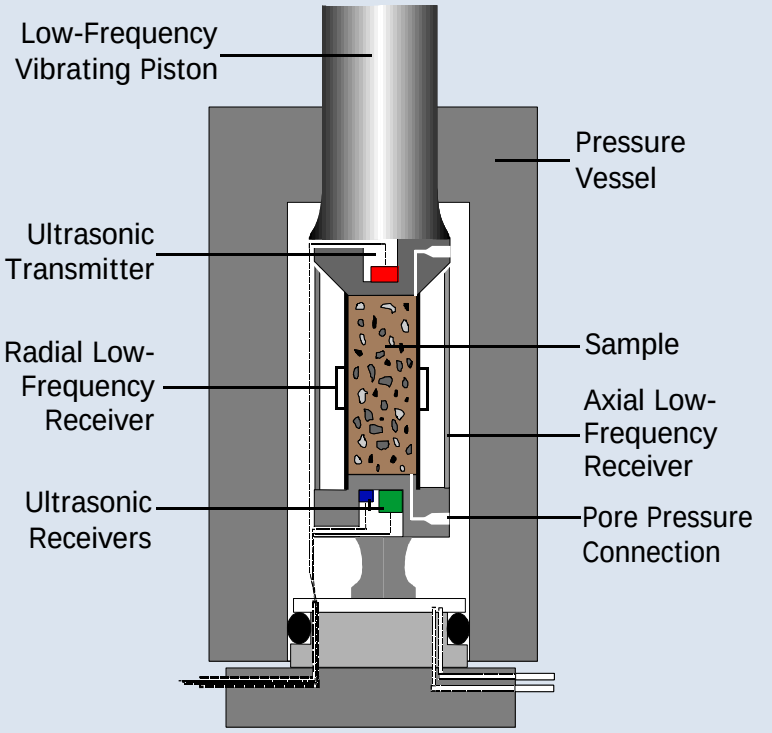
# Multi-Frequency Laboratory Measurements on Rock Cores

Core Lab operates a full-service geomechanics laboratory that provides customers with multi-frequency acoustic velocities, elastic properties and the engineering analyses that revolutionize log calibration.

Applications of Multi-Frequency Sonic Velocities:

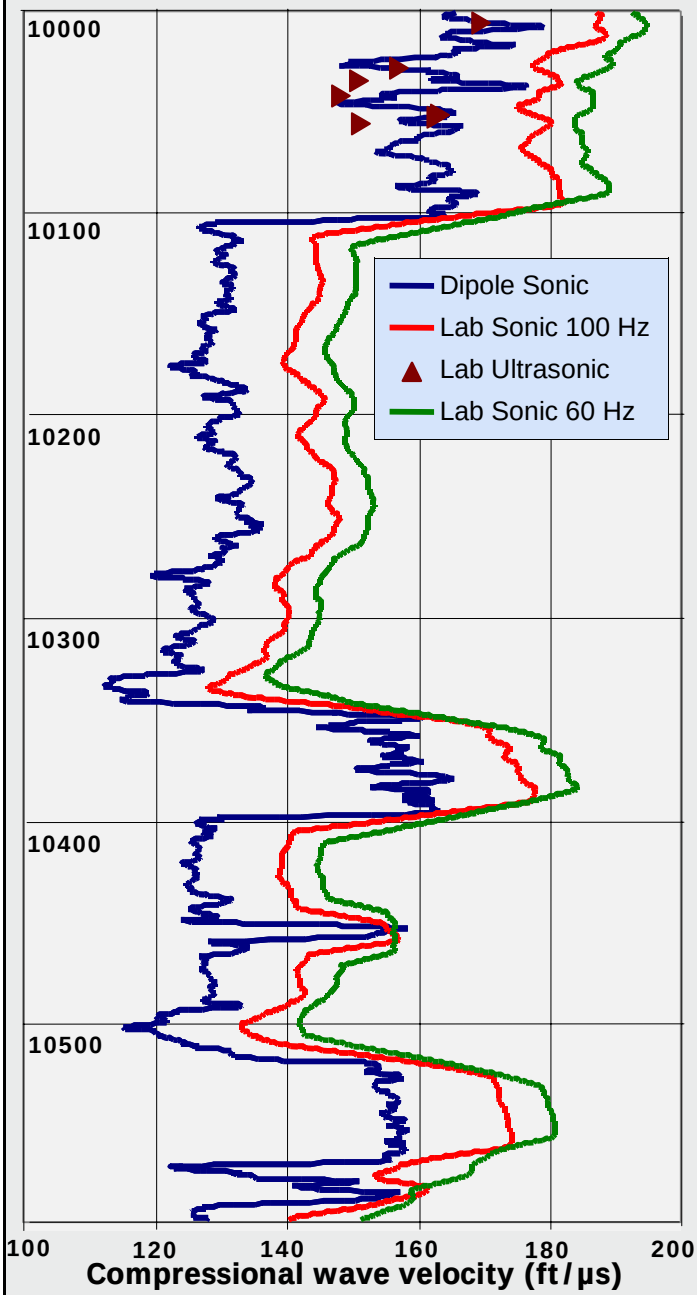
- Calibrate log to low-frequency seismic waves (20 Hz to 1000 Hz)
- Differentiate fizz gas from dry gas
- Determine gas/oil/water influences
- Vp/Vs ratio determination vs. frequency
- Determine elastic parameters vs. frequency

## Multi-Frequency Rock Testing System



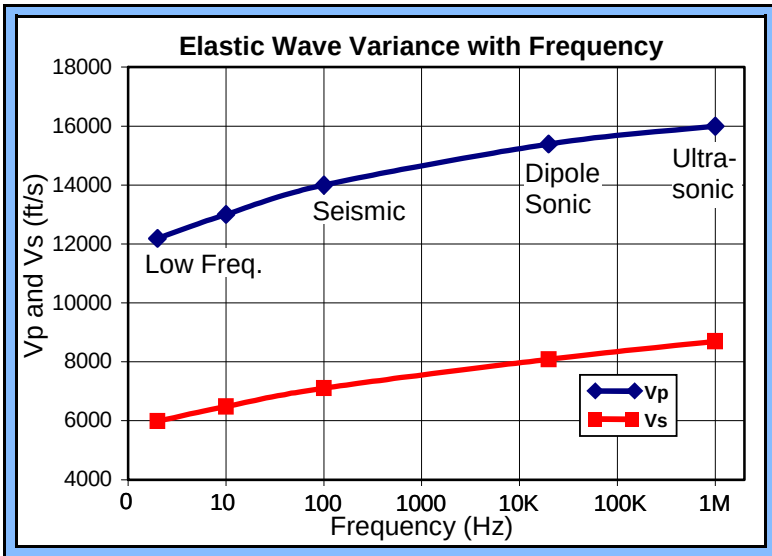

Rock strength is typically 20-60% of that predicted by high frequency measurements, which give information about elastic properties, but can not foretell plastic deformability or brittle behavior. In order to accurately reflect rock mechanical properties, logs must be calibrated with low and ultra-low (static) frequency data that can only be obtained in the laboratory.

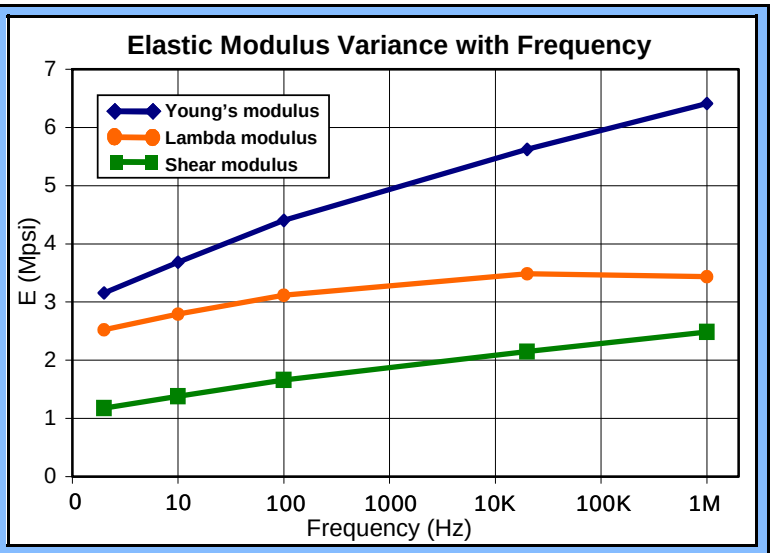
## Multi-Frequency Dipole Sonic Log Calibrated with Lab Data




Conventional dipole sonic logs are combined with lab measurements and transformed into powerful multi-frequency composites.

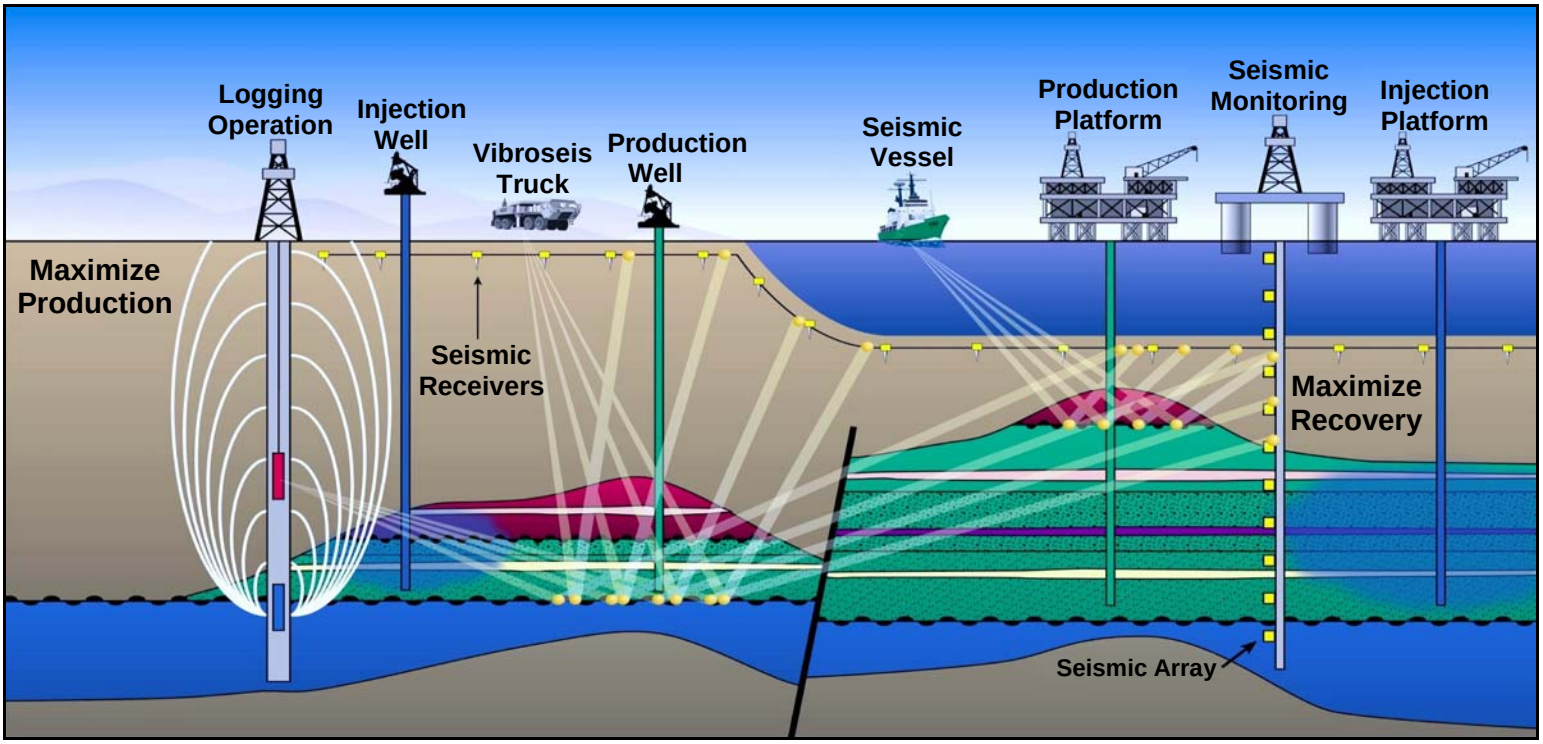
Knowledge of acoustic velocities in reservoir rocks under changing gas pressures and fluid states secures important data for drilling, completion, and geophysical applications in difficult geologies.

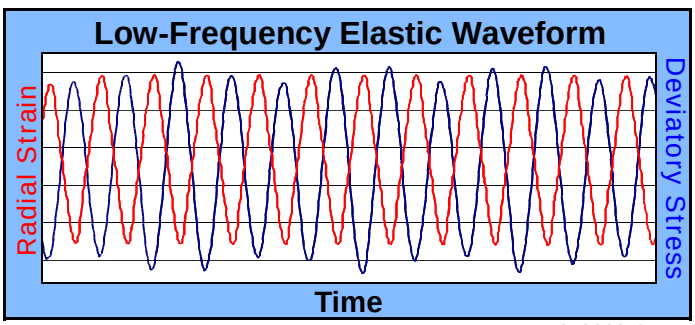



| Frequency (Hz) | Vp (ft/s) | Vs (ft/s) | Young's Mod (Mpsi) | Pois-son's Ratio | Shear Mod (Mpsi) | Lambda Mod (Mpsi) |
|---|---|---|---|---|---|---|
| 0.001 | 7039 | 3056 | 0.85 | 0.38 | 0.31 | 1.01 |
| 2 | 12189 | 5990 | 3.16 | 0.34 | 1.18 | 2.52 |
| 10 | 13003 | 6483 | 3.68 | 0.33 | 1.38 | 2.79 |
| 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 |

**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.

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