THE EFFECT OF GREEN'S FUNCTIONS ON THE DETERMINATION OF SOURCE MECHANISMS BY THE LINEAR INVERSION OF SEISMOGRAMS

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The moment tensor representation of seismic sources is applied to some close-in (2-13 km) accelerometer data of contained nuclear explosions. The two explosions studied are Handley and Pipkin, both detonated on Pahute Mesa at the Nevada Test Site. A variety of Green's functions are used in the inversions for the moment tensor to test the sensitivity of the procedure to assumed propagation path effects. The simplest model consisted of a half-space structure with the most complicated a three-layer over a half-space. The resulting source functions are dominated by the isotropic component of the moment tensor with the deviatoric component as much as a factor of twenty-five smaller. The time function of the source appears to have a double peaked nature. The fit of the calculated seismograms to the observed is not greatly affected by the assumed Green's function.
I. **Seismic Source Representation**

Given a set of observed waveforms from an explosion or earthquake and knowing the propagation path effects of the geological material, a quantitative procedure for determining the source function in space and time is desirable. The moment tensor source representation is such a formulation (Gilbert, 1970; Gilbert and Dziewonski, 1975; Backus and Mulcahy, 1976 a and b; Stump and Johnson, 1977; Backus 1977 a and b; Strelitz, 1977).

If an explosion or earthquake source can be represented as a set of equivalent body forces, then the source can be written as a series of moments. For small sources or large wavelengths only the first term of the series is retained and the displacements at any point and time can be written as:

\[ u_k(x', t') = G_ki,j(x', t'; 0, o) M_{ij}(0, t') \]  \hspace{1cm} (1)

Where \( u_k \) is the displacement in the k direction, \( G_ki \) is the Green's function, \( M_{ij} \) is the moment tensor, \( i \) indicates derivative with respect to \( x_i \), and \( \otimes \) represents temporal convolution. A more complete derivation of these results is given in Stump and Johnson (1977).

In the frequency domain, the equation becomes:

\[ u_k(x', f) = G_ki,j(x', f; 0, o) M_{ij}(0, f) \]  \hspace{1cm} (2)

Knowing the propagation path effects \( (G_ki,j) \), one can determine the source \( (M_{ij}) \) from a set of observational data \( (u_k) \).

In this study, the moment tensor formulation will be applied to a set of data from contained nuclear explosions. The sum of the diagonal elements of the moment tensor, the isotropic component, is proportional to volume changes in the source region and will be interpreted as the explosion component of the source. This component can then be compared to the remaining portion of the moment tensor, its deviatoric component, to analyze that portion of the source not accounted for by a symmetric explosion.

II. **Data Set:**

The two underground nuclear explosions from NTS used in this study were the Handley event detonated on 26 March 1970 with a Wood-Anderson magnitude at the U.C. Berkeley Seismographic Station of 6.3 and the Pipkin explosion of 8 October 1969 with a magnitude of 5.5. The locations of these two events are given in Figure 1. The depth of the Handley shot was 1.2 km while that for Pipkin was 0.6 km.