You can push, but you can't push too far...
limitations in prestack impedance inversion of legacy data volumes.

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ABSTRACT

AVO analysis has proven to be an insufficient technique to discriminate lithologies in the Paleozoic rocks of the Red Fork Formation. We integrated well log information to estimate a seismic wavelet and generate a background model to then obtain the simultaneous prestack impedance inversion to characterize channel morphology and discriminate lithologies.

LOCATION AND GEOLOGICAL BACKGROUND

The study area is located in the Anadarko Basin in west central Oklahoma. The formation of interest is the Middle Pennsylvanian age Red Fork Formation (Figure 1). The Red Fork sands were deposited as fluvial channels and offshore sand bars (Withrow, 1968) and are typical of other Lower Desmoinesian sands system as well (Henry and Hester, 1995). In the southern and western part toward the deep Anadarko Basin, Red Fork sands consist of channelized density transport (Whiting, 1984) with an average porosity of about 8 percent (Henry and Hester 1995). Low permeability (about 0.1 mD) and variable reservoir quality is expected in the entire area (Withrow, 1968; Whiting, 1984; Lavine, 1984). Most of the reservoir traps types are typically stratigraphic (Henry and Hester, 1995), with little structurally influence. Traps and seals could be formed by enclosing shales deposited over porous channel-filling subaerial or submarine sands, or over offshore bars (Withrow, 1968).

SIMULTANEOUS PRE-STACK SEISMIC INVERSION

CGG-VERITAS reprocessed several merged surveys using pre-stack time migration and one seismic survey as reference. The five legacy and infill surveys have different ranges of offsets, with more modern surveys having wider azimuths, longer offsets and greater fold. Figure 3 illustrated how the seismic data degrade beyond 11000 ft. offset, or approximately 28°. Examining the gathers shown in Figure 4, note the absence of far offsets information in much of the survey. The reflectors at far offsets are not well aligned with migration moveout artifacts from the surrounding wider offset legacy surveys filling the gap. The zone of interest is the Red Fork Formation incised channels fills between the top Pink Lime (low positive amplitude reflector) and top Novi Limestone (positive amplitude reflector).

We used model based simultaneous inversion to extract the P- and S-wave impedances tied to the well log information. The low frequency model was built from the well logs and seven interpreted horizons. A well not used in the seismic inversion or “blind well”, was used to verify the seismic impedance inversion results.

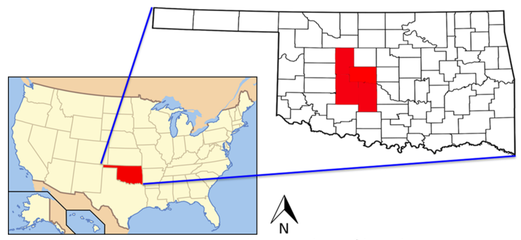


Figure 1.Location map showing the counties of the study area in red.

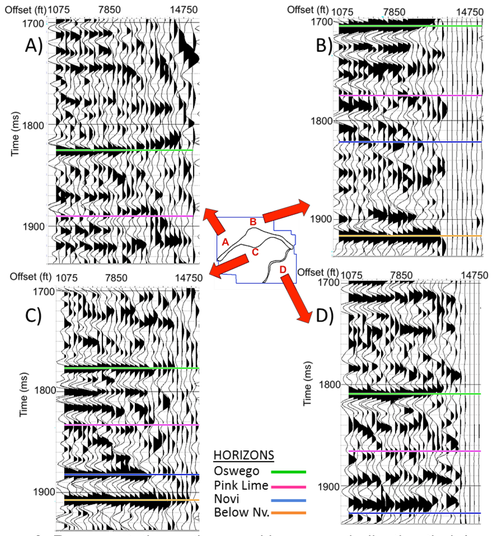


Figure 3. Representative gathers and base map indicating their location. Note that location A and D have good amplitude while B and C have low amplitude for far offsets. It appears that the maximum useable offset is about 10000 ft. for B and 12000 ft. for D. The small residual amplitudes

EON	System/Series		Group	Formation
PALEOZOIC	Pennsylvanian	Desmonesian	Marmaton	Big Lime
				Oswego Limestone
				Prue SS.
			Cherokee	Verdigris Lm.
				Skinner SS.
				Pink Lm.
				Red Fork Fm.
				Inola Lm.
		Atokan	Cherokee	Novi Lm.
				13 Finger Lm.

Figure 2. Columnar section showing in a magenta box the Red Fork Formation (highlighted by pink) and some of the geologic formations that appear as strong reflectors on seismic. (Modified from Clement, 1991)

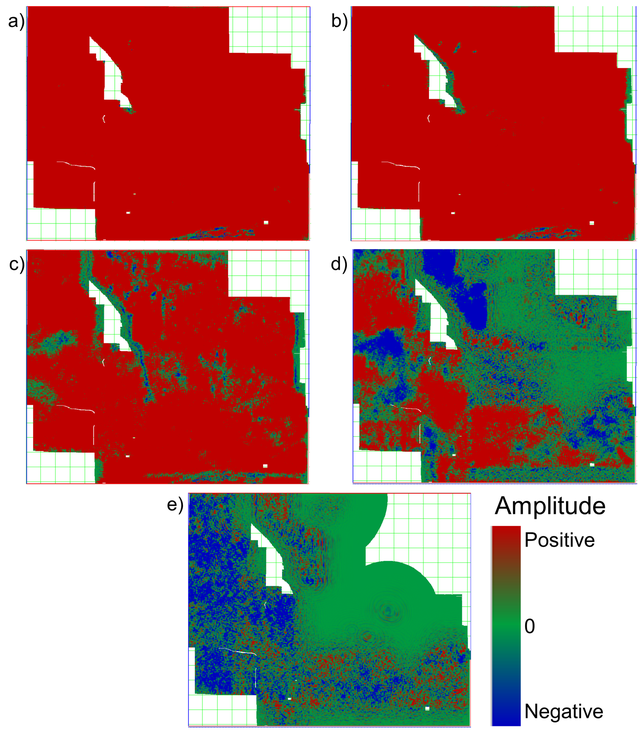


Figure 4. Horizon slice along the Top Oswego surface through offset-limited stacked amplitude volumes: (a) 0-5000 ft. (b) 5000-8000 ft. (c) 8000-11000 ft. (d) 11000-14000 ft. and (e) 14000-17100 ft. The Oswego Lime was interpreted as a strong peak along the seismic volume. Residual moveout (Figure 3) results in zero crossing and troughs at far offsets. Note how the amplitude approaches zero in the NE corner of the “mega-merged” survey for (e) 14000-17100 ft. offset.

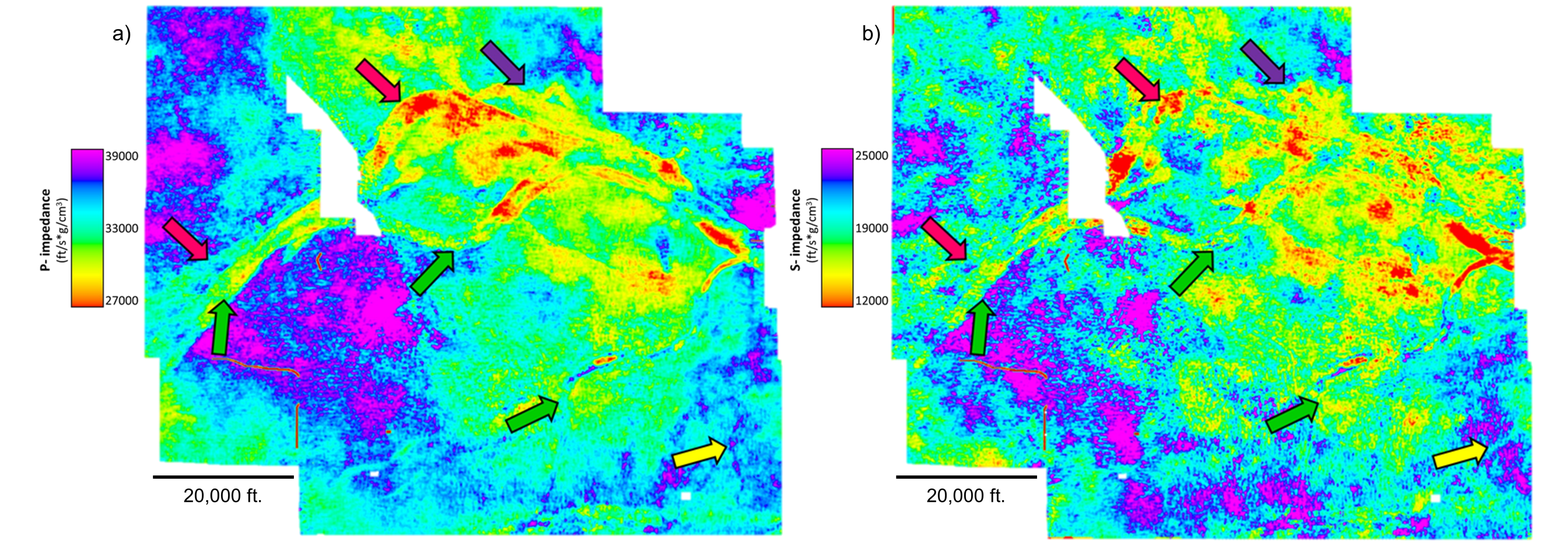
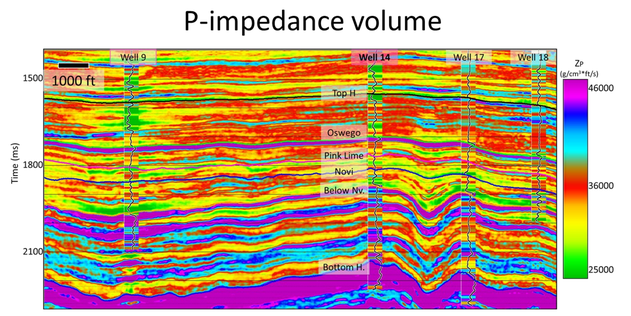


Figure 6. Phantom horizon slice 80ms below Oswego through the P-impedance (a) and S-Impedance (b) volumes. Different color arrows indicate different channels fill stages. Note better delineation of the channel features on the horizon through the P-impedance volume compared to S-impedance volume.



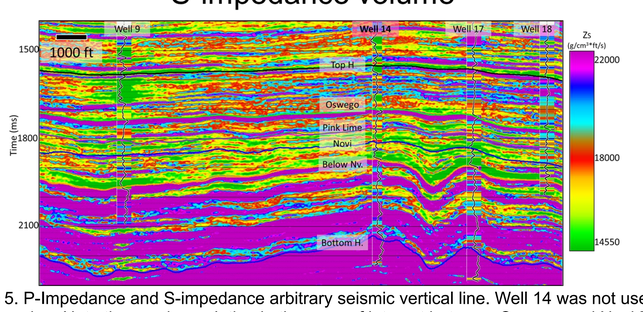


Figure 5. P-Impedance and S-impedance arbitrary seismic vertical line. Well 14 was not used in the inversion. Note the good correlation in the zone of interest between Oswego and Novi For-

CONCLUSIONS

- Simultaneous prestack seismic inversion is a technique that goes beyond AVO analysis, integrating the well log information to estimate a seismic wavelet and generate a background model.
- Seismic data need to be properly conditioned and well tops have to be accurate and tied to the seismic in order to have a valid result.
- show low impedance values correspond to high porosity sandier intervals while high impedance values correspond to low porosity shale or limestone rich intervals

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