Investigating power variation in first breaks, reflections, and ground roll from different charge sizes

Christopher C. Petten*, University of Calgary, Calgary, Alberta
ccpetten@ucalgary.ca
and
Gary F. Margrave, University of Calgary, Calgary, Alberta

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Summary

We investigate variation in power from different charge sizes in the first breaks, reflections, and ground roll components of a shot record. To observe power distributions, shot data from multiple charge sizes obtained in the Hussar low frequency experiment, conducted by CREWES, were analyzed using MATLAB. The first breaks, reflections, and ground roll were isolated using time windows defined by straight lines in x-t space. Upon defining these windows, the power in each component of the shot record was calculated by summing the squares of the samples in each window. Power was observed to increase quasi-linearly with charge size with the majority of shot power being present in the ground roll.

Introduction

Dynamite is a commonly used tool in exploration seismology to image reflectors in the subsurface, where the power of an explosion is directly related to the size of the charge used. Reflections are very important as they contain most of the valuable information pertaining to the subsurface. On a seismogram, power is directly related to the sum of the squares of the amplitudes of the trace and as a result, the charge plays a significant role in imaging features in the subsurface. In theory, it is possible to increase the amplitude of the traces recorded from a dynamite explosion by increasing the size of the charge used. However, a direct link between charge size and reflection strength is difficult to establish because of many unknowns such as radiation pattern, earth attenuation, near-surface variability, etc. Due to the importance of reflectors in geophysical exploration, it is worthwhile to investigate a potential link between charge size and the distribution of power in a seismogram as it could potentially improve survey design by increasing the amplitude of reflection events.

Method

To investigate the distribution of power in a seismogram test charges ranging in sizes between 1 and 4 kg were buried 15 meters deep at three separate locations along the seismic line used in the Hussar Low Frequency Experiment conducted by CREWES in the Fall of 2011. In order to investigate power distributions in seismograms that result from different charge sizes the power of each component, the first breaks, reflections, and the ground roll, was computed as the sum of the traces squared. This was accomplished by isolated each component using straight lines in x-t space and then summing up each individual trace in a triangular-shaped segment, as shown in Figure 1. Note that these windows were chosen based on a predefined set of criteria, which can also be seen in Figure 2. The first breaks were isolated by separating events that had the shallowest time dip on the shot record, following this procedure, the ground roll was then isolated by separating the events that had the steepest time dip from the rest of the shot record. After these two windows had been obtained the reflection window was chosen to be the region between the first breaks and the ground roll.

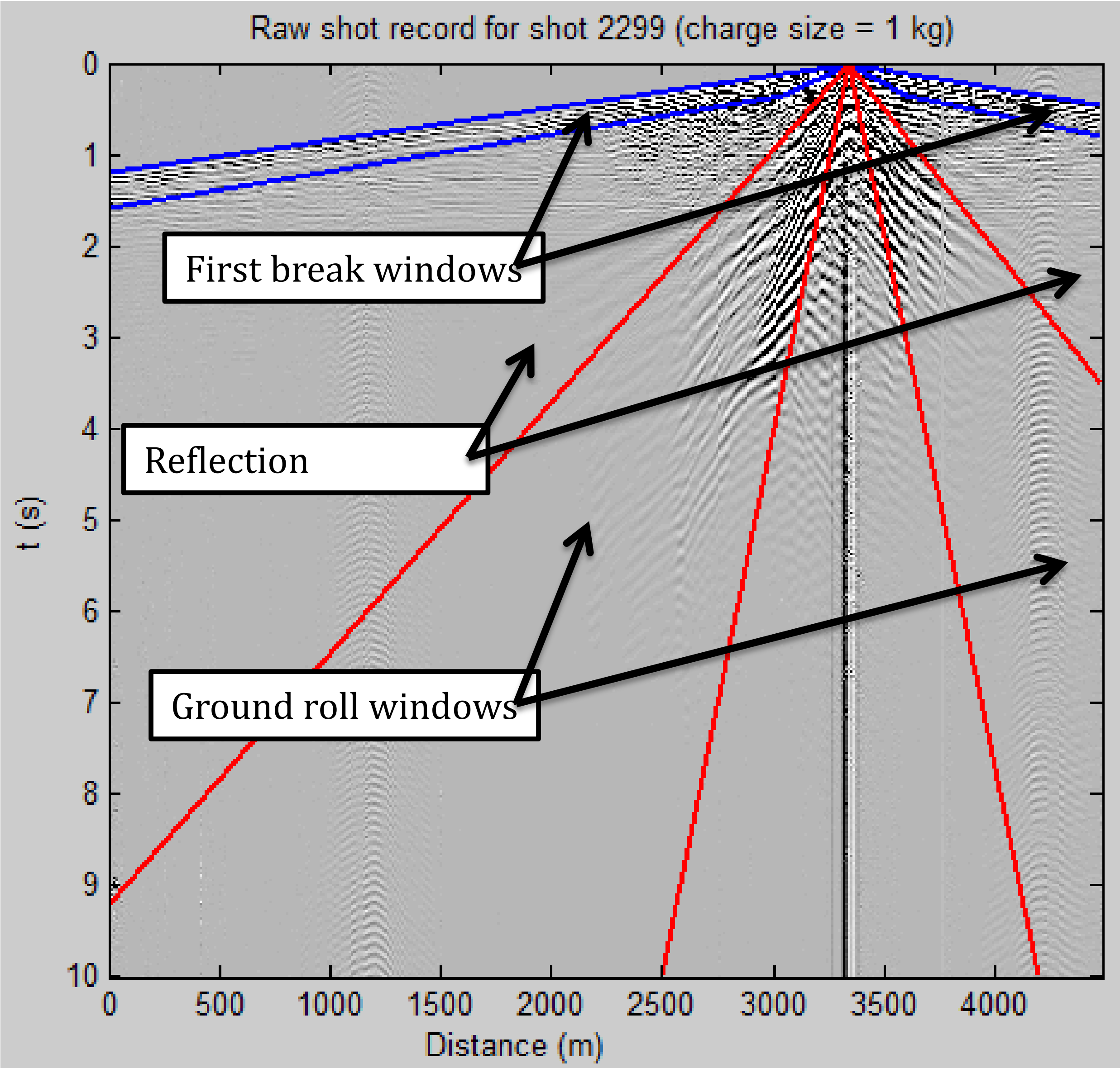

Figure 1: Time windows used to isolate each component of the shot record.

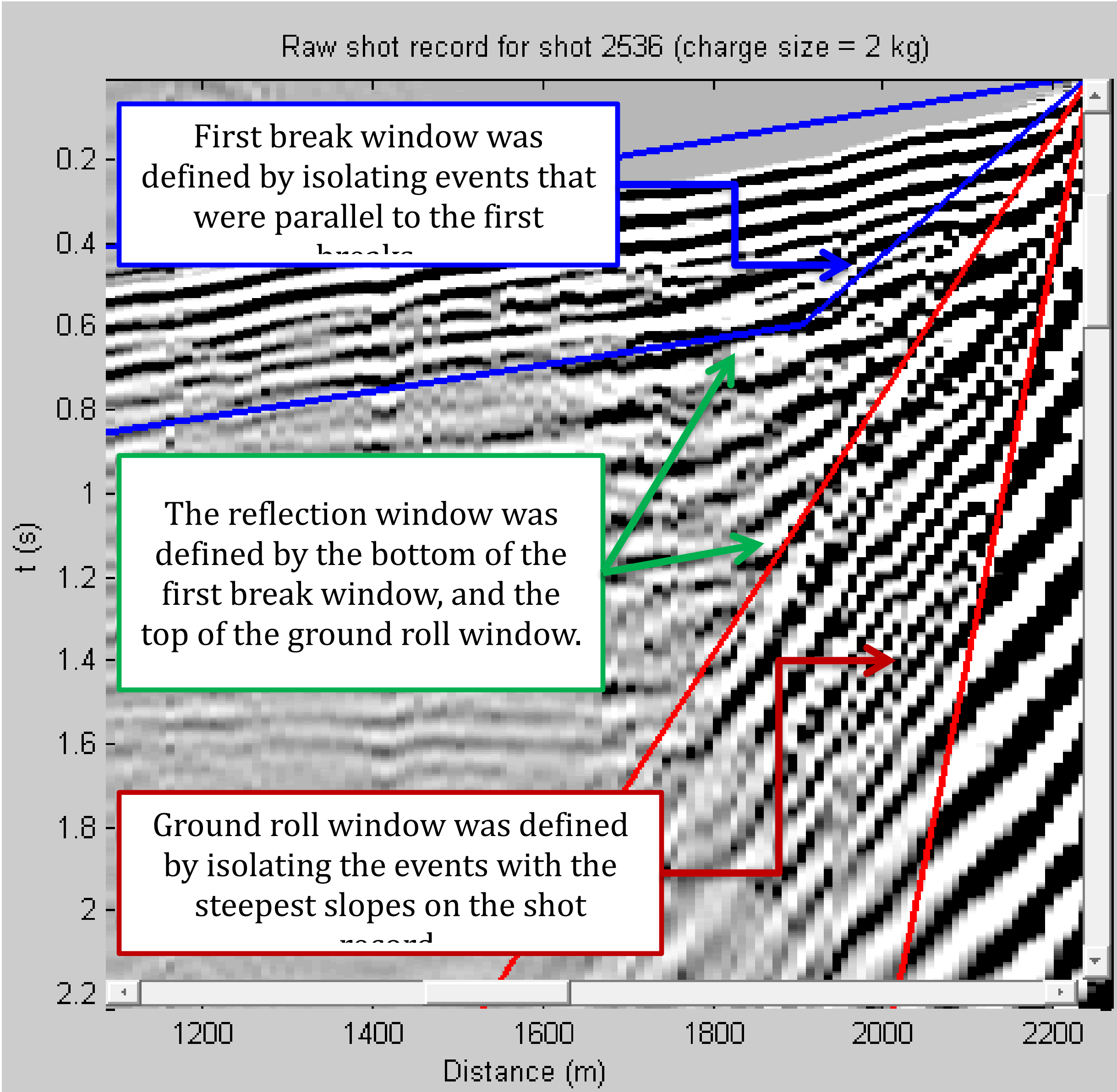

Figure 2: Criterion used to isolate each component from the rest of the shot record.

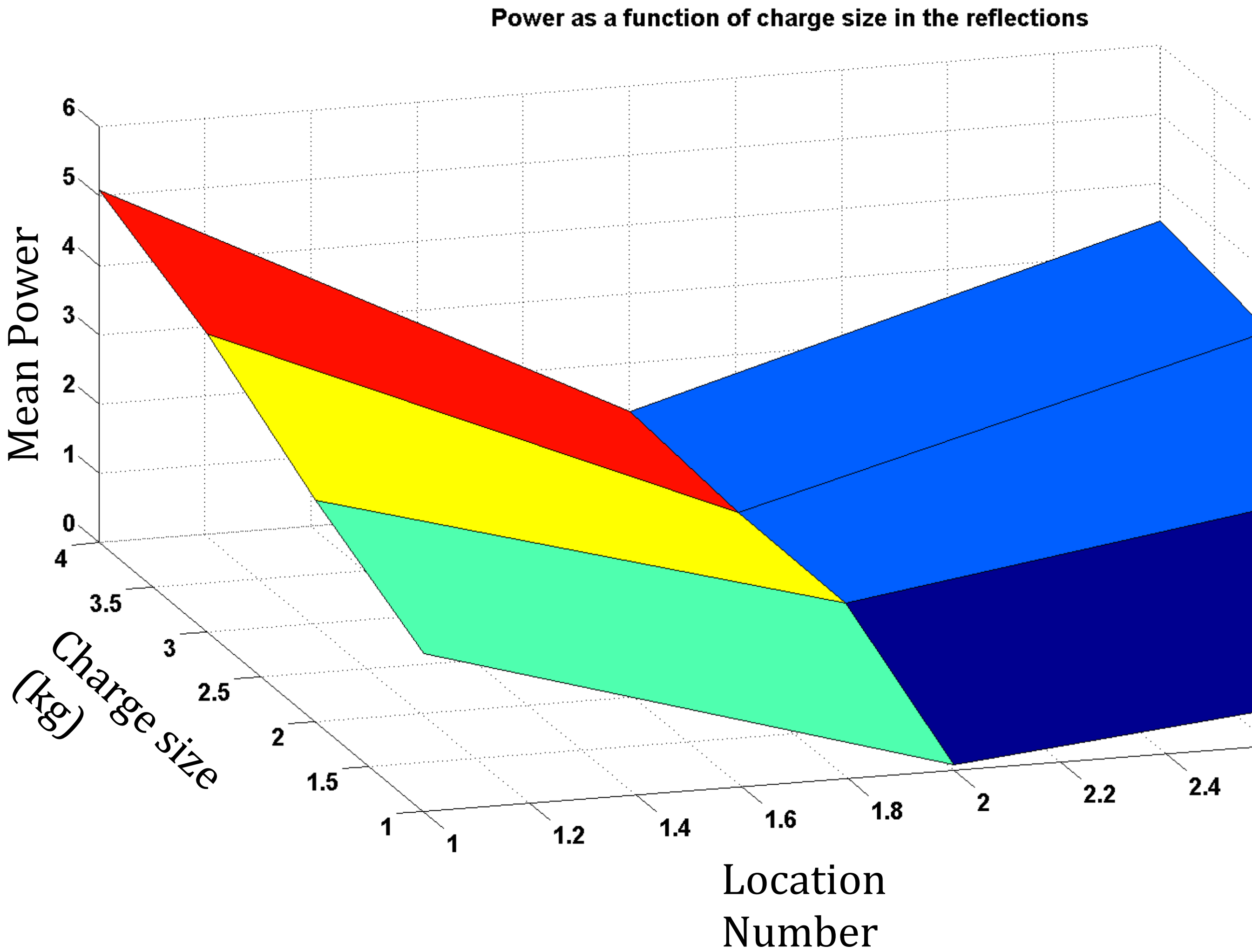

Figure 3: Mean power for the reflections resulting from different charge sizes at each location.

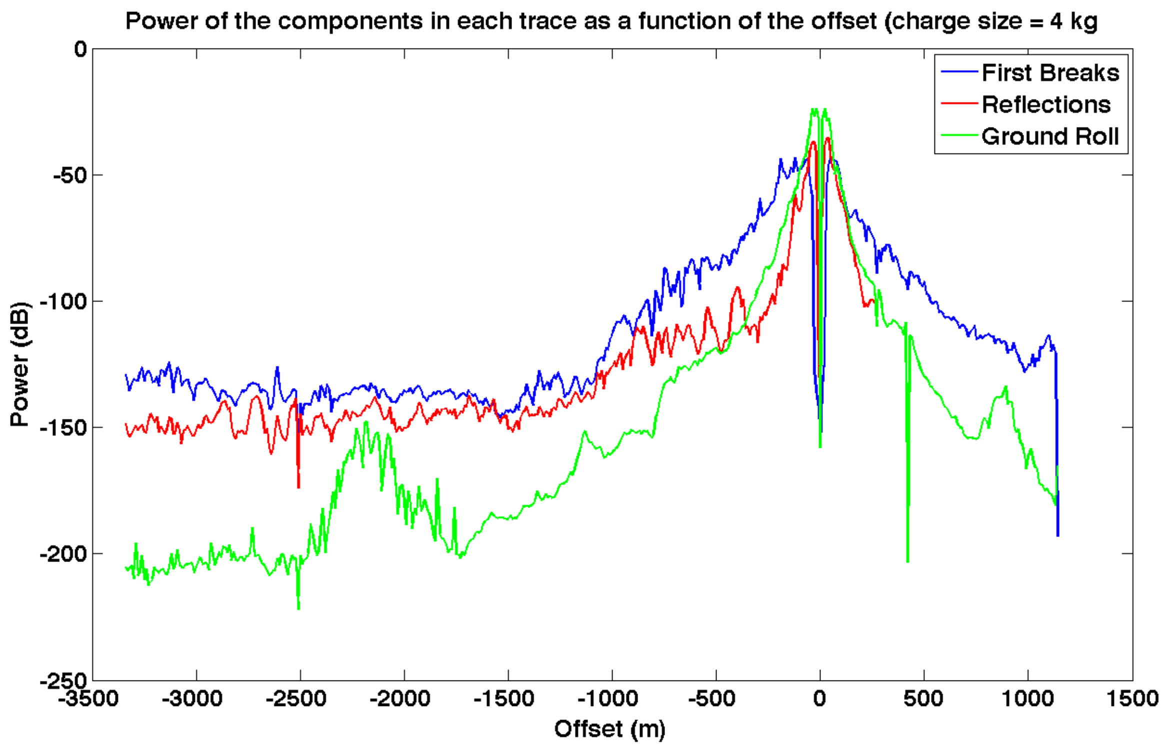

Figure 4: Power variation as a function of offset for a 4 kg test charge at location 1.

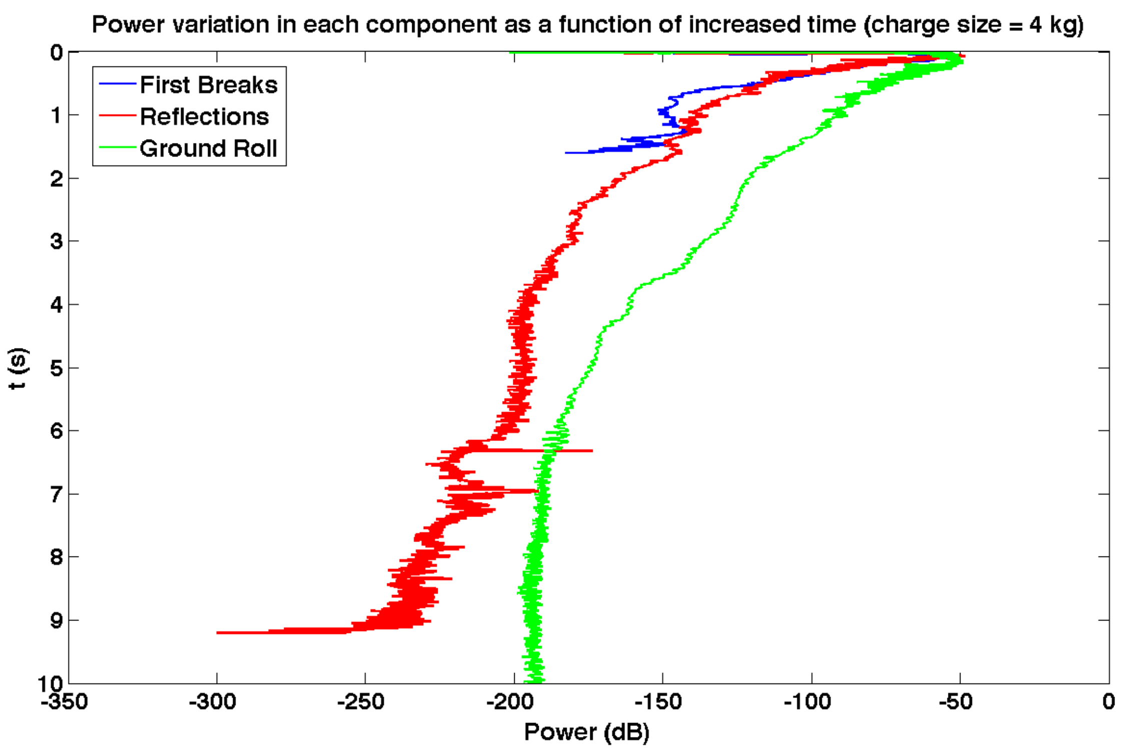

Figure 5: Power variation as a function of time for a 4 kg test charge at location 1.

Examples

Figure 3 shows the mean power obtained from the 4 different charge sizes used at each location. At each location where there were multiple test charges of the same size used, the mean power between charges of the same size was computed rather than considering them individually. There appears to be a quasi-linear relationship between reflection power and charge size. Figure 4 shows power variation, in decibels, with increased offset from the shot origin. Most of the power appears to have been dissipated within 1500 m of the shot origin. Figure 5 shows power variation with increased time from the shot detonation; the power in each component appears to taper off within 5 seconds of detonation.

Conclusions

Reflection power increases quasi-linearly with increased charge size, with the largest amount of power resulting from a test charge of 4 kg. Most of the power in all components has been dissipated within 1500 m of shot origin and within 5 seconds of the shot detonation.

Acknowledgements

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References

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