Chapter 4 – Help features in SU

- The selfdoc:
  - `$ suplane`
  - `$ ximage`
  - `$ xwigb`
  - `$ supsimage`

- `$ supswigp`
- `$ psimage`
- `$ pswigb`
- `$ supswigb`
- `$ pswigp`
Using “suname”

- $ suname
- $ suname filter
- $ suname migration
- $ suname decon
The “sudoc”

- $ suplane       --- to see the selfdoc
- $ sudoc suplane --- to see the sudoc
- $ suspecfx      --- to see the selfdoc
- $ sudoc suspecfx --- to see the sudoc
Exploring Trace Headers

- $ cd /gpfc/yourusername/Temp1
- $ cp /data/cwpscratch/Data1/*.*su .
- $ suximage < sonar.su &

How does suximage know the dimensions of the plot? Answer: trace headers

How many numbers does it take to describe a seismic observation?

- $ sukeyword -o " header keywords"
Using “surange”

- `$ suplane | surange`
- `$ surange < sonar.su`
- `$ surange < radar.su`
- `$ surange < seismic.su`

The program “surange" shows the ranges of the trace header values.
Using “sukeyword”

- $ sukeyword tracl
- $ sukeyword ns
- $ sukeyword dt
- $ sukeyword offset
- $ sukeyword cdp
Types of data formats

- Acquisition format --- recording in the field
- Internal formats --- processing in a particular software environment or “in-house at an company or institution”
- Data Exchange formats ---- sharing data between companies and for archival
Tips for obtaining data

- **Media** --- Tapes are difficult to work with. Today USB diskdrives are better.
- **Format** --- SEG-Y if possible
- **Header Map** --- the SEG-Y header may be redefined in commercial software packages.
- **Observers Logs** --- the original info that goes into the headers.
Concluding Remarks

- Learn help features
- Find out your data format
- Are your header values set? Correct?
- “Reading data is more of an art than a science”
Chapter 5 – Migration: trading time for depth.

- **Data** \((x_1, x_2, t)\) – recorded data
- **Time\_Image** \((y_1, y_2, \tau)\) – time section
- **Depth\_Image** \((y_1, y_2, y_3)\) – depth section

Note that coordinates on the image are different from coordinates in the data.

(We don’t call ‘simple depth conversion’ “migration”.)
Data-images

- Sonar and Radar produce data which are nearly a time image.
- Time-migrated seismic data also may be thought of as a “data image”

Such data need only be stretched to convert Time Images to Depth Images.
Time to depth conversion test

- $ cd   /gpfc/yourusername/Temp1
- $ suplane   >   junk.su
- $ suttoz   <   junk.su   t=0.0,0.15,0.2
  v=1500.0,2000.0,3000.0   >   junk1.su
- $ suxwigb   <  junk.su   title="test pattern"
- $ suxwigb   <  junk1.su   title="depth section"
Convert depth back to time

- $ \text{suztot} < \text{junk1.su} \ z=Z1,Z2,Z3 \\
v=1500,2000,3000 \ > \ \text{junk2.su}$

- $\text{suxwigb} < \text{junk2.su} \ \text{title=\"reconstructed time section\"}$

- Find the depths $Z1, Z2, Z3$ that you need to use so that “suztot” can convert the data from depth back to time correctly:
Approximating velocity

• Many ways exist to approximate velocity. Real well logs are extremely complicated, so some simplification is necessary.

• Piecewise constant versus piecewise linear.

• Modeling requires jumps in wavespeeds to make impedance contrasts.

• Imaging requires a correct velocity trend
What is the application?

- Modeling requires sharp jumps at “important reflectors” to model reflections properly,
- Imaging (migration) requires smooth profiles.
- Synthetic seismograms from well logs require some smoothing. How much?
Sonar, Radar and bad header values

- $ suttoz \ v=\text{SPEED\_OF\_SOUND\_IN\_WATER} < \text{sonar.su} | \text{suximage perc=99}$
- $ suttoz \ v=\text{SPEED\_OF\_LIGHT} < \text{radar.su} | \text{suximage perc=99}$

Non-seismic data provide an extreme example of header value difficulties.
Concluding Remarks

- Testing software on simple test patterns is an effective way of evaluating the assumptions in the code.
- Learn everything you can about data you use.
- “The velocity” may be very different if we are modeling or if we are imaging.
Chapter 6 - Zero-offset (post-stack) migration.

- 1912 – Ludger Mintrop – refraction seismic
- 1914 – Reginald Fessenden – sonar
- 1921 – John Clarence Karcher -- 1st reflection seismic experiment
- 1930s – interpretive
- 1954 – J. G. Hagedoorn – graphical migration
Karcher, 1921. The Vine Creek experiment---the first reflection seismic experiment

Depth of the Viola limestone at Vines Branch was measured with reflection seismograph on August 9, 1921—world’s first reflection seismograph geologic section.
a) Synthetic Seismogram

b) Simple Single-Reflector Model

\[ v = 2000 \text{ m/s} \quad \rho = \text{const.} \]

\[ v = 3000 \text{ m/s} \quad \rho = \text{const.} \]
Propagation in Simple Model

- $ cd /gpfc/yourusername/Temp1
- $ cp /data/cwpscratch/Data1/XSyncline .
- $ cp /data/cwpscratch/Data1/syncline.unif2 .
- $ more XSyncline
- $ more syncline.unif2
• $\text{XSyncline}$
• Click on the movie window and drag to stretch and enlarge.
• Use far right mouse button to stop, start, and reverse the movie.
• Observe the wavefronts. Do you see rays?
• Observe the bowtie. Run time forward and backward. \textbf{Backward Propagation} is part of imaging.
Hagedoorn's graphical migration

- Place compass point on $t=0$ of a trace.
- Strike a semi-circular arc through each seismic arrival on that trace.
- Repeat for all traces.
- Envelope of arcs delineate the reflector.
Hagedoorn graphical migration

Synthetic Seismogram
How the Hagedoorn method works

The solutions to the wave equation may be thought of as expanding wave fronts. If these expanding wave fronts are plotted in space and time, the result, assuming constant velocity, is a cone. Physicists call this the “light cone”. There are really two cones. A causal forward-in-time cone and an anti-causal backward-in-time cone.
Light cones
The Hagedoorn method:

Use the anti-causal cone to project an arrival on the seismogram back into the subsurface on all of the possible locations where the reflection could have originated.
An alternate view---the diffraction stack

If we perform the Hagedoorn method on the signal from a diffraction, we find the point at the apex of the hyperbola. If we instead think of summing over hyperbolae, we arrive at an equivalent view of migration.
(Only a few Hagadoorn arcs are shown)
Concluding Remarks

- Seismic methods began as a “dip and depth finder” to give auxiliary information for geologic cross sections.
- By the late 1960s, seismic migration became a “imaging technology.”
- Today, “parameter estimation” from seismic amplitudes is of growing importance.