Mud-rock line estimation via robust locally weighted scattering smoothing method

A.Nassir Saeed (ansaeed@ucalgary.ca), Laurence R. Lines, and Gary F. Margrave
CREWES, University of Calgary

ABSTRACT

We have estimated the mud-rock line for well 08-08 of the Blackfoot area using LOWESS method. The mud-rock line produced by LOWESS method has shown superiority over the Castagna's mud-rock line equation in mapping the Glauconitic sand reservoir of Blackfoot area. The produced graph has demonstrated to be a good visualizing tool for effective direct hydrocarbon indicators (DHI) as well as in differentiating sand and carbonate lines.

LOWESS METHOD

Cleveland, (1979) introduced the robust locally weighted scattering smoothing (LOWESS) method that smoothes the scatter plot and guards against outliers .

- Given (x_i, y_i) points, let *d* are the distance between x_i and it's *b*th nearest neighbors along the x-axis.
- *b* is the nearest integer to (*f*.n/2), n=number of point and *f* is smoothing factor (usually between 0.2 and 0.8).
- The weighted slope (b_w) and the intercept (a_w) of best fit line (y_w) are written as

$$b_w = \frac{\sum W_k^2 (x_i - \bar{x})\cdot(y_i - \bar{y})}{W_k^2 (x_i - \bar{x})^2}, \qquad \bar{y} \text{ and } \bar{x} \text{ are mean values}$$

$$W_k = \varpi\left(\frac{x_i - x_k}{d_i}\right), \varpi(x) = \begin{cases}(1-|x|^p)^p & \text{for } |x|<1 \\ 0 & \text{for } |x|\ge 1\end{cases}$$

$$a_w = \bar{y} - b_w .\bar{x}$$

$$y_w = a_w + b_w .\bar{x}$$

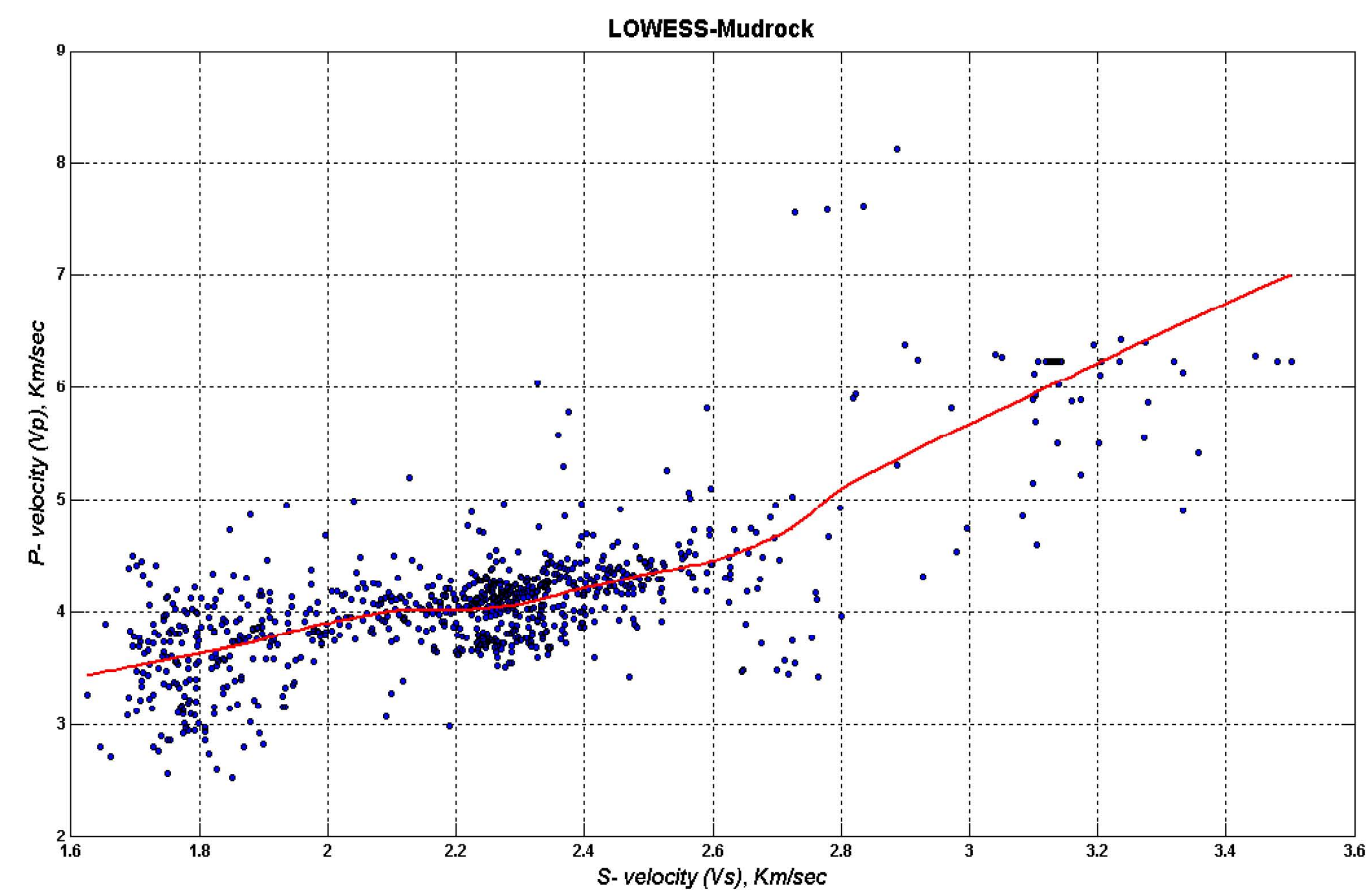

FIG. 1. LOWESS method for estimating mud-rock line.

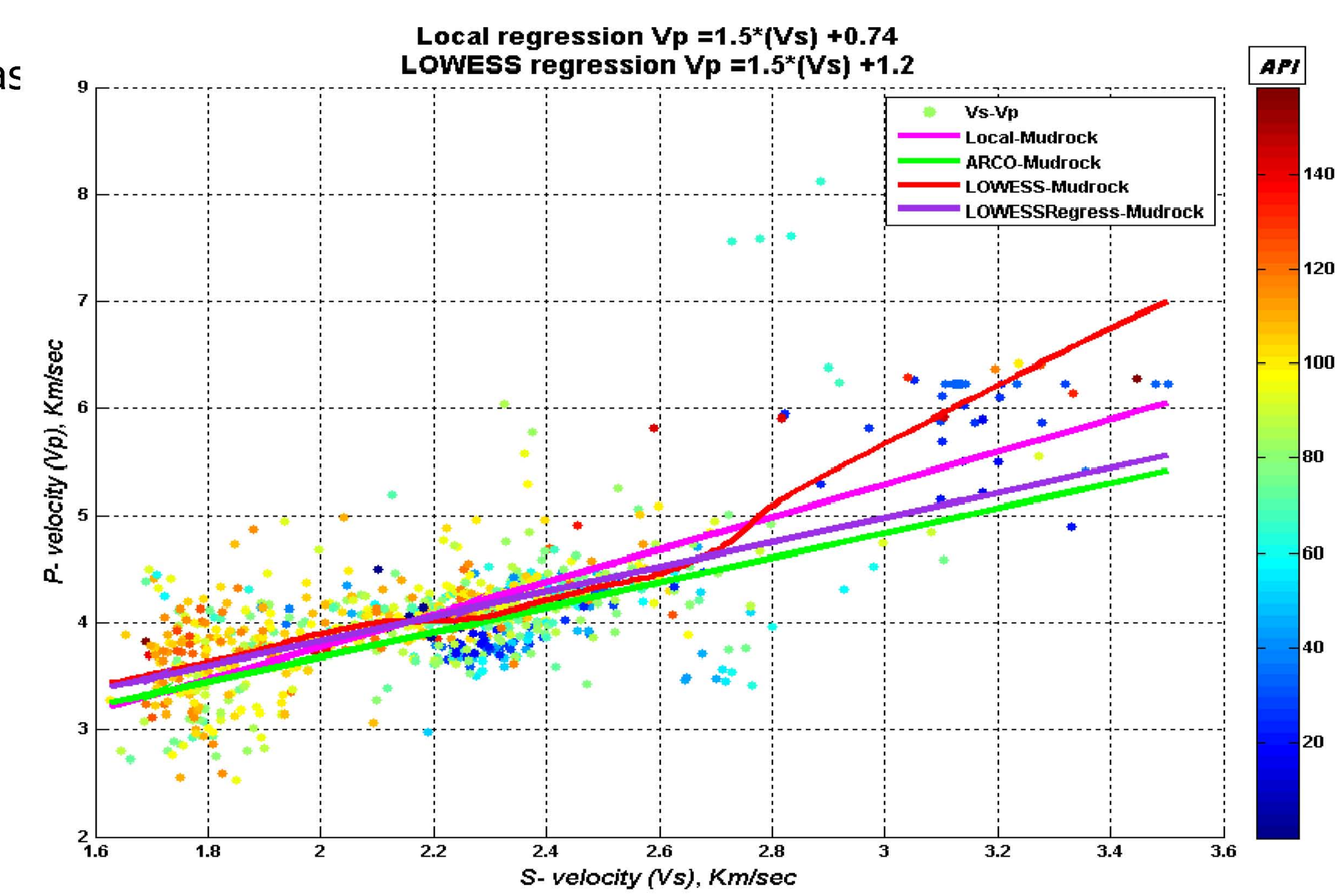

FIG. 2. LOWESS method for estimating mud-rock line. Data points are colored by Gamma ray.

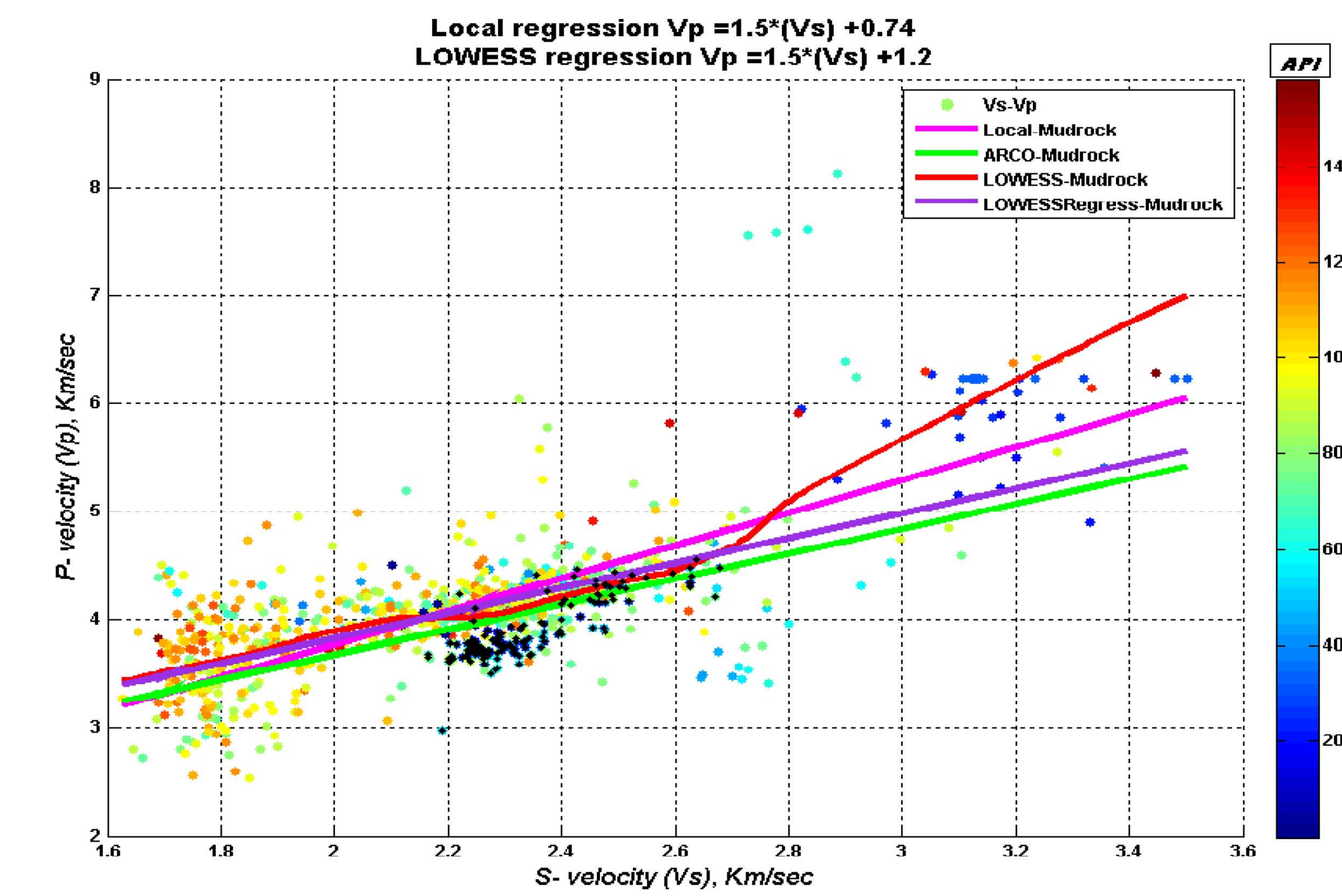

FIG. 3. LOWESS method for estimating mud-rock line. Sonic Vs of sand channel (in black color) are superimposed.

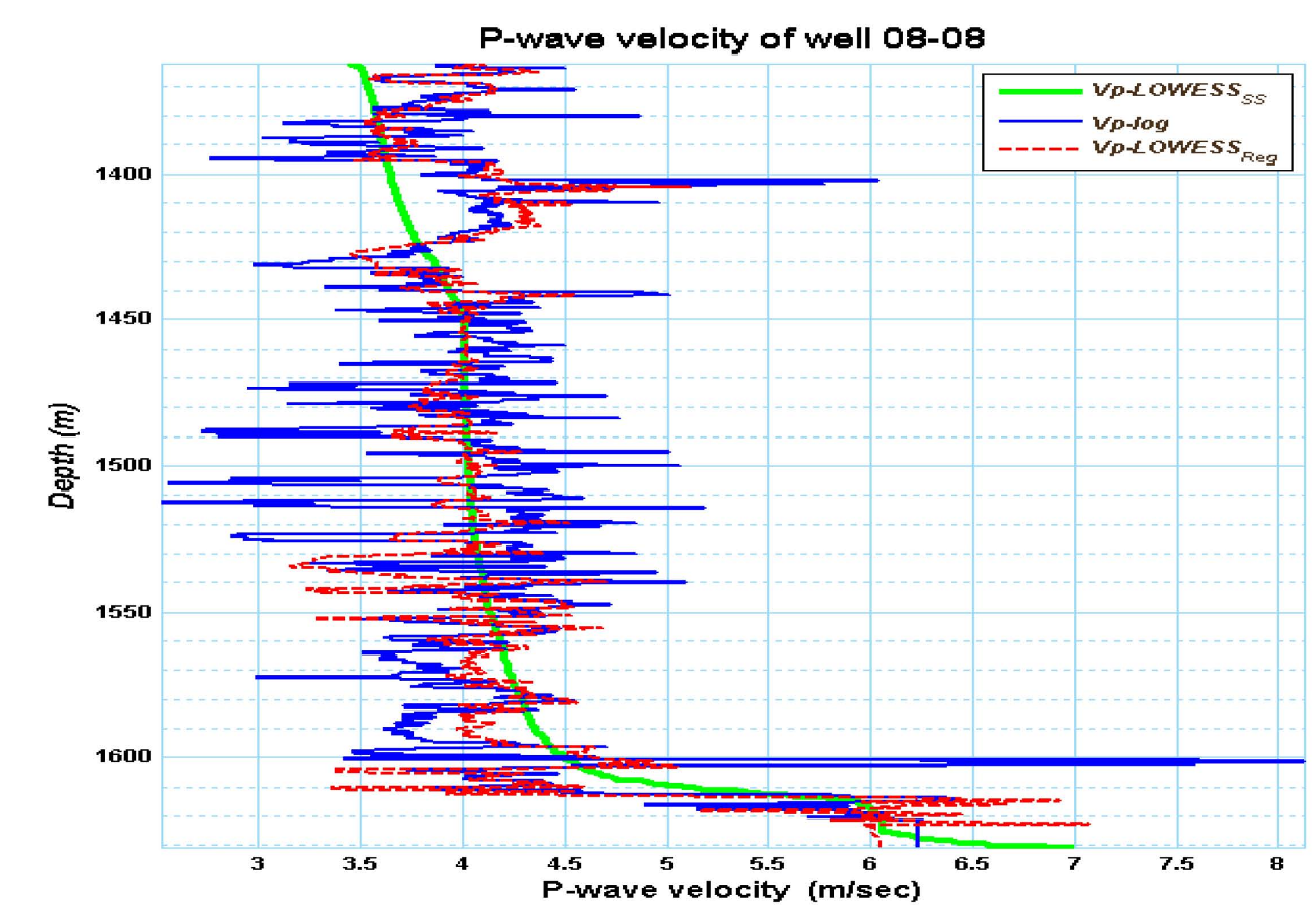

FIG. 4. P-wave sonic log, and derived P-wave velocity via the LOWESS method of well 08-08.

DISCUSSION

- Figure (1) shows the mud-rock lines produced by LOWESS method.
- Figure (2) shows the mud-rock lines from the LOWESS, locally-derived and Castagna's mud-rock methods. The data points are colored by gamma ray, where sand shows low gamma values.
- The slope and intercept values estimated via LOWESS method are used in Castagna equation, and produced new mud-rock line (purple color).
- Mud-rock line estimated by LOWESS method has successfully delineated channel sand, while locally-derived regression and ARCO methods did not.
- In figure (3), the sonic shear (Vs) of the Glauconitic channel sand (black dots) are superimposed.
- In figure (4) the sonic P-wave of the log and P-wave velocity produced via LOWESS method show good resemblances.
- The curve in green color represents the weighted P-wave velocity produced in smoothing scattering domain.

CONCLUSIONS

LOWESS method proves to be a good interpretive tool for hydrocarbon and lithology discrimination. The predicted log of P-wave velocity shows good resemblance to the original sonic P-wave log.

REFERENCES

•Castagna, J. P. Batzle, M.L. and Eastwood, R.L., 1985, Relationships between compressional-wave and shear-wave velocities in elastic silicate rocks: Geophysics, **50**, 571-581.

•Cleveland, W.S., 1979, Robust locally weighted regression and smoothing scatterplots: Journal of the American Statistical Assoc., **74**, 829-836.

ACKNOWLEDGMENT

Authors would like to thank all of CREWES sponsors for their financial support.