

# "DELAY TIMING AND VIBRATION CHARACTERISTICS AT LOW-FREQUENCY MINE SITES"

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## ABSTRACT

The Bureau of Mines performed a comparative study of nine sites at eight surface coal mines to determine if the presence of near-surfaced underground abandoned workings resulted in the generation of adverse long-duration, low-frequency blast vibrations. Six of the nine sites had underlying workings, and two had thick layers of low-velocity unconsolidated surface material.

Extended seismic arrays were used to identify the vibration characteristics within a few tens of feet of the blasts and also as modified by the propagating media at distances over one mile. Production and specially fired single-charge blasts allowed the determination of natural ground frequency and also the influence of the initiation delay timing.

Vibration amplitudes from the production blasts at all sites exceeded historical norms, particularly at the greater distances. This contrasts with near-normal results from single-charge blasts. Apparently, between-hole time delays were insufficient relative to low-frequency criteria of 8 ms minimum to separate vibrations from adjacent charges for the waves present. This suggests that the widely-used design delay separation may not be sufficiently long for sites with abnormal low frequencies. Both undermined and sites with thick unconsolidated overburden produced low-frequency surface waves.