

Penilaian Formasi Lanjutan

# Porosity Logs

Sonic Logs

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## Agenda

1. Sonic Log
2. The Borehole Compensated Log
3. Porosity Determination from Sonic Logs
4. The Long-Spacing Sonic Log

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## Sonic Log

- ◆ A Sonic logging tool measures the velocity of sound in formations penetrated by the borehole.
- ◆ Sonic tools consist of transmitters that emit sound, and receiver sections that pick up and record the sound pulse as it passes the receiver.
- ◆ The Sonic log is simply a recording of the time required for a sound wave to traverse a unit of rock formation with respect to depth.
- ◆ The interval travel time is the reciprocal of the velocity of the sound wave.
- ◆ The interval travel time for a given formation depends upon its lithology and porosity.

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## Basic Sonic Logging System

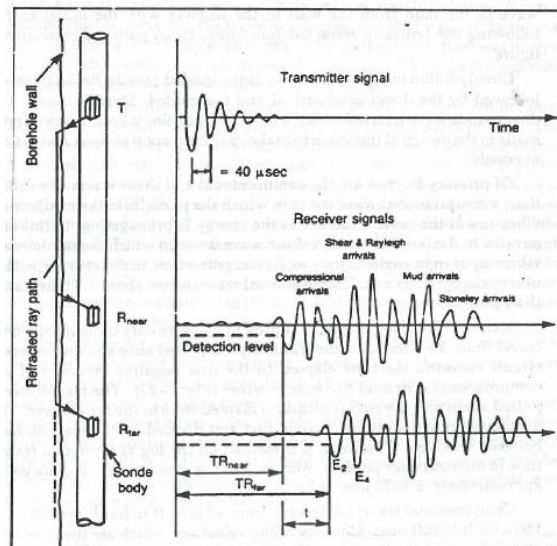


Fig. 5-27 Basic Sonic logging system (courtesy Schlumberger, © SPE)

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## The Borehole Compensated Log

- ◆ The Borehole Compensated (BHC) system uses one transmitter above and below two pairs of sonic receivers.
- ◆ This type of sonde reduces the spurious effect of hole-size changes and errors from sonde tilt. When one of the transmitter is pulsed, the time elapsed between detection of the first arrival at the two corresponding receivers is measured.
- ◆ The BHC tool transmitters are pulsed alternatively, and time values are read on alternate pairs of receivers.
- ◆ The time values from the two sets of receivers are averaged automatically for borehole compensation.
- ◆ Typically in the BHC system, the distance between the transmitter and first receiver is 4 feet, and the distance between receivers is 2 feet.
- ◆ The first arrivals of the sound energy at the receivers correspond to the sound travel paths in the formation near the borehole wall.

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## Borehole Compensated Sonic Logging System

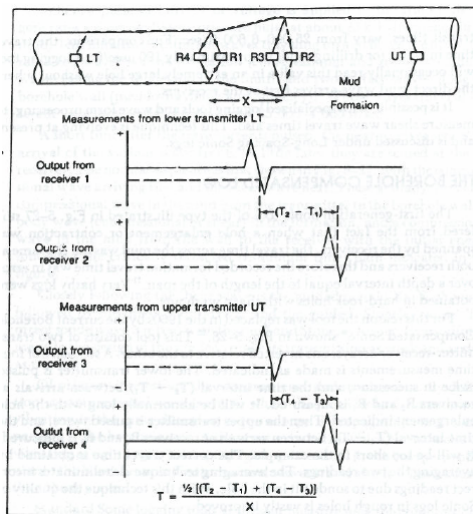
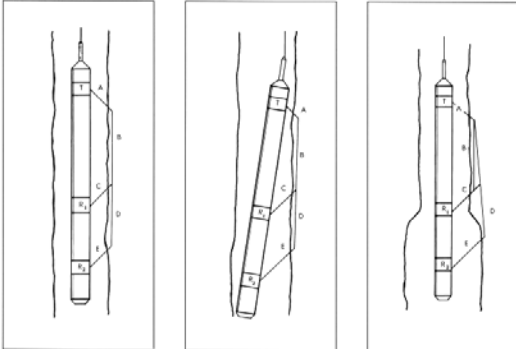
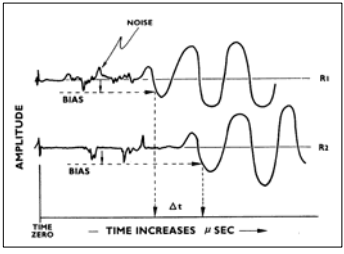


Fig. 5-28 Borehole Compensated Sonic logging system (after Thomas, courtesy SPWLA)

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### Dual detectors

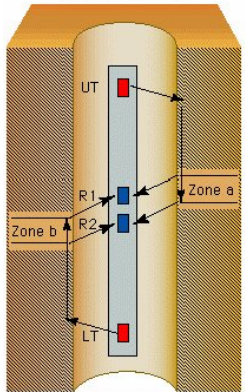



Tools with just one detector and one receiver were very sensitive to borehole and tool orientation, seeing borehole instead of formation. More transmitters and receivers can be used and the paths can be averaged to negate the effect of tilt and washout.

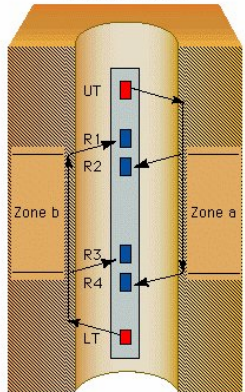
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### Other Compensation Schemes

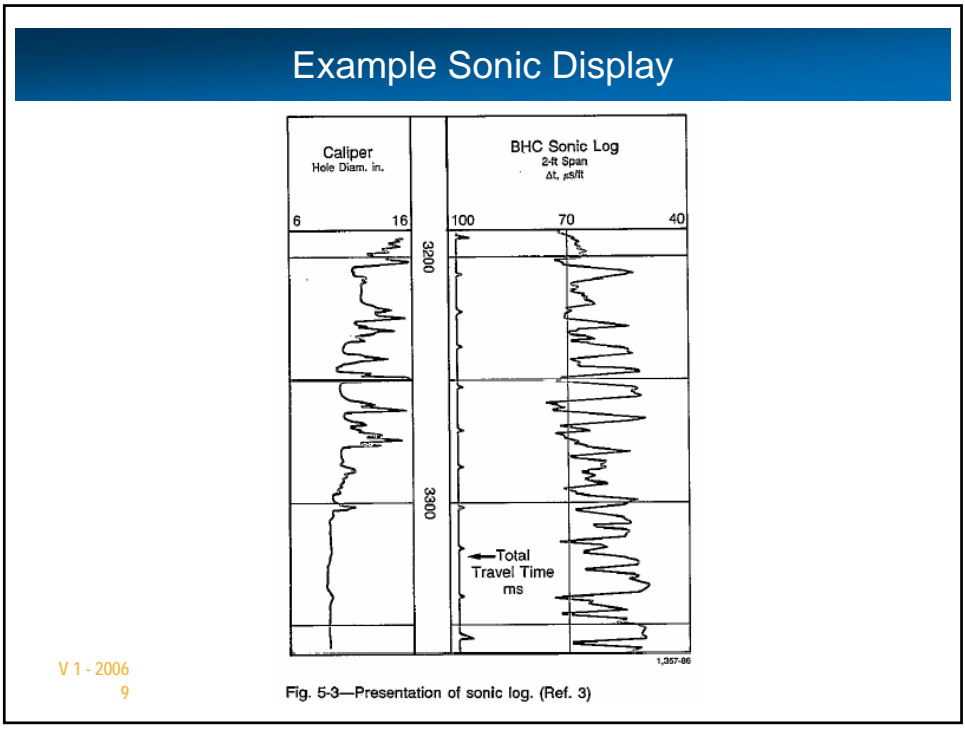
**Two Transmitters/  
Two Receivers**



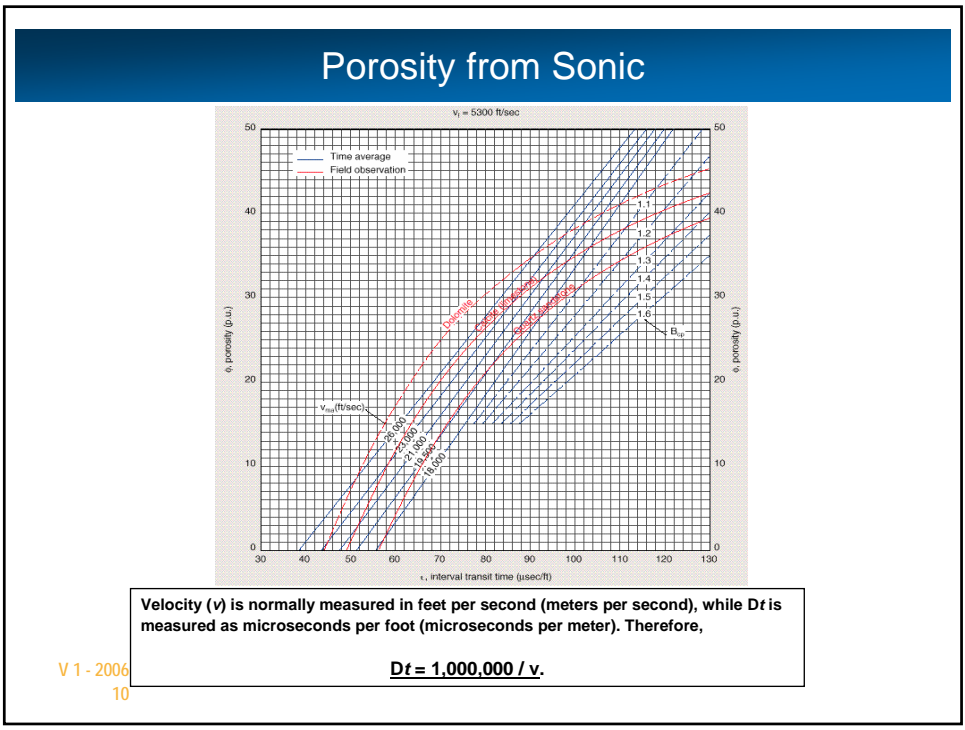
**Two Transmitters/  
Four Receivers**



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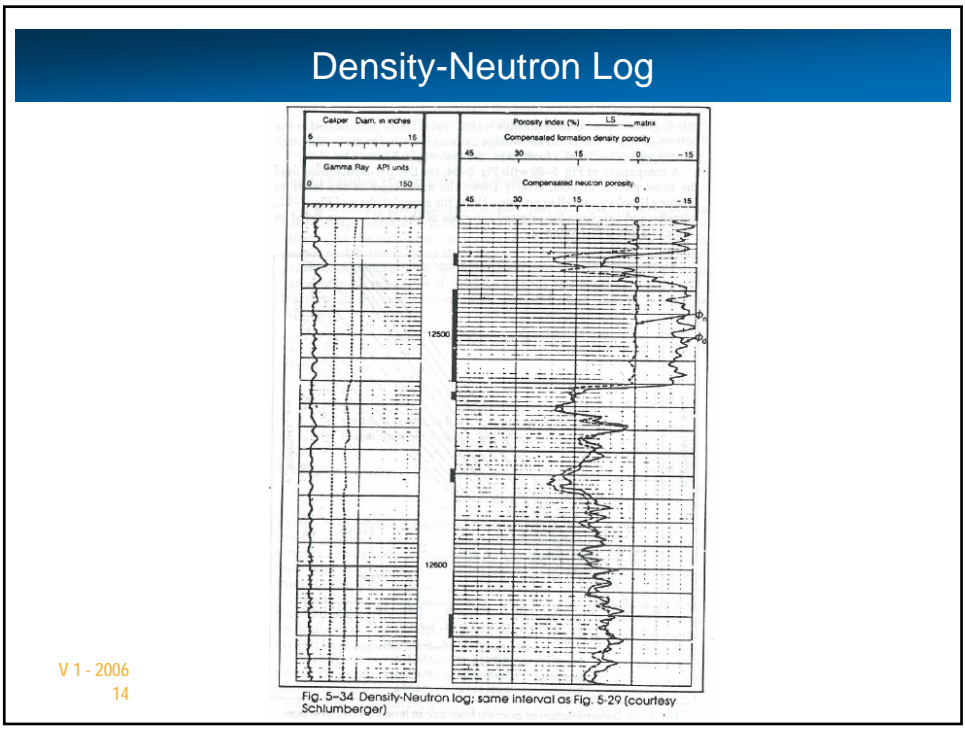
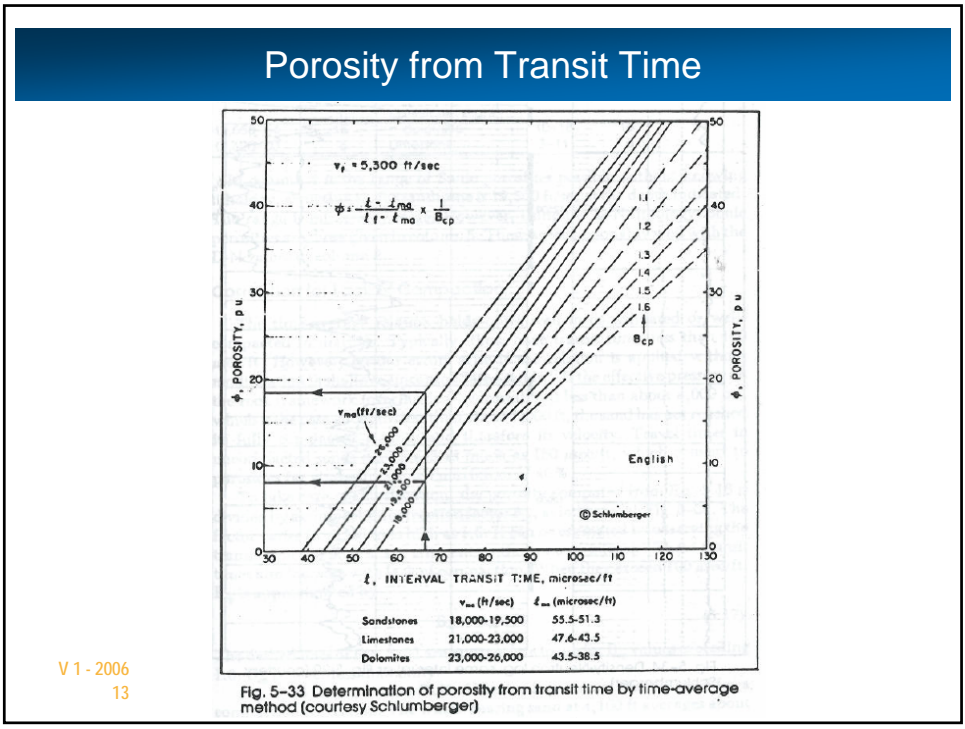


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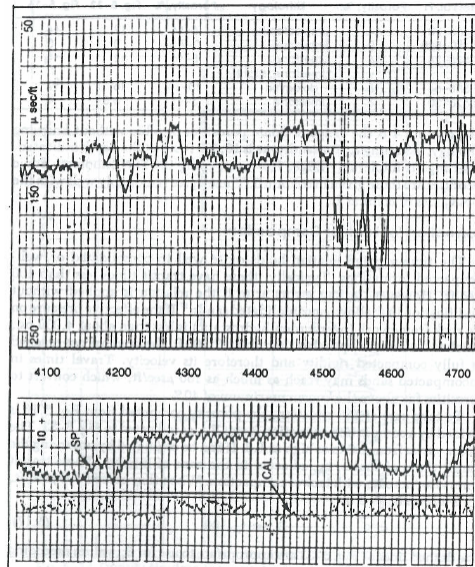
## Comparison of Sonic and Density-Neutron Por

**TABLE 5-3 COMPARISON OF SONIC AND DENSITY-NEUTRON POROSITIES**

Interval, Ft	Density-Neutron Porosity, %	Density-Neutron Lithology	Range of Sonic Porosity, %	Sonic Porosity with D-N Lithology	
				Fig. 5-33	Fig. 5-36
12,466-70	14	Limy dolomites	6-14	12	14
12,480-520	0	Anhydrite	0-7.5	0	0
12,525-28	16	Limestone	8-16	12	14
12,558-64	18	Limestone, slightly dolomitic	10-18	16	17
12,620-30	6	Limestone	3-11	6.5	6

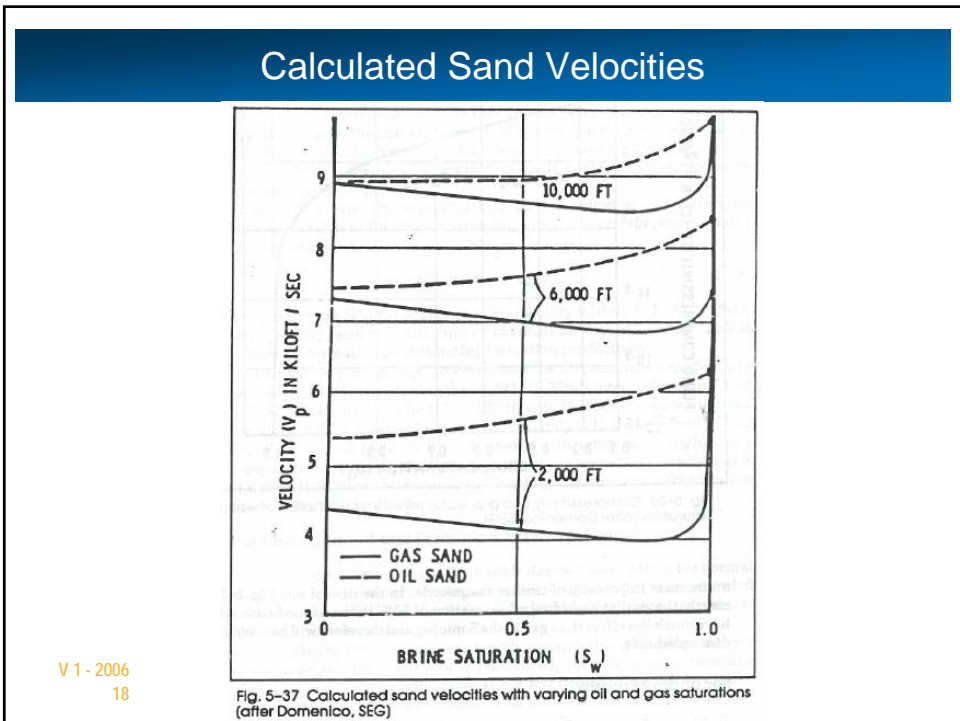
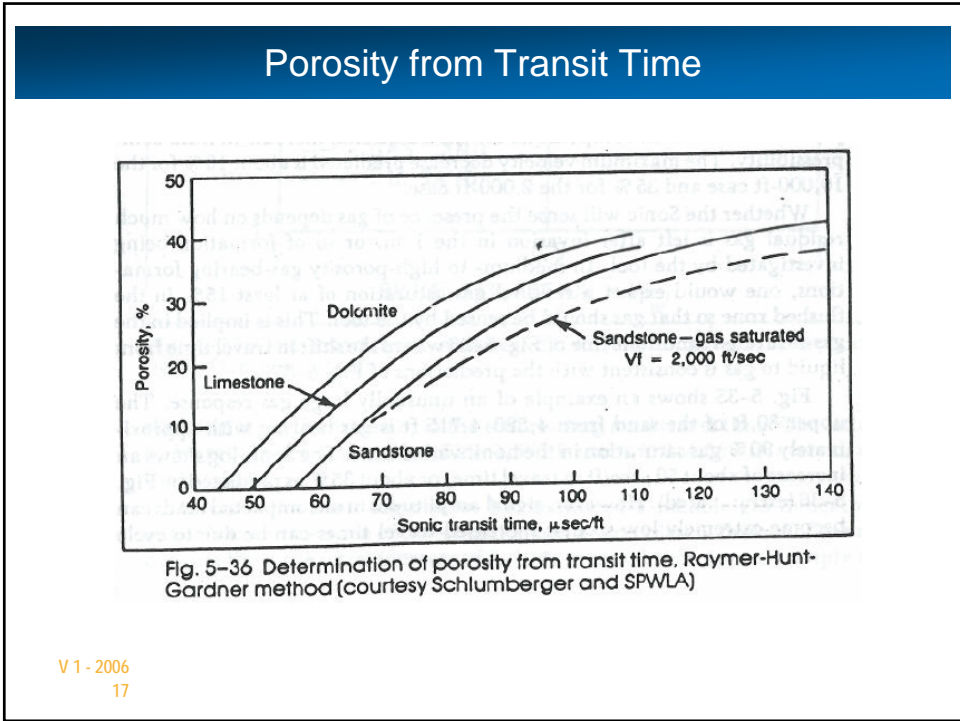
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## Compaction and Gas Effect



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Fig. 5-35 Lack of compaction and gas effect in soft sand (courtesy Schlumberger)



## Compressibility of a Gas-Water Mixture

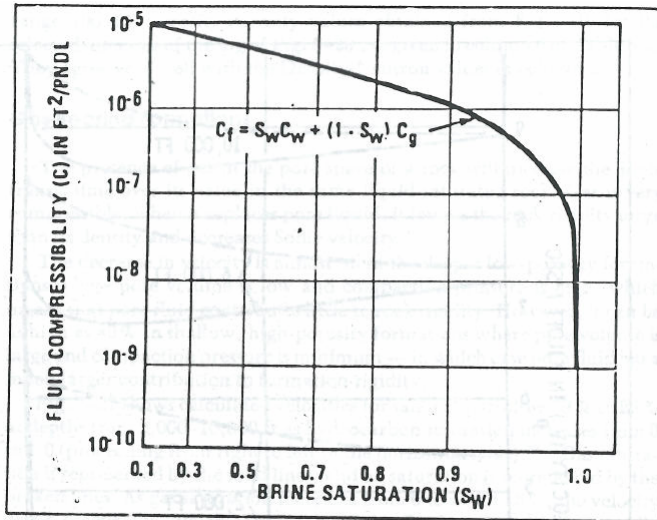


Fig. 5-38 Compressibility of a gas-water mixture as a function of water saturation (after Domenico, SEG)

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## Effect of Shale Alteration

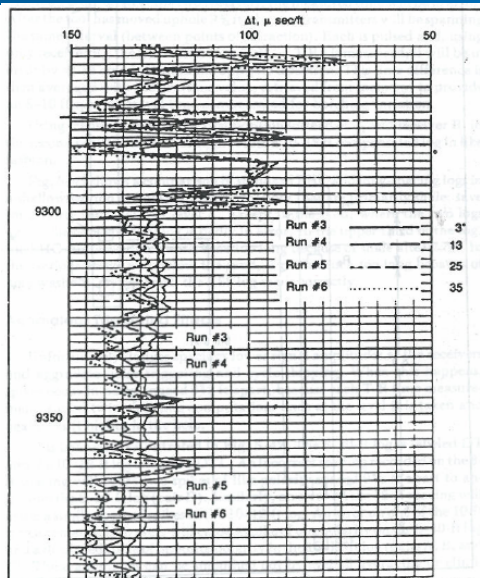
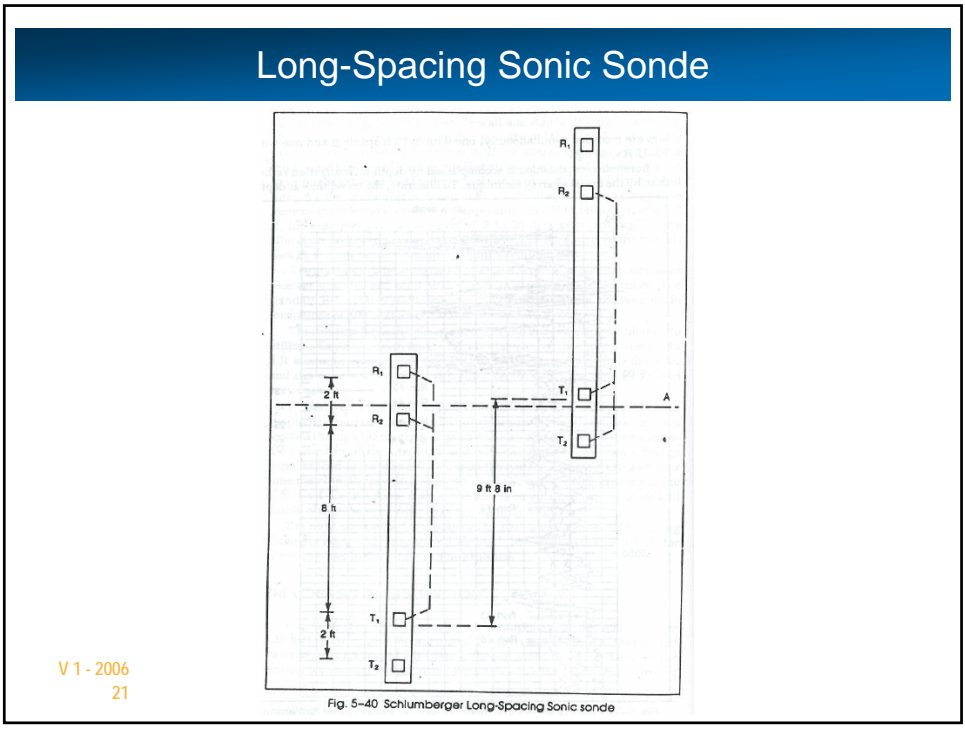
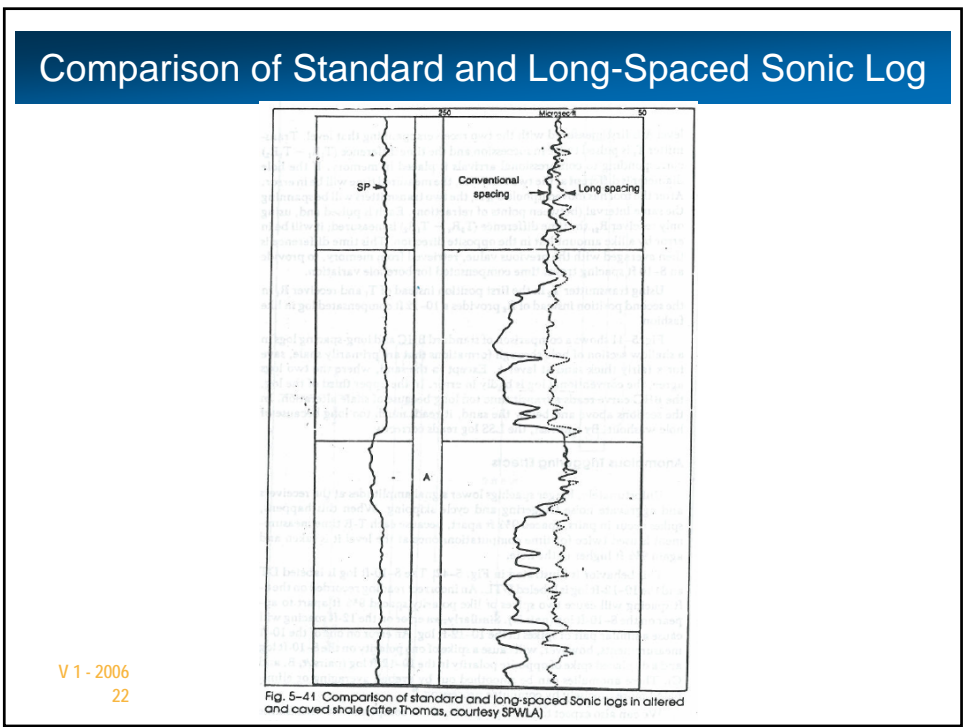


Fig. 5-39 Effect of shale alteration; \*days after drilling (after Bigkeman, courtesy SPWLA)

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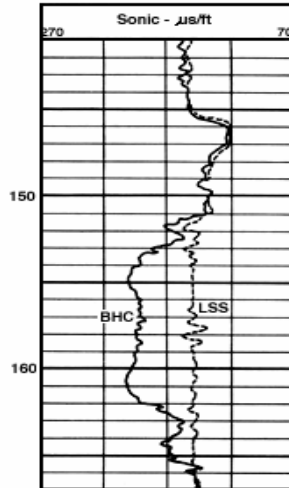


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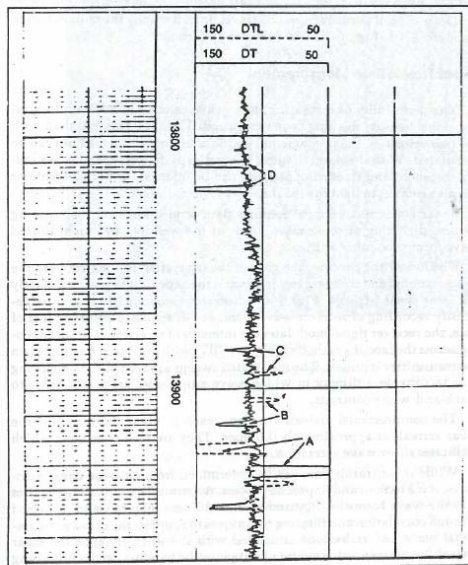
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## Altered Zone identified by Long Spaced Sonic



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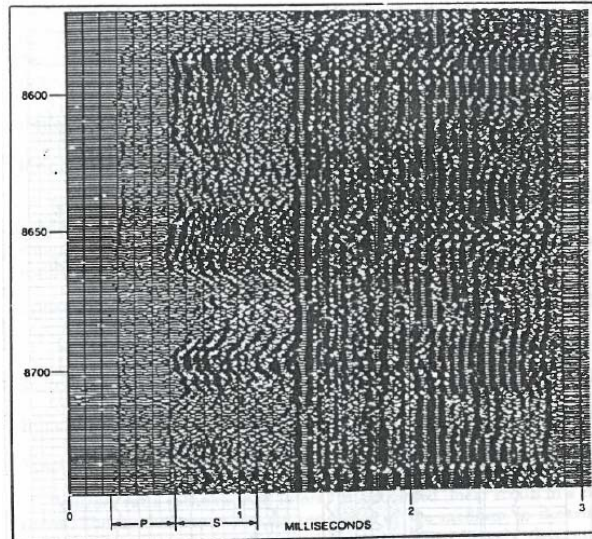
## Cycle Skips and Noise Triggering



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Fig. 5-42 Cycle skips and noise triggering, causing dual spikes on depth-derived Long-spacing Sonic log (after Purdy, courtesy SPWLA)

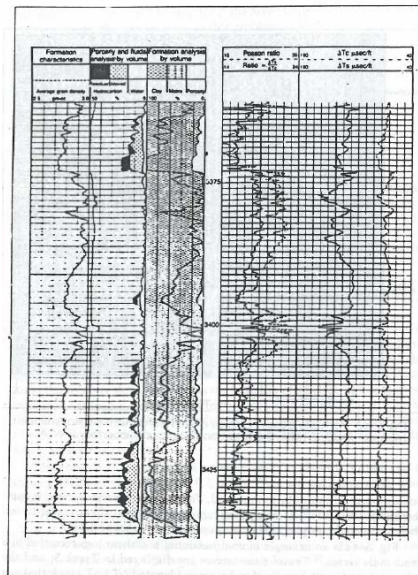
## Variable Density Display of Waveforms



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Fig. 5-43 Variable density display of waveforms with 8-ft transmitter-receiver spacing (after Siegfried and Castagna, courtesy SPWLA)

## Shear and Compressional Travel Time



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Fig. 5-44 Example of shear and compressional travel time recording in sand-shale series (courtesy Schlumberger)

## Comparison Between Lithology and Shear to Compressional Travel Time Ratio

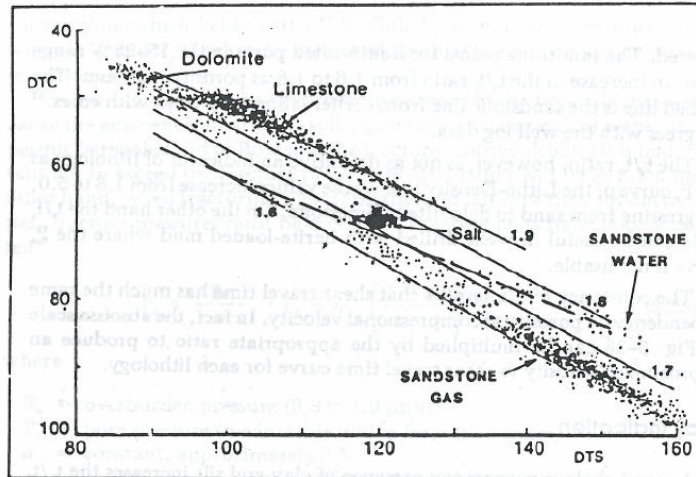


Fig. 5-45 Comparison between lithology and shear to compressional travel time ratio with data from several wells (courtesy Schlumberger and SPWLA)

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## Resources

- ◆ Course Materials: <http://www.geocities.com/ridwanwd/PFL/>
- ◆ The Society of Petrophysicists and Well Log Analysts: <http://www.spwla.org>
- ◆ Society of Petroleum Engineers: [www.spe.org](http://www.spe.org)  
Formation Evaluation: [http://www.spe.org/spe/jsp/basic/0,,1104\\_1714\\_1003934,00.html](http://www.spe.org/spe/jsp/basic/0,,1104_1714_1003934,00.html)
- ◆ Schlumberger Interpretation Chart: [www.slb.com](http://www.slb.com) or <http://content.slb.com/Hub/Docs/connect/reference/Chartbook/>

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## Question and Answer

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