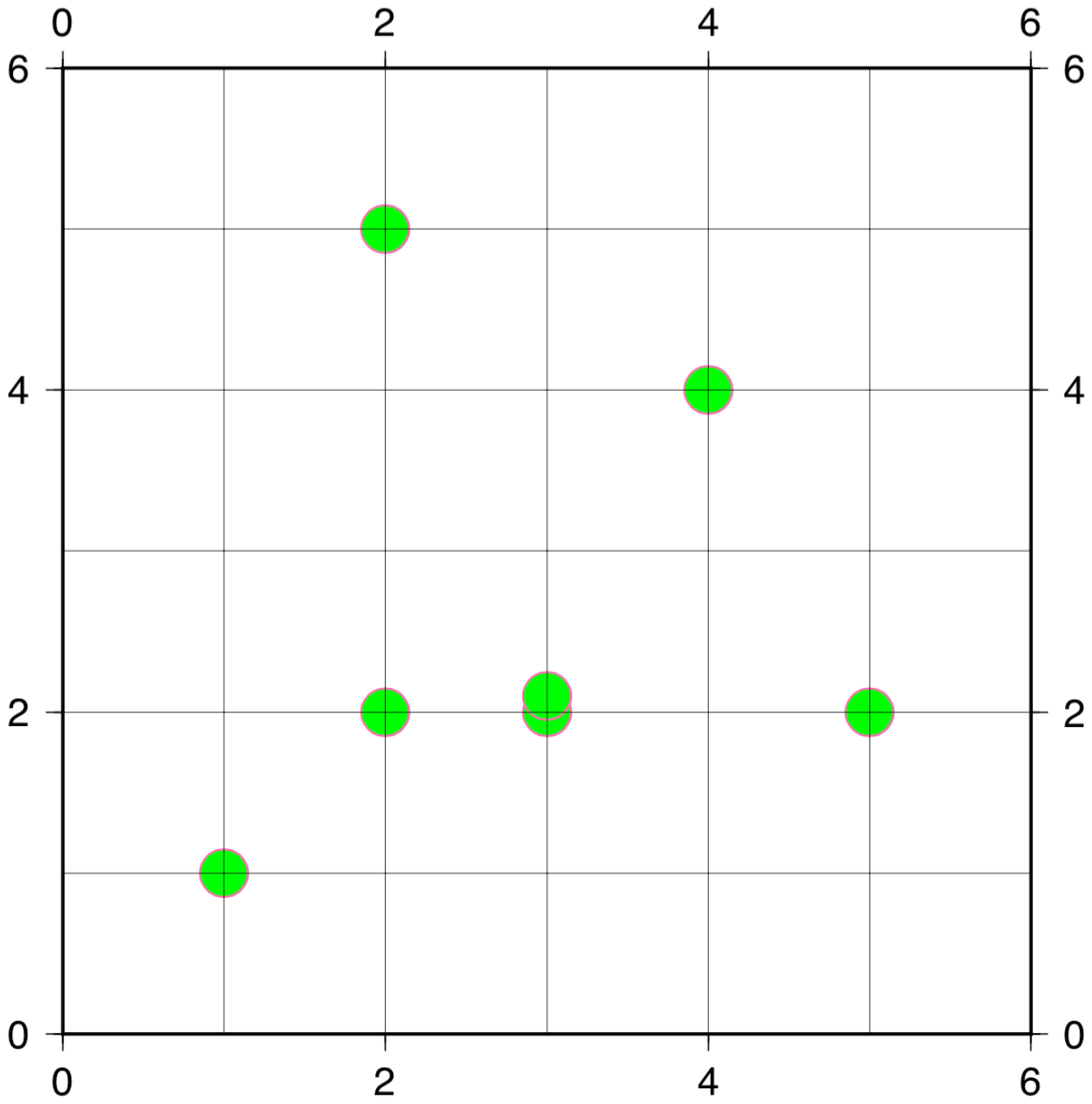
```
psxy data.txt -R0/6/0/6 -JX12 -B2g1 -Sc0.6 -P > ex4a.ps
```

- 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 >
   ex4b.ps
```

- Give them back an outline (e.g. -Wthin,hotpink)

```
psxy data.txt -R0/6/0/6 -JX12 -B2g1 -Sc0.6 -P -Ggreen -
   Wthin,hotpink > ex4c.ps
```

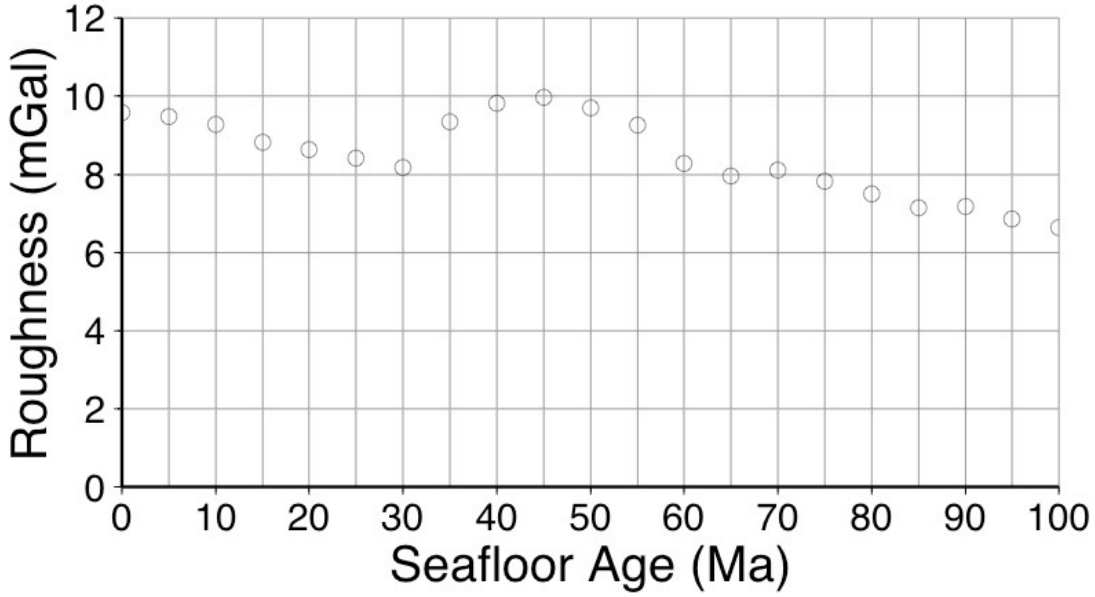

0
2
4
6
6
4
2
0
0
2
4
6
0
2
4
6

Exercise 5a: Use psxy to plot point data

- Copy over the file testpoints.txt
- Have a look at it using a text editor
- Use minmax (GMT4) or gmtinfo (GMT5) 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.

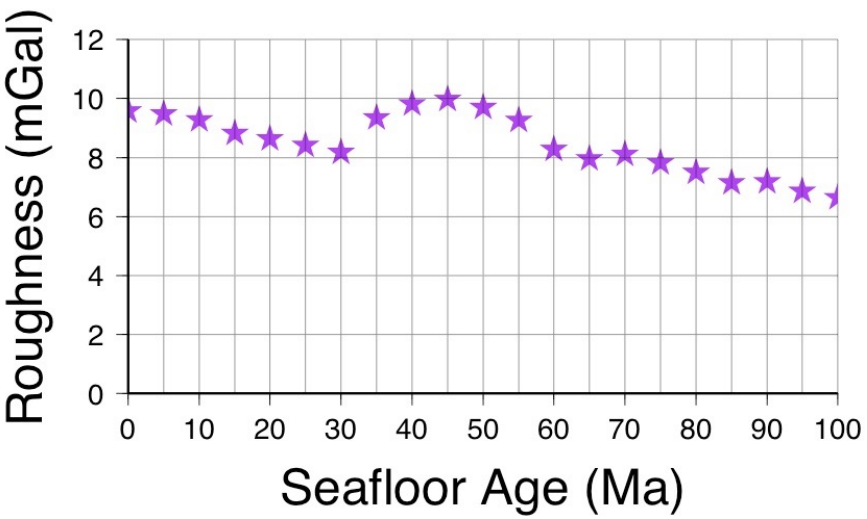
- minmax testpoints.txt
- psxy testpoints.txt -JX12/6 -R0/?/0/? -Ba10g5:"Seafloor Age (Ma)":/a2g2:"Roughness (mGal)":SW -Sc0.2 > testpoints_1.ps

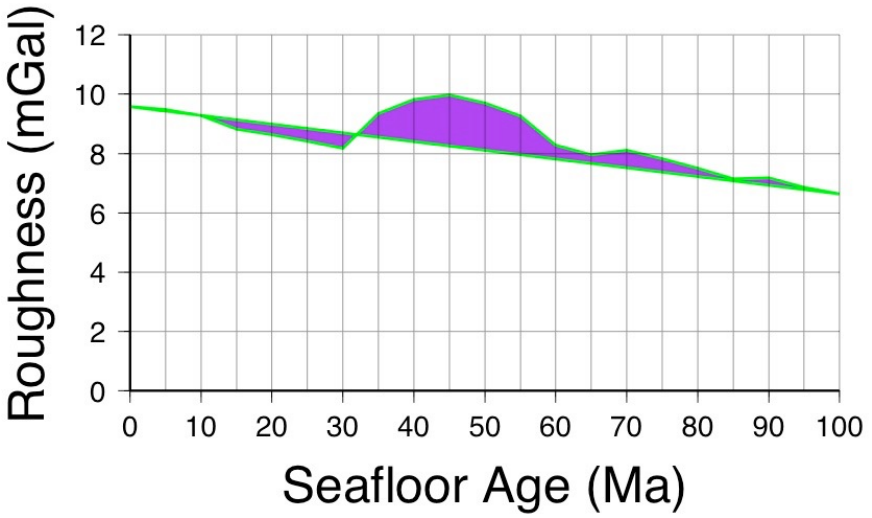
- -JX12/6 - We are plotting non-geographic data (i.e. these are not latitudes and longitudes) so we need to use -JX. 12/6 sets the width=12cm, and height=6cm.
- -R0/100/0/12 - Sets the region of the plot from 0 to 100 for the x-axis and 0 to 12 for the y-axis
- -Ba10g5:"Seafloor Age (Ma)":/a2g2:"Roughness (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.

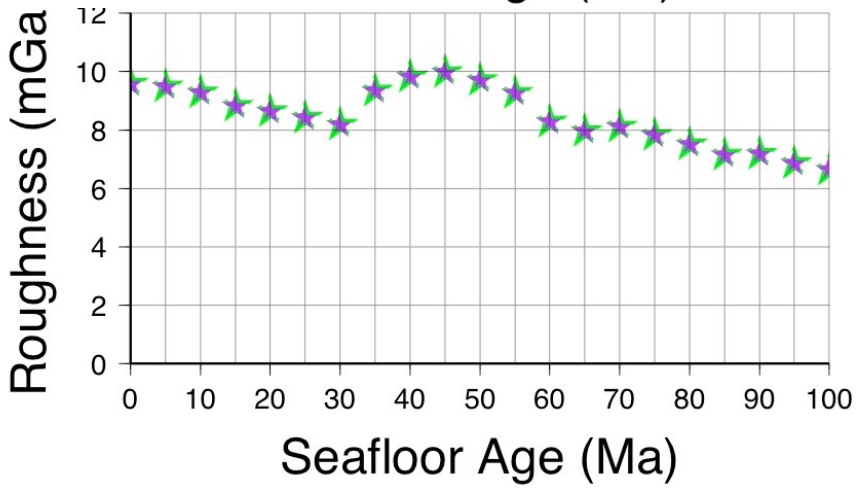


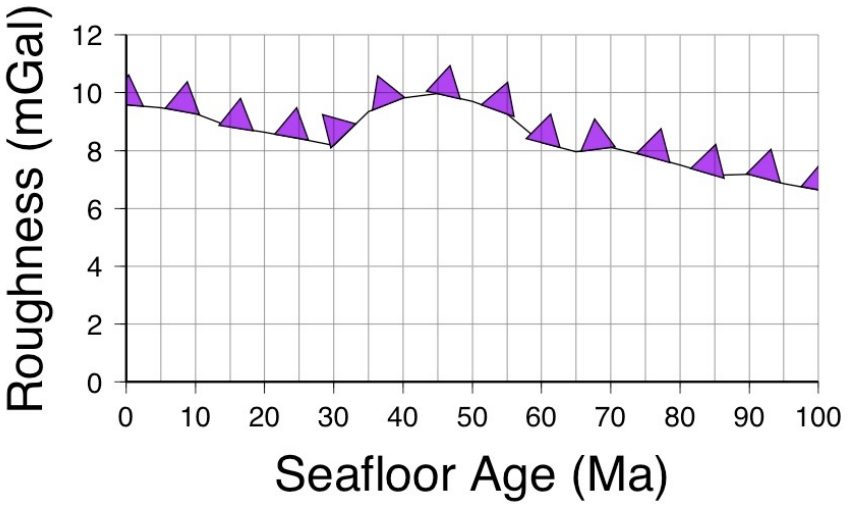
Exercise: Use psxy to plot point data cont…

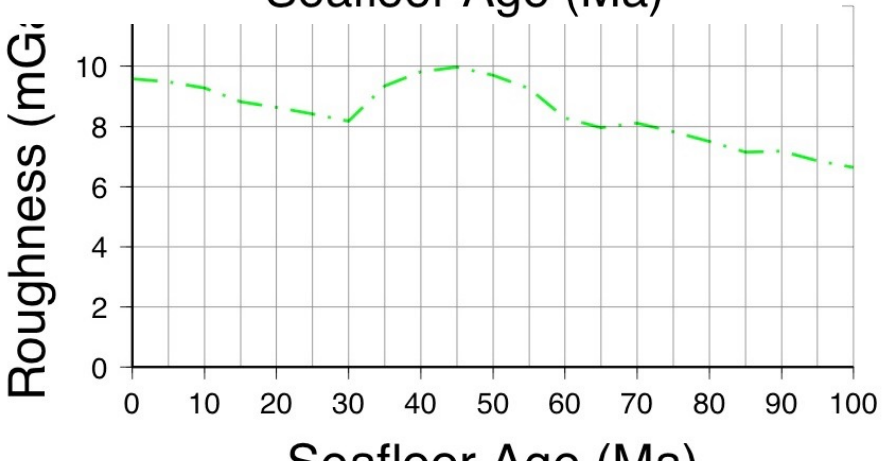
- Plot as solid purple stars
- Give your stars a thick (1.5p), dashed green outline (-W.....)
- Plot as line data (no symbols)
- Plot as filled polygon using your favorite color (use -L, -W and -G but no -S)
- Plot solid line with inverted triangles (0.6 cm) (hint: look at -Sf .....)


Roughness (mGal)
0
2
4
6
8
10
12
0 10 20 30 40 50 60 70 80 90 100
Seafloor Age (Ma)


Roughness (mGal)
0
2
4
6
8
10
12
0 10 20 30 40 50 60 70 80 90 100
Seafloor Age (Ma)


Roughness (mGa
0
2
4
6
8
10
12
0 10 20 30 40 50 60 70 80 90 100
Seafloor Age (Ma)


Roughness (mGal)
0
2
4
6
8
10
12
0 10 20 30 40 50 60 70 80 90 100
Seafloor Age (Ma)


Roughness (mG
0
2
4
6
8
10
0 10 20 30 40 50 60 70 80 90 100

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 6 – Specifying errors etc in the input file

- 1) Use the file testpoints_sizes.txt to plot different symbols for different points. (Hint: remove symbol from the command line e.g. -S0.5 rather than -Sa0.5 as the symbol is defined in the input file)
- 4) Use the file testpoints_errors.txt and the -E option with to plot error bars || to the y-axis

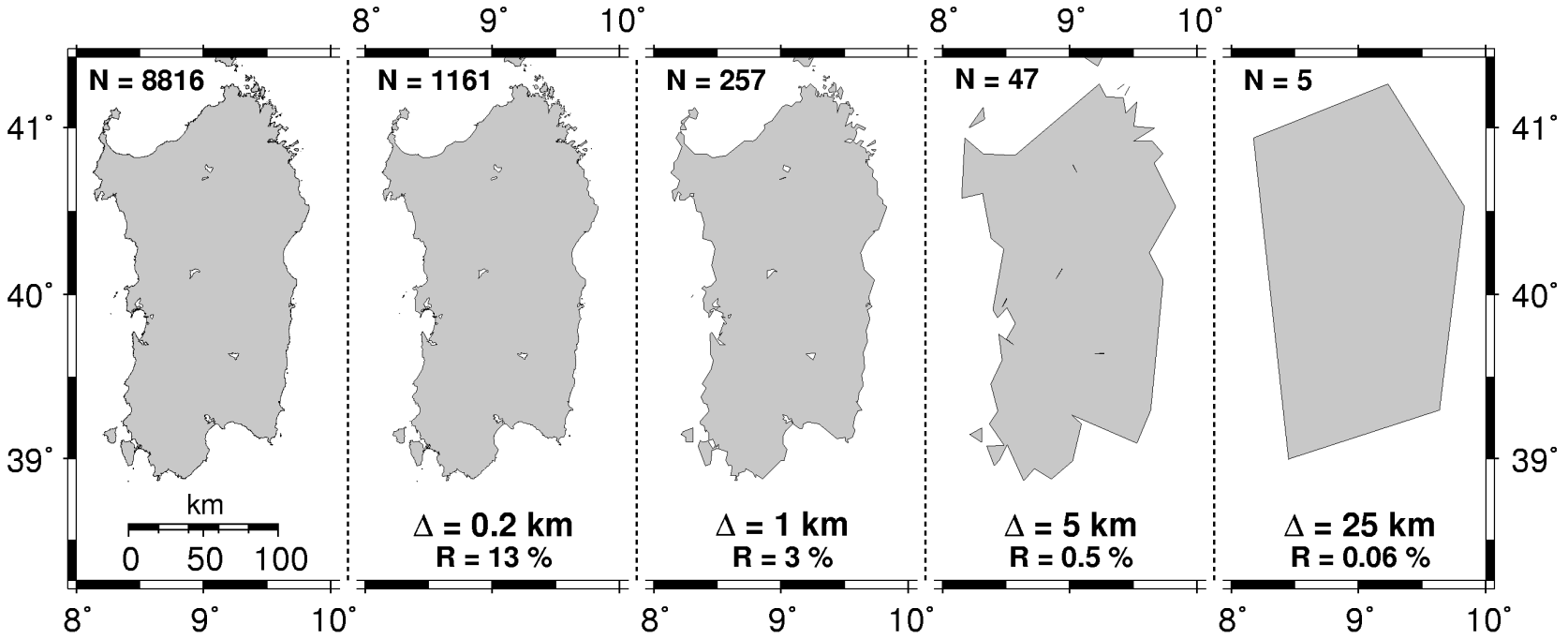
Plotting basic maps with pscoast

- 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 7a: 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/FORMAT_GEO_MAP**
- pscoast -R110E/160E/45S/5S -JM12 -Ba10g5/a10 -Glightbrown -Slightblue -Dh -Wthin,white > Australia.ps

UTM Projection

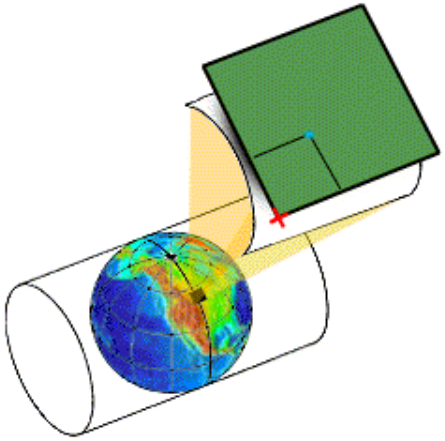
- Conformal and Cylindrical projection
- Syntax: -JUzone/width or -Juzone/scale
  - Height calculated automatically
  - Zone is a 6°wide longitude strip starting at 180°W
    - E.g., zone 1 is 180°W to 174°W, centered on 177°W
    - zone is usually provided, if not, compute from the central meridian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

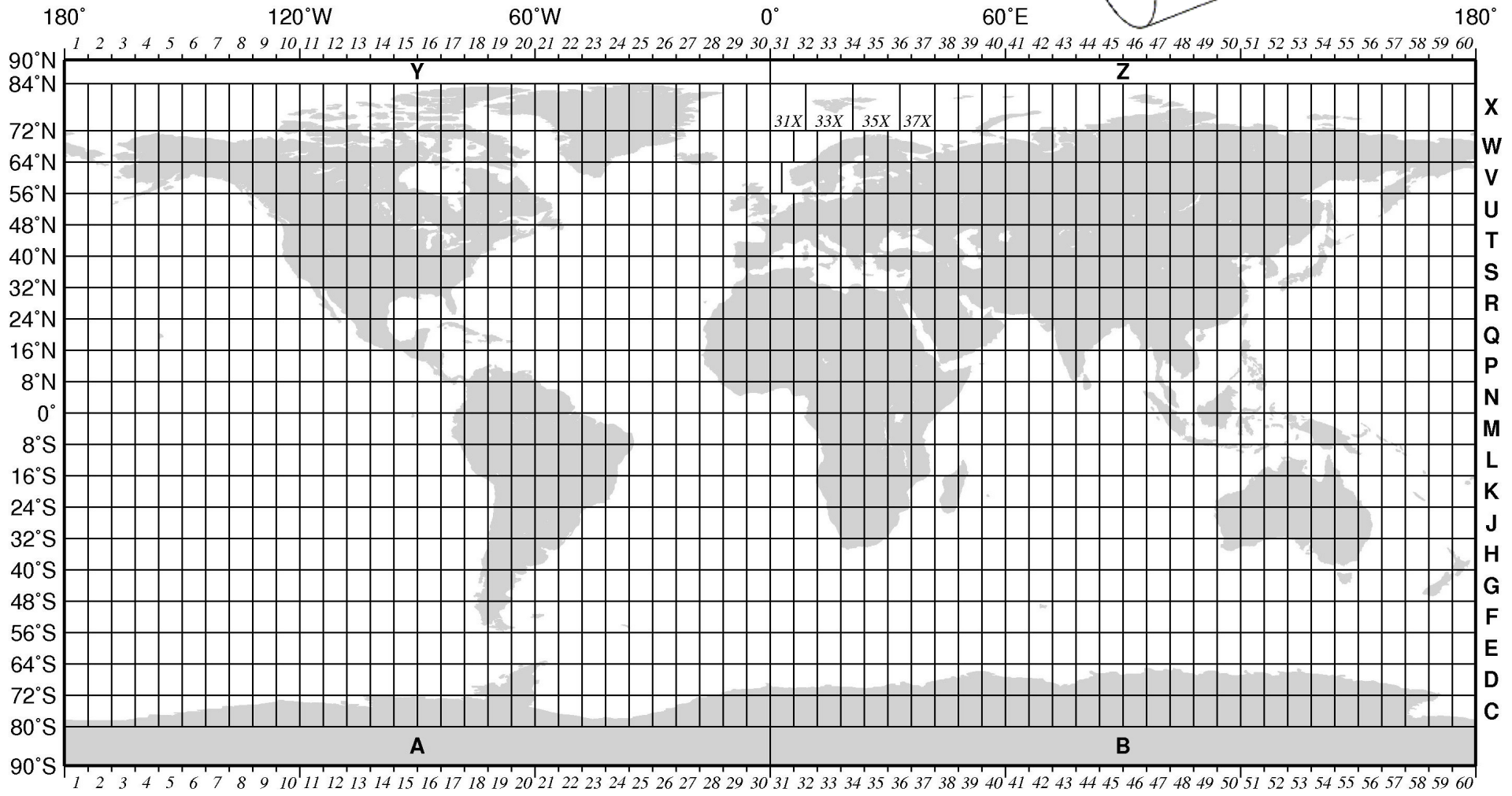
? zone = ((lon + 180)/6) / 60) + 1

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

  - 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

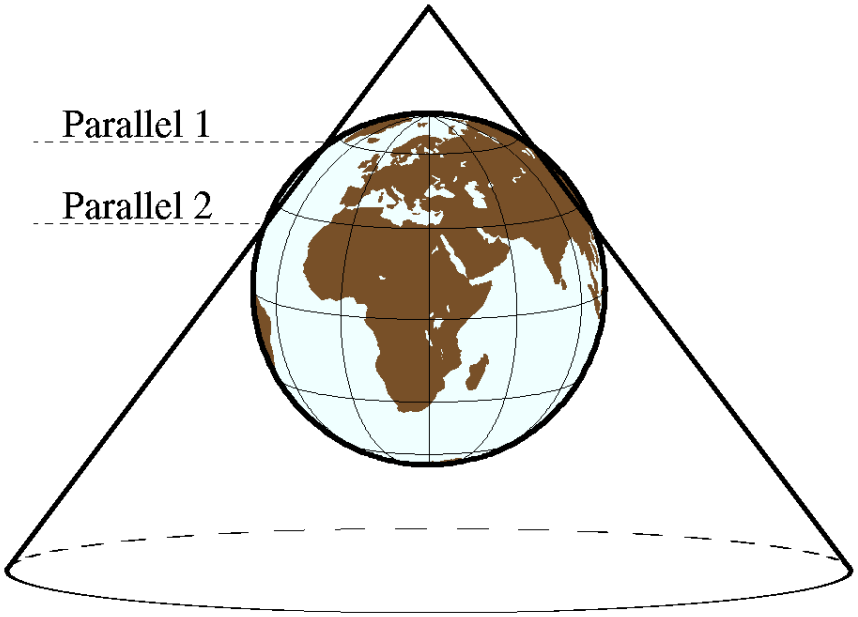
Exercise 8: UTM Afghanistan

- 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

Conical Projections

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



Conical Map Projections

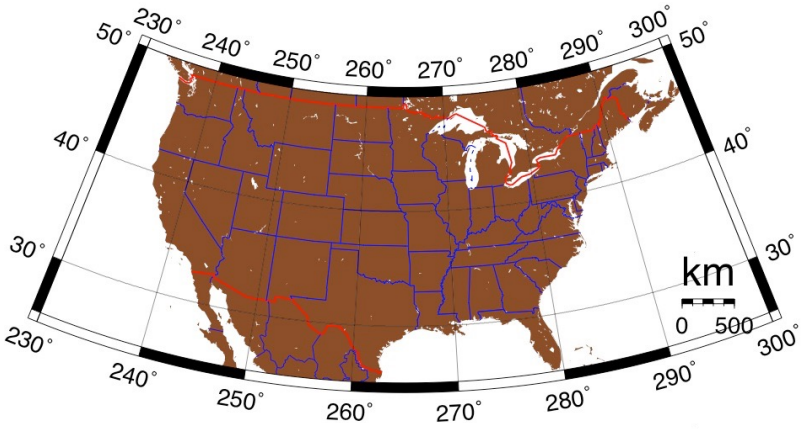
- Syntax:
  - **–JΔ**$lon_0/lat_0/slat_1/slat_2/width$
  - **–J**δ$lon_0/lat_0/slat_1/slat_2/scale$
  - scale can be
    - plot units per degree
    - 1:xxxxx
- Conical Map Projections include;
  - **B** (or **b**): Albers Equal-Area
  - **D** (or **d**): Equidistant
  - **L** (or **a**): Lambert Conformal

Exercise 9: Conical Map of the US

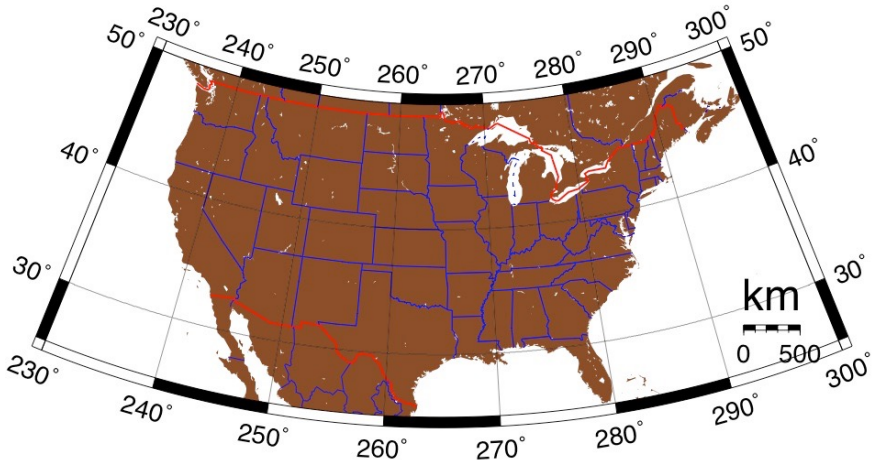
- Make a map of continental US, with 33N and 45N as parallels. Paint land, and draw national and state borders
- pscoast -R230/300/25/50 -JB265/35/33/45/10 -B10g10 -Gdarkbrown -Lf295/28/33/500k -P > conical_us.ps

Exercise 9: Conical Map of the US

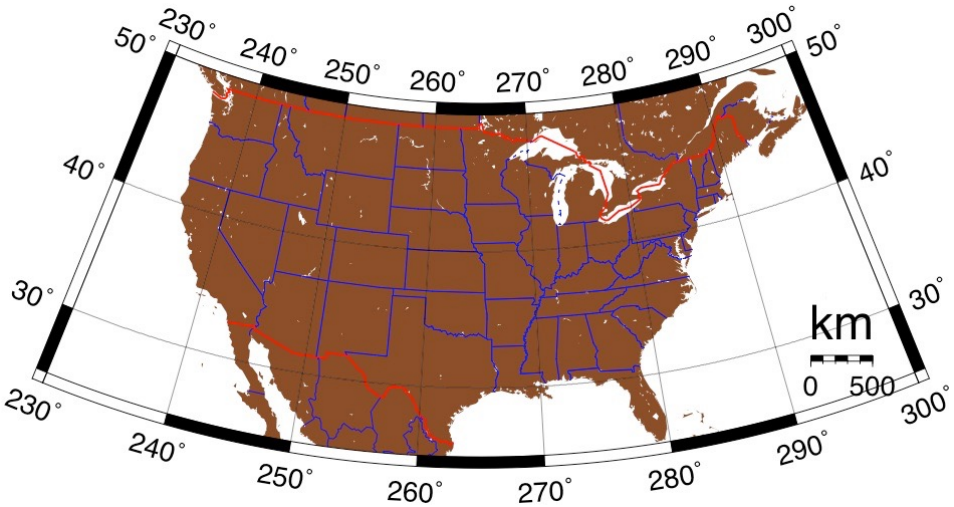
- Make a map of continental US, with 33N and 45N as parallels. Paint land, and draw national and state borders
- Draw grid crosses every 10 degrees
- Use rectangular region
- Add map scale with -L
- Now plot 3 maps which will show each of the 3 conic projections in GMT, applied to the continental US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



Albers



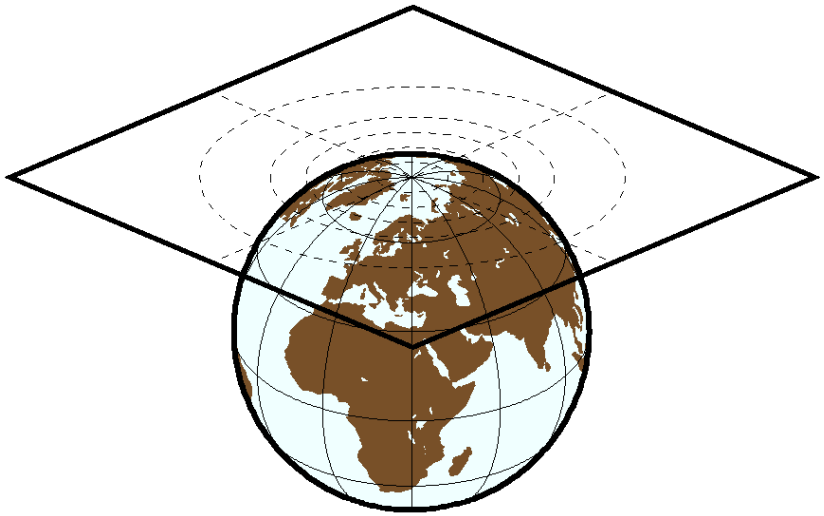
Equidistant

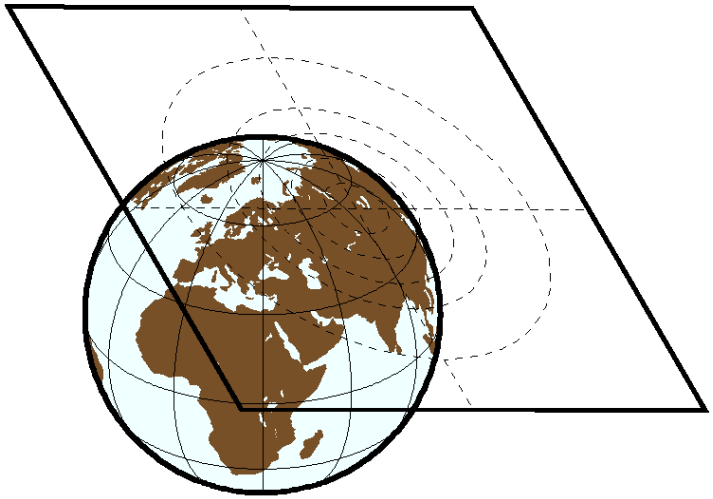


Lambert

Azimuthal projections

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



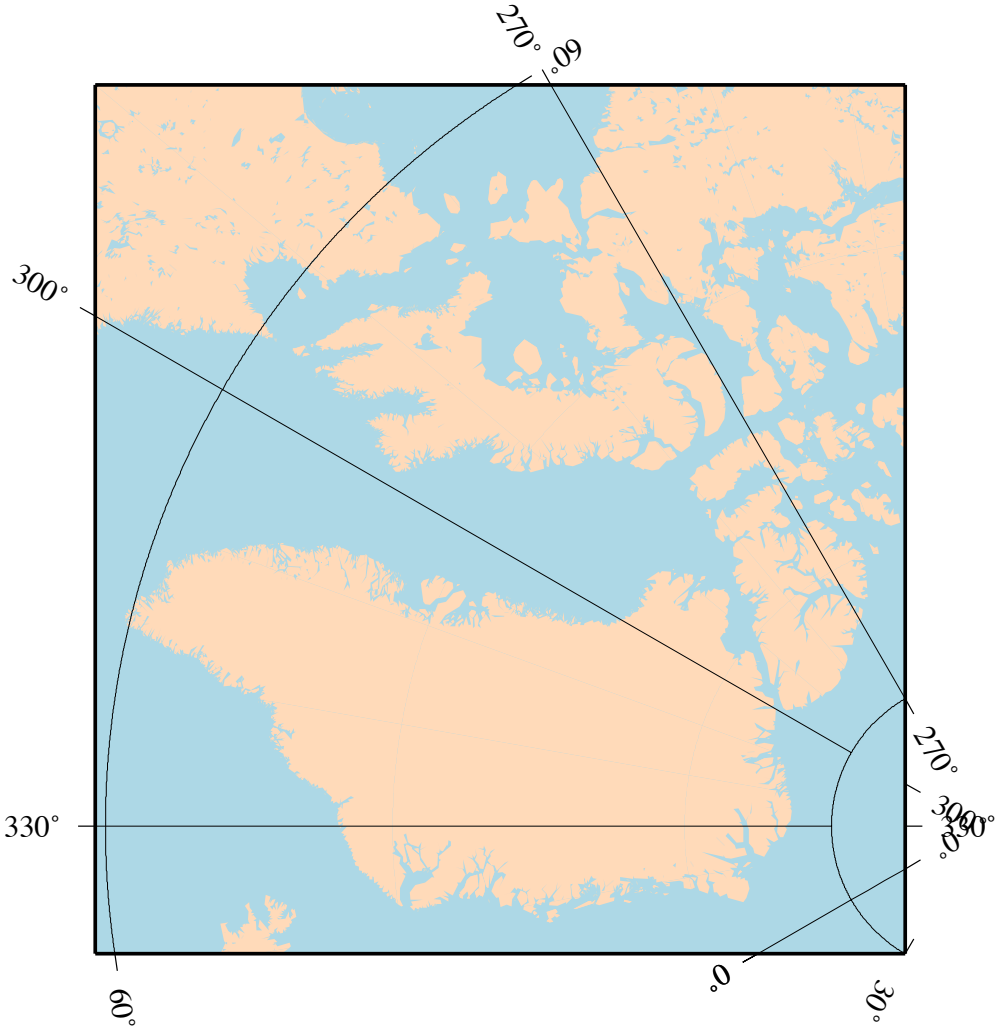


Azimuthal Map Projections

- 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)

Exercise 10: 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