Regional Hydrogeology of the Willamette Valley

Compiled By

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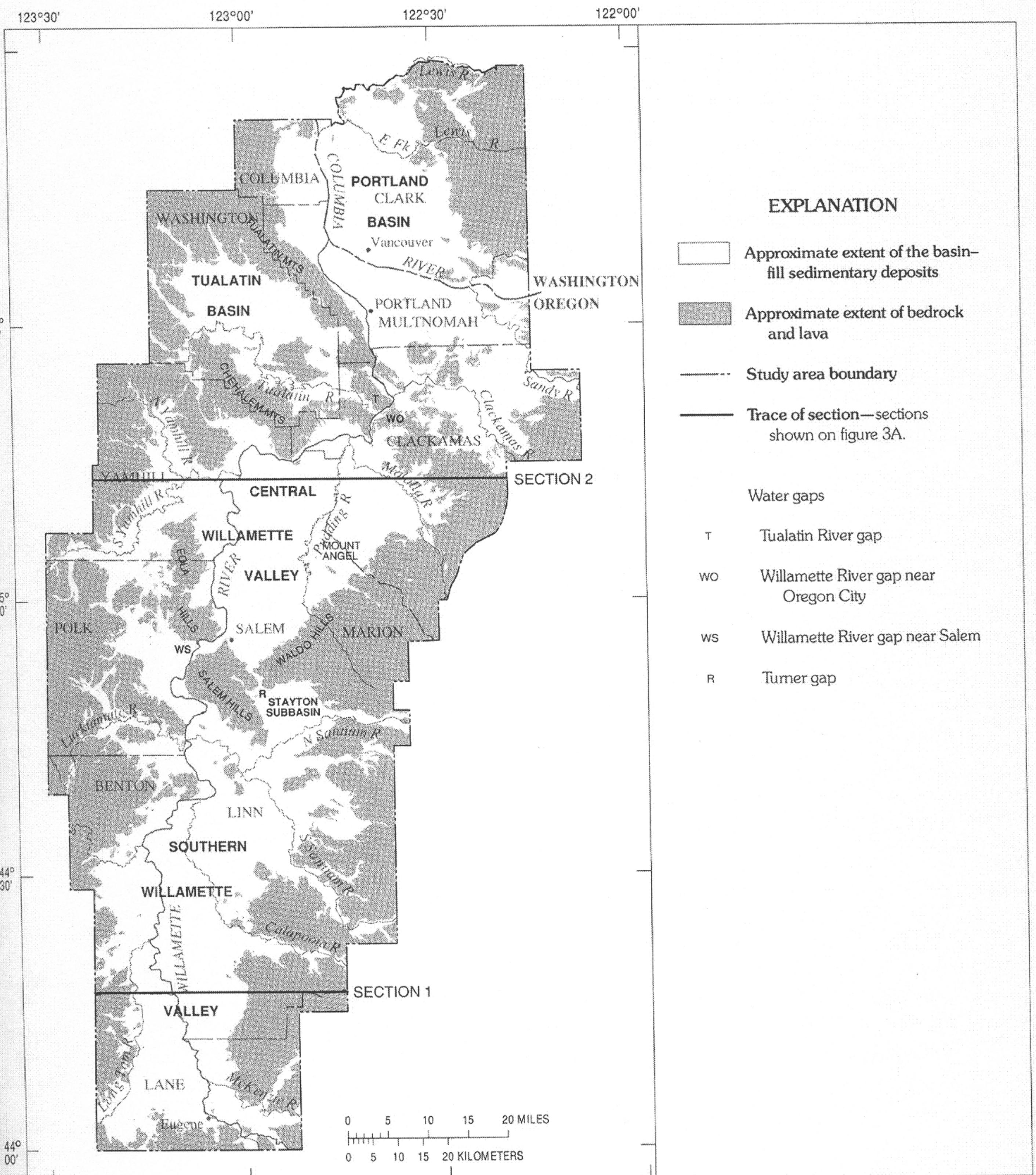
Derived from Gannet and Caldwell (1998); Yeats and Others (1991)



Basemap source information on page v.

Geologic data modified from Gannett and Caldwell, 1998, USGS Professional Paper 1424-A.

FIGURE 2.—Location of Willamette Lowland and structural basins.

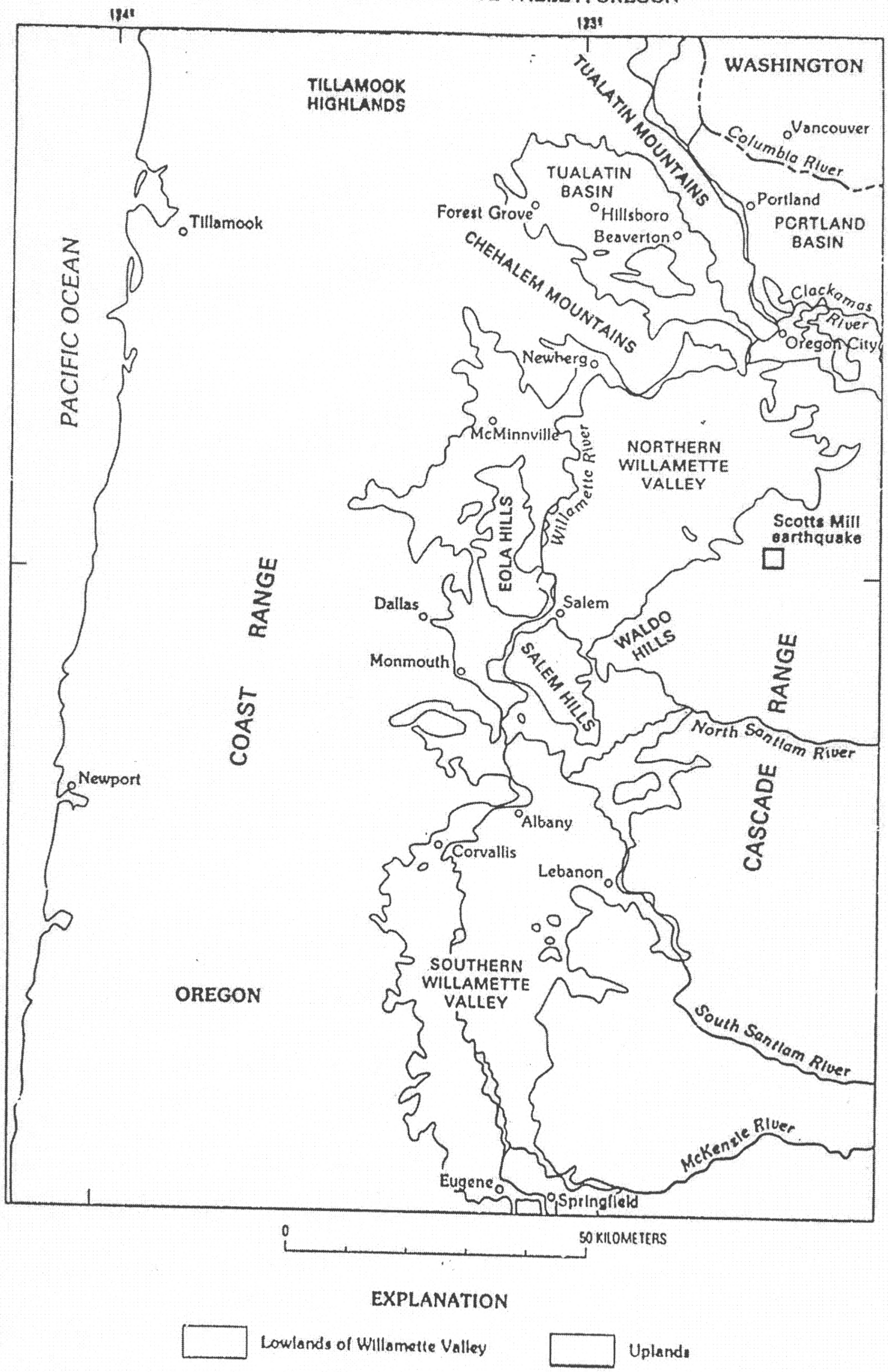


Figure 77. Geographic and physiographic features of the Willamette Valley and Portland and Tualatin basins, northwestern Oregon. The square indicates the epicenter of the March 25, 1993, Scotts Mills earthquake.

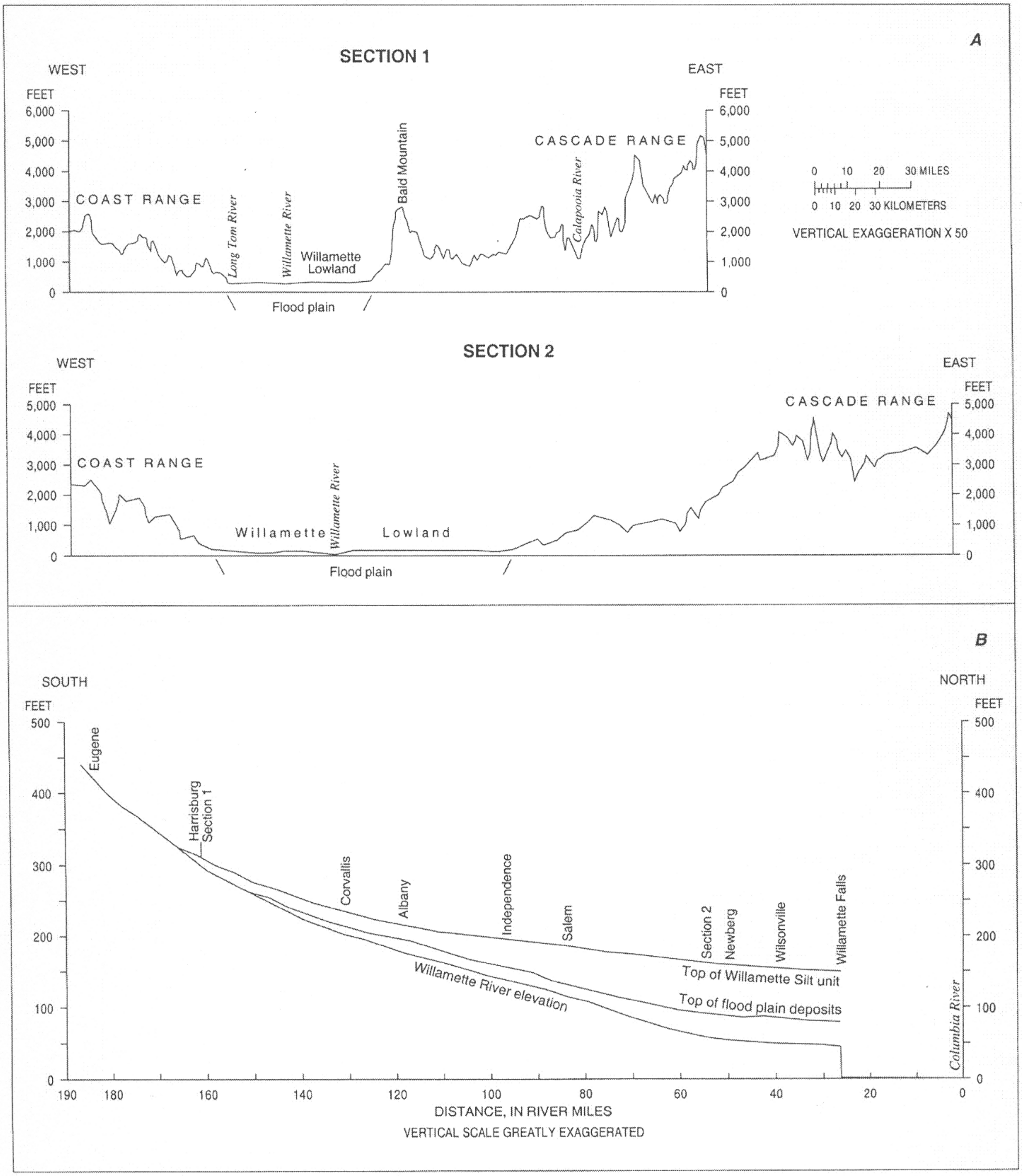


FIGURE 3. (A) Topographic sections west-east across study area and (B) Bank section along Willamette River. (Trace of topographic sections shown on figure 2.)

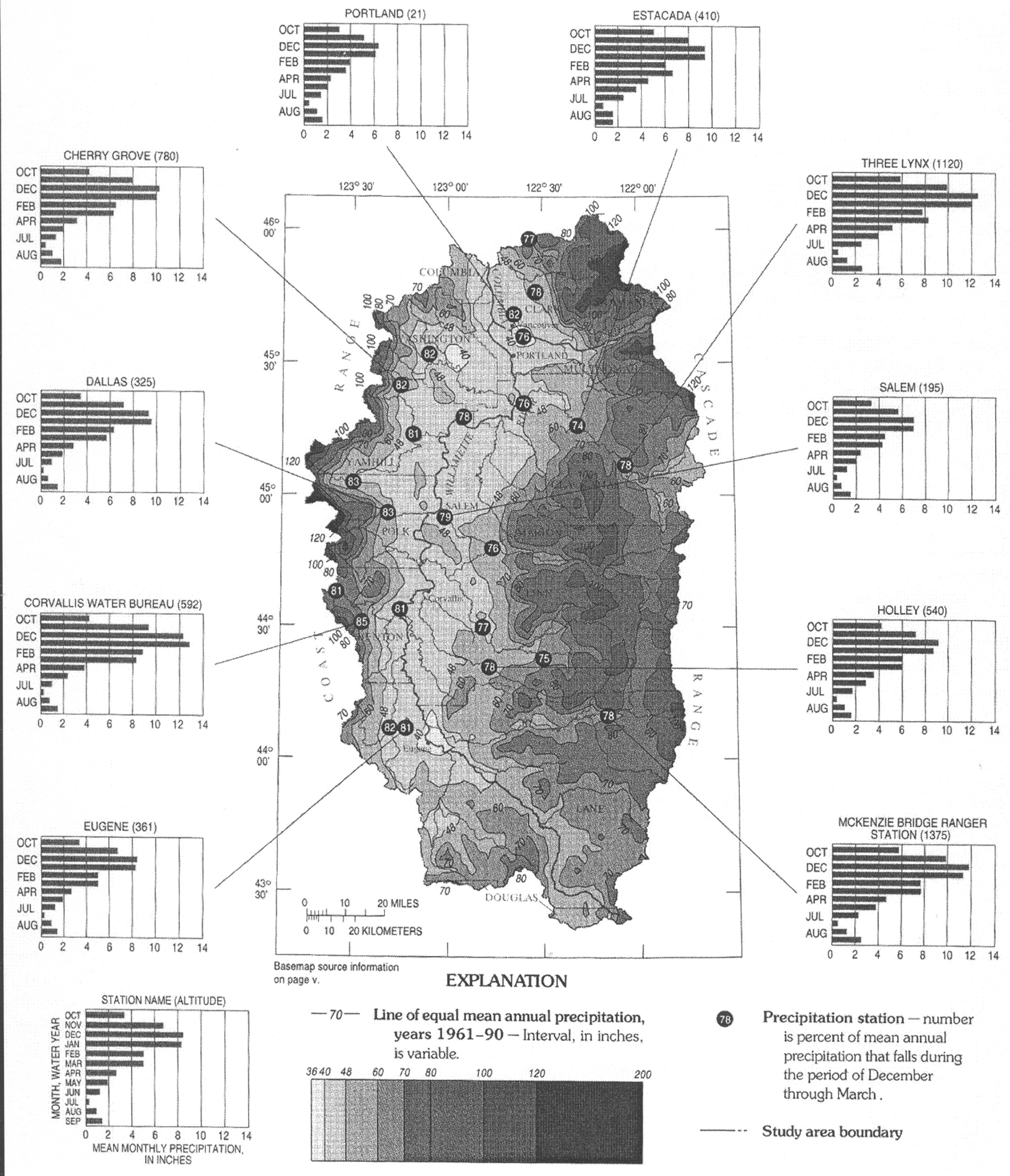


FIGURE 4.—Mean annual and mean monthly precipitation for the study area. (Precipitation data from Taylor, 1993.)

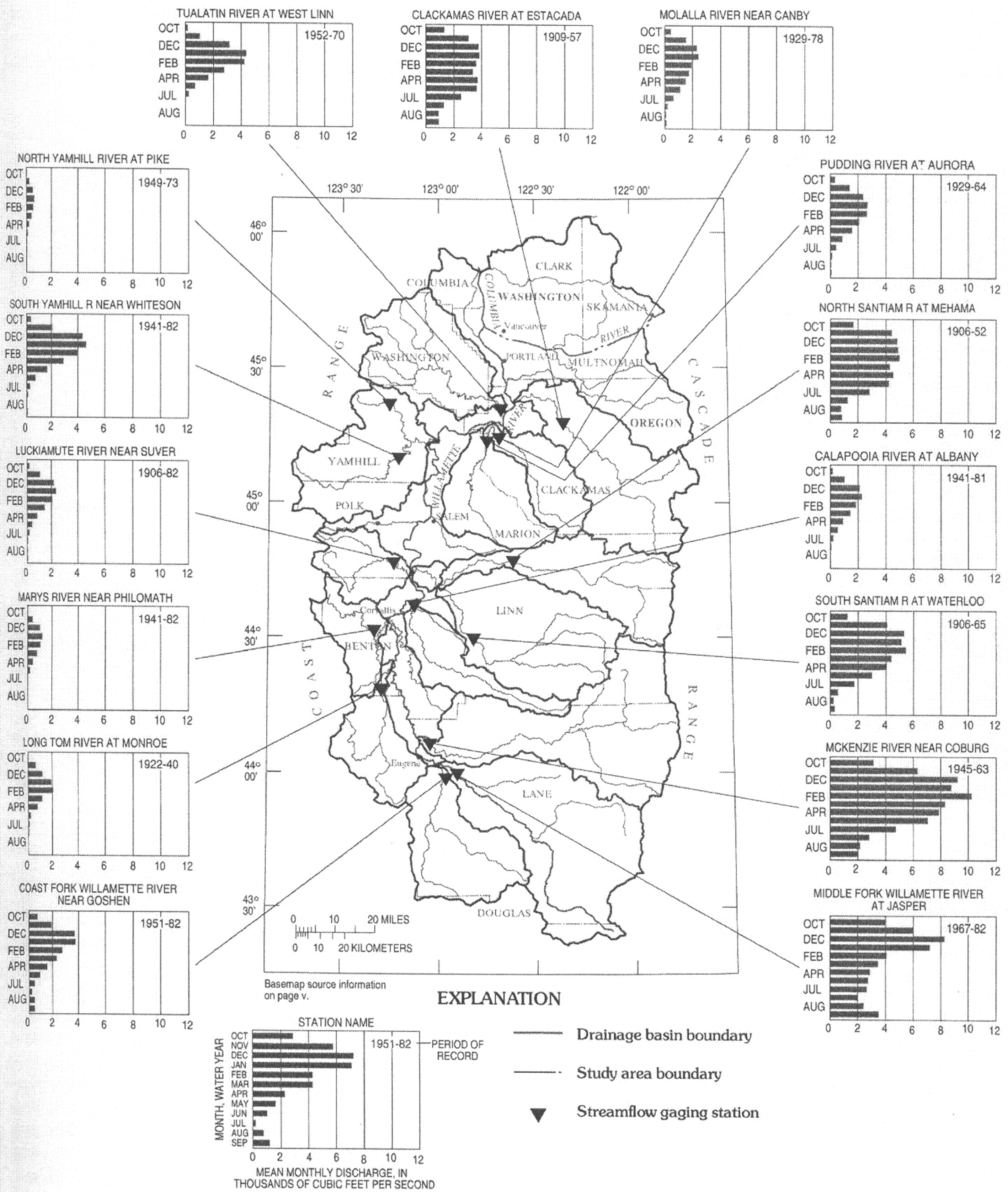


FIGURE 5.—Mean monthly discharge for selected major tributaries of the Willamette River.

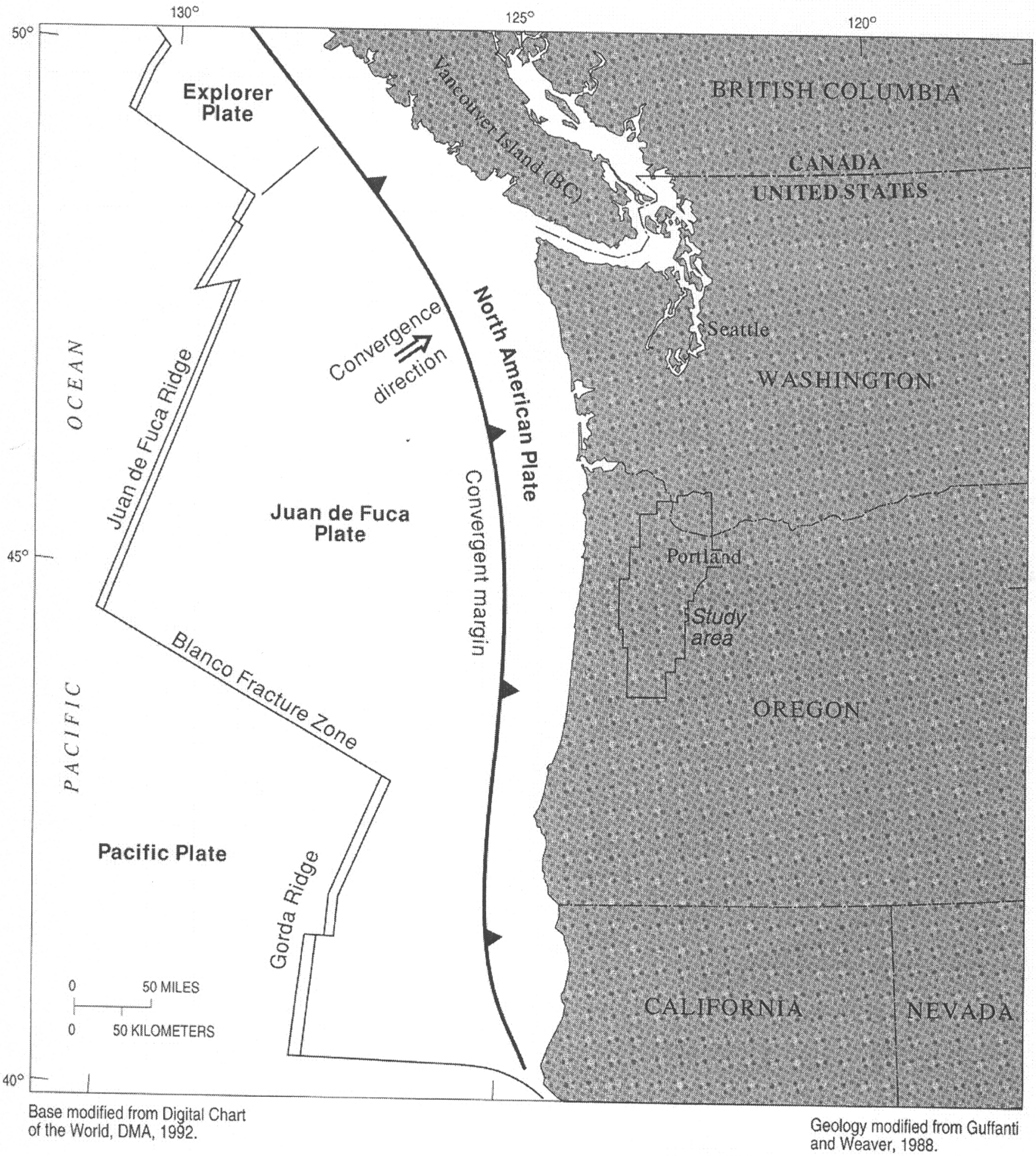


FIGURE 5.—Tectonic setting of the Oregon and Washington continental margin. (Modified from Guffanti and Weaver, 1988.)

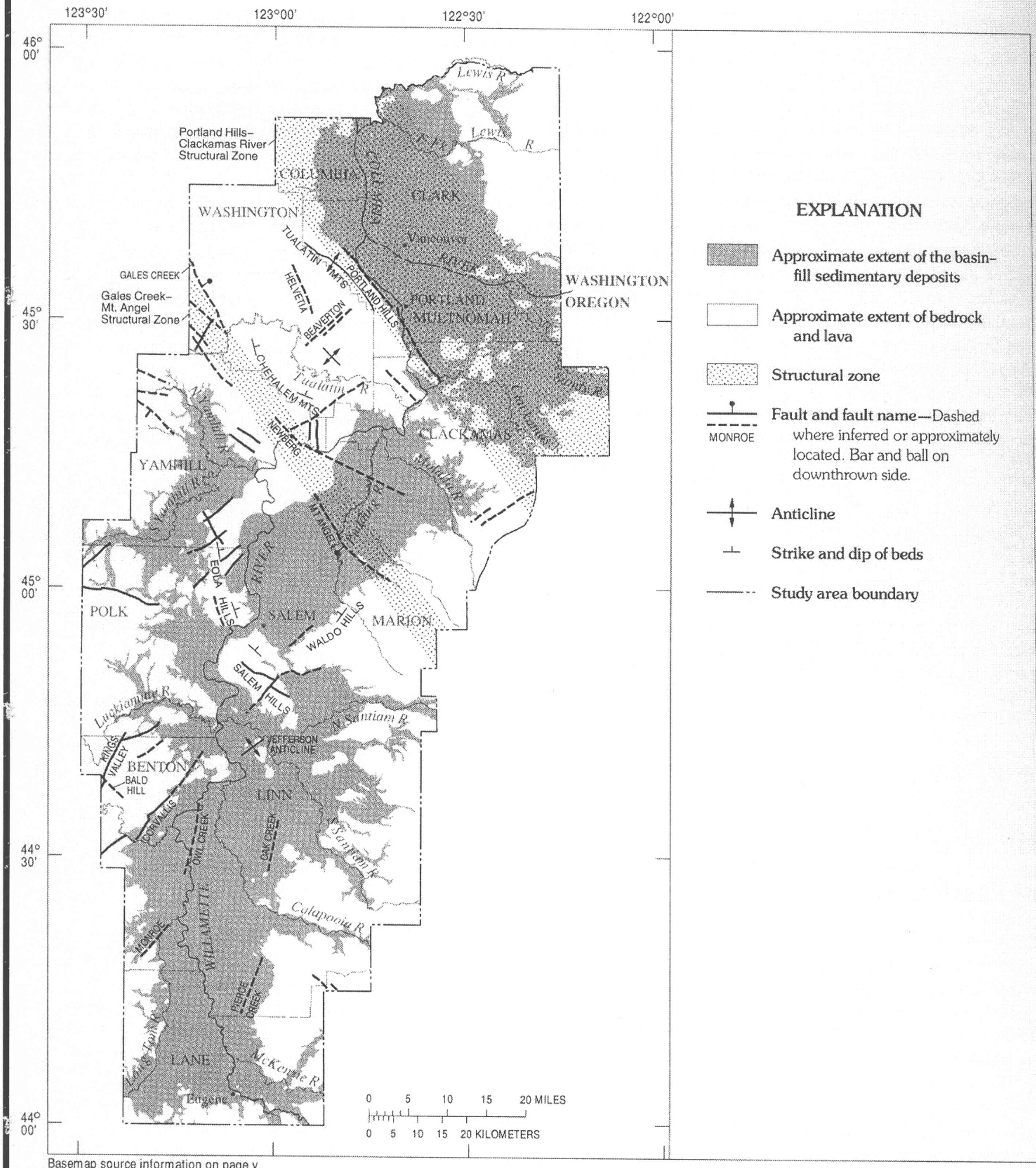


FIGURE 10.—Selected structural features in the Willamette Lowland. (Strike and dip symbols show the approximate attitude of the Columbia River Basalt Group.)

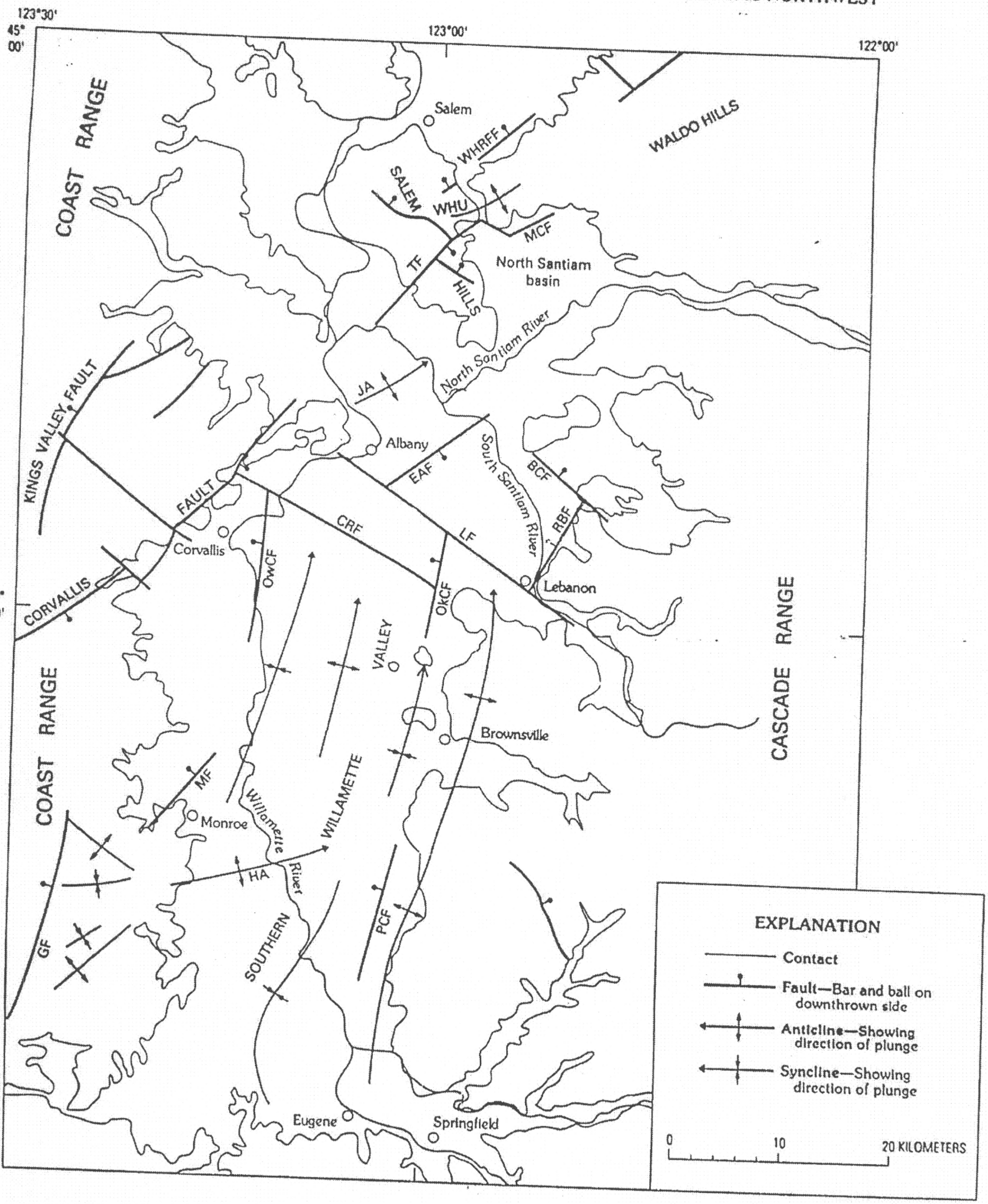
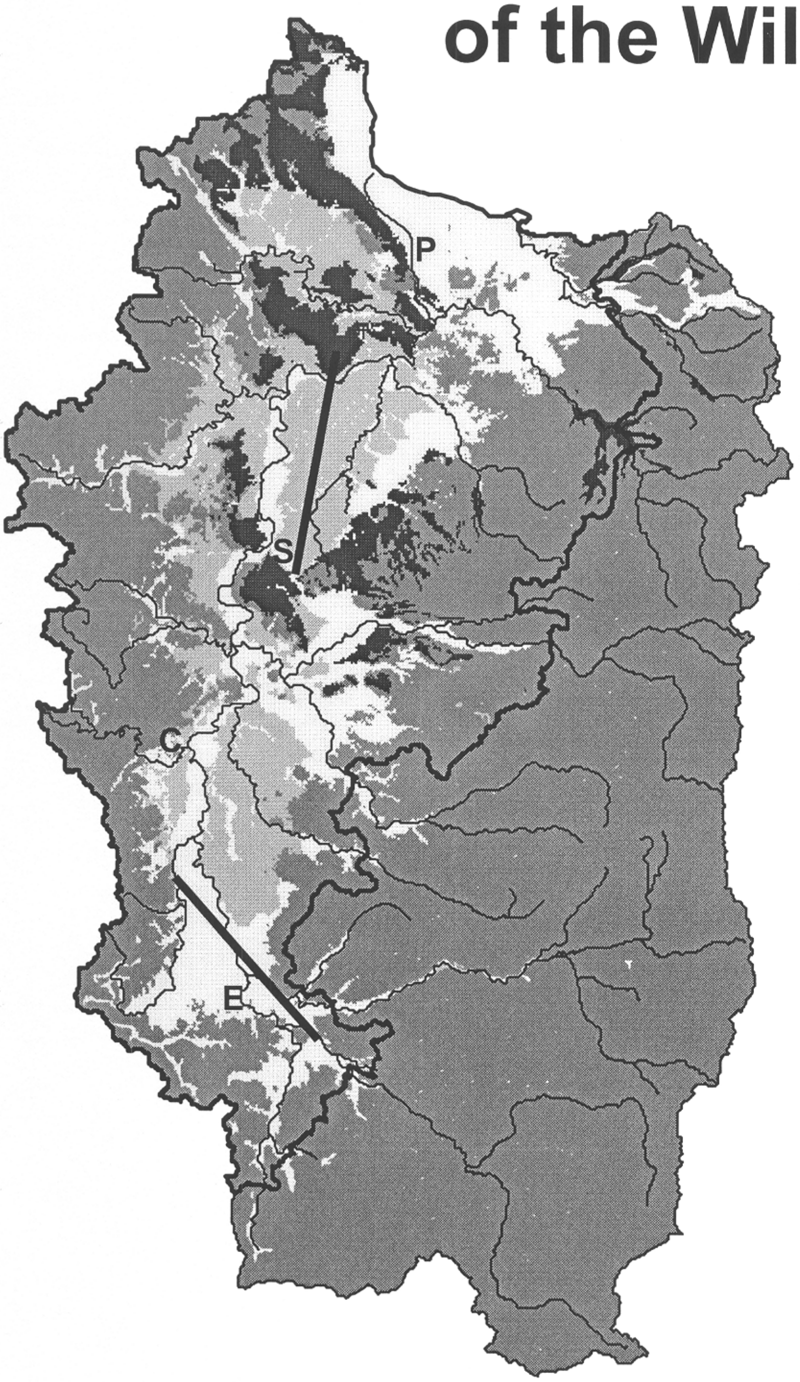


Figure 84. Tectonic map of the southern Willamette Valley, Oregon. Areas underlain by alluvial and fluvial deposits that postdate the Columbia River Basalt Group are unshaded; areas underlain directly by bedrock are shaded. BCF, Beaver Creek fault; CRF, Calapooia River fault; EAF, East Albany fault; GF, Glenbrook fault; HA, Harrisburg anticline; JA, Jefferson anticline; LF, Lebanon fault; MCF, Mill Creek fault; MF, Monroe fault; OwCF, Owl Creek fault; OkCF, Oak Creek fault; PCF, Pierce Creek fault; RBF, Ridgeway Butte fault; TF, Turner fault; WHRFF, Waldo Hills range-front fault; WHU, Waldo Hills uplift.

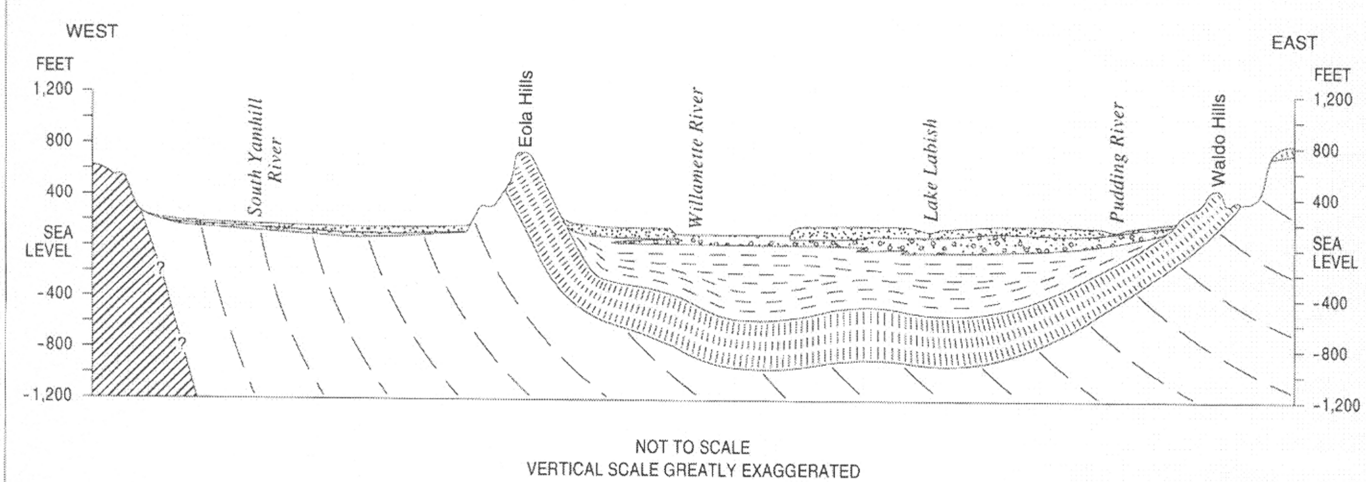
Generalized Geology of the Willamette Valley



- Willamette Silt
- Alluvium and basin-fill sediment
- Columbia River Basalt Gp
- Marine sedimentary rocks And Cascade Range rocks

Gannett & Caldwell, 1998

0 10 20 30 MILES



EXPLANATION

Geologic unit

- Silt and fine sand (Willamette Silt)
- Sand and gravel with minor silt and clay
- Clay and silt with minor sand and gravel
- Columbia River Basalt Group lavas
- Marine sedimentary rocks—lines show general bedding orientation
- Marine volcanic rocks

---?--- **Generalized geologic unit boundary**—queried where uncertain

FIGURE 7.—A generalized geologic section west-east through the central Willamette Lowland.

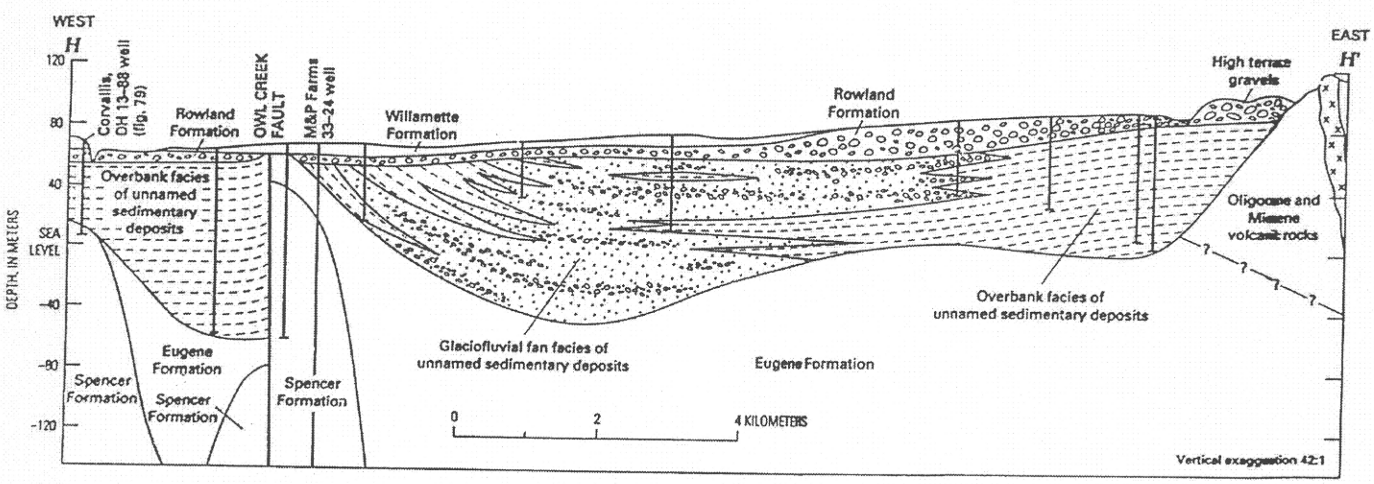
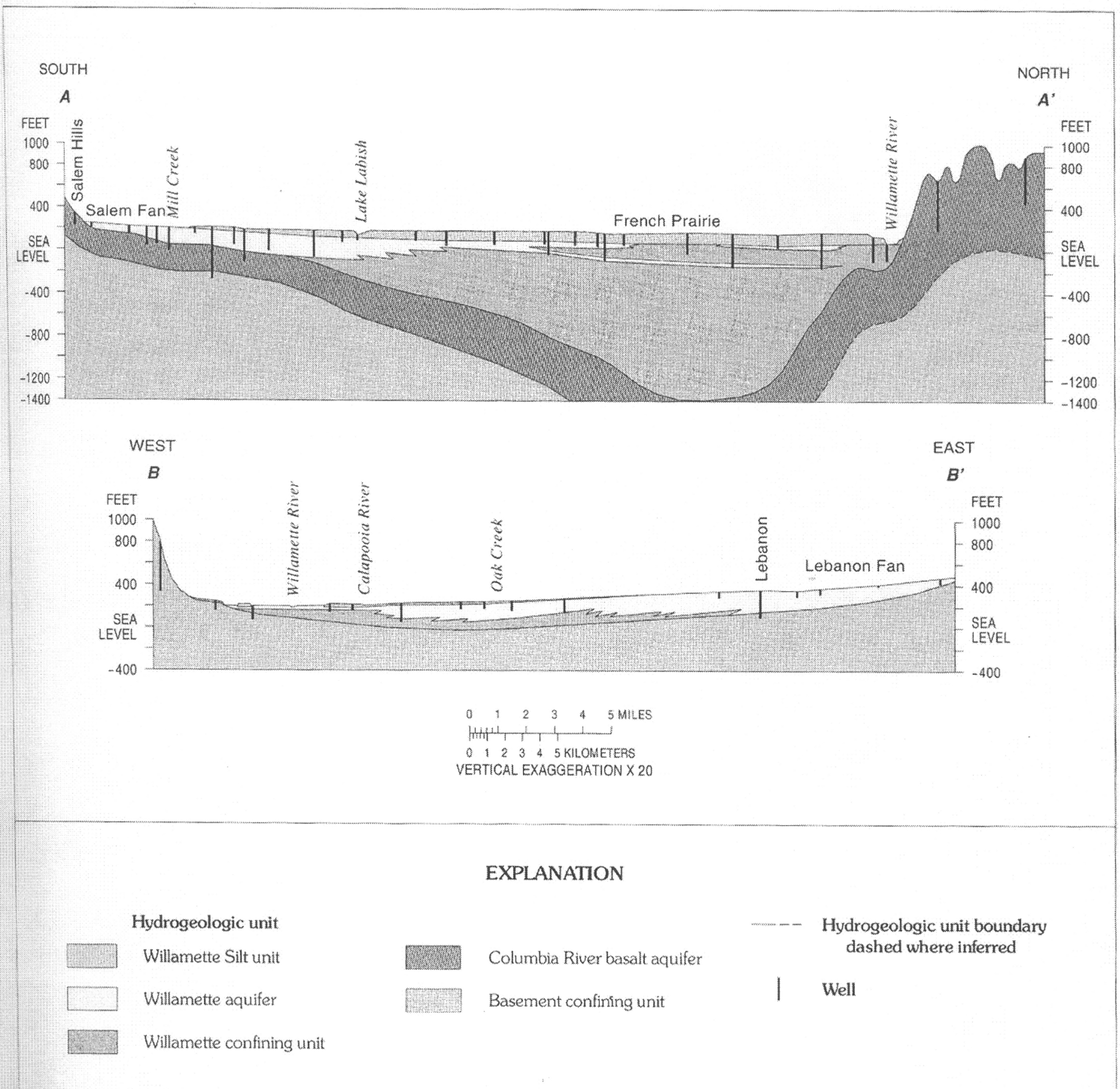
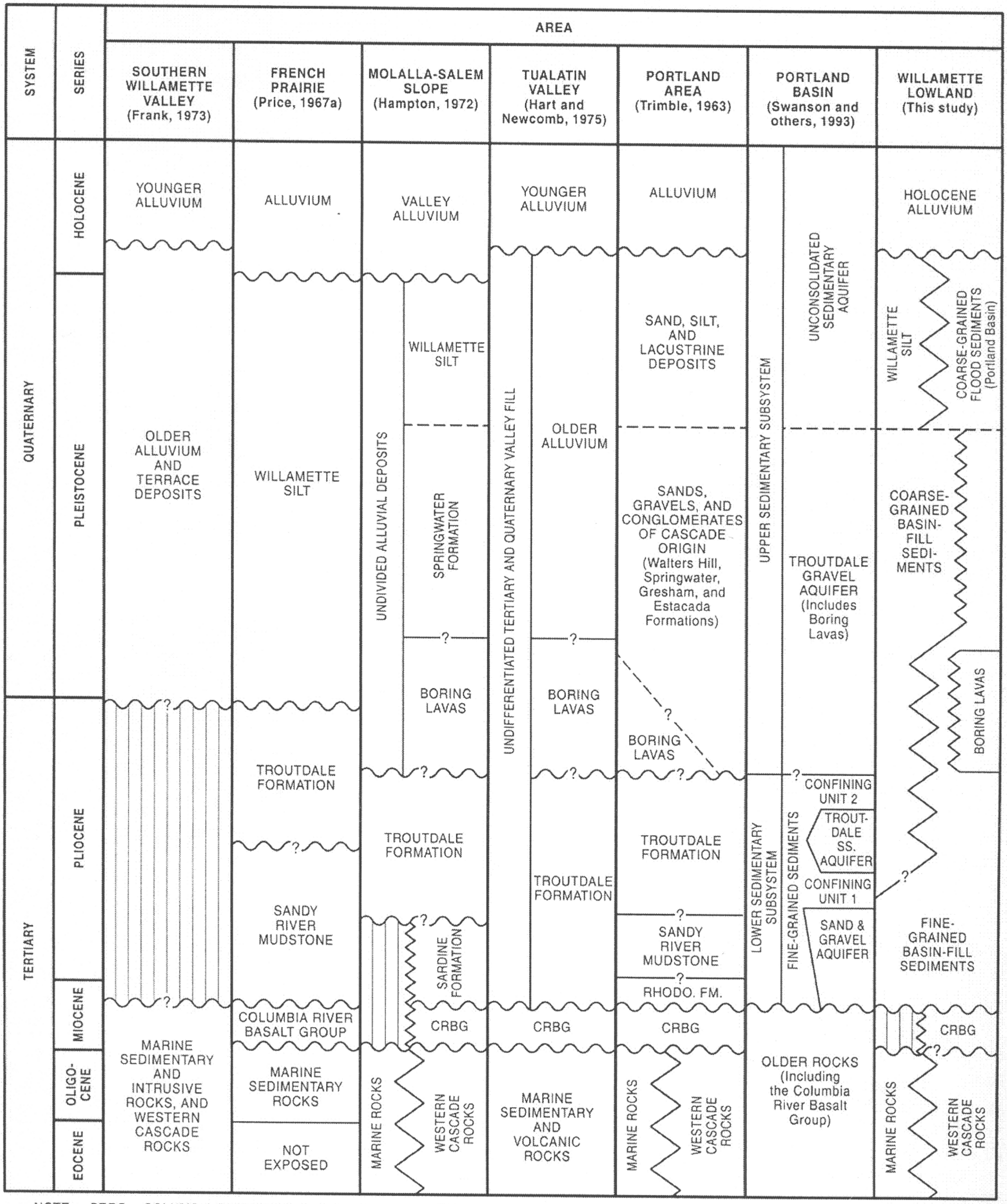


Figure 82. Structural cross section between Corvallis and Lebanon, Oreg., showing channel and overbank facies of unnamed fluvial sedimentary deposits, high-terrace gravels, late Pleistocene outwash deposits of the Rowland Formation, and catastrophic flood deposits of the Willamette Formation. Data are from water wells, engineering bore holes, and petroleum-exploration wells.



Geologic data modified from Gannett and Caldwell, 1998, USGS Professional Paper 1424A.

FIGURE 9.—Hydrogeologic sections. (*A–A'*–North-south section in central Willamette Valley. *B–B'*–East-west section in southern Willamette Valley. Trace of sections shown on figure 8.)



NOTE: CRBG = COLUMBIA RIVER BASALT GROUP; RHODO. FM.= RHODODENDRON FORMATION; FM.= FORMATION; SS. = SANDSTONE

FIGURE 6.—Selected geologic units in parts of the Willamette Lowland as delineated by previous investigators, and as generalized in this study.

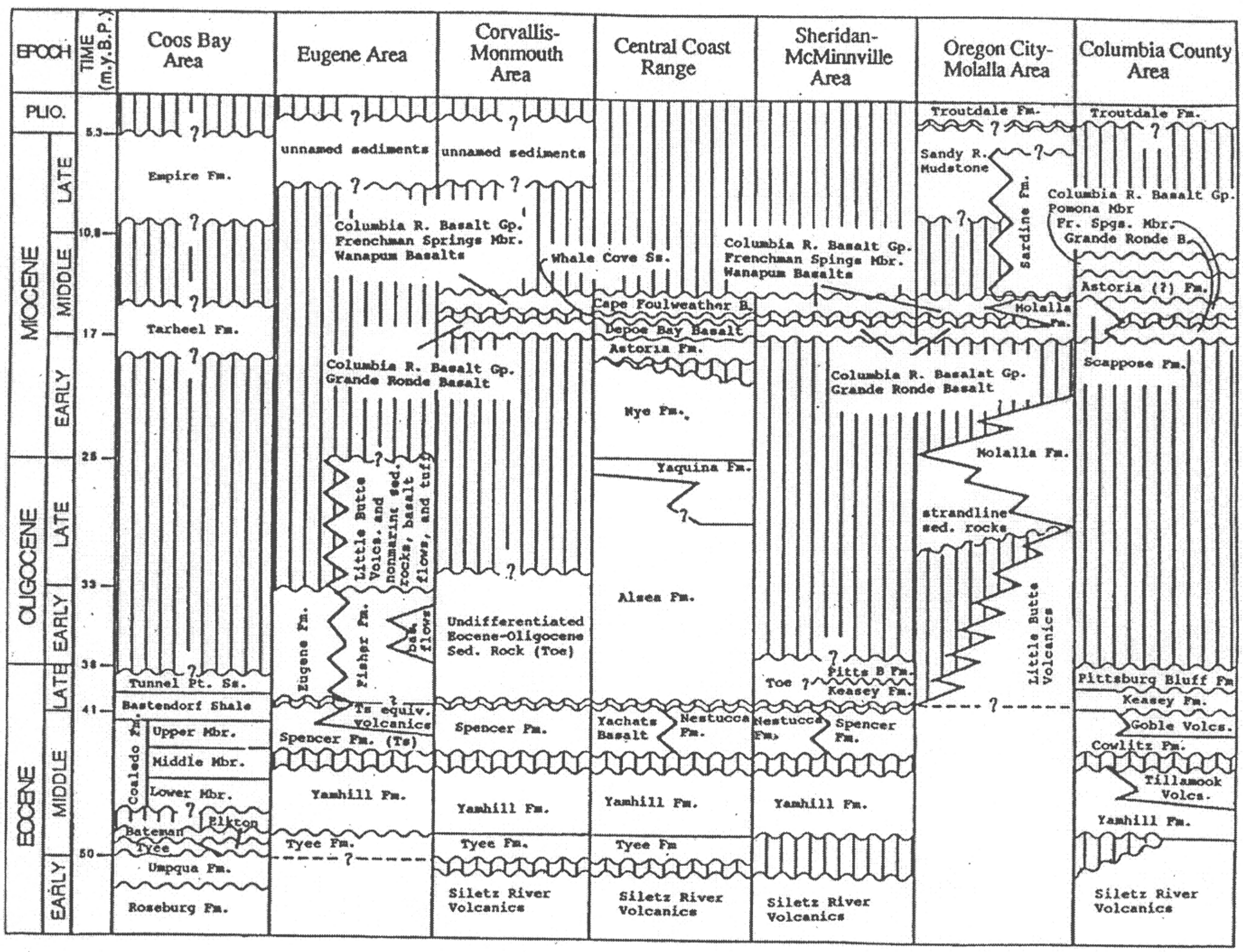
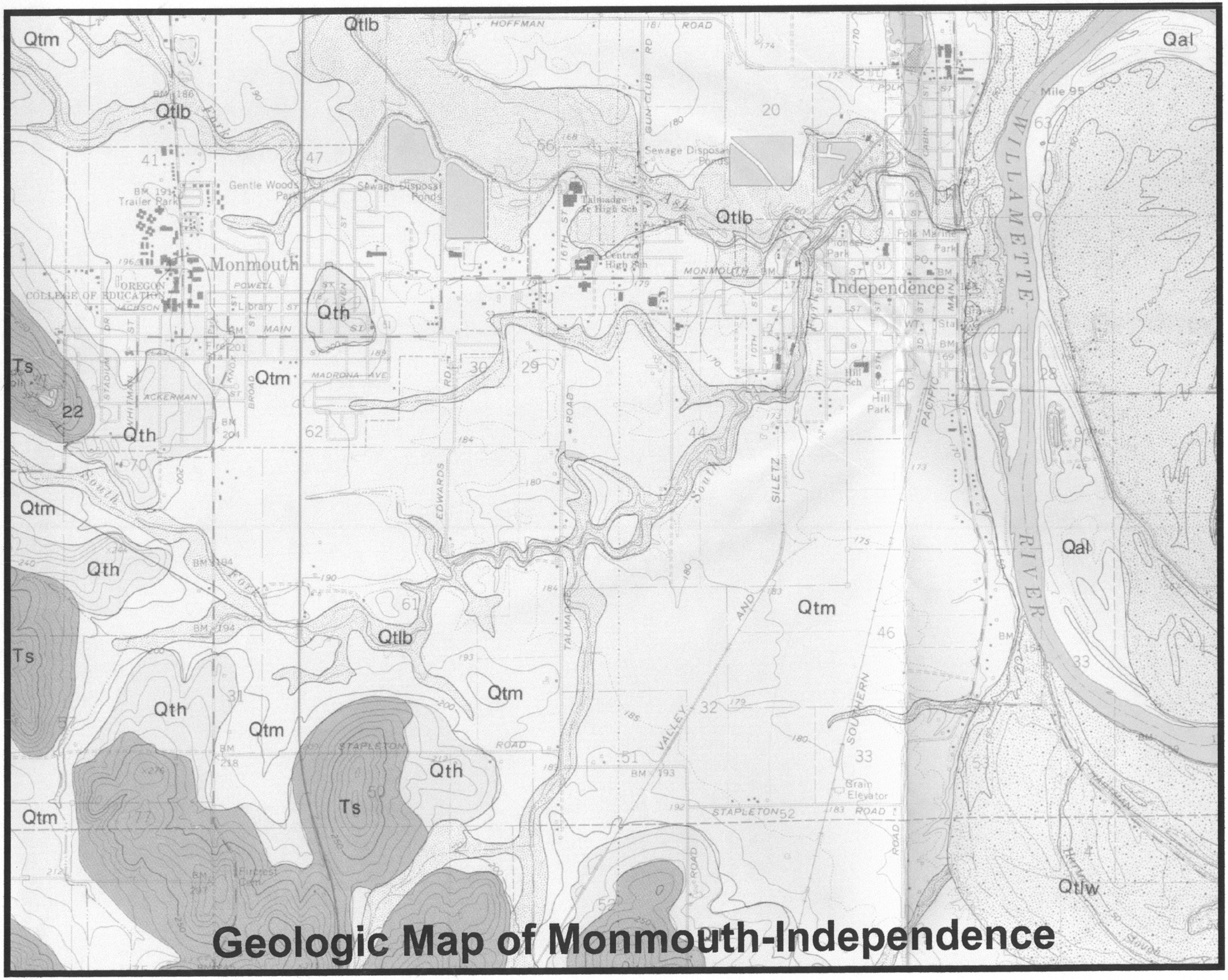


Figure 3. Stratigraphic correlation chart for Tertiary rocks of western Oregon (modified from Yeats and others, 1991).

Geologic Map of Monmouth-Independence



MONMOUTH GEOLOGIC MAP

EXPLANATION

SURFICIAL GEOLOGIC UNITS

Qal — **Recent river alluvium:** *Unconsolidated cobbles, coarse gravel, sand, and some silt and clay within active channels of Willamette River. Generally 15-45 ft thick, consisting of stratified sands and well-rounded pebbles, gravels, and cobbles of primarily basaltic and andesitic composition; often overlain by 3-15 ft of light-brown sand and silt overburden. Characterized by low relief, point-bar and channel-bar deposits; many areas unvegetated, others support dense stands of brush and phreatophytes, such as willows and cottonwoods. Subject to major flooding, critical stream-bank erosion, and lateral channel migration; includes many areas located between 1852 meander line and present channel that illustrate possible extent of future changes*

Qtlw — **Lower terrace deposits of the Willamette River (Quaternary):** *Unconsolidated to semiconsolidated cobbles, gravel, sand, silt, clay, muck, and organic matter of variable thickness (30-50 ft) on the flood plain and lowland terraces immediately above the Recent river alluvium* (**Qal**)*; typically 5-20 ft of light-brown silt and clay or very fine sand overlying 10-45 ft of moderately well-sorted sand and locally cemented gravel. Surface topography characterized by a low, undulating, fluvial surface with abandoned channels, meander scrolls, oxbow lakes, and sloughs; subject to major and local flooding, some catastrophic channel migration of major scale, ponding, and high ground water. Flood-plain soils are predominantly well drained and somewhat excessively drained silty clay loams, silt loams, and sandy loams; good ground-water yields generally of 100-500 gallons per minute*

Qtlt — **Lower terrace deposits of tributary rivers and streams (Quaternary):** *Unconsolidated to semiconsolidated gravel, sand, silt, clay, and organic matter generally 15-30 ft thick on lowland terraces and flood plains immediately above major tributary rivers of the Willamette River. Gravel deposits are very thin to variable in thickness, according to tributary drainage source, generally limited to active stream beds or former meander channels, and located at or near bed rock beneath 20-30 ft of sand, silt, and clay. Somewhat tortuous meandering streams entrenched 15-45 ft, often flowing on Tertiary sedimentary bed rock or semiconsolidated older valley-fill alluvium. Surface topography characterized by a low, undulating fluvial surface of swell and swale relief, abandoned meander loops, and oxbow lakes; subject to high ground water and ponding and major and local flooding; flood-plain soils are predominantly well drained and somewhat excessively drained silty clay loams, silt loams, and sandy loams. Some soft, compressible organic soils of low shear strength may occur locally, particularly within abandoned channels and oxbows. Major stream-bank erosion commonly occurs at outer bends of meander loops by shallow earthflow and slump due to undercutting. Ground-water yields generally small*

Qtlb — **Lower terrace deposits of alluvial bottomlands (Quaternary):** *Flat, moderately to poorly drained areas with soft, organic compressible soils of low shear strength locally; characterized by low relief, ponding, and high ground water. Deposits typically consist of somewhat stratified very fine sands, silty sandy clays, silty clays, and silty clay loams, with slight to moderate plasticity (ML-CL); 4-12 ft thick along bottomlands of interior drainages of low, rolling sedimentary bedrock units. Deposits locally may represent somewhat thicker accumulations of silt and silty clay materials of fluviatile and/or loessal origin derived in part from Willamette Silts. Similar deposits along creeks are associated with deposits of units* **Qtm** *and* **Qth** *and are often modified by ditching and field drainage for agriculture; typical examples are deep (more than 60 in.) clay (CH), silty clay (CH), and silty clay loam (CL or ML) black Bashaw clay soils of Baskett Slough (Rickreall quadrangle). Similar thicknesses of reddish-brown sandy silty material (ML-CH) in basaltic terrain* (**Tcr**)

Qtm — **Middle terrace deposits (Quaternary):** *Semiconsolidated gravel, sand, silt, and clay forming very flat terraces of major extent along the Willamette River. Generally 10-30 ft of light-brown silty clay and interbedded very fine sand and silt (ML or CL-CH) surficial material; believed primarily related to Willamette Silts, including associated glacial erratics consisting of tiny fragments and pebbles up to boulders greater than 4 ft in diameter. Soils somewhat poorly drained and poorly drained silt loams and silty clay loams to moderately well-drained and well-drained silt loams subject to seasonal high ground water and ponding. Sand and gravel (GP, SM), where present, usually occur below 30 ft depth; locally more abundant near Monmouth-Independence and in the lower part of Ash Creek. Total thickness 0-85 ft, but often only 40-50 ft; within Rickreall 7½-minute quadrangle, 15-35 ft of brown clay or silt generally occurs above several to 30 ft of gravelly clay, black sands, and gravels. Generally small ground-water yields, except near Monmouth-Independence, where sand and gravel may yield up to 300 gallons per minute*

Qlg — **Linn gravel (Quaternary-upper Pleistocene):** *Stratified fine to coarse fluvial gravels deposited as an alluvial fan in the Stayton-Turner-Salem areas during an early stage of the Santiam River; of limited extent within the map area; uppermost few feet of gravels extensively oxidized and weathered, often chalky; thickness ranges from 30-40 ft to possibly as much as 300 ft. Regionally, the upper foot or so of gravel is cemented by an impermeable clay pan locally, which restricts drainage. Composition of gravels (mostly basalt, but also andesite, dacite, rhyolite, quartz, and diorite) essentially uniform. Within map area near Salem, soils are well drained and somewhat poorly drained gravelly silt loam and gravelly loam. Extensively utilized as source of sand and gravel. Good ground-water yields greater than 100 gallons per minute*

Qth — **Higher terrace deposits (Quaternary-middle Pleistocene):** *Generally semiconsolidated ligh
and clay of variable thickness (3-15 ft) on higher terraces and remnants of old higher t
sedimentary bedrock foothills; mantled by moderately well-drained and well-drained silt l
colluvium, slope wash, and alluvial fan deposits near sedimentary bedrock foothills; d
transitional with pediments. Material generally similar to unit* **Qtm**, *particularly in West
glacial erratics related to Willamette Silt but also some gravelly alluvium. Some higher terra
side of Salem Hills between Salem and Illahe Hill not shown due to scale. Also includes weath
cobbles and gravels which extend beyond the study area west of Rickreall (8-10 ft thick) a
margin of Sidney quadrangle (10-50? ft thick), where they are equivalent to the Leffler gravel
These deposits also mantled by 3-15 ft of light-brown silt loam and silty clay loam soils. Ge
ground-water yield*

BEDROCK GEOLOGIC UNITS

Tcr — **Columbia River Basalt Group (Miocene):** *Medium-gray to black, fine-grained, even-textur
phyritic basalt; unweathered flows generally dense, fairly crystalline, exhibiting massive colun
base to diced or hackly jointing in entablature. Unit consists of weathered and unweathered b
with interflow zones characterized by vesicular flow-top breccia, ash, and baked soils. Ma
generally ranges 400-600 ft, with thickness greatly modified by erosion and weathering
individual flows range from 40 ft to more than 100 ft in thickness.*

*Formations recognized within the Yakima Basalt Subgroup (Beeson, 1980, personal commu
(1) Grande Ronde Basalt: two to four "low Mg" N_2 flows, including one to two "Winter Wat
(typical exposure at Dairy Queen, West Salem); one to two thick "low Mg" flow(s), 100-150 ft
quarried throughout map area; one to two flow(s) of "high Mg" N_2 basalt, generally deeply wea
above the "Winter Water" flow(s); and (2) a thinner layer of younger Wanapum Basalt, represent
flow(s) of the Frenchman Springs Member, observed only in South Salem within the study area
occurs outside the map area in the vicinity of Turner.*

*Weathered flows consist of reddish-brown to grayish-brown, crumbly to medium-dense basa
variable and believed related to individual basalt flows; some exposures are altered to red clay (l
of 30 ft, and occasionally as deep as 60-175 ft, while others are only slightly weathered at surfac
in Salem Hills (generally between 500-900 ft elevation within area bounded by Pringle Scho
Jackson Hill) show extensive laterization which has resulted in deposits of bauxite (Corcoran an
Soils are reddish-brown, well-drained silty clay loams and gravelly silty clay loams. Unit yiel
quantities of ground water from permeable rubbly zones between flows*

Ti — **Intrusive rocks (Oligocene):** *Dense basalt, andesite, and gabbro dikes and sills of very limited
map area (Roby Hill, Sidney quadrangle); Roby Hill quarry geochemically not part of Colum
Group (Beeson, 1980, personal communication). Another limited exposure of porphyritic intr
flow rock, with vertical columns 1-2 ft in diameter in contact with claystone along east bank of L
near Buena Vista Road (river mile 3.2). Presumed post-Eocene (Oligocene?) age (Helm and*

Toe — **Eocene-Oligocene sedimentary rock (middle and lower Oligocene and upper Eocene):** *Equival
marine sedimentary rocks (Tts) of Baldwin and others (1955), Illahe tuffs (Tit) of Mundor
Formation (Ti) of Thayer (1939), Eocene-Oligocene marine sedimentary rocks (Tm) of Pr
undifferentiated Tertiary rocks (Tu) of Gonthier (in press). Consists of two lithologic and faun
Willamette River (Baldwin and others, 1955) but undifferentiated in this map due to poor expos
light-gray to tan sandy tuffaceous siltstone equivalent in age to early Oligocene Keasey For
section near border of Amity-Rickreall 7½-minute quadrangles, where approximately 1,000 ft th
Oligocene strata well exposed in Yamhill River near Yamhill locks, where steeply dipping and co
Younger unit is fine- to coarse-grained tuffaceous sandstone equivalent in age to middle Olig
Bluff Formation; basal stratum approximately 150 ft of dark-gray, coarse-grained, calcareous
sandstone, chiefly composed of detrital igneous rock fragments. White, fine-grained, massively
pumiceous volcanic glass approximately 250 ft thick exposed for 3 mi along hillside south of Fin
quadrangle); good exposures of pebbly tuff, tuffaceous conglomerate, and fine-grained platy tu
Hill Road in Sidney 7½-minute quadrangle.*

*Tuffaceous marine sandstone and siltstone of Oligocene sedimentary rock correspond to Ol
Formation described by Hickman (1969), which contains early to middle Oligocene molluscan
foraminiferal analyses (McKeel, 1980) of oil and gas wells within the study area indicate unit
2,000 ft of upper Refugian and Refugian strata (Reichhold-Merrill #1, Sidney quadrangle) an
basal siltstone, claystone, and shale of late Narizian (provincial West Coast late Eocene) age (R
and Reichhold-Merrill #1)*

Ts — **Upper Eocene sandstone:** *Equivalent to Helmick beds (Thb) of Mundorff (1939) and Spencer (
(in press); very fine- to medium-grained, thinly laminated (fissile) to thin-bedded, as well as pr
massive, light-gray to yellowish-brown moderately well-sorted micaceous, calcareous, lithic
(tuffaceous) sandstones; frequently interbedded with fine-grained marine tuffaceous siltstone, t
clay shale, and claystone; comprised of almost equal proportions of quartz, feldspar, and
cemented with calcite (in concretions); minor constituents include approximately 2% glauc
(biotite, muscovite, and chlorite), and less than 1% authigenic pyrite; well compacted; carbon
consisting of plant stems, leaves, and other organic fragments common; calcareous concretions,
containing carbonaceous material, prominent along Willamette River south of Buena Vista (M
rangle); pebbly lenses, abundant organic matter, and paleoecology indicate strandline environm
from chiefly volcanic terrain. Weathered outcrops of massive, very fine- to medium-grained s
friable, ranging in color from white to yellowish-brown, pale-brown, or yellowish-orange.*

*According to McKeel (1980), this unit is bracketed by upper Narizian strata in the Reichho
(Amity quadrangle), by upper Narizian and Narizian strata in the Reserve-Bruer #1 well (Ami
and by upper Narizian strata in the Reichhold-Merrill #1 well (Salem West quadrangle). Ave
about 800 ft*

Ty — **Yamhill Formation (middle and upper Eocene):** *Medium- to dark-gray, massive to faintly bedd
tuffaceous shale and siltstone. Occasional beds of medium-gray to greenish-gray, fossilifero
sandstone; minor limestone concretions.*

*According to McKeel (1980), this unit contains 2,000-3,000 ft of Narizian and lower Narizia
Reichhold-Finn #1 and Reserve-Bruer #1 wells, located in the Amity quadrangle. Shown only in th*

OTHER SYMBOLS

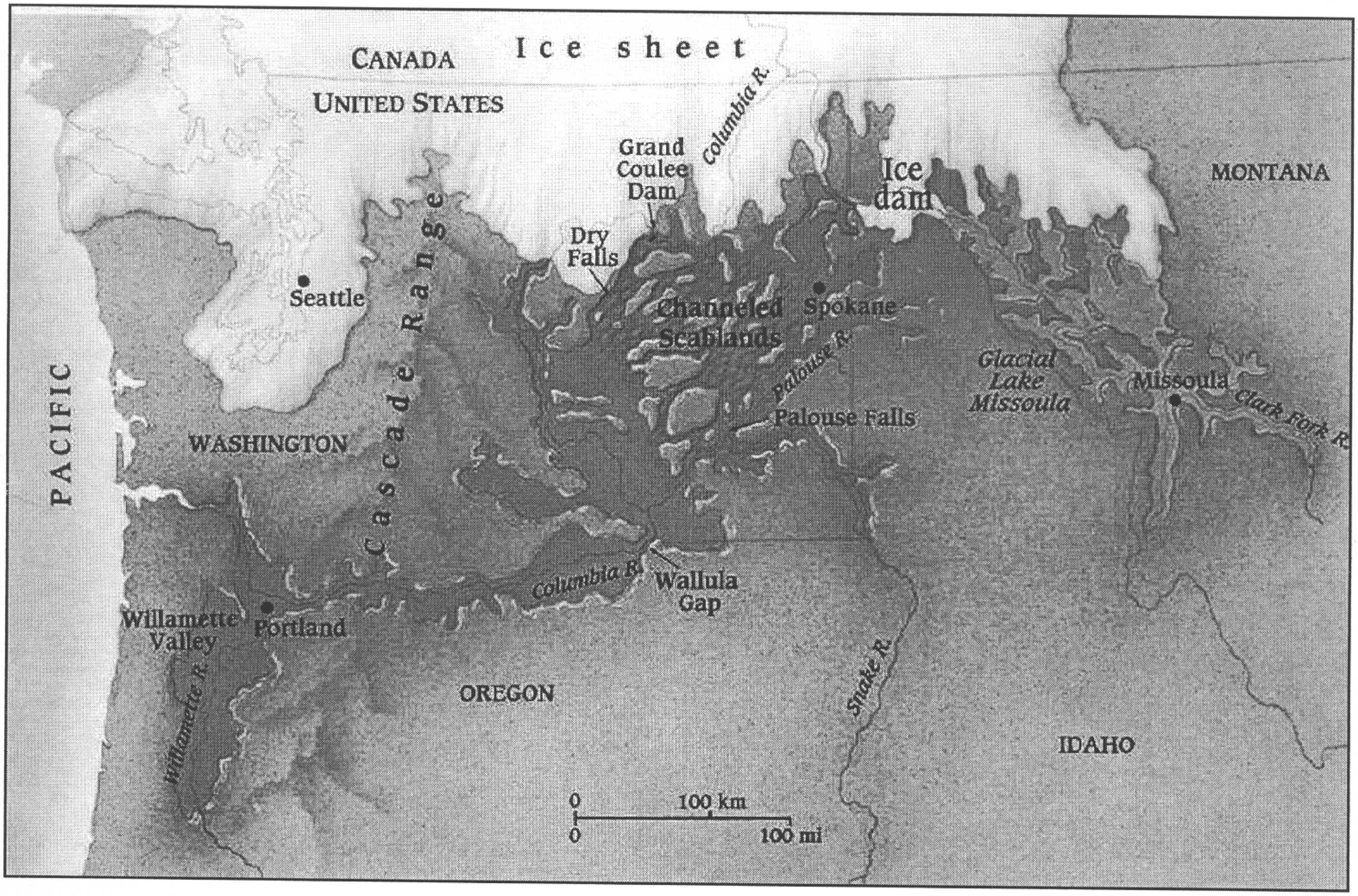
Lineament: *Selected major lineaments identified from 1:76,000 false-color infrared aerial phot
Army Corps of Engineers, 1978), orthophotoquads, and topographic maps. Features include a
major escarpments, concentric curvilinear drainages, aligned drainages across saddles, and par
ted are short linear segments along drainages of less than 1 mi length; general trends NE and
lineament features observed in western Oregon*

Landslide topography: *Large areas of deep bedrock failure characterized by irregular topogra
stratigraphy, overall anomalous moderate to shallow slope, prominent arcuate headscarps, b
blocks, springs, sag ponds, and disrupted drainage patterns. Most prominent along west side of S
south and west side of Eola Hills, where undercutting of soft marine sediments (Eocene to Oligoce
rock, unit* **Toe**) *has resulted in massive landsliding of blocks of more resistant unit* **Tcr**. *Subject
debris avalanche along oversteepened escarpments and to slump in some areas (bowed and tip*

Deep bedrock slides within upper Eocene sedimentary rock (**Ts**) *within Monmouth quadra
smaller than those associated with units* **Tcr/Toe**; *characterized by small knobby blocks of sea
within general hummocky terrain*

Landslide scarp: *Characterized by steep cliff, often arcuate, and backward-tilted block below*

bc — **Basaltic colluvium and/or landslide debris:** *Generally reddish-yellow or reddish-brown bas
and/or landslide debris, deeply weathered, overlying Oligocene sedimentary rock* (**Toe**), *ge
landslide topography or beneath steep cliffs capped by Columbia River Basalt Group* (**Tcr**)*; includ
and some earthflow and debris-flow topography. Probably generally 6-35 ft thick but may include
basalt of greater thickness. Soils well-drained silty clay loams and gravelly silty clay loams over
and clay*

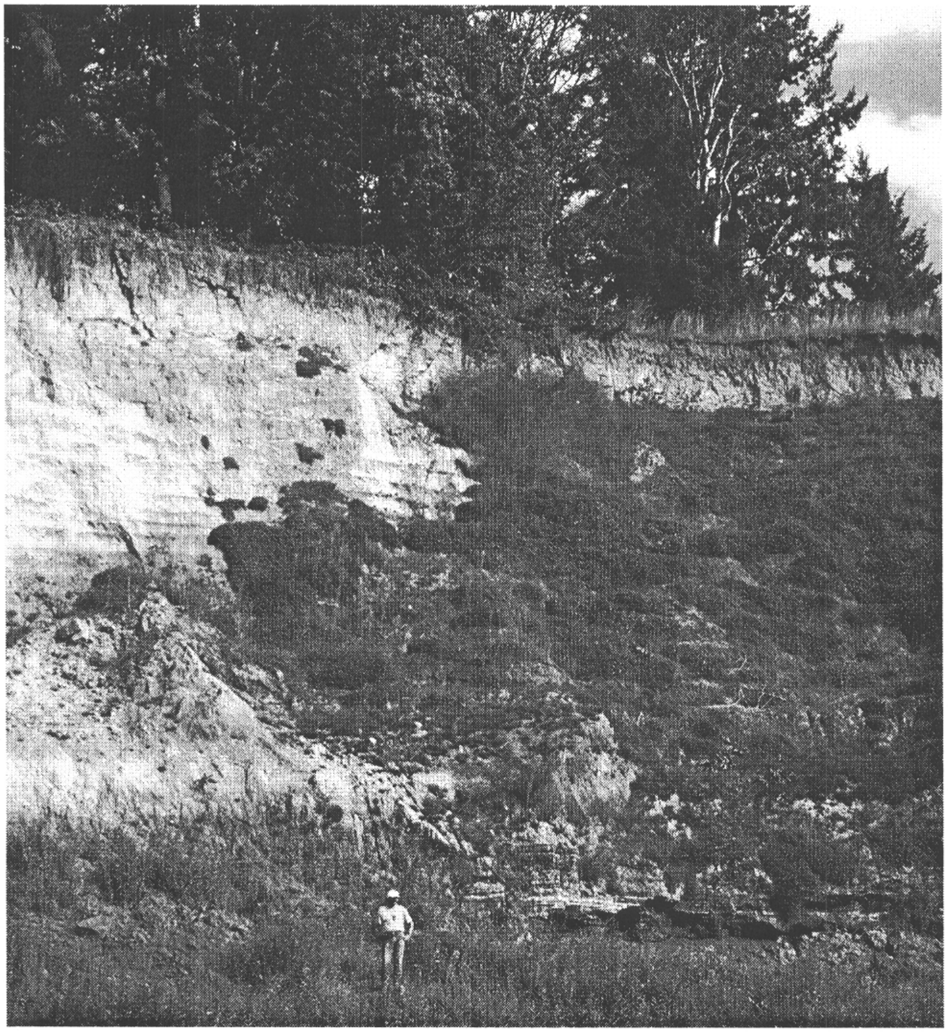


The Missoula Floods
- 15-12ka
- perhaps 100 floods
- 500 mi^3 of water, 40 hrs.
- 50 million cfs (3500 CR)

Jim O'Connor, 2003

15

Missoula Flood Deposits



Jim O'Connor, 2003

Up to 30 m thick in the northern valley.
Deposited in as many as 40 beds up to 2 m thick.
Deposited between 15-12 ka.
Contains ice-rafted erratics.

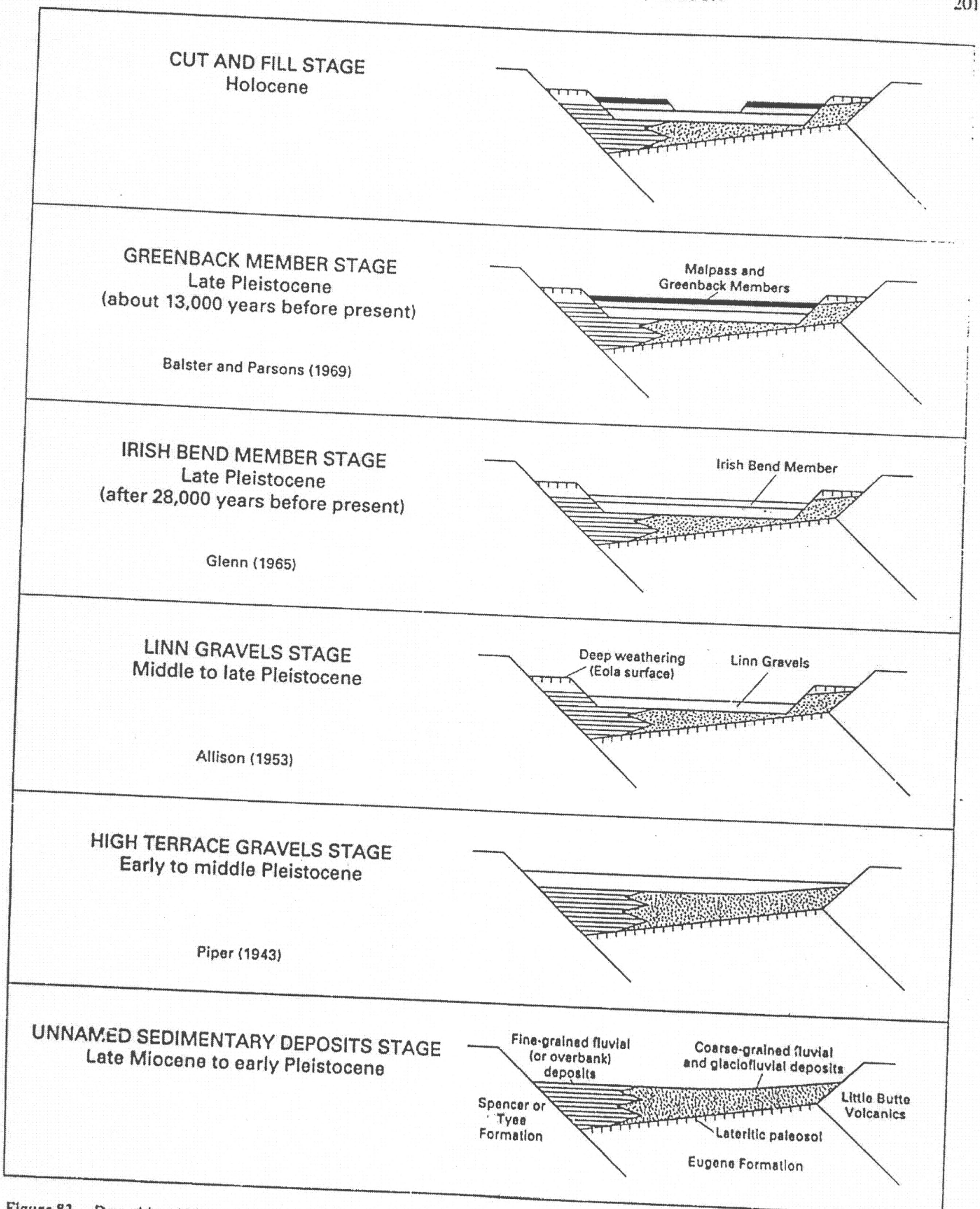
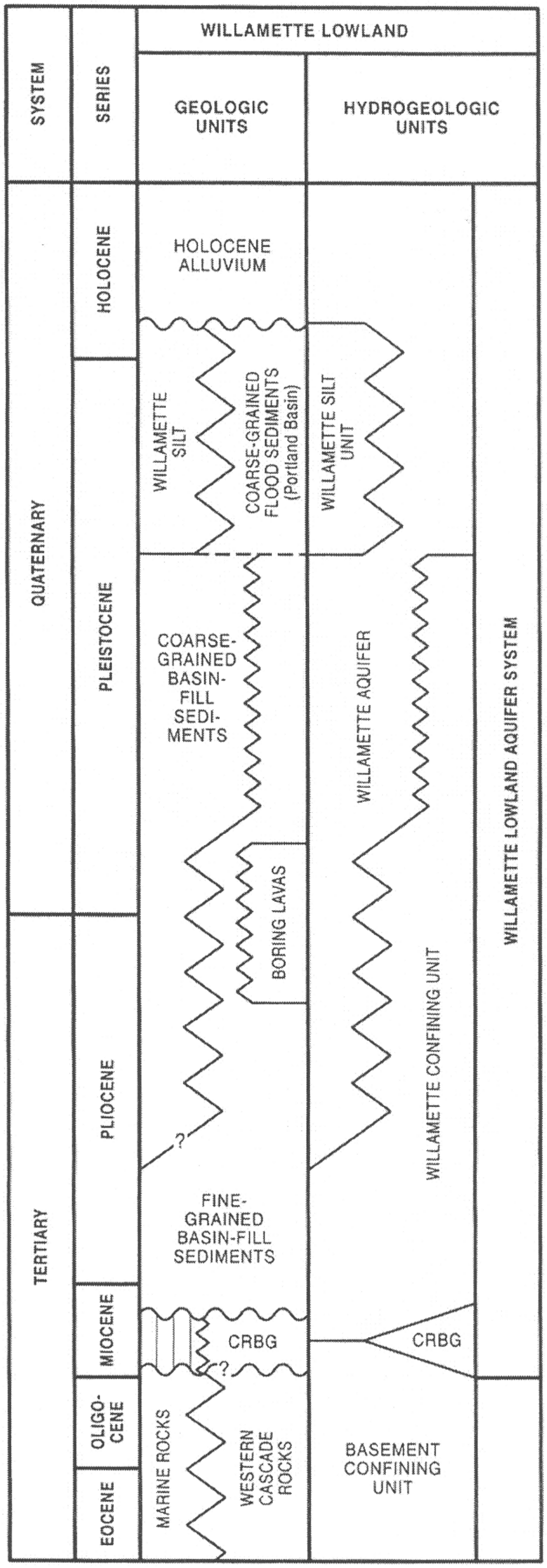


Figure 83. Depositional history of the southern Willamette Valley, Oregon, after Miocene time. Modified from Roberts (1984).



NOTE: CRBG = COLUMBIA RIVER BASALT GROUP

FIGURE 7.—Regional relation between generalized geologic units and hydrogeologic units in the Willamette Lowland.

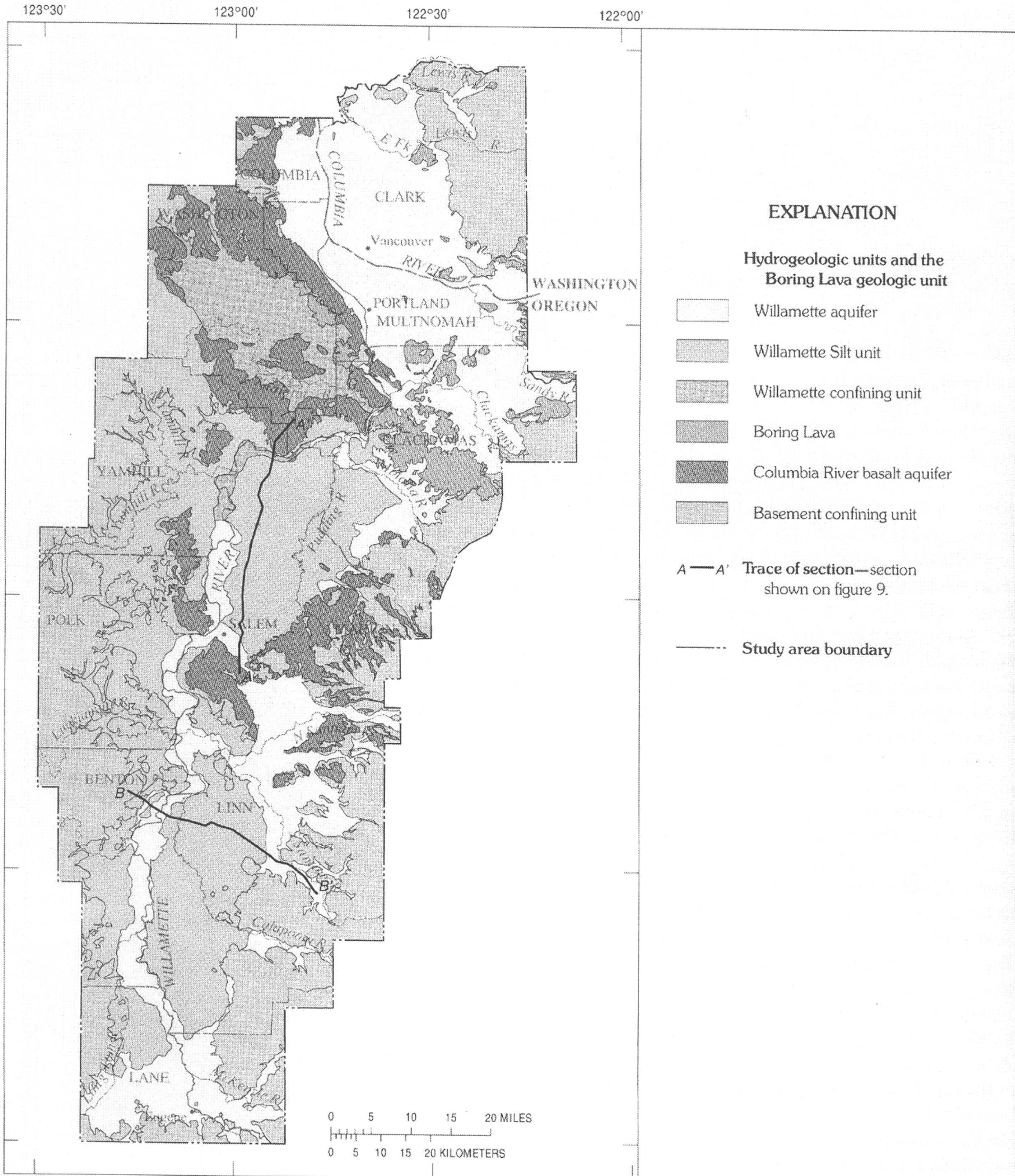


FIGURE 8.—Surficial extent of hydrogeologic units and the Boring Lava.

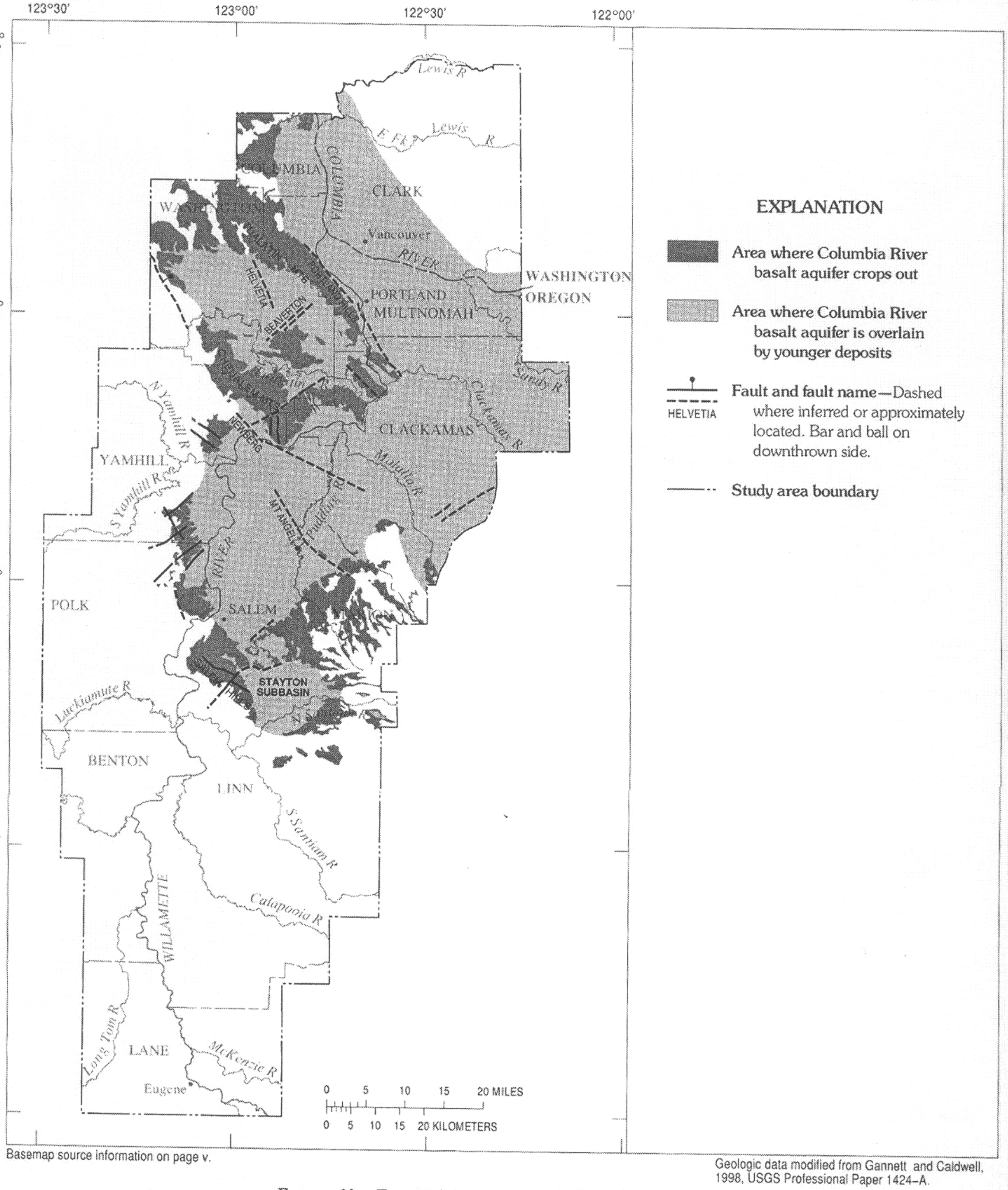
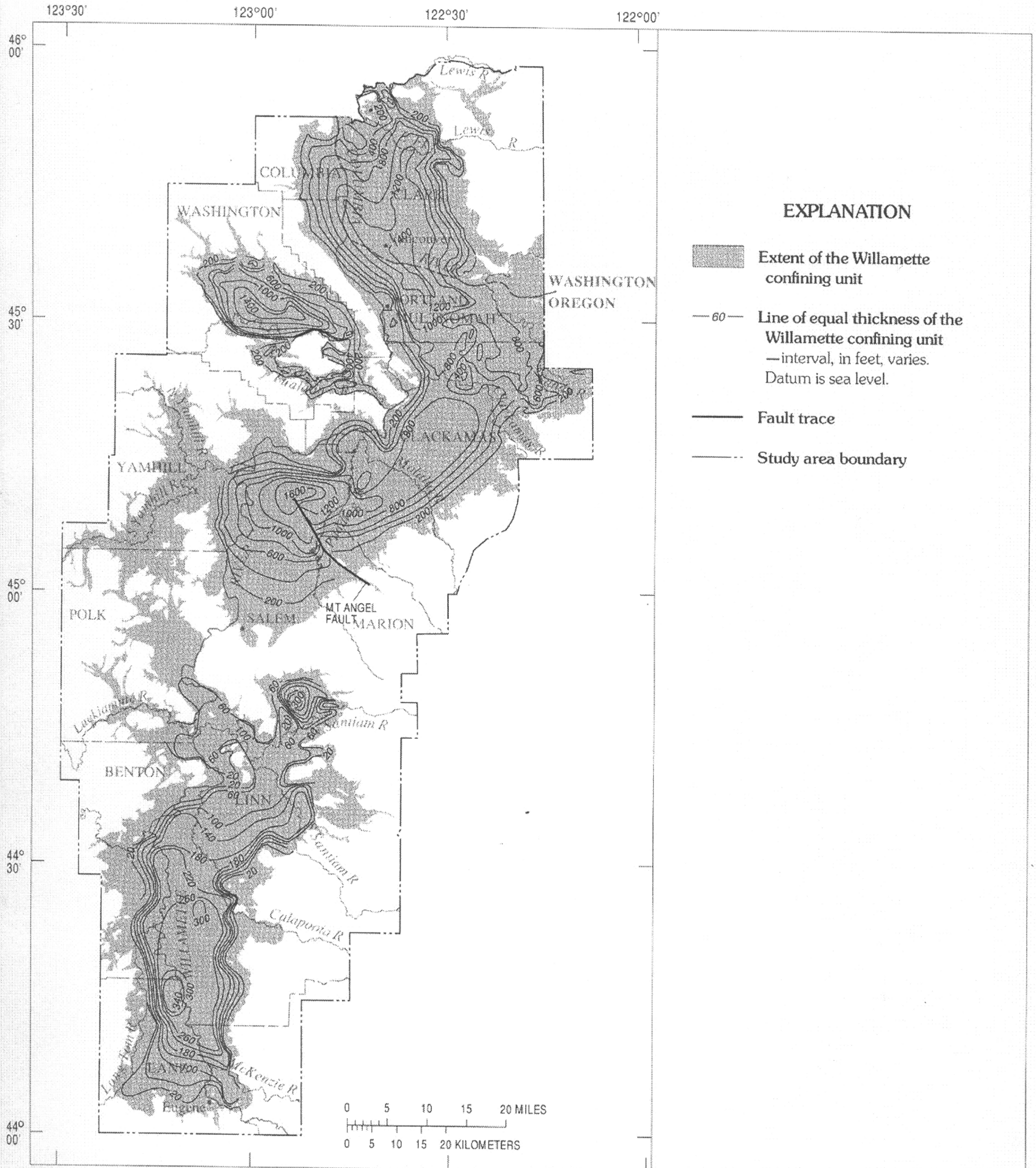


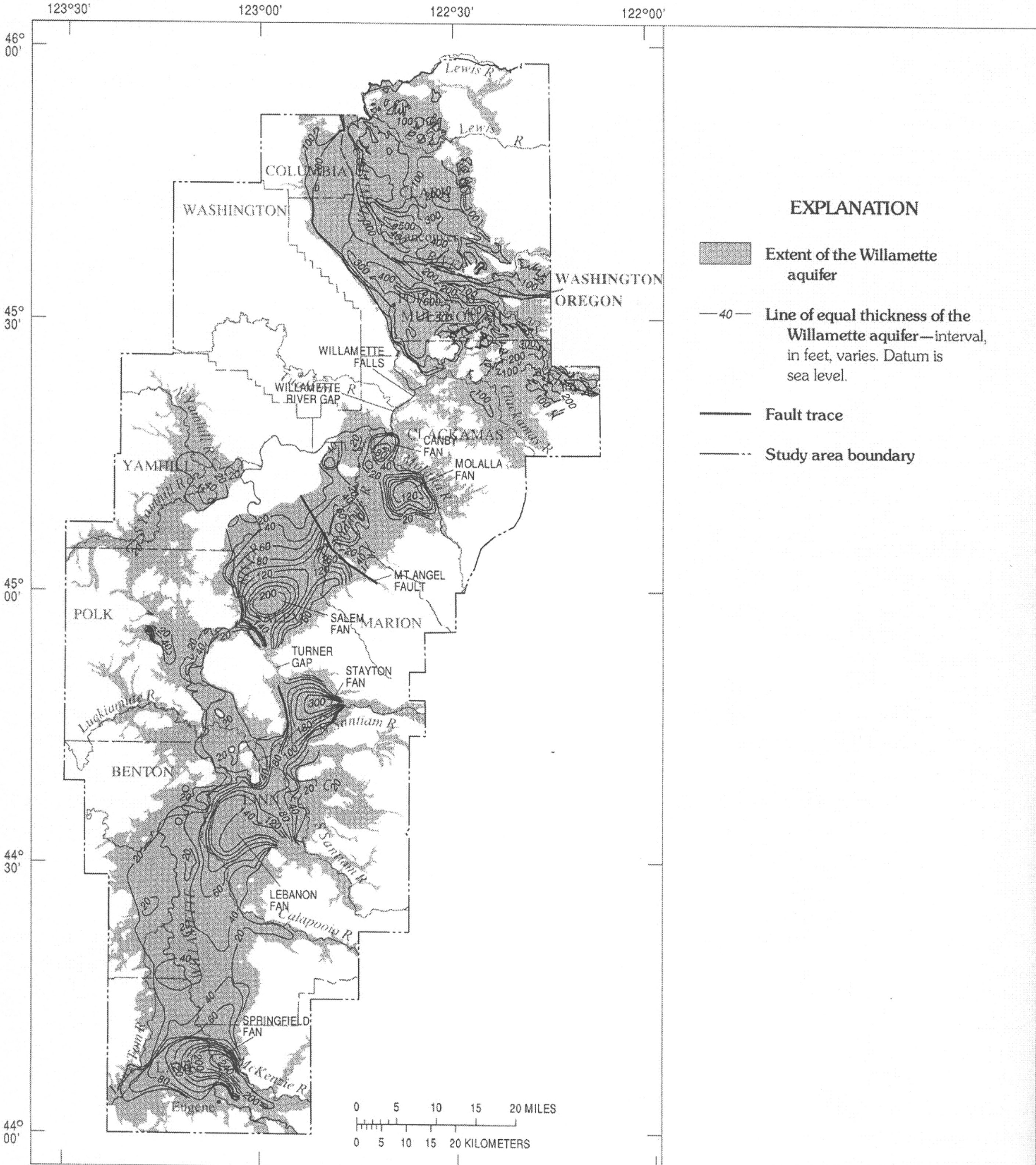
FIGURE 10.—Extent of the Columbia River basalt aquifer.



Basemap source information on page v.

Geologic data modified from Gannett and Caldwell, 1998, USGS Professional Paper 1424–A.

FIGURE 12.—Extent and thickness of the Willamette confining unit.



Basemap source information on page v.

Geologic data modified from Gannett and Caldwell, 1998, USGS Professional Paper 1424-A.

FIGURE 13.—Extent and thickness of the Willamette aquifer.

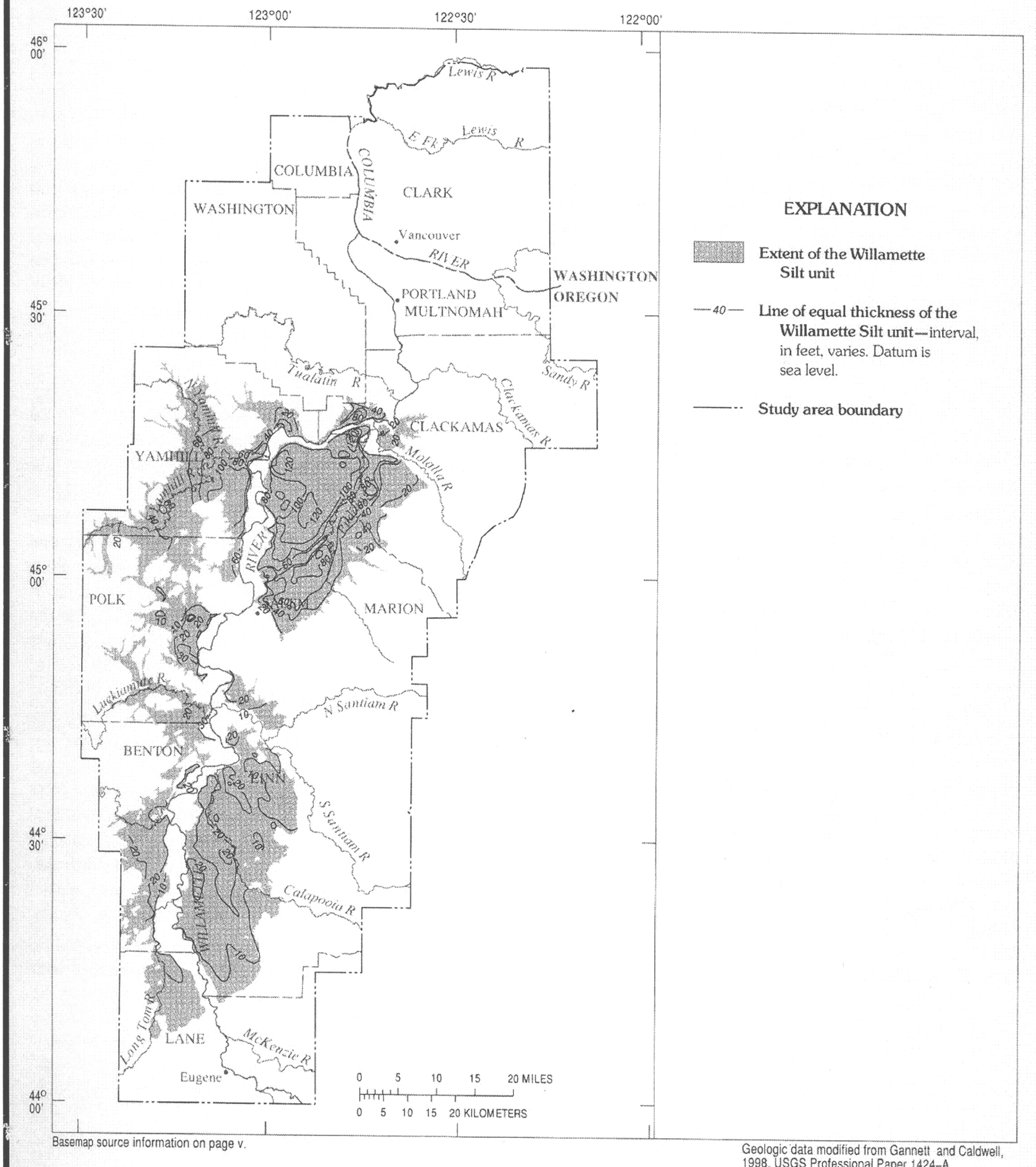
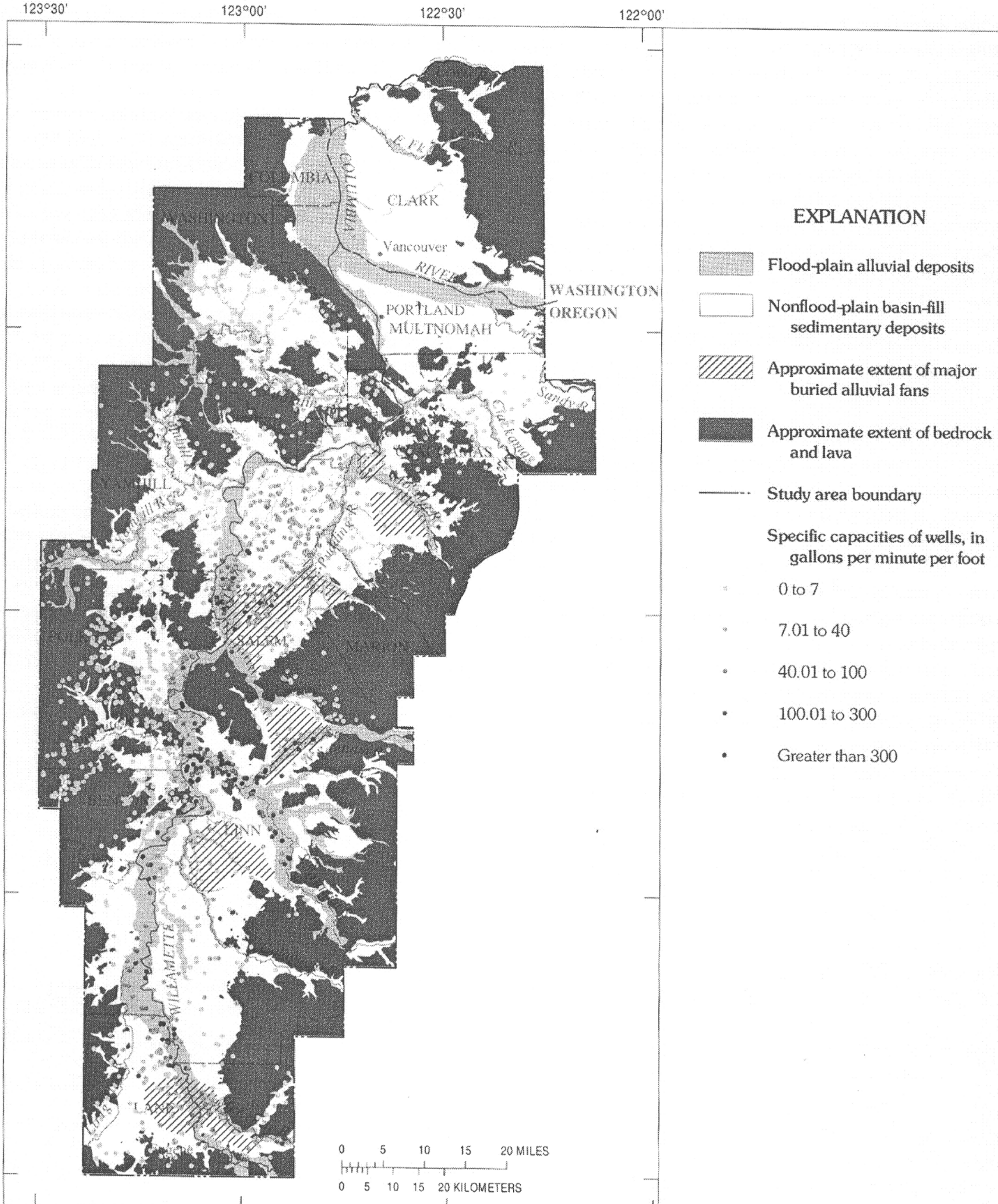


FIGURE 14.—Extent and thickness of the Willamette Silt unit.

TABLE 3.—*Estimates of hydraulic conductivity for the regional hydrogeologic units, Willamette Lowland, Oregon and Washington*
[--, unknown]

Hydrogeologic unit	Number of values	Hydraulic conductivity, in feet per day	
		Median	Range
Willamette Silt unit	5	0.1	0.01–8
Willamette aquifer	[1]90	240	0.03–7,000
	[2]1,178	110	3–440
	[3]268	7	0.03–1,500
	[4]2,094	15	3–200
Willamette confining unit	[5]113	2	0.01–90
Columbia River basalt aquifer[6]	--	1	0.001–750



Basemap source information on page v.

Geologic data modified from Gannett and 1998, USGS Professional Paper 1424-A.

FIGURE 15.—Distribution of specific-capacity values for wells in the Willamette Lowland.

#25

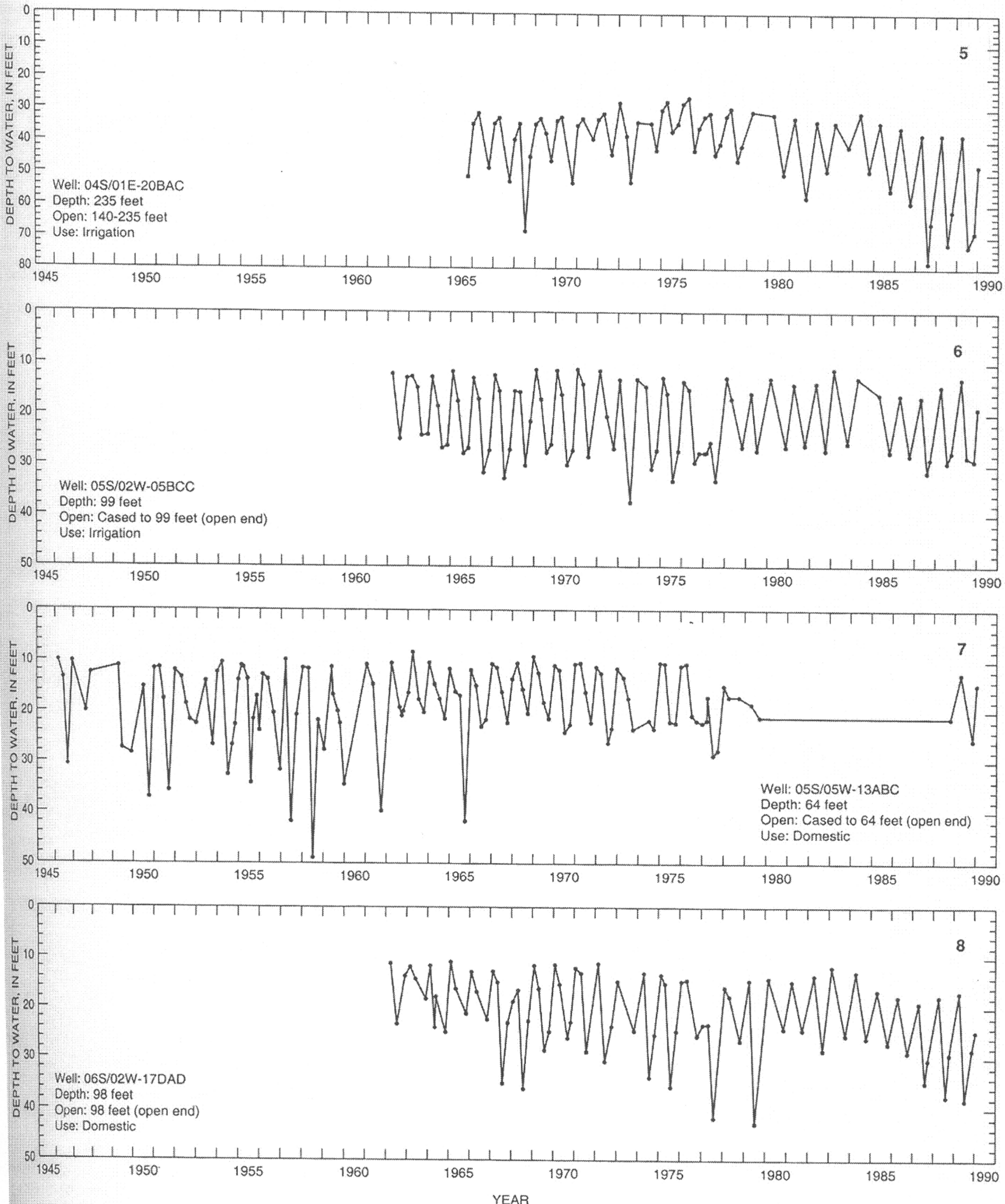


FIGURE 18b.—Water levels in wells completed in the Willamette aquifer, central Willamette Valley. Graph number (1-16) is also well number on figure 17.

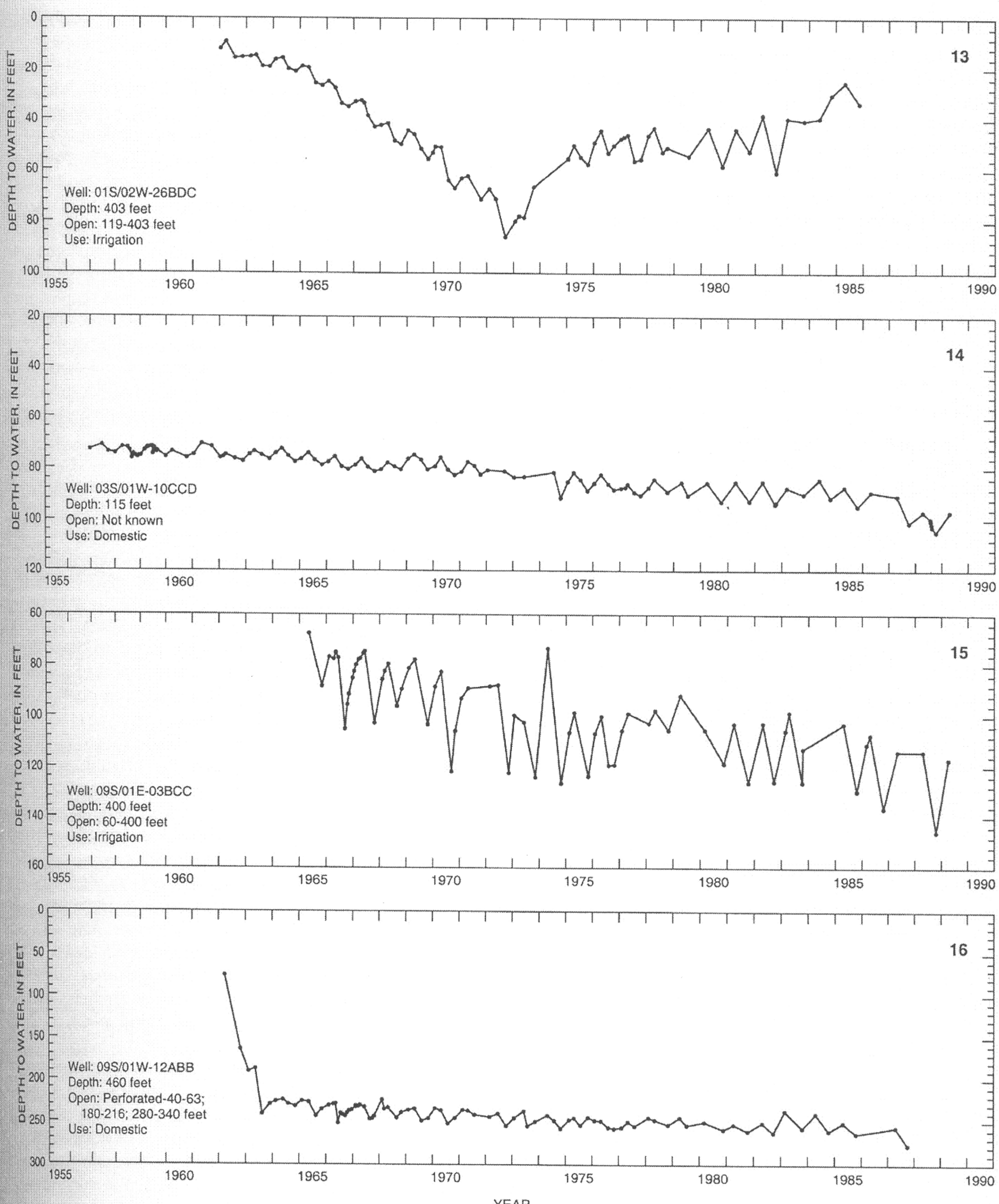


FIGURE 18d.—Water levels in wells completed in the Columbia River basalt aquifer. Graph number (1-16) is also well number on figure 17.

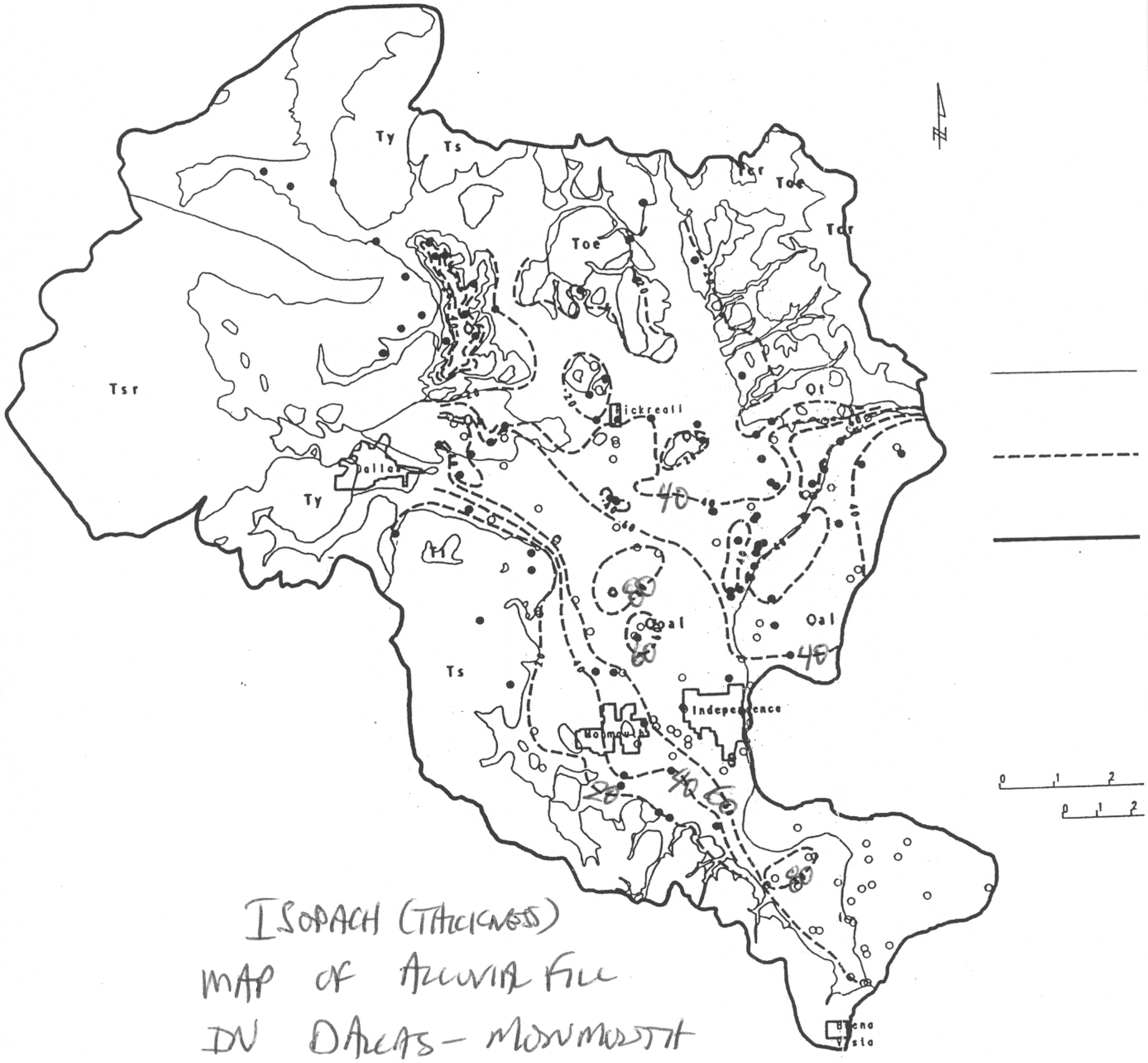
TABLE VII

HYDROGEOLOGIC CHARACTERISTICS OF THE GEOLOGIC/AQUIFER UNITS

AQUIFER	WELL DEPTH (ft) MEAN	STATIC WATER LEVEL (ft) MEAN	YIELD (gpm) MEAN	YIELD (gpm) MED.	SPECIFIC CAPACITY (gpm/ft) no. of wells	LOW	HIGH	MEAN	MED.	MED.*	HYDR.* CONDUC. (ft/d) MED.	STORAGE* COEFFICIENT	RE-* CHARGE (in)
Qal	48	19.5	302	75	36	1.10	607.1	59.9	40.0	40.0	170.0	0.2	8–15
Qoal	68	21.1	79	30	80	0.02	175.0	7.3	2.0	0.59	19.0	.001–0.2	2–5
Qt	95	12.8	13	8	13	0.04	2.4	0.5	0.3				
Toe	119	34.8	15	10	20	0.01	2.3	0.5	0.2	0.10	0.3	.00001–.001	2–5
Ts	134	37.9	11	8	41	0.01	30.0	1.6	0.1				
Ty	174	22.1	22	9	33	0.01	1.7	0.3	0.1				
Tsr	171	36.4	18	8	16	0.01	12.5	1.1	0.1	0.11	0.2	.00001–.001	2–5

*From Gonthier (1983)

The specific capacity of a well is defined as the pumping rate divided by the drawdown in the well (Freeze an



ISOPACH (THICKNESS) MAP OF ALLUVIAL FILL IN DALLAS-MONMOUTH AREA (THICKNESS in ft, C.I. =20ft)

Figure 7. Isopach map of alluvial f

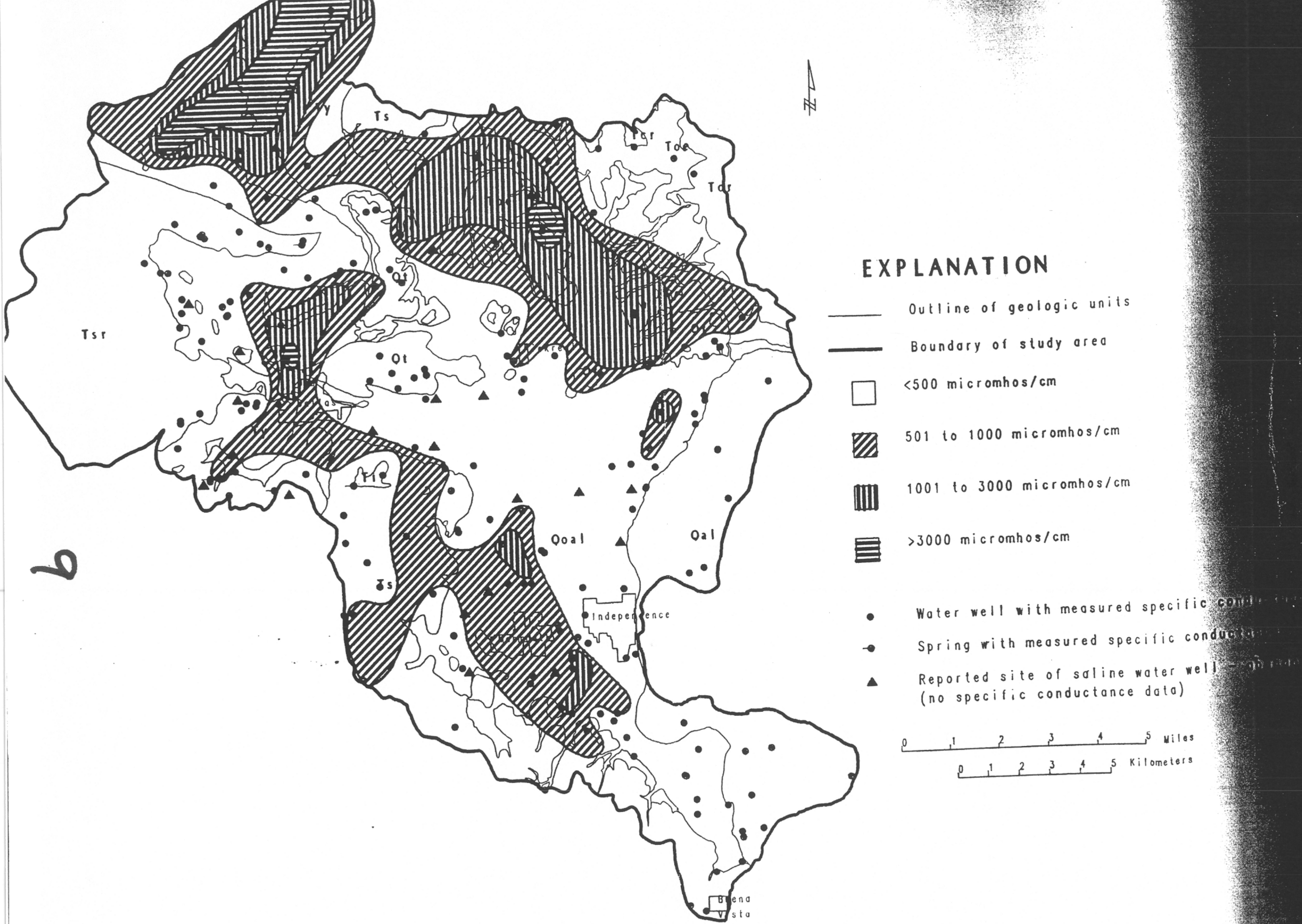


Figure 26. Groundwater salinity hazard map based on specific conductance measurements.

saline spring (6S/5W-21cad1), the oil and gas well (6S/4W-6bd), and ocean water plot below the best-fit line representing the more dilute waters.

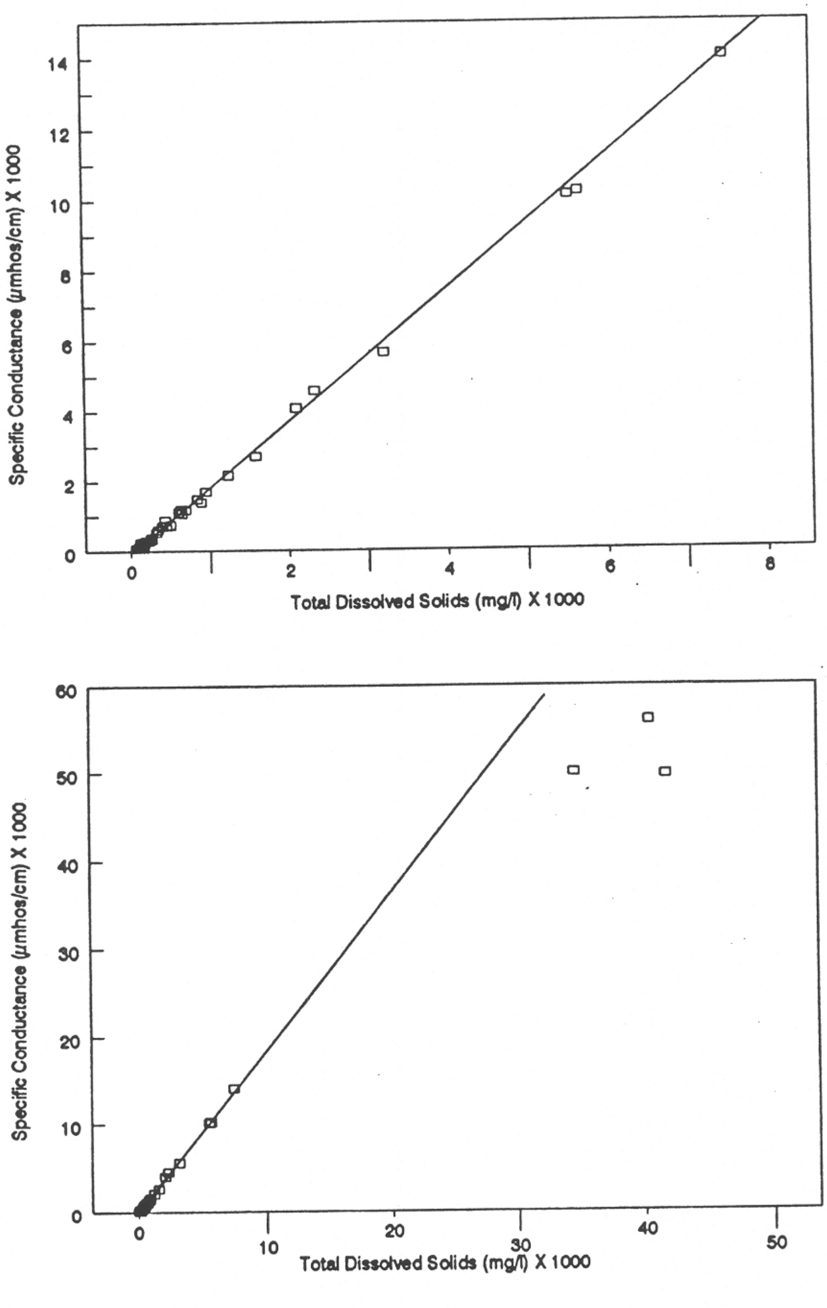


Figure 25. Plots of TDS versus specific conductance for Dallas-Monmouth area groundwater and seawater.