

ESCI 323 homework due Friday, October 9, 2009.

### Seismic moment and moment-magnitudes

The scalar seismic moment of an earthquake is defined as  $M_0 = \mu SD$ , where  $\mu$  is the shear modulus,  $S$  is fault area, and  $D$  is the average slip or displacement.

A typical value for  $\mu$  is  $4 \times 10^{10} \text{ N m}^{-2}$  (use this value everywhere below)

It has been estimated for the Sumatran Earthquake of 26 December 2004 that the fault was 1200 km long and 200 km wide (down dip dimension) and that the average slip,  $D$ , is 13 m. What is the fault area (in meters squared)?

What is the value of  $M_0$  for this earthquake (use SI units please)?

The formula for moment-magnitude is given by

$$M_w = (2/3) \log_{10}(M_0) - 6.0 \quad (\text{works only for SI units})$$

What is the moment-magnitude for the Sumatran Earthquake of 26 December 2004?

There are some theoretical reasons to believe that

$$D = kS^{\frac{1}{2}}$$

where  $D$  is average slip,  $S$  is fault area, and  $k$  is a constant of proportionality. From the values above for the Sumatran earthquake, what is your estimate of  $k$ ?

Suppose that the maximum possible fault plane along the San Andreas fault is 1000 km long and 20 km wide (down dip dimension). What is the fault area?

Using your value of  $k$  found above, what is the corresponding maximum value of average slip?

With these values, what is the seismic moment of this largest possible earthquake?

From this value of seismic moment, what is the moment-magnitude of this largest possible earthquake?

Now consider the hypothetical great circle fault that we mentioned in class. What is the length (in km) of a great circle?

Assume that the fault width is 50 km, which is a generous upper bound for a vertical fault. What is the area of the fault?

What is the indicated value of average slip for such a fault?

What is the corresponding seismic moment?

What is the corresponding moment-magnitude?

Finally, suppose that the entire earth is seismogenic and there is an earthquake that will rupture the entire Earth. What is the area of such a hypothetical fault plane (through a hemispherical cross-section of the entire solid earth [including the core])?

What do you calculate as being the average slip?

What is the seismic moment?

What is the moment-magnitude?