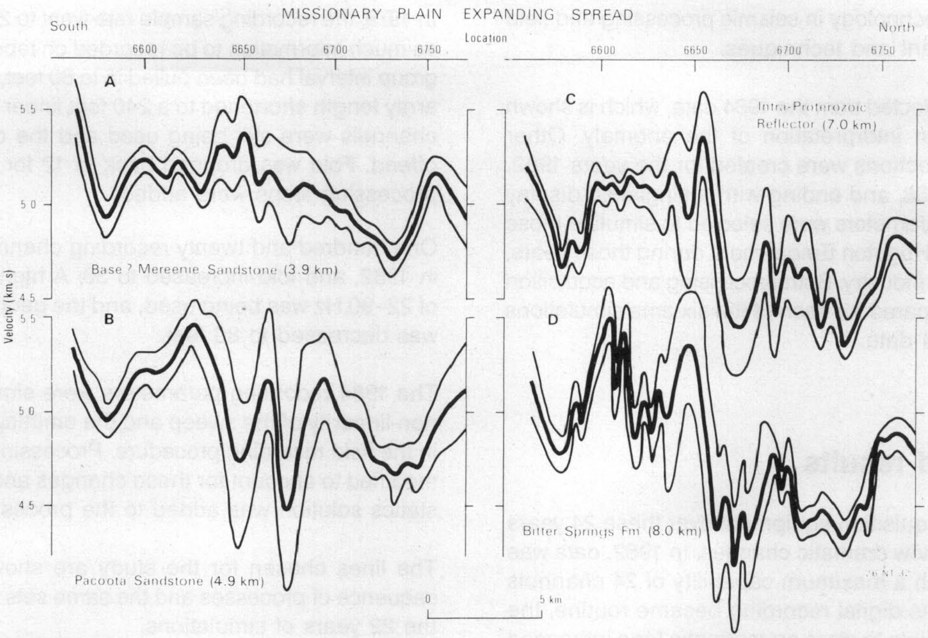

FIGURE 6
R.M.S. velocity variations for four key reflecting horizons A–D of Table 1 plotted as a function of receiver location. The depth of each horizon is given after the formation name.

The Recognition of Stratigraphic Anomalies Through Improved Acquisition and Processing Technology in the Hugoton Embayment

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Summary

Oil has recently been discovered in the Hugoton Embayment, Kansas, through the use of stratigraphic interpretation of seismic data. This oil is located in traps of channel sands in the Morrow and Chester Formations.

Current seismic data, from which producing well locations were selected, were 'deprocessed' to simulate older data. Field acquisition and seismic processing parameters were duplicated for six of the prior twenty-four years. This simulated data shows the logical progression of field acquisition and processing technology. This method also demonstrates the stratigraphic appearance of the anomaly on the data during those years.

Both field acquisition and processing parameters and techniques are reviewed on each of two lines. The resulting impact of the changes on each of the sections and its anomaly is noted as we progress through time.

In addition to showing full sections for each of the six years, blowups of the actual anomaly location on each of the simulations are shown with the original data for easy comparison.

Introduction

Channels in the Morrow and Chester sands in the Hugoton Embayment, Kansas, are the traps for oil of producing wells at a depth of approximately 6000 feet. This oil has been discovered recently through stratigraphic interpretation of seismic data.

At the suggestion of geophysical consultant Nigel Anstey, seismic lines from which these discoveries were drilled were 'deprocessed' to simulate field acquisition and processing parameters over the last 20 years. The objective was to determine when these stratigraphic anomalies became visible through increased technology in seismic processing and field acquisition equipment and techniques.

Drilling sites were selected from the 1984 data, which is shown *with and without an* interpretation of the anomaly. Other comparable stack sections were created for the years 1982, 1979, 1976, 1972, 1968, and ending with a singlefold display common in 1962. Parameters were selected to simulate those actually used in the Hugoton Embayment during those years, either by Mobil or by industry. Both processing and acquisition parameters are compared for each of the six time simulations and the actual 1984 data.

Procedure and results

Advances in field acquisition equipment over these 24 years represented here, show dramatic changes. In 1962, data was recorded analog with a maximum capability of 24 channels being put on tape. As digital recording became routine, the amount of data possible to store on magnetic tape increased in steps from 356 bits per inch on a one inch tape used in 1968, up to 6250 bits per inch on half inch tape currently in use on some systems today. Some basic processing in the field is also possible on some of this advanced equipment.

As field technology advanced and recording capabilities expanded, seismic processing equipment and capabilities had to advance accordingly. In 1962, Mobil had just begun to use digital processing for its singlefold data. Computer volume handling of data has increased along with the read/write capabilities of magnetic tape. Expanded number crunching ability in general has allowed many algorithms to be recently implemented for use on a production basis. These same algorithms were not even considered feasible for test purposes ten years ago, due to the difficulty in implementing them on a system.

Actual singlefold data recorded in Hugoton in 1962 had a dynamite source recorded analog on 24 channels. Our simulations show a vibroseis source and 28 channels to obtain the same offset. The geophone array length group interval was at 80 feet, and the sample rate 4 ms. The processing sequence included datum statics normal moveout, bandpass filter, and scaling.

For the 6 fold stack obtained in 1968, the geophone array was stretched to 320 feet. Spike deconvolution and stack were added to the processing sequence. Other parameters remained the same.

The number of recording channels doubled in 1972 and the fold increased to 10. The only other changes were to shorten the group interval to 240 feet in the field, and to include a phase compensation for spike deconvolution in processing.

Fold increased again in 1976, up to 24, with the 48 recording channels being laid out in an asymmetric spread. A 390 foot weighted geophone array was used. Computer technology and volume capabilities for seismic processing had increased to the point of allowing surface consistent statics to be computed and applied.

In 1979, the recording sample rate went to 2 ms, allowing twice as much information to be recorded on tape at each shot. The group interval had been pulled in to 80 feet, and the geophone array length shortened to a 240 foot linear. Only 48 recording channels were still being used and the cable was laid out offend. Fold was dropped back to 12 for this year. No new processing steps were added.

One hundred and twenty recording channels were common in 1982, and fold increased to 30. A high frequency sweep of 22–90 Hz was being used, and the geophone array length was decreased to 80 feet.

The 1984 recording parameters were similar except for the non-linearity of the sweep and the omitting of the notch filter in the field recording procedure. Processing parameters were modified to account for these changes and a common offset statics solution was added to the processing sequence.

The lines chosen for the study are shown with the same sequence of processes and the same sets of parameters over the 22 years of simulations.

In our example shown here, field acquisition parameters have varied. This is shown mainly in the number of recording channels available, fold, sample rate, geophone array length, group interval, record filters, and vibroseis sweep frequencies.

Processing parameter changes for these data sets are noted in seismic software advances, including the stacking process, wave shaping, phase adjustment and static programs.

These parameters are summarised in Table 1.

Conclusions

Two seismic lines which were instrumental in the location of two of these channel sand wells were selected for this study.

TABLE 1
Acquisition and processing parameter summary.

Parameters	*1962*	*1968*	*1972*	*1976*	*1979*	*1982*	*1984*
Field							
Fold	1	6	12	24	12	30	30
No. channels	24	24	48	48	48	120	120
Geophone array	80	320	320	390W*	240	80	80
Group interval	80	320	240	160	80	80	80
Sample rate	4	4	4	4	2	2	2
Filter	14–56	14–56	14–56	14–56	18–56	22–90	22–90
Notch filter	in	in	in	in	in	in	out
Processing							
Stack		X	X	X	X	X	X
Decon		X	X	X	X	X	X
Phase correction			X	X	X	X	X
Statics							
Datum	X	X	X	X	X	X	X
SC				X	X	X	X
NSC					X	X	X
CO							X

* Weighted.
Distances are given in feet.

Line A shows a seismic anomaly in the Morrow Formation. The Morrow is a basal sandstone unconformably overlying the Mississippian Chester Formation. The scoop feature which can be seen on the section, shows a channel with sand deposits in a structural low.

On line A, the anomaly can be seen possibly as early as 1972. At least there is a small sag present in the data for this year. As technology advances and data quality improves, the sag becomes more evident and better defined until 1982 when the anomaly is quite plain.

A Mississippian Chester anomaly can be seen on line B. This formation is a basal sandstone formed from channel sands. This anomaly is seen seismically as an extra peak in the Lower Chester. As the Chester thickens, the Ste. Genevieve formation below the Chester dims.

The data sets for each of the years show no indication of the Chester anomaly until 1982. At this time, we begin to see a thickening at the right end of the anomaly location. The anomaly cannot be defined, however, until the 1984 processing and field acquisition parameters are employed.

Improved knowledge of stratigraphic interpretation coupled with advanced data processing and field acquisition techniques makes the detection of subtle stratigraphic anomalies possible and practical.

Acknowledgements

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