FINAL REPORT

Waste Isolation Pilot Plant
(WIPP) Site Review

Los Medanos Area
Eddy and Lea Counties, New Mexico

Prepared for

SANDIA LABORATORIES
Albuquerque, New Mexico

By

G. J. Long & Associates, Inc.

May 25, 1977

Houston, Texas

Note: See WIPP-M80-0013
for Seismic Surveys
which accompany this
report

TABLE OF CONTENTS

Page

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May 25, 1977

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FINAL REPORT
GEOPHYSICAL REVIEW
LOS MEDANOS (WIPP) SITE
EDDY & LEA COUNTIES, NEW MEXICO

Dear Dr. Griswold:

This report, maps, and seismic data examples are the final report by G. J. Long & Associates, Inc., of the initial phase of the geophysical review of the Los Medanos (WIPP) site evaluation studies.

The various data are discussed at some length in the written portion of this report, but if you have any additional questions in regard to any portion of the report, contact me at your earliest convenience as we are bound by agreements with the contributing oil industry companies to either return or destroy the majority of the data made available to us for this review.

The assistance given by everyone associated with this project at Sandia Laboratories throughout the entire time period of this initial study is gratefully acknowledged.

Very truly yours,

G. J. LONG & ASSOCIATES, INC.

By
John L. Hern

JLH/ao

Enclosures

INTRODUCTION

The geophysical studies discussed herein comprise the initial phase of an evaluation of a proposed nuclear Waste Isolation Pilot Plant (WIPP) site. The area investigated is located in the northern portion of the Delaware Basin, Eddy and Lea Counties, New Mexico, in the Los Medanos vicinity approximately 25 miles east southeast of the town of Carlsbad. This evaluation was performed for and under the direction of Sandia Laboratories. The acquisition and interpretation of geophysical data was applied to the identification of potential geological hazards and the evaluation of the economic impact which could be anticipated as a result of a site withdrawal. The object of these investigations was to gather information to be used in selecting a disposal site having maximum geological stability and structural integrity especially as to long term isolation from ground water invasion and minimal hydrocarbon and other mineral potential.

Subsurface salt dissolution cavities, breccia pipes, shallow (late) faulting, igneous activity and jointing systems constitute some of the major hazards to a disposal site.

Geophysical data of the type which oil companies acquire as a part of their hydrocarbon exploration programs have been used as a basis for the interpretation and evaluation discussed herein.

Geophysical data used for this study consists of regional gravity over a large portion of the Delaware Basin of New Mexico, aeromagnetic data covering the New Mexico portion of the Delaware Basin, and seismic survey data within the proposed site and extending approximately ten miles to the north, twenty miles to the east, west and south embracing an area of approximately sixteen townships. The gravity data cover approximately 3,000 square miles with a station density of four per mile. Seismic survey data which is either owned by Sandia or for which "use" rights have been acquired for Sandia's benefit are as follows:

1. Twenty four-fold, Vibroseis source CDP survey recorded by Dresser-Olympic for Sandia during 1976. Lines 1, 2, and 3, totaling 26 miles.
2. Single fold, pattern hole, dynamite source shot by Globe Exploration during 1956-57 for Shell Oil Company, totaling 113 miles.
3. Single fold, single hole, dynamite source shot by Shell Oil Company in 1953, totaling 26 miles.
4. Twelve fold, single hole, dynamite, CDP shots by Globe Exploration during the early 1960's for Shell Oil Company, totaling 50 miles.

One hundred and five (105) oil companies were contacted by letter and fifty-six (56) were personally contacted with the request that they contribute their available data to the national cause of selecting a WIPP site.

As a result of these contacts, Skelly Oil Company loaned to G. J. Long & Associates a total of three hundred and eighty-one (381) line miles of CDP seismic data to be used on this project. Skelly stipulated that the data was loaned only to G. J. Long & Associates and was not to be reviewed by or transmitted to any other person or persons. An interpretation from these data could be made and forwarded to Sandia Laboratories or other governmental agencies. The data is to be destroyed by G. J. Long & Associates upon completion of the project.

Gulf Energy and Minerals Company loaned G. J. Long & Associates three hundred and twenty (320) miles of recent CDP data with the same security stipulations as Skelly with the exception that all loaned data must be returned to Gulf upon completion of the project.

Exxon Company contributed the use of one hundred and ninety-six (196) line miles of CDP data with the stipulation that the data be viewed in their offices in Midland, Texas. Computation sheets made by a geophysicist from G. J. Long & Associates was permitted to be removed from Exxon's premises. A hand plotted cross section and a Delaware interpretation was made from this data

Amoco Production Company contributed five hundred and thirteen (513) line miles of CDP data which was viewed in Amoco's offices with the stipulation that no computation sheets or contoured maps could be removed from their offices. We were allowed only to make notations of trends, possible fault cuts, and overall dips.

In summarizing the quality of the seismic data observed:

1. On none of the data investigated by G. J. Long & Associates was it possible to observe the Rustler horizon due to acquisition and processing parameters The same parameters are responsible for the poor to nonexistent record quality at the Castile level.
2. The CDP data gathered for Sandia by Dresser-Olympic was fair to good at the Devonian and Morrow levels, fair to good at the Delaware Sand level, and fair to very poor at the Castile level.
3. The CDP data shot by Shell Oil Company and reprocessed by Teledyne Exploration was fair to very poor at the Devonian and Morrow levels, fair to poor at the Delaware Sand level, and generally not usable at the Castile level.
4. The Single Fold data shot by Shell Oil and Globe Exploration was very poor in its present state and generally was not used in the interpretations.

5. The CDP data from Skelly was fair to good at the Delaware Sand level and from poor to nonexistent at the Castile level.
6. The CDP data from Gulf was poor to good at the Delaware Sand level and poor to nonexistent at the Castile level.
7. The CDP data at Amoco was poor to very poor at all levels due to the data having been processed using a relatively unsophisticated stacking technique.
8. The CDP data at Exxon was poor to good at the Delaware Sand level and poor to questionable at the Castile level.

The total cost to Sandia from the oil companies for the use of the information gleaned from the 1,410 miles of these data was a reproduction charge of $200.55. Had this data been obtained through normal data brokers, the cost would have been approximately $730,000 and, if the data had been gathered at today's prices, the cost would have been approximately $3.5 million dollars.

Preparation of composite horizon maps illustrating in detail the seismic coverage from all sources are desirable, but nearly impossible to achieve in a timely manner. Seismic measurements are relative rather than absolute and their relationship to the absolute is governed by parameters whose values are determined experimentally. As a further complication, differences occur between various configurations of recording instruments and their associated input devices. In the case of older systems the only reliable method of attempting to resolve these differences is by direct field comparison. In many instances the necessary background data for resolution is not readily available. Since the data used were obtained from a variety of sources, and neither time schedules nor budgetary considerations permitted the steps necessary to resolve these differences, these data were utilized in an "as is" condition.

Although detailed composite maps were not practical, much of the information may be and has been integrated into the overall interpretation. Phenomena such as faulting, intrusions, salt dissolutions, and structural axes are not subject to the problems discussed above and therefore may be included in the detailed maps.

GEOPHYSICAL-GEOLOGICAL INTERPRETATION

The geophysicist's work is wide ranging, from field acquisition through all the processing center operations, but possibly the most important aspect of all is the translation of the geophysical (generally seismic) information into geological terms. This process, geophysical-geological interpretation, calls for the greatest possible coordination between geology and geophysics if it is to be carried out successfully. It is in this area that the demands for technical competence are so stringent that it is hard for either geologists or geophysicists to meet them unless they work together. The following paragraphs will attempt to briefly discuss some aspects of seismic interpretation principles and problems.

The word interpretation has been given many different meanings by geophysicists who handle seismic reflection records and by geologists who put the information from them to use. To some it is virtually equivalent to data processing and is tied inextricably to computer software. To others it consists of mechanical transformation of seismic reflection data into a structural picture by the application of corrections, time-depth conversion, and migration.

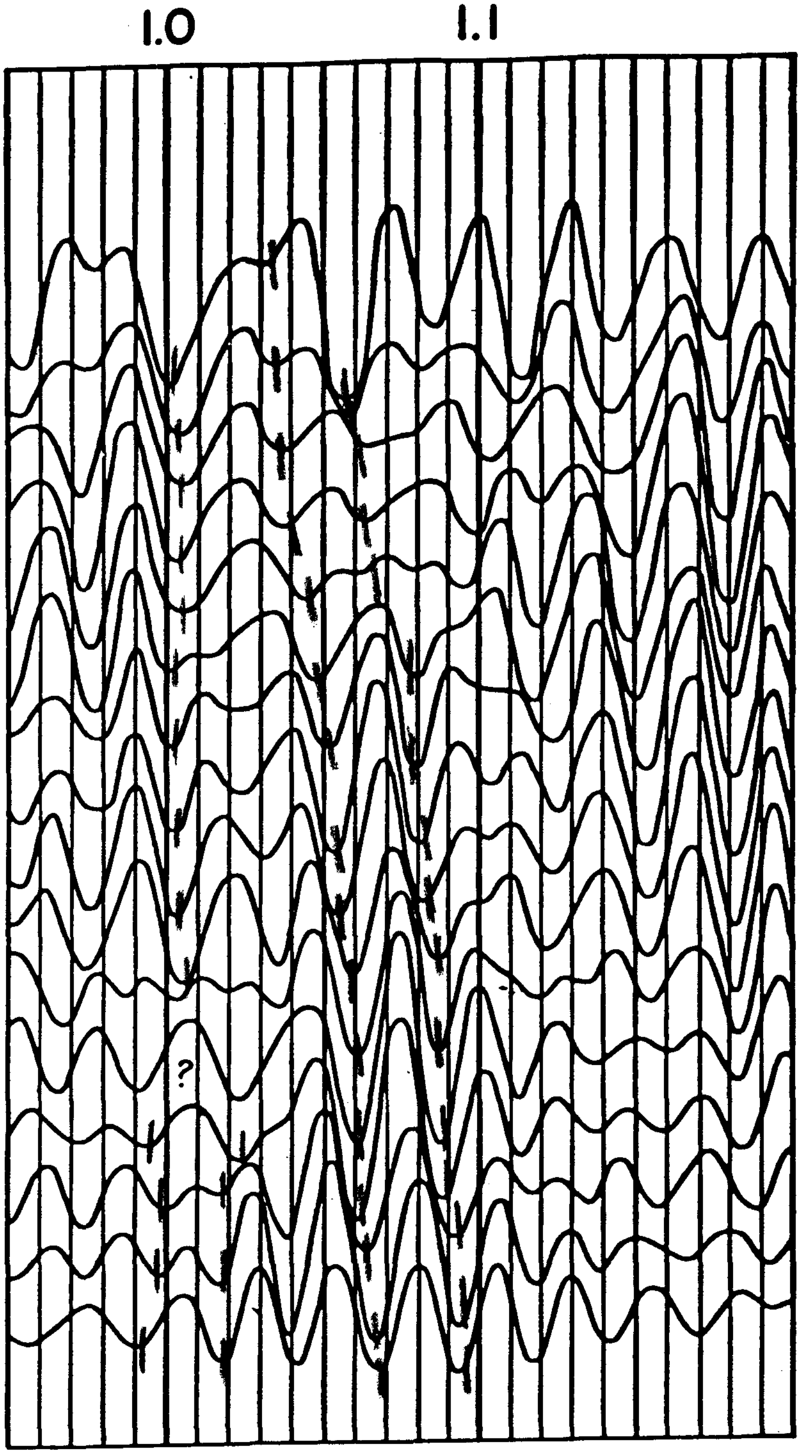
Interpretation can begin with planning and programming a seismic reflection survey in order that it may be guided by the geology of the area and by the economic or scientific objectives of the survey. It can involve the choice of field parameters, such as the kind of seismic source to be used, the geometry of source and receiver patterns, and the settings on the panels of the recording instruments, so that such choices are governed by the geological information desired. The selection of processing procedures and parameters is also an important part of the interpretation if it is supported by the same considerations.

After a seismic map is constructed, an important part of its interpretation is integrating the seismic data on it with geological information from surface and subsurface sources, e.g., fault traces or geologic contacts. This involves identifying reflections and making ties to wells or surface features. The extent to which this can be done depends on the amount of geologic information available.

Before corrected record sections came into universal use most seismograms were recorded as twelve or twenty-four trace strip charts. It was necessary to place adjacent records edge to edge and to correlate reflections from the last trace of one record to the first of the next. This was done to a considerable extent on some of the data available to us on this project. Record sections, which have almost entirely replaced the individual multitrace records, make it possible to follow events over long distances much more conveniently. The sections are corrected to eliminate irregularities caused by variations in the lengths of the ray paths, as well as topographic anomalies.

Even with the new kinds of display, correlation of reflections is not always as simple as it may appear. Often a reflection characterized on the record by a single trough evolves into two troughs over a very few traces. There may then be some doubt about which of the two events correlates with the one trough from which they branch. The interpreter may be guided by the pattern of an adjacent reflection of better quality. Although such changes in waveform may be associated with the geology of the reflecting formation, the most usual reason for them is noise of one type or another which causes distortion of the signal. Modern data-processing techniques are designed to suppress such noise and thus increase the reliability of correlation. Even so, it often requires considerable experience and good judgment, particularly when the data are marginal, to make correct correlations. An error of 1 cycle could mean that the predicted depth to a geological boundary is 100 to 200 feet higher or lower than it should be. Note Figure 1 as an example of this problem.

Although current recording and processing techniques have made it possible for the geophysicist to work with high-quality reflection data in a form more suitable for interpretation than was available a decade or so ago, the intrinsic limitations in the reflection process must be recognized. All these limitations are related to the basic physics of seismic reflection in a medium having the characteristics of earth materials. The



Break in continuity of reflection with attendant uncertainty in correlation. Event starting at top trace on time line marked 1.0 can be followed for nine more traces and then seems to terminate. Does continuation of event below this follow series of troughs marked in green or blue? The trend of other reflections suggests that the latter is more likely.

FIGURE 1

attenuation of seismic signals at a rate which is proportional to frequency strongly affects the resolution that can be expected from such signals. Seismic waves are generated at their source as pulses of such short wavelength that they can be looked upon as spikes for all practical purposes. If the pulses could actually travel as spikes for long distances through the earth, there would be few problems in resolving reflections. But the continual removal by attenuation of higher-frequency components as the signals propagate through earth materials results in a continual broadening of the basic signal spectrum with increasing travel time.

Another limitation associated with the seismic reflection process lies in the precision with which reflection times and depths of reflecting surfaces can be determined from events on seismic records.

Times of reflection events are ordinarily recorded for the highest-amplitude troughs (or sometimes peaks) of the oscillatory signals usually associated with them on the records. Such features are easiest to identify and observe, particularly in the presence of noise. Strictly, the times of the onsets of the reflections should be recorded rather than any troughs or peaks which follow the onsets. The problem is complicated by the fact that the signals, having been recorded by velocity-sensitive geophones, show peaks or troughs where the particle displacement has its greatest rate of change rather than its greatest amplitude. Also, digital processing operations such as deconvolution may cause phase shifts which make it difficult to identify phase shift so as to leave the greatest energy in the reflected wave as close to its onset as possible. Such manipulation can sometimes distort complex waveforms, obscuring the identity of events.

Thus it is more difficult to determine the absolute depth of a reflecting interface in the earth from a reflection signal than it is to measure relative depths of such a boundary between two points at which the same reflection has been recorded. Where all individual layers encompassed within the zone contributing to the reflection are conformable, the structural relief can be mapped with an accuracy of one or two milliseconds if the reflection quality is good. Where velocities do not change laterally, absolute depths can be obtained with comparable accuracy if the lines are tied to at least one well at which the reflection event is related to a particular well top (subsurface marker). The differences between the time for an event at the well tie and the times elsewhere on the line can readily be transformed into depth differences reliable to 10 or 20 feet if the reflections are good and the average velocity values are known precisely enough.

The detection of faulting on seismic sections can be quite easy under favorable circumstances. Often, however, the indications are subtle, and the identification and delineation of such features can be quite challenging.

The principal indications of faulting on reflection sections are the following:

1. Discontinuities in reflections falling along an essentially linear pattern
2. Misclosure in tying reflections around loops
3. Divergences in dip not related to stratigraphy
4. Distortion or disappearance of reflections below suspected fault lines.

Where discontinuities are well defined, the position of the fault trace may be highly evident on the record sections even to someone entirely inexperienced in seismic interpretation. Refer to Figure 2.

An important consideration that must be taken into account in evaluating maps and sections which have been converted to depth is the reliability of the velocity information on which the time-depth conversion was based. With computer programs available for determining velocity analytically from regular reflection records, we no longer need closely spaced well-velocity surveys in order to obtain reasonably trustworthy information on reflection depths. Yet the precision of conversion velocities obtained from these processes alone is subject to certain limitations. Accuracy depends on reflection quality, which is not always good in spite of computer-

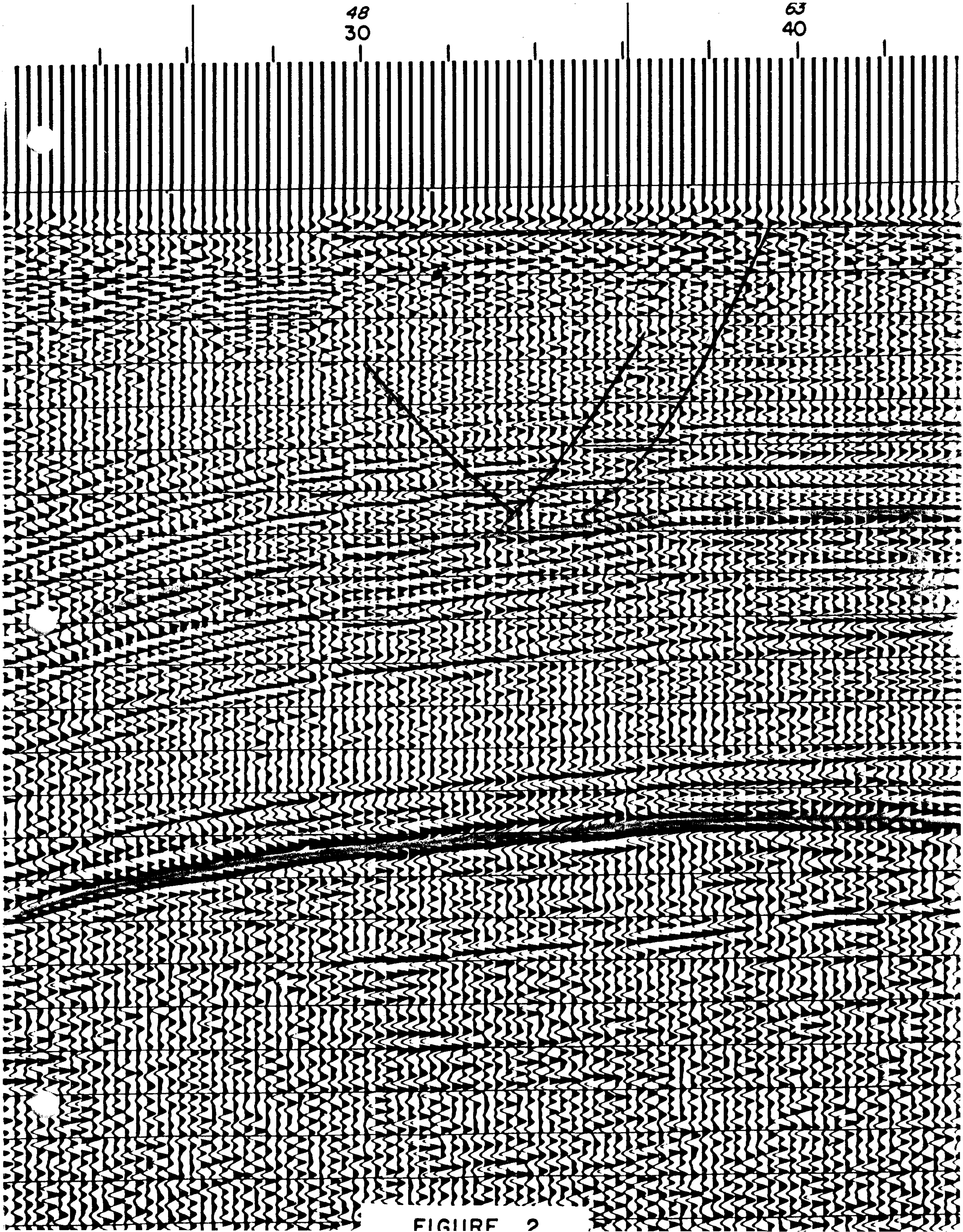


FIGURE 2

based data-enhancement techniques. Moreover, velocities determined by computers are based on slant ray paths and uniformly dipping reflectors; which, because of anisotropy and other reasons, usually differ from the vertical velocities which should be used for time-depth conversions.

There has been a difference of opinion among geophysicists over whether seismic results should be presented in time or in depth. Some have preferred cross sections and maps in time rather than in depth because they are based only on objective data and are not subject to change as new velocity information is acquired. Such a preference is hardly justified now that automatic computer programs like that for the velocity spectrum allow the determination of velocities directly from the reflection data and thus make it much easier to obtain detailed velocity information than was possible before such programs became available. It is even possible to plot record sections directly in depth from velocity information obtained with such programs.

The final presentation of seismic structures in terms of reflection times must often be looked upon as an evasion of the geophysicist's responsibility, which is to convert his data into a form that is as geologically meaningful as possible. Well tops and isopachs are expressed in units of distance, not time, and geophysical information to be coordinated properly must be presented in the same way. Maps in time do not incorporate the effect of lateral velocity changes, which in exceptional cases could even account for reversals in the direction of dip with respect to those indicated by time contours. Even admittedly imperfect and incomplete velocity control can prevent grossly erroneous conclusions in geological interpretation that might be made on the basis of time sections and maps alone. The geologist must rely on the geophysicist to provide the best possible interpretation the geophysical art allows. The geophysicist is not taking his professional responsibilities seriously enough if he presents only objective information and leaves it to others to convert it into geologically meaningful terms.

Throughout the history of the reflection method, its performance in locating stratigraphic features has been much less favorable than in finding structures. The principal explanation for the poor success of seismic methods in detecting stratigraphic features (other than reefs) lies in the limited resolution of the seismic pulse. Structural traps generally involve deformations in beds that remain conformable over at least a few hundred feet of section. In most types of stratigrapic traps, however, there is a variation in lithology which is often confined to a distance much shorter than a wavelength, so that resolution becomes a major problem. And it is evident from the composition of reflections that any change in stratification could result in the alteration or even the destruction by interference effects of reflection signals associated with beds on either side of the point where the layering characteristics change.

The greatest success of the seismic method in stratigraphic studies has not been related directly to the discovery of hydrocarbons but more indirectly in casting light upon the depositional environment and history of deposition in the area where exploration is being carried out. The patterns shown by reflections often make it possible to understand how the deposition took place in areas under investigation, and interval-velocity studies often enable the geologist to identify gross lithological features, allowing a more complete reconstruction of the depositional environment.

The various movements of a shoreline, progressive and regressive, are associated with geometrical patterns which are indicative of the types of deposition that took place at various periods of geological history. See Figure 3.

Unconformities can also be mapped from divergent pattern reflections on a seismic section. The presence of unconformable contacts on a seismic section can often cast important light on the depositional and erosional history of an area and on the environment existing during the time when the movements took place.

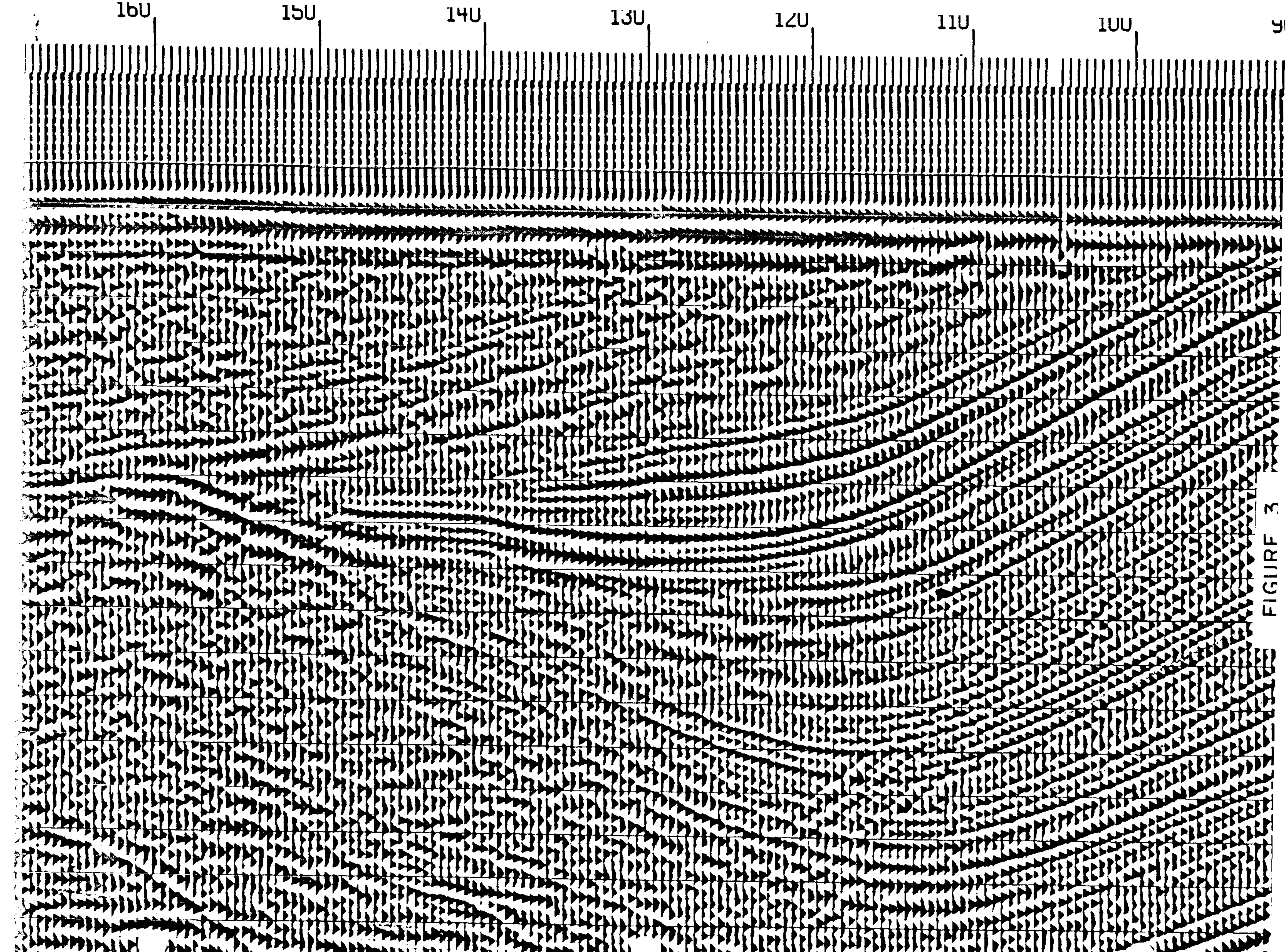


FIGURE 3

FIGURE 3

All of the above interpretative techniques were utilized in the review of the data available for study on this project. The "mini-stratigraphic" anomalies were noted on data not acquired in the field, nor processed in the computer center with that shallow zone of interest in mind (refer to Seismic "Anomaly" Location Map and related seismic examples). The fact the reflection seismic method gave indications as good as it has on these data emphasizes the likelihood of good resolution of the shallow zone of interest with a properly planned and executed geophysical program.

DISCUSSION OF PROJECT RESULTS

Seismic data in the area are of generally poor quality, although some horizons (Castile, Delaware and Devonian) frequently are of fair to good quality.

Acquisition and processing parameters used for most data are suitable for normal petroleum exploration objectives, but are not suitable for objective horizons shallower than the Castile Horizon.

Results of the interpretation are illustrated on six maps:

Castile Horizon (Approximately 700' above Delaware Horizon)

Delaware Sand

Morrow Limestone

Devonian

Composite Gravity-Seismic

Seismic "Anomaly" Location Map

Of these maps, the Castile, Morrow Limestone, and Devonian are structural interpretations based on data acquired and/or processed for Sandia and thus reduced to common references, thus rendering a detailed map in the vicinity of seismic control. The Delaware Sand map utilizes all coverage available, although variations in datum reference levels and parameters employed in acquisition and processing precludes a detailed structural portrayal. In order to utilize these data, the

Delaware Sand map has been generalized and is illustrative of direction and magnitude of dip, observed faulting and other structural phenomena. The Composite Gravity-Seismic map illustrates significant structural trends observed at all levels down to the Devonian on either seismic or gravity maps. Other known geologic features are also indicated on this map. A number of specific geologic features which do not lend themselves to display on structural maps are illustrated on Plates appended to this report. The locations and their associated plate numbers are indicated on the interpretation titled, Seismic "Anomaly" Location Map.

Structure maps (Castile, Delaware Sand, Morrow Limestone, and Devonian) are based on seismic and subsurface data. With the exception of the Delaware Sand, which has been generalized to accomodate a variety of seismic programs, misclosures between the seismic and subsurface data are common and are of significant magnitude. These closure errors are attributed primarily to three sources: inconsistencies in subsurface data, undetermined velocity gradients and geologic features not observable on seismic lines.

Inconsistencies in subsurface (well) information arises due to the multi-fold sources of this information, differences in nomenclature and the relative old age of some of the source data (well logs). Resolution of these inconsistencies is beyond the scope of the present assignment and may be impossible in some instances.

Horizon variations in vertical velocities are one of the most restrictive elements in seismic analysis. The seismic method, prudently applied, furnishes precise measurements of reflection time to acoustic interfaces. The determination of the depth of such phenomena is thus largely dependent on an accurate determination of sonic velocities from the surface to the interface. This velocity may be determined directly by borehole measurements or indirectly by surface methods. The present data do not adequately define velocity throughout the area, but are sufficient to infer the presence of a significant variation.

Seismic observations are necessarily limited in scope. The possibility of significant geologic features which are not observed must always be recognized. In some cases, such a feature may be inferred from seismic data without positive evidence. Such a case is observed on the Castile Horizon and will be discussed later.

Castile Horizon - (Approximately 700' above Delaware Sand):

Seismic data at this level range from good to poor in quality. A southwestward dipping surface with several anticlinal features is observed. Many of these anticlines are seen to be over deeper production. Relationships to the subsurface data (determined at the Delaware Sand level) vary from 743 feet above (Line San2, SP15, Sec. 15, T22S-R31E) to 839 feet above (Line GL346, SP497, Sec. 1, T23S-R30E) to 580 feet above (Line S1133, SP3508, Sec. 17, T22S-R32E). This mis-tie is attributed primarily to undetermined velocity variations. Some part of the problem may be due to inconsistencies in subsurface data as suggested by well data in Sec. 1, T23S-R30E and its vicinity.

Probably the most anomalous condition observed at this level is the steep northwest dip observed between Line San3, SP15 and Line San2, SP35. This rate of dip far exceeds that observed anywhere in the area, but is based on credible correlations between the lines. The possibility of a fault which is not observed on available seismic control may be considered as the cause of this anomalous condition.

Although several anticlinal features are observed, they may be discounted, insofar as this level is concerned, (unless they lie in presently productive areas) since all such features have been tested by the drill to this depth.

Delaware Sand:

Data at this level are of good to poor quality. Most of the recent (1970 or later) data is of fair to good quality. All available seismic data have been utilized in the preparation of this map. Parametric differences preclude the possibility of a detailed map from the varied sources of data within the scope of of the present assignment. The resulting portrayal is probably most significant with regard to observed faulting, since the seismic criteria associated with faulting are largely unaffected by such differences.

The surface illustrated dips east southeastward, with significant nosing and near closure observed over deeper anticlines. This map, while probably overly simplistic, is nevertheless regarded as being more representative of actual subsurface conditions than is the Castile Horizon.

Morrow Limestone:

Profiles used in the preparation of this map are the same as in the case of the Castile Horizon. Quality of reflected data at this level is generally poor. The map is further complicated by the characteristics of the limestone, which frequently deviates from a time equivalent horizon. Despite this phenomena, relationships to subsurface are generally more consistent than those observed at the Castile level.

The map shows a surface generally dipping to the southeast, with several closures. Most of these appear to be substantial by production. The most significant of these is one cresting at -10,000 feet in Sec. 16 and 17, T22N-R31E. Although in close proximity to the prime WIPP area, this feature appears to have been sufficiently tested to Morrow depths as to leave most of the prime area one mile or more from potential production. Further, the data suggesting such a structure at this level are of rather poor quality.

Devonian:

This map is also based on seismic profiles acquired and/or processed for Sandia. Data at the Devonian level are generally of fair to good quality. Subsurface data is scarce due to the paucity of wells drilled to this depth. The relationship of seismic to subsurface appears to be better than observed at Castile and Morrow levels.

As at shallower levels, a southeastward dipping surface with several anticlinal features is observed. These generally conform to those observed at the Morrow level. The structure in Sec. 16 and 17, T22N-R31E, appears to intrude further into the area of interest, although its effect is largely confined to the northern portion of that area. Substantially more faulting is observed at this level as might be expected.

Composite Seismic-Gravity:

This map illustrates, by a series of symbols and colors, the primary structural trends observed at shallow and deep seismic horizons as well as significant gravity anomalies, known surface features, and producing wells. Although not detailed, this map serves as a primary reference for the location of structural and other features, which are more fully represented on the structural maps and/or plates.

Seismic "Anomaly" Location Map:

On the Los Medanos Site quadrangle map (Salt Lake), there are twenty-six (26) observed seismic anomalies in the surface to Delaware section; fourteen of the above fall within the 10 x 10 mile area of prime interest. The reason the predominance of these observed anomalies are within this outline is directly attributable to the fact that the vast majority of good detail seismic data available for review is also in the outlined area.

Of the fourteen anomalies within the Los Medanos Site area of interest, two are considered good examples of possible indication of salt dissolution (SL 1 and 4). Xerox copies of each anomaly are enclosed with the maps and should be reviewed in detail to obtain a feel for the potential shallow geologic features that exist throughout the area.

CONCLUSIONS

1. The location of breccia pipes and active salt solution phenomena can be identified by good quality seismic data as evidenced by an "Anomaly" map and supporting evidence.
2. Structural conditions observed do not preclude a location within Sec. 20, 21, 28, and 29, T22S-R31E, although the anomaly in Sec. 16 and 17 cannot be considered to be fully tested at all levels. Further definition of this anomaly is definitely indicated.
3. Evidence of minor faulting is seen at the Delaware Sand and Castile Horizons. These faults cannot be identified directly with basement movement. Faulting at Devonian depth is of greater magnitude and is associated with basement movement.
4. A direct relationship between the locations of known breccia pipes and gravity has not been established. While some of the breccia pipes are coincident with gravity minima, others are not. The deeper Morrow-Devonian-basement trends show excellent correlation with gravity.
5. Results obtained from the aeromagnetic data will be discussed in a report by Mr. Charles Elliot of Elliot Geophysical Company.

6. The results of this study indicate that with the exception of the seismic evidence of minor faulting observed within the proposed WIPP site, the proposed Los Medanos disposal site is essentially free of major geologic hazards which would provide a basis for its abandonment.

7. Definite conclusions as to the quality of the shallow fault interpretation at the Delaware Sand and Castile levels are difficult to evaluate from the data that we have investigated due to the poor quality of the shallow data. More definite conclusions could be made by obtaining new data with acquisition and processing parameters selected to enhance the shallow data. A detailed seismic program is recommended to properly evaluate the area(s) of interest. As stated previously, the available data does not allow accurate delineation of the anomalies or even the type of anomalies that are indicated on many of the seismic section examples. This should be done before a final decision is made to accept or abandon the Los Medanos site based on geological stability.

Respectfully submitted,
G. J. LONG & ASSOCIATES, INC.

By____________________
John L. Hern

GEOPHYSICAL GLOSSARY

acoustic	refers to compressional P waves
aeromagnetic	magnetic measurements made from an aircraft
anomaly	(1) a deviation from uniformity in physical properties (2) a portion of a geophysical survey which is different in appearance from the survey in general (3) used for unexplained seismic events
CDP	(1) common-depth-point (2) the situation where the same portion of the subsurface is involved in producing reflections at different offset distances on several profiles (3) common-depth-point shooting produces redundant reflection data from which a common-depth-point stack can be made (4) different shot point-geophone combinations are used to record the same reflection (5) also called roll-along
datum	(1) the arbitrary reference level to which measurements are corrected (2) the surface from which seismic reflection times or depths are counted, corrections having been made for local topographic and/or weathering variations
fold (as in twelve fold)	(1) common-depth-point multiplicity (2) where the same CDP point is sampled at 12 offset distances, e.g., it is referred to as "12-fold"
geophysics	the study of the earth by quantitative physical methods, especially by seismic reflection and refraction, gravity, magnetic, electrical and radiation methods

gravity	-	(1) the force of attraction between bodies because of their mass (2) usually measured as the acceleration of gravity
mis-tie	-	(1) the difference obtained on carrying a phantom or reflection or some other measured quantity around a loop (2) the difference of values at identical points on intersecting lines or of values determined by independent methods
P-wave	-	(1) an elastic body wave in which particle motion is in the direction of propagation (2) the type of seismic wave assumed in conventional seismic exploration (3) also called compressional wave, longitudinal wave, primary wave, pressure wave, dilatational wave and irrotational wave
reflection	-	(1) the energy or wave from a shot or other seismic source which has been reflected (returned) from an acoustic-impedance contrast (reflector) or series of contrasts within the earth (2) the objective of most reflection-seismic work is to determine the location and attitude of reflectors from measurements of the arrival time of primary reflections and to infer from the reflectors the geologic structure and stratigraphy
stack	-	a composite record made by mixing traces from different records
statics	-	corrections applied to seismic data to eliminate the effects of variations in elevation, weathering thickness or weathering velocity
velocity	-	(1) a vector quantity which indicates time rate of change of displacement (2) usually refers to the propagation rate of a seismic wave without implying any direction (3) average velocity is the ratio of a given depth divided by the seismic travel time to that depth, often (but not always) assuming straight-raypath travel

Vibroseis - a seismic method in which a vibrator is used as an energy source to generate a wave train of controlled frequencies

weathering - (1) the low-velocity layer, a zone of low-velocity material near the earth's surface at the base of which the velocity abruptly increases
(2) the seismic weathering is usually different from the "geologic weathering" and the term LVL (lower velocity layer) is often used

seismogram - a seismic record

raypath - (1) a line everywhere perpendicular to wavefronts (in isotropic media)
(2) while seismic energy does not travel only along raypaths, raypaths constitute a useful method of determining arrival times through models by ray tracing

correlation - (1) indicating that events on two seismic records are reflections from the same stratigraphic sequence
(2) the matching of different well logs and other well data either in the same well or in different wells

spike - an impulse

geophone - (1) the instrument used to transform seismic energy into an electrical voltage
(2) a seismometer, a jug, or a pickup

phasing - a change in waveslope as a result of filtering or interference