PRAKLA-SEISMOS GMBH

Seismic Land Surveys

PRAKLA-SEISMOS GMBH
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Contents

Applied Land Seismics • Data Acquisition

There are people which are interested in nearly everything valuable beneath the surface of the earth, how it can be detected and extracted, and thus made available to our civilization.

To these people – whether they represent private undertakings, communities or governments – we as a geophysical contractor offer our services, based on scientific background and technical know-how, to detect the hidden treasures in our earth.

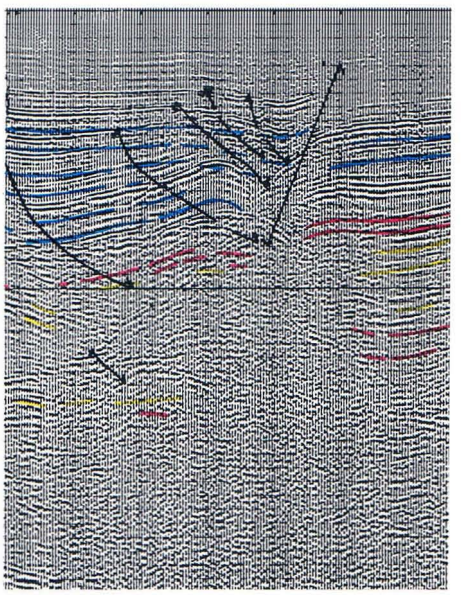
This is our business since 1921 – and we are proud enough to say: with some success!

What we provide is:

Data Acquisition – Data Processing – Data Interpretation.

We felt that the first of these three items was long enough standing in the shadow of the two other ones, as far as publicity and communication is concerned.

Data Acquisition → **Data Processing** → **Data Interpretation**



One of our first seismic crews (Texas 1925)

Modern seismic party in the tropics

This brochure is confined to **Data Acquisition,**

restricted to the field of **Applied Seismics,**

carried out on **Land** for the prospection of

- Mineral Oil
- Natural Gas
- Coal
- Minerals
- Thermal and Mineral Waters

and for solving problems in the field of

- Engineering and Hydro-Geology
- Well Surveying

It should be emphasized that applied seismics has become the most important tool and almost the only one to find oil and gas fields. At the same time exploration for these natural products has become the dominant task and challenge for applied geophysics.
Acquisition as the first link in the data chain – yor remember – is the most expensive one. Mistakes in the field techniques can hardly be 'smoothed over' and compensated by later procedures.
Mistakes made by using weak and inadequate material or by a misbalanced crew or outfit may lead to enormous but avoidable losses. On this account PRAKLA-SEISMOS has always laid vigorous stress upon all aspects of modern field techniques and on carrying out surveys as efficiently as possible using the best material the international market and our own workshops are prepared to offer at the very moment.
In the following chapters we will show some features of our seismic land activity: Where it is done, by whom, with what vehicles, drilling rigs, vibrators, instruments and technical tools. Finally we will demonstrate the methods and techniques we rely on and the trends we have decided to support and follow.

A seismic party in the desert

Areas and Working Conditions

The rapid expansion of geophysical exploration over the whole world during the last decades left hardly any place untouched. This development is pushed forward by the tremendous need for energy and natural products and was accelerated by a 'thunderclap' in 1973, worldwide known as the 'Energy Crisis'. For applied seismics great tasks have to be attacked and solved in order to meet the different and increasing requirements of the industry and to adapt equipment and personnel to the extreme working conditions encountered abroad.

To demonstrate PRAKLA-SEISMOS' worldwide activity and to show how well the company has gained its share, a simple count of continents and countries would not make much sense. Let us pick out some extremes:

The Deserts

Cable truck in Libyan dunes

The Tropics

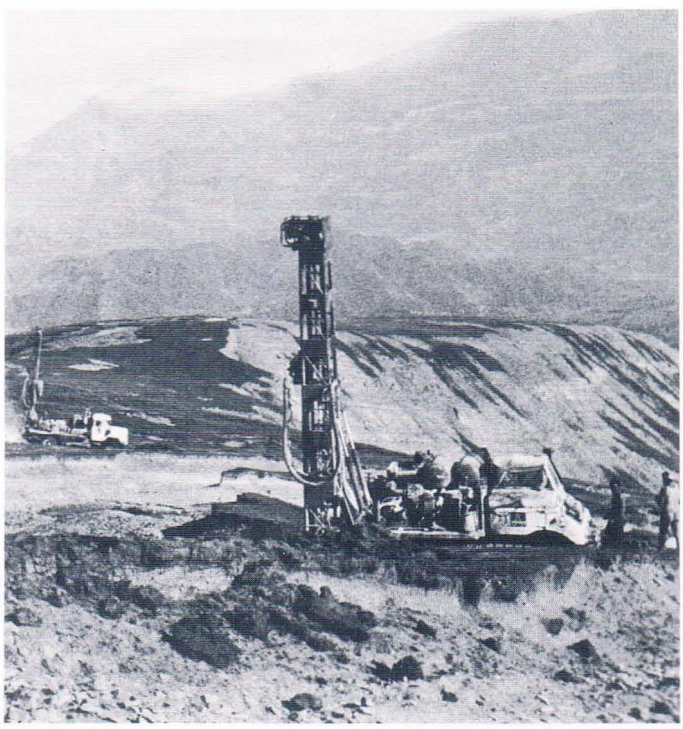
Linemen in the rainforest of Peru

The Built-up Areas

Vibrators working through a German town

The Mountains

Transport of a recording cabin by helicopter, Persia

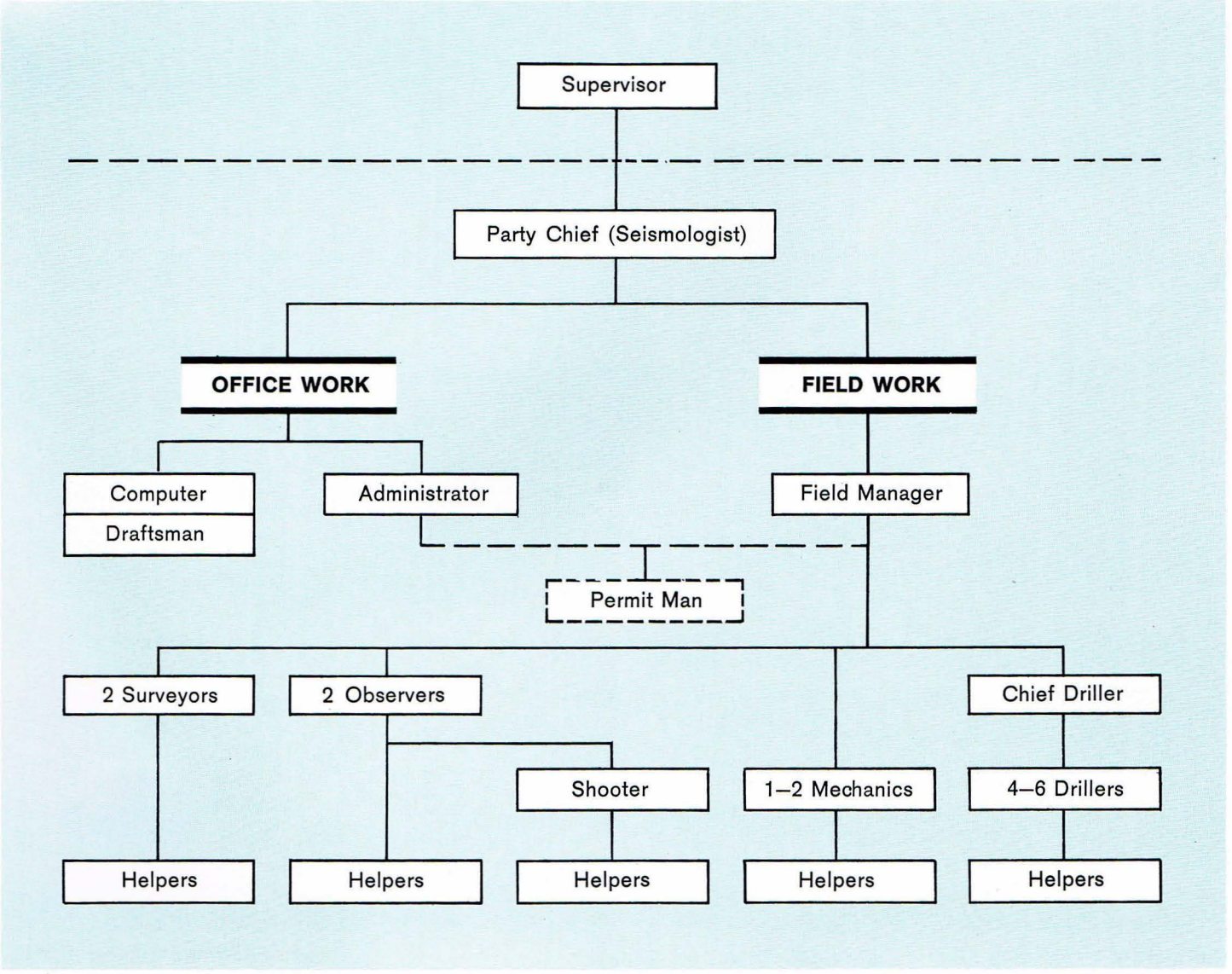


Drilling rigs in the Apennines, Italy

Crew and Accomodation

The Men . . .
Field and office work are done by well trained and experienced personnel, ensuring proper performance.

The standard organization of a 'conventional party' (dynamite -method) may be outlined as follows:



The above scheme and the number of staff personnel vary to a certain extent, depending on working conditions, the seismic techniques applied and whether well trained personnel can be hired locally as surveyors, draftsmen, shooters, drillers, and mechanics.
The field manager and permit man are only employed in cultivated areas.
In practice the number of staff ranges from 2 to 40. For a conventional party in a non-civilized area, 16 may be considered normal.
The size of the local labour force also varies to a large degree: from 50 in a desert area up to 1000 for portable works in rain forest and jungle.

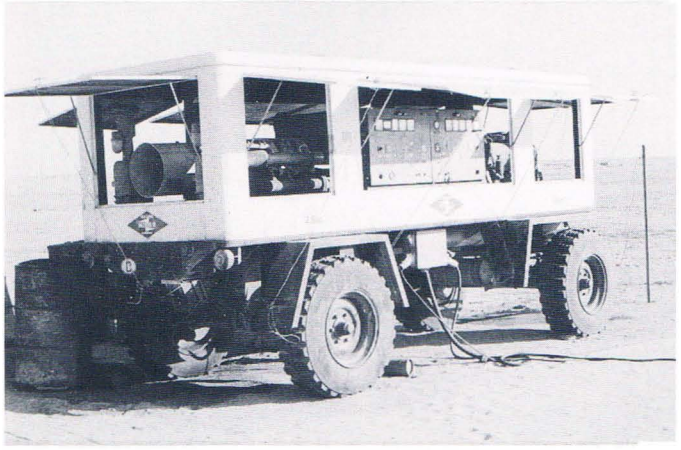
. . . and where and how they live:

In civilized areas • like Europe	in towns and villages
In desert areas • like the Sahara	in tent camps, with containers for office, store, workshop, trailers for kitchen, shower, workshop. Power supply: generator (35/70/105 KVA)
In swampy areas • like the Amazonas	in prefabricated houses, wherever a tent camp is inadequate

The camp is linked to the nearest town and supply base by SSB-radio sets.
Contact between the field office in the camp and the vehicles operating in the field is maintained by VHF transceivers.

Part of a tent camp in Persia, with workshop and generator

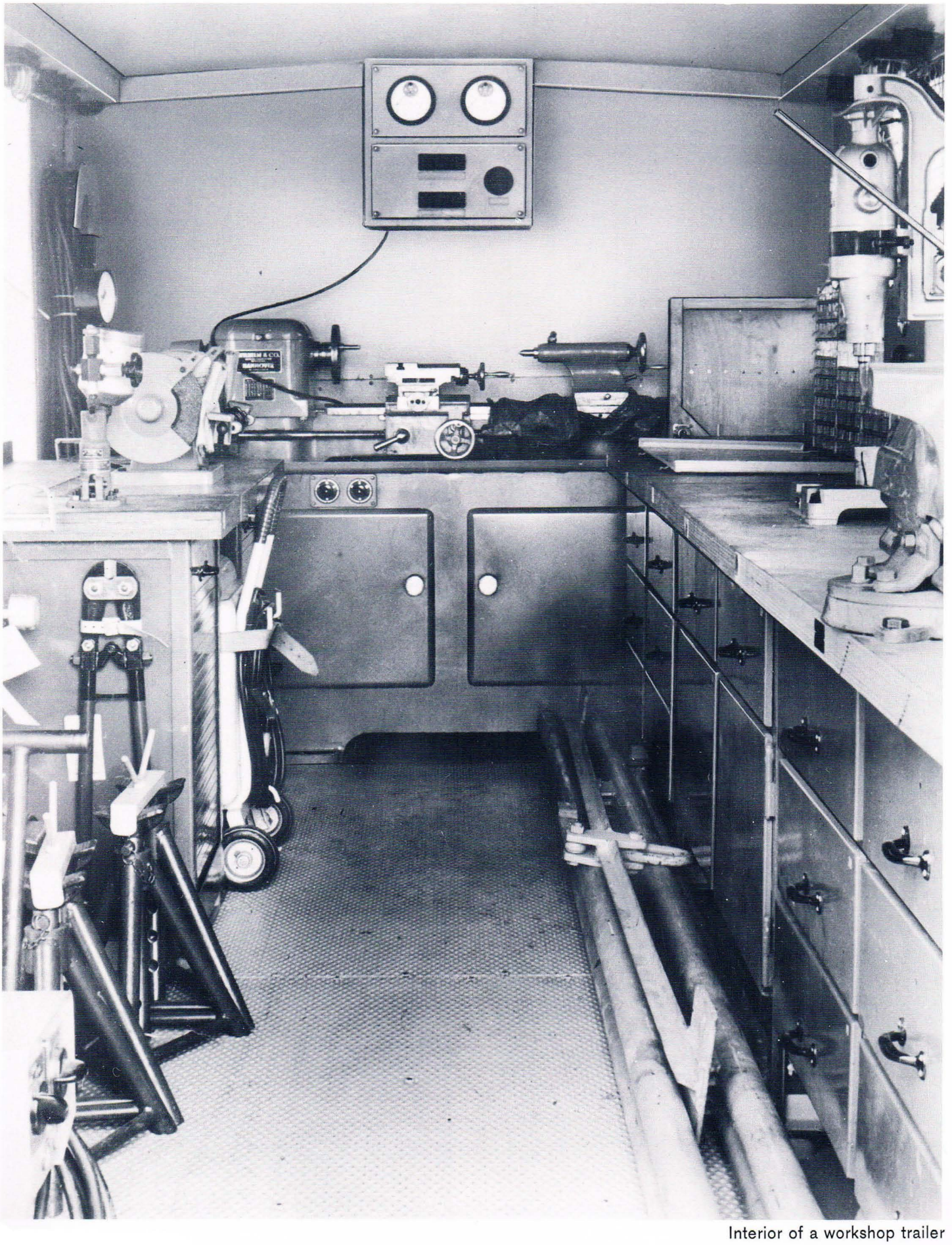
Workshop; trailer combined with tent



Generator (35/70/105 KVA)

Office containers, kitchen, and shower trailers in the background

Prefabricated houses in Peru



Interior of a workshop trailer

The Vehicles

The means of transportation are of great importance for every seismic party. During the last decades and after hard experience gained in rough and rugged terrain, PRAKLA-SEISMOS has learned to stick only to certain types of vehicles, which have proven to be best adapted to the enormous strain they have to suffer. For keeping maintenance problems as low as possible, PRAKLA-SEISMOS has reduced the number of types to only four. These four **standard types** may then be modified according to their special uses:

Mercedes Daimler-Benz Truck UNIMOG

Type: 416 (Diesel)
HP: 90 or 110
Total weight: 6 or 6.6 metric tons

Because of their extreme versatility, the UNIMOGs have become the real 'work-horses' of every party.

Single-Cabin Version, used as:
- Recording truck
- Cable truck
- Water truck (drilling)
- Fuel truck
- Salvage truck

Double-Cabin Version, used as:
- Surveyor's truck
- Shooter's truck
- Chief driller's truck

All versions are equipped with winches.

Magirus-Deutz Truck

Type: M 176 D 15 AK (Diesel)
HP: 176
Total weight: 15 metric tons

The MAGIRUS with its air-cooled engine has proven to be pretty indestructible and well adapted to hot areas. All versions are equipped with winches. They are used as:
- Recording truck (CFS I)
- Supply truck (with crane)
- Fuel truck
- Water truck (capacity: 2 x 2100 l)

Landrover Liaison Vehicles

Type: 109" (petrol or Diesel)
HP: 72
Total weight: 2.8 metric tons

This well-known vehicle is used in its version as 'station car' and 'pick-up' for many roles i. e. for reconnaissance and liaison trips.

Volkswagen Light Truck

Type: Transporter (petrol)
HP: 50
Total weight: 2.3 metric tons

The VW-Kombi is used in areas with an adequate road system for the transportation of geophones, cables, explosives, equipment and personnel.
Three versions are in use:
- VW Kombi
- VW Delivery Van
- VW Double-Cab Pick-up

For liaison purposes also the smaller passenger vehicle VW GOLF is used.
Most vehicles are equipped with VHF transceivers.

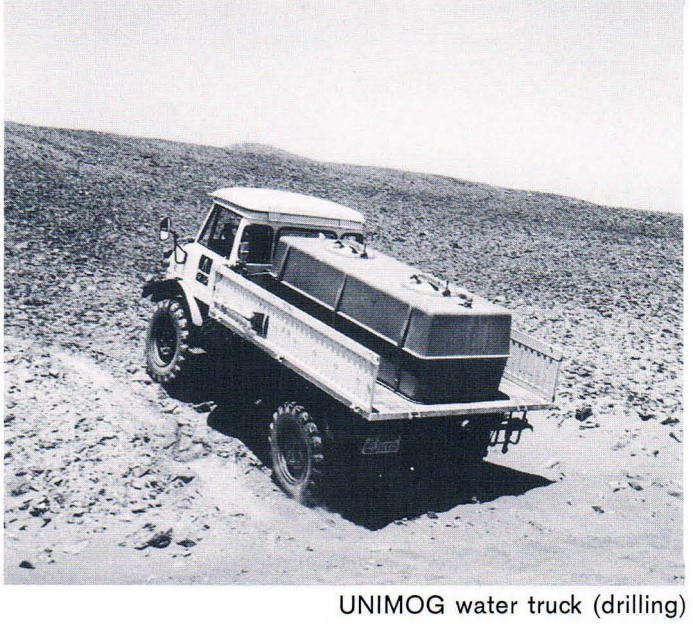
UNIMOG recording truck

UNIMOG cable truck

UNIMOG double cabin

UNIMOG salvage truck

UNIMOG fuel truck



UNIMOG water truck (drilling)

UNIMOG water truck

MAGIRUS recording truck

MAGIRUS water truck

MAGIRUS supply truck

Landrover pick-up with shooter

VW double-cab pick-up

UNIMOG and MAGIRUS in the tropics

The Drilling Equipment

Drilling for our seismic land parties is carried out by our 100%-owned subsidiary
PRAKLA-SEISMOS Geomechanik GmbH.

All drilling rigs and associated equipment are developed, built and maintained in the company's plant and workshops at Uetze near Hannover.

The following rig types are at disposal:

Category	Type	Vehicle	max. Depth	Flushing System	Pumps
Heavy Rigs	5001	Magirus-Deutz 320 D 22 FAK · three axle	500 m	water or air or water/air	piston (duplex power)
	4001	Magirus-Deutz 230 D 16 AK	400 m		
Medium-Heavy Rigs	3034	Magirus-Deutz 170 D 15 FAK	300 m		
	3023	Magirus-Deutz F6L 413, on an Intertrack Crawler	300 m		
	3012	Mercedes Unimog U 90 · three axle	300 m		
	3001	Magirus-Deutz 170 D 12 AK	300 m		
Light Rigs	1002	Mercedes Unimog U 90	120 m	water	
	0511	Mercedes Unimog U 34	50 m		centrifugal
Portable Light Rigs		Jacro (rotary)	30 m		
		Jet (flushing)	20 m		

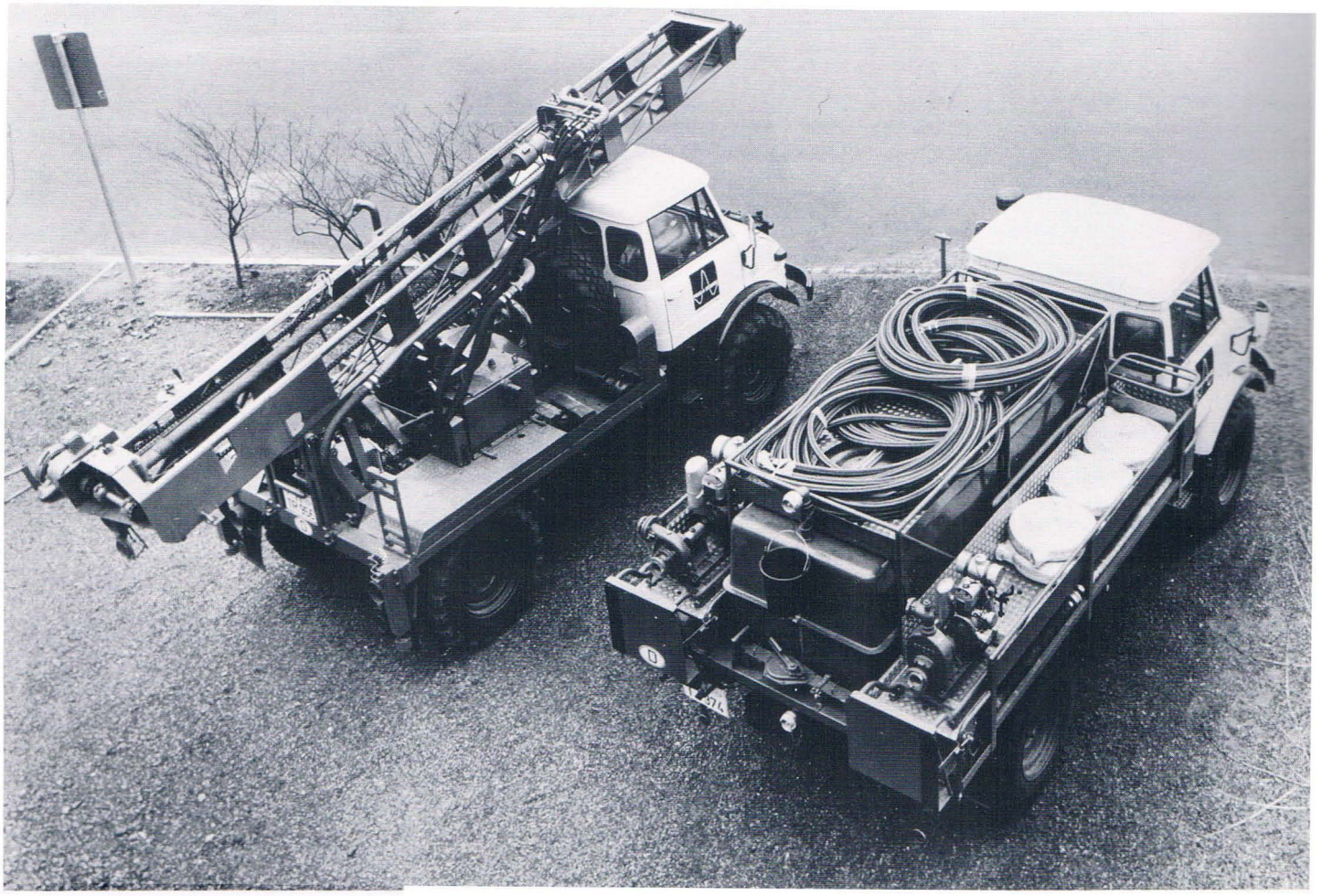
Rig types in white boxes: standard types

You may find more detailed information in our brochure:
PRAKLA-SEISMOS Geomechanik GmbH
— Engineering geophysics · Drilling —

PRAKLA-SEISMOS Geomechanik plant at Uetze, Germany

Heavy rig type 5001 in action

Medium-heavy rig type 3023, track mounted (crawler)



Light rig type 1002 with water truck

Medium-heavy rig type 3034

Rig type 3034 in action

The Vibrators

As our drilling equipment, the vibrator systems too have been developed, built and maintained in the PRAKLA-SEISMOS Geomechanik plant at Uetze, near Hannover. Our long experience in VIBROSEIS * techniques has led to the development of the new **standard vibrators:**

- VVCA
- VVDA

The new Type VVCA has fully stood the test in difficult areas abroad.

The new Type VVDA will be at our CLIENT's disposal as of spring 1977 and will replace, from that time onward, the proven but older road vibrator VVB.

The Standard Vibrators are provided with:

- Control unit with Automatic Digital Phase Compensator
- Sound attenuation of approx. 7 db for reduction of environmental disturbance

The vibrator outfit will then comprise:

Type	Category	Total Weight	Peak Force
PRAKLA-SEISMOS VVCA	All-Terrain Vibrator	14.4 t	12.48 t
MERTZ GSC/VSH-10	Crab Tractor	11.6 t	10.0 t
PRAKLA-SEISMOS VVDA	Road ** Vibrator	15.0 t	12.48 t
PRAKLA-SEISMOS VVB	Road ** Vibrator	12.5 t	11.20 t

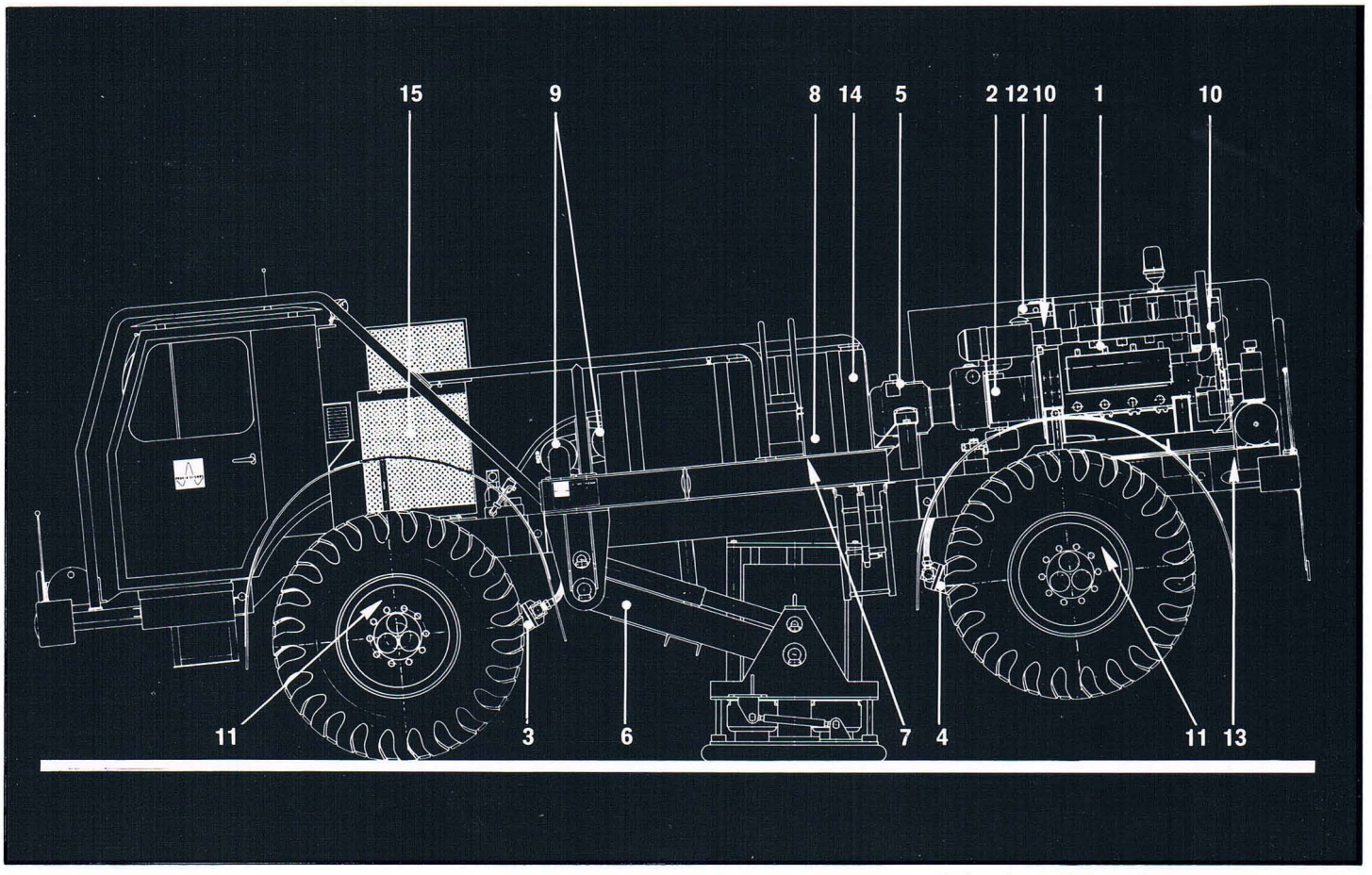
** The term 'Road Vibrator' was introduced in comparison to the 'All-Terrain Vibrator'. Medium-difficult terrain is, however, also mastered by a 'Road Vibrator'

VVCA all-terrain vibrator

*) Trade mark of Continental Oil Comp.

The **vibrator system VVCA** combines the characteristics of the traditional road vibrator with the advantages of a cross-country all-terrain carrier. The vehicle has two separate hydrostatic drive motors in the individual steerable axles for cross-country manoeuvrability and is capable of speeds of up to 42 km/h. The entire carrier and vibrator power is obtained from one aircooled 162 HP (DIN ratings) V8 Deutz Diesel engine.
The carrier and its vibrator are an integral design. It is a 'system' and not some accidential combination of a vehicle with a vibrator. Without sacrifice in regard to maximum output or low-frequency operation, the PRAKLA-SEISMOS VVCA vibrator is capable of performing on roads or highways as well as in rugged or desert terrains. The unique 'lever-arm lift system' (patent applied for) without cables and easily-damaged hydraulic vertical columns, is practically maintenance-free. The lift system has a soft 'lift-up' characteristic, avoiding the often troublesome 'whip lash' to the operator's back. In operation the VVCA lift system provides a variable, 'surface to bottom-plate contact angle' for optimum terrain-to-vehicle coupling.

1 Internal combustion engine
2 Axial-flow pump (adjusting double pump)
3 Oil engine (front axle)
4 Oil engine (rear axle)
5 Axial-flow pump (vibrator unit)
6 Lift system
7 Vibrator control unit
8 Vibrator
9 Hydraulic accumulators
10 Gear pump (steering system)
11 Steering system
12 Oil tank (steering system)
13 Double gear pump (main oil circuit)
14 Oil tank (main oil circuit)
15 Oil cooler

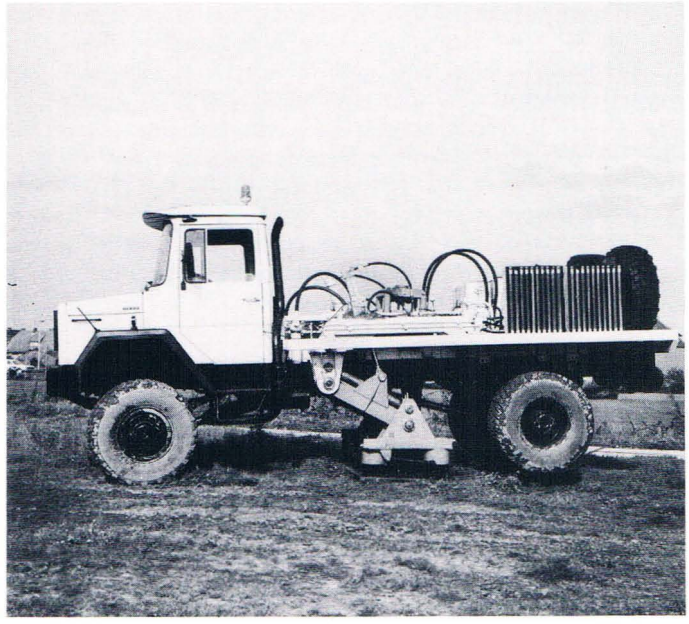


Side view of the vibrator system VVCA

The **vibrator system VVDA** is mounted on a cross-country Magirus-Deutz truck of the type 170 D 15 AK/HD with an air-cooled 176 HP (DIN ratings) Diesel engine, allowing speeds up to 80 km/h.

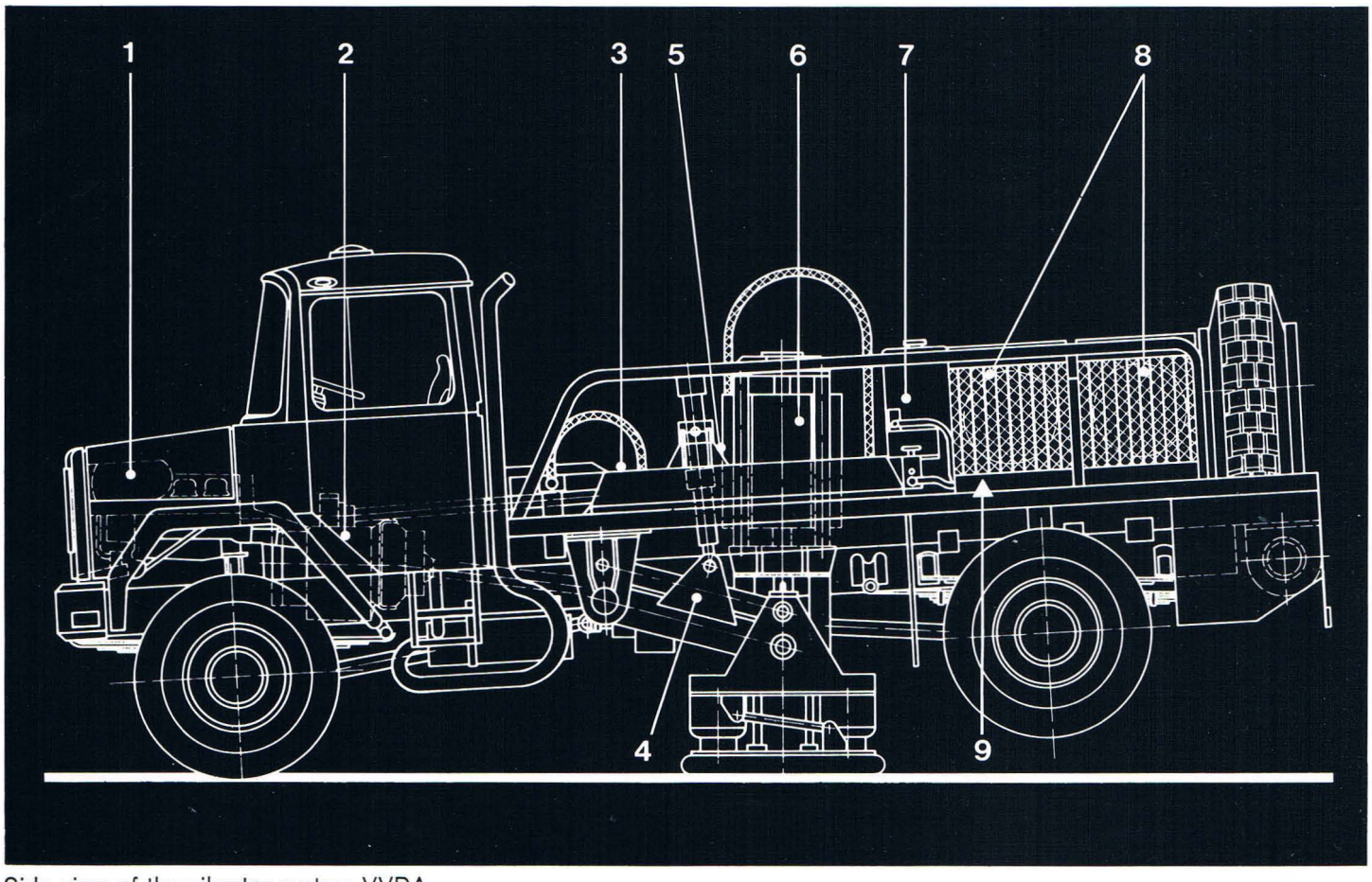
The vibrator is driven by the truck engine itself, which is made possible by the so-called Voith adapting gear.
The same lever-arm lift system as used for the VVCA vibrator has been applied here in a slightly modified form (see vibrator VVCA).
The main advantages of the new VVDA vibrator are:

- High speed on roads and therefore good economy
- All-terrain properties
- Low centre of gravity



VVDA vibrator

1 Internal combustion engine
2 Adapting gear
3 Axial-flow pump (vibrator unit)
4 Lift system
5 Vibrator control unit
6 Vibrator
7 Hydraulic accumulators
8 Oil tank (main oil circuit)
9 Oil cooler



Side view of the vibrator system VVDA

VVCA vibrators in action

VVB vibrators in action, Belchen Tunnel, Switzerland

The Instruments and Technical Tools

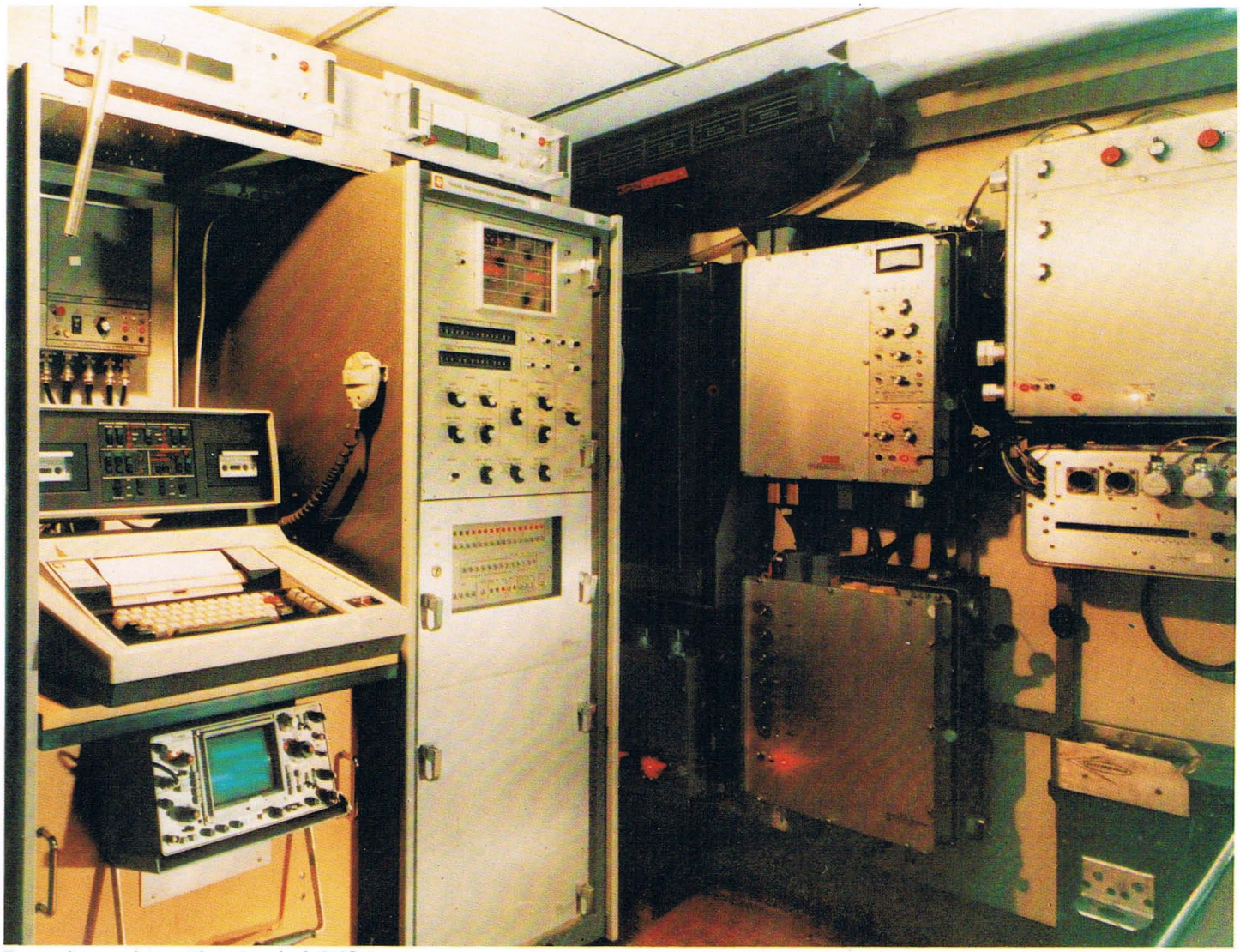
The hardware summarized by the above heading may be subdivided into:

- **Seismic Instruments**
  - **Geophones**
    - **Cables**
      - **Peripheral and Auxiliary Equipment**

PRAKLA-SEISMOS has found – as we see it – a good balance between buying the most advanced electronic instruments on the market and developing many of the auxiliary and adapting devices in its own workshops.

In the following you will find a short compilation of the hardware which we consider our **standard.** On the other hand you will find omitted certain items (i. e. geophones, cables) which we have on stock in limited quantities for very specialized problems (besides large quantities of material classified as 'most modern' just a few years ago). Two more aspects which should be mentioned:

- All equipment for newly emerging techniques (i. e. telemetry, high resolution recording) will find acceptance as fast as possible and whenever advisable.
- All of our CLIENTS' special wishes regarding types (i. e. geophones) or dimensions (i. e. cables) are taken into account according to our principle: FLEXIBILITY.



Recording cabin with extended CFS I

Seismic Instruments

Recording is done with 24-, 48-, 96- and 120-trace digital equipment.

Texas Instruments: DFS III Binary Gain
DFS IV Inst. Floating Point (IFP)
DFS V Inst. Float. Point
(portable, if needed)

Sercel: SN 338 B Inst. Float. Point
(portable, if needed)

For VIBROSEIS * operations two modifications are used [1]):
DFS IV combined with:

- IFP-Stacking Unit ADD-IT I or II of Mandrel Industries, enabling besides conventional stacking: Automatic Noise Reduction
  Inverted Stacking
- Sweep Generator:
  PELCO Advance I of Pelton Company Incorp., or SHV/RCV (various types) of Mandrel Industries
- Field Correlator:
  Model 24 of Quantum Electronics Corp. for 24 traces, providing 8 bit for sweep, and 8 bit for trace

Extended CFS I (**C**omputerized **F**ield **S**ystem) of Texas Instruments together with input moduls of DFS IV 24- or 48-channel system, enabling besides automatic noise reduction:

- Standard or Diversity Vertical Stacking
- Sweep Generation
- Field Correlation on magnetic tape

In addition to portable work the DFS V instrument is well adapted to high-resolution surveys as, for instance, in underground mining surveys [2]) because of its ability for 0.5 ms sampling.

Tests:
At the beginning and during a survey, all prescribed initial-, daily-, weekly- and monthly instruments tests and calibrations are thoroughly executed. Print-outs are handed over to the CLIENT on request.

Geophones

Our mainly used types:

- **Sensor**

SM-4 B, 10 Hz,	PE-2 case PE-8 case (marsh)	reflection geophones
SM-4 G, 30 Hz,	PE-2 case, for high resolution	reflection geophones
SM-6, 4.5 Hz,	PE-5 case	refraction geophone

- **Geo Space**

HS-1, 4.5 Hz	refraction geophone

[1]) see page 42, New possibilities and trends in VIBROSEIS *-Techniques
[2]) see page 58, Underground Seismic Surveys for Mining

- **Special Devices**

• Self-orientating (Gimbal) geophones, type HGLB, PRAKLA-SEISMOS, provided with SM-4 B system, 10 Hz	for shallow-water surveys
• Geophones fitted in tubes to be placed in prepared boreholes, provided with HS-JK system, 28 Hz, (horizontal axis)	for underground mining surveys, in particular for channel-wave seismics in coal-seams
• Geophones with two horizontal components, to be pneumatically clamped in prepared boreholes, type HGUA, PRAKLA-SEISMOS, provided with Mark L-21 systems (horizontal axes).	for underground mining surveys, in particular for channel-wave seismics in coal-seams

As a rule, six reflection (or five refraction) geophones are connected in strings, the spacing between adjacent geophones being 10 m. But other configurations too (in equidistant or linear tapered arrays) can be manufactured if desired.

Cables

Standard types and dimensions which are always in stock:

- **Cable with 36 'active' pairs:**
  Spacing between take-outs 60 m, unit length 120 m
  Spacing between take-outs 85 m, unit length 170 m
  Spacing between take-outs 110 m, unit length 220 m
- **Cable with 48 'active' pairs:**
  Spacing between take-outs 85 m, unit length 170 m

Cable types which are not specified here might nevertheless be on stock or can easily be manufactured if necessary.

Peripheral and Auxiliary Equipment

Remote Firing Control System
with time-break and uphole-time transmit controller.
Type: ZXDD; Manufacturer: PRAKLA-SEISMOS

Trace Switching Devices

- 120 input-traces and 60 output-traces,
  Type: RLS 100; Manufacturer: Input-Output
- 96 input-traces and 48 output-traces,
  Type: ZMEB; Manufacturer: PRAKLA-SEISMOS

Oscillographs (electrostatic)

- 56- and 60-galvanometer versions,
  Type: SDW 400; Manufacturer: ETL Mandrel
- 28- and 32-galvanometer versions,
  Type: OXBB; Manufacturer: PRAKLA-SEISMOS

Weathering-Survey Units

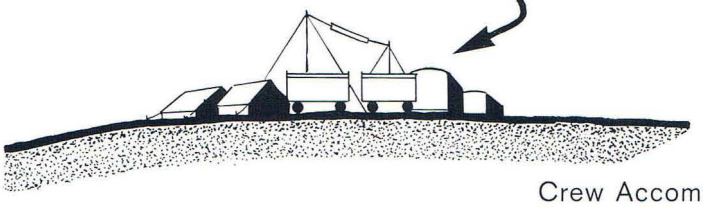
- 12 traces; Type: RS-4, Manufacturer: SIE
- 24 traces; Type: RS-44, Manufacturer: SIE

CLIENT

Contract + Planning

PRAKLA-SEISMOS

Seismic Party

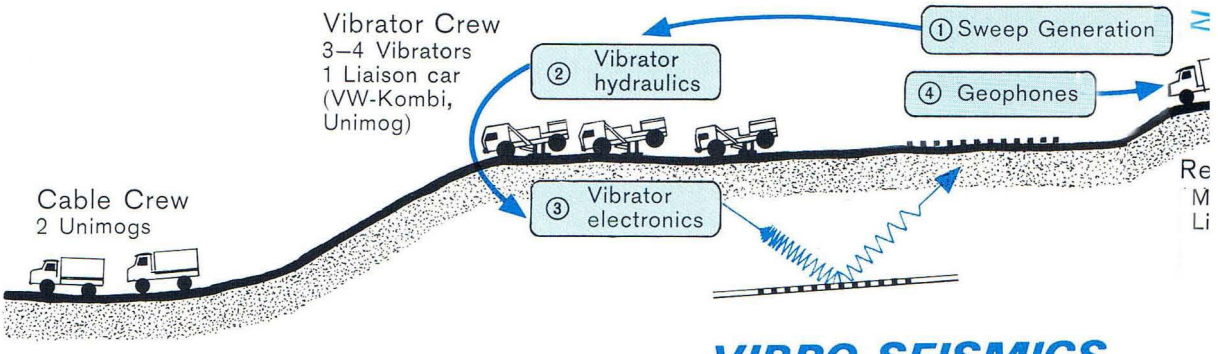


Crew Accomodation
Town or Camp:
Container (Office, Store)
Trailer (Workshop, Shower, Kitchen)
Tents (Personnel)
Liaison and Supply Vehicles
(Magirus, Unimog, Landrover)

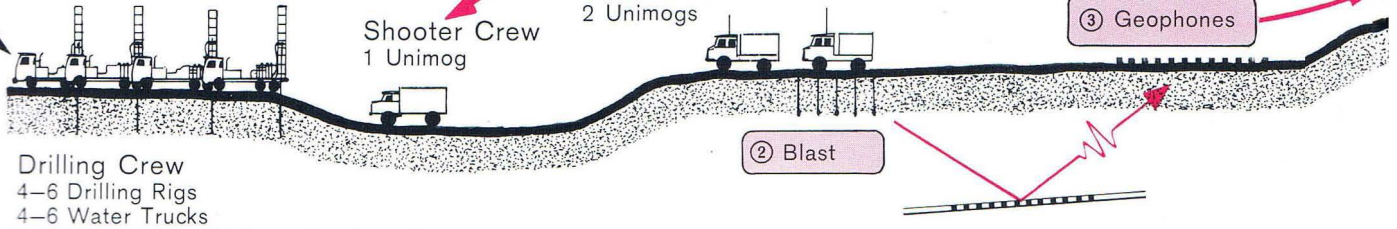
Surveyor Crew
2 Vehicles (Unimog, Landrover)

Vibrator Crew
3–4 Vibrators
1 Liaison car
(VW-Kombi,
Unimog)

Cable Crew
2 Unimogs



VIBRO SEISMICS

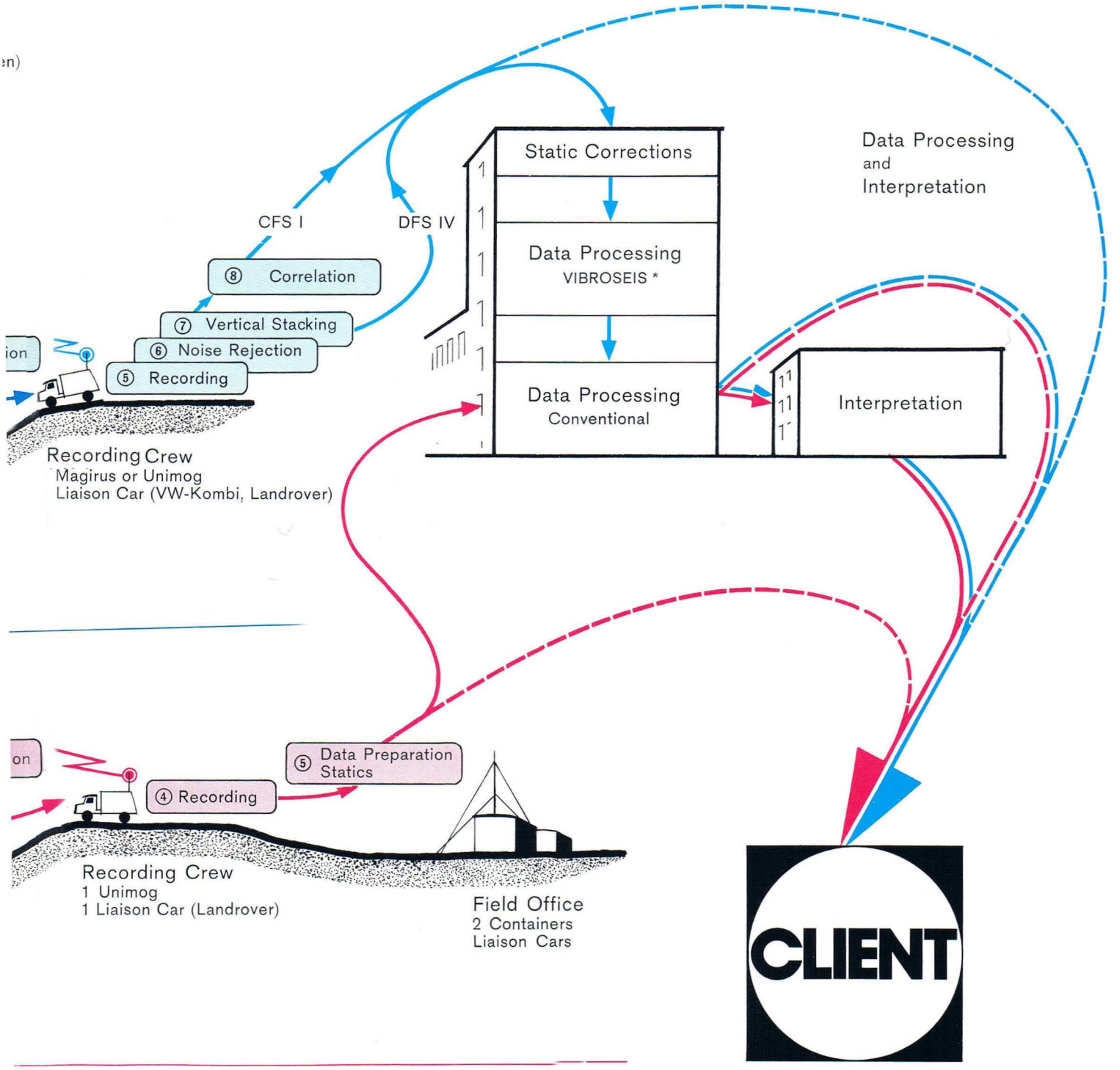


Drilling Crew
4–6 Drilling Rigs
4–6 Water Trucks
1–2 Liaison Cars (Unimog, Landrover)

IMPULSE SEISMICS

FLOW DIAGRAM OF REFLECTION SEISMIC LAND OPERATIONS

→ Data Acquisition → Data Processing → Interpretation



Preliminaries:
Topographical Survey • Line Clearance

Wherever a seismic campaign may start, the first steps in the field are made by the party's surveyor crew, consisting as a rule of 2 surveyors and a small force of about 6 to 10 helpers.

The task of this crew can be summarized as follows:

- to locate the exact line positions in the field, according to the client's prospective aims,
- to scout the prospective lines, to find out whether and what kind of line modifications are preferable or necessary in order to avoid built-up areas, escarpments, swamps and rivers etc.,
- to survey the lines, to mark the emitter and receiver stations in the field, to deliver their exact altitudes and positions in form of location maps and lists.

What else can be considered as preliminaries, carried out with additional personnel and equipment:

- to get permission from landowners for penetrating cultivated areas,
- to cut trails in bush areas, to build bridges, to clear lines and access roads in dense tropical forests by bulldozers and frontloaders,
- to clear areas for seismic lines, camp-sites and roads of mines and shells in war-zones.

In order to perform a topographical survey under all possible aspects, a broad range of geodetic skills and methods must be at one's disposal:

- Traversing and levelling as routine procedures,
- Triangulation, trilateration, and electronic distance measurements in special cases,
- Positioning by astronomical or satellite methods in areas, where no satisfactory maps are available.

Line clearance by bulldozer in a tropical rain forest (Gabon)

The instruments we use:

Theodolites:	WILD RDS, T0, T1, T2, T3
Levels:	ZEISS Ni 2
Electronic Distance Measuring Systems:	TELLUROMETER MRA 3 EPTL – GRUNDIG Distameter
Astrolabs:	WILD System (based on WILD T2 and T3) ZEISS-System (based on ZEISS Ni 2)
Satellite Survey System MAGNAVOX Mx-702-3D	

Mine detecting

Levelling in a tropical rain forest

Tellurometer MRA 3

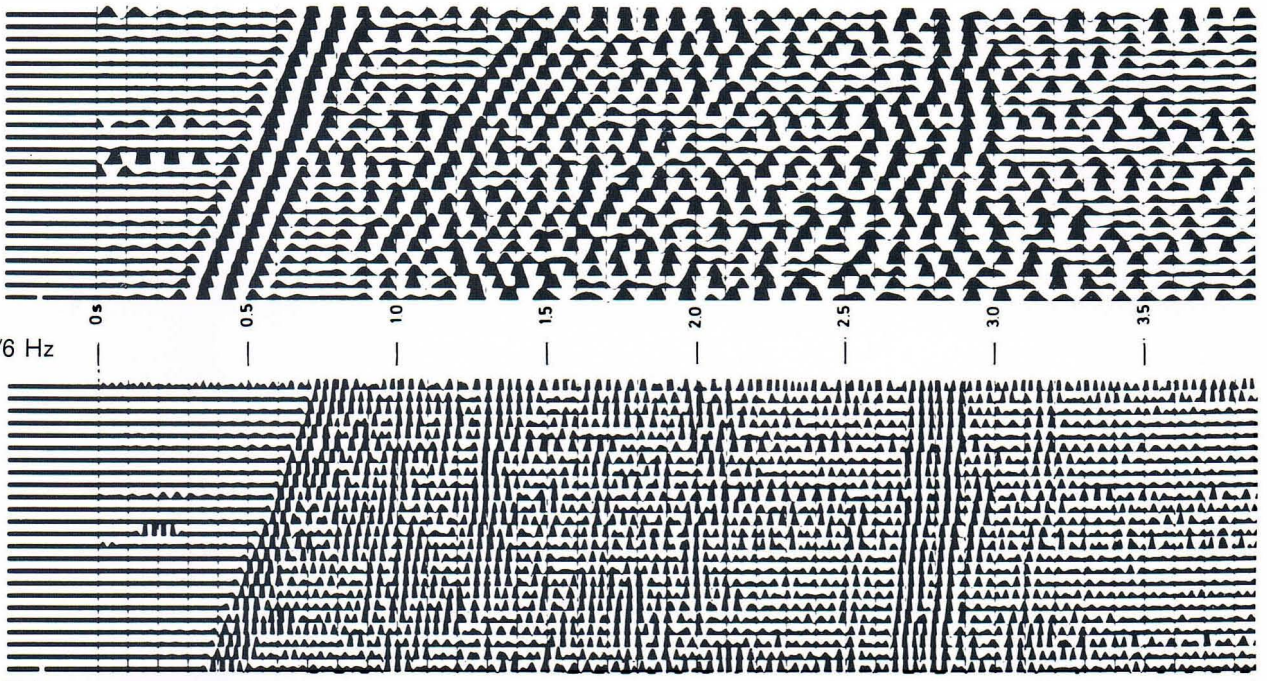
Astronomic positioning

The Field Parameters • Tests and other Criteria to select them

In order to determine the optimum emitter/receiver parameters in a new area, a series of tests is carried out at the beginning of a survey and whenever changes in the surface and subsurface conditions make a revision necessary.

Micro spreads	show all noise wave types created by single shots or at single vibrator positions and supply raw data for trace compositing studies (see page 37).
Uphole surveys	show the frequency content of shots fired at different depths in deep boreholes, thus allowing conclusions about the optimum charge depth to be made (beside other determinations concerning velocity distributions and base of the weathering layer).
Gamma- and Neutron-Gamma techniques	are additional means to explore the optimum charge depth.
Shot-pattern tests	Single shots in comparison with shot patterns of different multiplicity, dimension, depth, and charge. Line-charge patterns (detonating cord) in comparison with drilled patterns. Air-shooting in comparison with hole-shooting.
Sweep tests	Pilot signals of different duration (2—25 s), frequency range (6—140 Hz), shape (tapering) and type (up- or down-sweep) are to be compared (see right page).
Vibrator-pattern tests	Comparisons between various pattern lengths, pattern configurations, varying number of vibrators used, and number of sweeps, transmitted by each vibrator for one pattern.
Geophone-pattern tests	Comparisons between geophone arrays of different geophone numbers, lengths and areal distributions (see right page).
The combination of	different geophone arrays with different shot or vibrator patterns helps to determine empirically the emitter/receiver modifications with optimum noise-wave cancellation.

Emitter and receiver arrays — single or combined — serve as wavenumber filters and can improve the signal-to-noise ratio considerably (see geophone-pattern test, right page).

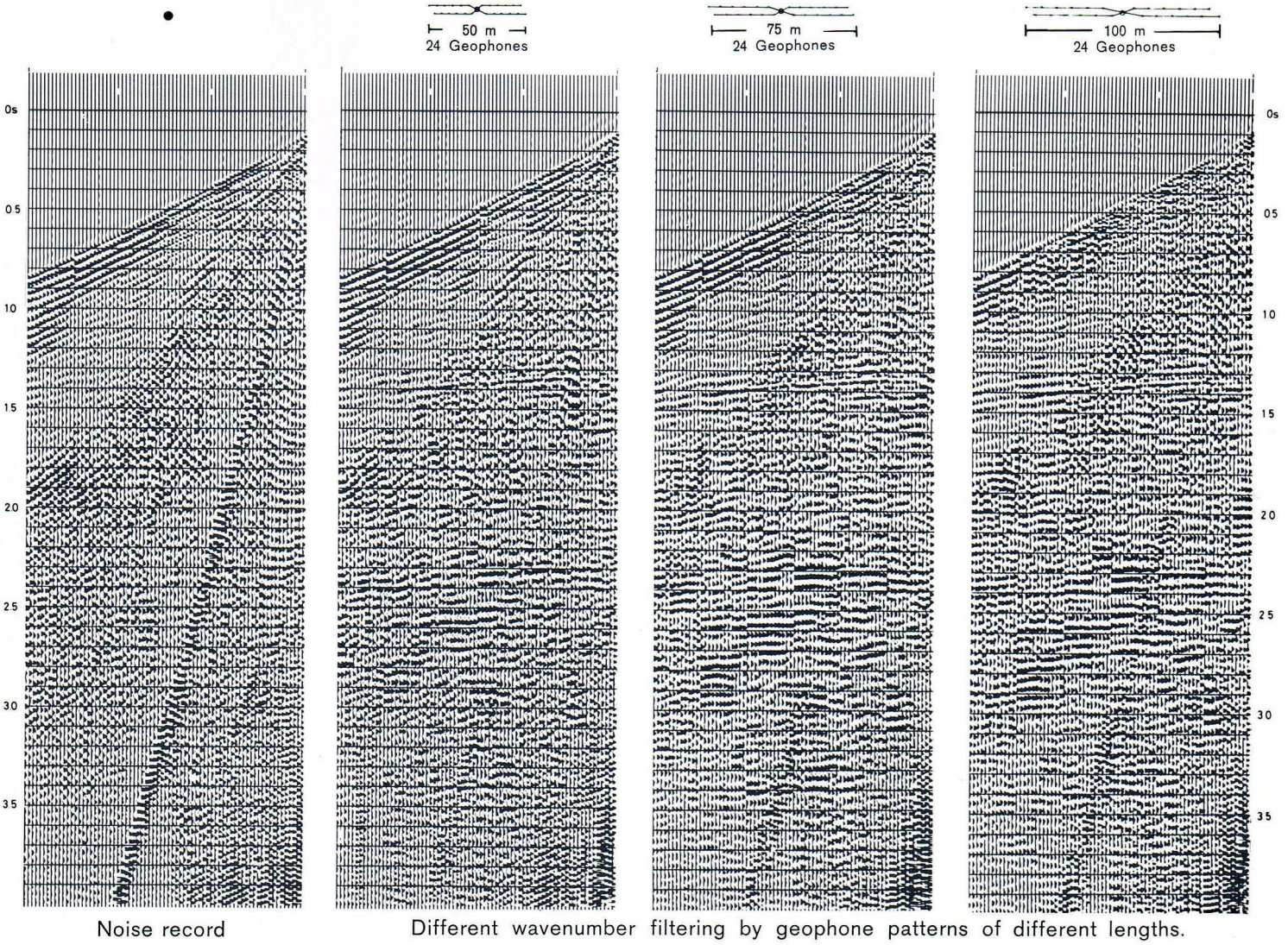


Pilot signal: 15/6 Hz
(down sweep)

Pilot signal: 18/47 Hz
(up sweep)

Influence of different sweeps

Pilot signal: 15/65 Hz



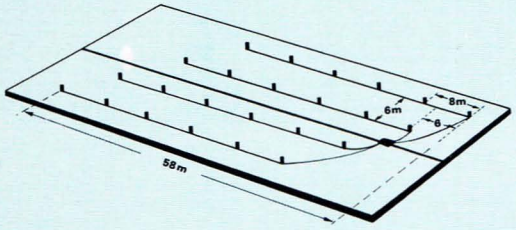
Noise record

Different wavenumber filtering by geophone patterns of different lengths.

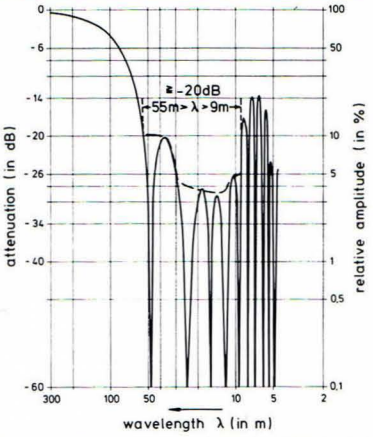
Some geophone arrays which have proven to be favourable in many areas, and their corresponding array-response curves:

Areal Patterns: built up from equidistant 6- or 12-geophone strings. Preferably employed where laterally incident noise waves may occur.

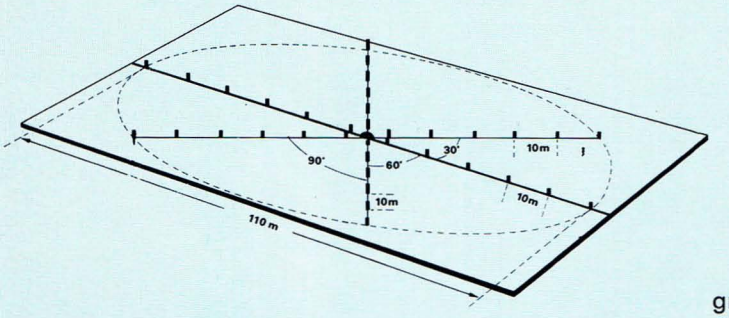
Half-Feather Pattern, 45° (24 geophones)
(HF-Pattern)



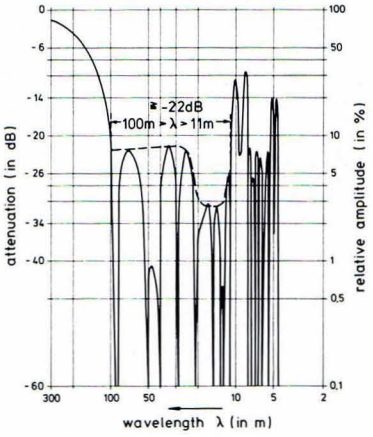
group length 58 m
(4 strings of
6 geophones each)



Asymmetric 6-arm Star, 30°/60°/90° (36 geophones)

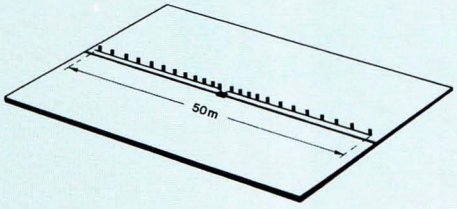


group length 110 m
(6 strings of
6 geophones each)

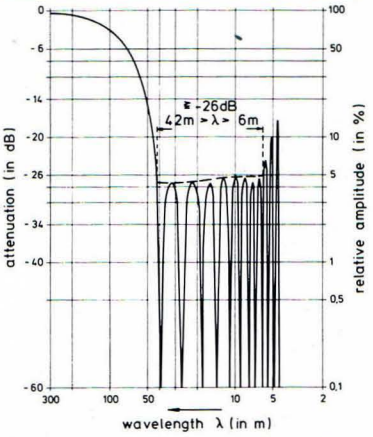


Linear Tapered Arrays: unequal geophone spacings based on Chebyshev-Polynomial designs.

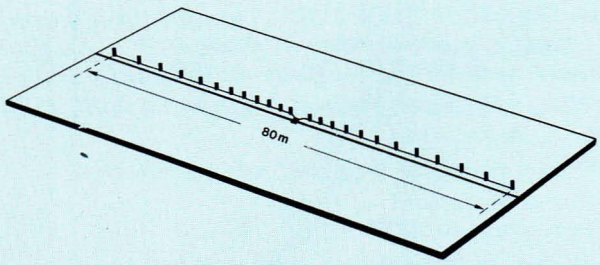
Medium-Band-Attenuation Pattern (24), 50 m
(MBA-Pattern)



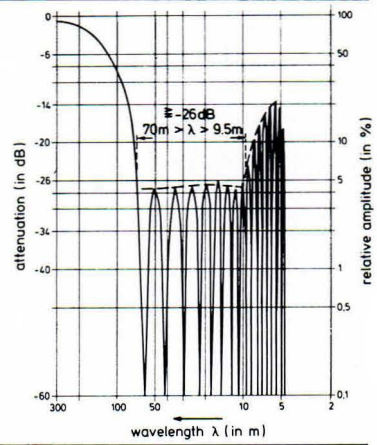
group length 50 m
(2 strings of
12 geophones each)



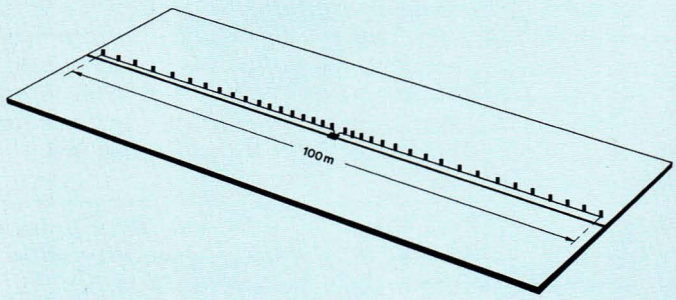
Medium-**B**and-**A**ttenuation Pattern (24), 80 m
(MBA-Pattern)



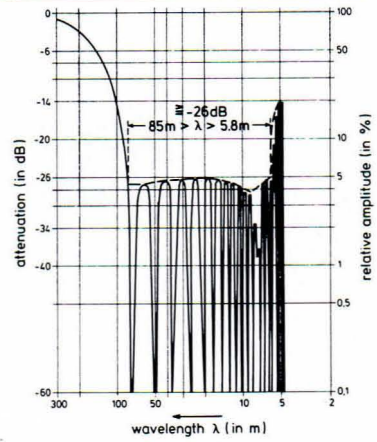
group length 80 m
(2 strings of
12 geophones each)



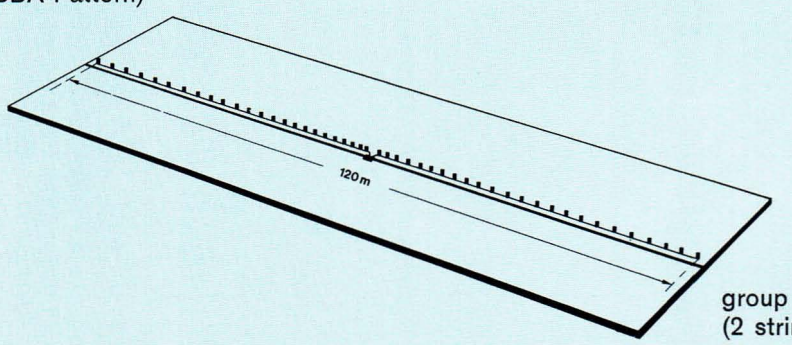
Broad-**B**and-**A**ttenuation Pattern (36), 100 m
(BBA-Pattern) •



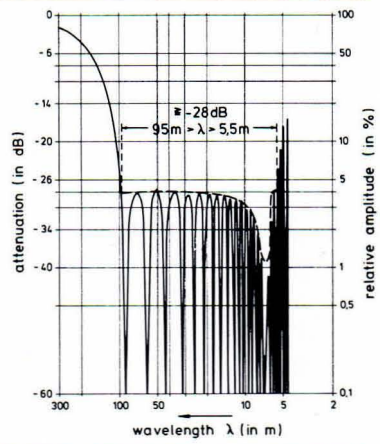
group length 100 m
(2 strings of
18 geophones each)



Broad-**B**and-**A**ttenuation Pattern (48), 120 m
(BBA-Pattern)



group length 120 m
(2 strings of
24 geophones each)



Specific advantages of linear tapered arrays:

- Excellent noise-wave attenuation. Each geophone within a group coincides exactly with its theoretical location, as long as the strings are fully stretched out, which can easily be realized and checked in the field.
- The geophones are planted along the line, facilitating checks and exchanges.
- The laying out of geophones is simple even in dense forest and bush areas, where a proper areal distribution of geophones is difficult.
- Crop damages can be reduced in cultivated areas.

For every desired or experimentally found receiver or emitter array — or the combination of both — the corresponding array-response curves can be calculated and optimized by a special computer program.

The Survey Methods: Routine Work and Special Techniques

Different problems call for different means and methods. To solve exploration tasks by seismics, we first have to decide:

what method we will choose: reflection or refraction, conventional or vibro-seismics etc.,

in what manner the survey should be carried out: degree of coverage, emitter-receiver configuration, linear or areal arrangement etc.,

and what **auxiliary measurements** should be applied at the beginning and/or during the survey itself, i. e.:

- Tests, to find the optimum field parameters,
- Expanding spreads, to facilitate the choice of an optimum emitter-receiver configuration and to reveal velocity distributions for dynamic corrections and subsequent depth presentations.
- Uphole surveys, 'Meissner-Spreads' [1]), Short-Refraction Lines to get additional information for better static corrections and for shot-depth control.

What should be understood by 'Survey Methods and Special Techniques', as far as Seismic Land Surveying is concerned? Let us try to bring the various subjects under the simple headings:

- reflection seismics
- refraction seismics

Reflection Seismics

Reflection Seismic Land Surveying in its broadest sense can be carried out with

- different degrees of subsurface coverage: mainly used: 6-, 12-, 24- and even 48-fold,
- different numbers of traces recorded: 24, 48, 96 and even 120,
- different modes of recording field geometry: linear arrangement areal arrangement [2]),
- different emitter-receiver configurations: split spread, symmetric or asymmetric, with or without inline offset, unilateral spread,
- Long-Offset Seismics [3]).

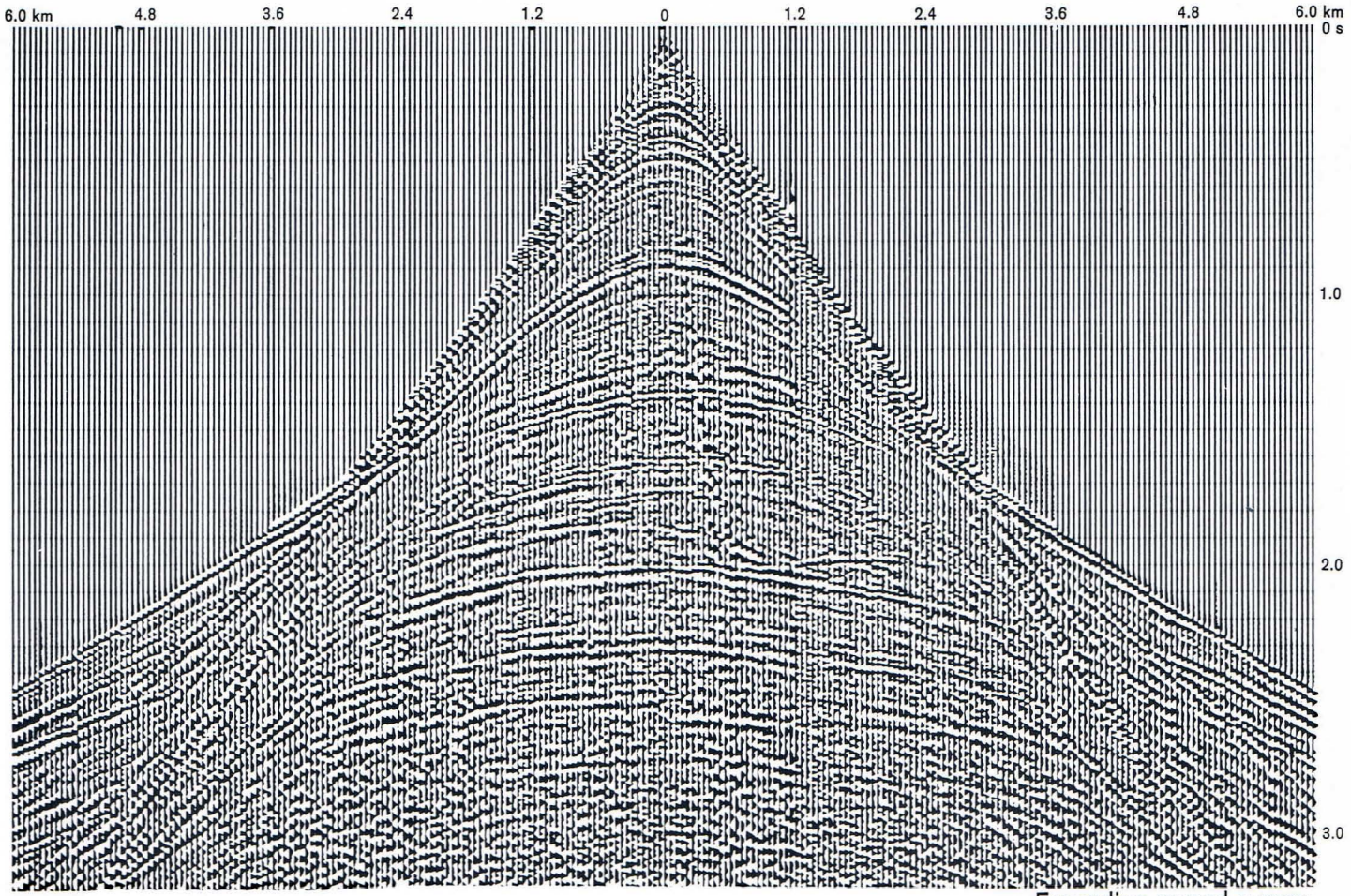
The adequate emitter-receiver configuration depends on the prospective interest of the survey. The Expanding-Spread Measurement is a good means – besides its properties for velocity determination – to demonstrate at what distance from the energy source the reflections of the interesting horizons can be recorded with minimum impairment by first arrivals, ground roll and refraction events. An optimum spread length and inline offset may thus be determined.

---

[1]) Combination of uphole surveys with short-refraction recording. Traveltimes in wavefront presentation show the velocity distribution in the near-surface layers.

[2]) see page 46 ff., Areal Reflection Seismics

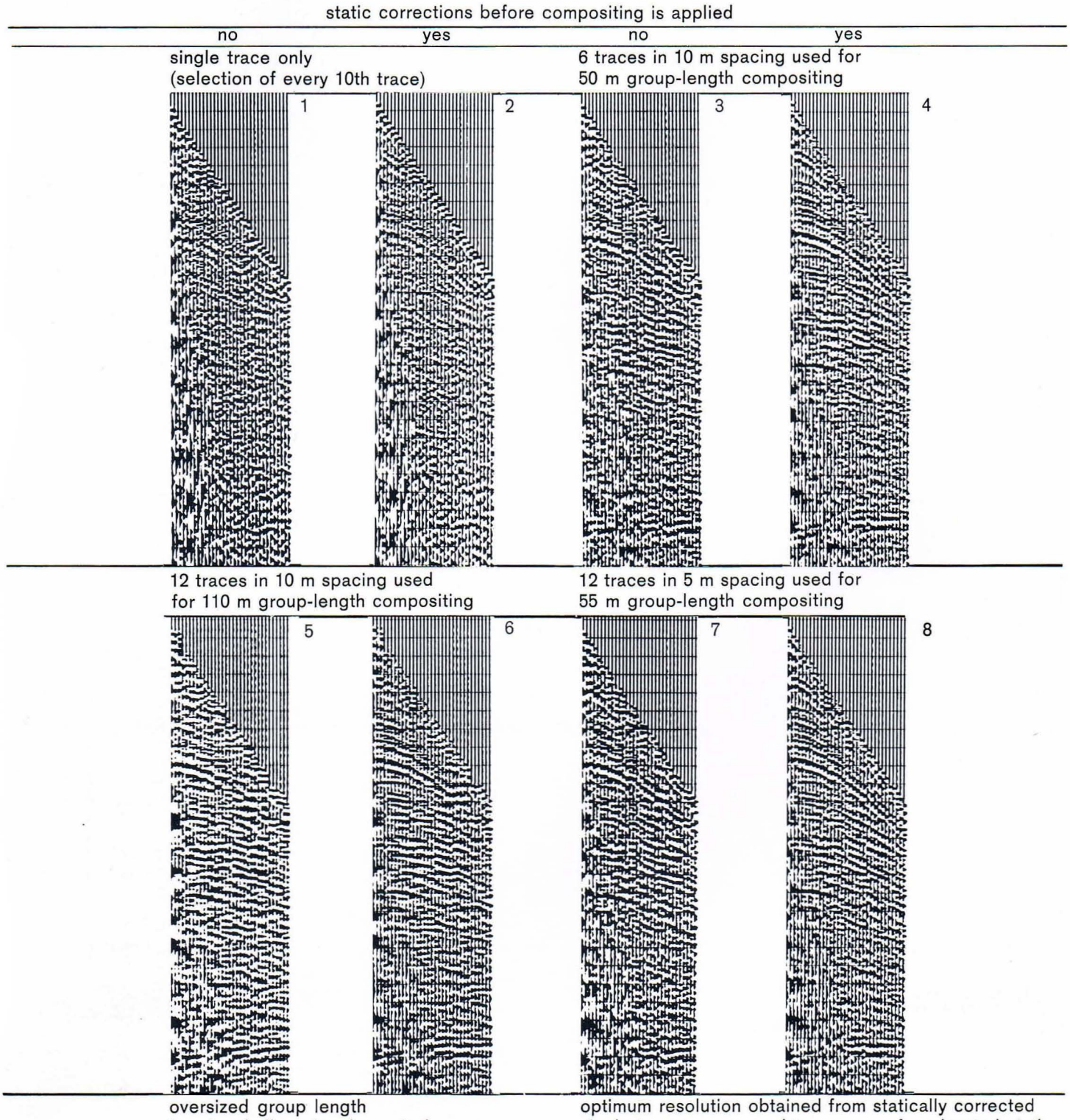
[3]) see page 44 ff., Salt Dome Undershooting



Expanding spread survey

Trace Compositing

The presentation below shows, how an expanded micro spread may serve for trace compositing. Trace compositing is employed for enhanced reflection seismic resolution after selection out of an expanding micro-spread (1.6 km). The procedure simulates the effects of 50 m-spaced receiver patterns composed from single-receiver traces arrayed in 5 m spacings (as long as excessive groundroll does not completely govern the respective time ranges of the seismic traces). Trace compositing can, in particular, produce clear reflection line-ups of the composed traces, when the individual traces involved in compositing are beforehand provided with proper static corrections.



Energy Source: Dynamite

In spite of an increasing number of non-explosive seismic methods like VIBROSEIS*, the so-called 'conventional method' has always maintained its realm and importance. Its special attraction is: FLEXIBILITY, one of the most essential virtues necessary for seismic work. You may transport your 'energy' to difficult places, like mountain peaks, or tropical swamps, even on foot, and there you may deposit your 'source' even by hand.

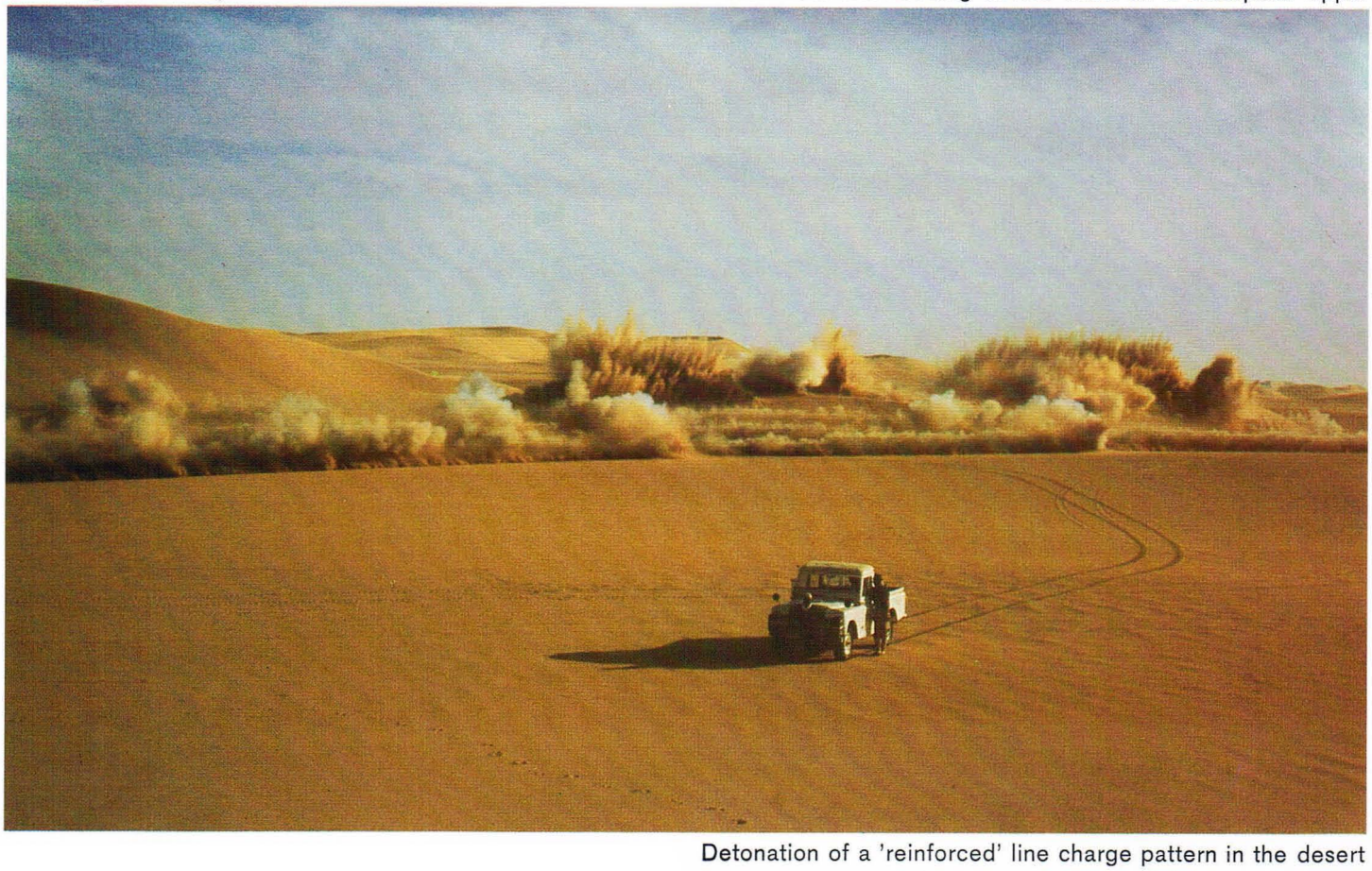
Specific Advantages of the Dynamite-Method

- High energy output
- Penetration of the weathering zone by drilling or flushing yields
  - reduced noise-wave generation,
  - uphole times, readable first-breaks, both essential for proper static corrections.
- A large variety of rig types, ranging from high-powered heavy rigs over medium, light-weight, crawler-mounted rigs down to portable flushing devices, makes rock, sand or swamp penetration possible in adequate time in nearly every region and however difficult the conditions may be.
- Air shooting – dynamite distributed and fired on the surface – as a means of avoiding the drilling effort, where
  - sufficient results are obtained,
  - drilling progress is extremely low,
  - no access is possible for heavy rigs.
- Line-charge techniques as a special kind of air shooting. Detonating cord is laid out on the ground or buried with plough-like devices, arranged to areal patterns with good properties of wavenumber filtering. ('Spiders', 'Half-Feather' etc.).
  To intensify the energy output, the detonating cord may be duplicated or reinforced with cartridges of ordinary seismic dynamite.
  When using unilateral spreads, the detonators are placed spreadfar to profit from the 'directivity effect'. Special pattern arrangements have been designed in order to accomplish an optimum wavenumber filtering.

Crawler-mounted drilling rig

Flushing unit in tropical rain forest

Cord-reel and feeding device fixed on a caterpillar ripper



Detonation of a 'reinforced' line charge pattern in the desert

Energy Source: Vibrator

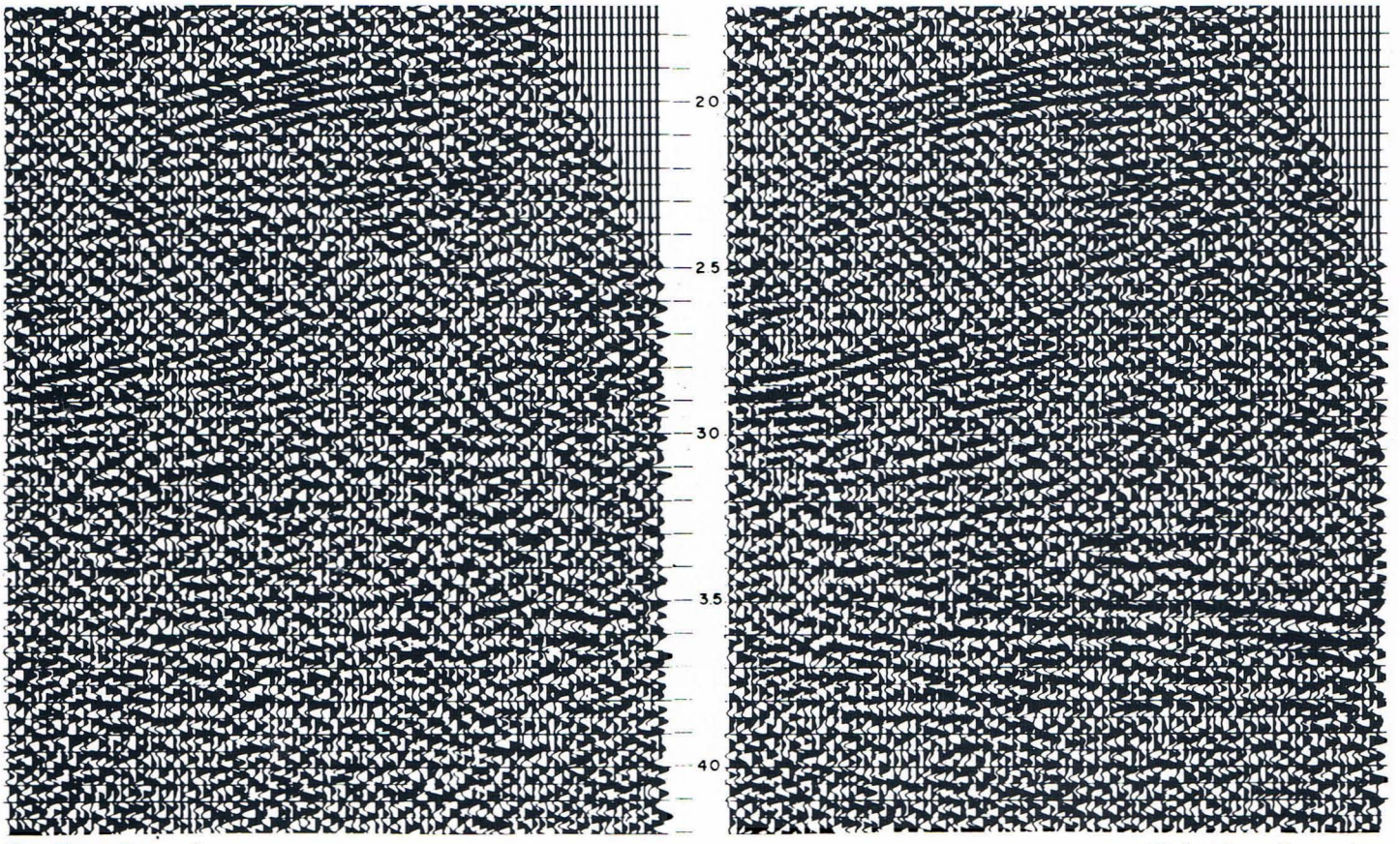
The specific advantages enumerated for the conventional dynamite method are balanced to some extent by distinct properties of the VIBROSEIS * method. It has to be admitted that the flexibility of the dynamite-method, as pointed out in the preceding chapter, cannot or not yet be accomplished by vibro-seismics. But a great step forward was made by developing the new all-terrain vibrator PRAKLA-SEISMOS VVCA, making vibro-seismics usable not only along roads or in more or less 'civilized' regions, but also in rugged and desert areas, where excellent results have been obtained. A severe flexibility gap could thus be closed.

Specific Advantages of the VIBROSEIS *-Method

- No explosives and drilling equipment are required, reducing costs and safety hazards.
- Being a non-explosive method, recording in built-up areas may be executed during quiet night-hours, thus keeping random noise low. The spreads are laid out during day-time.
- Routine in our VIBROSEIS * crews:
  - Spread layout during day-time
  - Recording during night-hours (see sections below).
- Towns and other highly built-up areas need no longer stay 'white'. The varying and relatively high frequencies of the emitted pilot signals ('sweeps') do not agitate and damage even extremely close constructions.
- Most important: As the frequency range of the sweep signal is selectable, the resolution and penetration of the signals are to be influenced to a high degree:
  - the low-frequency sweep signals result in deeper penetration
  - the high-frequency sweep signals lead to better resolution of shallow horizons (see next page, above).

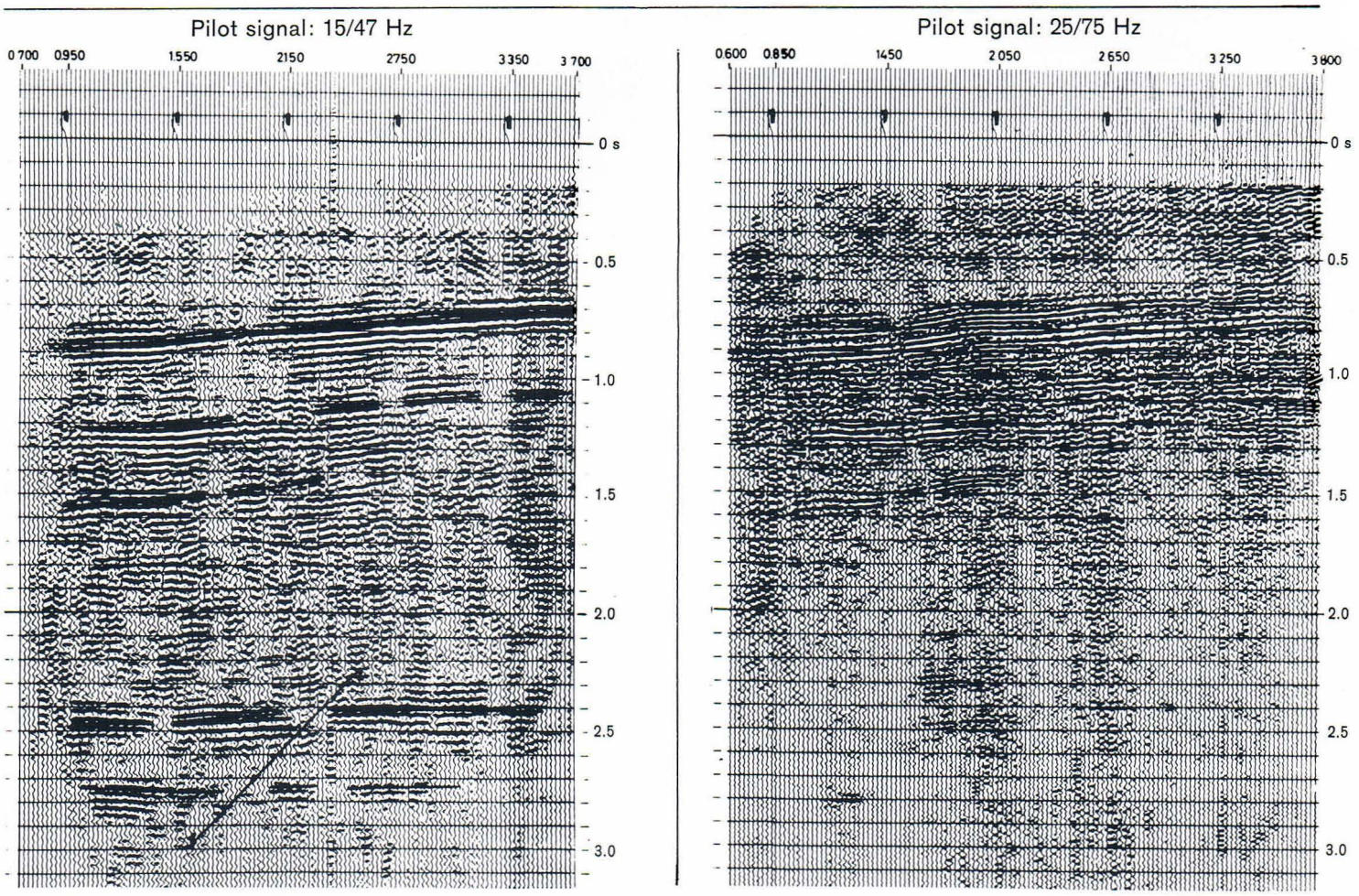
By choosing high-frequency sweep signals and adequate field parameters and emitter-receiver configurations, an extremely high resolution of shallow horizons (as shallow as 100–200 ms reflection time) can be realized. This property of VIBROSEIS * opens up new and large fields, for instance in the domain of mining and engineering.

VIBROSEIS * as a surface method has to cope more with interferences by surface waves than the dynamite method. Careful selection of patterns for both, emitters and receivers, therefore, is essential. An example for such a combined section is shown in the respective response curves on page 41. But, moreover, the specific noise waves of an area may be met by sweeps which avoid the prevailing noise frequencies.

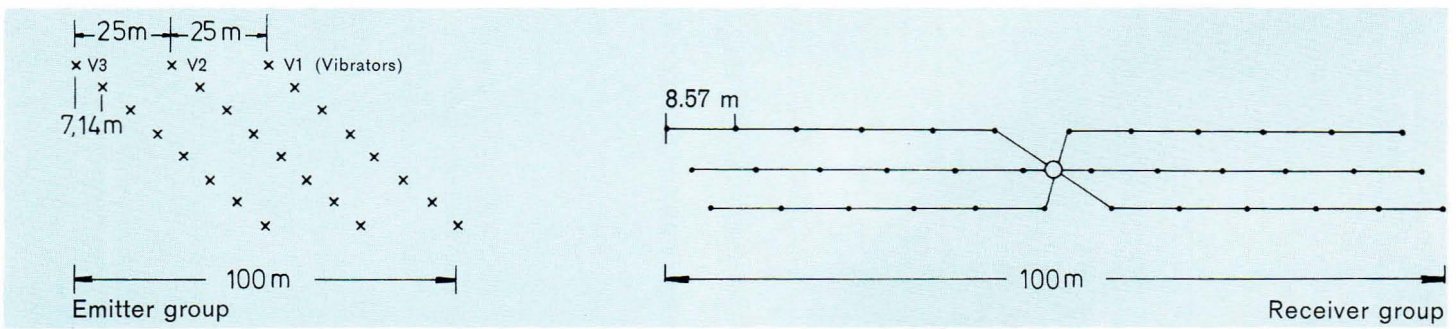


Day Time Recording

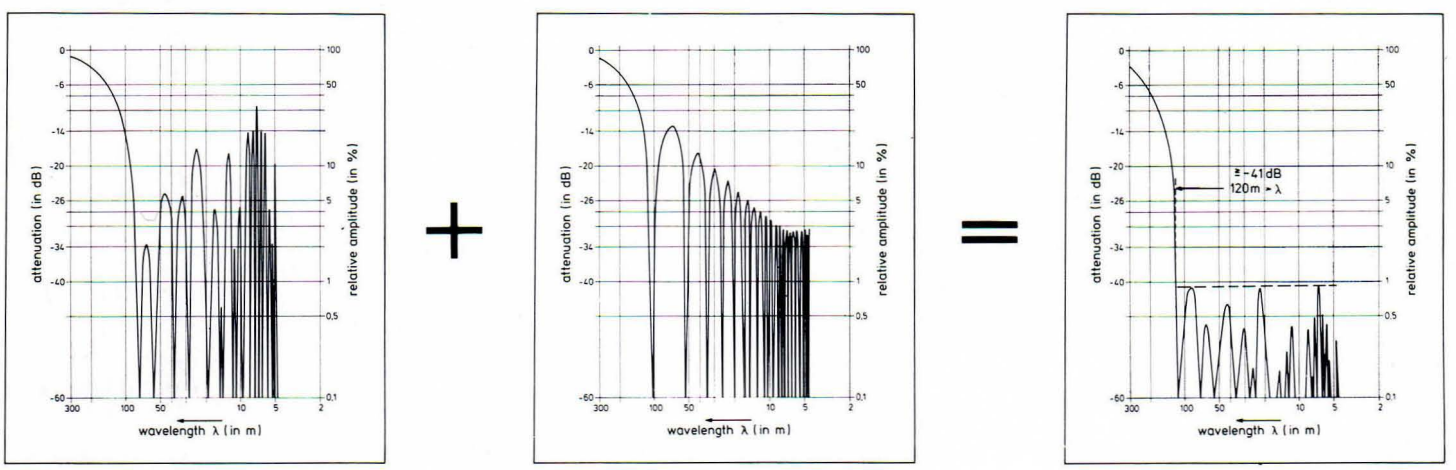
Night Time Recording



Influence of different frequency ranges on stacked sections

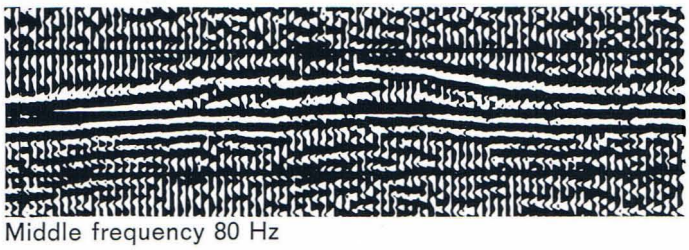


Example for combined wave-number filtering by both, emitter and receiver arrays.

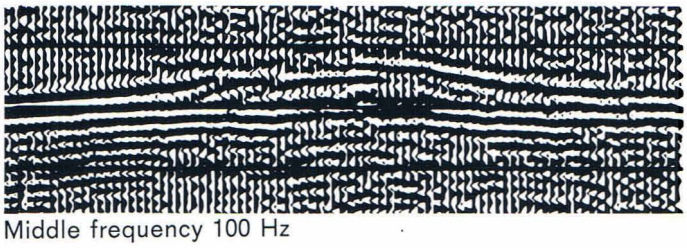


Vibrator pattern response | Geophone array response | Total response

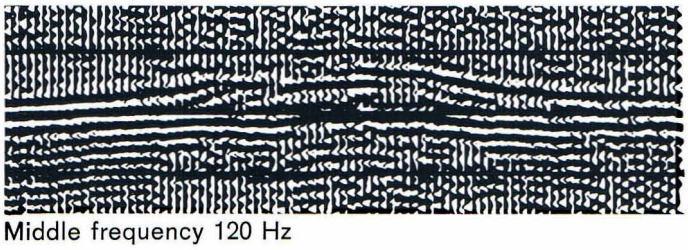
Exploration of algal reefs, an example for high resolution of shallow horizons by high-frequency sweep signals:



Middle frequency 80 Hz



Middle frequency 100 Hz



Middle frequency 120 Hz

New Possibilities and Trends in VIBROSEIS*-Techniques

- Areal Reflection Seismics (3-D Techniques)
- Deep penetration by using:
  - low-frequency sweep signals in form of 'down-sweeps',
  - long duration of sweep signals: 10–20 s,
  - more vibrators,
  - higher rate of vertical stacking
- Seismic velocity surveys in deep wells [1])
- Special recording and processing techniques:
  - Diversity stack
  - Improved correlation by using filtered sweep signals
  - Optimum noise elimination by automatic rejection of noisy traces – or only parts of traces – during field recording
  - VIBROSEIS* TV-Deconvolution

Energy Source: Weight-dropping

In 1976 a weight-dropping device, mounted on a Mercedes-Benz Unimog, has been introduced at PRAKLA-SEISMOS.

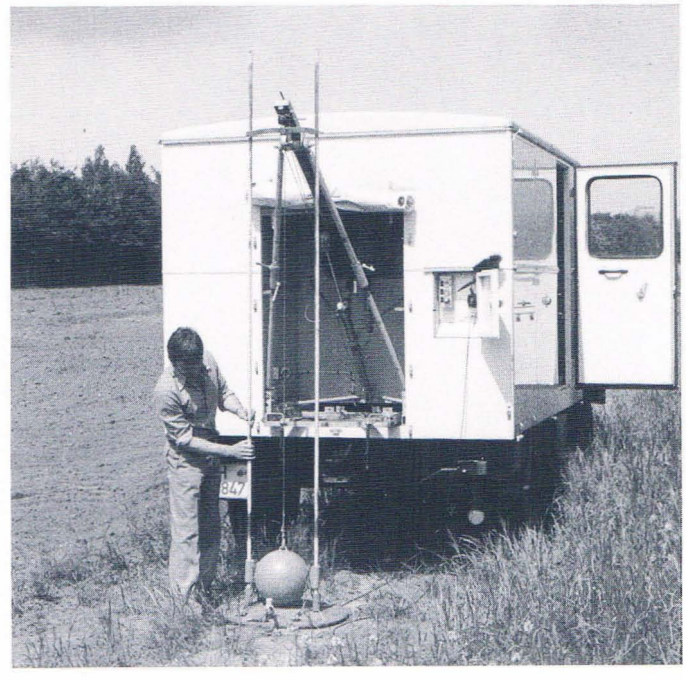
The recording cabin is equipped with a 24-trace DFS II system in connection with an ADD-IT unit for vertical stacking, allowing 1 ms sampling rate.

Some details

- weight of dropping mass: 100 kg
- hydraulic lift-system with electronic control of the pre-selected drop number

This tool is provided for

- bridging of survey gaps, where the dynamite-method might cause damage (as long as the prospective horizons are not too deep say, not exceeding 1 s),
- special, in general 'shallow' surveys in the fields of engineering, mining, hydro-geology etc [2]).



[1]) see page 60, Seismic Well Surveys
[2]) see page 59, Seismic Surveys for Civil Engineering and Hydro-geological Problems

Special Tasks for Reflection Seismics

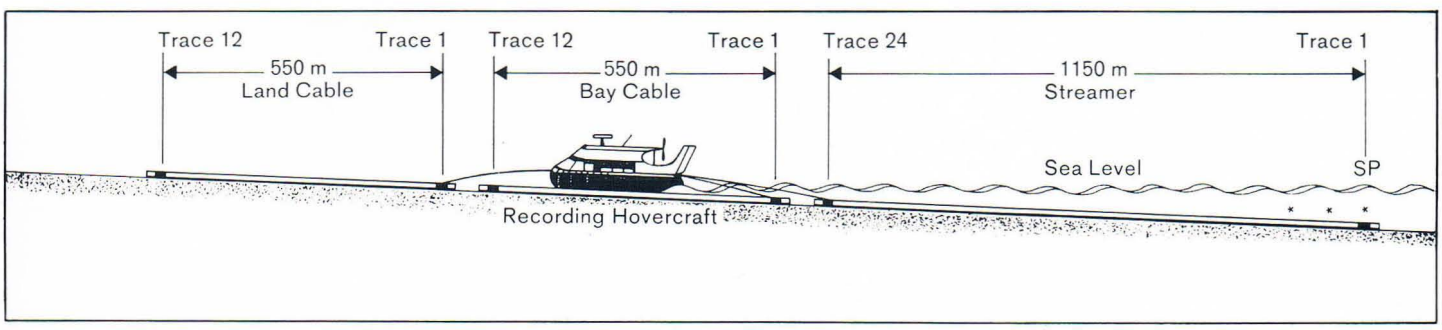
Extension of Land Surveys into Shallow-Water Areas (Land ties) [1])

Wherever land and marine surveys have to be linked, utmost flexibility in equipment and methods is indispensable (as well as highly experienced personnel):

- Special vessels and equipment:
  Hovercraft · pontoons · coasters · amphicats · speed boats · rubber dinghies · mud sledges · barges, etc.
- Special recording equipment:
  Bay cables · self-orientating geophones · Telseis*-system, etc.
- Versatile drilling equipment:
  Drilling and flushing units · drilling devices mounted on pontoons, etc.
- Energy sources:
  - Dynamite shooting in boreholes
  - normal dynamite water shooting
  - line-charge shooting with detonating cord
  - airgun, (in water depths exceeding 1.5 m)

[1]) see our brochure PRAKLA-SEISMOS GMBH: Shallow Water Surveys

* Trade mark of Fairfield Industries Inc.



Continuous recording from land to sea with land cable, bay cable and fixed streamer

Drilling at low tide under extreme working conditions. Shot will be fired later at high tide.

Working with Hovercraft (here in sanddunes)

Saltdome Undershooting

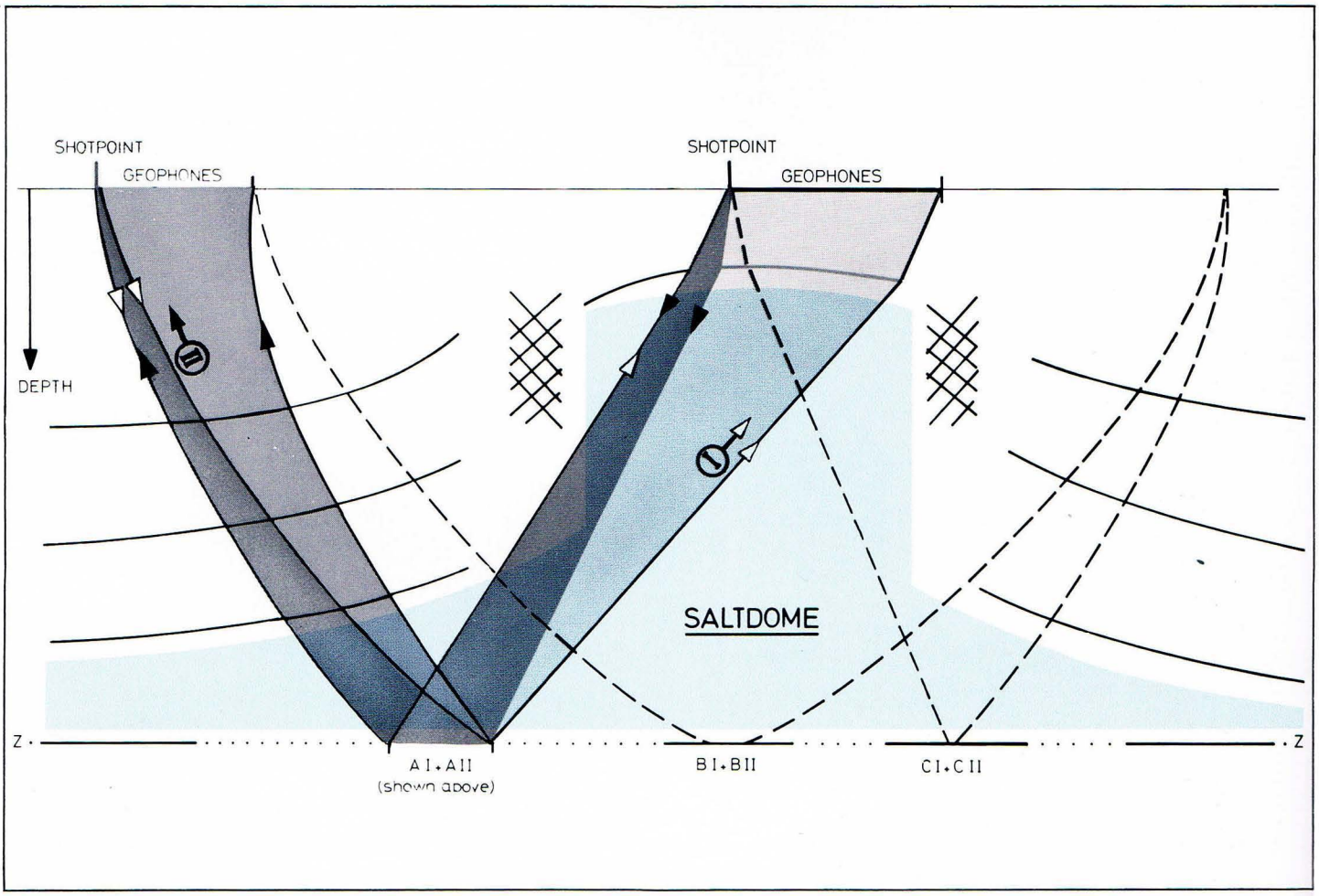
Working for many decades in Northern Germany, PRAKLA-SEISMOS was obliged early on to develop saltdome undershooting to a rather sophisticated technique which has since obtained importance in applied seismics. By arranging emitter and receiver positions in such a way that the ray paths run beneath the heterogeneous and highly tectonized salt structure, good reflections from deeper horizons are recorded without being impaired by velocity irregularities. For depth presentation a modified wavefront method was developed, taking the differing salt and non-salt velocities into consideration.

Basically the following trajectories are taken into account:
- shots on, geophones off the saltdome and/or vice versa for undershooting the saltdome flanks
- shots and geophones off the saltdome for total saltdome undershooting

For a proper field arrangement, the boundaries of the salt body should be known from previous seismic surveys.

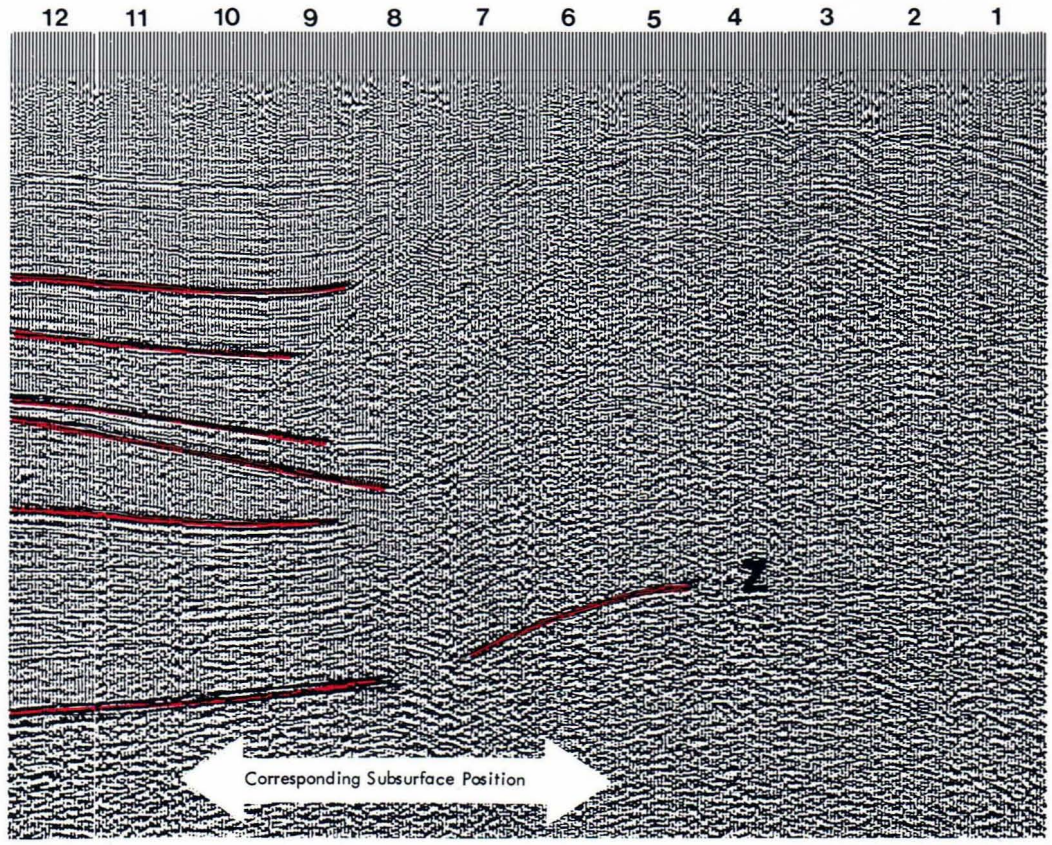
Inline offsets of up to 14 km are common. Besides increasing energy losses, a distance limit is imposed by the critical angles.

After having extended the undershooting technique to shallow water surveys, saltdome undershooting is now also carried out offshore.

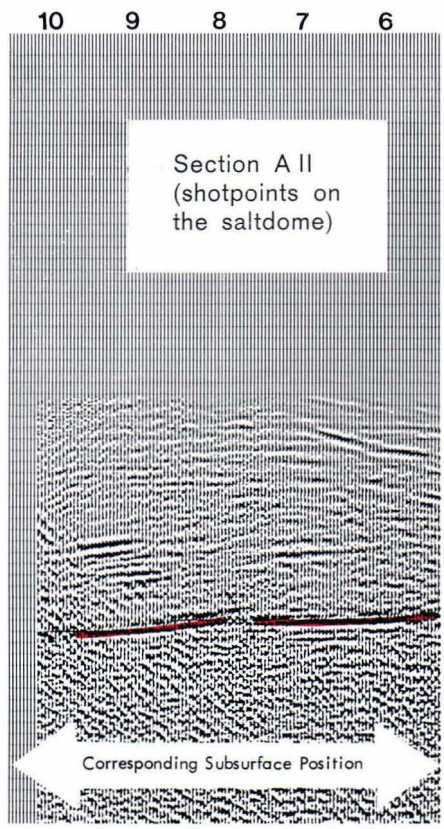


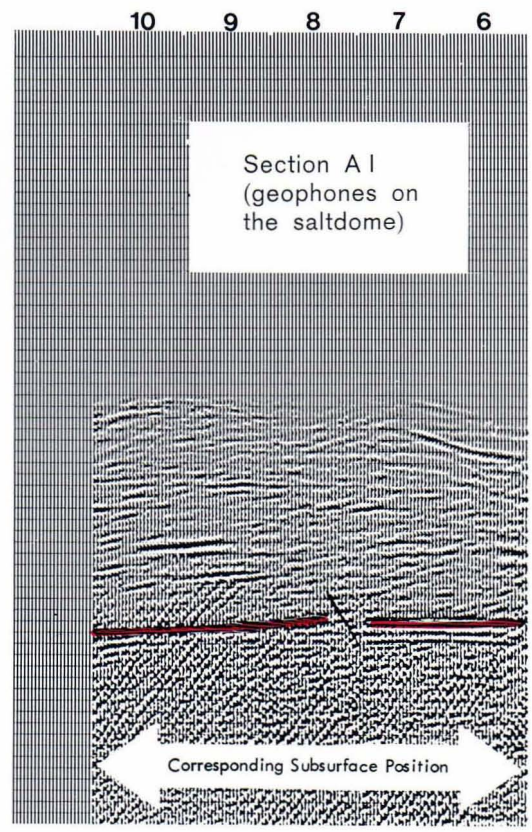
Scheme of undershooting

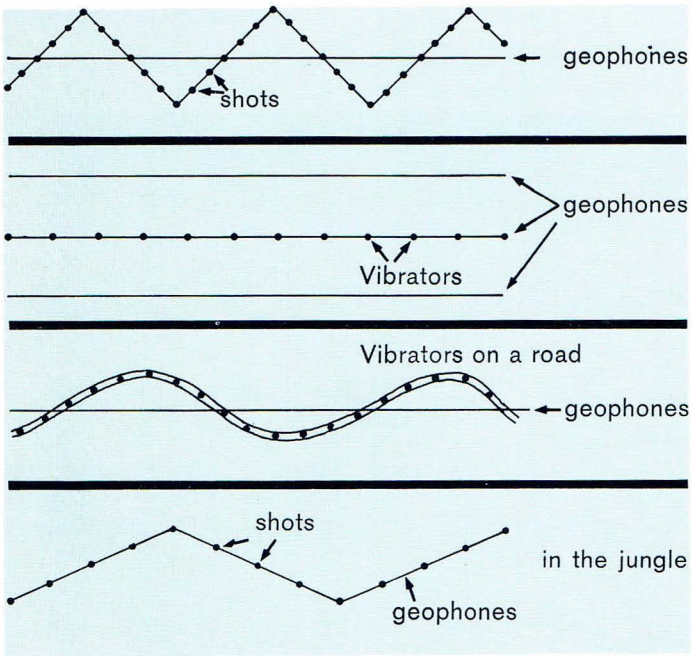
Routine section



Sections based on flank-undershootings (6 fold)







Some types of strip recording for cross-dip determination

Areal Reflection Seismics (for 3-D processing)

The step from the common linear field recording in reflection seismics, as carried out for decades, to 'more areal' and finally to 'really areal' field recording was achieved recently with amazing success.
The motivation for this new development was the attempt to win the third dimension for migration processing. Spatial migration necessarily requires a change in field techniques, which had led at first to a certain strip recording as an economic compromise, allowing cross dip determination (see left). It has finally led to the field recording of a regular areal grid by a systematic multiple subsurface coverage.

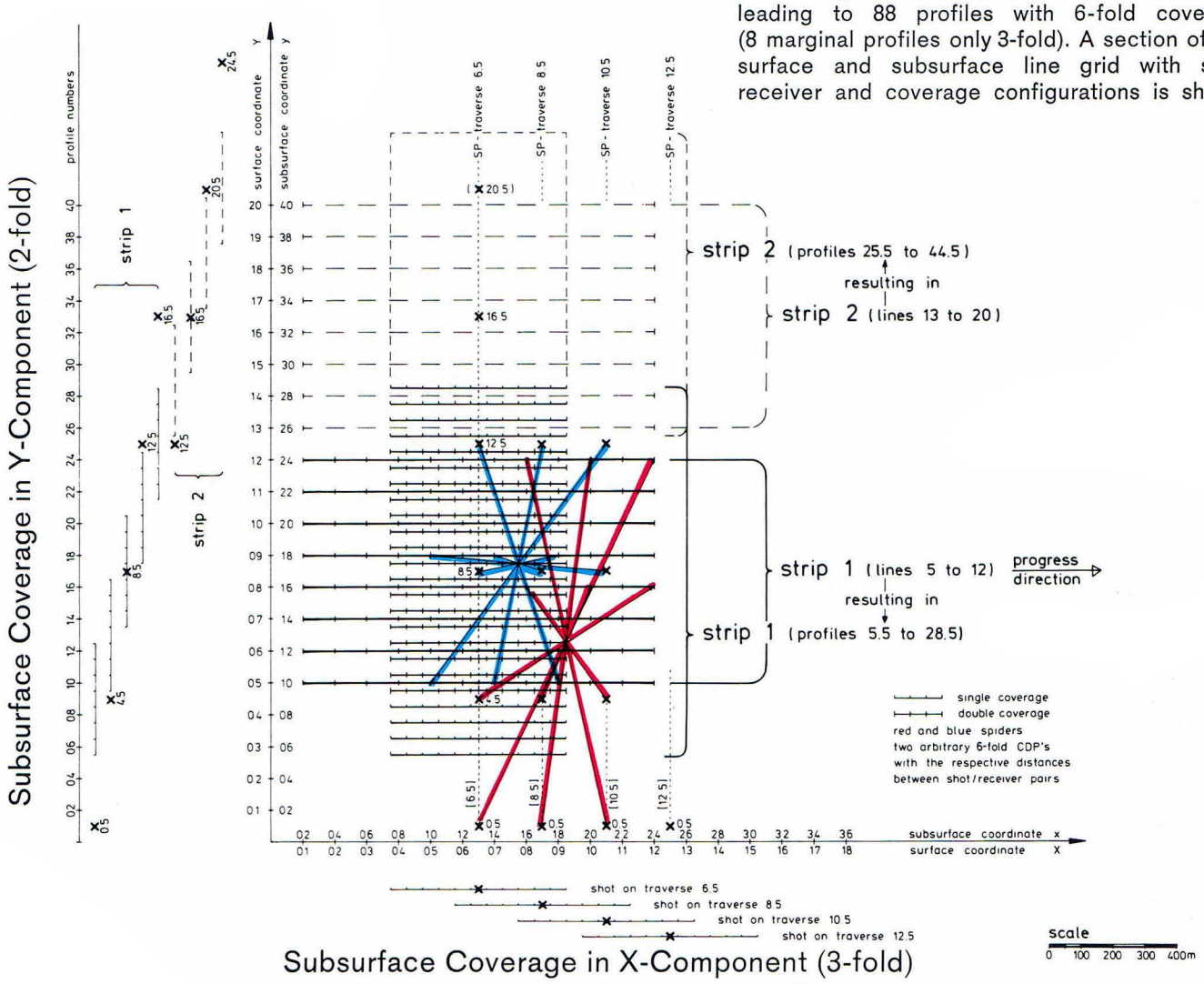
Two essential aspects of this method shall be pointed out:

Areal Reflection Seismics is

- a prerequisite for 3-D migration processing and
- a means for high-resolution interpretation.

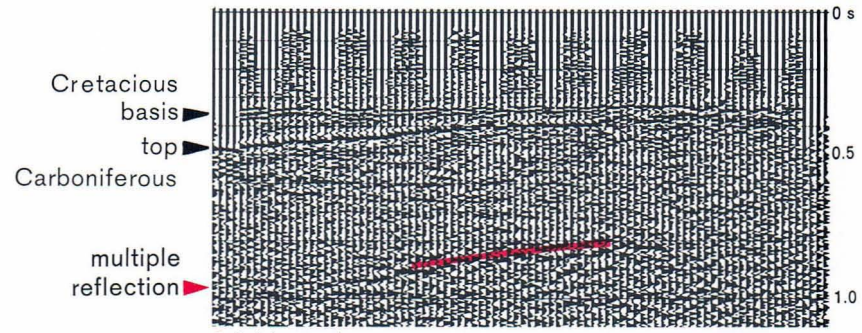
Some details of an actually realized areal field recording for a prospective coal mining area in the German Ruhr District may illustrate this.

An areal grid of 40 seismic lines was recorded, leading to 88 profiles with 6-fold coverage (8 marginal profiles only 3-fold). A section of this surface and subsurface line grid with shot-receiver and coverage configurations is shown.

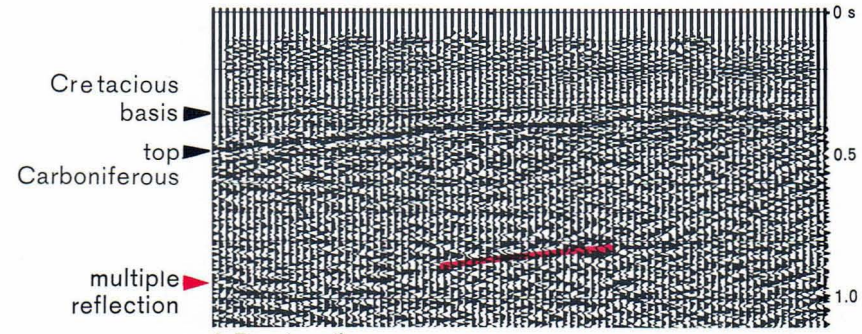


Shot-Receiver configuration and respective subsurface coverage

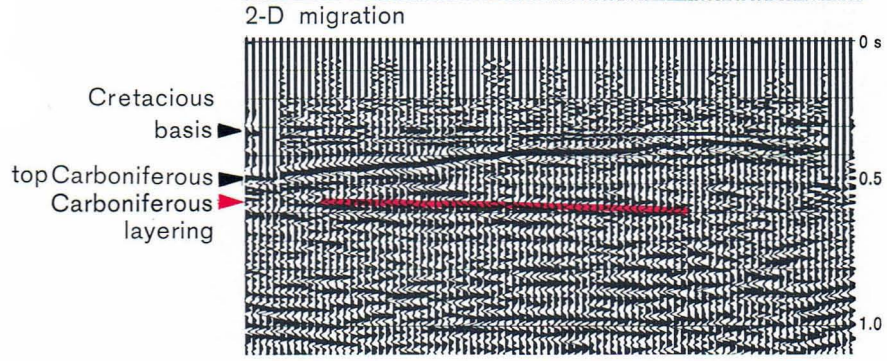
Section displays of a profile show the improvement by 3-D processing: A multiple reflection in the two upper sections – dipping to the left from 0.8 to 1.1s – is suppressed, a discordant horizon – rising to the left from 0.6 to 0.5s – enhanced (see lower section).



6-fold stack

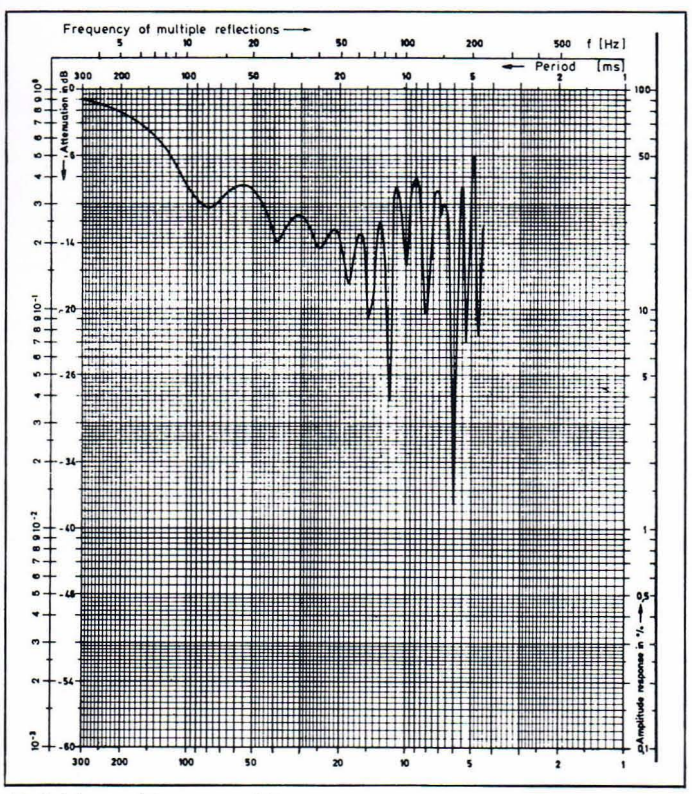


2-D migration

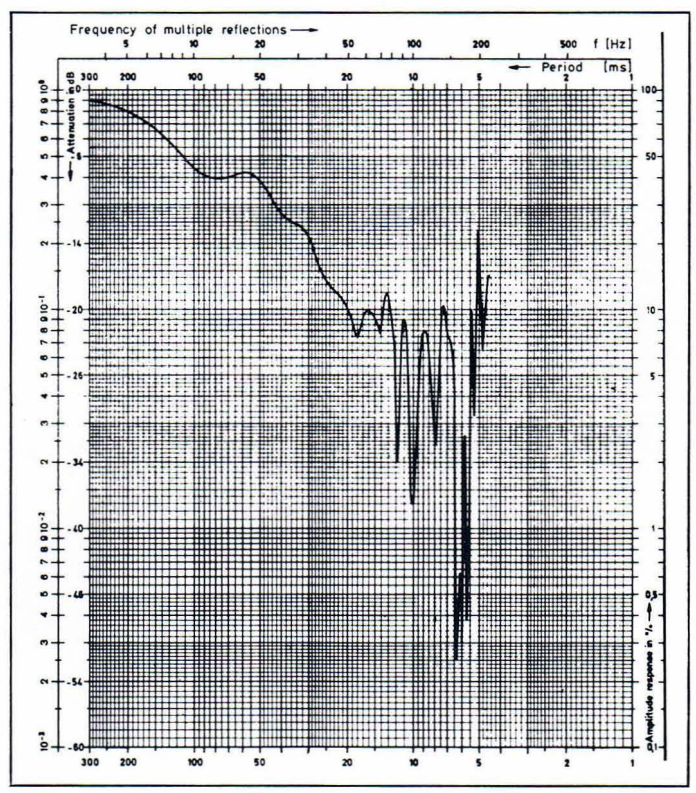


3-D migration

Areal stacking leads to a variety of differently composed CDP-families and consequently to profile-wise different multiple remainders. By final 3-D migration processing these residual amplitudes are considerably reduced. 3-D migration may thus be understood as a filter process for attenuation of multiple reflections as shown below.



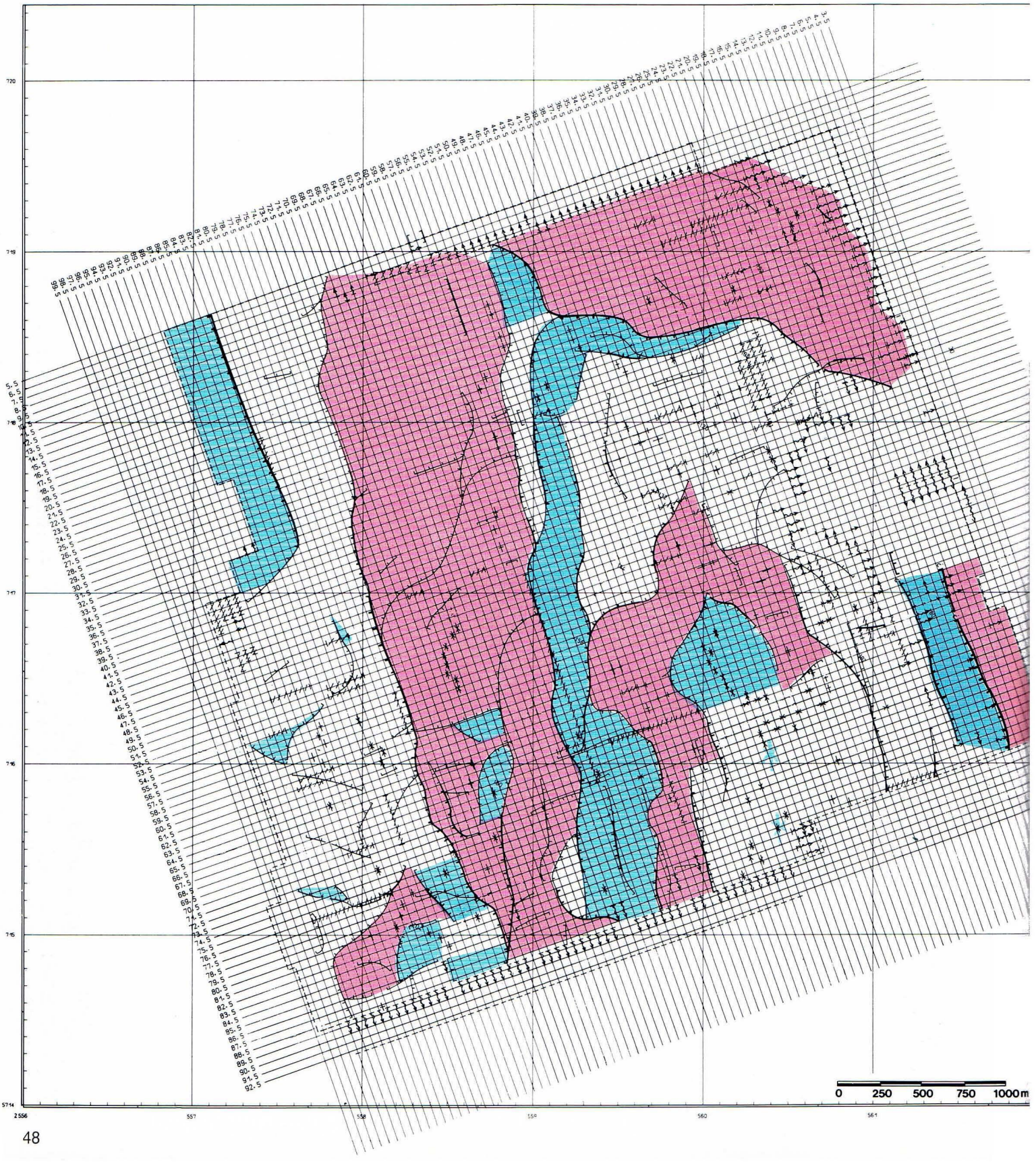
12-fold stacking as a filter process
(x_{max} = 1150 m; $\Delta\Delta t$ = 50 ms)



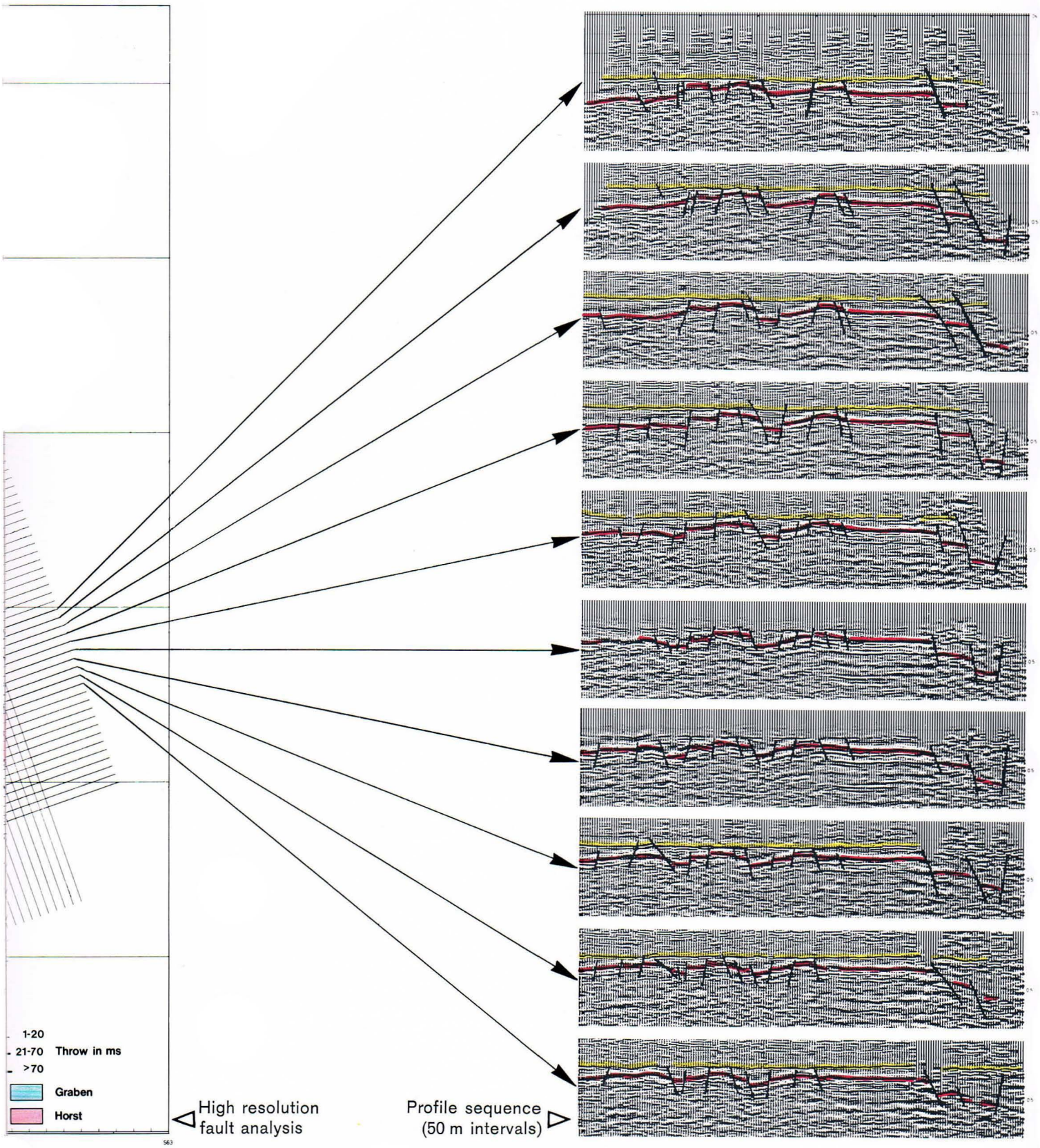
3-D migration as a filter process
(x_{max} = 1275 m; $\Delta\Delta t$ = 50 ms)

The profile sequence in 50 m-intervals adds a new quality to interpretation. The extraordinarily high information density enables unambiguous correlations. This 'modern' way of presentation behaves to the familiar one — to profiles widely spaced — as a movie to some snapshots.
A high-resolution fault analysis shows the complicated structure of top Carboniferous.

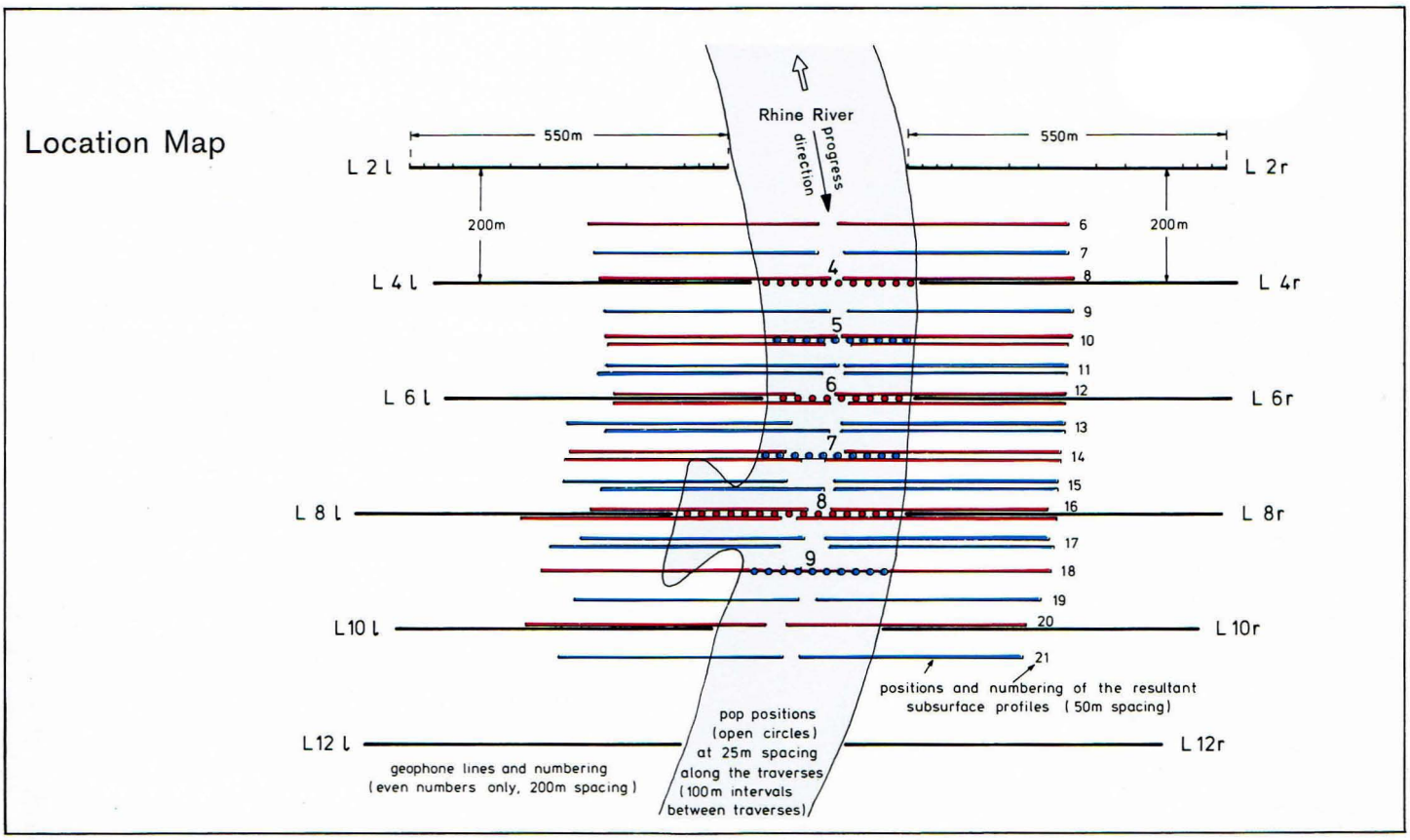
How we forecast the development in this special field:
We believe that areal seismics will be introduced very soon wherever intensive detailing is required to solve special problems.
To render areal seismics more attractive from an economic point, multichannel systems with a minimum of 96 channels are now in use. Seismic telemetric systems using



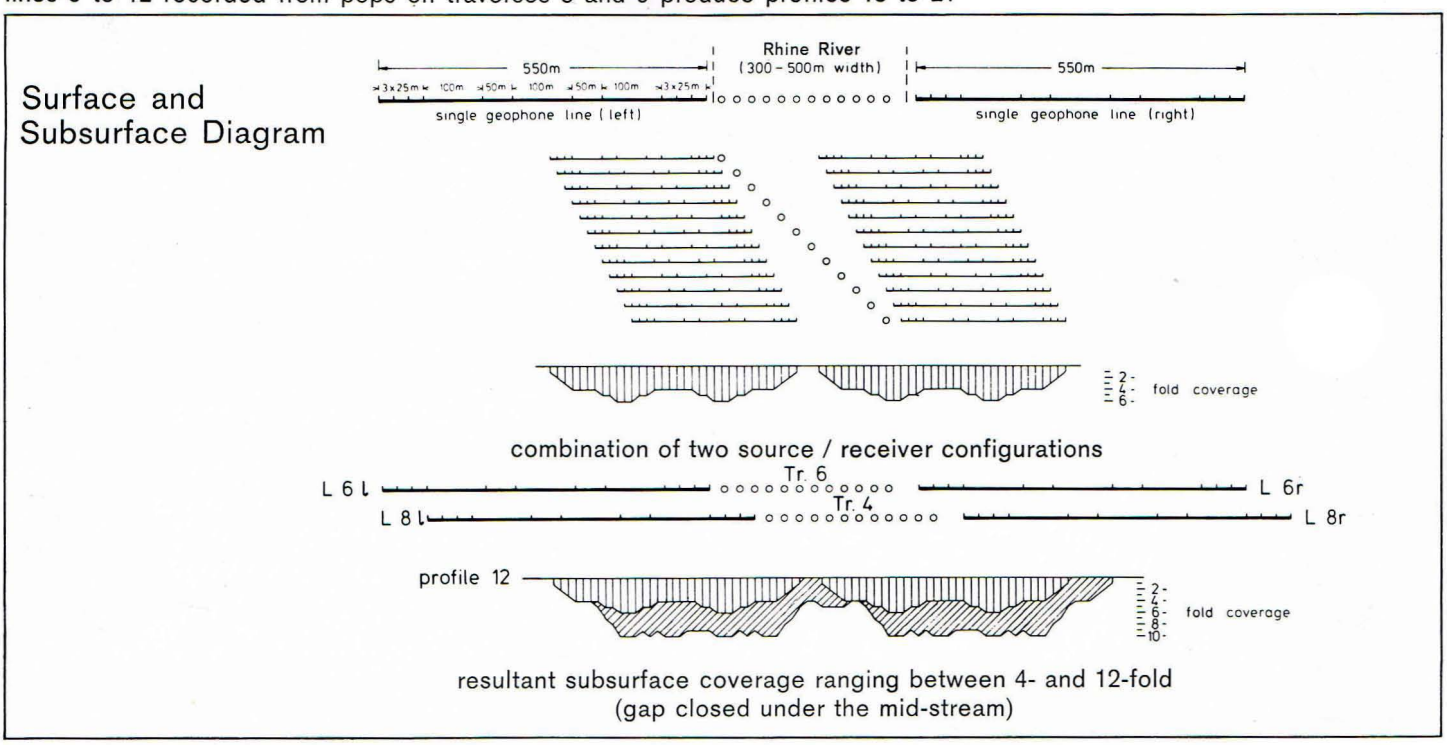
about 200 channels for simultaneous recording will be the near future tools.



Another design already realized:
Rhine-River Areal Seismic Survey
using airgun pops along traverses across the river, recorded from 48 channels each on both river sides.



4 parallel geophone lines (12 stations each) on both river sides recorded simultaneously by 2 48-traces digital recording units, using airguns as energy source along traverses across the river:
lines 2 to 8 recorded from pops on traverses 4 and 5 produce profiles 6 to 13
lines 4 to 10 recorded from pops on traverses 6 and 7 produce profiles 10 to 17
lines 6 to 12 recorded from pops on traverses 8 and 9 produce profiles 13 to 21



The latest design:

Building-Block Systems for Areal Seismics

The outstanding properties of a Building-Block System are:

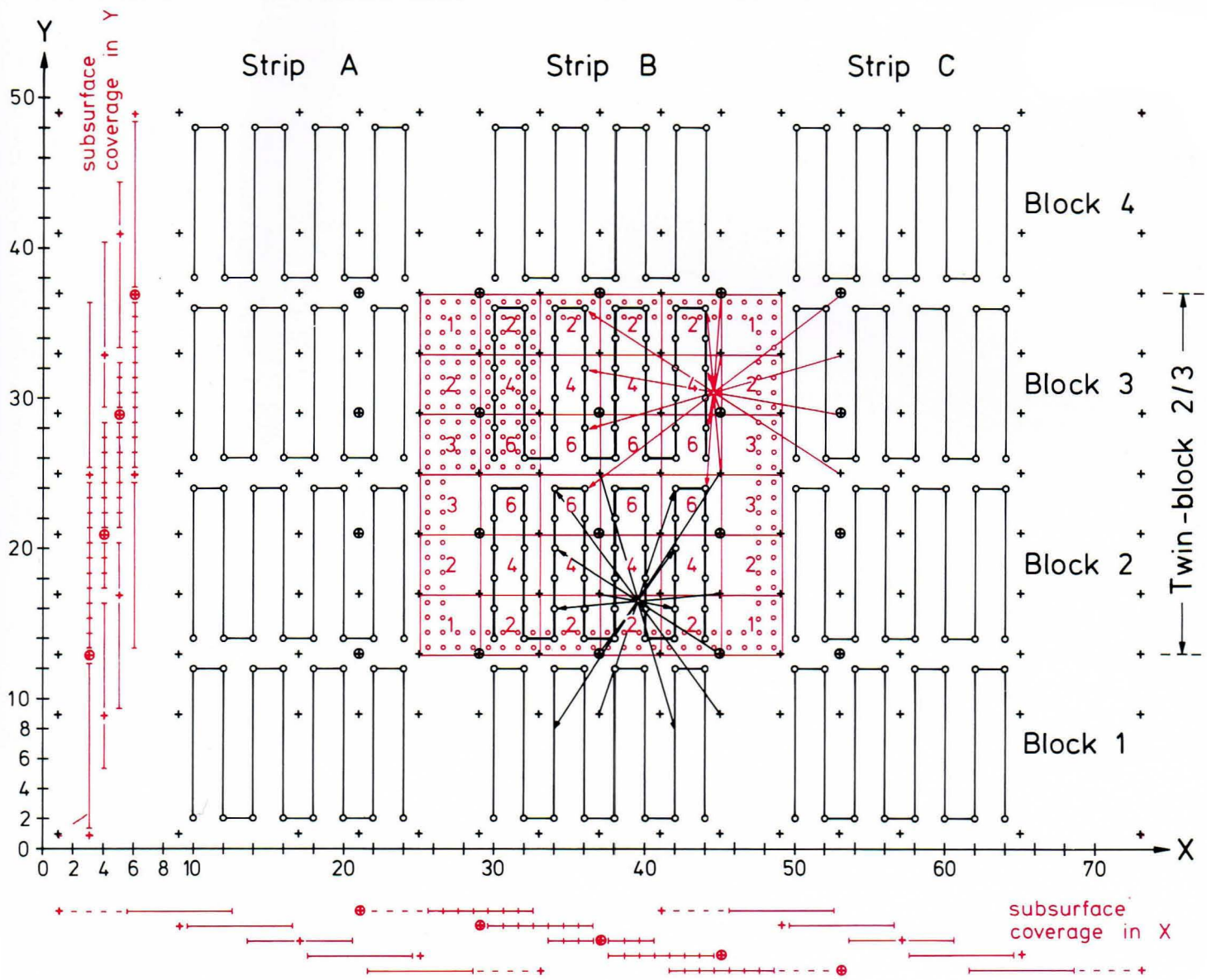
- easy adaptation to the need for resolution and areal extension of the prospective object
- economic field performance
- sufficient coverage already for shallow layers
- powerful attenuation of multiples, in particular after application of 3-D migration processing.

In the example shown 20 shots per block are recorded from 96 channels. (Receiver-intensive type of the building-block system. Other types are emitter-intensive, for example: 48 channels, 35 SP's, 6fold coverage.)

Every block is built up from 36 subsurface compartments, each one comprising 16 regularly distributed CDP's. The compartments differ from each other by a typical distribution of coverage degree (see figure). Specific subsurface overlaps of adjoining blocks produce uniform 8fold coverage for the prospective area (see figure). The large number of differently composed CDP-families ensures effective multiple suppression.

Building-Block System for Areal Seismics

here: 2fold in X and 4fold in Y ≙ 8fold areal coverage
2 x 48 = 96 channels



CDP's

Red figures indicate degree of coverage in the respective compartments.

geophone cable and stations

SP's for twin-block 2/3

SP's for other blocks

Multileg spiders show 2 CDP-families and their shot-receiver configurations

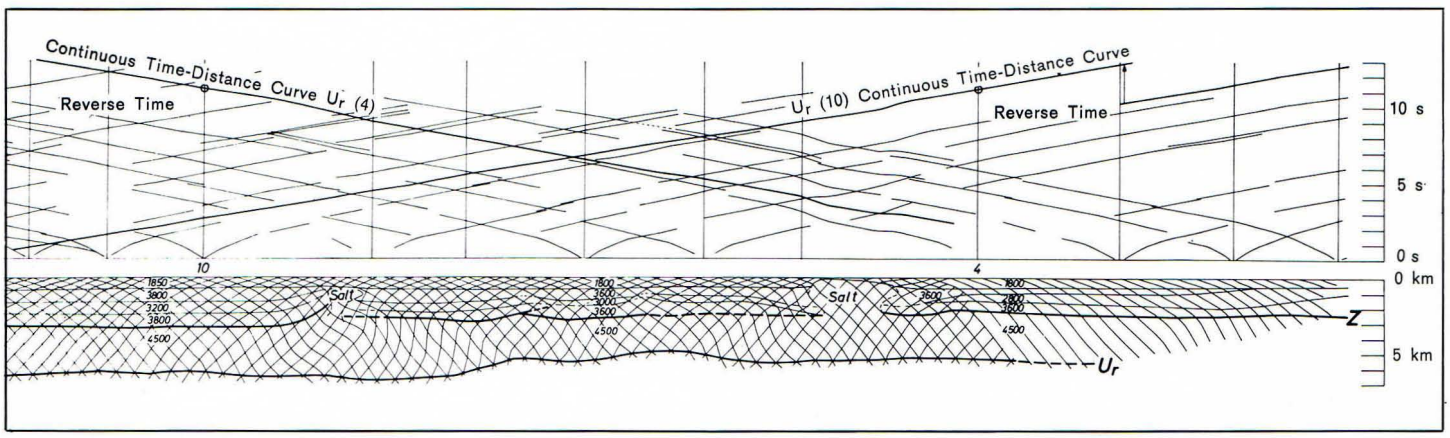
Refraction Seismics

It is true that refraction seismics has lost the predominance it once possessed at the beginning of the seismic era. Though this method was soon placed in the shade of reflection seismics, it still maintained a significant share in the field of seismic exploration due to the fact that certain problems can very often be solved more favourably by refraction seismics than by other methods, for example:

- Reconnaissance of the basement
- Structural investigation of deeper high-velocity layers in such areas in which reflection seismic results remain unsatisfactory due to strong influences of multiples, absorption etc.

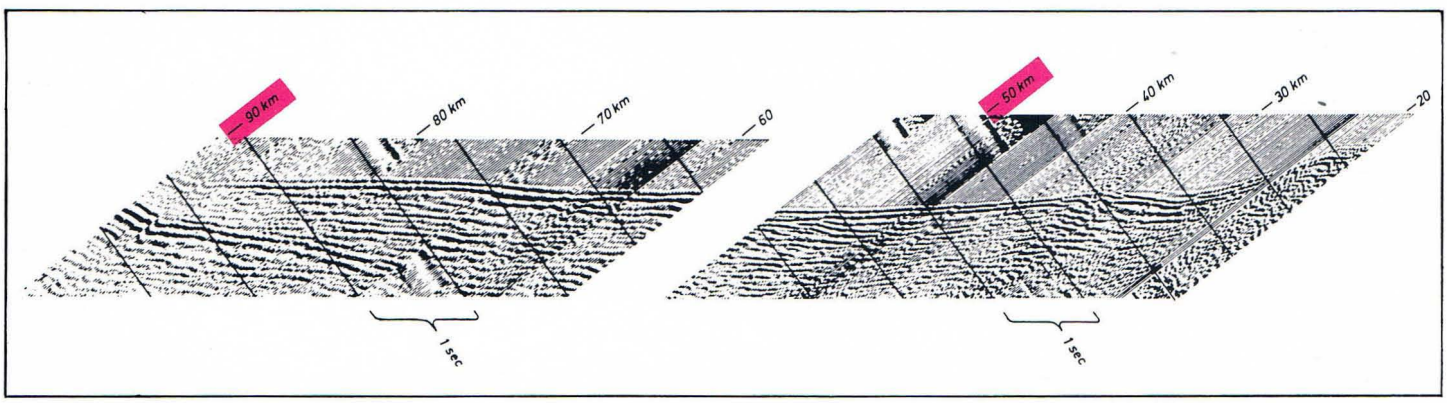
Here it should be recalled that for SEISMOS, founded as the world's first geophysical contractor in 1921, refraction seismics was the backbone of its first years of existence. It should also be mentioned that this same company discovered the first oilbearing structure (saltdome) by this very method near Houston, Texas, in 1924.
Refraction seismic surveys are still carried out by PRAKLA-SEISMOS in many countries, e. g. Turkey, Libya, Indonesia, Egypt and in Germany itself, where refraction seismics has a long tradition.

Application of refraction seismics to subsalt tectonic problems in a deep saltdome basin in Northern Germany.



Z = Base of Zechstein

Traveltime curves and depth presentation for a part of a 300 km refraction line. The pre-Permian horizon U_r can be traced over long distances (Presentation using Thornburgs wavefront method).



Corresponding seismogram sections; shot-receiver distances up to 50 km, in some cases up to 90 km have been used.

A certain renaissance of refraction seismics in the last decade brought methodical progress as well as refinements in field technique and interpretation. The early and basic techniques of

- Line shooting and
- Fan shooting

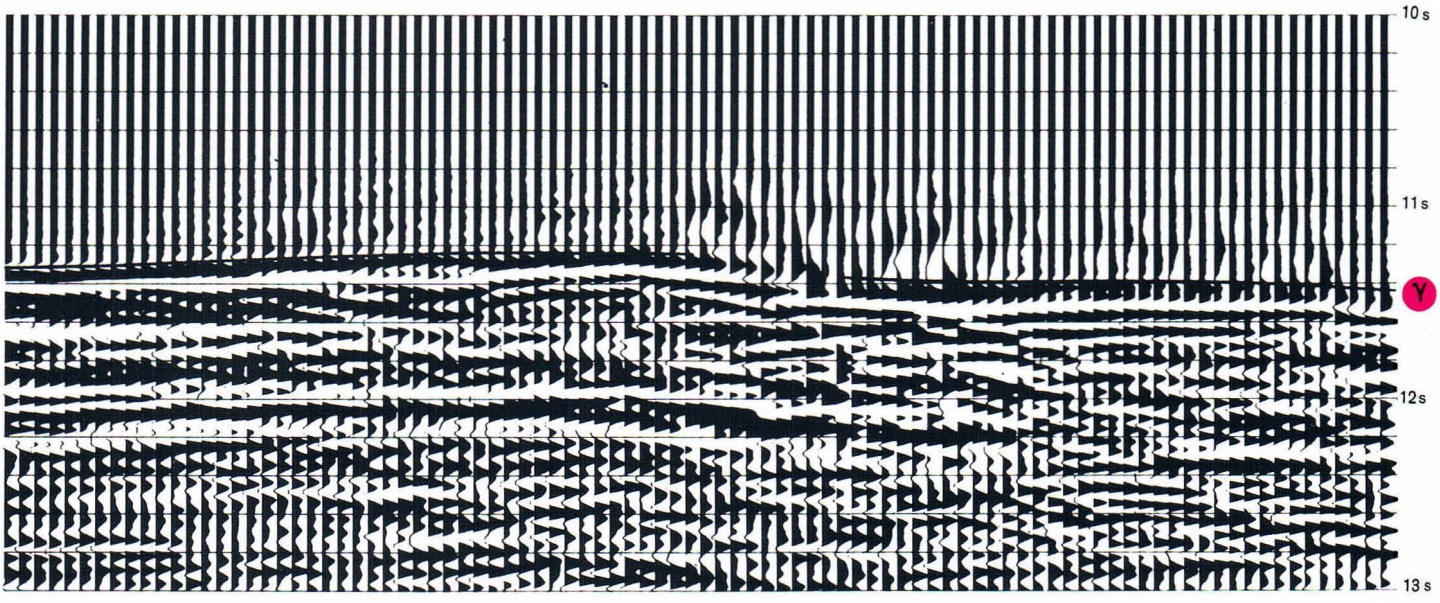
were supplemented by such techniques as

- Broadside (arc) shooting and
- Radial shooting.

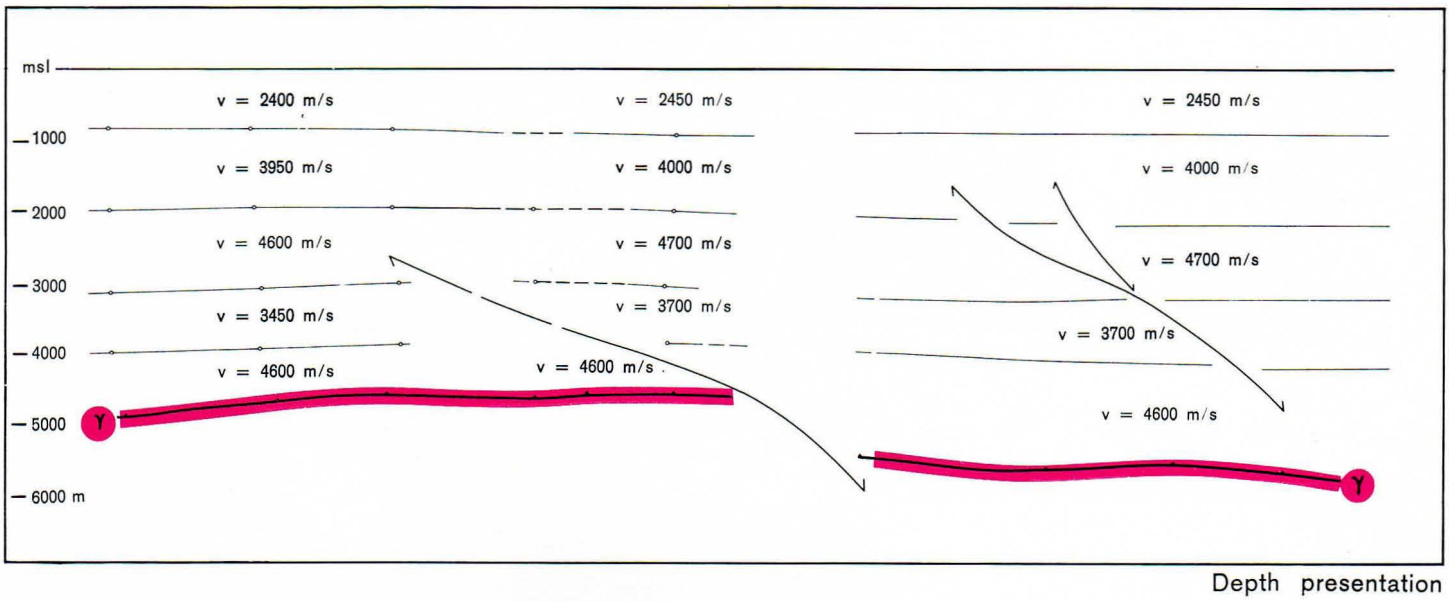
In refraction-broadside or arc shooting central shots are recorded on circle segments with radii depending on the depth of the refractor in question.

In refraction radial shooting, the 'inversion' of arc shooting, a geophone is suspended in a well at the refractor level. Shots are fired at those locations, where information about the refractor is desired.

Fault detection by broadside-refraction shooting (offset between shots and receivers = 56 km).



Seismogram section



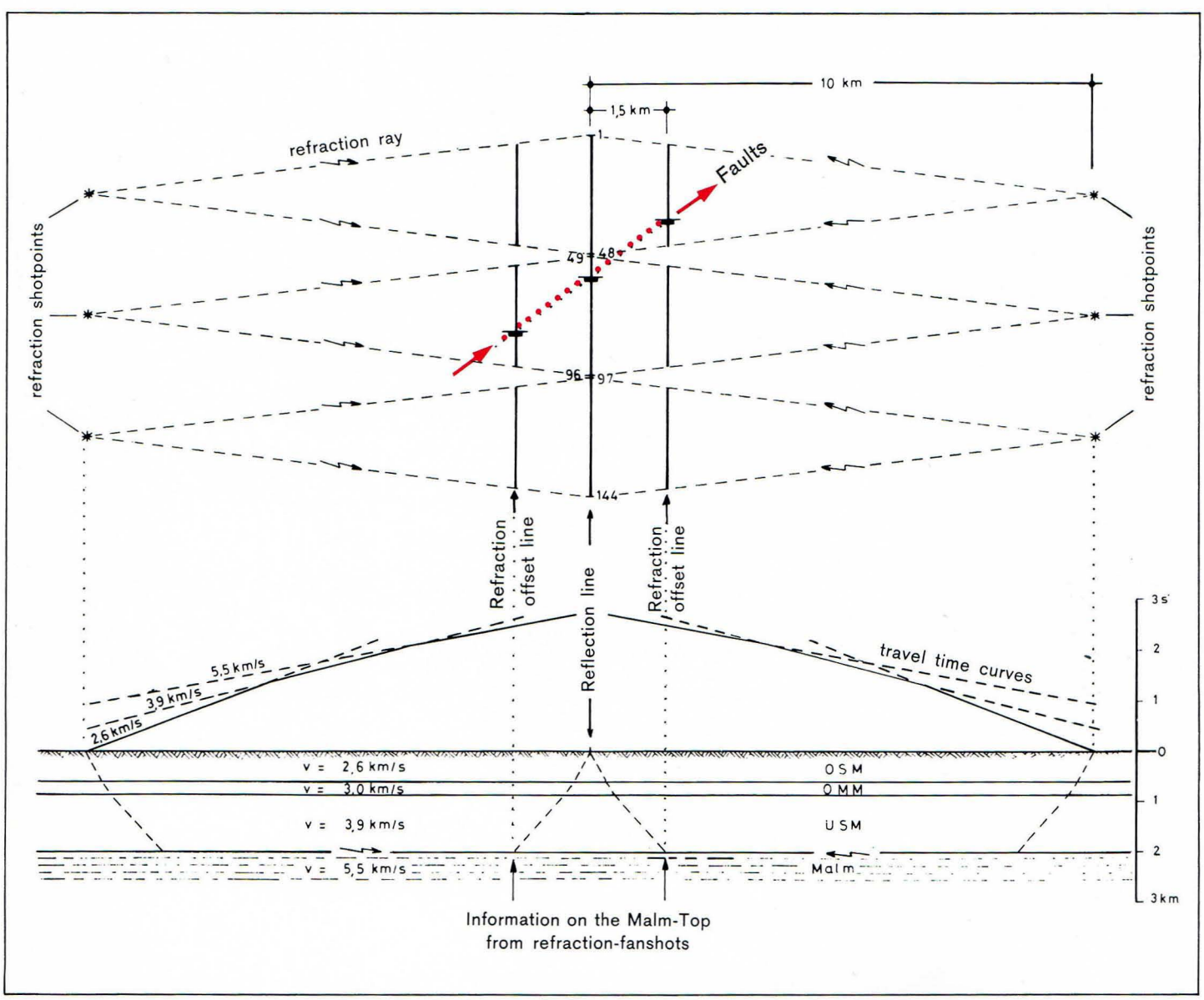
Depth presentation

A combined reflection/refraction survey method has been introduced by PRAKLA-SEISMOS, leading to improved fault determination and correlation: During routine reflection surveys the regular geophone arrays are used additionally for broadside-refraction shooting, i. e. emitted from distant shotpoints on either side of the line. The refractor top is determined at the two 'refraction offset lines' where the refraction rays leave the refractor and emerge to the receiver groups. Thus **one** geophone spread delivers **three** fault locations which may now easily be traced and the fault strike thus determined.

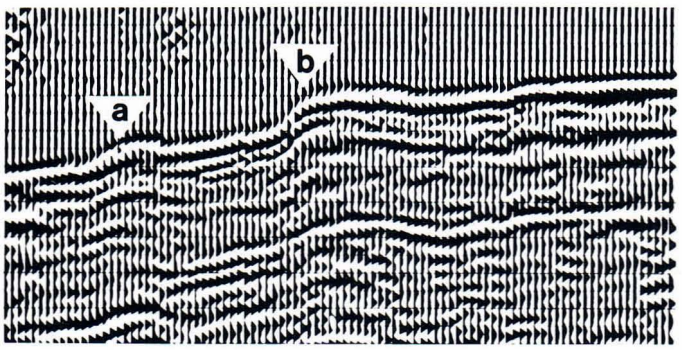
The specific advantages of this method are:

- Faults can be very clearly recognized from the first arrivals, in contrast to reflection sections, where faults are often superimposed by unwanted events.
- The refraction shots additionally provide uphole information for neighbouring reflection lines. (Of special importance when the Vibroseis-method is used.)

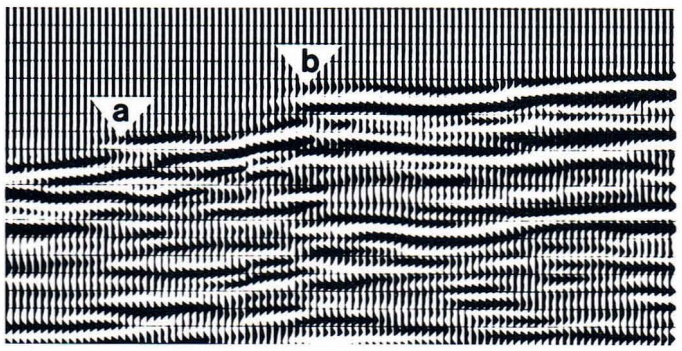
An example of this method, carried out in the South German Molasse Basin, is given below:



The development pushed forward by reflection seismics has always been exploited for the refraction method too, whenever this was possible. Thus refraction seismics need not be excluded from migration processing as seen below:



Without Migration



With Migration

Two faults (a, b) detected by broadside shooting. The refraction events were corrected to standard distances of 30 km.

Some more rules and techniques nowadays applied in refraction seismics:

- Multiple shots are used in many areas, often fired with time delays yielding directivity effects corresponding to the occuring refractor velocities.
- Multiple geophones are used for noise reduction.
- Recording is often executed during night-hours keeping random noise as low as possible.
- Special techniques and equipment are used for 'shallow' problems at low costs, especially in the fields of mining, engineering and hydro-geology (see later chapters).

Special Services

Underground Seismic Surveys for Mining

PRAKLA and SEISMOS were founded with the purpose of facilitating mining exploration activity by preceding geophysical work. In spite of the fact that gas and oil exploration became the main activity of PRAKLA-SEISMOS, applied geophysics – especially seismics – never lost its significance for mining. Even minor tectonic faults prevent modern fully mechanized faces from working economically. It is therefore of great importance to explore zones ahead of the faceline with utmost accuracy.

Our main activities in the underground seismic field:

Exploration of:
- Coal seams
- Ore deposits
- Salt boundaries etc.

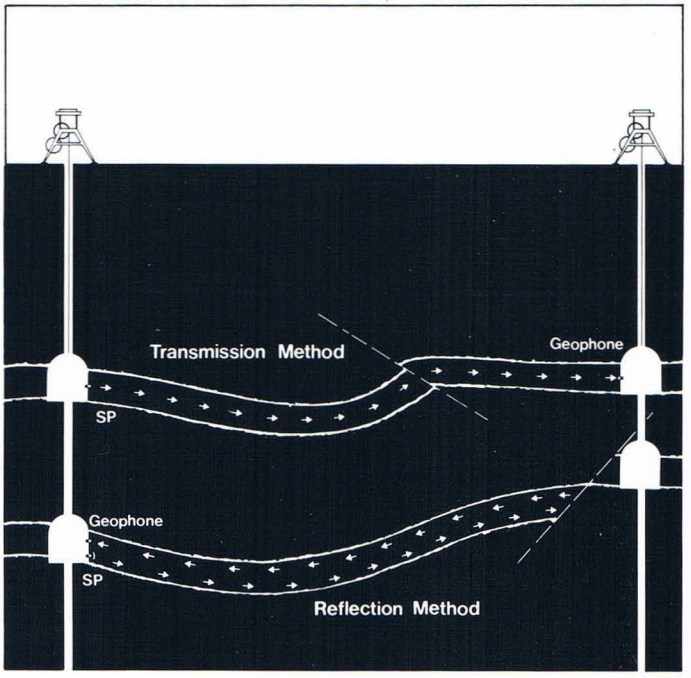
The waves
and methods used for underground seismic surveys:

Channel waves: (Seam waves) Love- and Rayleigh-type waves, guided by coal seams. Transmission and/or reflection surveys in order to detect and locate faults and other disturbances within the seam.

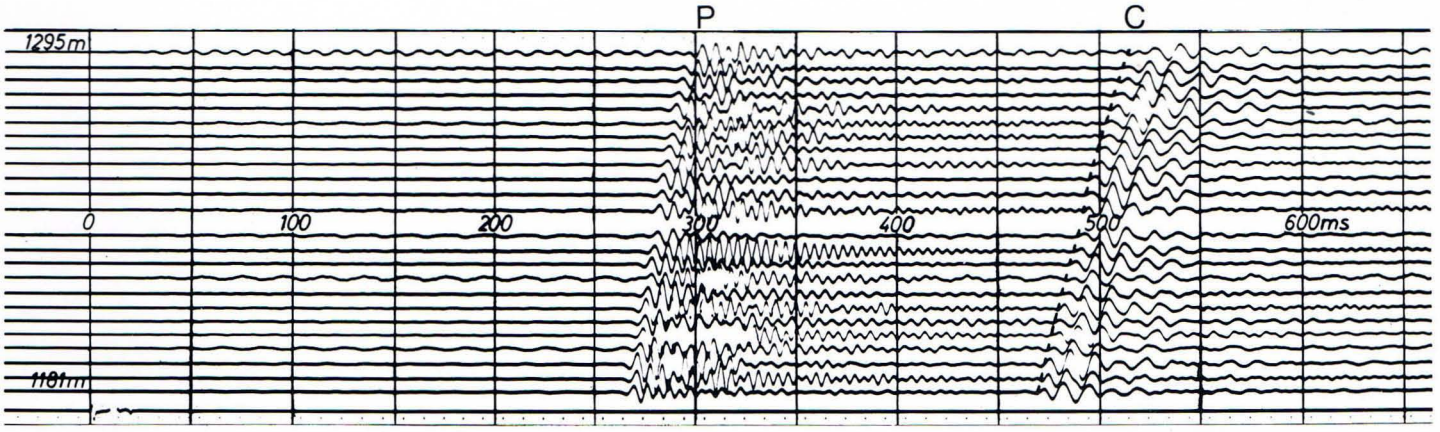
Body waves: Compressional and shear waves, running in country rocks of coal seams, ore deposits, and salt bodies.
Transmission, reflection and/or refraction surveys with the aim of exploring structure, layer sequence, and boundaries of deposits and surrounding rocks.

The principles of the underground reflection and transmission methods using channel waves are shown on the right.

For optimizing results, multiple coverage has become routine not only for the more common body-wave recording, but also when channel waves in coal seams are used.

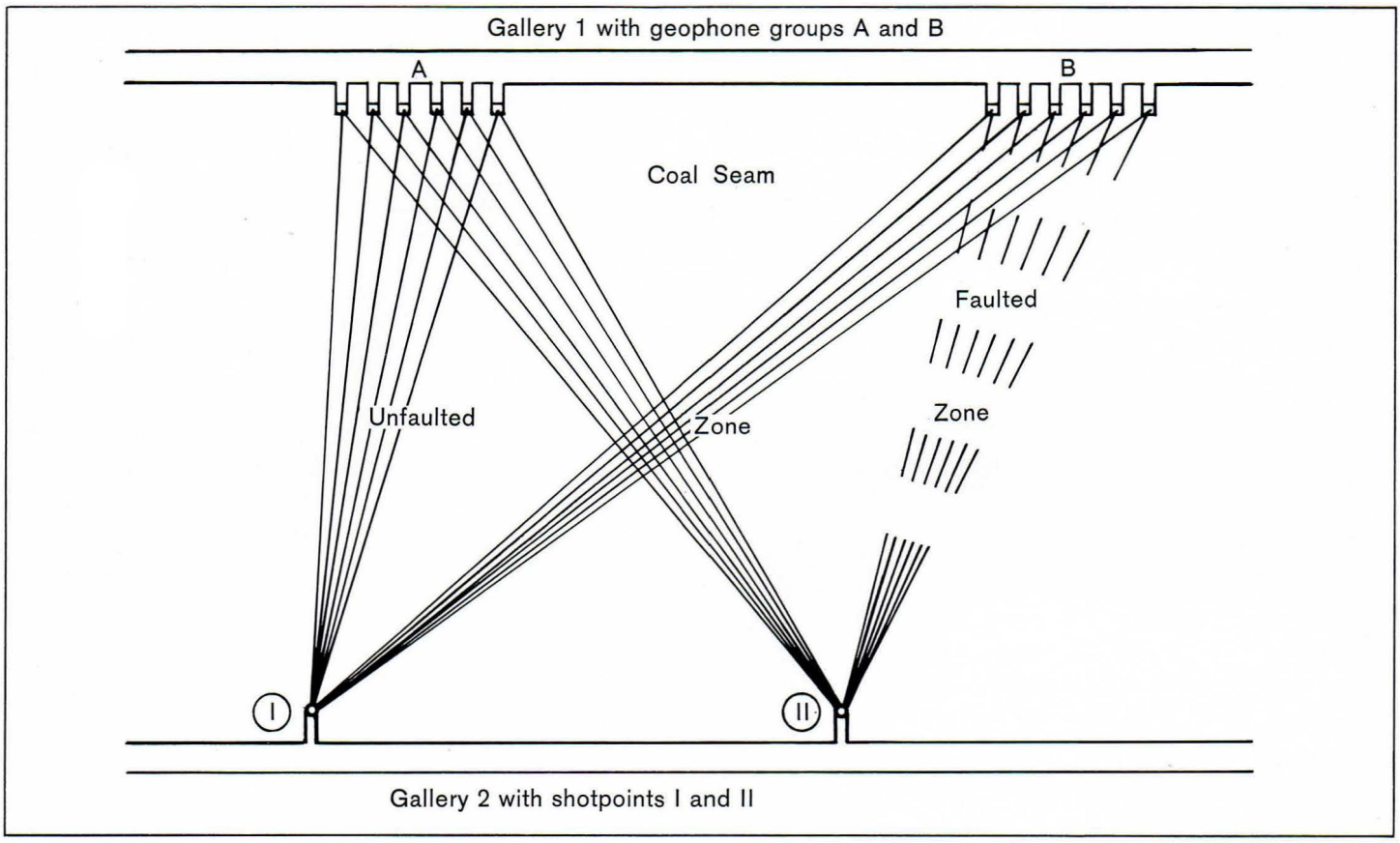


Reflection and transmission methods using channel waves



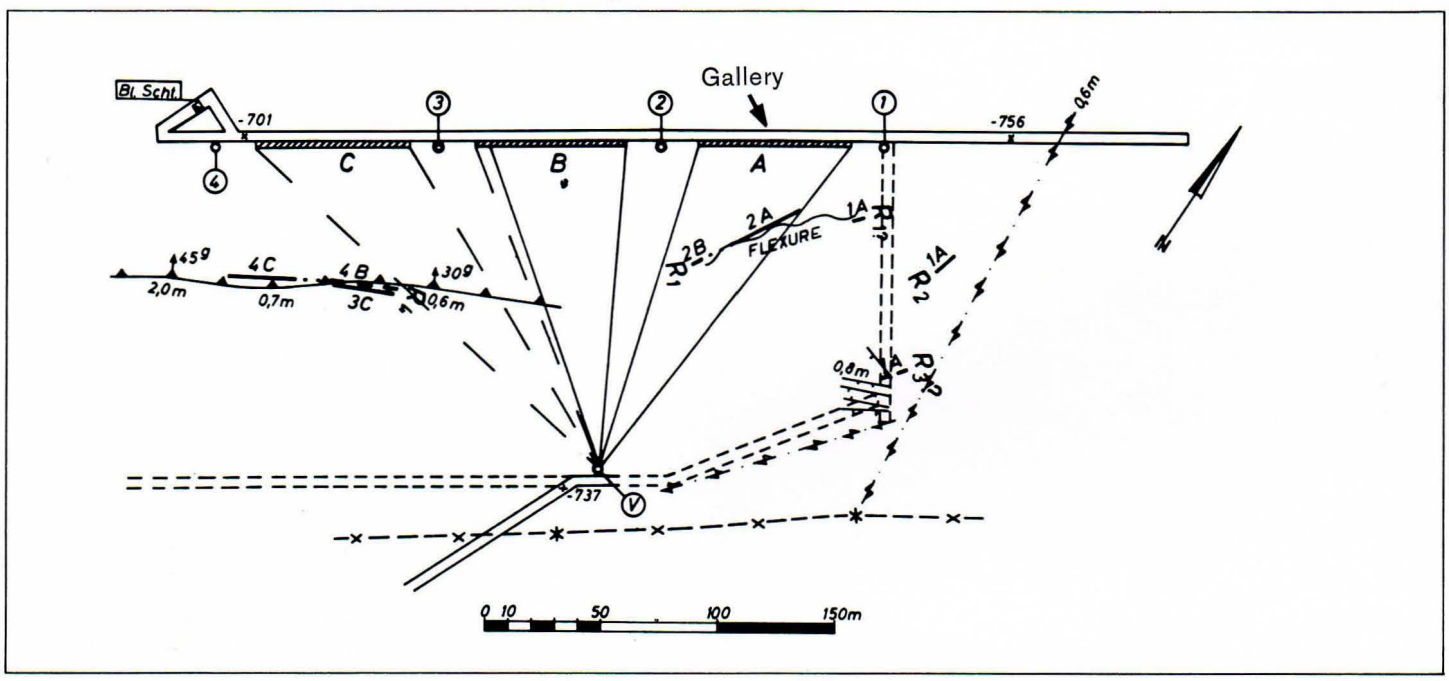
Record with P = compressional wave of country rock, and C = channel wave

Scheme of a transmission survey using channel waves.



No channel waves pass through the faulted zone if the throw of the fault is larger than the thickness of the seam.

A combined reflection and transmission survey using channel waves.



4 C Reflection

C Geophone spread

Actual Faults

Shotpoint

In the left of the figure several **reflections** of channel waves detected a fault which proved to be an overthrust with a throw decreasing towards the right. Obviously the **transmission** of channel waves to spread C was impaired to a certain degree. Here, the throw of the fault mentioned still comprises about half the thickness of the seam.

The **Fire-damp proof Equipment** used:

- Recording: Instruments with high resolution properties; 24–48 traces; fire-damp proofing carried out by PRAKLA-SEISMOS.

  GSU PRAKLA-SEISMOS; analog, up to 600 Hz,

  DFS V Texas Instruments; digital, up to 500 Hz, 0.5 or 1 ms sampling rate.

- Receiving: Geophones with high natural frequency, for instance HS-JK 28 Hz Geo Space used as basic systems vertically and horizontally adjusted.

  The following arrangements are applied:

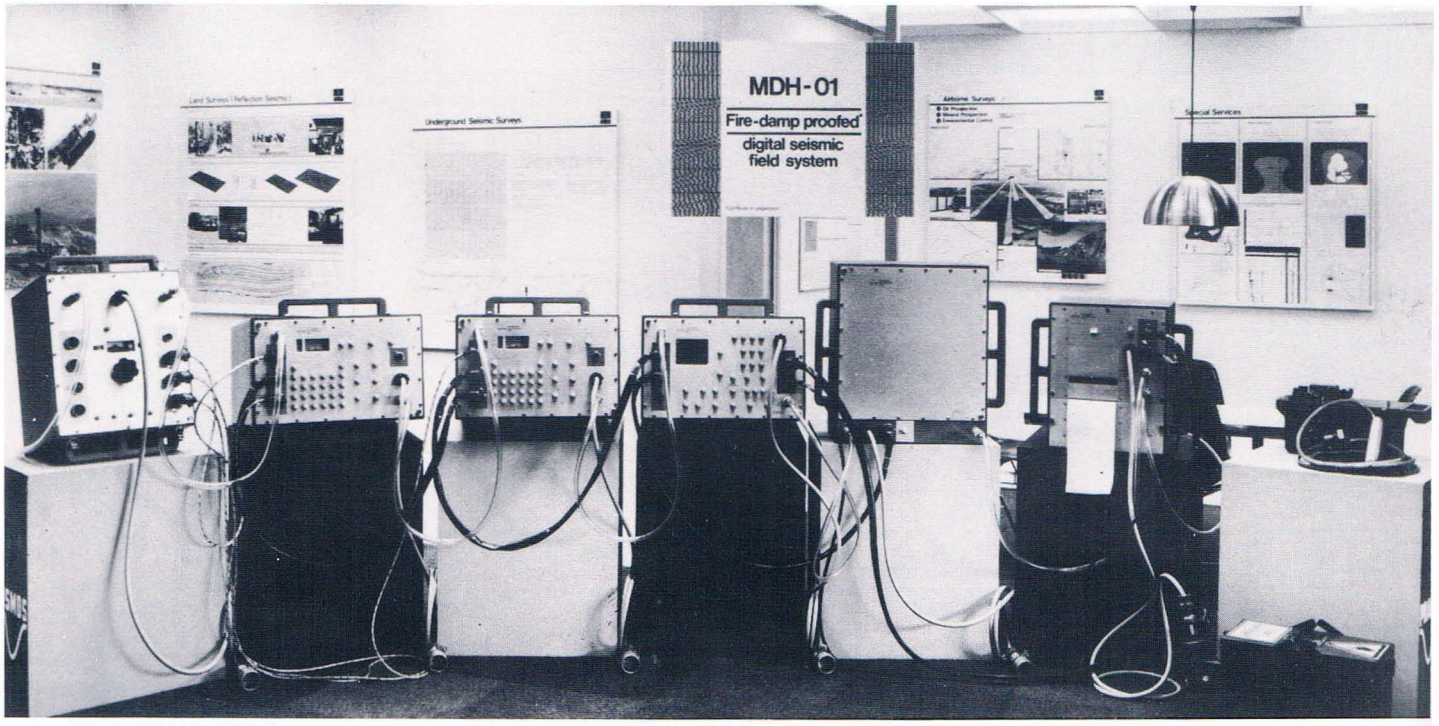
  - One component, PRAKLA-SEISMOS: geophones welded into hollow bars to be inserted into boreholes.
  - •• Two components, WBK (Westfälische Berggewerkschaftskasse). Rock-coupling in the borehole by airpressure.
  - ••• Three components, NLfB (Niedersächsisches Landesamt für Bodenforschung): Rock-coupling in the borehole mechanically achieved.

The output of three or more geophones is fed into one trace.

Energy Sources

- Small changes of dynamite fired in boreholes
- Hammer blows made on an oscillation-damped iron bar – the so-called 'Baule-bar' – which is fitted into a borehole.

Underground seismic activity need not be restricted to coal prospection. PRAKLA-SEISMOS carried out reflection and refraction surveys to locate ore-filled dykes and to solve problems in potash mining.



MDH-01, the fire-damp proof system containing DFS V
(exhibited on International Mining Exhibition 1976, Düsseldorf)

Seismic Surveys for Civil Engineering and Hydro-geological Problems

It has been strongly emphasized in previous chapters that seismic methods prove more and more practicable for solving civil engineering problems, attacking them from the surface by modern techniques:

- high signal resolution by applying high-frequency signals,
- high fault resolution by using areal field recording,

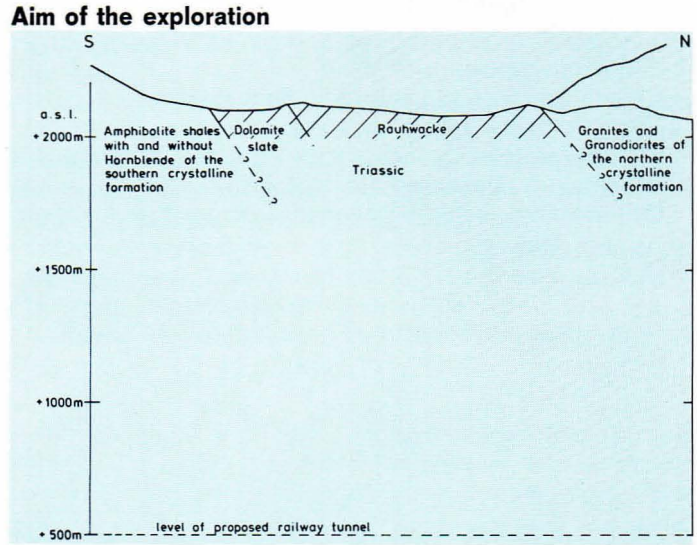
whenever near-surface layers and fault systems are to be investigated, as might be necessary for a dam foundation etc.

It is well understood that helping civil engineering implies in many cases high flexibility in means and methods. The problems offered in these fields may seldom be called 'routine'. Tools must be adapted to 'shallow' problems using weight-drops or vibrations instead of dynamite etc. A special weight-dropping device is shown on page 42. How complex engineering problems can be solved by a combination of different methods as:

- refraction, reflection, transmission surveys, well logging, velocity surveys, carried out from
- surface and subsurface,

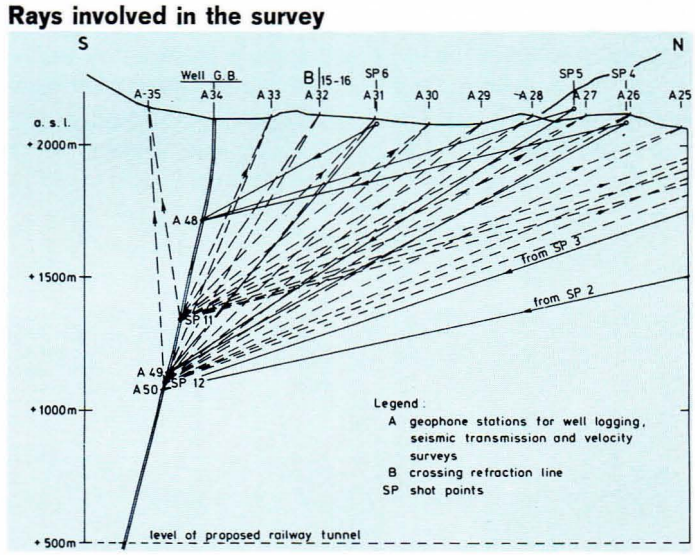
is shown here by an actually executed survey for a tunnel project in the Alps (see right).

Aim of the exploration



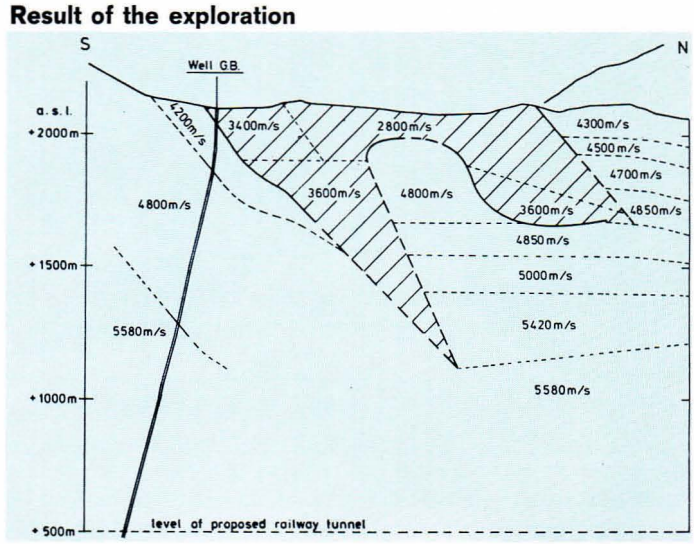
Delineation of a triassic body containing many small caverns, fractures, breccies etc. which might cause water break-ins in the projected tunnel.

Rays involved in the survey



Combined seismic refraction and transmission survey, well logging and velocity survey.

Result of the exploration



The delineation of the boundaries was interpreted by employing GARDENER curves using the wave-front method and utilizing the HERGLOTZ-WIECHERT method for the determination of a possible maximum increase of velocities in the northern crystalline formation.

Seismic Well Surveys

PRAKLA-SEISMOS executes seismic well surveys for the following purposes:
- Determination of average- and interval-velocities
- Check shots for calibration of sonic-logs
- Vertical seismic profiling incl. studies of amplitudes, frequencies, absorption etc.
- Determination of salt boundaries and other interfaces

Energy sources are
- Dynamite
- Air guns
- VIBROSEIS *

Recording is carried out with a well geophone which operates with various detecting systems (horizontal and vertical geophones; hydrophones); it is equipped with a clamp system enabling sufficient coupling to the borehole wall, thus improving the signal-to-noise ratio considerably.
Besides receiving sufficiently large amplitudes by means of this well geophone, specially developed by PRAKLA-SEISMOS, the application of the VIBROSEIS *-method needs signals free of delays caused by analog frequency filters in the seismic instruments. Cross-correlation is therefore carried out by using a filtered sweep; that means: the sweep undergoes the same changes by analog amplifiers and filters as the signals to be cross-correlated.

Additionally, **synthetic seismograms** can be computed which proved to be extremely helpful for all aspects of interpretation.

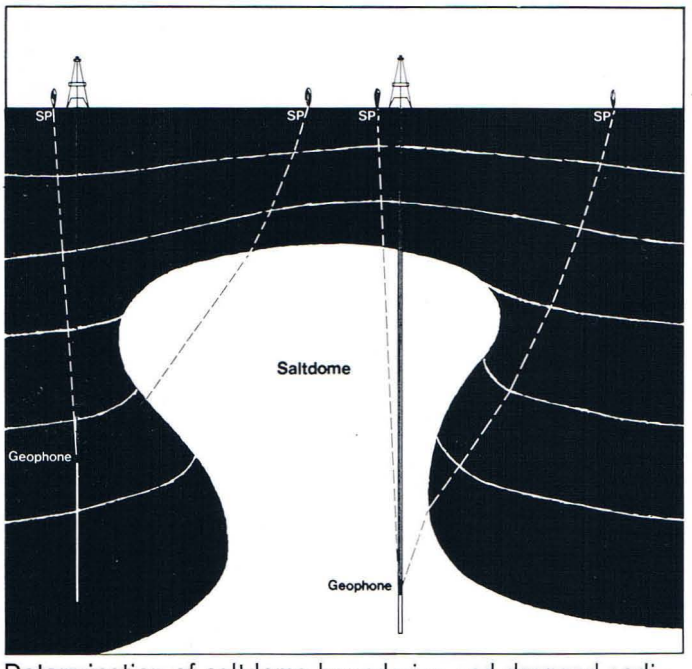
1 Integration of Continuous Velocity Logs with Seismic Well Velocity results

2 Calculation of Reflection Coefficients (optionally with or without density-information)

3 Calculation of Spherical Spreading and/or Transmission Losses (optionally) or of Amplitude Decay, according to seismic well survey

4 Derivation of Synthetic Seismograms (Spike and filtered) without Multiples

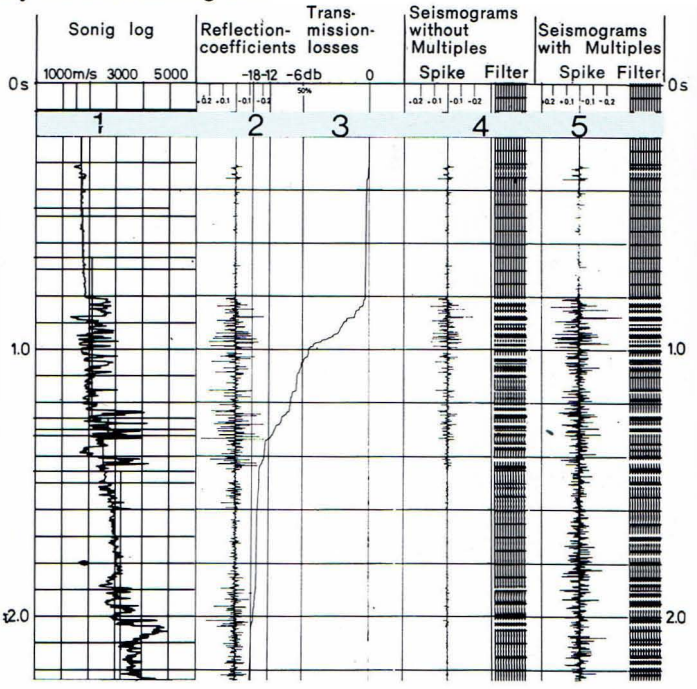
5 Derivation of Synthetic Seismograms (Spike and filtered) with inner and/or Surface Multiples



Determination of saltdome boundaries and dragged sediments on their flanks

Type 1:	Type 2:
well outside saltdome	well inside saltdome
shotpoint above saltdome	shotpoint off the saltdome

Synthetic Seismograms



The Efforts to get Optimum Static Corretions

In order to compensate the unavoidable effects caused by variations in elevation, weathering thickness and velocity, we have to 'correct' the travel times of the received data. After this procedure, the arrival times of the reflection or refraction events should have values, as if these near-surface irregularities did not exist. As a rule, a so-called datum plane is introduced as a time reference for all data, the level of which may depend on the average elevation of the area in question.

PRAKLA-SEISMOS has always laid vigorous stress upon developing and applying methods to obtain optimum static corrections as an indispensable prerequisite for optimum stacked seismogram sections.

In close connexion with routine production work, special surveys are carried out to gather additional information about the velocity distribution in near-surface layers:

- Uphole Surveys (partly recorded as 'Meissner-Spreads')
- Weathering Surveys (Short-Refraction Lines)

As a routine, the static corrections are based on

Surveyors's data:

- Terrain elevations

Monitor seismograms:

- Uphole times of the production shots
- Refractions (first breaks)
- Reflections

Uphole and weathering surveys:

- Velocity distribution in near surface layers
- Uphole times of deeper boreholes

Additionally, in particular for surface methods like VIBROSEIS *:

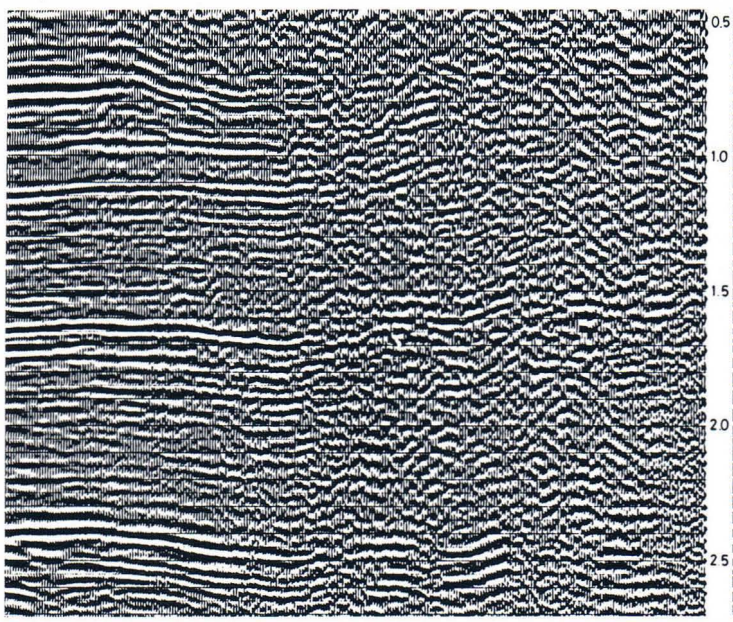
- information gathered by previous 'dynamite' surveys, as
- uphole times etc.

The steps and methods we use to calculate static corrections are:

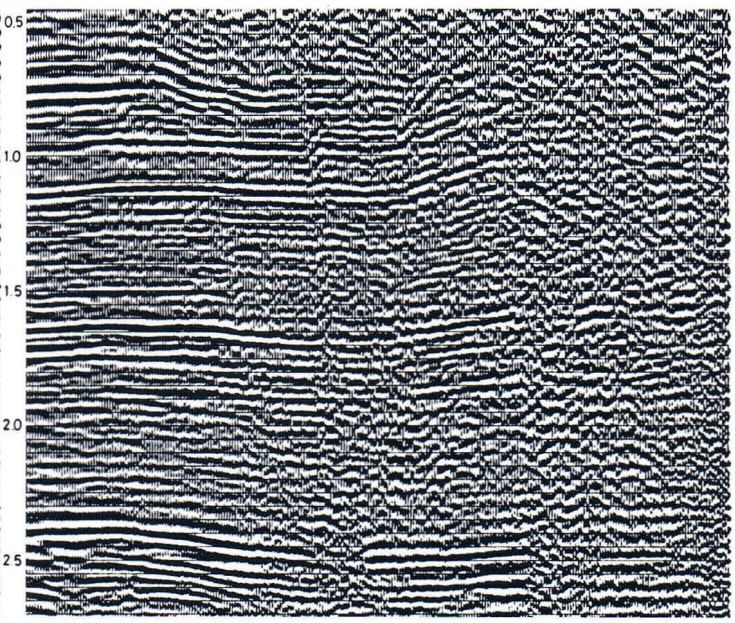
- Basic corrections derived from terrain elevations, uphole and weathering surveys, and/or uphole times. (For Vibroseismics: from terrain elevations, uphole and weathering surveys, and weathering and sub-weathering velocities found by previous 'dynamite' surveys)
- Improved statics by using first-breaks and refraction methods (e. g. plus-minus). To be used when no reflections of sufficient quality are available.
- Improved statics by using reflections which are plotted and compared to proper hyperbolae. This statistical method is preferably applied, wherever reflection quality is sufficiently good. To optimize results the procedure is repeated iteratively. An example of the result of this method is shown below.
- Residual static corrections are obtained by automatic processes based on special cross-correlation methods and carried out in our Data Center.
- Seismic Stripping Corrections have been introduced by PRAKLA-SEISMOS for special problems (see page 62).

Static correction problems can be solved sufficiently only by using the above methods with utmost flexibility and by taking into account that every problem needs its own special approach to solve it.

The computation of static corrections is carried out either in the party's field office or in PRAKLA-SEISMOS' head office in Hannover by special correction groups.



VIBROSEIS * surveys in the folded molasse. Static corrections according to terrain elevation and averaged sliding sub-weathering velocities.
Results: Unsatisfactory



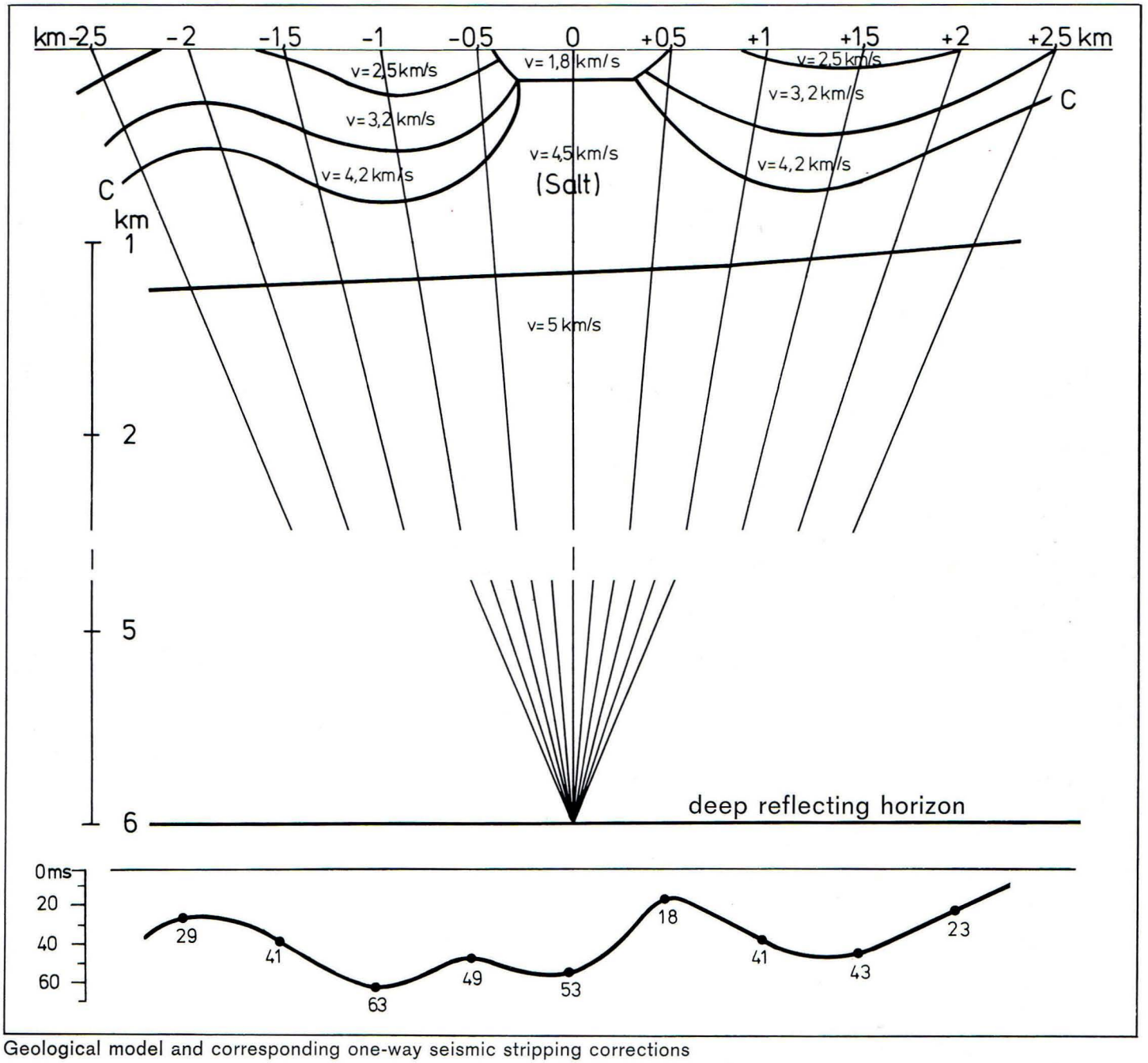
The same part of the section as to the left. The considerable improvement in the results of stacking was achieved by:

1. plotting a reflection in the corrected single seismograms, application of an initial compensating curve; stacking
2. improvement of the compensating curve from step 1 giving total residual correction values to a maximum of 50 ms for both geophone and vibrator positions; stacking.

Seismic Stripping

In some survey areas strong lateral velocity differences are encountered not only in the uppermost layers (weathering zone, uppermost subweathering zone), but also in a much thicker underlying zone, as for instance in the case of strongly marked halokinetic tectonics (Fig.) or in regions with folded allochthonic layers over unfolded autochthonic layers. If thereby, especially for deeper objectives, large shot-geophone distances (3–6 km) are used, the signals of different traces, belonging to one CDP-family, lie on ray paths with different average velocities; thus no appropriate correction hyperbola can be found for a successful stacking.

In such cases PRAKLA-SEISMOS applies a correction procedure before stacking, called "seismic stripping". In this method all layers of lower velocity within this aforementioned thicker zone are replaced by one layer of the highest velocity; for the example below this means that the layers down to reference horizon C having velocities of 2.5, 3.2, and 4.2 km/s respectively are mathematically removed and replaced by one layer of 4.5 km/s. The resulting time differences which occur between the surface and the reference horizon are the stripping corrections, as indicated in the lower part of the figure and ranging from about 10 to 70 ms. Information on the velocity distribution in the critical thicker zone is extracted from the interpretation of reflections in sections without seismic stripping, from velocity surveys in wells, from refraction seismic interpretation of first arrivals, etc.



Geological model and corresponding one-way seismic stripping corrections

After Data are acquired: What to do next?

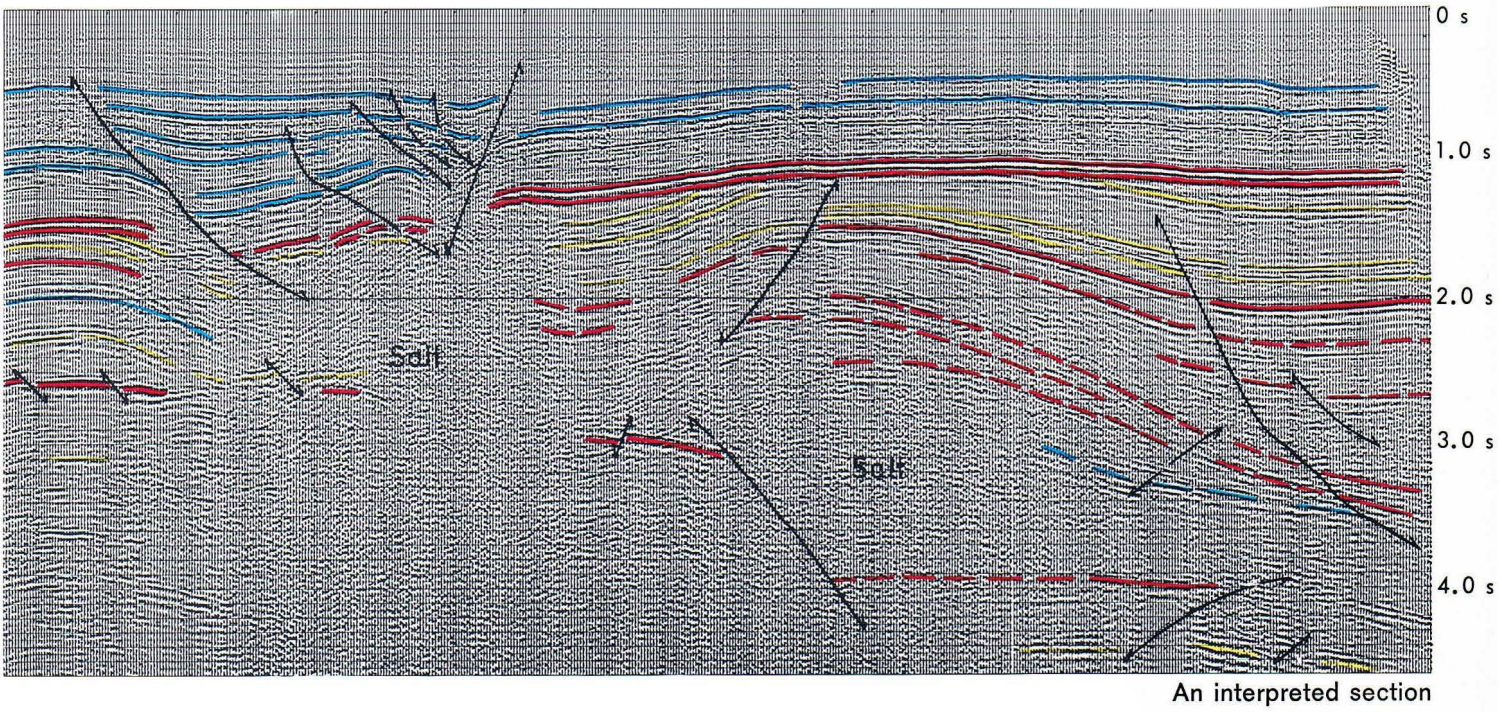
When Data Acquisition is completed and every step well done, our work is finished – at least for the moment (and at least for those who wrote this brochure). But a new important question now arises: How to proceed with all these eagerly gathered data?

ONE possibility is to entrust them to PRAKLA-SEISMOS for

DATA PROCESSING and/or
INTERPRETATION

in our Hannover Processing and Interpretation Center, where advanced and sophisticated programs and techniques are at your disposal and where a qualified staff is keen on meeting every kind of challenge.

You will find detailed information about data processing and interpretation in our brochures:
PRAKLA-SEISMOS GMBH, Data Processing
PRAKLA-SEISMOS GMBH, Seismic Interpretation



An interpreted section

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