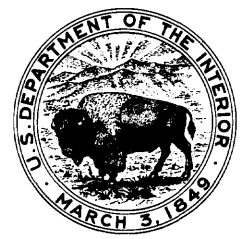
HYDROGEOLOGIC SECTIONS OF THE EDWARDS AQUIFER AND ITS CONFINING UNITS IN THE SAN ANTONIO AREA, TEXAS

By Ted Small

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 85-4259



Prepared in cooperation with the
SAN ANTONIO CITY WATER BOARD and the
TEXAS DEPARTMENT OF WATER RESOURCES

AUSTIN, TEXAS
1986

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
649 Federal Building
300 E. Eighth Street
Austin, TX 78701

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HYDROGEOLOGIC SECTIONS OF THE EDWARDS AQUIFER AND ITS CONFINING UNITS IN THE SAN ANTONIO AREA, TEXAS

By Ted A. Small

ABSTRACT

Twenty-seven hydrogeologic sections illustrate structural and stratigraphic relationships within the 180-mile-long Edwards aquifer in the San Antonio area, Texas. These sections were used by Maclay and Small (1984) to interpret the location of barriers within the Edwards aquifer.

The sections are oriented generally south-southeast, which is approximately normal to both the east-northeast trending Edwards aquifer and the strike of the major faults of the Balcones fault zone. Section lengths represent the distance necessary to cross the aquifer, which is 5 to 40 miles wide. The updip (north) end of the sections is drawn to indicate exposures of the Glen Rose Formation; from there the sections indicate downdip geologic conditions within the freshwater zone and the salinewater zone. The sections are approximately parallel and illustrate geologic conditions at 5- to 10-mile intervals. The sections indicate the geologic conditions from near the eastern boundary of the aquifer in Hays County to near the western boundary of the aquifer in Uvalde County.

Several sections show places where faults have sufficient vertical displacement to offset the entire, or almost entire, thickness of the aquifer. At these places the faults are barriers to ground-water flow directly downdip across the fault.

INTRODUCTION

The Edwards aquifer includes the Edwards Group of Early Cretaceous age described by Rose (1972) and its stratigraphic equivalents and the Georgetown Formation of Early Cretaceous age in the San Antonio area of Texas. It is a highly productive aquifer that is complexly faulted. To determine the ground-water-flow path through the aquifer system, a detailed knowledge of the stratigraphic units and their continuity and relative permeabilities is needed. Nearly vertical normal faults within the Balcones fault zone have been found to strongly influence the direction of ground-water flow and the local hydraulic gradient of the flow system (Holt, 1959; Maclay and Small, 1983).

Since 1970, the U.S. Geological Survey, in cooperation with the San Antonio City Water Board and the Texas Department of Water Resources, has collected geological, geophysical, hydrologic, and hydrochemical data of the Edwards aquifer in the San Antonio area and has prepared data and interpretative reports. This report is one of the products of this program. Other reports include Maclay, Rettman, and Small (1980); Maclay and Small (1976, 1983, 1984); Maclay, Small, and Rettman (1980, 1981); and Small and Maclay (1982).

The purpose of this report is to present a set of 27 hydrogeologic sections showing the geologic framework of the 180-mi long, 5- to 40-mi wide Edwards aquifer in the San Antonio area. Information used to prepare these sections included geophysical logs, drillers' logs, surface geologic maps, and subsurface structural contour maps. Each section illustrates the geology along a line that extends downdip from near the northern limit of the outcrop of the Edwards aquifer or from the outcrop of the Glen Rose Formation through the freshwater zone to a location within the salinewater zone. These hydrogeologic sections document the Edwards aquifer geologic framework. The hydrogeologic sections show the vertical displacement of the faults and show where the displacement is sufficient to completely or nearly completely offset the entire thickness of the aquifer, thus obstructing the flow of ground water. The fault locations were used to map the position of the barriers to ground-water flow directly or nearly directly downdip (Maclay and Small, 1984).

WELL-NUMBERING SYSTEM

The wells and test holes used in the cross sections in this report are identified by the standard well-numbering system which was developed by the Texas Department of Water Resources for use throughout the State. Under this system, each 1-degree quadrangle is given a number consisting of two digits. These are the first two digits in the well number. Each 1-degree quadrangle is divided into 7-1/2 minute quadrangles which are given two-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7-1/2 minute quadrangle is divided into 2-1/2 minute quadrangles which are given a single-digit number from 1 to 9. This is the fifth digit of the well number. Finally, each well within a 2-1/2 minute quadrangle is given a two-digit number in the order in which it was inventoried, starting with 01. These are the last two digits of the well number. Some of the wells used in this report have not been inventoried by the Texas Department of Water Resources and therefore do not have the last two digits of the well number. In addition to the five- or seven-digit number, a two-letter prefix is used to identify the county. The prefixes for counties where well logs were used for correlation

are as follows: AY, Bexar; DX, Comal; KX, Guadalupe; LR, Hays; RP, Kinney; TD, Medina; and YP, Uvalde. An example of a well numbered by this system is AY-68-29-506.

HYDROGEOLOGIC SECTIONS

To document the geologic framework of the Edwards aquifer, 27 hydrogeologic sections of the aquifer and its confining units were constructed. Lines of sections and the depositional provinces crossed by these sections are shown in figure 1 (for description of depositional provinces, see Maclay and Small, 1984).

The sections show stratigraphic and structural relationships along lines which are oriented approximately south-southeast generally parallel to the regional dip of the rocks forming the aquifer and its confining units. This orientation is normal to the major faults of the Balcones fault zone. The Balcones fault zone is a series of en echelon, normal, mostly down-to-the-coast faults that displace the Edwards aquifer as much as 1,000 ft from the outcrop area to the salinewater zone near the downdip limit of freshwater, locally known as the "bad-water" line.

The section lines are approximately parallel and show stratigraphic and structural conditions at 5- to 10-mi intervals across the aquifer. Section A-A' illustrates the geologic conditions along a line near the eastern boundary of the aquifer in Hays County, and section ZZ-ZZ' shows the geologic conditions along a line in Uvalde County near the western boundary of the aquifer. The sections illustrate geologic conditions from the outcrop area to the salinewater zone (fig. 1). Each section shows the contacts of the stratigraphic units of the aquifer and its confining layers as well as the contacts of the units overlying the Del Rio Clay, the upper confining bed of the aquifer. The stratigraphic correlation of those units is shown in figure 2.

The approximate potentiometric surface, or water level, is shown in each section to illustrate the thickness of the saturated portion of the aquifer along the section. Also the location of the approximate contact between freshwater and salinewater is shown in the sections that cross into the salinewater zone.

The individual hydrogeologic sections are shown in figures 3-29. These sections show the location and vertical displacements of the faults they cross. Some vertical displacements are sufficient to completely offset the aquifer (figs. 4, 6, 8, 9, and 12-19). The dip of most of the faults is shown as vertical. George (1952), Holt (1959), Arnow (1959) and DeCook (1963) stated that the dip of the faults in the Balcones fault zone was, in general, almost vertical. In the three sections where a well bore is shown crossing the plane of a fault (figs. 3, 17, and 21), the hade, which is the angle of the fault plane with the vertical (the well bore in these illustrations) was slightly exaggerated in order to show the local structural relationship.

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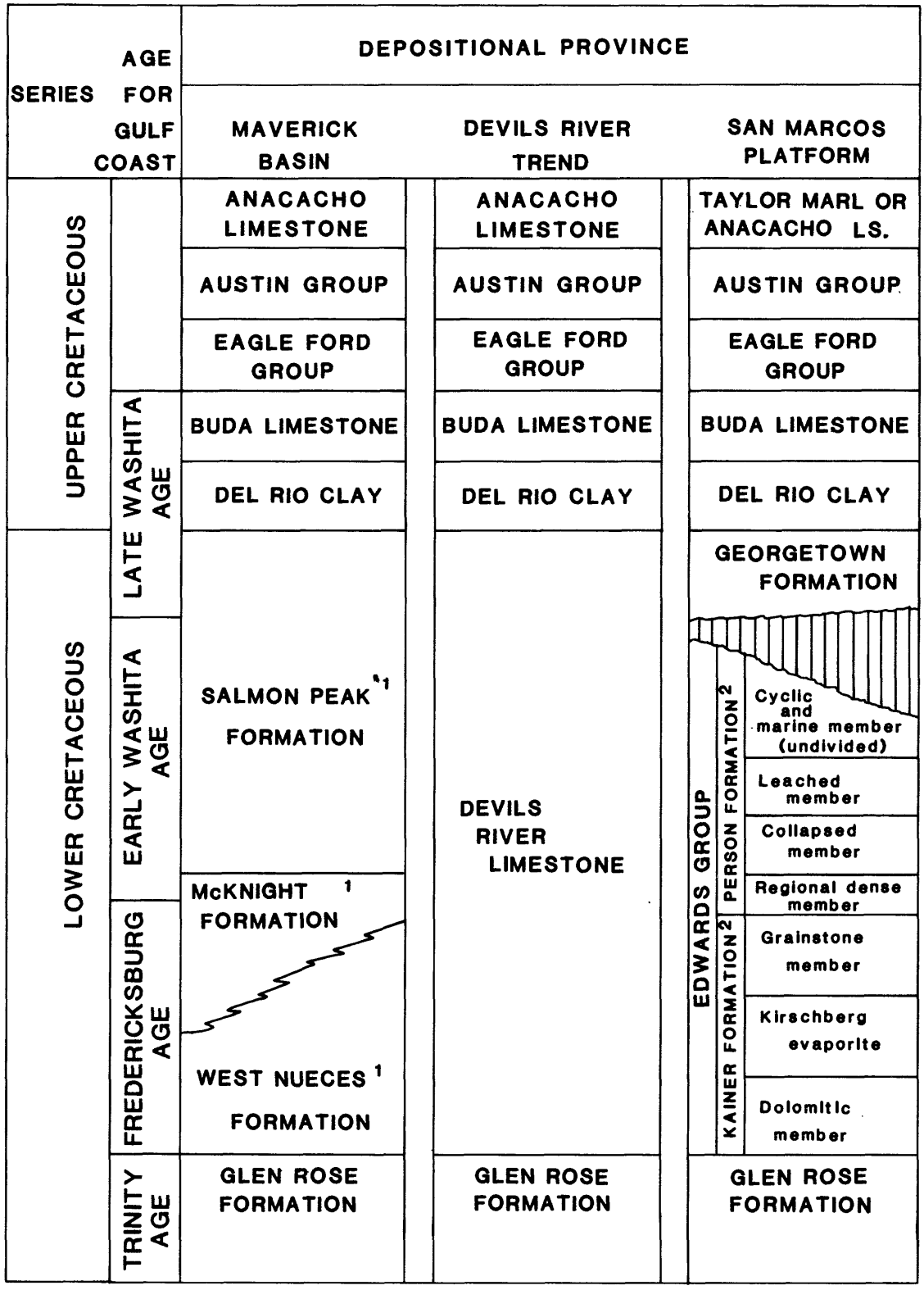

[1] Of Lozo and Smith (1964)

[2] The Edwards Limestone was raised to a stratigraphic group by Rose (1972), and includes his Kainer and Person Formations

Figure 2.--Correlation of stratigraphic units of the Cretaceous System of South Texas.

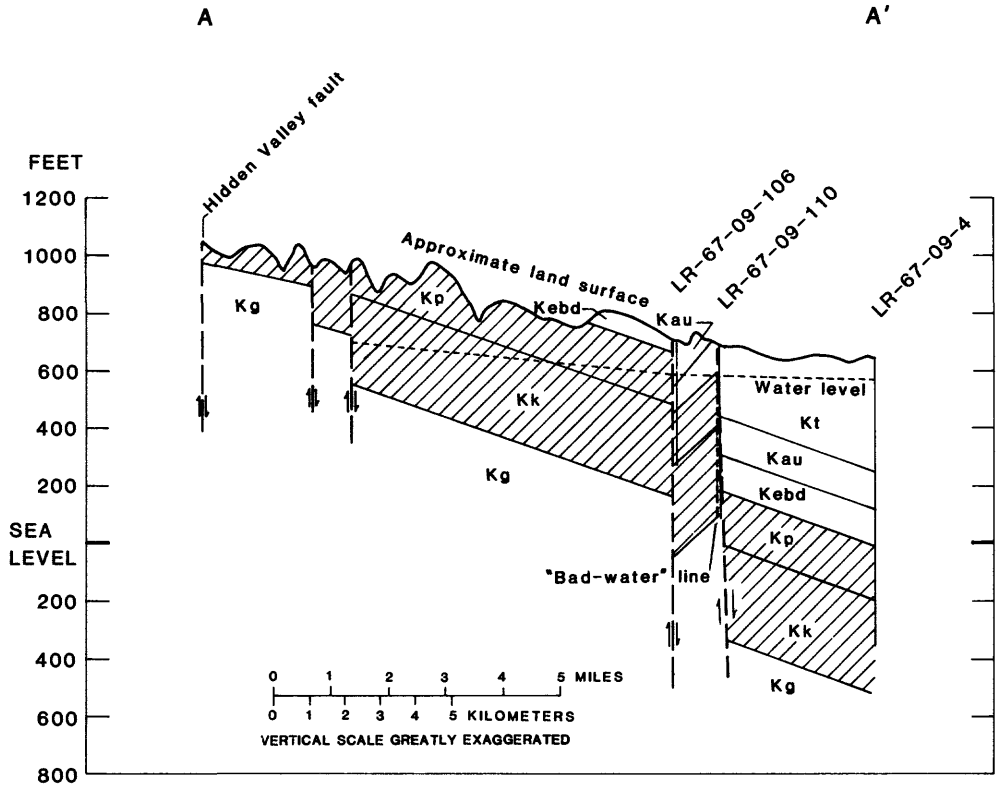

Figure 3.--Hydrogeologic section, A-A'.

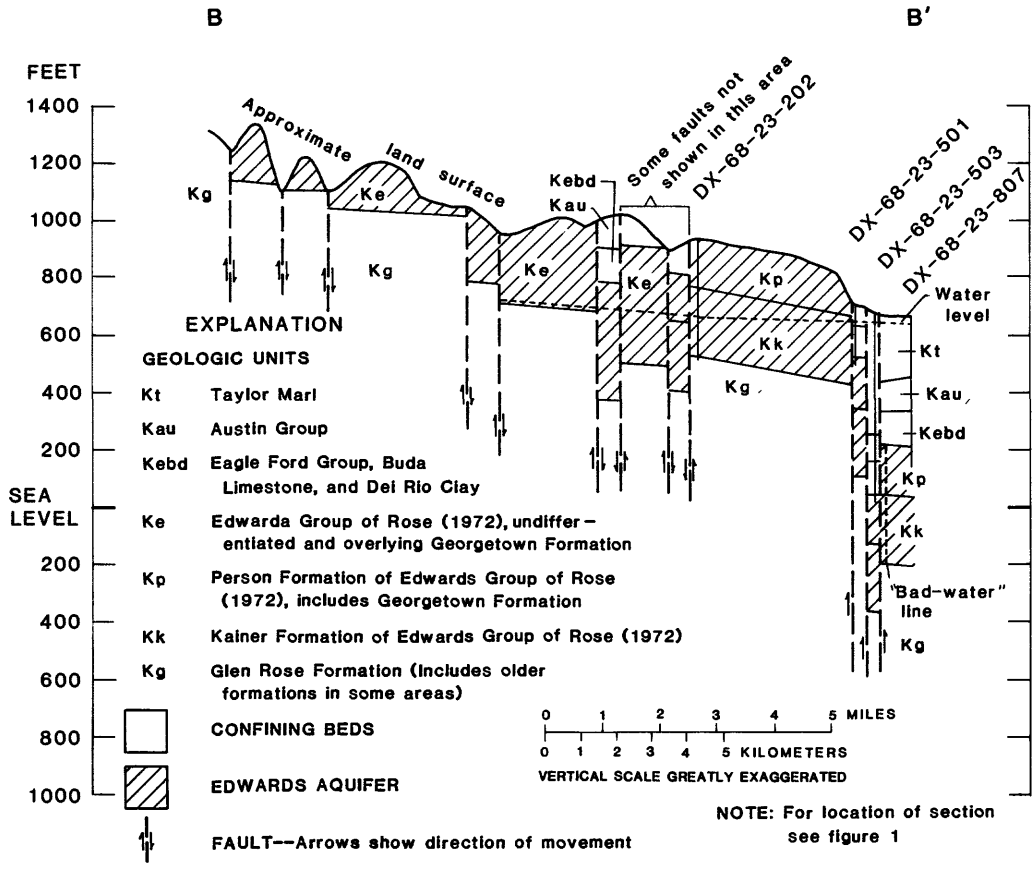

Figure 4.--Hydrogeologic section, B-B'.

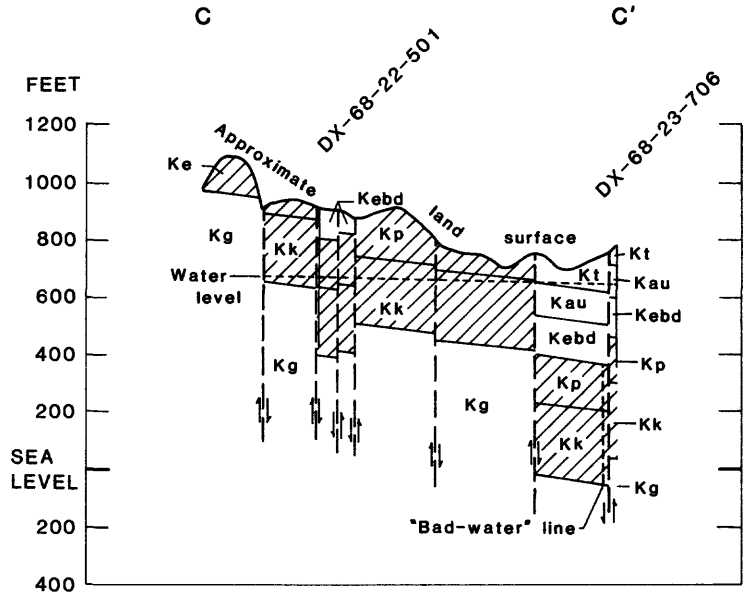

Figure 5.--Hydrogeologic section, C-C'.

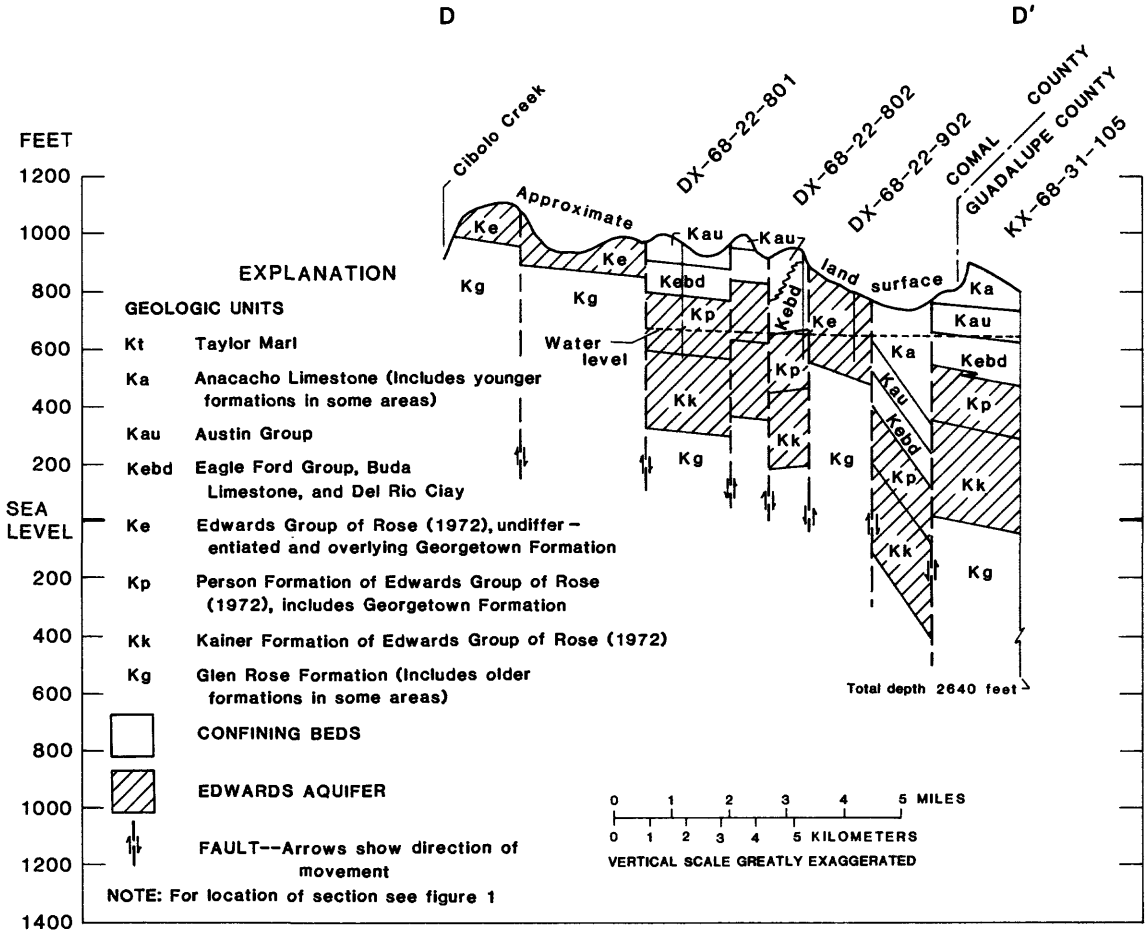

Figure 6.--Hydrogeologic section, D-D'.

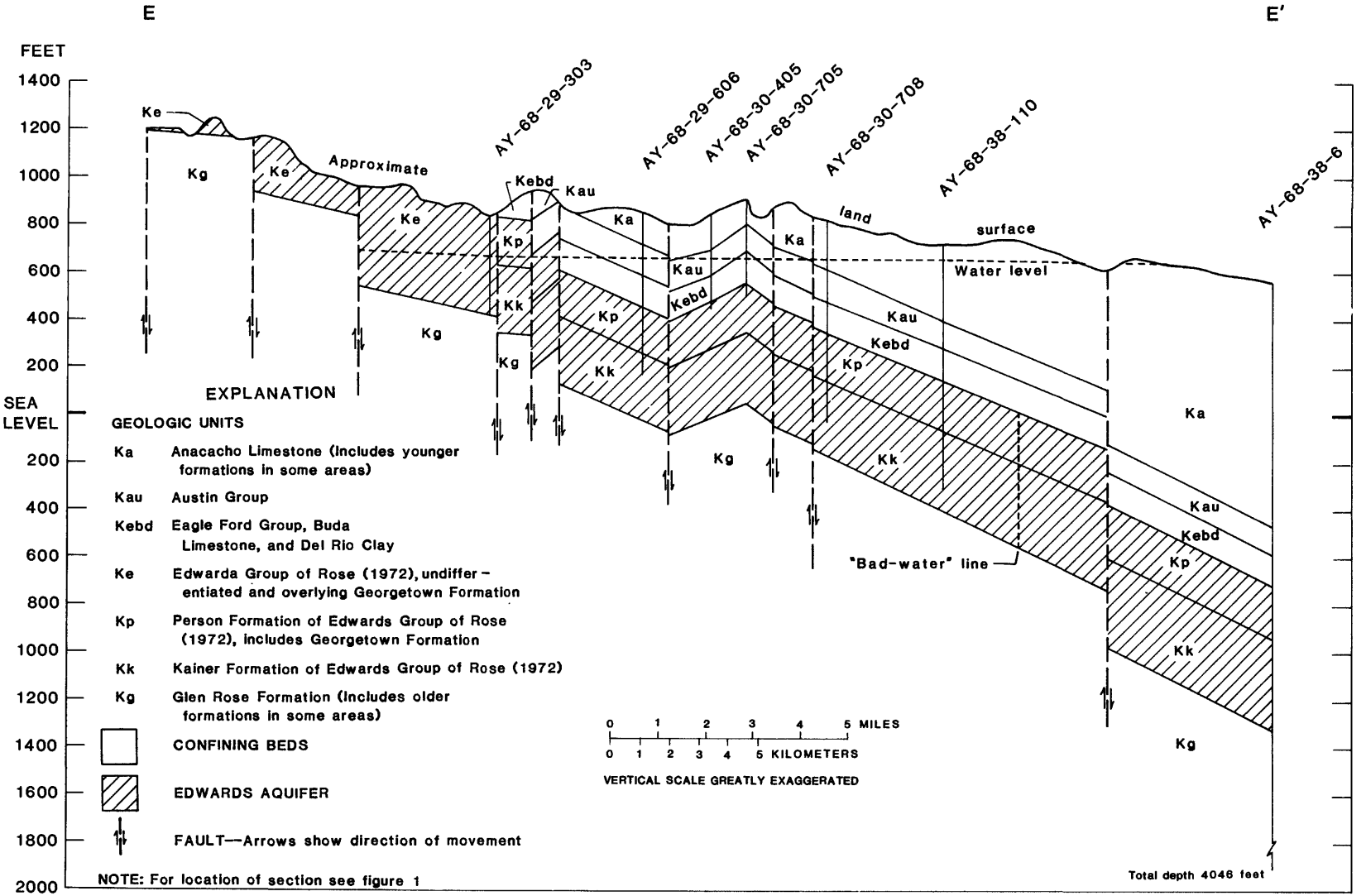

Figure 7.--Hydrogeologic section, E-E'.

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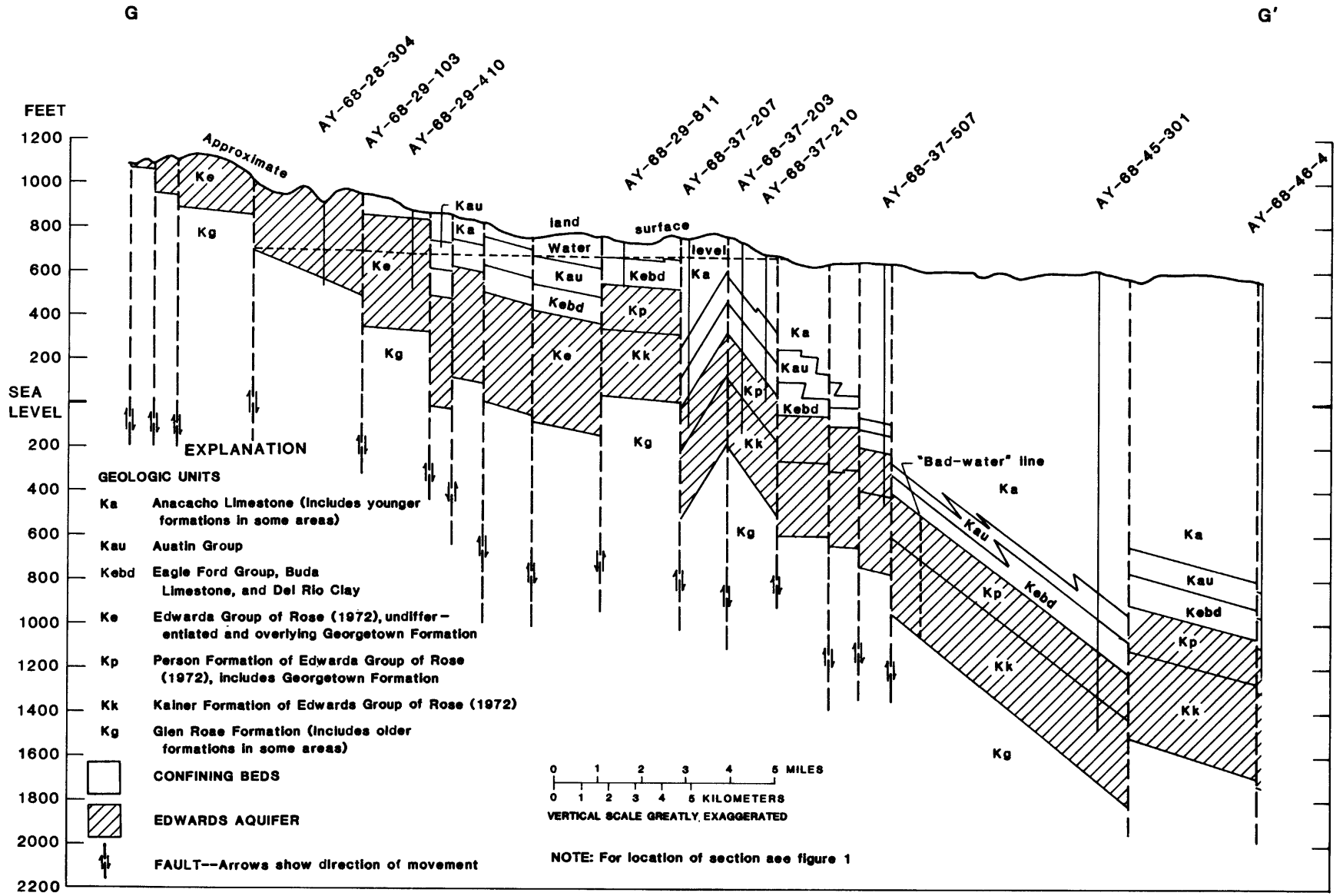


Figure 9.--Hydrogeologic section, G-G'.

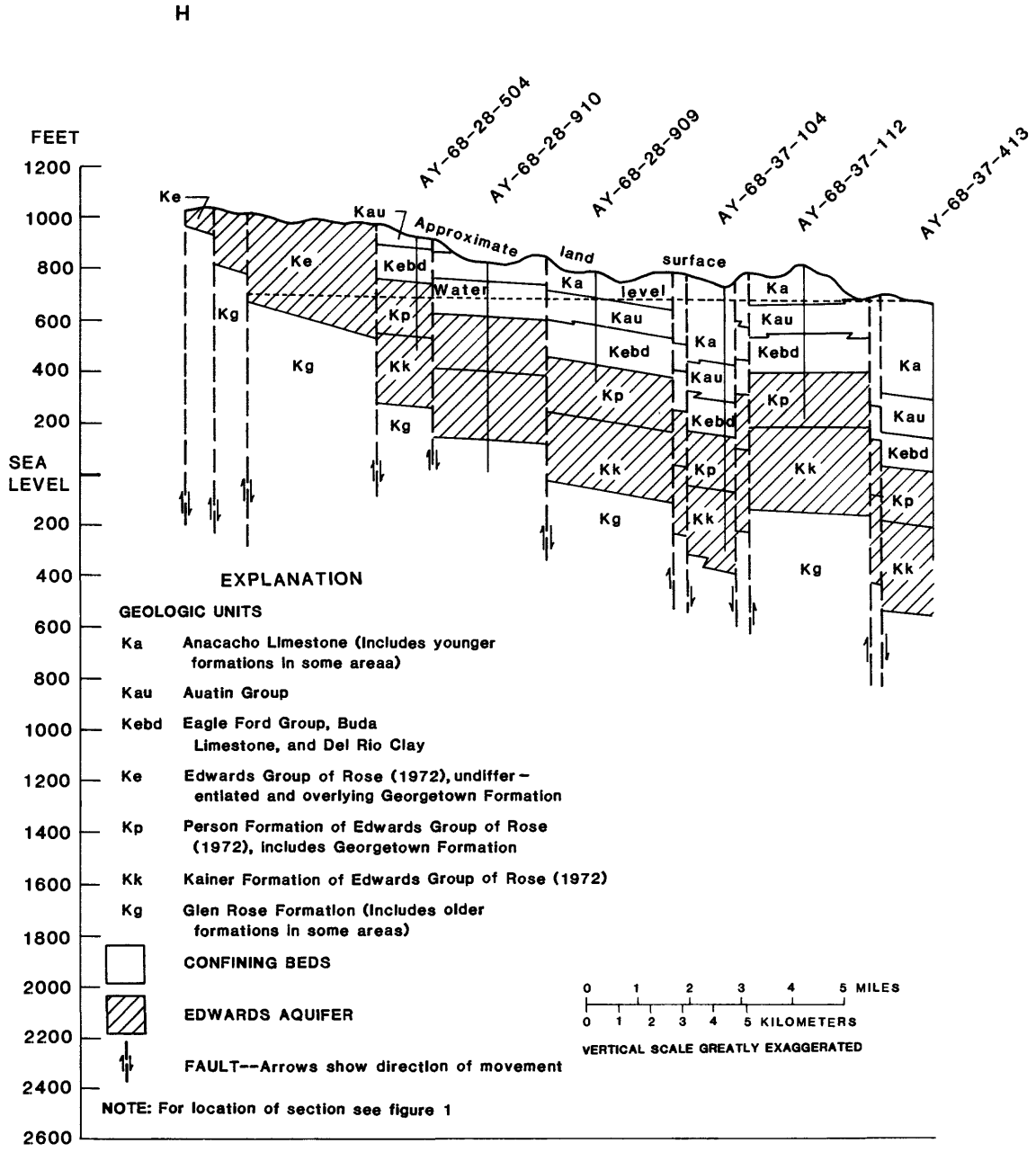
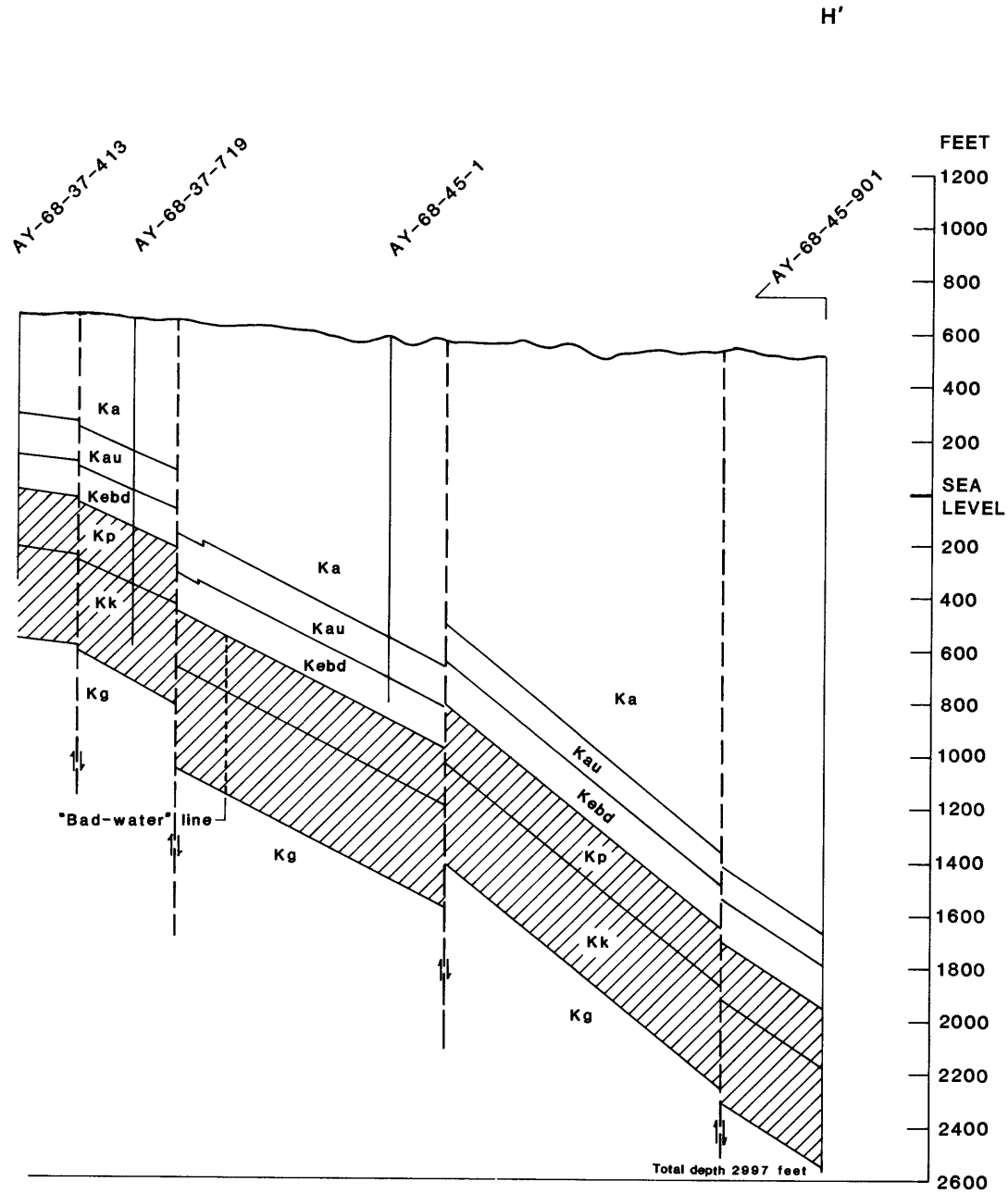


Figure 10.--Hydrogeologic section, H-H'.



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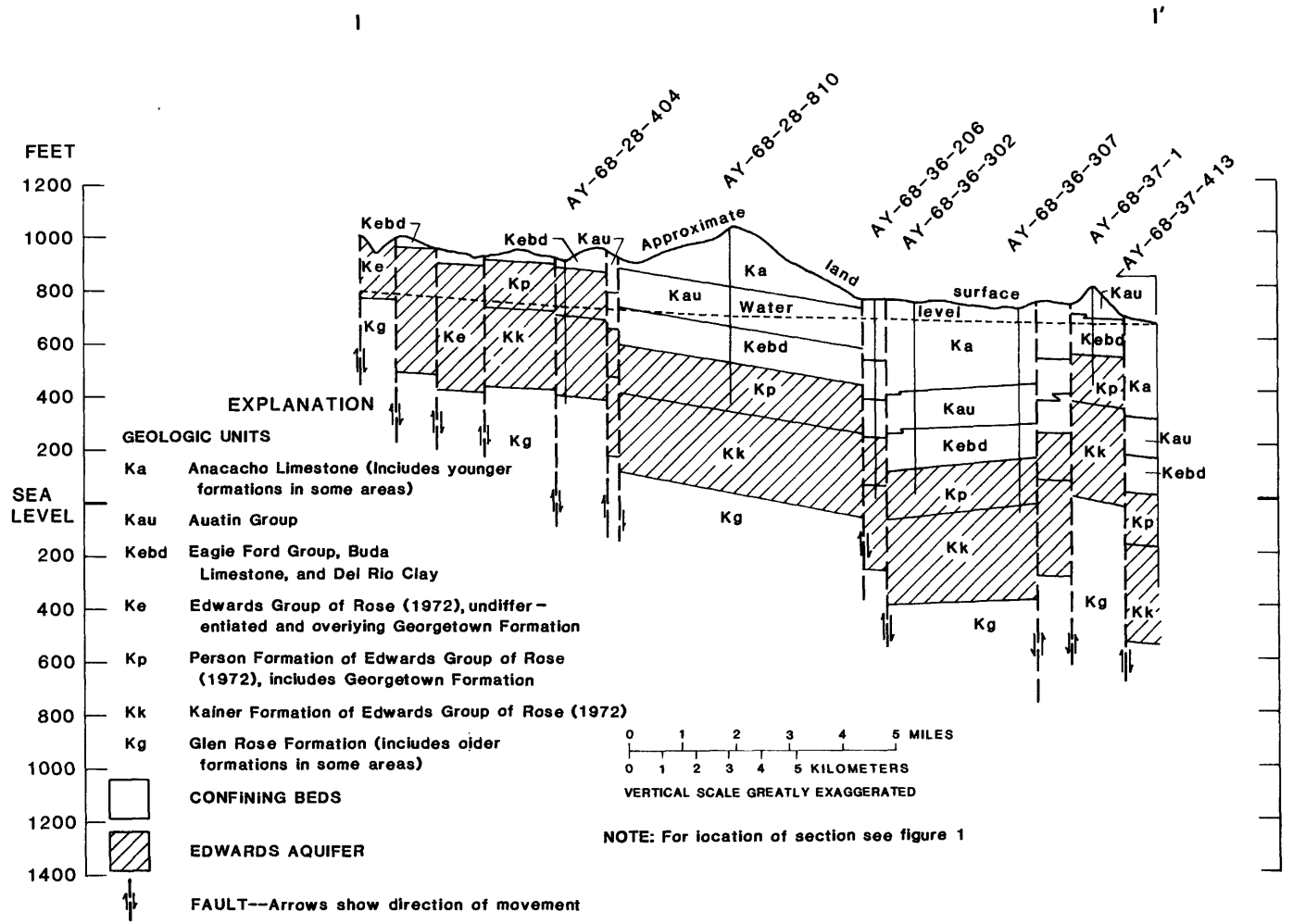


Figure 11.--Hydrogeologic section, I-I'.

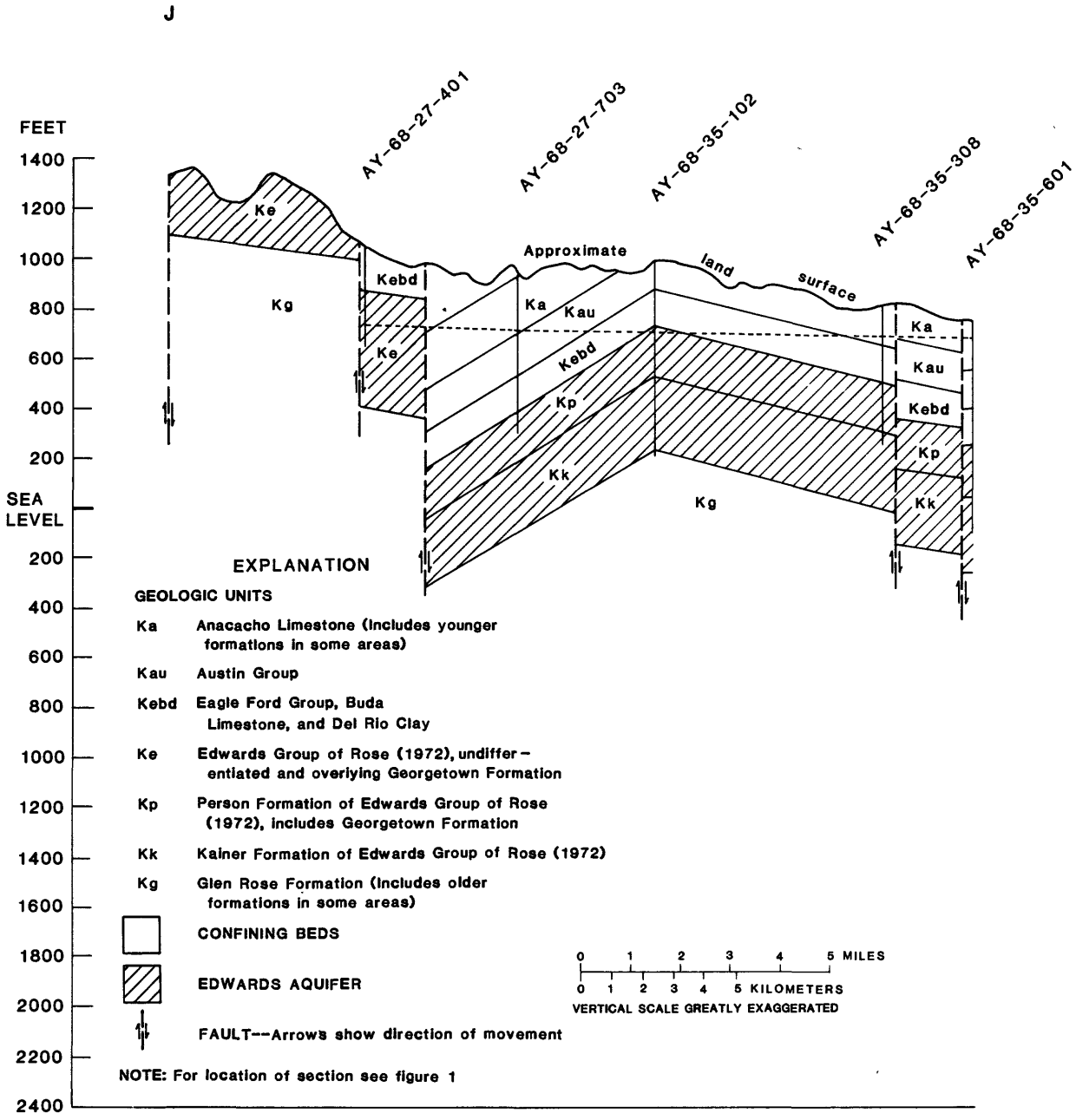
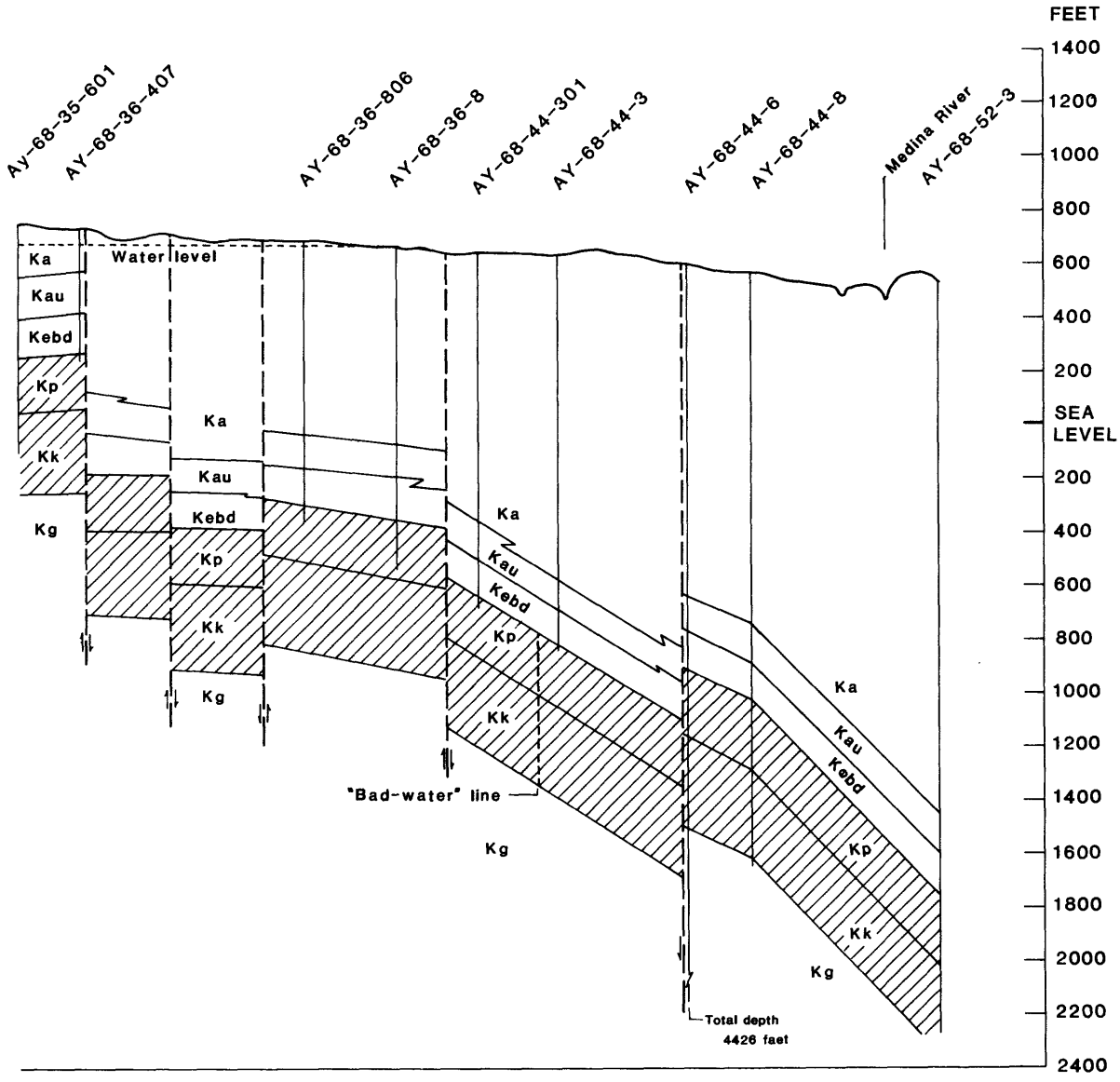


Figure 12.--Hydrogeologic section, J-J'.

J'


FEET
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Ay-68-35-601
AY-68-36-407
AY-68-36-806
AY-68-36-8
AY-68-44-301
AY-68-44-3
AY-68-44-6
AY-68-44-8
Medina River
AY-68-52-3
Water level
Ka
Kau
Kebd
Kp
Kk
Kg
"Bad-water" line
Total depth
4426 feet

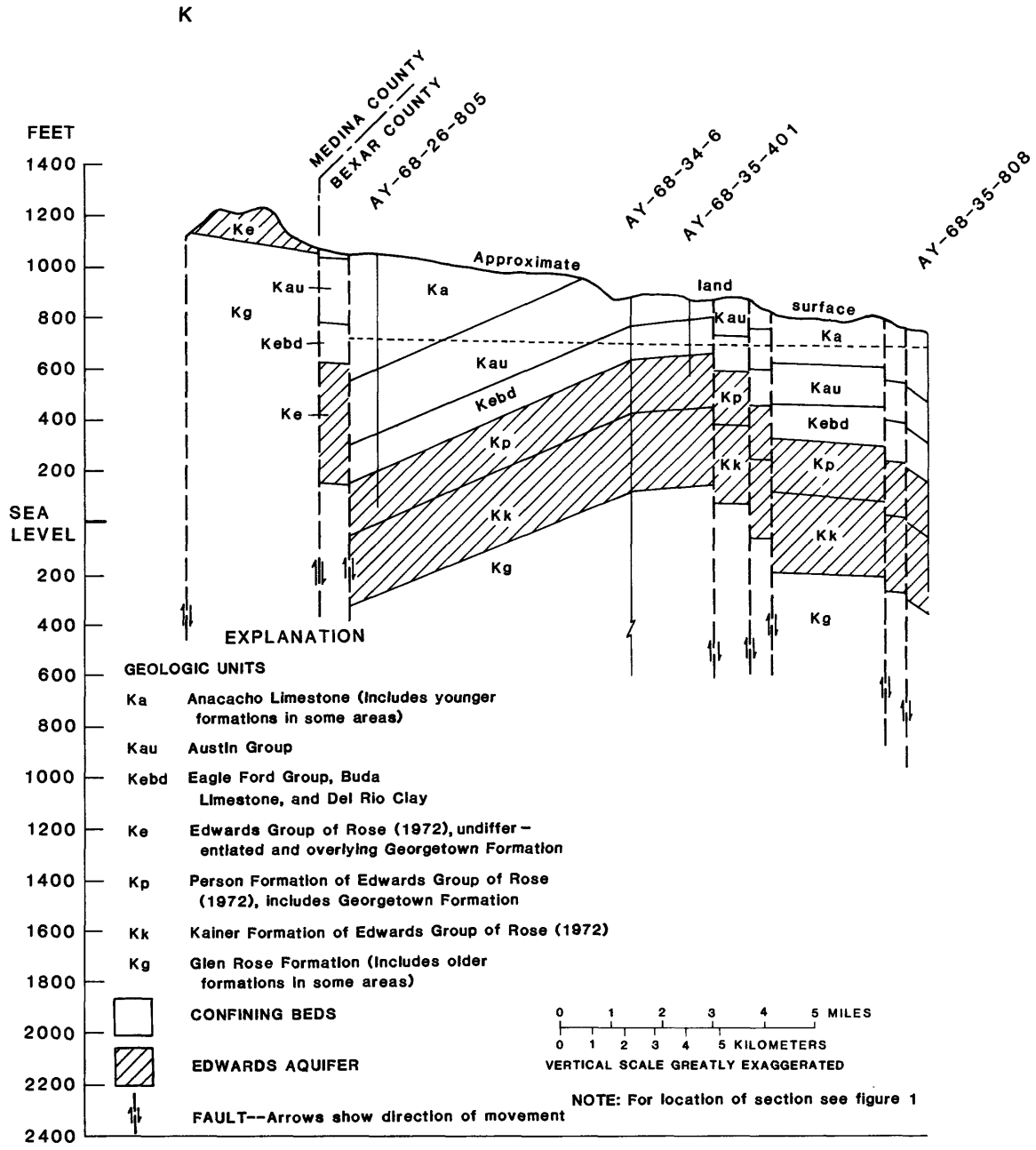
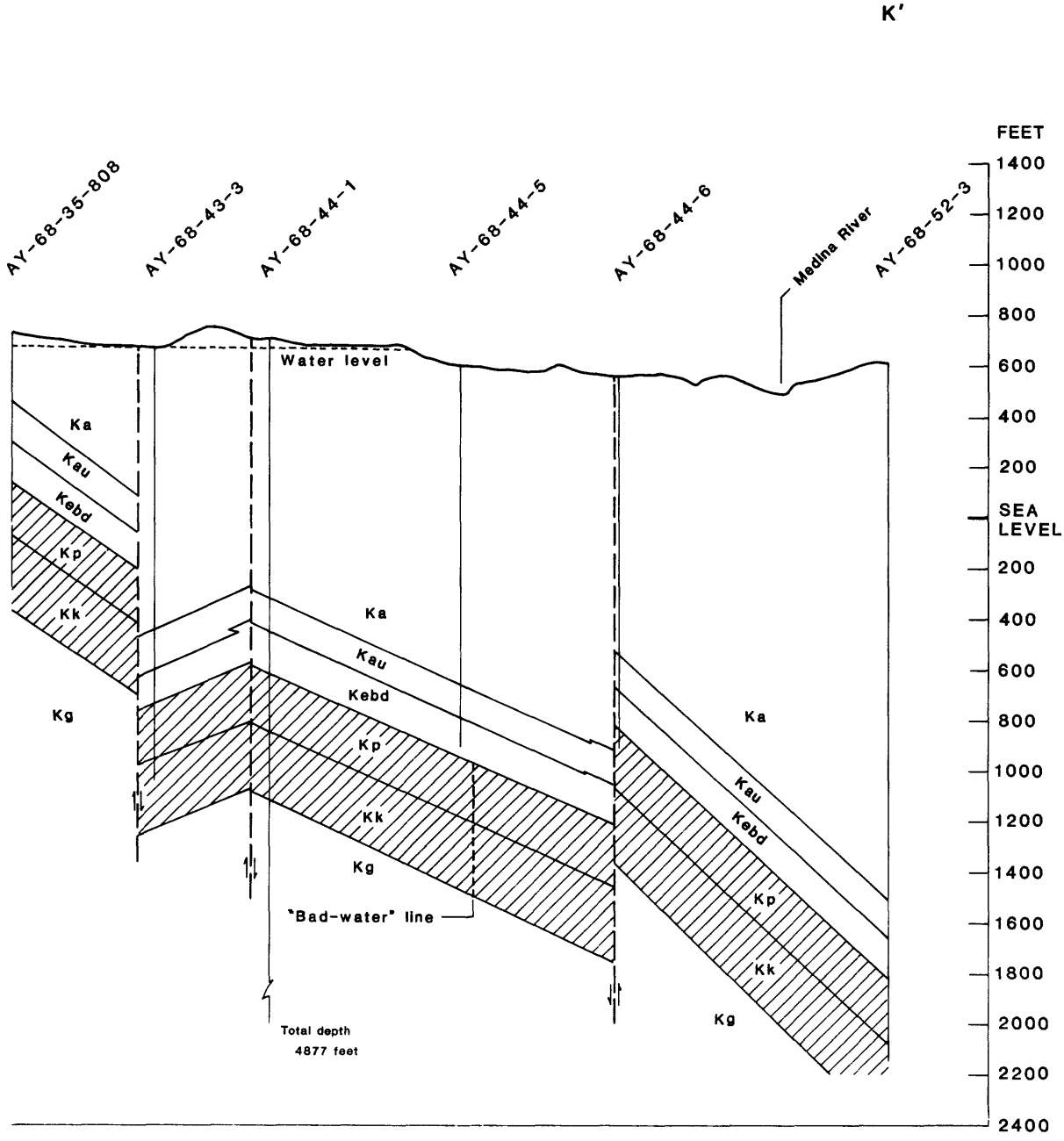


Figure 13.--Hydrogeologic section, K-K'.


K'
FEET
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
AY-68-35-808
AY-68-43-3
AY-68-44-1
AY-68-44-5
AY-68-44-6
Medina River
AY-68-52-3
Water level
Ka
Kau
Kebd
Kp
Kk
Kg
"Bad-water" line
Total depth
4877 feet

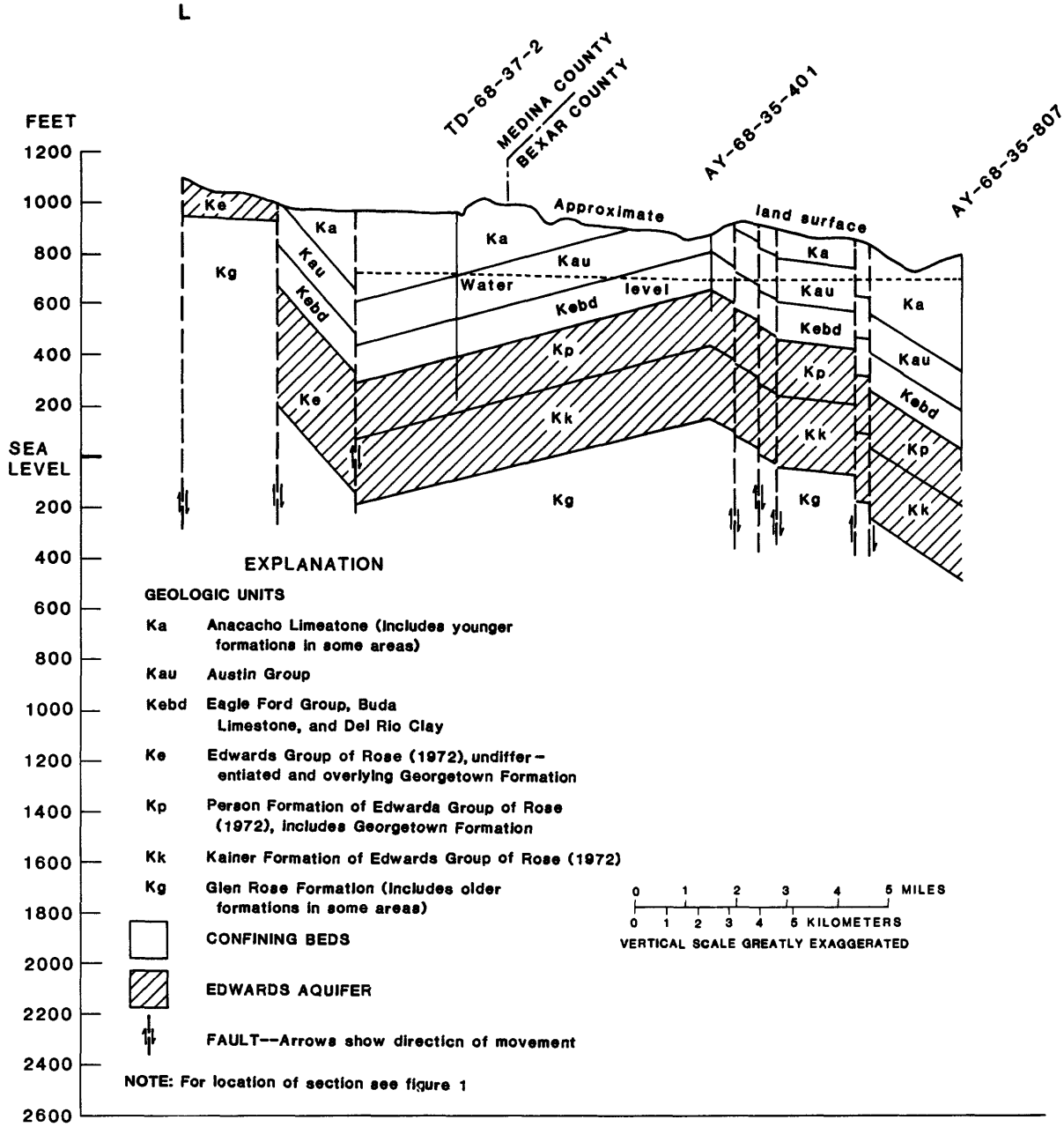
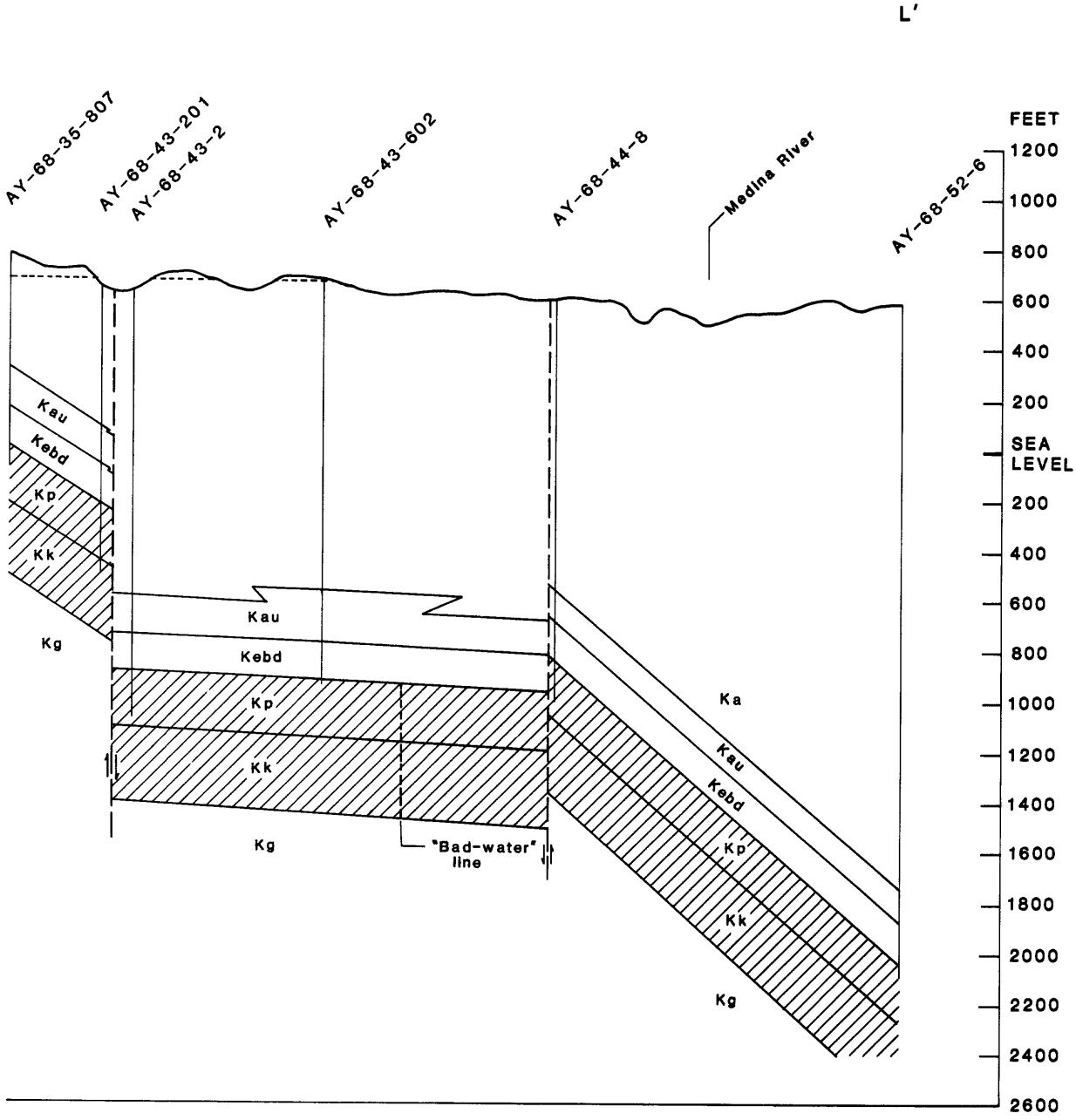


Figure 14.--Hydrogeologic section, L-L'.


L'
AY-68-35-807
AY-68-43-201
AY-68-43-2
AY-68-43-602
AY-68-44-8
Medina River
AY-68-52-6
FEET
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Kau
Kebd
Kp
Kk
Kg
Ka
"Bad-water" line

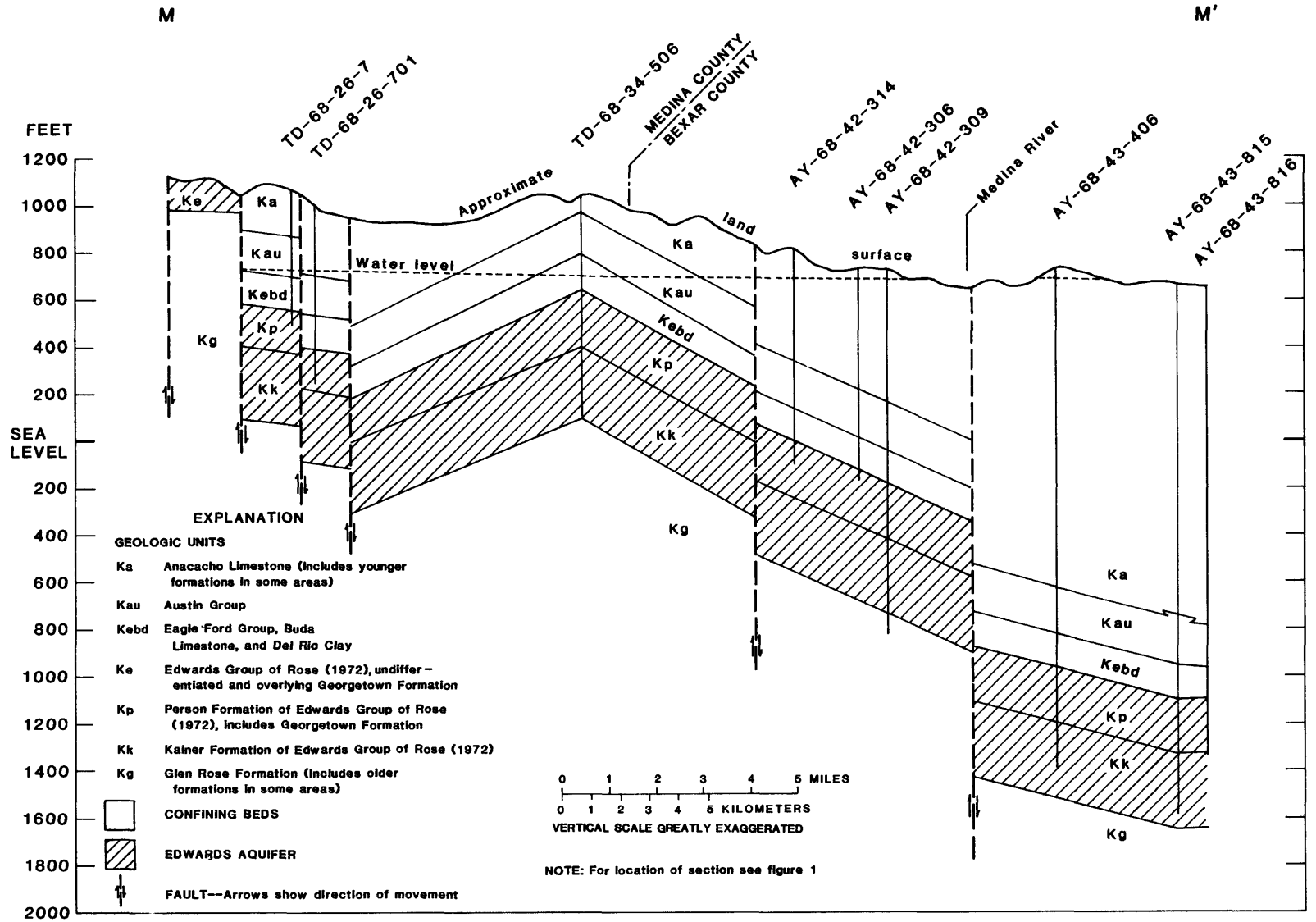


Figure 15.--Hydrogeologic section, M-M'.

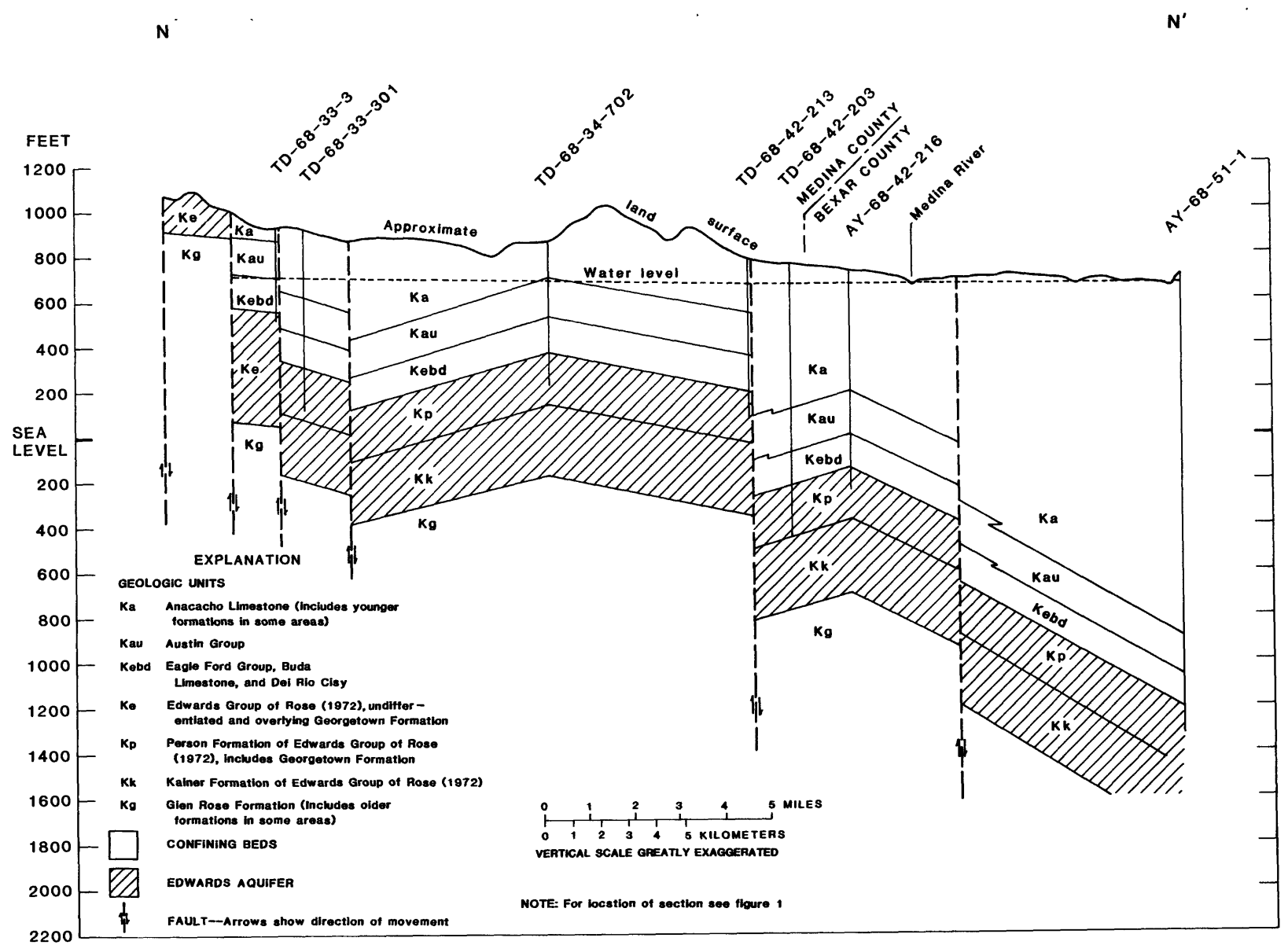


Figure 16.--Hydrogeologic section, N-N'.

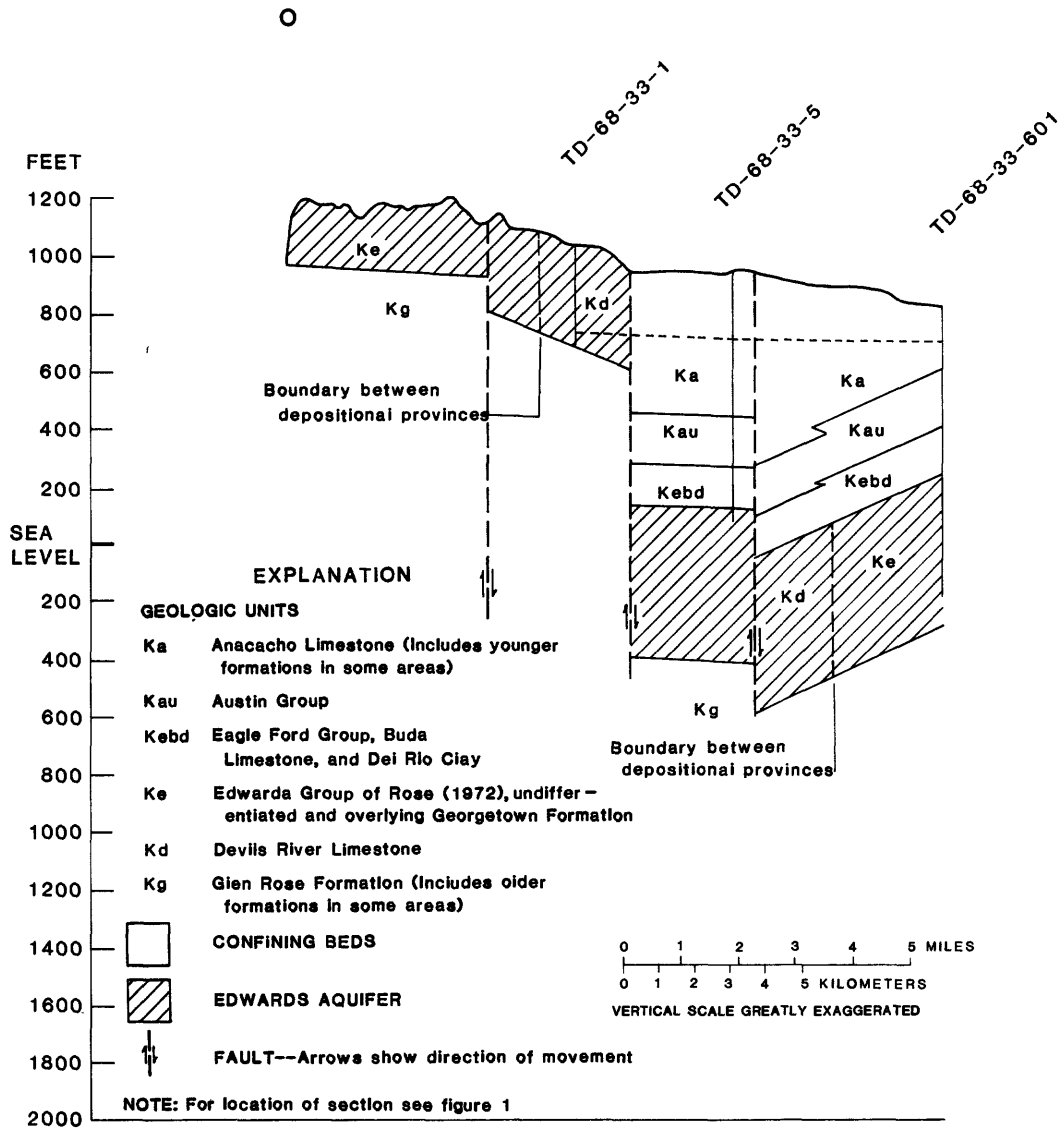
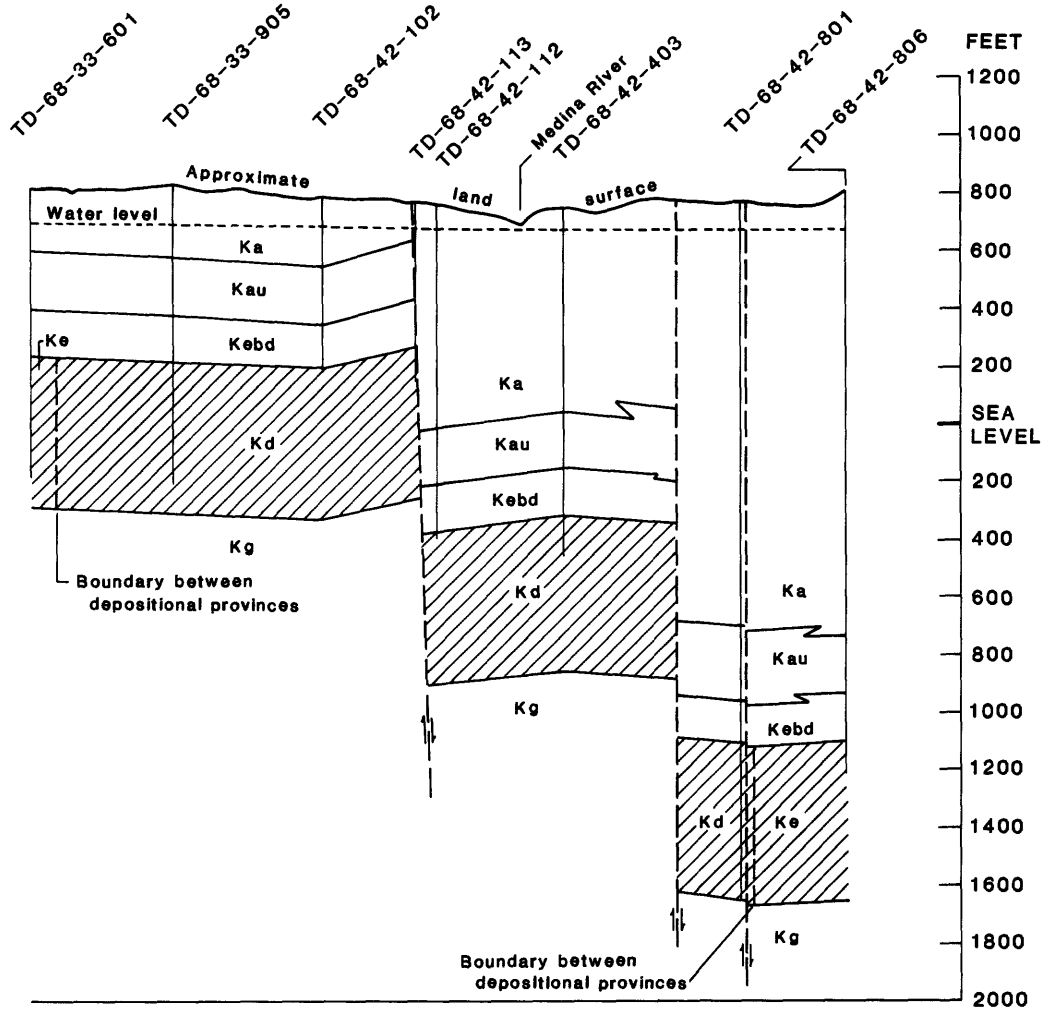


Figure 17.--Hydrogeologic section, O-O'.

O'


TD-68-33-601
TD-68-33-905
TD-68-42-102
TD-68-42-113
TD-68-42-112
Medina River
TD-68-42-403
TD-68-42-801
TD-68-42-806
FEET
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
Approximate land surface
Water level
Ka
Kau
Kebd
Ke
Kd
Kg
Boundary between depositional provinces
Ka
Kau
Kebd
Kd
Kg
Ka
Kau
Kebd
Kd
Ke
Kg
Boundary between depositional provinces

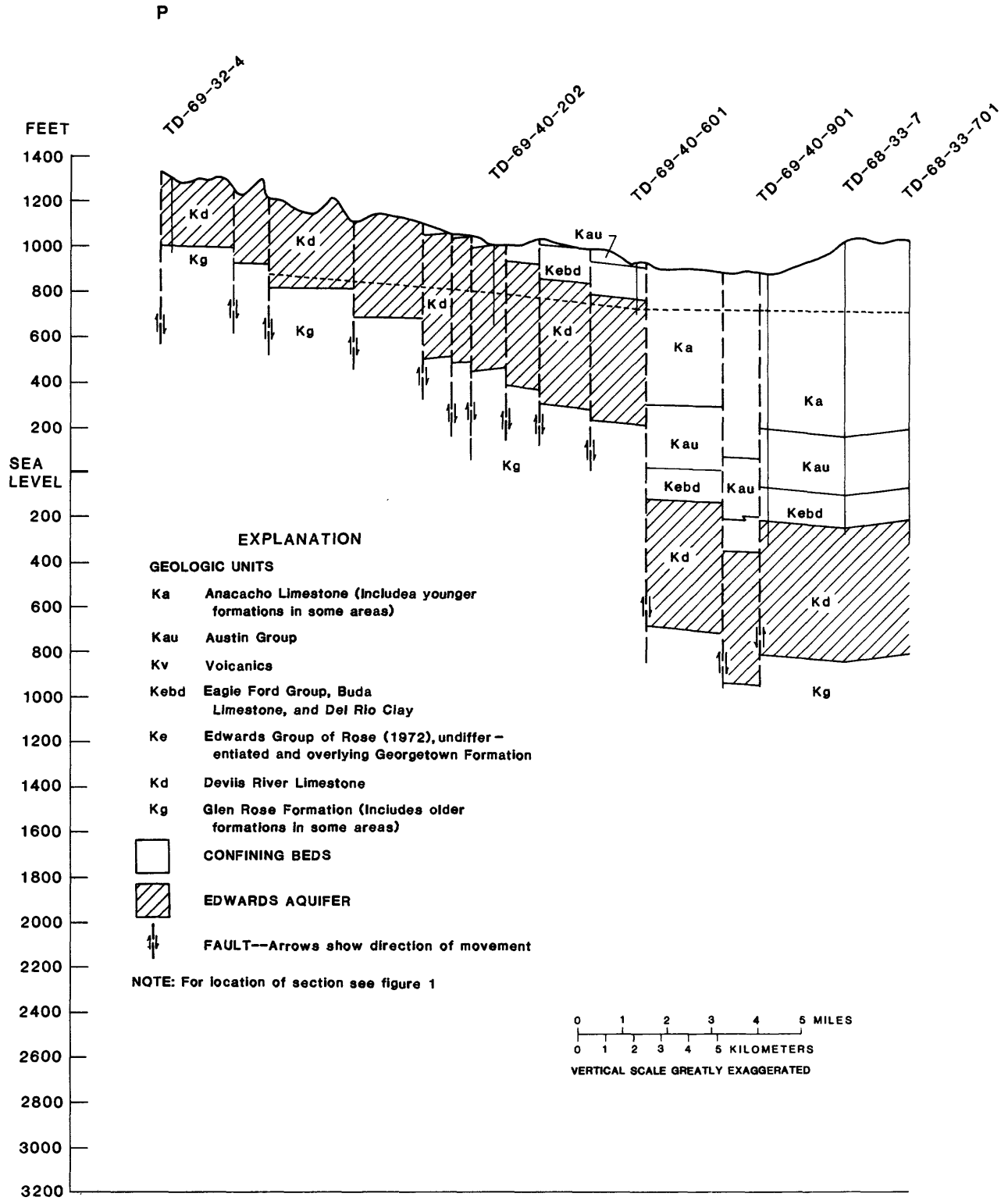
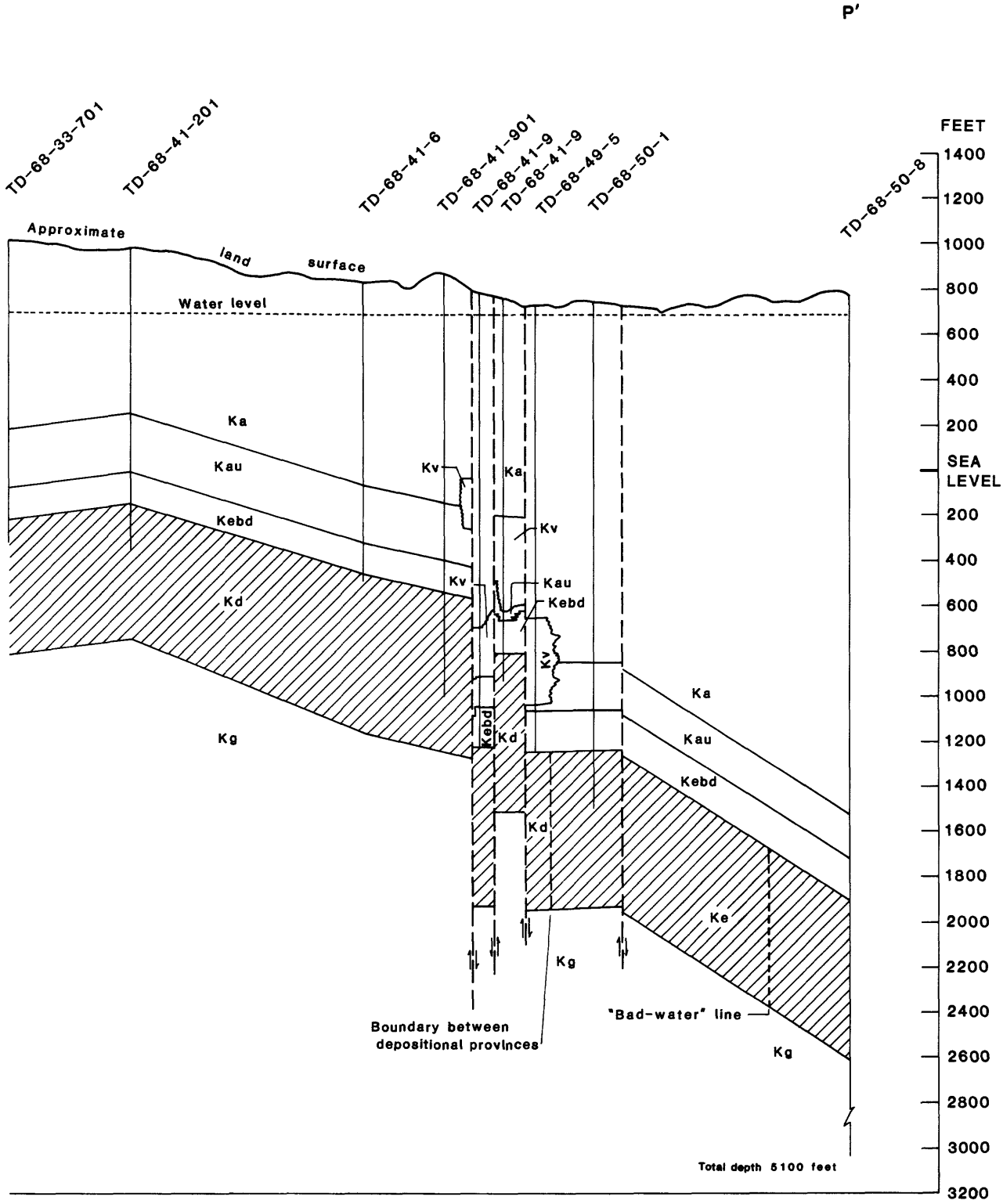


Figure 18.--Hydrogeologic section, P-P'.



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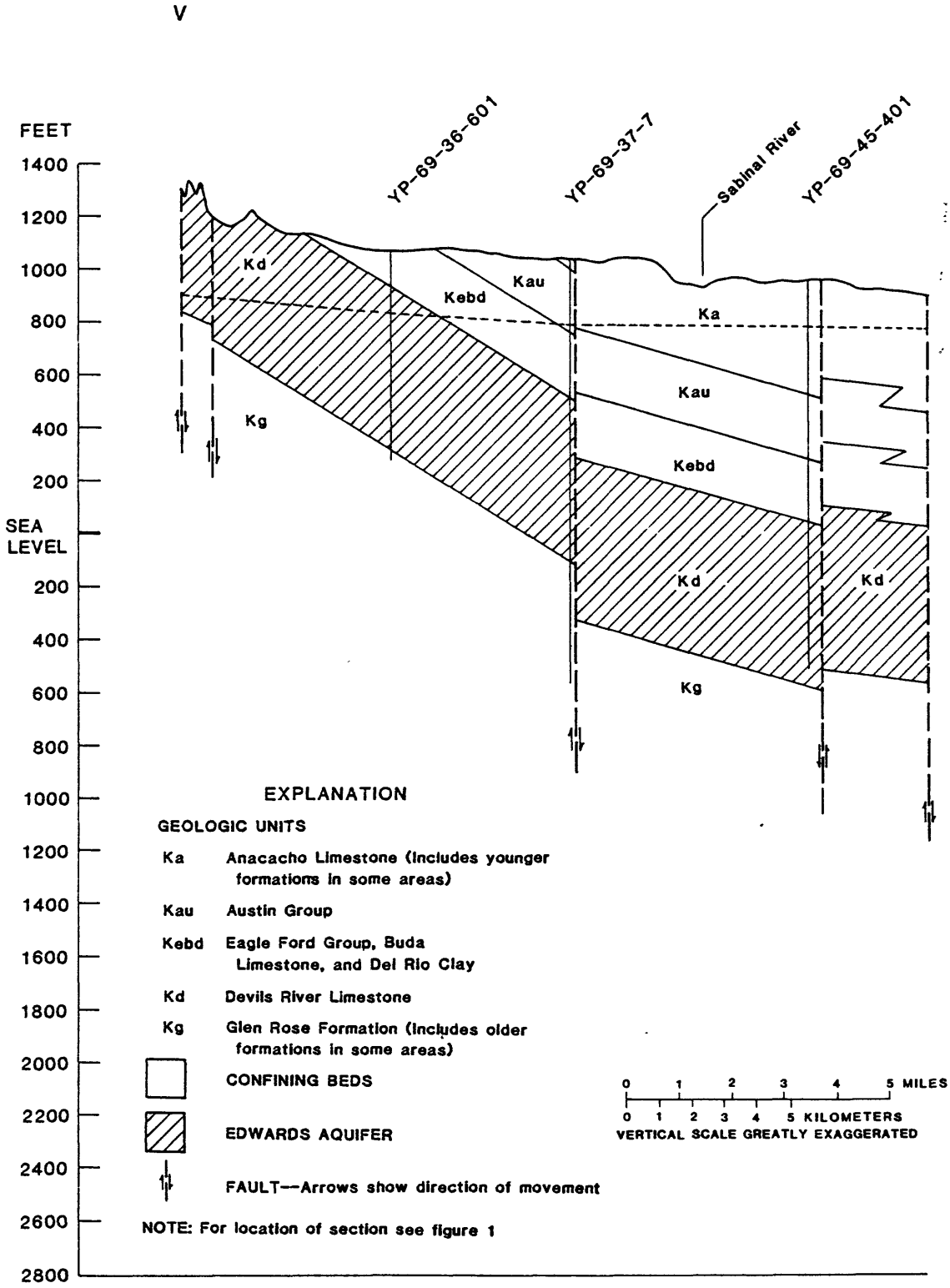
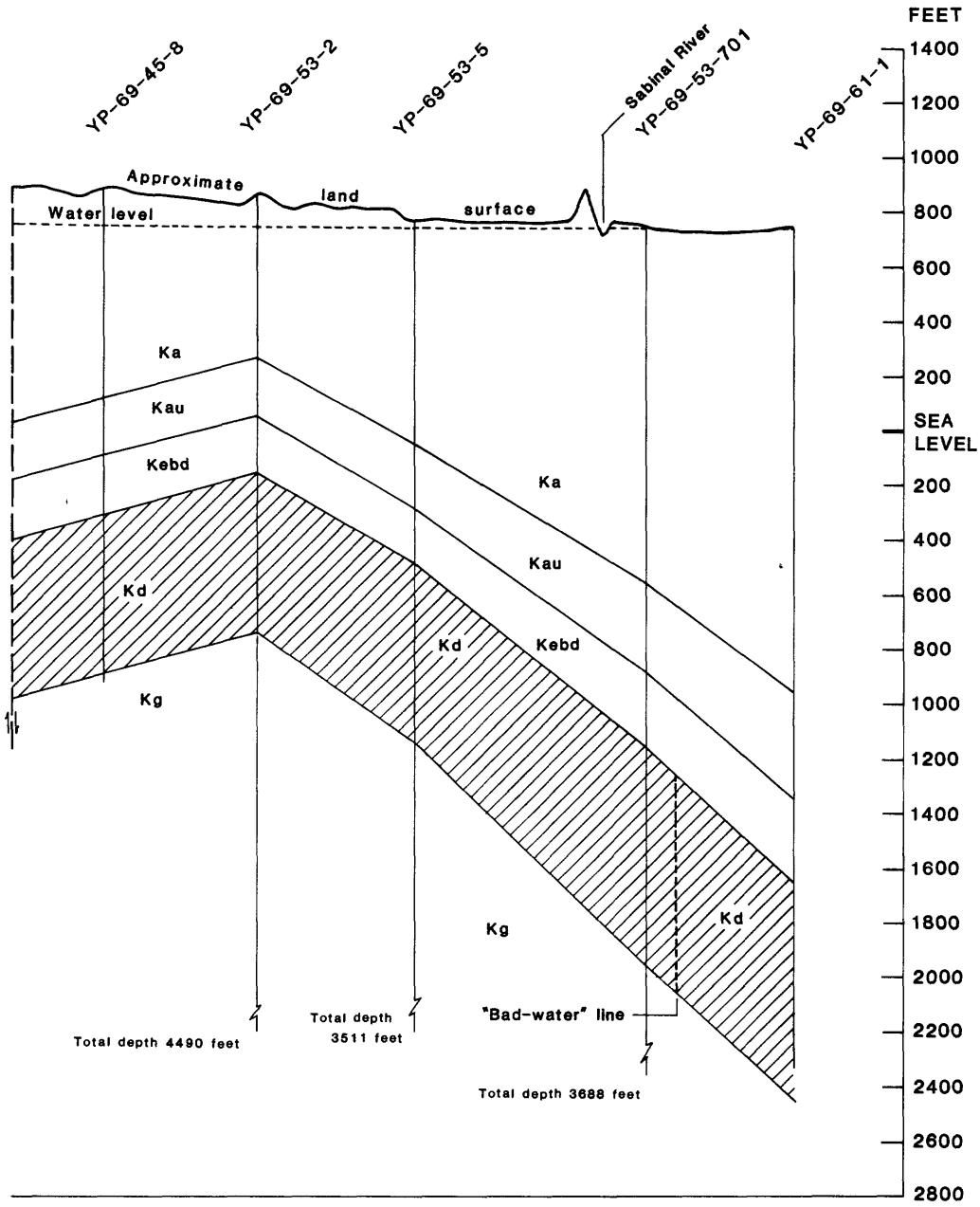


Figure 24.--Hydrogeologic section, V-V'.

V'


FEET
YP-69-45-8
YP-69-53-2
YP-69-53-5
Sabinal River
YP-69-53-701
YP-69-61-1
Approximate land surface
Water level
Ka
Kau
Kebd
Kd
Kg
Ka
Kau
Kebd
Kd
Kg
Kd
"Bad-water" line
Total depth 4490 feet
Total depth 3511 feet
Total depth 3688 feet
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

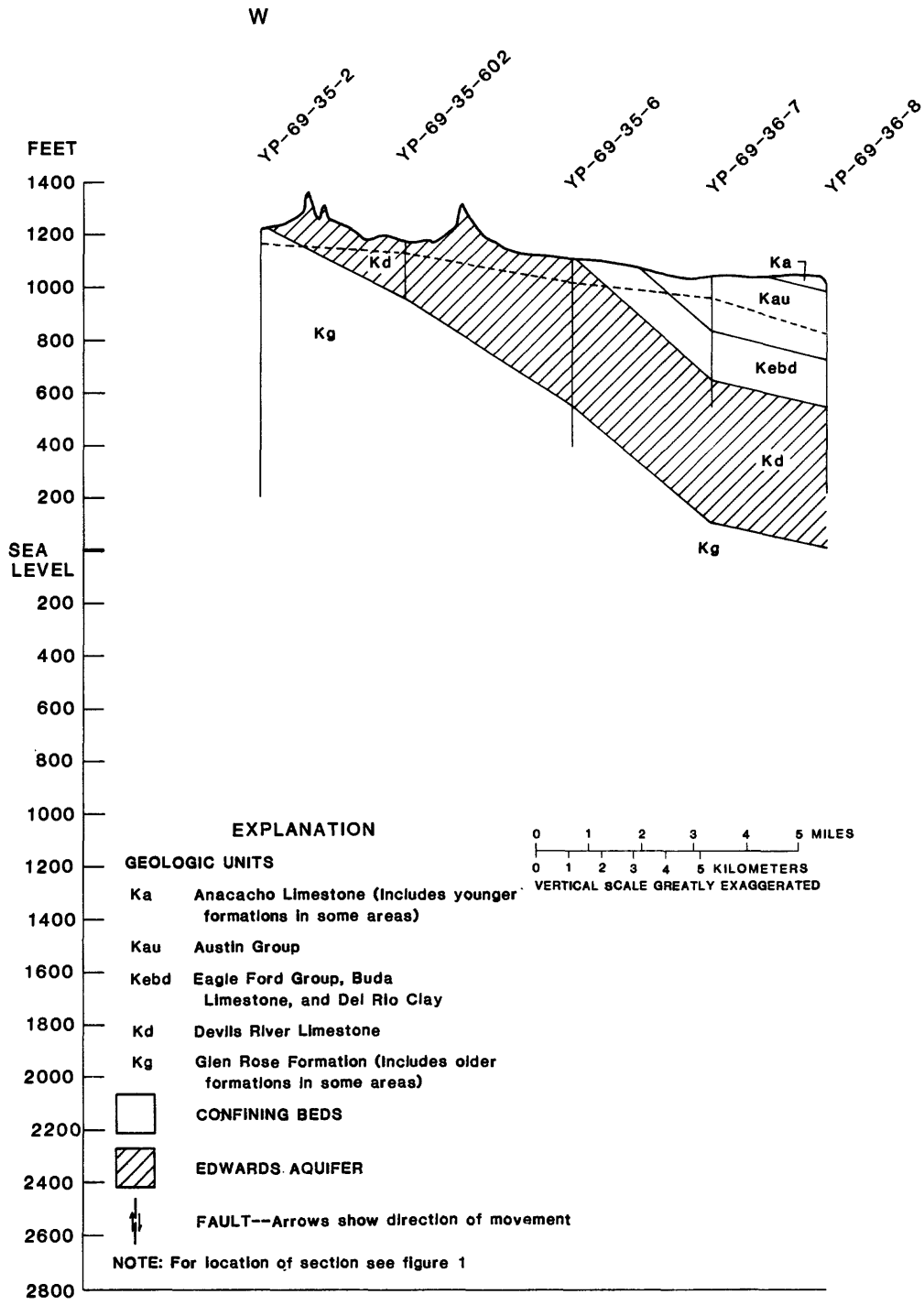
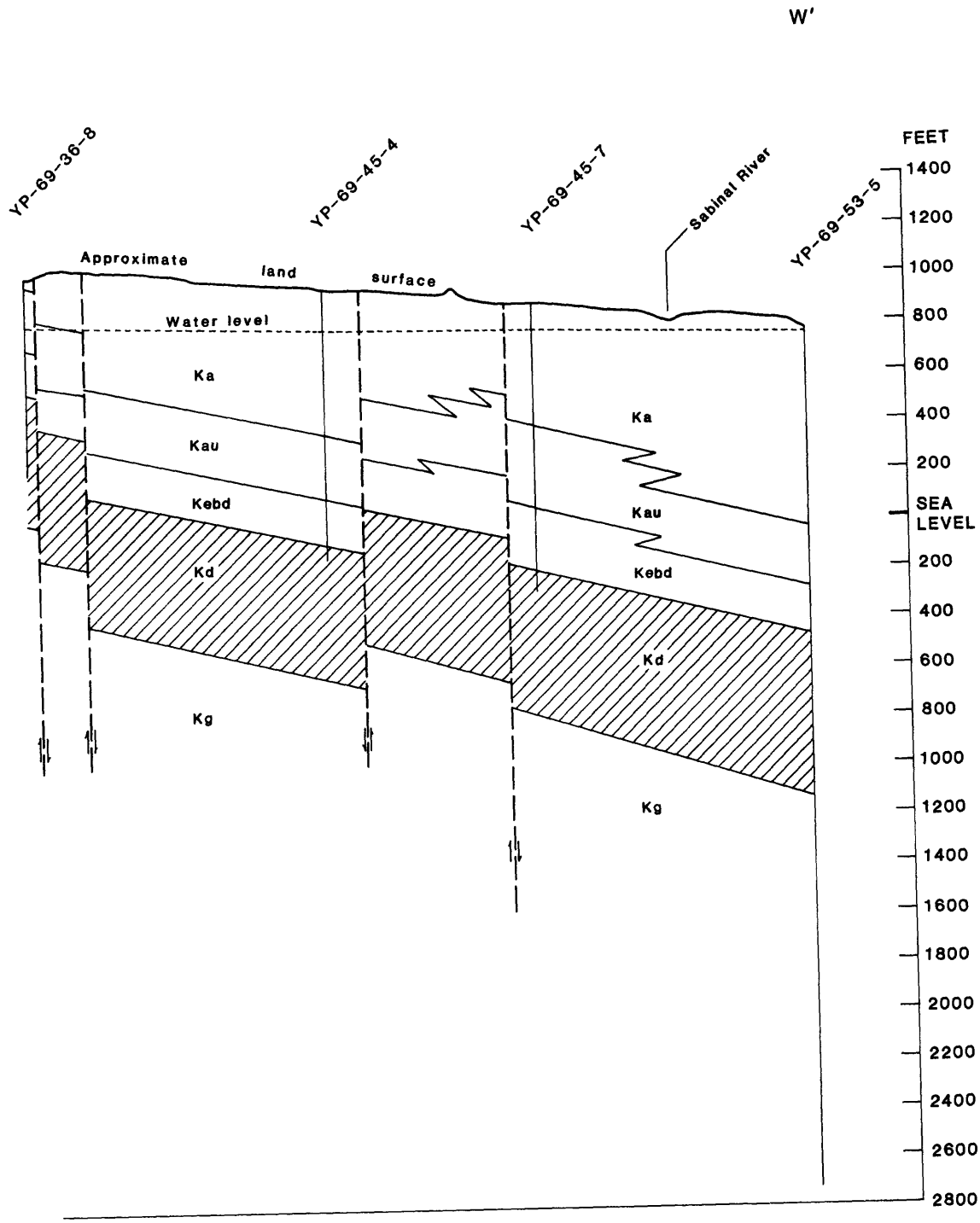


Figure 25.--Hydrogeologic section, W-W'.


W'
YP-69-36-8
YP-69-45-4
YP-69-45-7
Sabinal River
YP-69-53-5
FEET
Approximate land surface
Water level
Ka
Kau
Kebd
Kd
Kg
Ka
Kau
Kebd
Kd
Kg
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

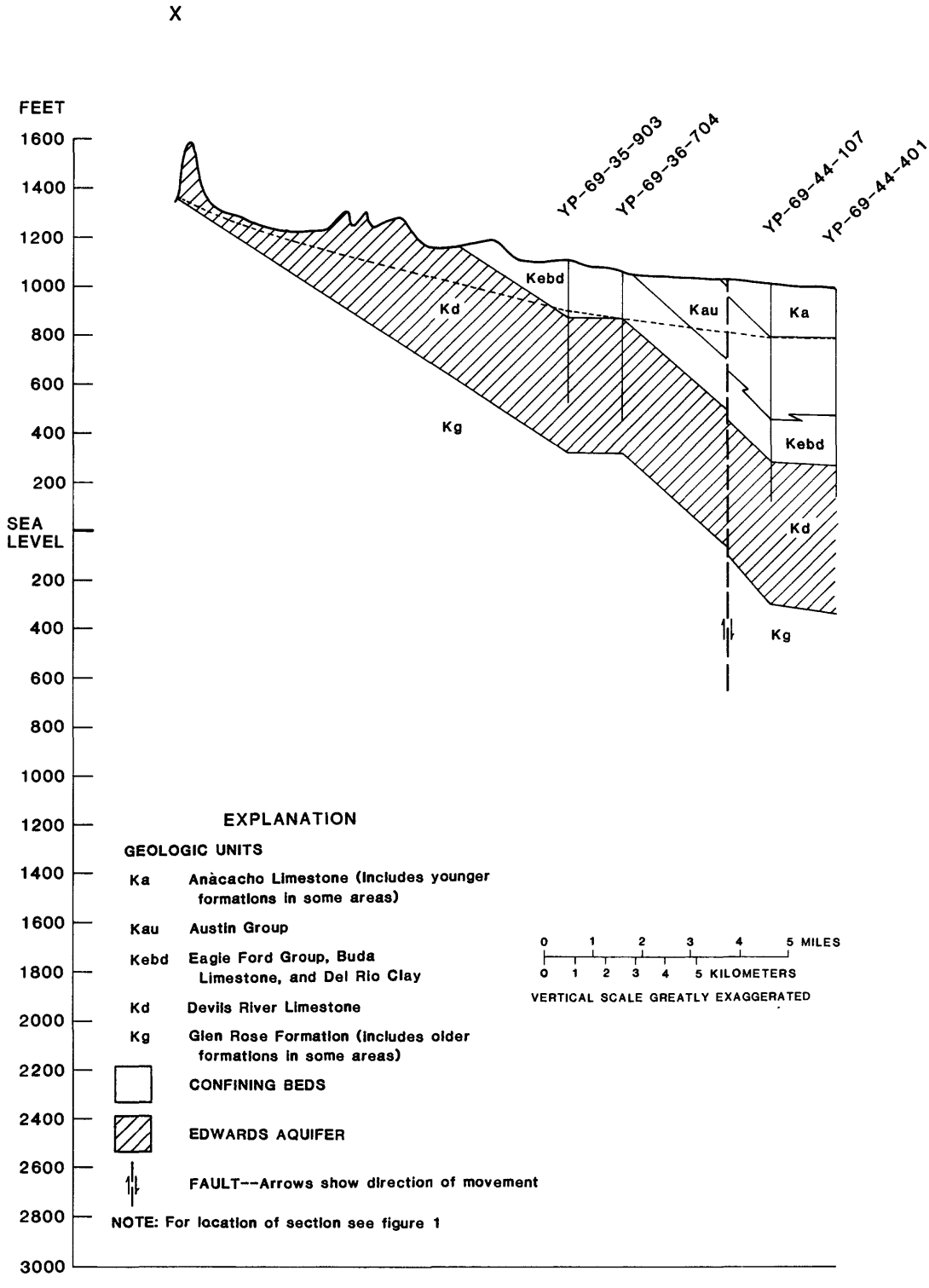
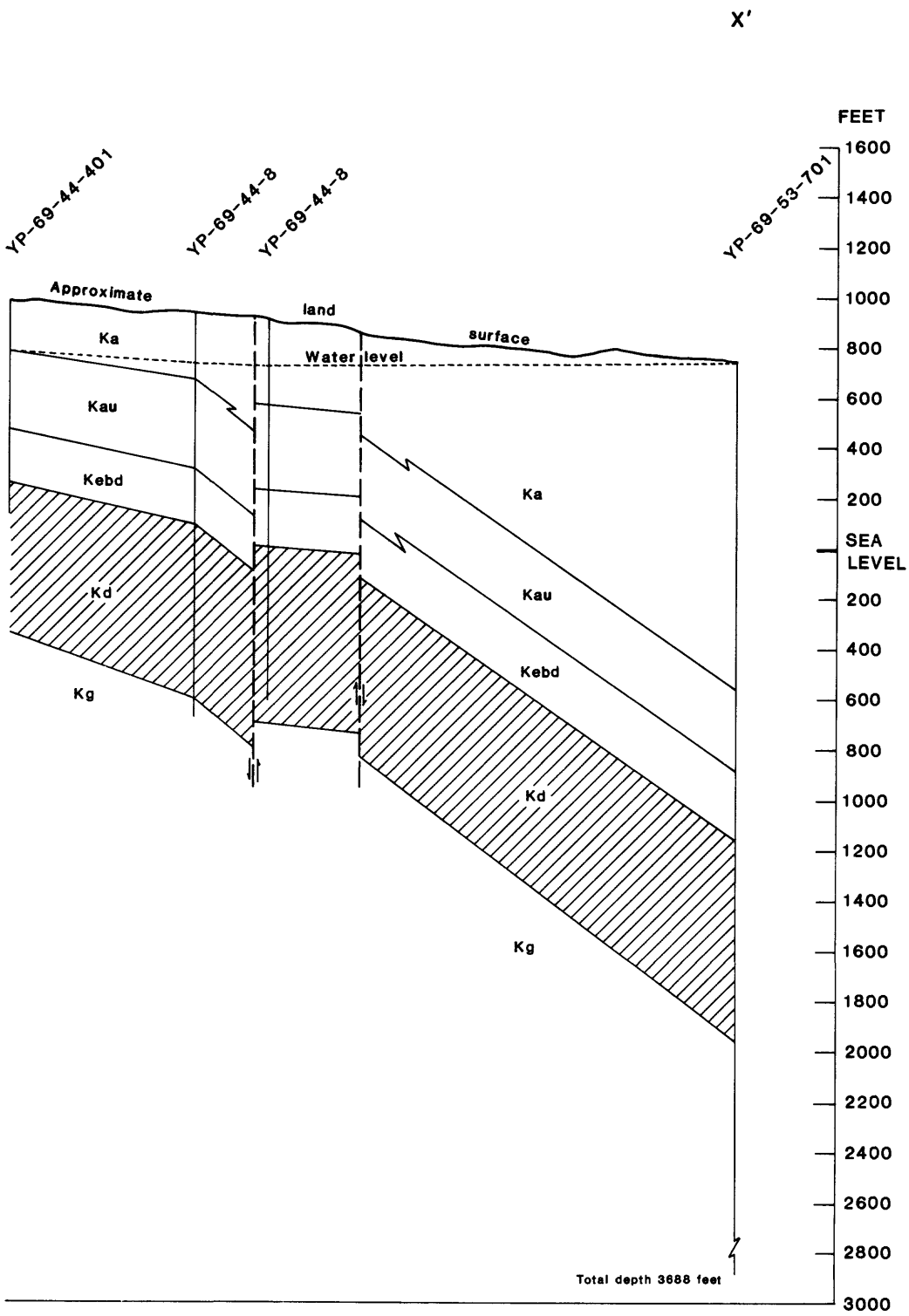


Figure 26.--Hydrogeologic section, X-X'.


X'
FEET
YP-69-44-401
YP-69-44-8
YP-69-44-8
YP-69-53-701
Approximate land surface
Water level
Ka
Kau
Kebd
Kd
Kg
Ka
Kau
Kebd
Kd
Kg
Total depth 3688 feet
1600
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000

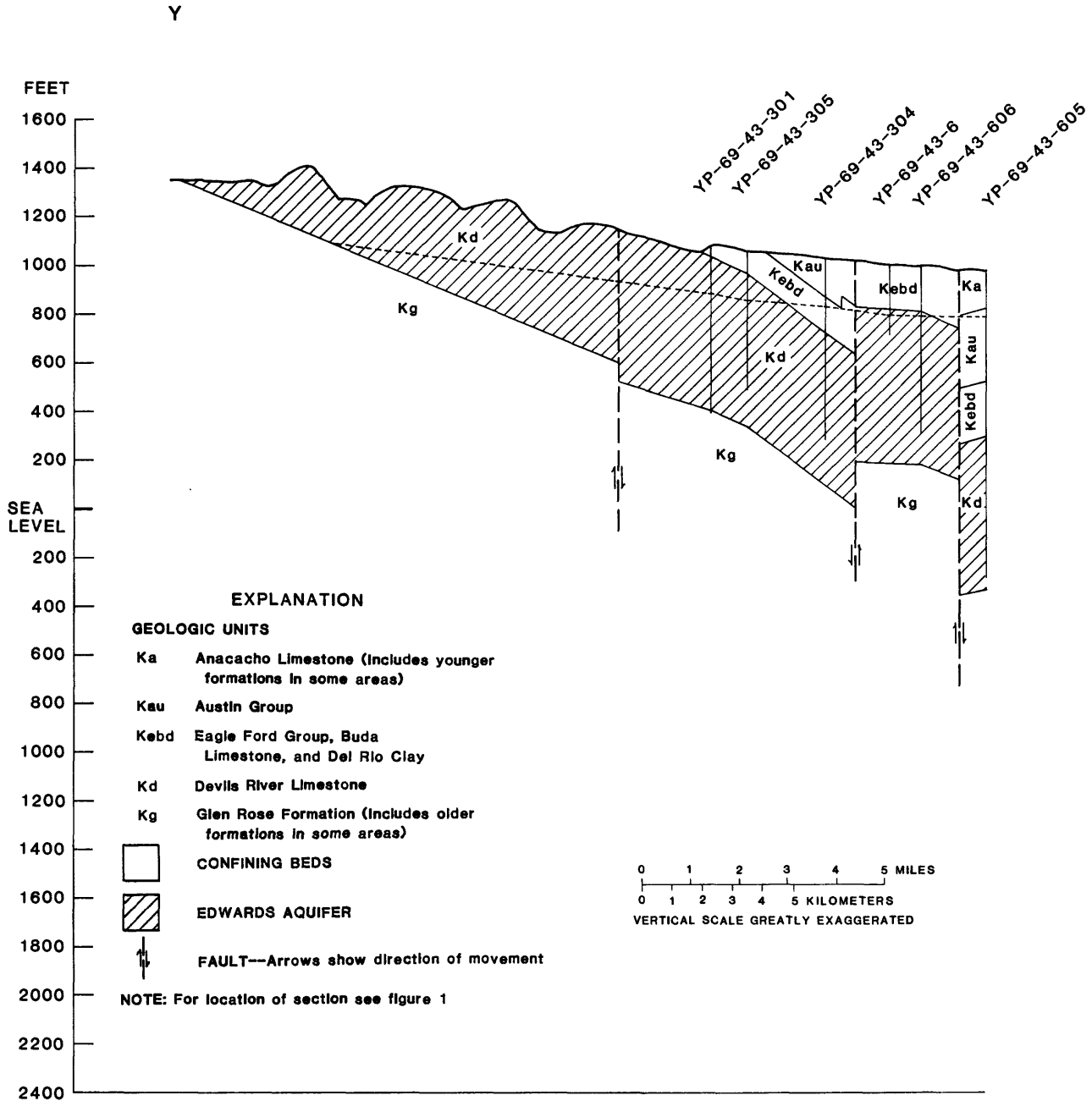
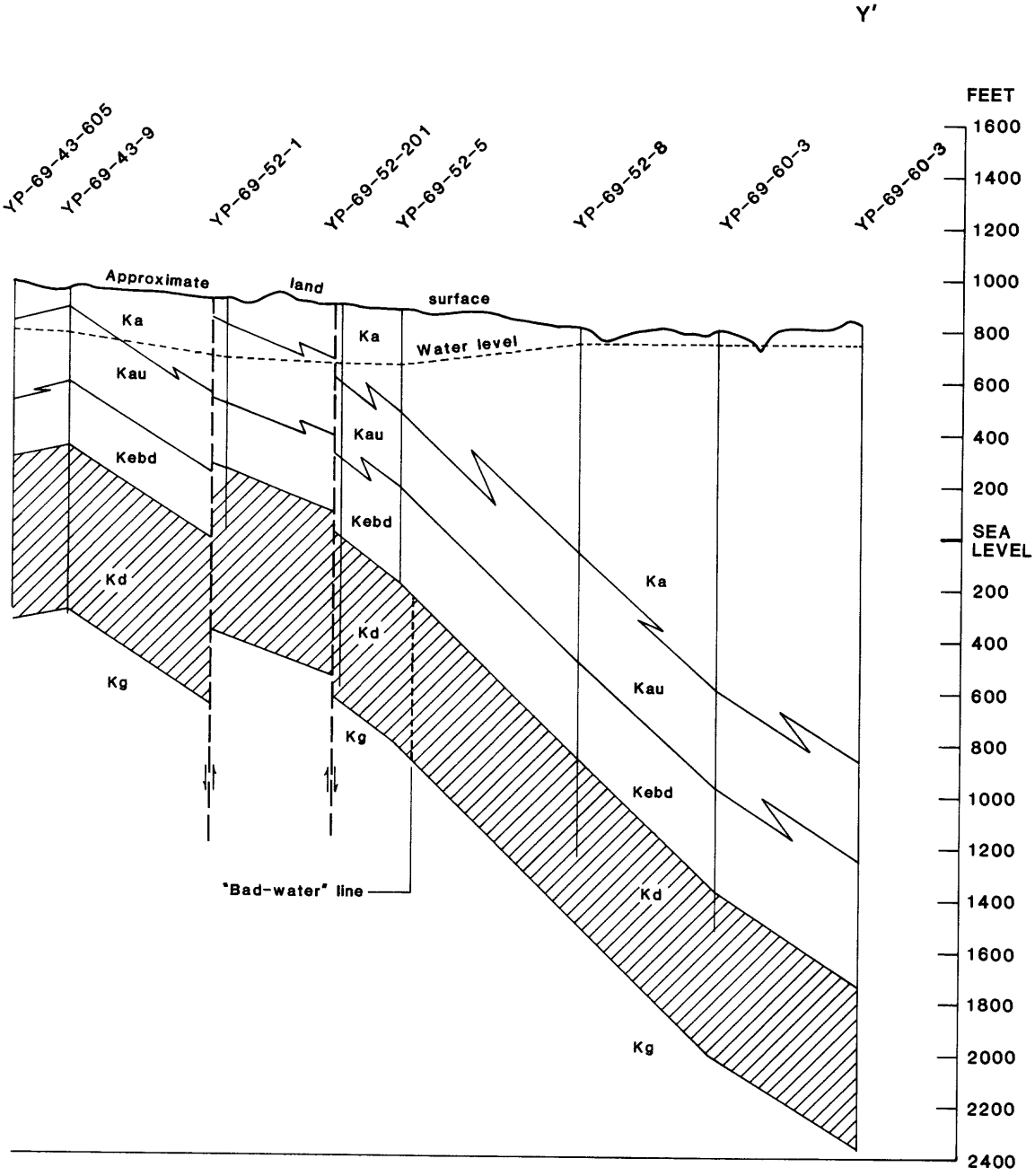


Figure 27.--Hydrogeologic section, Y-Y'.


Y'
FEET
YP-69-43-605
YP-69-43-9
YP-69-52-1
YP-69-52-201
YP-69-52-5
YP-69-52-8
YP-69-60-3
YP-69-60-3
Approximate land surface
Water level
Ka
Kau
Kebd
Kd
Kg
"Bad-water" line
1600
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400

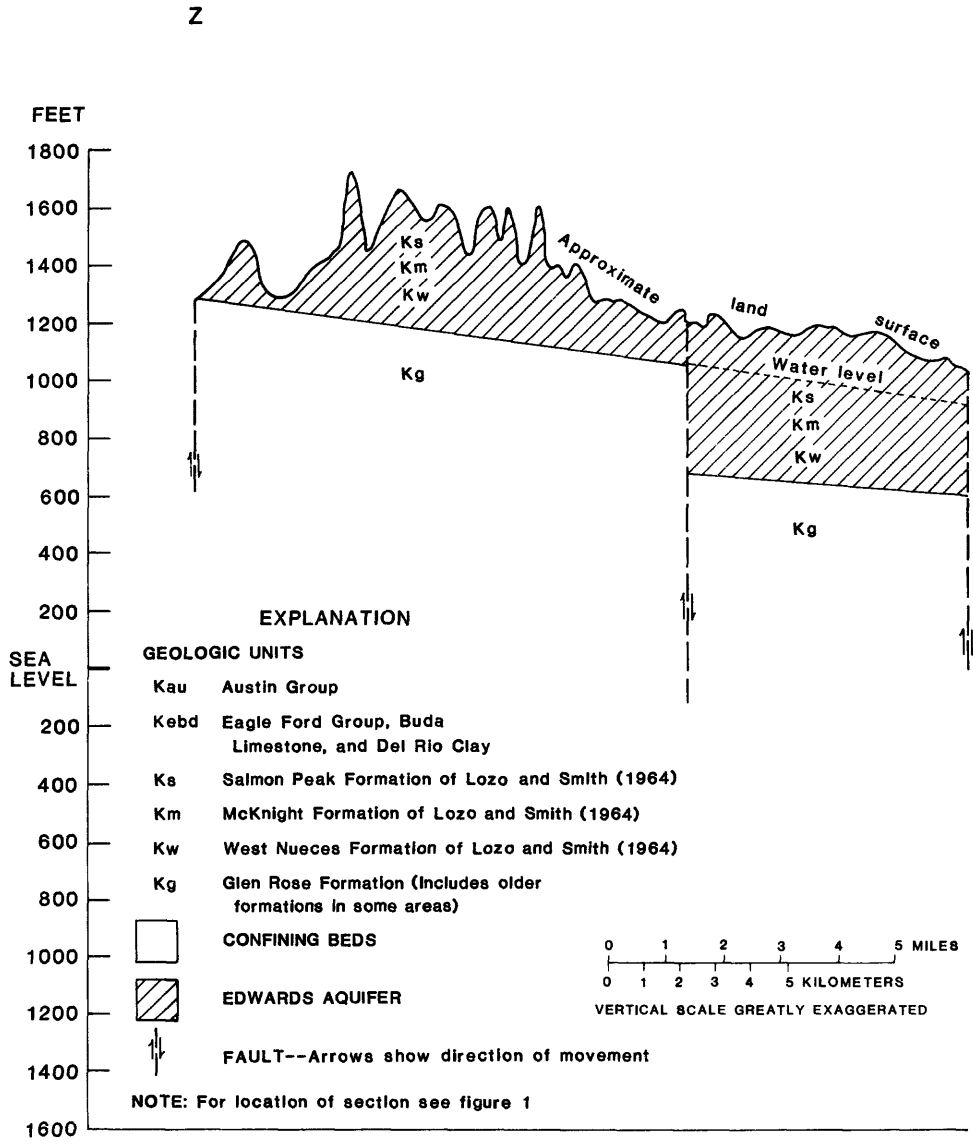
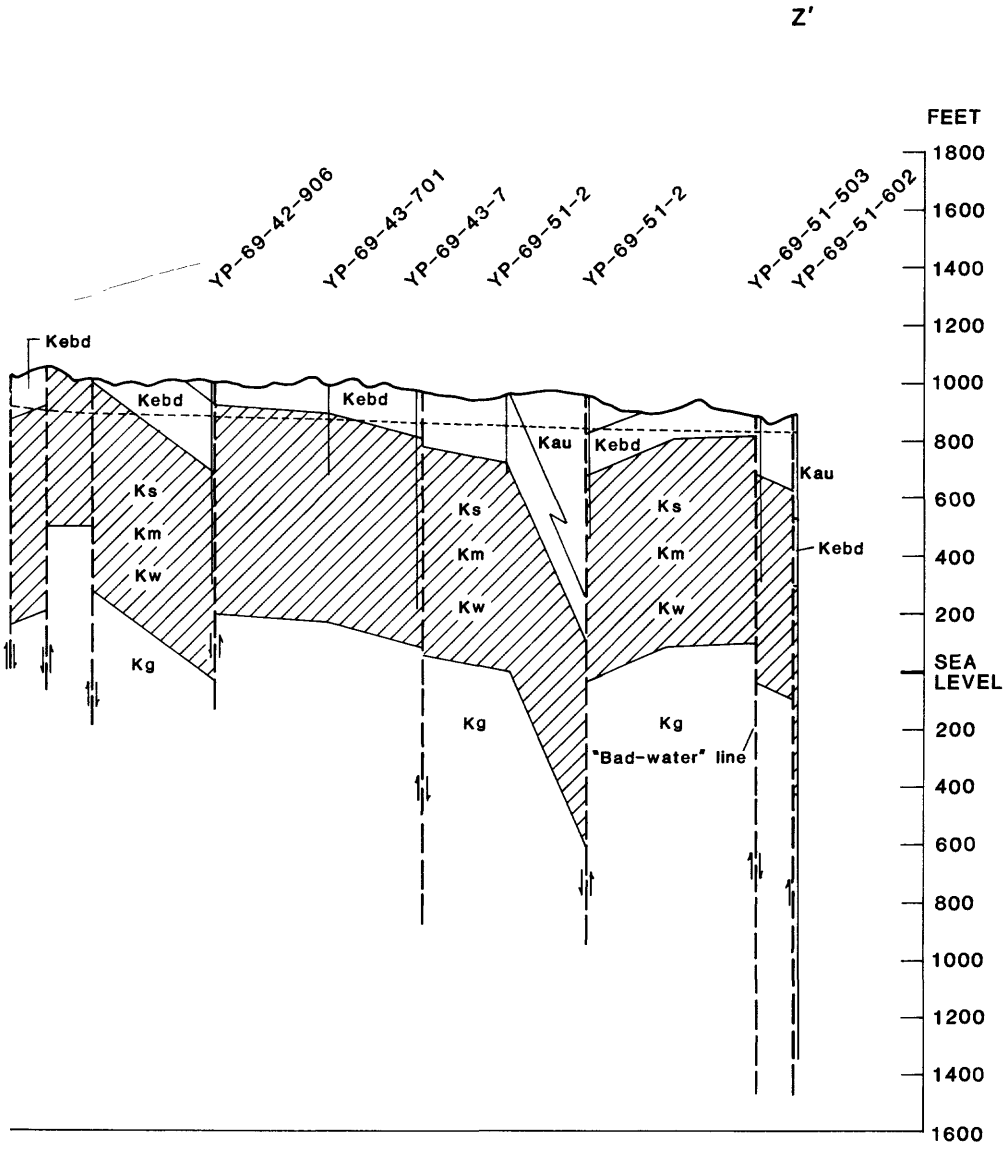


Figure 28.--Hydrogeologic section, Z-Z'.


Z'
FEET
1800
1600
1400
1200
1000
800
600
400
200
SEA LEVEL
200
400
600
800
1000
1200
1400
1600
YP-69-42-906
YP-69-43-701
YP-69-43-7
YP-69-51-2
YP-69-51-2
YP-69-51-503
YP-69-51-602
Kebd
Kebd
Kebd
Kebd
Kebd
Kau
Kau
Ks
Km
Kw
Kg
Ks
Km
Kw
Kg
Ks
Km
Kw
Kg
"Bad-water" line

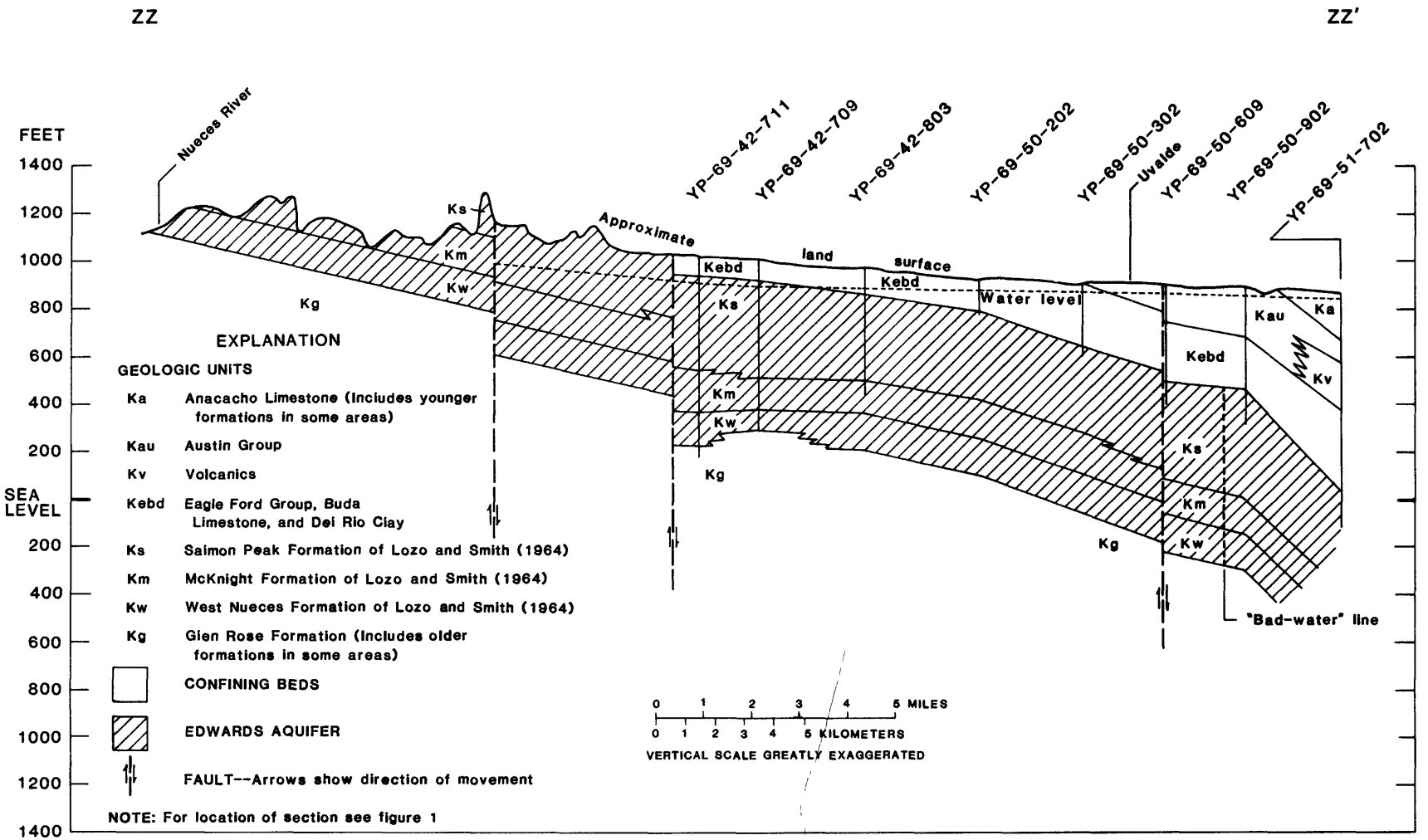


Figure 29.--Hydrogeologic section, ZZ-ZZ'.

SUMMARY

Twenty-seven hydrogeologic sections are presented that show the Edwards aquifer to be complexly faulted. Some faults offset the entire thickness of the aquifer at locations along the fault strike. These places of complete separation of the aquifer act as barriers to ground-water flow, and the local flow pattern is disrupted and diverted around the barriers.

REFERENCES

Arnow, Ted, 1959, Ground-water geology of Bexar County, Texas: Texas Board of Water Engineers Bulletin 5911, 62 p.

DeCook, K. J., 1963, Geology and ground-water resources of Hays County, Texas: U.S. Geological Survey Water-Supply Paper 1612, 72 p.

George, W. O., 1952, Geology and ground-water resources of Comal County, Texas: U.S. Geological Survey Water-Supply Paper 1138, 126 p.

Holt, C. L. R., Jr., 1959, Geology and ground-water resources of Medina County, Texas: U.S. Geological Survey Water-Supply Paper 1422, 213 p.

Lozo, F. E., and Smith, C. I., 1964, Revision of Comanche Cretaceous stratigraphic nomenclature, southern Edwards Plateau, southwest Texas: Transactions of the Gulf Coast Association of Geological Societies, v. 14, p. 285-307.

Maclay, R. W., Rettman, P. L., and Small, T. A., 1980, Hydrochemical data for the Edwards aquifer in the San Antonio area, Texas: Texas Department of Water Resources LP-131, 38 p.

Maclay, R. W., and Small, T. A., 1976, Progress report on geology of the Edwards aquifer, San Antonio area, Texas, and preliminary interpretation of borehole, geophysical, and laboratory data on carbonate rocks: U.S. Geological Survey Open-File Report 76-627, 65 p.

------, 1983, Hydrostratigraphic subdivisions and fault barriers of the Edwards aquifer, south central Texas, U.S.A.: Journal of Hydrology, v. 61, p. 127-146.

------, 1984, Carbonate geology and hydrogeology of the Edwards aquifer in the San Antonio area, Texas: U.S. Geological Survey Open-File Report 83-537, 72 p.

Maclay, R. W., Small, T. A., and Rettman, P. L., 1980, Water-level, recharge, discharge, specific-capacity, well-yield, and aquifer-test data for the Edwards aquifer in the San Antonio area, Texas: Texas Department of Water Resources LP-133, 83 p.

------, 1981, Application and analysis of borehole data for the Edwards aquifer in the San Antonio area, Texas: Texas Department of Water Resources LP-139, 88 p.

Rose, P. R., 1972, Edwards Group, surface and subsurface, central Texas: Austin, University of Texas, Bureau of Economic Geology Report of Investigations 74, 198 p.

Small, T. A., and Maclay, R. W., 1982, Test-hole data for the Edwards aquifer in the San Antonio area, Texas: Texas Department of Water Resources LP-171, 153 p.

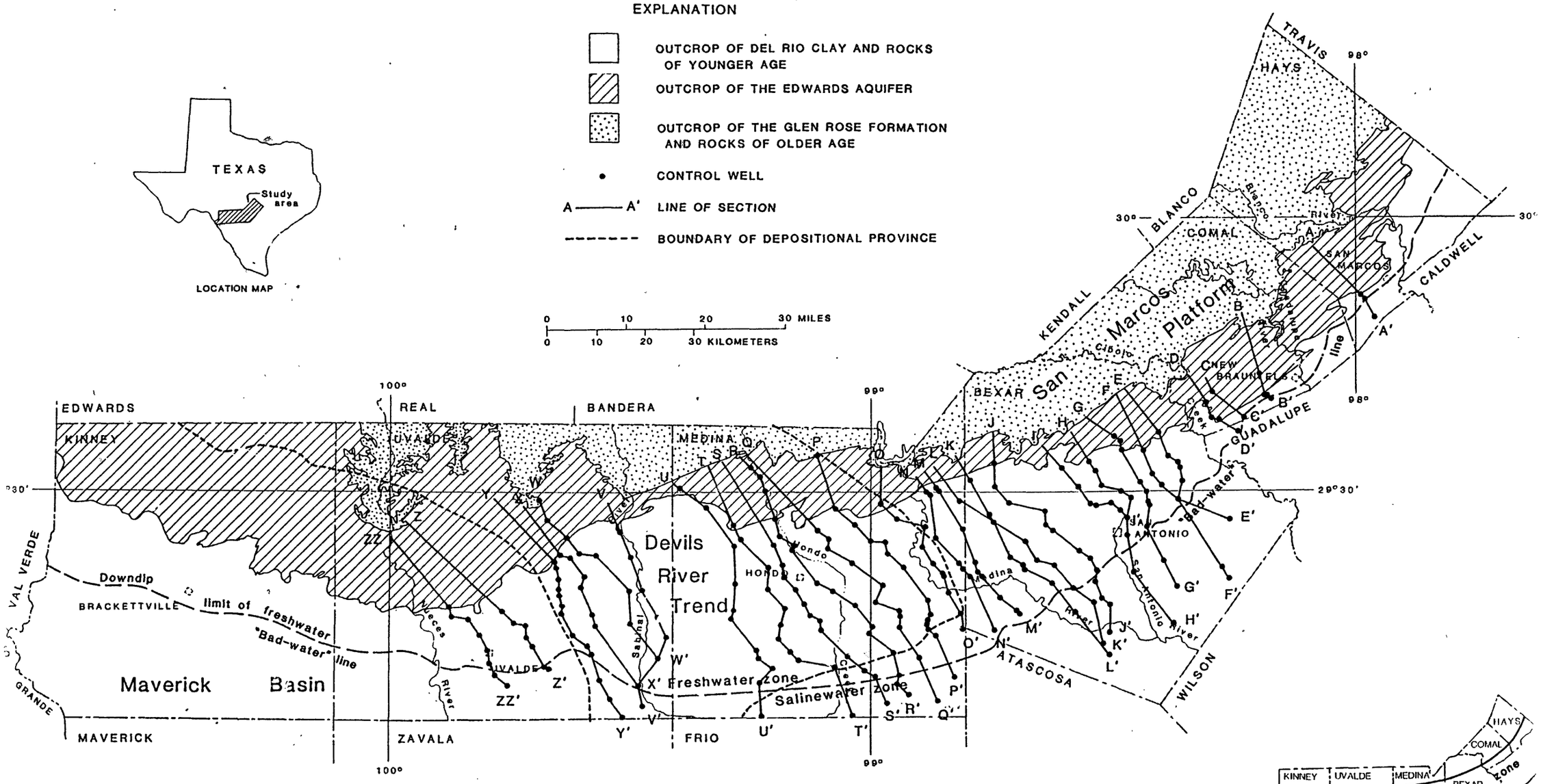


Figure 1.--Location of sections, outcrop of Edwards aquifer, downdip limit of freshwater, and the Maverick basin, Devils River trend, and San Marcos platform depositional provinces.

85-4259

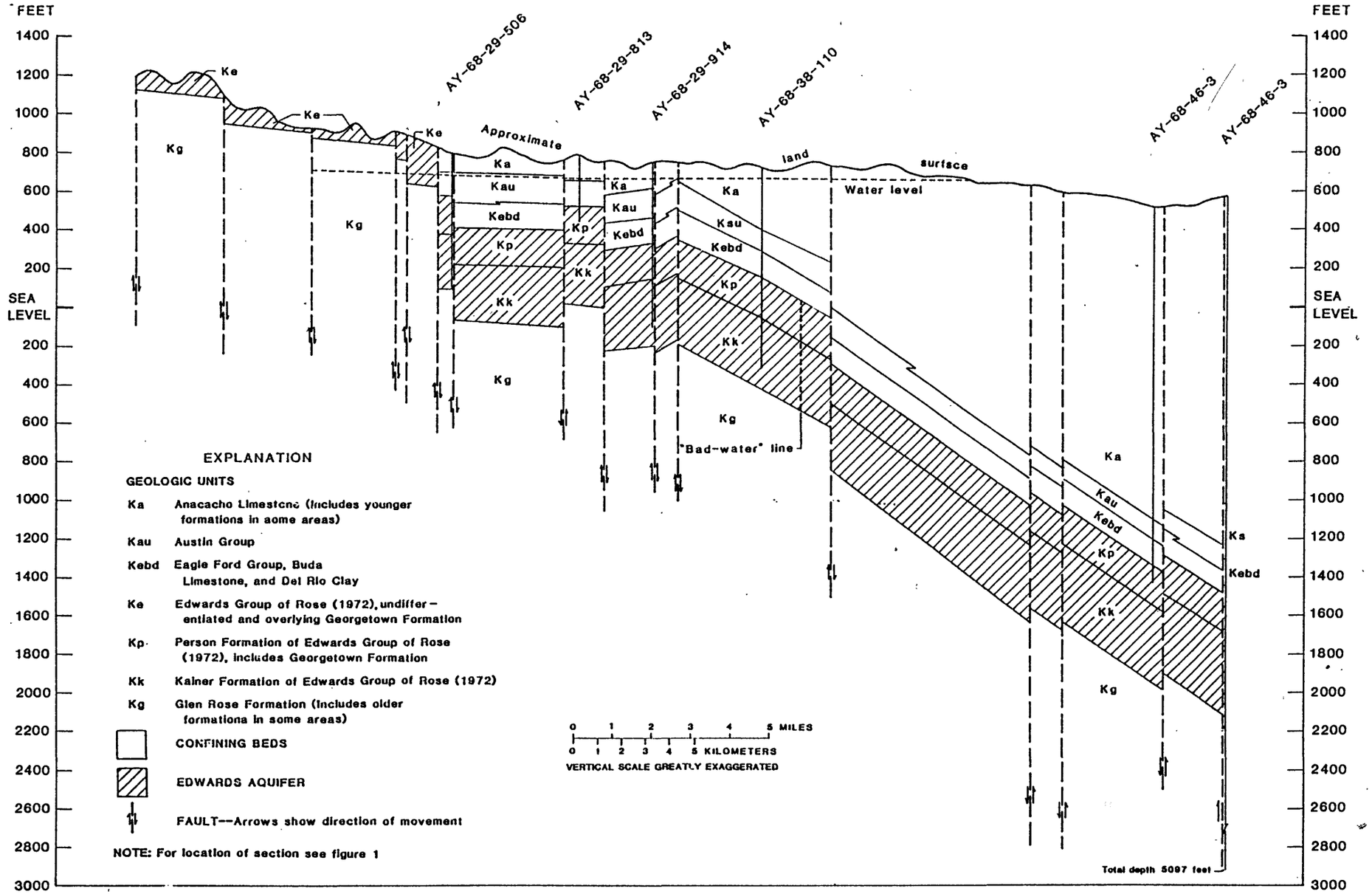


Figure 8.--Hydrogeologic section, F-F'.

85-4254

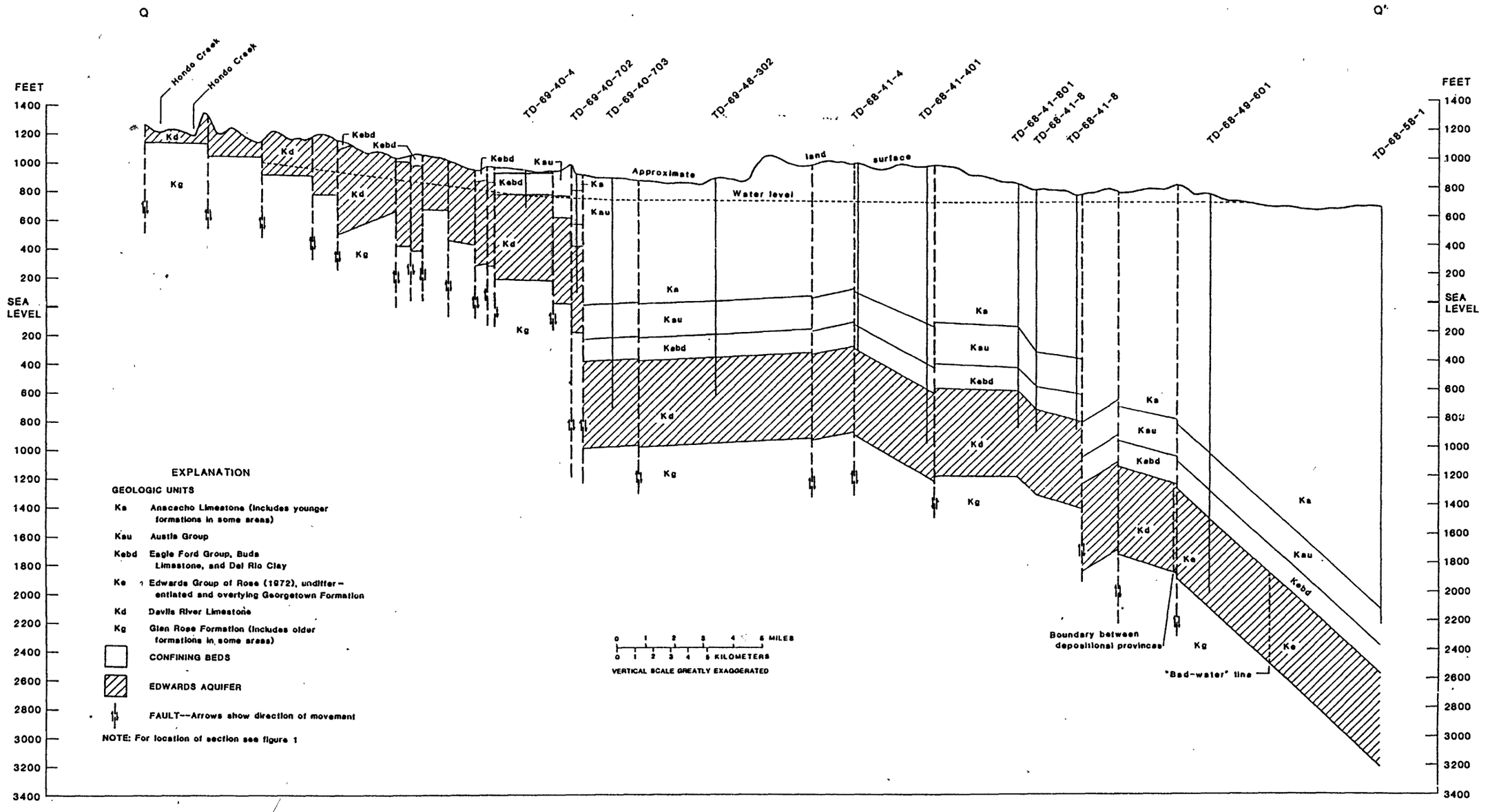


Figure 19.--Hydrogeologic section, Q-Q'.

85-4259

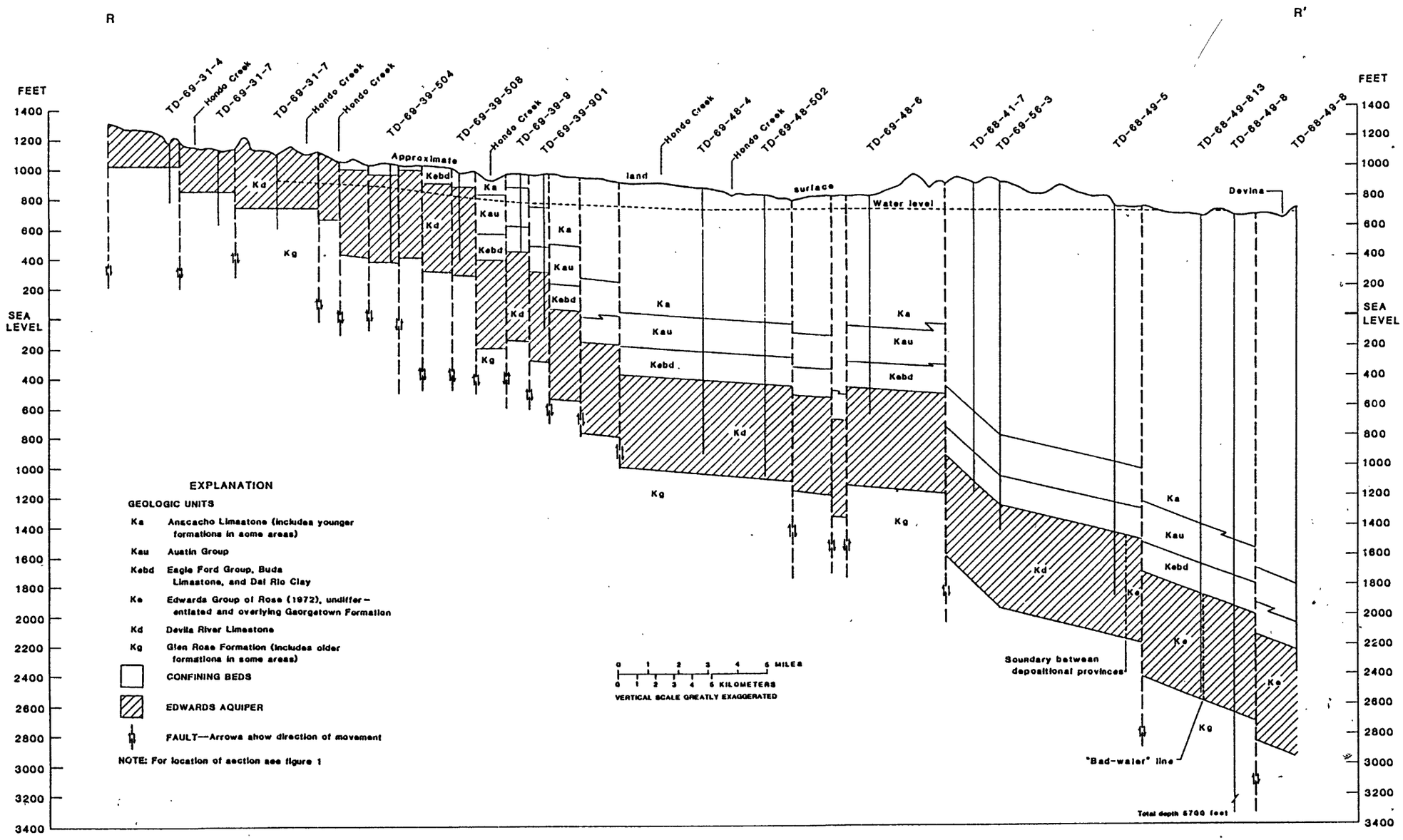


Figure 20.--Hydrogeologic section, R-R'.

85-4259

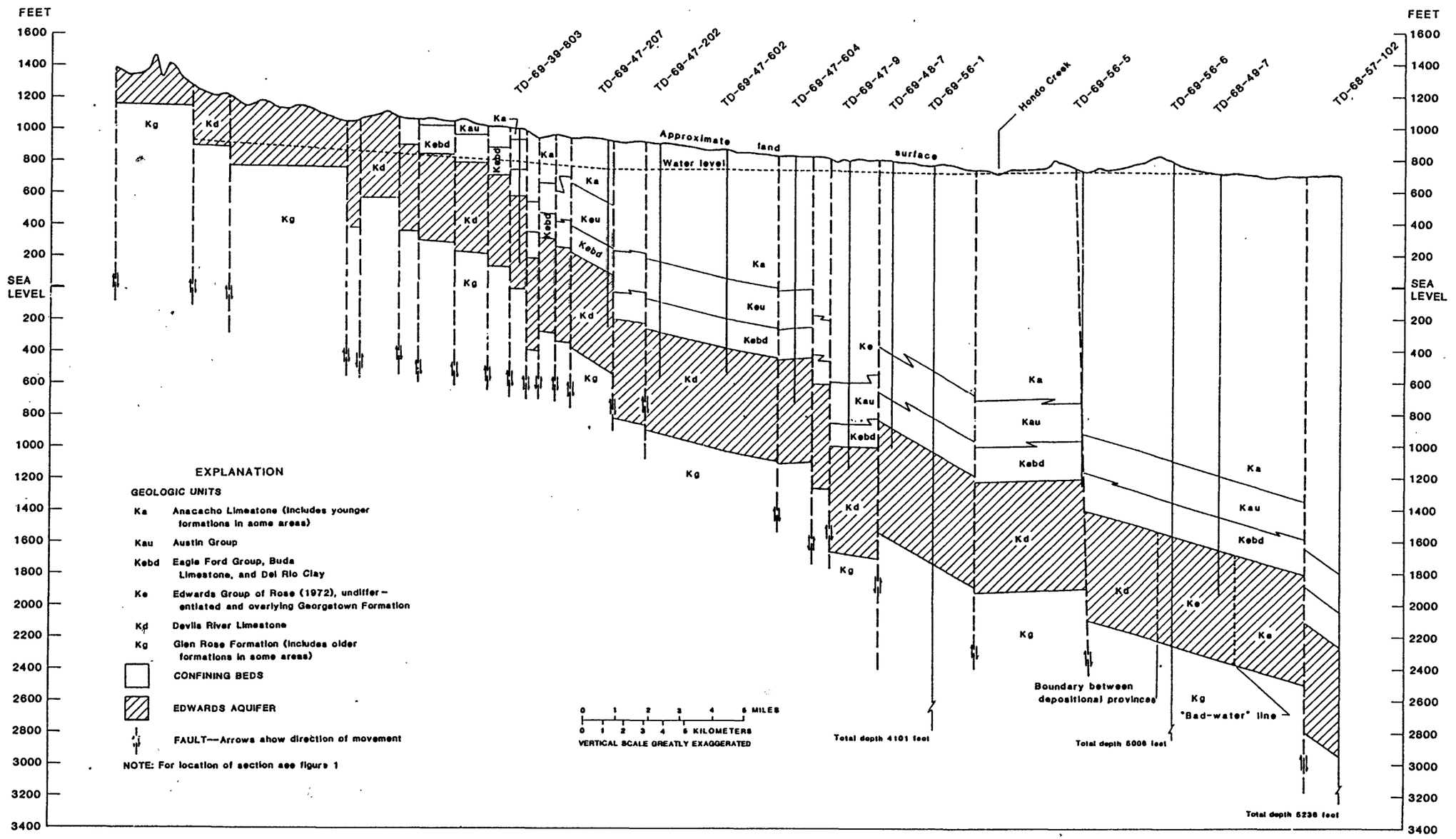


Figure 21.--Hydrogeologic section, S-S'.

85-4259

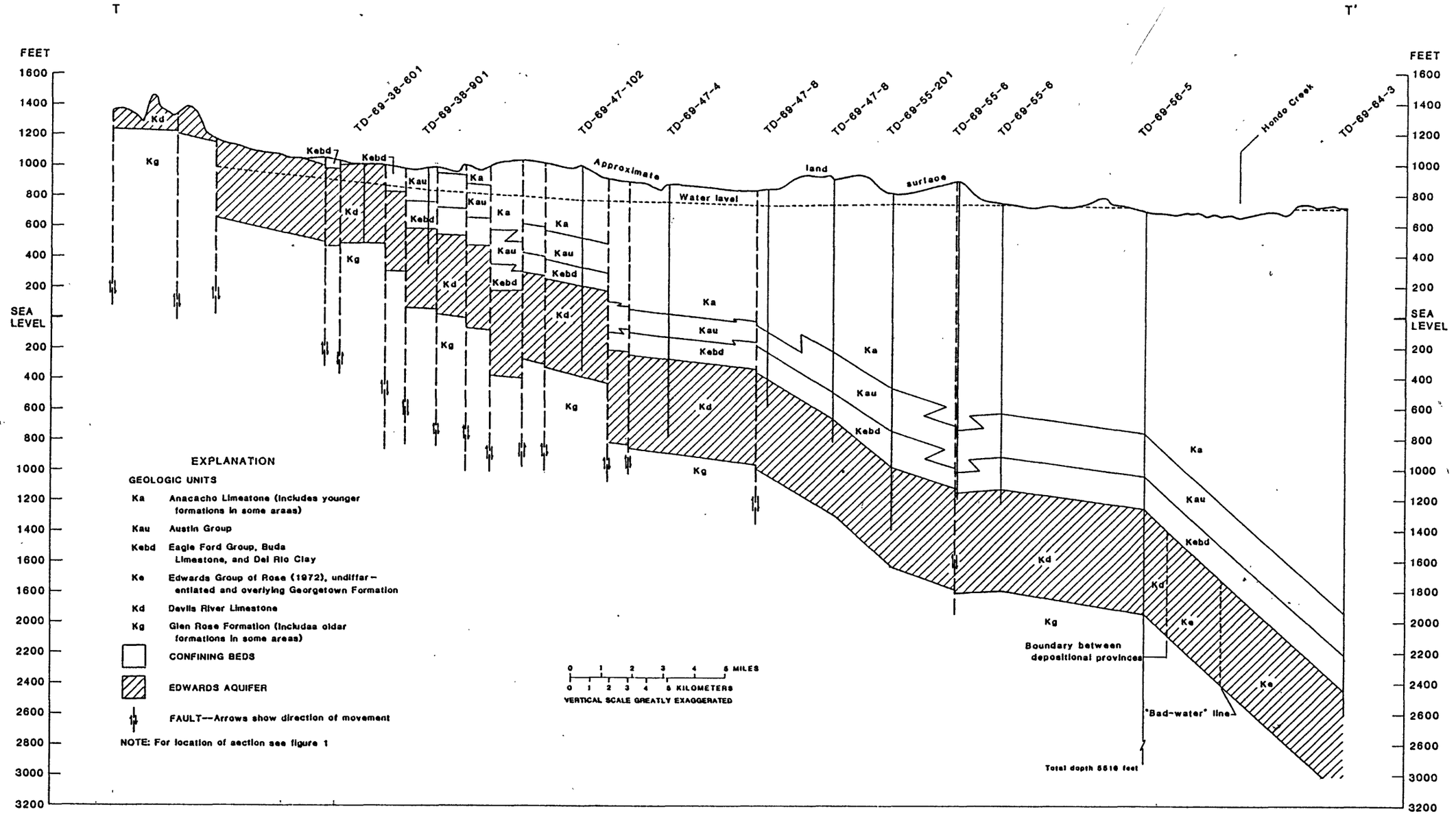


Figure 22.--Hydrogeologic section, T-T'.

85-4259

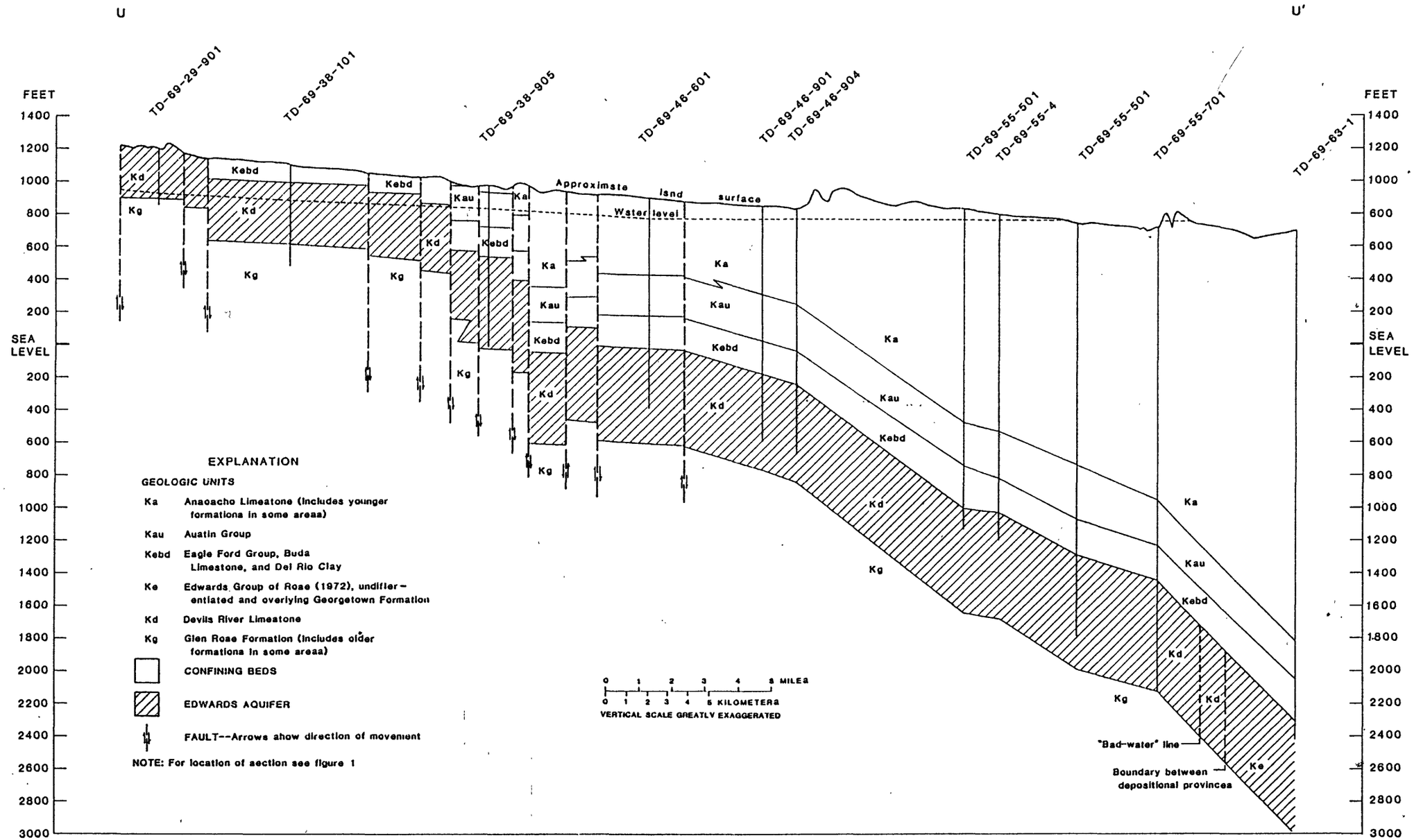


Figure 23.--Hydrogeologic section, U-U'.

85-4259