EAS 8803 - Obs. Seismology
Lec#15-16: Inverse Problem/EQ Location

- Dr. Zhigang Peng, Spring 2011

Figure 7.2-1: Geometry for earthquake location in a homogeneous halfspace.

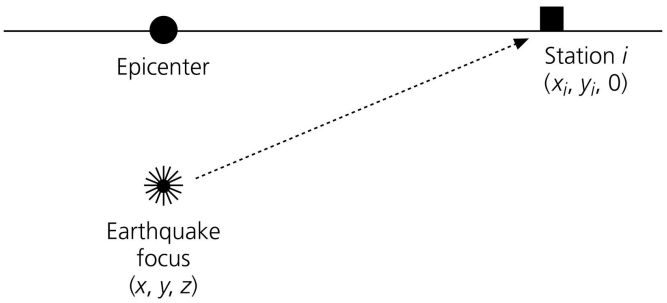
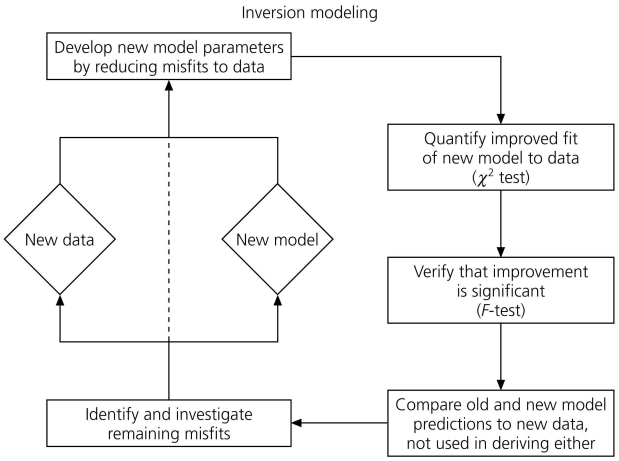


Figure 1.1-8: Inversion modeling flow chart.



Earthquake Location

Figure 7.2-1: Geometry for earthquake location in a homogeneous halfspace.

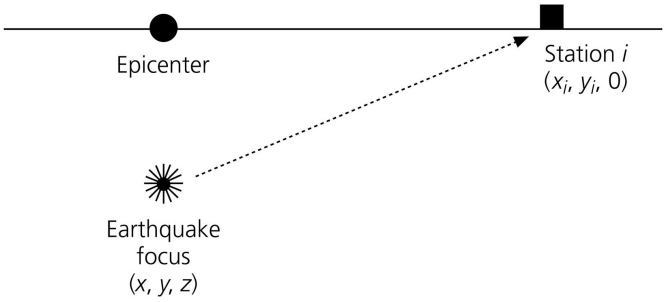


Figure 7.2-2: Illustration of the the effect of linearizing about an inverse problem starting model.

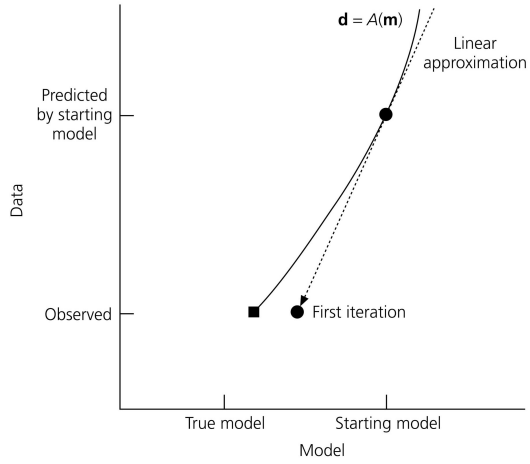


Figure 7.2-3: Illustration of the misfit to data as a function of inverse problem iteration.

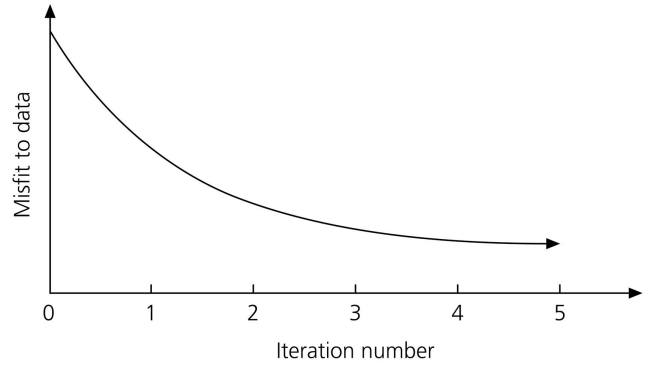


Table 7.2-1 Earthquake location example with error-free data.

Invert for location and origin time				
		model evolution		
parameter	actual value	model for iteration number		
		0	1	2
x	0.0	3.0	−0.5	0.0
y	0.0	4.0	−0.6	0.0
z	10.0	20.0	10.1	10.0
origin time	0.0	2.0	0.2	0.0
station location		residual for iteration number		
		0	1	2
35.0	9.0	−2.1	−0.4	0.0
−44.0	10.0	−3.0	−0.2	0.0
−11.0	−25.0	−3.8	−0.1	0.0
23.0	−39.0	−3.0	−0.2	0.0
42.0	−27.0	−2.6	−0.3	0.0
−12.0	50.0	−2.0	−0.3	0.0
−45.0	16.0	−2.9	−0.2	0.0
5.0	−19.0	−3.7	−0.2	0.0
−1.0	−11.0	−4.1	−0.2	0.0
20.0	11.0	−2.4	−0.4	0.0
error		92.4	0.6	0.0

Invert for location, origin time, and velocity

model evolution

parameter	actual value	model for iteration number 0	1	2
x	0.0	3.0	0.2	0.0
y	0.0	4.0	0.3	0.0
z	10.0	20.0	10.2	10.0
origin time	0.0	2.0	0.7	0.0
velocity	5.0	4.0	4.9	5.0

station location		residual for iteration number 0	1	2
35.0	9.0	−4.0	−0.9	0.0
−44.0	10.0	−5.6	−1.0	0.0
−11.0	−25.0	−5.7	−0.9	0.0
23.0	−39.0	−5.6	−1.0	0.0
42.0	−27.0	−5.2	−1.0	0.0
−12.0	50.0	−4.6	−0.9	0.0
−45.0	16.0	−5.6	−1.0	0.0
5.0	−19.0	−5.2	−0.9	0.0
−1.0	−11.0	−5.3	−0.9	0.0
20.0	11.0	−3.8	−0.8	0.0
error		261.3	8.3	0.0

Table 7.2-2 Earthquake location example with errors.

Invert for location and origin time

model evolution

parameter	actual value	model for iteration number 0	1	2	3
x	0.0	3.0	−0.2	0.2	0.2
y	0.0	4.0	−0.9	−0.4	−0.4
z	10.0	20.0	12.2	12.2	12.2
origin time	0.0	2.0	0.0	−0.2	−0.2

station location		residual for iteration number 0	1	2	3
35.0	9.0	−2.0	−0.1	0.1	0.1
−44.0	10.0	−3.0	−0.1	0.0	0.0
−11.0	−25.0	−3.8	0.0	0.1	0.1
23.0	−39.0	−3.2	−0.1	0.0	0.0
42.0	−27.0	−2.8	−0.2	−0.1	−0.1
−12.0	50.0	−2.1	−0.3	−0.1	−0.1
−45.0	16.0	−2.9	−0.1	0.0	0.0
5.0	−19.0	−3.7	−0.1	0.0	0.0
−1.0	−11.0	−4.0	−0.1	0.0	0.0
20.0	11.0	−2.5	−0.3	0.0	0.0
error		93.74	0.33	0.04	0.04

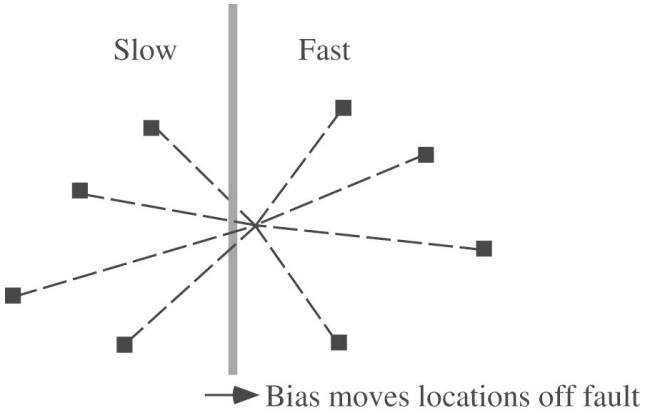
data standard deviation 0.10

model variance–covariance matrix

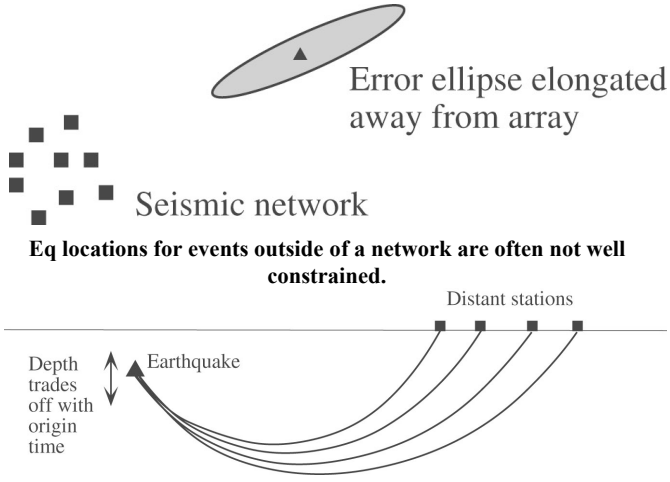
0.06	0.01	0.01	0.00
0.01	0.08	−0.13	0.01
0.01	−0.13	1.16	−0.08
0.00	0.01	−0.08	0.01

model standard deviation

x	*y*	*z*	origin time
0.25	0.28	1.08	0.10



Earthquakes located along a fault will be mislocated if the seismic velocity changes around the fault.



Eq locations for events outside of a network are often not well constrained.