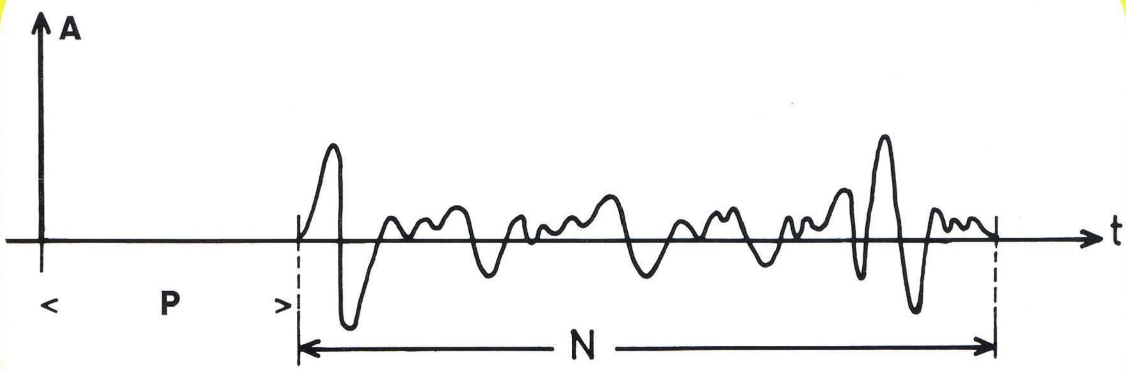
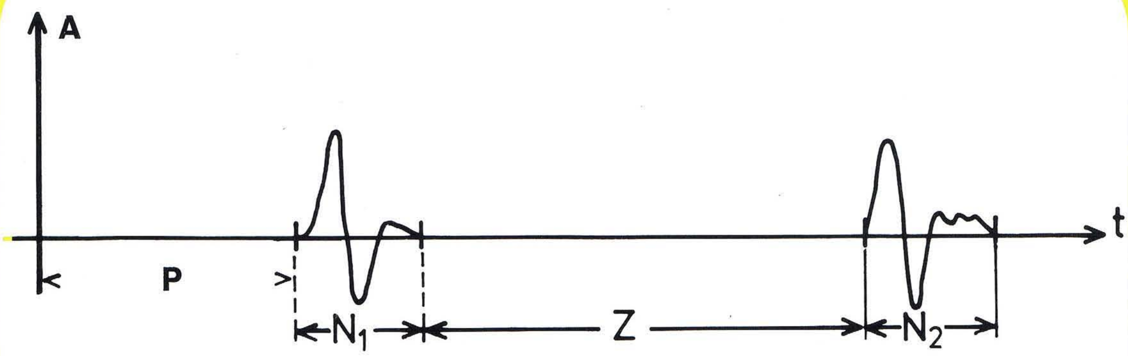
PRAKLA-SEISMOS INFORMATION No. 6

Attenuation of Multiples, Deconvolution

Operator for Predictive Deconvolution



Operator for Predictive Gap Deconvolution



Attenuation of Multiples, Deconvolution

Multiples are one of the main problems in geophysical data processing. There are different types of multiples (e.g. ghosts, reverberations, peg-legs) and several methods of suppressing them. Some procedures of multiple attenuation, available at PRAKLA-SEISMOS, are presented here, whereby a rough classification into two types is carried out: methods with linear and with non-linear operators.

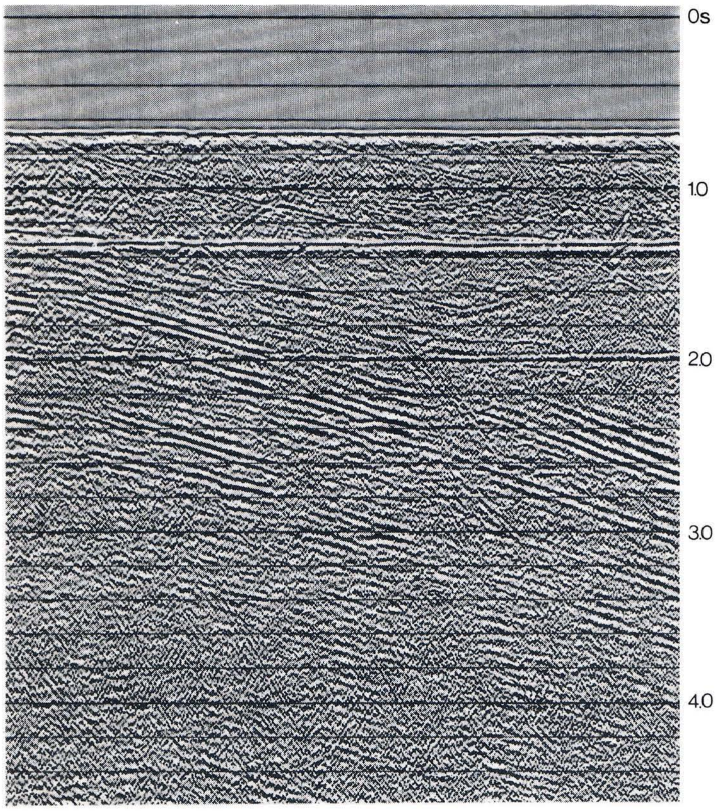


Fig. 1a: Stack

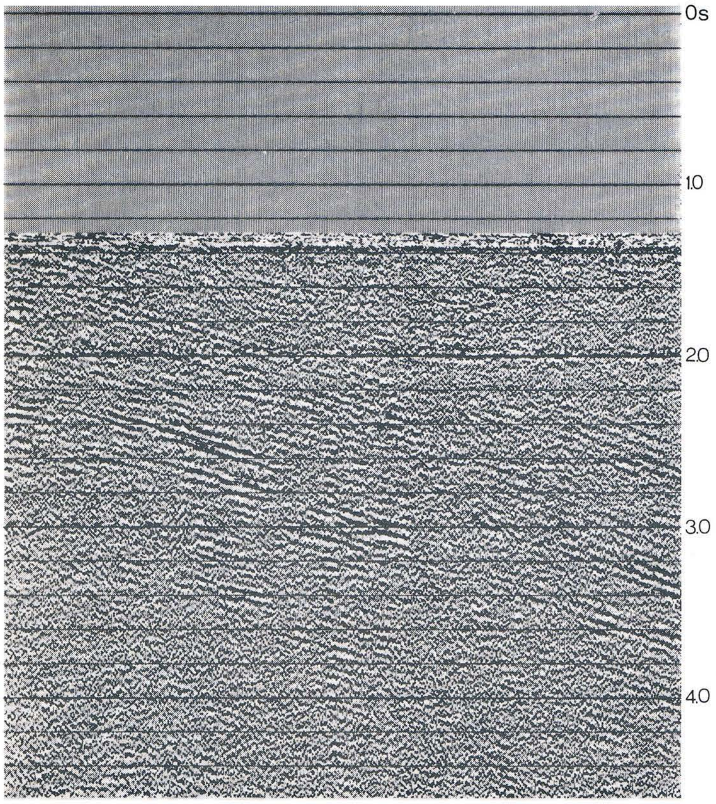


Fig. 1b: Predicted Part of Stack

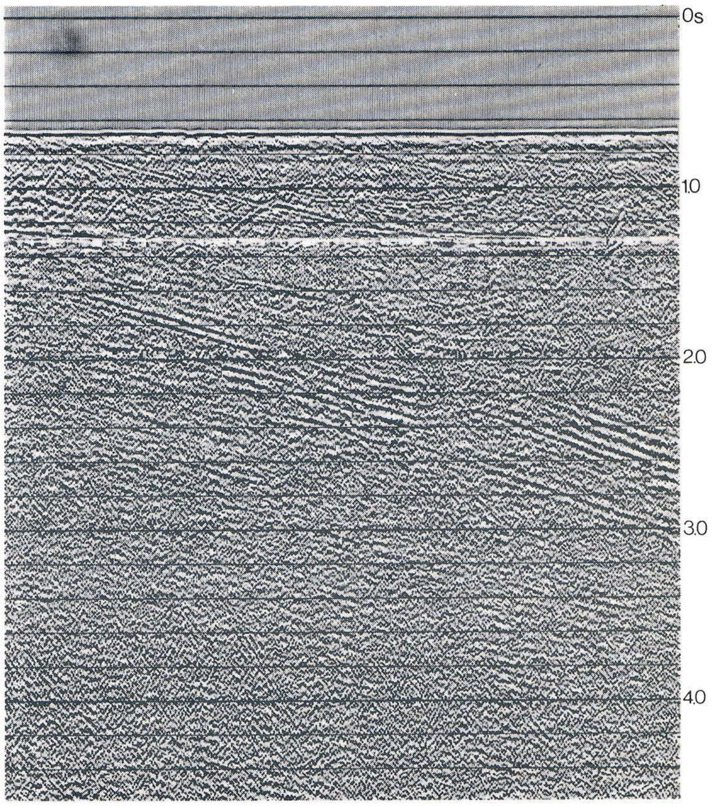


Fig. 1c: Adaptive Deconvolution on Stack

1. METHODS WITH LINEAR OPERATORS:
   - Conventional deconvolution
   - Adaptive deconvolution
   - VIBROSEIS* deconvolution
   - Multichannel methods
     - AMEL
     - Fan filter

2. METHODS WITH NON-LINEAR OPERATORS:
   - MUKO
   - MUVE
   - MABS

* Trademark of Continental Oil Comp.

Fig. 2a: Stack

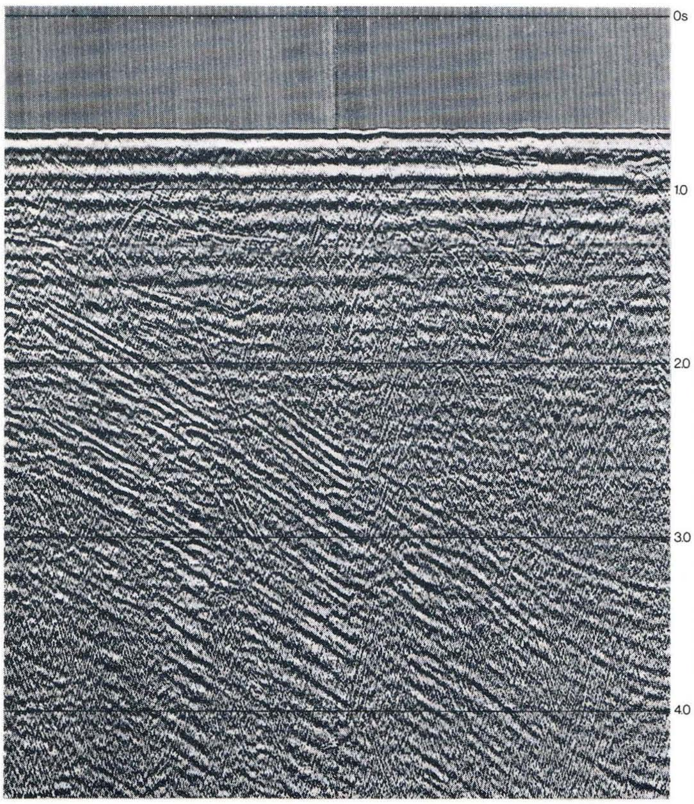


Fig. 2b: Stack after MUVE

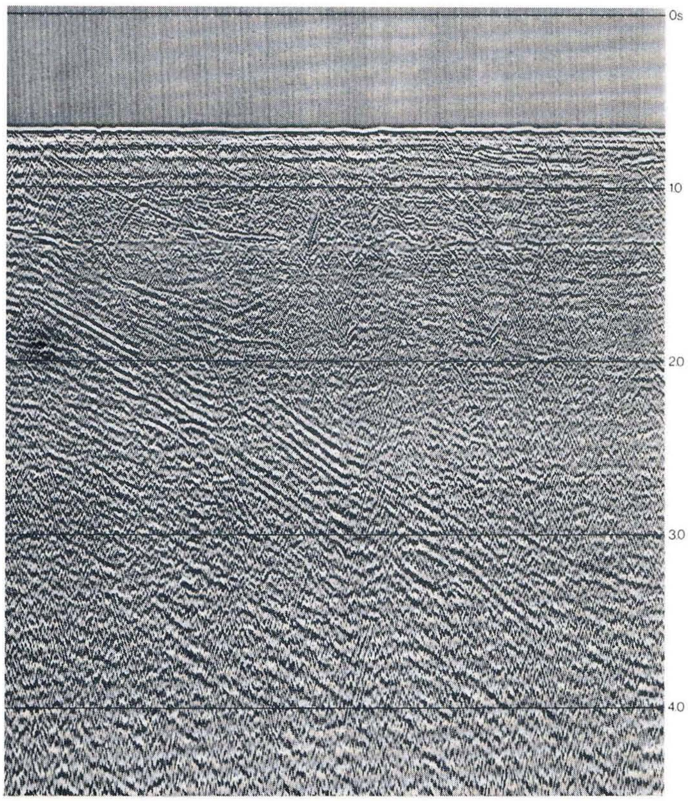


Fig. 2c: Adaptive Deconvolution on Stack after MUVE

1.1 Conventional Deconvolution

Conventional Deconvolution

Suppression of multiples in single and stacked records using constant operators determined by means of autocorrelation. The process works with either spike- or predictive-operators; time-variant deconvolution is possible.

In the conventional Wiener-Levinson deconvolution a prediction filter is computed by means of the autocorrelation of a trace or parts of it. This prediction filter computes and simultaneously eliminates from the trace any predictable events of a trace such as e.g. internal multiples, ghosts, reverberations. The operator is calculated at a few discrete points of a trace with the possibility of interpolation for time-variant operations.

1.2 Adaptive Deconvolution

Adaptive Deconvolution

Suppression of multiples in single and stacked records using time variant operators determined by an updating method. The process works with either spike- or predictive-operators; gap deconvolution is possible.

In contrast to conventional deconvolution, adaptive-sequential operators change from to sample: with adaptive methods predicted values are compared with actually measured values, and the operator, as a function of the difference of both values, is updated.
Adaptive deconvolution can be applied with or without gap, both possibilities using either spike- or predictive-operators. The front cover shows above an operator for predictive deconvolution; below is an operator for predictive gap deconvolution, particularly suitable for the elimination of long-period multiples. For $p=1$ (p = prediction interval) corresponding spike-operators are obtained.

Figs. 1—3 show, in various examples, the effect of adaptive deconvolution. Using this procedure it is possible to display the predictable portion (Fig. 1b) of the section shown in Fig. 1a. The result after application of an adaptive predictive gap deconvolution is presented in Fig. 1c. Whilst peg-legs and the 2nd, 3rd, and following sea-bottom multiples have been well eliminated by using the adaptive deconvolution, the result for the first sea-bottom multiple is not satisfactory. Fig. 2 shows how a better result can be achieved by the coalescence of various procedures for multiple suppression.
After having applied process MUVE (for description see 2.1) the sea-bottom multiples, contained in the stack (Fig. 2a), are eliminated (Fig. 2b). The remaining peg-legs are cancelled by an adaptive predictive gap deconvolution applied to this stack (Fig.2c).
Fig. 3 presents a section (complete and an enlarged extract) without (Fig. 3a and 3aa) and with adaptive predictive deconvolution (Fig. 3b and 3bb).

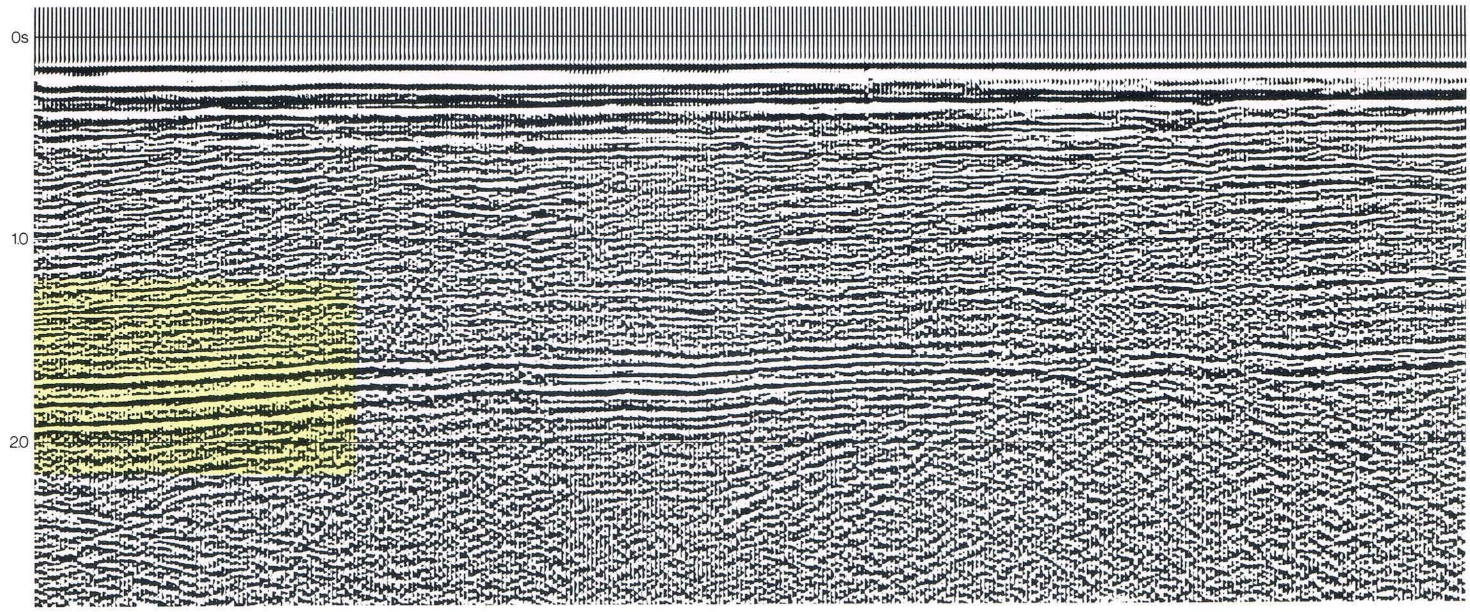


Fig. 3a: Stack

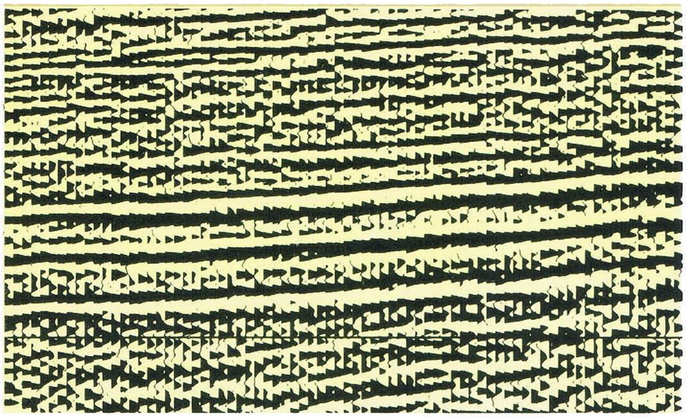


Fig. 3a a

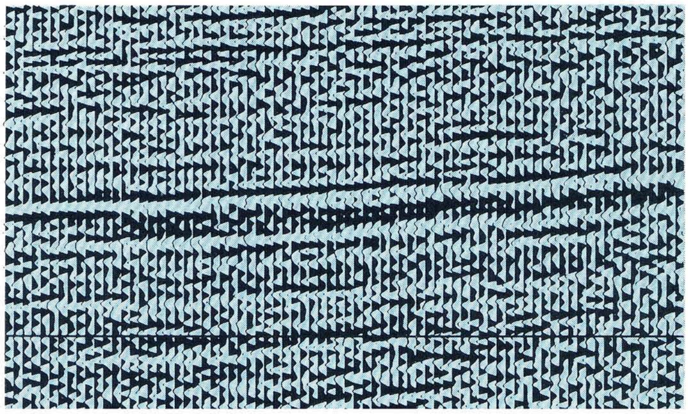


Fig. 3bb

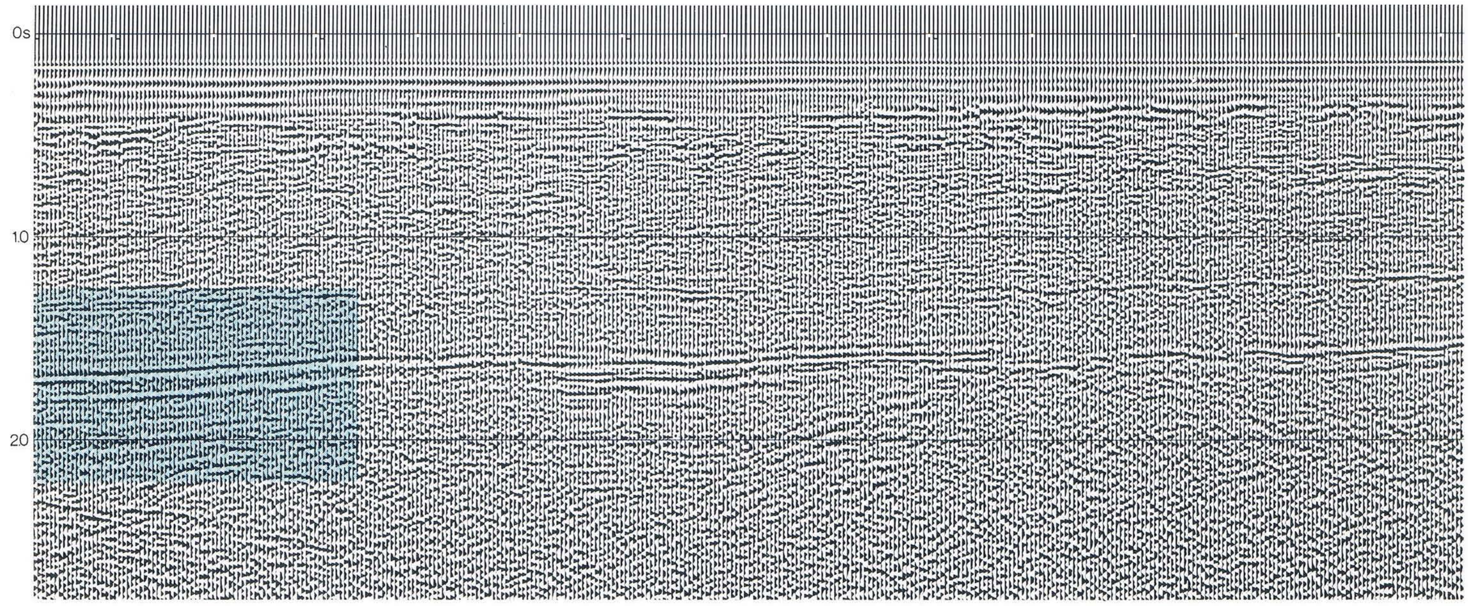


Fig. 3b: Adaptive Deconvolution on Stack

1.3 AMEL

AMEL

Suppression of multiples in single records
using Destructive Interference Weighting of single traces.

A well known procedure to support the natural behaviour of multiple suppression of the stack is the weighting of certain traces of a CDP-gather. Through special selection of weighting values in the AMEL-process this relatively simple and fast procedure can be extremely successful. Fig. 4 shows an example of an application of AMEL.

Because of great water depths (about 2.9 s) no multiples can be expected up to about 5.8 s; therefore, both stackings must here be identical. Below 5.8 s multiples disappear in the weighted stacking (Fig. 4b); as can be seen, events arise which were superimposed by multiples in the unweighted stack (Fig. 4a).

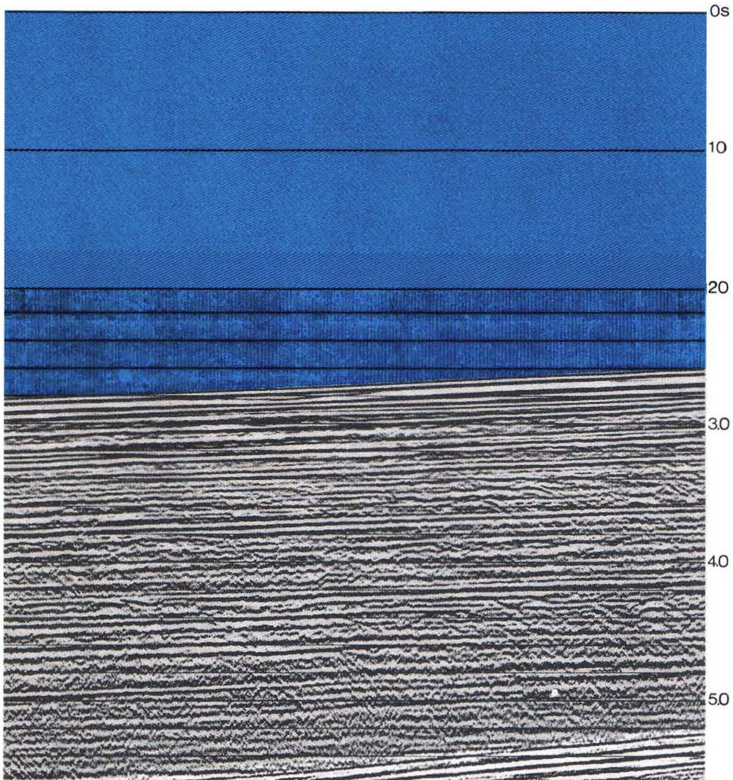


Fig. 4a: Stack

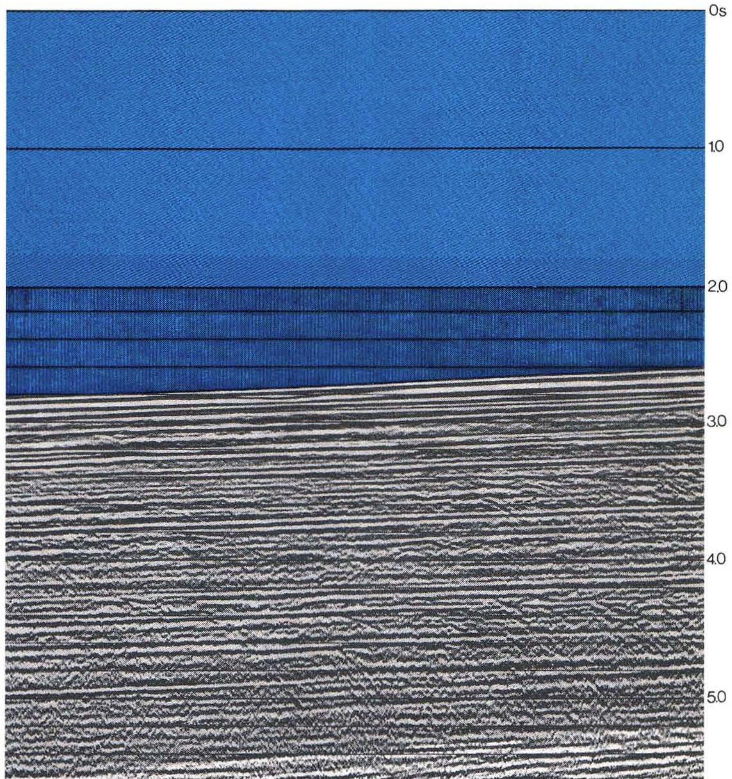


Fig. 4b: Stack after AMEL

2.1 MUVE

MUVE

Suppression of multiples in single records
taking account of multiple-velocity and coherency criteria.

MUVE checks the traces of a subsurface point on an optimal line-up of events by taking account of the velocity of multiples. If the line-up quality is above a certain level, the corresponding events are regarded as multiples and attenuated reciprocal-proportionally to the line-up quality so that the subsequent stack becomes free from multiples. If there are, at the same time, multiples with strongly varying velocities in a line, the MUVE process must probably be repeated until the desired result is obtained.

Fig. 2 shows how two procedures in such a case are able to act together. After having applied MUVE only once (Fig. 2b), sea-bottom multiples disappeared, but peg-legs remained (arrow) which, however, were eliminated by an adaptive predictive gap deconvolution applied to the stack (Fig. 2c).

(Process MUVE has been developed in cooperation with B. Buttkus, BGR, Hannover).

2.2 MABS

MABS

Suppression of multiples in single records
using pre-determined multiple traces.

MABS produces single traces, containing only multiple events. After having adequately adapted the traces, according to their amplitudes, to the actually measured field traces, both are combined in such a way that the field traces, and thus the stacking, are free from multiples. Fig. 5 shows an example of an application of MABS.

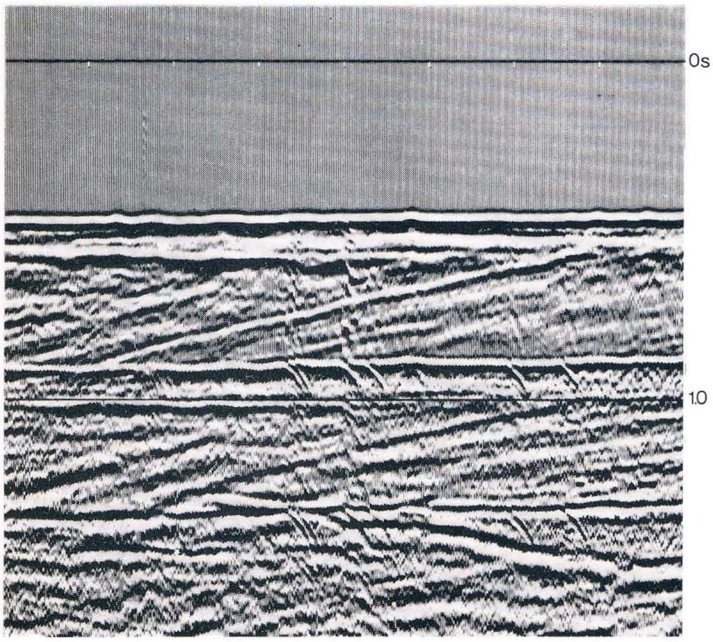


Fig. 5a: Stack

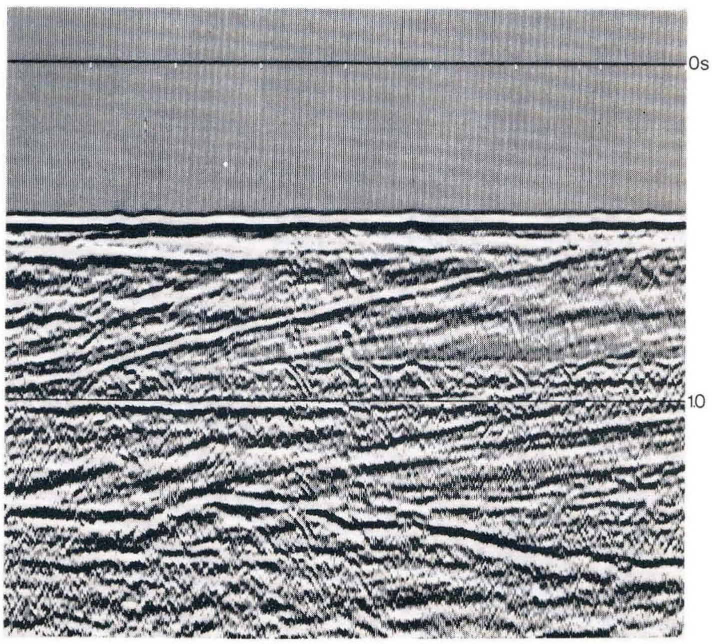


Fig. 5b: Stack after MABS

MUKO

Suppression of stronger multiples in single records using Amplitude Scanning.

MUKO enables the suppression of strong multiples (especially sea-bottom multiples). Since a rough knowledge of the amplitude behaviour of primaries and multiples is necessary, MUKO is applicable after Real Amplitude Processing. MUKO locates multiple amplitudes, characterized by their size and low velocity, and replaces them with amplitudes which — in the presence of primary reflections — should be expected.

Fig. 6 shows how MUKO destroys a strong sea-bottom multiple.

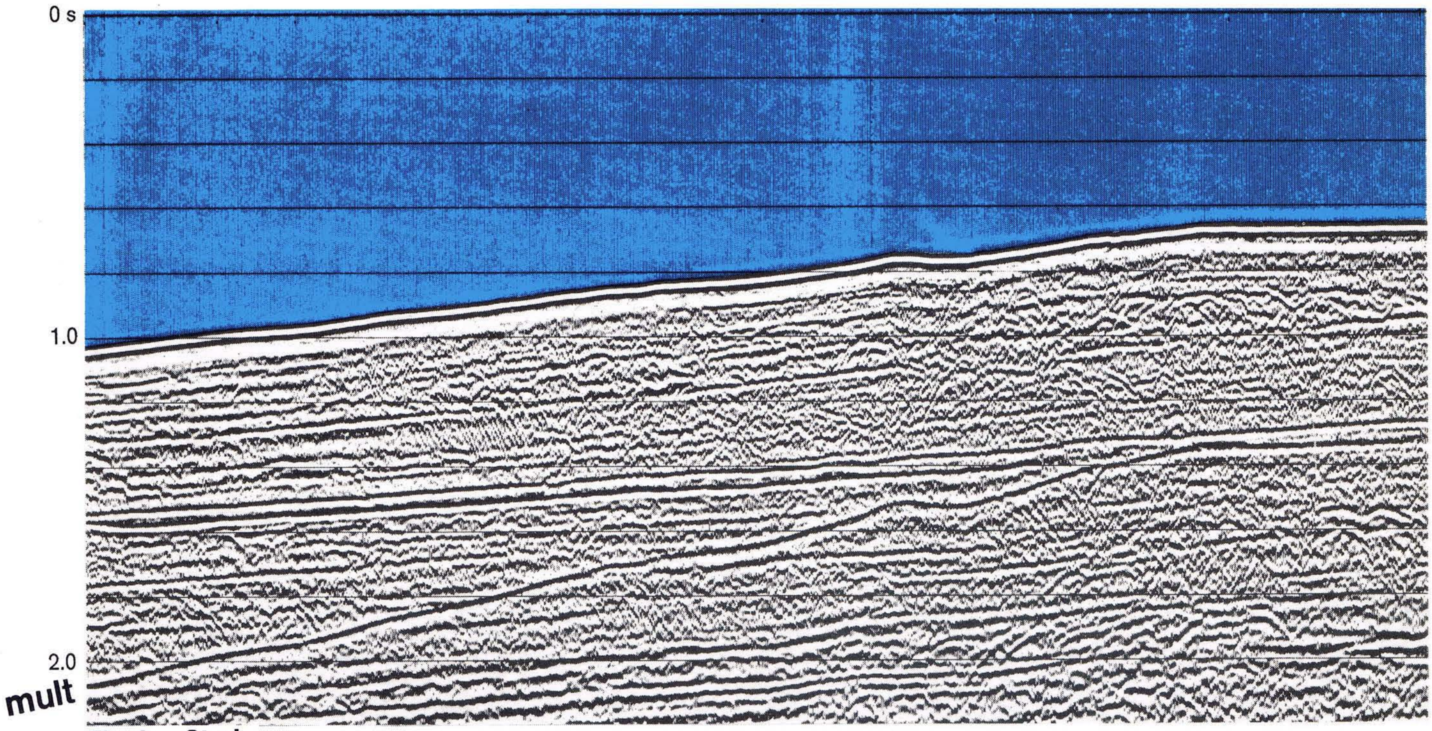


Fig. 6a: Stack

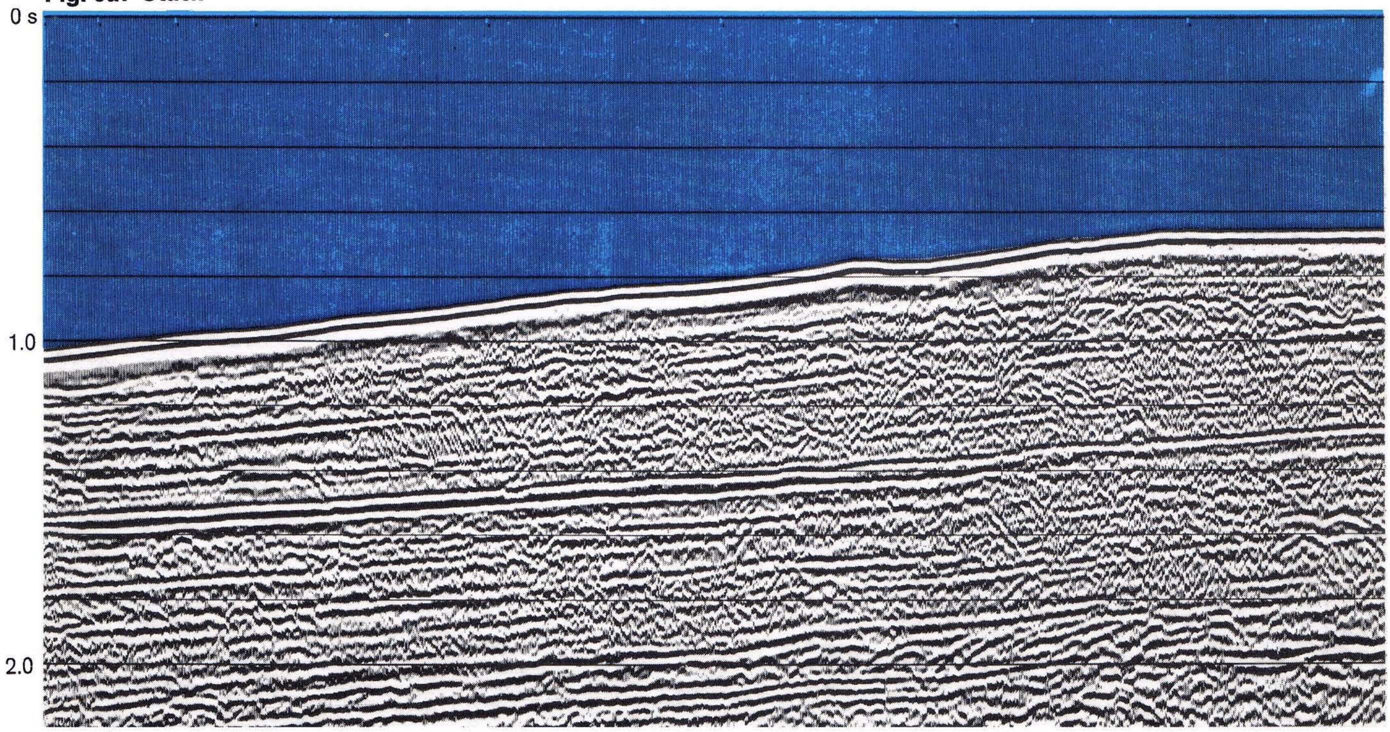


Fig. 6b: Stack after MUKO

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