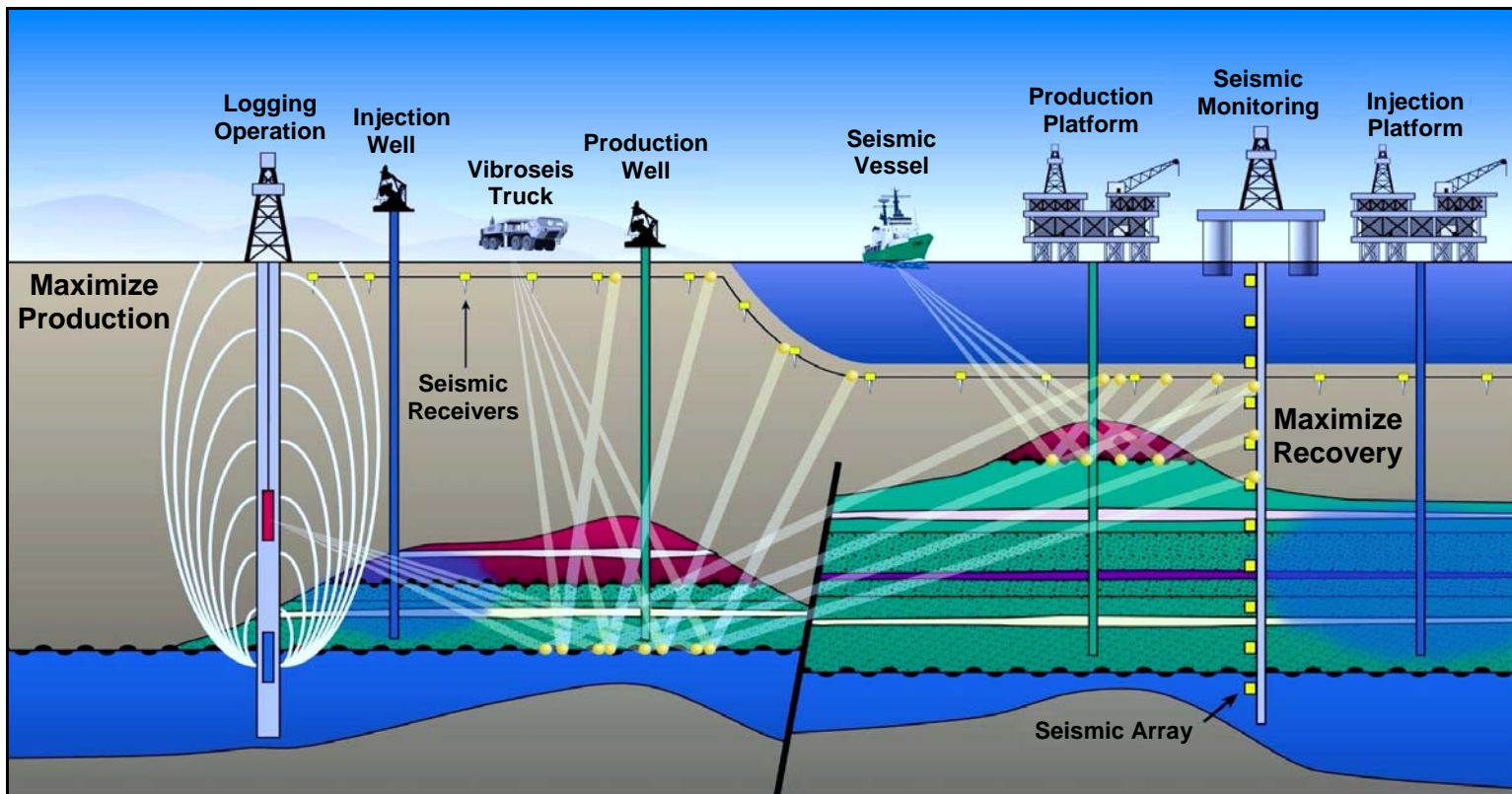


Low-Frequency Laboratory Measurements on Rock Samples



Core Lab operates a full service geomechanics laboratory that provides customers with multi-frequency acoustic velocities and elastic properties for revolutionary seismic and log calibration.



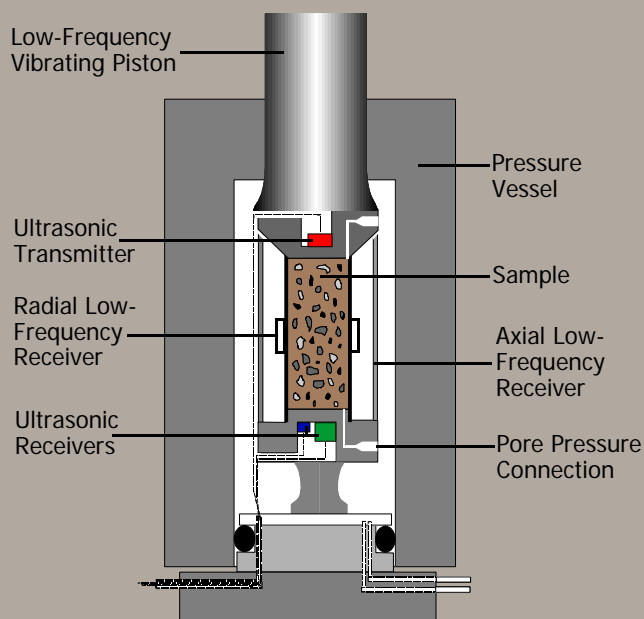
Why low-frequency data are useful:

- They provide a baseline of known rock properties that tie seismic and sonic measurements to ground truth.
- Calibrating logs with low-frequency lab data elucidates dispersive and viscoelastic effects.
- Most rock elastic properties are frequency dependent.
- Seismic attributes such as formation reflectivity vary with frequency.

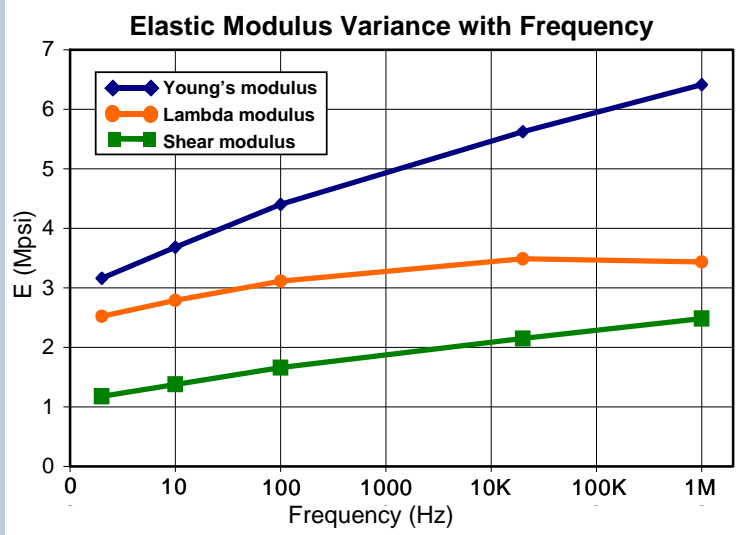
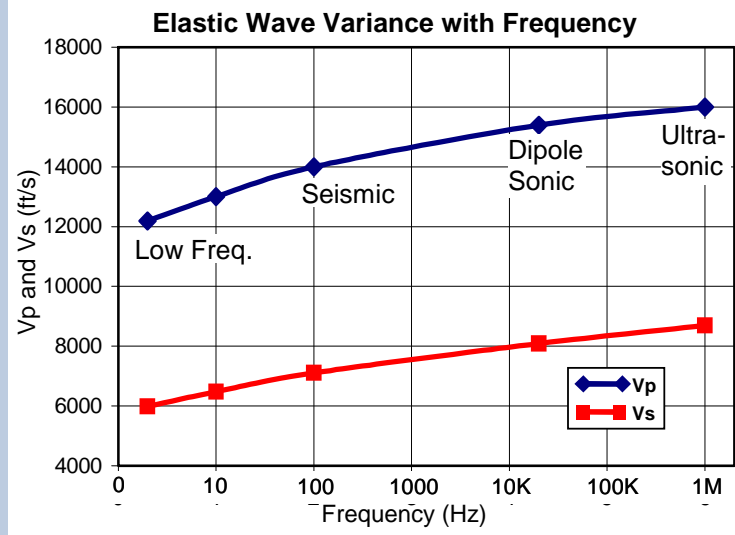
Solutions provided by core testing:

- Differentiate dry gas from fizz water gas
- Determine gas/oil/water influences
- V_p/V_s ratio determination for seismic analysis
- V_p and V_s versus frequency and saturation
- Acoustic velocities in crude oils and brines
- Cross-well seismic calibration
- Fracture mapping using microseismic calibration

Multi-Frequency Rock Testing System

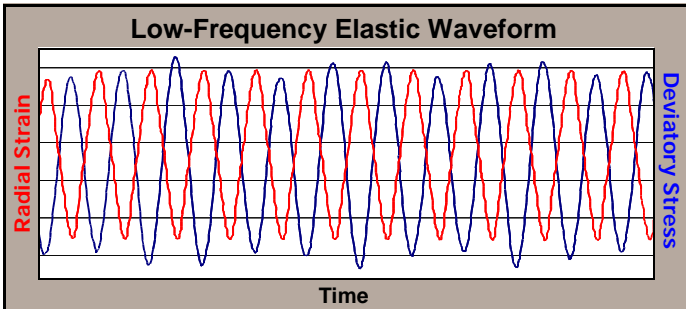


Low-frequency determination of the behavior of reservoir rocks under changing fluid states and reservoir pressures establishes otherwise impossible-to-predict correlations between static and dynamic data.

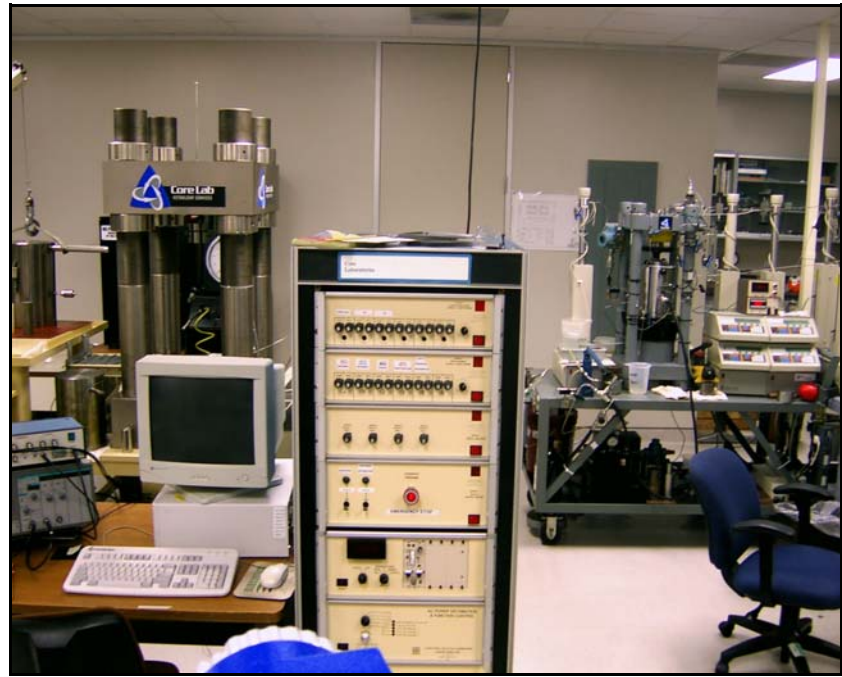
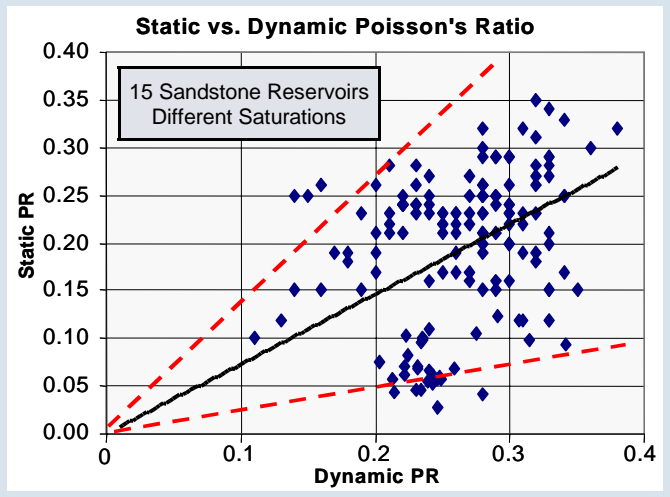


Frequency effects: Both P-wave (compressional) and S-wave (shear) velocities increase as frequency increases from low frequency to seismic to logging and ultrasonic frequencies. Calibration with only ultrasonic data overestimates velocities at lower frequencies. Elastic moduli change dramatically with frequency whereas Poisson's ratio varies less.

Frequency (Hz)	Vp (ft/s)	Vs (ft/s)	Young's Mod (Mpsi)	Poisson's Ratio	Shear Mod (Mpsi)	Lambda Mod (Mpsi)
2	12189	5990	3.16	0.34	1.18	2.52
10	13003	6483	3.68	0.33	1.38	2.79
100	13999	7109	4.40	0.33	1.66	3.11
20,000	15395	8088	5.62	0.31	2.15	3.49
1,000,000	15999	8698	6.41	0.29	2.48	3.44



Correlations between static and dynamic elastic constants are difficult to establish because they depend on many reservoir-specific variables. Without core data acquired at low frequencies in the lab, reservoir models are highly variable and subjective.



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