18.4 Estimate of Energy Release Per Unit Time

Now consider how the energy of earthquakes is released in time and how it relates to other energy. Recall the number of small shocks, dN, can be written as:

\[
\log dN = -0.48 + 0.90 (8-M_s)
\]

18.4.1

this is a recent estimate of equation 18.3.1 which can be expressed as:

\[
\log \left( \frac{1}{10} \frac{dN}{dM} \right) = 6.72 - 0.90 M_s
\]

18.4.2

Converting to an exponential base where dN/dM is equal to the number of shocks per year in the magnitude range dM:

\[
\frac{dN}{dM} = 5.25 \times 10^7 e^{-0.9M}
\]

18.4.3

Then using the expression for energy relation to magnitude: \( \log E = 12.24 + 1.44 M \) we can write:

\[
E = 1.74 \times 10^{12} e^{3.32M}
\]

18.4.4

which combines with 18.4.3 and determine the total energy in ergs per year, dE, for the dN earthquakes in the magnitude range, dM:

\[
\int dE = \int E dN = \int_{M_i}^{M_{i+1}} 9.13 \times 10^{19} e^{1.25M} dM
\]

18.4.5

This integrates the total energy for a magnitude interval \( M_i \) to \( M_{i+1} \):

\[
E_{i, i+1} = 7.35 \times 10^{19} [e^{1.25M_{i+1}} - e^{1.25M_i}]
\]

18.4.6
For example, consider the total energy released for all earthquakes from magnitude -3 to +8.7 the $E_{(-3,8.7)} \approx 3.9 \times 10^{24}$ ergs. This seems like a great deal of energy, but the average heat flux of the earth is $\sim 10^{28}$ ergs at HF - 1.5 m cal/cm$^2$ sec.

Thus, the seismic flux is $\sim 0.05\%$ of the heat release and it is not a significant total energy source. However, the manner in which the seismic energy is released is what is important, i.e. the seismic energy flux with most energy released very narrow belts on the earth.

The greatest contribution of energy is released in the large, M7+, earthquakes. Thus, the common belief that the presence of many small shocks in a seismically active area will reduce the potential of large shocks by releasing the energy in a dissipative way is incorrect. In fact, we know that some of our large earthquakes in the western U.S. occur in areas of no pre-existing seismicity as well as in areas with persistent on-going seismic activity.