Shear waves may not behave uniformly for all directions of propagation in sedimentary basins. Splitting of seismic shear-waves (bi-refringence) is observed in many sedimentary basins, and appears to be caused by propagation through a combination of two phenomena: 1) the azimuthal isotropy of fine horizontal layering or lithology, leading to transverse isotropy with a vertical axis of symmetry, and velocity anisotropy of anything up to 30 or 40%; and 2) the azimuthal anisotropy of stress-aligned fluid-filled cracks, microcracks, and preferentially oriented pore-space, leading to transverse isotropy with a horizontal axis of symmetry, and much weaker velocity anisotropy (often less than 5%). The combination of the two transverse isotropies with orthogonal axes of symmetry leads to an orthorhombic symmetry system.

In most directions of propagation in anisotropic solids, seismic shear waves split in regular and predictable ways that, in principle, can be directly related to the degree of anisotropy and the anisotropic symmetry of the rockmass. In all anisotropic solids, however, there are directions of propagation, known as shear-wave singularities, where the split shear-waves have the same phase-velocities. For directions of shear-wave propagation near the commonest type of singularity, the point singularity, the relationship between the phase and group-velocities may undergo rapid variations for small changes in direction. This results in shear-waves along rays, propagating at the group-velocity in a cone of directions about the singular direction, behaving anomalously, with irregular polarizations and amplitude changes as if they were propagating near cusps, although the degree of anisotropy may too small to cause conventional cusps on the group-velocity wave surfaces.

The particular combination of anisotropy due to layering and anisotropy due to cracks or fractures in sedimentary basins leads to orthorhombic symmetry with many point singularities (commonly 20), including some which may be very close to to the directions of vertical raypaths. This means that in some circumstances, shear waves could be severely disturbed along nearly vertical raypaths. (It should be noted that the anomalies in the directions of point singularities are independent of P-wave propagation, which may well behave uniformly for all directions.) The effects of shear waves propagating near such point singularities have been identified in sedimentary basins. These irregular effects are demonstrated by calculating synthetic shear waves in directions near a point singularity in a material simulating a possible sedimentary basin.

Such anomalies may be important in exploration seismology as point singularities can occur along nearly vertical raypaths in sedimentary basins. A remarkable property of singularities is that shear waves along raypaths either side of a singularity may change polarization by up to 90° while still retaining significant delays between the split shear-waves. If not identified correctly, the irregularities associated with such point singularities could be mistakenly attributed to structural irregularities. If correctly identified, the directions of such singularities can place tight constraints on the possible combinations of azimuthal isotropy and azimuthal anisotropy in sedimentary basins.