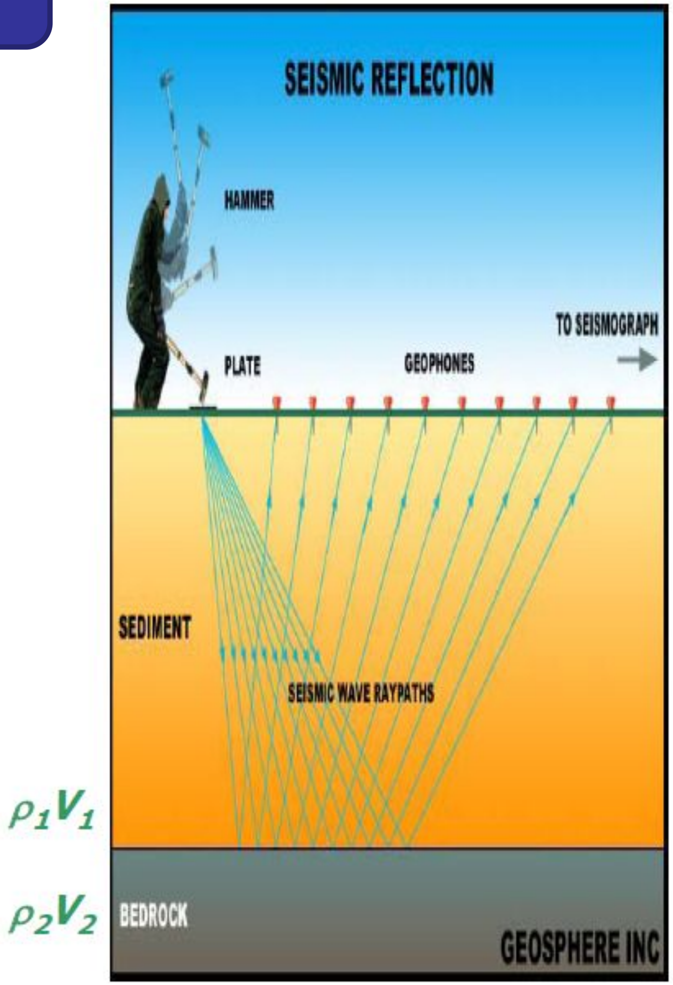
Метод отраженных волн.

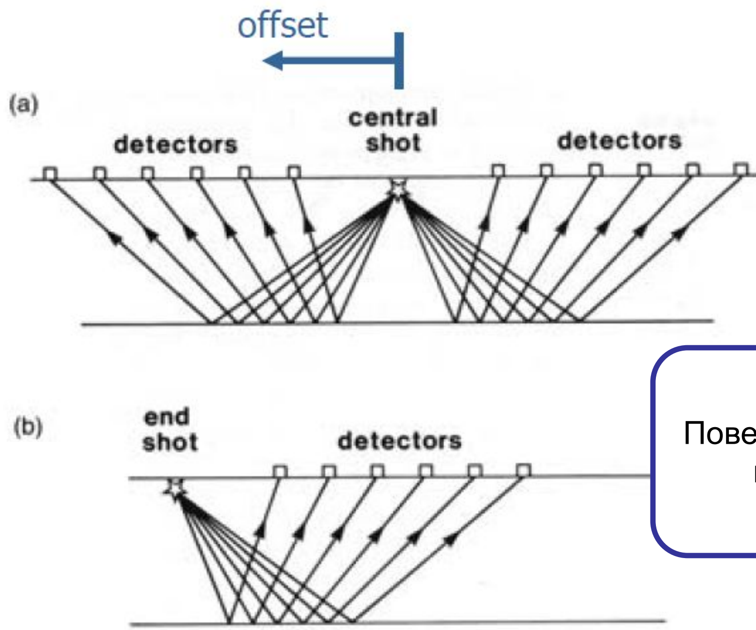
- Чувствителен к границам на которых происходит изменение акустического импеданса.
- Используются, в основном, продольные волны.

Масштабы объектов

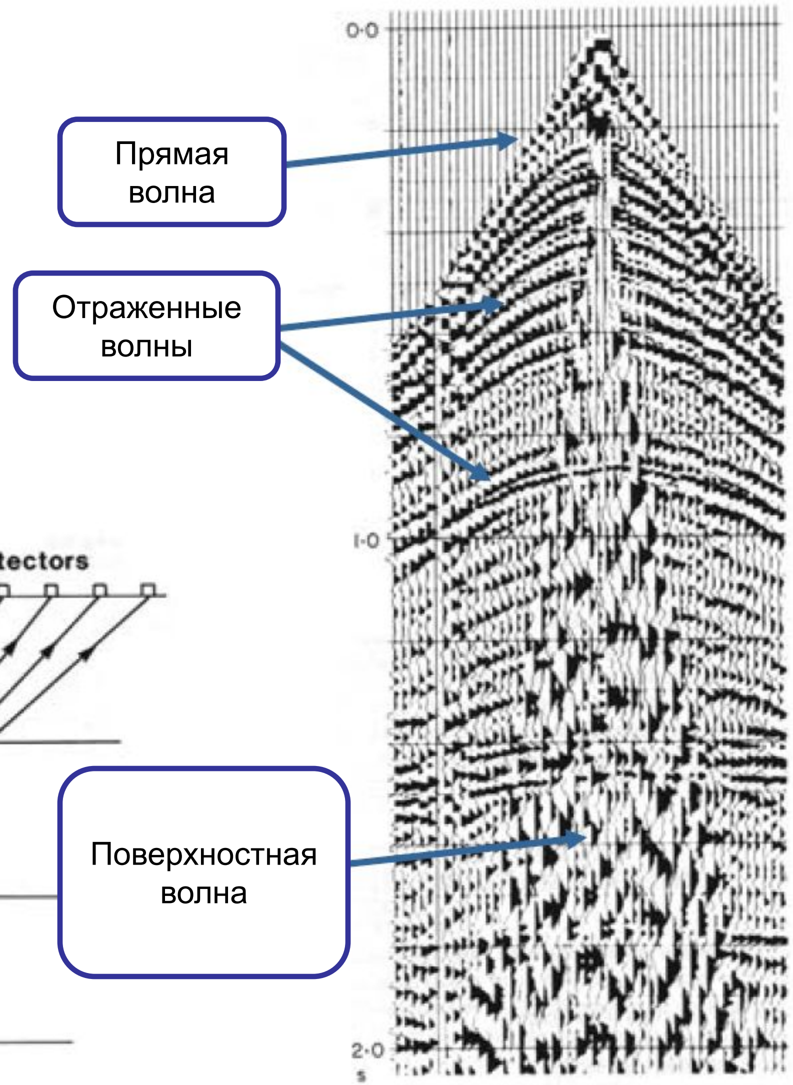
- 10’ки метров - инженерные задачи.
- Первые километры – разведка МПИ.
- 10’ки километров – структура коры.



Выборка ОПВ



offset
(a)
detectors
central
shot
detectors
(b)
end
shot
detectors



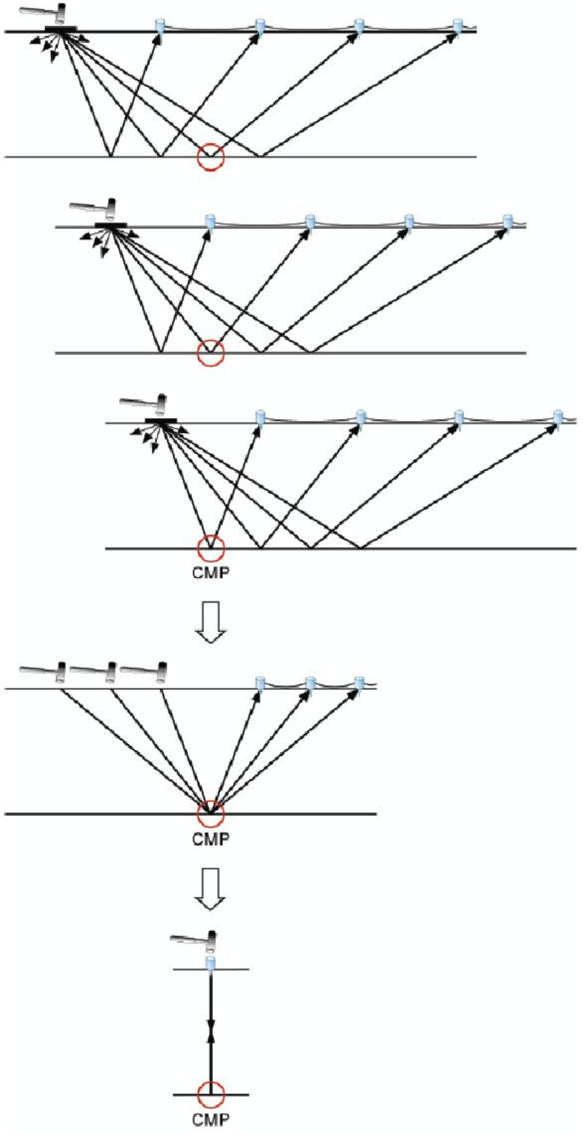
Прямая
волна
Отраженные
волны
Поверхностная
волна
0·0
1·0
2·0
s

Выборка ОСТ (осуществление)

Sequentially move shot and receiver string across the surface

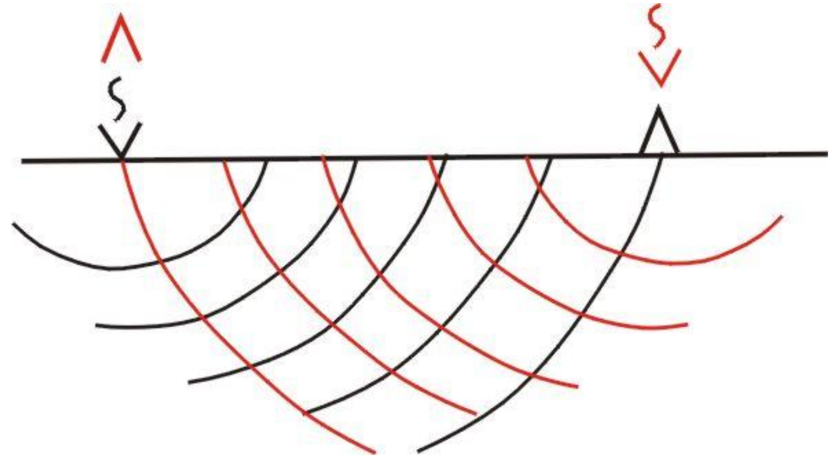
Кратность – Количество трасс в выборке ОСТ.

Типичные значения – около 6 для инженерных работ . 20-50-100 и более для нефгазотеразведочных

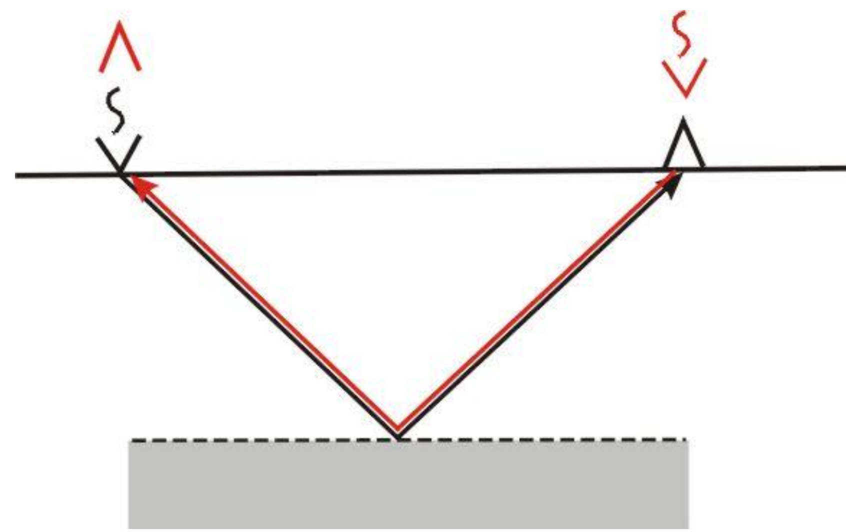


Принцип суперпозиции, принцип взаимности

- Принцип суперпозиции: при интерференции (наложении) нескольких упругих волн, их распространение можно изучать независимо для каждой волны.



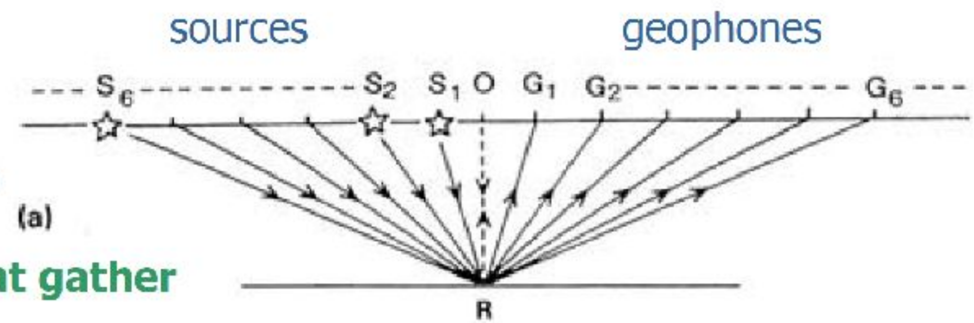
- Принцип взаимности: если поменять местами источник и приемник, то время прихода сигнала, форма лучей и характер колебаний частиц геологической среды не изменятся.



Common midpoint gathers

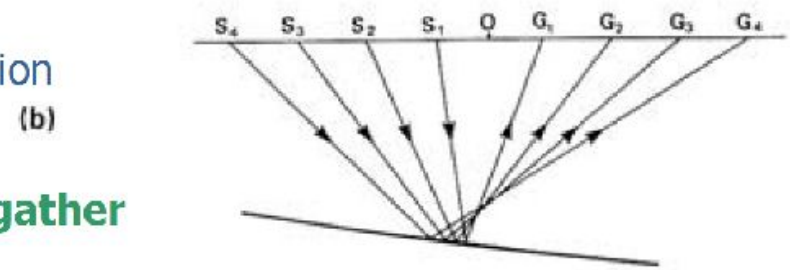
To enhance signal to noise we use more than one shot

Reflections from the same point are recorded by different source-station pairs



➔ **Common depth point gather**

For dipping layers the reflection points are "smeared"



➔ **Common midpoint gather**

Fig. 4.16 (a) Ray paths of reflections belonging to the common-depth point (CDP) which is located below the shot–geophone common midpoint, O. The arrangement shown gives a six-fold coverage of the subsurface reflection point, R, on a horizontal reflector. (b) For a dipping reflector, the reflection point is not vertically below the shot–geophone midpoint, O.

Normal move out (NMO) correction

The reflection traveltime equation predicts a hyperbolic shape to reflections in a CMP gather. The hyperbolae become fatter/flatter with increasing velocity

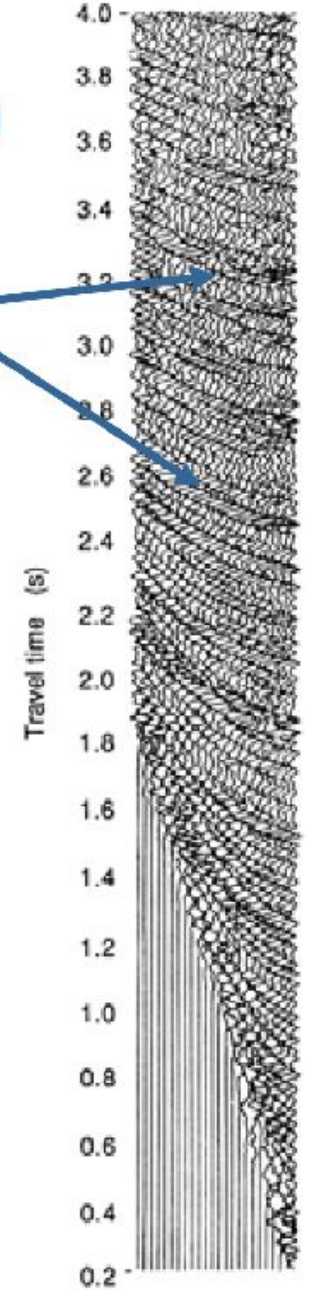
$$T_x^2 = T_0^2 + \frac{x^2}{V_1}$$

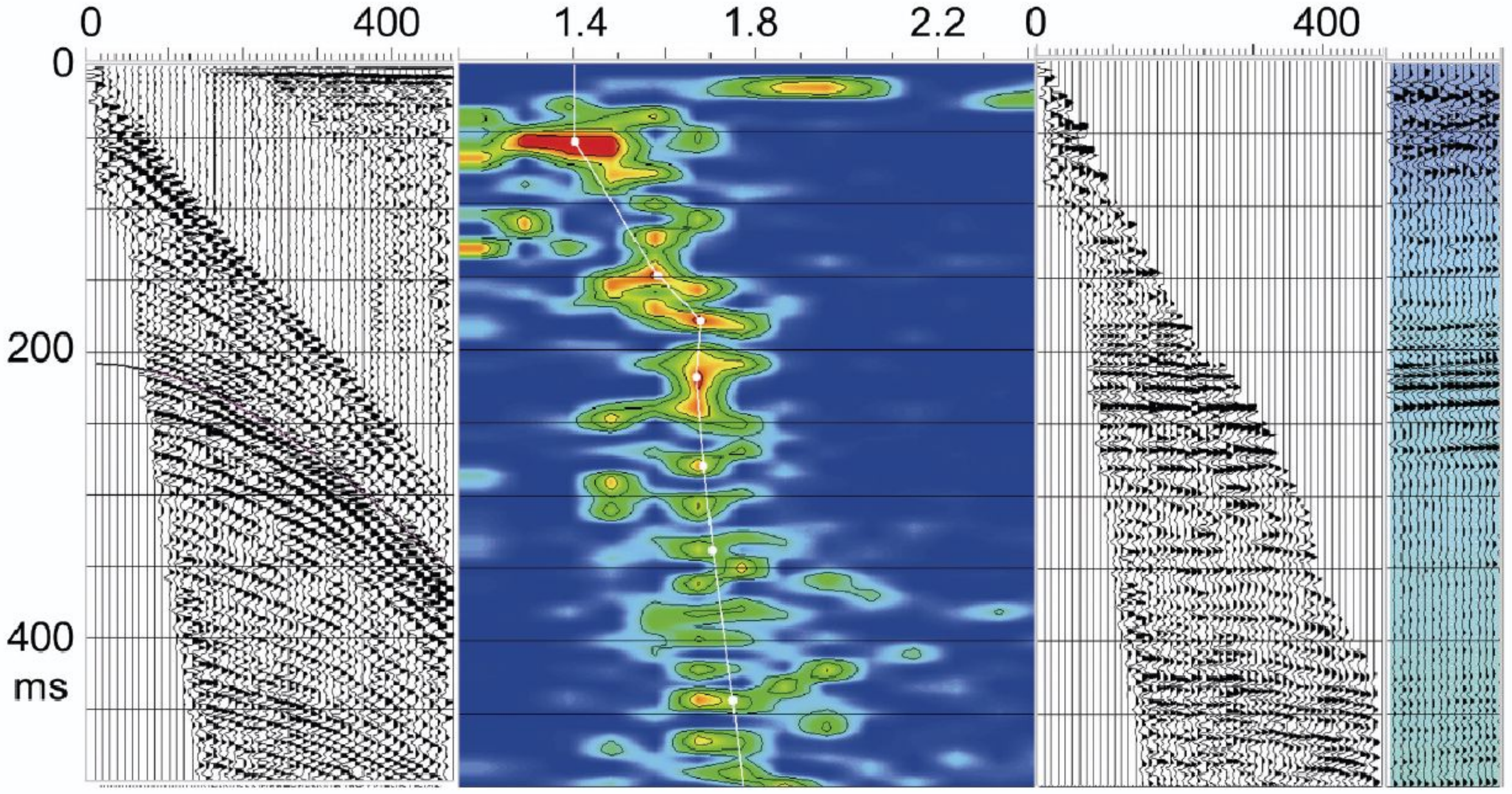
We want to subtract the NMO correction from the common depth point gather

$$\Delta T_{NMO} \approx \frac{x^2}{2T_0V_1^2}$$

But for that we need velocity...

reflection hyperbolae become fatter with depth (i.e. velocity)




0
400
1.4
1.8
2.2
0
400
0
200
400
ms

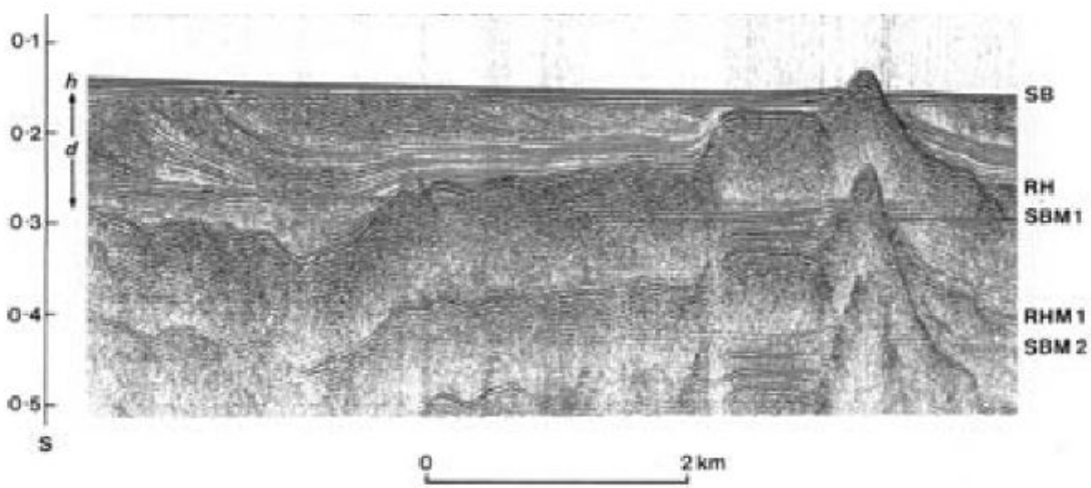
Multiples

Due to multiple bounce paths in the section

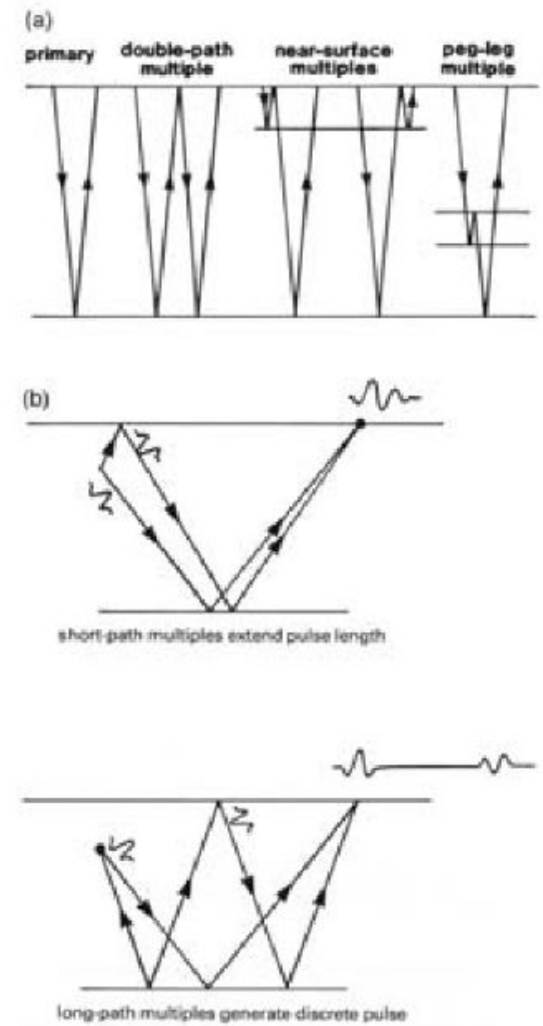
➔ Looks like repeated structure

These are also removed with deconvolution

- easily identified with an autocorrelation
- removed using cross-correlation of the autocorrelation with the waveform



Sea-bottom reflections

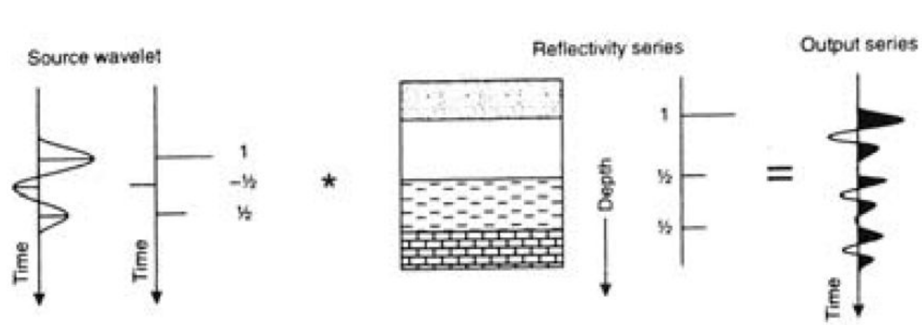


Импульсная характеристика среды, свертка.

Сейсмический волны чувствительны к скачкам импеданса, которые могут быть представлены в виде импульсной характеристики среды(R).

W – сигнал от источника, тогда сейсмограмма S записанная на поверхности может быть представлена как:

S = W * R



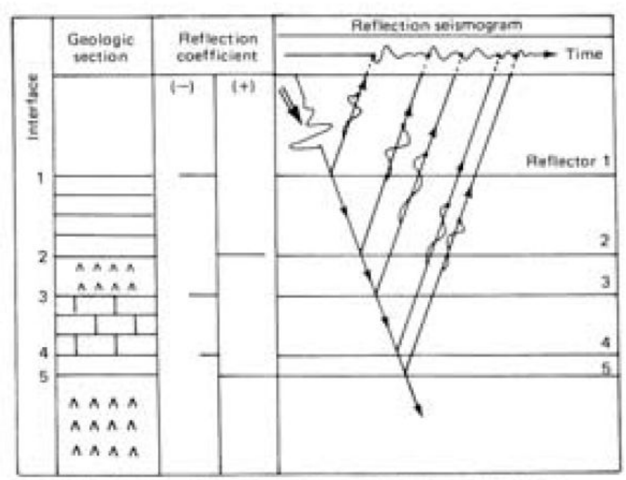
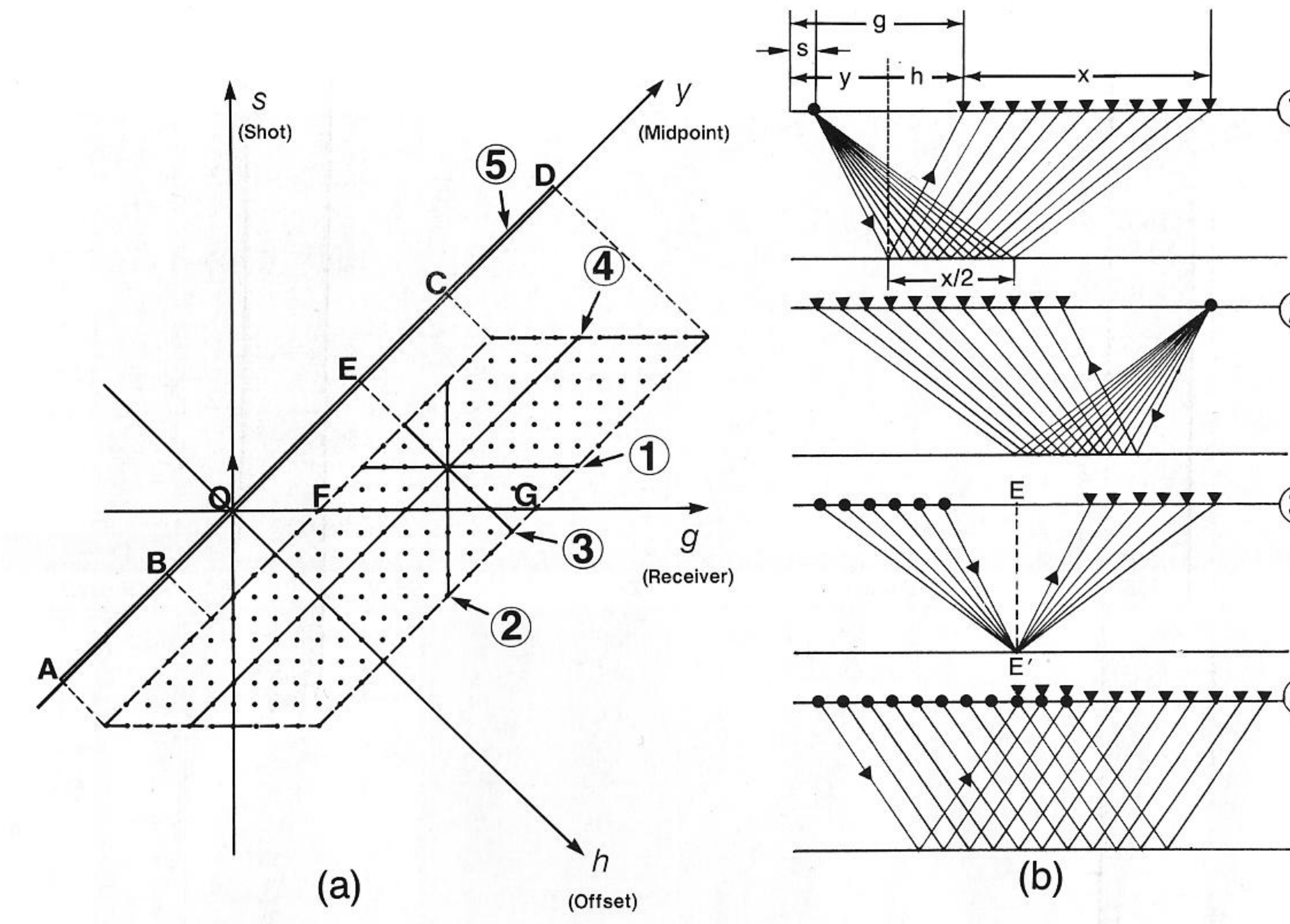


Fig. 4.18 Schematic of a model geological section, a reflectivity log, and a synthetic seismogram. The last is produced by convolving the input wavelet with the reflection effects at each interface derived from the reflectivity log. (Modified from Al-Sadi, 1982.)

Обобщенное изображение системы наблюдений



Статические поправки.

Correct for surface topography and the weathered surface layer

Surface topography

Time correction to each trace:

$$t_g = (E_g - E_d)/V$$

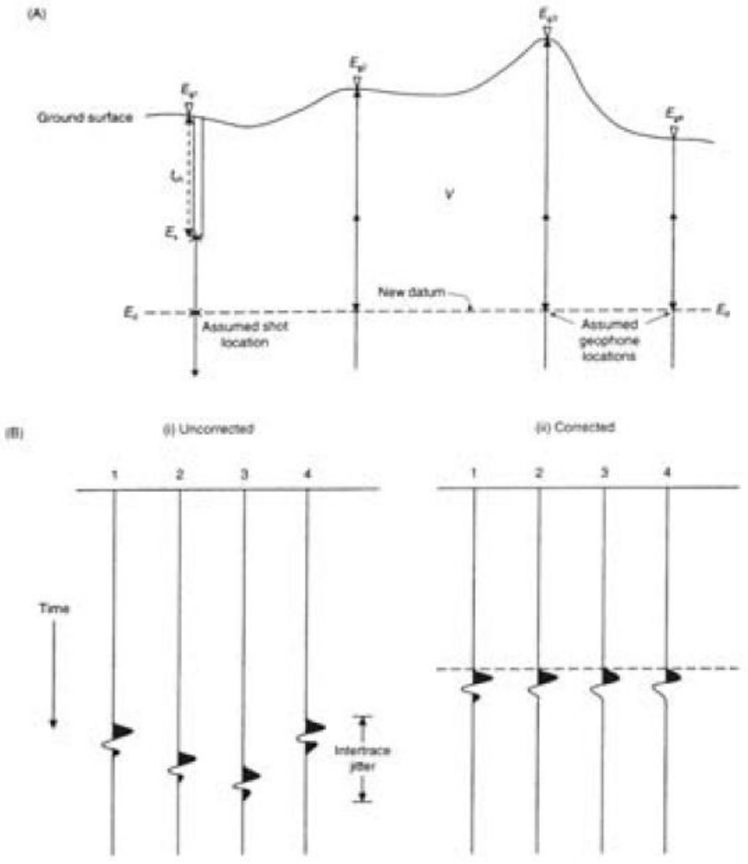
Source depth

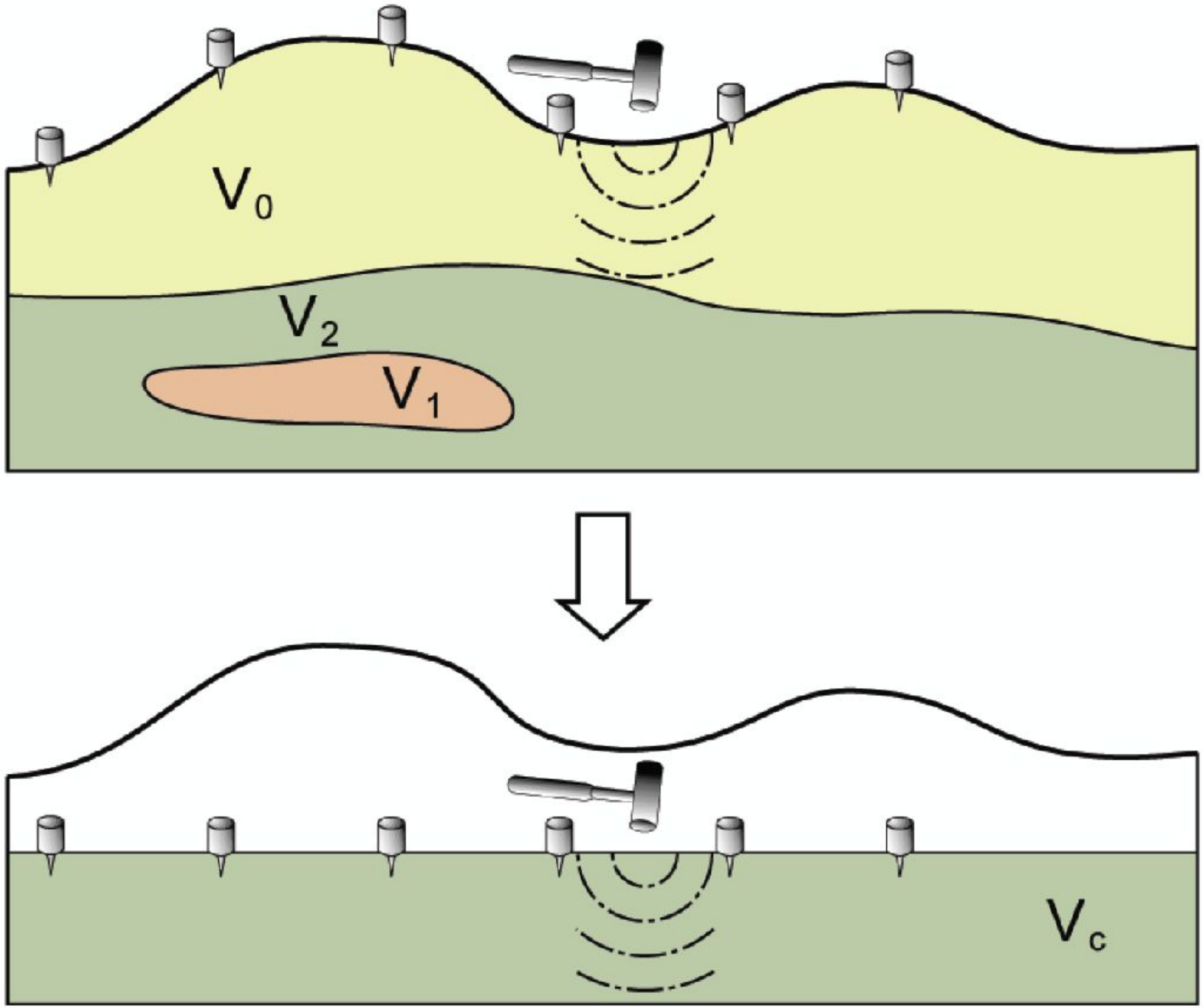
$$t_s = (E_s - E_d)/V$$

total correction

$$t_e = t_s + t_g$$

Shift each trace by this amount to line up deeper reflectors





V_0
V_2
V_1
V_c

Статические поправки.

An example

(a)

Pre-correction

(b)

Post-correction

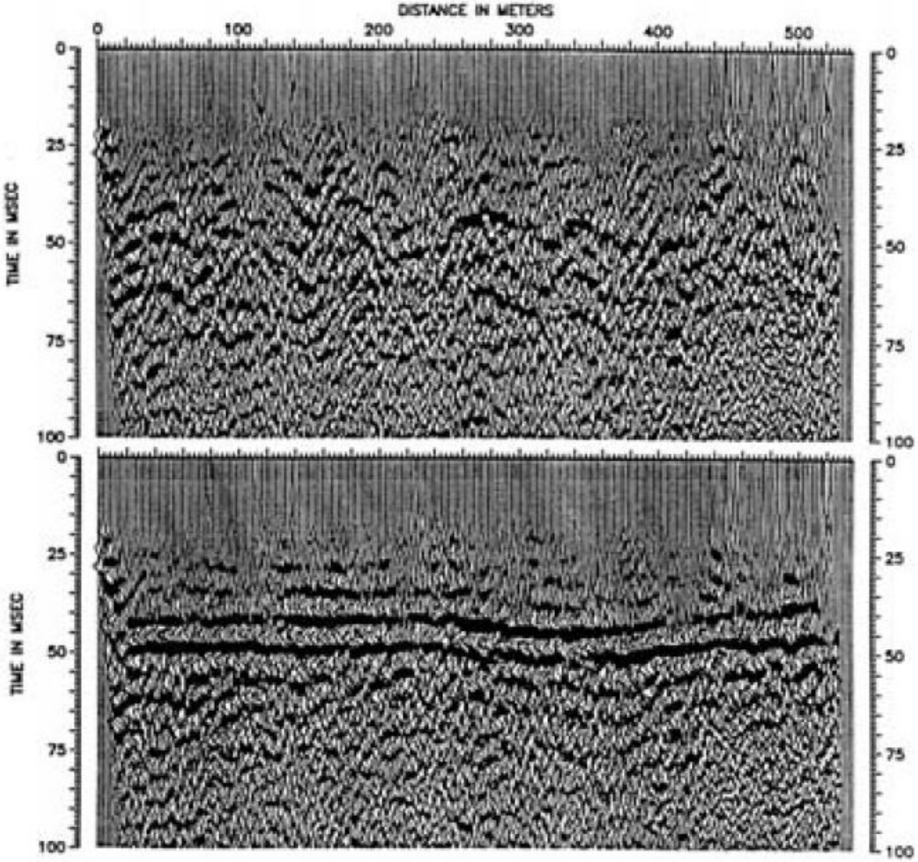
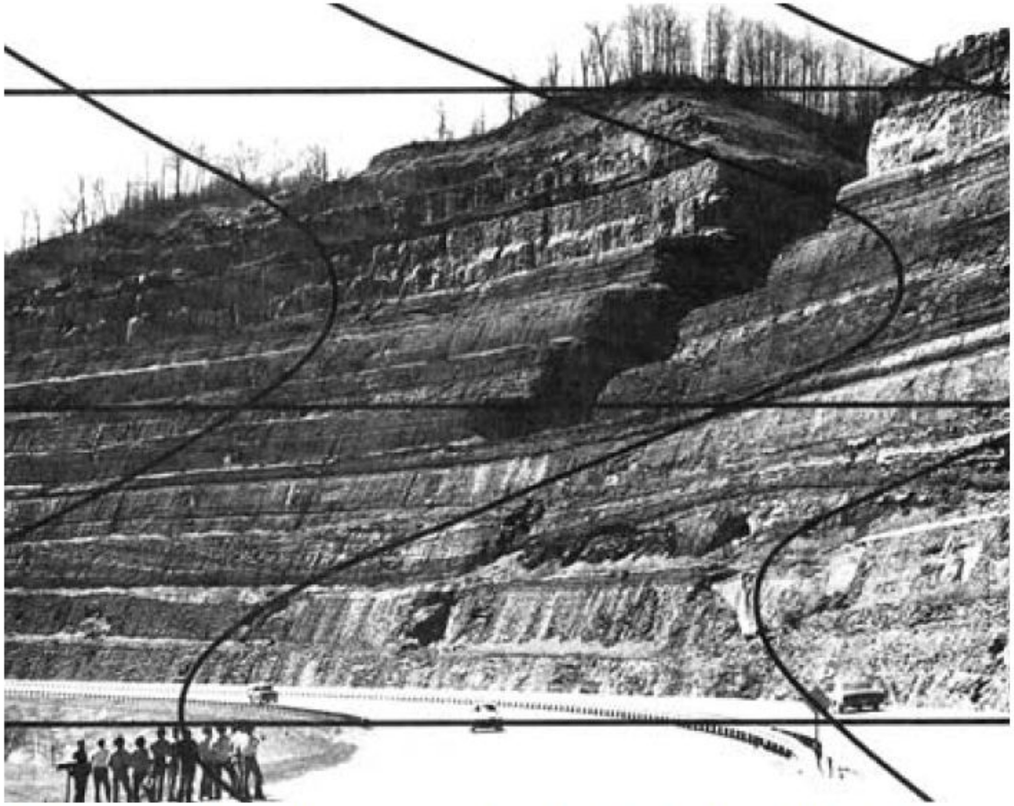
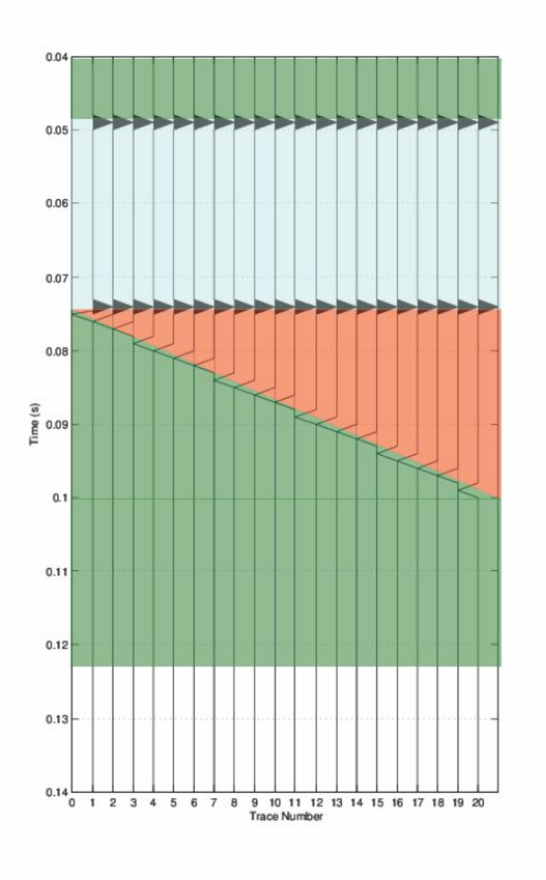


Fig. 4.17 Effect of applying residual static corrections on CDP reflection data recorded at a waste-dump site in Zealand, Denmark. Time section (a) before application of statics and (b) after application of statics. (After Ploug, 1991.)

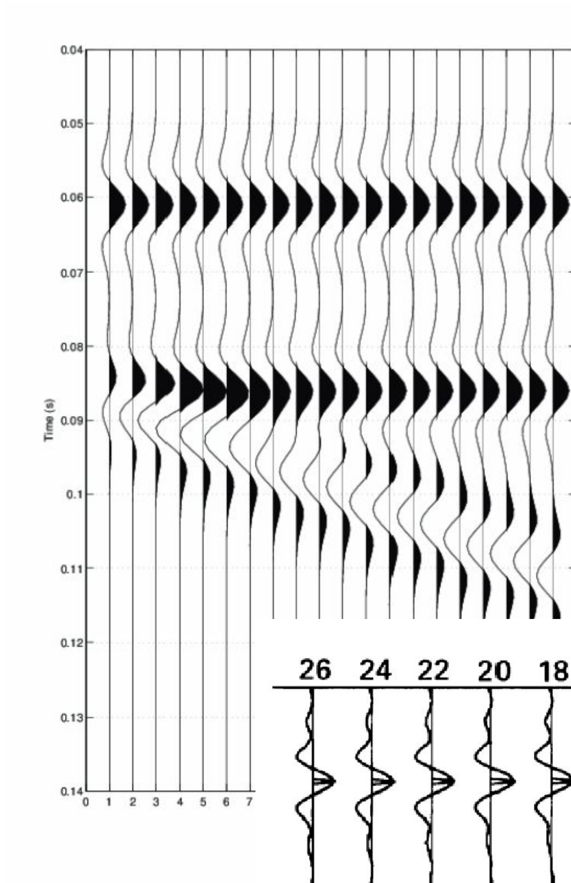
Resolution of structure



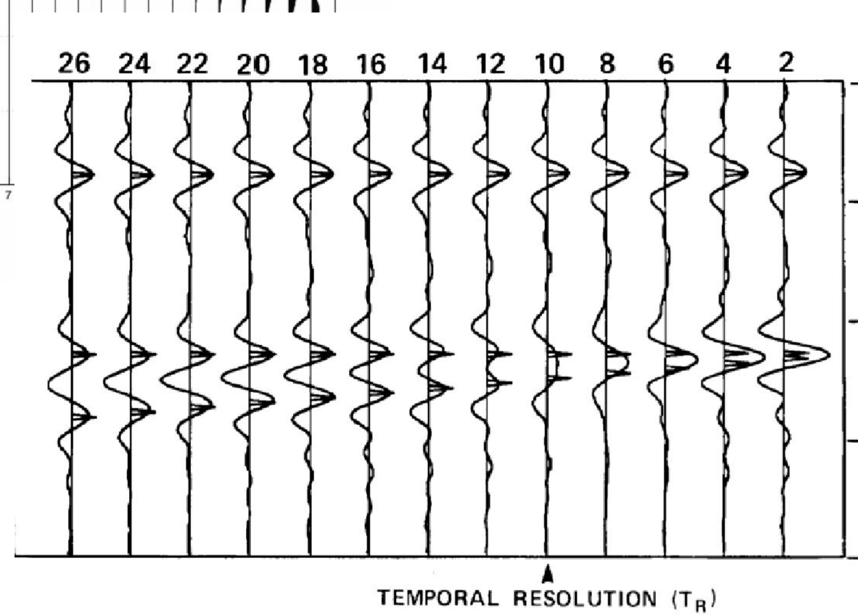
When you have been mapping faults in the field what were the vertical offsets?



Time (s)
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trace Number



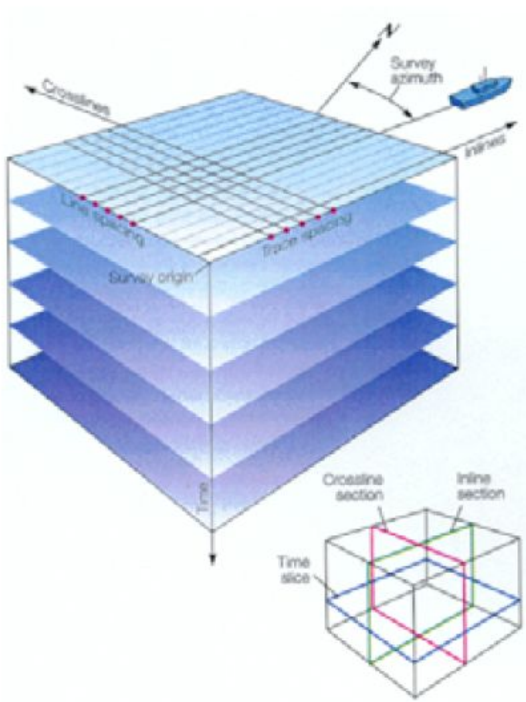
Time (s)
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0 1 2 3 4 5 6 7

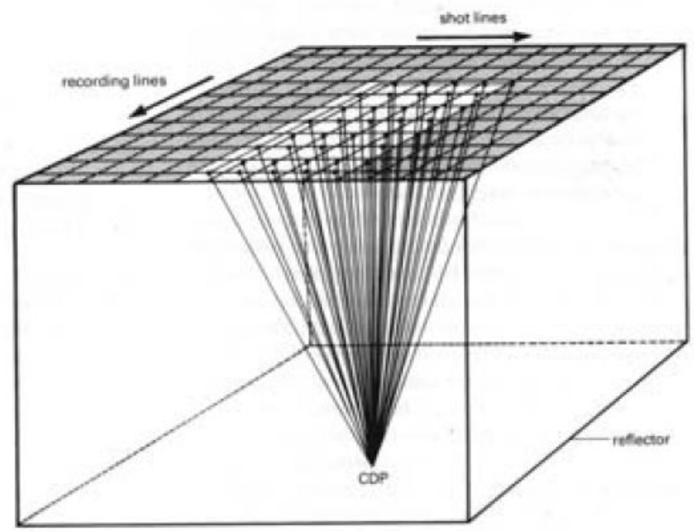


26 24 22 20 18 16 14 12 10 8 6 4 2
TEMPORAL RESOLUTION (T_R)

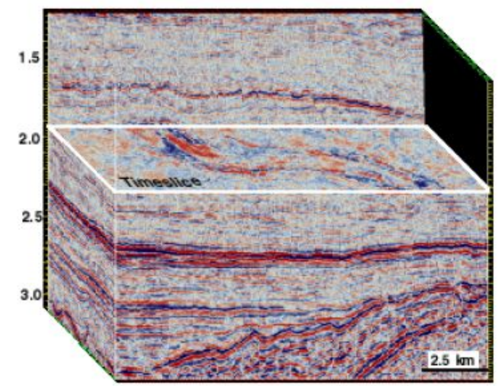
3D surveys

Collect data on a grid rather than along a line





Produces a data cube rather than a line



Head wave

- Occurs due to a low to high velocity interface
- Energy travels along the boundary at the higher velocity
- Energy is continually refracted back into the upper medium at an angle i_C
- Provides constraints on the boundary depth e.g. Moho depth

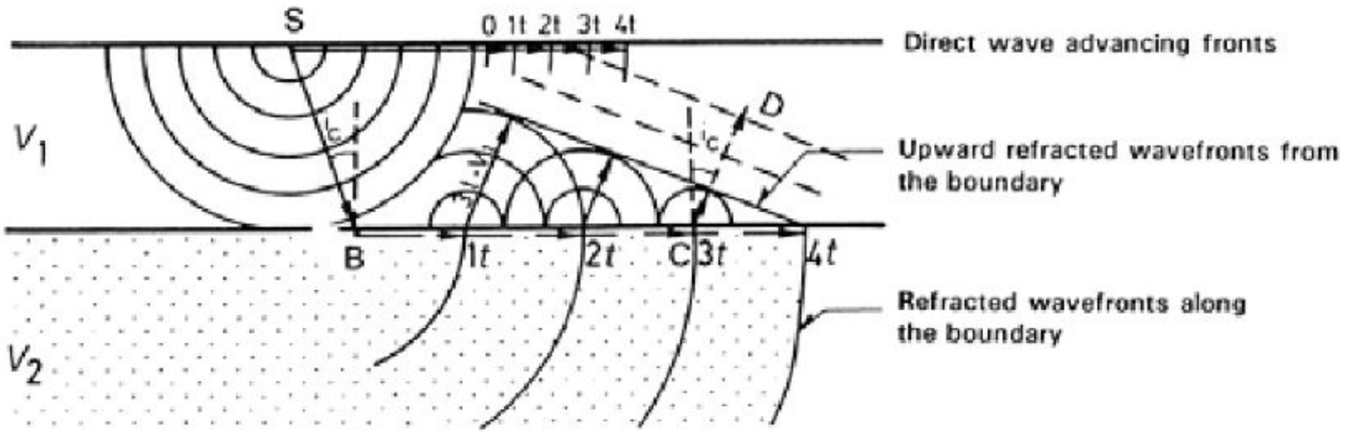


Fig. 4.6 Schematic illustration showing the ray paths of the incident wave (SB) striking the boundary at critical angle (i_c), and the refracted wave (BC) traveling along the boundary with velocity V_2 ($>V_1$). The latter is refracted back to the first medium (V_1) at the same angle (i_c) and re-emerges with a ray path such as CD. Advancement of the wavefronts is shown from the instant ($t=0$) when the incident ray strikes the boundary at B. (Modified from Klitten, 1987.)