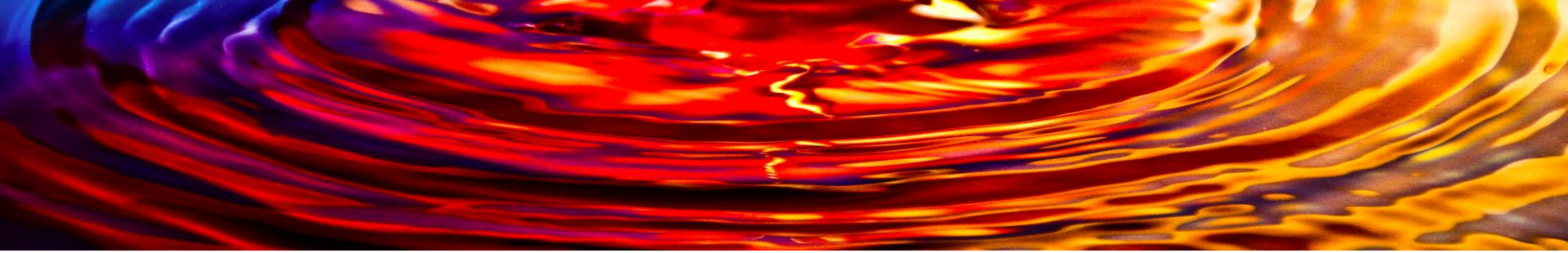

CORRELATION BETWEEN ELECTRICAL RESISTIVITY AND ANISOTROPIC ELASTIC PROPERTIES OF PIERRE SHALE, WATTENBURG FIELD, COLORADO

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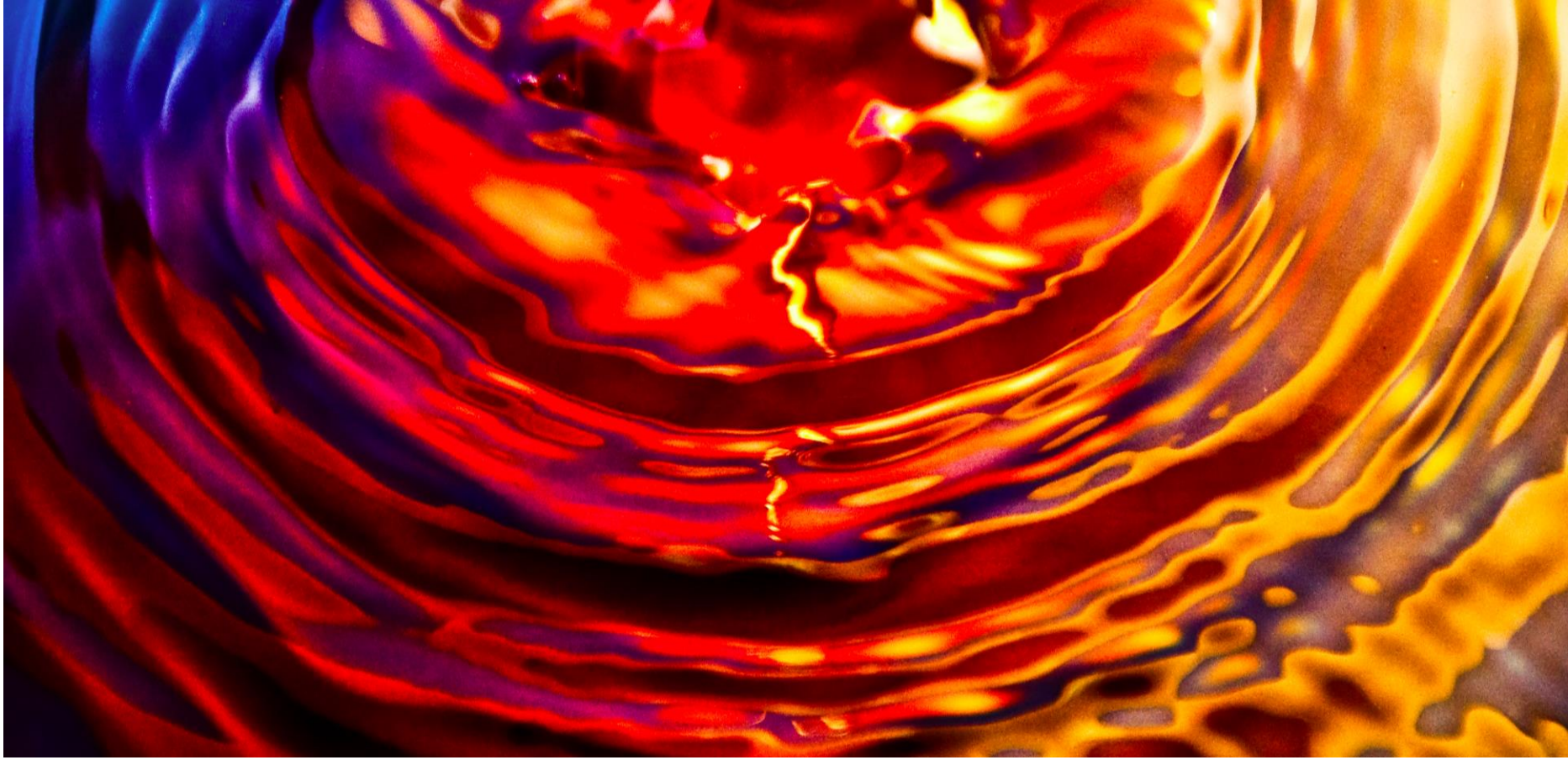
SIGMA³ (Sigma Cubed Inc.), Englewood, CO

November 2015

RCP COLORADOSCHOOLOFMINES IN PURSUIT OF NEW IDEAS

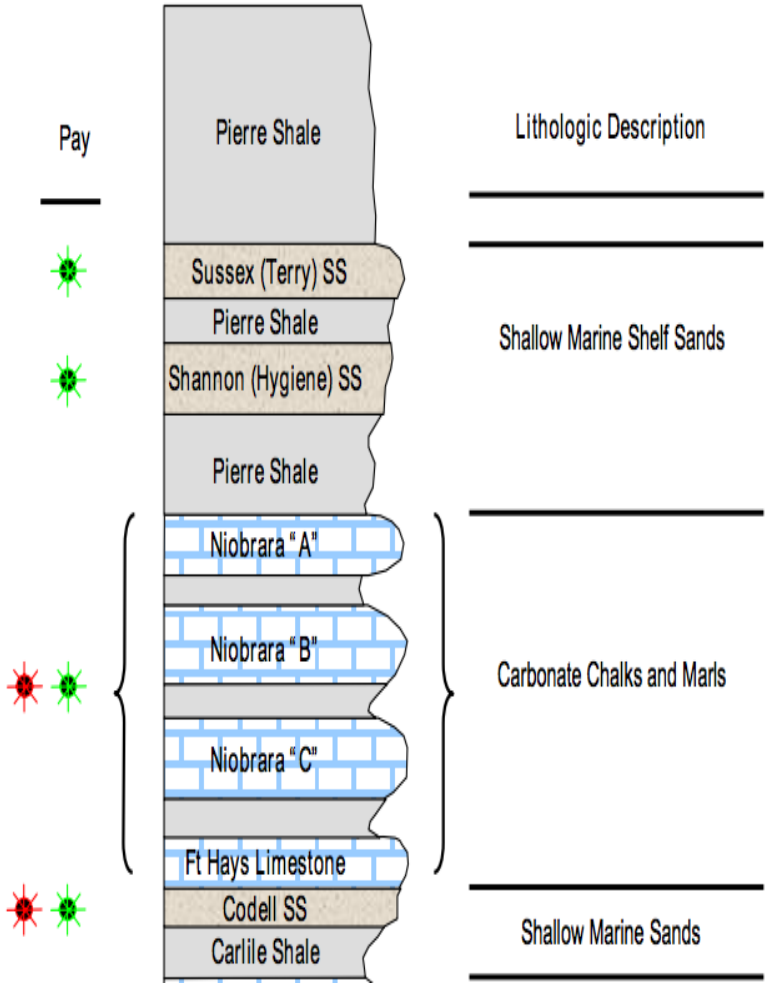
SIGMA³

1-4 NOVEMBER GSA 2015 Baltimore, Maryland, USA

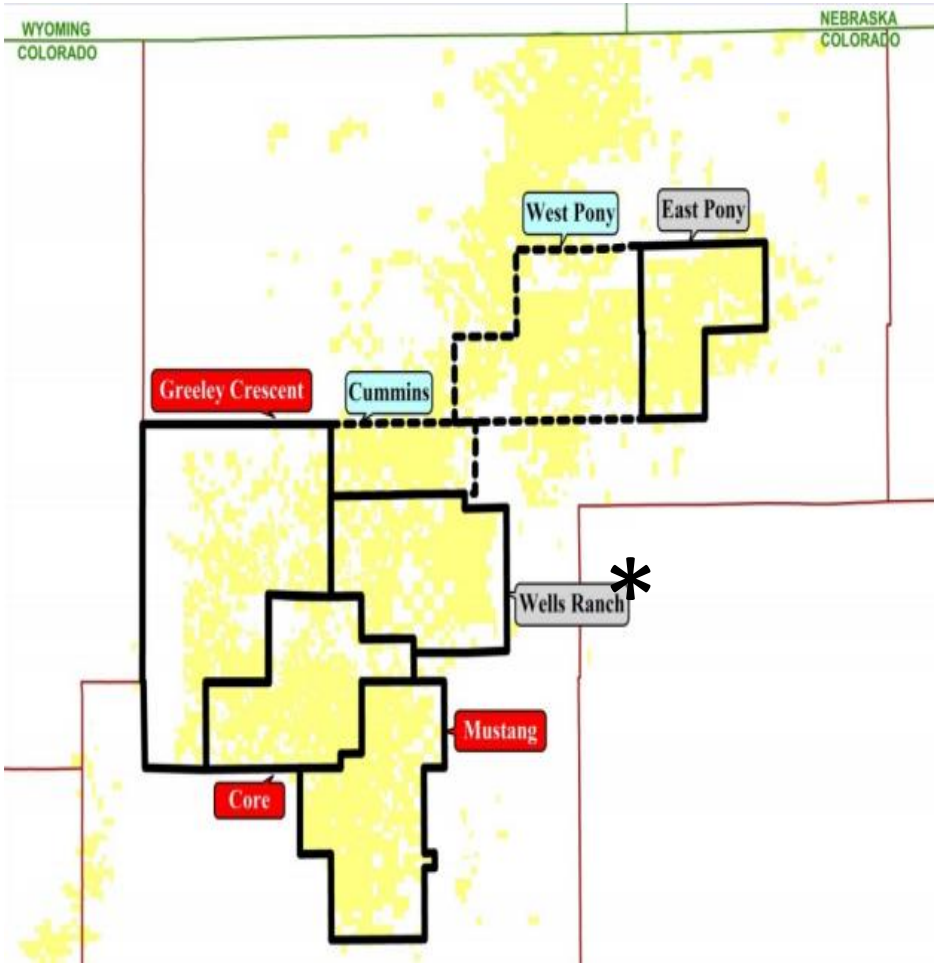


Case Study

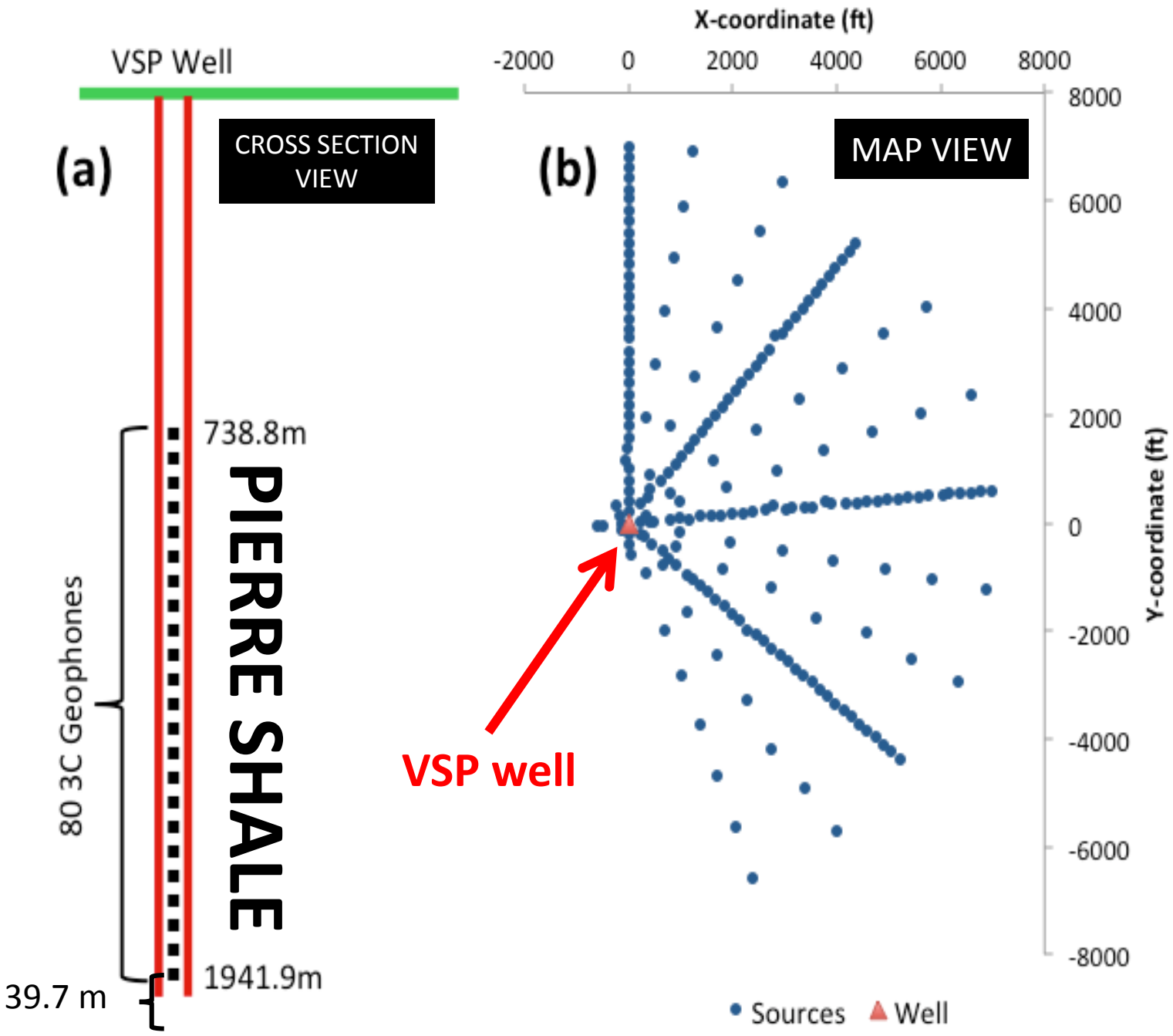
Geology

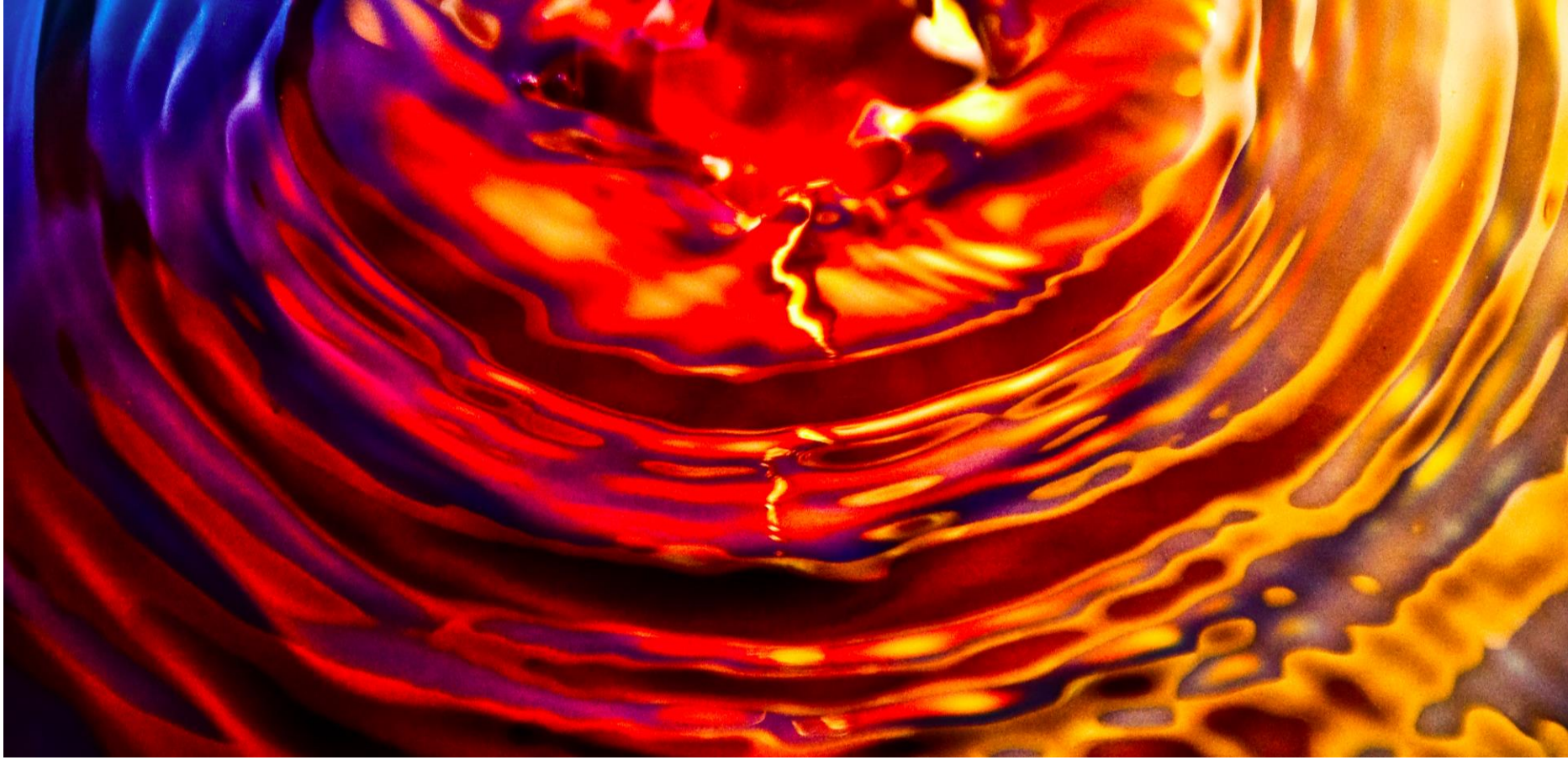


WATTENBERG FIELD



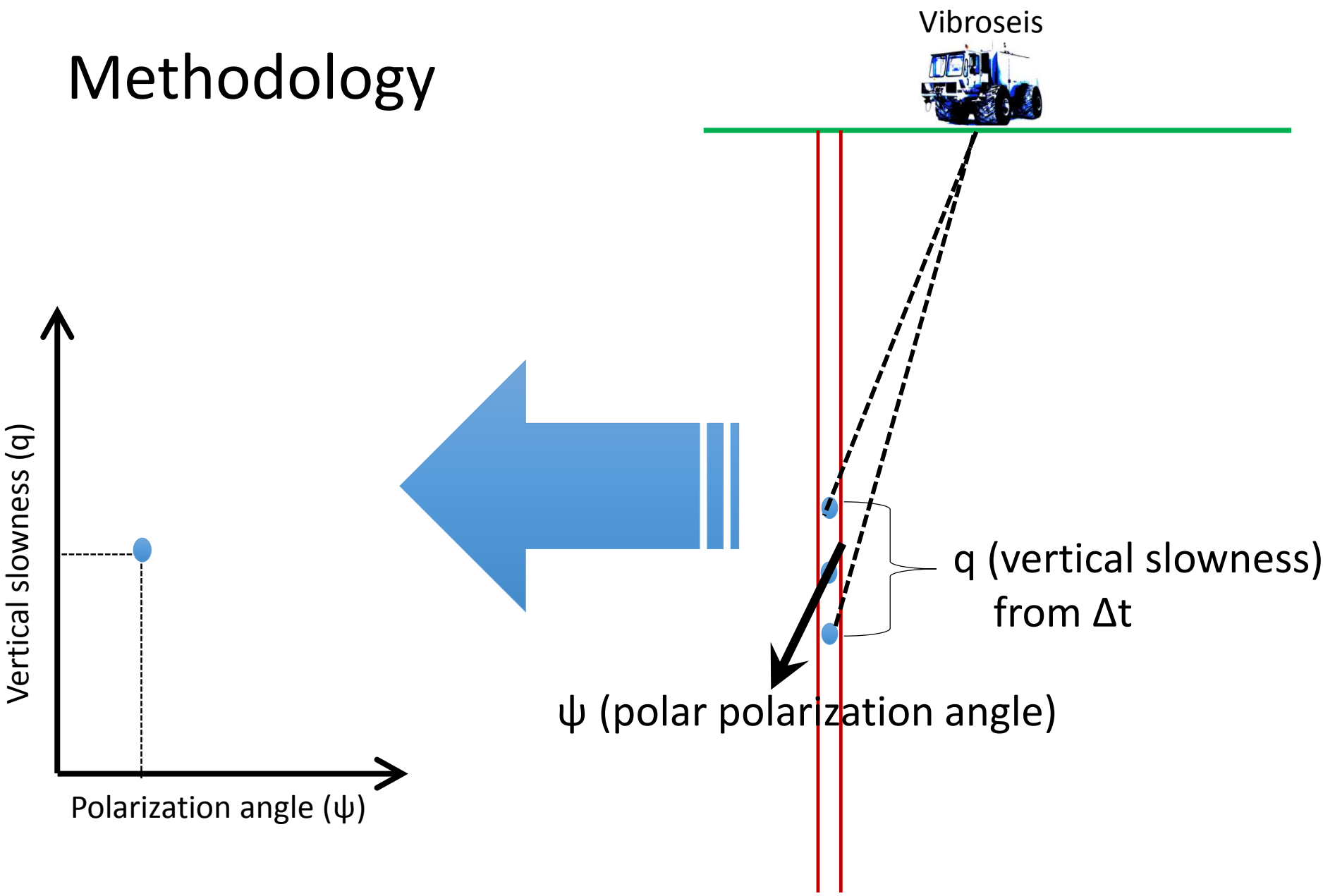
The Wattenberg Field is located in NE of Denver.


VSP Well
(a)
CROSS SECTION VIEW
738.8m
PIERRE SHALE
80 3C Geophones
1941.9m
39.7 m
Top of the Niobrara Fm.
(b)
MAP VIEW
X-coordinate (ft)
-2000
0
2000
4000
6000
8000
Y-coordinate (ft)
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
VSP well
Sources
Well

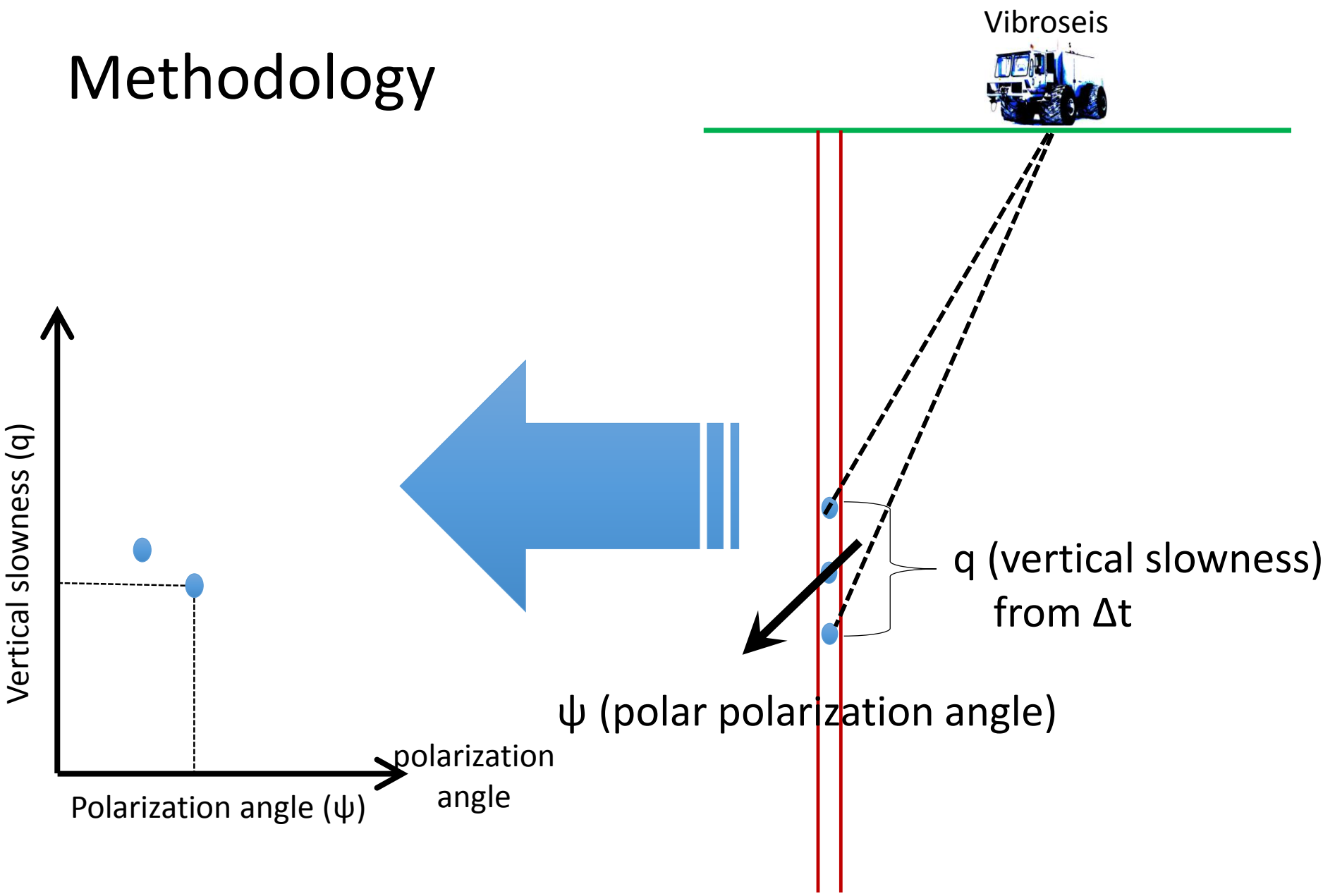


Methodology

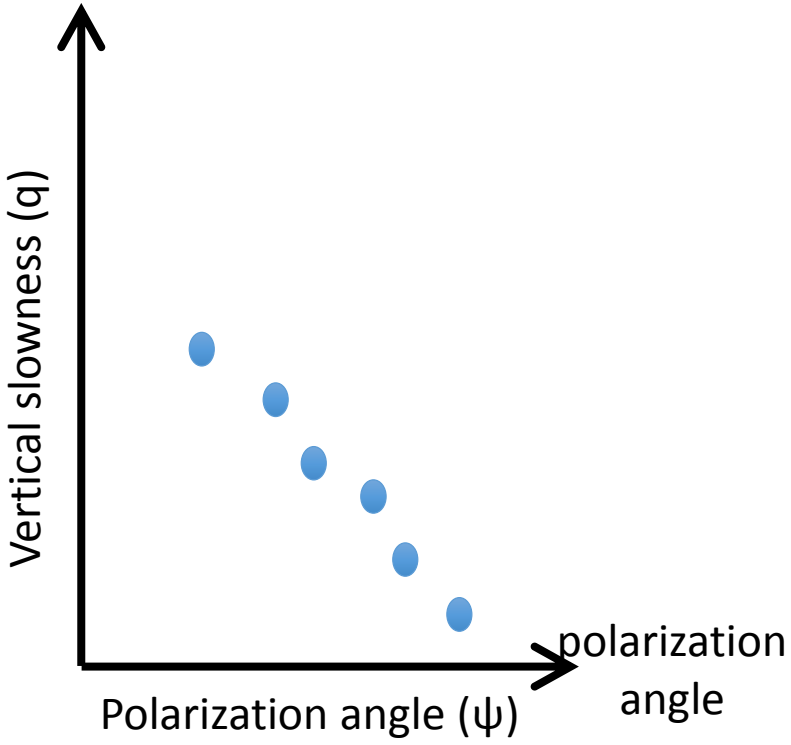
Methodology

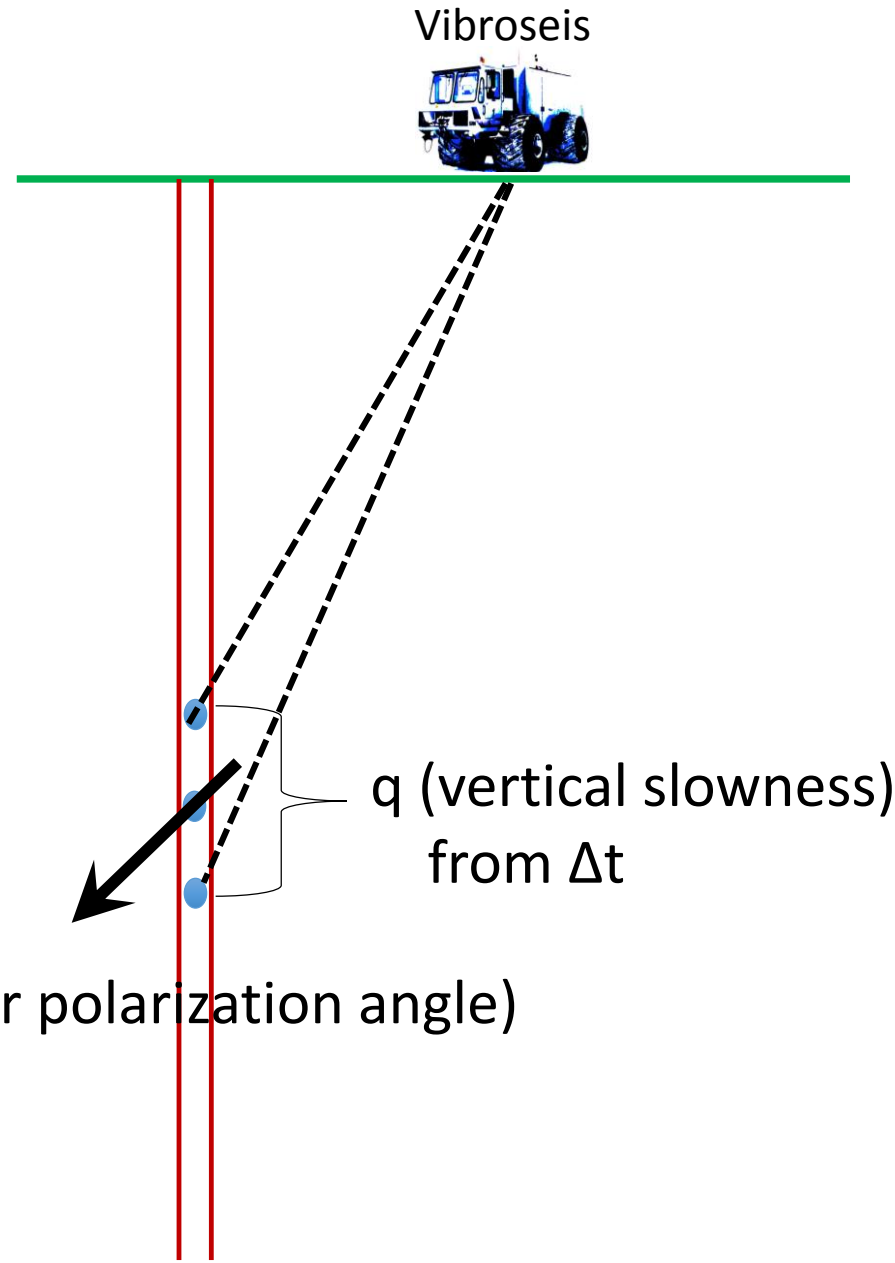


Methodology

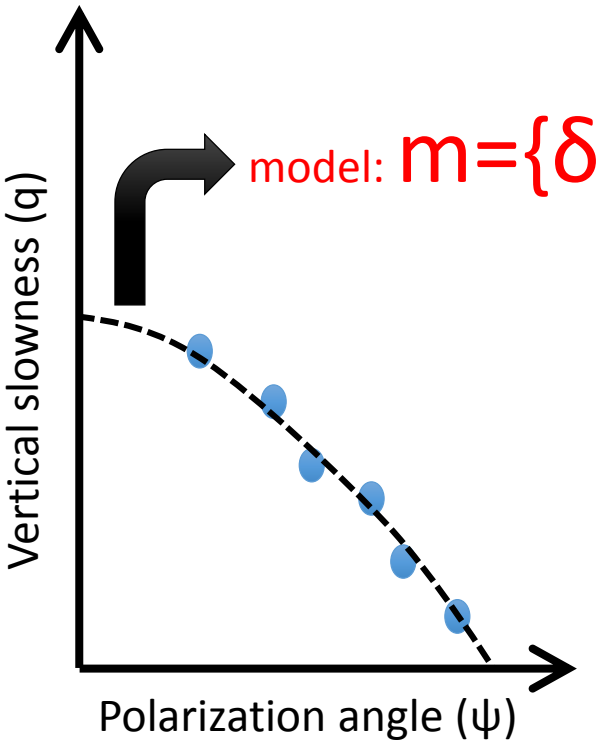


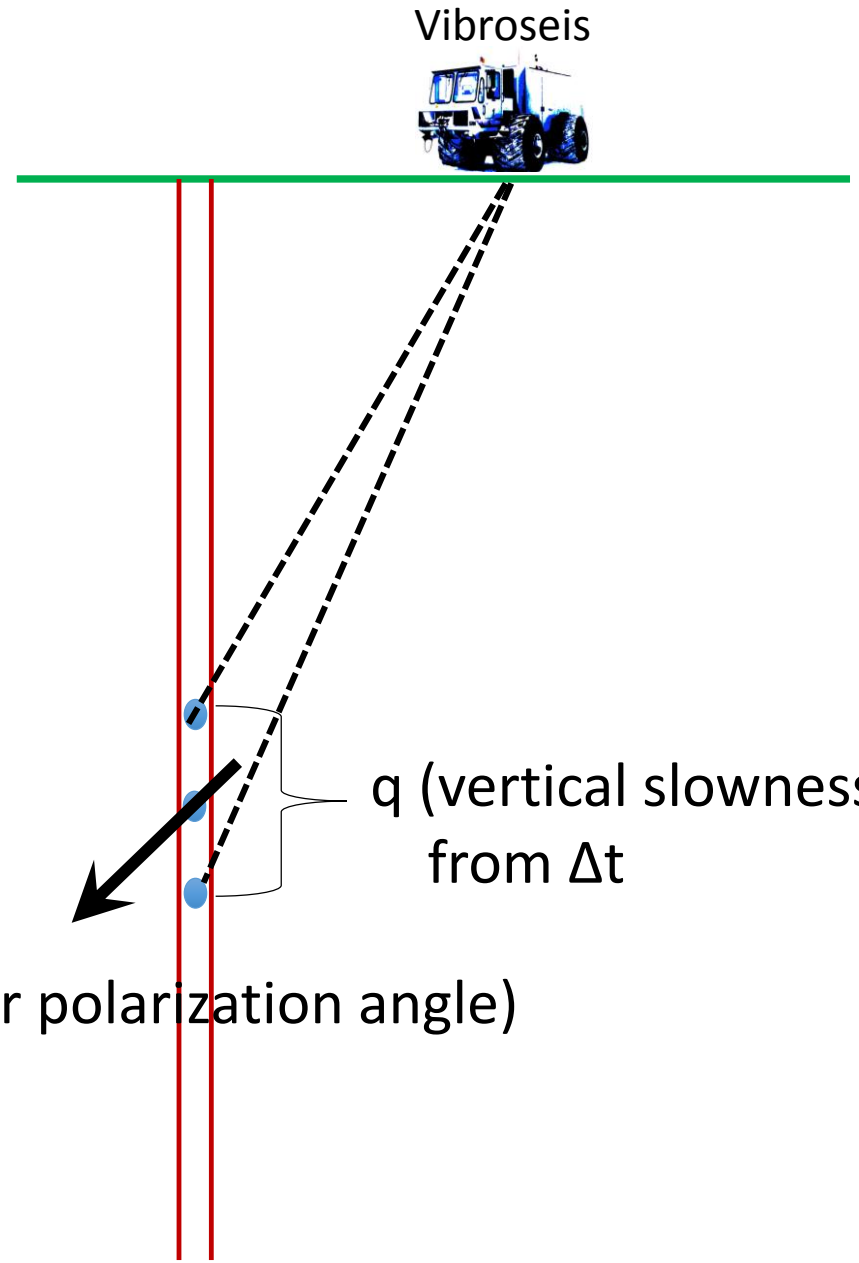
Methodology



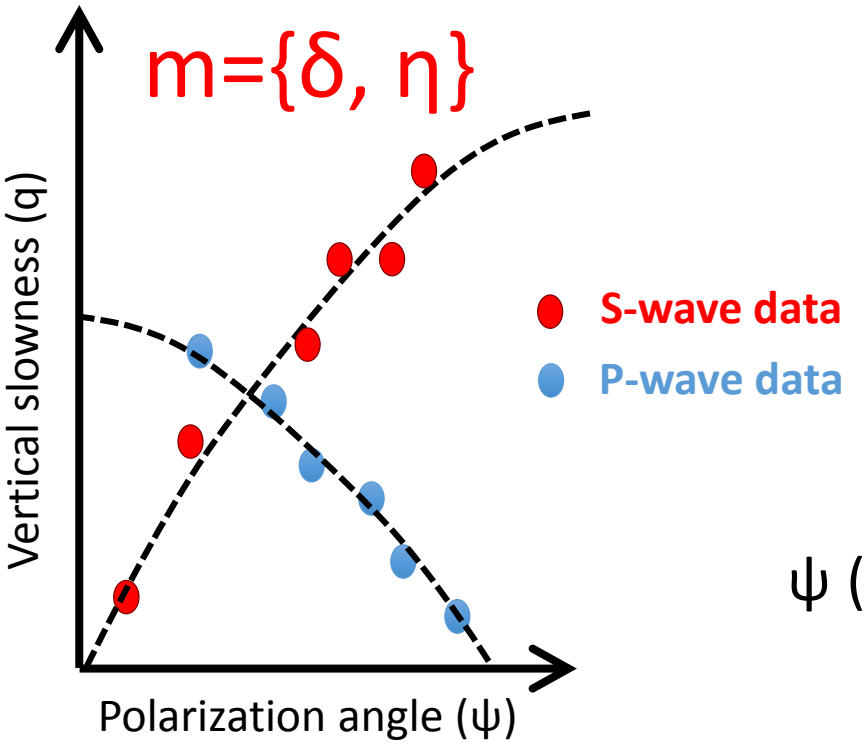


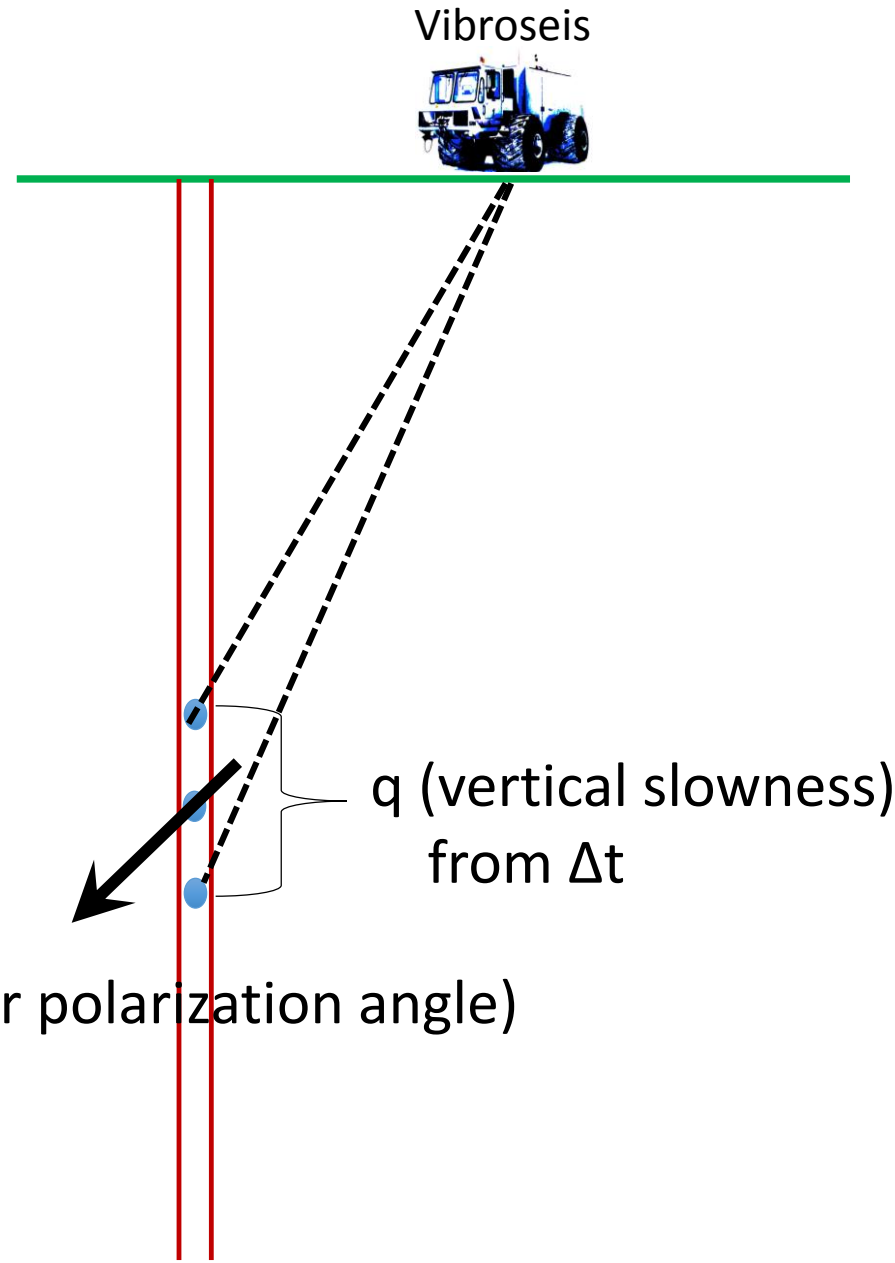
Methodology



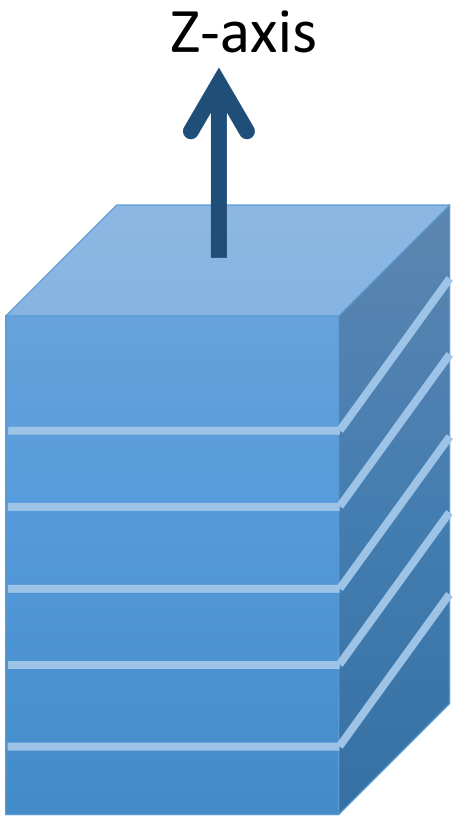


Joint Slowness-Polarization Method (JSPM)





Anisotropy parameters δ and η



VTI model

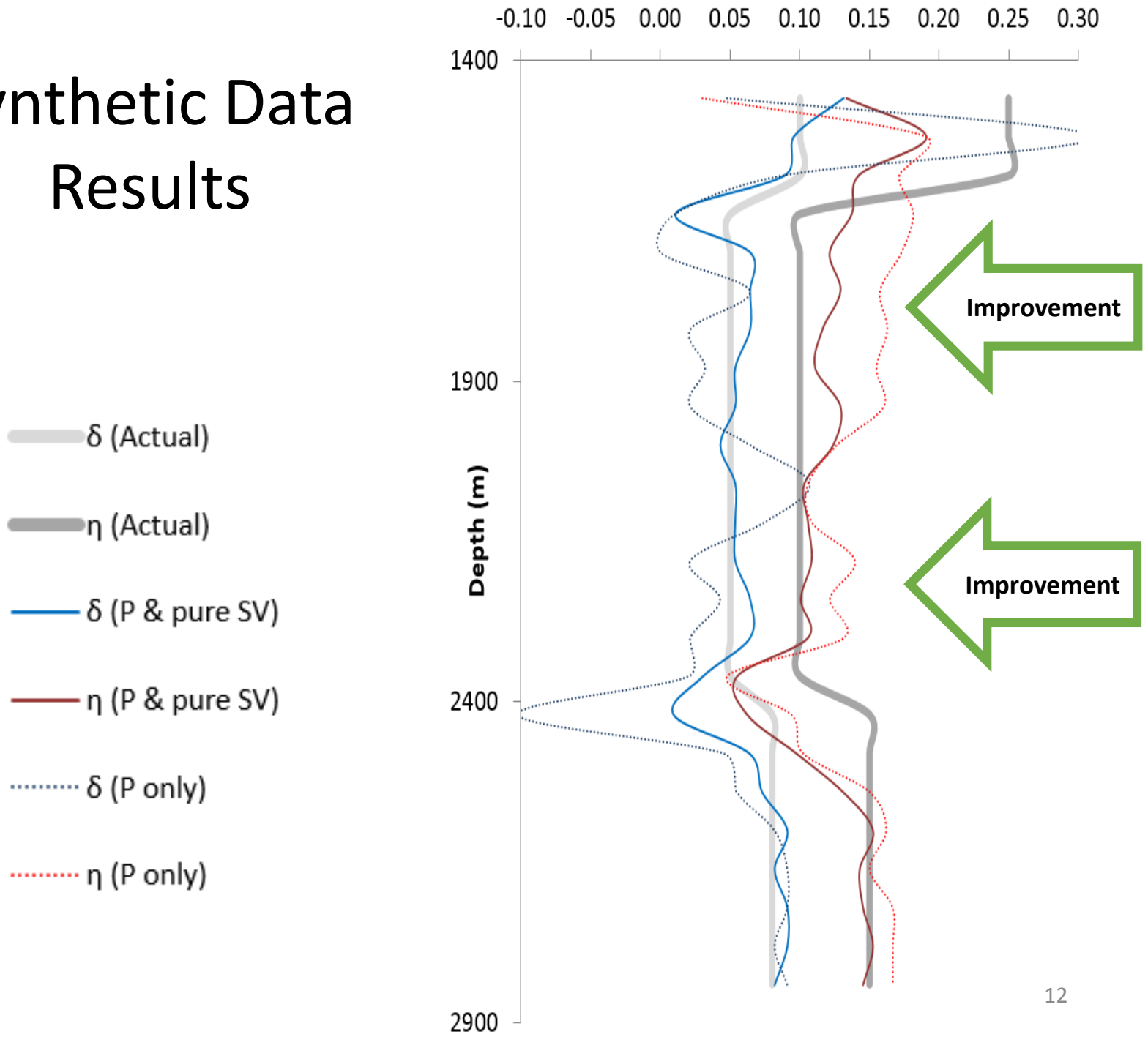
$$\epsilon = \frac{c_{11} - c_{33}}{2c_{33}}$$

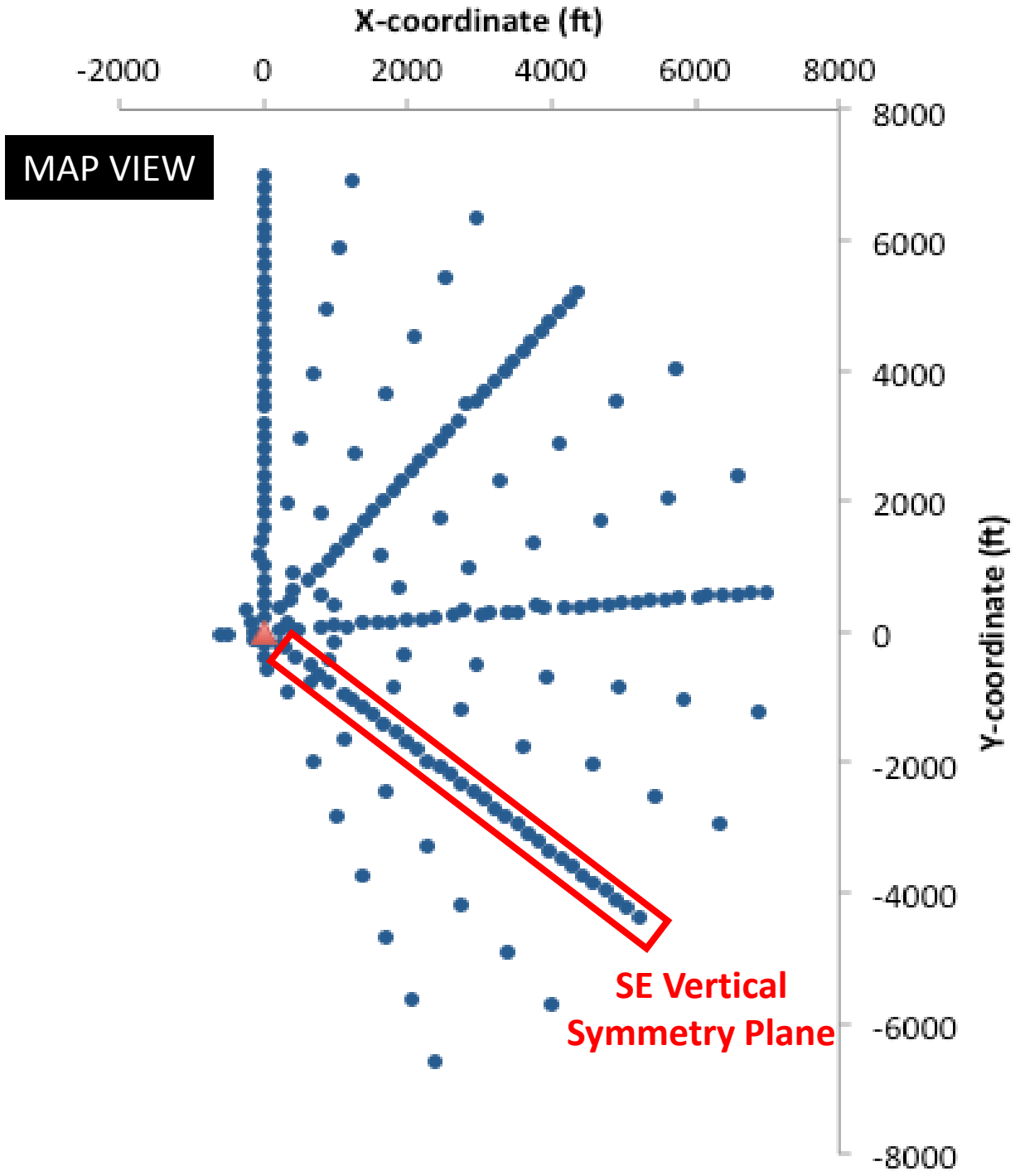
$$\delta = \frac{(c_{13} + c_{44})^2 - (c_{33} - c_{44})^2}{2c_{33}(c_{33} - c_{44})}$$ (Thomsen, 1986)

$$\eta = \frac{\epsilon - \delta}{1 + 2\delta}$$ (Alkhalifah and Tsvankin, 1995)

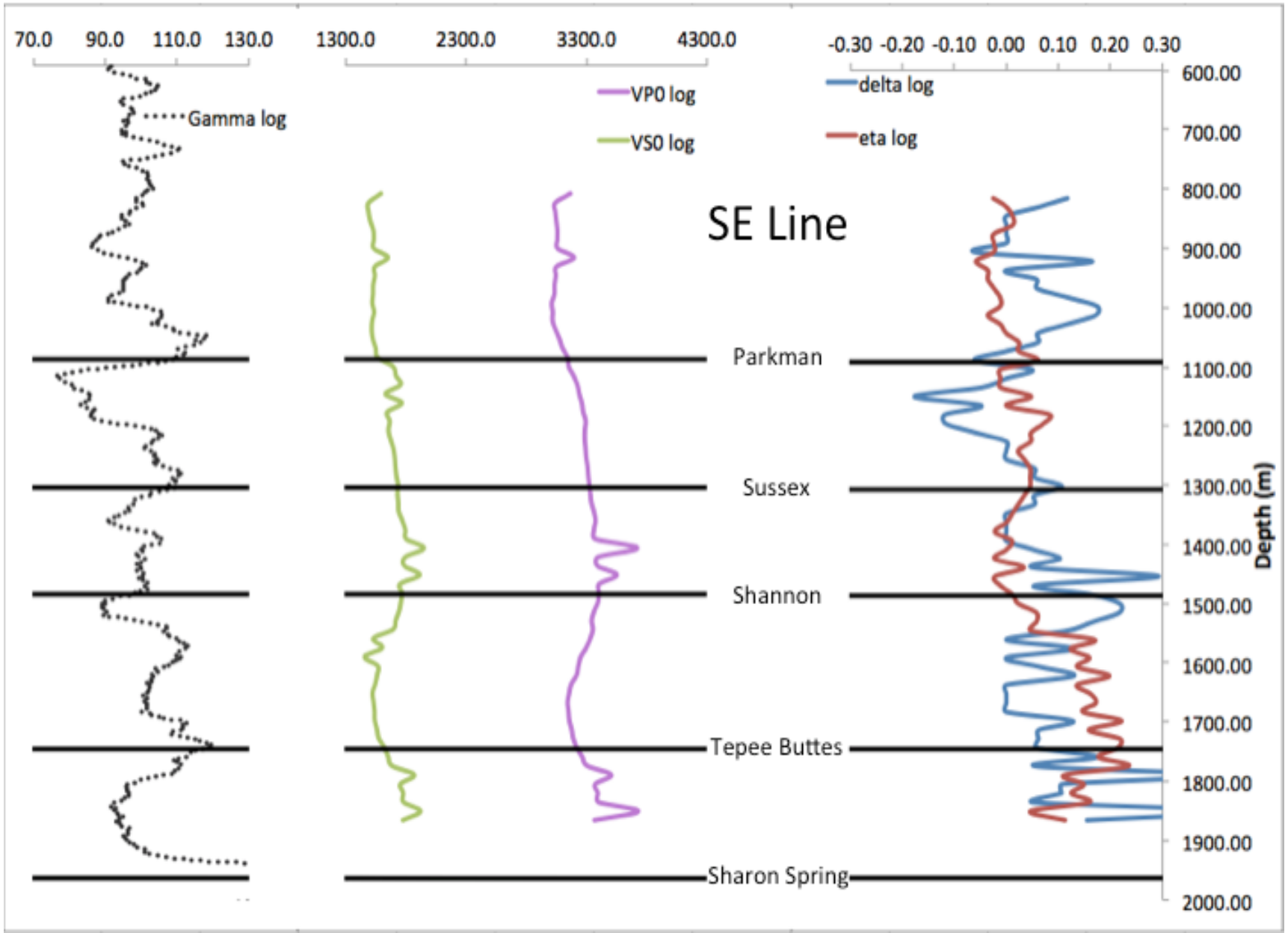
C_{ij}s are stiffness coefficients.

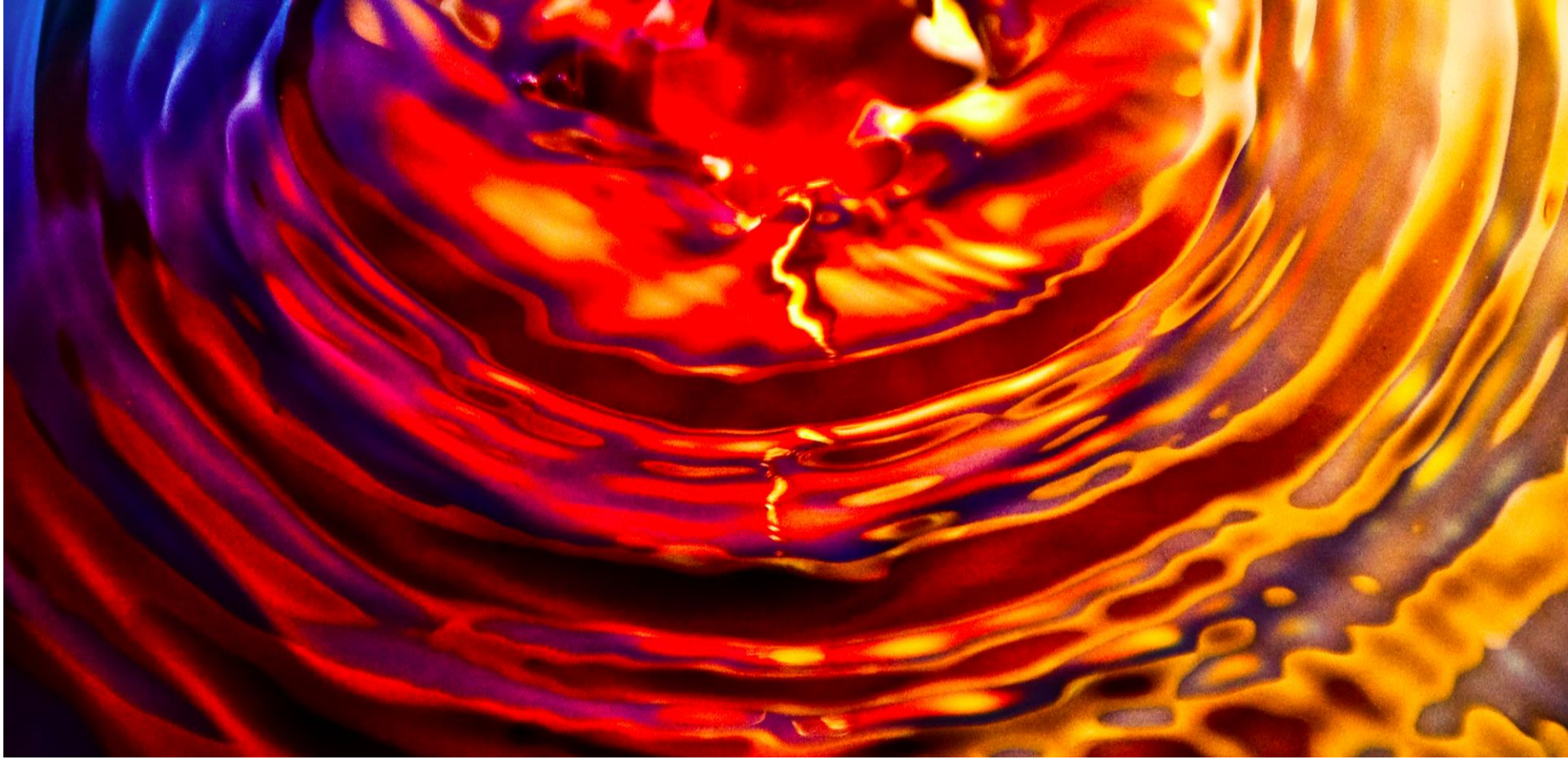
Synthetic Data Results




X-coordinate (ft)
-2000
0
2000
4000
6000
8000
MAP VIEW
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
Y-coordinate (ft)
SE Vertical
Symmetry Plane

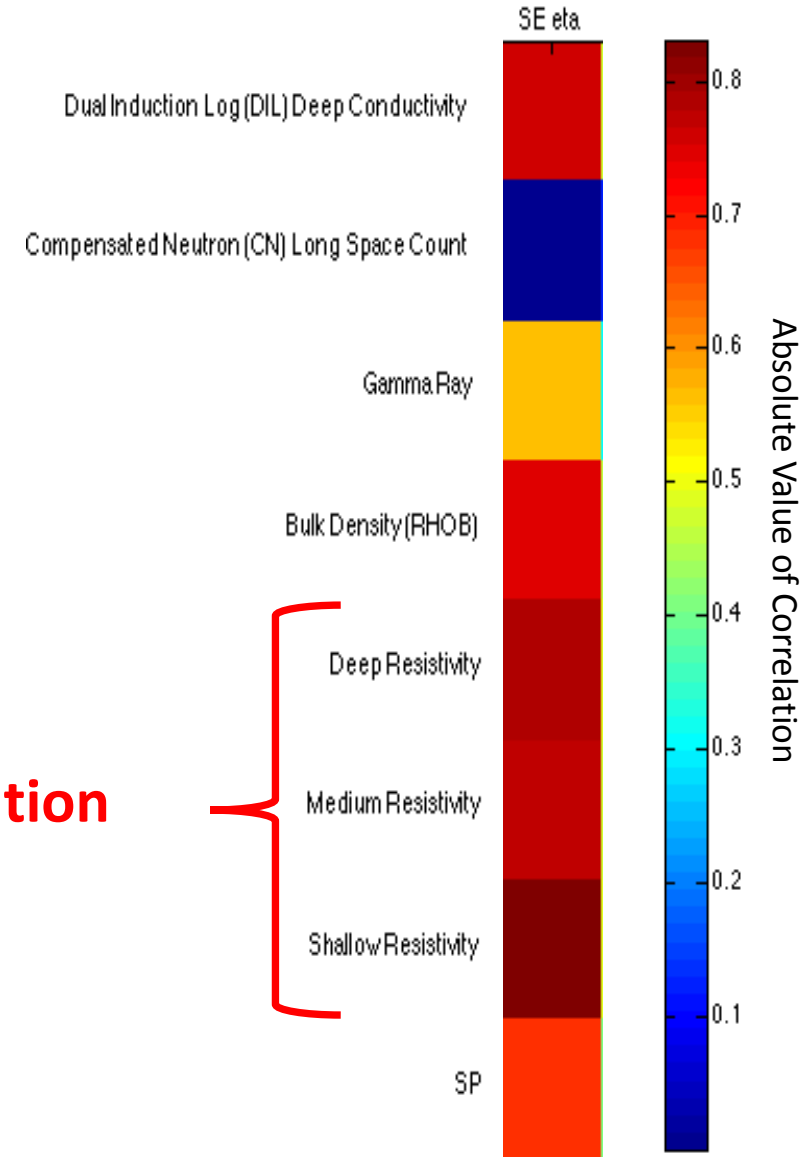
JSPM Results





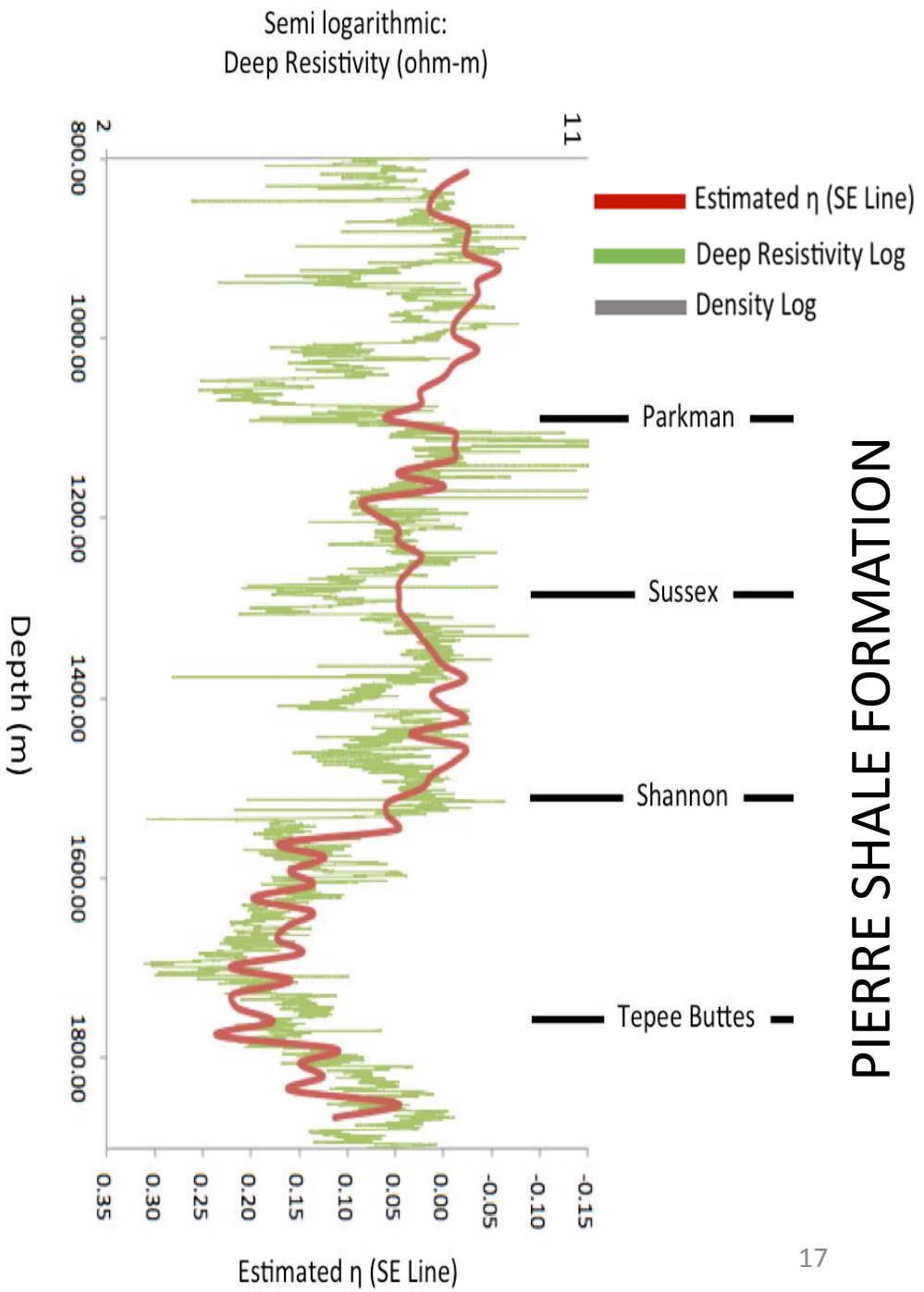
Results and Discussion

Correlation between the estimated anisotropy parameter η and well logs

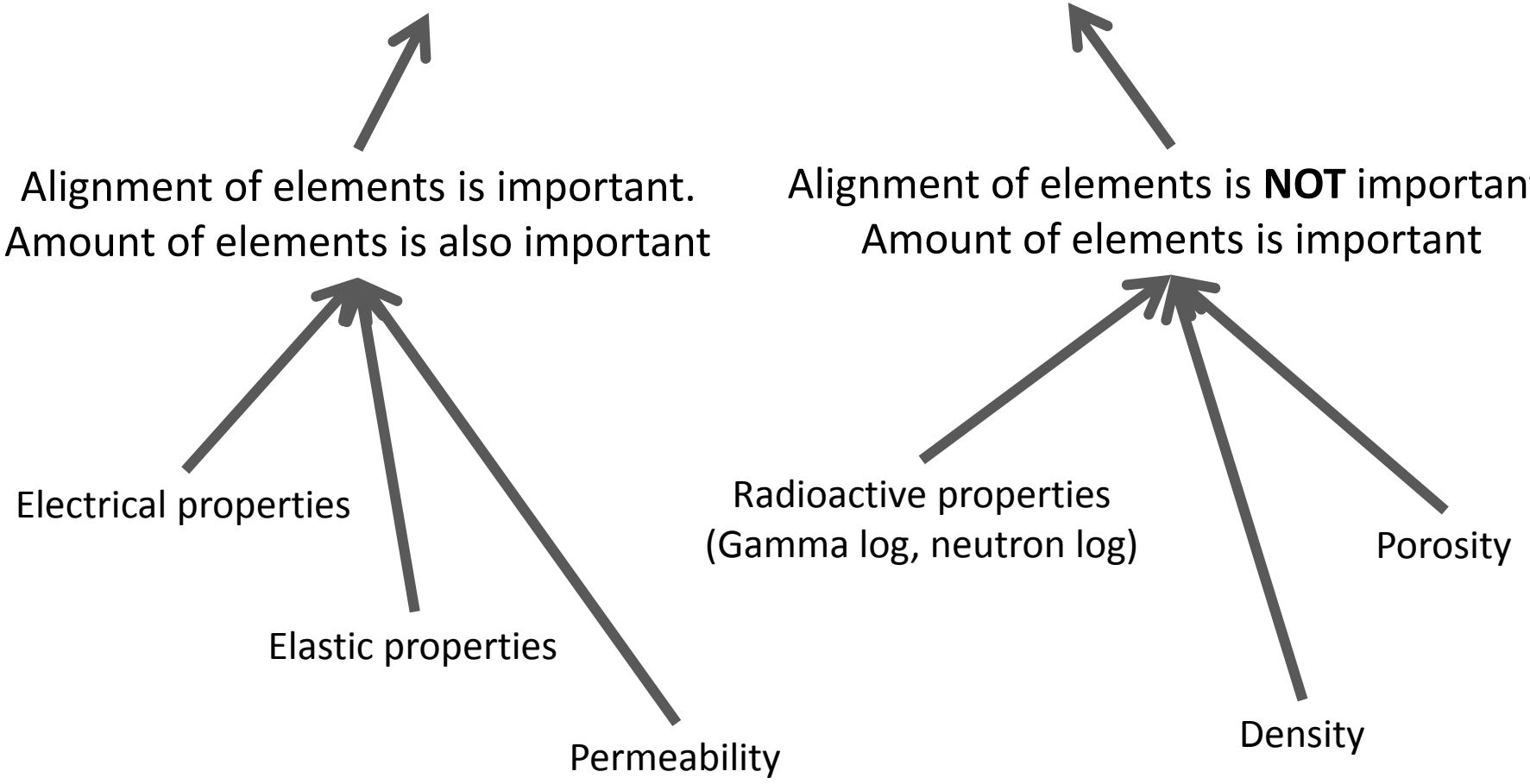


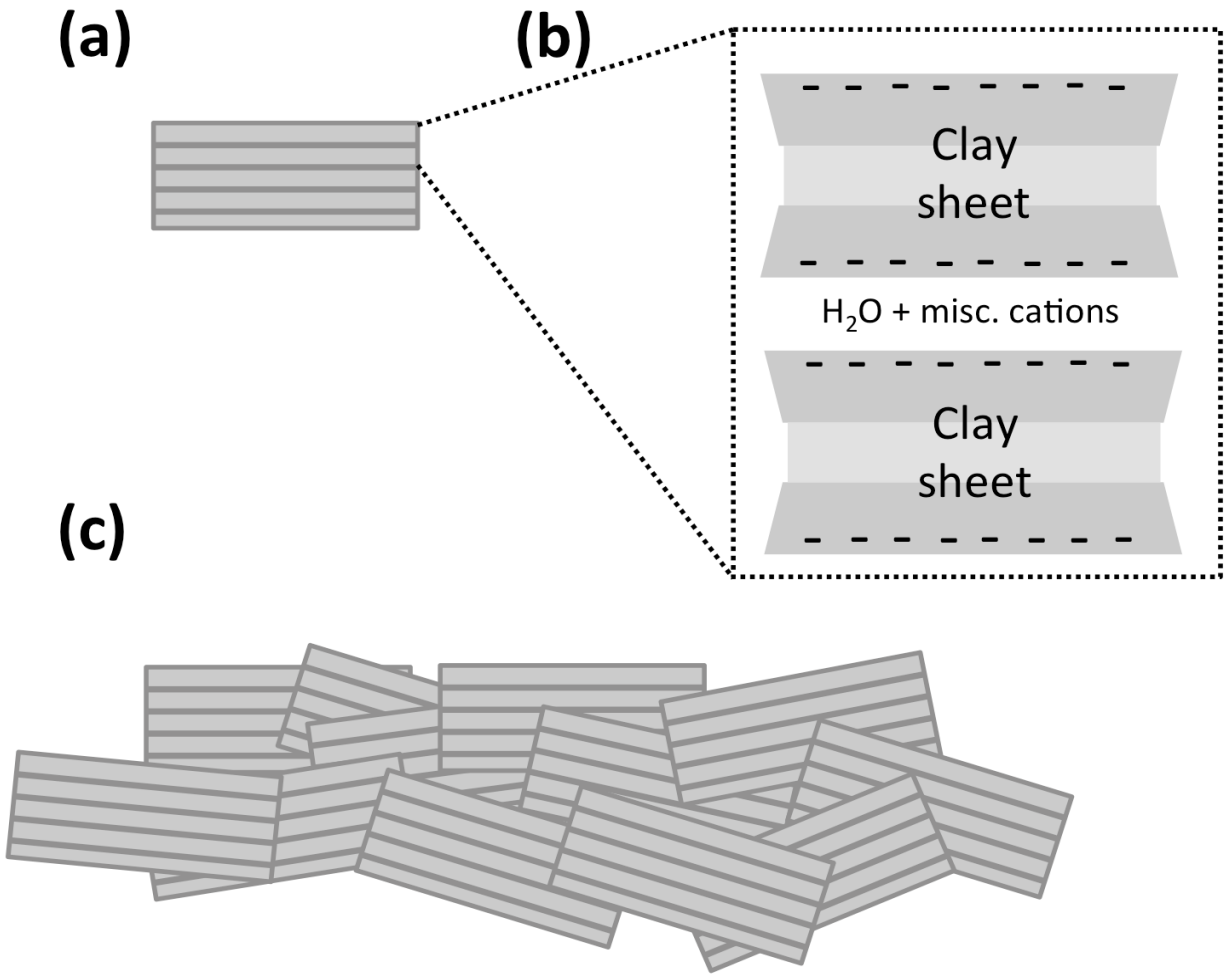
High Correlation

Correlation between the estimated anisotropy parameter η and resistivity log



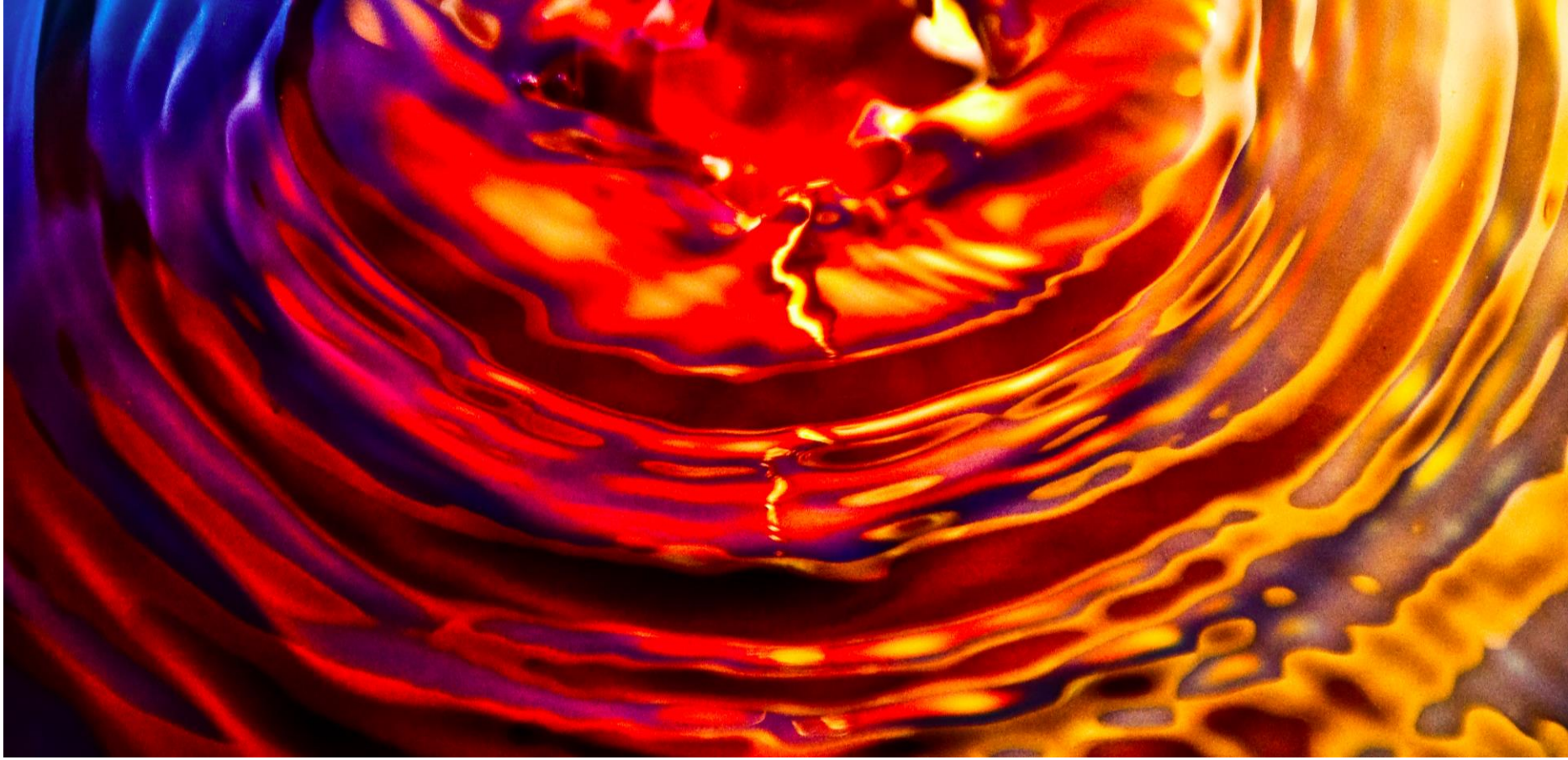
Fabric vs. Concentration




(a)
(b)
Clay
sheet
H_2O + misc. cations
Clay
sheet
(c)

CONCLUSIONS

1. Using the joint P- and SV-wave slowness-polarization method (JSPM) and borehole seismic data, I could determine anisotropic properties of Pierre shale more precisely.
2. Comparing anisotropic properties (derived from seismic data) with well logs showed a high correlation with resistivity logs.
3. Rock fabric properties are highly correlated and they could be good source of information for confirming each other.



End .