Creating and Cross Plotting Lambda-Mu-Rho Logs in HRS-9

January 2013, David Worsick
With the $Z_P$ and $Z_S$ volumes now available, it is very easy to further generate Lambda Rho and Mu Rho volumes.

The Lamé parameters, $\lambda$ and $\mu$, and density $\rho$ define seismic velocity.

\[
V_P = \sqrt{\frac{\lambda + 2\mu}{\rho}} \quad \text{and} \quad V_S = \sqrt{\frac{\mu}{\rho}}
\]

therefore:

$Z_S^2 = (\rho V_S)^2 = \mu \rho$

and:

$Z_P^2 = (\rho V_P)^2 = (\lambda + 2\mu) \rho$

so:

$\lambda \rho = Z_P^2 - 2 Z_S^2$

$Z_P = \text{acoustic impedance} = \text{Velocity} \times \text{Density}$
The interpretation of a Lambda-Mu-Rho cross plot as presented by Goodway et al.
There are other options for log processing as shown in the Process menu.

As one example, we will generate LMR logs from the P-wave, S-wave and density logs.

1. Select Log Processing>Other>LMR to bring up the LMR dialog.
The LMR Dialog

2. Set whether you are using one or several wells, and select the wells.

3. Select the impedance logs to use.

Two equations are defined as follows:

\[ \text{Lambda-Rho} = \lambda \rho = Z_p^2 - cZ_s^2 \]

\[ \text{Mu-Rho} = \mu \rho = Z_s^2 \]

where \( 2.0 \leq c \leq 2.5 \)
Showing the LR and MR logs.
4. To cross plot the $\lambda$-$\rho$ and $\mu$-$\rho$ logs, select **Cross plot logs** from the **Process** menu.

5. Select **LMR** for the plot type and name the plot.

6. After entering the parameters, click **OK**.
The LMR Cross Plot Results

7. Click the **Rectangle Zone** icon and draw a box around the points shown.

We are interested in the points that fall outside the normal trend.

This zone will be put into this set of zones.
8. Select **Options>Cross section** to open an interactive mapping of the crossplot zone onto the logs.
9. Save the zone through the **File** menu and close the **Cross Plot** window.

This zone now shows potential reservoirs as indicated by their $\mu$-$\rho$ versus $\lambda$-$\rho$ plots.
As you add, move, resize or remove zones, the **Log Cross Section** display will update.

We have also added a new zone that is now shown on the cross section.

Here, we have made the zone smaller...

And the cross section shows the thinner zone.
Displaying the LMR Cross Plot Zones

The cross plot zones can be displayed on any log curve.
10. Click the **Eye** icon to bring up the **Log Display** dialog.

11. First, make changes in the **Curves** tab.
12. Then, in the **Layout** tab, select the cross plot zone set you had made earlier.

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