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NORSAR PHASE 3

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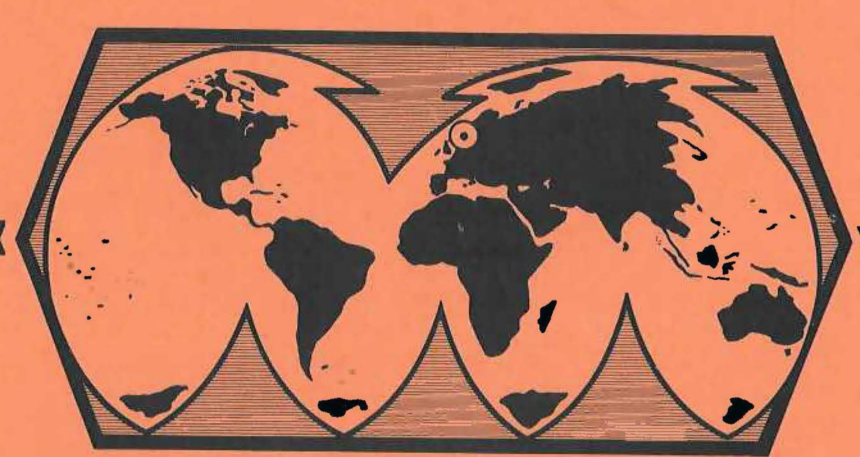


K. FURTHER m_b:M_s STUDIES AT NORSAR

A comprehensive m_b:M_s analysis has been undertaken using a data base of 60 presumed nuclear explosions and 45 presumed earthquakes in Eurasia recorded at NORSAR between 1971 and 1974. The data have been selected subject to the requirement that both PDE location and magnitude estimates should be available in addition to the recordings at NORSAR. The geographic distribution of these events is given in Fig. K.1; notice that 35 of the presumed explosions are confined to a small area in Eastern Kazakh.

The m_b:M_s relationship was investigated using both NORSAR and PDE estimates for the body wave magnitude m_b. It was found that while m_b(NORSAR) gave a slightly better separation for the Eastern Kazakh data (see Fig. K.1), m_b(PDE) gave significantly better results when applied to the complete data set, this being due to a magnitude bias caused by a larger power loss in array beamforming for events with smaller travel distance ($<30^o$).

The basic results of this m_b:M_s analysis are given in Fig. K.2, where m_b(PDE) is plotted versus M_s(NORSAR). It was possible to estimate M_s for 44 of the presumed explosions, for the other 16 an upper bound is given, determined by the noise level at that particular time. Among the 44 explosions there are 3 difficult events, all on the edge of the earthquake population. Two of those are from the Ural Mountains (March 22, 1971, and October 26, 1973), while the smallest and most difficult one to identify is from Novaya Zemlya (July 22, 1974). Several of the events for which no Rayleigh waves have been identified occurred during a period when the noise level was low enough to allow identification based on negative evidence, while others are falling between the two populations.

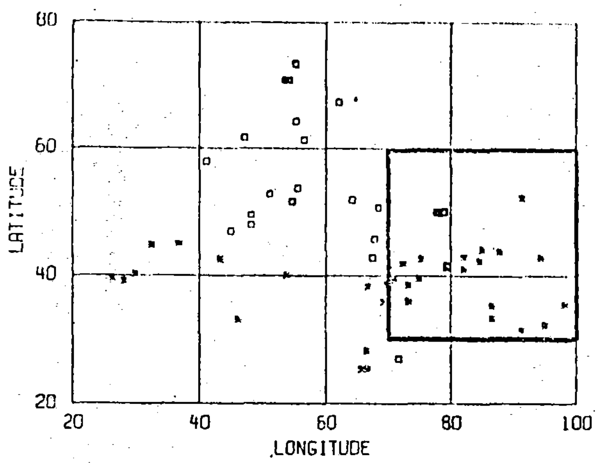
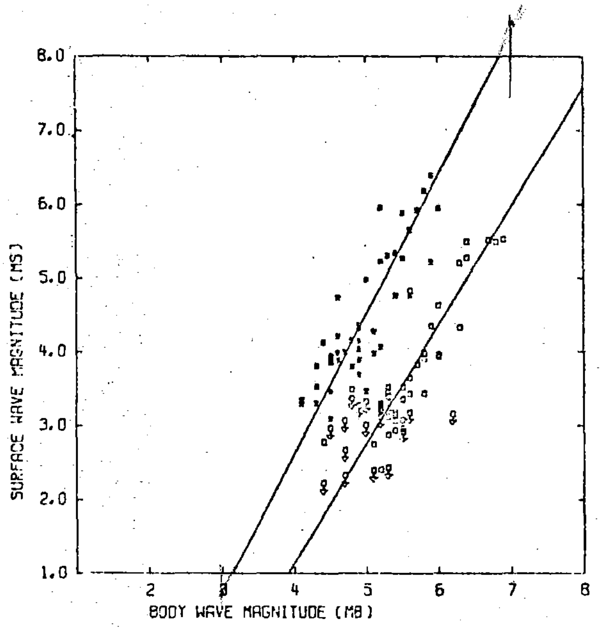


Fig. K.1 The geographic distribution of the 60 explosions and 45 earthquakes used in this study. Explosions are depicted by squares and earthquakes by stars. The area between 30° - 60°N and 70° - 100°E is that called 'Eastern Kazakh'.



$(8.4 - 0.8)/4 = 1.9$

Fig. K.2 $m_b : M_s$ diagram for the complete data base of 60 explosions and 45 earthquakes from Eurasia, including 16 explosions for which no Rayleigh waves have been detected at NORSAR. The symbol for each of these 16 events includes an arrow to indicate that the M_s value has been replaced by a noise estimate representing the largest possible M_s value.

In order to evaluate numerically the separation in Fig. K.2, a discriminant was defined which is a linear combination of m_b and M_s such that it is zero everywhere on the explosion regression line. From the distributions of the explosion and earthquake discriminant values the identification probability can be estimated for any particular false alarm rate. It was found for the data in Fig. K.2 that for a false alarm rate of 1% one would have an identification probability of 90.3%. Furthermore, if the 16 explosions with no Rayleigh waves detected were removed, the identification probability would increase to 95.4%, still for a false alarm rate of 1%.

The 16 noise measurements in Fig. K.2 are distributed almost randomly in time over about 4 years. The average value, which is $M_s=2.9$, can therefore be used as a measure of the detectability level for explosion Rayleigh waves from Eurasia, and the standard deviation is estimated to $\pm$ 0.4 M_s units. This large standard deviation is caused by large long term fluctuations in the noise level, and in order to investigate that effect more thoroughly, the on-line system at NORSAR was extended to allow for calculation of the average long period noise level. One year of such analysis is shown in Fig. K.3, and a separate calculation of the distribution shows that 70% of the time the variation is within $\pm$8 dB of the median. Provided that there is an inverse linear relationship between noise level and detectability this corresponds to a standard deviation of about $\pm$0.4 M_s units in detectability, which is equal to the value we estimated using the direct method.

H. Bungum

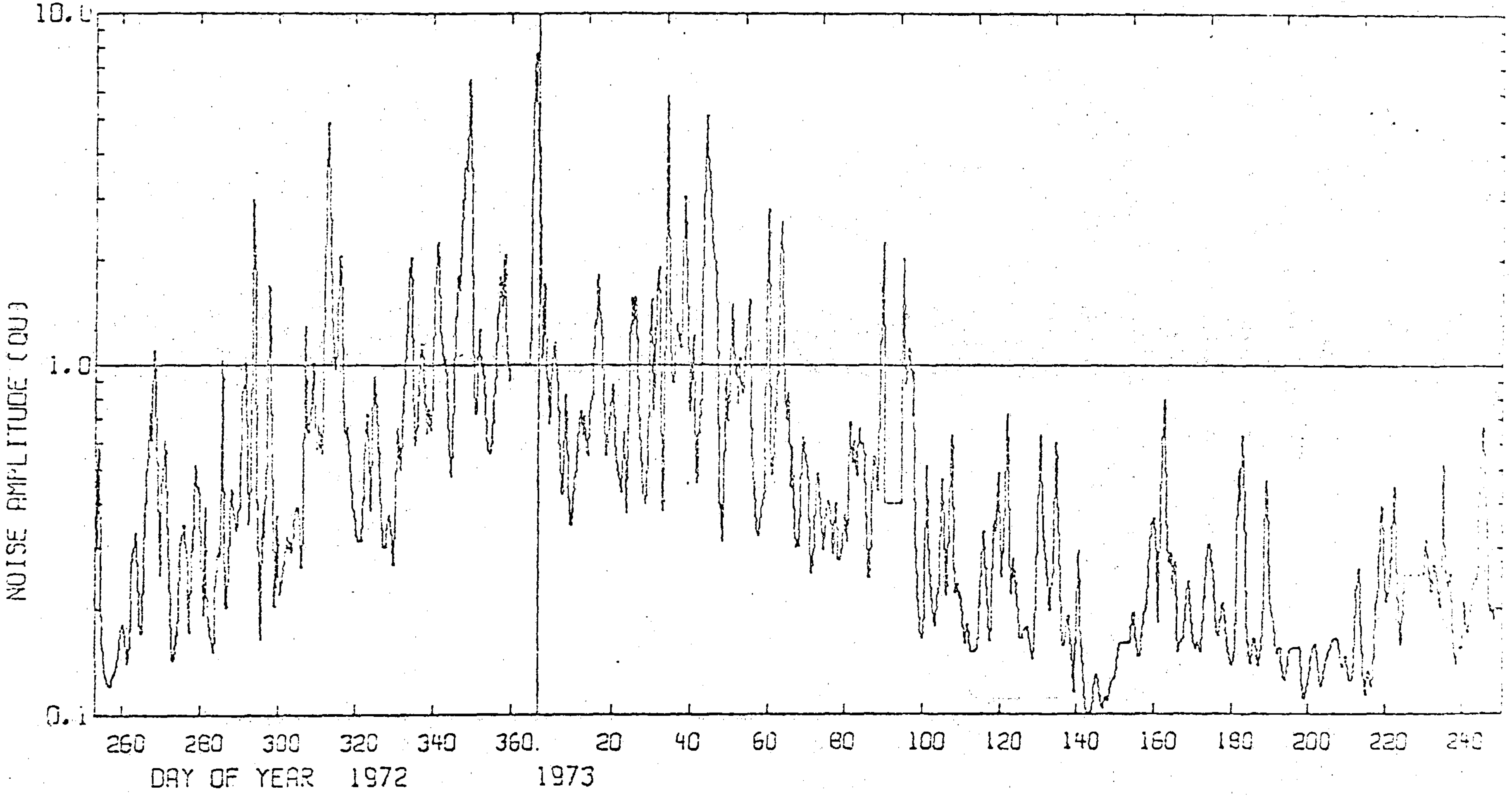


Fig. K.3 Average long period noise level at NORSAR for one year from day 253/72 to day 252/73. The data are actually the average of the noise levels at 14 vertical long period seismometers, where, for each noise sample the highest four and lowest four of the 22 subarrays have been excluded for reasons of stability. The amplitudes are given in arbitrary units, and the sampling rate is 20 per day.