Generating Vs from Vp sonic logs

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INTRODUCTION

The correct identification of primary events on the converted S-wave section in the absence of a VSP or S-wave sonic log may be difficult (Corbin et al.,1983). Shear wave transit times can be inferred by making lithologic assumptions based on Vp/Vs ratios thus expected (McCormack et al.,1984). However this method is at best qualitative due to the large overlaps in rock lithologies for Vp/Vs ratios as shown by the example in Figure 1 for brine-saturated samples. The accuracy of this ratio may depend on the data quality if based on isochron times or stacking velocities. The errors in this method are demonstrated in Figure 2. Many of the problems in the application of this quantity to exploration may be related to its misinterpretation. A recent redefinition of the Vp/Vs ratio based on Pickett's velocity equation (Pickett, 1963) results in a simple linear equation relating S-wave transit time (Δts) to P-wave transit times (Δtp) (Ikwaukor, 1988).

$$\Delta ts = (\Delta tms - Bs/Bp(\Delta tmp)) + Bs/Bp(\Delta tp)$$

Where Δtmp and Δtms represent intercept terms; Bs and Bp express the rate of change of effective transit time with porosity as shown in Figure 3. It should also be noted that Δtms and Δtmp are relatively constant at all effective stresses while Bs and Bp vary as shown in figure 4. This equation is demonstrated for a series of rock types in figure 5 as a cross plot of Δtp versus Δts. It can be seen that the various rock types can be represented by a linear trend as in the above equation for a given rock type and effective stress. The slopes and intercepts are lithologic indicators.

PROPOSAL

It is proposed that the use of Bs/Bp ratios to indicate blocked lithology on the P-wave sonic log may be a viable approach to obtaining S-wave synthetic seismograms. Further, by evaluating the P-SV conversion points in depth, based on the Vp/Vs given by this equation, over a range of source-receiver offsets an accurate P-SV synthetic seismogram may be obtained.

REFERENCES

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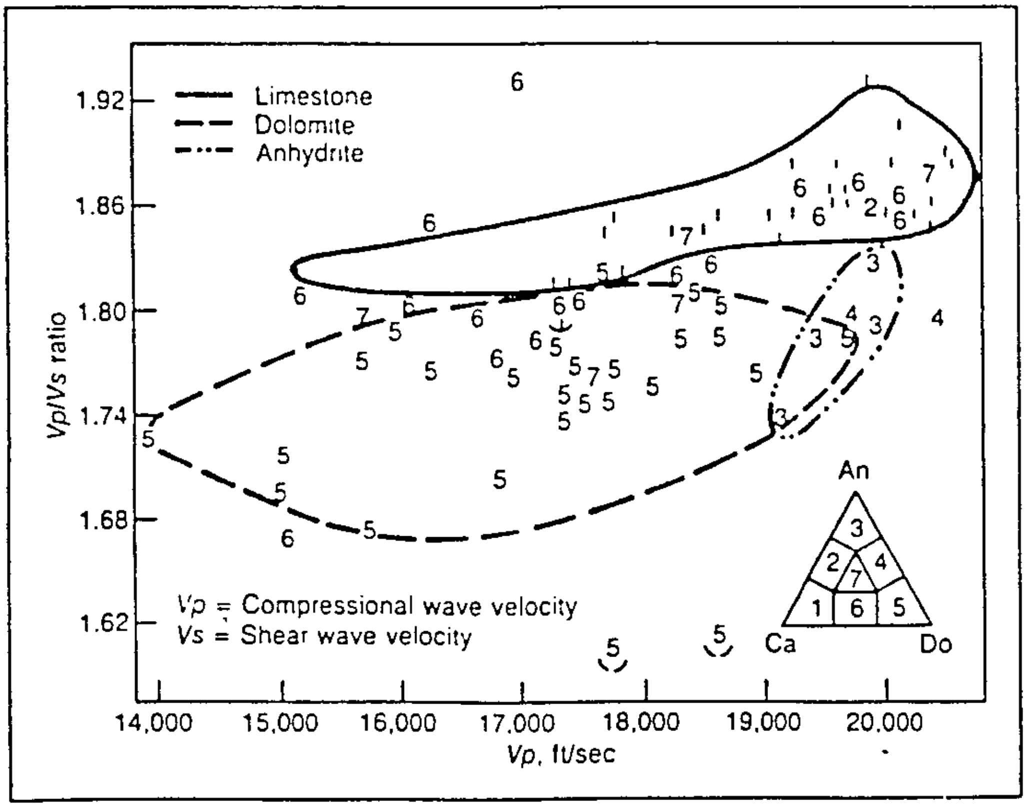

Figure 1. Plot of Vp/Vs versus compressional wave velocity (Vp) for brine saturated samples (after Rafavich et al., 1984).

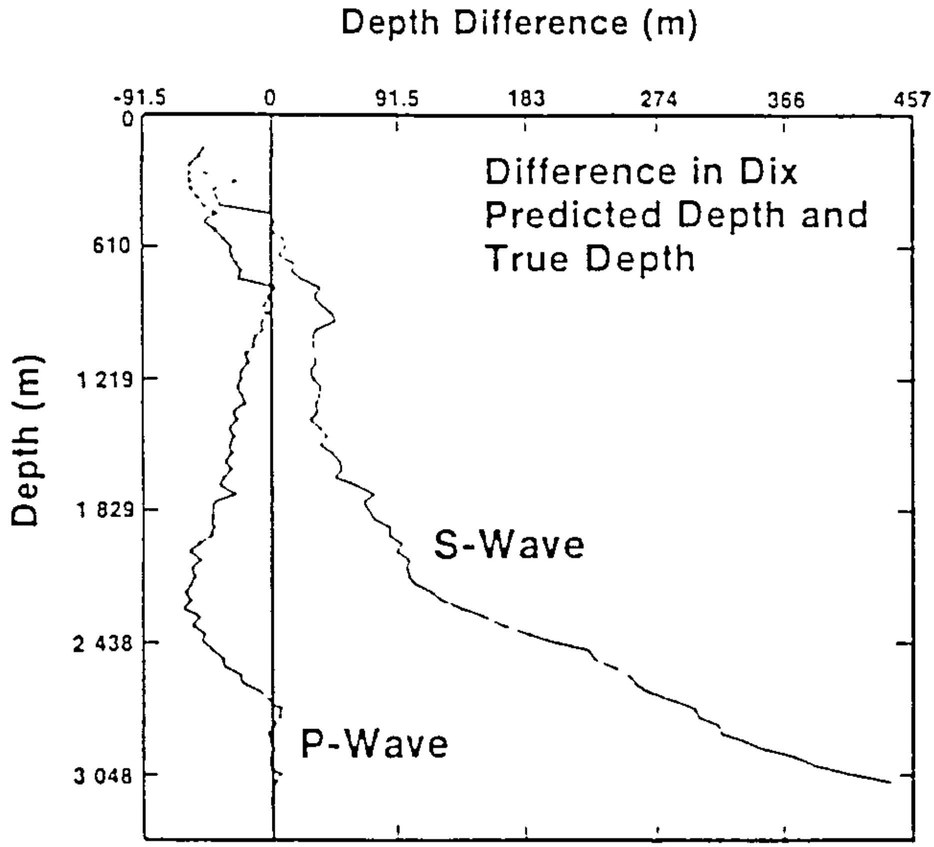

Figure 2. Difference in true depth (as measured from VSPs) and predicted depth (calculated from stacking velocities by Dix's equation) for P- and S- wave reflections (after Corbin et al., 1983).

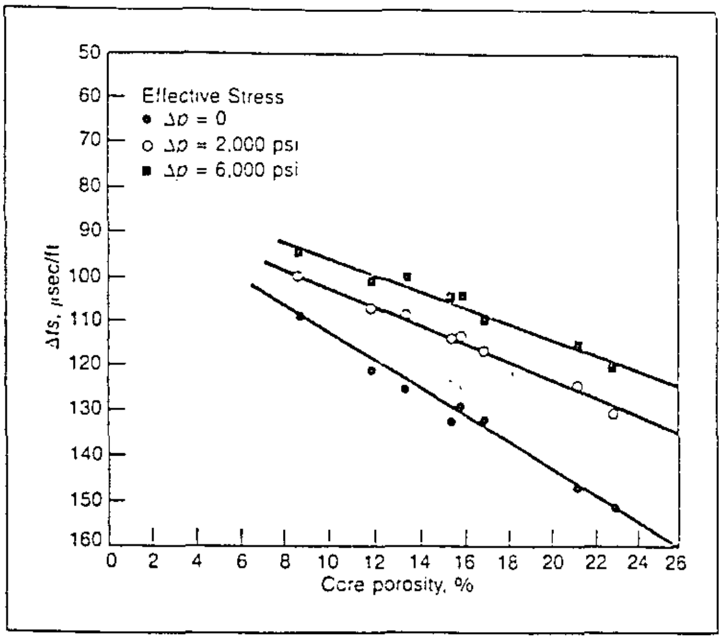

Figure 3. Reciprocal shear wave velocity (Δts) versus core porosity at different effective stresses (Δp) for laboratory measurements on water-saturated dolomites (after Pickett, 1963).

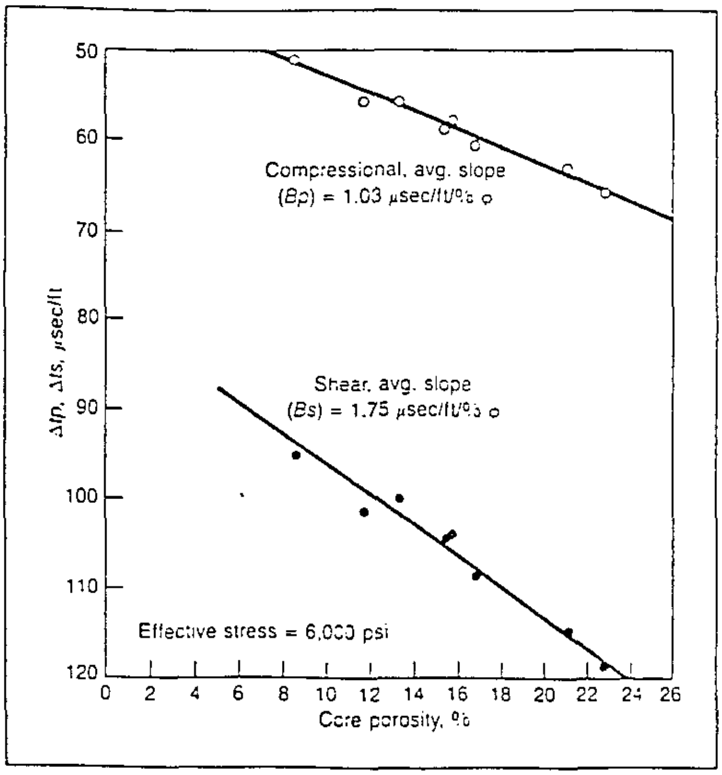

Figure 4. Reciprocal compressional wave velocity (Δtp) and reciprocal shear wave velocity (Δ ts) versus core porosity for dolomites at effective stress of 6,000 psi (after Pickett, 1963).

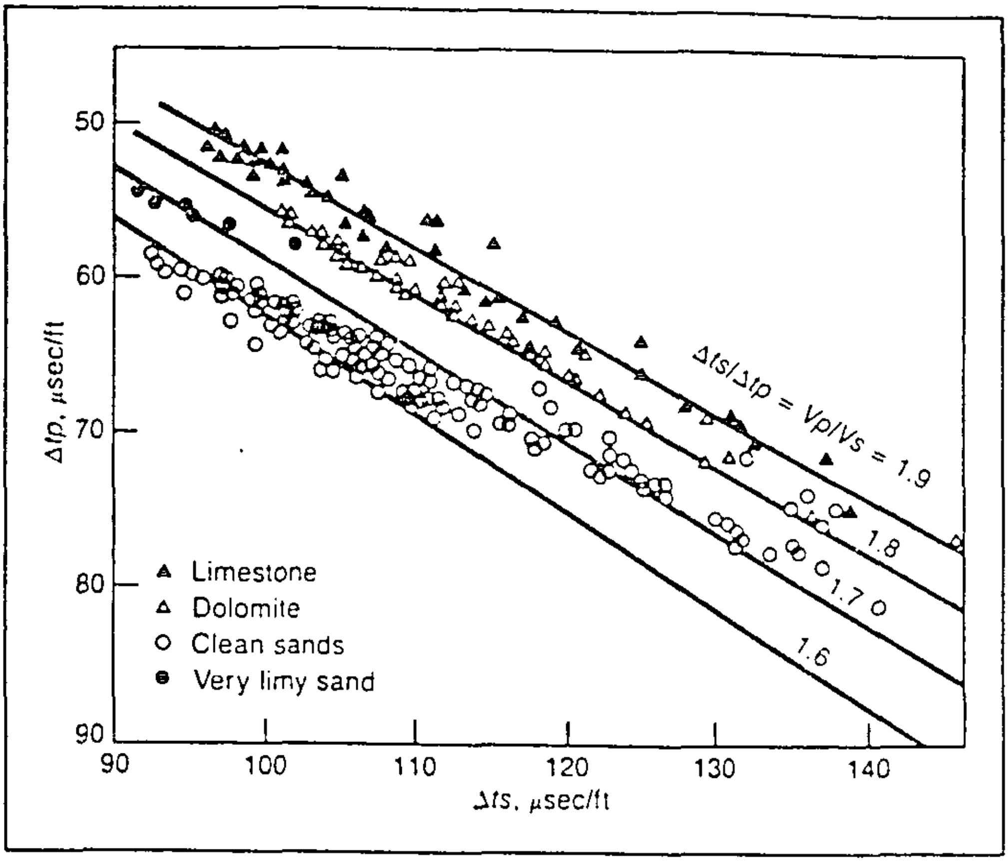

Figure 5. Reciprocal compressional velocity (Δtp) versus reciprocal shear velocity (Δ ts) for laboratory measurements on limestones, dolomites and sands (after Pickett, 1963).