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I. AUTOREGRESSIVE REPRESENTATION OF SEISMIC P-WAVE SIGNALS AND SHORT-PERIOD DISCRIMINATION

It is shown that seismic P-wave signals can be represented by parametric models of autoregressive type. These are models having the form

$$X(t) - a_1 X(t-1) - \ldots - a_p X(t-p) = Z(t)$$

where $X(t)$ is the digitized short-period data time series defined by the P-wave signal, and $Z(t)$ is a white noise series. The autoregressive analysis was undertaken for 40 underground nuclear explosions and 45 earthquakes from Eurasia. For each event a separate analysis of the noise preceding the event as well as of the P-wave coda has been included. It is found that in most cases a reasonable statistical fit is obtained using a low order autoregressive model.

The autoregressive parameters characterize the power spectrum (equivalently, the autocorrelation function) of the P-wave signal. In fact, for an autoregressive process of order p, the theoretical power spectrum is given by

$$G(f) = \frac{\sigma_z^2/f_c}{\left| 1 - a_1 e^{-\pi i (f/f_c)} - \ldots - a_p e^{-p\pi i (f/f_c)} \right|^2}$$

for $0 \leq f \leq f_c$, where i is the imaginary unit, and $f_c = 1/2h$ is the cutoff frequency, h being the time interval between samples. These parameters should form a convenient basis for studying the possibilities of short-period discrimination between nuclear explosions and earthquakes, since given the autoregressive parameters one is able to reconstruct the power spectrum for the considered event. In principle, therefore, the study of discriminants using power spectral properties should reduce to a study of the associated autoregressive parameters, that is, essentially to a study

of plots such as the one given in Fig. I.1. From this figure and various similar plots we reach the tentative conclusion that it seems difficult to construct really good discriminants based solely on power-spectral properties. However, the autoregressive parameters are of value when combined with other discriminants such as the m_b:M_s criterion (Bungum and Tjøstheim, 1975).

D. Tjøstheim

REFERENCES

Bungum, H., and D. Tjøstheim (1975): Discrimination between Eurasian earthquakes and underground explosions using the m_b:M_s method and short period autoregressive parameters, This report.

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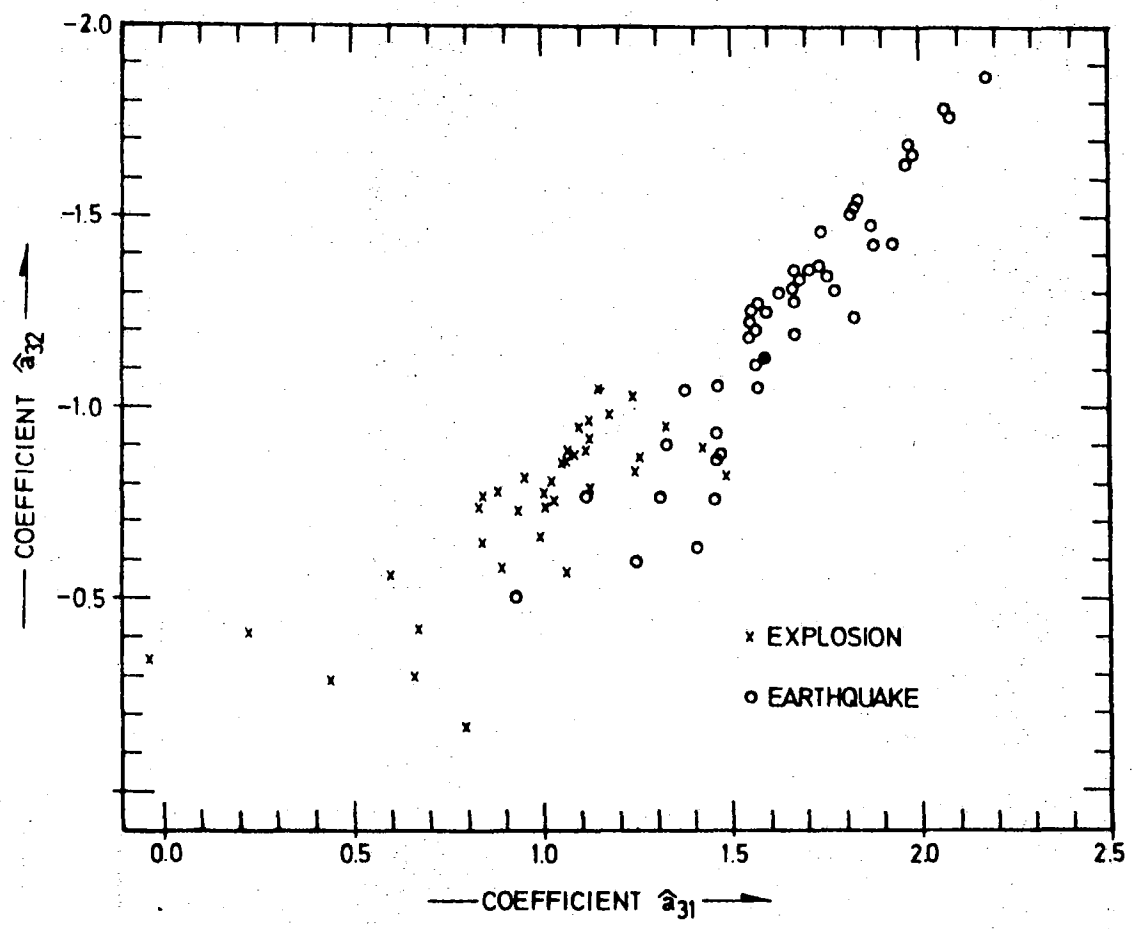

Fig. I.1 Estimated coefficients $\hat{a}_{31}$ and $\hat{a}_{32}$ assuming a 3rd order autoregressive model.

$$X(t)-a_{31}\,X(t-1)-a_{32}\,X(t-2)-a_{33}\,X(t-3) = Z(t).$$