KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 89-15

SEISMIC-REFLECTION SURVEY INVESTIGATIN SURFACE SUBSIDENCE AT THE BUERKI FARM NEAR WICHITA, KANSAS

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Lawrence, Kansas 66046-2598
913-864-3965

August 5, 1988

Ms. Bea Stong
Kansas Corporation Commission
202 West First Street
Wichita, Kansas 67202

Dear Bea:

The seismic reflection data collected by the Kansas Geological Survey in November of 1987 at the Buerki farm near Wichita is of sufficient quality and has been processed enough to allow a reliable geologic interpretation.

As you know, high-resolution seismic reflection has been used at several locations in Kansas to delineate the subsurface structure of sinkholes posing a risk to property, water resources, and/or the welfare of local residents (Steeples et al., 1986; Knapp et al., in press; Miller et al., 1985; Miller and Steeples, 1984). The seismic reflection technique is discussed in some detail in the included paper titled "Concepts of Seismic Reflection Prospecting".

The goal of the reflection survey at the Buerki farm was to generate high-frequency reflection sections with sufficient signal-to-noise ratio to allow the identification of several geologic layers above and below the Hutchinson salt. This information would allow us to generate a geologic cross-section showing the lateral extent of the dissolution as well as the faulting and distortion in the overlying beds. Approximate maximum surface subsidence expected before the ground surface stabilizes can be determined if the near-surface seismic velocity variations can be effectively removed and a reasonably good velocity model generated for the seismic data.

The data consist of two 12-fold common-depth-point (CDP) seismic reflection lines that cross near the center of the sinkhole located approximately 25 m directly south of the Buerki residence (Figure 1). Line 1 is oriented approximately north/south and line 2 is oriented east/west with CDP 280 of line 1 and CDP 480 of line 2 representing the same subsurface reflecting point. Each seismic line consisted of about 150 CDP's of full-fold data with a 2.5 m CDP spacing. Line 1 possessed the highest quality data and was used to derive the geologic cross-section and probable mechanism involved with the gradual subsidence observed at the surface.

The data processing was done on a Data General computer at the Kansas Geological Survey in Lawrence. The software used was a proprietary set of algorithms that has been in standard use on TIMAP seismic systems marketed by Texas Instruments. The general processing flow was very similar to that used on seismic data for petroleum exploration (Table 1). The primary distinctions were increased emphasis on velocity analysis, lack of extensive wavelet processing, higher degree of detail during the static correction operations (elevation and surface consistent statics), and the extra care exercised in muting (refracted arrivals and the air-coupled wave). No processing procedure or step, after the detailed velocity analysis, altered the general appearance or interpretation of the data.

Reflection events identifiable on raw (unprocessed) field files of line 1 can be followed through the entire processing sequence to the final stacked section. The time-to-depth conversion made using the normal moveout velocities of the seismic reflections in conjunction with well-log information suggests reflections from within the Hutchinson salt should arrive between 100 msec and 120 msec two-way travel time. Line 1 has several strong reflecting events both above and below this time window. The very distinctive broken, non-uniform appearance of reflectors above the salt is characteristic of areas where the salt is or has been dissolved or partially dissolved and reflectors above the salt are or have been actively subsiding.

The reflectors below 125 msec are flat and continuous across the entire area surveyed. This clearly isolates the source of the subsidence to the salt unit. The reflector at approximately 55 msec is disturbed, yet relatively coherent, and doesn't possess the more extreme undulations in its surface that are observable in the reflector from near the top of the salt at around 90 msec. This would seem to indicate that the rock units above the dissolving salt are gradually slumping into the void created by the salt's removal. If this pattern of dissolution and subsidence remains consistent the sinkhole forming gradually at the surface should continue developing at a very similar rate. There appears to be about 7 to 10 m of slumping in the subsurface at a depth of about 40 to 50 m. With a 10% expansion factor in the slumping materials, between 2 and 5 m of subsidence at the surface will be necessary before a stable state is reached. The amount of surface subsidence necessary to reach a stable state will increase if dissolution continues.

Most pertinent to discussions about the present source of fluids responsible for the salt dissolution are the two paleosinkholes interpretable on seismic data. By comparing the reflectors at 55 msec and 90 msec, a relative thickening can be observed at CDP 210 and again at CDP 337. The majority of this thickening is in the form of synclinal structures in the 90 msec reflector at both CDP 210 and 337. These synclinal structures are paleosinkholes that resulted from natural dissolution of the Hutchinson salt before the deposition of the rock units above 70 msec. Sometime after deposition of the layers represented by reflecting events at 70 msec (thousands or millions of years ago), fluids migrated to the salt and dissolved these two very localized sections of the salt (near CDP 210 and CDP 337). The resulting subsidence produced these two sinkholes, both approximately 10 to 15 m deep and 25 m across. The overlying rock units were deposited after the termination of this dissolution and subsidence process.

The presence of paleosinkholes on the seismic sections suggests this area has natural migration paths that have allowed previous fluid contamination of the salt and natural dissolution. With the absence of any known drill hole within a physically reasonable distance to act as an avenue for fluids (either natural or disposal) and the obvious presence of previous natural dissolution and subsidence, it is our opinion that the sinkhole forming at the Buerki farm is most likely a natural phenomenon.

Don't hesitate to contact us if you have any questions.

Sincerely,

Richard D. Miller
Geophysicist

Don W. Steeples
Deputy Director

Enclosure
cc: Lynn Buerki, landowner

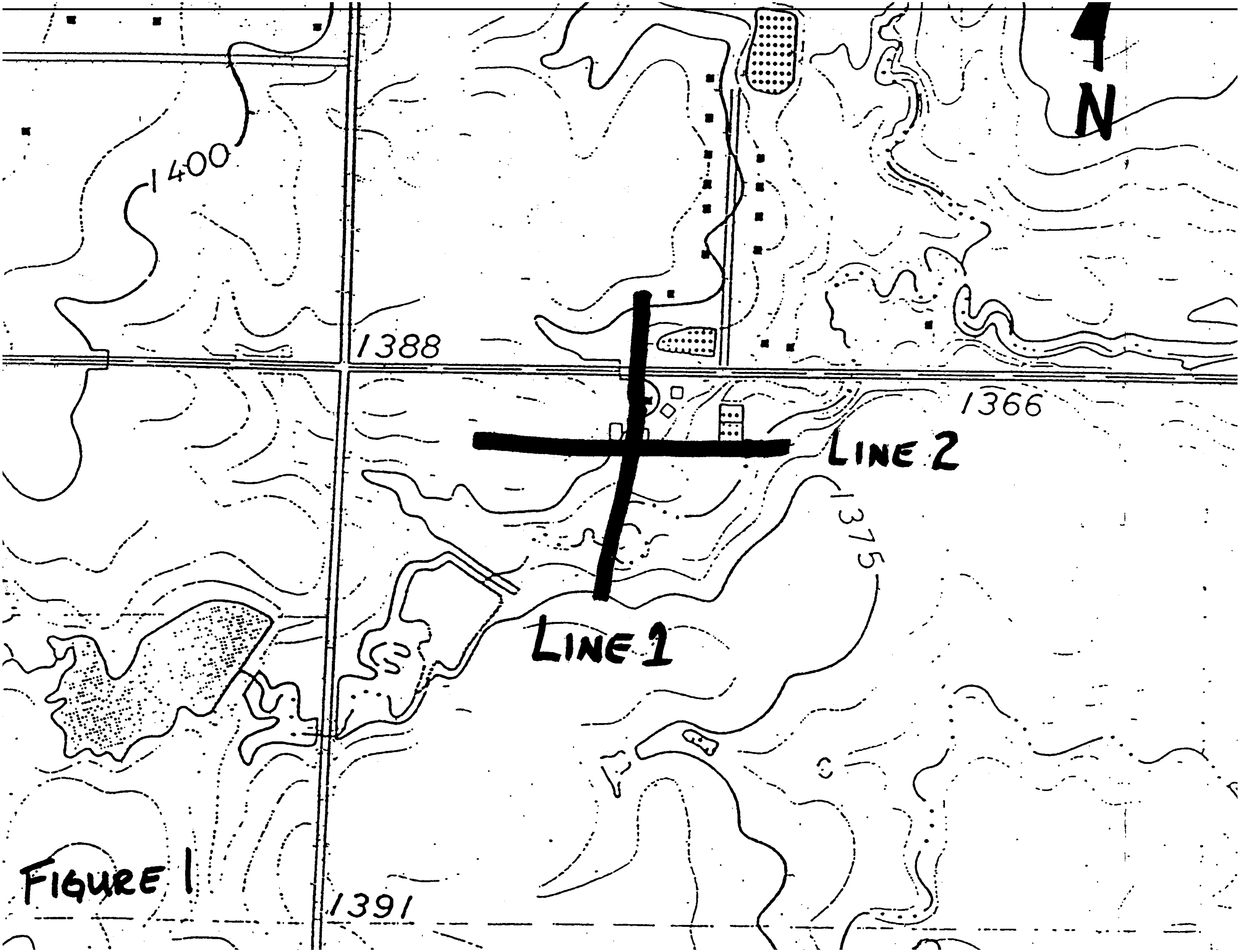

FIGURE 1

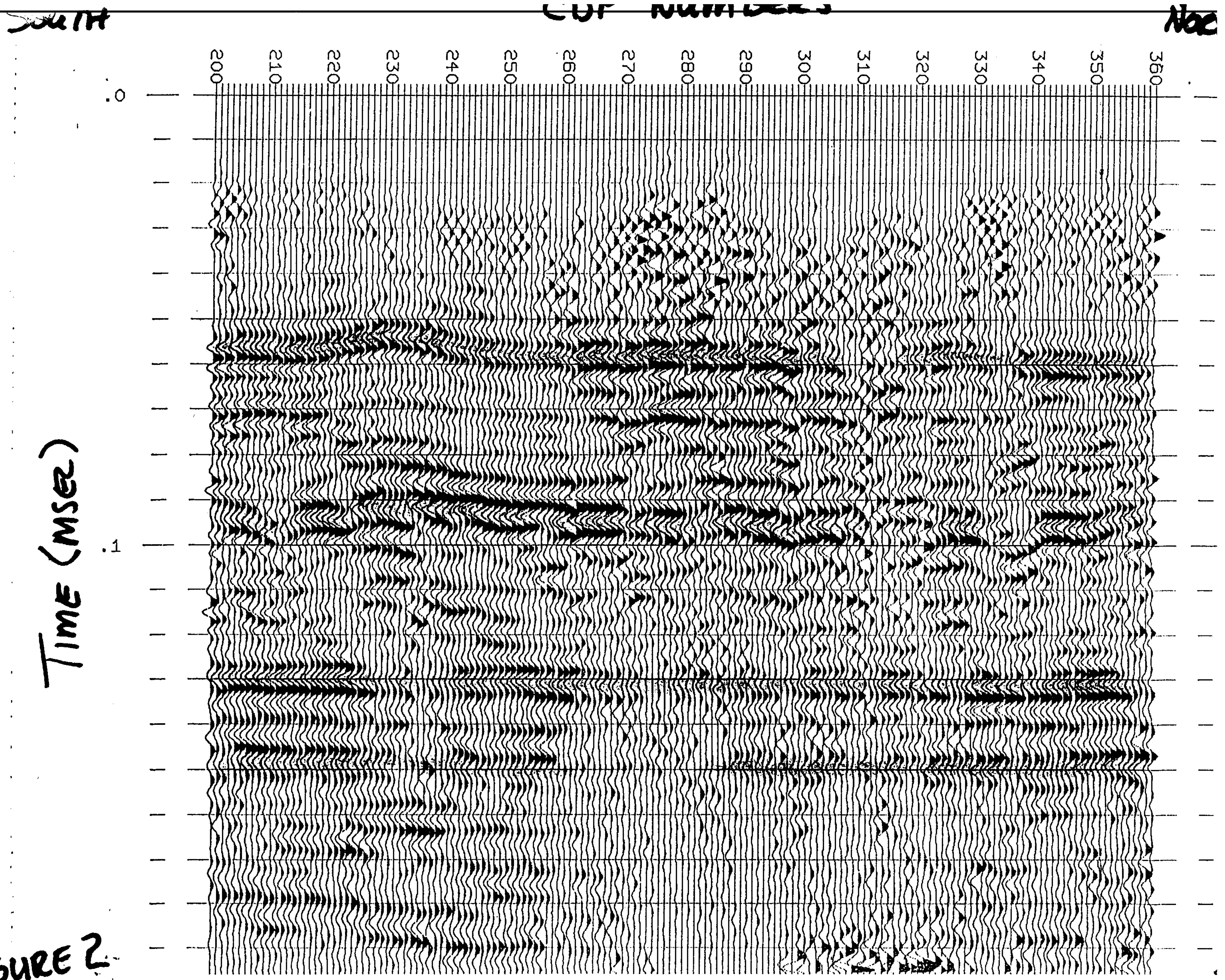
South
CDP NUMBERS
Nor
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
.0
.1
TIME (MSEC)

FIGURE 2

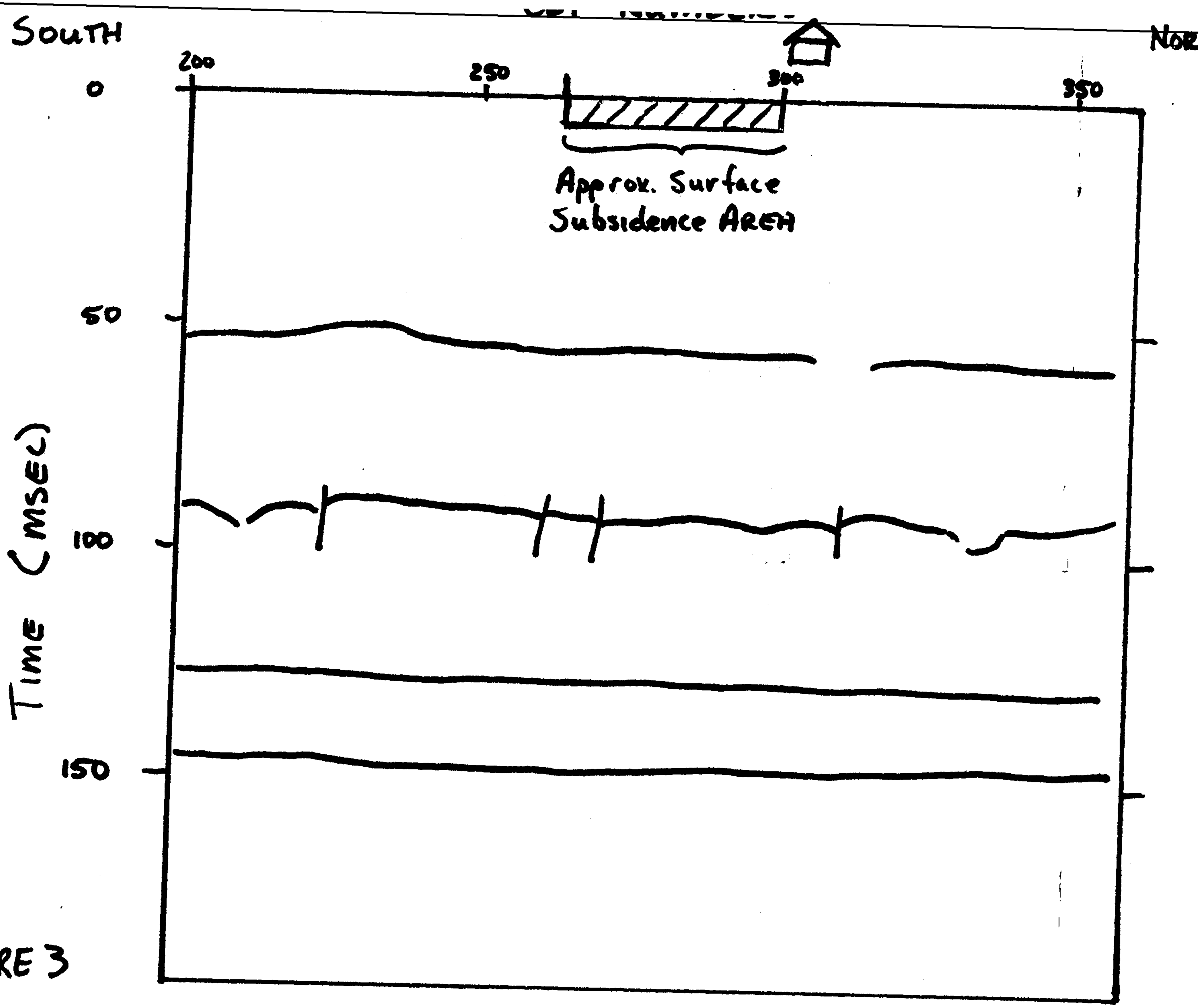
SOUTH
NOR
200
250
300
350
0
50
100
150
TIME (MSEC)
Approx. Surface
Subsidence AREA

FIGURE 3

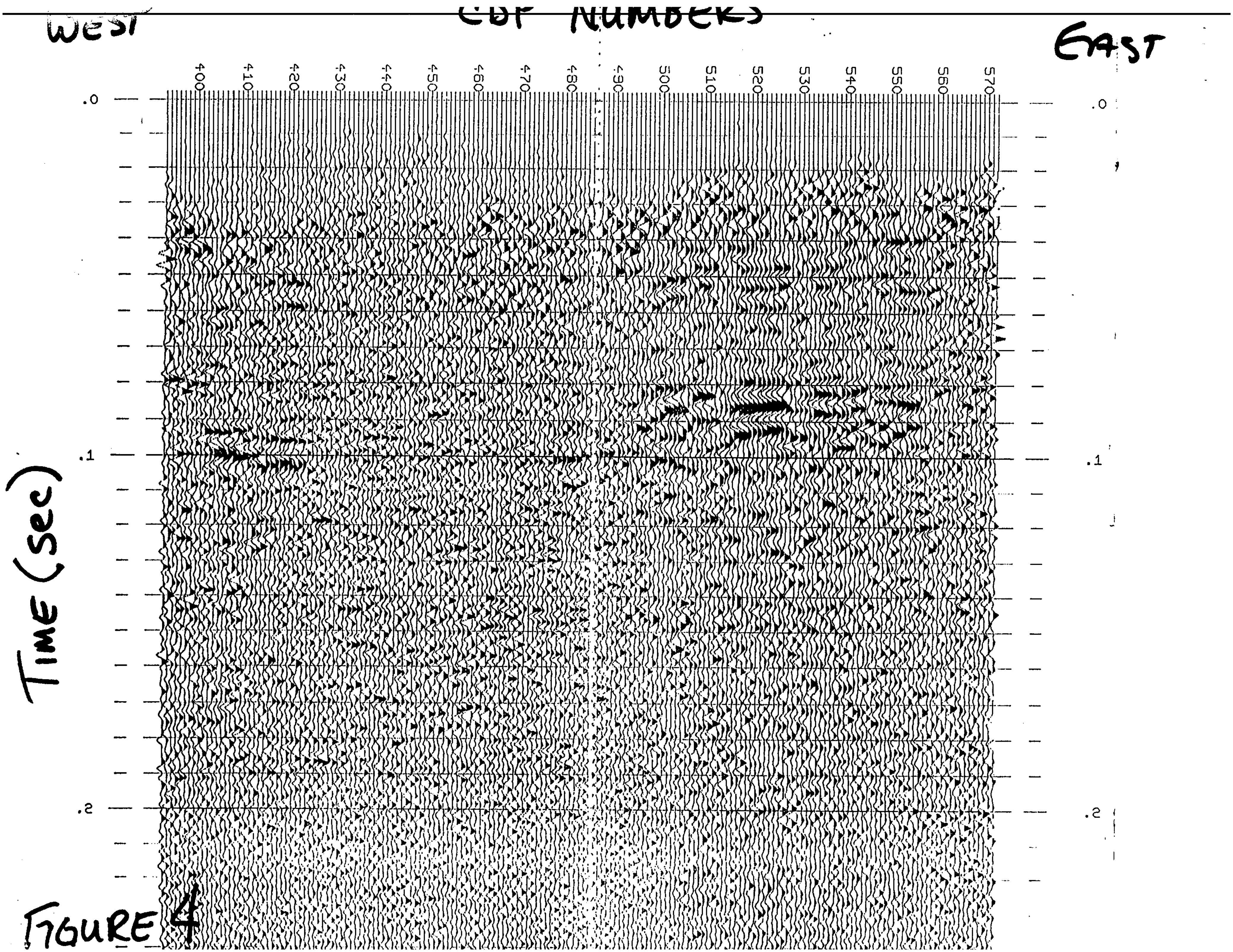
WEST
CDP NUMBERS
EAST
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570
TIME (sec)
.0
.1
.2
.0
.1
.2

FIGURE 4

TABLE 1.

1) Bad trace edit
2) Elevation statics
3) First-arrival mute
4) Spectral analysis
5) 2nd zero crossing auto-predictive deconvolution
6) CDP sort
7) Velocity analysis
8) Surface-consistant statics
9) Bandpass filter
10) AGC scale
11) CDP stack