CONTRIBUTION OF SUBSOIL TO MICROSEISMIC INTERFERENCE AT FLORISSANT, MISSOURI

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In the course of microseismic investigations at Florissant, Missouri, concerning vibrations of .2 to .5 seconds, certain difficulties presented themselves. A tripartite arrangement is being used at Florissant. At the north vault or station of the tripartite setup the recorded microseisms show phase shifts with relation to the other two stations. Wave forms of the same configuration as those recorded at the north vault could seldom be found on recordings from the other two stations. A simple sine wave having a period of from .2 to .4 seconds often overrode the microseisms recorded at the north vault.

The problem investigated in the paper is that of proving or disproving that topographic or geological conditions at the site contribute to the anomalous recordings from the north vault.

The investigation was carried out in two phases. In the first part of the investigation the Century Refraction Equipment was set up at various places about the tripartite station, particularly at the site of the north vault. This was done during quiet hours and with the amplifier adjusted for maximum gain. Various

distances between geophones were used from zero to eight feet. From these records the following conclusions can be made:

1. The most common and best correlated period is near .01 - .02 seconds. They may be standing waves, but the geophone spacing is too close to be certain, or they may represent a free period of the ground. They may represent the geophone-ground reaction of Wolf.[1]

2. Flying airplanes can induce relatively high amplitude vibrations in the ground of periods .02 and shorter.

3. Longer period waves near .06 - .07 seconds commonly appear but their source is unknown.

4. At the north vault, at least, larger separations, and multiplicity of known sources, seem to cause a lack of correlation between traces.

The second phase of the investigation consisted of setting up a grid twelve meters on a side about the north vault. The geophones were placed at the intersections of the grid lines and the ground energized by means of an unbalanced automobile wheel. The grid network was occupied twice during the investigation, once with the geophones spread in a northwest, south-

1. "The Equations of Motion of a Geophone on the Surface of an Elastic Earth," Geophysics, 9: 29 - 35, (1944).

east line, and again with the spreads along northeast, southwest lines. The last set of tests were made with the amplifier gain set at one fourth maximum.

These tests indicated that the frequency response of the area about the north vault varies from place to place, and with time, depending upon the condition of the soil. During one test the soil was dry, during the other, very moist.

It was found that the amplitudes of the forced vibrations varied with distance from the source in a manner, which, according to the literature, indicates a high velocity layer at depth. An electrical depth probe indicated no such layer down to fifteen meters, and statements in the literature based on experience suggest a lower possible limit of about twenty meters. The velocity of transverse waves in the lower layer as found by formulas is 2000 meters per second, suggesting a limestone. It is quite possible that the longer period microseisms are similarly influenced by this or other layers. Thus large variations in amplitude at the different corners of the tripartite station might be expected.

If the microseisms have their source in the same azimuth and distance, it is possible that the interference between the direct and refracted arrivals could

produce the sine wave observed at the north vault. The microseisms may have their source at the same location or locations, if we assume that certain characteristics are necessary at the origin before the microseisms can be generated. A possible mode of origin was suggested by Haskell (25), in which an area covered by a certain depth of sediment having very low seismic wave velocities is necessary. Although the longer period microseisms (.2 - .5 sec.) may not be generated at the site of the north vault, it was found in this study that airplanes could induce vibrations of a period near .02 seconds in the ground, somewhere in the area. The low velocity of vibrator induced waves, 143 meters per second, could indicate that Haskell's theory may be applicable.

A natural period of the ground of near .02 seconds was fairly well established and evidence indicates that a natural period near .065 seconds might also exist.

Because of the nature of the equipment, the reaction of the ground to longer period waves could not be investigated, but many articles in the literature suggest that loess or alluvium often has a natural period near .5 seconds. If this condition applies here, the interference between the natural .5 second period and the approaching microseisms may influence

the records. It is also possible, if the response of the seismometer is broad enough, that interference between the incoming microseisms and .02 or .065 second natural period vibrations may influence the records.