20.0 Fault Plane Solutions

In our earlier material in Tectonophysics and Elastic Waves we developed the expressions relating the principal stresses to the criteria for shear failure assuming a Coulomb-Navier failure criteria. But just how does the force distribution on a fault plane develop, how are they related to the principal stresses and how can we measure properties of the stress distribution from the propagating seismic waves?

Reid's "theory of elastic rebound" was the first theory to relate fault failure to earthquakes and was used to describe the regional strain pattern following the M8.5, 1906, San Francisco, California earthquake. Reid assumed that the earthquake mechanism was a result of continuous strain energy storage that deformed the region around the fault with time until the elastic limit of the bedrock was reached. The stored strain energy was then being relieved by a shear failure (dislocation) and the media on either side of the fracture then returned to its original position (with respect to its original coordinate system).

Steps in Reid's Rebound Theory

Using the Navier-Coulomb fracture theory, we can infer the attitude and motion of a fault (eg. from a fault plane solution) and hence can determine the directions of the principal stresses,
σ₁, σ₂ and σ₃, and with a knowledge of μ, internal coefficient of friction, we can infer the stress directions. For example if μ = 0.6 implies that the angle between the maximum principal stress and the minimum principal stress is α = 30°.