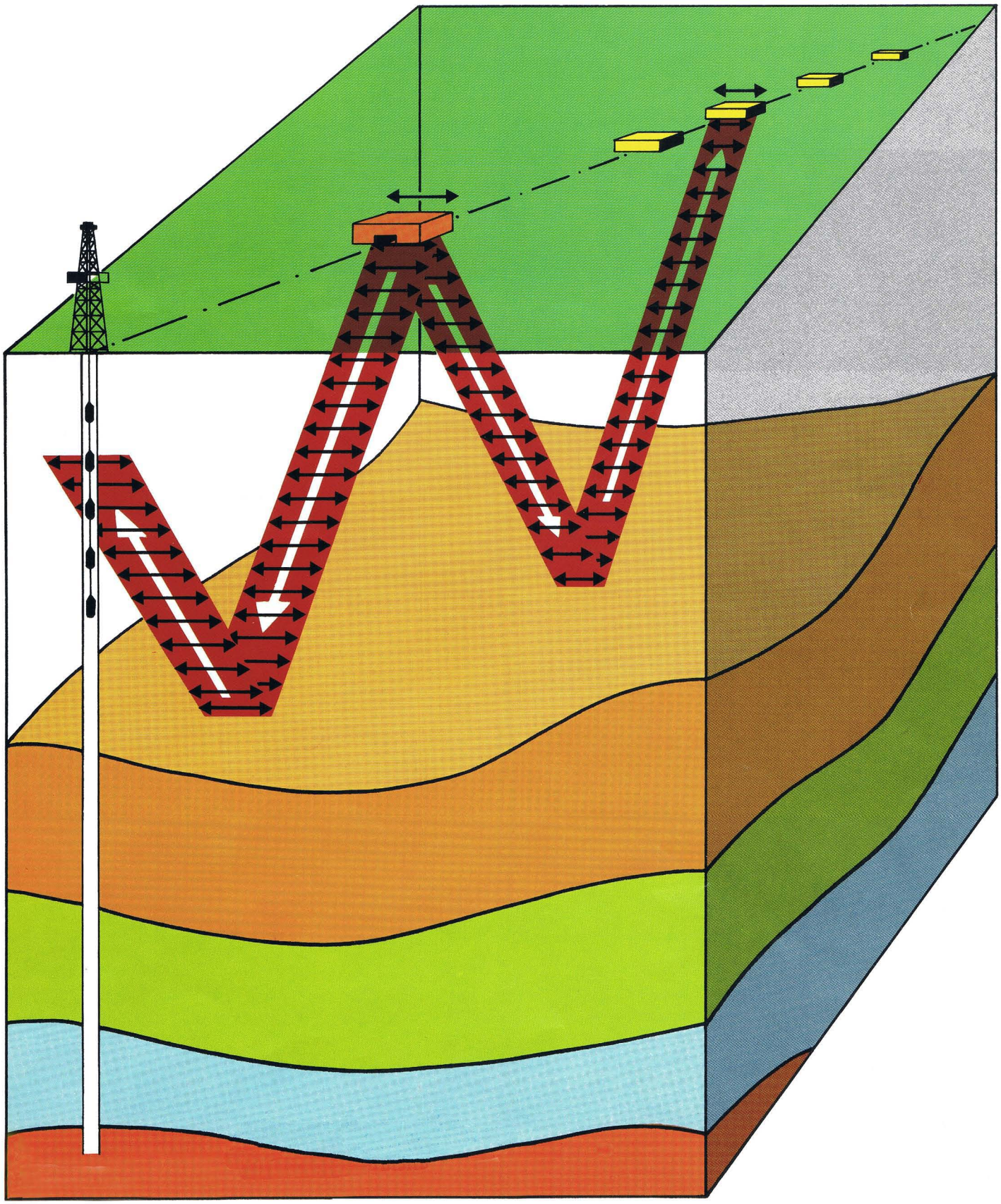
PRAKLA-SEISMOS INFORMATION No.52

Shearwave Surveys and Equipment



Shearwave Surveys and Equipr

The shearwave is an inevitable wave component when making seismic surveys. During the last ten years shearwaves have developed from a disturbing event to an exploration tool.

At a first glance it seems to be more economical to record shearwaves which are generated by wave conversion at interfaces together with compressional waves. Data processing then has the difficult task of separating the shearwave mode of interest from compressional- and various other converted wave types.

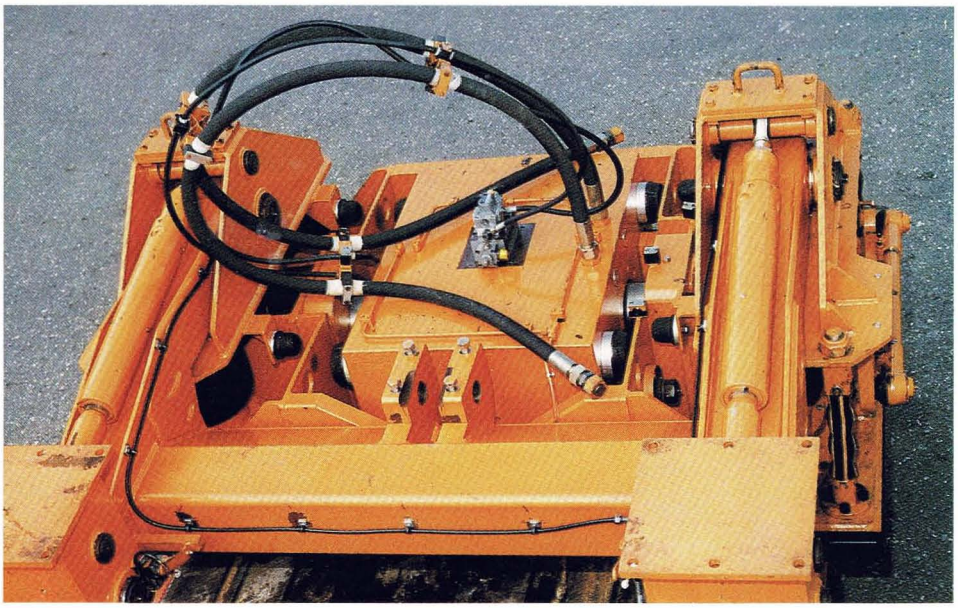
Relying upon converted waves, therefore, means that the strength of reflection signals very much depends on parameters strongly determined by the local structures to be investigated. Effects induced by structure or stratigraphy are therefore difficult to separate. We thus follow the line of generating pure SH-waves, avoiding any interference from converted waves.

The generation of SH-waves means applying horizontal stress to the ground. Techniques to achieve this are more or less universal, horizontal hammers and horizontal vibrators have become the most popular techniques. These methods are independent of the structure and fairly independent of the properties of the near-surface layers where the shear stress is generated. Vibrators are comparatively flexible and use a technique which is already well proved.

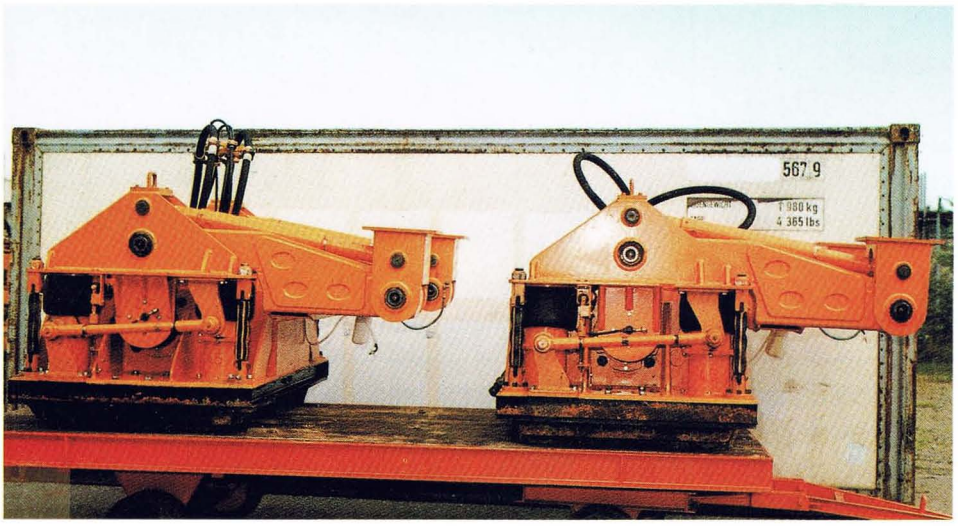
The shearwave vibrator can be used for refraction and reflection surveys in a broad and selectable frequency range. For downhole reflection measurements, either VSP or MSP (Multi Offset VSP), the vibrator is an extremely flexible source which gives results well comparable with the reflection seismic sections.

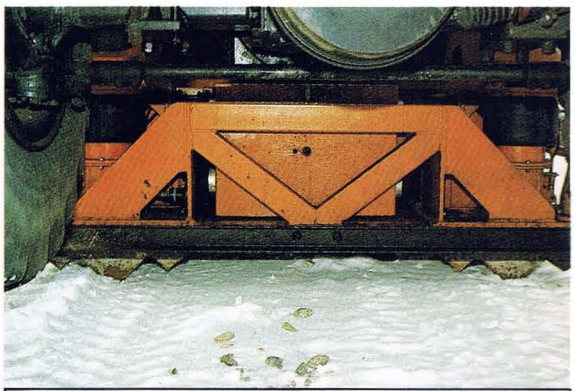
When using special baseplates, damage on roads can be avoided. The coupling on soft ground can be achieved by baseplates with pyramids tuned to the penetration resistance of the soil. The shearwave vibrator gives the possibility of optimizing sweep signals with respect to coupling and penetration.

Either special shearwave vibrators type SH 17 S can be offered or standard P-wave vibrators type VVCA can be converted for use as shearwave vibrators type SH 13 S with lower peak force using a separate shear-wave vibration unit.

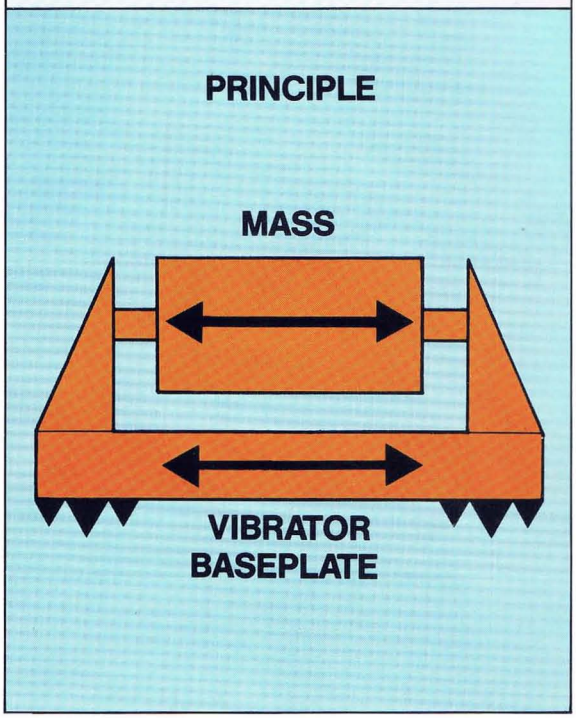


▲▼ **Shearwave Vibrator Units**





Rearview of Shearwave Vibrator with baseplate in working position



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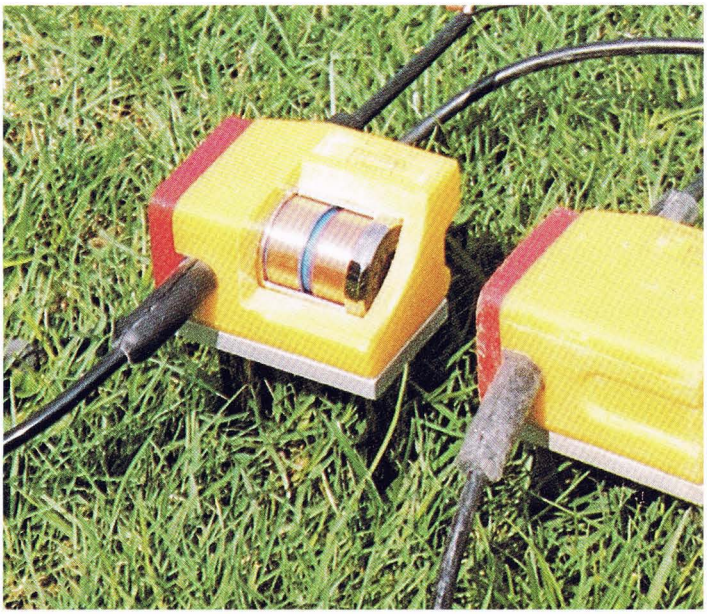
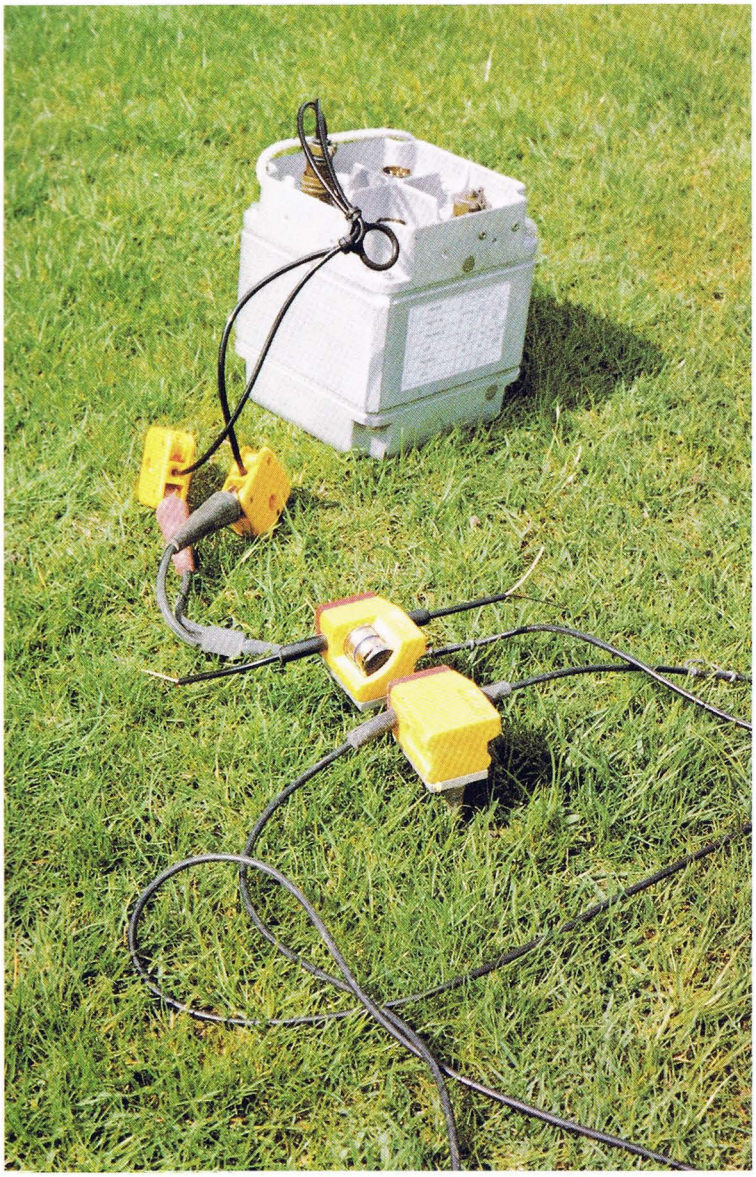
On the **recording side** horizontal geophones are the most important elements for shearwave surveys. To avoid excessive differences with respect to coupling and transient behaviour we have selected a type of horizontal geophones which have a characteristic as similiar as possible to the vertical geophone type.

Two-component geophones which are used by some companies give operational advantages in some respects. In most areas, however, the geophone patterns for P- and S-wave recording must be separately tuned according to the different types of surface waves generated by the compressional- and shearwave generators.

Planting of shearwave geophones demands good vertical and horizontal orientation. Vertical setting is simplified by using double spiked geophone plates. The horizontal orientation is achieved by adjusting the geophones according to markers set by the surveyor. Both horizontal and vertical orientation can be controlled by levels and colour caps attached to the geophone cases.



▲ **Horizontal geophone, type SM-9 model HB (with cut-away view)**



▲ **Horizontal geophone, type SM-9 model HB**

▲ **Horizontal geophone pattern**

▲ Shearwave Vibrator, type SH 17 S

▲ Shearwave Vibrators, type SH 13 S

Technical Data

VVCA – Heavy Duty Construction

Vibrator Specifications

Type	SH 13 S*	SH 17 S**
Weight on baseplate	135 000 N	147 000 N
Peak force	125 000 N	169 000 N
Actuator mass	2100 kg	2650 kg
Piston area	59.55 cm^2	80.93 cm^2
Usable stroke	50 mm	50 mm
Baseplate area	2 x 0.66 m^2	2 x 0.66 m^2
Lift system	One cylinder lever-arm system (PRAKLA-SEISMOS patent)	
Vibrator isolation	air bags	air bags
Lift stroke	800 mm	800 mm

Vehicle Specifications

Vehicle type	4 x 4 crab tractor	4 x 4 crab tractor
Engine type	KHD F 6 L 413 F (KHD F 8 L 413 F)	KHD F 8 L 413 F
Engine power (DIN 6270)	107 (142) kW at 2150 rpm	142 kW at 2150 rpm
Vehicle dimensions (L x W x H) (without winch)	7200 mm x 2500 mm x 2750 mm	7200 mm x 2500 mm x 2750 mm
Wheelbase	4000 mm	4000 mm
Tires	20.5 x 25 Continental E 58	20.5 x 25 Continental E 58
Power transmission	hydrostatic, power regulated	hydrostatic, power regulated
Vibrator pump	A 6 V 117 HA	A 6 V 164 HD
Drive pump	A 4 V 56 HD	2 x A 4 V 125 HD
Max. Speed	42 km/h (26 mph)	28 km/h (17.3 mph)
Hill – climbing ability	70 %	60 %
Engine fuel tank capacity	480 l	480 l
Hydraulic reservoir capacity	120 l	2 x 120 l
Turning radius	6.75 m	6.75 m
Total weight* **	158 000 N	160 000 N – 180 000 N

* standard carrier vehicle usable
** only for modified heavy duty construction
***varies with equipment

Technical changes without notice

Technical Data

SM 9 (Model HB) – Horizontal Geophone

Electrical Specifications

Natural Frequency	10 Hz
Frequency Tolerance from Horizontal to 14° Tilt	± 5 %
Frequency Specification at 20° Tilt	10.2 Hz ± 5 %
Typical Spurious Frequency	330 Hz
Coil Resistance	375 Ohm ± 5 %
Distortion with 0.7 In/Sec pp Coil to Case Movement from Horizontal to 5° Tilt	< 0.2 %
Distortion with 0.7 In/Sec pp Coil to Case Movement from Horizontal to 10° Tilt	< 0.3 %
Distortion with 0.7 In/Sec pp Coil to Case Movement from Horizontal to 15° Tilt	< 0.4 %
Distortion with 0.7 In/Sec pp Coil to Case Movement from Horizontal to 20° Tilt	< 0.5 %
Distortion Measured at Frequency of	12 Hz
Open Circuit Damping for 375 Ohm Coil	0.250
Shunt Resistance Used for Damping Calibration with 375 Ohm Coil	1339 Ohm
Damping with Shunt for 375 Ohm Coil	0.60
Damping Tolerance from Horizontal to 15° Tilt	± 6 %
Sensitivity	28.8 V/m/s ± 5 %
Suspended Mass	11.1 g
Coil to Case Travel Limit	4 mm (0.16 in)

Physical Specifications

Dimensions	Basic Unit (element)	HPE-case
Length	–	57 mm (2.24 in)
Width	–	45 mm (1.77 in)
Diameter	25.4 mm (1.00 in)	–
Height	36.0 mm (1.42 in)	35 mm (1.38 in)
Weight	81 g (2.86 oz)	192.5 g (6.79 oz)

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