LECTURE VI

SEISMIC DATA ACQUISITION

Seismic data acquisition

- Reflection seismic data are acquired using multiple sources and receivers.

- The receivers record the travel times and magnitudes of the reflected seismic energy.

- The initial display of seismic profile data is normally in groups of seismic traces recorded from a common shot, known as **shot gathers**.

- Desired arrivals are generally called **a signal** and undesired arrivals called **noise**.

- Field procedures have been developed to **improve the signal to noise ratio**, thereby producing more useful seismograms.

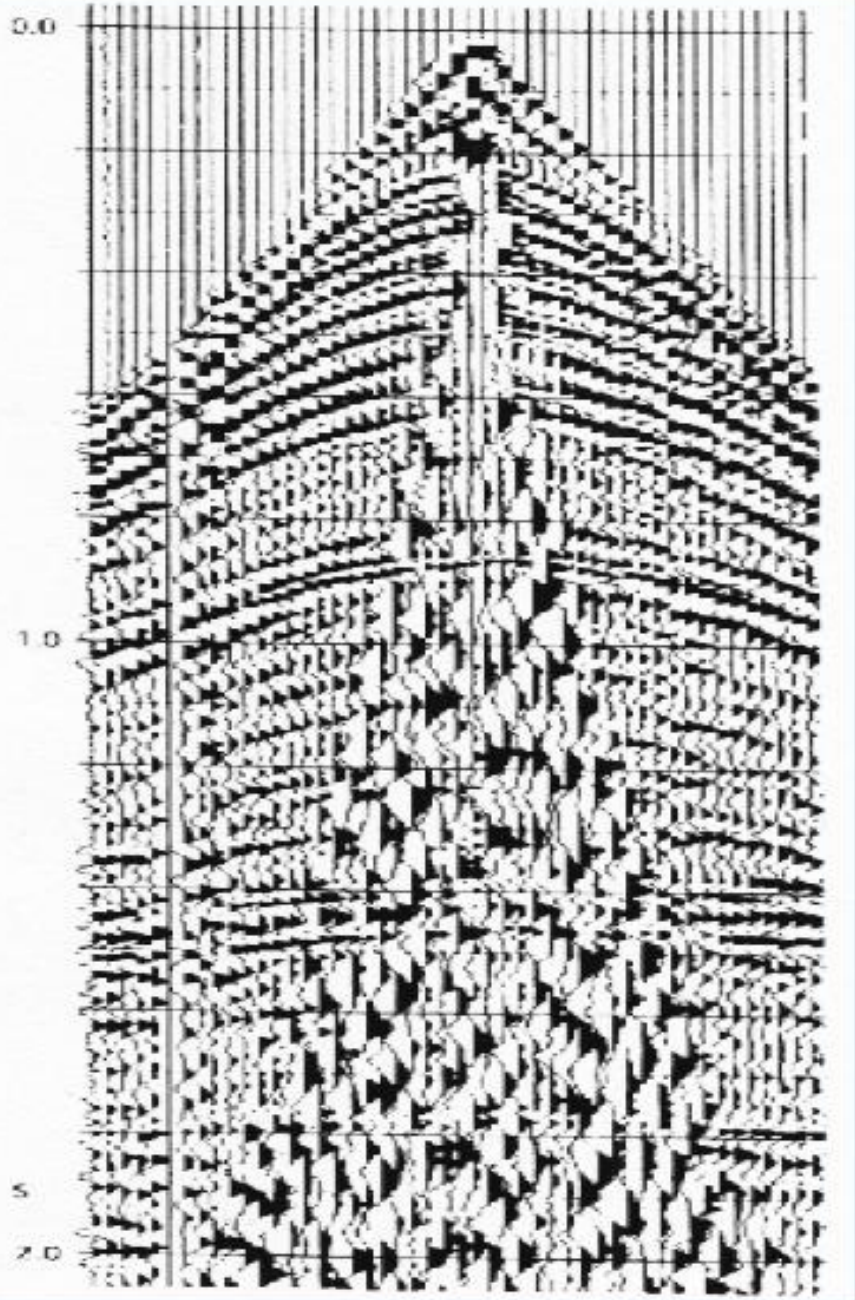
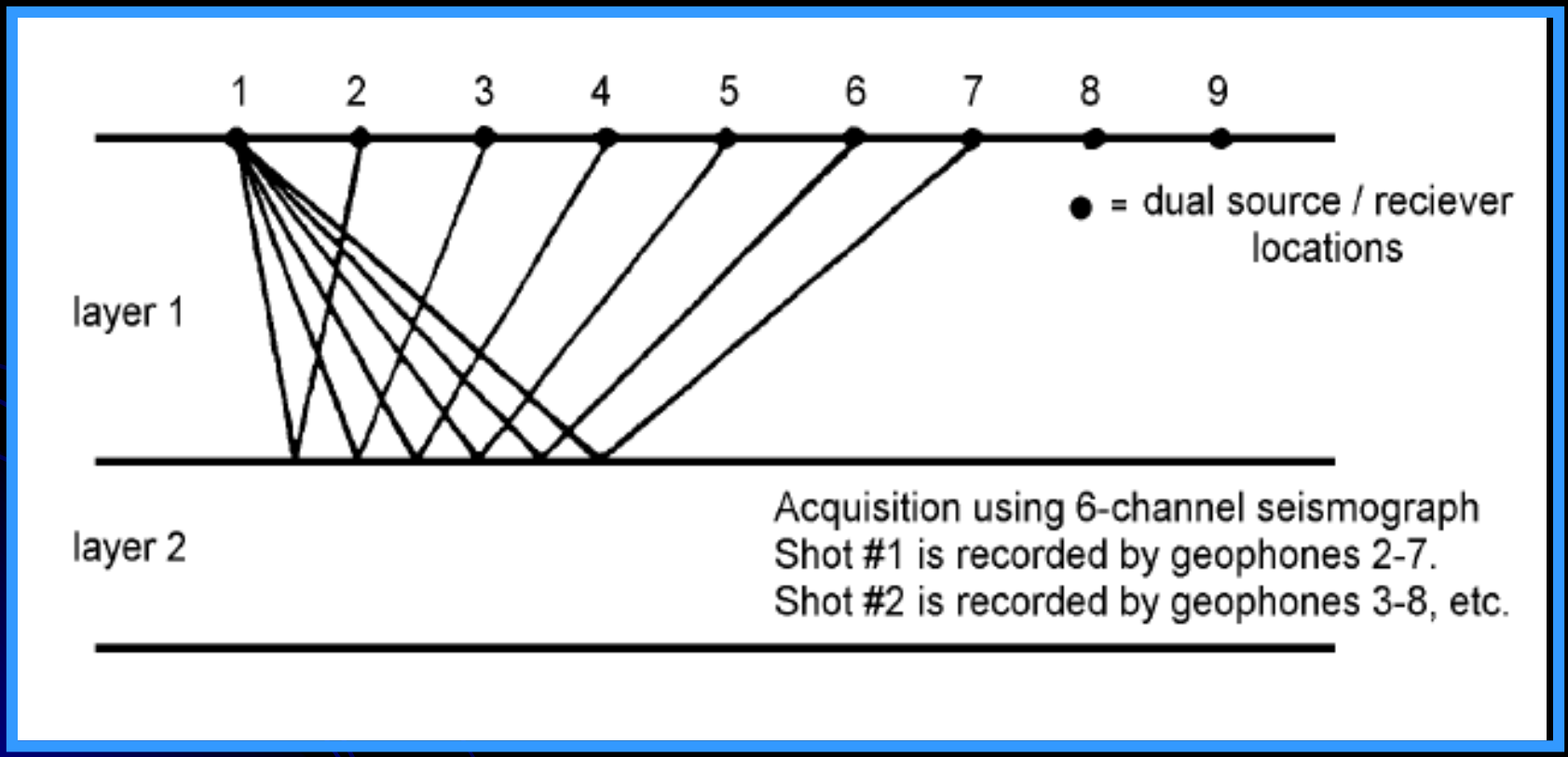


Fig. 13: A draped seismic record of a shot gather from a split spread. Sets of reflected arrivals from individual interfaces are recognizable by the characteristic hyperbolic alignment of seismic pulses. The late-arriving high-amplitude, low-frequency events, defining a triangular-shaped central zone within which reflected arrivals are masked, represent surface waves (ground roll). These latter waves are a typical type of coherent noise. [1]

- **A spread** is the arrangement of geophones that is used to record seismic waves.

- For most purpose, interpretation of seismograms is simplest if the geophones are arranged in **a straight line**.

- Reflection seismic data are acquired using mostly non-zero offset sources and receivers (Figure 12).



Multiple shotpoints and common mid-point

If more than one shot location is used, reflections arising from the same point on the interface will be detected at different geophones. The common point of reflection is known as the common mid-point (CMP).

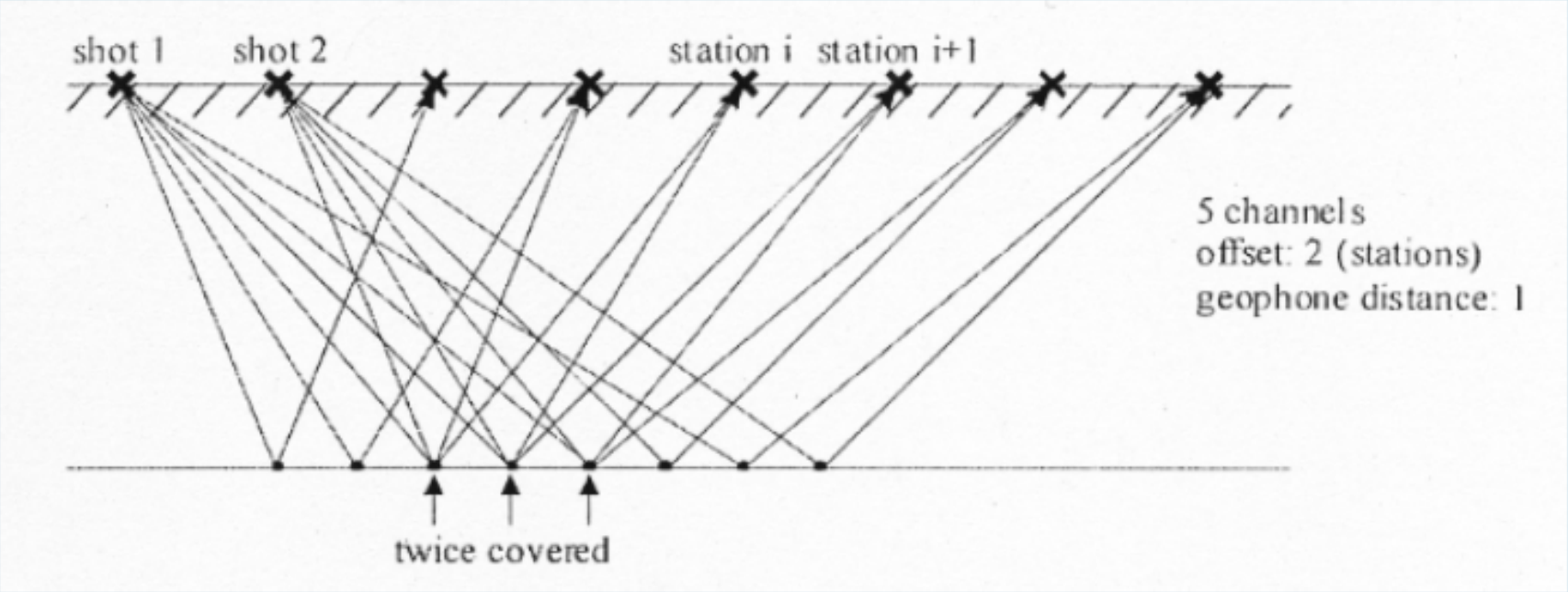


Fig. 14: Data acquisition for reflection seismic. [4]

Common mid-point

The number of times the same point on a reflector is sampled as the fold of coverage.

For example: 12 different shot-geophone locations
→ 12-fold coverage

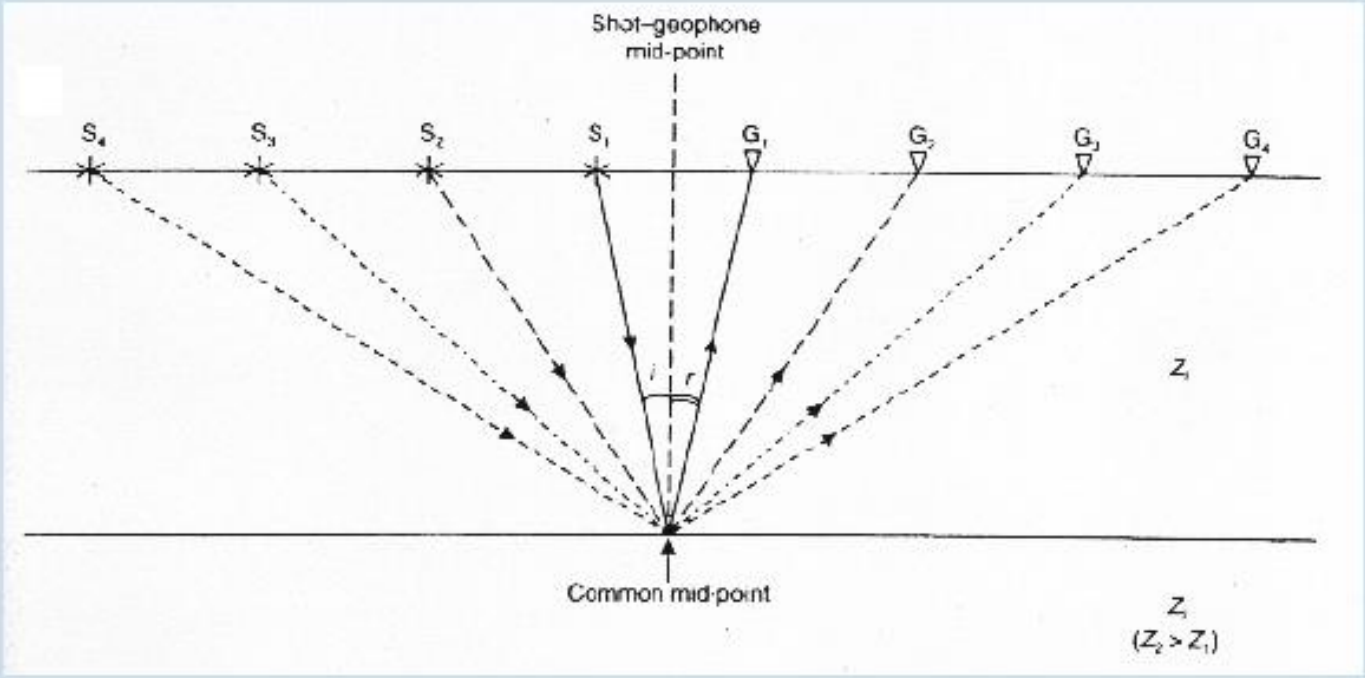


Fig. 15: Principle of the common mid-point over a horizontal interface. [2]

- The quality, utility, and cost of output processed stacked migrated (or non-migrated) seismic profiles are functions of the array parameters.
- Careful consideration must be given to line spacing, the fold of the data, and to array design, particularly: line length, line orientation, near offset, far offset, receiver spacing, number of receivers, array type, receiver (group) configuration, and shot spacing (Figure 17).

- These parameters are usually best determined in the field.

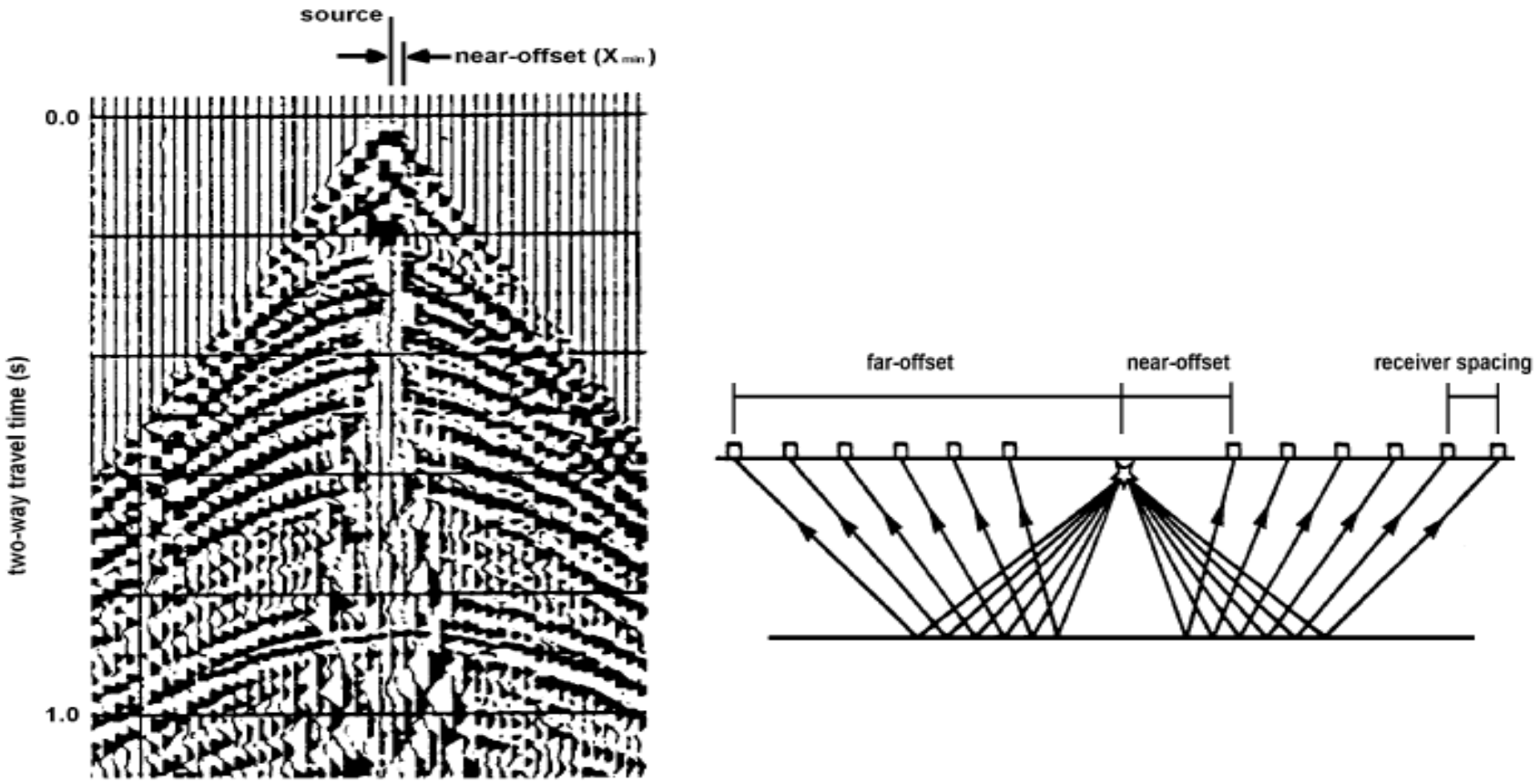
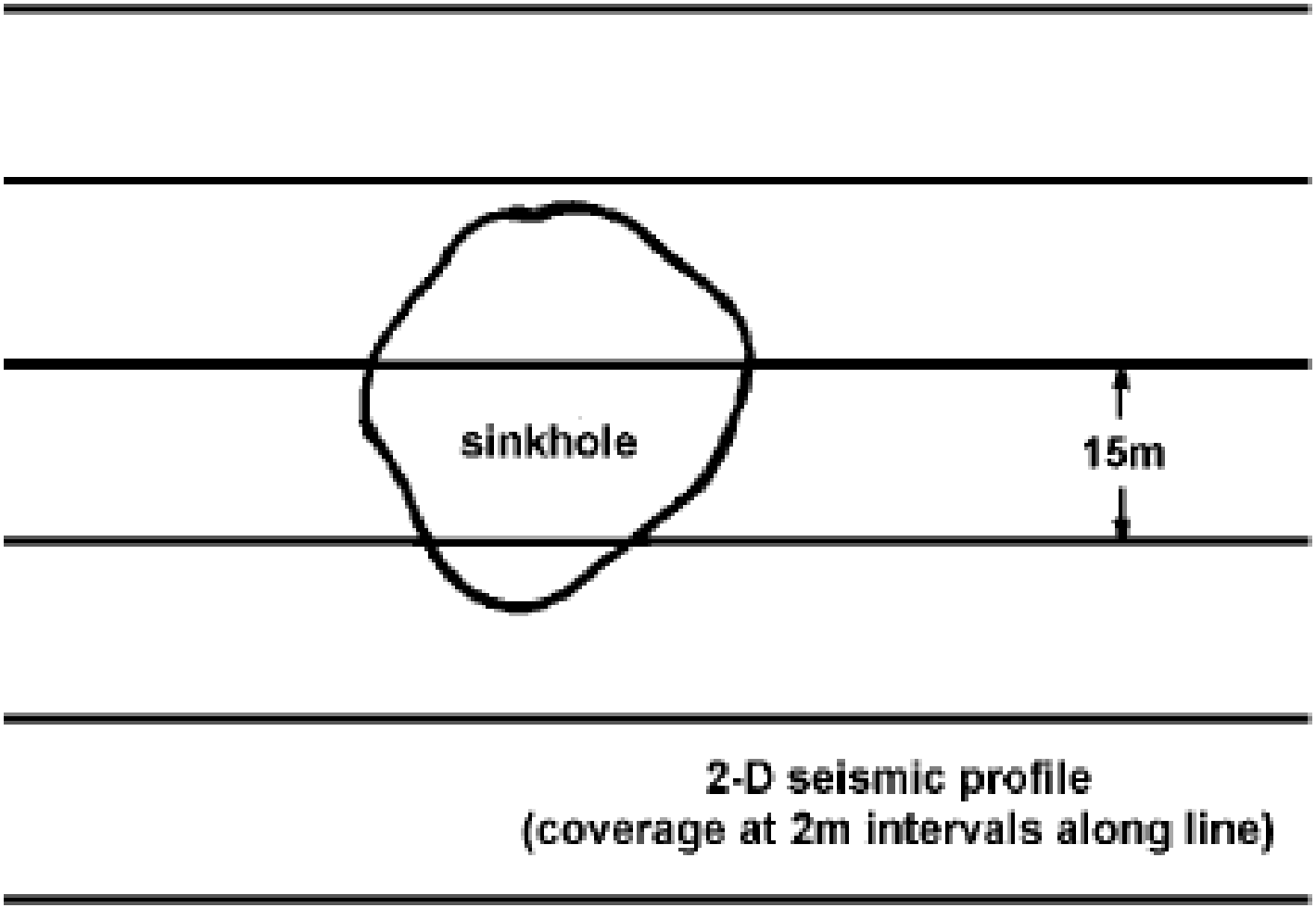


Figure 17: *Typical split spread field array (16A) and corresponding shot gather (16B). Careful consideration must be given to line spacing, the fold of the data, and array design, particularly: line length, line orientation, near offset* ***(X_{min}),*** *far offset* ***(X_{max}),*** *receiver spacing, number of receivers, array type, group (receiver) interval, and shot spacing. (After Keary and Brooks, 1991.)*

Line spacing

- The spacing of seismic lines should be a function of the target size and overall survey objective.

- For example, if the target has a basal diameter of 30 m,, then lines should be spaced at 15m intervals or less (Figure 18).

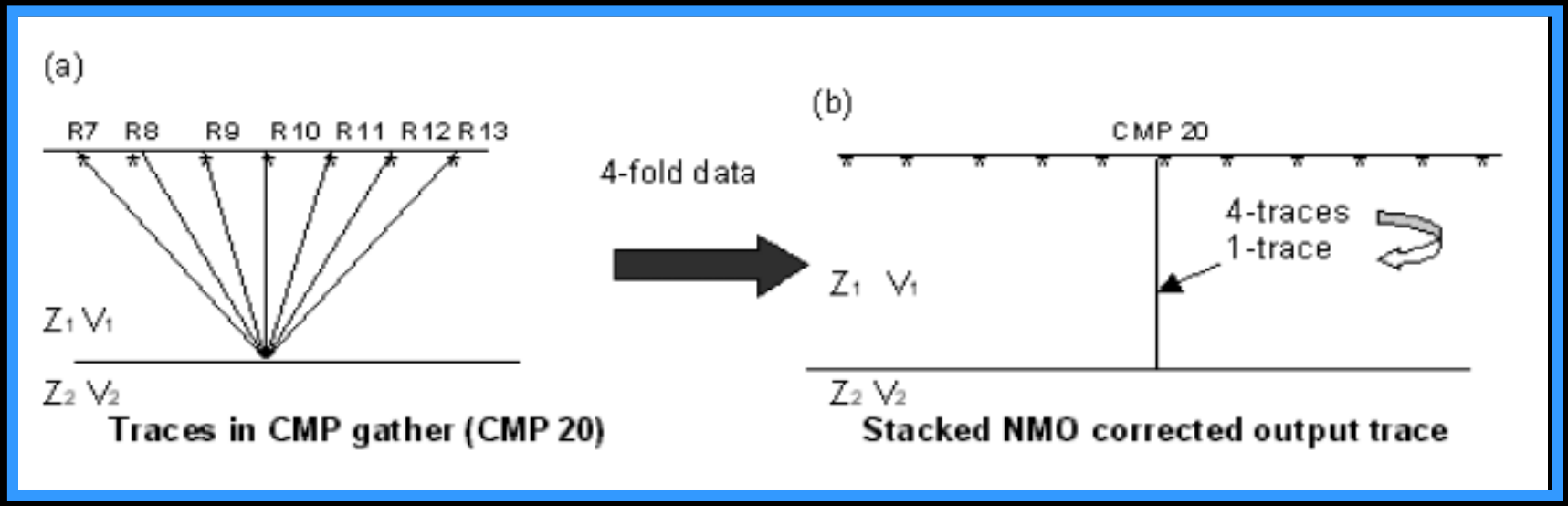

sinkhole
15m
2-D seismic profile
(coverage at 2m intervals along line)

Fold or Multiplicity

- The term “fold” **(F)** refers to the multiplicity (number) of traces incorporated into each common midpoint gather (Figure 16 and 26).

- Fold is a function of the receiver spacing **(ΔR)**, the number of receivers **(R)**, and the shot spacing **(ΔG)**.

- **F = R/(2 [R/ ΔG])**


(a)
R7 R8 R9 R10 R11 R12 R13
Z1 V1
Z2 V2
Traces in CMP gather (CMP 20)
4-fold data
(b)
CMP 20
4-traces
1-trace
Z1 V1
Z2 V2
Stacked NMO corrected output trace

Array type

- A number of different arrays are commonly used for shallow reflection seismic surveys (Figures 14 and 22).

- Usually an end-on or split-spread array is employed. Often times, when split-spread arrays are used, the source is offset from the linear receiver array, to minimize ground-roll effects on the near-offset traces..

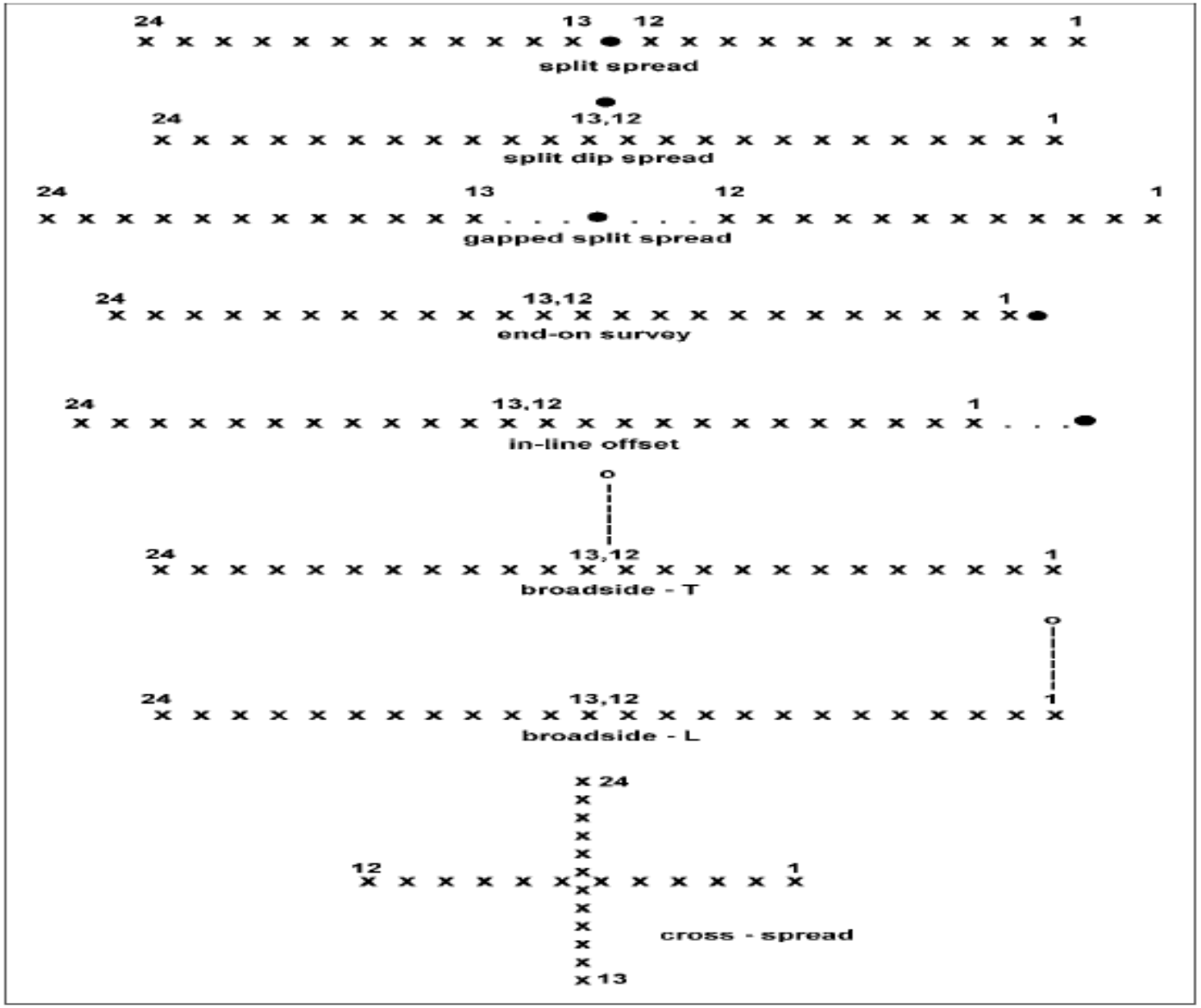


Figure 22: *A number of different arrays are commonly used for shallow reflection seismic surveys. Usually an end-on or split-spread array is employed. Often times, when split-spread arrays are used, the source is offset from the linear receiver array, to minimize ground-roll effects on the near-offset traces. (After Sheriff and Geldart, 1995.)*

- The most commonly used spread is the split spread.
- Geophones are arranged in two opposite lines with the source at the centre.
- The arrivals from a split spread are needed to detect dipping reflectors.
- Unless the spread is aligned in the dip direction, only the value of apparent dip can be measured.

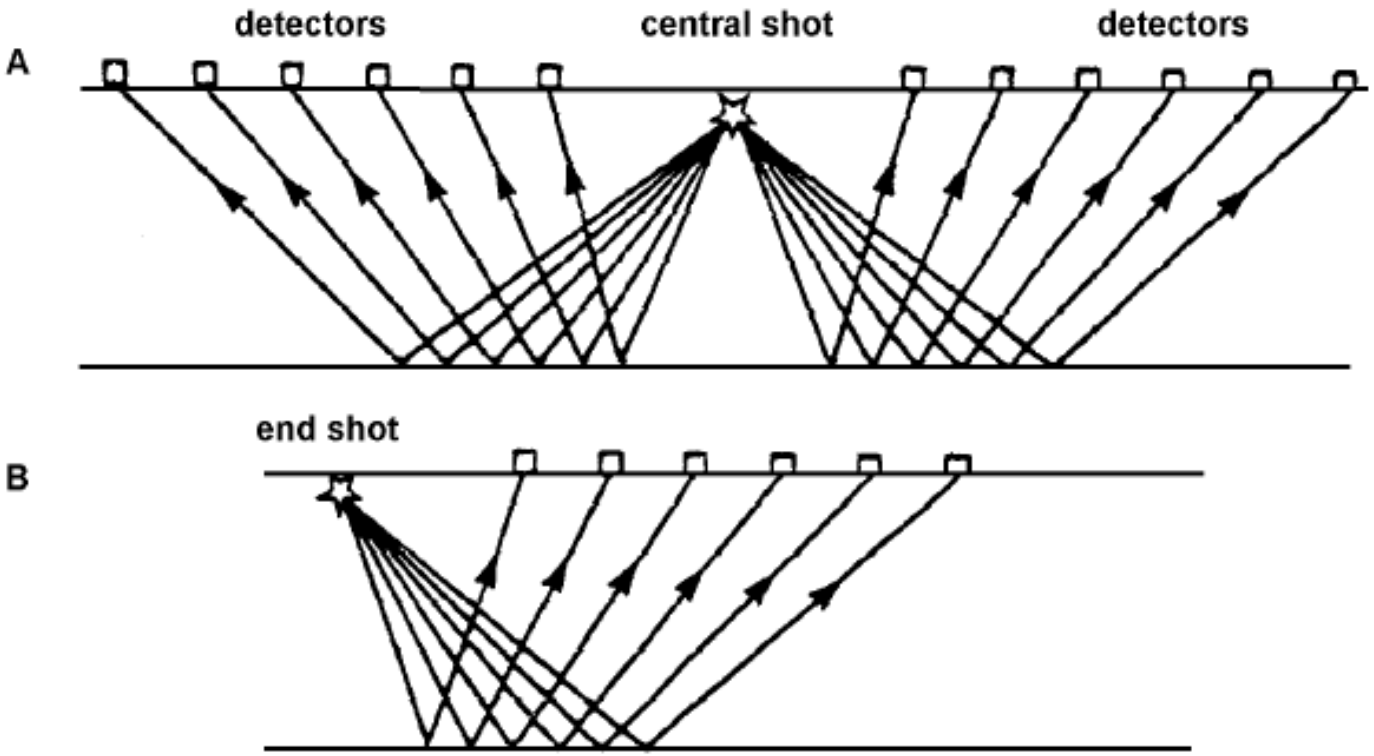
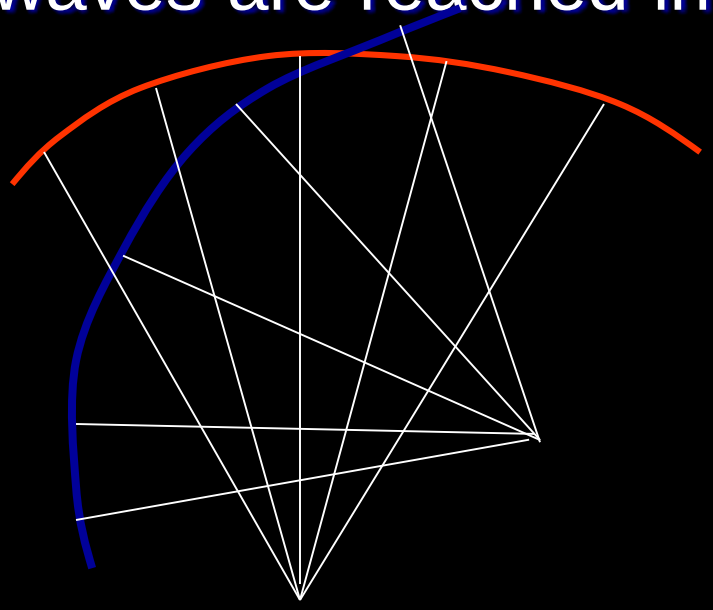


Figure 14: *Split-spread shot array (14A) and end-on shot array (14B). (After Keary and Brooks, 1994.)*

- To determine the true dip we use the **cross spread**.
- This spread is consists of two split spreads centered about the source.
- To save time, an **L spread** can be used in place of a cross spread.
- It consists of two lines extending in different directions from the same source.

- Another kinds of spread is used of prospecting for **shallow salt domes**.
- In this spread the geophone is placed in **arc, fanning out** in different directions from the source.
- This type is called **fan shooting**.
- in this shoot the refracted waves are reached in the same time.
- When contact salt surface , their velocity become higher and the travel time become shortening.



THANK YOU