COMPARISON OF OPTICAL AND ELASTIC BREWSTER'S ANGLES TO PROVIDE INVUITIVE INSIGHT INTO PROPAGATION OF P- AND S-WAVES

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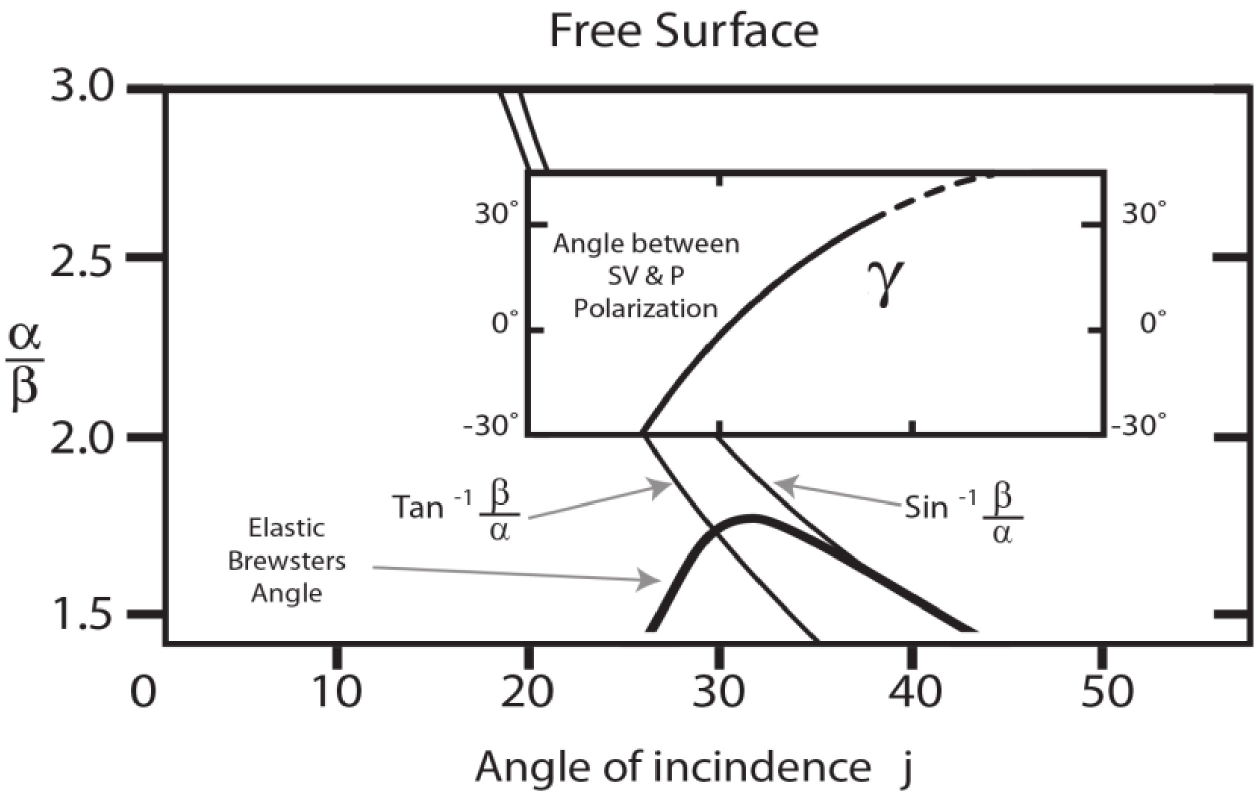
ABSTRACT

The Brewster's (polarization) angle of reflection in optics is well understood and leads to distortion, including polarization filtering, of reflected waves. Further, the values of the Brewster's angle (a zero crossing in amplitude) are closely related to the contrast in physical properties across the reflecting interface. I investigate elastic analogues to the optical Brewster's angle for the case of incident seismic shear waves at a reflecting interface. Both optical (light) and elastic shear waves are characterized as transverse waves, and both are subject to polarization distortion upon reflection. For this exploratory study, I limit the seismic case to situations of only two reflected or transmitted waves where one of the waves vanishes 1.) SH-SH reflection-refraction across a solid-solid interface where the reflected SH wave vanishes and 2.) SV-P reflection (mode conversion) at a free interface where the reflected SV wave vanishes. In the optical case, the rays defining the refracted and reflected waves at the Brewster's angle are at 90° to each other. In the shear-wave examples, the reflected and refracted SH waves are normal to each other only if there is no density contrast. For the free surface, the rays for the incident SV and reflected P waves are at right angles only for a Poisson's solid, $\lambda = \mu$. Understanding these geometric relations should improve our intuitive insight into reflection, refraction and mode-conversion processes for P, SV and SH waves and improve interpretation of contrasts in elastic properties, including anisotropic conditions. Further investigations into characterizing contrasts in elastic properties through reflection/refraction/mode-conversions processes are continuing.



Angle of incidence j where the amplitude of the reflected SV polarized shear wave from a free-surface interface vanishes (elastic Brewster's angle), as a function of α/β. The angle γ is the angle between the polarization direction of the input SV wave and the polarization of the reflected P-wave. Values of γ for the range of j where there is a zero crossing in Rsv-sv (only P-wave reflected) are included in the insert. In the optical case, γ is always zero.