

## II. BACKGROUND

### A. Motivation

The reflection seismologist is principally interested in determining physical properties of the near surface in order to locate stratigraphic traps which may contain accumulations of hydrocarbons. The goal of the earthquake seismologist is to determine the earth's internal structure and the source mechanisms for earthquakes. Both use interpretation of seismic observations as their primary tool.

Seismic observations convey information about the earth's response to excitations resulting from natural phenomena such as earthquakes or from man-made energy sources such as those used in reflection seismology. These observations are generally digitally sampled and recorded as a function of time by sensors on the earth's surface.

The resultant time series is composed of redundant information about the source characteristics and the transmission paths of the energy. Also recorded is noise, contaminating information caused by instrument distortion and phenomena which are too complex to be modeled, such as attenuation and scattering.

### B. Convolutional Model

To explain the seismograms a model is required which tries to account for the observations and avoids complexity of explanation. The convolutional model, first proposed by Robinson (1) is employed. The earth is represented as a linear filter which is excited by some source mechanism. The observed seismogram is the output of the earth filter plus additive

noise. Schematically this is represented by Figure 2-1.

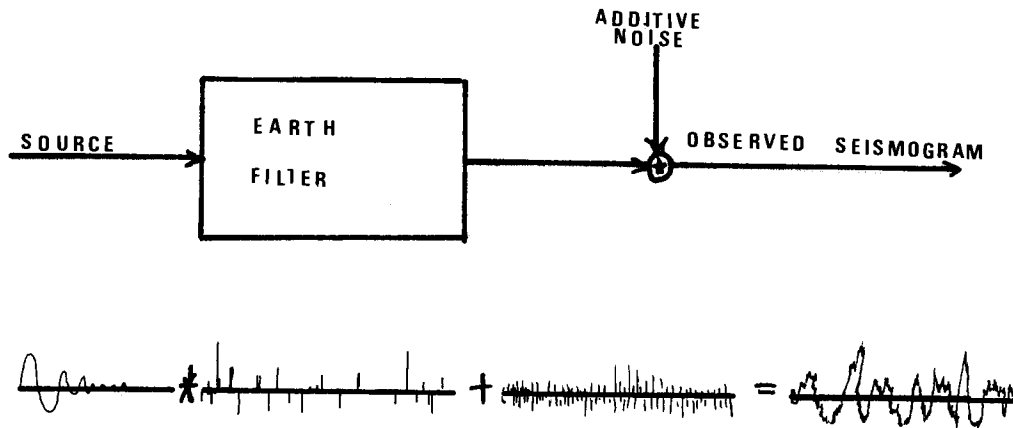


FIGURE 2-1. Schematical representation of convolutional model.

This model is represented mathematically, where \* denotes convolution, by

$$b_t * x_t + n_t = y_t \quad (2-1)$$

where

$b_t$  is a time series representing the source

$x_t$  is the impulse response of the transmission path

$n_t$  is additive noise

and

$y_t$  is the observed seismogram.

In reflection seismology,  $x_t$  is normally called the reflectivity series. It represents the amplitudes of propagating waves which have reflected or refracted off inhomogeneities in the earth below. These

reflection amplitudes contain information about the subsurface structure and some of its properties such as velocity and density.

### C. Deconvolution

Convolution is a smoothing operation which superimposes a wavelet at each non-zero reflection. An amplitude on the observed seismogram may be the sum of many superimposed wavelets representing reflections of different amplitudes at earlier times.

Deconvolution is a signal processing method which tries to unravel the effects of convolution. It has application in diverse fields, such as speech processing and astronomy, where observations are the result of a noisy convolutional process. The objective of deconvolution is to determine from the observations themselves the source wavelet and reflectivity series. If the earth effects filter is described as a linear system, the problem is one of estimating both the system and its inputs from the outputs. To solve the problem some properties of the inputs or system must be assumed. The presence of additive noise is a further complication which requires statistical methods be employed.