KANSAS GEOLOGICAL SURVEY
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SHALLOW HIGH-RESOLUTION SEISMIC REFLECTION PROGRAM AROUND THE PROPOSED SUPERCONDUCTING SUPER-COLLIDING FACILITY IN KANSAS

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SSC SEISMIC DATA

High-resolution seismic-reflection data were collected at eleven different sites at critical locations over the proposed Superconducting Super-Collider (SSC) facility. The eleven seismic lines possessed data with varying signal-to-noise ratios as well as dominant-frequency content. Of the eleven lines collected, eight were deemed of sufficient quality to allow confident interpretations. The eight lines used in interpreting the subsurface geology were processed in such a way as to allow confident correlations between lines. Correlating seismic lines that do not intersect and are separated by several kilometers generally does not produce a conclusive or confident interpretation due to localized variations in interval velocities, near surface conditions, relative slope of reflecting interfaces, and topography. However, due to the very consistant character and frequency content of the seismic energy recorded in this area, a confident correlation can be made between the seismic lines and the subsurface geology.

DATA ACQUISITION

The data were all acquired using a 24-channel, 12-bit digital seismograph, two single 100-Hz geophones in series and a projectile energy source (either a .30 or .50 caliber downhole rifle). All of the selected seismic-line sites were situated around the proposed ring in such a way as to optimize each site's potential to assist in later drilling or tunneling operations. The spacing of sources and receivers were determined according to each individual site's target-depth range. Generally, two shots were recorded at 1/4 msec sampling interval with a total listening time of 250 msec at each shot location. Analog low-cut filtering in the field was either 220 Hz or 340 Hz depending on the specific site characteristics and depth of interest. The energy sources, modified .30 and .50-caliber hunting rifles, were partially buried to increase the couple to the earth and to reduce air-coupled waves. All the seismic data presented here were collected over a two-week period.

DATA PROCESSING

The seismic-reflection data was all processed into 12-fold CDP stacked sections using common oil-company type signal analysis techniques. The main processing steps include first-arrival muting, air-blast muting, bad-trace edit, spiking deconvolution, common depth point (CDP) sorting, bandpass filtering, surface-consistant statics, normal moveout velocity correction, residual status, (AGC) trace scaling, and CDP stack. Each seismic line was individually processed with each of the previous steps applied in the optimum order and with the optimum parameters selected for each operation.

On certain lines due to specific surface or near-surface conditions encountered, specialty techniques such as trace mixing, auto-shaping deconvolution, auto-predictive deconvolution, time-varying filtering, and predictive deconvolution were necessary in order to obtain the most representative, correlatable seismic section.

INTERPRETED SEISMIC DATA

The final stacked sections used for interpreting the subsurface geology have a signal-to-noise ratio easily in excess of 10. The dominant frequency of the data varied from 140 to 350 Hz, depending on site characteristics and recording parameters. The line drawings from the seismic data represent all coherent reflections with relative amplitudes at least an order of magnitude greater than the ambient noise. The reflectors interpreted on the seismic sections are from the base of the Oread limestone and the base of the Lawrence Formation.

The interpretive line drawings are used as an aid to show only the significant seismically-derived information. The identified geologic units were chosen with consideration to depth/time, signal character, reflection interval, wavelet phase, and drill data. Correlating seismic data with minimal well control, significant distance between lines, and no acoustical marker forces strong dependence on stacking velocities, reflector time intervals, and wavelet character. The interpretive line drawings are basically a seismically-derived geologic cross section.

All the CDP-processed seismic sections with an interpretable base of the Oread and base of Lawrence have a very (seismically) quiet zone in the time window of the Lawrence Formation. Only the Osage City and possibly the Scranton lines show evidence of the Amazonia limestone. However, the resolution of most of the seismic data only allows identification of units with 3 to 5 meters of vertical separation. Therefore, if the Amazonia is less than 3 meters beneath the base of the Oread, the unit would be seismically invisible.

Seismic data collected on the south and southeast portions of the ring do not possess the data quality of the other lines. This is due to the near-surface repetitive limestone sequences that can be seen in outcrop all over the southern portion of the study area. The result of these limestones on the seismic records is the ringing of acoustic energy between the surface and the tops of the limestones with slight variation in phase velocity according to offset from the source. Therefore, seismic data collected between Lyndon and Quenemo and from Quenemo to 4 km north of Pomona lack the minimum quality to be used in this study.

Seismic data from the north and west portions of the study area are of excellent quality and easily correlatable simply from wavelet character and reflection-time intervals. The Burlingame, Scranton, and Overbrook-2 seismic sections have a strong reflector at about 107 meters identified as the base of the Oread Formation and another strong reflector at about 134 to 140 meters identified as the base of the Lawrence Formation. The reflections from the base of the Oread and the base of the Lawrence have about a 140-180 Hz dominant frequency and, therefore, a bed resolution of about 4 meters. Slight undulations in the reflectors across the seismic sections are probably the result of either slight lateral velocity variations or statics associated with near-surface geologic variations. All three lines have a very (seismically) quiet time interval between the two interpreted reflections. The only coherent event between these two reflections on any of the three sections is between CDP 240 and 280 on the Scranton line; there appears to be a very emergent and then gradually decaying event. This could be the Amazonia limestone.

The seismic data from the southwest part of the ring have signal character not consistent with each other or the other data sets. However, from existing well data, the reflection-time intervals, and the stacking velocities the two reflectors of significance can be correlated and identified. The dominant frequency of the Lyndon line is about 250 Hz resulting in a minimum bed resolution of about 2 meters. The Osage

City line has a dominant frequency around 200 Hz and therefore a bed resolution of about 3 meters. Both lines have sufficient resolution to detect any significant geologic unit with a strong acoustic impedence contrast greater than 3 meters in thickness. The Lyndon line is seismically quiet within the Lawrence Formation. The Osage City line, on the other hand, has a weak reflector that traverses the entire line and seems to indicate a syncline structure. This structure is real since the reflectors above and below are flat and continuous. This implies the structure observed is not a result of uncompensated surface static variations or incorrect normal moveout velocity correction. Geologic identification of this unit, as on the Scranton line, relys on the existing stratigraphic section for the area. The reflector that lies within the Lawrence Formation is either the Amazonia limestone or possibly a cut-and-fill feature resulting in a sand lens.

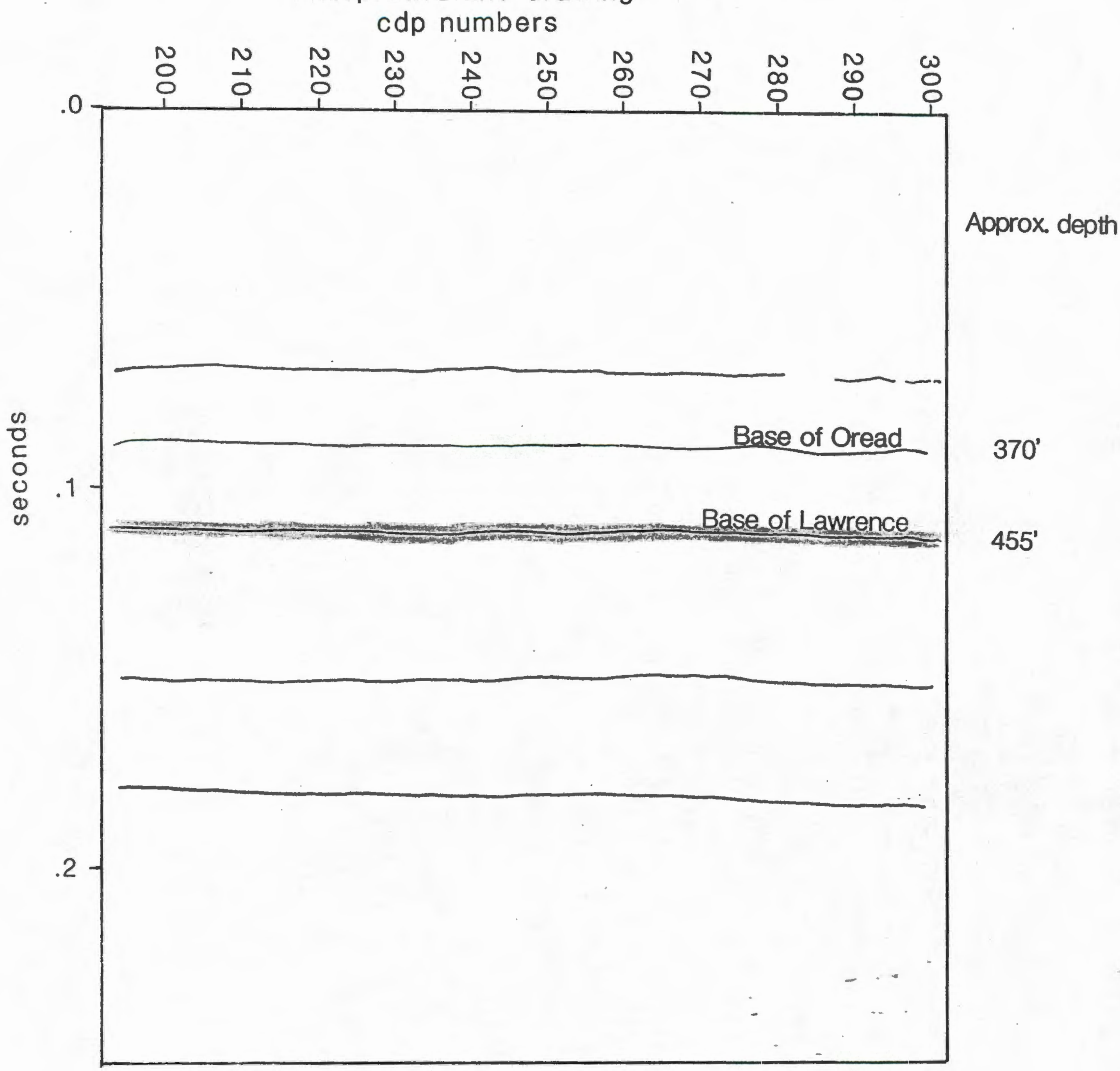
The northeast line, Overbrook-1, has two very strong reflectors identified as the base of the Oread and Lawrence formations at a depth of 55 and 76 meters, respectively. The dominant frequency of this data is about 140 Hz, yielding a minimum bed resolution of 4 meters. There is no seismic evidence on the Overbrook-1 line to suggest anything but gradational lithologic changes of relatively continuous geologic units within the interpreted Lawrence Formation.

The east line, Franklin, shows a very thick Lawrence Formation with an acoustic impedence contrast near the bottom of the formation. This contrast could possibly be the top of the Robbin shale, beneath the Ireland sandstone. This acoustic constrast is very subtle and low amplitude and, therefore, is a good candidate for a shale/sandstone interface. The upper portion of the Lawrence Formation is extremely quiet with only a single coherent event that traverses the section. This reflector is probably the result of a shale stringer or some other geologic unit with an interface that has a very low acoustic impedence contrast. The increased thickness of the Lawrence Formation here is probably a result of the observed increase in thickness of the Ireland sandstone in this area on drill data. Aside from the very low amplitude events previously noted, the Lawrence Formation is very (seismically) quiet here as noted on earlier lines. The dominant frequency here is about 350 Hz resulting in a minimum bed resolution of about 2 meters. The data quality on the Franklin line is the best seen on any data recorded in this area and, therefore, yields an interpretation with a great deal of confidence associated with it.

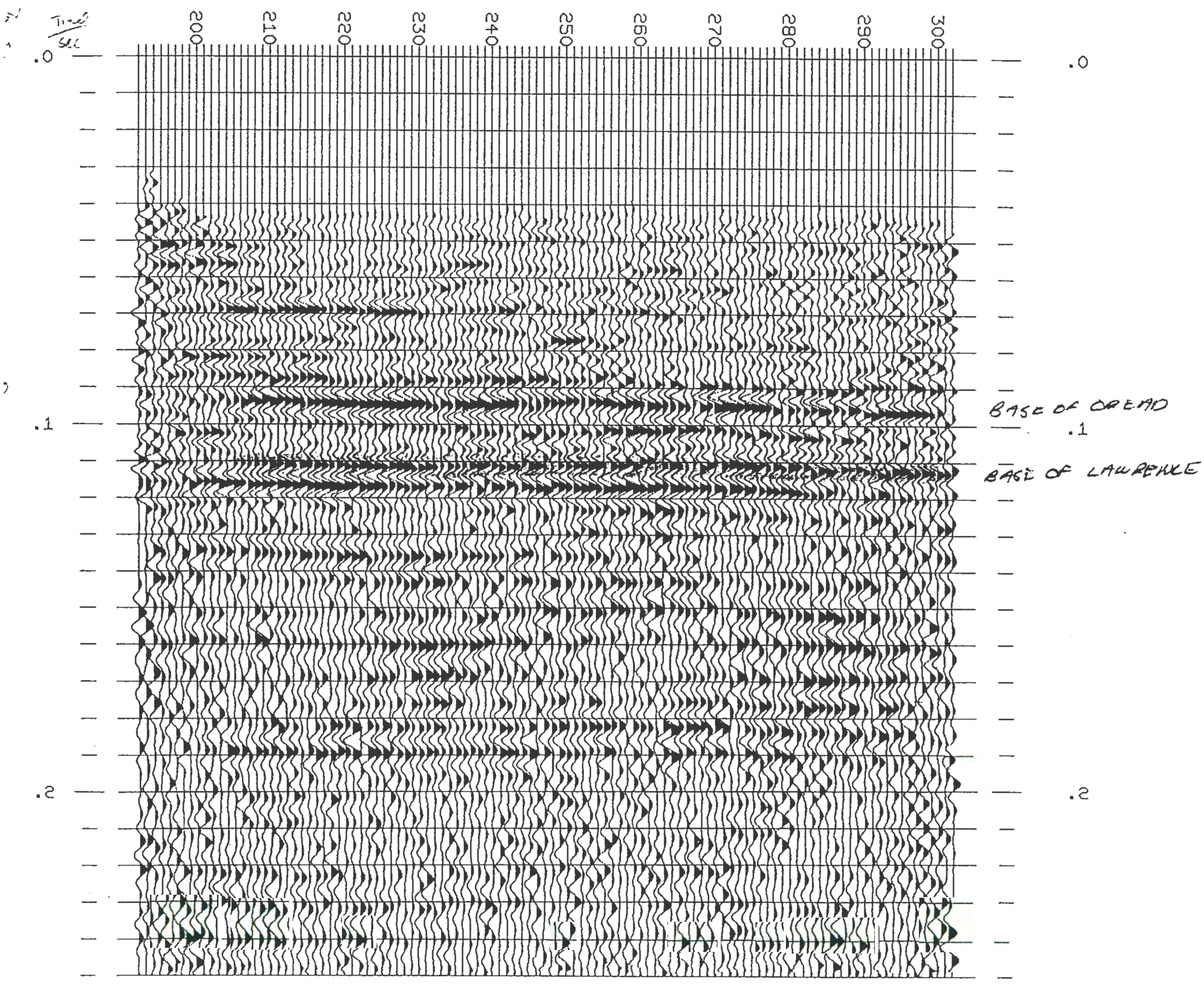
	Elevation to base of - (ft)		
Site Name	Oread	Lawrence	Thickness of the Lawrence Fm.
Lyndon	755	630	125
Osage City	673	563	110
Burlingame	726	636	90
Scranton	745	660	85
Overbrook-2	795	910	100
Overbrook-1	980	910	70
Franklin	975	840	135

SCRANTON

interpretive line drawing

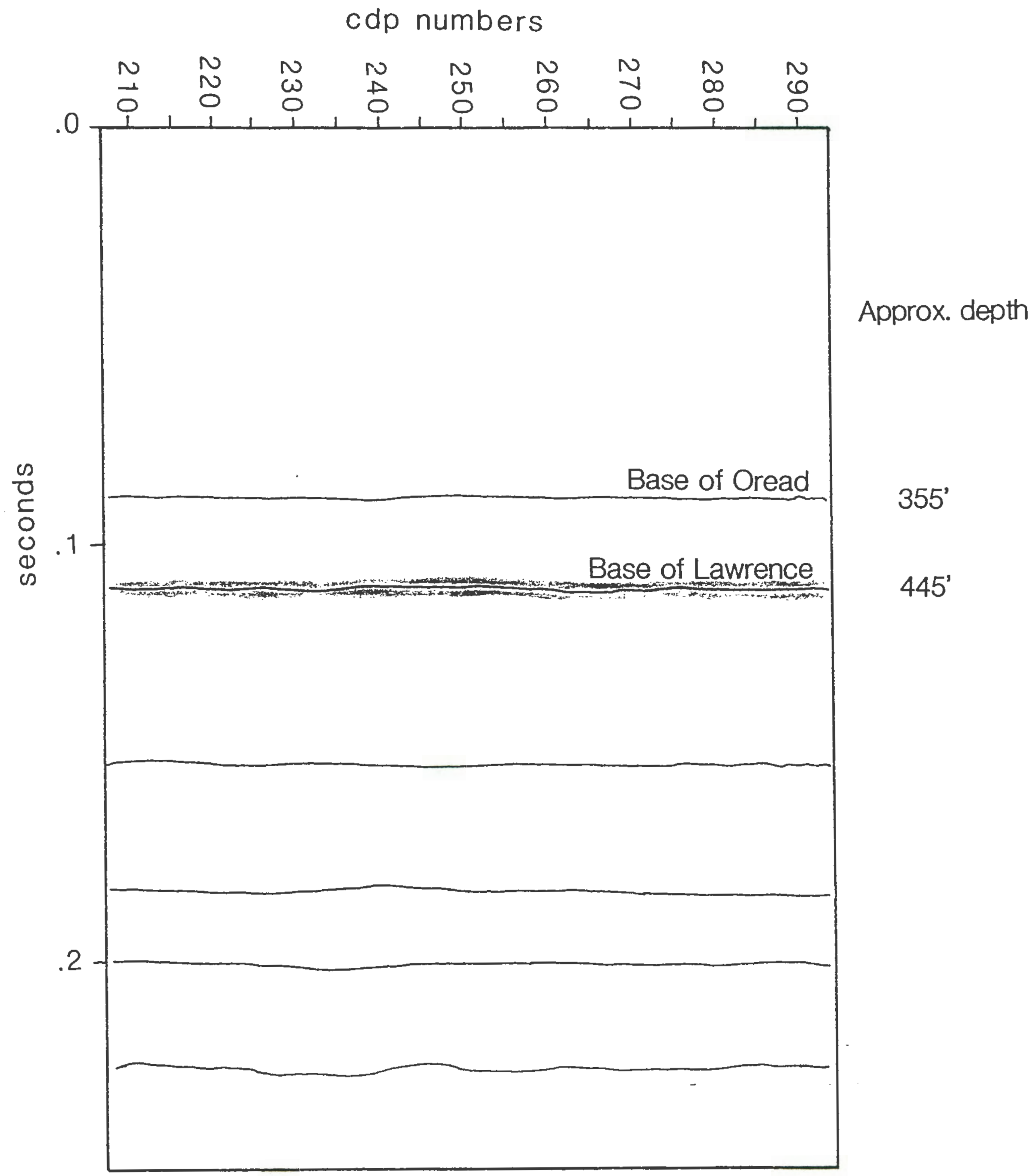


SCRANTON



Time sec
200
210
220
230
240
250
260
270
280
290
300
.0
.1
.2
.0
.1
.2
BASE OF OREAD
BASE OF LAWRENCE

BURLINGAME -1
interpretive line drawing



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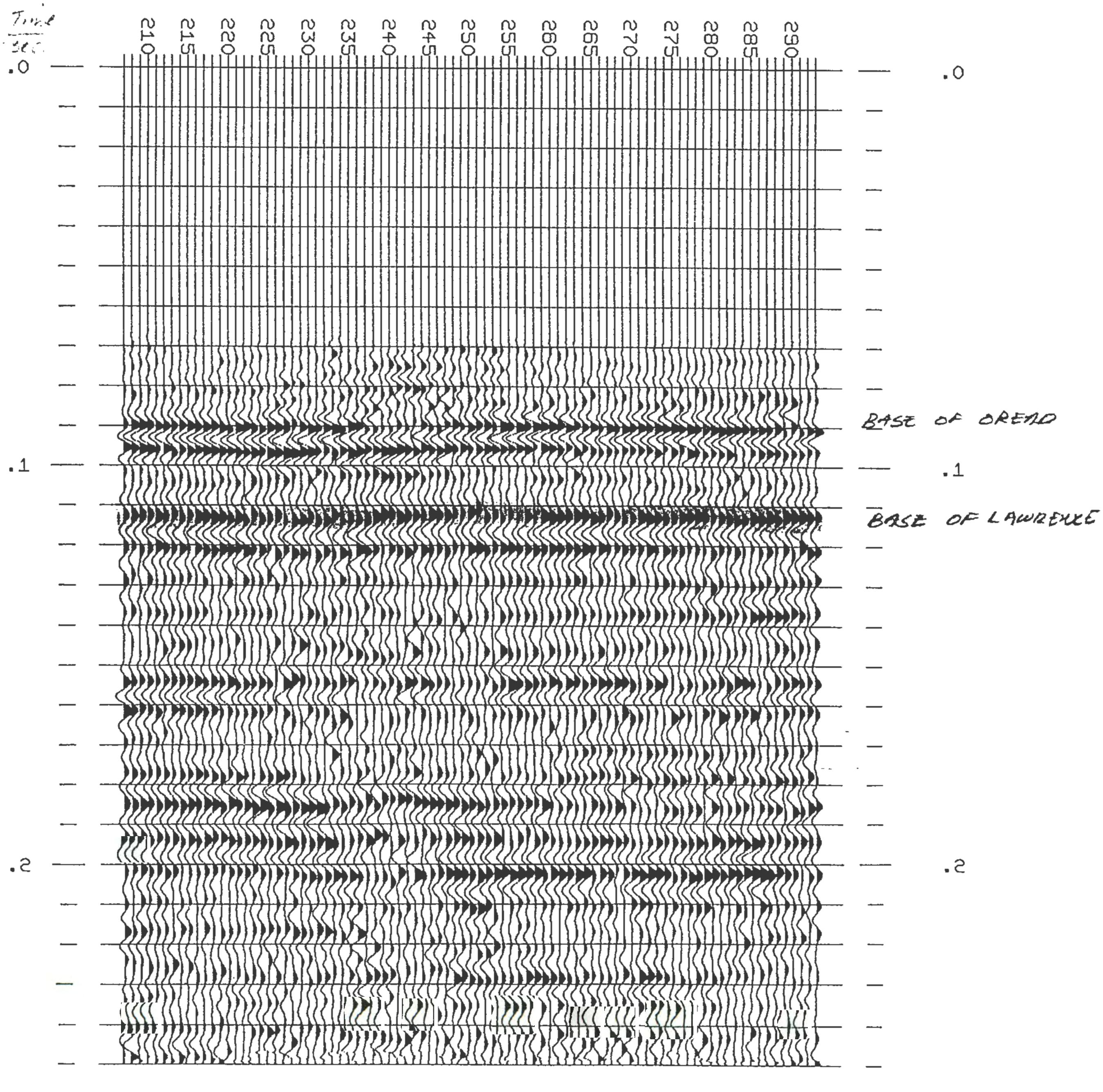
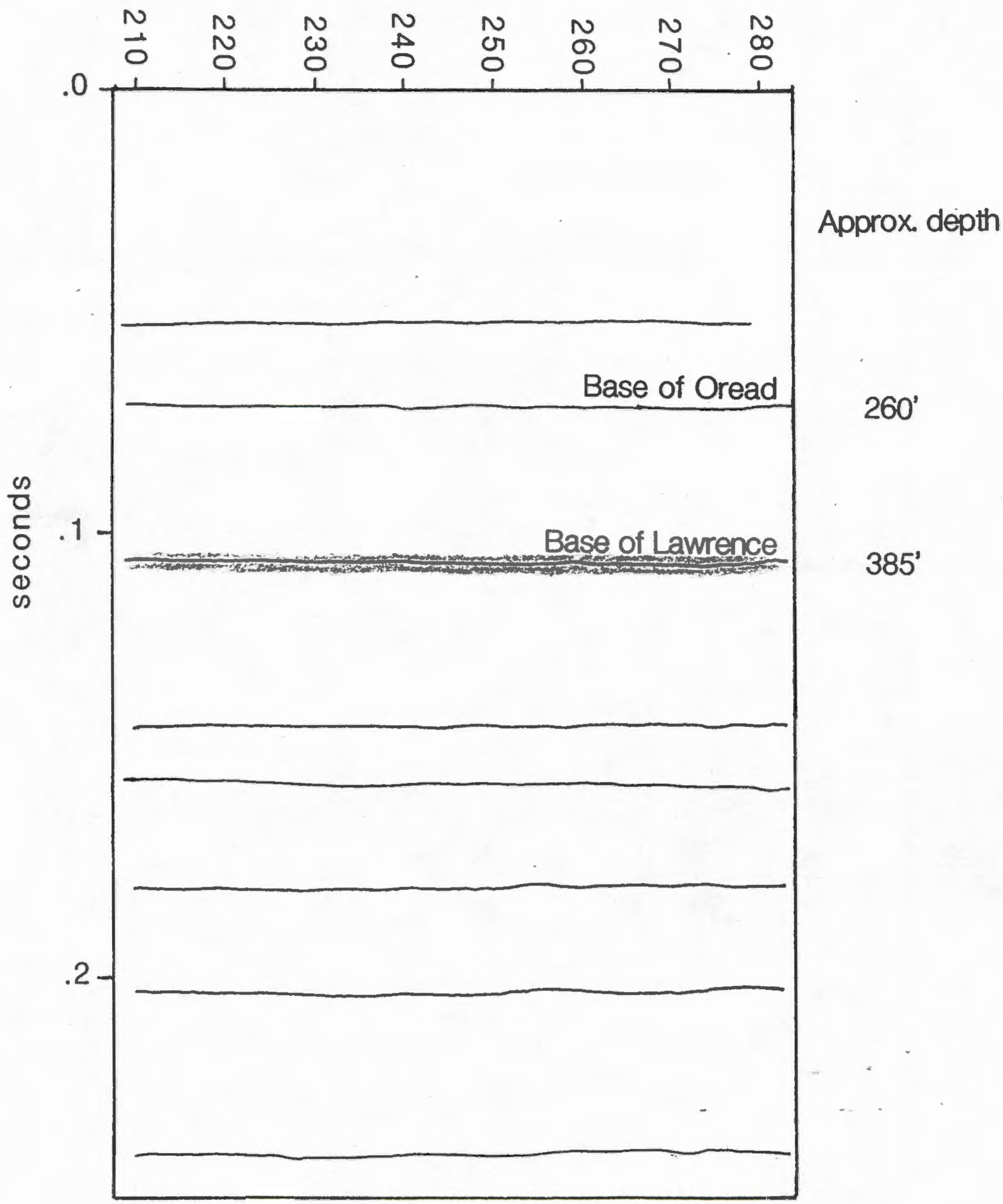


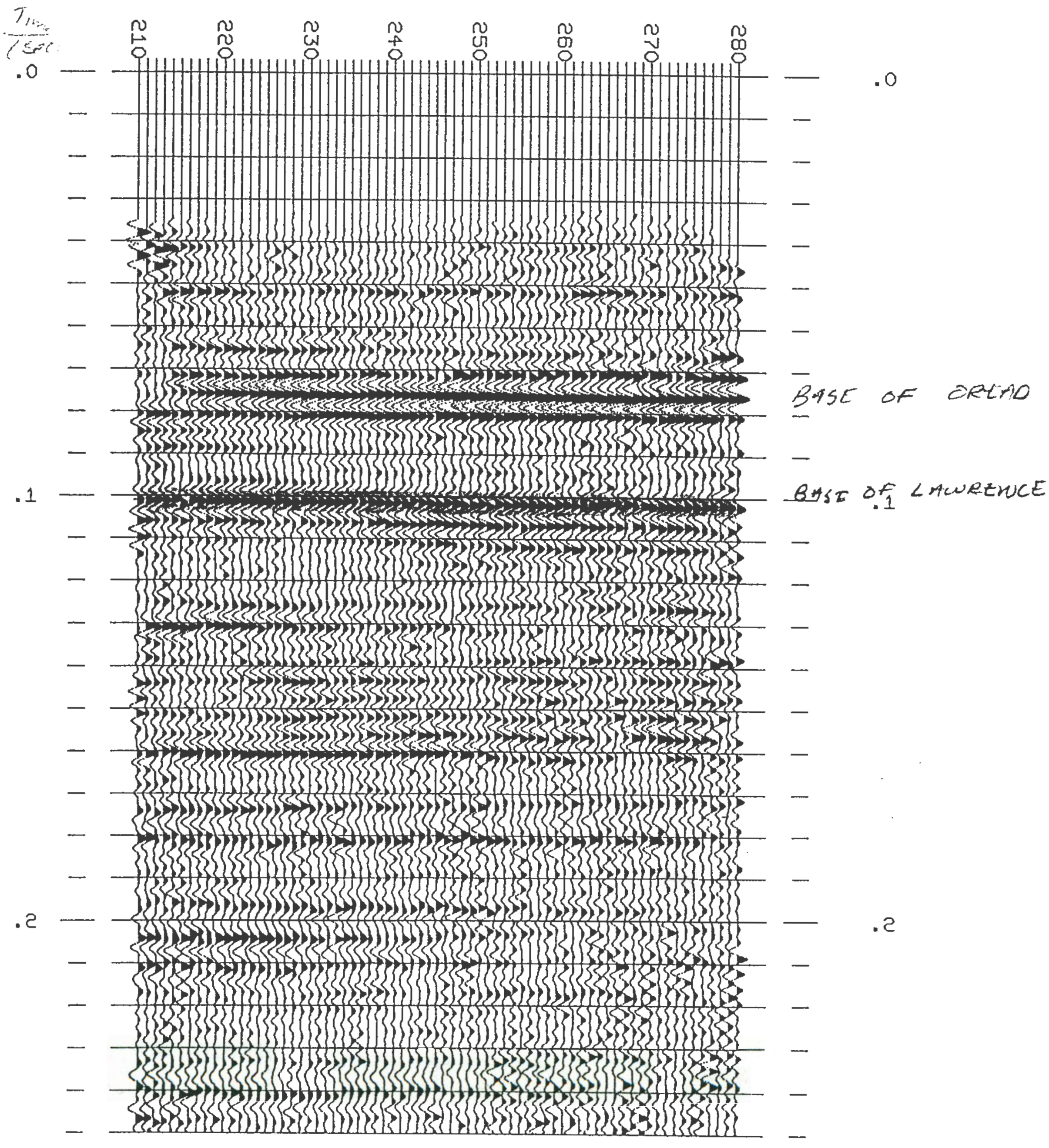
210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290
.0
.1
.2
BASE OF OREAD
BASE OF LAWRENCE
55
75

LYNDON -1

interpretive line drawing



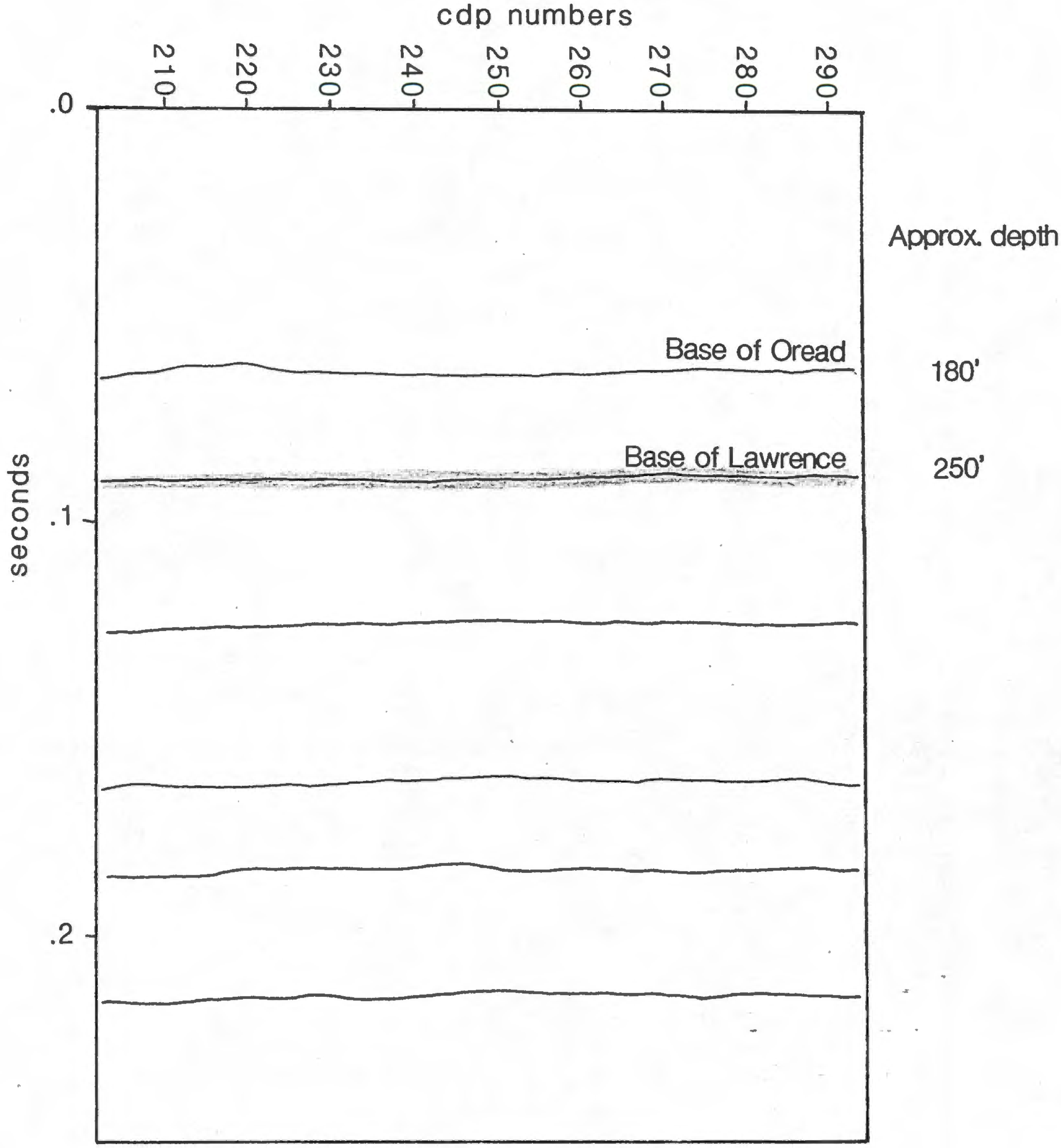
LYNDON

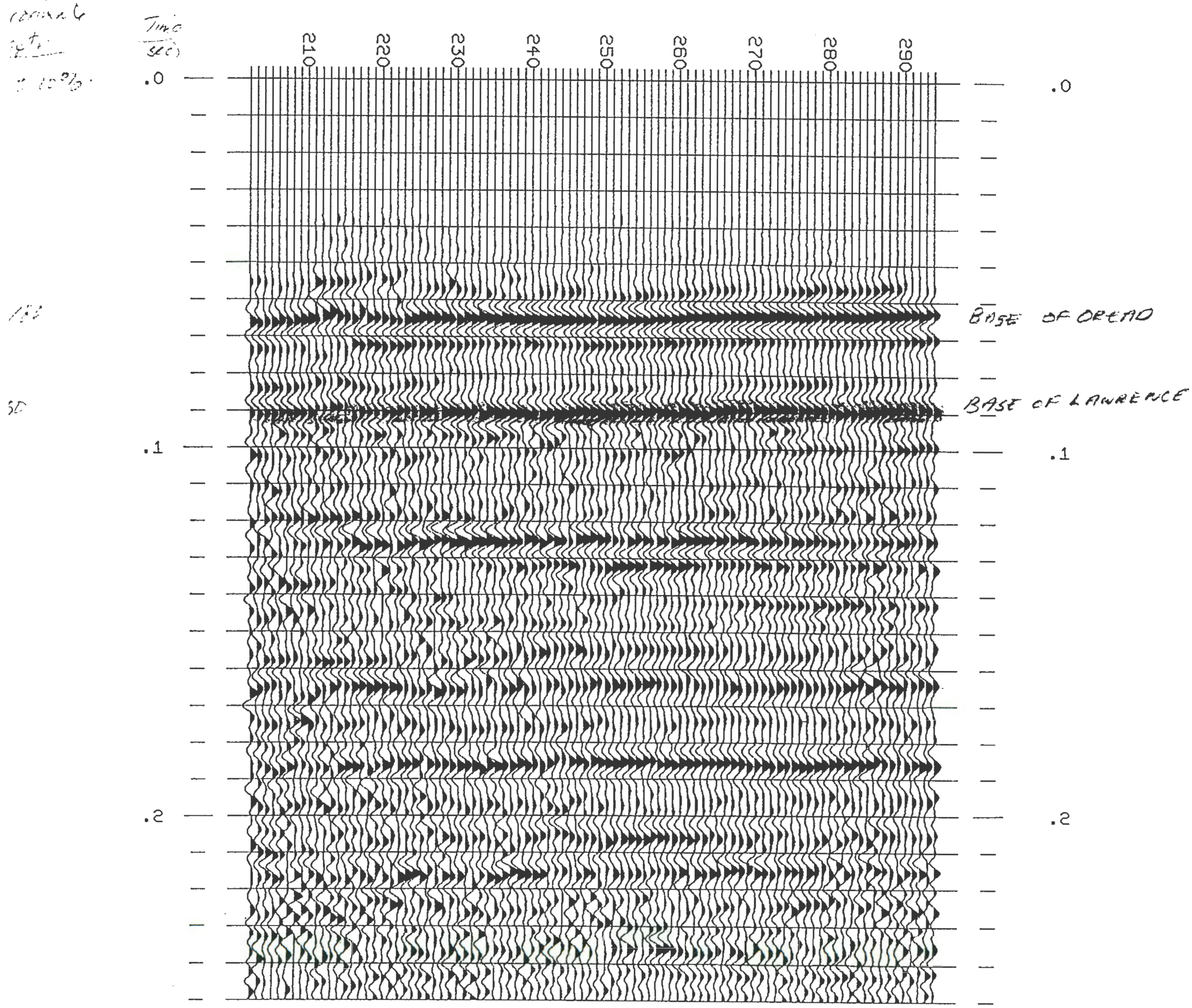


Time (sec)
210
220
230
240
250
260
270
280
.0
.1
.2
BASE OF OREAD
BASE OF LAWRENCE

OVERBROOK -1

interpretive line drawing

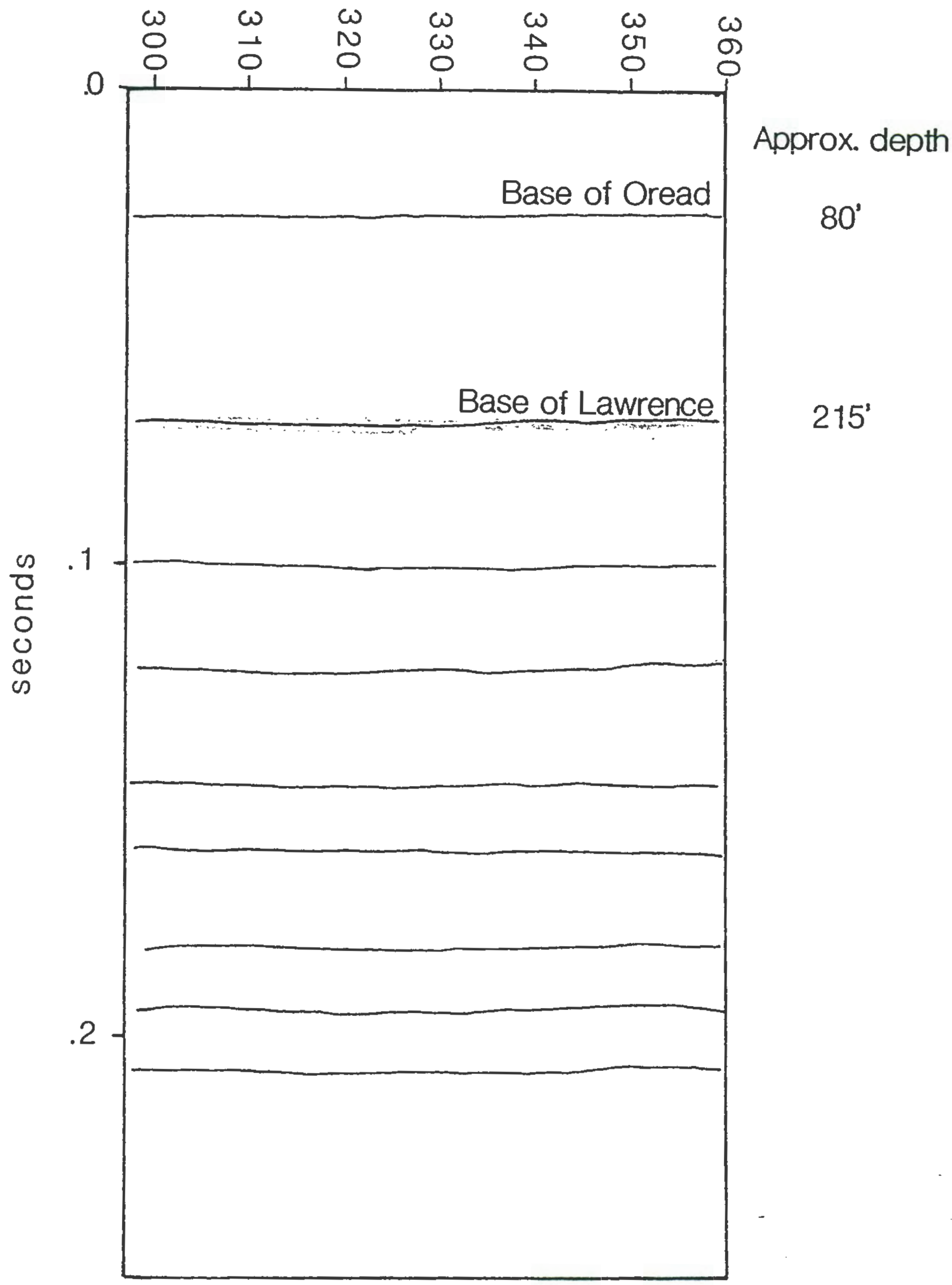




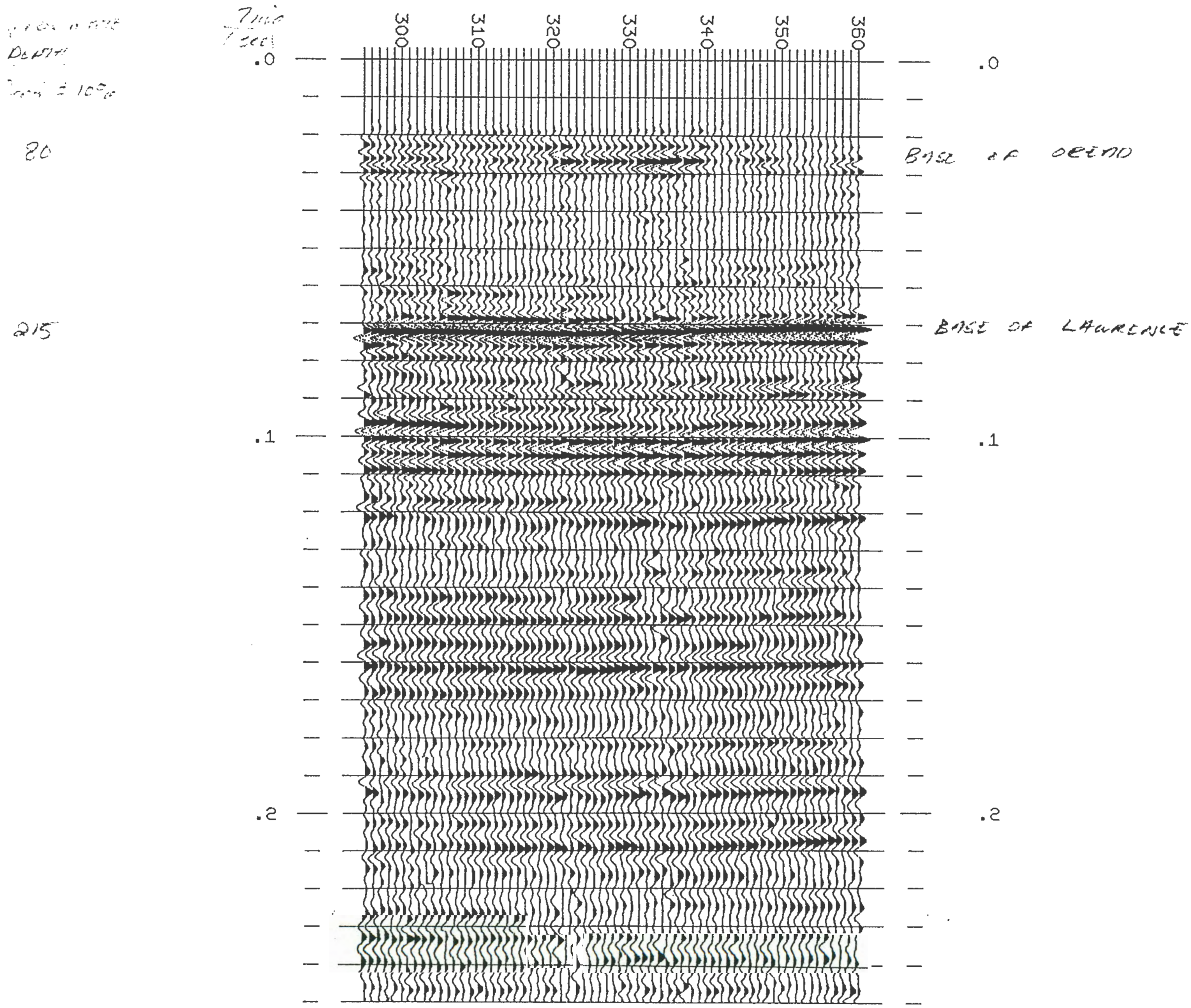
Time
(sec)
210
220
230
240
250
260
270
280
290
.0
.1
.2
BASE OF OREAD
BASE OF LAWRENCE

FRANKLIN

interpretive line drawing
cdp numbers

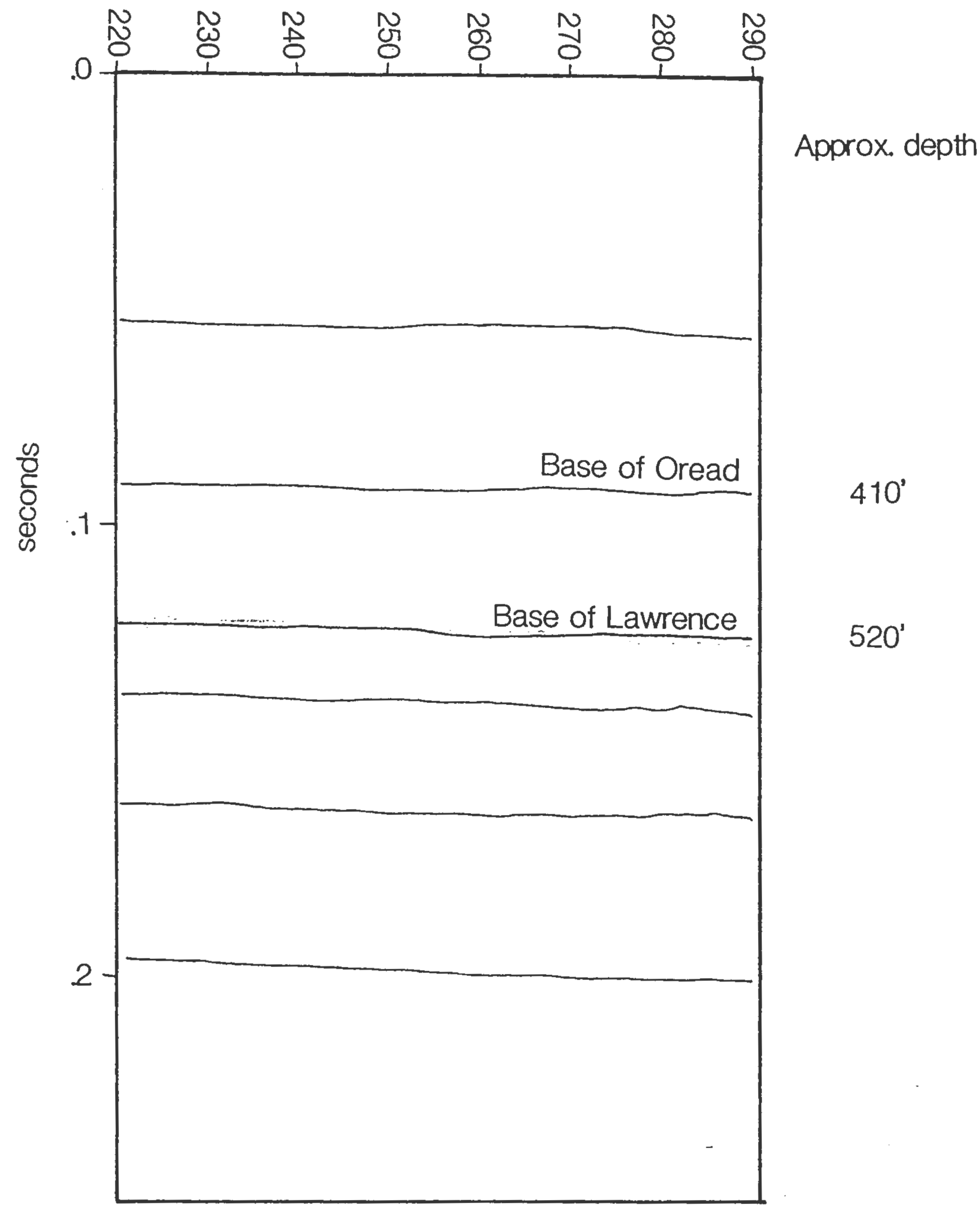


FRANKLIN

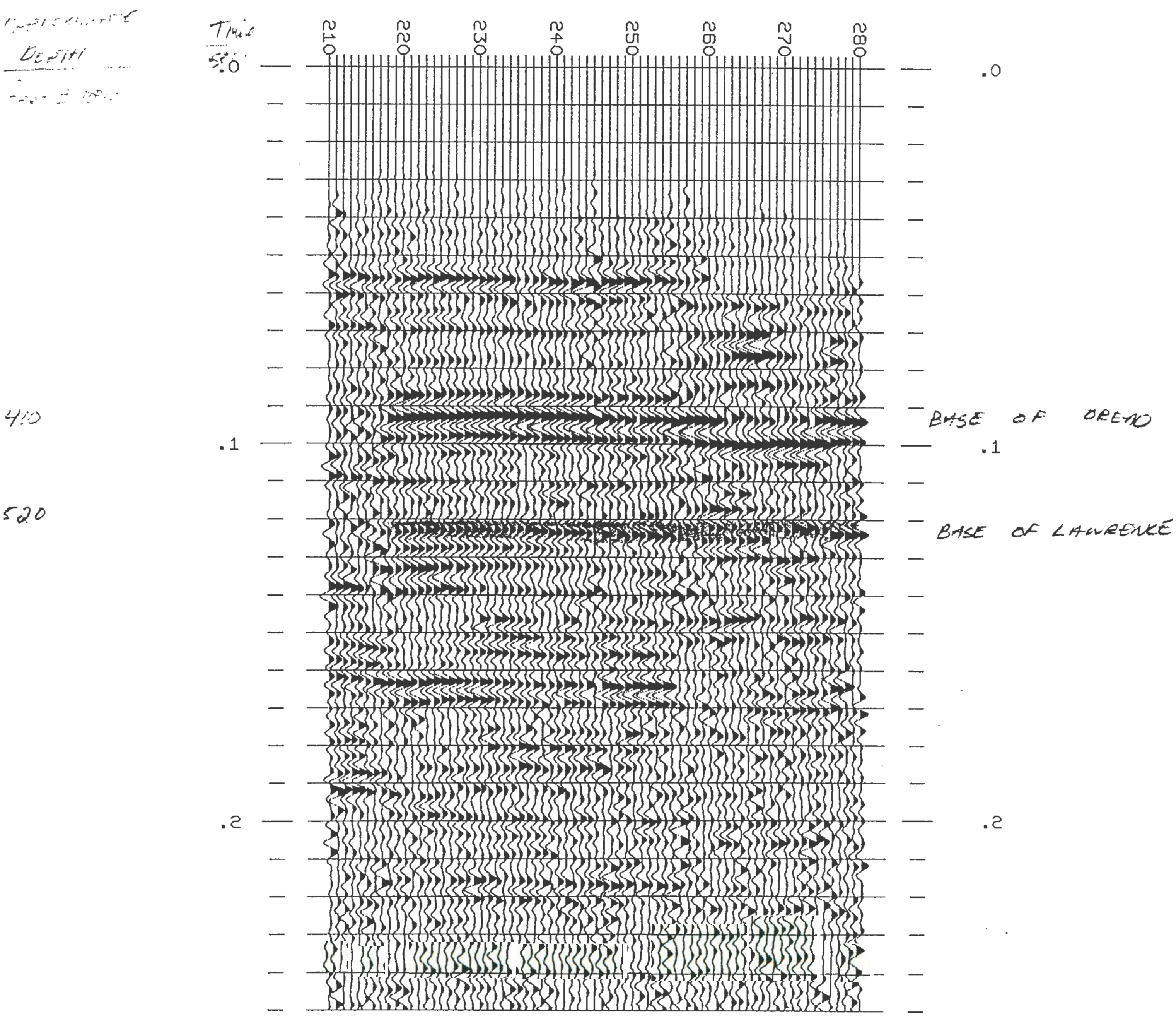

DEPTH
80
215
.0
.1
.2
300
310
320
330
340
350
360
BASE OF OREAD
BASE OF LAWRENCE

OSAGE CITY

interpretive line drawing
cdp numbers



OSAGE CITY

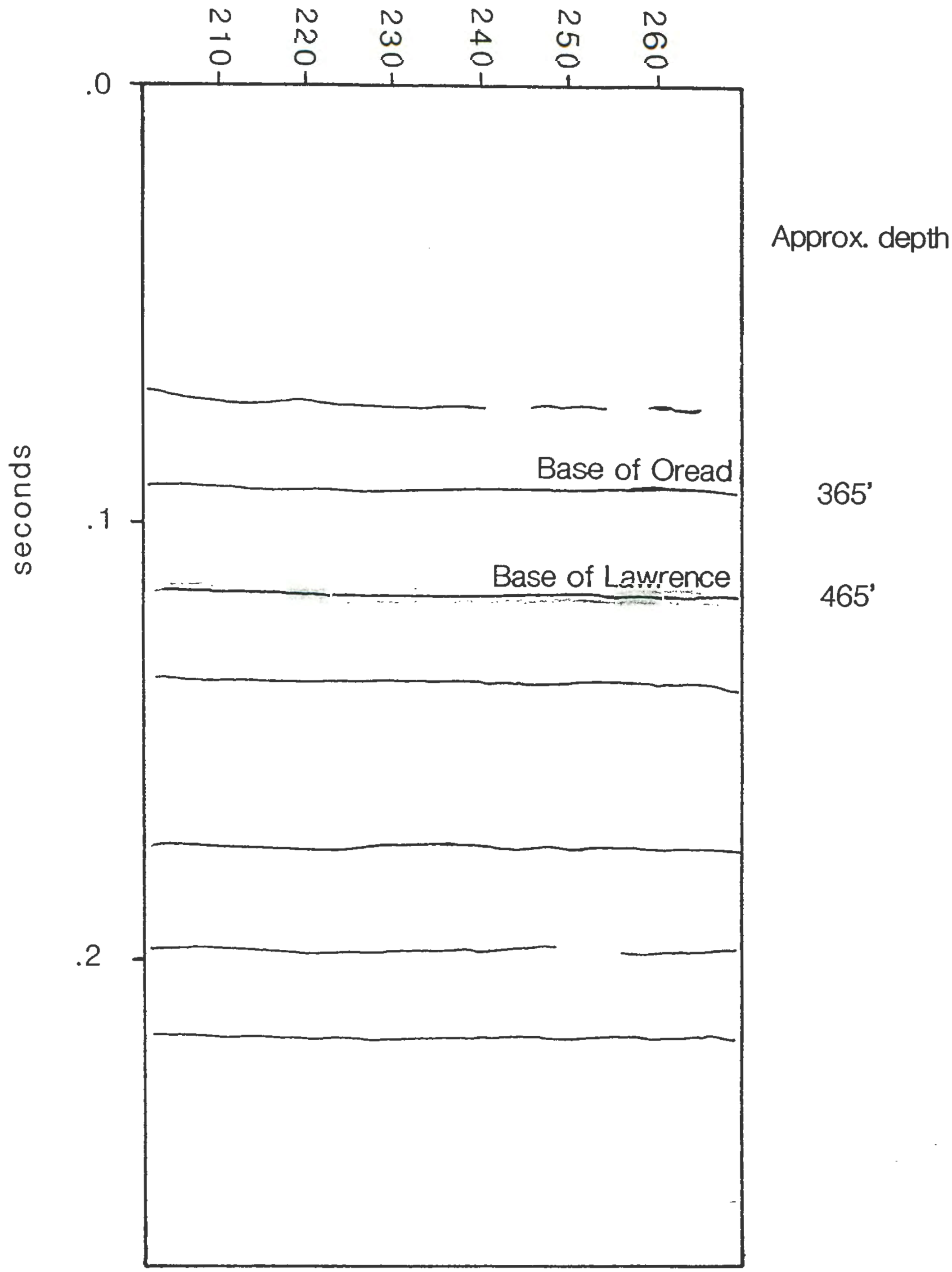


DEPTH
TIME
210
220
230
240
250
260
270
280
.0
.1
.2
410
520
BASE OF OREAD
BASE OF LAWRENCE

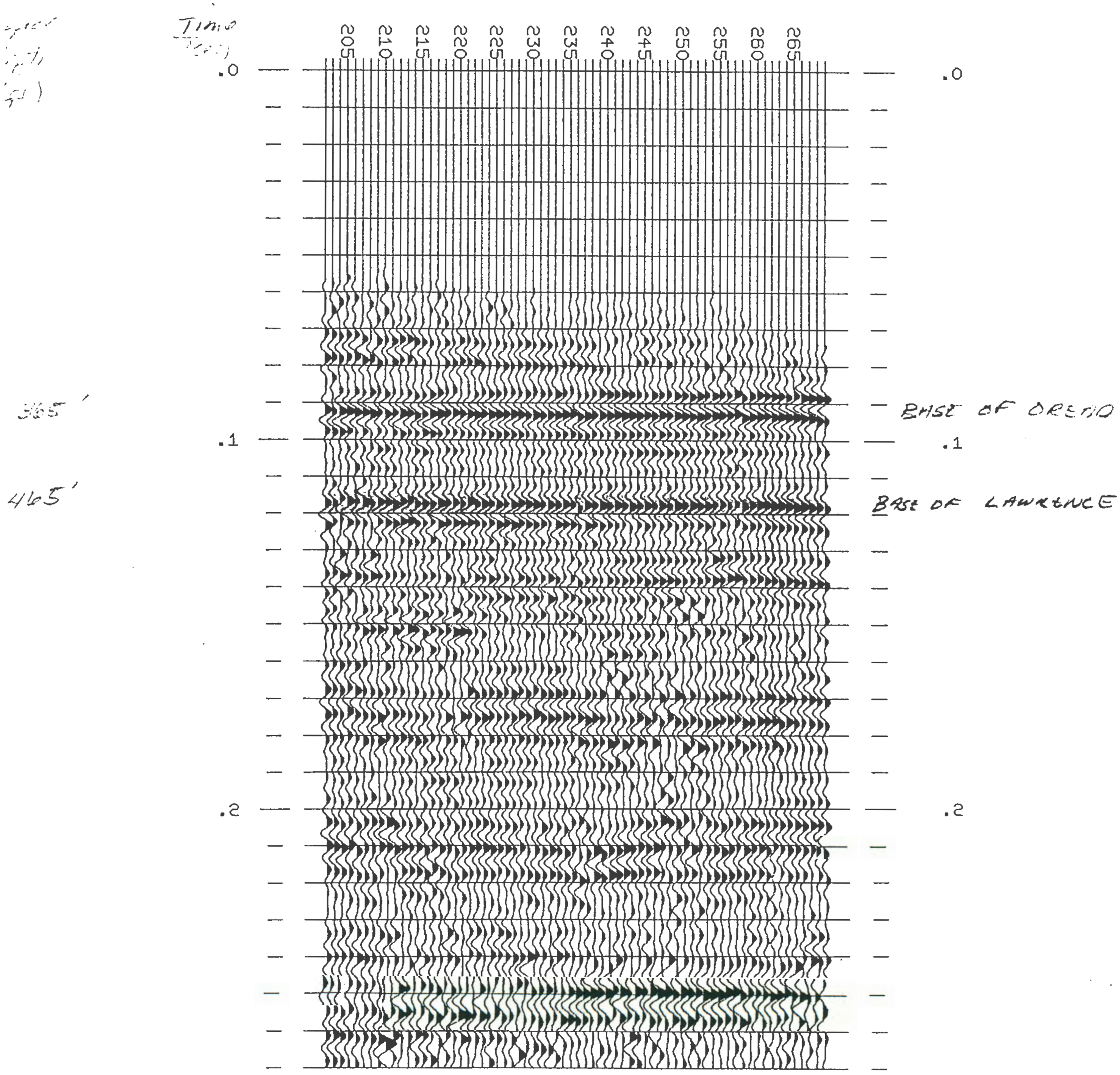
OVERBROOK - 2

interpretive line drawing

cdp numbers



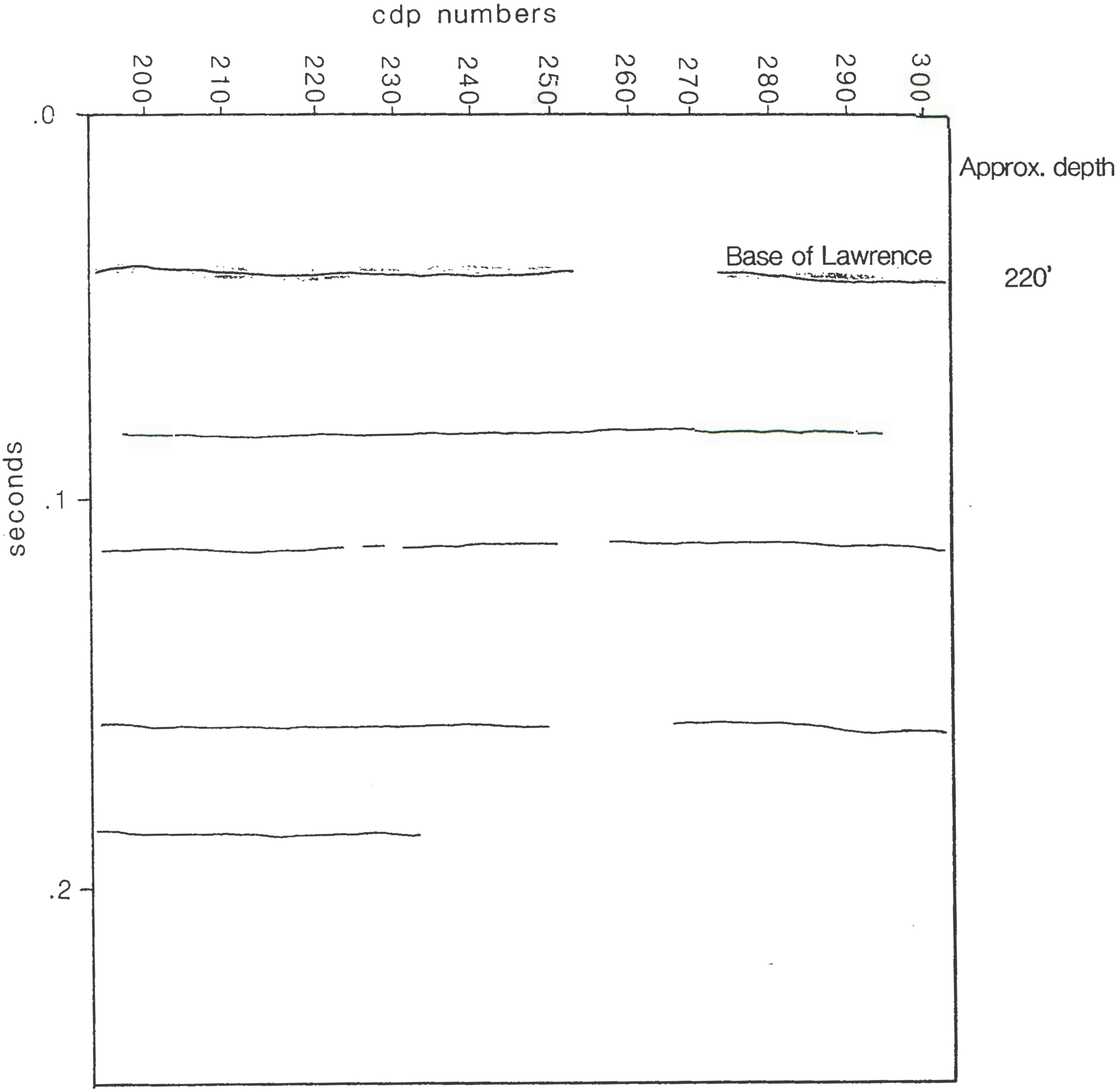
Overbrook 2

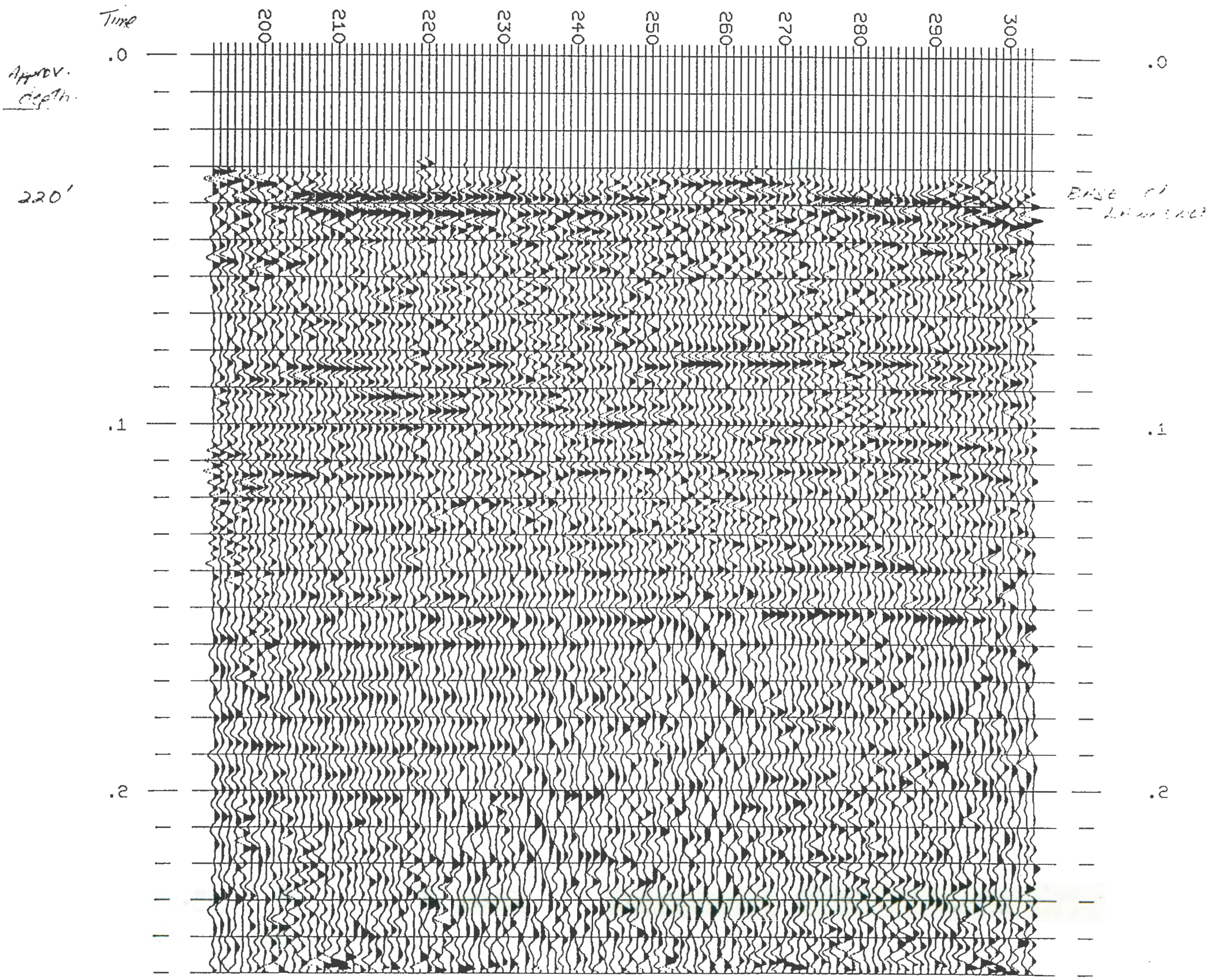


Time
205
210
215
220
225
230
235
240
245
250
255
260
265
.0
.1
.2
365'
465'
BASE OF OREAD
BASE OF LAWRENCE

POMONA

interpretive line drawing





Time
Approx. depth
220'
200
210
220
230
240
250
260
270
280
290
300
.0
.1
.2
Base of