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Introduction

In this paper we present the transformation of land data into *Pseudo VSP* data. The pseudo VSP generation technique has proven to be very useful in the interpretation of seismic data, since it illustrates the propagation of waves through the earth in depth as well as time (Ala'i and Wapenaar, 1994). The nucleus of pseudo VSP generation is downward extrapolation of a wave field from the surface into the subsurface. The pseudo VSP generation technique requires a macro model of the subsurface.

Field data example

Here we present the application of the pseudo VSP generation technique on a field data example. The field dataset was measured on land (three-component recordings) using a vibrator. The multicomponent line consists of shots with 80 traces per record and a record length of 5000ms. The spacing between the detectors is 30m. The data contains also three-component zero offset VSP data. The well is located approximately at station 1281 (cdp 2562). Fig. 1a represent the raw shot record along the seismic line, which is closest to the well location. The shot record is contaminated with very strong groundroll. The groundroll is clearly visible due to its low frequency, high amplitude and its low group velocity. In the following we present the generation of pseudo VSP data from the preprocessed shot record. Fig. 1b illustrates the record after the removal of linear noise by an adaptive linear Radon-based method (adaptive least-squares subtraction of estimated noise from the original data) and alpha-trim median filtering. As noticed, the groundroll is clearly removed. Fig. 1c shows the real VSP data (vertical component) in which the noisy traces above 460m depth have been removed. We have used the preprocessed shot record (Fig. 1b) to generate pseudo VSP data from the data. The pseudo VSP data is generated for two different offsets to avoid the effect of the noise in the near traces of the shot record. Fig. 1e and 1f present the pseudo VSP generation at 93m and 902m offset respectively. It can be easily seen that the influence of near offset noise is reduced for the pseudo VSP at 902m offset and events are better identifiable. Acoustic two-way wave field extrapolation operators are used for the downward wave field extrapolation of the surface data (only reflected wave fields in the shot record are used as input; the direct source wave field is not taken into account). To understand to which depth the time-events in the shot record are mapped, the pseudo VSP data (at 93m offset) is displayed along a part of the stack of the dataset, see Fig. 1d (CDP stack with a conventional processing sequence including linear noise removal, spiking deconvolution, residual statics, slow agc, nmo and cdp stack; a 4:1 trace sum has been applied after stack). This facilitates following an event at the well through the stacked section to the pseudo VSP data and trace it back down to the intersection with the direct source wave field at the original reflector depth (see arrows). It is important to notice that the generation of the pseudo VSP provides us with an unambiguous tie between seismic events on a time section and their geological interface in depth. The macro velocity subsurface model used for the pseudo VSP generation is depicted in Fig. 1g. The real VSP (Fig. 1c) and the pseudo VSP (Fig. 1f) can be compared: the reflected wave fields are better identifiable in the pseudo VSP generated at 902m offset in comparison with that generated at an offset of 93m. The pseudo VSP data may have a better signal-to-noise ratio after proper preprocessing (this may include a thorough study of the sources and detectors that are used in both situations, because the *acquisition* of the real VSP data is completely *different* from the surface data). In practical situations both VSPs may enhance each other significantly.

Currently, the concept of Common Focus Point (CFP) gathers (Berkhout and Rietveld, 1994) is being integrated with our pseudo VSP research.

Conclusions

In this paper we have demonstrated the application of the pseudo VSP generation technique on land data. The pseudo VSP has been generated for two different offsets, thus improving the interpretation of seismic events (time to depth conversion).

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References

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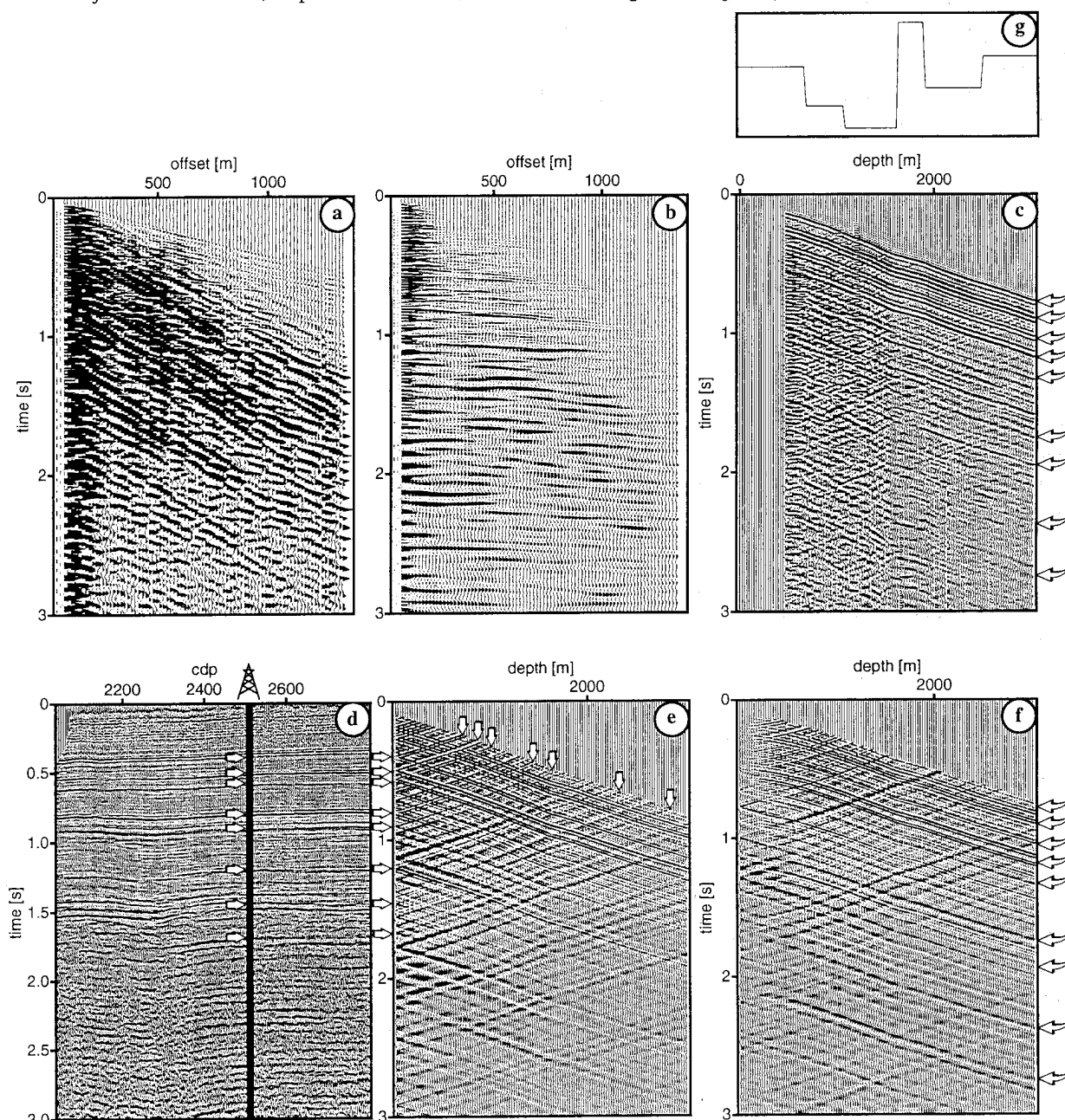


Fig. 1. a) Raw land shot record 1281, b) Same shot after adaptive linear noise removal (Radon based method) and alpha-trim median filtering, c) Zero-offset Real VSP, d) Part of the stack of the data, e) Pseudo VSP generated at 93m offset, f) Pseudo VSP generated at 902m offset and g) Estimated macro velocity model.