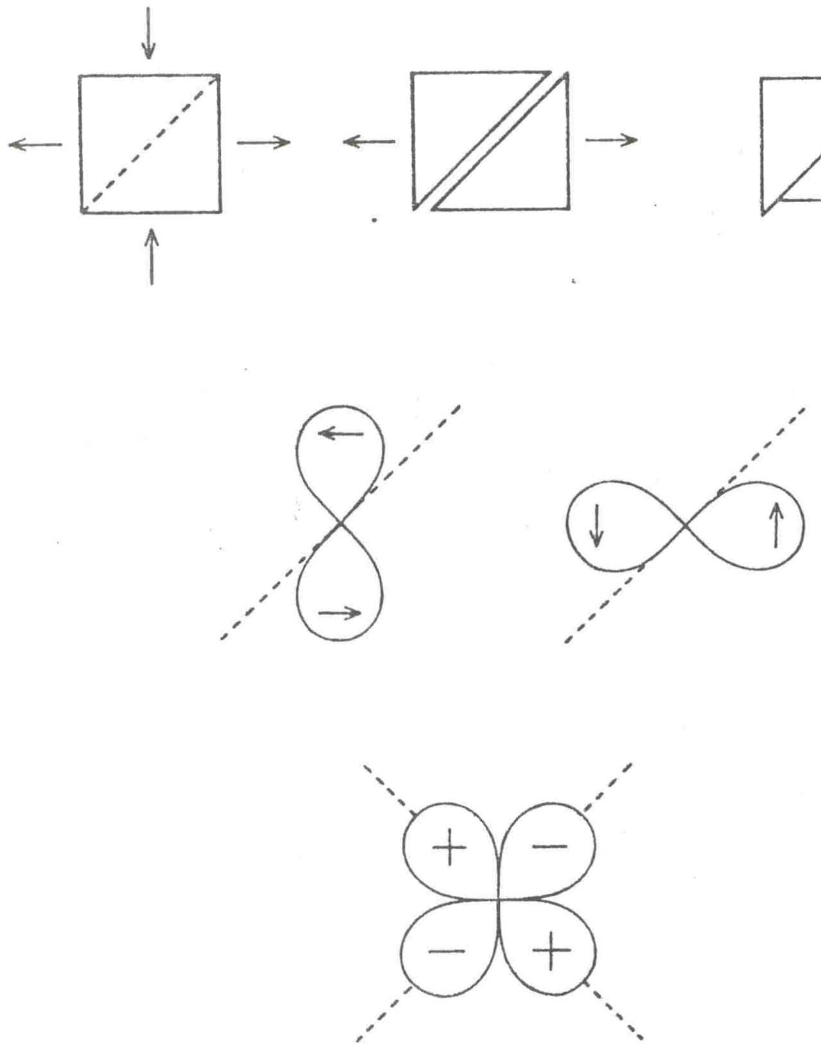

Fig. 8. Schematic representations that sequentially illustrate (top row, left to right) the components of shear stress considered to induce failure of a stronger material confined within a weaker material at high pressure (to about 50 kbar) by means of extensional rupture with extensional displacement into the weaker material, followed by recombination by means of a compressional translation. The middle row shows nodal pattern cross sections for seismic shear waves caused by the respective translations of extension and compression relative to the plane of rupture (dashed line). The bottom row shows a cross-sectional schematic of the nodal pattern of initial seismic waves of compression (plus signs) and rarefaction (minus signs) caused by the normal component of displacement of the rupture surface.

fusion, is that given for the type I earthquake focal mechanism [*Hodgson and Stevens,* 1964]. This mechanism describes a sliding motion on a rupture surface.

SHEAR STRENGTH OF ROCK UNDER COMBINED HIGH PRESSURES AND HIGH TEMPERATURES

Thus far discussion has been centered on room temperature data. For the failure model to have serious usefulness for earthquake studies, the downmoving crustal slab and the geothermal gradient must be considered.

Sykes et al. [1969] studied the spatial distribution of low-magnitude earthquakes in the Fiji-Tonga region and found a 45° dip relative to depth, foci being clustered over depth ranges 0–150, 200–300, and 500–650 km. They also discovered that seismic activity within the slab was concentrated within a 20-km thickness.

Toksöz et al. [1971] analyzed the thermal regime for an 80-km-thick crustal slab descending within the earth along a 45° dip. The temperatures calculated for the central part of such a slab moving at 8 cm/yr were 200°–400°C (depending on the magnitude used for the contribution from shear strain heating) at 50 km of depth, 500°–600°C at 100 km, 600°–700°C at 150 km, 800°–950°C at 250 km, 900°–1000°C at 300 km, and 1100°–1300°C at 400 km.

The thermal profiles derived by Toksöz et al. suggest that the 20-km apparent thickness of the Fiji-Tonga slab may reflect the temperature boundary wherein the rock is sufficiently cool to accumulate elastic strain and undergo catastrophic failure. Furthermore, the 800°–1000°C range of temperature given for the slab interior between 250 and 300 km of depth suggests that 1000°C is an adequate temperature to apply to the failure model at the upper transition, which occurs at 75–100 kbar of confining pressure.

There are only limited experimental data on the shear strength of rock under high pressure and high temperature. *Griggs et al.* [1960] studied various rocks in triaxial tests at 5 kbar of confining pressure to 800°C and in shearing tests to 20 kbar and 800°C. Their general conclusion was that most rocks show an increasing ductility with increasing temperature. Peridotite, pyroxenite, and granite were found