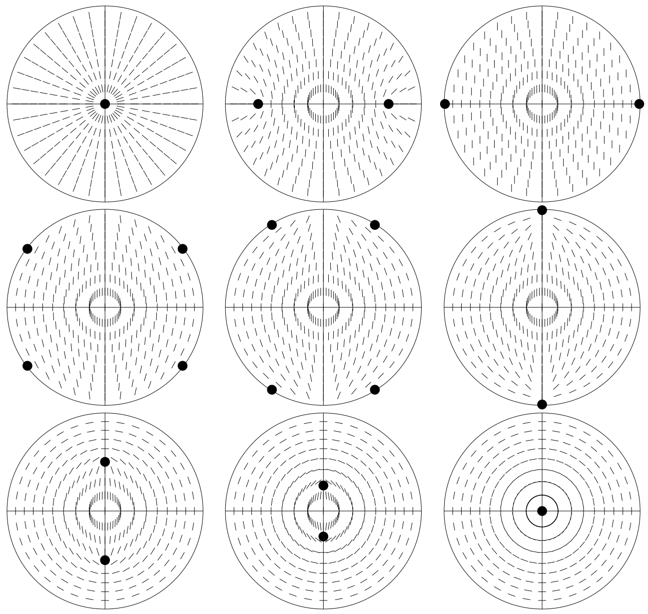

Figure 2. Relationship of breakout orientations to stress directions and magnitudes in arbitrarily oriented drill holes [*Mastin*, 1988]. Lower hemisphere stereographic projections show the breakout orientations, projected onto the horizontal plane, for a variety of drill hole orientations and stress regimes. Solid circles are points at which the stress anisotropy is zero and corresponds to borehole orientations with no preferred breakout direction. The low maximum compressive stress at the borehole wall at these positions indicates that breakouts might be absent. If breakouts are present near the nodal points, however, they will change orientation rapidly as borehole orientations vary. In these figures, Poisson's ratio was taken to be 0.25, and the orientation of the maximum horizontal principal stress is always east-west for nondegenerate stress regimes. (top left) Degenerate thrust stress state, (top center) thrust regime for $\phi = 0.5$, and (top right) combination of thrust and strike-slip faulting ($\phi = 0$). (middle left) Strike-slip stress regime ($\phi = 0.5$), (middle center) strike-slip stress regime ($\phi = 0.8$), and (middle right) combination of normal and strike-slip regimes ($\phi = 1$). (bottom left) Normal stress regime ($\phi = 0.5$), (bottom middle) normal stress regime ($\phi = 0.2$), and (bottom right) degenerate normal stress regime ($\phi = 0$).

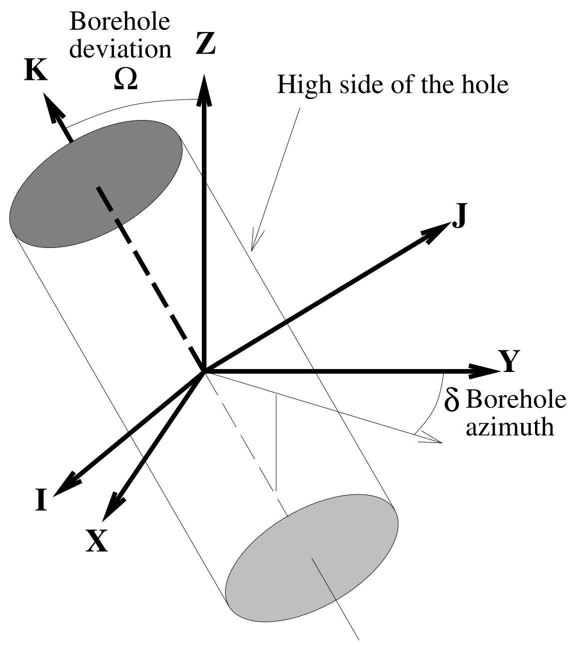

Figure 3. View of the two coordinate systems associated with the borehole. The **X**, **Y**, and **Z** axes are aligned with the geographic coordinate system. The **IJK** coordinate system rotates as the borehole orientation changes.

depth. So the orientation of this reference frame moves with respect to the geographic (**XYZ**) reference frame. The axes are named **I**, **J**, and **K** and are oriented as follows. The **K** axis points up along the borehole axis, the **J** axis is perpendicular to the **K** axis and in the same plane as the **K** and **Z** axes, while **I** is perpendicular to both the **J** and **K** axes and lies in the horizontal plane. With this definition the **J** axis always points to the high side of the hole. If the borehole is vertical, then this coordinate system coincides with the geographic coordinate system. The borehole reference frame will be referred to as the **IJK** reference frame for short.

Two rotations are required to rotate a coordinate system that is initially aligned with the **XYZ** coordinate system into alignment with the **IJK** coordinate system. The first rotation about the **Z** axis rotates the geographic coordinate system clockwise by the angle δ till **X** coincides with **I**. The resulting coordinate system will be referred as the $\xi\eta\zeta$ axes. The second step rotates the $\xi\eta\zeta$ axes about the ξ axis by a counterclockwise angle Ω, producing the **IJK** coordinate system. The two angles, δ and Ω, in geological terms, are the borehole trend and deviation, respectively. See Figure 3 and