)CORP DEEP SEISMIC REFLECTION TRAVERSE ACROSS THE SOUTHERN OKLAHOMA AULACOGEN

R. Good, L. Brown, J. Oliver and S. Kaufman
Department of Geological Sciences, Cornell University

INTRODUCTION

The Consortium for Continental Reflection Profiling (COCORP) recorded deep seismic profiles across the Southern Oklahoma aulacogen. The profiles run from the Hardeman basin, across the Wichita Uplift, and into the northern part of the Anadarko basin. The location of the COCORP lines and major geologic features are shown on Figure 1. The three major findings of the survey include evidence for: (1) an extensive Proterozoic basin lying south of the Wichita Mountains; (2) thrusting of the Wichita Mountains over the Anadarko basin by several kilometers; and (3) anticlinal structures within the Anadarko basin that can be interpreted as cored by blind listric thrust faults. These features are illustrated on the two seismic lines and the generalized geologic cross section. The following summary is abstracted from more detailed description published by Brewer et al (1981, in press).

GEOLOGIC SETTING

The Southern Oklahoma aulacogen is a major tectonic element of the southern midcontinent. The exact definition of the aulacogen and even the time of the initiation is unclear, with some authors using the term for the deep Paleozoic Anadarko basin (the most obvious manifestation), while others suggest it also includes the Wichita Mountains and Hardeman basin to the south. The Southern Oklahoma aulacogen was placed within a plate tectonic framework by Burke and Dewey (1973) and Hoffman et al (1974), who suggested that the aulacogen may represent a "failed" rift arm which was reactivated by Pennsylvanian deformation associated with closure of an ocean to the southeast.

Initially, subsidence was thought to have started in the Late Cambrian with transgression of the basal Reagan sandstone over Precambrian basement. However, extensive studies by Ham et al (1964) showed that thick sequences of pre-Reagan sandstone, rhyolites, basalts, and metagraywackes are also present in this area. Ham et al (1964) suggested that major downwarping of the whole area occurred in the Late Precambrian or Early Cambrian, followed in the middle Cambrian by outpouring of basalts over the graywackes and intrusion by gabbros. Faulting and differential erosion was followed in the middle Cambrian by extrusion of silicic volcanic fields and intrusion of granites, forming what is now the Wichita Mountain block. Paleozoic subsidence and sedimentation was then concentrated in the Anadarko basin with deformation culminating in the Pennsylvanian.

A PROTEROZOIC BASIN

Pronounced, widespread, and relatively undeformed layering in the Precambrian basement south of the Wichita Mountains extends to approximately 13 km (8 mi) depth (Line 1, Station 685-200). Based on limited data described by Oliver et al (1976) these layers were interpreted as a sequence of igneous rocks (Lynn, 1980), but more extensive data suggest they are due to depositional processes in a Proterozoic basin, possibly 1,200 to 1,400 m.y. old (Brewer et al, 1981). Based on regional Precambrian geology, and on the geology of rocks of similar age elsewhere in the world, clastic sediments and felsic volcanics are thought to be the most likely constituents of this inferred basin, although other lithologies (such as basalts or carbonates) are possible. The areal extent of the layered Precambrian rocks south of the Wichita Mountains is at least 2,500 sq km (965 sq mi) based on the COCORP data, and some oil exploration data indicates that it is probably very much larger.

The deep layering seems to be truncated, or at least offset, on the south side of the Wichita Mountains (VP 210 on Line 1). Discontinuous remnants may exist under the Wichita Mountains. The truncation and/or offset suggests a Precambrian or Early Cambrian fault, possibly associated with the intrusion of Cambrian granites. This fault was reactivated, with a reverse dip-slip sense, in Pennsylvanian times as the Burch fault (index map; Line 1).

PENNSYLVANIAN OVERTHRUSTING

The Wichita Mountains appear to be thrust over the Anadarko basin along faults of the Wichita Frontal System that dip south at roughly 30 to 40° and which can be traced to depths possibly as great as 20 to 24 km (12.5 to 15 mi; Brewer et al, 1982). The northern boundary of the fault system (Mountain View Fault) is clearly delineated by the COCORP data but the southern boundary (with crystalline rocks overthrust along the Meers Fault) is less well imaged (Line 2, 2A; cross section). Severely folded and faulted Lower Paleozoic rocks that were uplifted from the deepest part of the Anadarko basin lie within the Frontal Fault System (Harlton 1963, 1972; Takken, 1967). Discontinuous reflections and diffractions from this area, together with the moderate dip of the Mountain View and Meers faults, strongly suggest that, in the region of the COCORP lines, these sedimentary rocks exist 6 to 7 km (3.7 to 4.3 mi) deep beneath the Frontal Fault System (significantly greater depths than usually drilled there) and that they may extend as much as 8 to 9 km (4.9 to 5.5 mi) south under the overthrust crystalline rocks of the Wichita Uplift.

If this interpretation is correct, possibly as much as 10 to 15 km (6.2 to 9.3 mi) of Pennsylvanian crustal shortening occurred in the Southern Oklahoma aulacogen. The geometry of the Mountain View Fault suggests deformation was mainly compressional, although it may have been accompanied, or followed, by left-lateral strike-slip movements such as are thought to be an important cause of uplift of the Arbuckle Mountains to the east (Booth, 1981). The en echelon pattern of the faults bounding the northern and southern sides of the Wichita Uplift (Ham et al, 1964, Figure 1), and their reverse dip-slip sense on the COCORP data (see cross section), is consistent with some component of oblique, left-lateral slip along the Wichita trend.

Anticlinal structures within the layered sedimentary rocks of the Anadarko basin close to the Wichita Uplift can, in some cases, best be interpreted as hanging-wall anticlines cored by blind, listric thrust faults (Line 2A, below Station 1000). These listric thrusts probably propagated out into the layered rocks of the basin from the Frontal Fault System as the Wichita Mountains were uplifted. An example is the Cordell anticline in Pennsylvanian strata (index map, Line 2, 2A), cored by a thrust fault that apparently flattens above the Mississippian Chester Limestone and roots in the Frontal Fault System. Although the evidence is less clear, rocks deeper in the section were possibly deformed by another listric thrust which flattens near the base of the sedimentary section and probably also roots in the Frontal Fault System. To the best of our knowledge this structural style has never been recognized in the Anadarko basin, and it suggests that the origin of other anticlinal structure within the basin should be reevaluated.

Truncation of Ordovician and earlier layered rocks of the basin suggests down-to-the-basin normal faulting during Upper Precambrian(?)-Lower Paleozoic subsidence of the Anadarko basin (cross section). During Pennsylvanian deformation, some of these inferred normal faults may have been reactivated as thrusts of the Frontal Fault System, and others may have acted as ramps for the listric thrusts.

SUMMARY

Interpretation of COCORP's Oklahoma surveys suggest that a Proterozoic basin underlies a large area south of the Wichita Mountains, that the Wichita Uplift was thrust over the Anadarko basin, and that hanging-wall anticlines are cored by listric faults within the Anadarko basin.

ACKNOWLEDGMENTS

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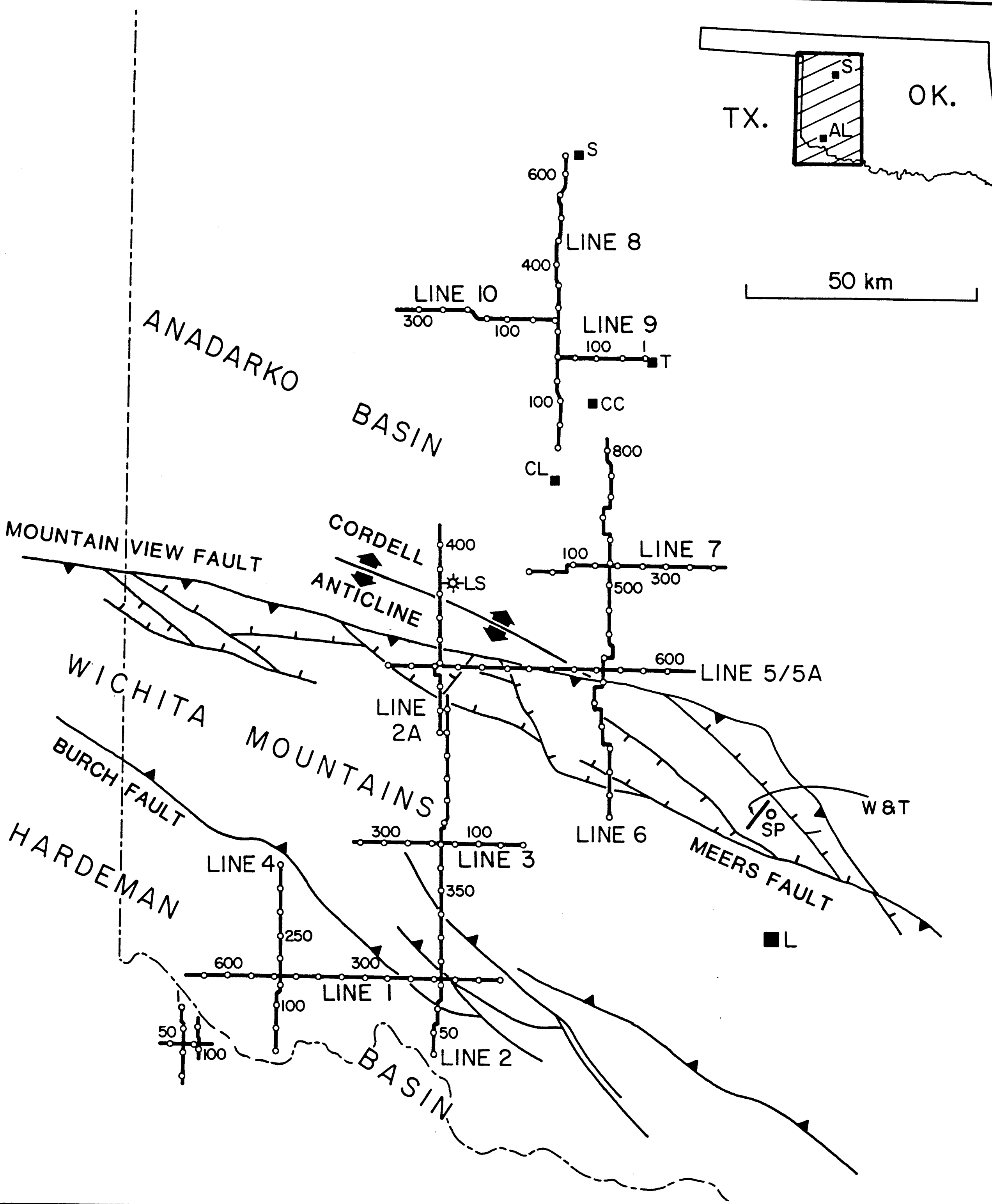
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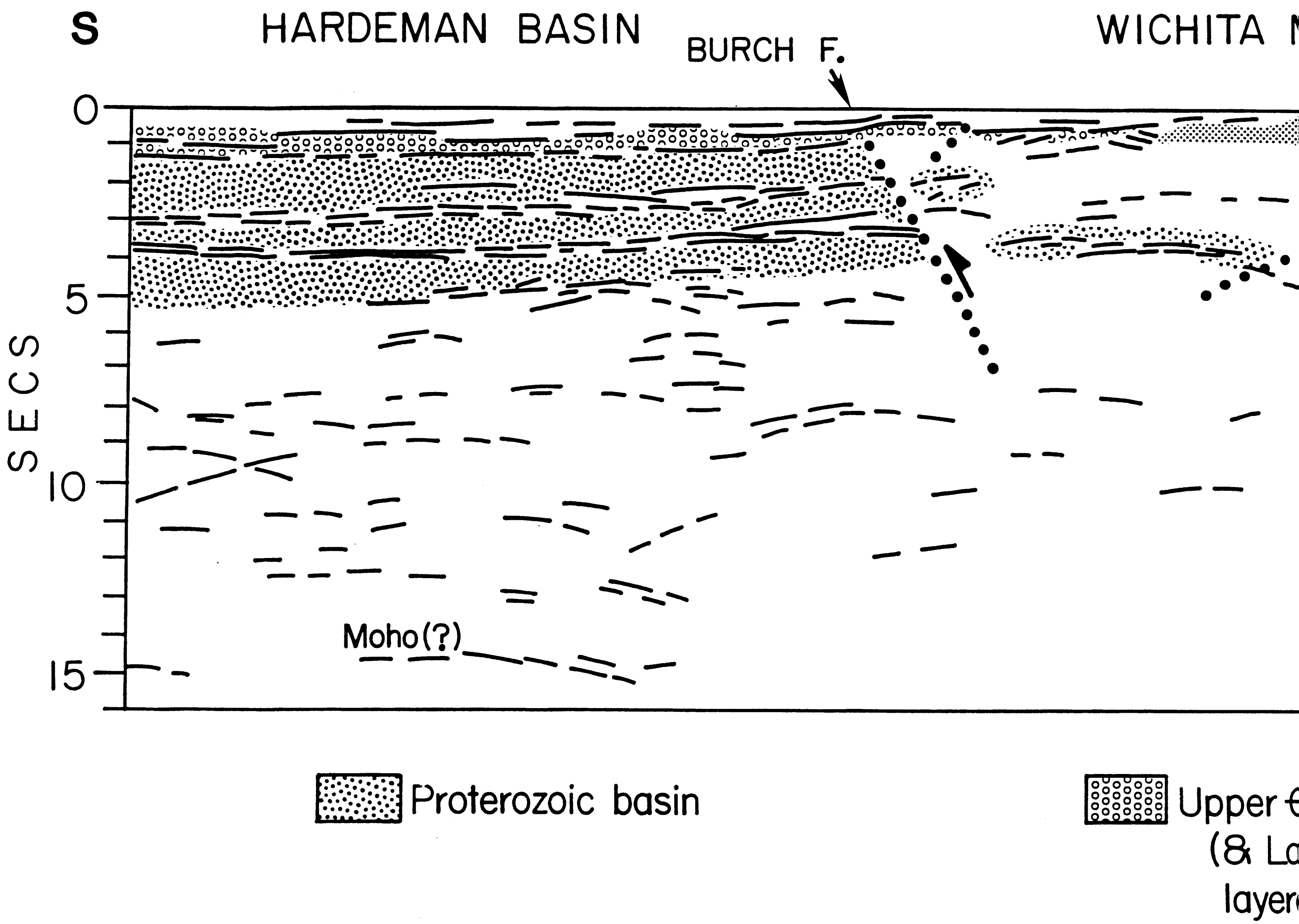
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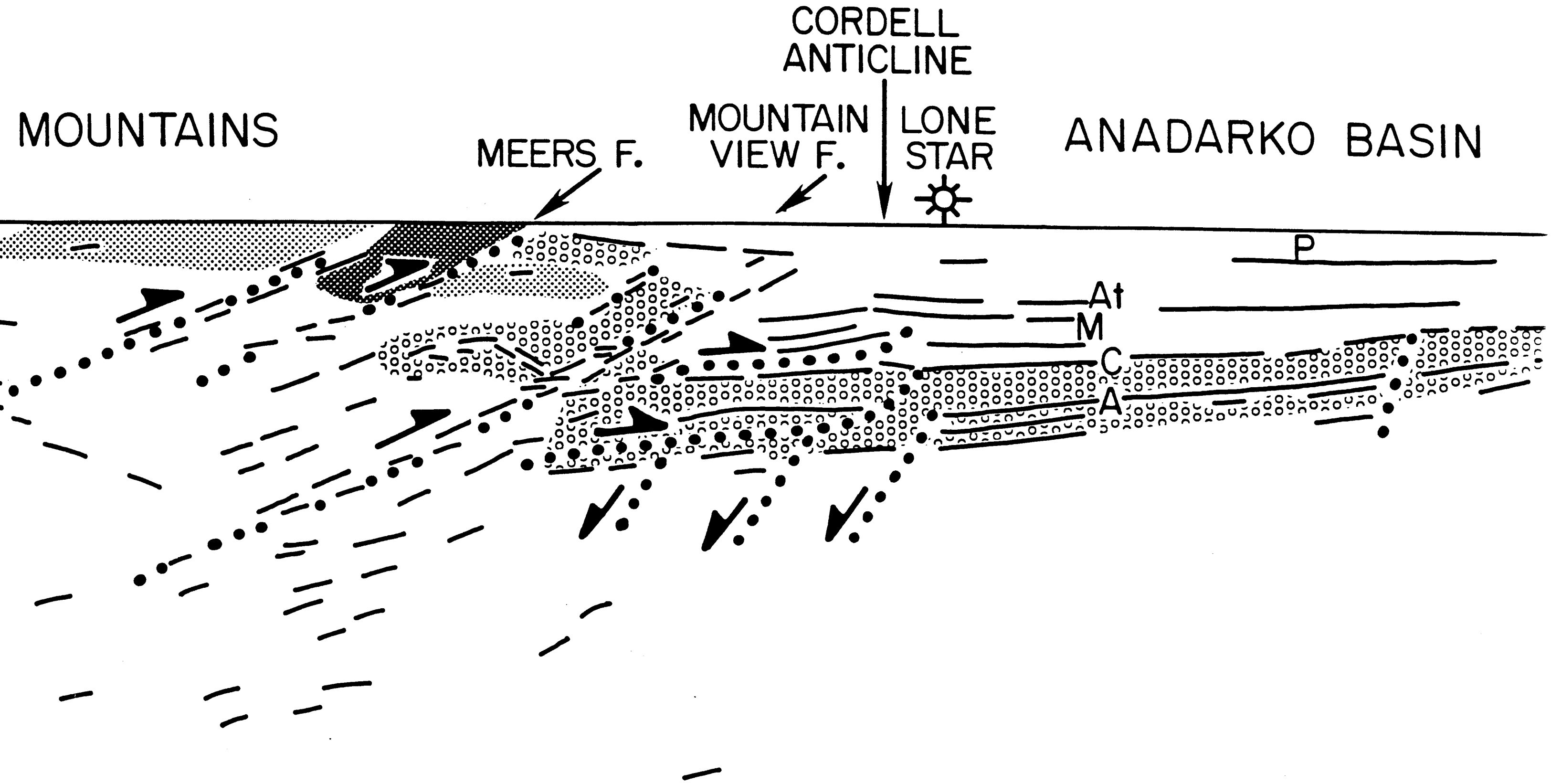
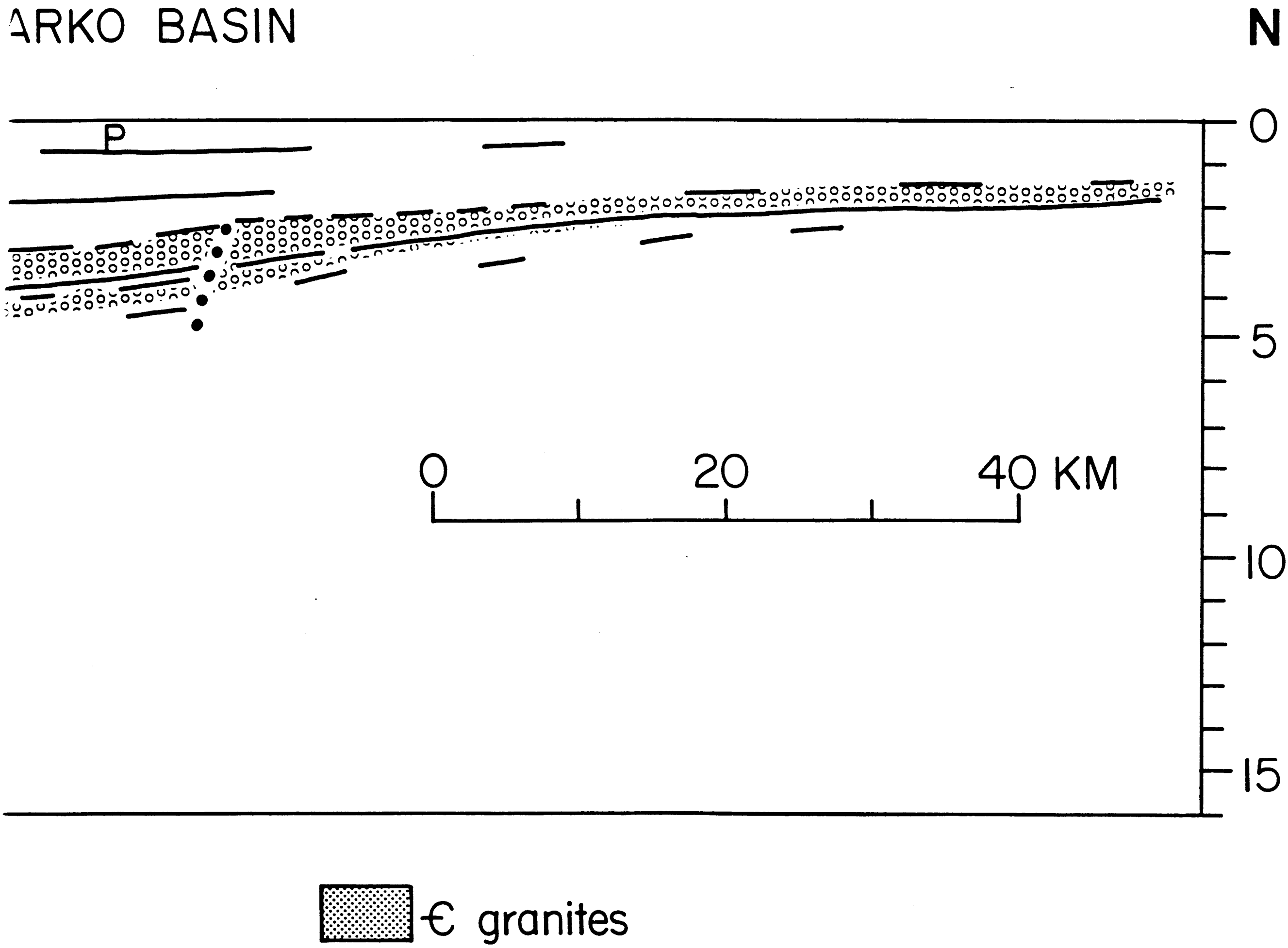


r Є-Miss. sediments
Late PЄ(?)-Middle Є
ered rocks in Anadarko Basin)

Є(?)-gabbro

ARKO BASIN



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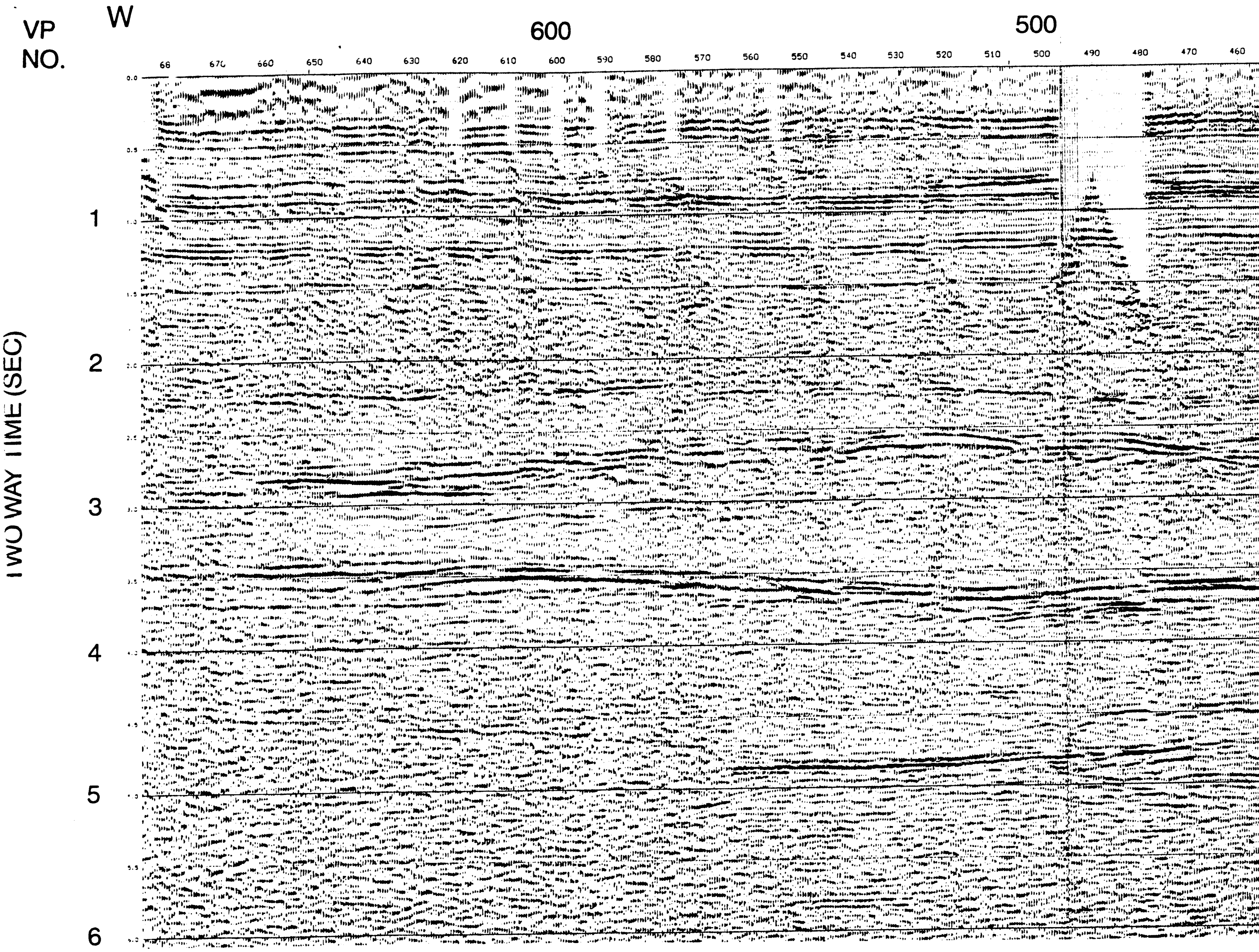
LINE 1

HARDEMAN BASIN



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Maximum Offset Distance: 32,340 ft (9,857.2 m)
Static Corrections: elevation / auto-residual statics
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Other: AGC with a 1 sec window
Migration: no
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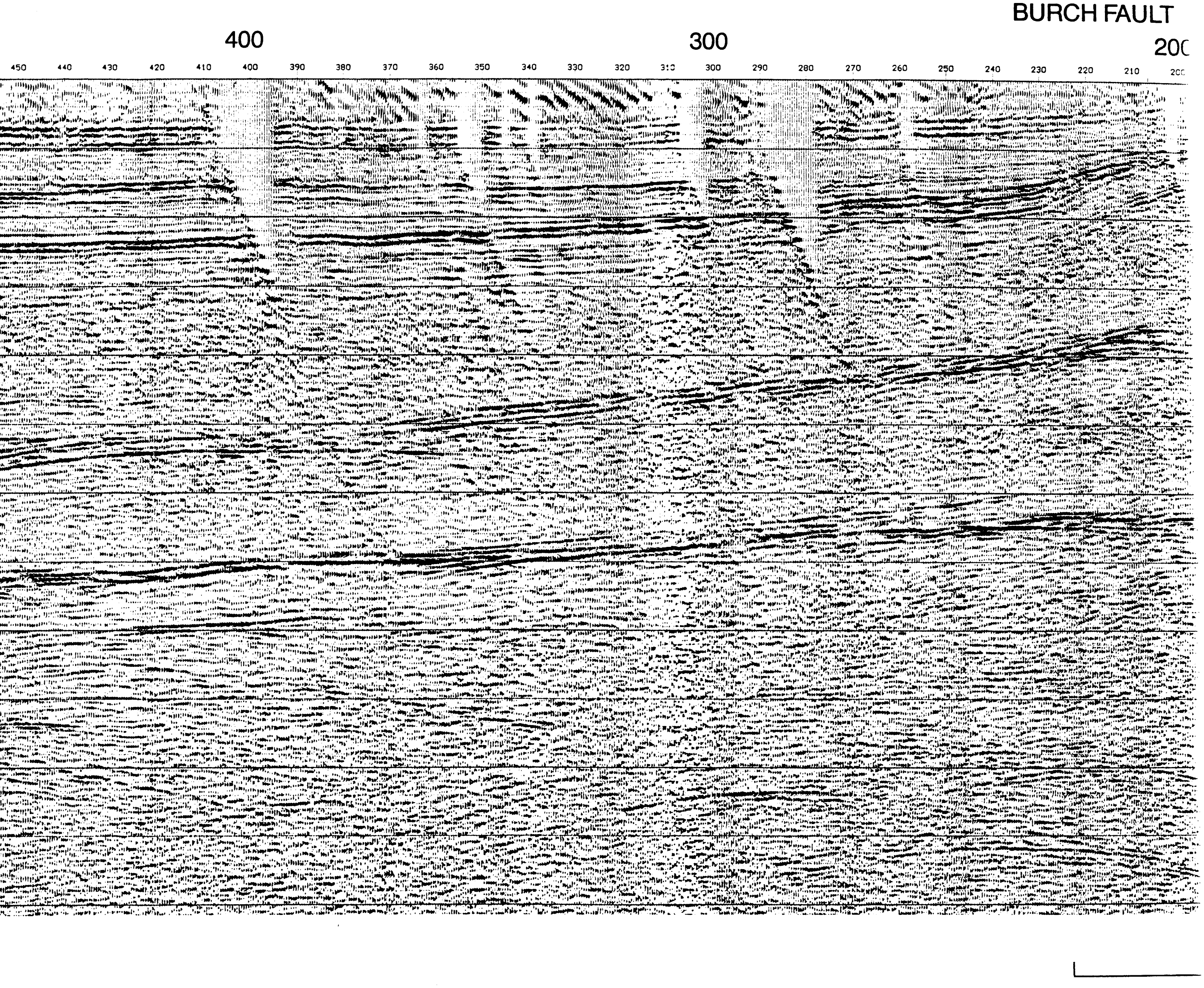
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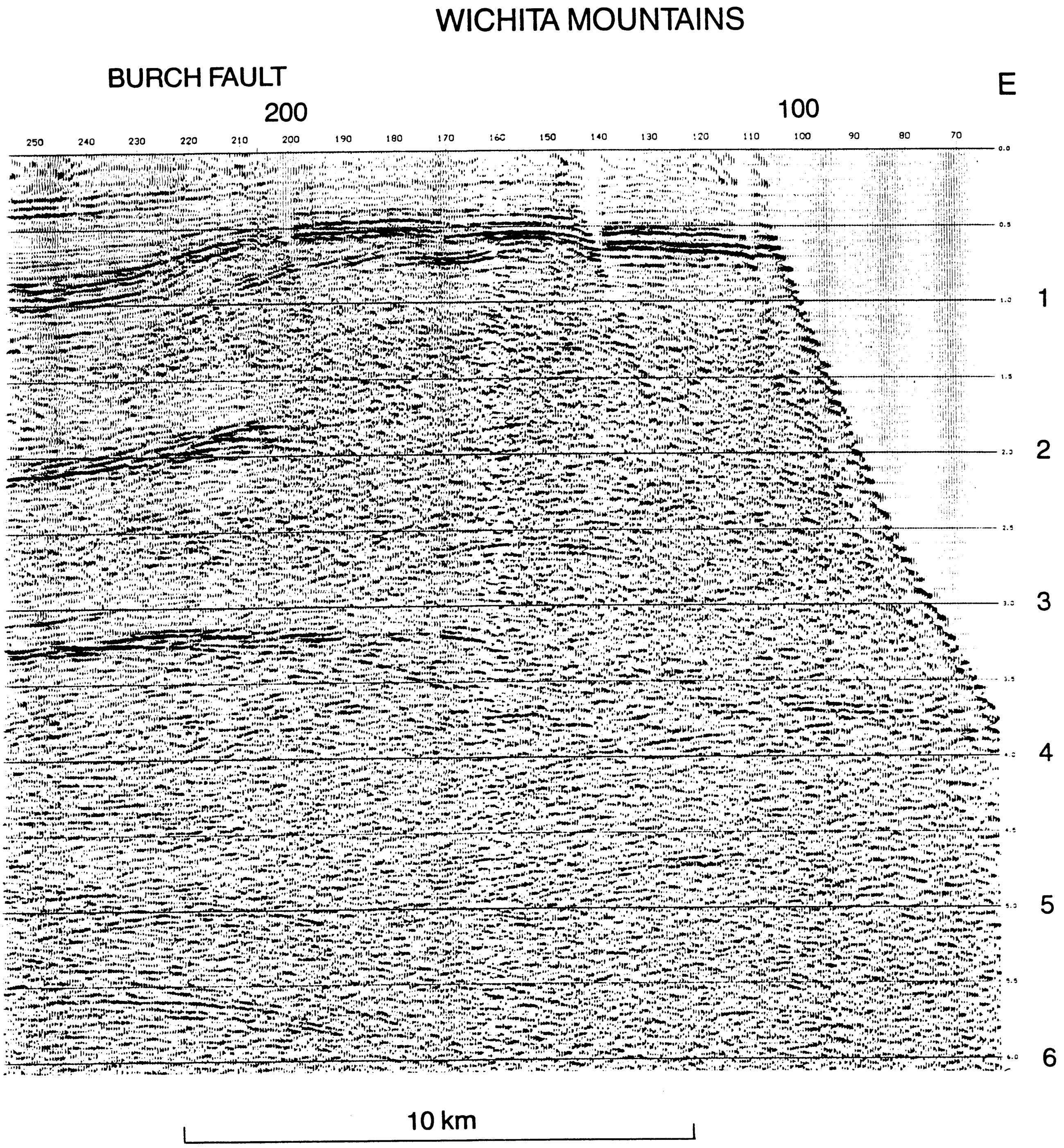
WICHITA MOUNTAINS
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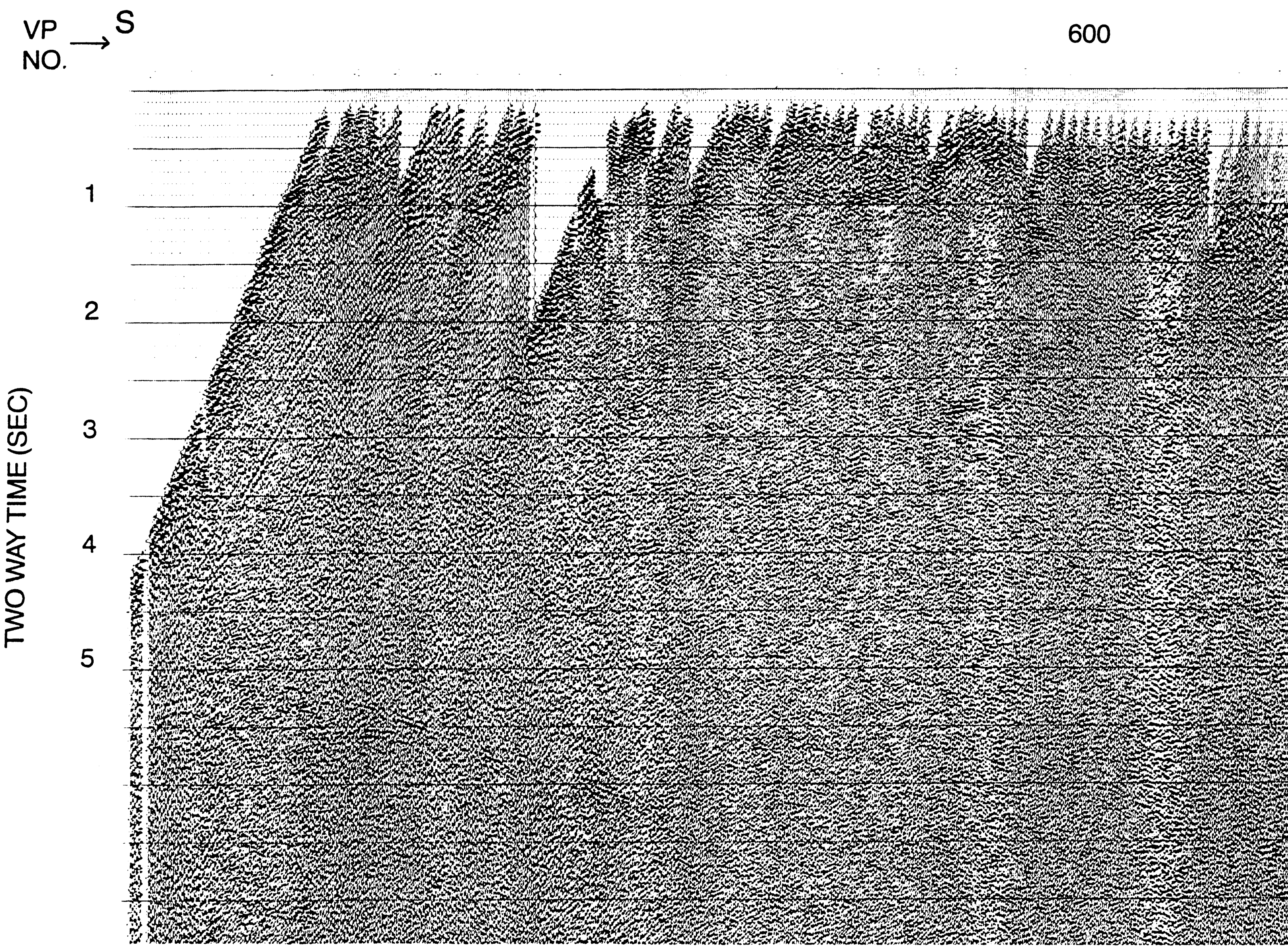
LINES 2 2A

WICHITA MOUNTAINS



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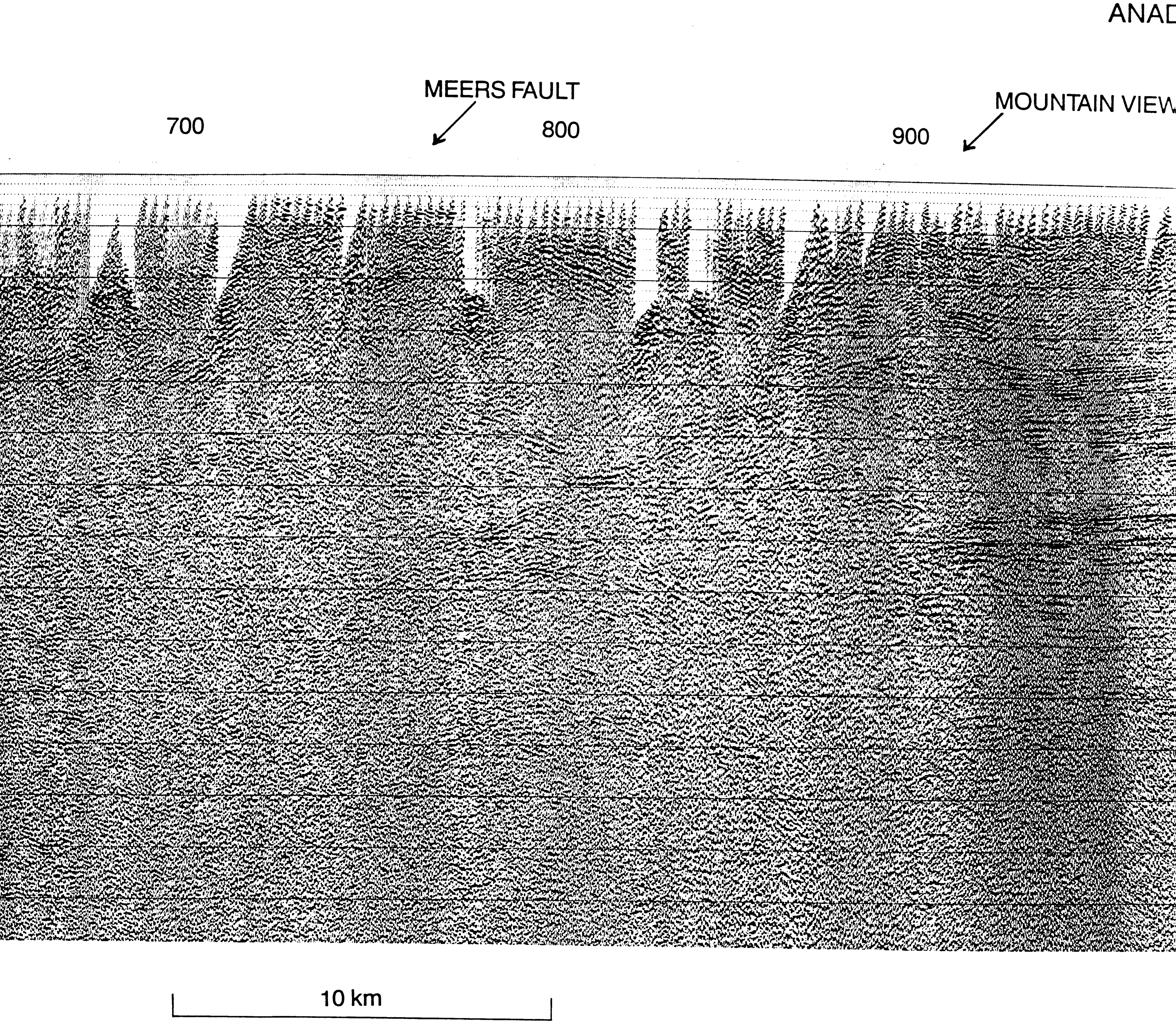
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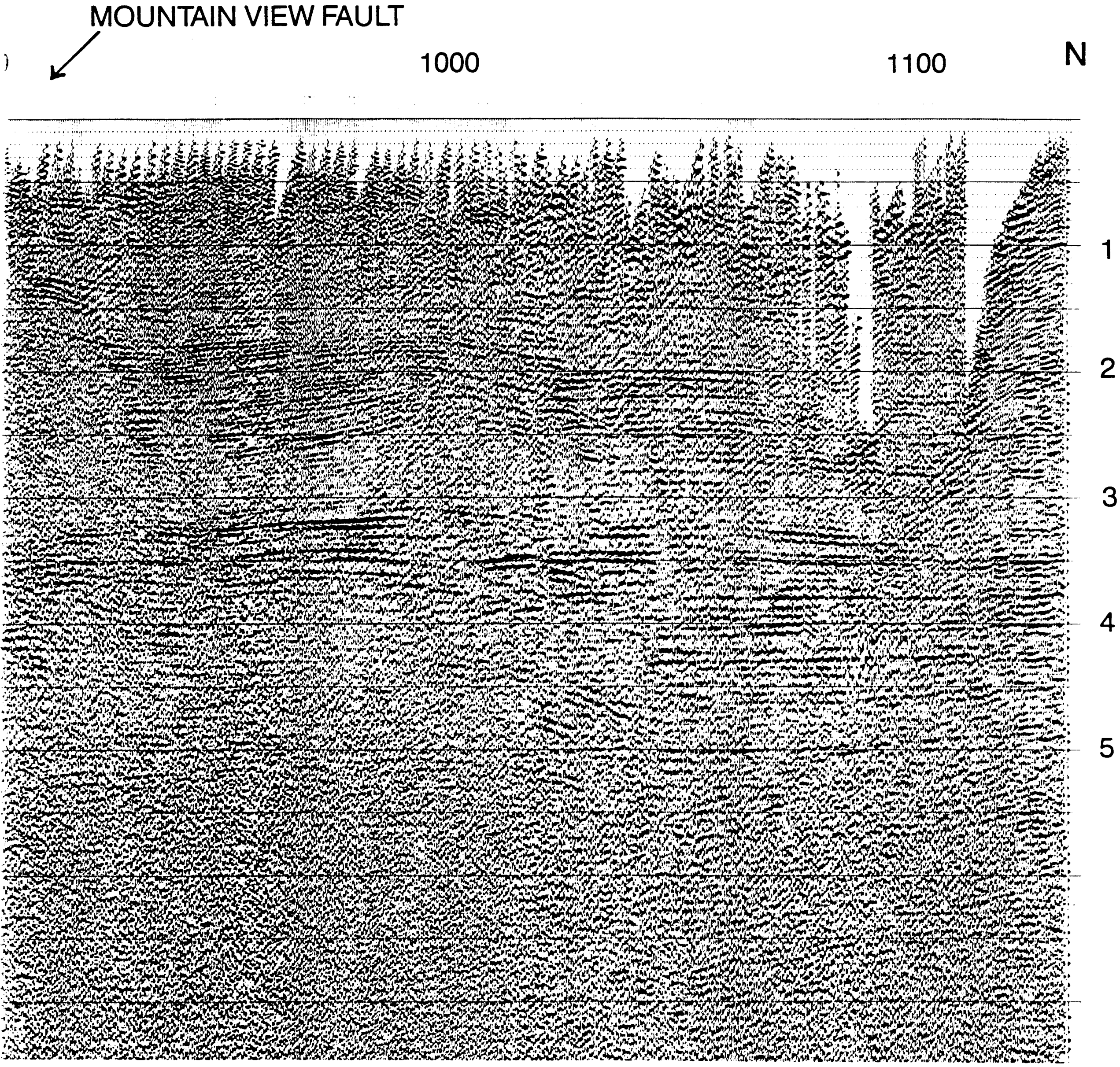
ANADARKO BASIN



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