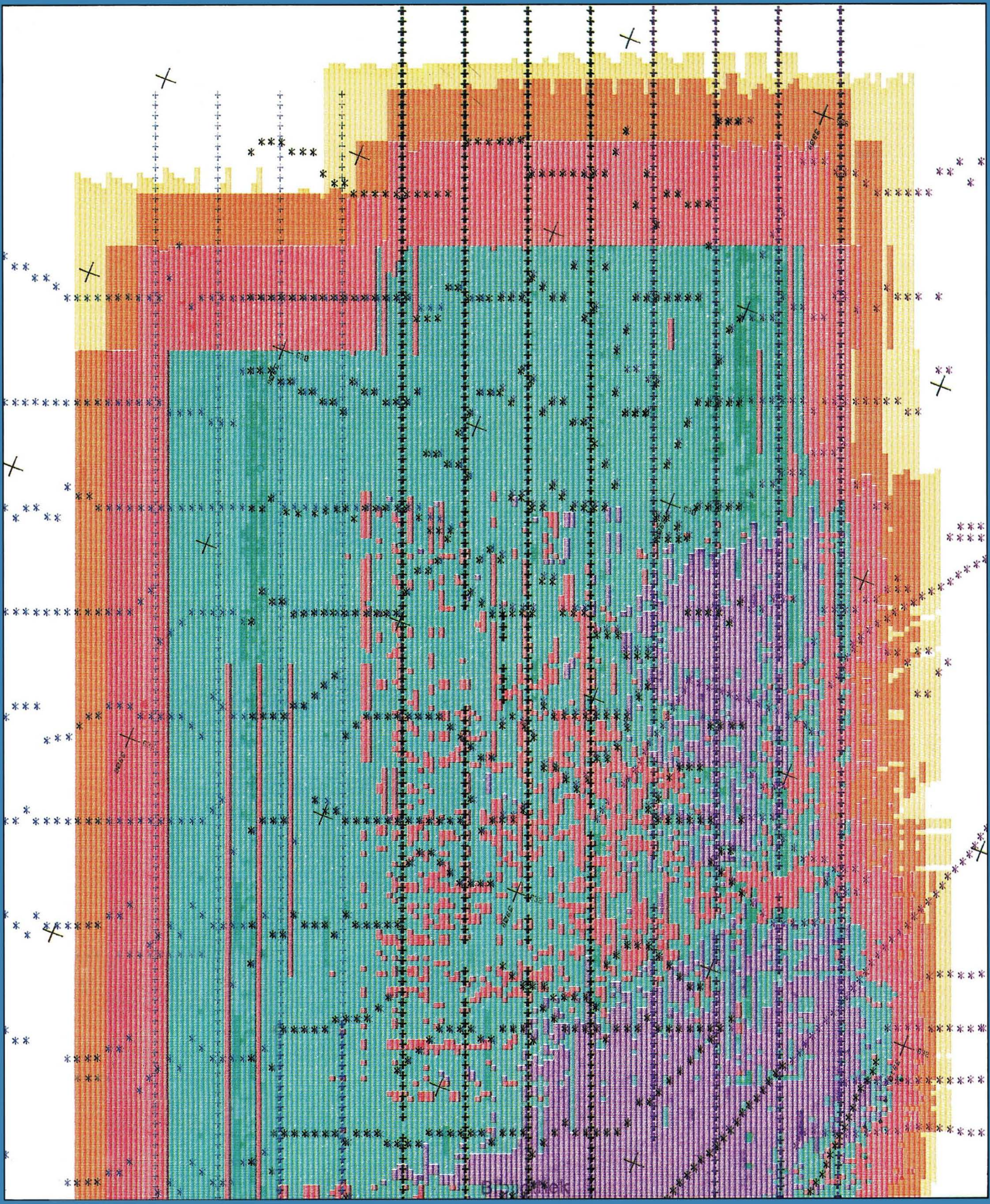
# PRAKLA-SEISMOS INFORMATION No.50

# 3-D Land Seismic Data Acquisition



# 3-D Land Seismic Data Acquisition

## Introduction

Ten years have elapsed since our first "areal seismic surveys" were set going in W-Germany for coal-mining, and in the Netherlands for an experimental 3-D survey in December 1975. PRAKLA-SEISMOS' contribution to this field was first introduced to the public in their main brochure "Land Seismic Surveys" late in 1976. Four of our "Information Brochures" (Nos. 3, 18, 19 and 35) were dedicated to 3-D techniques to show the spectrum of acquisition methods applied to a variety of specific, and sometimes spectacular objects.

After ten years experience 3-D land seismics has come of age, and is accepted by the industry as a superior alternative to line – or 2-D – surveys. During the nine years – from 1976 to 1984 – an area of about 1750 km$^2$ has been surveyed by our land crews, compared to 770 km$^2$ worked already in the first half-year 1985, i.e. the area of the 10th year approaches the total of the 9 foregoing 3-D years.

The areas to be surveyed have become larger and larger, ranging from 100 km$^2$ to several hundreds of square kilometres, including towns, harbours and complex amphibic areas to be overcome by combined land and shallow-water 3-D surveys; also sources are to be combined, such as airgun and VIBROSEIS with dynamite and hydraulic hammer etc.

## 3-D Routine Acquisition Systems

Field procedures and survey arrangements are permanently subjected to optimization, the tendency being: Maximum quality at minimum cost! On pages 3 and 4 the schemes of four 3-D survey systems are presented which have come to be our standards for routine detailing and reconnaissance 3-D work. These standards are extended variations of the basic crossed-array concept shown in figure 1.

The first three systems are applicable to a certain standard situation in oil and gas exploration, where the target depth ranges between 2500 m and 3500 m, and the structural dip is moderate enough to allow for a 25 m square CDP grid. The systems shown in figures 2 to 4 correspond to 240-, 480- and 640-channel recording, respectively. Which one of these systems is applicable in a distinct case is primarily a question of the instrument capacity available. Expected data quality is basically the same with all of the three systems. (The maximum shot-geophone distances for the 640-channel system of 2793 m may be excessive for target depths markedly less than 2800 m.) Otherwise the 640-channel version is by far superior from the economical point of view. Supposing 120 records per day, the daily production would be 1.5 km$^2$ for 240-, 3.0 km$^2$ for 480- and 4.0 km$^2$ for 640-channel recording.

The 800-channel version shown in figure 5 is oversized for the standard situation as to depth and grid width. It is usable, however, where narrower gridding is required (e. g. 20 m × 20 m) or where the target is markedly deeper than supposed for our standard systems.

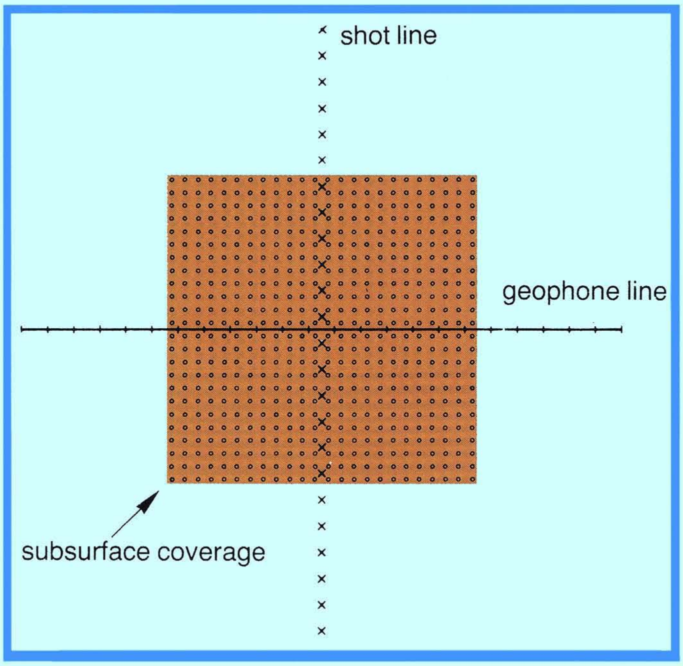



**Fig. 1:** Crossed-array concept

Cover: Pre-binning (enlargement of part of fig. 17)

## Layout System for 240-Channel Recording
## 1200 m Strip Width

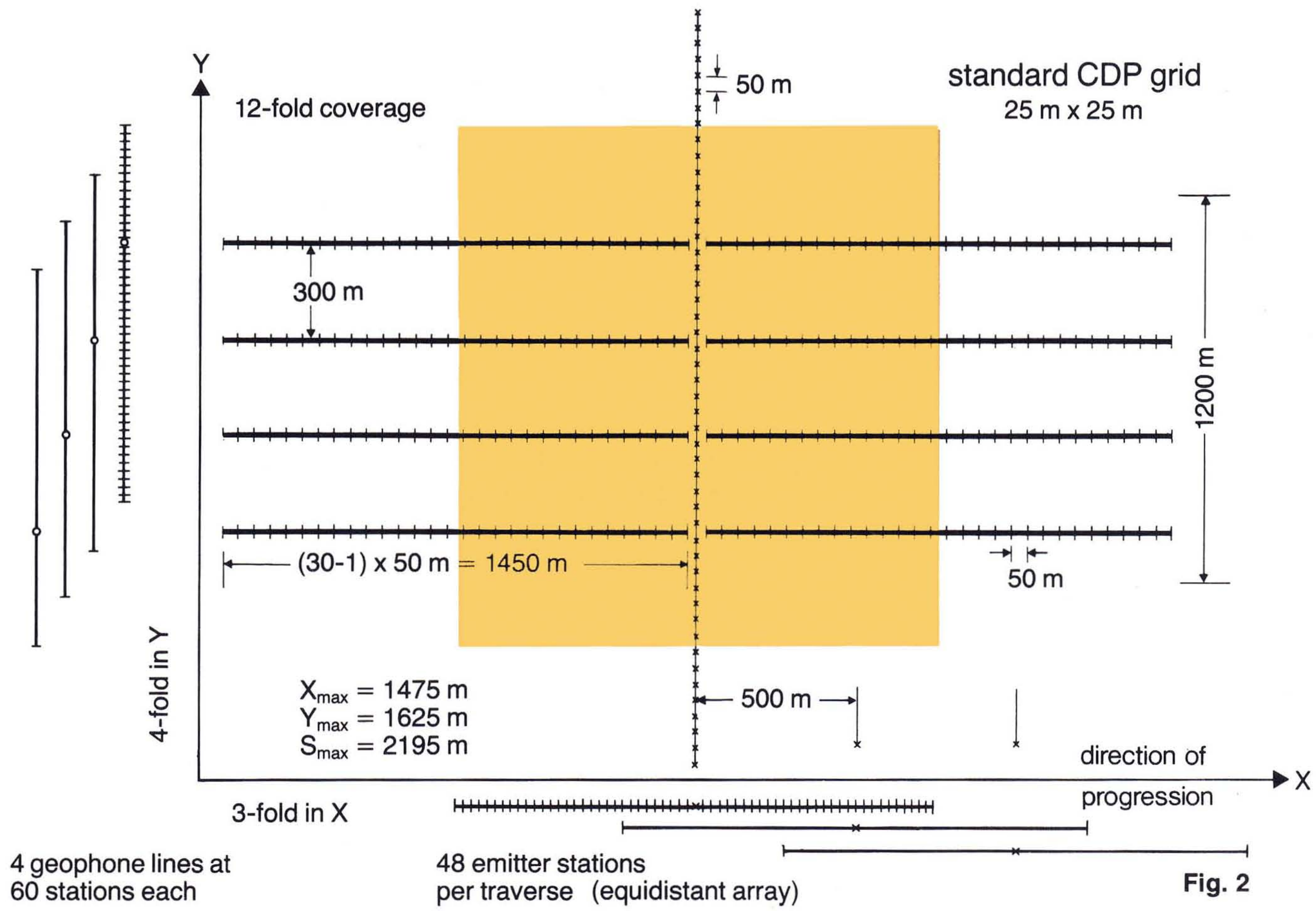



**Fig. 2**

## Layout System for 480-Channel Recording
## 1200 m Strip Width

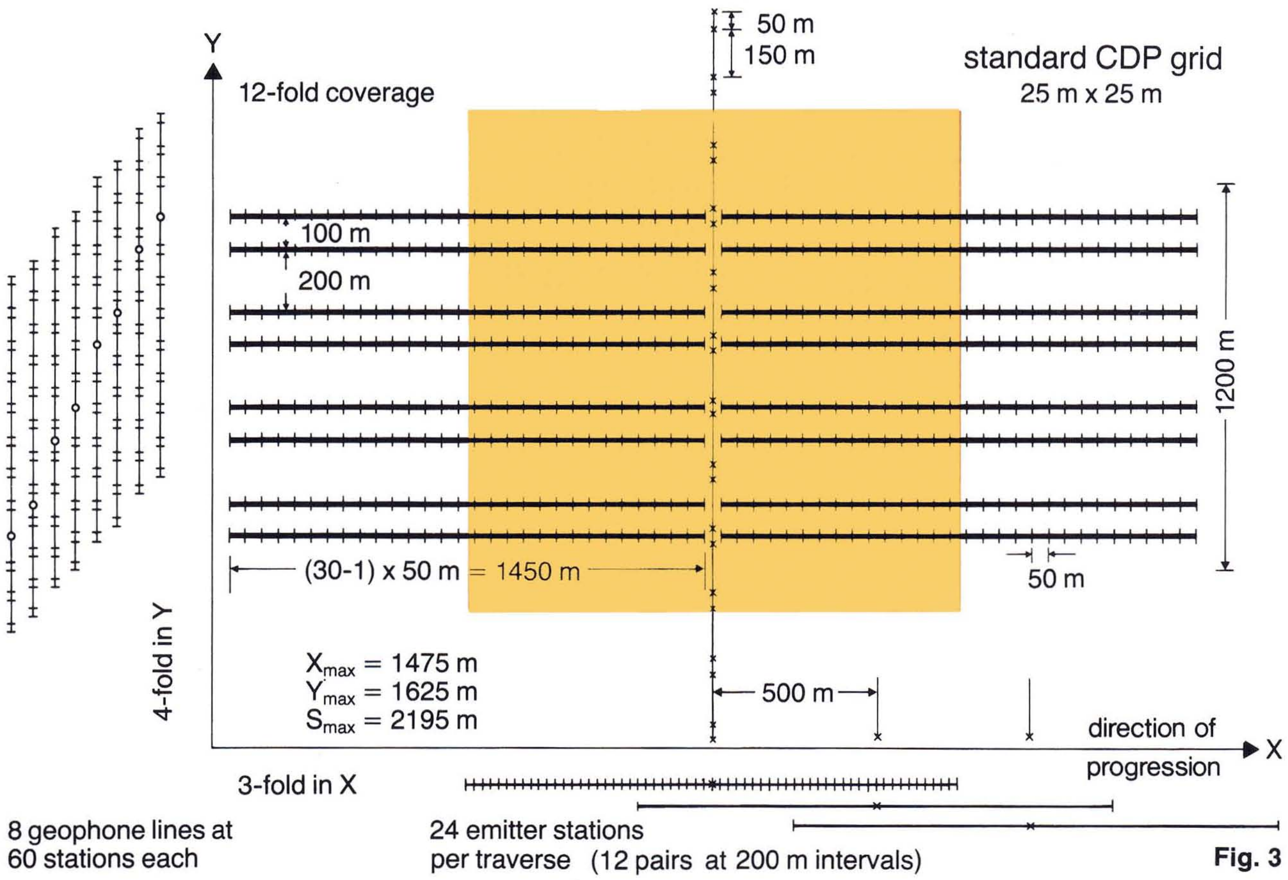



**Fig. 3**

## Layout System for 640-Channel Recording
## 1600 m Strip Width

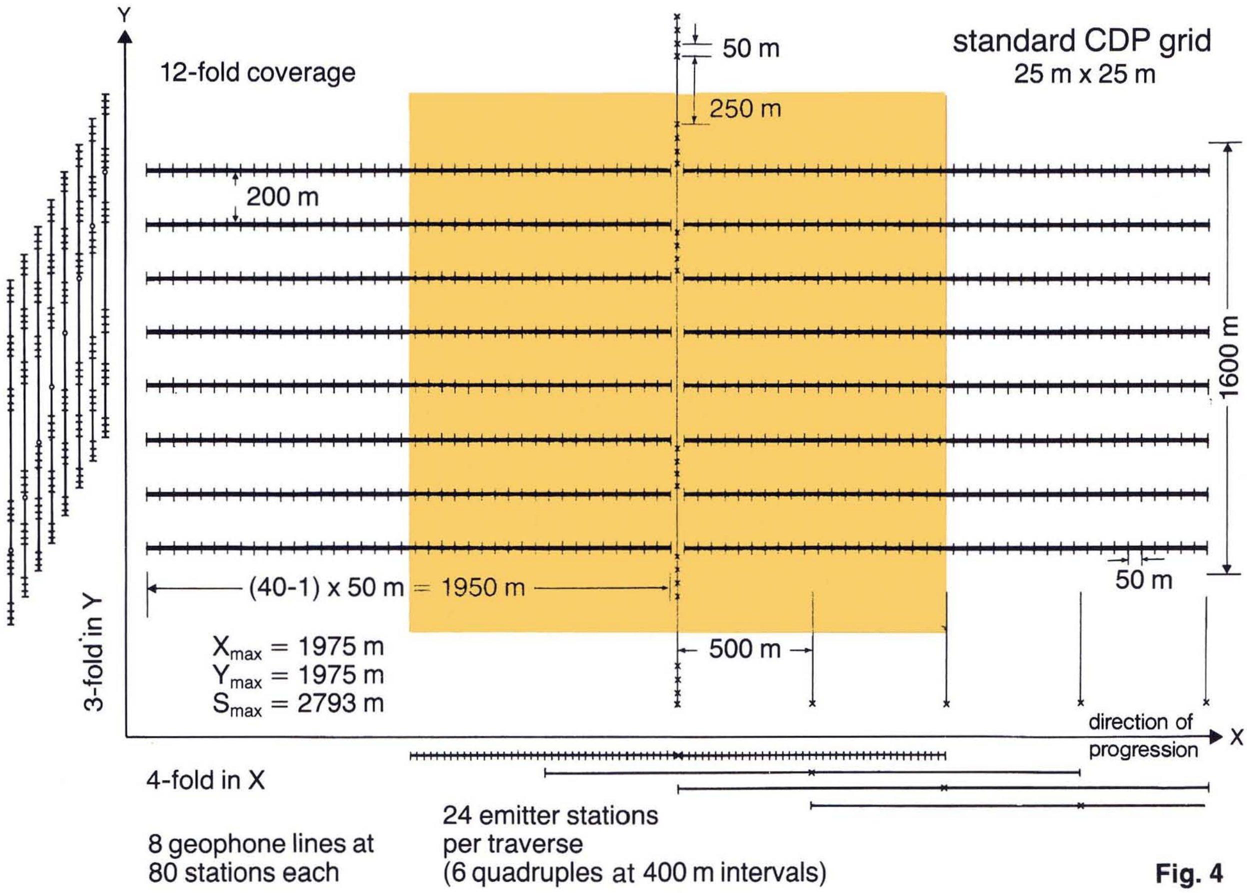



**Fig. 4**

## Layout System for 800-Channel Recording
## 1200 m Strip Width

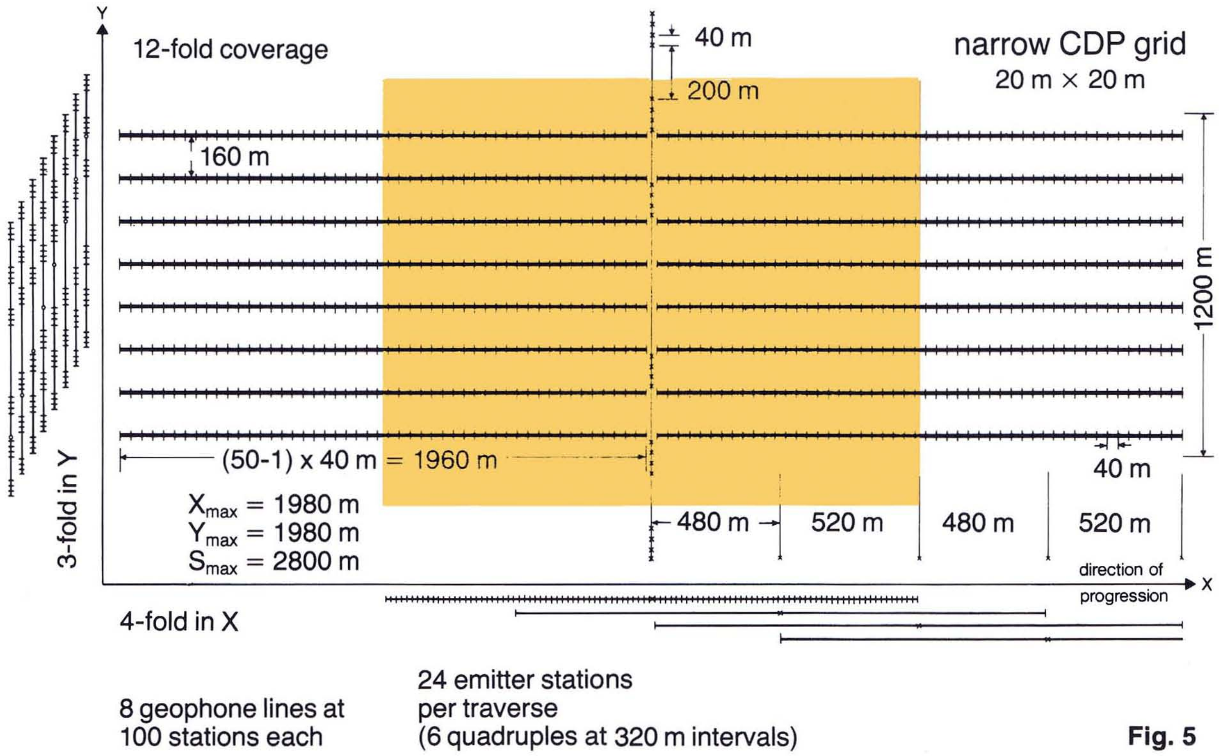



**Fig. 5**

**SERCEL SN 348 (left)**
**Correlator Stacker CS 2502 (centre)**
**Recording truck and container, in which the above units are installed (right)**

## 3-D Recording Instruments and Devices

| | | |
|---|---|---|
| **Seismic Recording Systems Available** | – SN 348 Telemetry, Sercel | 480 channels, 4 ms or 240 channels, 2 ms |
| | – SN 368 Telemetry, Sercel | 480 channels, 4 ms or 240 channels, 2 ms (expandable to 1200 stations at 2 ms) |
| | – DFS V, Texas Instruments | 240 channels, 4 ms or 120 channels, 2 ms |
| | – MDS-16 Telemetry, Geosource | preferably for more than 480- (up to 1000-) channel recording |

| | | | |
|---|---|---|---|
| **Additional Equipment for 3-D VIBROSEIS Operations** | – for SN 348: | Correlator Stacker CS 2502 | 480 channels, 4 ms or 240 channels, 2 ms |
| | – for DFS V: | Correlator Stacker CS 2502 | 240 channels, 4 ms |
| | – for DFS V: | ADD-IT IV (stacking and monitor correlation) | 240 channels, 4 ms or 120 channels, 2 ms |

**Pre-binning in the Field Office**

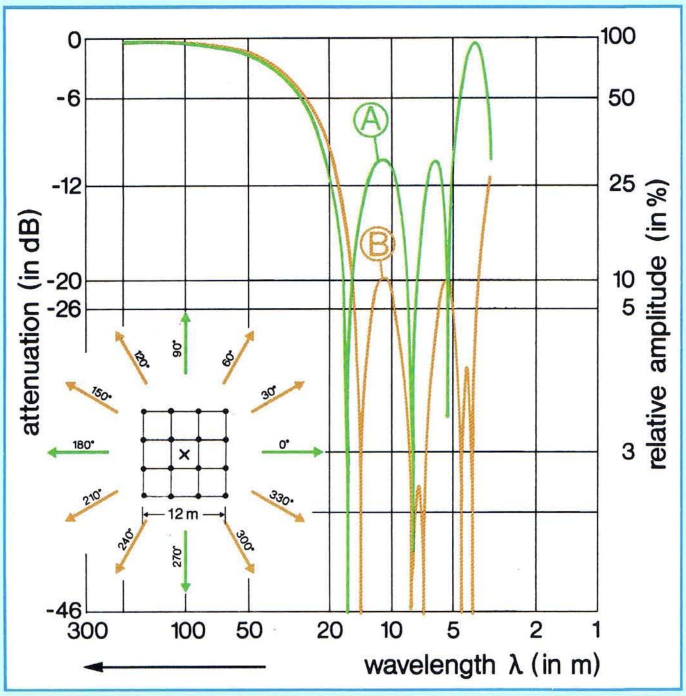
Hardware configuration:
- Desk computer HP 9020 with 1.5 Mbyte internal memory
- Digitizer Calcomp 60 cm × 60 cm
- Plotter HP 7586 B (DIN A 0)
- Mass Memory Winchester Drive (c. 130 Mbyte)

## Combined Source-Receiver Pattern Responses

(pages 6 and 7)

Our omnidirectional 3-arm-windmill pattern has been in general use with us as a 3-D receiver pattern since 1978. When VIBROSEIS was introduced as a routine for 3-D surveys the source-pattern discussion came up again. On page 6 (figs. 7 to 9) an example is illustrated how the square shape of four vibrators, operating on four stacking positions (a version for a desert survey), acts together with the 3-arm-windmill. Two basic responses A and B of the square are combined with the corresponding receiver responses a and b, resulting in four total responses A-a, A-b, B-a and B-b, shown in detail on page 7 (figs. 10 to 13). The four azimuth-specific responses are representative of the full azimuth spectrum of square/3-arm-windmill constellations.

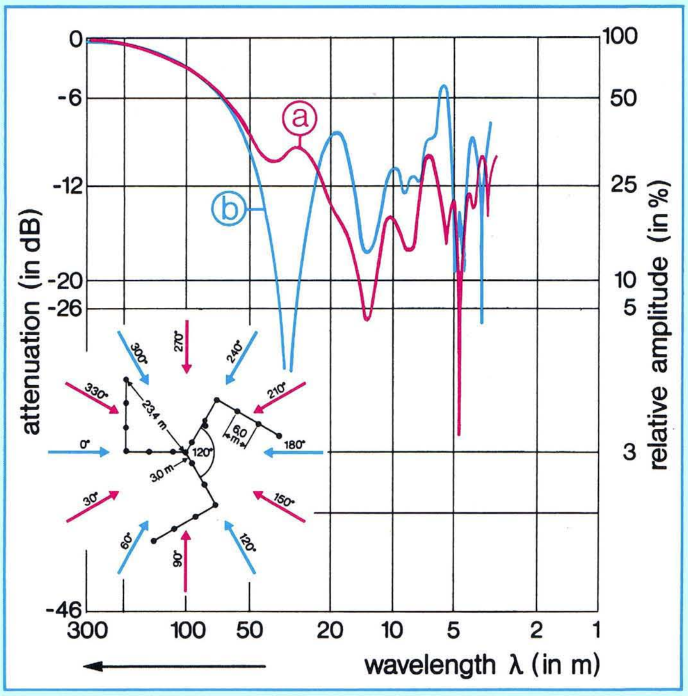
**Fig. 7:** Omnidirectional
**Square** Vibrator Pattern




Source responses A and B
to distinct source-receiver vectors

A: 0°, 90°, 180°, 270°
B: 30°, 60°, 120°, 150°, 210°, 240°, 300°, 330°

**Fig. 8:** Omnidirectional
**3-Arm-Windmill** Geophone Pattern




Receiver responses a and b
to distinct azimuths of incidence

a: 30°, 90°, 150°, 210°, 270°, 330°
b: 0°, 60°, 120°, 180°, 240°, 300°

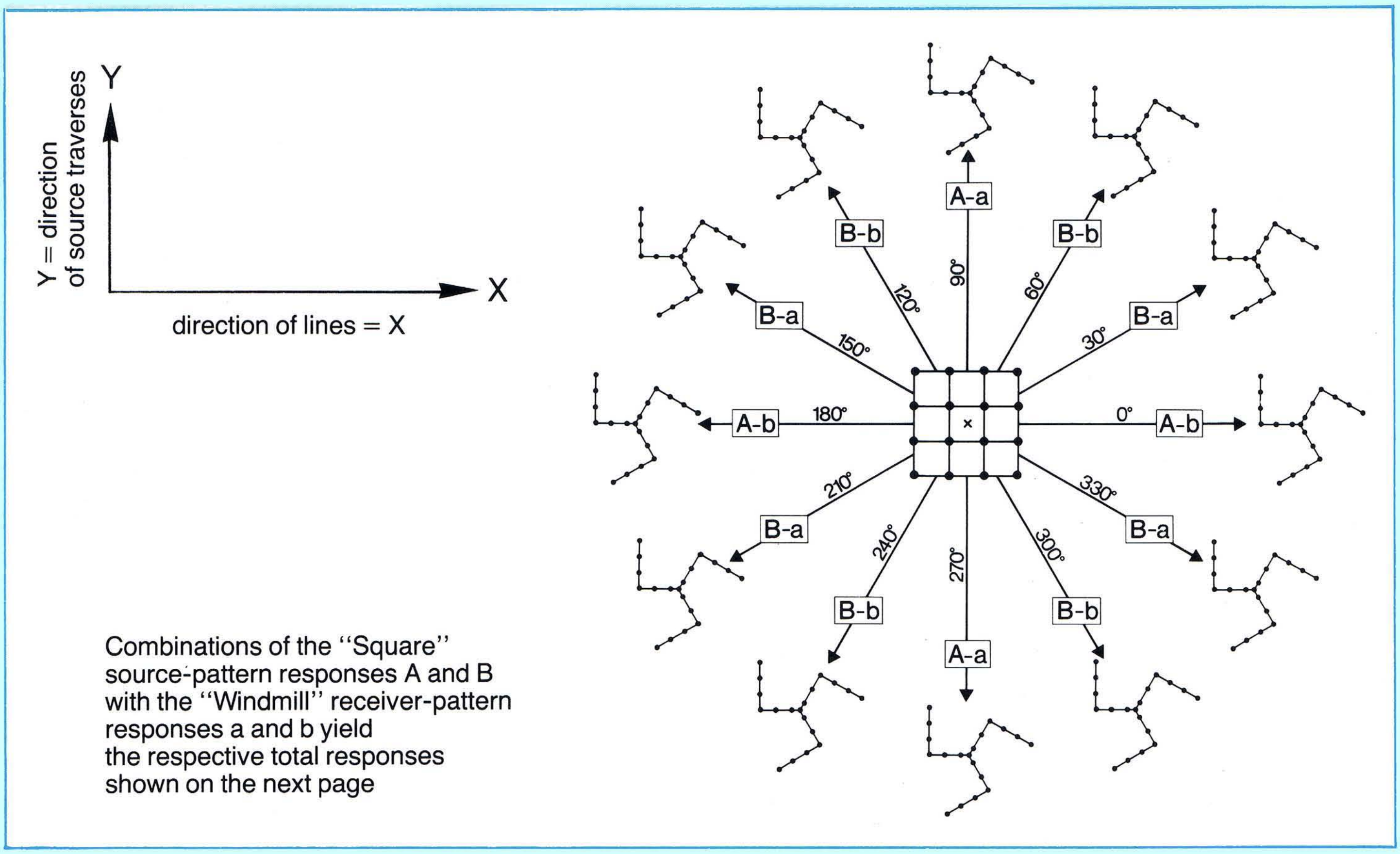



**Fig. 9:** Specific "Square-Windmill" Source-Receiver Constellations

## Total Source-Receiver Responses

**A-a**

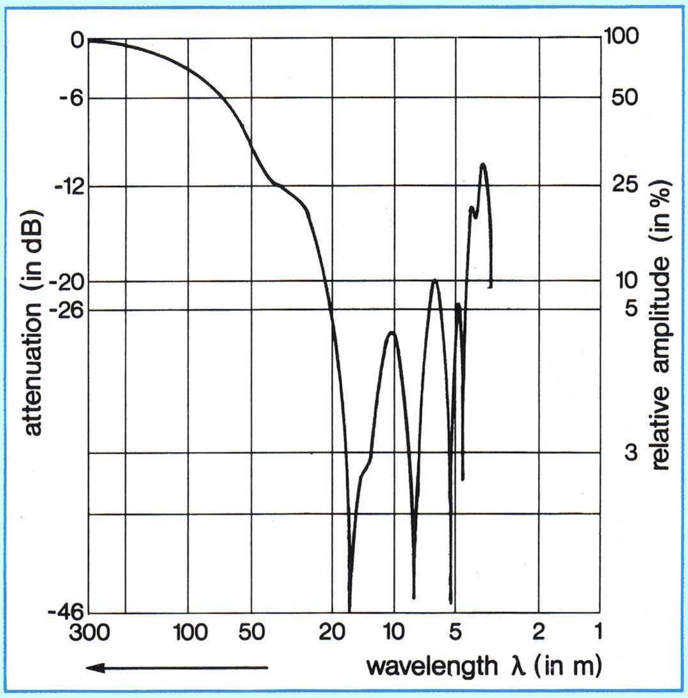



**Fig. 10**

**A-b**

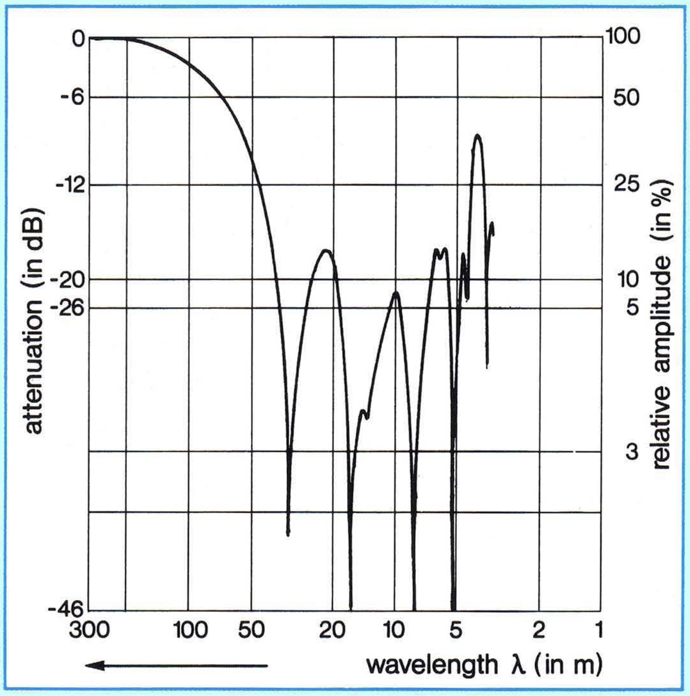



**Fig. 11**

**B-a**

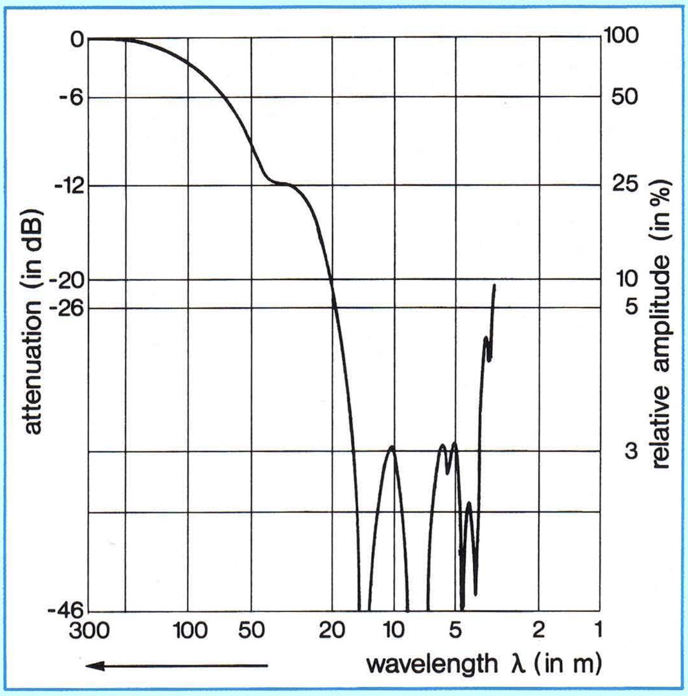



**Fig. 12**

**B-b**

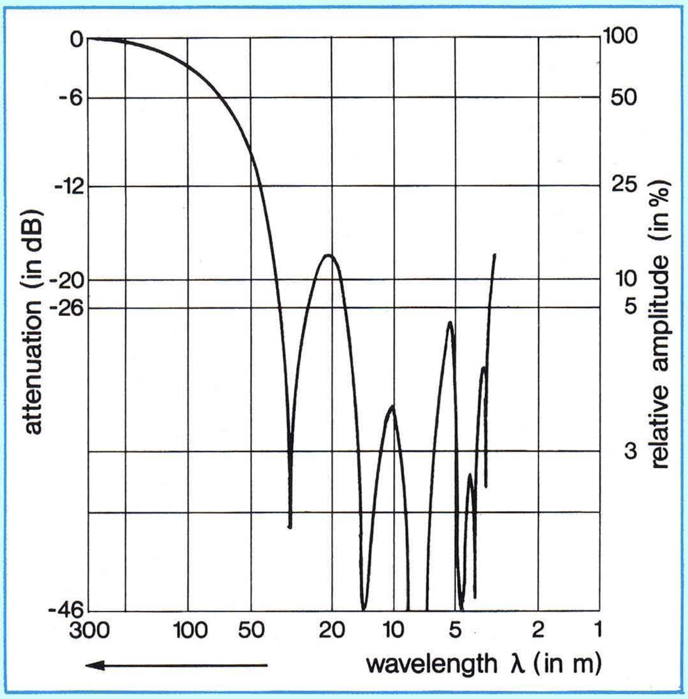



**Fig. 13**

## Pre-binning

(back cover)

Under difficult circumstances when towns, railway stations, harbours etc. are included in the regular layouts, the receiver and – in particular – the emitter stations have to be shifted to positions where they actually can be placed. An irregular surface layout necessarily produces an irregular subsurface situation: the subsurface points are no longer CDPs but collected in "bins" of a distinct size, say 25 m × 25 m.

To control whether sufficient coverage will result from a given irregular source-receiver configuration at the surface, a pre-binning procedure is initiated in the field-office. Plots of such a pre-binning program are shown in figures 14 to 17 on the back cover. For an easier analysis of the coverage situation concerned the pre-binning program displays the short, medium and long distance ranges between sources and receivers (figs. 14 to 16) as well as the total coverage (fig. 17). In the case of insufficient coverage in distinct subareas additional excitation stations must be found and inserted.

Pre-binning is indispensable when a 3-D crew has to deal with irregular acquisition conditions.

## Pre-Binning

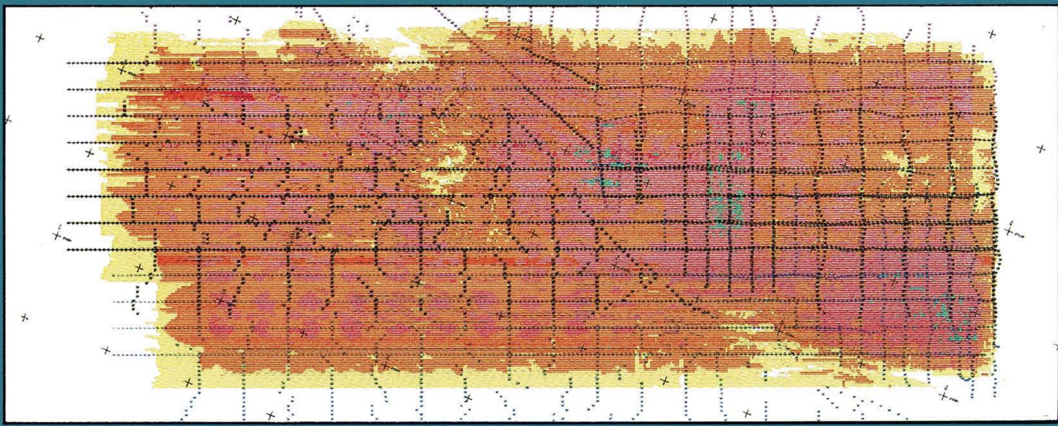


**Fig. 14. short range**
0 to 1000 m

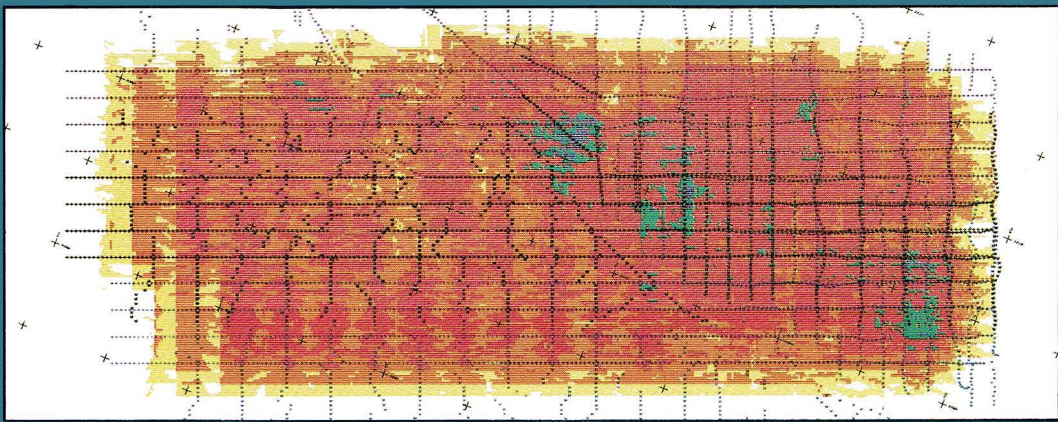


**Fig. 15: medium range**
1000 to 1700 m

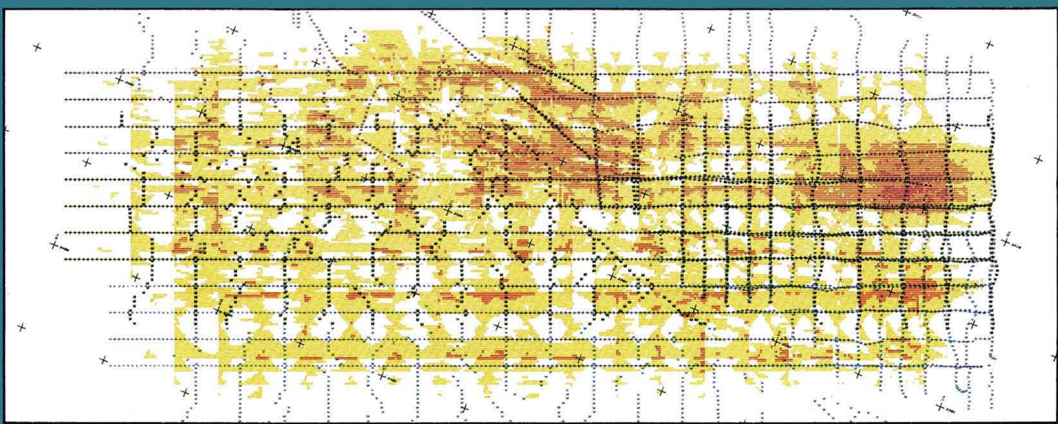


**Fig. 16: long range**
1700 to 2500 m

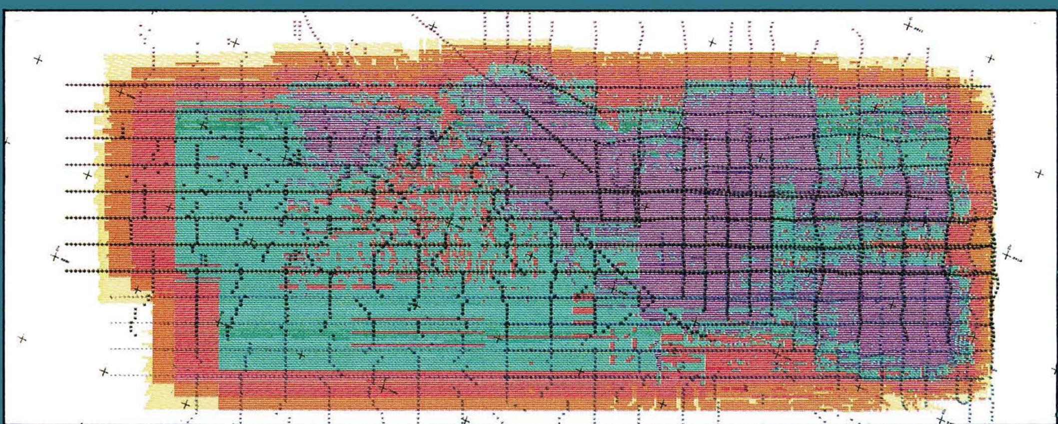


**Fig. 17: total coverage**
0 to 2500 m

- 1 to 2-fold
- 3 to 5-fold
- 6 to 10-fold
- 11 to 13-fold
- > 13-fold

Nominal
coverage: 12-fold

Courtesy NAM Assen (NL)

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