The Polarization of Microseisms and Its Application to Signal-to-Noise-Ratio Improvement*

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Abstract

Analysis of microseisms observed at the German stations Moxa and Berggiesshubel was performed and the result was utilized to improve the signal-to-noise ratio for the observation of the real seismic events.

This investigation rests upon the records of two sets of seismographs which are installed at the German stations Moxa and Berggiesshubel. Every set consists of seismographs SSJ-I for EW, NS and the vertical component. All amplitude- and phase-characteristics are identical. For periods of from 1 sec to 20 sec the magnifications are 1000. All evaluation techniques are developed so as to permit the use of an electronic computer for the purposes indicated in the headline. Firstly the records of 7 microseismically stormy days without times of earthquakes were digitized to construct the spatial particle orbits of the 2–10 sec microseisms. After that the same was done with body waves of pure earthquakes and superpositions of noise and seismic signals. Also cases of invisible earthquakes were investigated. The aim was to find geometrical quantities for distinguishing pure microseisms and signals mixed with or even suppressed by noise. This also be interesting for focal mechanism investigation, because this period domain is important for the main movement in the focus. (AKASCHE, BERCKHEMER; 1968) The results are briefly summarized as follows:

1. The first, second and total curvatures are also large for pure noise in a few exceptional cases and so they are not proper for distinction.
2. For pure microseisms 99.9% of the trajectories of the ground particle is representable nearly in a plane.
3. Such a plane and the circulation sense of the particle define a normal vector for every point of time. For some minutes the normal direction is always in a very small dihedral angle domain in the case of microseisms. This corresponds to a polarization of microseismic oscillation planes.
4. This conservation tendency remains also for some hours, but the normal direction changes slowly in dependence on the weather situation over the North Atlantic. (WALZER; 1969) Fig. 1 is a typical example for the normal directions of pure microseisms in five hours. The direction is represented by azimuth and altitude angle $h$.
5. In contrast to coastal stations (STROBACH; 1962) only one oscillation type exists. This type is roughly spoken perpendicular elliptic with a predominance of long axes inclined some degrees against the source. The circulation sense is retrograde.
6. The horizontal projections of the microseismic particle orbits give sharp beam patterns directed towards the source. (WALZER; 1969).
7. The described features can be explained by a high percentage of first mode Rayleigh waves, but they are more understandable by the theory of Das Gupta (Das GUPTA; 1956). (For detailed explanations see WALZER; 1969).
8. In case of a real seismic event, even...
when the earthquake was hidden by noise, the normal points in the azimuth-altitude-plot left the cluster area, wandered over the whole plot and did not return until the end of the earthquake waves. (WALZER; 1969, WALZER; 1968a)

9. The idea of the new and tested signal-to-noise-ratio enhancement method (WALZER; 1969; 1968a; 1968b) consists in forming a mean value of the normal directions for the past and in substracting from it the actual direction, i.e., geometrically spoken, in forming the difference angle as a detection function. Even in cases when neither suspect changes of amplitudes nor of periods are to be seen, the detection function disclosed the beginning of body wave groups. The applied method needs only one three-component seismograph station on geologically consolidated ground with corresponding homogeneous instrumental characteristics. The station must be at a distance of a few 100 km from the coast and must be screened against the other oceans by huge continents.

References


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