THE MAJOR COALS OF BOWMAN, SLOPE, ADAMS, AND HETTINGER COUNTIES, NORTH DAKOTA

by

Edward C. Murphy, Ned W. Kruger, and Gerard E. Goven

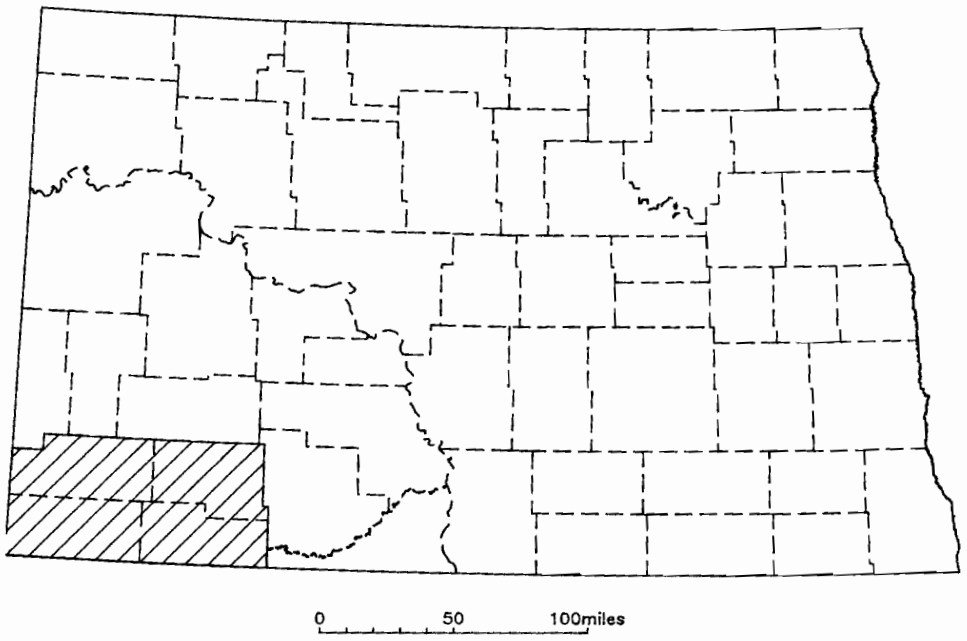

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TABLE OF CONTENTS

ACKNOWLEDGMENTS

This work was made possible by the National Coal Resource Data System (NCRDS), a matching grant program from the U.S. Geological Survey. The NCRDS program is administered by M. Devereux Carter in Reston, Virginia. This grant was supplemented by funds from the Fort Union Coals of the Rocky Mountains and Great Plains Project under the National Coal Assessment Program. The Fort Union Coals Project is under the direction of Dr. Romeo Flores, U.S. Geological Survey, Denver, Colorado.

ILLUSTRATIONS

Figure

INTRODUCTION

Stratigraphic data on the Fort Union from all of the available oil and gas, coal, and uranium holes in Bowman, Adams, Slope, and Hettinger counties were entered into a computer database (Stratifact). Lithologic data from 1746 holes was entered into the system for this area of approximately 5,500 square-mile area (Figure 1). The majority of logs available were suites of gamma, density, resistivity, and spontaneous potential logs from coal and uranium holes. Unfortunately, these holes were seldom more than 400 feet deep. Deep well control was provided by gamma logs run through surface casing in oil wells. Lignites are often difficult to detect on gamma logs run through casing and are impossible to verify without an accompanying density log.

The Cedar Creek anticline and badlands topography created by incision of the Little Missouri River has resulted in the exposure of strata ranging from the Pierre Formation (Upper Cretaceous) to the Arikaree Formation (Miocene) in this part of southwestern North Dakota (Figure 2). The Fort Union Group (the coal-bearing strata) is absent along the western edge of Bowman and the southwestern edge of Slope counties but is 1400 to 1500 feet thick in north-central Hettinger county. Any given locality in this area, with the exception of western Bowman and Slope counties, may be underlain 20 or more beds of coal. Most of these coals are less than 3 feet thick, but there are at least three major coal horizons within this four-county area: HT Butte, Harmon/Hansen, and T Cross where the coals typically approach or exceed 10 feet in thickness.

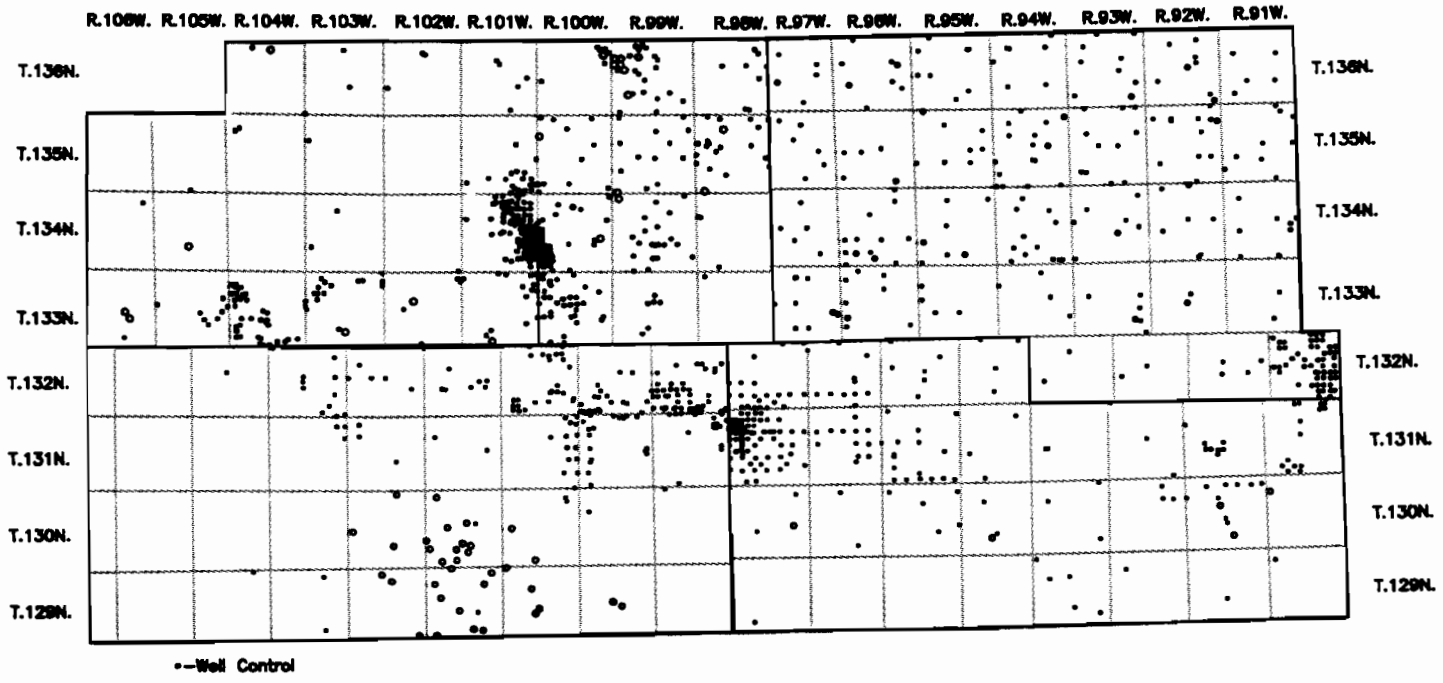

Figure 1. Well control in Bowman, Slope, Hettinger, and Adams counties.

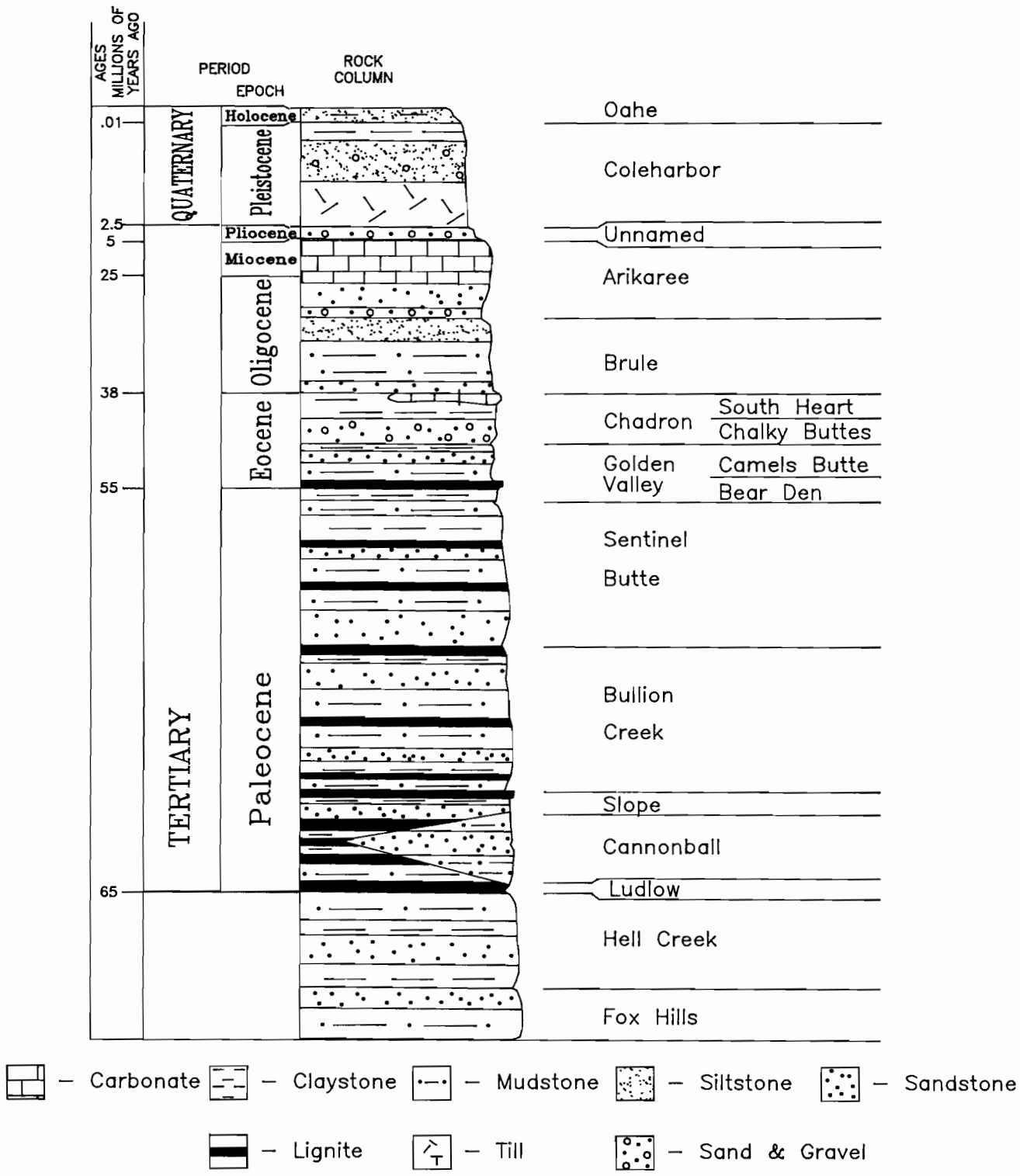

Figure 2. Generalized stratigraphic column of surface strata in western North Dakota.

BOWMAN COUNTY

Introduction

Lithologic data from 575 holes in Bowman County was entered into the database. Approximately 90% of the electric logs entered into the system came from coal and uranium exploration holes (Figure 3). Only 55 of the 127 oil wells in the eastern two-thirds of the county were of any use, either because they had run gamma logs through surface casing or had terminated surface casing within the Fort Union Group.

The coal-bearing strata in Bowman County ranges in thickness from zero along the western edge to over 800 feet in the northeastern corner of the county. The Cedar Creek anticline and the badlands topography has exposed strata in Bowman County ranging from the Pierre Formation (upper Cretaceous) to the Sentinel Butte Formation (Paleocene). Cretaceous strata is exposed at the surface in the western one-third of the county (Figure 4). There are very few coals in Fox Hills and Hell Creek strata and none reported from the Pierre. These Cretaceous coals are generally very thin (typically less than three feet) and not very continuous. As a result, this portion of the county can virtually be eliminated as an area containing potential coalbed gas. However, as will be discussed later, gas has been reported from sandstones in the Fox Hills Formation in this area.

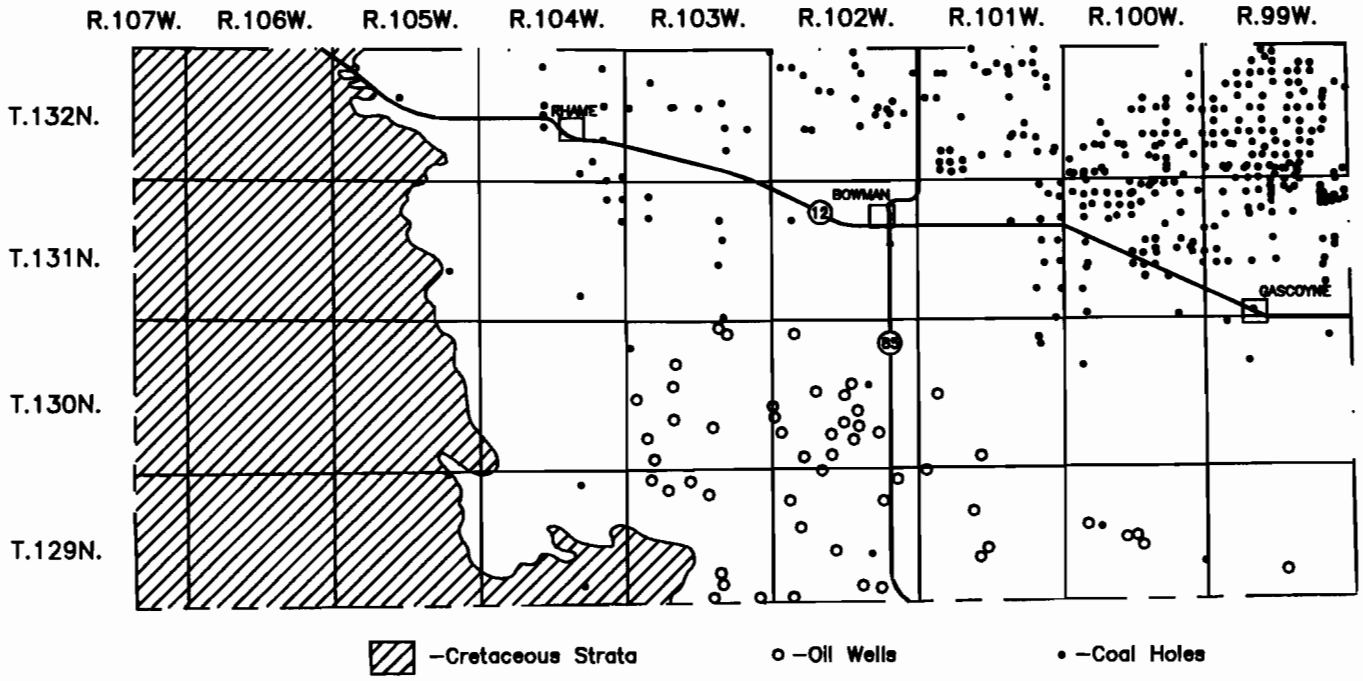

Figure 3. Well control in Bowman County.

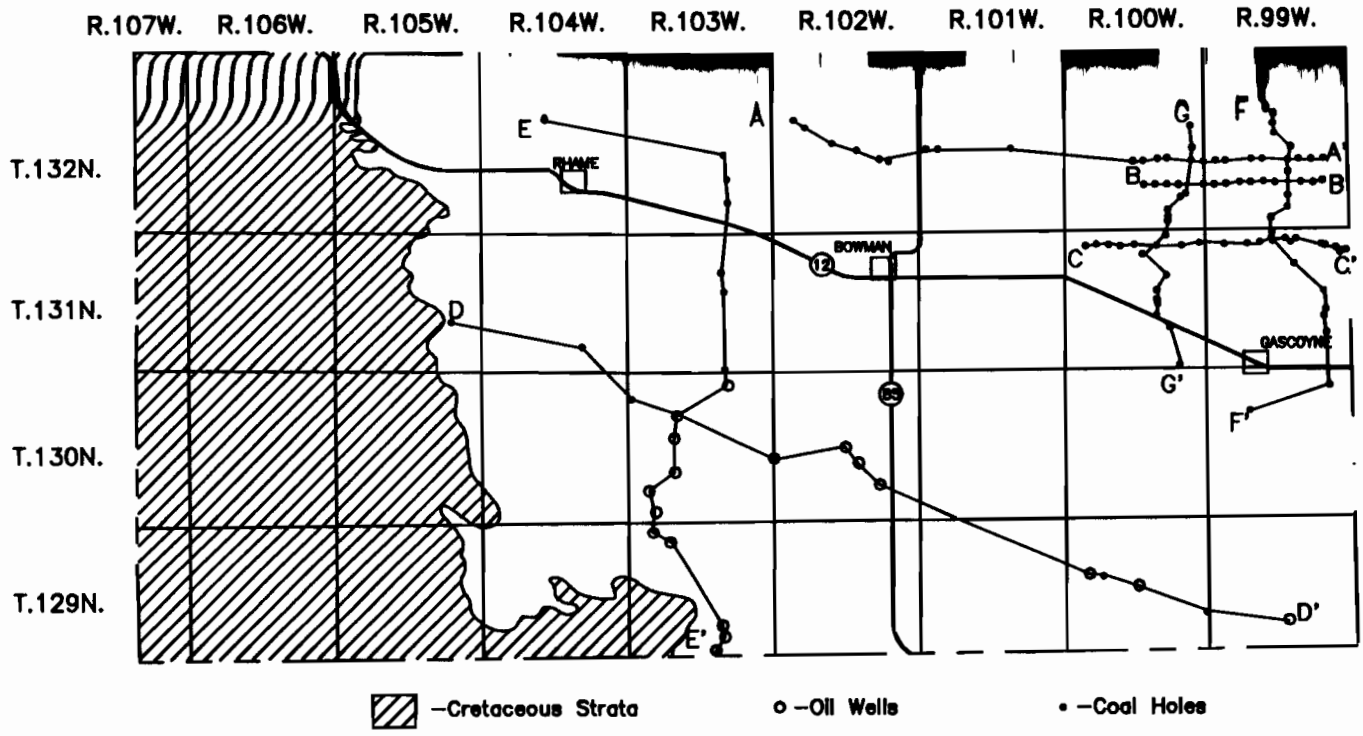

Figure 4. Traces of geologic cross-sections in Bowman County.

There are two major coal horizons in Bowman County, the Harmon/Hansen and the T Cross (Figures 5-11, Appendix A). These coals often change dramatically in thickness over a relatively short distance due to thinning, thickening, and splitting of the beds. Most of the coal exploration holes in this county are concentrated in the area of the old Gascoyne coal mine which closed in the 1990s. Drillhole spacing throughout much of this area averages one-half mile in comparison to the average three or four mile spacing found throughout much of western North Dakota. Even with this close spacing, it is often difficult to trace the coals in this area.

Fox Hills Formation

The Fox Hills Formation consists of 100 to 200 feet of marine mudstones and sandstones. The top of the Fox Hills Formation is generally marked by the Colgate Member, a 20-50 foot-thick sandstone. This member, and therefore the top of the Fox Hills Formation, is often difficult to identify in the subsurface due to the similarity between the log profiles of the Colgate and overlying channel sandstones in the Hell Creek Formation (Figures 8 and 9).

In recent years, farmers and ranchers have complained about gas and odors coming from their Fox Hills wells (Kris Roberts, ND Health Department, per. comm., 2/11/99). The North Dakota Health Department has recently been sampling Fox Hills wells in an area approximately three miles wide and 14 miles long south of Rhame. Although the wells have at times exuded and effervescence, gas would not support a flame. The gas has not been analyzed for methane but has ranged from less than one to two parts per million H_2S.

The State Water Commission, while monitoring groundwater in the Fox Hills in McKenzie County in the 1980s, encountered gas. The gas was analyzed at several locations and generally contained 33-65% methane, the remaining component was nitrogen (Alan Wanek, NDSWC, per. comm. 2/11/99).

T Cross Lignite

The T Cross coal is located at the base of the Slope Formation. At the type section of the formation in Slope County the T Cross bed is approximately 10 feet thick. A coal, located at the appropriate stratigraphic position, was identified as the T Cross and correlated in cross-sections D and E (Figures 8 and 9). The T Cross is approximately 10 feet thick in west-central Bowman County but thins to five feet or less in the eastern part of the county (Figure 12). It reaches a maximum (single bed) thickness of 15 to 20 feet in the Rhame area (Figure 12). The T Cross was present as a single bed throughout most of Figure 8 but split into as many as three beds in Figure 9, with a cumulative coal thickness of as much as 25 feet. The T Cross could not be correlated across the entire length of either cross-section. Channel sandstones appear to be responsible for the absence of this bed in the northern portion of cross-section E (Figure 9). The T Cross bed crops out in the western and southern portion of the county but is present at depths of over 600 feet in the northeastern corner of the county (Figure 13). The coal bed dips to the northeast at an approximate rate of 25 feet per mile (Figure 14).

Harmon and Hansen Beds

The Harmon and Hansen beds occur in the lower portion of the Bullion Creek Formation in western North Dakota. The Harmon bed overlies the Hansen bed and the intervening strata between these coal ranges from a few feet to over 50 feet. The Harmon is typically the thicker of the two beds obtaining a maximum thickness of 32 feet in north-central Bowman County (T.132 N., R.102W.) (Figures 5 and 15). The Harmon bed has burned throughout much of this area. In Bowman County, the Harmon bed ranges from a single bed of coal to four beds or splits with cumulative coal thicknesses up to 20 feet. Typically, the Harmon is less than 10 feet thick throughout most of the northeast portion of the county. The Hansen bed ranges from one to three beds of coal, is generally less than five feet thick, and obtains a maximum thickness of 24 feet in section 1, T.131N., R.100W. (Figures 7 and 15). The Harmon and Hansen beds outcrop along Highway 12 in the vicinity of the town of Gascoyne. Although the Harmon and Hansen beds

are no longer mined by Knife River Coal Company they are mined by the American Colloid Company from shallow excavations where they have been oxidized to form Leonardite. Underground mining occurred in the Harmon bed in the early part of this century north of Bowman (T.132N., R.102W., sections 14 and 15) and just east of the school at Scranton (Bruce Beechie, ND Public Service Commission, per. comm., 3/18/99).

The Harmon and Hansen beds are restricted by erosion to the northeast portion of Bowman County. Throughout much of this area, the Harmon and Hansen beds are at a depth of less than 100 feet (Figure 16). These beds are at least 250 feet beneath the surface in an area north of Gascoyne (Figure 16). The Harmon and Hansen beds dip to the northeast at an approximate rate of 23 feet per mile (Figure 17).

As noted by Carlson (1979) the Harmon and Hansen beds are persistent throughout this area but sometimes must be correlated as zones rather than individual beds. Even with the excellent drillhole control that is available in northeastern Bowman County it is extremely difficult to correlate these coals due to rapid thickness changes, numerous splits, and elevation changes. In at least one locality, the Harmon and Hansen beds are absent and appear to have been removed by a channel sandstone or not deposited due to the presence of this fluvial system (Figure 11). If these relatively thin beds are deemed viable candidates for coalbed methane, the geologic cross-sections in this report demonstrate careful analysis of existing data and a detailed exploration program will be needed to target the thickest occurrences of coal.

Information from coal companies and published data suggest that the Harmon and Hansen beds typically have heating values of 5,900 to 6,700 Btu/lb, an average ash content of 6.0 percent, and a sulfur content between 0.6 and 1.4 percent on an as received basis (Keighin et al., 1998).

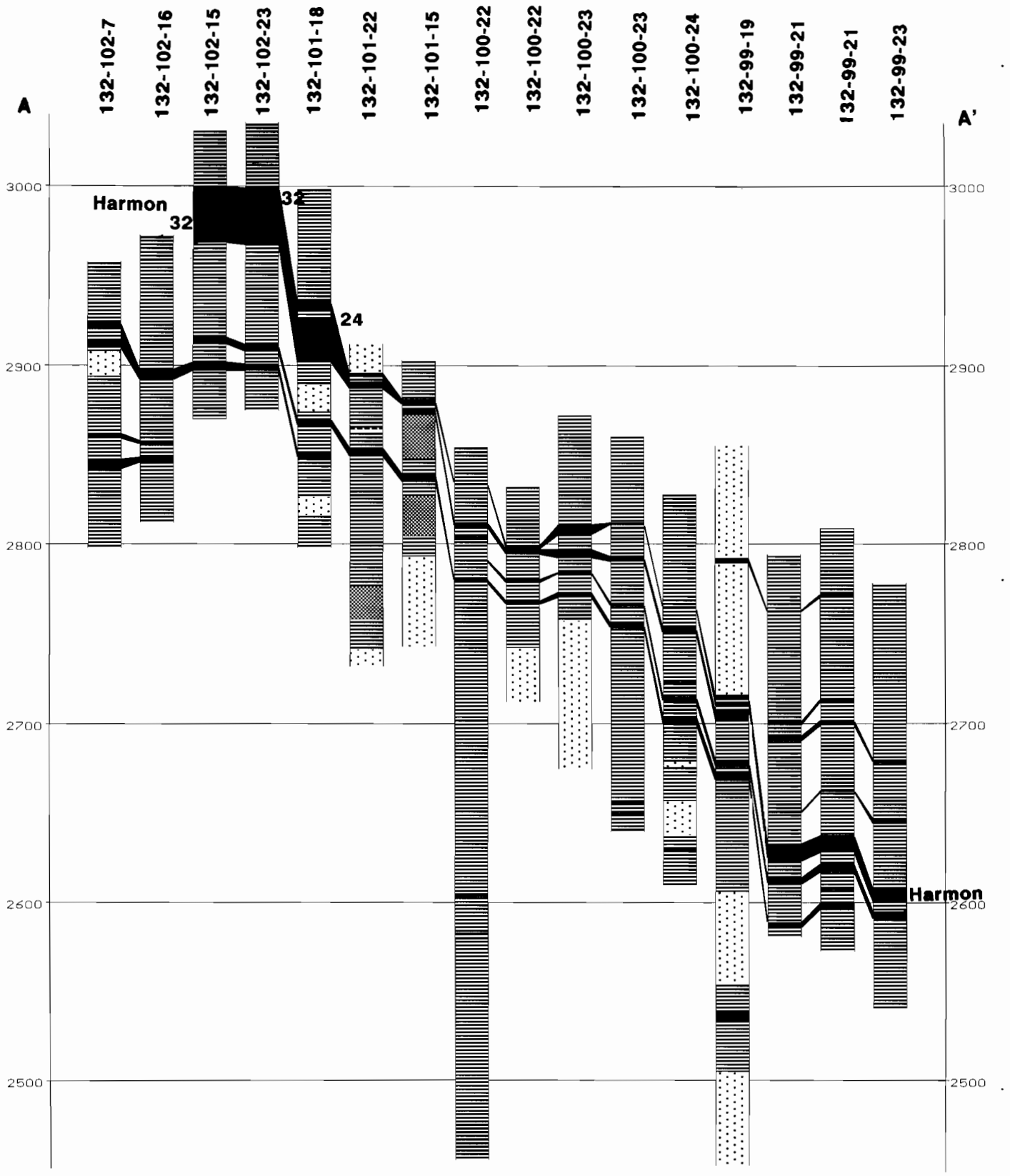

Figure 5. Cross-section A-A' of Fort Union strata in northern Bowman County.

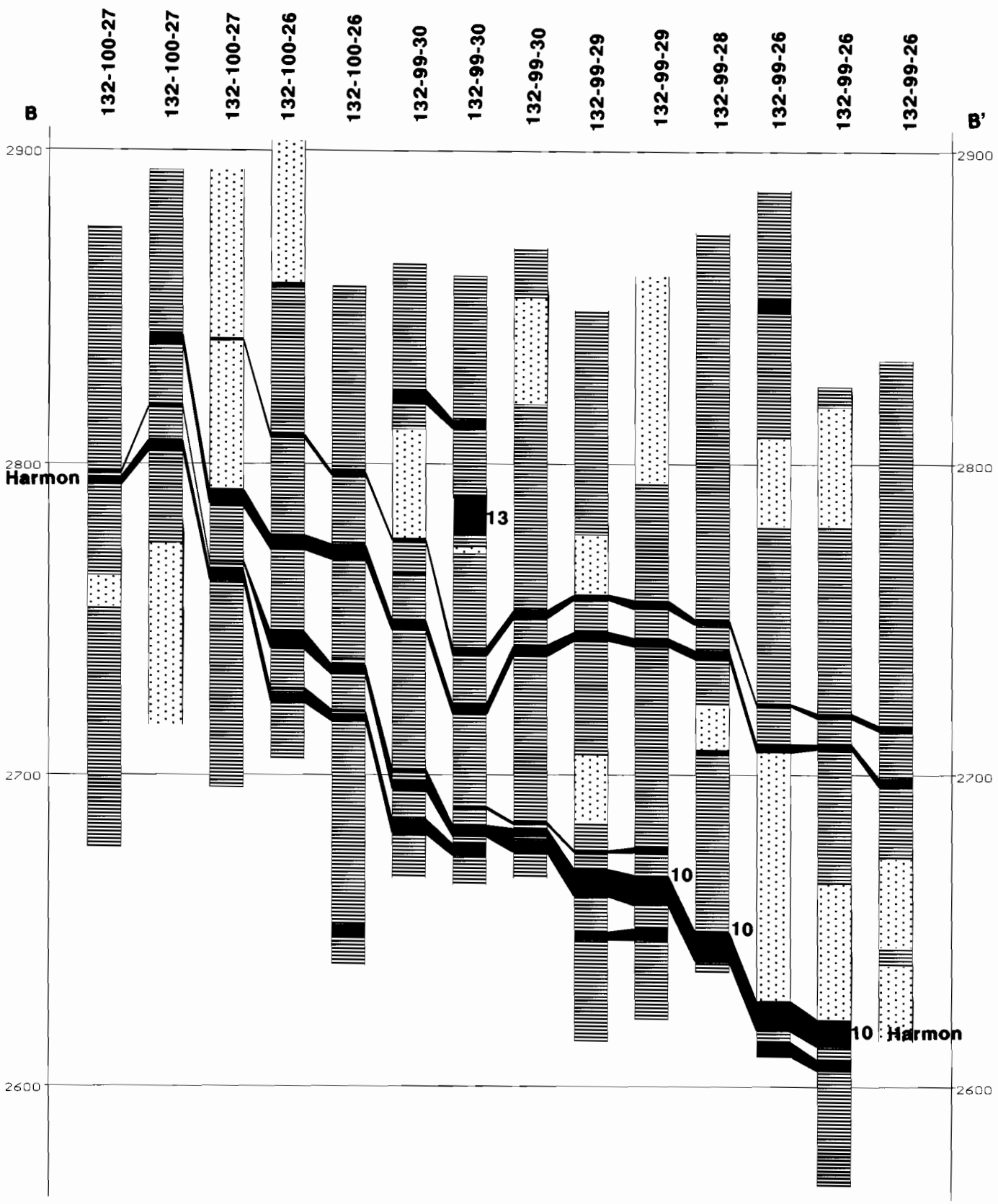

Figure 6. Cross-section B-B' of Fort Union strata in northeastern Bowman County.

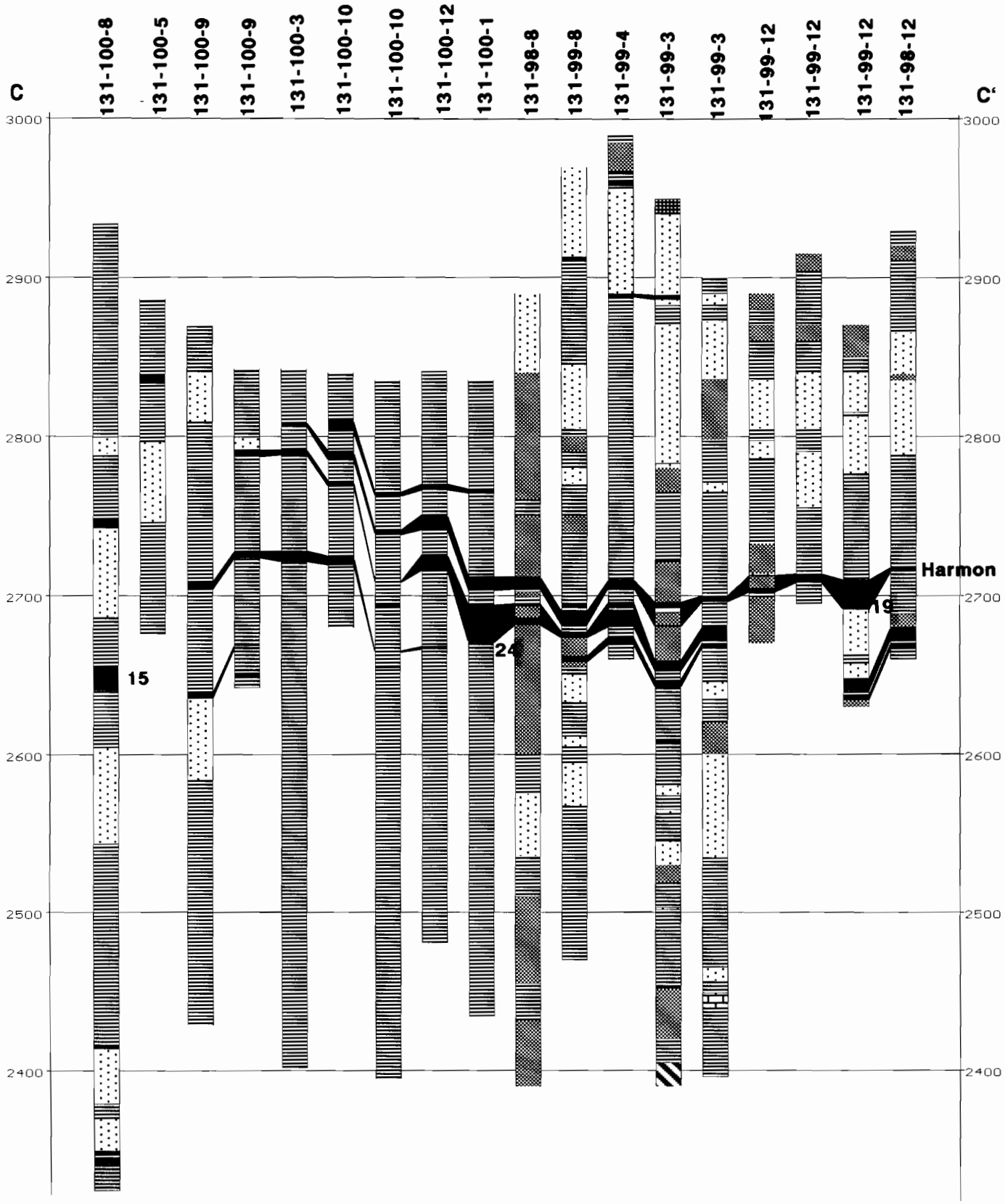

Figure 7. Cross-section C-C' of Fort Union strata in northeastern Bowman County. Only beds of coal thicker than 10 feet are noted on the sections. Thicknesses obtained from multiple beds are noted by an (*).

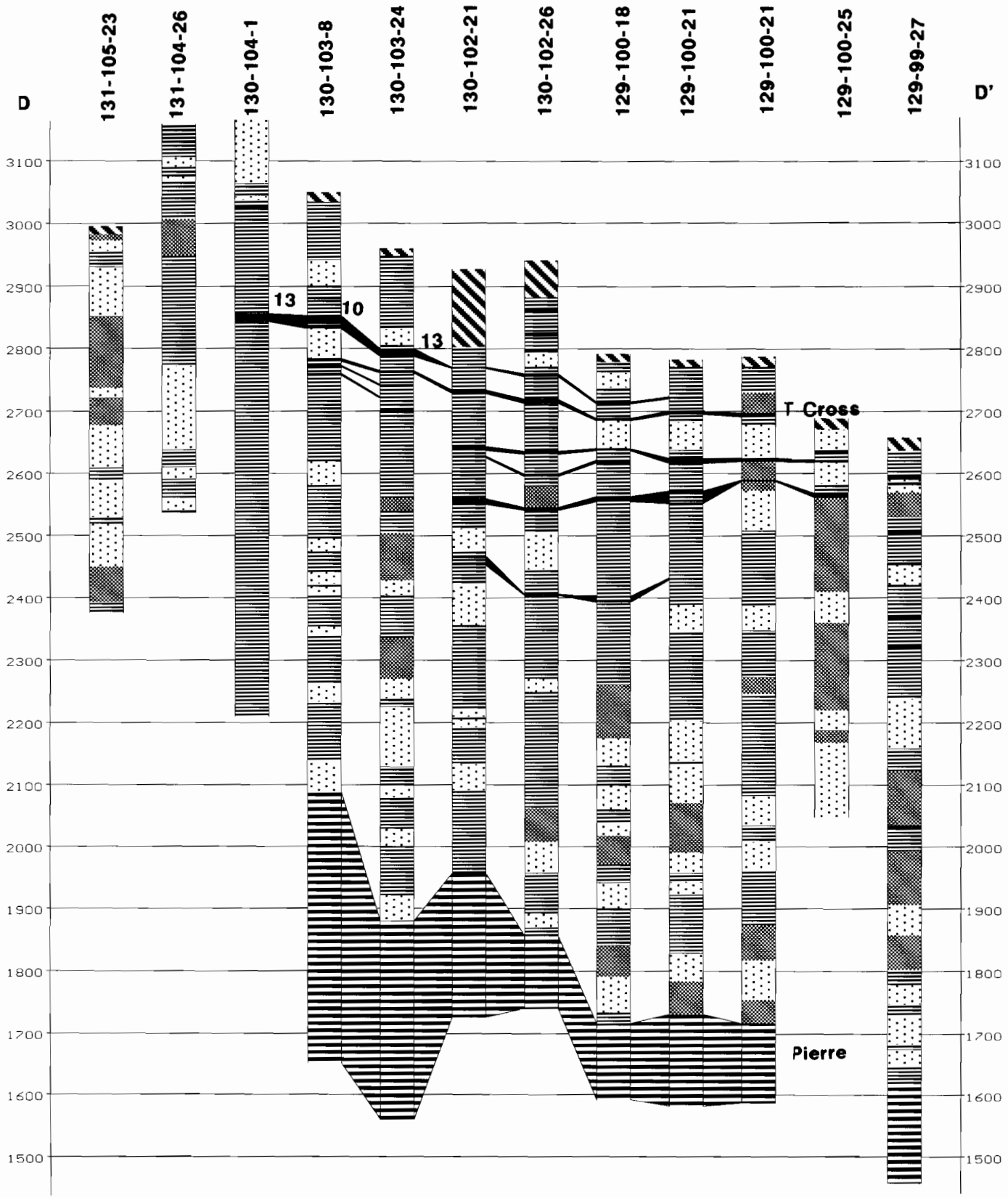

Figure 8. Cross-section D-D' of Upper Cretaceous and Fort Union strata in southern Bowman County.

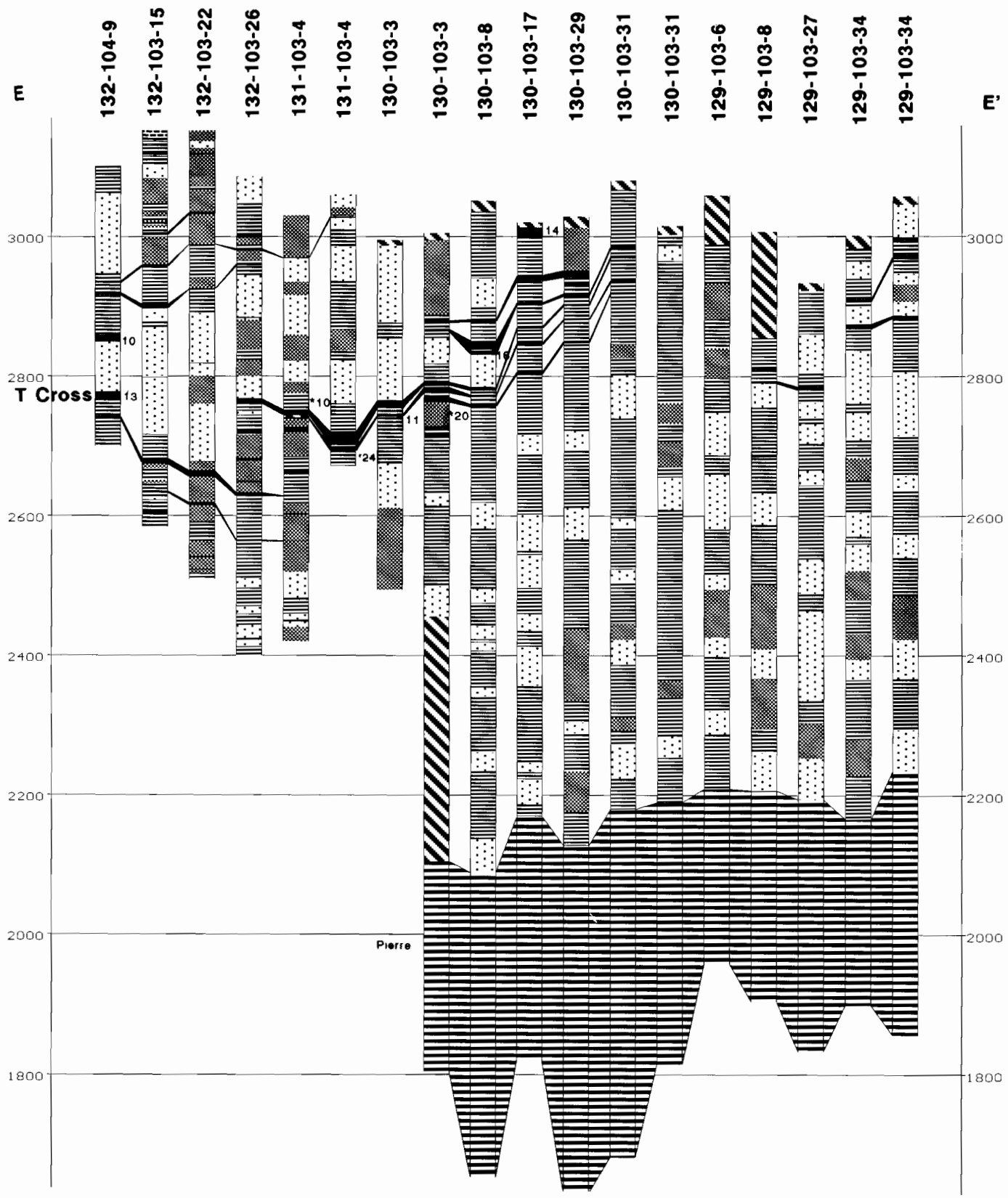

Figure 9. Cross-section E-E' of Upper Cretaceous and Fort Union strata in central Bowman County.

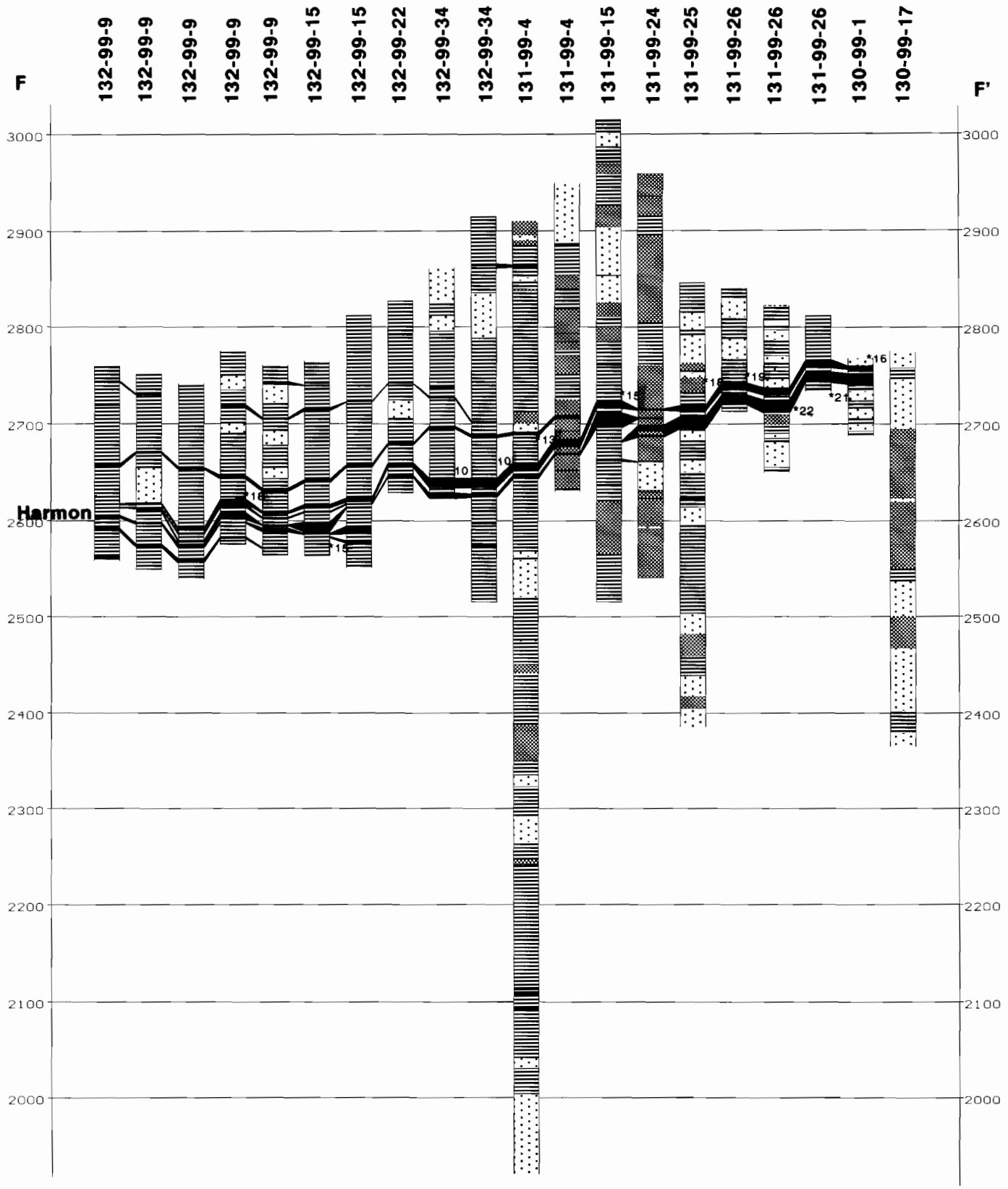

Figure 10. Cross-section F-F' of Upper Cretaceous and Fort Union strata in northeastern Bowman County.

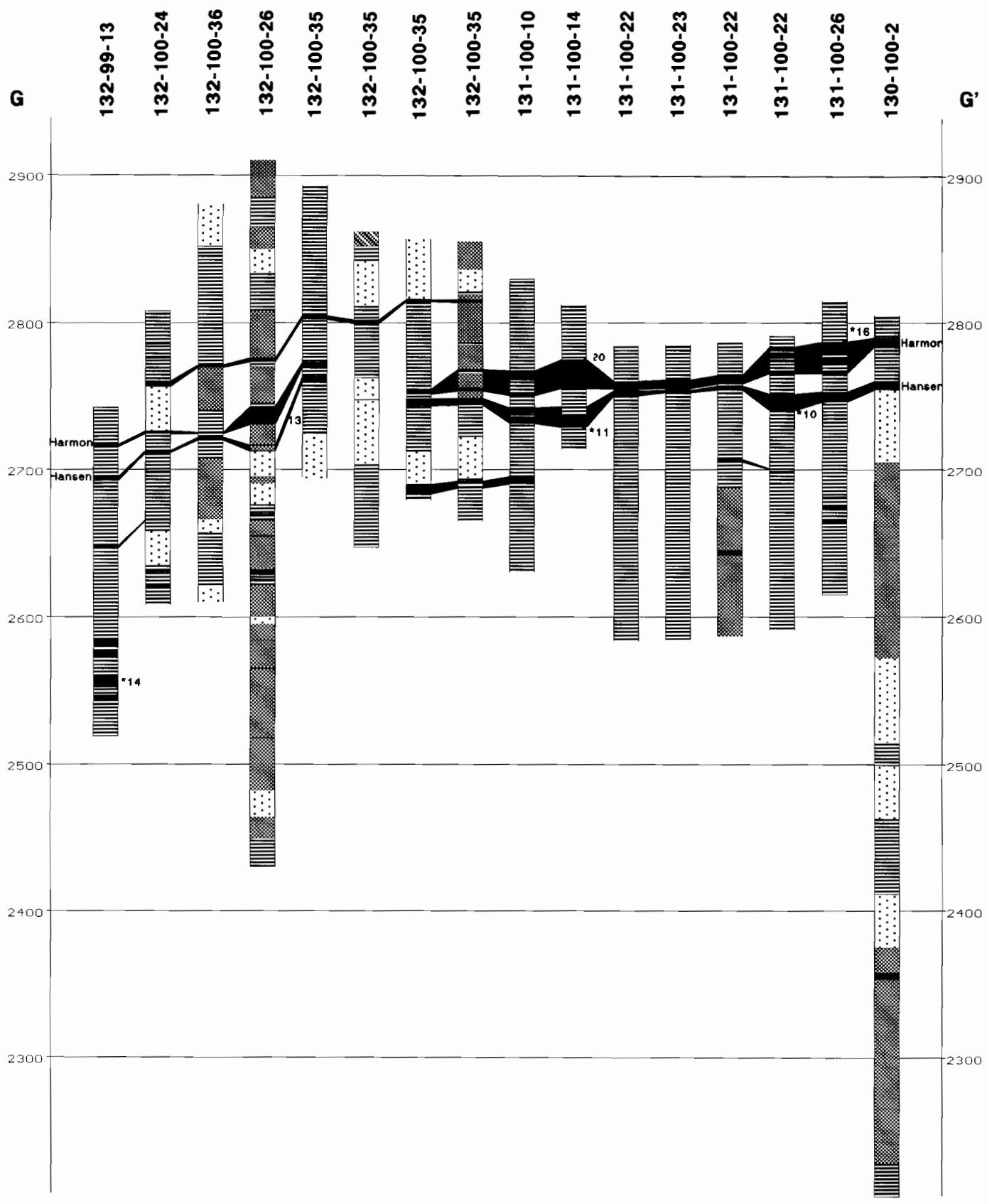

Figure 11. Cross-section G-G' of Fort Union strata in northeastern Bowman County.

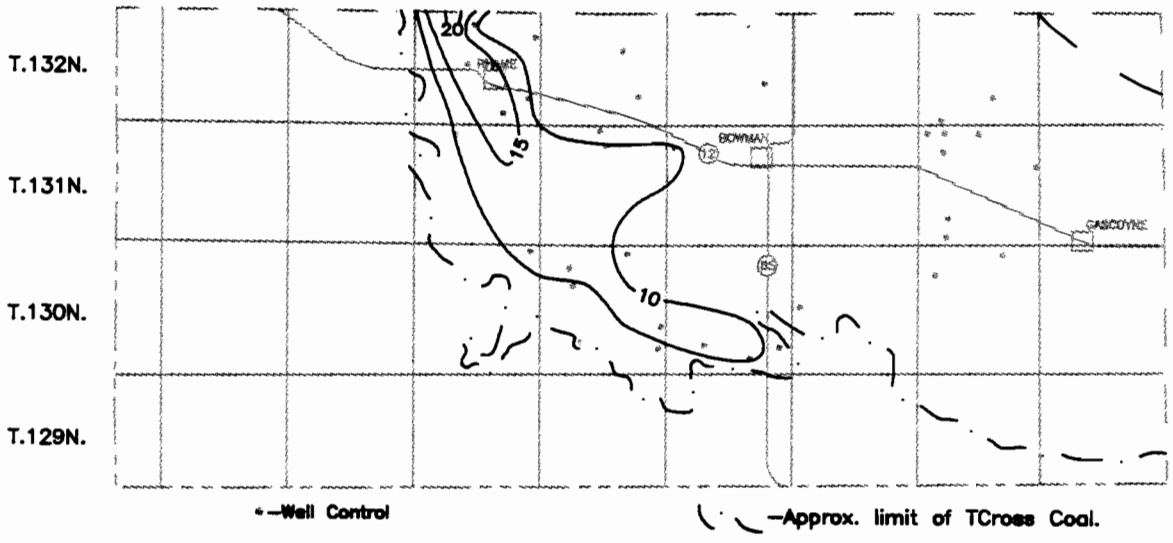

Figure 12. Isopach of the T Cross coal in Bowman County.

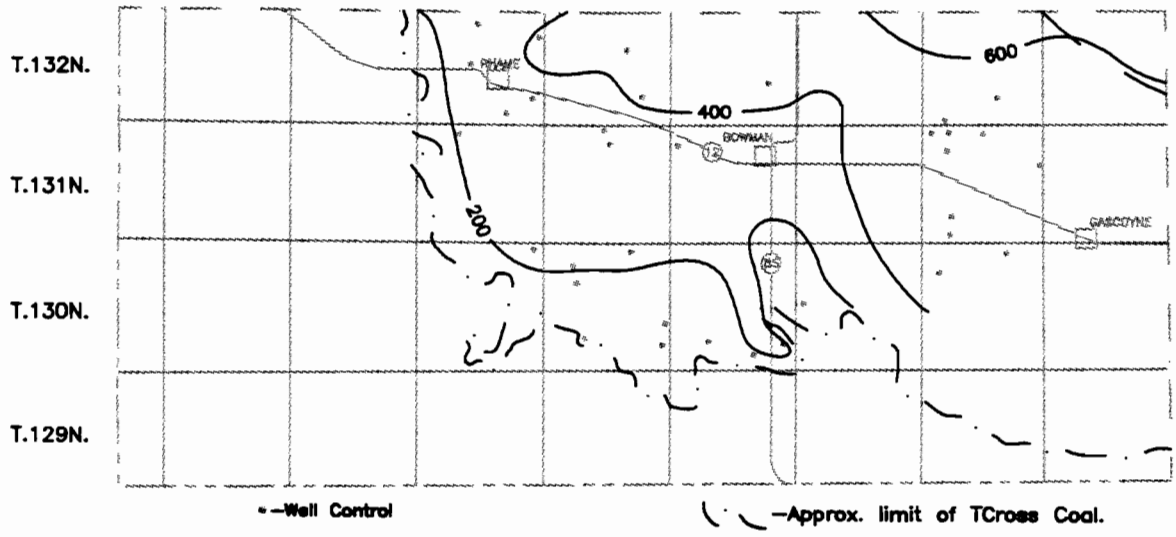

Figure 13. Contour map of the depth of the T Cross bed in Bowman County.

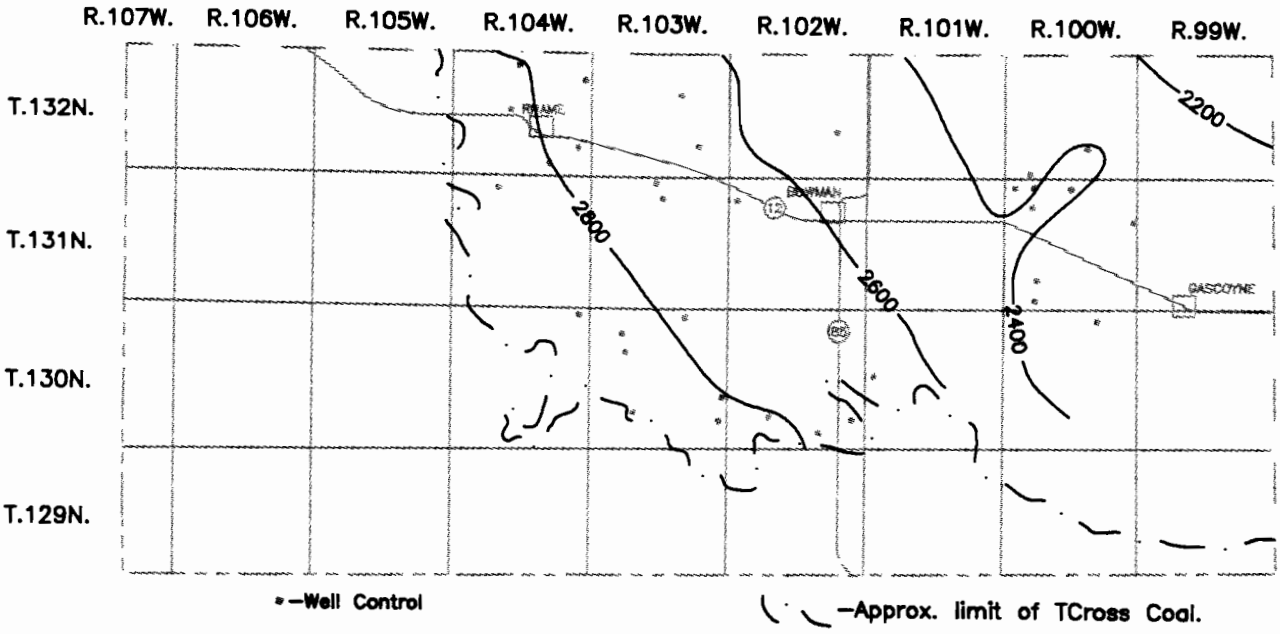

Figure 14. Contour map of the elevation at the top of the T Cross bed in Bowman County.

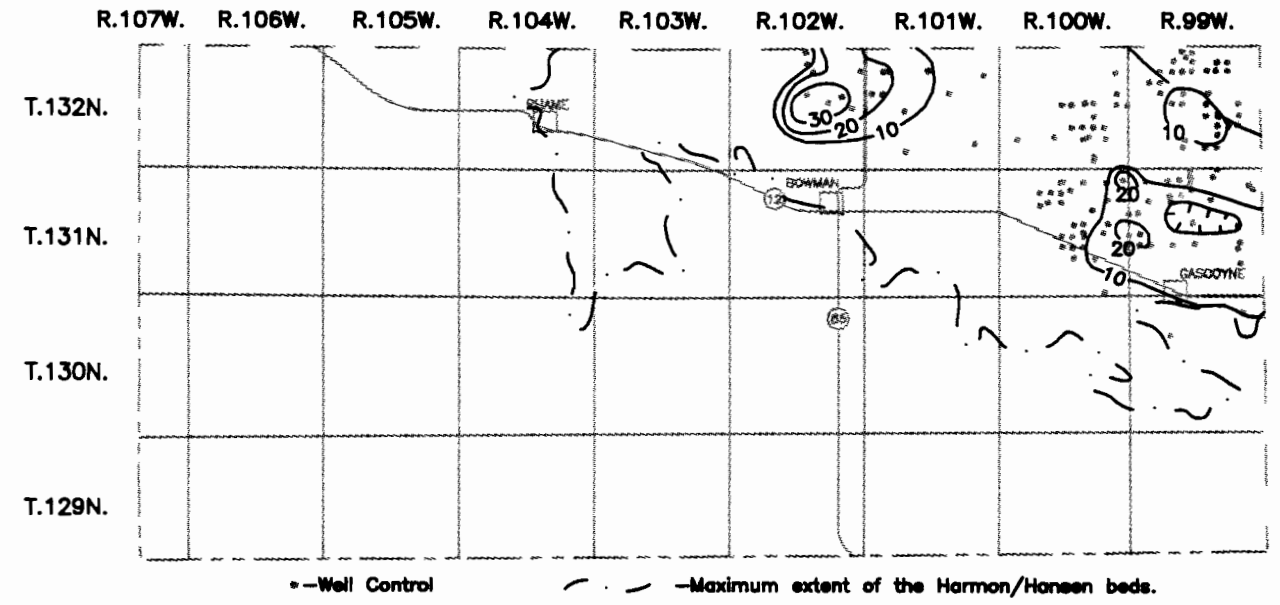

Figure 15. Isopach of the Harmon bed in Bowman County.

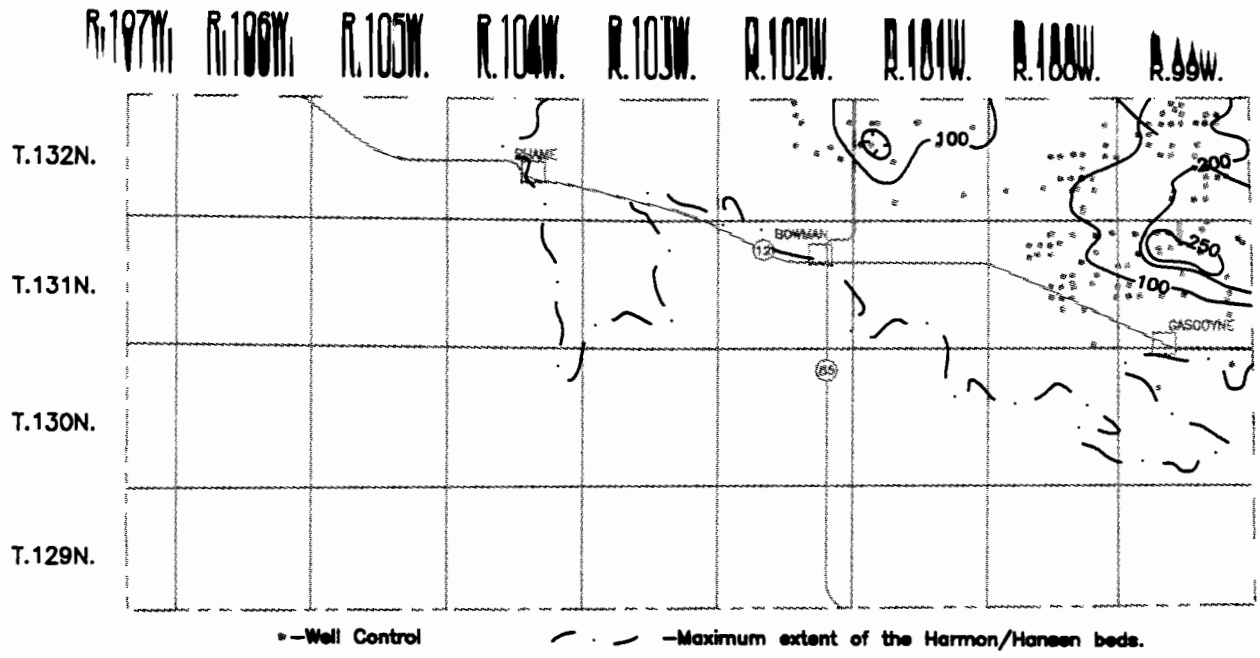

Figure 16. Contour map of the depth of the Harmon bed in Bowman County.

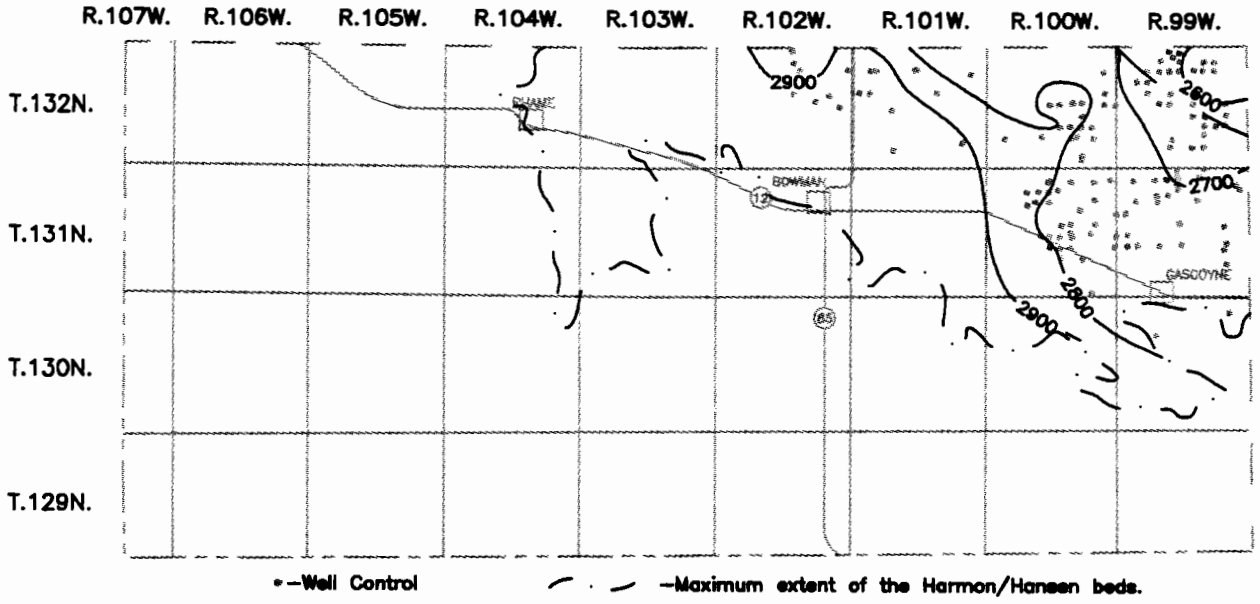

Figure 17. Contour map of the elevation at the top of the Harmon bed in Bowman County.

SLOPE COUNTY

Introduction

Lithologic data from 635 holes was entered into the database for Slope County. The majority of these holes were drilled by companies exploring for uranium in the vicinity of Chalky Buttes (Figure 18). Less than half of the oil wells in the county, 47 out of 119, ran a gamma log through casing to the surface.

The coal-bearing strata in Slope County ranges in thickness from zero along the southwestern edge to over 1300 feet in the northeastern corner of the county. Structure imposed by the Cedar Creek anticline and the badlands topography that resulted from incising by the Little Missouri River has exposed strata in Slope County ranging from the Pierre Formation (upper Cretaceous) to the Arikaree Formation (Miocene). Cretaceous strata is exposed at the surface in the southwestern corner, representing approximately ten per cent of the county (Figure 19). There are very few coals in Fox Hills and Hell Creek strata and none reported from the Pierre. When present, these coals are generally thin and relatively discontinuous. As a result, the southwestern corner of the county can essentially be eliminated as an area of potential coalbed gas. However, as previously discussed, gas has been reported from sandstones in the Fox Hills Formation in North Dakota.

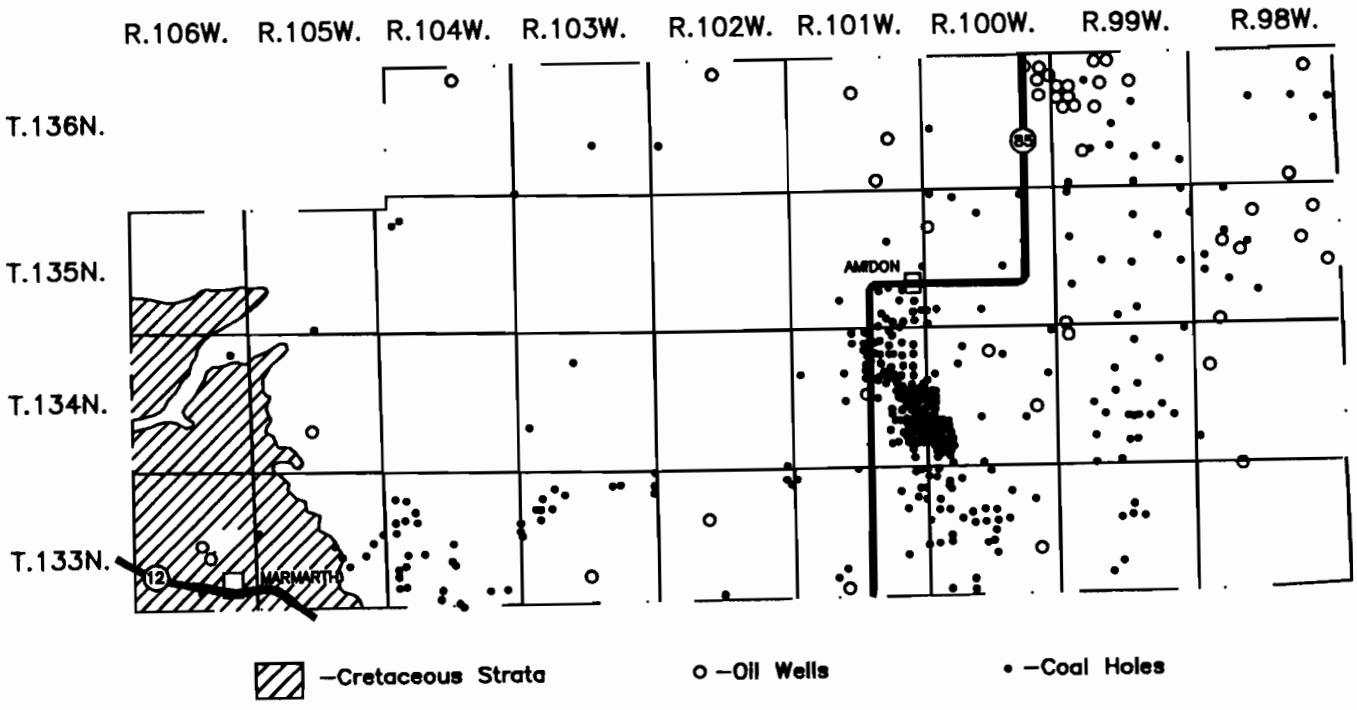

Figure 18. Well control in Slope County.

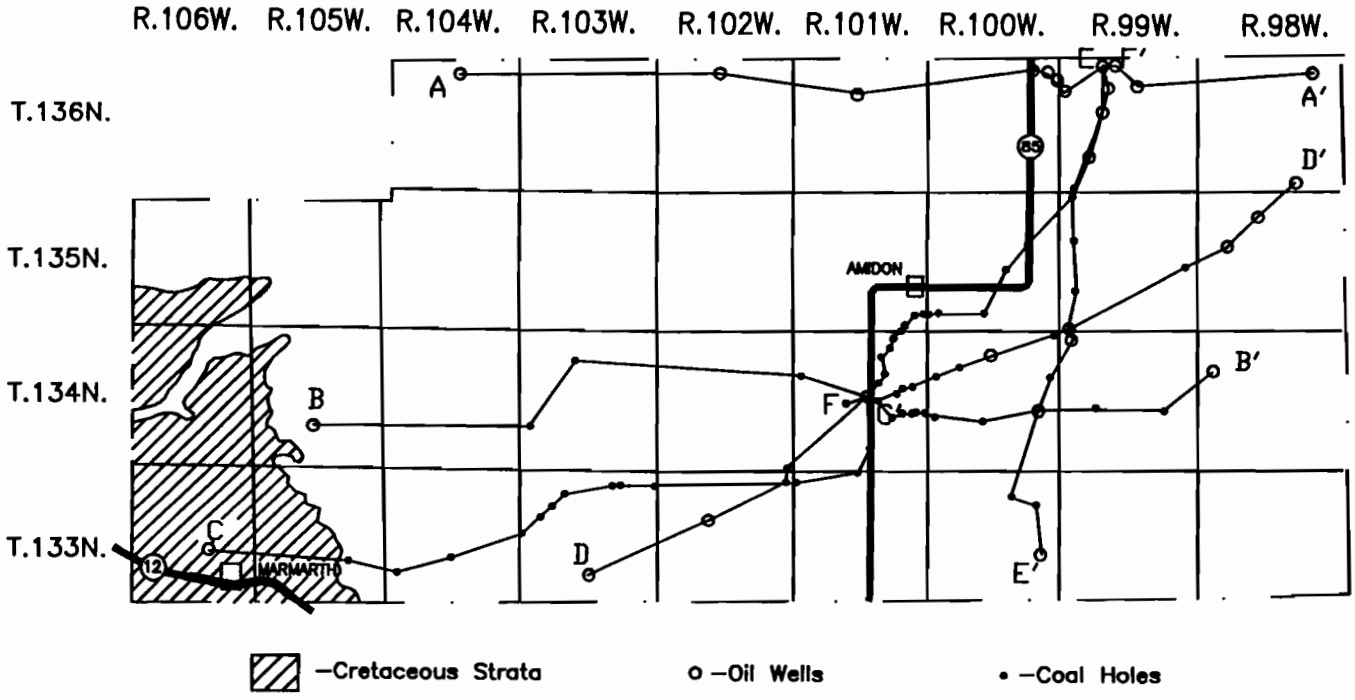

Figure 19. Traces of geologic cross-sections in Slope County.

As is the case in Bowman County, there are two major coal horizons in Slope County, the Harmon/Hansen and T Cross beds (Figures 20-29). In addition, the HT Butte bed was more than 10 feet thick in at least one locality. These coals vary in thickness but do not appear to be as variable in Slope County as they are in northeastern Bowman County. Drillholes are concentrated in the eastern portion of the county, especially in the vicinity of the Chalky Buttes (T.134N., Rs. 100 - 101W.) where many uranium holes are spaced only a few hundred feet apart.

T Cross Lignite

The T Cross coal is located at the base of the Slope Formation. At the type section of the formation in T.135N., R.105. the T Cross bed is approximately 10 feet thick. A series of up to three thin coal beds, located at the correct stratigraphic position, was identified as the T Cross coal. The T Cross coal(s) is less than 10 feet thick throughout most of the county but did exceed 30 feet in T.133N., R.104W. (Figures 22 and 26). The T Cross outcrops in western Slope County but is at depths of 1000 feet or more in the northeastern corner of the county (Figure 27). The T Cross bed dips to the northeast at a rate of approximately 33 feet per mile (Figure 28).

Leonard (1908 and 1925) and Hares (1928) identified several coals (in ascending order: Cannonball, Beta, T Cross, B, C, and C') within a stratigraphic interval of approximately 150 feet. These coals are typically less than five feet thick and proved difficult to separate given the

poor well control and problems associated with identifying thin coals on a gamma log run through surface casing. Therefore, the horizon identified on some of the cross-sections as T Cross may often as not be one of these other coals.

Hares (1928) traced the T Cross bed along the Little Missouri River badlands in western Slope County and determined that it generally was three to seven feet thick. The thickest occurrence of the T Cross identified by Hares in outcrop was 24 feet, in T.133N., R.104W., section 20.

Harmon and Hansen Beds

The Harmon and Hansen beds occur in the lower portion of the Bullion Creek Formation in western North Dakota. The Harmon bed overlies the Hansen bed and the intervening strata between these coal ranges from a few feet to over 75 feet. Both the Harmon and Hansen beds are generally present in Slope County as single beds of coal, unlike Bowman County where they each may consist of up to four thin beds or splits. The Harmon is typically the thicker of the two beds obtaining a maximum thickness of 37 feet in central Slope County (T.134N., R.101W., section 9) (Figures 21, 23, and 25). The Harmon is more than 30 feet thick over an area of approximately 20 square miles in portions of townships Ts.134 and 135N., Rs.101 and 102W. (Figure 29). In north-central Slope County the Hansen is occasionally the thicker of the two beds attaining a maximum thickness of 25 feet (Figure 20 and 24).

The Harmon and Hansen beds are exposed at the surface at Logging Camp Ranch (Hansen ranch) as well as numerous localities in west-central Slope County. The Harmon and/or Hansen beds have burned in the past forming clinker-capped buttes throughout areas of western and central Slope County. Hares (plate 14, 1928) mapped surface exposures of the Harmon and Hansen beds along Sand and Deep creeks in central Slope County. He noted the Harmon bed reached a maximum exposed thickness of 34 feet in T.135N., R.101W., section 30.

As previously noted, the stratigraphic interval between the Harmon and Hansen beds ranges from a few feet to over 75 feet. An isopach of the Harmon and Hansen beds indicates that the cumulative thickness of these coals exceed 35 feet in portions of several townships in Slope County: primarily, T.136N., R.99W.; T.134N., R.99W.; T.134N., R.101W.; and T.133N., R.101W (Figure 30). The Hansen bed was not included in this cumulative thickness when it was separated from the Harmon bed by more than 50 feet. In T.136N, R.100W., section 31, there is a 32-foot-thick coal present that is 73 feet stratigraphically above the Harmon. To the southeast, this bed splits, into three, 4-to 5-foot thick coals (T.135N., R.100W., section 8), and to the east splits into two, 7-foot thick beds (T.135N., R.100W., section 3). It is easy to confuse this bed with the underlying Harmon due to thickness, close stratigraphic proximity, and lack of well control in this area.

The Harmon and Hansen beds are exposed at the surface in river and creek drainages

throughout central Slope County. Throughout most of eastern Slope County, the Harmon and Hansen beds are at depths of 300 to 400 feet (Figure 31). The Harmon and Hansen beds are at a maximum depth of 500 to 600 feet in northeastern Slope County (Figures 20, 25, and 31). These beds generally dip to the north-northeast, toward the center of the Williston Basin, at an average rate of about 25 feet per mile (Figure 32).

HT Butte Bed

The HT Butte bed is a coal that occurs at the contact between the Sentinel Butte and Bullion Creek formations. The bed is 14 feet thick in surface exposures along the base of Black Butte (T.134N., R.101W., section 19). Hares (1928) determined the HT Butte bed averaged nine feet thick in southern Billings County. However, we were unable to identify it in the subsurface of eastern Slope County with any degree of certainty. It is likely one of the two coal beds, at an elevation of approximately 2600 feet in T.136N., R.100W., section 2, is the HT Butte bed (Figure 20).

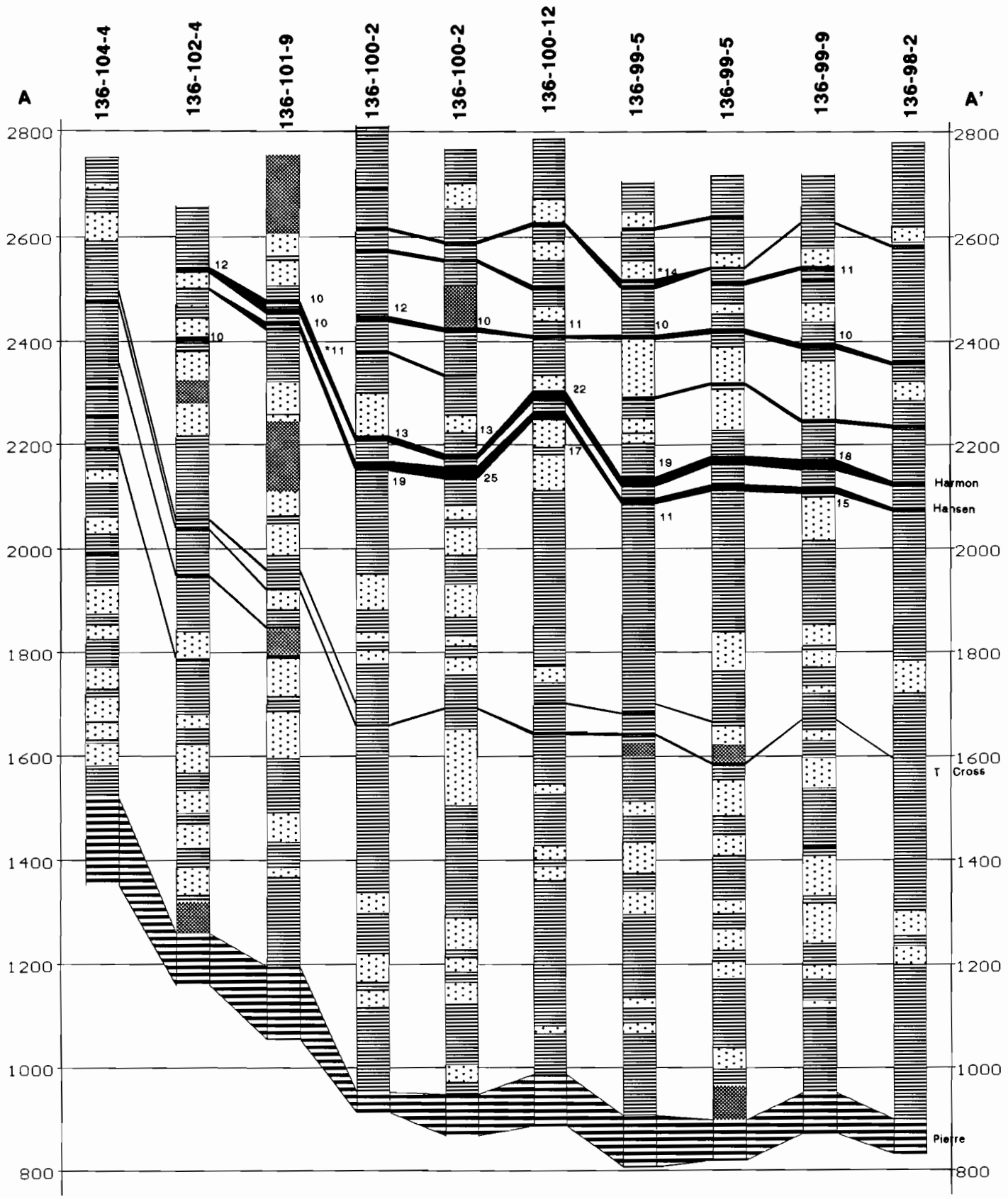

Figure 20. Cross-section A-A' of upper Cretaceous and Fort Union strata in northern Slope County.

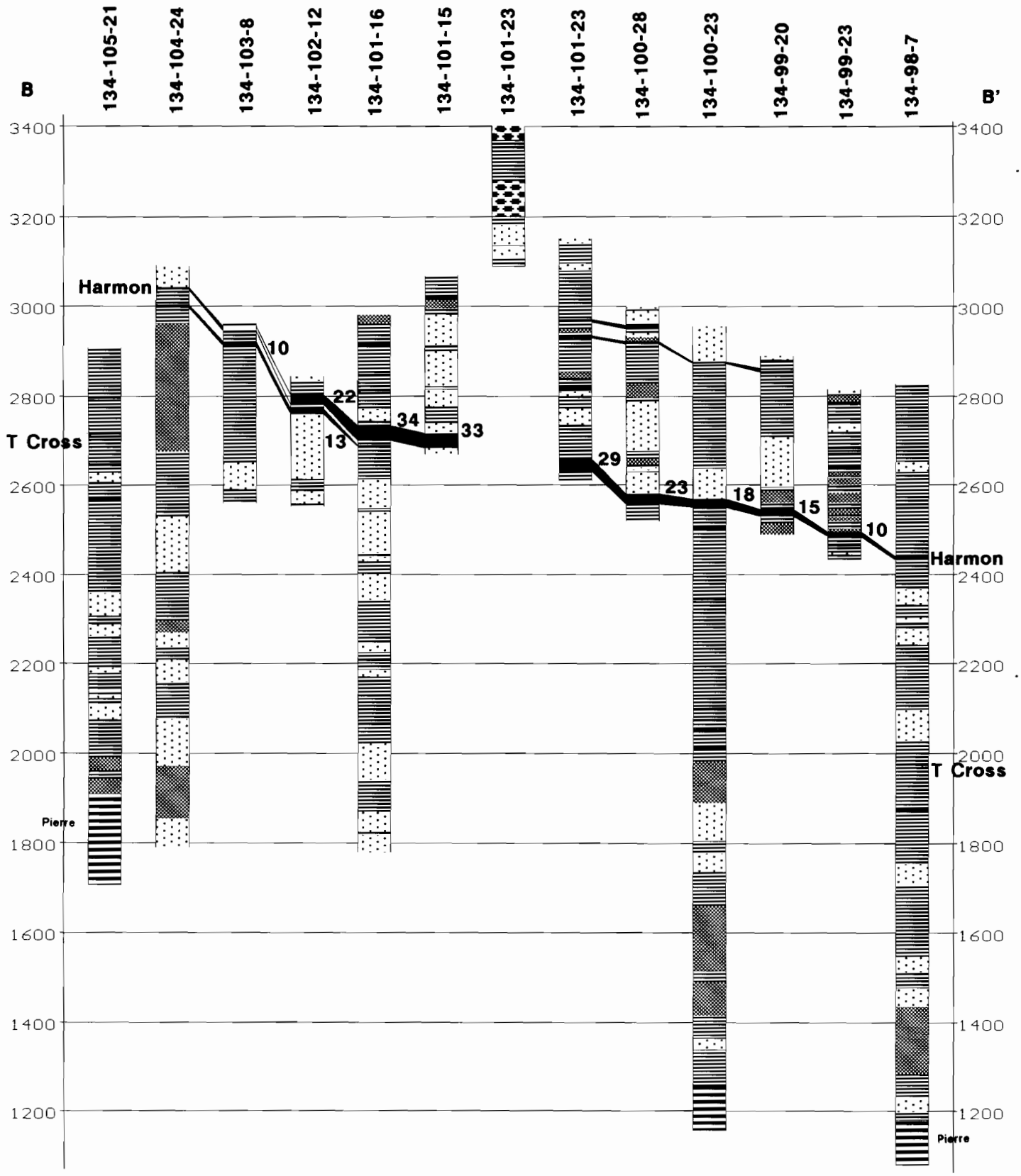

Figure 21. Cross-section B-B' of upper Cretaceous and Fort Union strata in south-central Slope County.

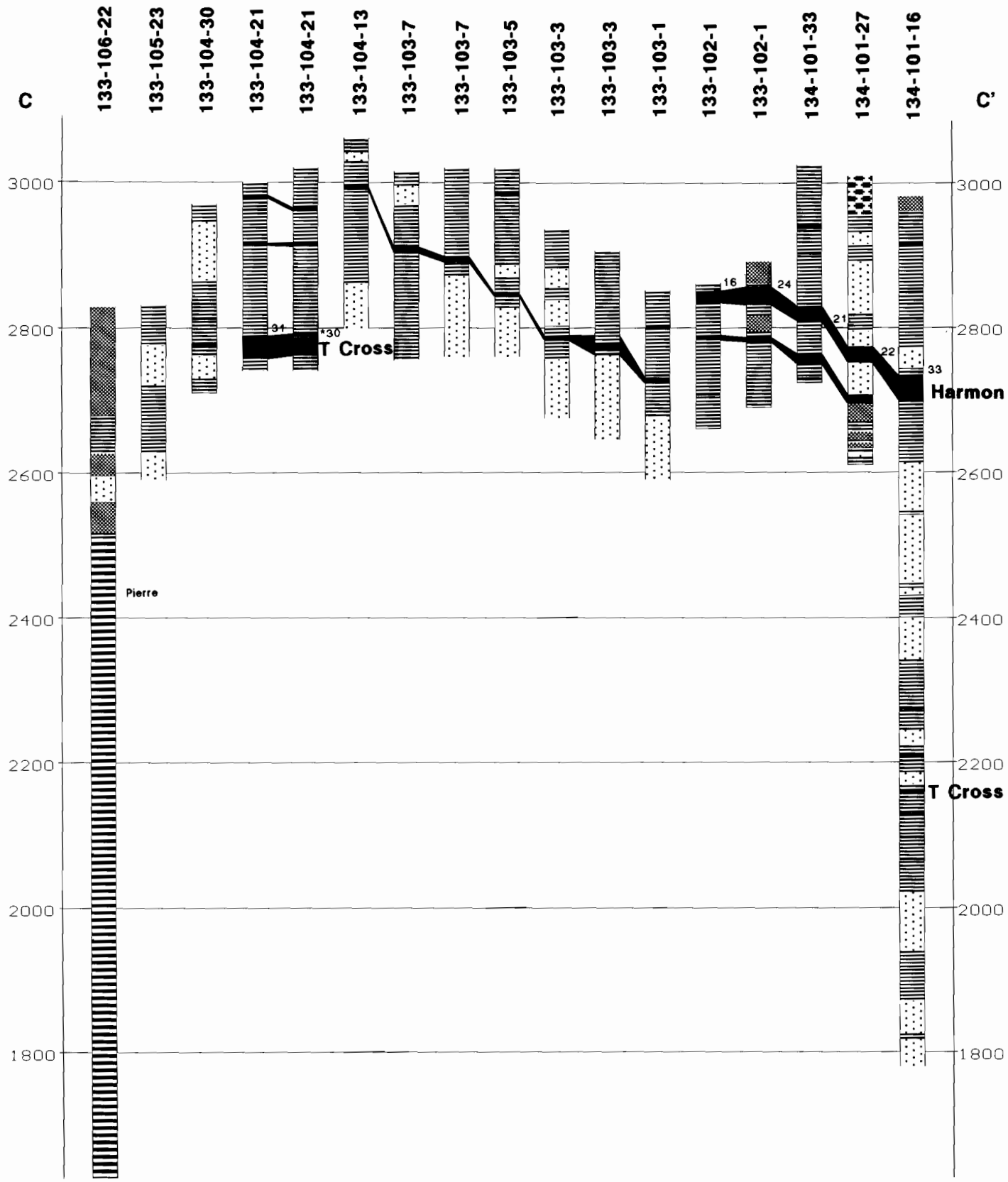

Figure 22. Cross-section C-C' of Upper Cretaceous and Fort Union strata in southwestern Slope County.

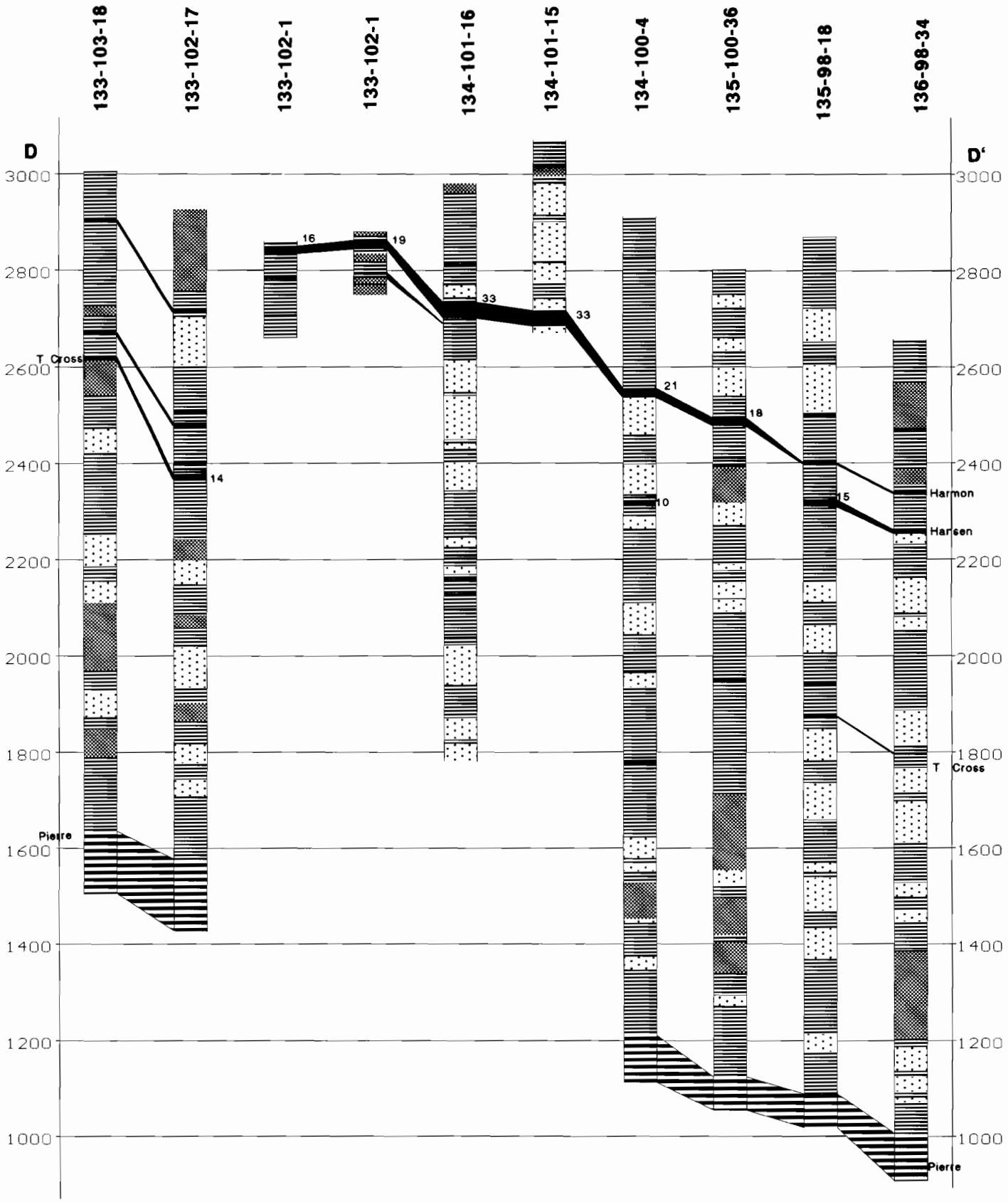

Figure 23. Cross-section D-D' of upper Cretaceous and Fort Union strata in Slope County.

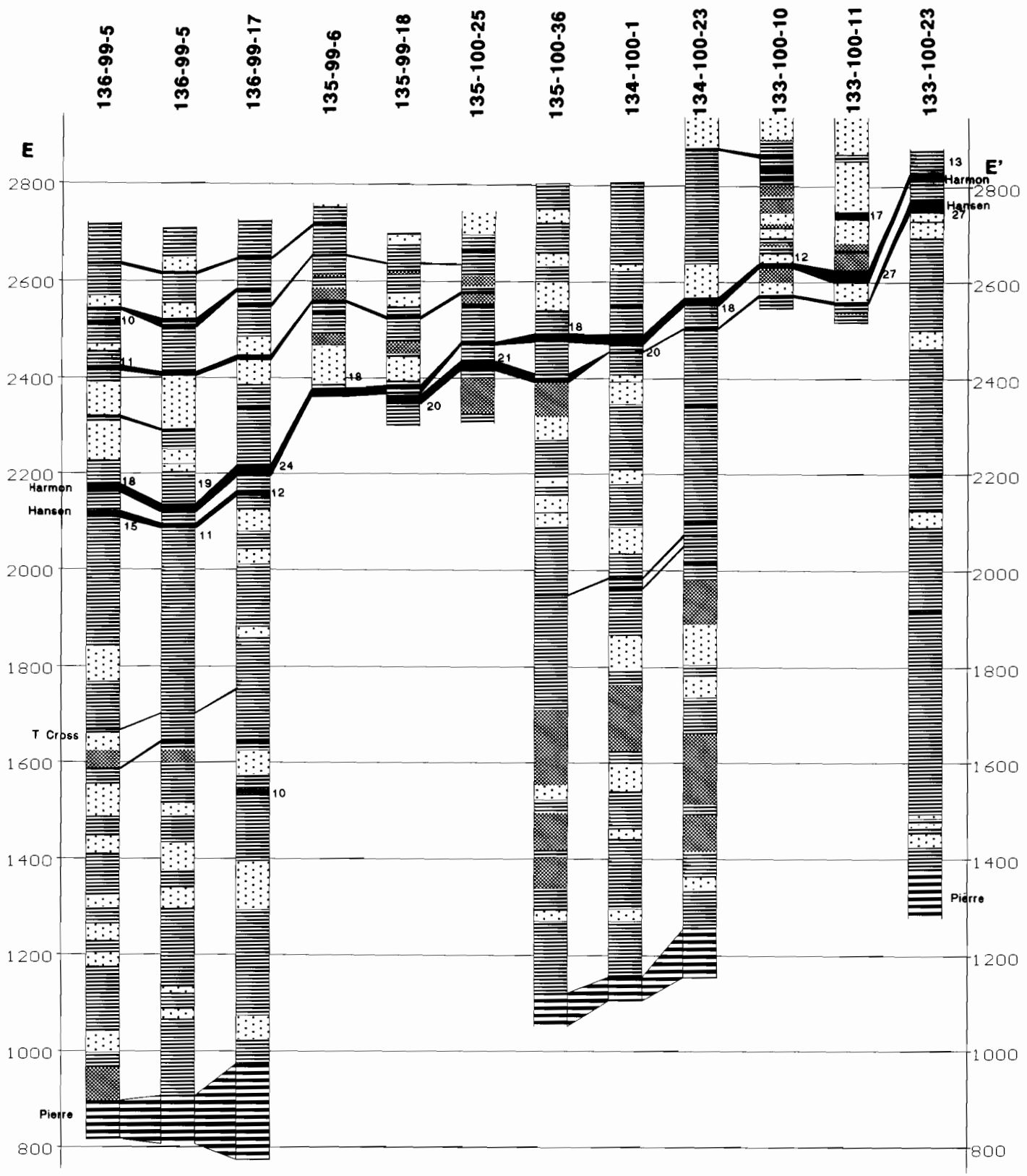

Figure 24. Cross-section E-E' of upper Cretaceous and Fort Union strata in eastern Slope County.

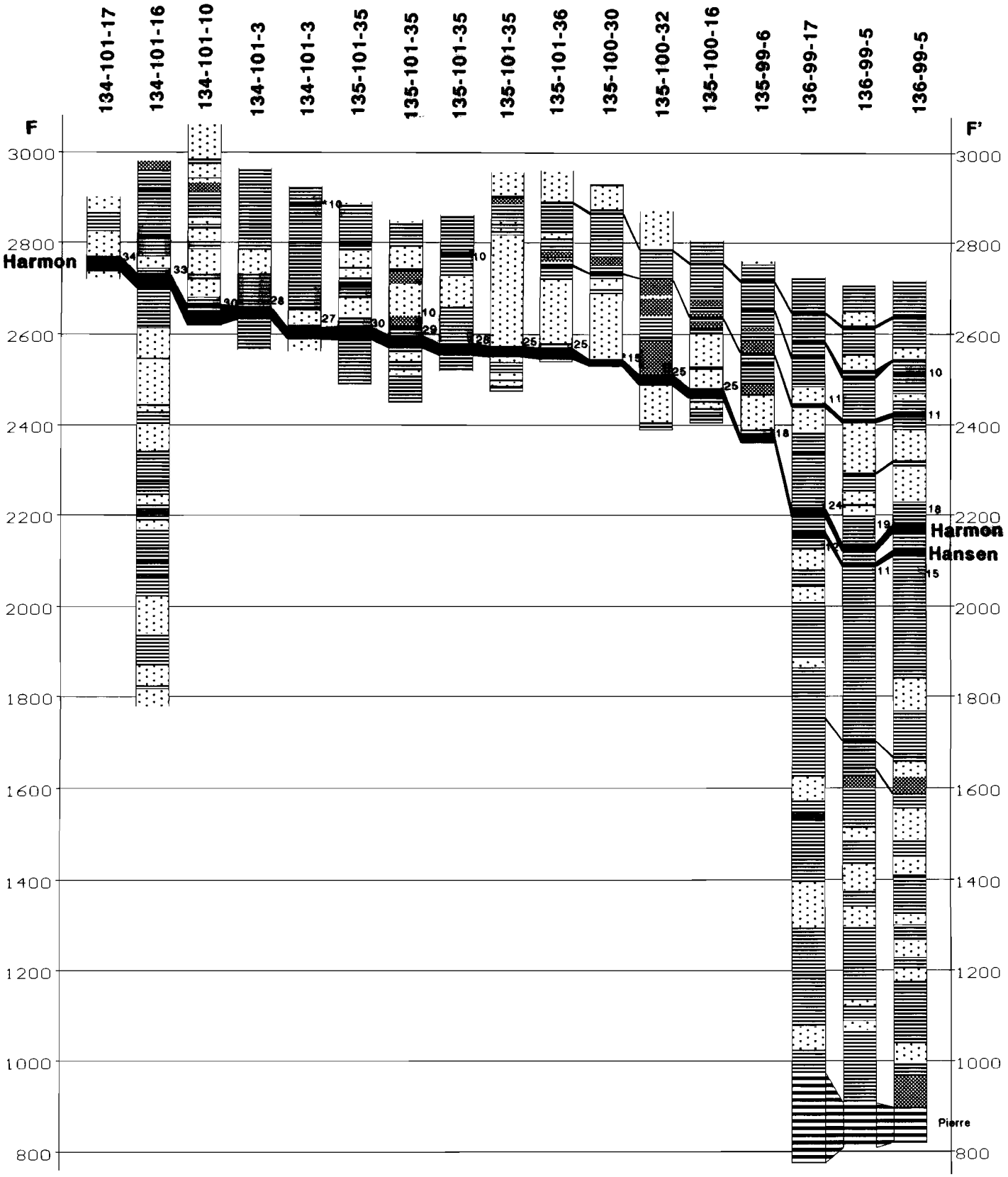

Figure 25. Cross-section F-F' of upper Cretaceous and Fort Union strata in eastern Slope County.

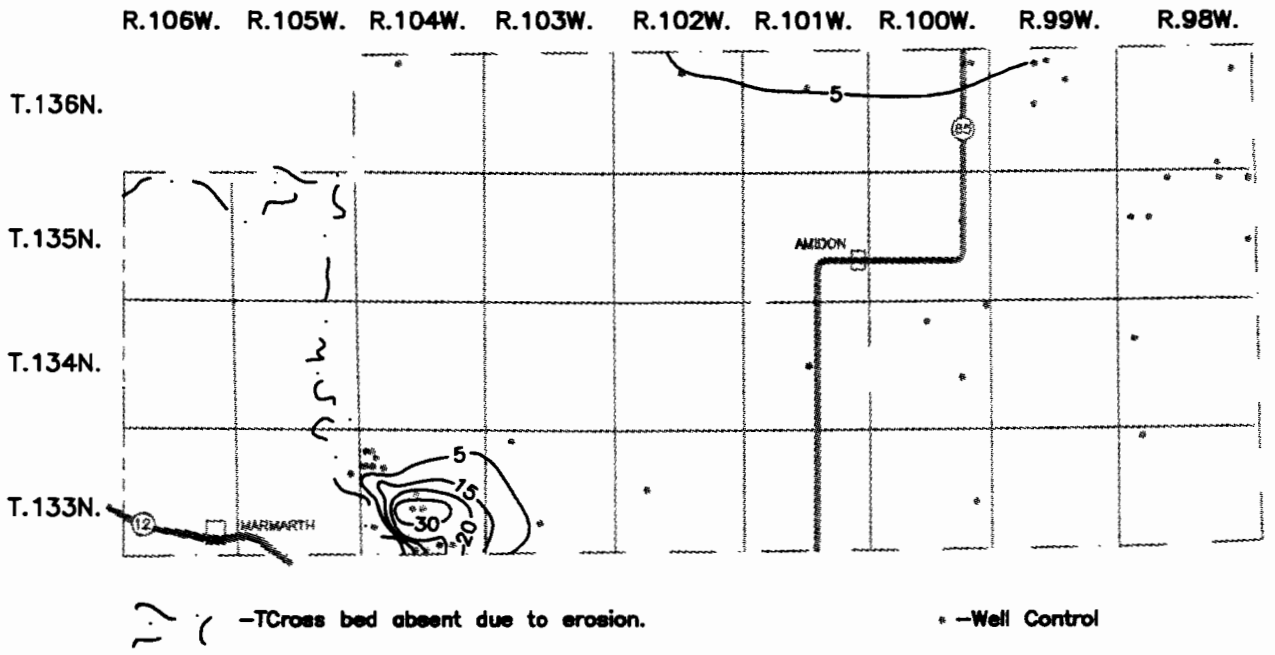

Figure 26. Isopach of the T Cross bed in Slope County.

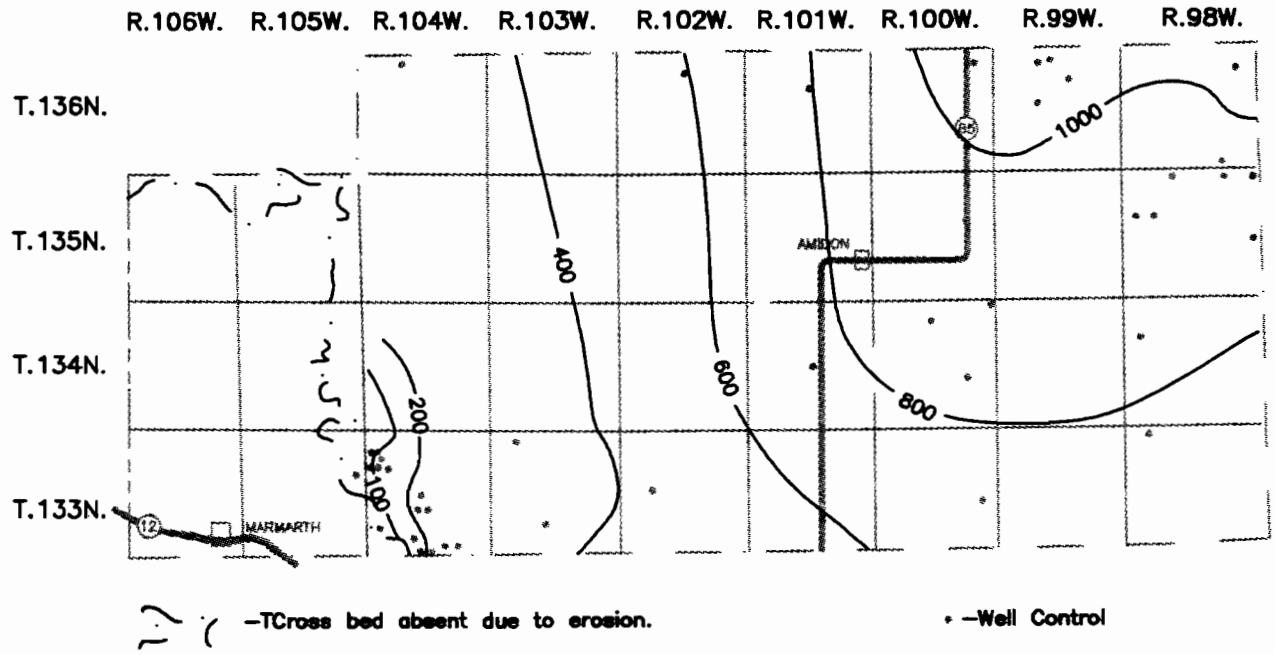

Figure 27. Contour map of the depth to the T Cross bed in Slope County.

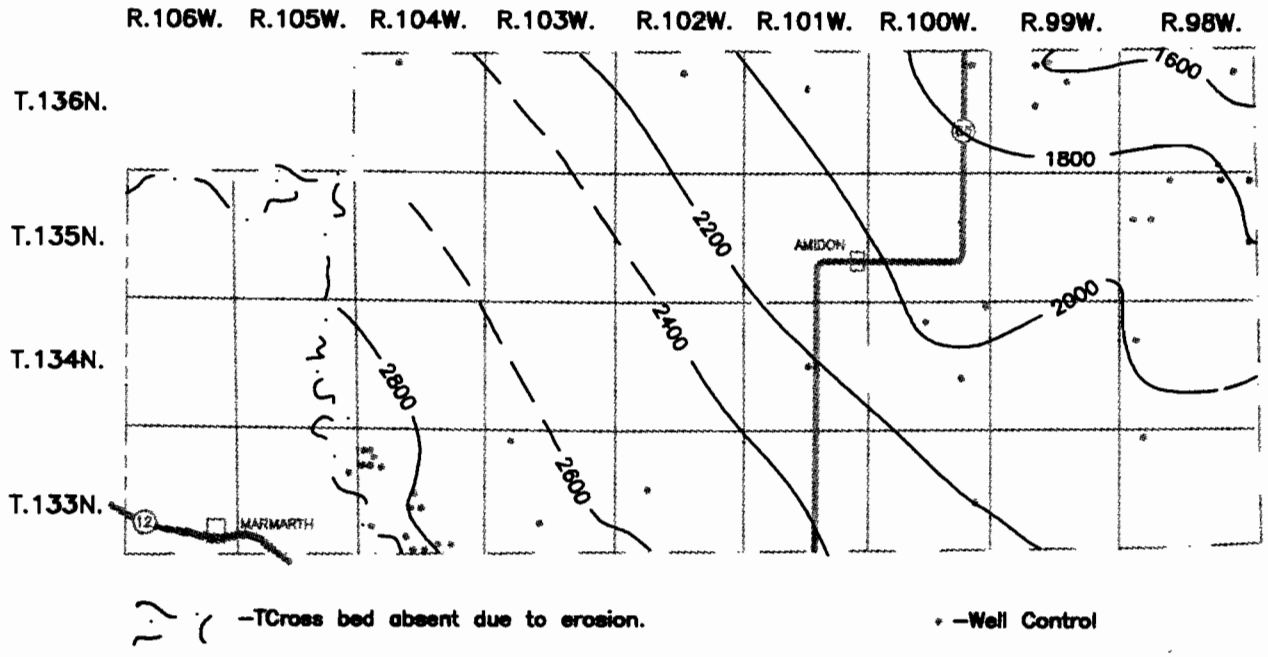

Figure 28. Contour map of the elevation at the top of the T Cross in Slope County.

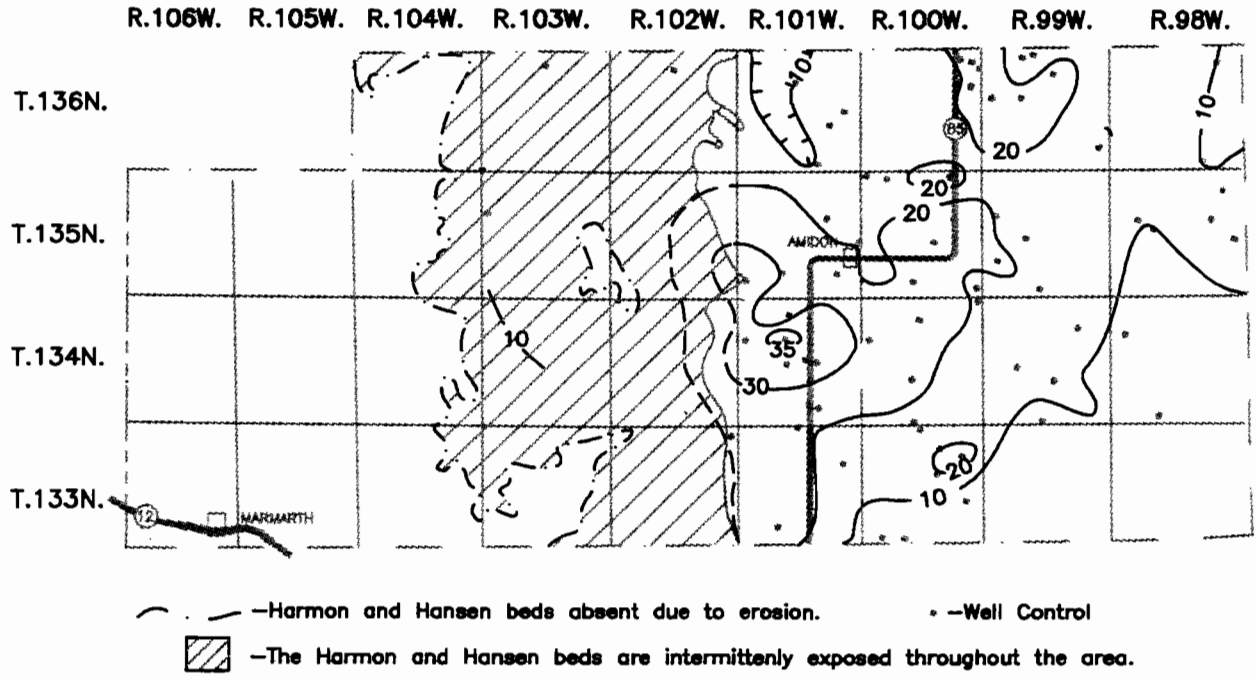

Figure 29. Isopach of the Harmon bed in Slope County.

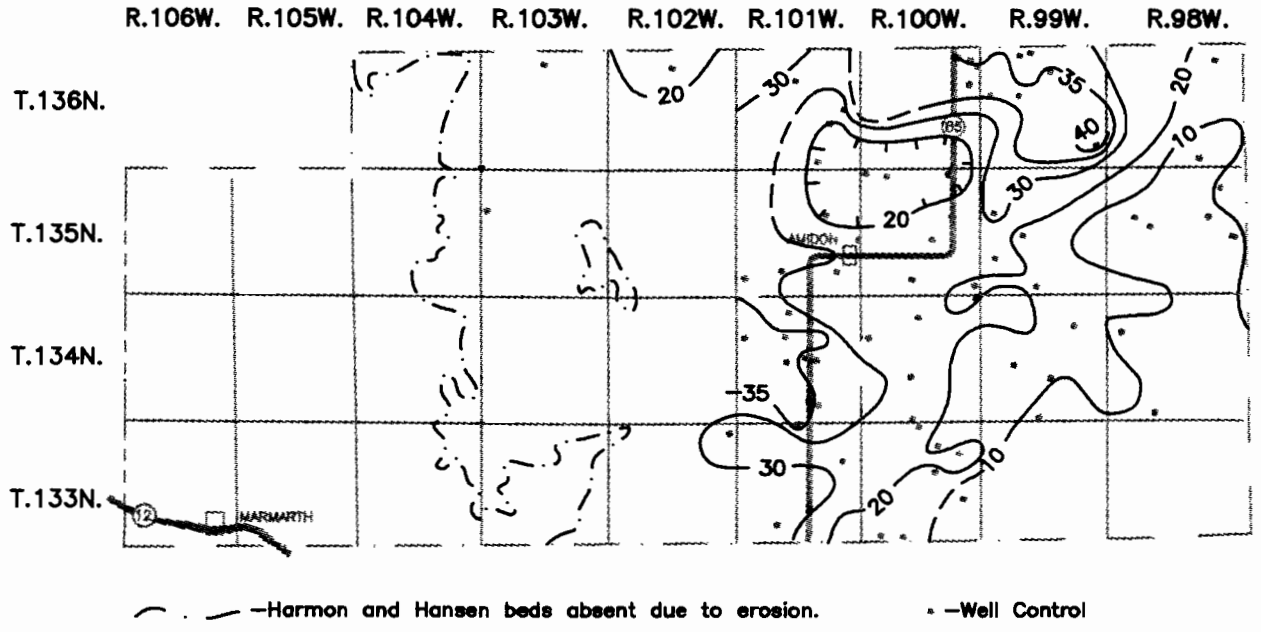

Figure 30. Isopach of the Harmon and Hansen beds in Slope County. The Hansen bed was not included in the total thickness if it was more than 50 feet below the Harmon bed.

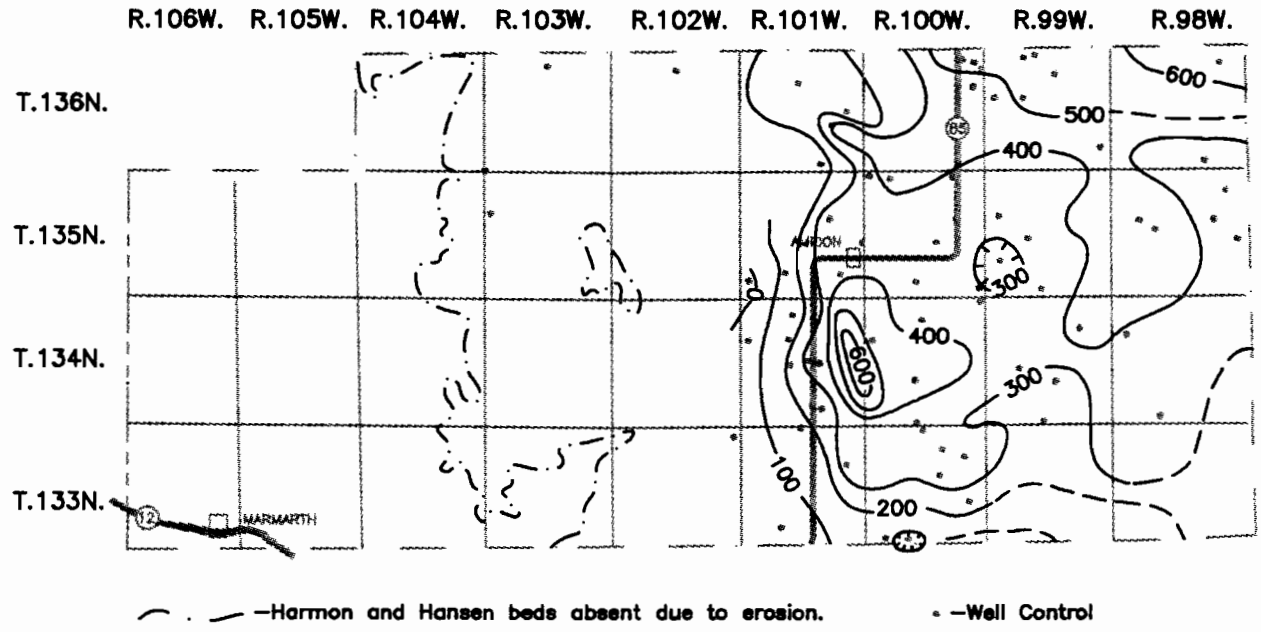

Figure 31. Contour map of the depth of the Harmon bed in Slope County.

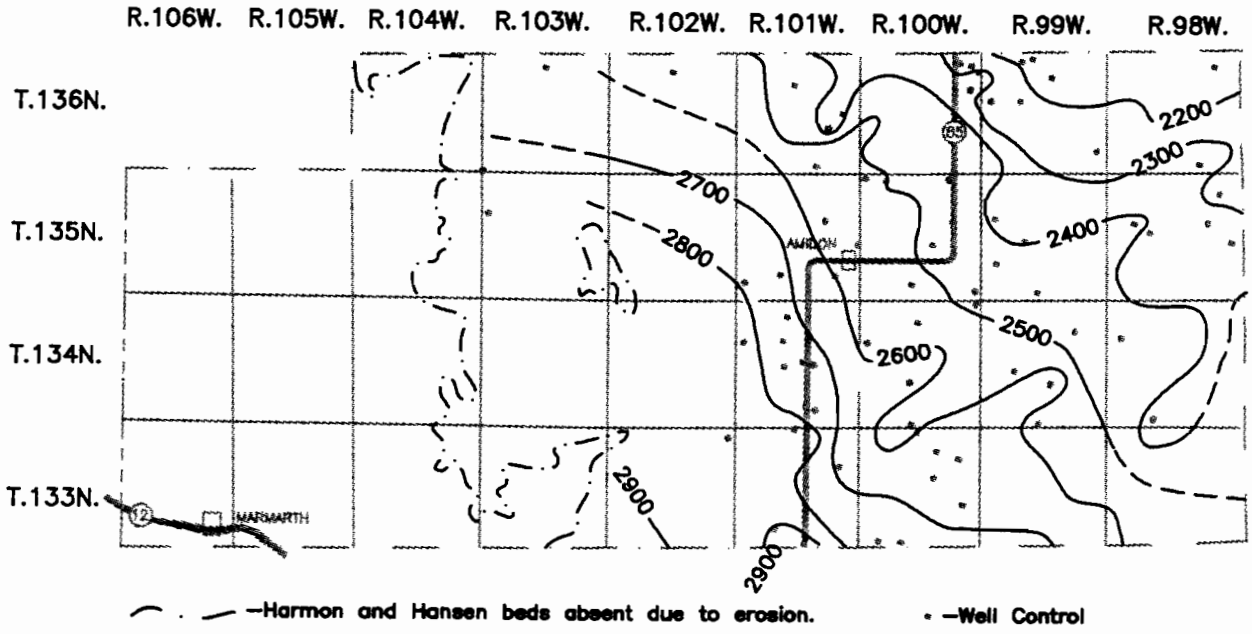

Figure 32. Contour map of the elevation at the top of the Harmon bed in Slope County.

HETTINGER COUNTY

Stratigraphic data from 283 holes was entered into the database for Hettinger County. The majority of the electric logs came from coal exploration holes (Figure 33). Twenty-three of the 32 oil wells drilled in Hettinger County provided valuable information on Fort Union stratigraphy because a gamma log was run through casing or they terminated surface casing within the Fort Union. Throughout most of the county, two to three mile spacings are the general drill hole control. Although many of these holes are only a few hundred feet deep, there are a number of 500- to 600-foot holes drilled by the U.S. Geological Survey in the 1980s that provide valuable information.

The Sentinel Butte Formation is present at the surface throughout most of Hettinger County. The uplands in the northwestern portion of the county and the high buttes contain Golden Valley and White River strata. Bullion Creek strata are exposed along many of the major drainages and the rolling prairie in the southeastern part of the county. The U.S. Geological Survey holes demonstrate the propensity for numerous thin coals in the Fort Union of the Williston Basin. Seven geologic-cross sections, primarily east-west, were generated for Hettinger County (Figure 34).

The T Cross Bed

Several thin coals are present at the approximate stratigraphic position marking the top of

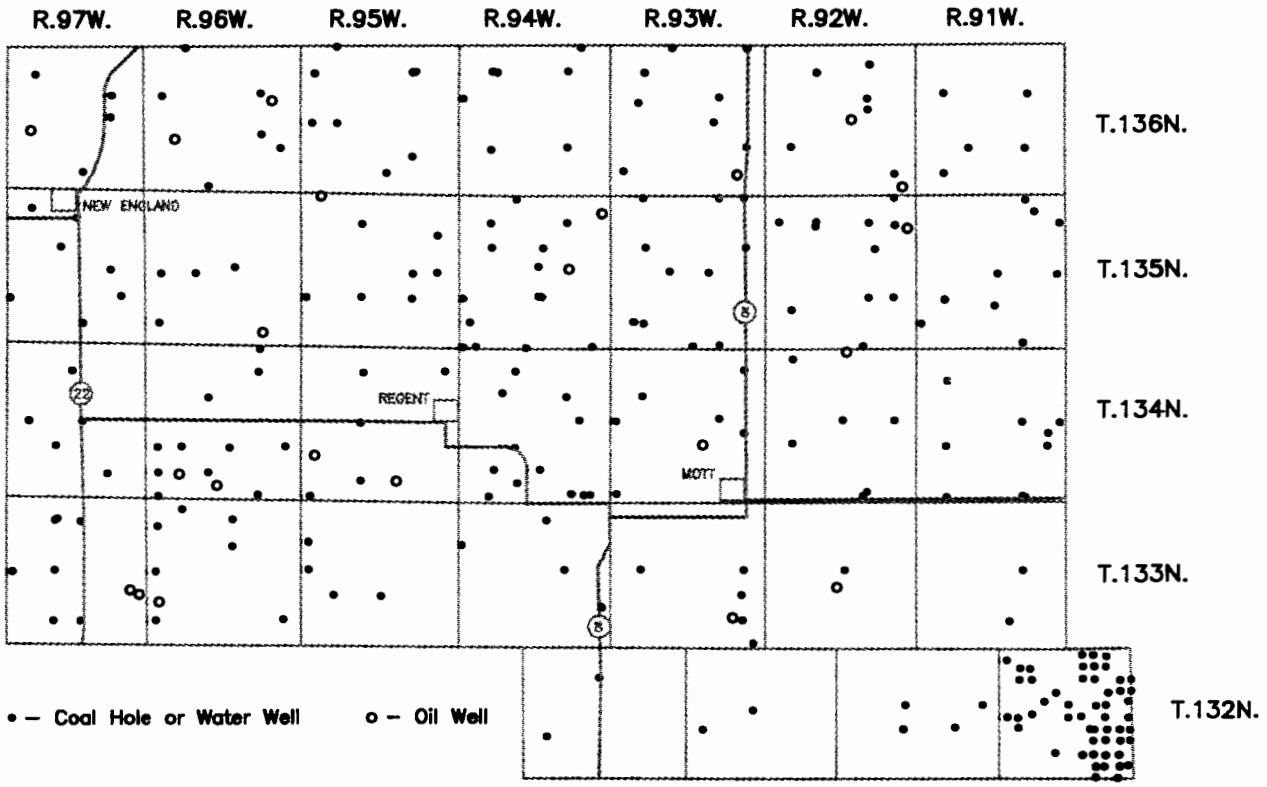

Figure 33. Well control in Hettinger County.

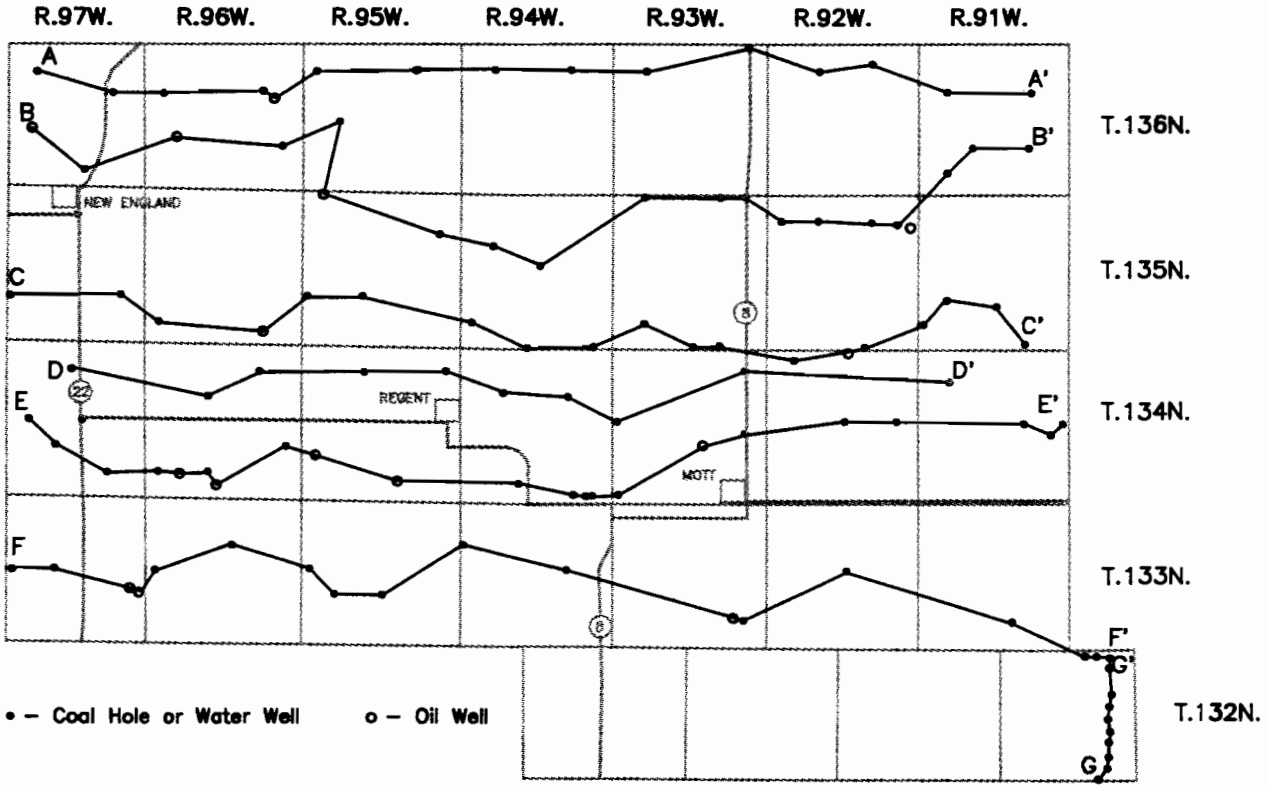

Figure 34. Traces of geologic cross-sections in Hettinger County.

the Ludlow Formation. There is not sufficient control to correlate these coals to the T Cross bed in central Bowman and Slope counties (Figures 35 - 41). From the Bowman/Adams county line on east, the Ludlow Formation is overlain by mudstones and sandstones of the Cannonball Formation and a coal may or may not be present at this horizon.

Harmon and Hansen Beds

The Harmon and Hansen beds can be traced throughout most of Hettinger County. There are generally one or two thin beds throughout the county at this approximate stratigraphic position (Figures 35-41). These beds were identified as the Harmon and Hansen beds but may not, in all cases, be correlative. When present, the Harmon bed ranges from a few feet to 20 feet thick in the western half of Hettinger County and, in general, is less than 5 feet throughout the eastern part of the county. Typically, the Hansen bed is less than 5 feet thick throughout the county.

There are two major areas, south of New England (T.135N., R.97W.) and north of Regent (portions of Ts.134N.-135N., Rs.94W.-95W.), where the Harmon bed is more than 15 feet thick (Figures 37, 38, and 42). The Hansen bed is absent in the Regent deposit but is generally present near New England. Throughout most of the rest of the county, the Harmon bed is less than 10 feet thick. The coal deposit south of New England is buried under 300 to 400 feet of strata while most of the deposit near Regent is buried by 200 to 300 feet of strata (Figure 43). The Harmon bed dips to the northeast at a rate of approximately 10 to 20 feet per mile (Figure 44).

In 1977, Consolidated Coal Company drilled a number of closely spaced holes in the southeastern corner of Hettinger County. They apparently were interested in a 5-10 foot thick coal that is typically present within 100 feet of the surface. Throughout most of this area the coal is immediately overlain, and at times truncated, by a channel sandstone (Figure 41). This coal may be correlative with the Harmon bed.

HT Butte Bed

The HT Butte bed is typically only a few feet thick when present in Hettinger County but is up to 13 feet thick in some areas of the county (Figures 37 and 38). Tracing thin beds of coal with well spacings of two or three miles results in correlations that are tenuous at best. The HT Butte bed may, in fact, be absent from most of the county but a thin bed(s) of coal is often present at the approximate stratigraphic horizon between the Bullion Creek and Sentinel Butte formations.

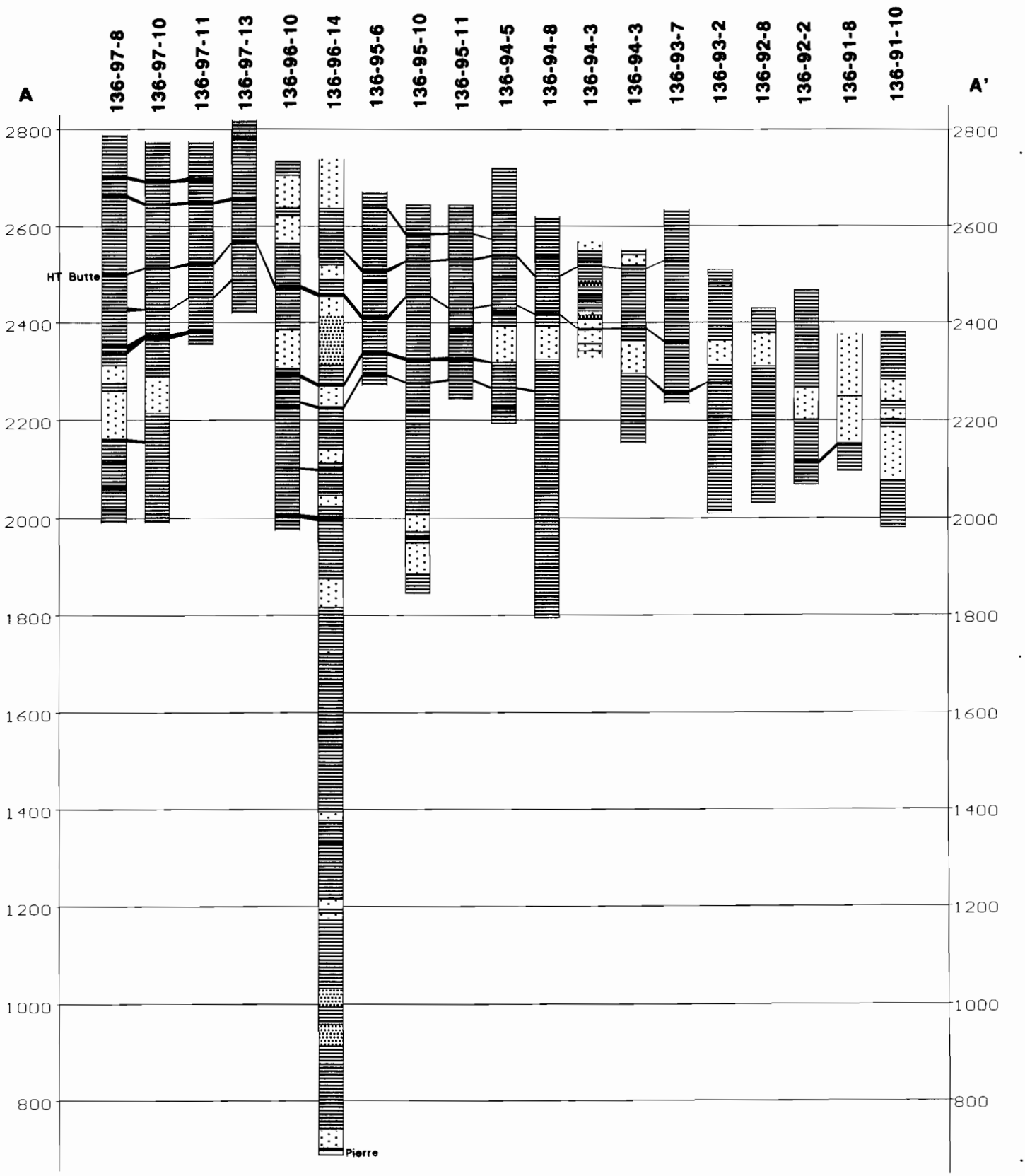

Figure 35. Cross-section A-A' of Upper Cretaceous and Fort Union strata in northern Hettinger County.

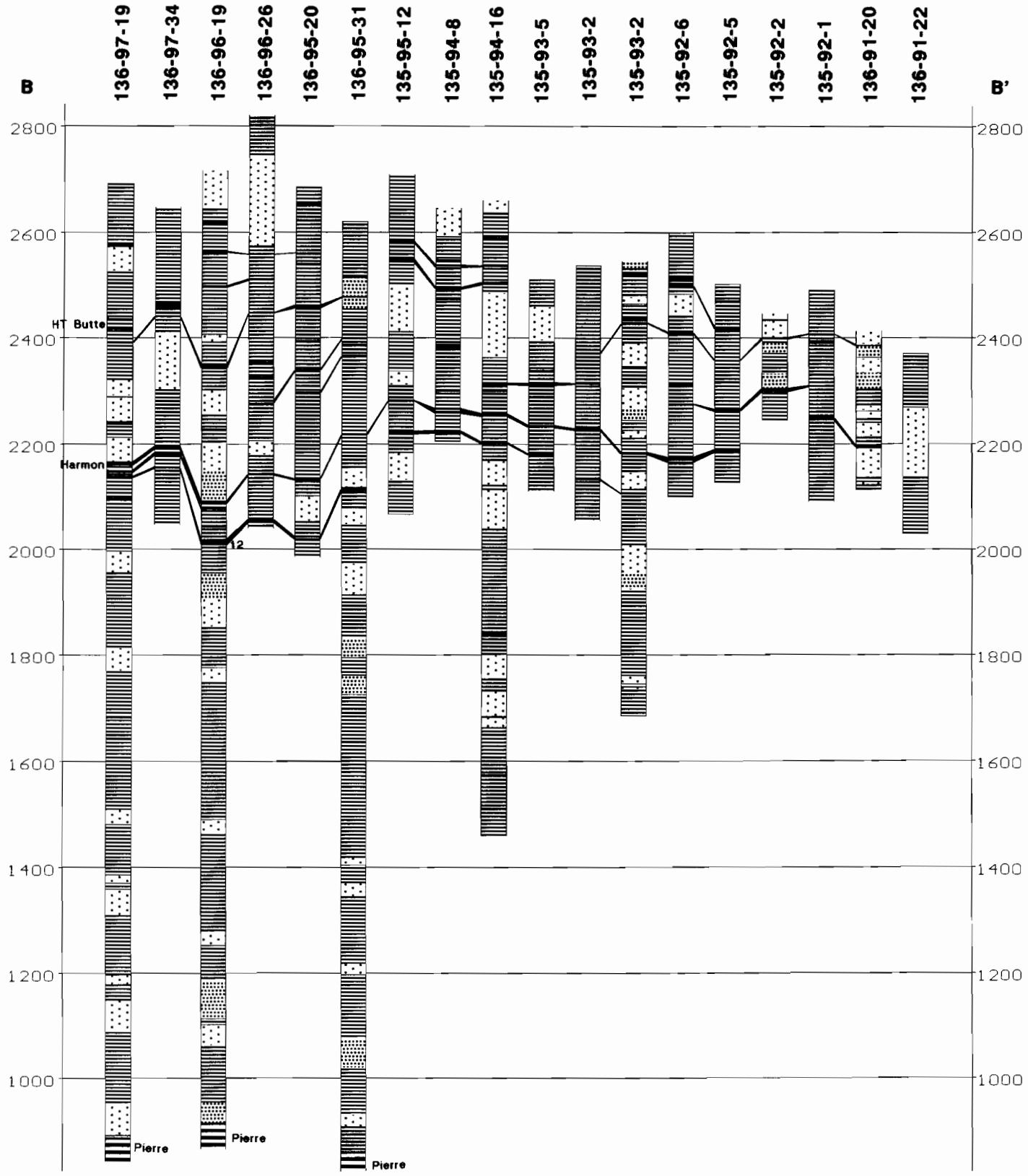

Figure 36. Cross-section B-B' of Upper Cretaceous and Fort Union strata in northern Hettinger County.

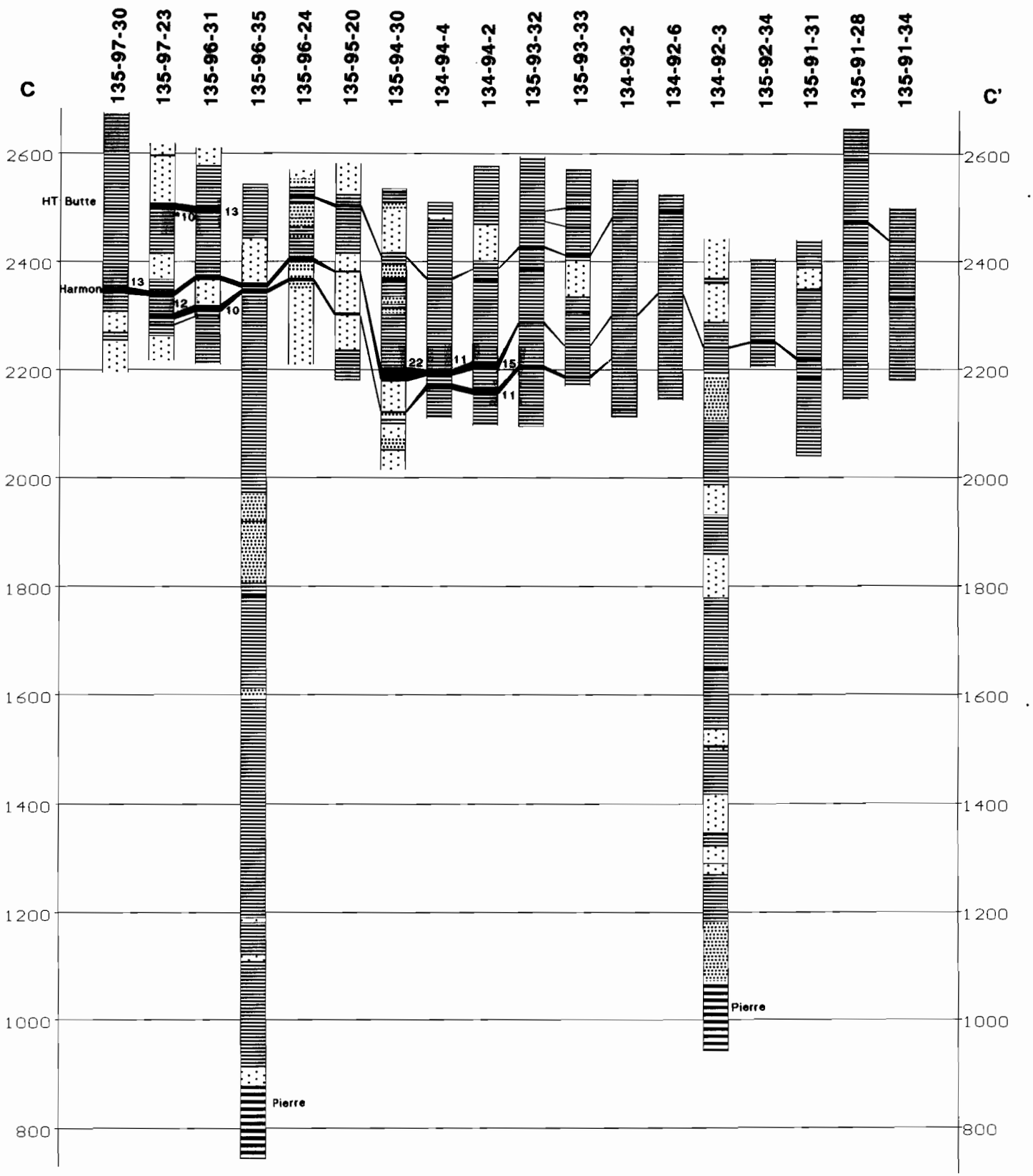

Figure 37. Cross-section C-C' of Upper Cretaceous and Fort Union strata in central Hettinger County.

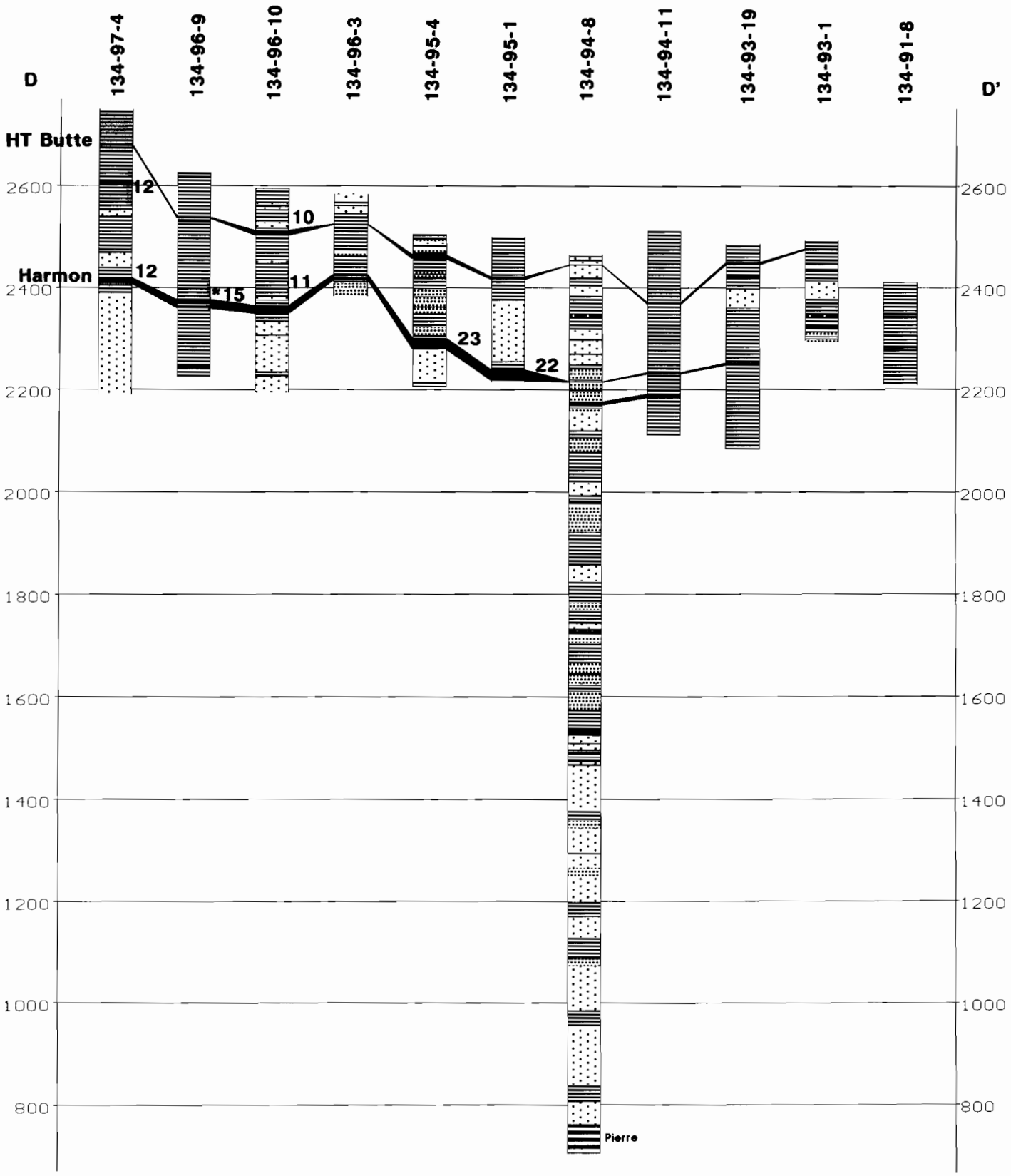

Figure 38. Cross-section D-D' of Upper Cretaceous and Fort Union strata in central Hettinger County.

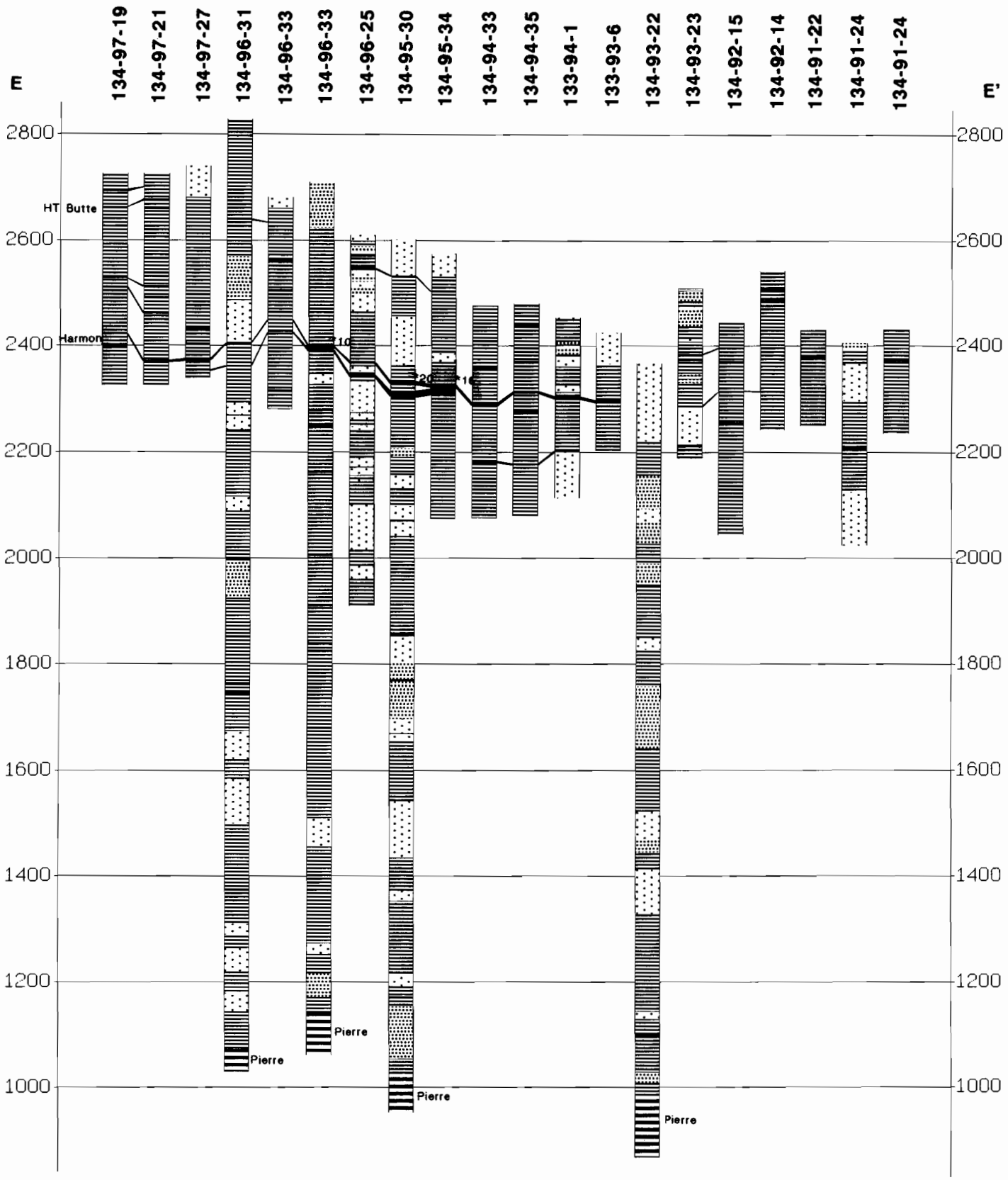

Figure 39. Cross-section E-E' of Upper Cretaceous and Fort Union strata in south-central Hettinger County.

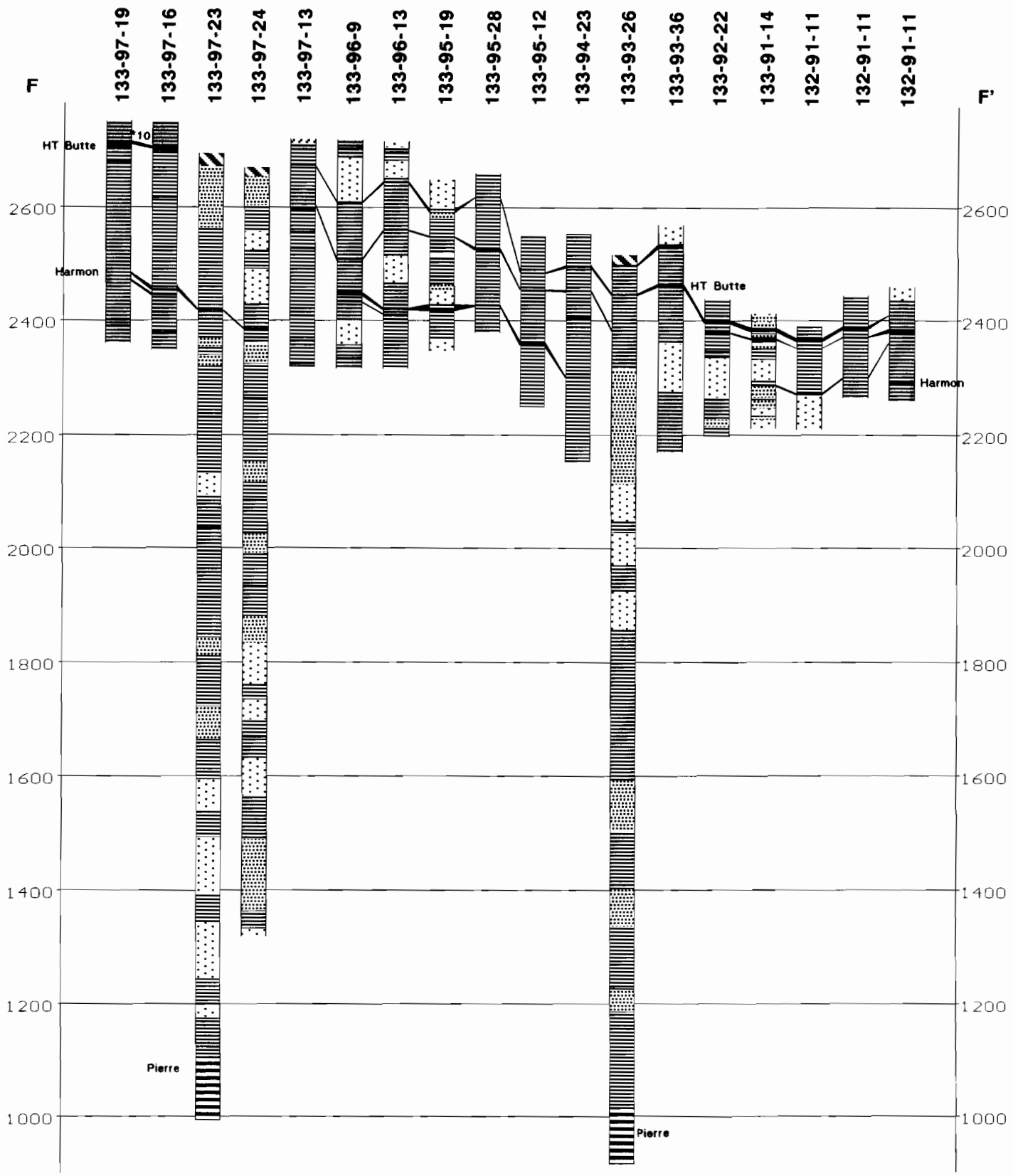

Figure 40. Cross-section F-F' of Upper Cretaceous and Fort Union strata in southern Hettinger County.

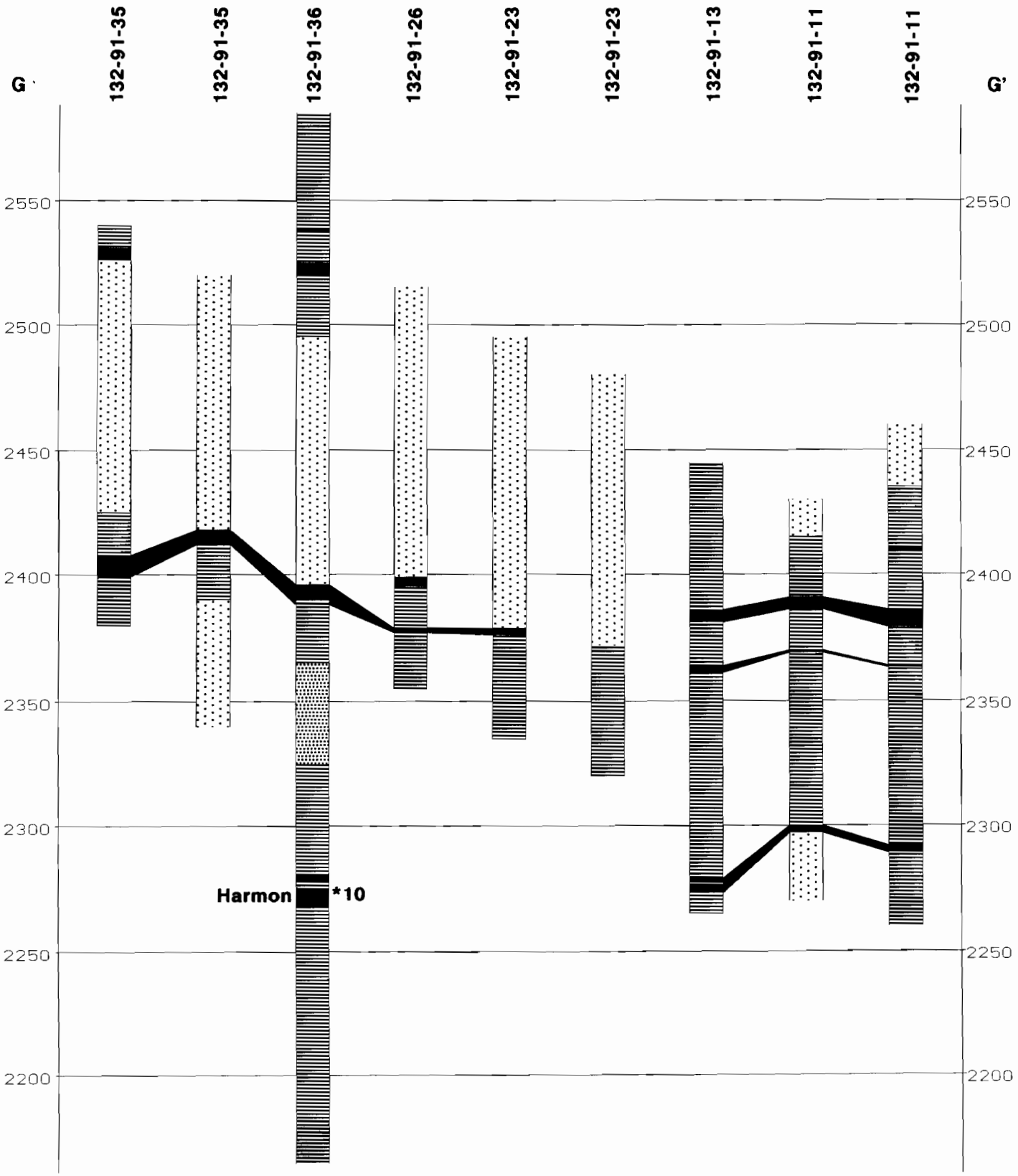

Figure 41. Cross-section G-G' of Fort Union strata in southeastern Hettinger County.

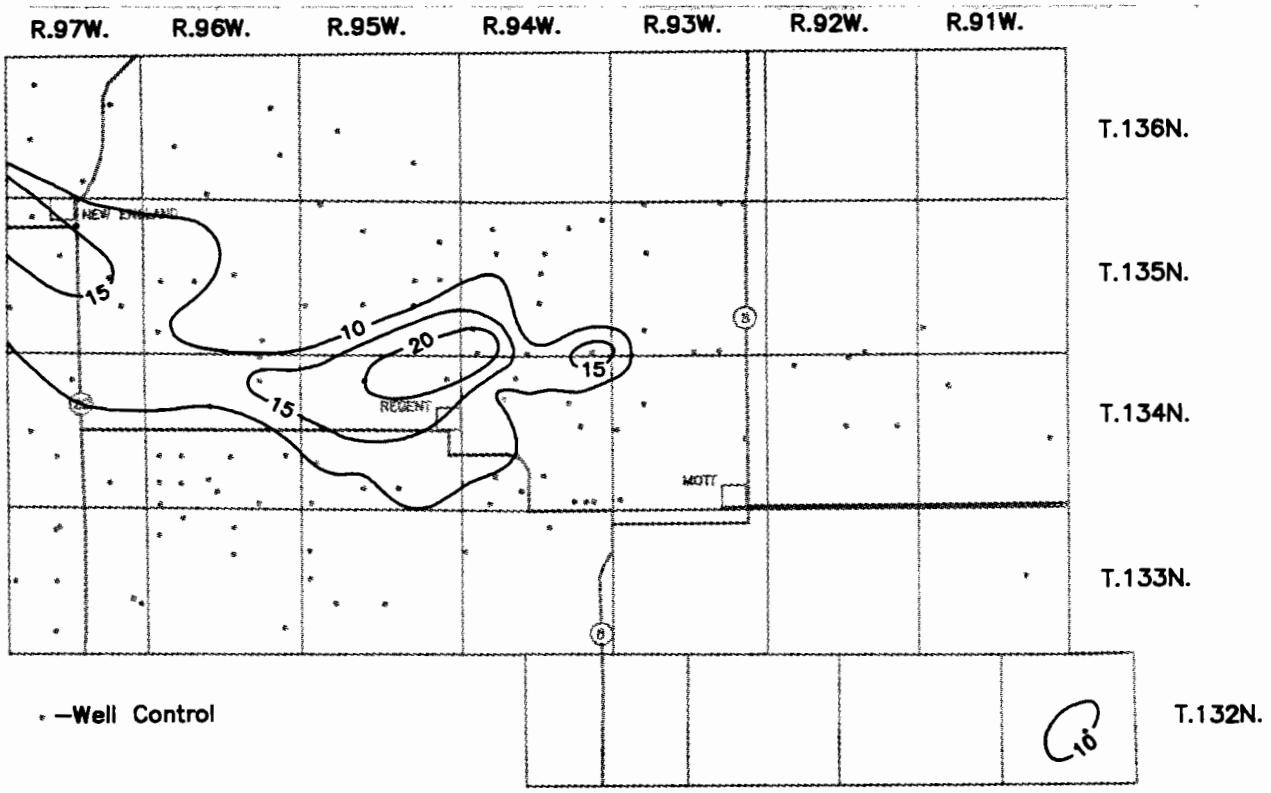

Figure 42. Isopach of the Harmon bed in Hettinger County.

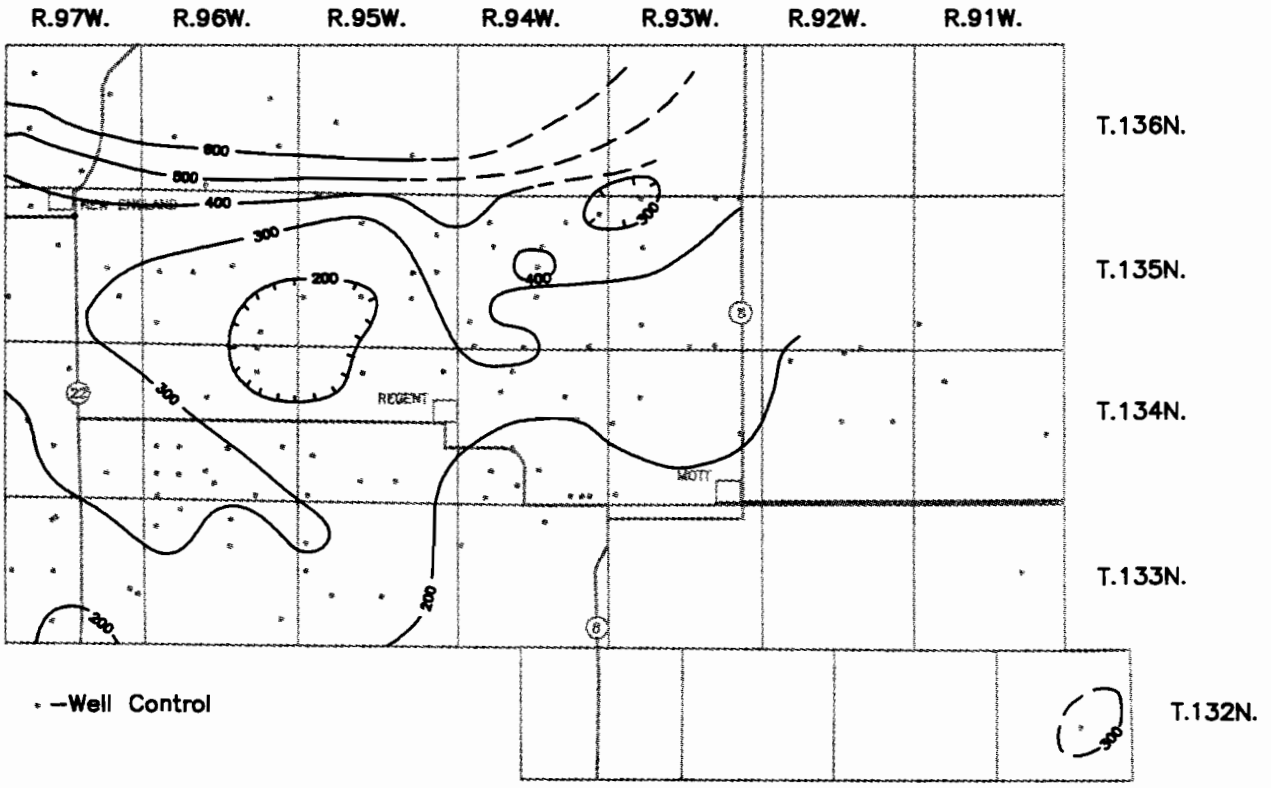

Figure 43. Contour map of the depth to the Harmon bed in Hettinger County.

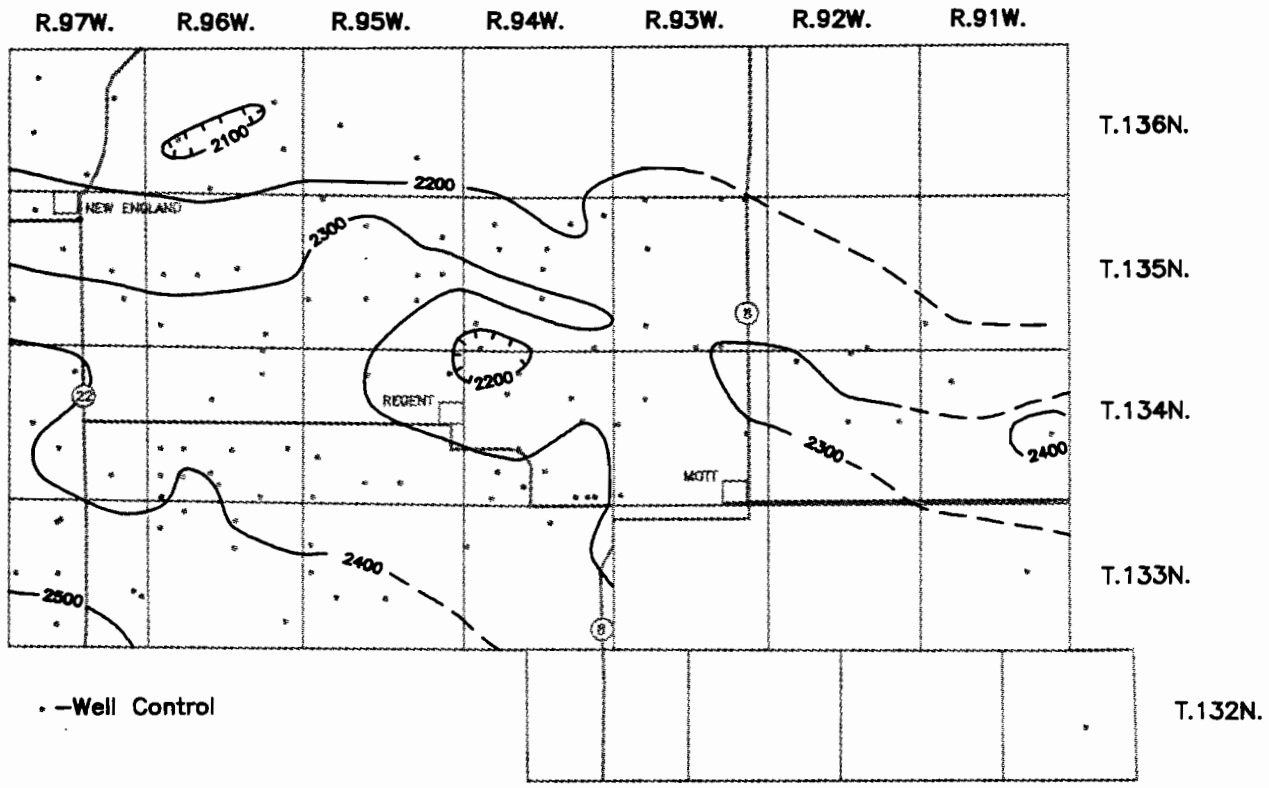

Figure 44. Contour map of the elevation at the top of the Harmon bed in Hettinger County.

ADAMS COUNTY

Introduction

Stratigraphic data from 253 holes was entered into the database for Adams County. The majority of the electric logs came from coal exploration holes, only six of the 12 oil wells drilled in Adams County provided stratigraphic information on the Fort Union. Stratigraphic control is poor throughout all but the northwest portion of the county. Several townships have fewer than three control points, some have none at all (Figure 45). Well control averages a mile or less north of Reeder (T.131N., R.98W.) but averages four to six miles throughout most of the rest of the county. Although most of these holes are only a few hundred feet deep, there are a number of 500 to 600 foot holes drilled by the U.S. Geological Survey in the 1980s that provide valuable information.

Surface geology in the county ranges from White River strata that caps a few buttes in the northwestern part of the county to the Ludlow Formation in southwestern Adams County. The Cannonball Formation is present at or near surface throughout approximately 20% of the county. The marine strata of the Cannonball Formation is devoid of coal. Six geologic-cross sections were constructed for Adams County (Figures 46-52).

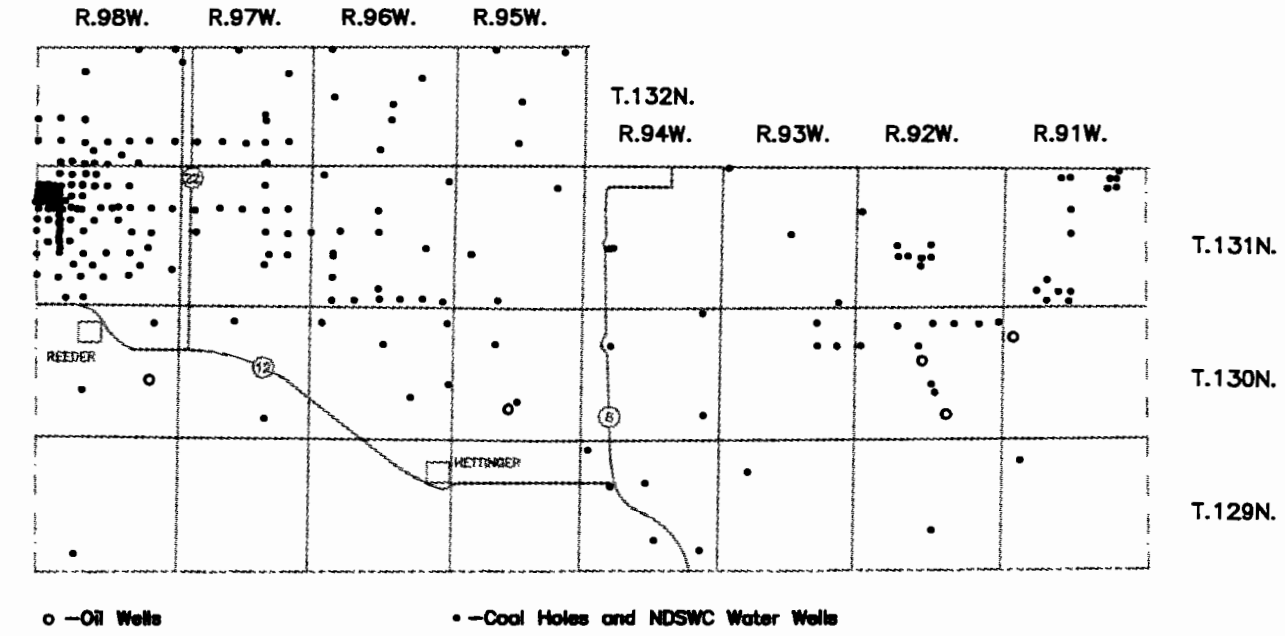

Figure 45. Well control in Adams County.

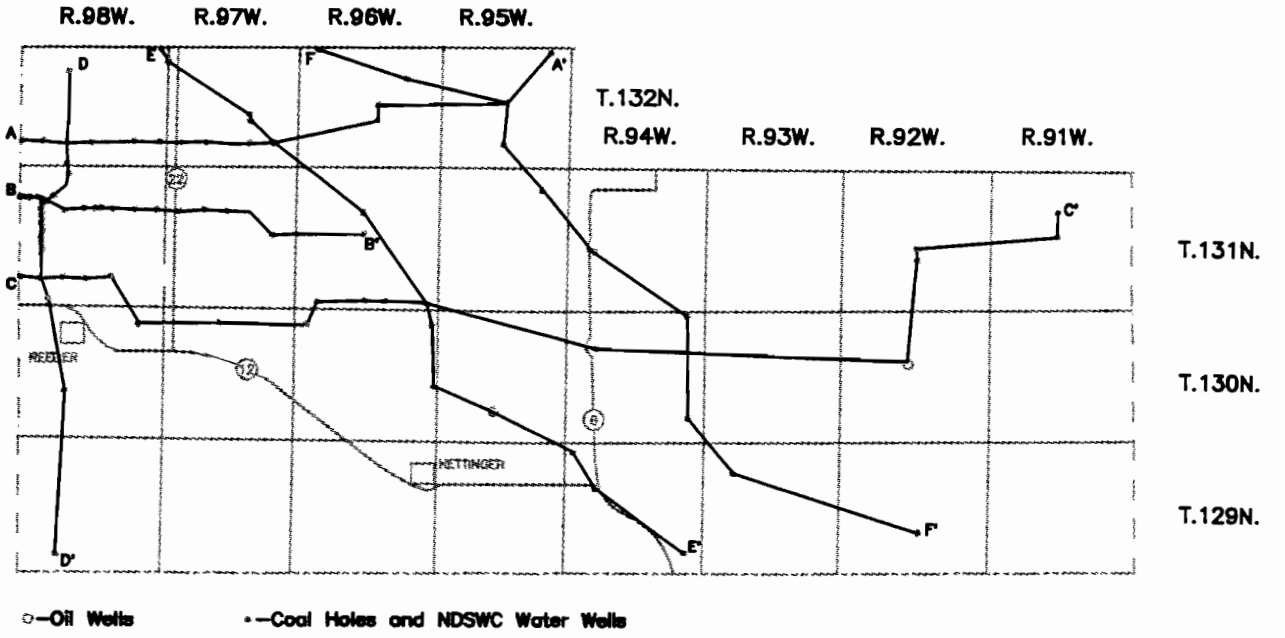

Figure 46. Traces of geologic cross-sections in Adams County.

The Harmon and Hansen Beds

The Harmon and Hansen bed have been removed by erosion from approximately 60% of the county (Figure 53). Due to very good well control, the Harmon and Hansen beds can be traced with confidence north of Reeder (T.131N., R.98W.). Individually, the Harmon and Hansen beds are seldom more than 10 feet thick in this area and tend to split into three or four beds to the east (Figures 50 and 53). However, collectively, they are more than 15 feet thick north of Reeder and exceed 20 feet in a small area along the Bowman/Adams county line (Figures 47-50). In this area the top of the Harmon bed is 200 to 300 feet beneath the surface (Figure 54). The Harmon and Hansen beds dip to the northeast at a rate of approximately 20 feet per mile (Figure 55). A 10- and a 7-foot thick coal are at the appropriate stratigraphic position in the northeastern corner of the county and have been tentatively identified as the Harmon bed (Figure 53).

HT Butte Coal

The Sentinel Butte Formation, and therefore the HT Butte coal, is restricted primarily to the northwest corner of the county. It averaged about 3 feet thick throughout this area (Figures 47, 48, and 50).

Additional Coals

Well control is poor in the southern and eastern portions of the county. As a result, few conclusions can be drawn concerning coals in this area. Only a few coals were encountered and most could not be correlated due to the lack of well control (Figures 51 and 52). These coals were generally less than 10 feet thick, most less than five. A 14-foot thick coal is present in T.130N., R.94W. section 36, it likely is not the Harmon bed because it appears to be stratigraphically too low. The extent of the coal could not be determined due to poor well control in the area. However, if it is the Harmon bed, it will be restricted to an area of only a few square miles due to erosion. A 12-foot thick coal, possibly the H bed, is present in a hole north of Reeder (T.131N., R.98W., section 12). This coal was not present in any of the adjacent holes (Figure 48).

The available data suggests that there are no thick coals in the lower Fort Union Group in Adams County. However, there are so few deep wells that it is conceivable a thick coal or coals of limited extent may be present.

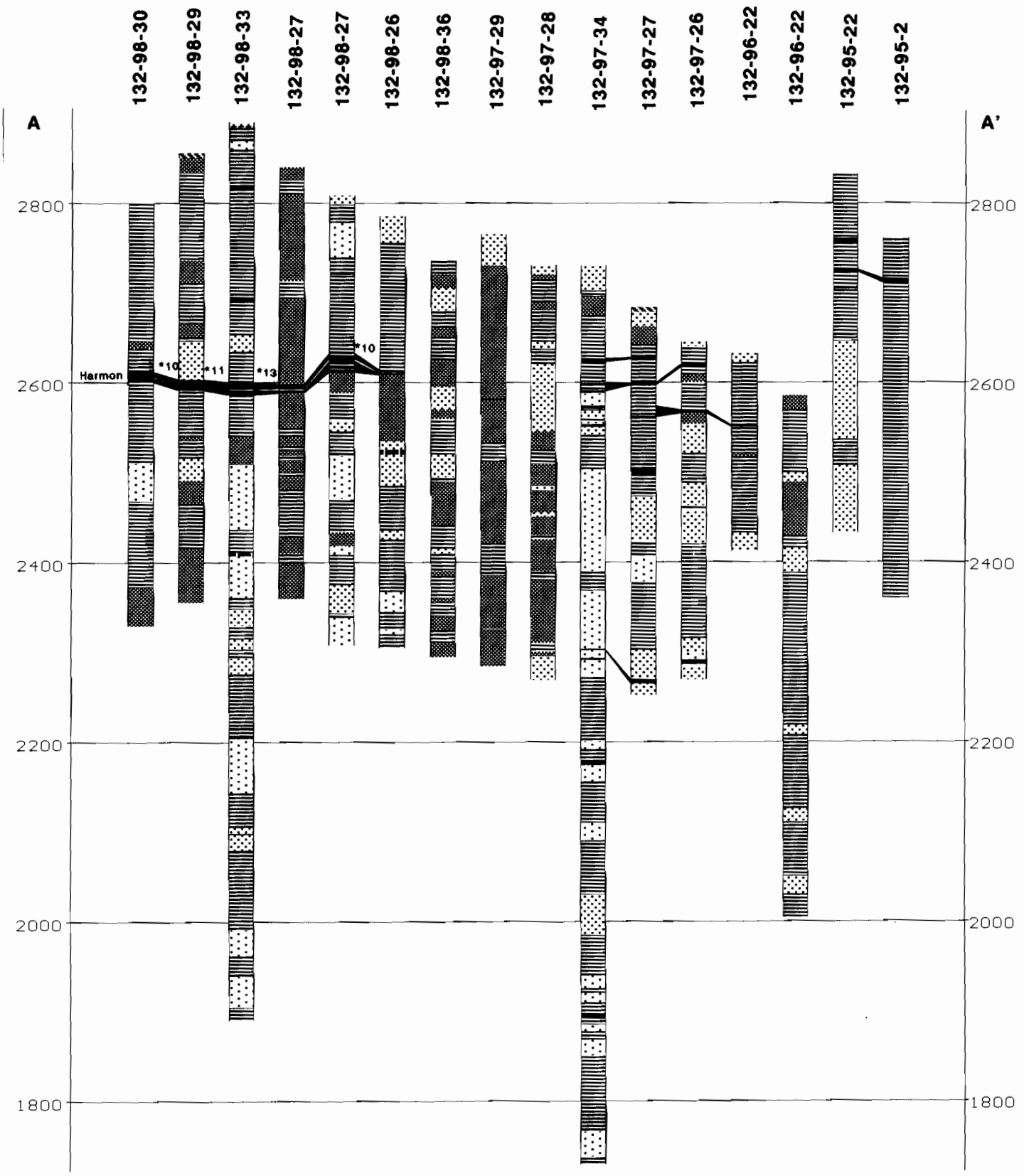

Figure 47. Cross-section A-A' of Fort Union strata in northern Adams County.

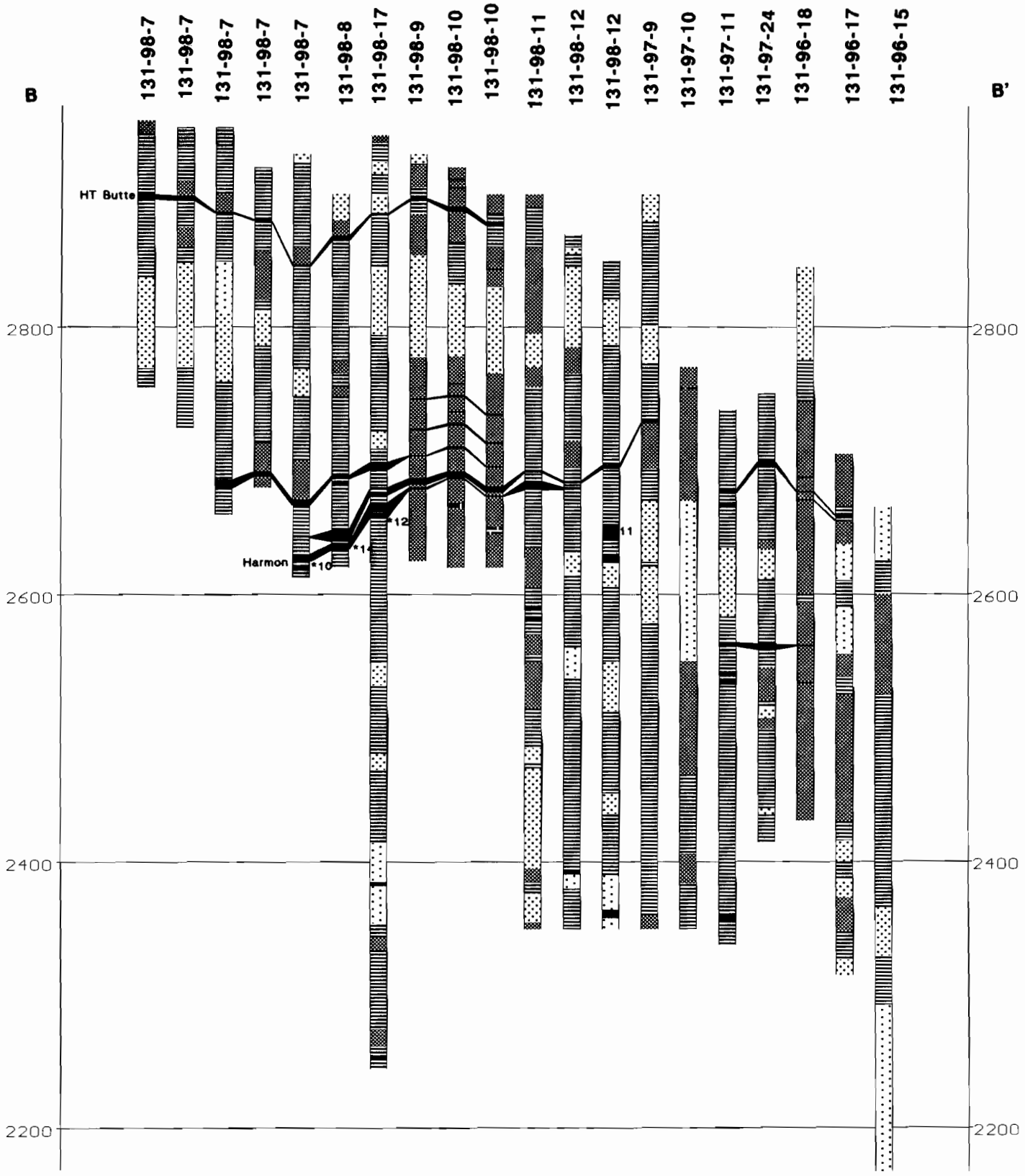

Figure 48. Cross-section B-B' of Fort Union strata in west-central Adams County.

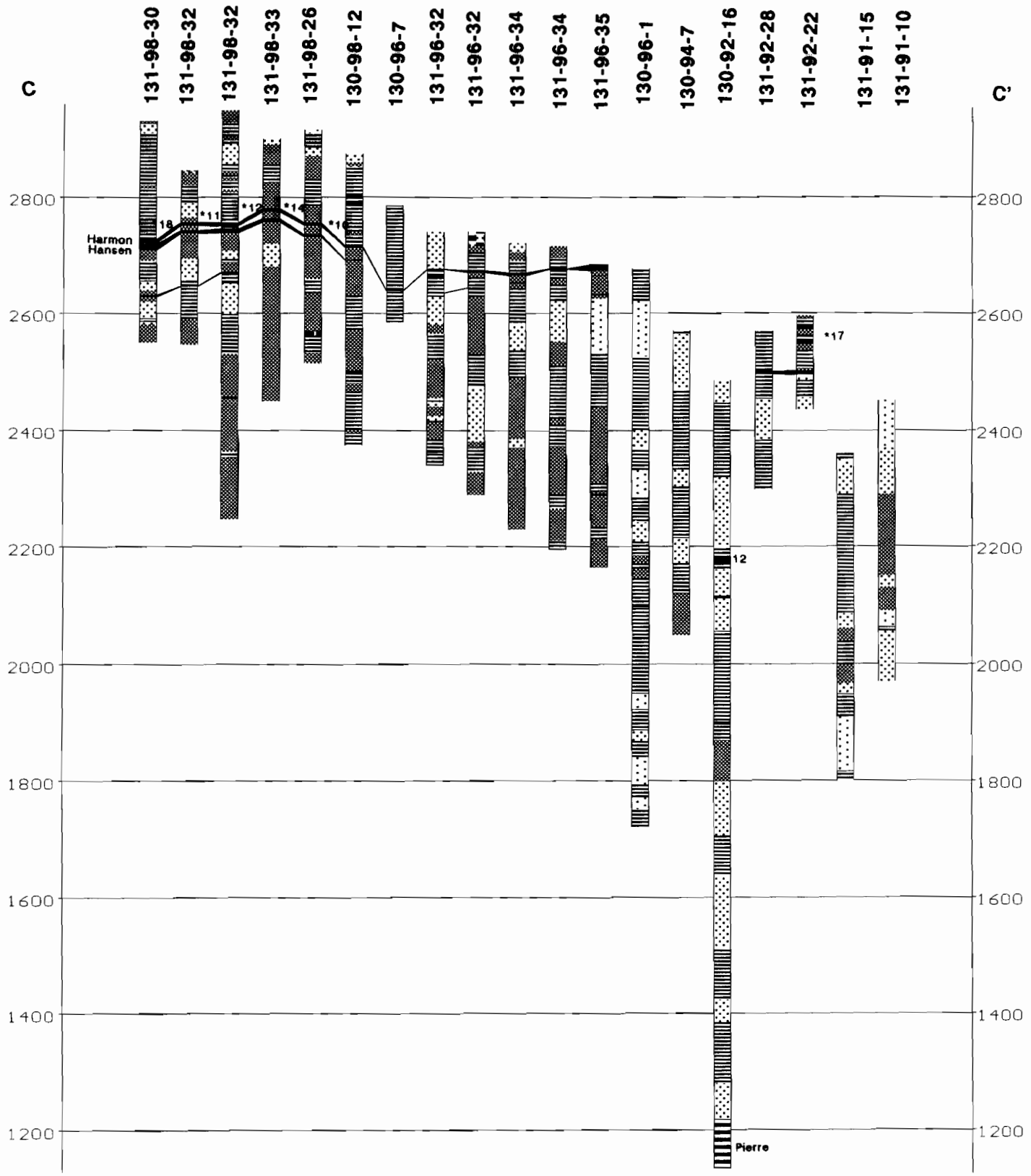

Figure 49. Cross-section C-C' of Upper Cretaceous and Fort Union strata in central Adams County.

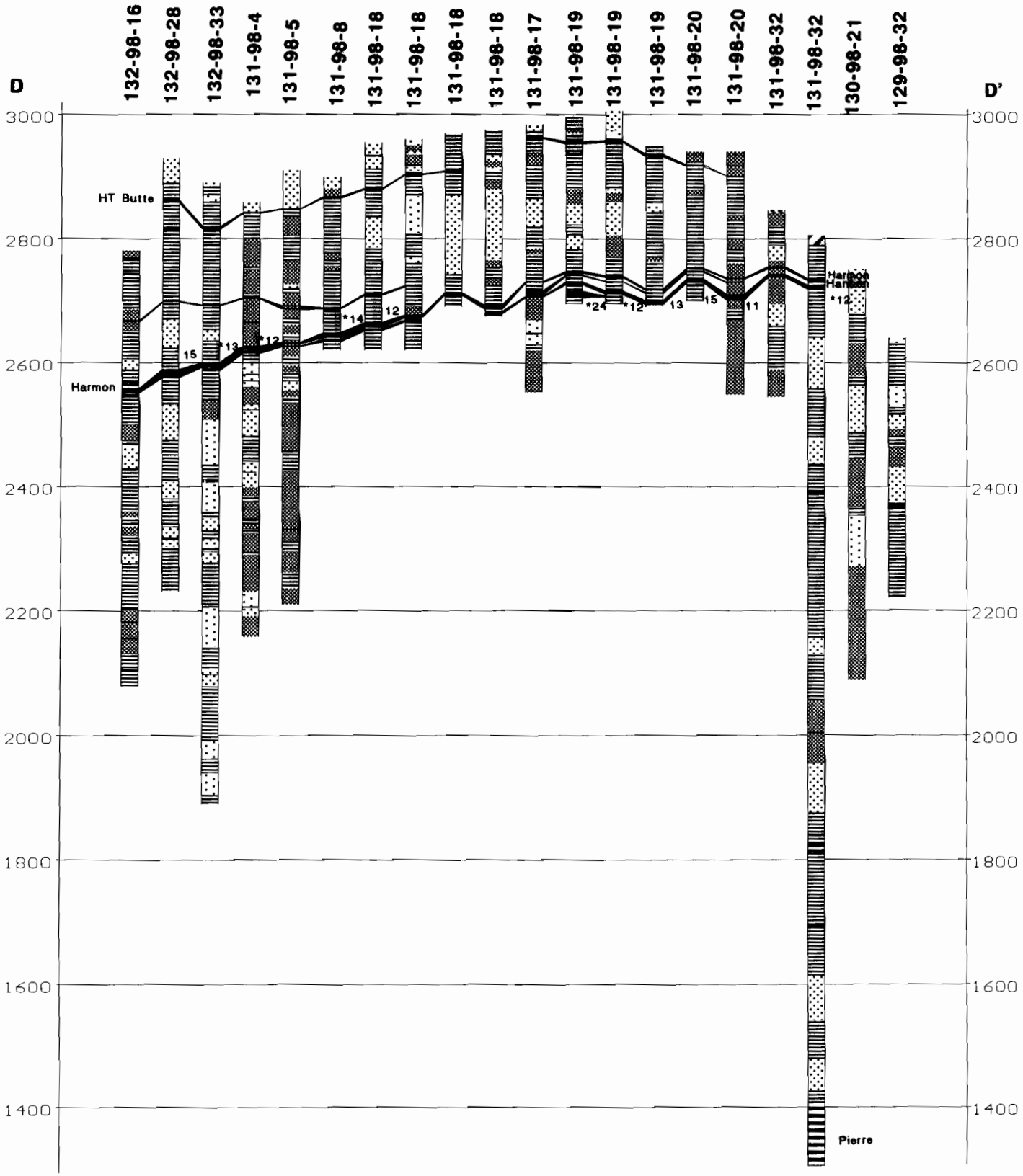

Figure 50. Cross-section D-D' of Upper Cretaceous and Fort Union strata in western Adams County.

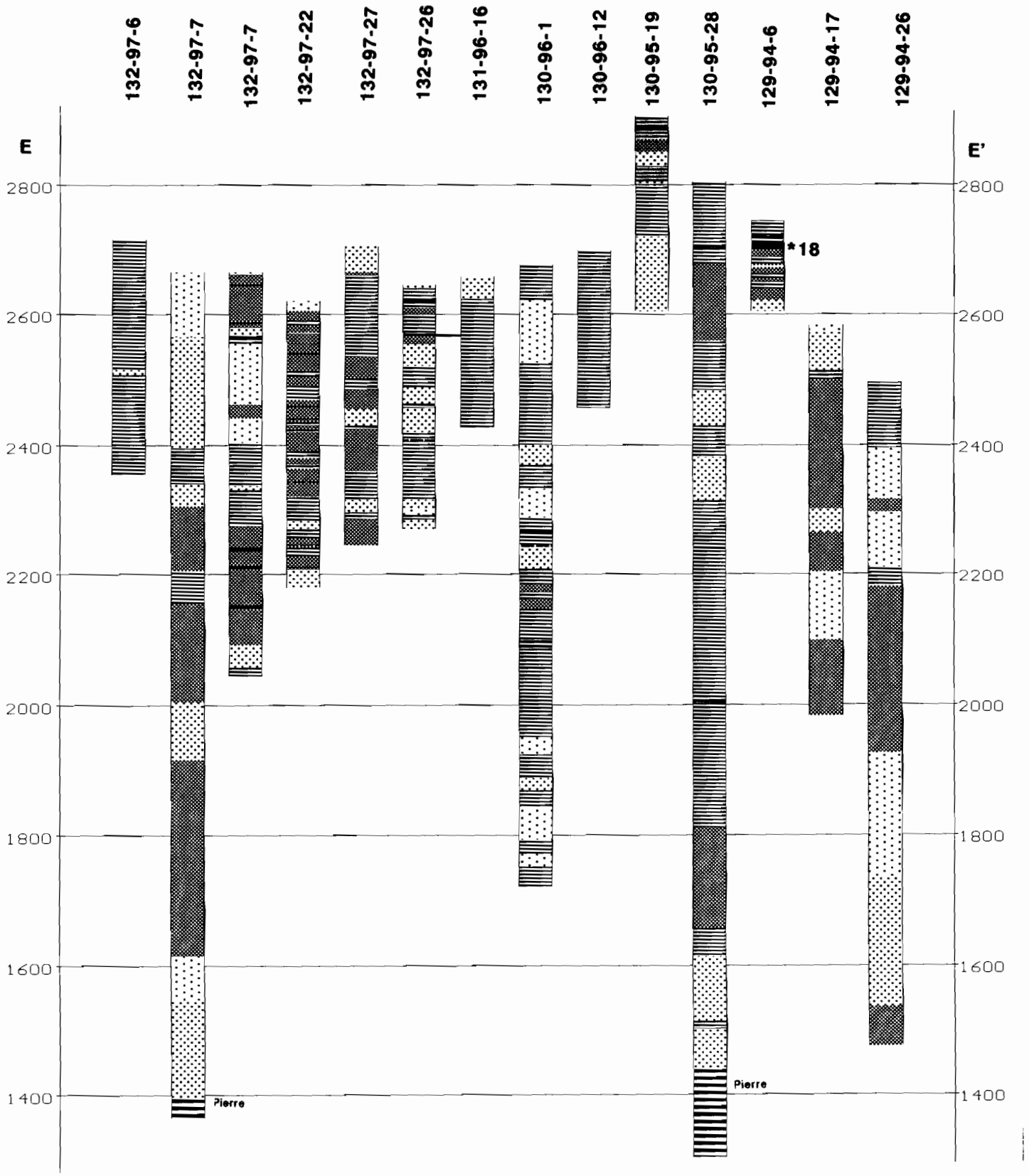

Figure 51. Cross-section E-E' of Upper Cretaceous and Fort Union strata in central Adams County.

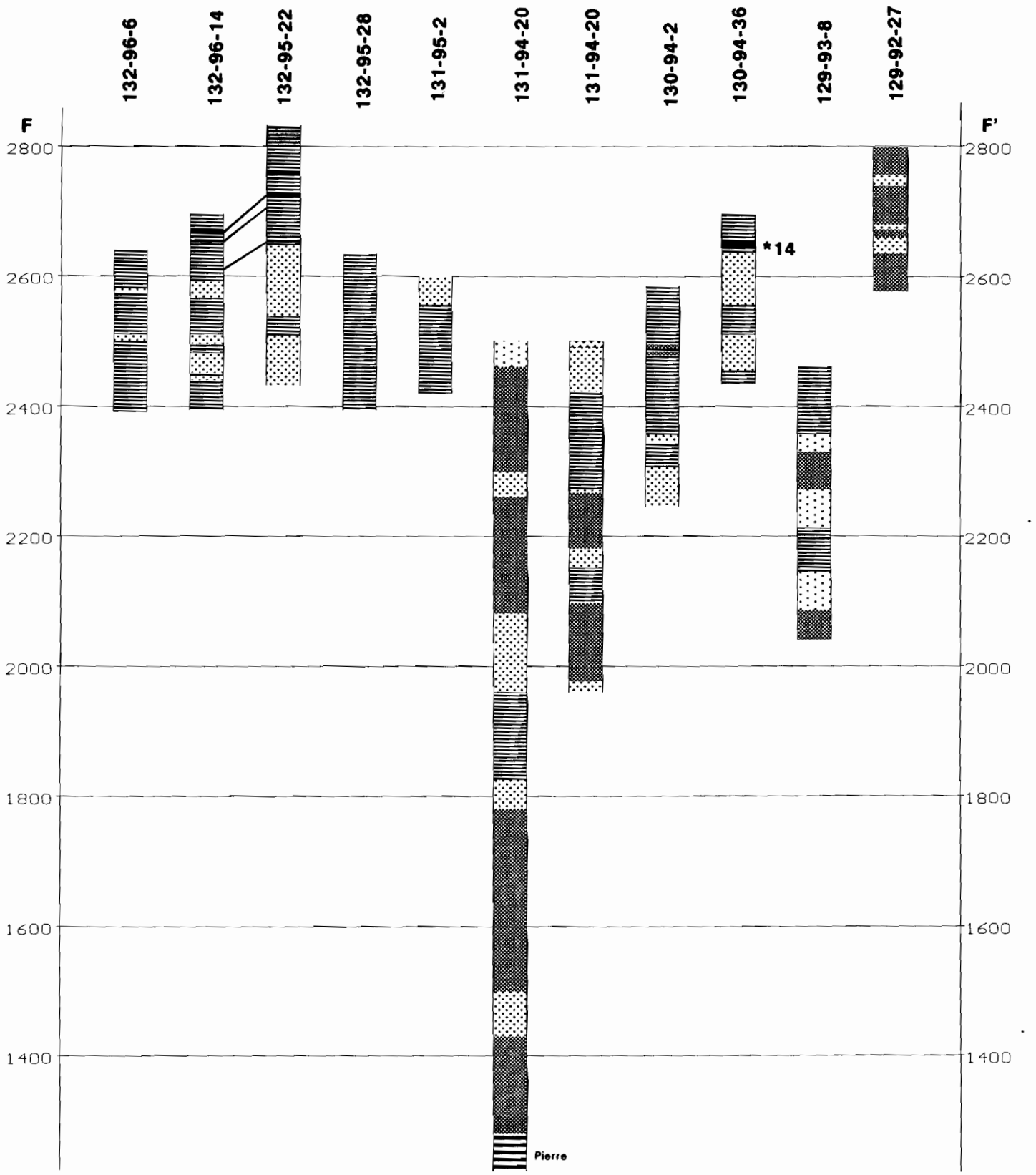

Figure 52. Cross-section F-F' of Upper Cretaceous and Fort Union strata in east-central Adams County.

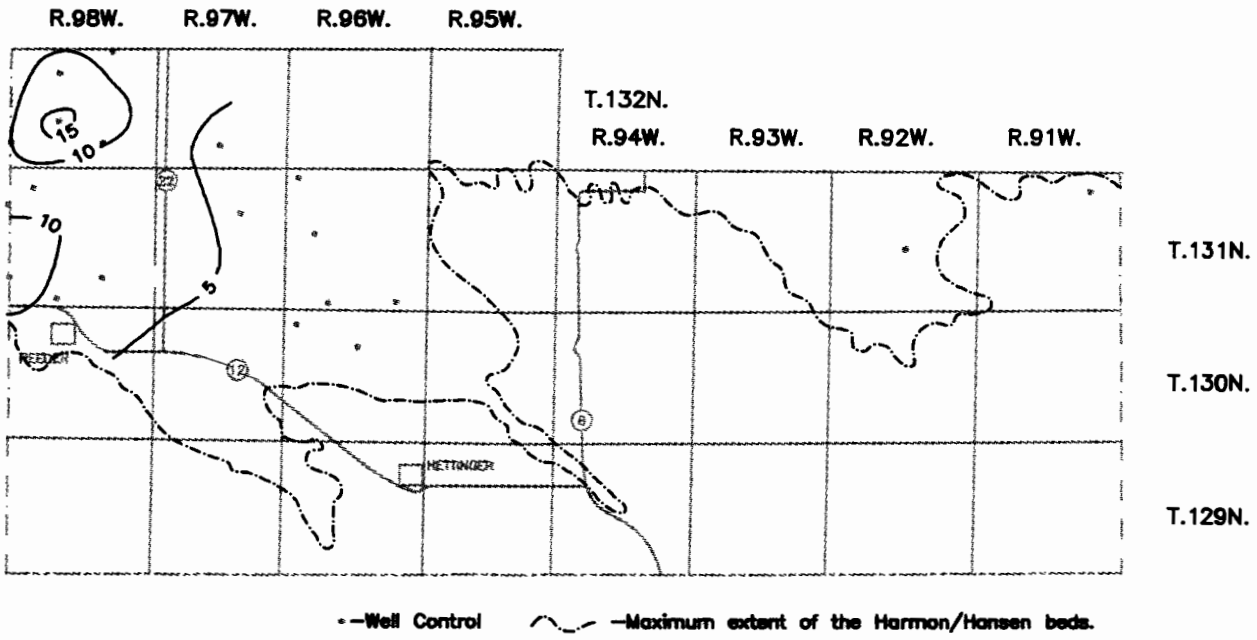

Figure 53. Isopach of the Harmon bed in Adams County.

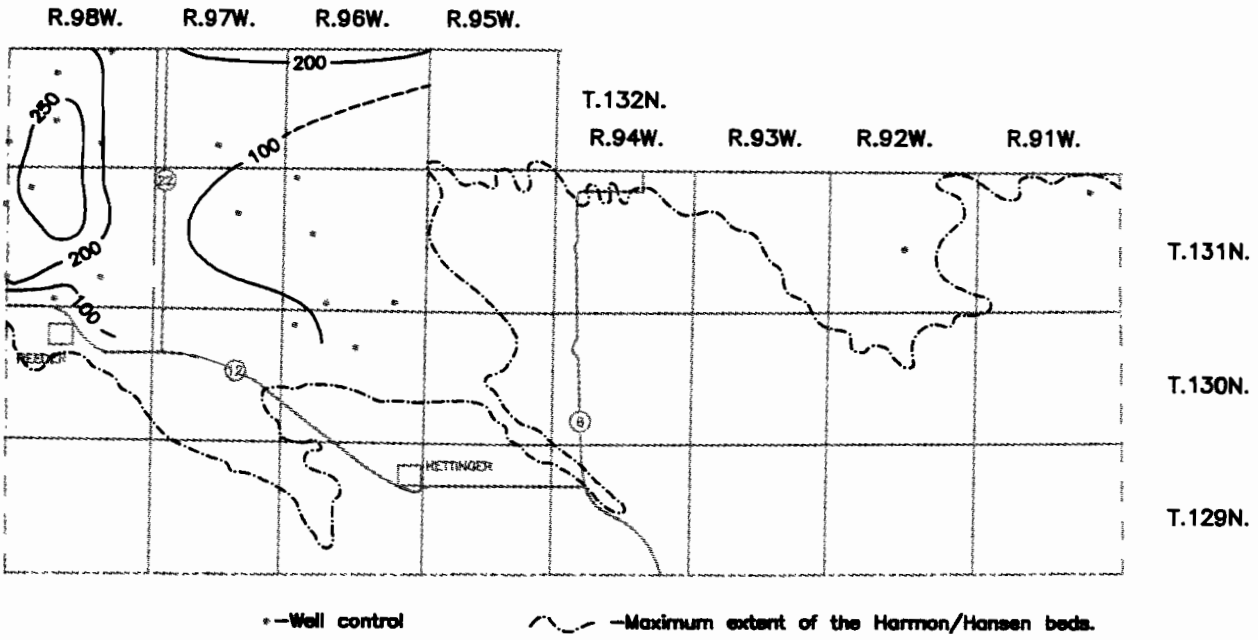

Figure 54. Contour map of the depth to the Harmon bed in Adams County.

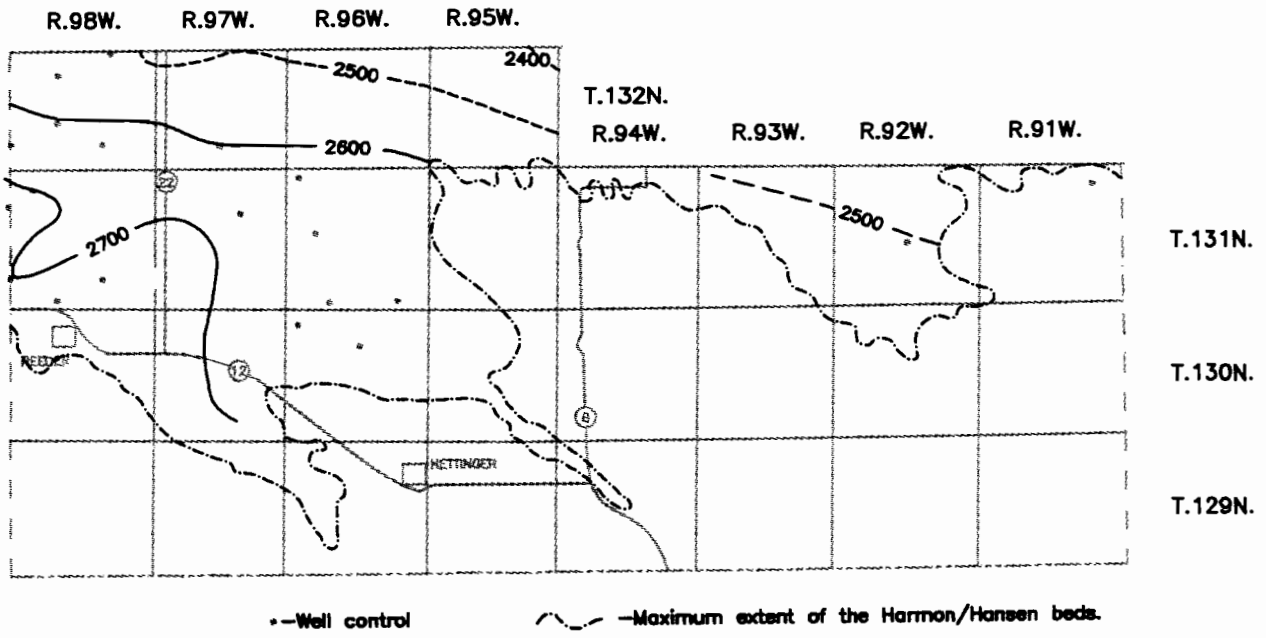

Figure 55. Contour map of the elevation at the top of the Harmon bed in Adams County.

SUMMARY

The Harmon and Hansen beds comprise the thickest, most extensive coal interval in the four-county area. The Harmon and Hansen beds are thickest in north-central Bowman, central and northeastern Slope, west-central and central Hettinger, and northwestern Adams counties (Figure 56). Collectively, the Harmon and Hansen beds approach 40 feet in thickness in northeastern and east-central Slope County (Figure 30). The Harmon bed is thickest near the Chalky Buttes in central Slope and northeast Bowman counties where it is more than 30 feet thick (Figure 56). The Harmon and Hansen beds outcrop along the sides of buttes and drainages in western and southern Bowman, western Slope, and in eastern and southern Adams counties. The Harmon is generally within a few hundred feet of the surface in this area and reaches a maximum depth of 500 to 600 feet in northeastern Slope County (Figure 57). The maximum depth of burial for the Harmon bed in western North Dakota may have been on the order of 2000 feet. The Harmon and Hansen beds dip to the north-northeast, towards the center of the Williston Basin, at an average rate of 15 to 20 feet per mile (Figure 58).

The HT Butte and T Cross coals can be traced throughout part of this area but are seldom more than 10 feet thick. The T Cross is more than 30 feet thick in a several square mile area of T.133N., R.104W (Figure 26).

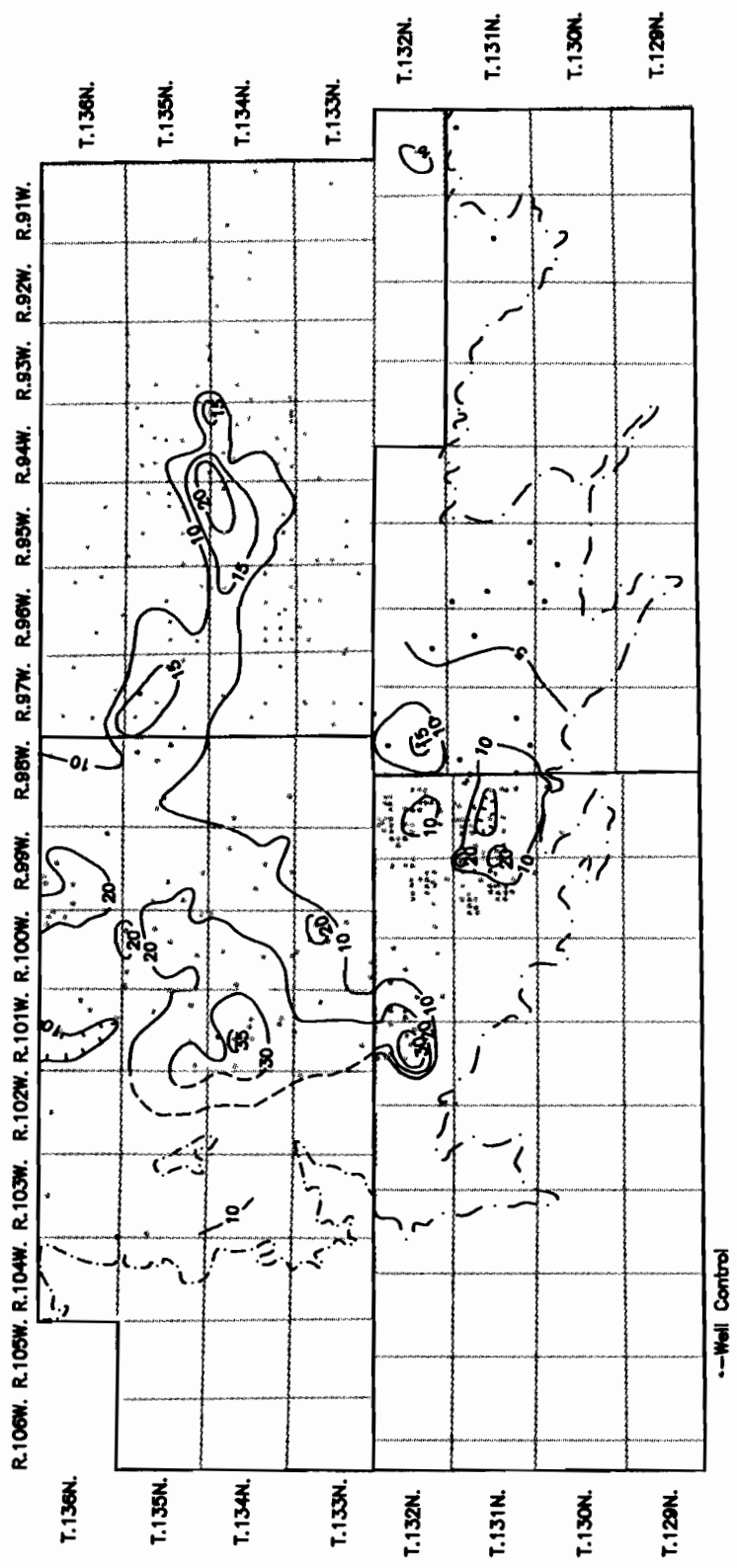

Figure 56. Isopach of the Harmon bed in Bowman, Adams, Slope, and Hettinger counties.

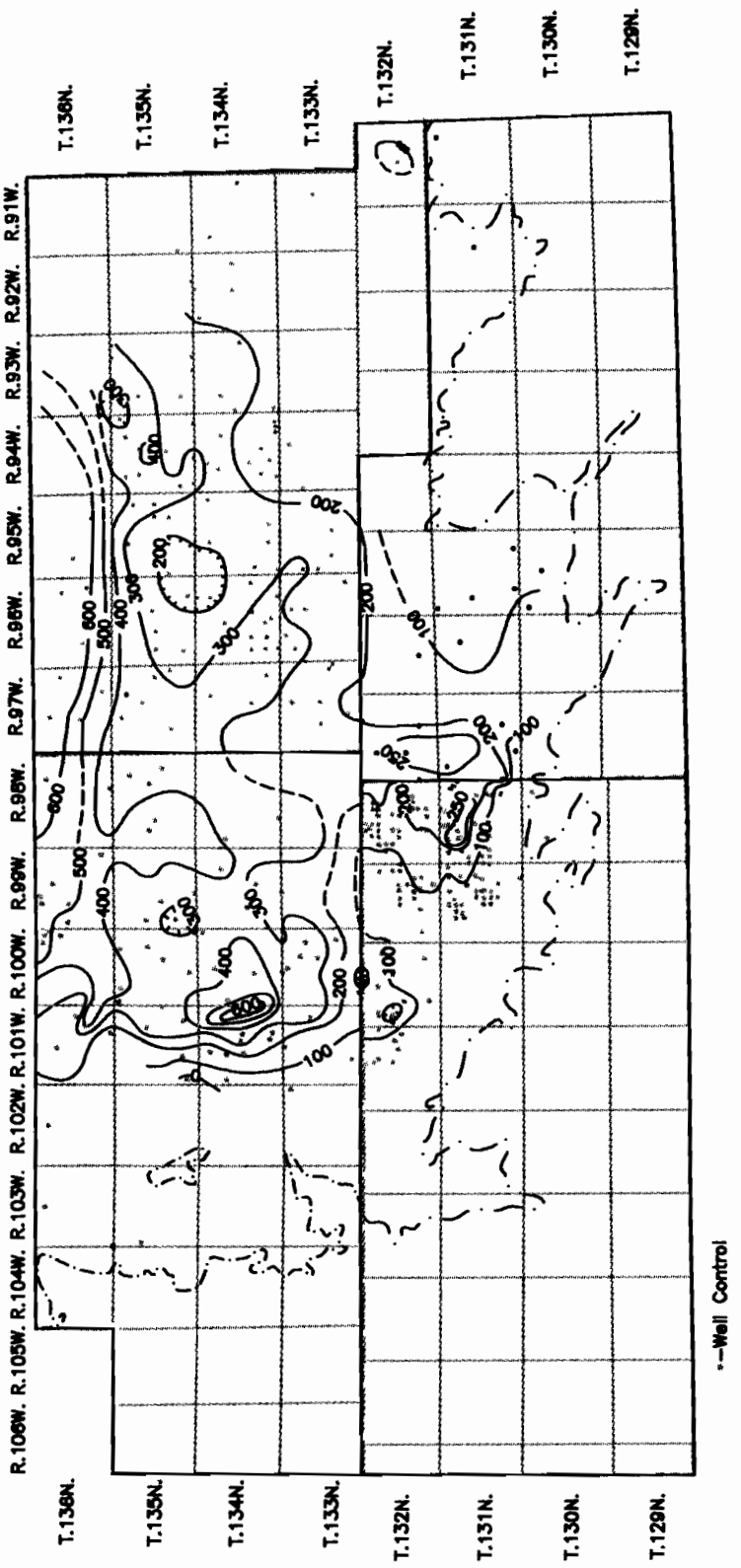

Figure 57. Contour map of the depth to the Harmon bed in Bowman, Adams, Slope, and Hettinger counties.

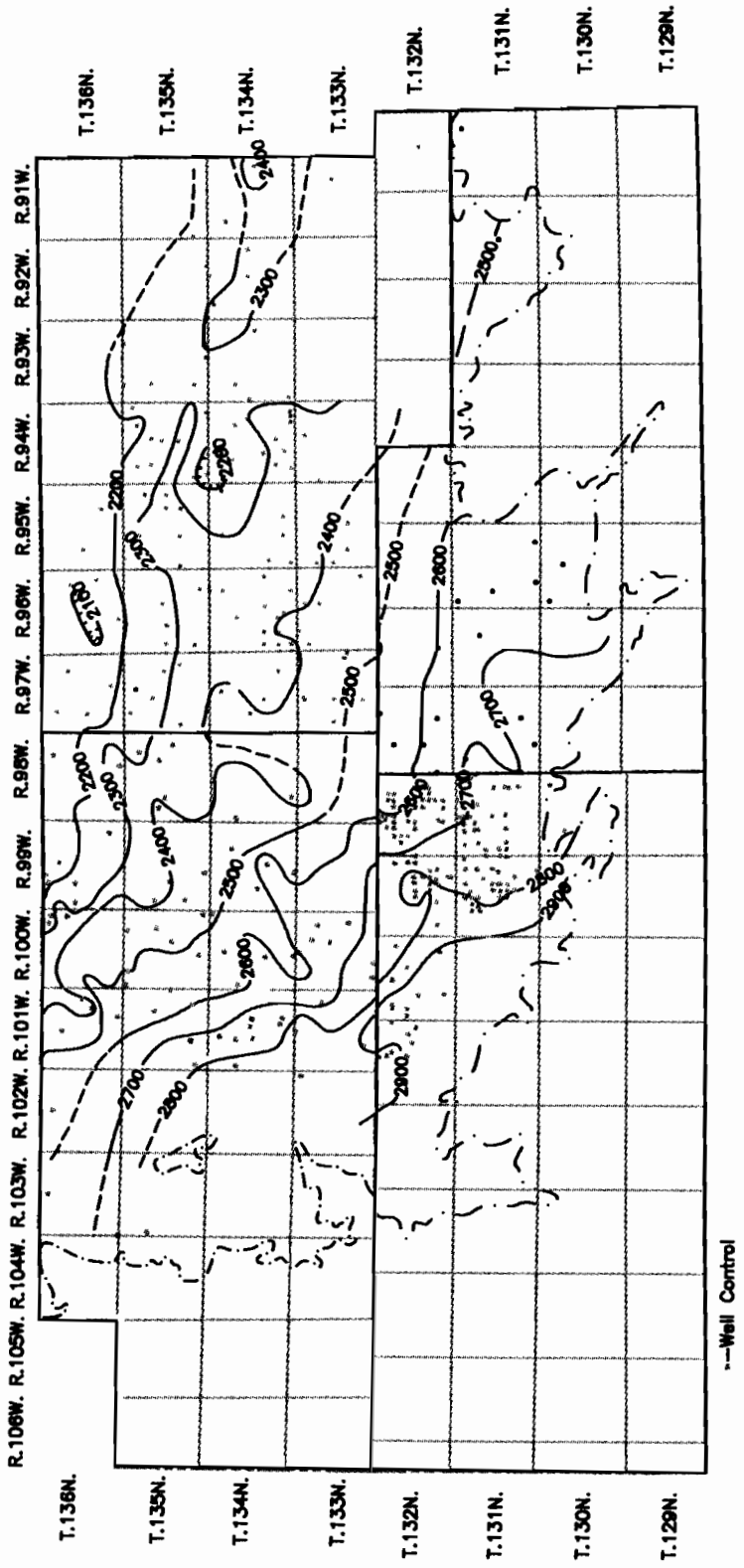

Figure 58. Contour map of the elevation at the top of the Harmon bed in Bowman, Adams, Slope, and Hettinger counties.

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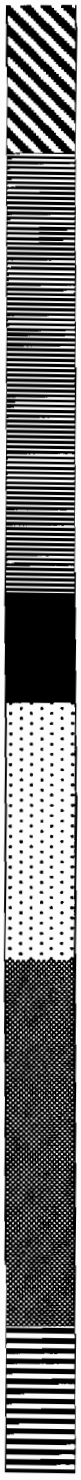
APPENDIX A

Lithologic Symbols Used on Geologic Cross-Sections



No Record.

Mudstone and/or Claystone.

Lignite.

Sandstone.

Siltstone.

Shale.