GENERATION OF RAYLEIGH WAVES

BY

CONTAINED EXPLOSIONS

by

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A series of field experiments, designed to record the motion on the free surface over a contained explosive source, was conducted in clay to gain a clearer understanding of the generating mechanism for Rayleigh waves. The experiments were instrumented with mechanical three-component Sprengnether portable seismographs and 1 cps vertical geophones, which were recorded through 0-13 cps and 14-100 cps filters, along profiles from the shot point to 15 meters. In addition profiles were recorded to greater distances, approximately 300 meters, to record the dispersive Rayleigh wave train. These data were used to calculate source functions, by a phase equalization technique, to determine the nature of the motion over the source that would give rise to the observed Rayleigh motion.

The calculated source functions were oscillatory in nature with the maximum amplitudes delayed 0.2 to 0.3 second after the origin time for contained shots and occurring near the origin time for a surface shot. It was concluded that the Fourier spectrum at one test site, Suffield, Canada, was controlled by the near surface layering, resulting in a very narrow spectrum and a long oscillatory source function. The delay in maximum amplitude from the contained shot is considered to be due to the generation mechanism which comes into play after the compressional energy has arrived at the

free surface.

The experiments designed to record the motion over the source revealed the presence of oscillatory long period motion as predicted by the source function studies. The frequency of this motion was the same as that of the Rayleigh wave at close range. Analysis of this long period motion revealed that there is a region of the free surface which undergoes an initial upward displacement beginning some time after the compressional arrival. The radius of this region is approximately 1.6 times the source depth. Outside of this region the initial long period motion is downward and the motion propagates outward with the velocity of the Rayleigh wave.

These data make it possible to formulate a hypothesis for the generation of Rayleigh waves from a contained explosion which is similar to the mechanism from a surface source. This may be stated as follows: 1) within some zone, of radius approximately 1.6 times the source depth, the free surface undergoes an initial upward displacement at a time greater than the travel time of the compressional wave from the source (this time varies with shot depth, more nearly approaching the arrival of the compressional wave as depth of source increases); 2) this upward displacement continues to increase in amplitude, reaching a maximum over the source at a time after initial movement equivalent to approximately one-quarter of the Rayleigh wave period at close range; 3) this initial upward motion produces an initial downward movement outside of this zone, 1.6 times the source depth, which spreads outward with the Rayleigh velocity; 4) the free surface in the source region continues to oscillate, and within the critical boundary of Nakano it appears to oscillate as a unit, but outside this zone energy which is propagating outward interferes with the standing energy, resulting in motion that becomes somewhat complex; 5) thus, a long period warping of the free surface in the source region, representing the response of the free surface to the energy traveling from the buried source, produced the Rayleigh motion observed at distance.