g7 Lynn Sykes' proof of seafloor spreading < first motions >

The first guessed at nature rather than studying it; the others, while thinking they are only verifying the systems they admire, study it truly; and it is thus that the sciences—like peoples—pass from poetry to history. —Cuvier.[1]

Mid-ocean ridges are frequently in their trends right- and left-offset across seafloor lineaments. If the offsets are due to strike-slip faulting, the lineaments will have fault seismicity along their lengths and fault motions will be in the sense of the offsets. Alternatively, if the ridge offsets are original, and the seafloor originates and spreads from the ridges, fault seismicity will be confined to the portions of the lineaments joining between ridge segments, and fault motions will be in the opposite sense to the apparent fault displacements. First motions of earthquakes generated by slip on the fault lineaments can decide (***Figure g7.1***) using a method pioneered by P. Byerly.[2] In 1966, **Lynn Ray Sykes** realized that his work on calibrating a worldwide standard seismograph network (WWSSN) for the U.S. Coast and Geodetic Survey (for the purpose of detecting nuclear-bomb tests) would let him do this. He achieved, in the same year, the first decisive proof of seafloor spreading from first motions on faults, each of which connect ends of offset ridge-segments of the South East Pacific Rise. In 1967, he published further evidence of first motions on "Wilson" transform faults of the Atlantic Mid-ocean Ridge.[3] ❑

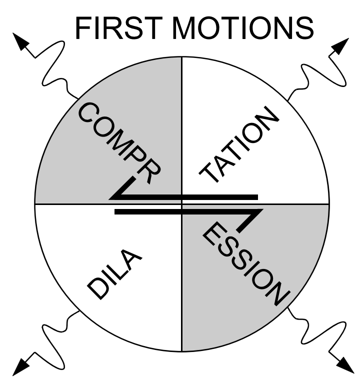

Figure g7.1 **Diagram of a left-lateral slip fault first motion fields** A focal mechanism solution (FMS) is the result of an analysis of the first motion of the P-wave received at seismograph stations about an earthquake source. Receiving-stations locations are plotted with respect to the earthquake focus put at the center of a lower-hemisphere stereographic projection. The first motion that each station records is plotted. Found fields of recorded compressions and dilatations can be separated by two great circles drawn at right angles to each other. The two quadrants so found with compressions are shaded (black). The resulting "beachball diagram" is a FMS in which the great-circle arcs are nodal planes, one of which coincides with the fault surface that slipped to generate the earthquake.

In textbooks, explanations of FMS usually proceed (confusingly) from a consideration of the stress tensor which describes the stress that existed at the time of the faulting. To the wise, this is silly as the first motion recorded in the stereogram plot of receiving seismic stations has little to do with the state of stress about the earthquake focus and has (simply) everything to do with the actual slip motion (***Scholium g7.1, Footnote g10.1***). In the case of transform faults, the strike of the fault is known and so the reading of the beach ball diagram is unambiguous. As a result, Sykes was able to prove that the motion on the transform faults between ridge-segment offsets accords to Wilson's "plate" theory of seafloor-spreading movement and so lay to rest the older notion that the offsets were due to transcurrent faulting (which flip images of the beachballs he plotted would have proved).

Note: In early works, the dilatational fields are the ones that are shown shaded.

Scholium g7.1 Outside the San Andreas fault zone, bore-hole data show that the principal axis of compression is nearly perpendicular (and not at 45 ^{o}) to the strike of the fault. Therefore, it is only a small component of that stress, resolved as shear in the plane of the fault, that causes it to slip.[4]