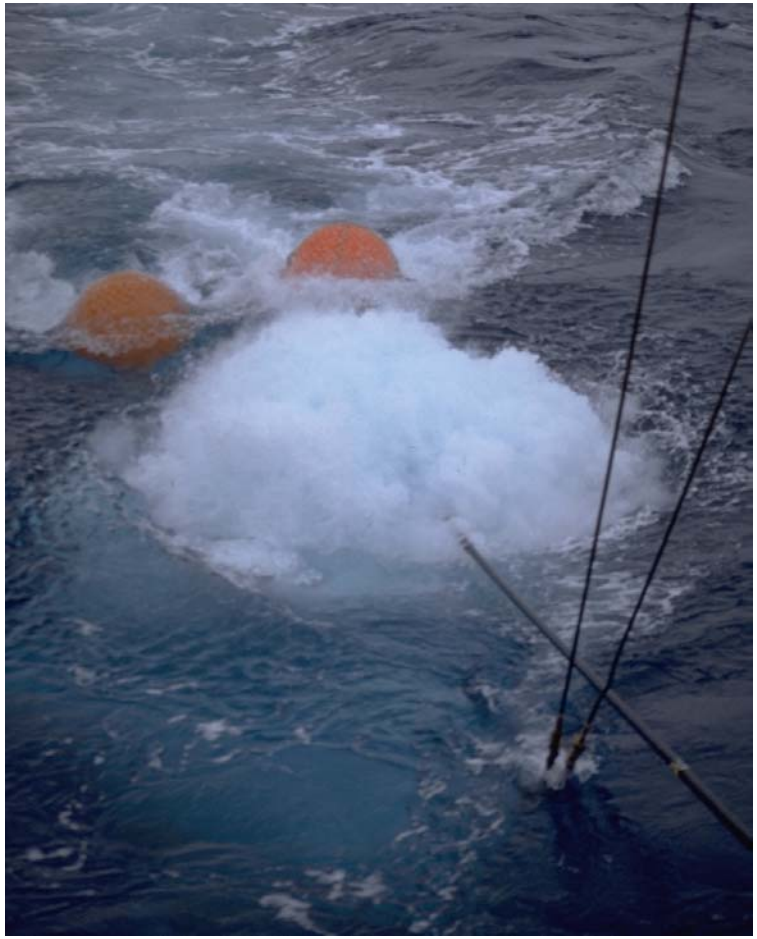
Reflection seismic 1
script

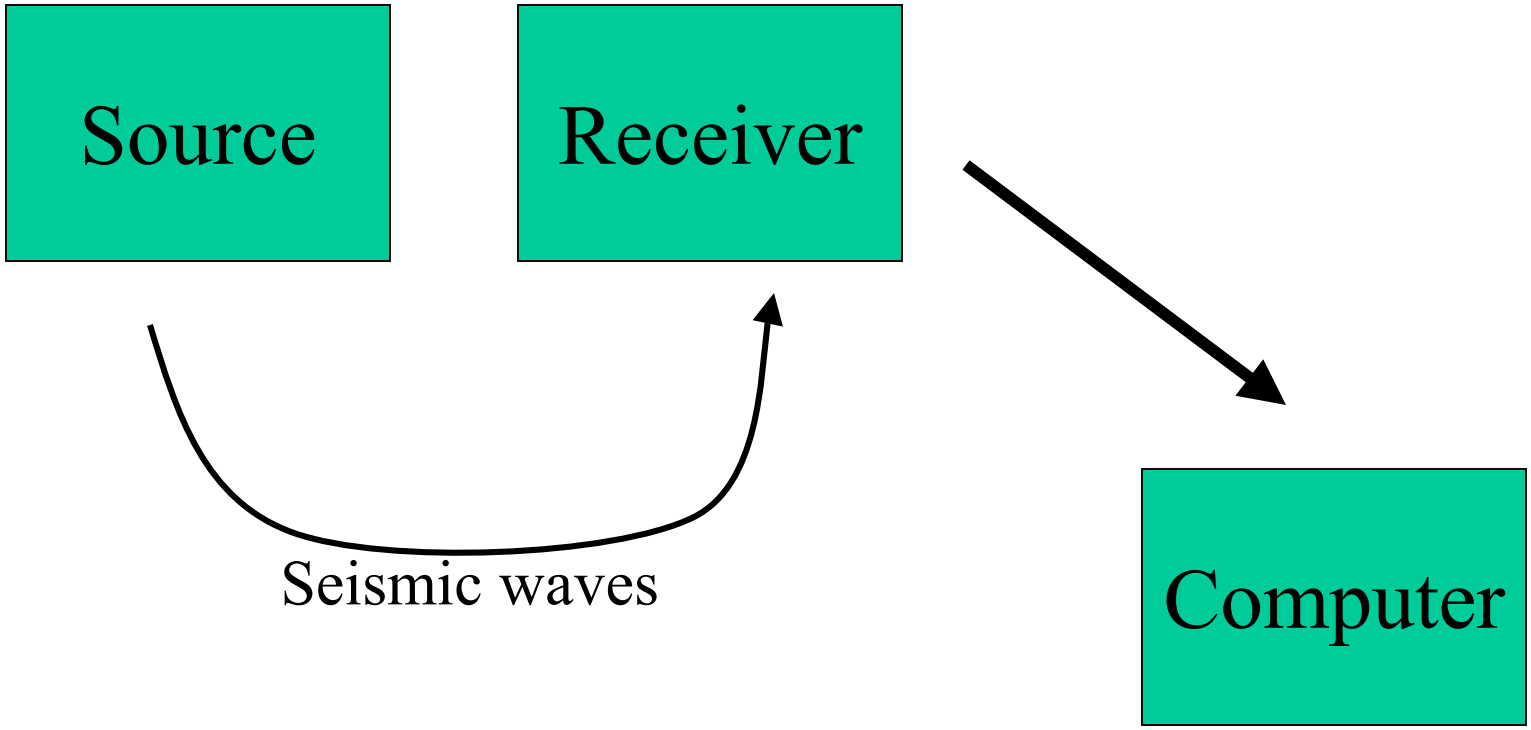
Seismische Mess-Systeme

Land



Marine

Seismic System

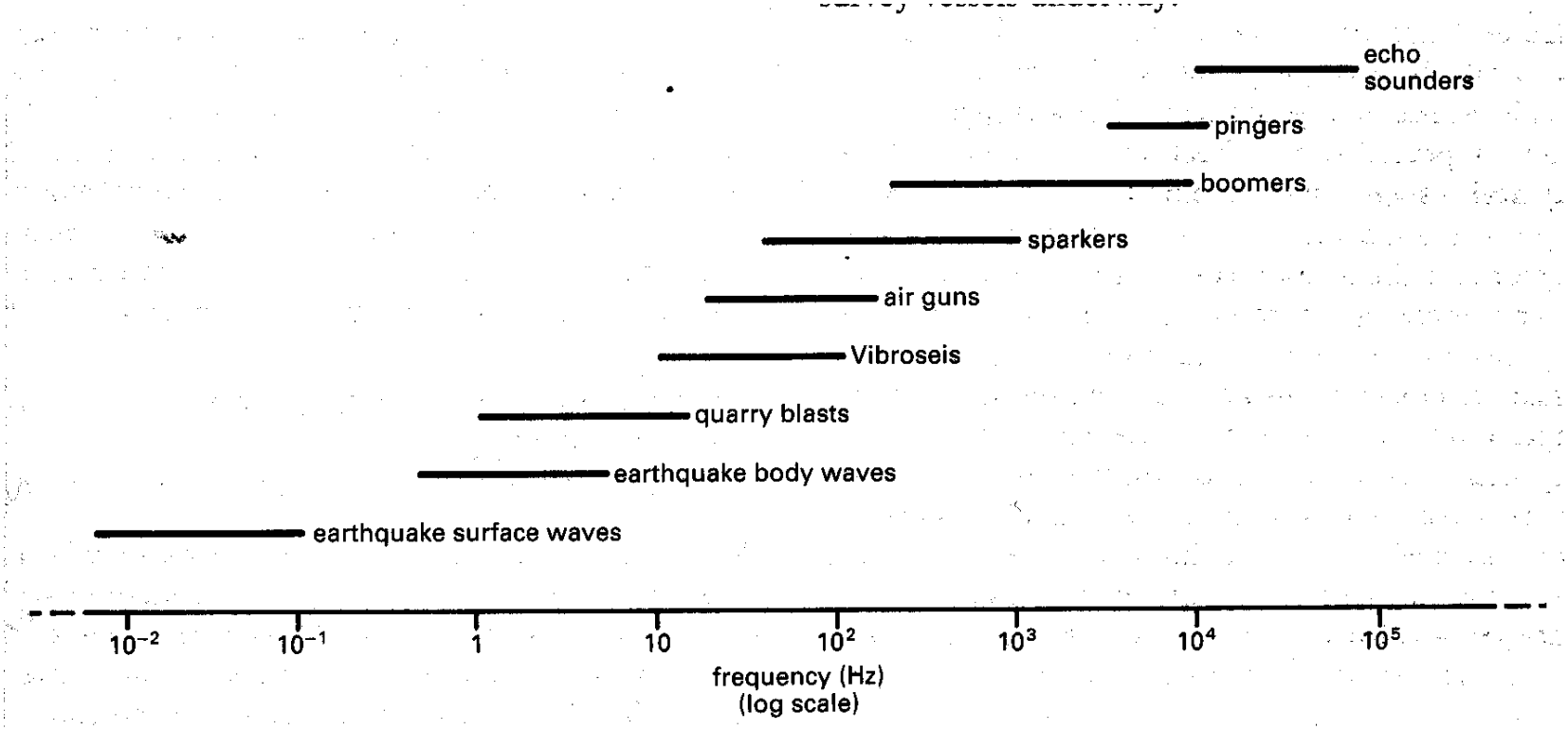


Seismic sources

Important properties:

- Energy
- Waveform
- Repeatability
- Cost and use in the field

Seismic/Acoustic spectrum



Seismic sources

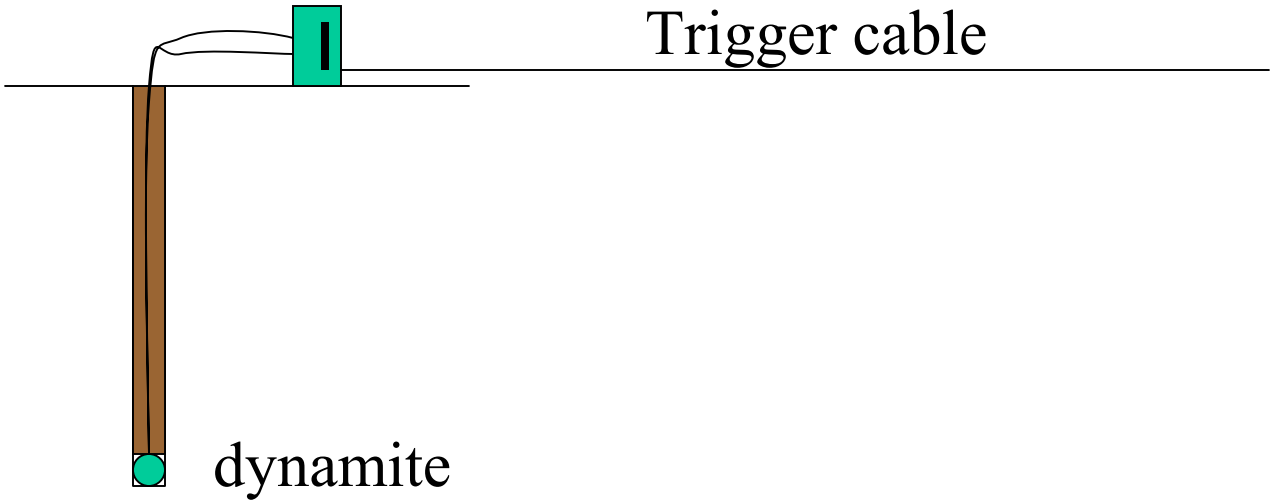
Impulsive source/Non impulsive source

Explosive source/Non explosive source

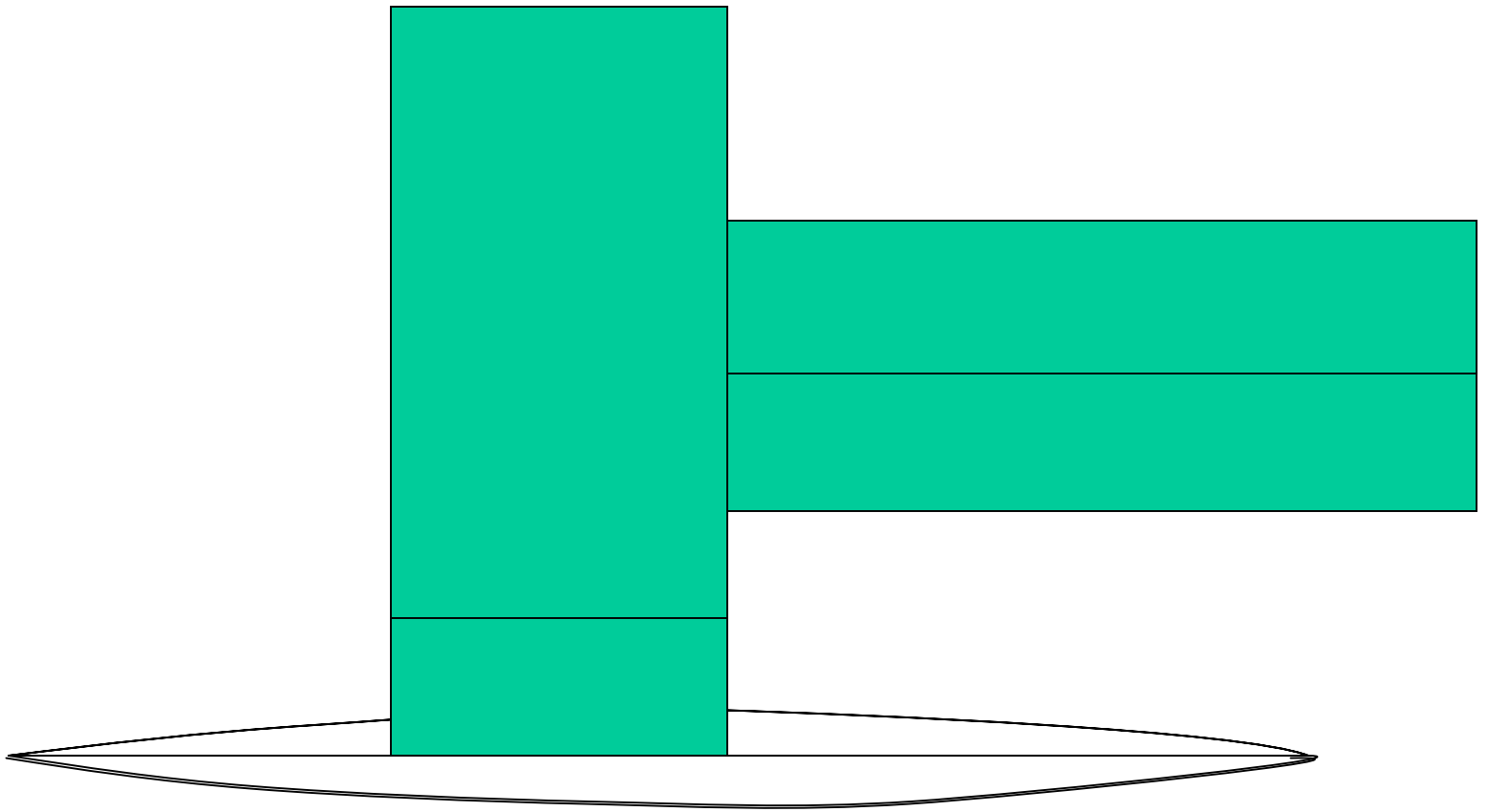
Advantages/disadvantages

Dynamite (explosive impulsive source):

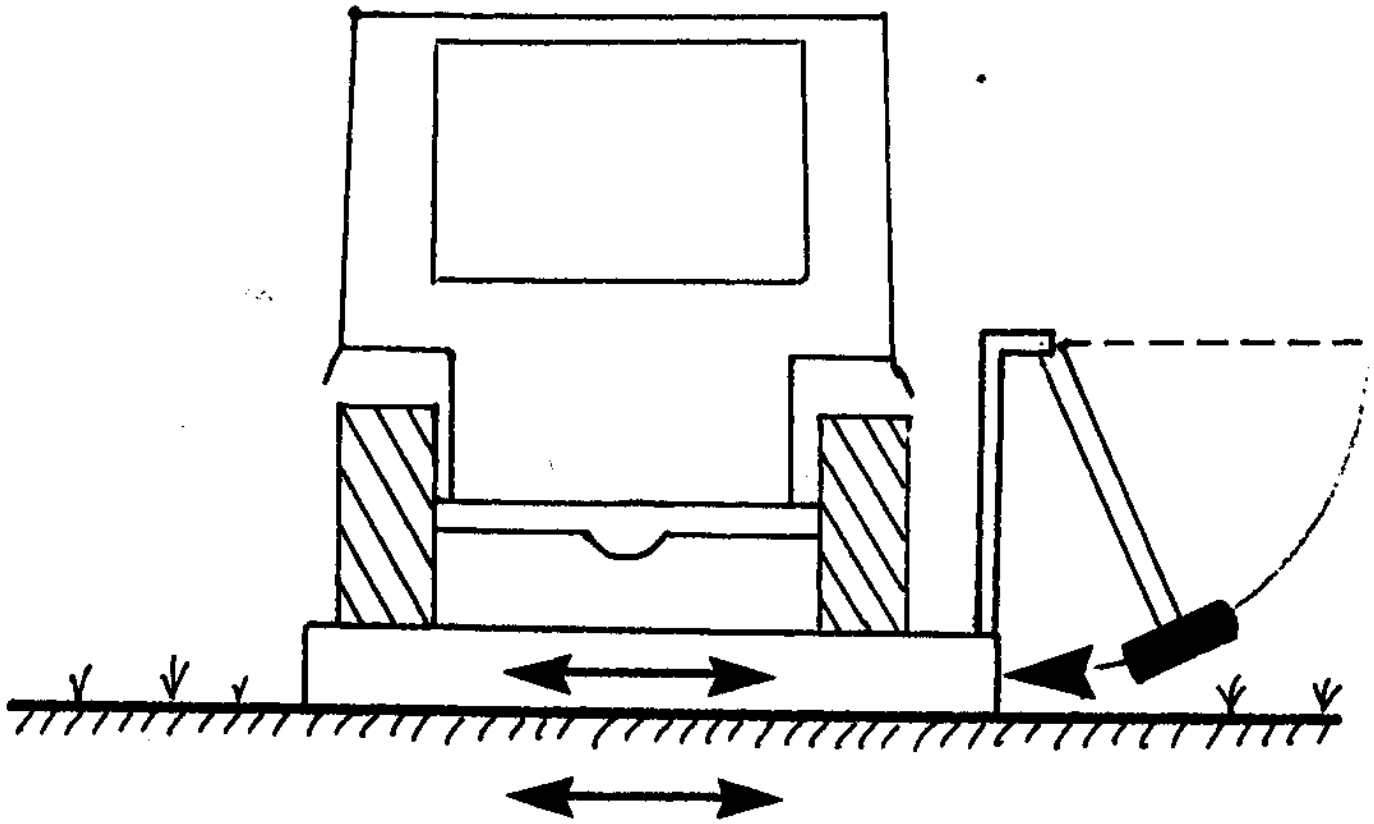
- 40% of the seismic measurements
- Not really repeatable
- Exact time of detonation is difficult to obtain
- Detonators are sometimes used for shallow applications
- High energy
- For each application the amount of dynamite can be adjusted



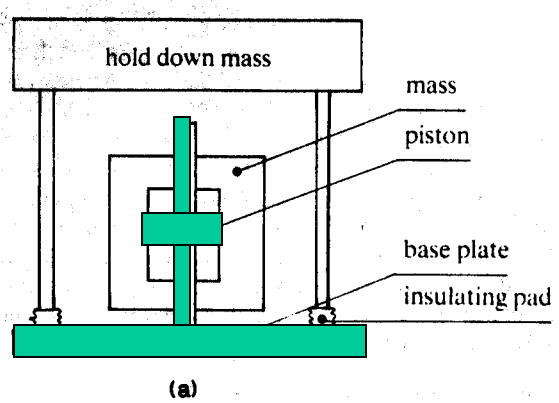
Hammer

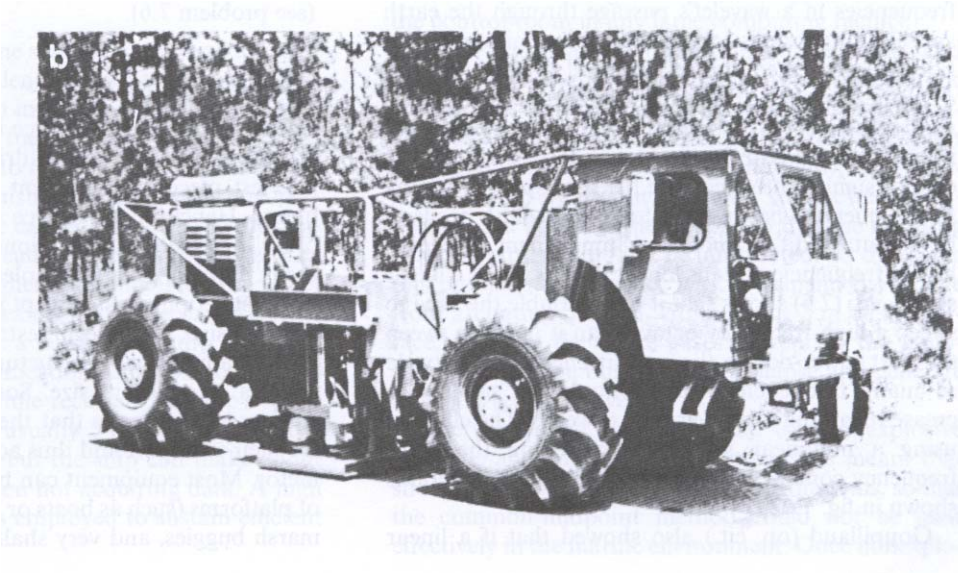


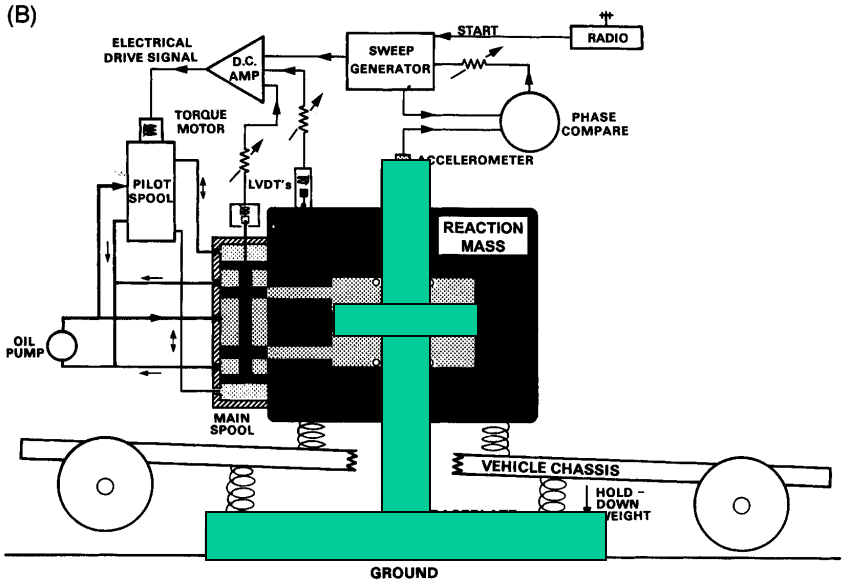
Shear wave hammer

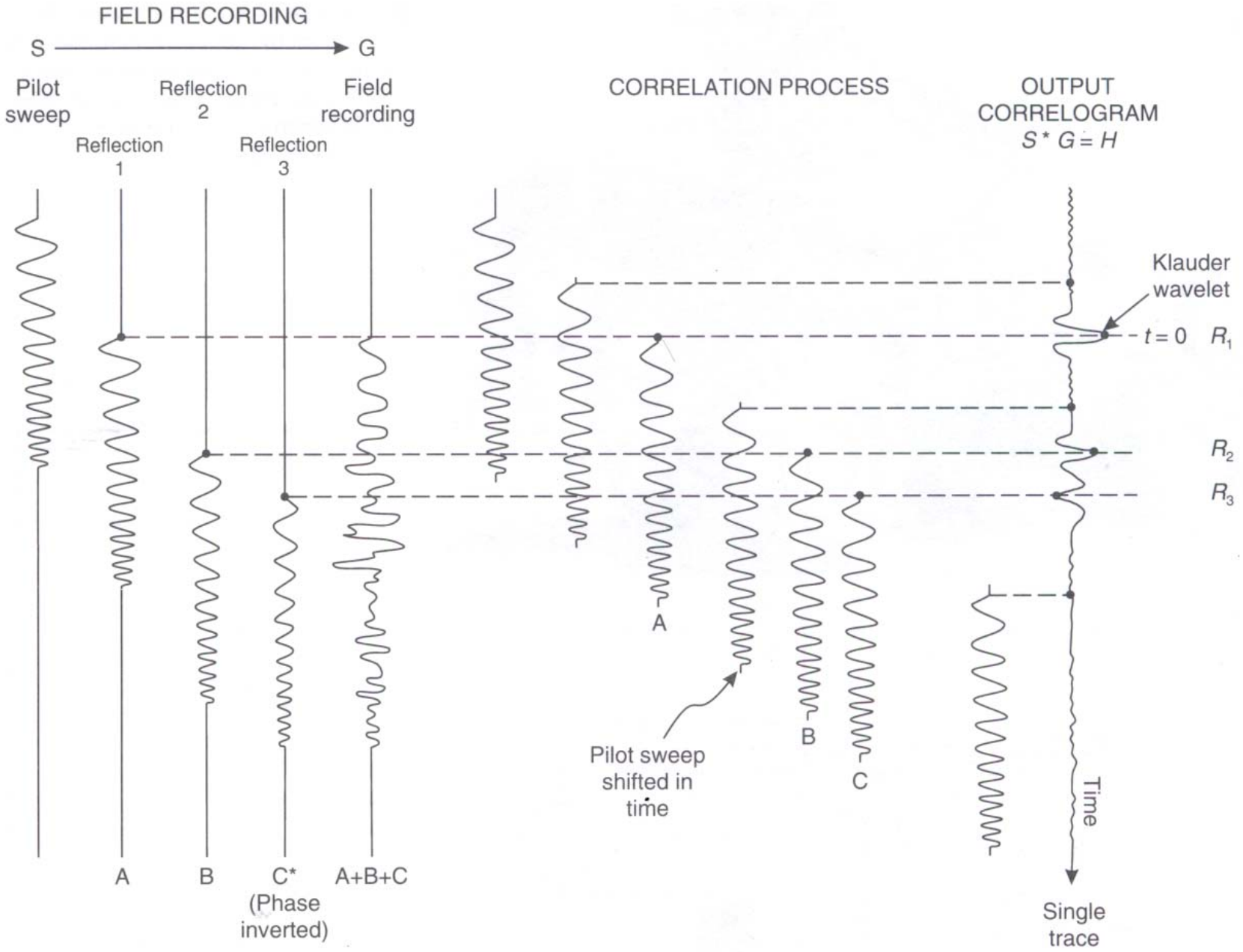


Vibroseis truck





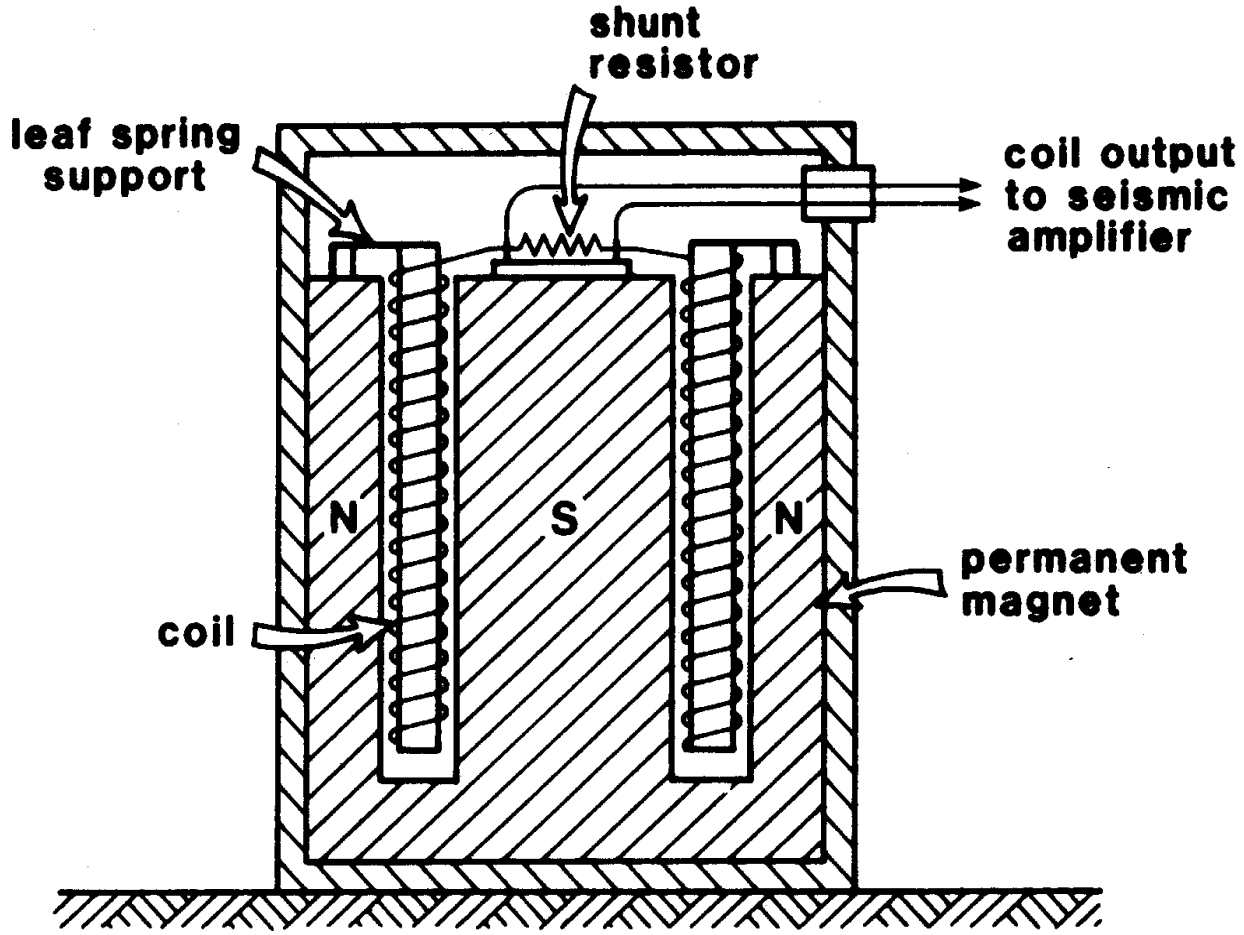




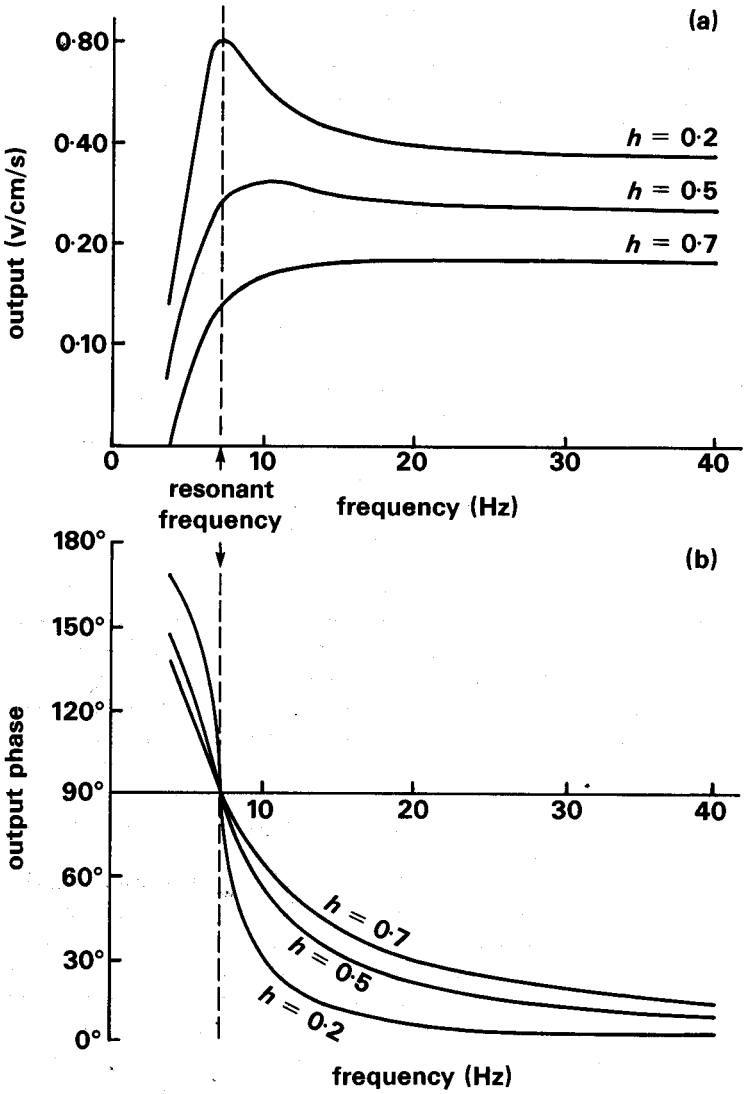
Reynolds, 1997

Earliest known seismoscope

Principle of a geophone



Characteristic of a geophone

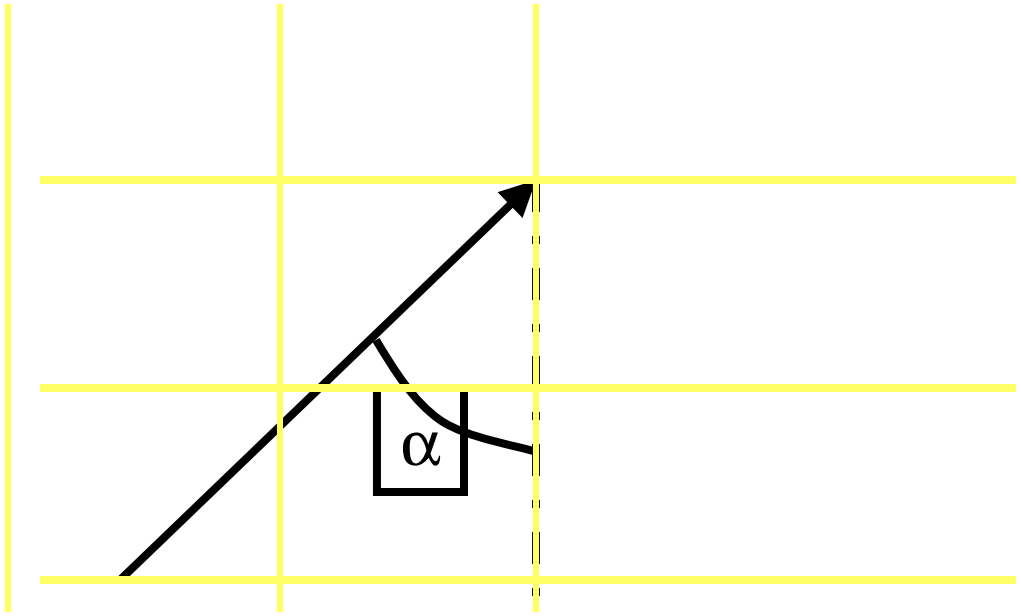


Damping factor h

Array of geophones

$V_{app} = v$

$\lambda_{app} = \frac{v}{f}$



$V_{app} = \infty$

$\lambda_{app} = \infty$

Apparent velocity:

$$V_{app} = \frac{v}{\sin\alpha}$$

Apparent wavelength:

$$\lambda_{app} = \frac{V_{app}}{f}$$

Response function:

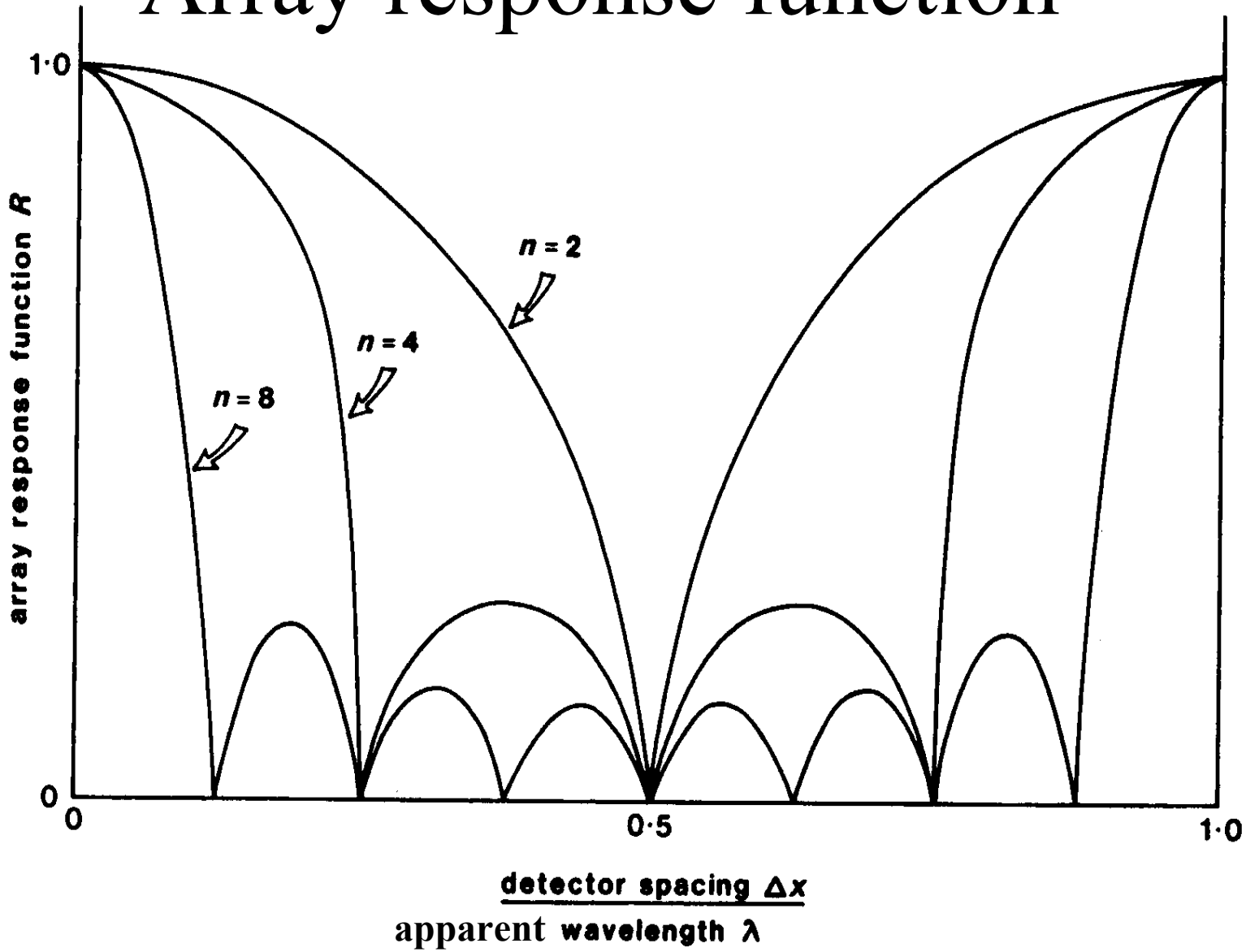
$$R = \frac{\sin(n\beta)}{\sin(\beta)}$$

where:

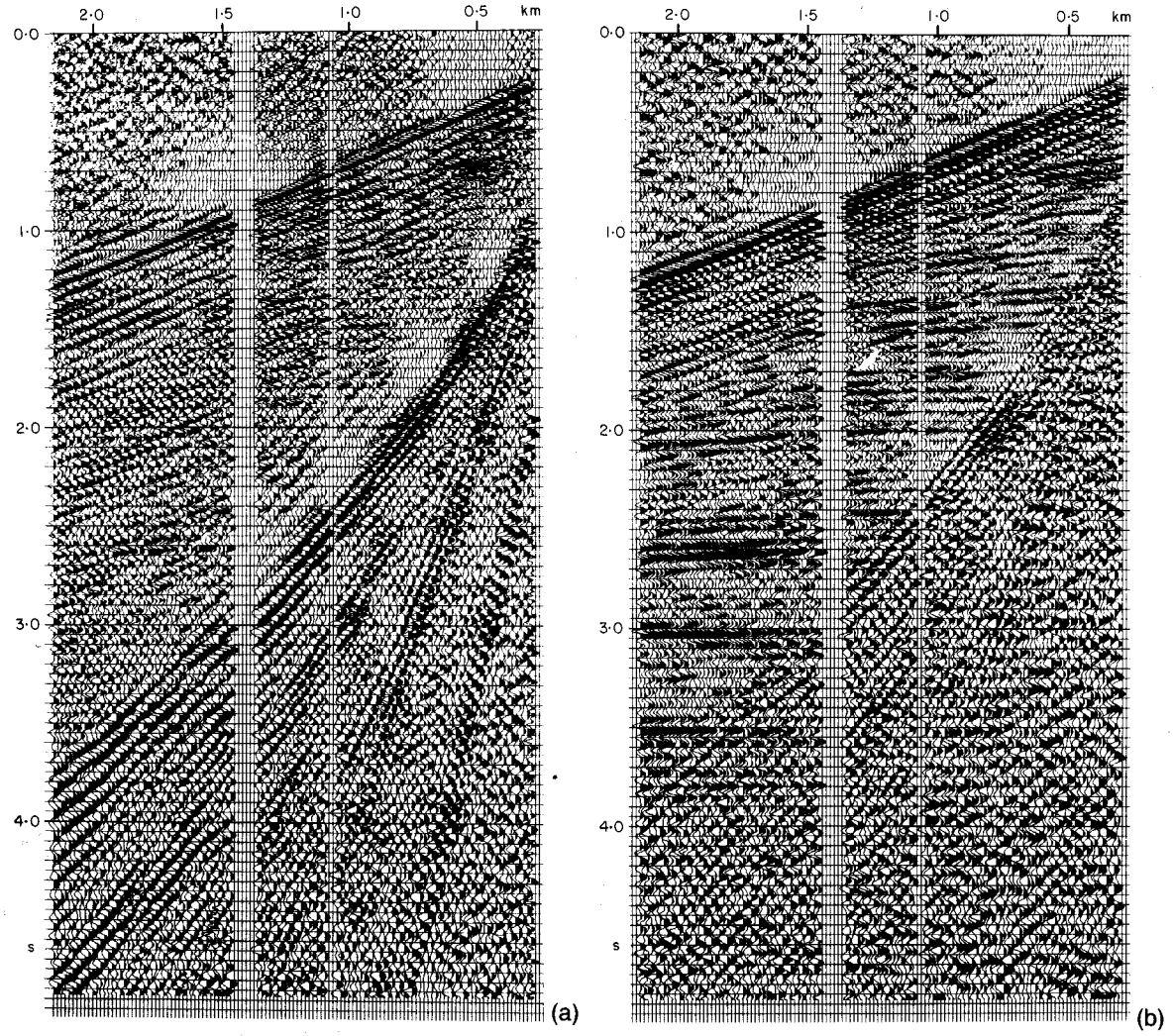
$$\beta = \frac{\pi \Delta x}{\lambda_{app}}$$

And n is the number of geophones in a group

Array response function



Geophone array



Clustered geophones

Geophone arrays

Marine seismic data acquisition

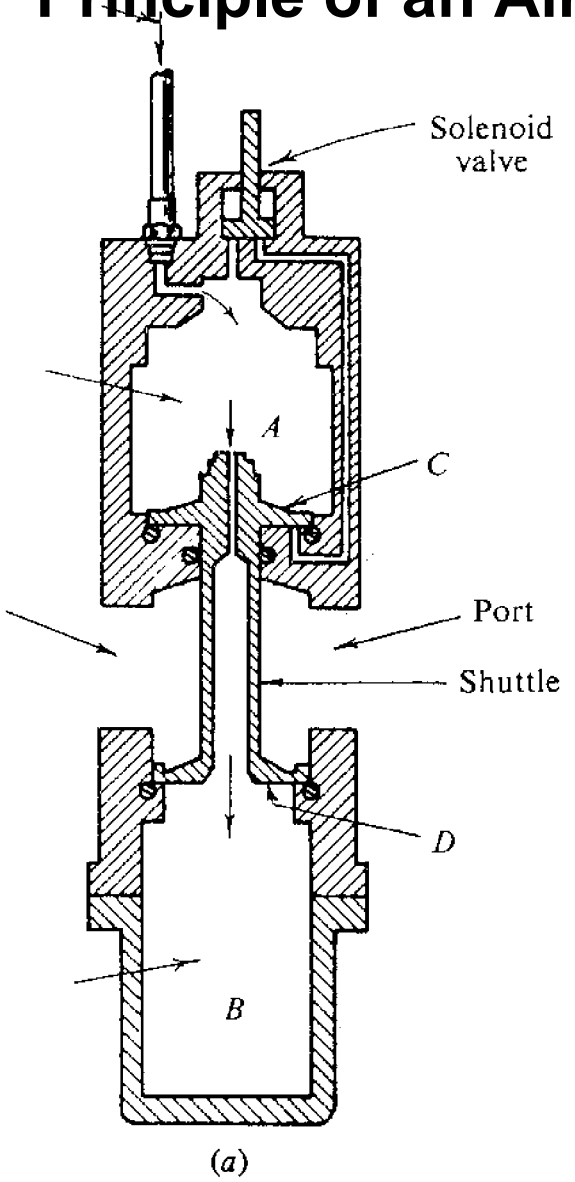
PGS J.W. Schoolmeesters

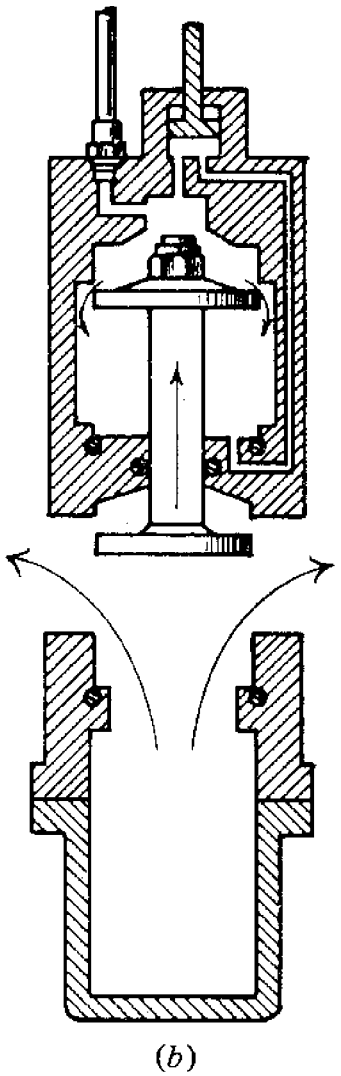
Chirp

Boomer

(Huntec-systems)

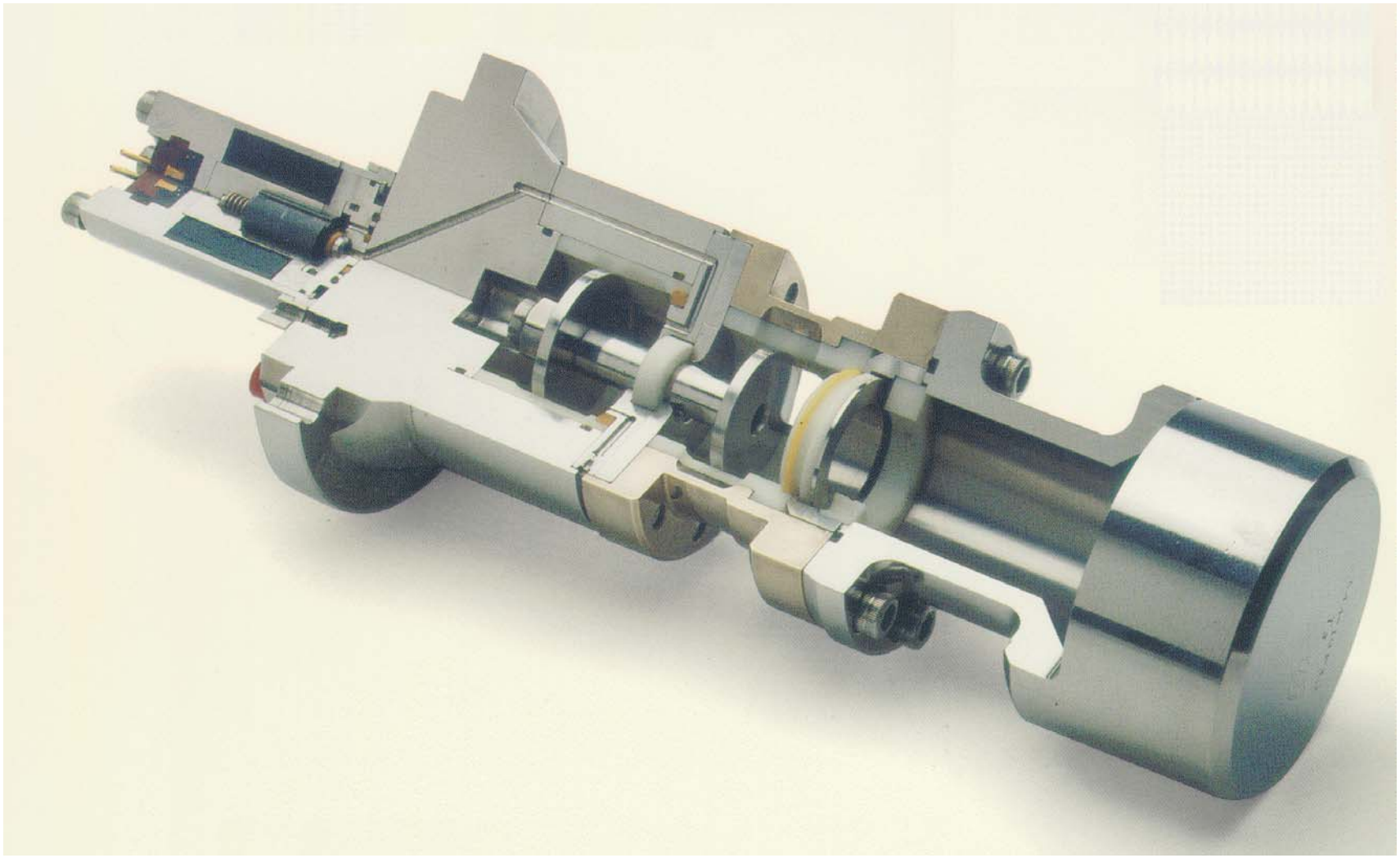
Principle of an Airgun



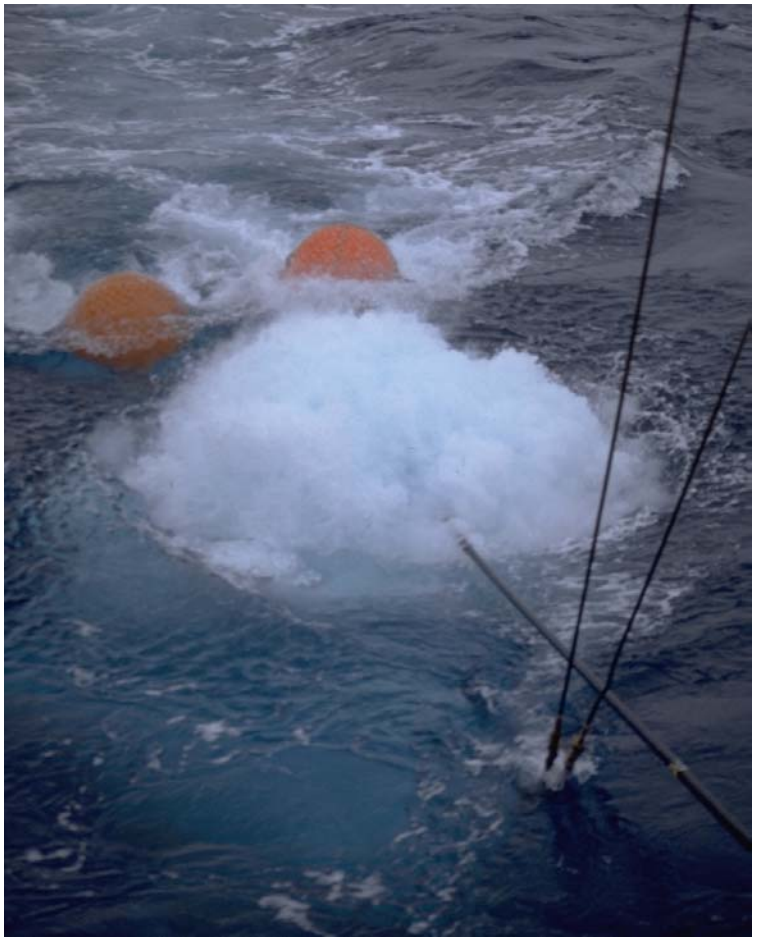


(Bolt-Systems)

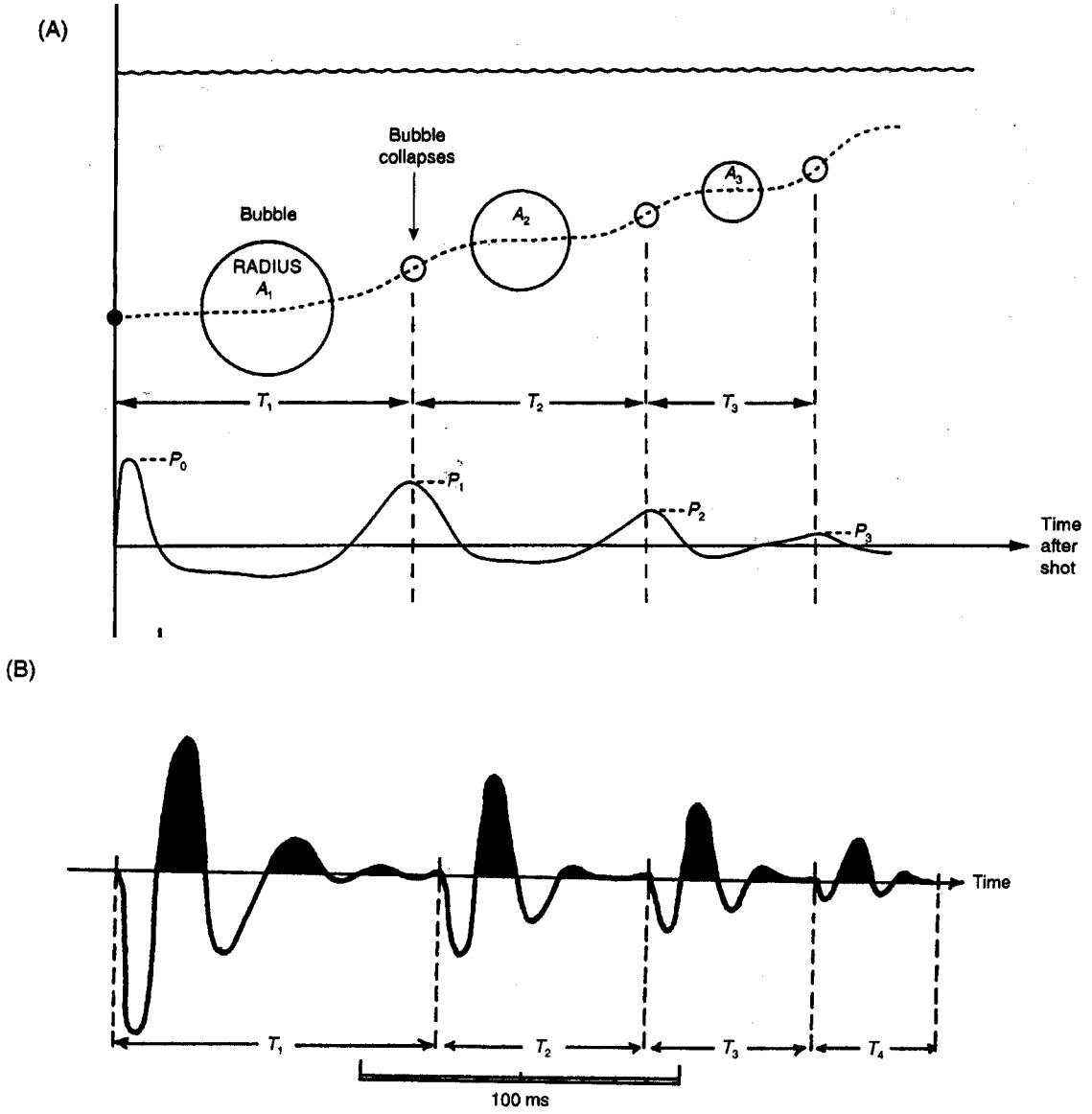
Inside of an airgun



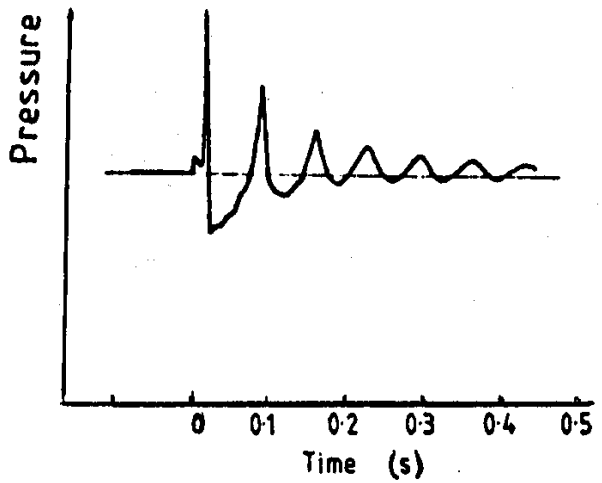
(Bolt-Systems)



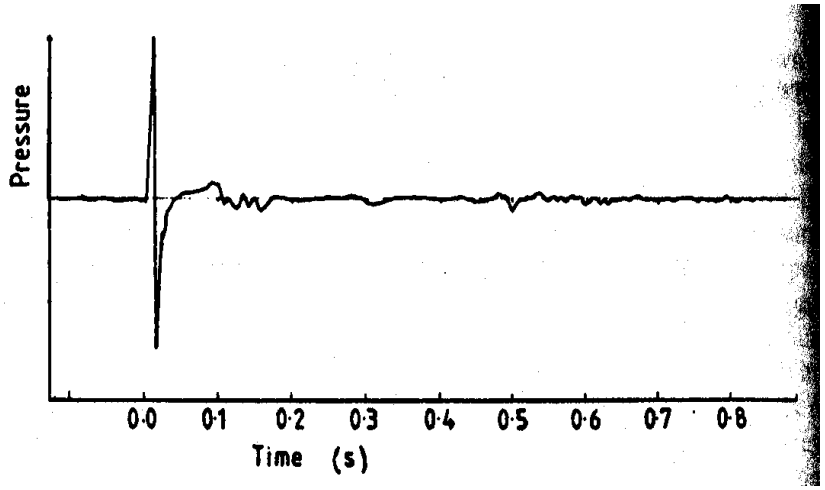
Response from an airgun



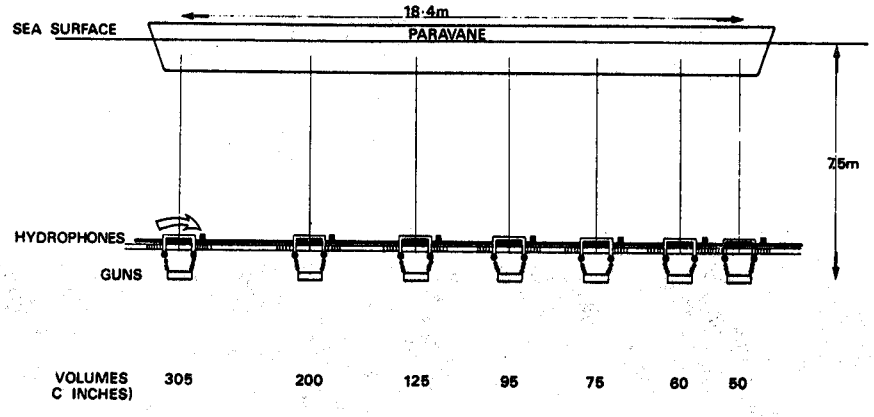
Air gun array



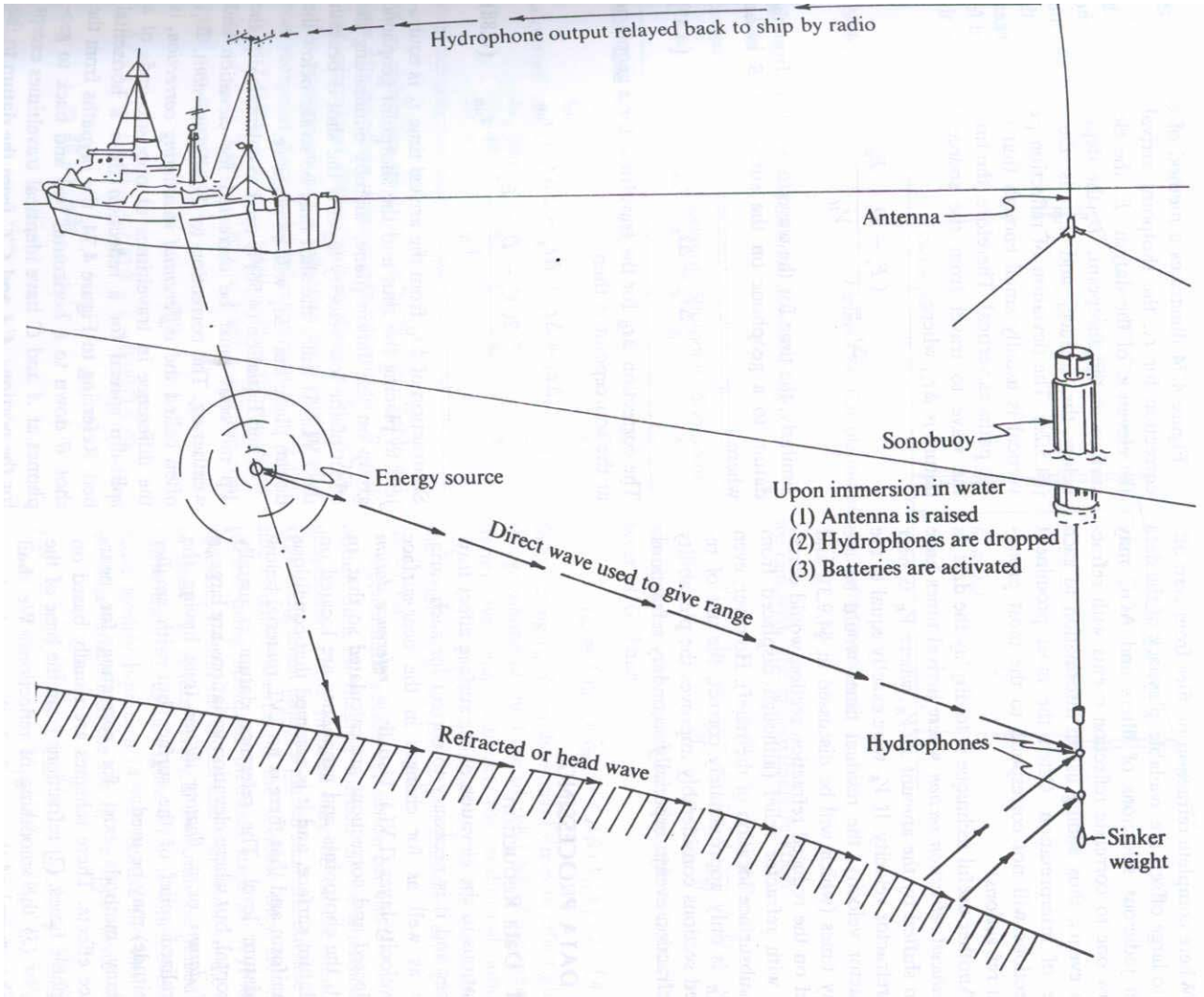
One air gun



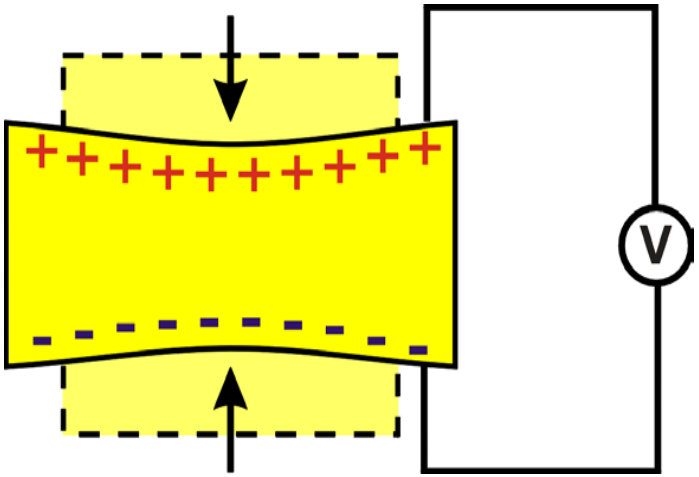
Array of air guns



Sonobuoy


Hydrophone output relayed back to ship by radio
Antenna
Sonobuoy
Energy source
Upon immersion in water
(1) Antenna is raised
(2) Hydrophones are dropped
(3) Batteries are activated
Direct wave used to give range
Refracted or head wave
Hydrophones
Sinker weight

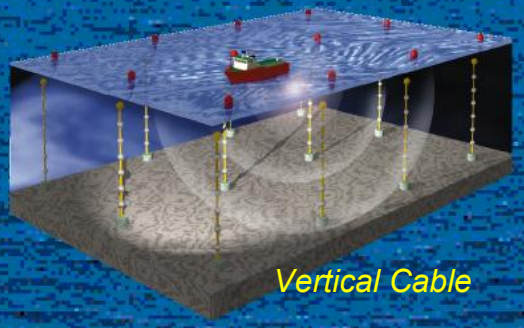
Hydrophone



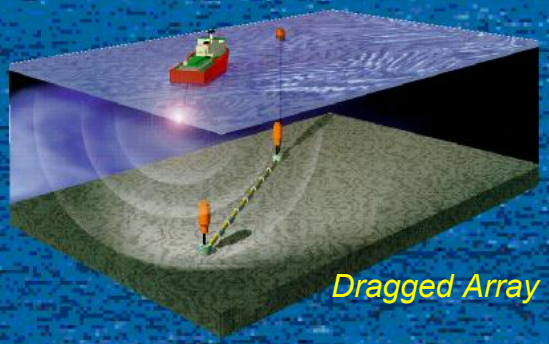
Principle of piezoelectric effect

Voltage proportional to the variation of the pressure

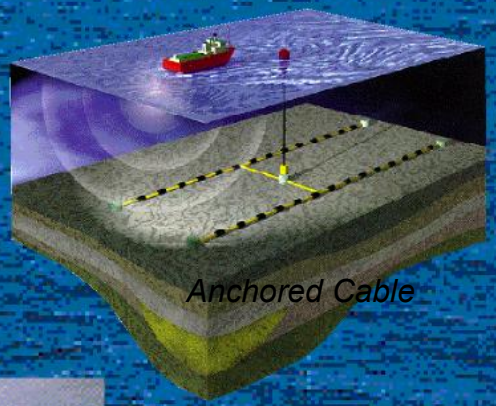
Acquisition Techniques



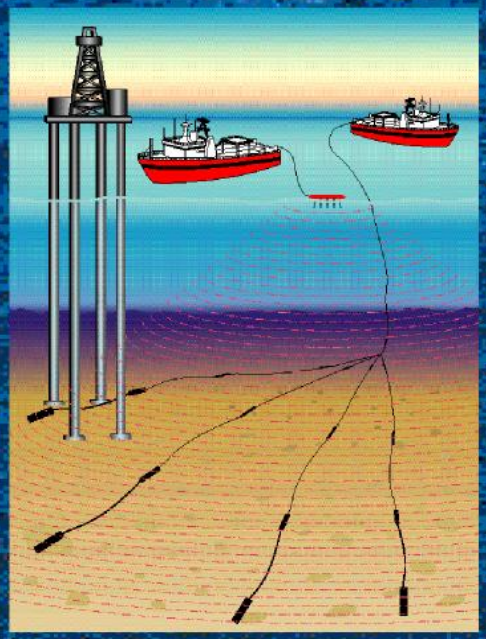
Vertical Cable



Dragged Array



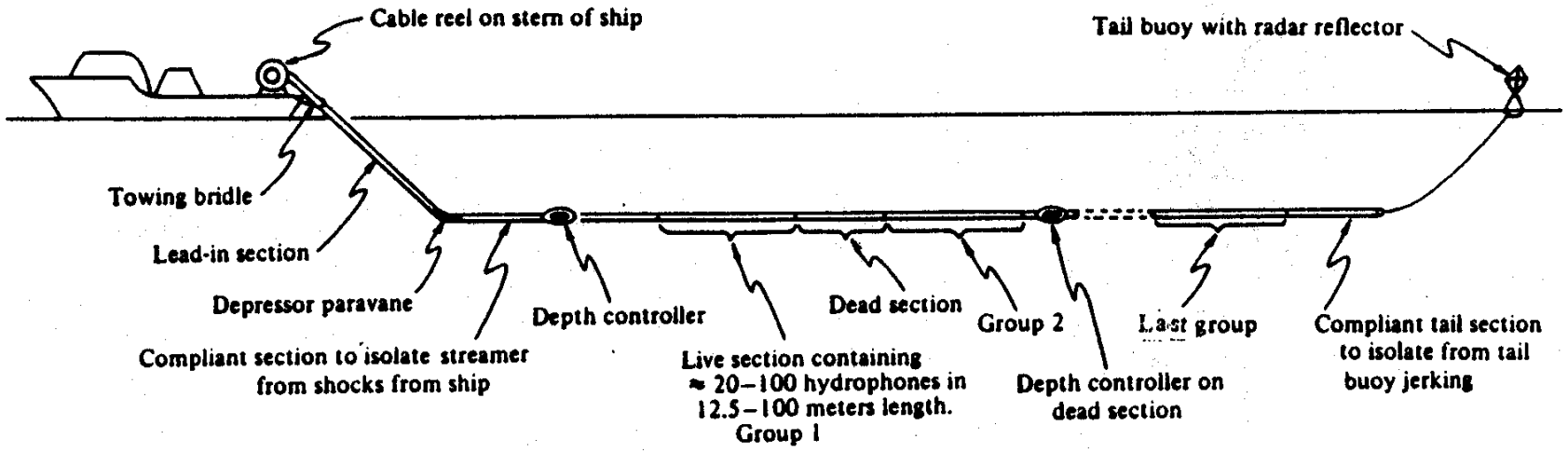
Anchored Cable



Ocean Bottom Cable

Streamer

Marine streamer

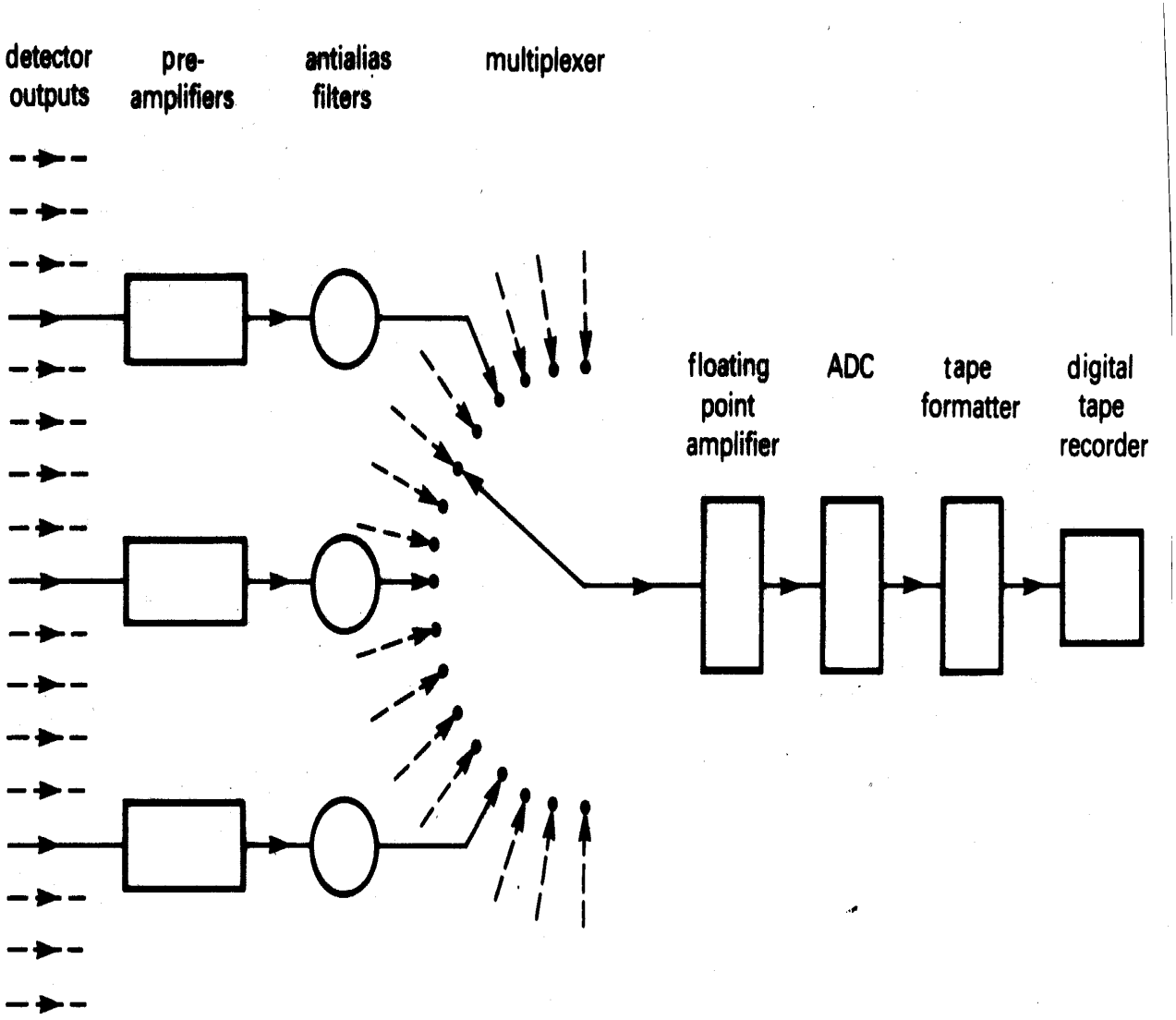


PGS J.W. Schoolmeesters

Tail Buoy

Processing room

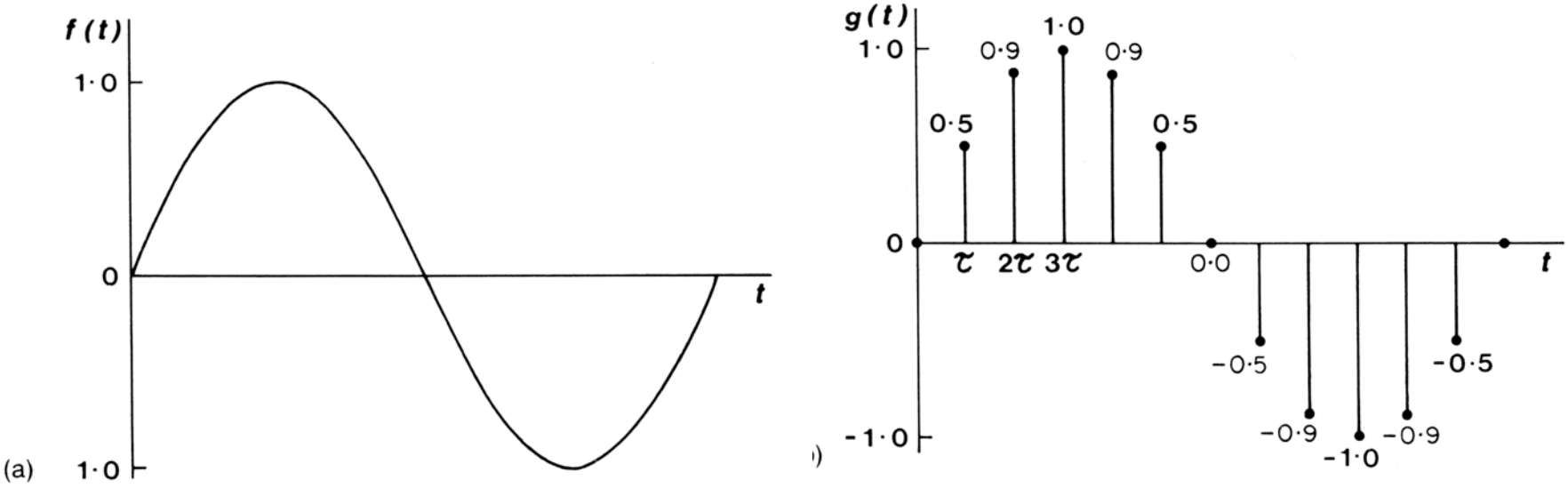
Multi-channel seismic recording system



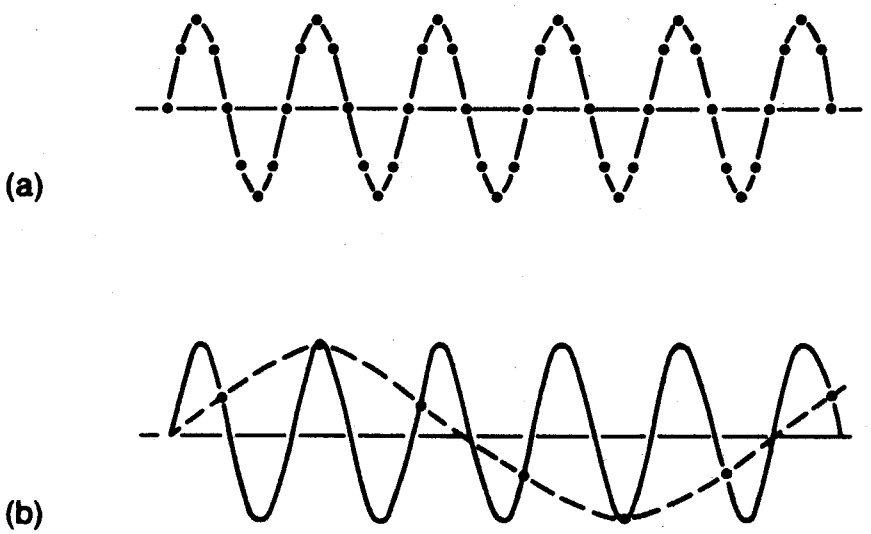
sampling

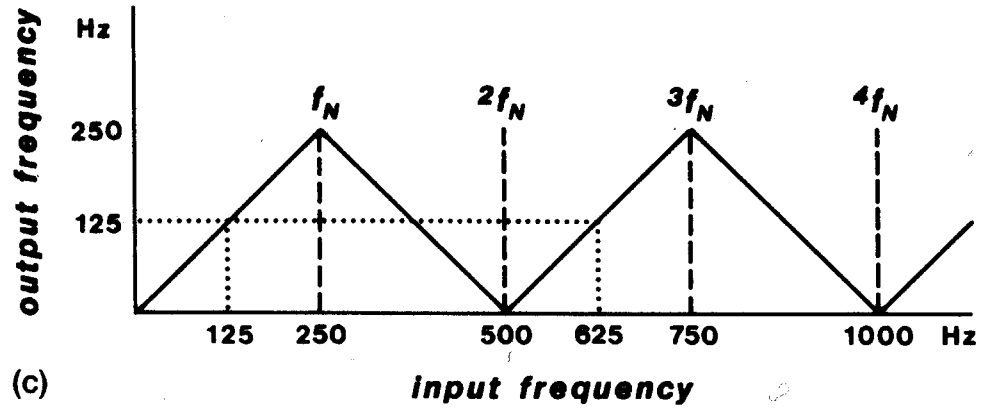
Registration of the measured data at certain time intervals

Sampling interval Δt
sampling rate $1/\Delta t$
Sampling will preserve all frequencies up to the Nyquist frequency:
$f_N = 1/(2\,\Delta t)$



Aliasing





(Kearey and Brooks, 1991)

Nyquist Frequency:

$$f_{Ny} = \frac{1}{2}\,\frac{1}{\Delta t}$$

Typical sampling distances:

0.25,0.5 ms:

High resolution seismic

1 ms, 2 ms

Oil exploration

4 ms or larger

Crust seismic

Dynamic range

Range which can be measured using different number of bits:

8-bit : **1 mV - 256 mV**

24-bit: **1 μV - 16 V**

Dynamic range is expressed in dB,

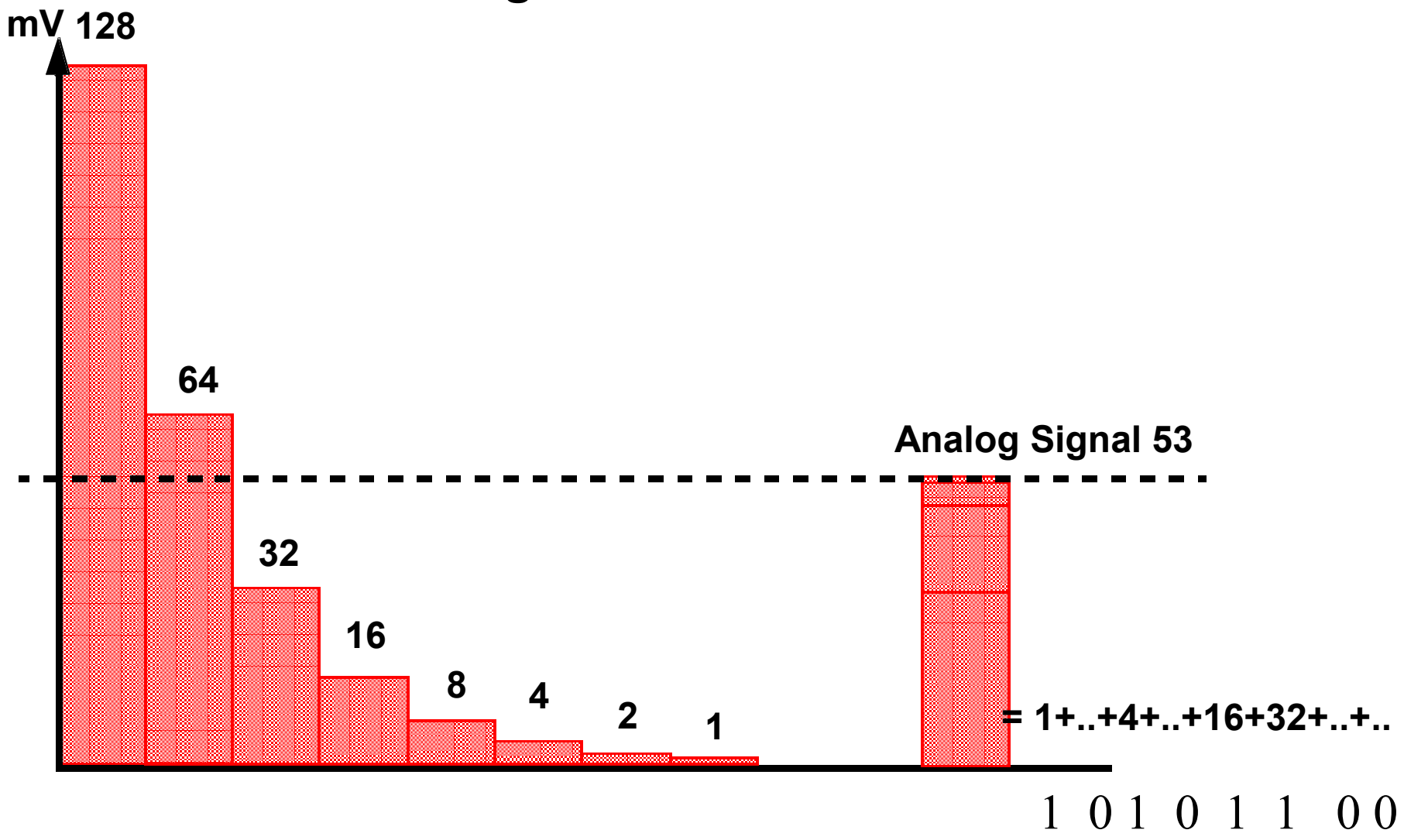
$$20\log\left(\frac{A_{\max}}{A_{\min}}\right)$$

Examples:

$$20\log\left(\frac{256\text{mV}}{1\text{mV}}\right) = 48\text{dB}$$

$$20\log\left(\frac{16\text{V}}{1\mu\text{V}}\right) = 144\text{dB}$$

Working of an AD-converter



Saving requirements

Saving requirements depend on:

- **Number of channels**
- **Number of values per channel**
  (Sampling rate,Time window of sampling)
- **Number of bytes per sampled value**

Example

Channels:	**96**
Sampling rate:	**2 ms**
Time window:	**0.8 s**
Format:	**4 Bytes per value**

$\Rightarrow$ (800 / 2) Values x 96 channels x 4 Bytes = 0.146 MBytes