Amoco model

Trevor Irons

Data Type: *2D subset of a synthetic 3D acoustic model*
Source: *British Petroleum*
Location: *http://www.software.seg.org*
Format: *Native*
Date of origin: *Model was produced for an SEG convention presented in 1998*

INTRODUCTION

The Amoco dataset found within the Madagascar repository was created in 1997 and presented formally at the talk *Strike shooting, dip shooting, widepatch shooting – Does prestack migration care? A model study* given by John Etgen and Carl Regone at the 1998 SEG convention. Its creators describe the model as the Carpatheans thrusting over the North Sea. The model was specifically created to illustrate the limitation of Kirchhoff migration. The model presented here is a single 2D line from the 3D model presented at the talk. The information presented here was taken from the abstract to their paper which can be found at the SEG website.

The Madagascar Amoco repository contains all the files listed in table 1. The repository contains several velocity models of varying smoothness as well as a shot record.

```
-rwxr-xr-x    1 root     root        352292 2005-04-20 07:34 velsmooth.HH
-rwxr-xr-x    1 root     root        352278 2005-04-20 07:34 velsmoother.HH
-rwxr-xr-x    1 root     root       2269415 2005-04-20 07:34 velmodel.hh
-rwxr-xr-x    1 root     root     151395933 2005-04-20 07:34 shots.hh
```

Table 1: *A list of files contained within the Madagascar amoco dataset repository*

MODEL

This model is a 2D subset of a 3D model, however the model does not vary perpendicularly to this line. The velocity model is 22 km across and 4 km in depth.

The *velmodel.hh* file did not need to be updated appreciably in this example. However, the appropriate header settings are found in table 2. Datums were spread every 12.5 meters to produce a 22km by 4 km grid.

n1=321	d1=0.0125	o1=0	label1=Depth	unit1=km
n2=1761	d2=0.0125	o2=0	label2=Position	unit2=km

Table 2: *Amoco unsmoothed velocity model header information*

A python *SConstruct* script that fetches the data sets, appends the header slightly and plots the velocity model can be found in Table 3. An image of the velocity profile is found in Figure 1.

```
from rsf.proj import *
import fdmod

# Fetch Files from repository
Fetch("velsmooth.HH","Amoco")
Fetch("velmodel.hh","Amoco")
# Convert Files to RSF
Flow('velsmooth','velsmooth.HH', '''dd form=native | put
    unit1=km unit2=km label1=Depth\ Z label2=Position title=Velocity\ Model''')

Flow('velmodel','velmodel.hh', '''dd form=native | scale rscale=.001 | put
    unit1=km unit2=km label1=Depth\ Z label2=Position title=Velocity\ Model
    ''')

Result('velmodel',
       '''
       grey  scalebar=y barreverse=y
       color=j allpos=y bias=1.9
       screenwd=8.8 screenht=1.6
       barlabel=" " barunit=km/s
       title="Amoco Velocity Model"
       labelsz=4 titlesz=6
       wheretitle=t
       ''')

End()
```

Table 3: *Scons* script that generates RSF formatted Amoco velocity model

Typing Command 1 within the *amoco/model* directory runs the script.

`bash-3.1$ scons view` (1)

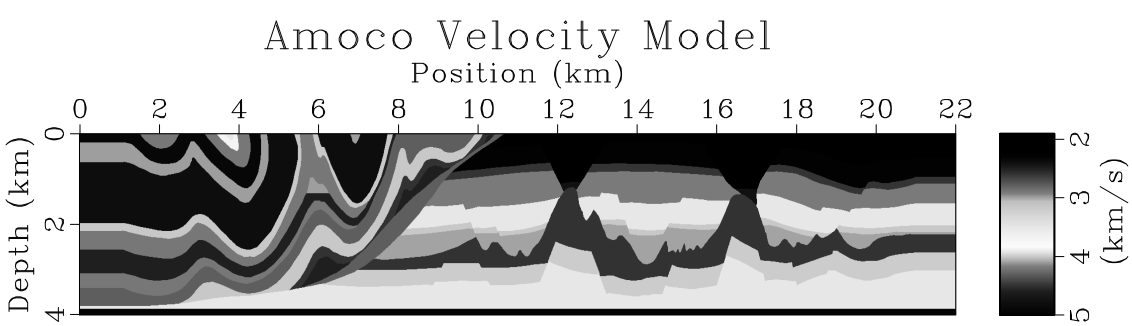

Figure 1: Amoco velocity model.

SHOTS

A synthetic off-end survey was performed on the model. Shots were fired every 50 meters along the model while 256 receivers with 25 meter spacing were pushed to the right. Each receiver receiver recorded 384 time samples per shot with gates every 9.9 milliseconds. The header should be formatted as is shown in Table 4

The file *amoco/shots/SConstruct* is presented in Table 5. This file fetches the shot data, appends the header slightly and produces several images from the record.

n1=384	d1=0.0099	o1=0	label1=Time	unit1=s
n2=256	d2=0.025	o2=0	label2=Offset	unit2=km
n3=385	d3=0.05	o3=0	label3=Shot	unit3=km

Table 4: Amoco shot header information

```
from rsf.proj import *
# Fetch Files from repository
Fetch("shots.hh","Amoco")
# Convert Files to RSF
Flow('shots','shots.hh', '''dd form=native |
     put  label1=time label2=offset label3=Shot unit1=km unit2=km unit3=km |
     scale rscale=.0003048''')
# Plotting Section
Result('zeroOne','shots','''window $SOURCE min2=0 max2=0 size2=1
     max3=10.6 |
     grey  pclip=96 color=I screenratio=1.5 gainpanel=a
     label2=Position label1=Time title= label3=  unit2=km unit1=s
     labelsz=6''')

Result('zeroTwo','shots','''window $SOURCE min2=0 max2=0 size2=1
     min3=10.6 |
     grey  pclip=97 color=I screenratio=1.5 gainpanel=a
     label2=Position label1=Time title= label3=  unit2=km unit1=s
     labelsz=6''')



Result('shot40','shots','''window $SOURCE  min3=14 max3=14 size3=1 |
     grey  pclip=99 color=I gainpanel=a wantframenum=y  unit1=s label1=Time
     label2=Offset unit2=km label3=Shot unit3=km title=
     screenratio=1.35 labelsz=3''')
End()
```

Table 5: *Scons* script that generates *RSF* formatted Amoco velocity model

Typing Command 2 within the *amoco/shots* directory runs the script.

`bash-3.1$ scons view` (2)

Several plots are produced. Figures 2a and 2b show the zero offset data acquired on the Amoco model. The plots are split as the large velocity contrast between the left and right side of the model muddles the image when the gainpanel filter plots the data.

FD MODELING

Madagascar can perform finite difference modeling on the Amoco Velocity model. This is done using the function fdmod found within the program The raw velocity model needs to be formatted in a similar fashion to the Model Section of this paper.

For the purposes of this example a shot will be fired at 10 km along the horizontal coordinate and at a depth of 10 meters. Receivers are spread at a depth of 25 meters every 12.5 meters along the entire scope of the model. This 22 km long receiver cable is impractical but useful for these purposes. Data is recorded on every receiver at time increments of 1 ms 5000 times resulting in 5 seconds of data.

An *SConstruct* file located within *amoco/fdmod/* properly formats the model and inputs necessary parameters to perform a shot on the Amoco model. This file is reproduced below in Table 6.

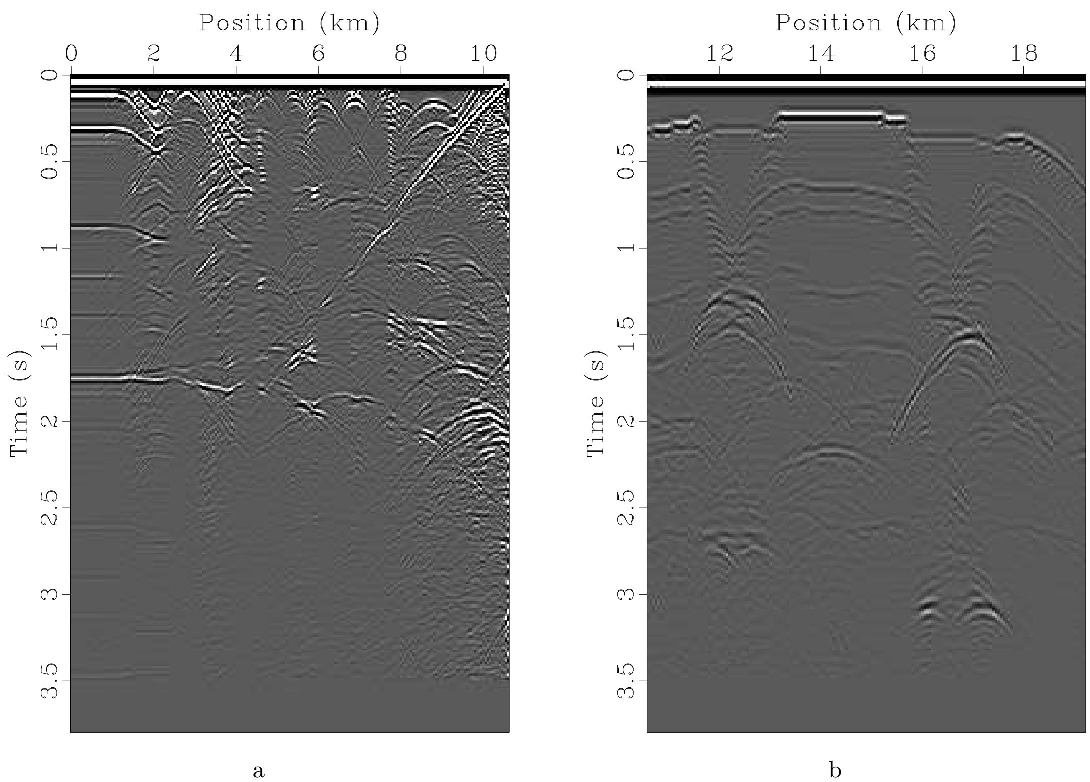

Figure 2: Amoco zero offset shot data, plot (a) goes from 0 to 10.6 km and (b) goes from 10.6 to 20 km. The plots were split as the large velocity contrast in the model makes it difficult to plot both sides on one scale.

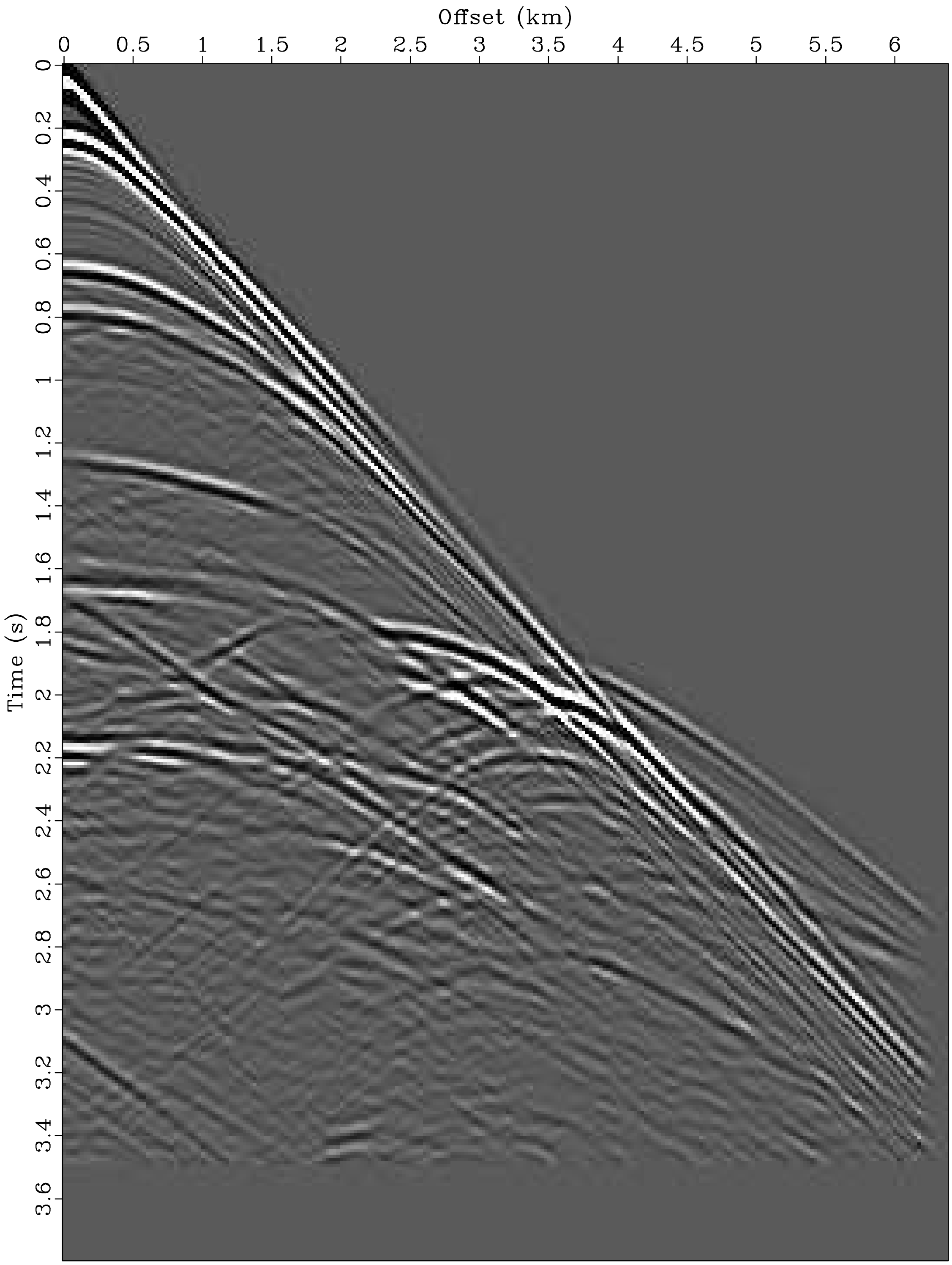

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Figure 3: Amoco shot number 280; the source is 14 km from origin

```
from rsf.proj import *
import fdmod
# Fetch Files from repository
Fetch("velsmooth.HH","Amoco")
Fetch("velmodel.hh","Amoco")
# Convert Files to RSF
Flow('velsmooth','velsmooth.HH', '''dd form=native | put
    unit1=km unit2=km label1=Depth\ Z label2=Position title=Velocity\ Model''')
Flow('velmodel','velmodel.hh', '''dd form=native | scale
    rscale=.001 | put
    unit1=km unit2=km label1=z label2=x title='' ''')
# Make image of velocity model
Result('model','velmodel',
       '''
       grey scalebar=y barreverse=y
       color=j gainpanel=a allpos=y bias=1.9
       screenwd=8.8 screenht=1.6
       barlabel=" " barunit=km/s wanttitle=n
       labelsz=4
       ''')
# ------------------------------------------------------------
par = {
    'nt':5000, 'dt':0.001,'ot':0,    'lt':'t','ut':'s',
    'kt':100,     # wavelet delay
    'nx':1761, 'ox':0,   'dx':.0125 ,'lx':'x','ux':'km',
    'nz':321, 'oz':0,    'dz':.0125 ,'lz':'z','uz':'km',
    }
# add F-D modeling parameters
fdmod.param(par)
# ------------------------------------------------------------
# wavelet
Flow('wav',None,
     '''
     spike nsp=1 mag=1 n1=%(nt)d d1=%(dt)g o1=%(ot)g k1=%(kt)d |
     ricker1 frequency=15 | scale axis=123 |
     put label1=t label2=x label3=y | transp
     ''' % par)
Result('wav',
       'window | window n1=200 | graph title="" label1="t" label2= unit2=')
# ------------------------------------------------------------
# experiment setup
Flow('r_',None,'math n1=%(nx)d d1=%(dx)g o1=%(ox)g output=0' % par)
Flow('s_',None,'math n1=1      d1=0      o1=0      output=0' % par)
# receiver positions
Flow('zr','r_','math output=.025')
Flow('xr','r_','math output="x1"')
Flow('rr',['xr','zr'],'''cat axis=2 space=n
     ${SOURCES[0]} ${SOURCES[1]} | transp
     ''', stdin=0)
Plot('rr',fdmod.rrplot('',par))
# source positions
Flow('zs','s_','math output=.01')
Flow('xs','s_','math output=10.0')
Flow('rs','s_','math output=1')
Flow('ss',['xs','zs','rs'],'''
     cat axis=2 space=n
     ${SOURCES[0]} ${SOURCES[1]} ${SOURCES[2]} | transp
     ''', stdin=0)
Plot('ss',fdmod.ssplot('',par))
# ------------------------------------------------------------
# density
Flow('vel','velmodel',
      '''
      put o1=%(oz)g d1=%(dz)g  o2=%(oz)g d2=%(dz)g
      ''' % par)
Plot('vel',fdmod.cgrey('''allpos=y bias=1.5 pclip=97 title=Survey\ Design
                          titlesz=6 labelsz=4 wheretitle=t''',par))
Result('vel',['vel','rr','ss'],'Overlay')
# ------------------------------------------------------------
# density
Flow('den','vel','math output=1')
# ------------------------------------------------------------
# finite-differences modeling
fdmod.awefd1('dat','wfl','wav','vel','den','ss','rr','free=y dens=y',par)

Plot('wfl',fdmod.wgrey('pclip=99',par),view=1)
Result('dat','window j2=5 | transp |' + fdmod.dgrey('''
pclip=99 title=Data\ Record label2=Offset
wheretitle=t titlesz=6 labelsz=4
''',par))
times=['5','10','15','20']
cntr=0
for item in ['5','10','15','20']:
    Result('time'+item,'wfl','''window f3=%s n3=1 min1=0 min2=0 | grey gainpanel=a
              pclip=99 wantframenum=y title=Wavefield\ at\ %s\ ms labelsz=4
              label1=Depth unit1=km label2=Distance unit2=km
              titlesz=6 screenratio=.18 screenht=2 wheretitle=t''' % (item,item))
End()
```

Table 6: *Scons* script that performs a finite difference synthetic shot on the Amoco model.

Typing Command 3 within the *amoco/fdmod/* directory runs the FD modeling script.

```
bash-3.1$ scons view
```
(3)

This script first constructs the survey acquisition geometry as was previously mentioned. An image of the survey is created and presented in Figure 4.

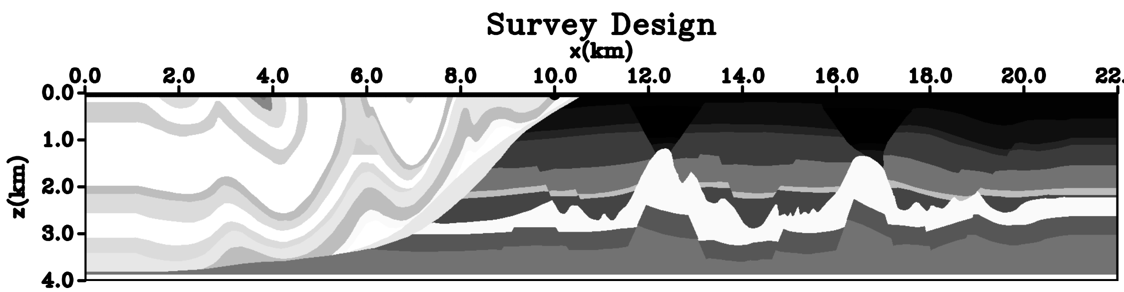
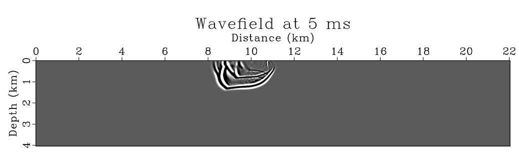


Figure 4: FD model geometry as performed on the Amoco velocity model. The X represents the shot while the smaller * symbols represent receivers. The receivers extent along the right hand side although it is not clear in this image.

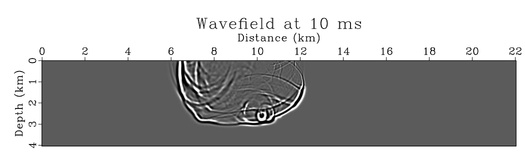
Firing the shot results the propagation of a wavefield which can be seen in the movie *wfl.vpl* that is generated. Typing Command 4 within the *amoco/fdmod* directory displays the wavefield movie.

```
bash-3.1$ scons wfl.vpl
```
(4)

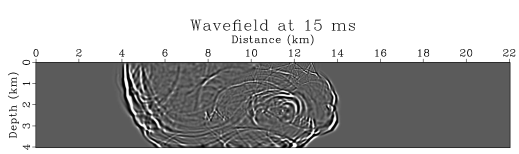
Four frames from this movie are presented in Figure 5 illustrating the propagation of the wavefield in the model.



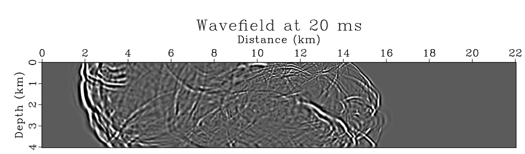
a



b



c



d

Figure 5: Images of the propagating wavefield in the Amoco model generated by a finite difference model.

The resulting data is then presented in the file *dat.vpl*. This plot is reproduced here in Figure 6. This shot is interesting as it clearly illustrates the different moveout witnessed on the two sides of the model.

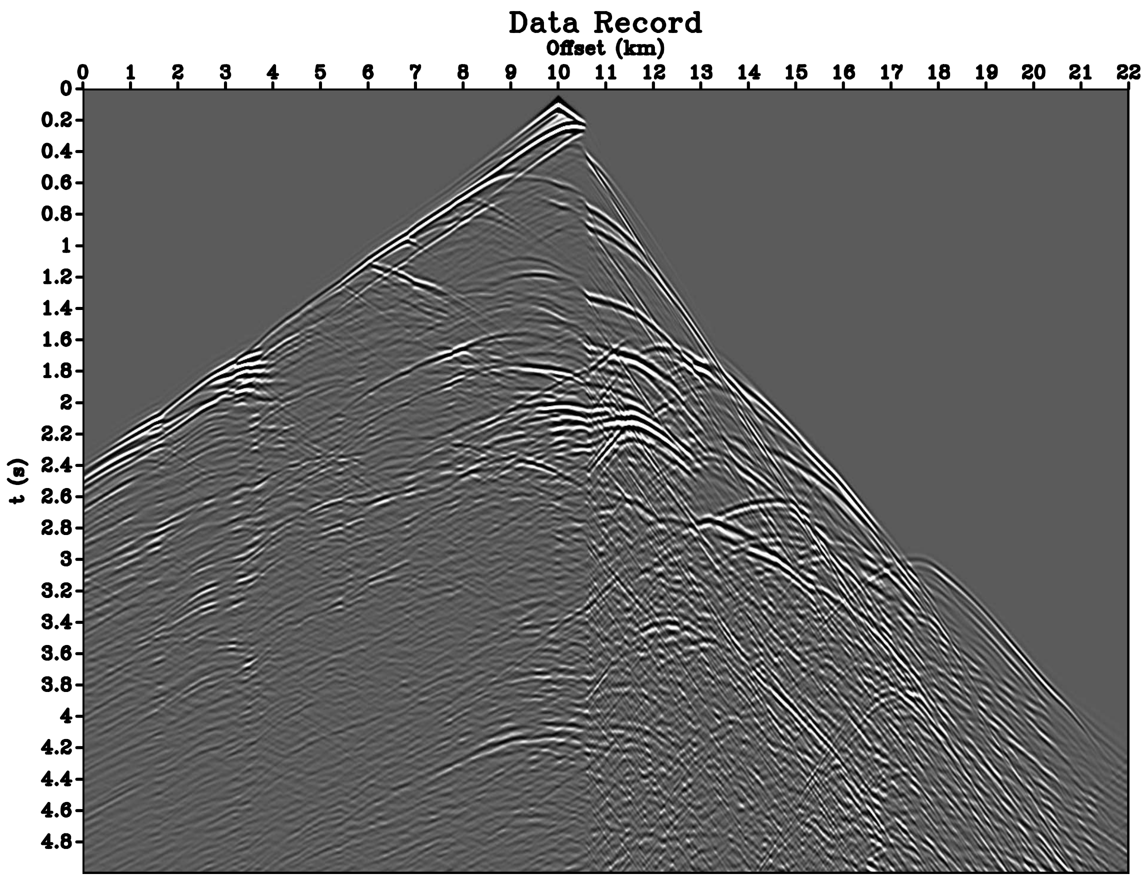


Figure 6: Data gathered by the receivers in the FD model survey.