



Fluid Replacement Model and Rock Physics Template (Cross Plot) Analysis to Delineate Fluid and Rock Properties Using HR Software

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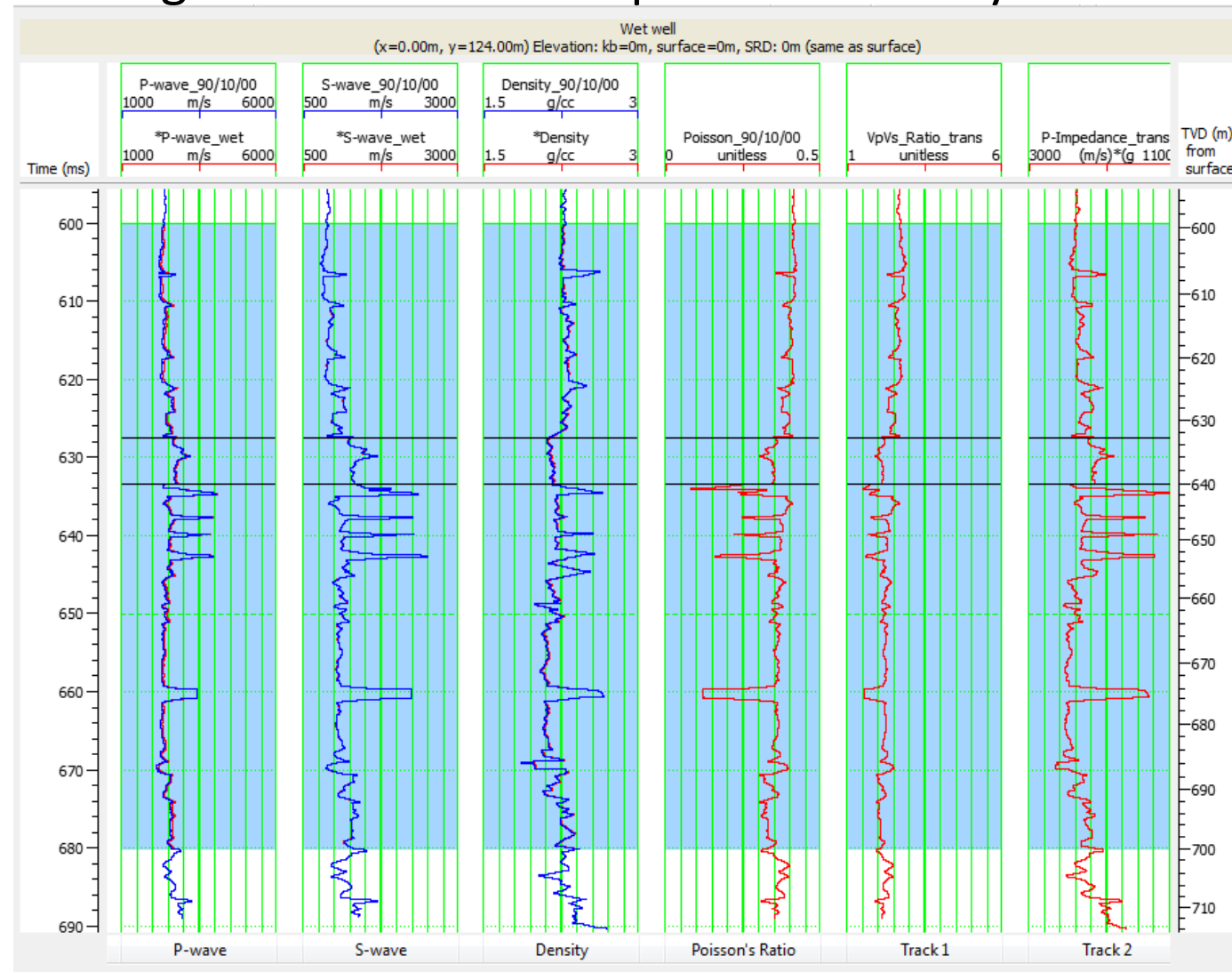
Input Parameters

- Porosity Calculate from density log.
- Water density=1.09 g/cc
Oil density= 0.75 g/cc
- Gas density=0.1 g/cc

Rock Matrix Property

Bulk Modulus	40	GPa
Shear Modulus	44	GPa
Density	2.65	g/cc

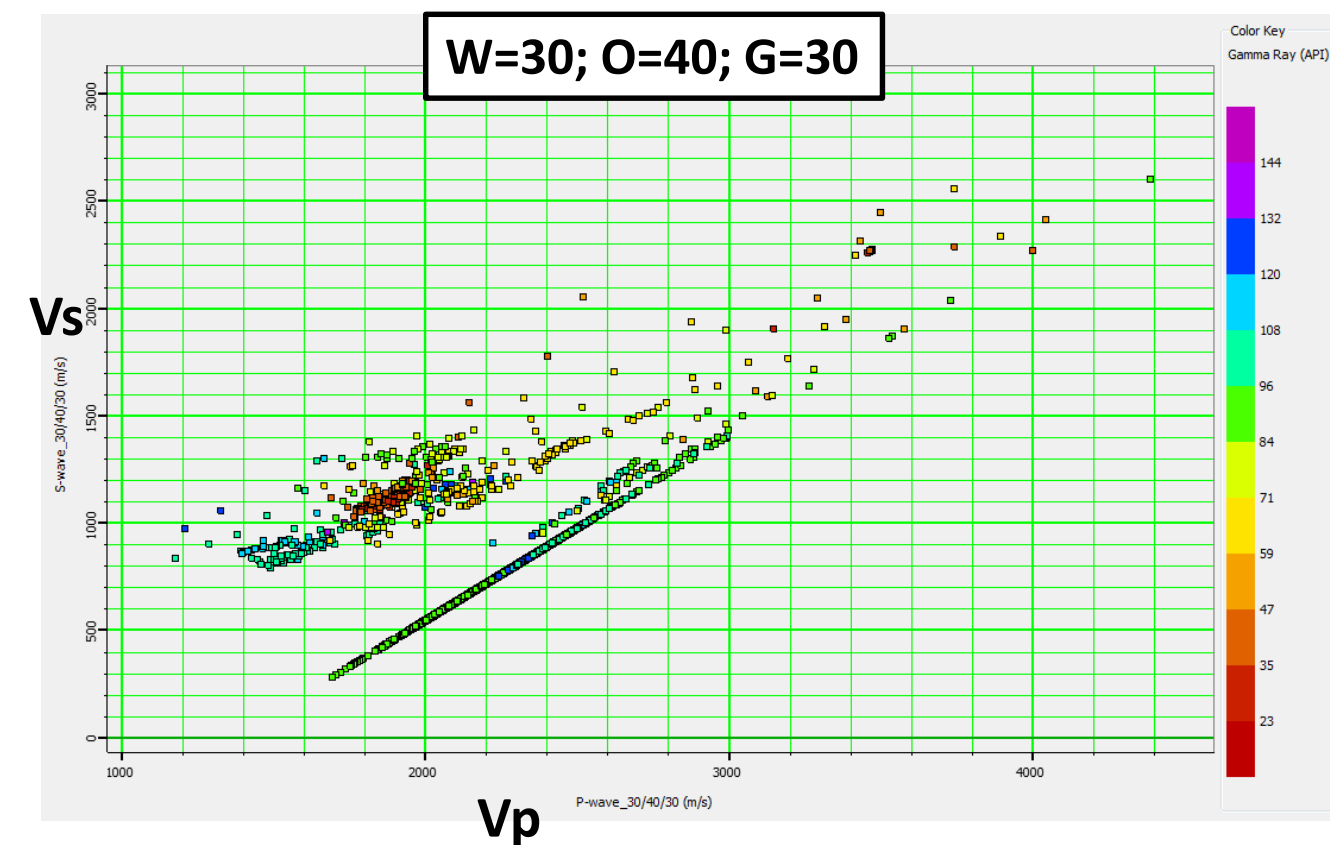
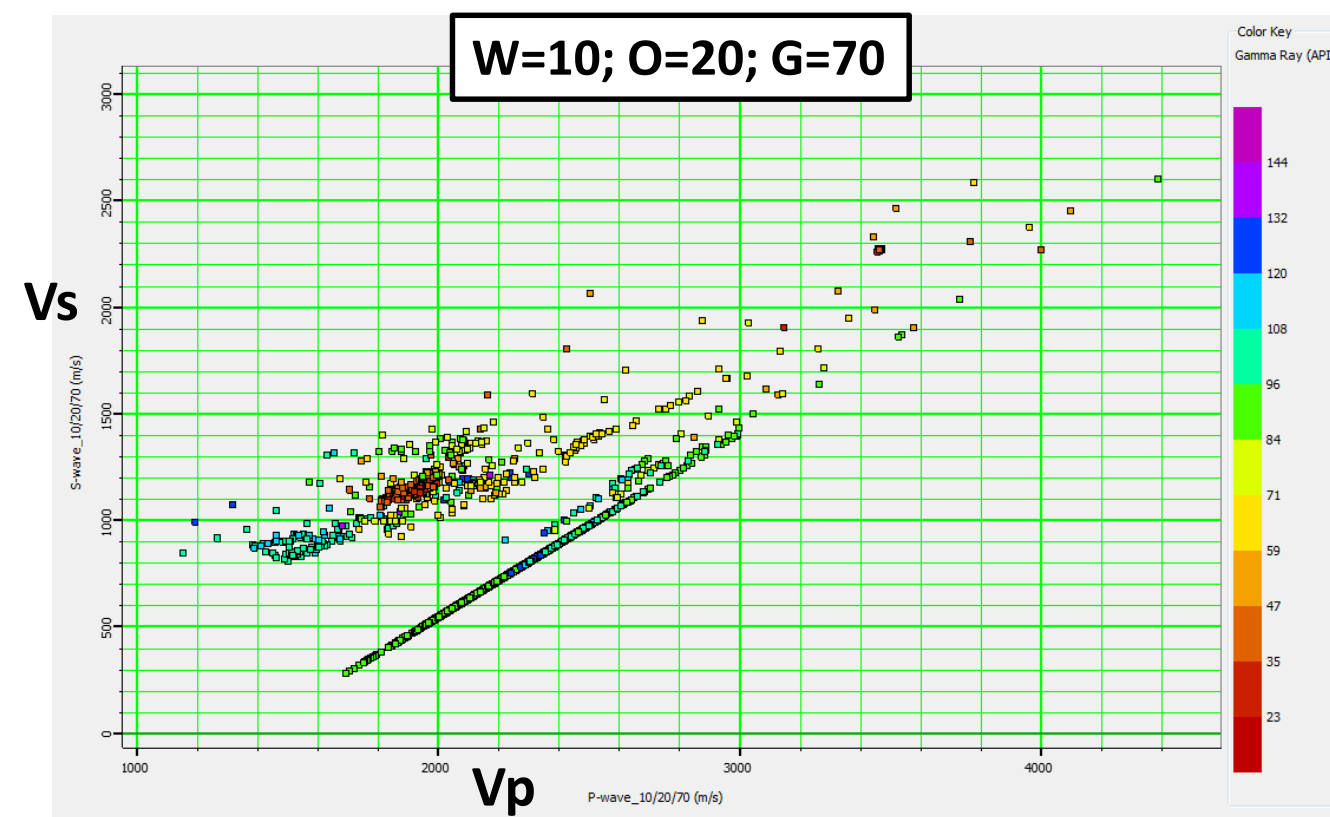
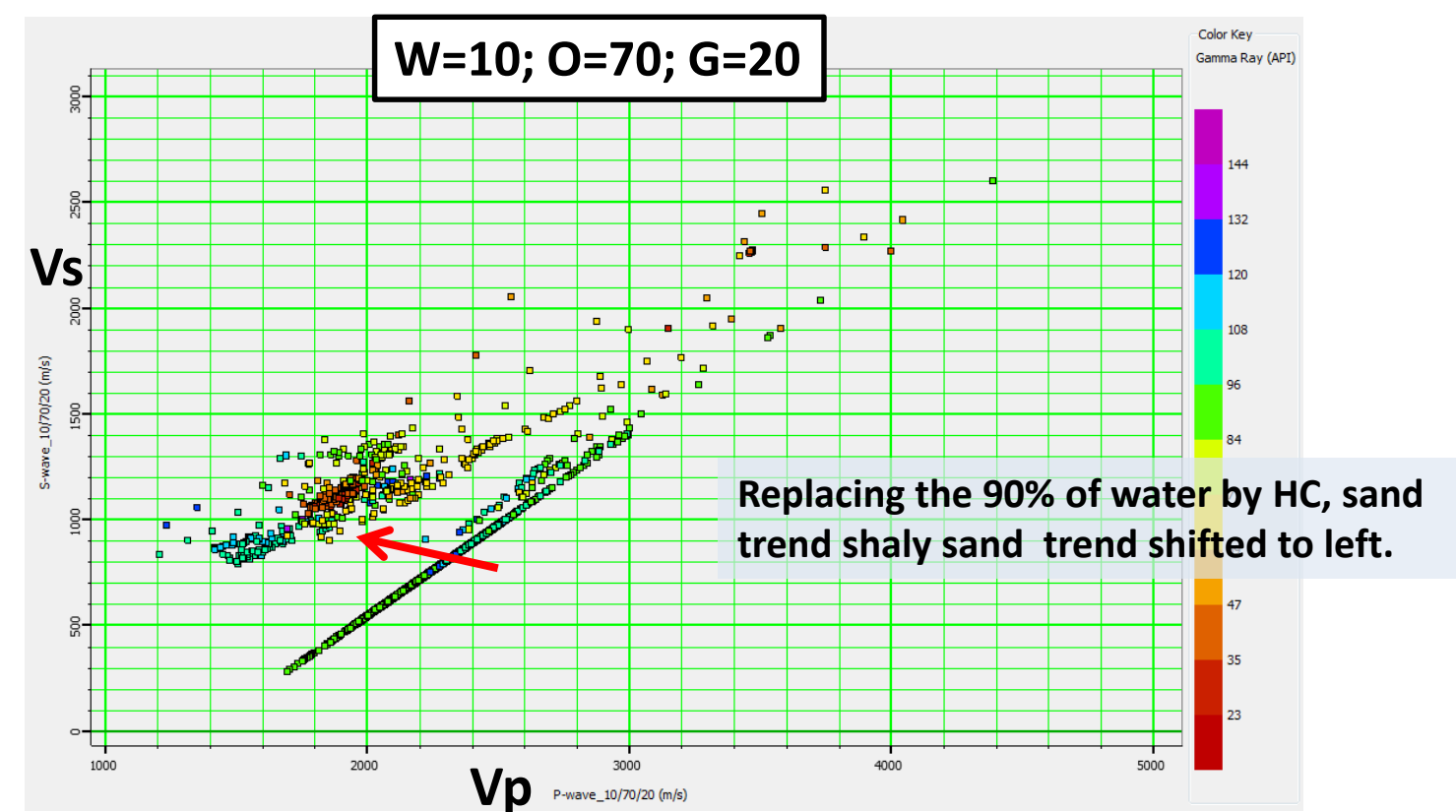
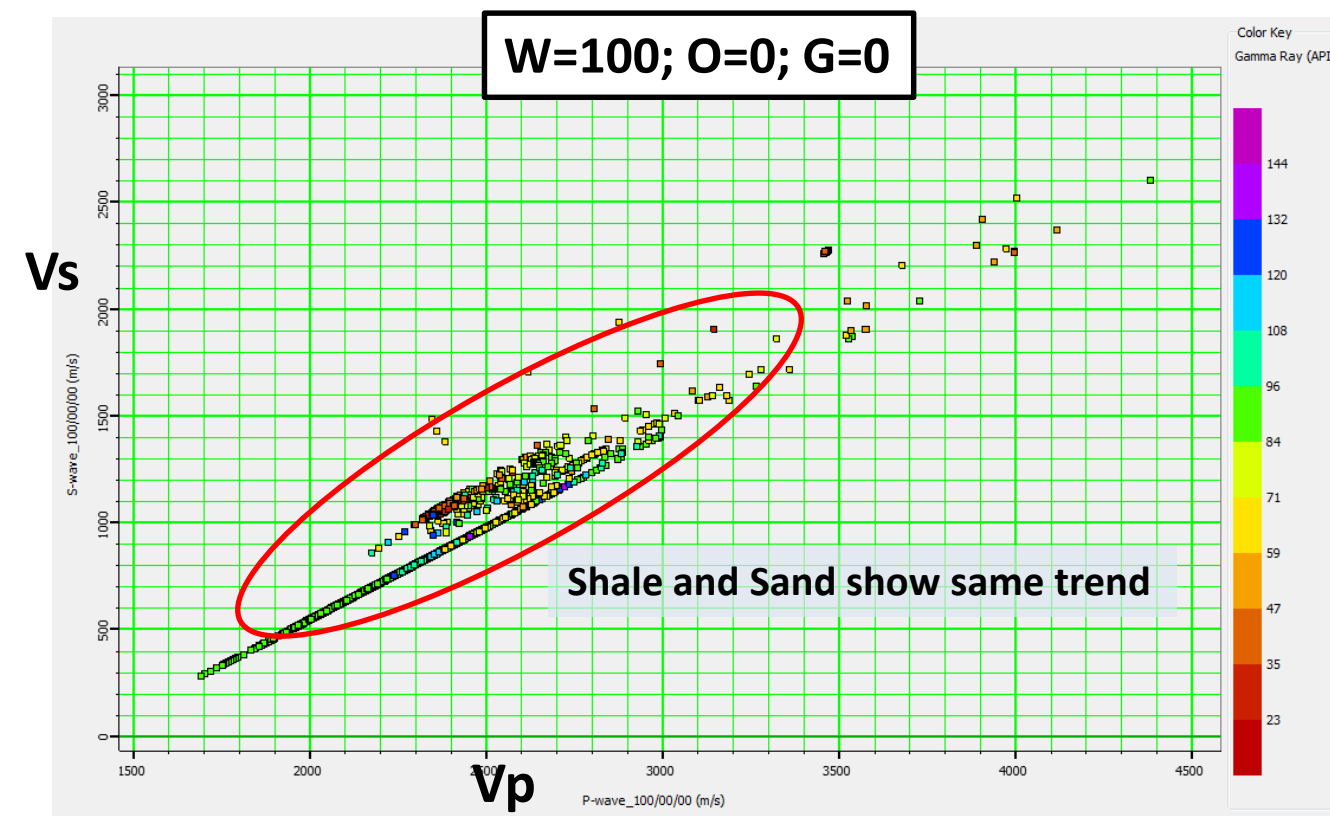
Used log interval for fluid replacement analysis: 600-700m



Fluid Properties

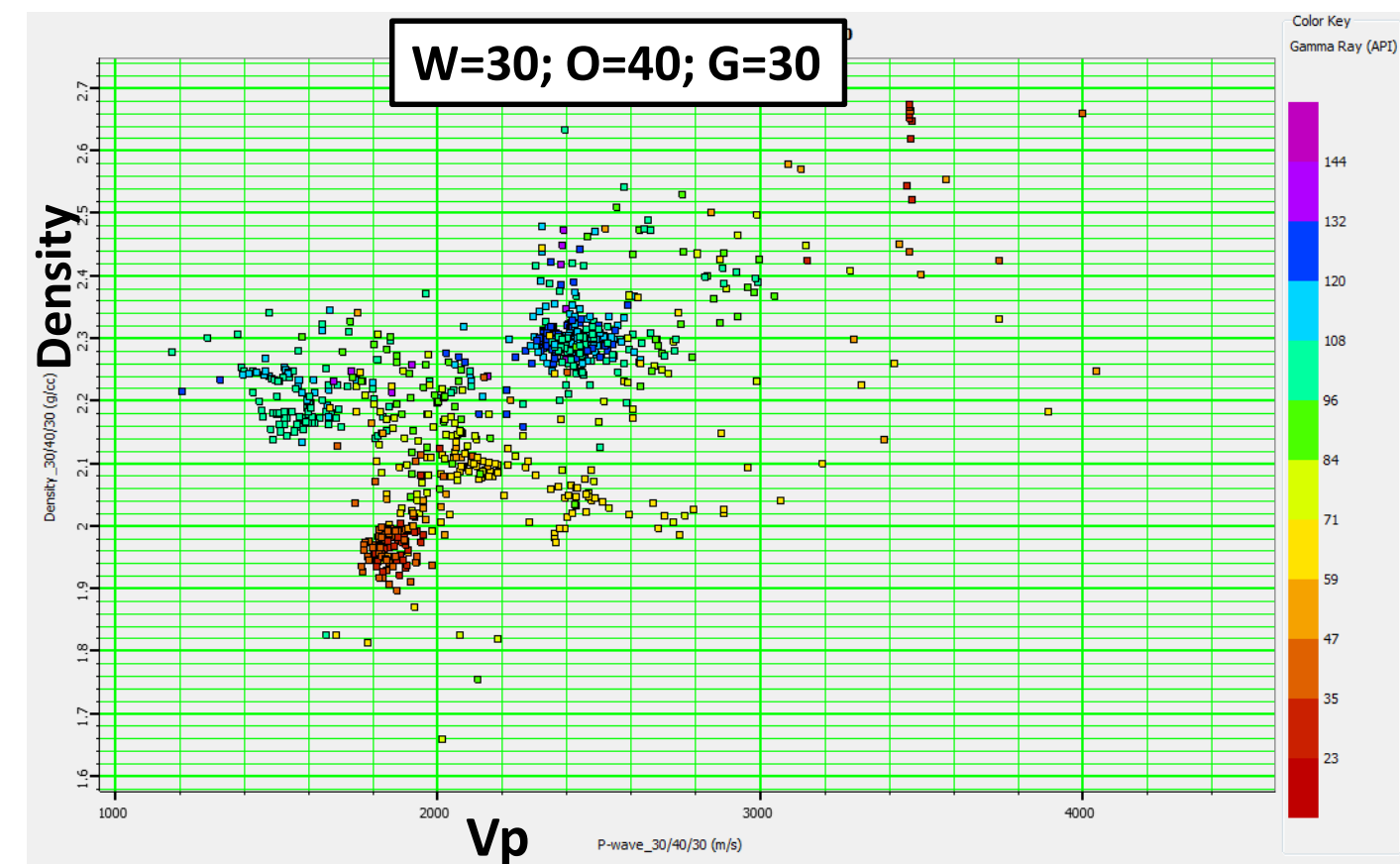
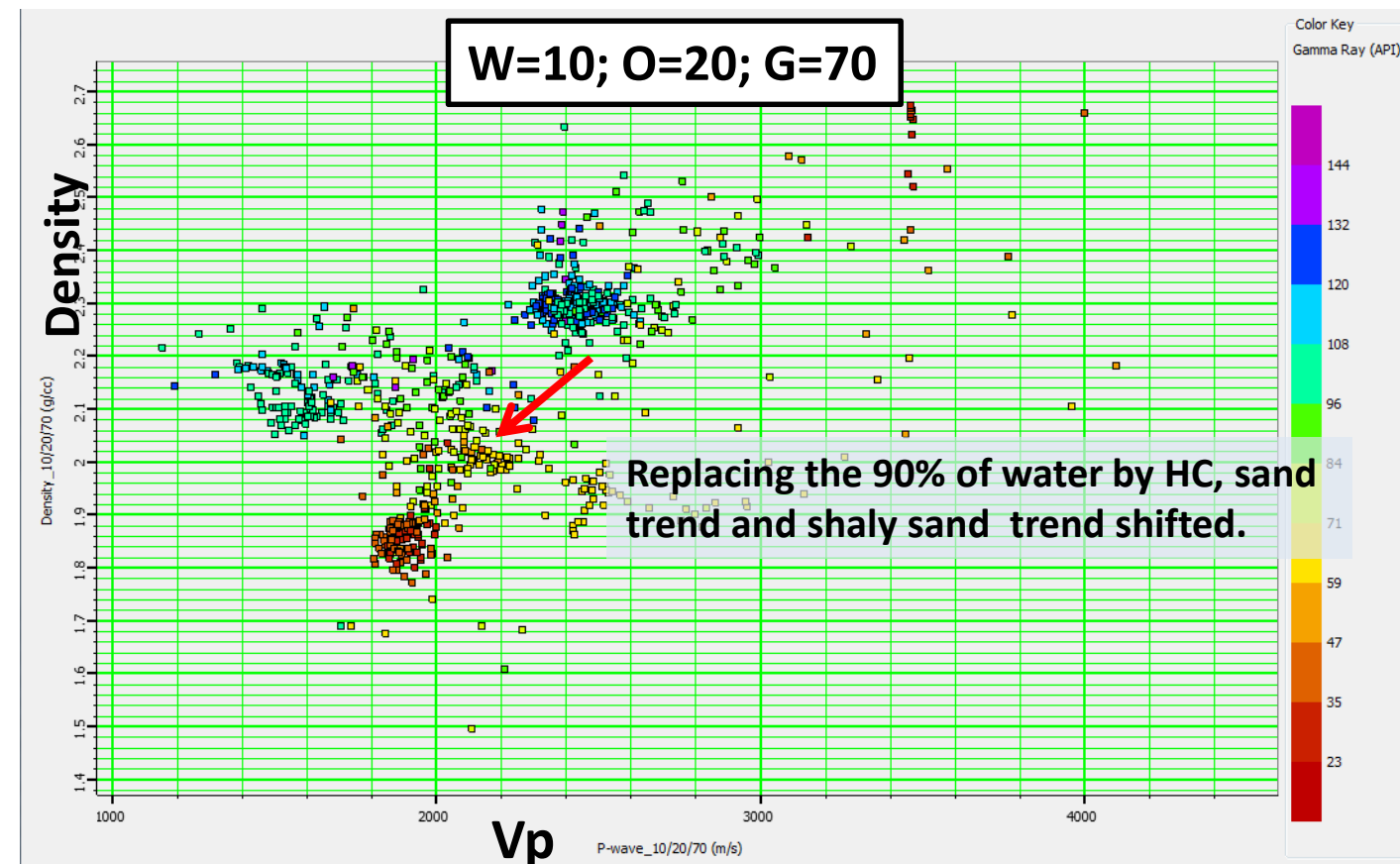
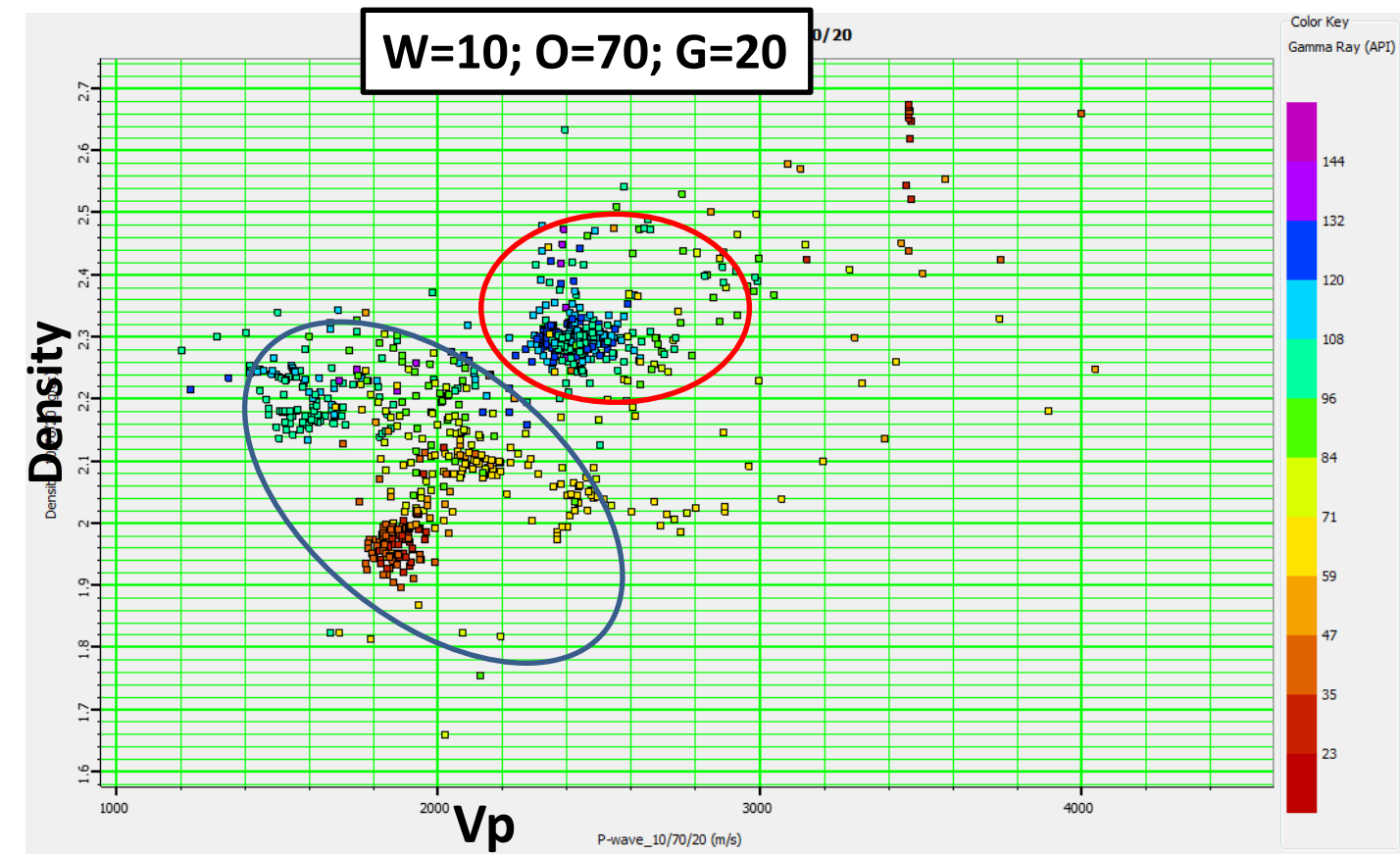
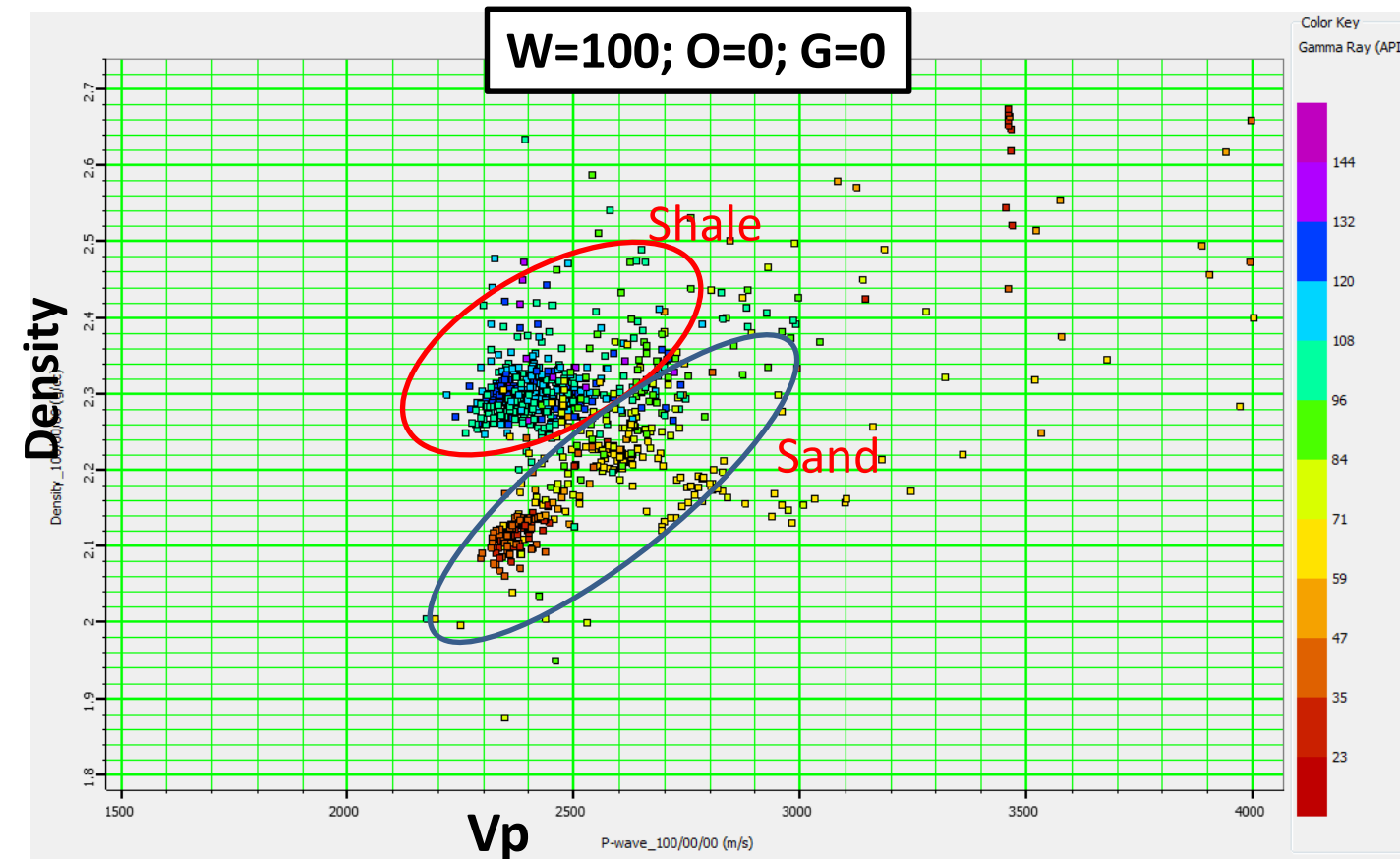
Oil Density:	0.75 g/cc 750 kg/m3
Oil Bulk Modulus:	1000 MPa 1 GPa 10000 bar 145038 psi
Oil Velocity:	1154.7 m/s 3788.39 ft/s
Oil Maximum GOR:	0 Unknown 0 scf/bbl
Free Gas:	0 fraction 0 %
Gas Density:	0.1 g/cc 100 kg/m3
Gas Bulk Modulus:	21 MPa 0.021 GPa 210 bar 3045.79 psi
Gas Velocity:	458.258 m/s 1503.47 ft/s
Water Density:	1.09 g/cc 1090 kg/m3
Water Bulk Modulus:	2380 MPa 2.38 GPa 23800 bar 345190 psi
Water Velocity:	1477.66 m/s 4847.97 ft/s
Water flash Pressure:	0.0406048 MPa 4.06048e-05 GPa 0.406048 bar 5.88923 psi
Fluid Density:	1.09 g/cc 1090 kg/m3
Fluid Bulk Modulus:	2380 MPa 2.38 GPa 23800 bar 345190 psi
Fluid Velocity:	1477.66 m/s 4847.97 ft/s

S-Wave Vs. P-Wave



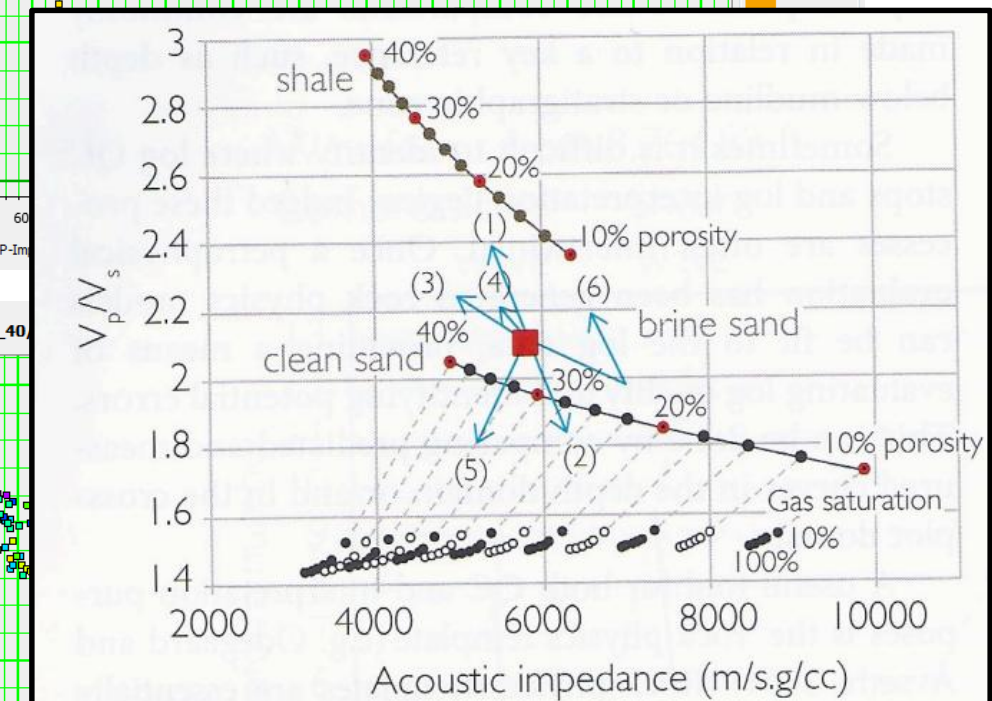
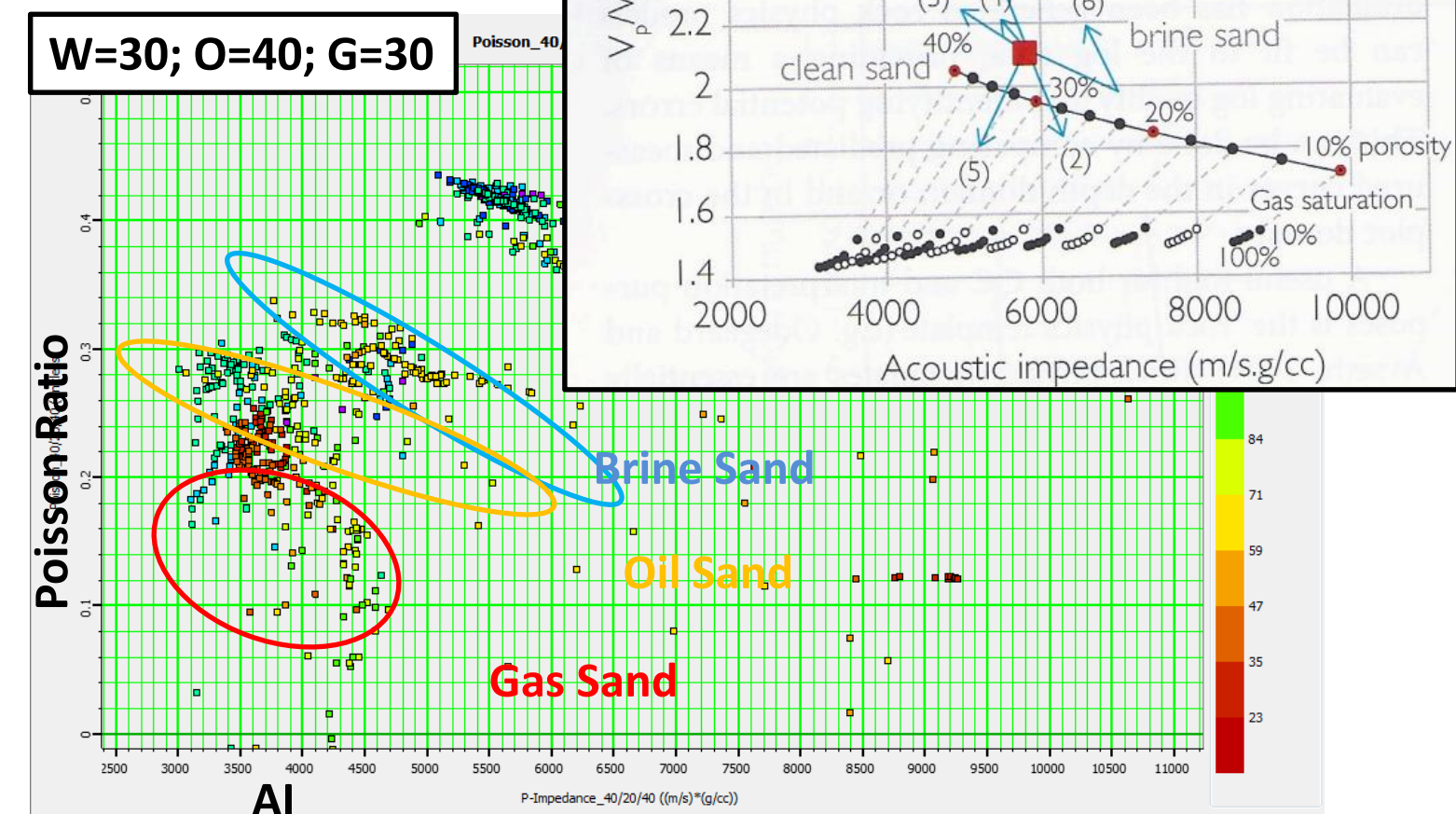
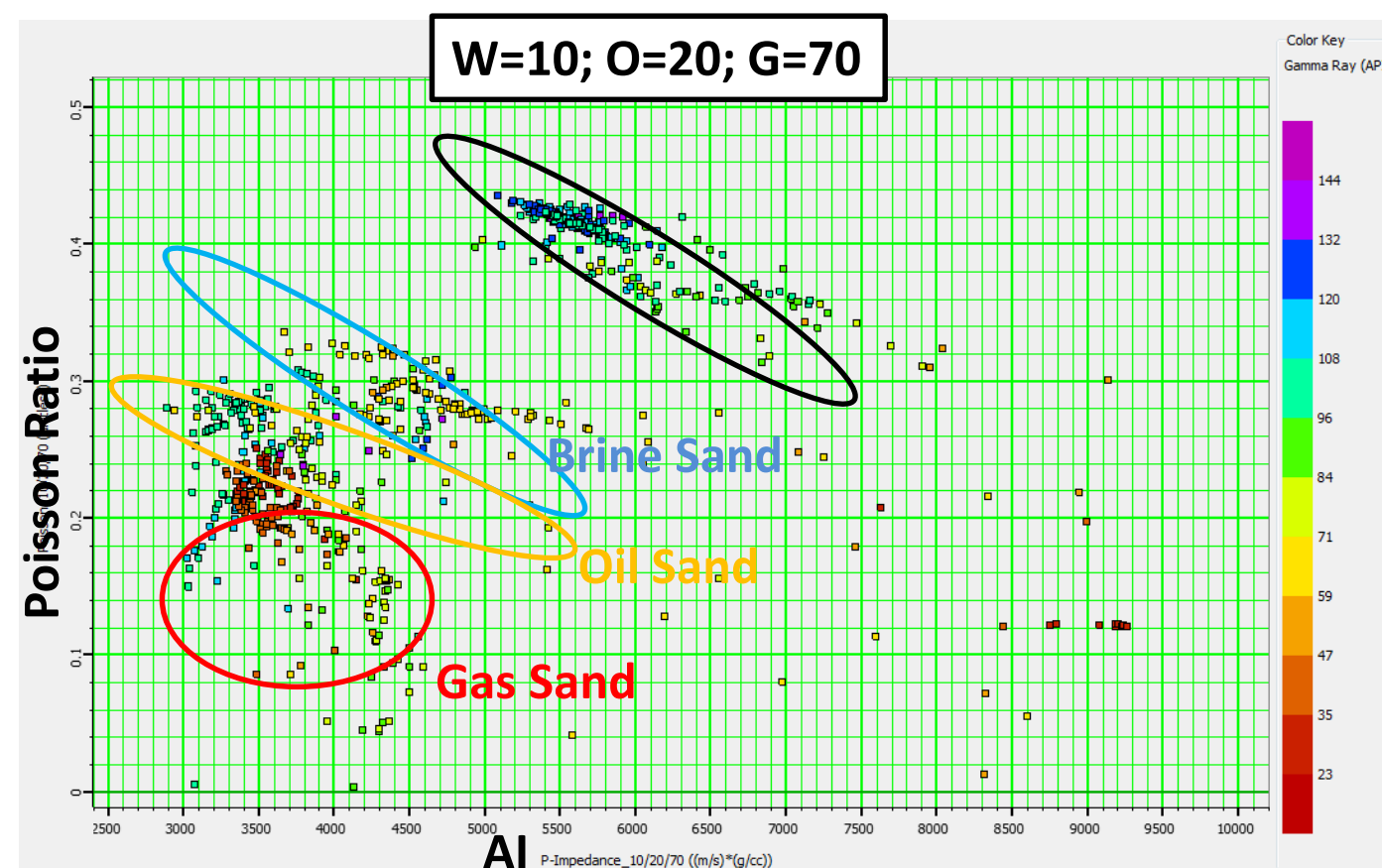
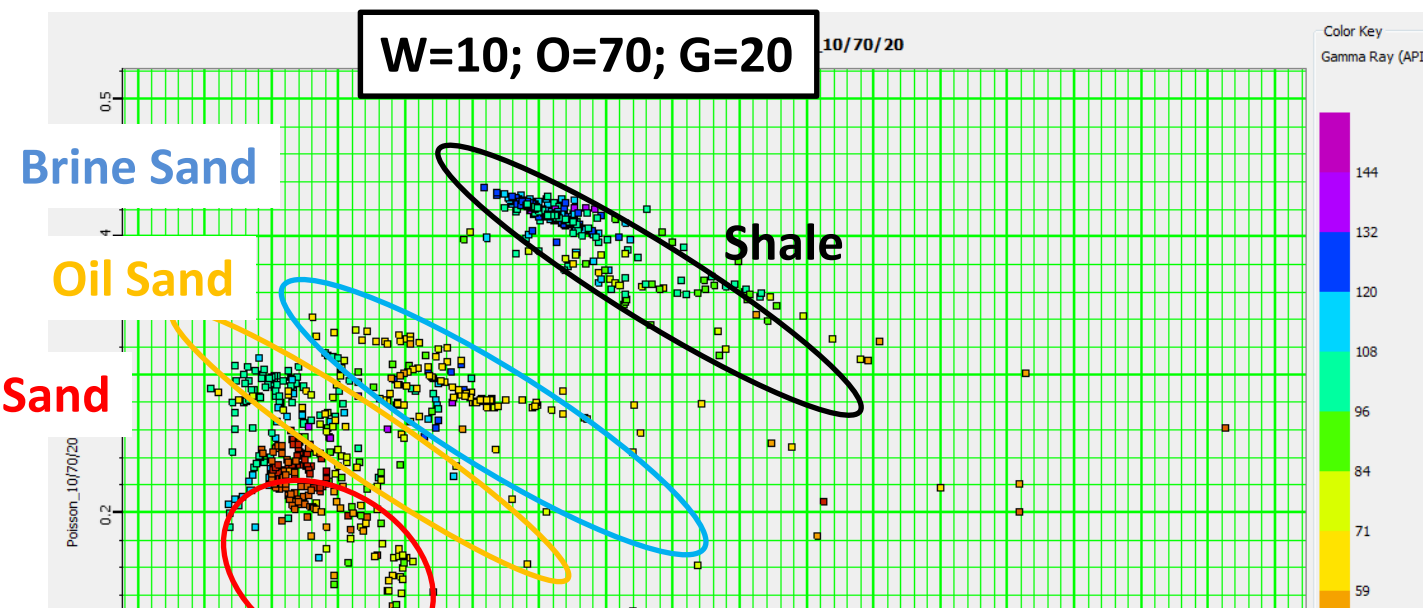
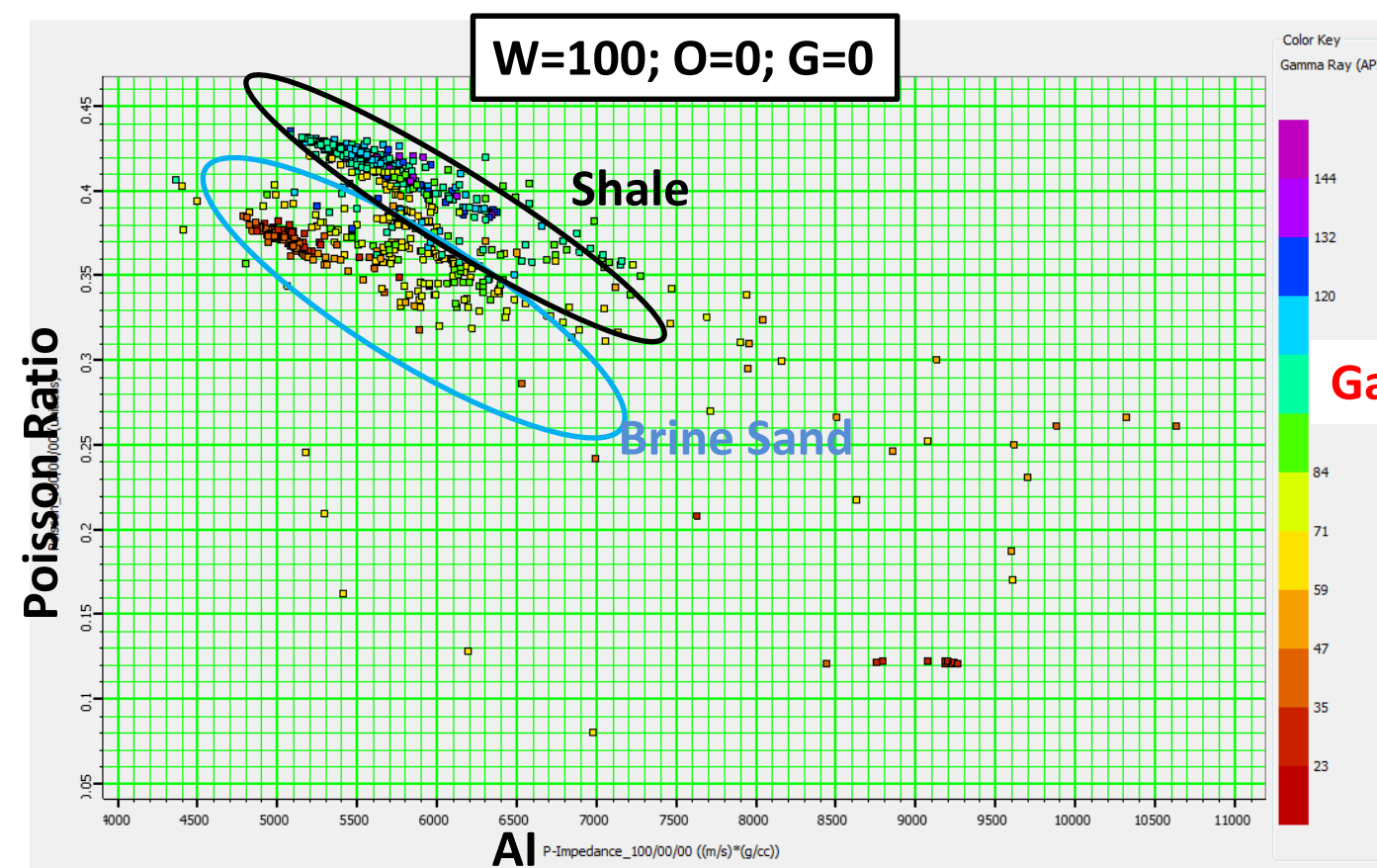
Replacing the water by oil and gas shows the good separation. But relative percentage of oil and gas don't effect to much. However increasing gas percentage decrease the P-wave velocity slightly.

Density Vs. P-Wave



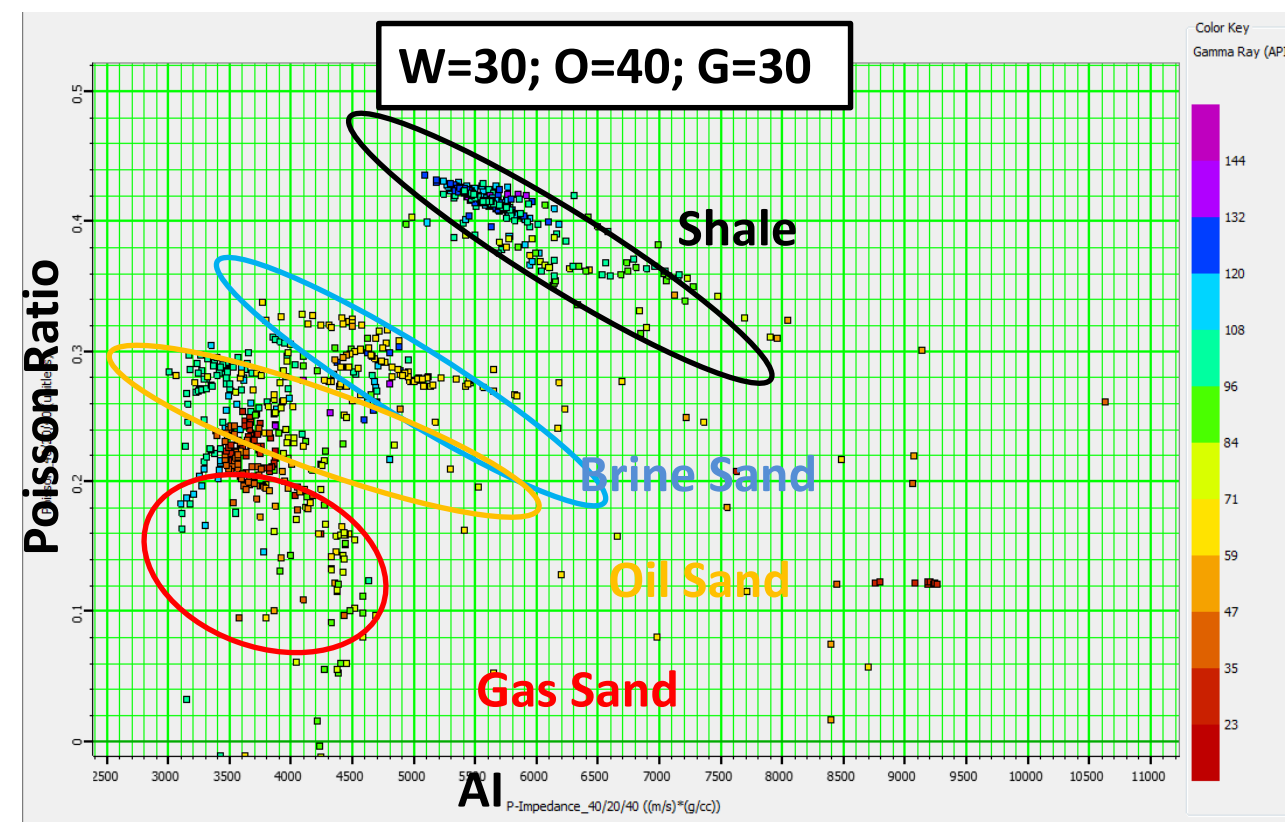
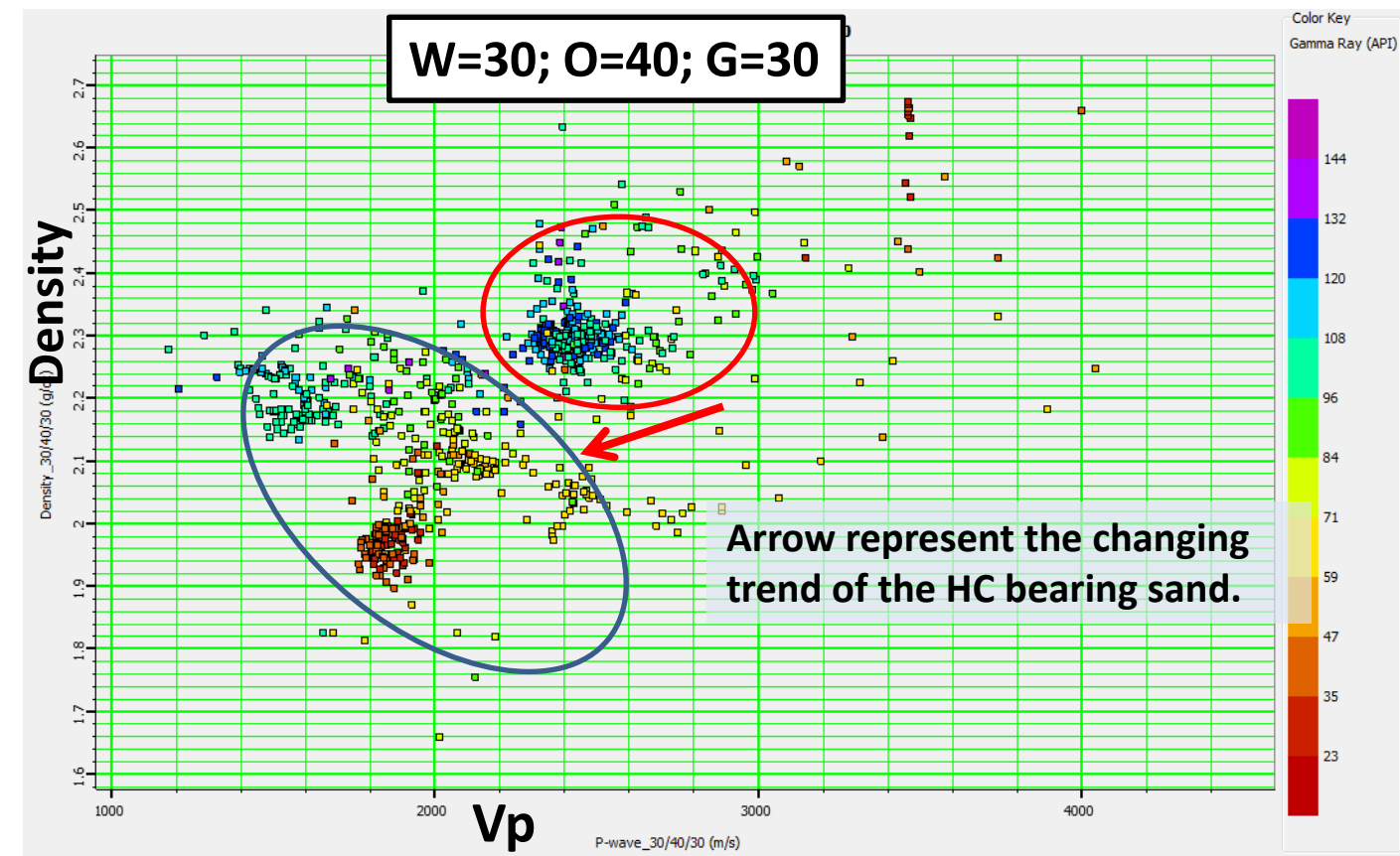
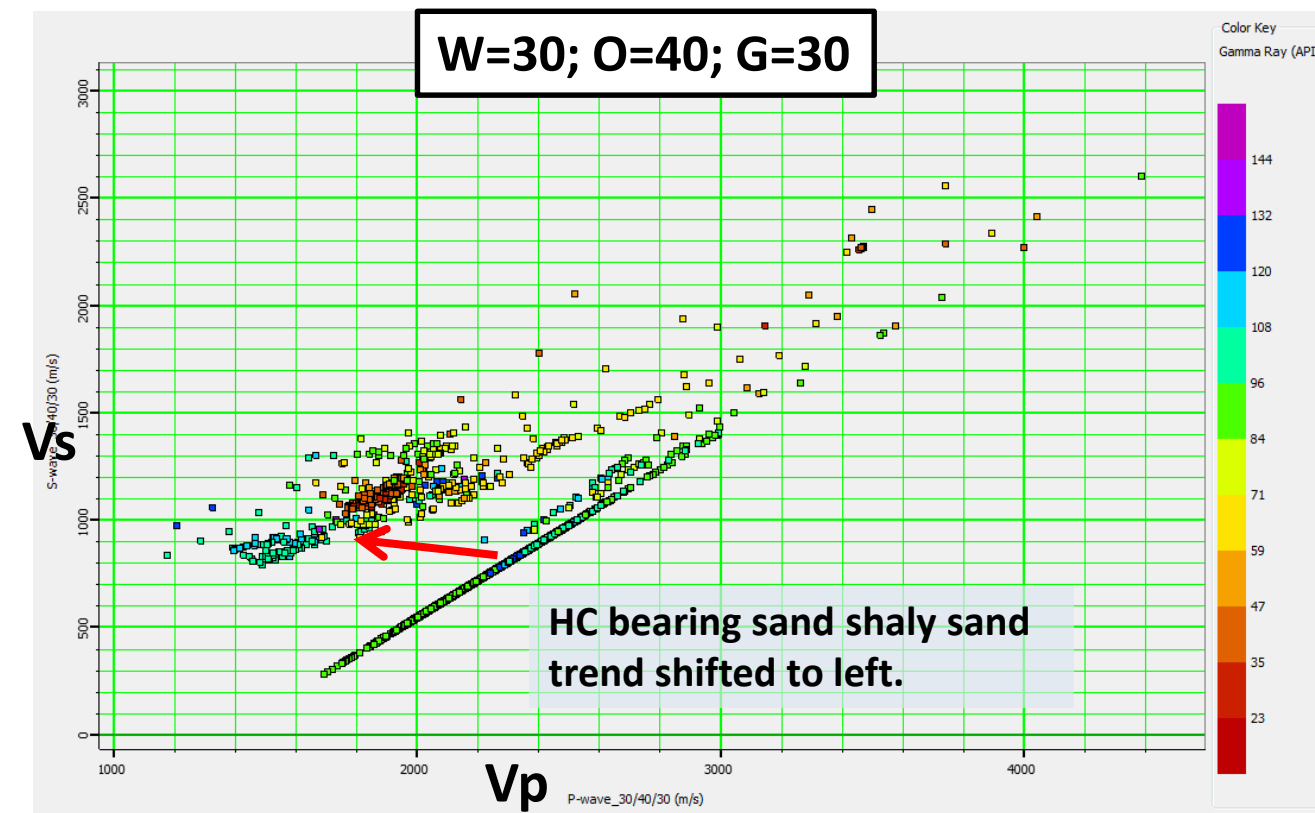
Shale and sand in 100% water saturation shows separate trend. Replacing the water by oil and gas has provided dramatic change trend specially for sand. HC played a great effect on the P-wave velocity and slight effect on density of sand and shaly sand.

Poisson Ratio Vs. AI



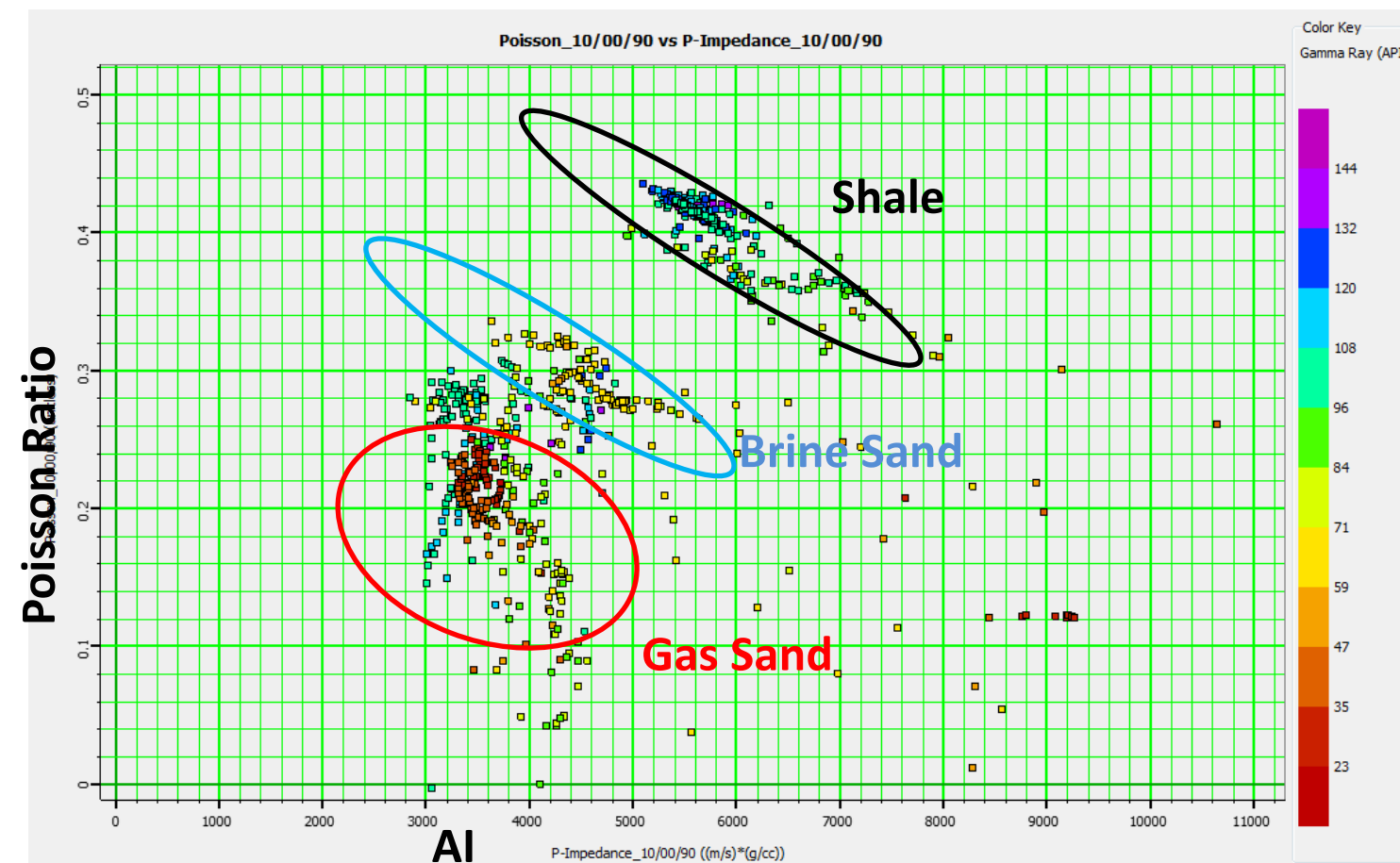
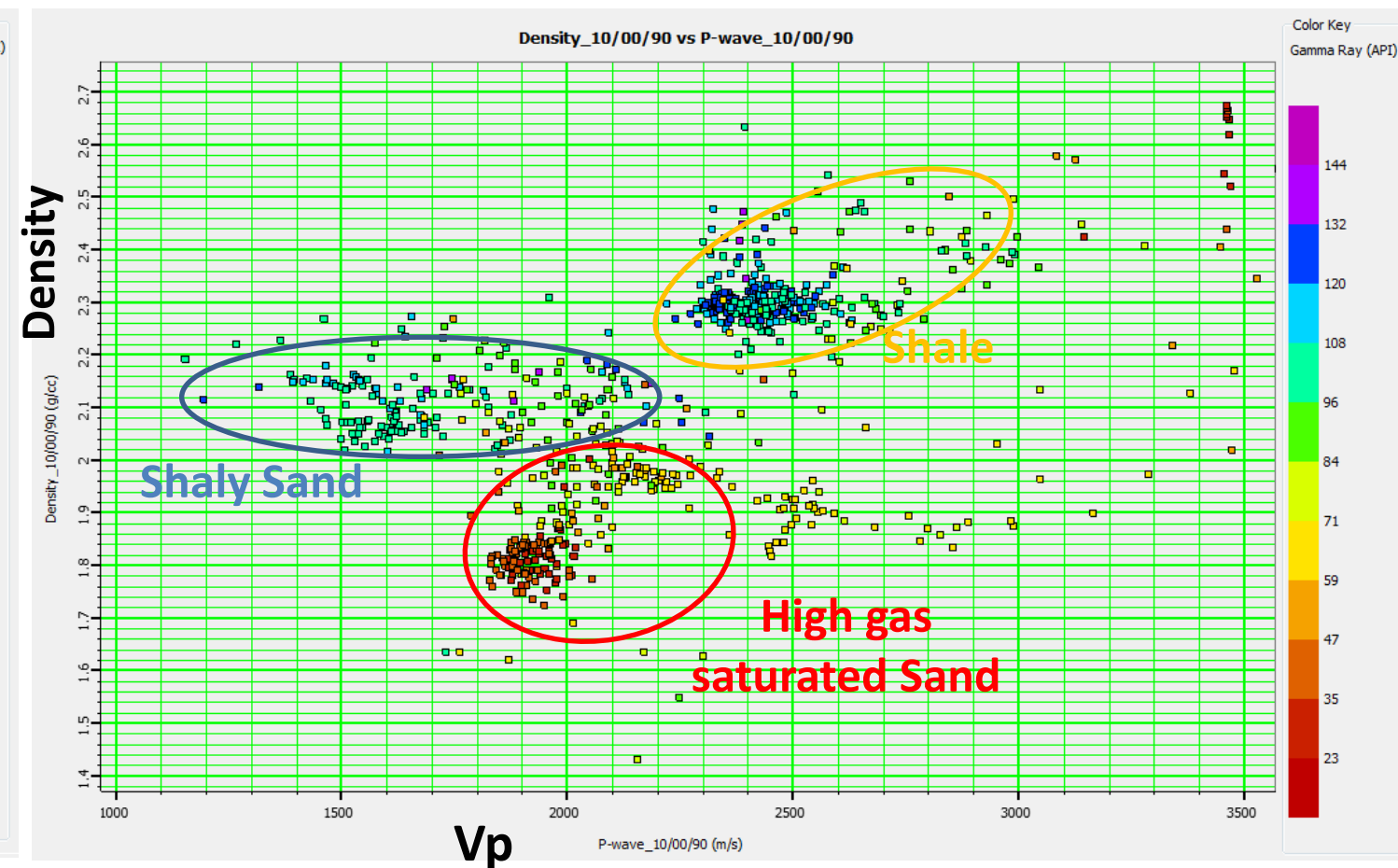
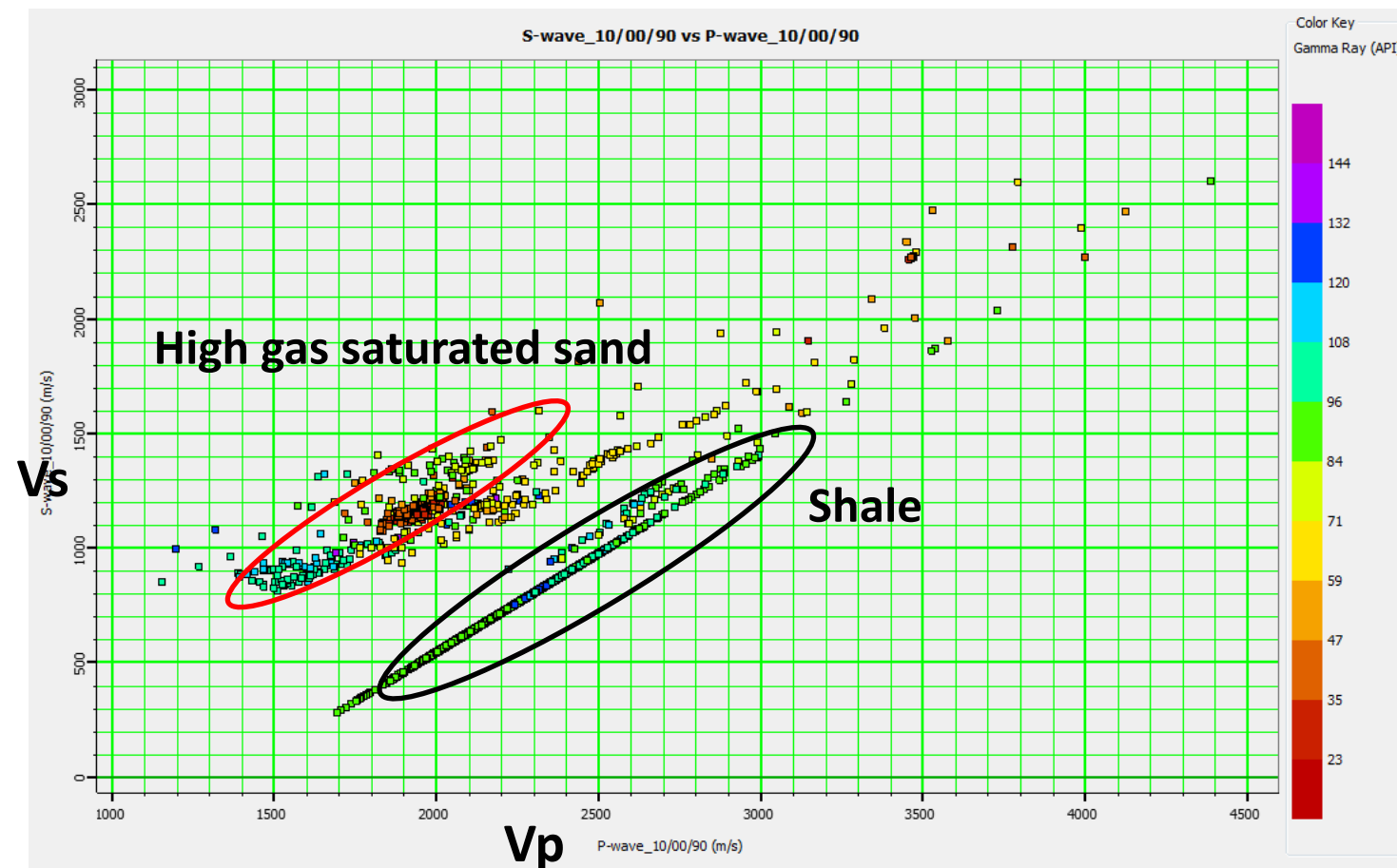
Poisson Ratio vs AI shows relatively good identical trend for each type of the fluids. Shale has very high Poisson ratio and low Poisson ratio related to gas bearing sand.

Comparison of different Cross Plot



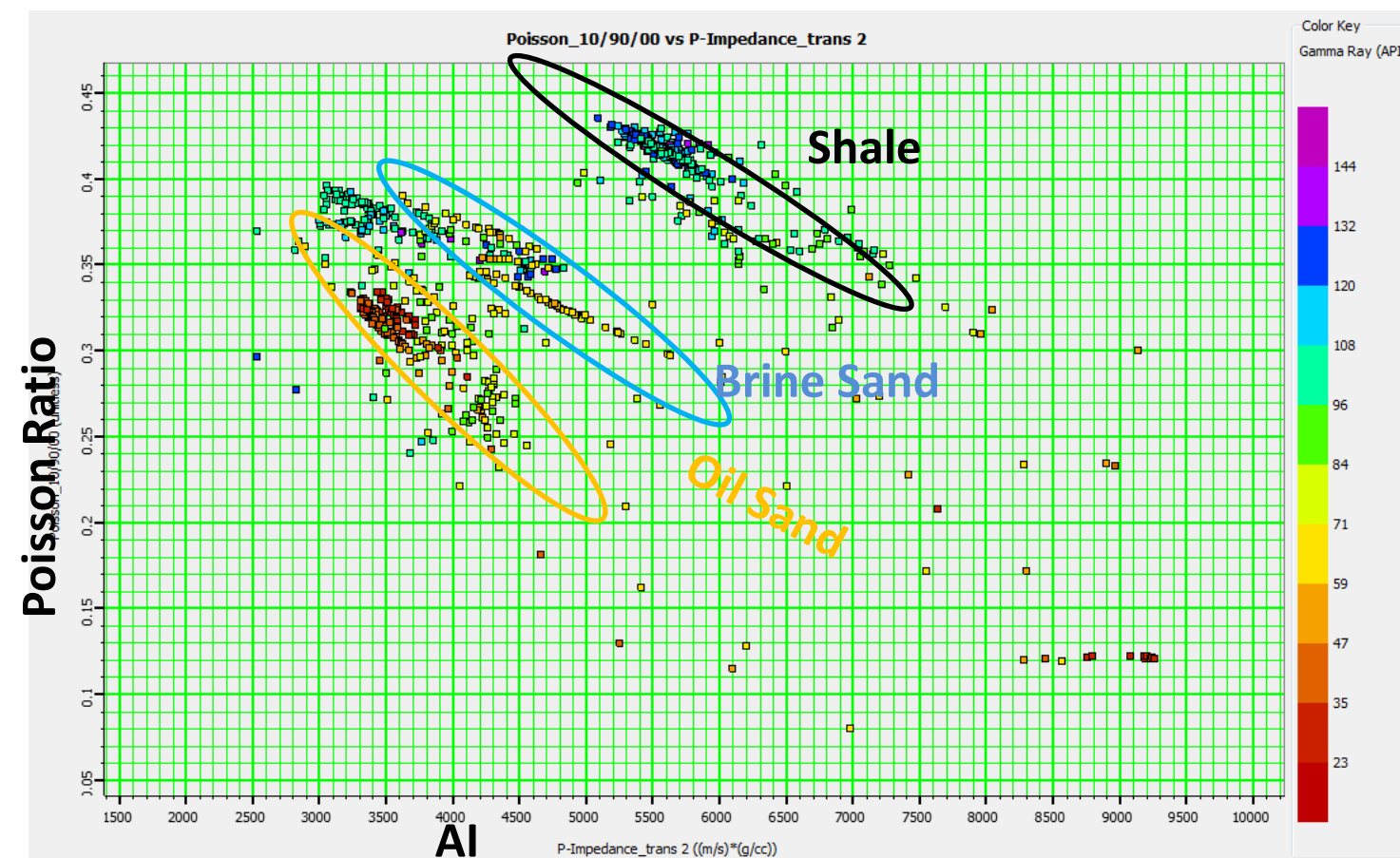
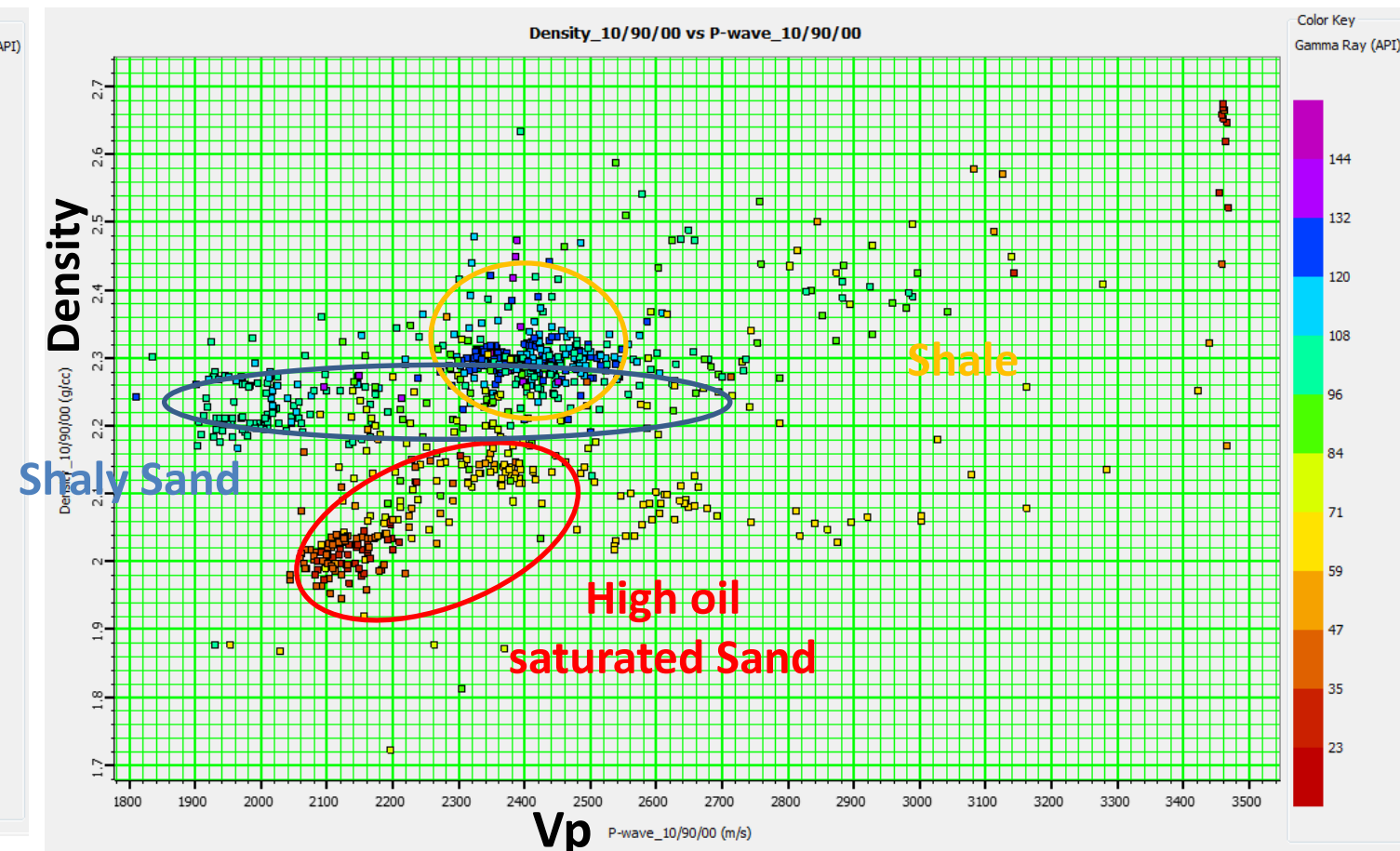
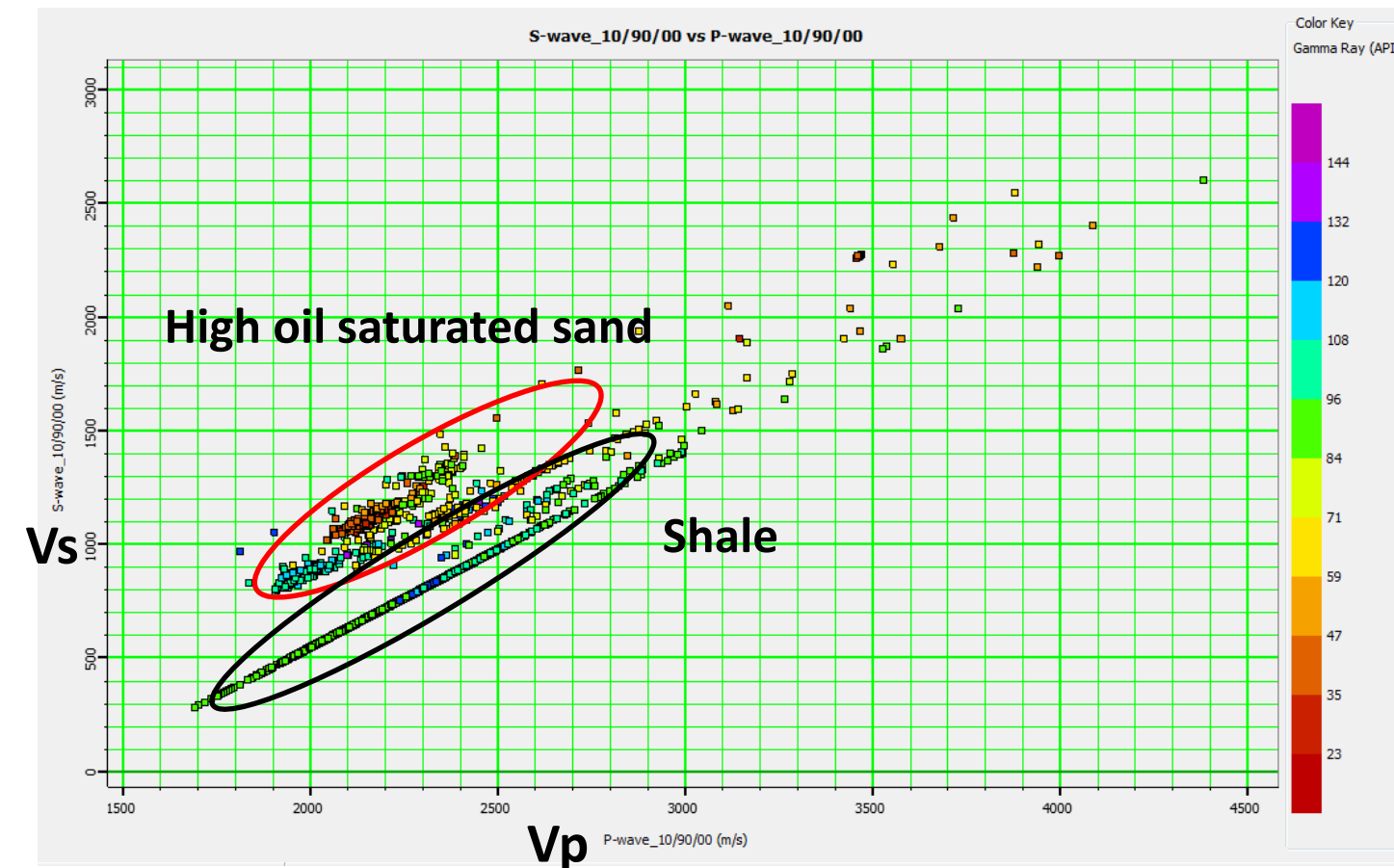
These crossplot are made for 40% oil and 30% gas and water. All of the plots gave clear lithology separation. But separation based on fluid type isn't clear except Poisson ratio vs. AI plot.

2 Phase Fluid: 90% Gas and 10% Water



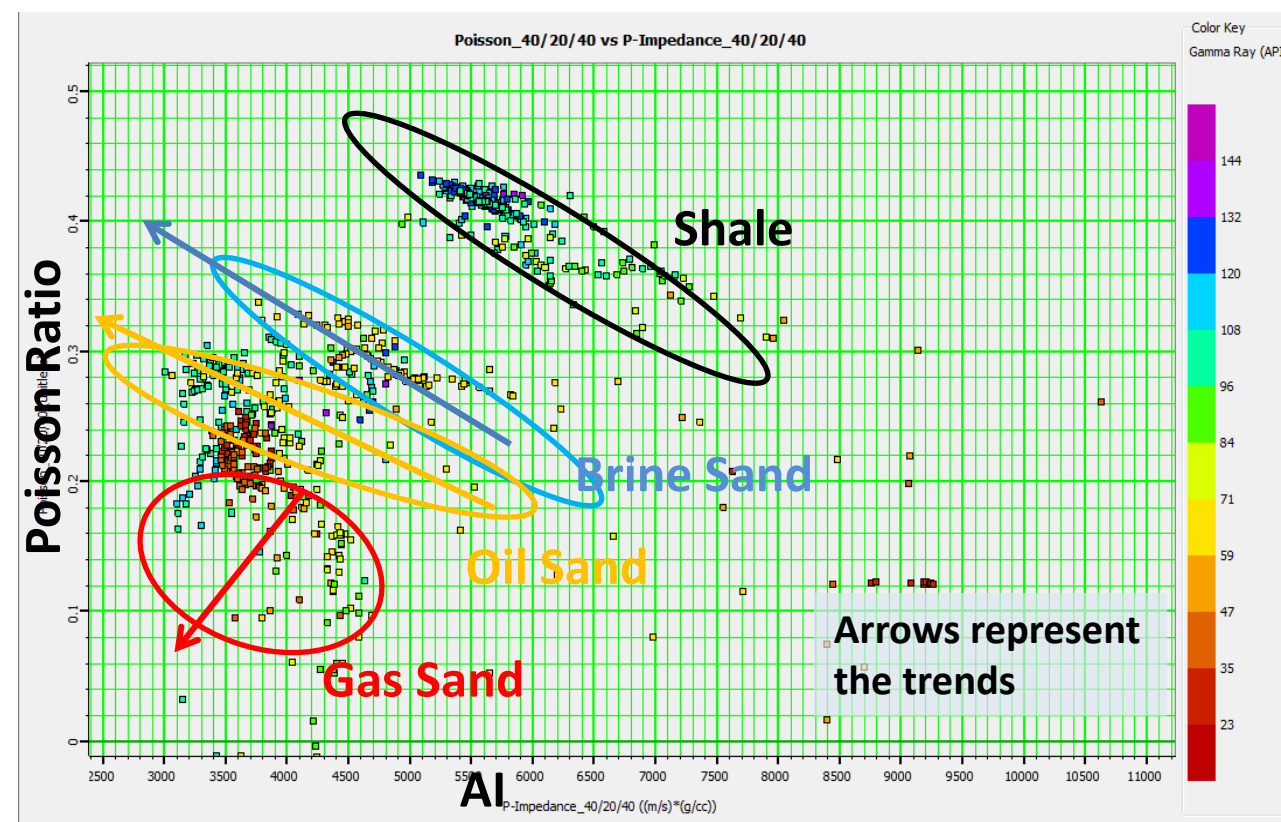
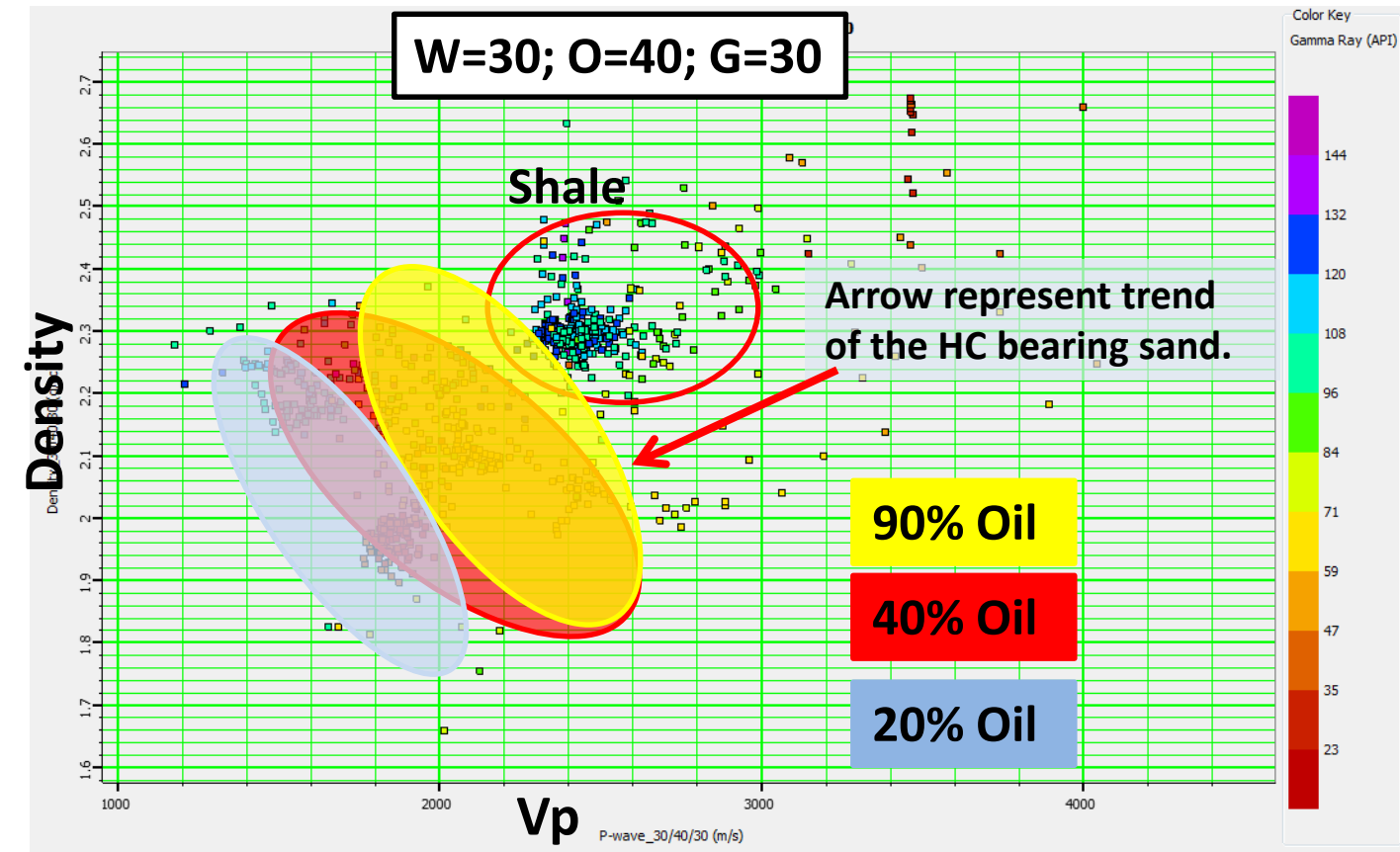
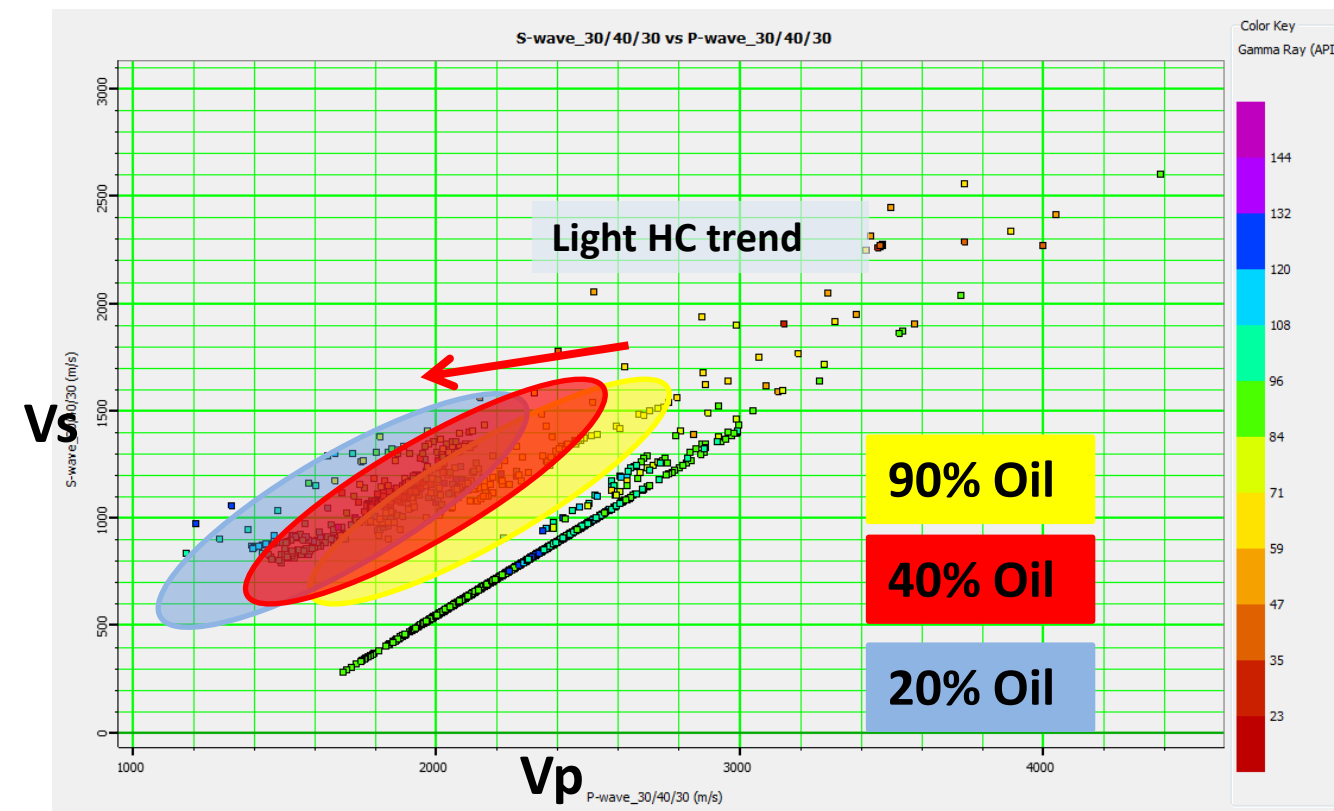
- Very high gas saturation has provided quite large separation between gas saturated sand shale trend in V_s - V_p crossplot.
- Poisson ratio vs. AI plot shows clear separation among fluid types and lithology.

2 Phase Fluid: 90% Oil and 10% Water



- Vs-Vp crossplot : Changing the fluid type from 90% gas to 90% oil gap between the oil saturated sand and shale trend is decreased.
- Density vs. AI: 90 % Oil saturation shifted the clean sand trend towards the left (compare with 90% gas saturation sand).
- Poisson ratio vs. AI: plot shows clear separation among fluid types and lithology.

Fluid Effect Trend



- Vs-Vp crossplot : Increasing the percentage of gas this plot provide large separation and has significant effect on V_p .
- Density vs. AI: Increasing the gas percentage HC bearing sand move toward the center and has significant effects on both density and V_p .
- Poisson ratio vs. AI: arrows are represent the trend for individual fluids type. Oil and brine sand similar trend direction with comparatively low separation.

Summary

- Vs-Vp crossplot provides very clear separation between HC and non HC bearing layer. Increasing percentage of gas saturation separation is more obvious. But fluid effects is not too intense. In addition, this plot doesn't provide distinct trend for different fluid types.
- Density vs. AI plot good HC bearing sand separation for higher percentage of light HC. Moreover lithology separation is also comparatively low overlapping for light HC.
- Compare among the three types of cross plot Poisson ratio vs. AI cross plot has given the best separation for the fluid types and lithology. Oil and water bearing sand have same direction trends but oil bearing sand trend has comparatively lower Poisson ratio as well as AI. Again gas bearing sand shows very low Poisson ratio and trend is towards the center.