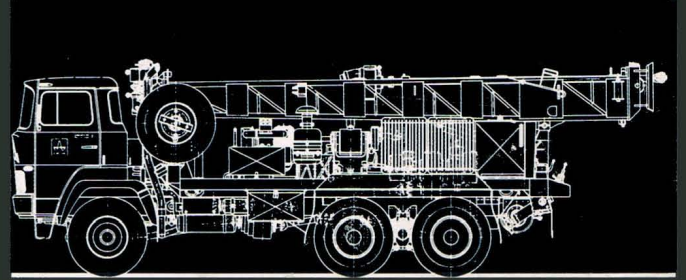
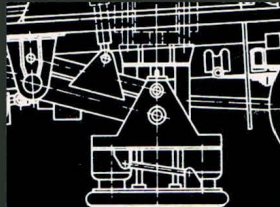


Information No. 60

Onshore Seismics- Equipment



Explosive Energy Sources:
drilling and
implantation techniques



Non-Explosive
Energy Sources



Instrumentation



PRAKLA-SEISMOS AG



Onshore Seismics — Equipment

Emitting seismic energy into the earth and receiving plus recording the echos returning to the surface are the elementary procedures of seismic acquisition work. This brochure deals solely with onshore seismics, a large enough topic.

In order to earn merit in the onshore seismic field, you have to pay attention to three essentials (— assuming there is a client who needs your services): you must have well-trained and experienced crews, the know-how for

carrying out complicated surveys in a state-of-the-art manner, and last but not least: you need first class and versatile equipment. And PRAKLA-SEISMOS has always laid particular stress upon all aspects of modern field techniques, especially on using the best materials which the international market and our own workshops are in a position to offer at any particular moment.



Part of the Technical Department of PRAKLA-SEISMOS. Here special electronic and peripheral devices are developed and produced. The building in the fore-

ground (left) houses the Service Department, where all the company's seismic electronics is serviced and tailored for its special application.

CONTENTS

Explosive Energy Sources: drilling and implantation techniques	4
► Drilling Equipment — truck-mounted and heli-borne systems	4
► Drilling Equipment — portable systems	9
Non-Explosive Energy Sources	14
► Standard Vibrators	14
► Other Non-Explosive Sources	18

Instrumentation	19
► Recording Systems	19
► Auxiliary Equipment	20
► Receivers	20
► Tools for the Topographical Survey	21
Installation of Equipment and Transport	23

This brochure gives a rough impression not only of our standard equipment but also of special developments prompted by increasing challenges like 3D surveys in built-up areas, multi-source recording, environmental demands and, generally spoken, the necessity to cope with the vastly differing conditions in the company's worldwide operations.

You will find in this brochure the arsenal of 'energy sources' developed, constructed and serviced by PRAKLA-SEISMOS Geomechanik in Uetze, near Hannover, eg vibrators, drilling rigs and a large variety of portable and heli-portable implantation devices — a speciality of PRAKLA-SEISMOS. And you will find a compilation of the most modern seismic and topographical surveying instruments we use, to a large extent purchased from specialist firms — eg Sercel, Texas Instruments and Geodimeter — but also to a notable extent developed and produced in our own Technical Department.



PRAKLA-SEISMOS Geomechanik.
Construction of heavy drilling rigs.

PRAKLA-SEISMOS Geomechanik plant at Uetze, near Hannover, where, amongst others, the vibrators and drilling rigs are developed, built and serviced.



Explosive Energy Sources: drilling and implantation techniques

Drilling work for our onshore seismic parties is carried out by our wholly-owned subsidiary PRAKLA-SEISMOS Geomechanik GmbH. All drilling rigs and associated equipment are developed, built and serviced in the company's plant and workshops in Uetze, near Hannover.

After non-explosive seismic energy sources like weight-dropping and vibroseis had sprung into existence, many experts predicted the demise of the dynamite era. This prognosis was too hasty. Introduction of a large variety of light-weight, even portable and heli-portable drilling devices led to a vast field of onshore seismics being reclaimed or newly conquered by the dynamite method, especially concerning 2D and 3D work in difficult areas, such as in swamps, mountain regions (s. pages 12/13), built-up areas and even in greenhouses (s. page 10).

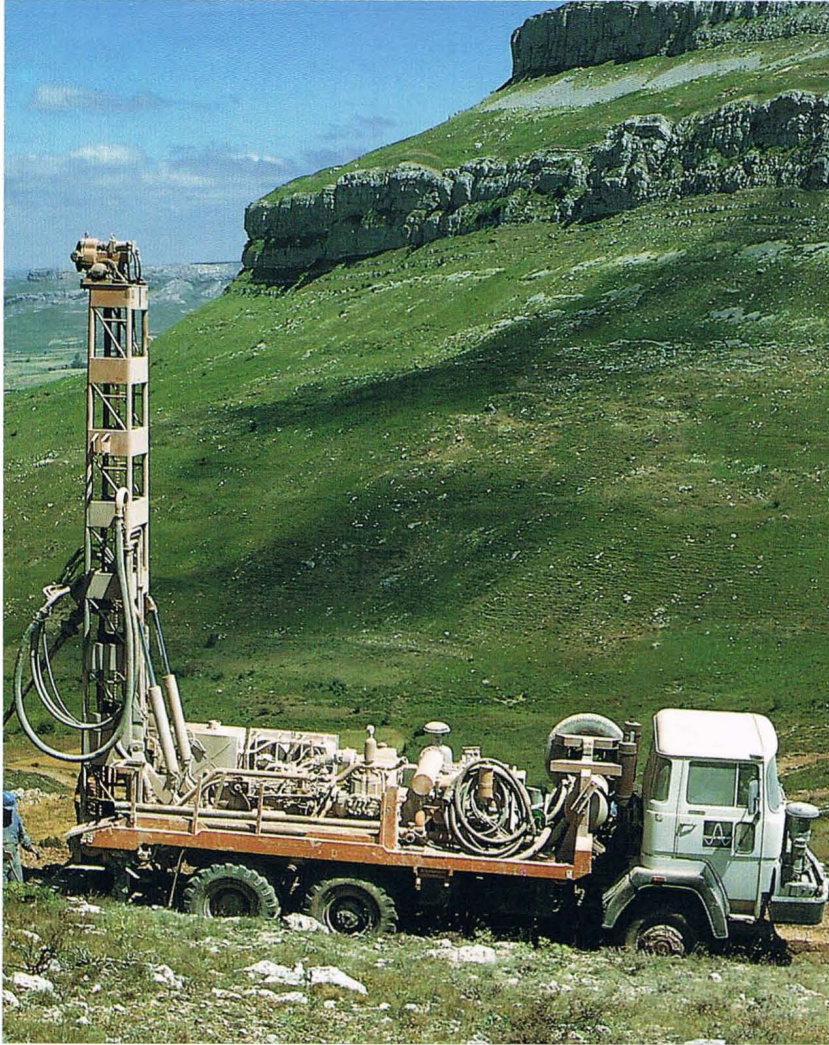
Tremendous progress has been made in recent years at PRAKLA-SEISMOS in the domain of light-weight, mobile, portable and heli-portable drilling devices. Development here is advancing rapidly. Whoever dares to write a brochure on this topic has to realize — unlucky for him, good for the client — that his compilations, pictures and statements will be soon out-dated. That's the way it must be.

The Standard Rig Types

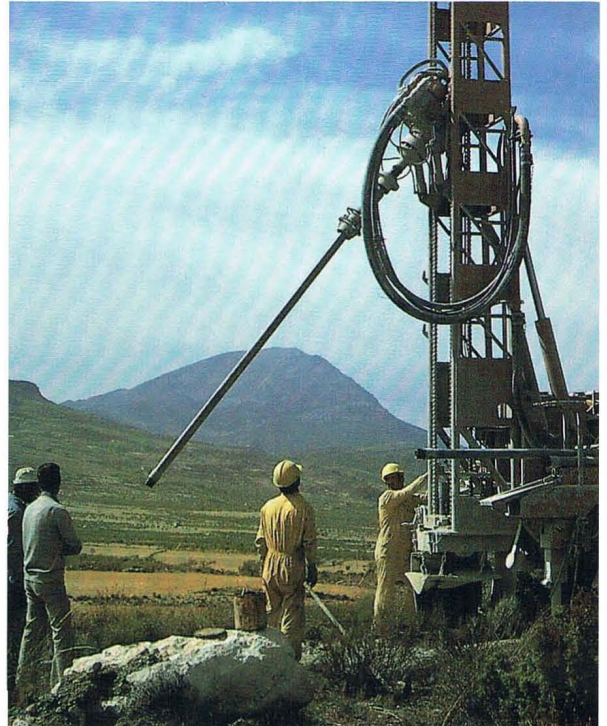
^{*)} or in-hole hammer
^{**)} Pump and compressor are separate units

Category	Type	Type of Carrier	Main Power Unit	Weight (kg)	Max. Depth (m)	Circulation Systems	Pumps	Compressors
Heavy-weight rig	P 5001	Iveco 6 x 6	235 kW (320 HP)	18 650	500	water/air	Piston (duplex) 750 l/min; 22 bar	9.6 m ³ /min 9 bar
Medium-weight rig	P 3002	Iveco 4 x 4	168 kW (228 HP)	11 500	300	water/air	Piston (duplex) 450 l/min; 20 bar	9.6 m ³ /min 9 bar
Light-weight rigs	P 1002	Unimog 4 x 4	66 kW (90 HP)	6 050	100	water	Piston (duplex) 450 l/min; 20 bar	—
	P 1011	MB trac 4 x 4	70 kW (95 HP)	6 500	100	water	Piston (duplex) 450 l/min; 20 bar	—
Very light rigs	P 0501 V	MB trac 4 x 4	48 kW (65 HP)	5 360	30	air ^{*)}	—	5.8 m ³ /min 8 bar
	P 0501			5 200	50	water	Piston (duplex) 450 l/min; 20 bar	—
	P 0501			4 600	50	water	Centrifugal pump 830 l/min; 5 bar	—
Heli-portable ultra-light rig	P-HD 0511	(mountable wheels)	30 kW (41 HP)	680	50	water/air	Centrifugal pump ^{**)} 600 l/min; 5 bar	5.8 m ³ /min ^{**) 8 bar}

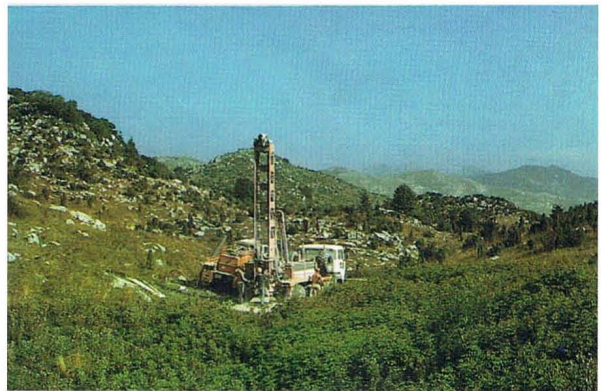
Rough terrain — no problem for the P 5001



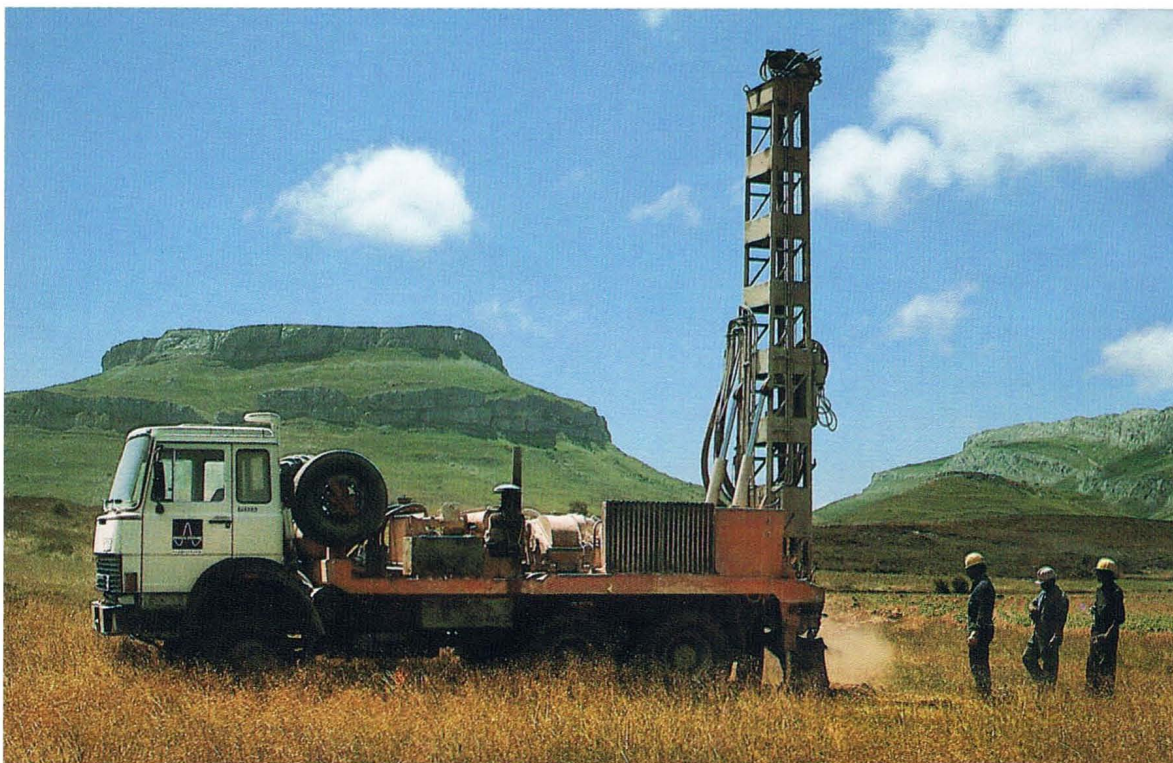
P 5001 with hydraulically controlled swivel



P 5001, our Heavy-Weight Champion



*P 5001 with watertruck –
a home from home
in rugged landscape*



Spanish scene



Four P 3002 rig units in the Umbrian Apennines, Italy

P 3002, our Medium-Weight Rig Type



Hard drilling in limestone

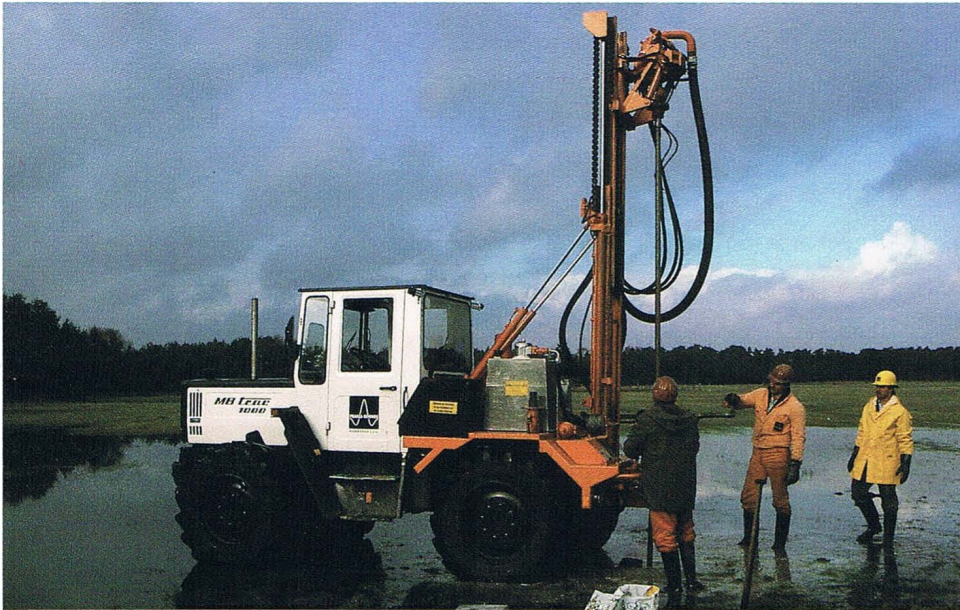


P 3002 rigs built in Uetze and ready for use

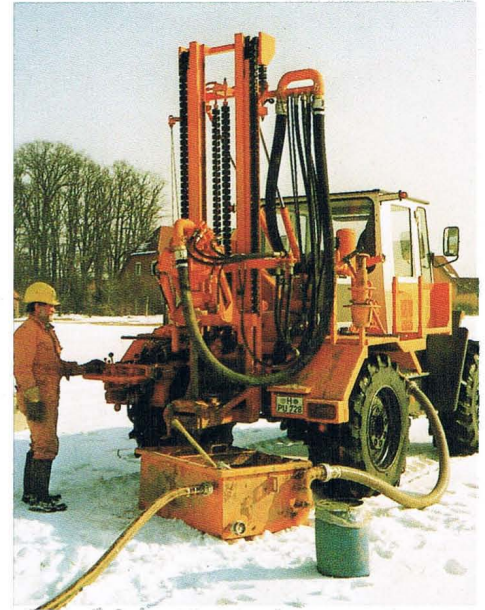
P 1002, Light-Weight Standard of our Arsenal

P 1002 unit on site in Rotterdam





P 1011 light-weight rig in flooded terrain



... drilling with mud circulation



**P 1011 and P 0501
— from Light-Weight
to Feather-Weight**

*P 0501 ready to move (piston-pump version,
s. table on page 4)*

P 0501 V



These two light-weight rig types present the link between the heavier units shown before and the heli-borne and portable systems described next. They are extremely manoeuvrable. Their small dimensions and weight minimize environmental damage, an important feature which — besides others — was decisive for this development by PRAKLA-SEISMOS Geomechanik in the last years.

Watertruck, trailer and P 0501 rig form a very mobile entity. Long moves are easily managed.



P-HD 0511, the Fly-Weight Solution

The lifter

Construction of a heli-portable drilling device is feasible, as is shown by several examples on the market. However, to build an extremely light and stable system is not so common, but is an art which we claim to master.

The system allows versatile use:

- With in-hole hammer and separate compressor unit it penetrates the hardest rock.
- Soft and medium-hard layers are drilled with water.
- Three wheels are easily attached. One of them is steerable. This allows the unit to be towed on small roads, tracks, mountain platforms, in swampy areas by a jeep, a horse, other willing creatures, even by men.

The compressor



System with wheels



... while drilling hard rocks

*Compressed-air lance LL 10 in action ►***Drilling Equipment
— portable systems**

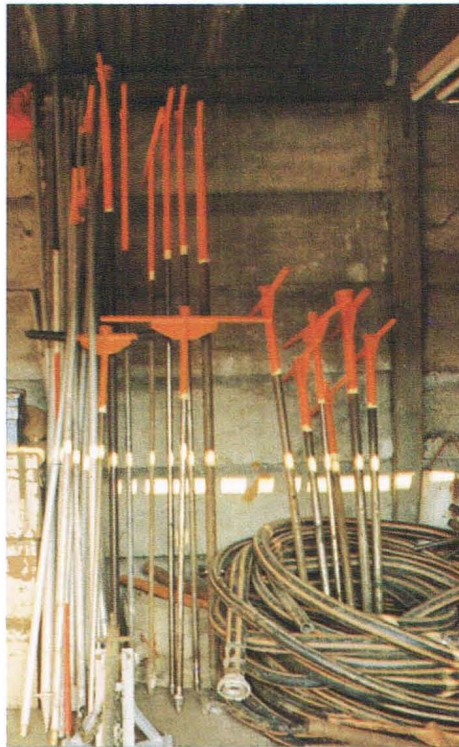
A number of good reasons led us to create suitable devices for small-diameter, shallow-hole and small charge lancing techniques: hand-lancing, compressed-air and water-lancing, pneumatic percussion hammers as well as displacement devices.

Specific advantages:

- real portability
- minimal field damage
- high productivity
- high resolution due to small charges
- flexible use for all types of rock and soil

Hand Lances

A tool as simple as it is efficient to sink slim holes — 2 m deep and 30 mm in diameter — into soft ground by manpower (s. page 10).



*Hand lances.
Arsenal of a seismic crew
in the Netherlands*

**Compressed-Air Lances LL 10**

To be used in areas where the ground can be blown out and the holes thereafter stand up for charging. Slim holes down to about 6 m can be sunk. Heart of the equipment is a lance consisting of sections 2.5 m long and 35 mm in diameter. A 3.5 m³/min compressor suffices for a single unit. For simultaneous operation of two or more lances a larger compressor (eg 9.5 m³/min) is advisable. The air lance LL 10 can be used parallel with ram hammers of type RH 65/75 (s. page 11).

Flushing Equipment T 20

Holes down to 20 m can be sunk by water or compressed air, depending on the ground. Thin layers of clay and marl can easily be penetrated. The standard equipment has 7 aluminium tubes each 3 m long. The 45 mm diameter allows small dynamite cartridges to be charged through the tubes. The system can be used in connection with the T 15.

Flushing Equipment T 15

Holes down to 15 m can be flushed in sandy ground. The flushing-pipe diameter of 50 mm allows conventional dynamite charges to be inserted, provided the holes stand up.



Flushing equipment T 20



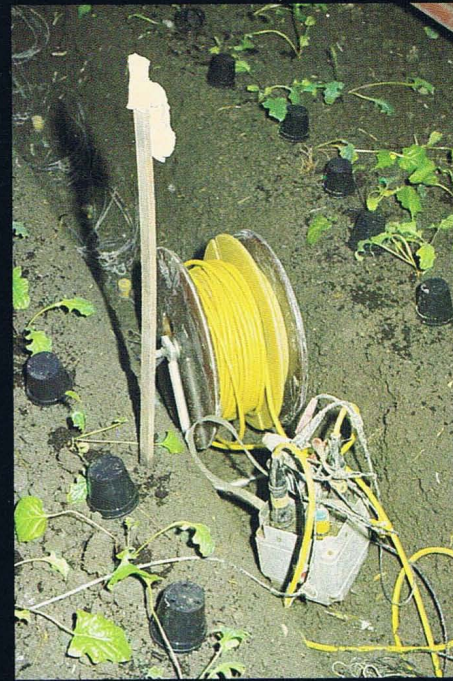
Flushing unit T 15 with pump and water circulation



Cable



Layout

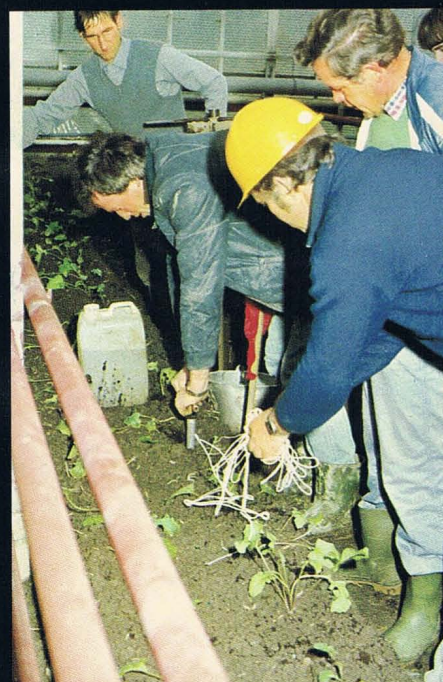


*Telemetry station
(disinfected!)*

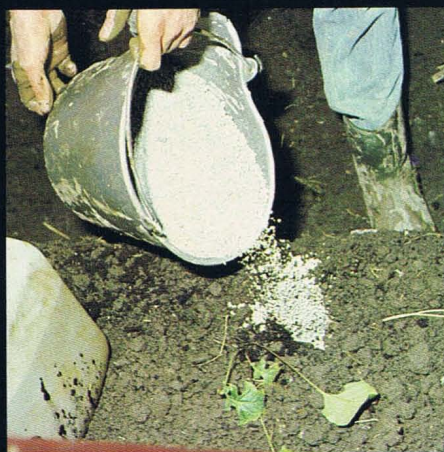


*Hand lance
between flowers*

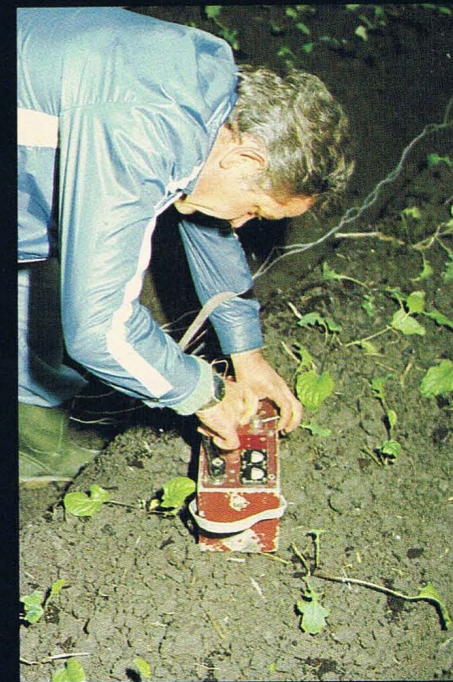
**3-D seismic lines crossing Holland's greenhouses.
Shotholes are prepared with lances.**



Charging (30 g)



Tamping



Shooting

Pneumatic Ram Hammers

Three ram hammer types have been added to our drilling outfit and modified to suit the clients' needs. These systems have proven extremely versatile and flexible. Line parts which are inaccessible even for light mobile rigs can be bridged by hammer work, executed by the rig crews using their own compressors, as is shown overleaf.

A short description of the different types and what they are good for:

Ram Hammer RH 65/75 (TRACTO-TECHNIK)

Power is supplied by a compressor, the size of which depends on the number of ram hammers to be operated.

Penetration rate in light to medium soil ranges from 1 to 2 m per minute. Two skilled helpers can sink 20 to 30 holes, up to 4 m deep, within one hour. The ram rods of the hammer are 2 m long and 35 mm in diameter.

The system is restricted to areas where the soil can be displaced, eg solid clay. It doesn't work in hard rocks or in loose, sandy ground. The holes have to stand up. Drilling is done by hammer blows without rotation. After the projected depth is reached, rod extraction is achieved by upward hammer blows.

The small diameter of the ram rods allows the holes to be charged with just 125 g dynamite cartridges.

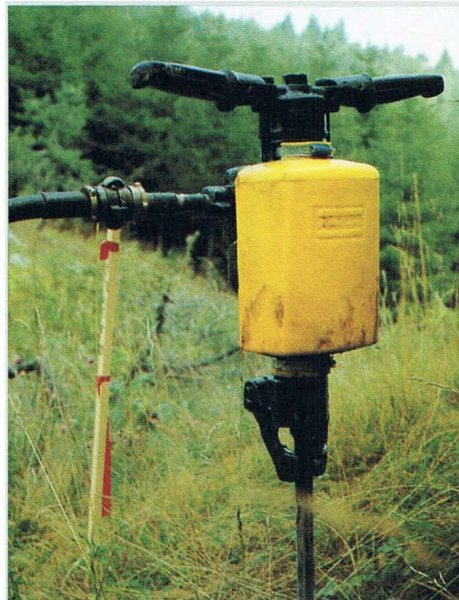
In order to minimize environmental damage, distances up to 500 m can be bridged by hoses.

The basic data:

Weight:	25 kg
Length:	1.20 m
Impact rate:	8/s
Air consumption for max. pressure of 7 bar:	0.8 m ³ /min



Ram hammer RH 65 in action



Ram hammer RH 571 in mountainous area

Ram Hammer RH 571 (Atlas Copco)

The system is used in hard rock and is driven by compressed air, which also blows out dust and cuttings. Drilling is done by hammer blows and rotation. When the hammer is shut down, the total output of compressed air can be used for blowing out the cuttings. The small diameter of the rods allows the holes to be charged with just 125 g dynamite cartridges.

The panorama overleaf demonstrates how flexible the ram hammer can be used.

The basic data:

Weight:	18.9 kg
Length:	0.51 m
Impact rate:	37/s
Air consumption for max. pressure of 6 bar:	2.22 m ³ /min



Ram hammer RH 130 S.

The integrated motor makes this system independent of compressed-air supply

Ram Hammer RH 130 S (Pionjär)

The RH 130 S has its own integrated two-stroke engine and is thus not dependent on a compressed-air supply. The fuel-tank capacity of 1.4 l is sufficient for one working hour.

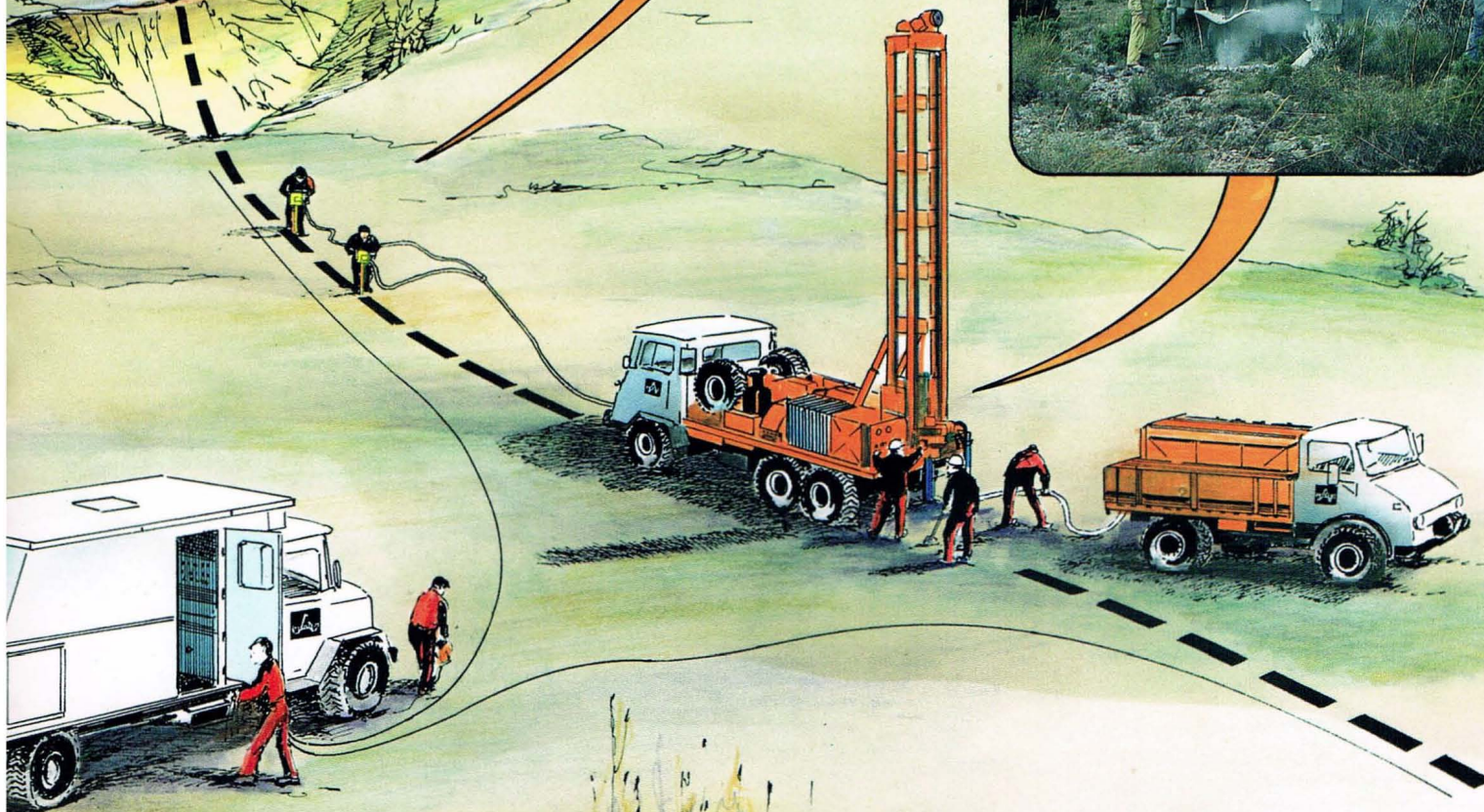
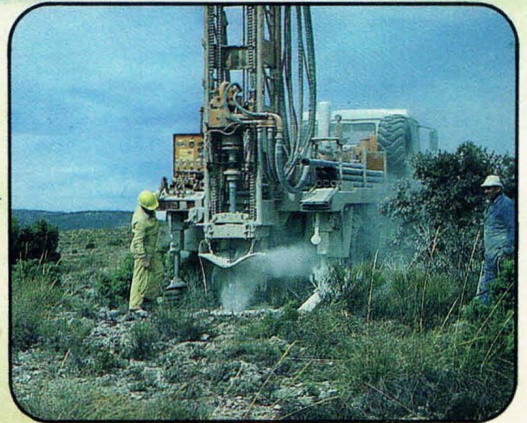
Holes down to 15 m are driven into displaceable ground, eg clay. The pipes of one meter length and 54 mm diameter are sunk by blows and vibrations. After reaching the projected depth, the 'lost spike' is detached and the hole can be charged through the pipe. If compact rods with 32 mm diameter are used, the hole must stand up for charging.

In any case, immediate tamping with Compactionit prevents the charge from being illegally removed.



How to overcome a mountain chain?

Preferably with a flexible outfit, ranging from heavy-weight rigs through light ones to heli-portable units. And where the terrain is too steep or forested even for those systems, ram-hammer compressors or the compressors of the mobile units. (Needless to say that the seismic instruments as well as the geophones and cables are portable, too, eg carried by men, mules or helicopters.)



Non-Explosive Energy Sources



A VVCA/C party in the Sahara

Standard Vibrators

PRAKLA-SEISMOS has now been carrying out vibroseis surveys for 25 years. And for nearly the same length of time the company has been developing and constructing all kinds of vibrators not only for its own use but also for sale.

The specifications in the following table and some pictures provide an impression of the variety and the high standard of our arsenal.

The Standard Vibrators

Type	Vehicle	Engine Power (kW at rpm)	Total Weight (kg)	Weight on Base-Plate (kg)	Size of Base-Plate (m ²)	Reaction Mass (kg)	Peak Force (N)	Frequency**) Range (Hz)
VVCA/C	Crab (4 x 4)	141/2500	14 300	12 760	2.36	1 450	84 369	6 — 105
VVCA/E	Crab (4 x 4)	141/2500	15 950	13 500	2.36	1 962	125 000	6 — 160
VVCA/S*)	Crab (4 x 4)	188/2500	17 500	14 500	2 x 0.66	2 650	169 000	6 — 80
VVFA	Crab (4 x 4)	207/2300	20 600	17 600	2.40	2 830	203 000	6 — 160
VVEA	Truck (6 x 6)	188/2500	18 970	16 400	2.14	2 003	125 000	6 — 160
VVDA	Truck (4 x 4)	130/2650	13 316	12 201	1.75	1 503	84 369	8 — 116

*) Shear-wave vibrator **) The frequency-range values are 'realistic' ones. Frequencies up to 250 Hz are feasible by changing the servo-valves.



VVCA/C vibrators active in Spain



Dunes and gypsum don't impose problems on VVCA/Cs

VVCA/C — Crab Vibrator and a Hit for Years.
Hardly any other system has seen so many exotic landscapes in so many countries

VVCA/E — The Modern Crab Version
of our All-Terrain Work-Horse



VVCA/E with sand tyres for the desert



VVCA/Es in Italy



VVCA/E party for a deep-crustal study in the Alps

Shear-wave vibrator VVCA/S



VVCA/S — Shear-Wave Version of the Successful VVCA-Family

VVFA — Heaviest and Most Up-to-Date Crab Vibrator

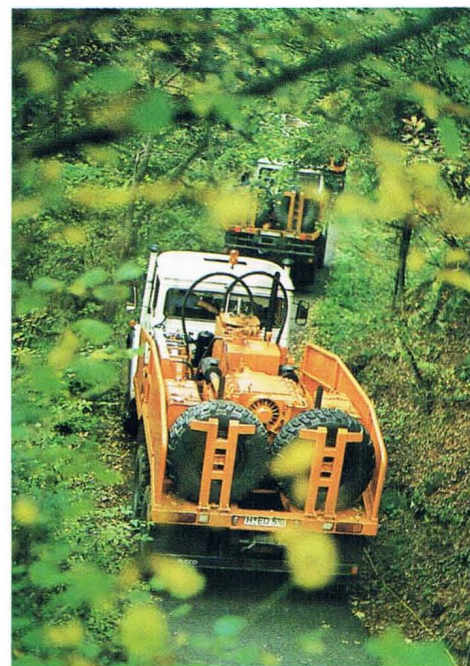


VVFA active in autumn and winter





VVEA in the Bavarian Forest



VVEA in the Black Forest



VVEA — Our Modern Heavy-Weight Truck Vibrator

*VVEA party active for a deep-crustal study.
A small bridge caused the gap*



VVDA — A Successful and Versatile Truck-Mounted System

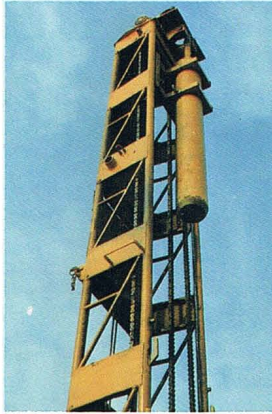
*VVDA party, quite a common sight in
Central Europe*

Weight-Dropping

The weight-dropping unit is mounted on a drilling rig and is used for:

- ▶ Short-refraction surveys
- ▶ Uphole surveys, especially in connection with vibroseis.

The weight at the mast head of a P 1002 ready for being dropped



Weight and base-plate after the drop



Surface Source VAKIMPAK*)

The system is moved under its own power. It can be used for:

- ▶ Short-refraction surveys
- ▶ Shallow-reflection surveys.

The hammer-blow energy is built up by a vacuum which is produced in the tube when the hammer is moved upwards.

Characteristics

Total weight:	500 kg
Speed:	5 km/h
Potential energy:	2500 J
Firing rate:	6—7 s

*) Produced by INTERFELS, Salzburg, Austria



A SOURSILE® hammer mounted on a Mercedes Unimog, here in travelling position. Clearly seen: the base-plate and one of the sideways swinging hammers for S-wave generation

Surface Source SOURSILE® P & S

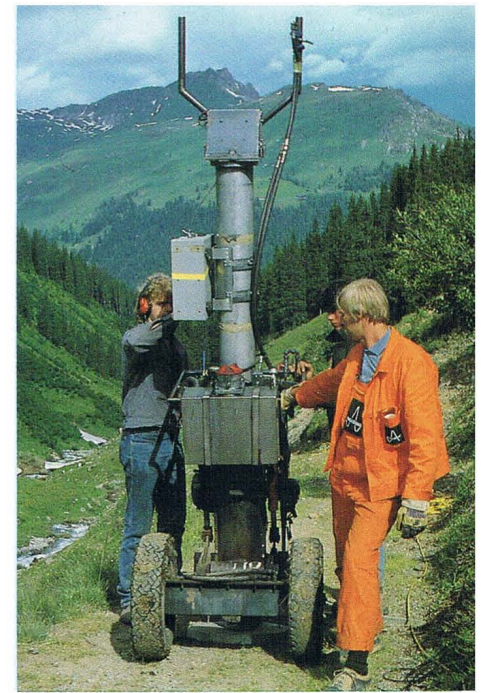
The system is designed to generate P-waves as well as polarized SH-waves at the surface.

P-waves are generated by dropping a weight on a base-plate; SH-waves are produced by the alternating freefall of two hammers on the base-plate, one for obtaining y+ waves, the other for creating y- waves.

Characteristics

	P-Source	SH-Source
Weight of falling mass:	200 kg	80 kg
Height of drop:	2 m	2 m
Potential energy:	4000 J	1600 J
Firing rate:	8 s	8 s

® IFP registered trade mark



VAKIMPAK, manoeuvrable in difficult terrain

Instrumentation



Telemetry boxes for digitizing the signals picked up by hydrophones



Not flowers, but just as lovely: cables and remote data units (RDUs). — A huge mountain of material must be brought together and checked before a survey can begin. Here in Turkey.

Recording Systems

	Capacity
► SERCEL SN 368 + LXU (Telemetry)	2400 channels, 4 ms SR 1200 channels, 2 ms SR
► SERCEL SN 348 + LIM (Telemetry)	480 channels, 4 ms SR 240 channels, 2 ms SR
► GEOSOURCE MDS 16 (Telemetry)	1016 channels, 2 ms SR
► SERCEL SN 358	120 channels, 2 ms SR
► TEXAS INSTRUMENTS DFS V	240 channels, 4 ms SR 120 channels, 2 ms SR

In connection with vibroseis:

► Stacker:	— GEOSOURCE ADD-IT IV for DFS V, SN 348
► Correlator/Stacker:	— SERCEL CS 260 for SN 368 — SERCEL CS 2502 for SN 368, SN 348 — INPUT/OUTPUT FPCS for SN 368, SN 348, DFS V

Their characteristics in tabular form:

	Sercel CS 260		Sercel CS 2502		I/O-FPCS	
sample rate (ms)	2	4	2	4	2	4
max. no. of channels	1200	2400	240	480	240	480
max. record length (s)	no limit		no limit		32	64
max. listening time (s)	32	32	6	6 12*)	12	24
max. sweep length (s)	no limit		no limit		record length minus listening time	

► Vibrator Controls:	— GEOSOURCE: SHV-RCV 310 C } with automatic Force Control
	— PELTON: Pelco Advance II }



SERCEL SN 368 with Correlator/Stacker CS 2502

*) 12 s for 240 channels and a sample rate of 4 ms

Auxiliary Equipment

- ▶ Units for Weathering and Uphole Surveys
 - ABEM Terraloc Mark III (portable) 24 channels
 - Geometrics, type ES-2415 F, combined with a tape recorder DMT-911 24 channels
 - SIE, type RS-44 24 channels
 - SIE, type RS-4 12 channels
 - OYO, type McSeis 150 6 channels
- ▶ Remote Firing Control: PRAKLA-SEISMOS, type ZXDG
- ▶ Wireless Seismic Data-Link: PRAKLA-SEISMOS, type ZXMA.
A pair of matched electronic units allows a Sercel SN 348 or SN 368 telemetric cable to be replaced by a wireless network in order to cross inaccessible terrain, such as swamps, rivers, roads or railways, by a line-of-sight radiowave propagation up to distances of more than 1500 m.

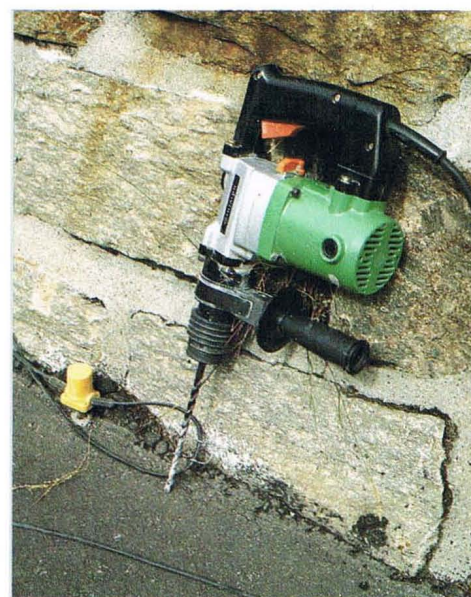
Receivers

Geophones:

- | | |
|--------------------|--|
| — Sensor SM-4/S-B | 10 Hz, as standard |
| — Sensor SM-4/U-B | 10 Hz, in marsh casing |
| — Sensor SM-7/S ET | 20 Hz |
| — Sensor SM-7/GT | 30 Hz |
| — Sensor SM-6/H-B | 8 Hz, horizontally orientated for shear-wave recording |

Hydrophones:

- | | |
|---------------------|--|
| — Geospace MP-24-LZ | 10 Hz, connected to bay cables for crossing lakes and rivers |
|---------------------|--|



An occurrence in a narrow mountain valley: Geophones had to be planted into asphalt, the holes for the spikes being drilled. (Naturally with permission of the Roads Department)

For crossing an obstacle — One of two electronic units of PRAKLA-SEISMOS' ZXMA which establish a wireless link for digital seismic data in connection with a SERCEL SN 348 or SN 368 system

Tools for the Topographical Survey

There is no doubt that precise, quick and comprehensive topographical surveys for the seismic field work — and also for data processing later on — are of major significance. The exorbitant demands on modern applied seismics

- increasing performance
- work in difficult areas like mountain regions and rainforests
- execution of special surveys like 3D

have to be matched by the topographical survey work as regards methods and equipment. For this reason a leading geophysical contractor has no option but to use the best and most modern material the market has on offer.

To our standard equipment belong:

Instruments

- Total Stations: — Geodimeter 440
— Geodimeter 140
- Distancemeter: — Geodimeter 220

- Data Recorder: — Geodat 126
— Geodat 124

Brief specifications of the instruments Geodimeter 440, 140; 220

Distance Measurement

- Range (at standard clear):
2.5 km on 1 prism
5.5 km on 9 prisms

- Accuracy (3-method system):

Geodimeter 140/220

- Standard $\pm (5 \text{ mm} + 5 \text{ ppm})$
Precision $\pm (5 \text{ mm} + 3 \text{ ppm})$
Tracking $\pm (10\text{--}20 \text{ mm} + 5 \text{ ppm})$

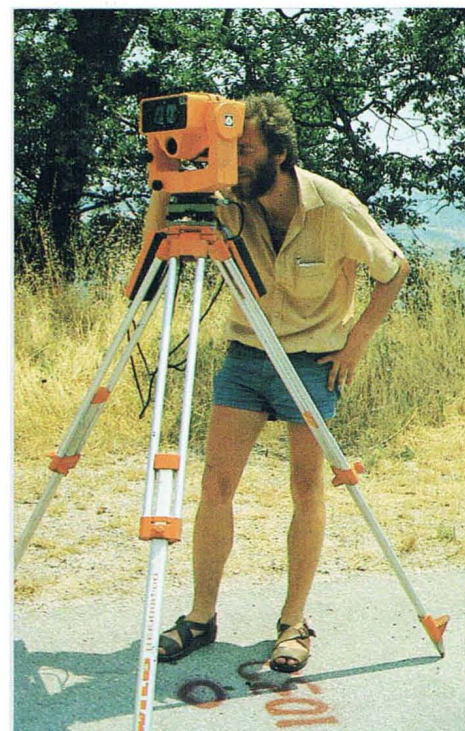
Geodimeter 440

- Standard $\pm (5 \text{ mm} + 5 \text{ ppm})$
Precision $\pm (3 \text{ mm} + 3 \text{ ppm})$
Tracking $\pm (10 \text{ mm} + 5 \text{ ppm})$

- Measuring Time:
0.4 s (tracking)
5.0 s (short range)
7.0 s (long range)



Total station Geodimeter 440.
The surveyor is operating the data recorder Geodat 126. In the background a tiltable prism-reflector



Total station Geodimeter 140

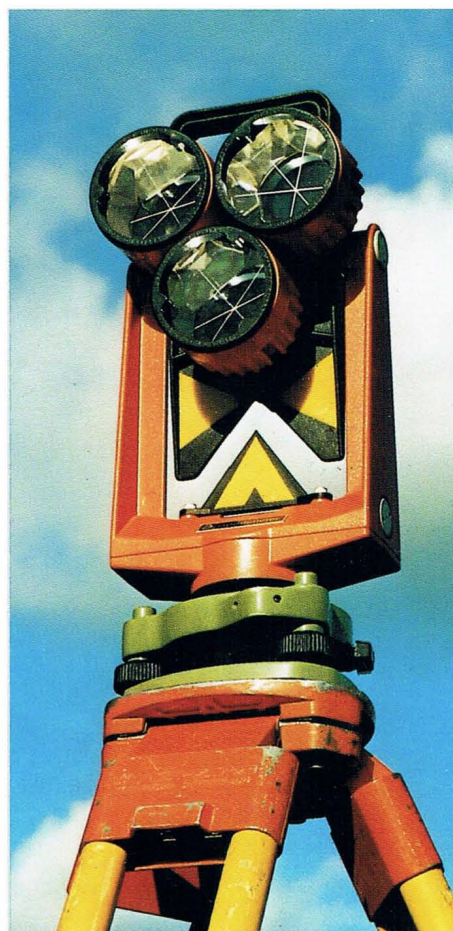
► Angle Measurement

- Geodimeter 440/140
 - automatic level compensator (dual axis)
 - storing of collimation and horizontal-axis errors
 - accuracy (single-face measurement): $\pm 6''$ ($\pm 0.6 \text{ mgon}/\pm 2''$)
 - levelling: circular level on tribrach
10'/2 mm
- Geod. 440: electronic 2-axis level in the LCD-Display with resolution of $20''$ ($2 \text{ mgon}/6''$)
- Geod. 140: plate level on alidade
20'/2 mm
- centering: optical plumb on tribrach
- telescope: magnification 30×
- Geodimeter 220
 - automatic reduction sensor
 - adjustable to theodolite within $\pm 2.5''$ ($0.25 \text{ mgon}/1''$)
 - angle adjust resolution $5''$ ($0.5 \text{ mgon}/2''$)

► General Features

- Measurements are carried out by infra-red sensors
- Operating temperature: -20°C to $+50^\circ\text{C}$
- Data communication:
 - Geod. 440/ 140: input/output to Geodat 126/124 and RS232 C/V24 interface
 - Geod. 220: output to Geodat 126/124 and RS232 C/V24 interface
- Special features for Geodimeter 440
 - 4-row display with automatic illumination and heating
 - keyboard with 20 keys
 - menu control
 - programmable from keyboard (20 user-definable recording sequences)
 - internal data recorder (storing up to 900 points)
 - editing from keyboard

*Tilttable prism-reflector.
The infra-red impulses sent out by the
distancemeters and total stations are
reflected here*



*Distancemeter Geodimeter 220 on a WILD
TO theodolite*

**Brief specifications of the data
recorders Geodat 126/124**

- programmable from keyboard
- user-definable recording sequences
- alphanumeric keyboard
- two-way data communication to all Geodimeter instruments
- connectable to computers (RS 323 C interface) and cassette recorders

Only for Geodat 126:

- field calculation programs
- formats and protocols are user-definable
- external memory function in combination with Geodimeter 440

	Geodat 126	Geodat 124
CMOS memory	32 K	32 K
LCD-display	14 characters	16 characters
storage capacity	max. 1400 points	max. 1000 points
storage time	approx. 3 months	approx. 3 months
operating temperature	− 10°C to + 50°C	− 20°C to + 50°C
memory structure	field data coordinate bank	field data
identification characters (used for defining the prompting sequences and for computer communication)	0 to 79 80 to 99 user-definable	0 to 9 A to F

Installation of Equipment and Transport

The means of transportation are of great importance for every seismic party. 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 bear. These few standard types may then be modified according to their special uses:

- ▶ **MERCEDES-BENZ Truck — Unimog**
 - Recording truck (dynamite seismics)
 - Cable/geophone truck
 - Surveyor truck (double cabin)
 - Explosive truck (double cabin)
 - Salvage truck (double cabin)
 - Water truck

- ▶ **IVECO-MAGIRUS Truck**
 - Recording truck (vibro-seismics)
 - Supply truck
 - Water truck with crane (3 axles)

- ▶ **VOLKSWAGEN Light Truck**
 - Explosive transport vehicle
 - Cable/geophone vehicle

- ▶ **MERCEDES-BENZ Light Truck**
 - Explosive transport vehicle

- ▶ **Liaison Vehicles**
 - VW-Polo
 - VW-Golf
 - VW-Passat
 - VW-Bus
 - MERCEDES-BENZ 4 x 4

MERCEDES-BENZ Unimogs, our real work-horses in deserts, rainforests and mountains. Here as cable trucks in the Alps



IVECO-MAGIRUS truck, instrument carrier for vibro-seismics

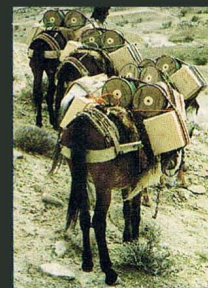
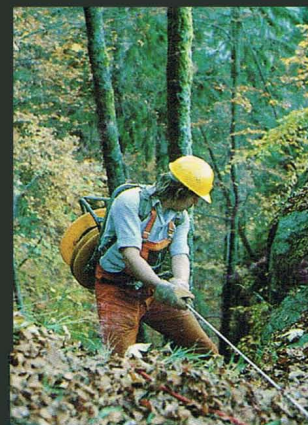


MERCEDES-BENZ Unimog, instrument carrier for dynamite seismics





What cannot be handled
by 'standards'
must be overcome by FLEXIBILITY



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