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G. Randy Keller, William R. Seager, and Thompson, Sam, III.
1986, pp. 139-142. https://doi.org/10.56577/FFC-37.139

in:

Truth or Consequences Region, Clemons, R. E.; King, W. E.; Mack, G. H.; Zidek, J.; [eds.], New Mexico Geological Society 37th Annual Fall Field Conference Guidebook, 317 p. https://doi.org/10.56577/FFC-37

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A SEISMIC-REFLECTION STUDY OF PART OF THE SOUTHERN JORNADA DEL MUERTO

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Abstract—A 50 km long seismic-reflection profile was recorded as part of the CARDEX-81 (Caldera and Rift Deep Seismic Experiment) cooperative seismic experiment. These data were gathered by Exxon U.S.A. and extend NNW across the Jornada del Muerto from Organ, New Mexico. The southern portion of the profile is very complex because it crosses the Rio Grande uplift which is a Laramide feature exposed in the nearby San Andres Mountains. The remainder of the profile depicts the structural simplicity of Paleozoic, Mesozoic, and Cenozoic strata along the eastern flank of the Jornada del Muerto syncline, and also illustrates gradual southerly thickening of Paleozoic carbonate and Cenozoic clastic strata.

INTRODUCTION

In 1981, a major cooperative seismic experiment (CARDEX-81) was undertaken to study the crustal structure of the Rio Grande rift and Valles caldera. Most of the results of this study will appear in a special issue of the Journal of Geophysical Research (e.g. Sinno et al. in press, Daggett et al. in press, Olsen et al. in press). Exxon U.S.A. has had an ongoing exploration effort in southern New Mexico and has been kind enough to provide a long seismic-reflection profile to the data base for this experiment. The purpose of this brief paper is to report the results of this seismic-reflection survey.

SURVEY PARAMETERS AND LAYOUT

As shown in Fig. 1, the reflection survey was conducted along a line extending approximately 50 km north–northwest from Organ. The first 9 km of the line trends north, paralleling the San Andres Mountains, and is only about 3 km from outcropping Paleozoic, Mesozoic, and Tertiary rocks. Near Bear Canyon the line bends to a more northwesterly trend and extends out into the central portion of the Jornada del Muerto Basin.

The survey was conducted in 1981 and the data quality is generally very good. Vibroseis (trademark of Conoco Inc.) was the source employed and the range of frequencies used in the sweep was 9–36 Hz.

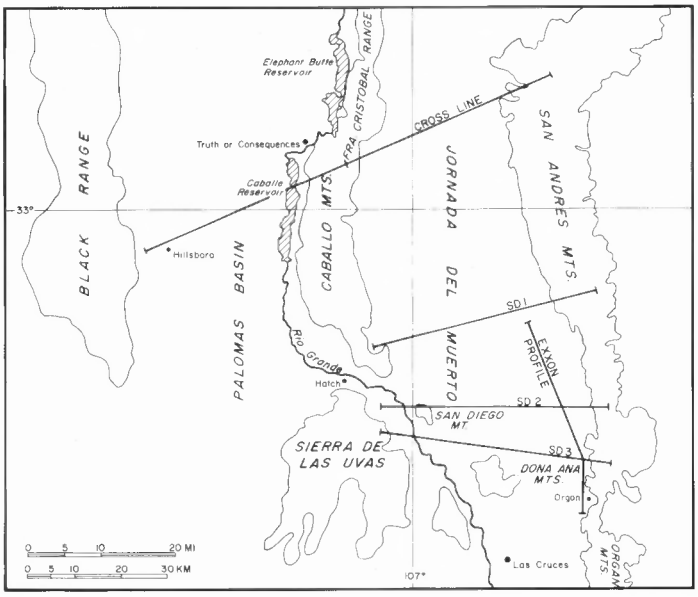


FIGURE 1—Index map showing location of Exxon seismic-reflection profile and seismic-refraction profiles (SD1, SD2, SD3, Cross line) of Harder et al. (this guidebook).

A 96-channel recording system was employed and the data were recorded at a sample rate of 4 ms. The groups of geophones were spaced at an interval of 67 m and the sources were spaced so that 48-fold (4,800%), common-depth-point (CDP) coverage was obtained. The multiplicity of shots and receivers as well as the CDP stacking resulted in each trace on the seismic-record sections (Figs. 2, 3) being in fact the sum of approximately 14,000 discrete seismic signals.

INTERPRETATION

Because of the good data quality, the record sections (Figs. 2, 3) to some extent speak for themselves. The stratigraphic picks shown in Fig. 3 were provided by Exxon and are probably tied to the Exxon #1 Prisor well through other seismic lines.

Stratigraphic relationships

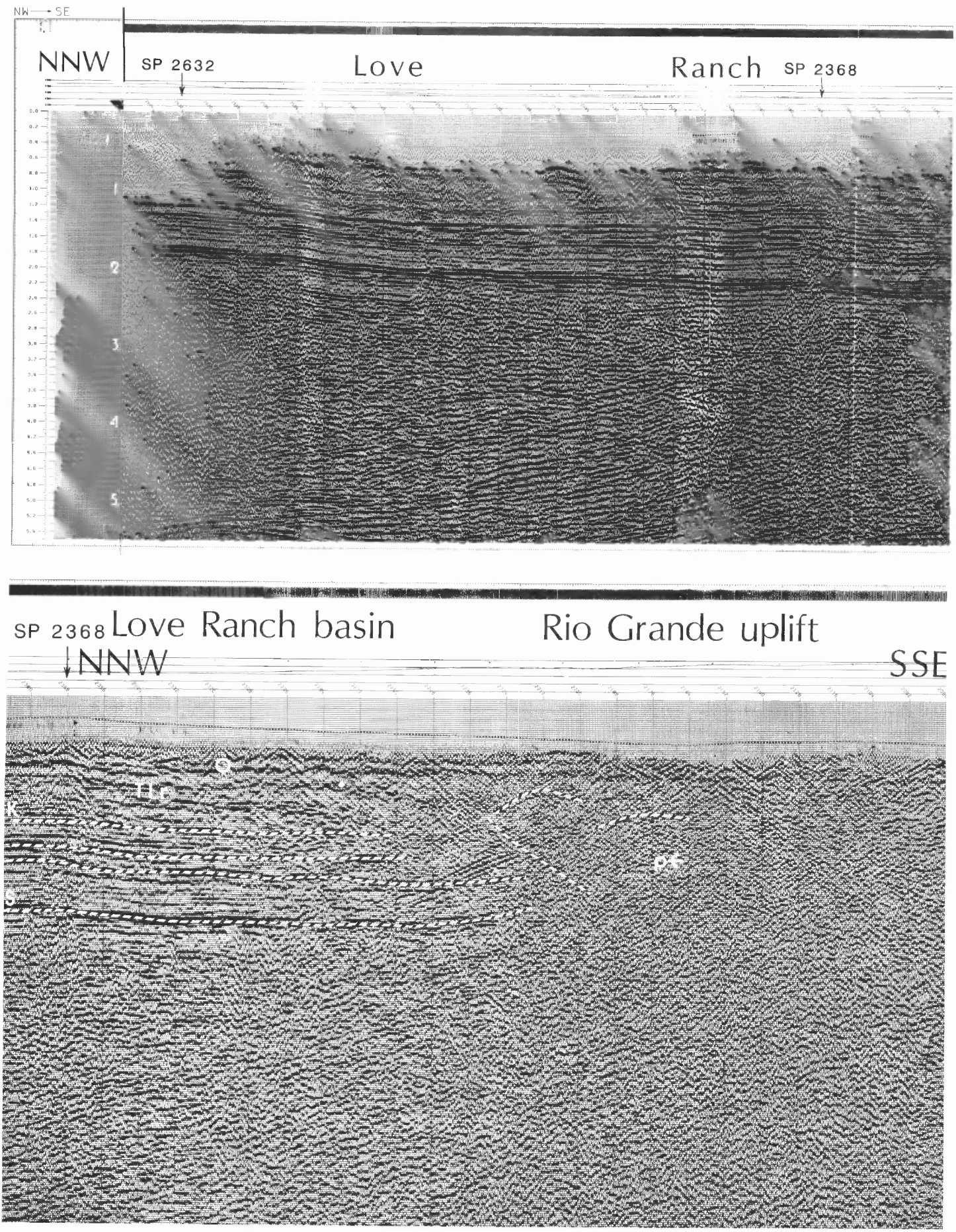
At shot points 2632 (north) and 2368 (south), the Exxon seismic interpreter indicated depths to selected stratigraphic horizons. Above the top of the Cretaceous are 1,372–1,982 m of Tertiary and Quaternary sedimentary rocks, most of which are probably alluvial-fan and basin-center clastic rocks of the Love Ranch Formation (Kottlowski et al. 1956) deposited in the Laramide Love Ranch Basin (Seager et al. in this guidebook). The 610–762 m of section between the top of the Cretaceous and the top of the Permian probably includes Lower Cretaceous Sarten Sandstone, Upper Cretaceous Dakota Sandstone, Mancos Shale (including Tres Hermanos Sandstone Member), and the Gallup Sandstone as shown by Seager (1981: 20, 33–34, fig. 22).

The 152–305 m section designated as Permian probably includes the Hueco Limestone, Abo Formation red beds, Yeso Formation sandstones, mudstones, and limestones, and San Andres Limestone. The 1,372–1,677 m between the top of the Pennsylvanian and the top of the Fusselman probably includes the Devonian Percha Shale, Mississippian Caballero–Lake Valley (shelf limestones) and Las Cruces–Rancheria Formations (basin limestones and cherts), and Pennsylvanian Lead Camp Limestone (shelf deposits) and Panther Seep Formation (sandstone, siltstone, and dark limestones deposited in the Orogrande Basin) (Seager 1981: 29–31).

The top of the Silurian Fusselman Dolomite is indicated at depths of 3,506 and 4,726 m at these two shot points. Note the high-amplitude reflections that are so typical of such a massive carbonate unit. About 305–457 m below top of the Fusselman is the top of Precambrian basement consisting of granite, diorite, and metamorphic rocks. Between these two horizons are: Cambrian–Ordovician Bliss Sandstone, Ordovician El Paso Formation limestones and dolostones, Ordovician Montoya Formation dolostones, and Fusselman Dolomite (Seager 1981: 21–24).

Structural relationships

Perhaps the most striking feature of the seismic section is the comparatively undeformed Phanerozoic sequence across the northern three-


NW → SE
NNW
SP 2632
Love
Ranch
SP 2368
SP 2368 Love Ranch basin
Rio Grande uplift
↓NNW
SSE
Q
Tp
pK

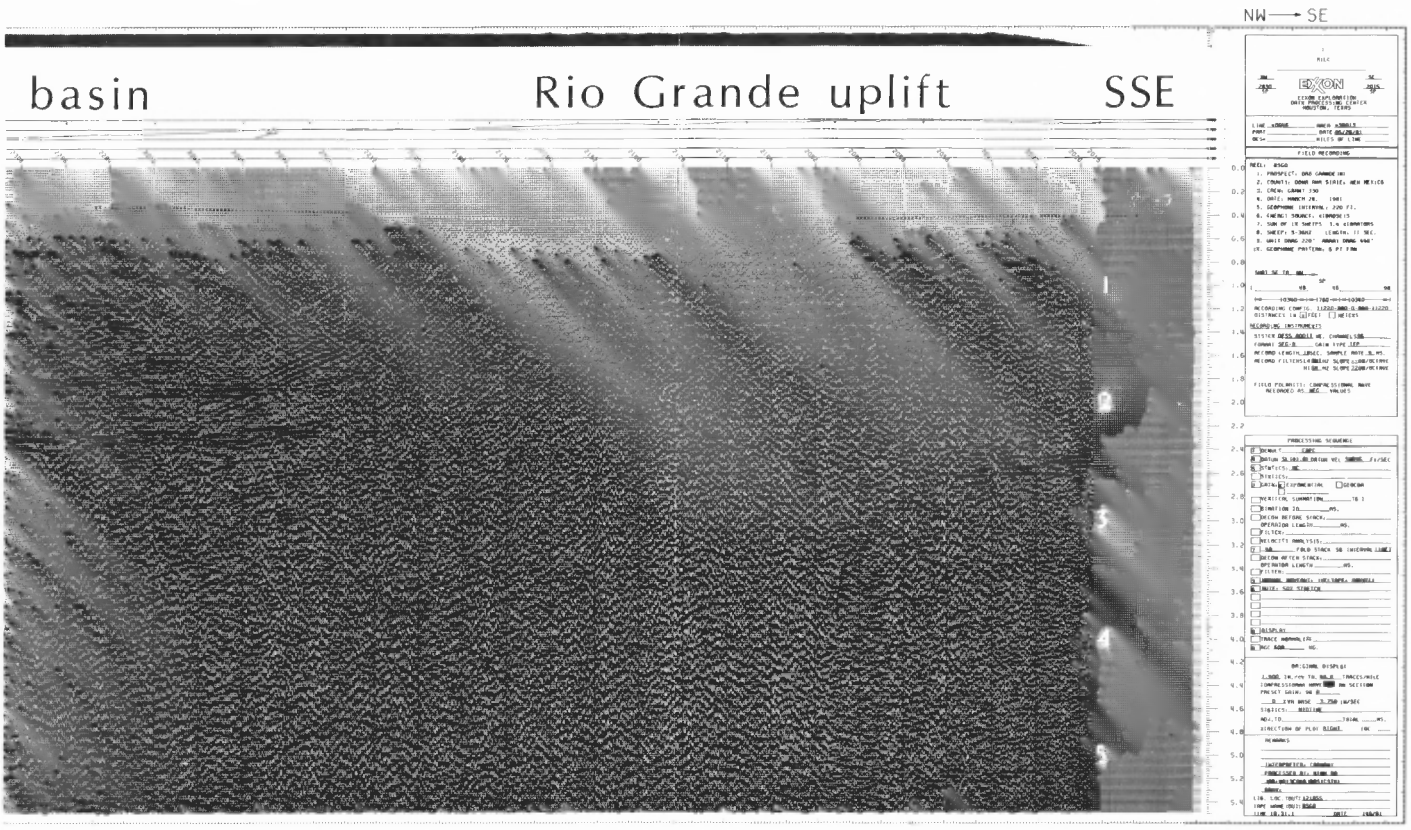


FIGURE 2—Uninterpreted seismic-reflection profile with locations of shot points 2368 and 2632 shown.

fourths of the profile. Near-horizontal reflectors in the profile represent apparent dips only, however, as the seismic section parallels the strike of strata in the San Andres Mountains. Actually, all formations, except Quaternary alluvium at the top of the section, probably dip west–southwest approximately 10–15°, the attitude of strata in the adjacent mountain range. Although the lack of faulting or folding is notable, it is not surprising considering the structural simplicity of the adjacent parts of the San Andres Mountains (Seager et al. 1986). The lack of structural complexity is encouraging for the preservation of oil or gas in the Jornada del Muerto Basin, and, indeed, the basin has been the site of several oil tests (Thompson 1976).

In contrast to the northern part of the profile, the southern quarter is more complex. This area is interpreted to be the subsurface extension of a major Laramide basement block uplift (Rio Grande uplift) which is exposed in the adjacent Bear Canyon–Bear Peak area of the southern San Andres Mountains (Seager 1981, Seager et al. in this guidebook). The uplift trends west–northwest and is bordered on its northeastern side by the Bear Peak fold and thrust belt, a zone of basement thrust and reverse faults displaying as much as 3 km of dip separation. A projection of the Bear Peak fold and thrust belt northwestward beneath alluvium of the Jornada del Muerto would intersect the seismic profile near shot point 2220. Disruption of the near-horizontal reflectors at this point is obvious on the profile and is interpreted to be this marginal fault zone of the Laramide uplift. The transparent region south of shot point 2220 is interpreted to be uplifted Precambrian basement above which deformed Paleozoic strata may be represented by discontinuous reflectors. Love Ranch fanglomerate and Quaternary alluvium may onlap the uplift in the profile just as they do in outcrops along the westernmost exposures of the Bear Peak fold and thrust belt (Seager 1981). The thick, undeformed section of Love Ranch Formation north of the Rio Grande uplift on the profile was deposited in the Love Ranch Basin, a complementary downwarp to the uplift (Seager et al. in this guidebook).

The Rio Grande uplift and its marginal thrust fault are exposed again in the Tonuco uplift (San Diego Mountain) on the western side of the Jornada del Muerto (Seager et al. in this guidebook). Thus, the seismic profile is important in helping to establish the continuity of the uplift across the Jornada del Muerto Basin from outcrops on either side.

ACKNOWLEDGMENTS

The authors would like to thank the Exxon Company U.S.A. for permission to publish the data in this paper. Partial funding for this study was provided by National Science Foundation grant EAR-8025371.

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FIGURE 3—Critical portion of seismic-reflection profile with interpretations shown. In the Love Ranch Basin (NNW), the Love Ranch Formation is indicated by Tlr and the tops of the Cretaceous (K), Permian (unlabeled), Pennsylvanian (unlabeled), and Silurian (S) are extrapolated from shot point 2368. Quaternary fan deposits are designated by Q and Precambrian rocks by P€. The interpreted structure of the Rio Grande uplift is also shown (SSE).

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