

Short Note

The fluid factor as an AVO indicator

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INTRODUCTION

Castagna and Smith (1994) presented a very interesting comparison of some of the different amplitude variation with offset (AVO) indicators used in the industry today. They used a worldwide sample of data to compute their examples. In their paper, they alluded to the "fluid factor" of Smith and Gidlow (1987) but they did not compute this attribute for their data. In the following, we suggest how the fluid factor can be computed, and compare the results with the $(R_p - R_s)$ and $(A + B)/2$ techniques. We have used Castagna and Smith's (1994) notation.

THE FLUID FACTOR

The fluid factor is defined in Fatti et al. (1994) by their equation (6):

$$\Delta F = R_P - M^*(V_S/V_P)^*R_S, \quad (1)$$

where ΔF = fluid factor, and $A4$ = slope of the mudrock line.

We are interested in selecting a value, g , to substitute for $M^*(V_S/V_P)$ in the above equation, to obtain the "best" separation of gas-associated reflectors from those of shale/brine-sand interfaces as

The first two characteristics according to Castagna and Smith (1994) which are highly desirable for a hydrocarbon indicator are:

- 1) Background (nonpay) should be relatively constant and near zero; and
- 2) The indicator should be negative for shale over gas-sand interfaces and significantly more negative than for shale over brine-sand interfaces.

Figure 3 shows the "ideal" gas detector. Background (non-pay) reflections have zero fluid factor values, shale/gas-sand interfaces are all negative and gas-sand/brine-sand interfaces are all positive. This result is achieved by making g equal to R_p / R_s for the shale/brine-sand interface for each of the 25 data points separately. Of course, the result is trivial. Incidentally, sample 17 is anomalous because the gas-sand impedance lies on the "wrong" side of the mudrock line connecting the shale and brine-sand impedances on an S-wave impedance/P-wave impedance crossplot.

Figure 4 is a plot of $R_p - 0.63 * R_s$ for all the data. By the criteria listed above, this is better than $R_p - R_s$ or $(A + B)/2$.

A "quality" based on these criteria can be devised,

$$Q = \frac{\Sigma[(R_P - g^*R_S) \text{ for gas-sand/water-sand} - (R_P - g^*R_S) \text{ for shale/gas-sand}]}{\Sigma |R_P - g^*R_S| \text{ for shale/water-sand}}, \quad (3)$$

$$\Delta F = R_P - g^*R_S. \quad (2)$$

In Figures 1 and 2, we have regenerated Figures 4 and 6 of Castagna and Smith (1994) adding the reflections from gas-sand/brine-sand interfaces. Figure 1 shows $(R_p - R_s)$ for the 25 sets of data and Figure 2 shows $(A + B)/2$.

so that a high Q is desirable. Q plotted against g is shown in Figure 5, which shows a high Q at $g = 0.63$. $R_p - R_s$ as an indicator is the rightmost point of Figure 5, and R_p alone is the leftmost point.

Thus from the 25 data points given, a "global" optimum fluid factor would be $R_p - 0.63 * R_s$.

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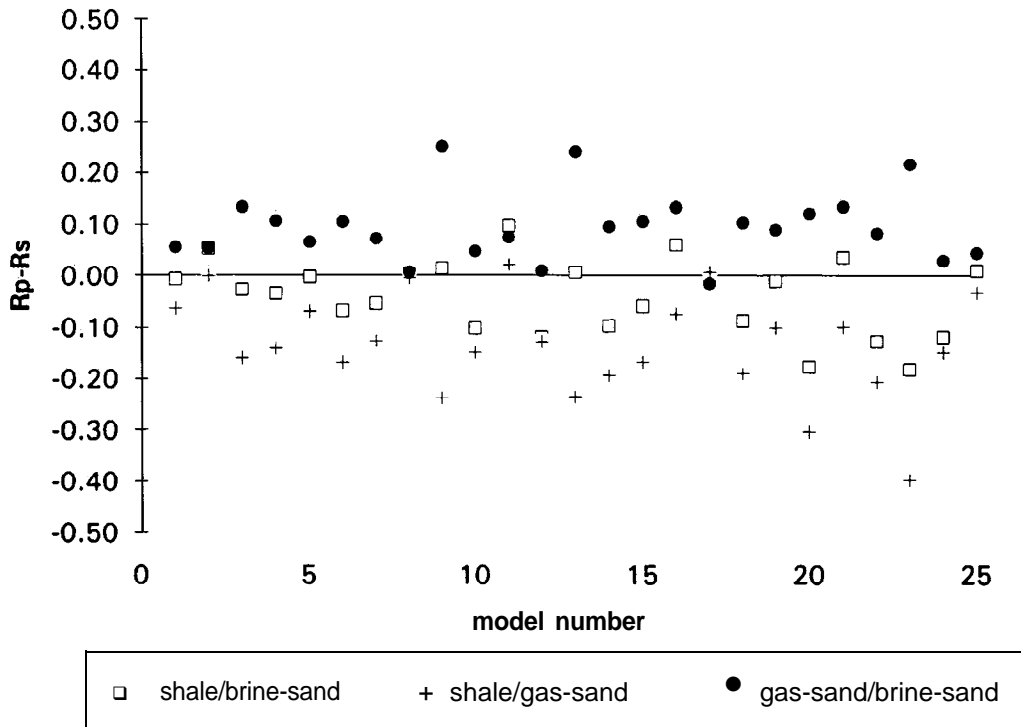


FIG. 1. $R_p - R_s$ for 25 sets of shale, brine-sand, and gas-sand V_p , V_s , and ρ measurements. Modified from Castagna and Smith (1994).

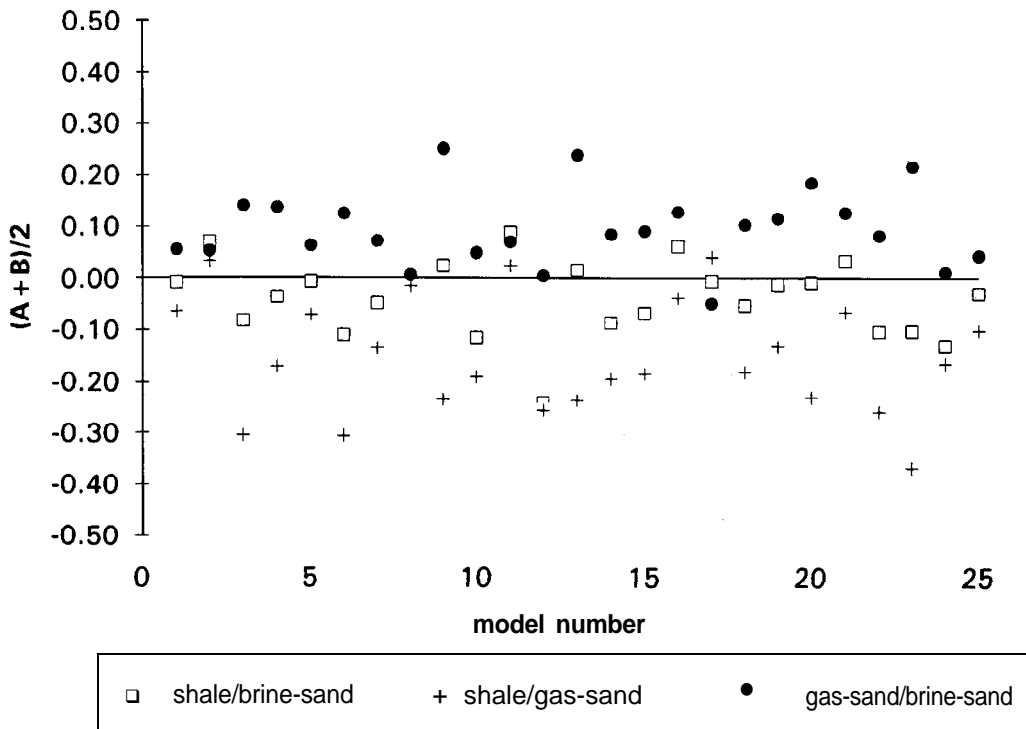


FIG. 2. $(A + B)/2$ for the 25 measurements. Modified from Castagna and Smith (1994).

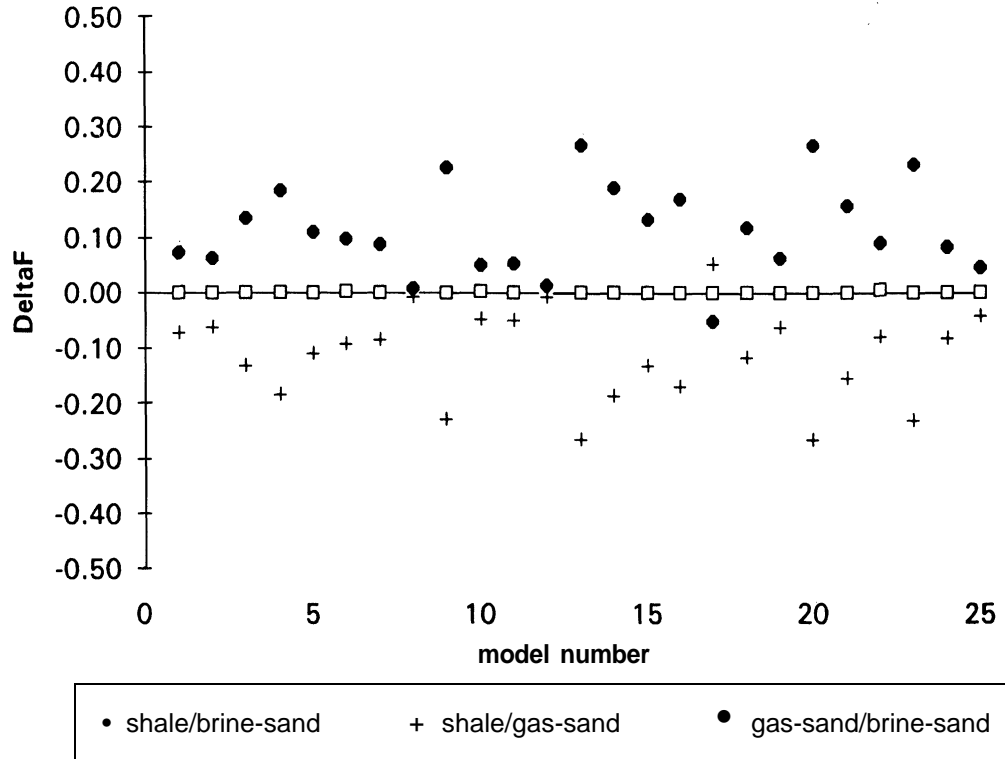


FIG. 3. "Ideal" gas indicator for the 25 measurements.

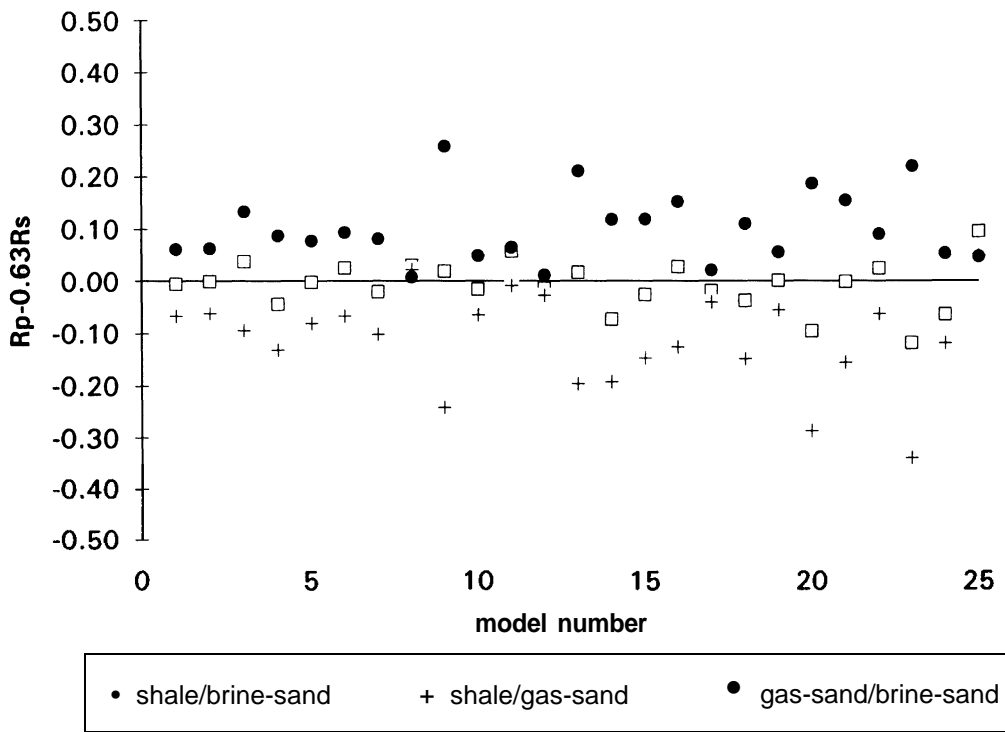


FIG. 4. $R_p - 0.63R_s$ for the 25 measurements.

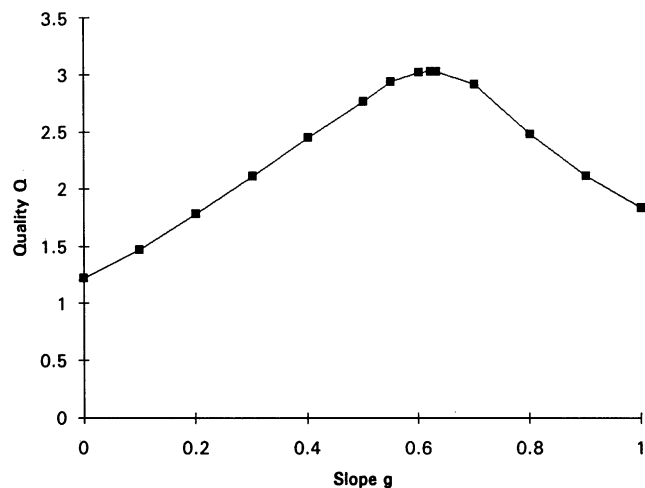


FIG. 5. Anomaly quality Q plotted against g for the 25 measurements. The peak is at $g = 0.63$.

CONCLUSION

A local or global fluid factor approach to "anomaly hunting" will, in general, be superior to either $R_p - R_s$ or $(A + B) / 2$.

REFERENCES

- Castagna, J. P., and Smith, S. W., 1994, Comparison of AVO indicators: A modeling study: *Geophysics*, **59**, 1849-1855.
- Fatti, J. L., Vail, P. J., Smith, G. C., Strauss, P. J., and Levitt, P. R., 1994, Detection of gas in sandstone reservoirs using AVO analysis: A 3-D seismic case history using the Geostack technique: *Geophysics*, **59**, 1362-1376.
- Smith, G. C., and Gidlow, P. M., 1987, Weighted stacking for rock property estimation and detection of gas: *Geophys. Prosp.*, **35**, 993-1014.