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LATE PLEISTOCENE SEDIMENTS AND FLOODS IN THE WILLAMETTE VALLEY

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Continuation

The first portion of this article was printed in the November ORE BIN, v. 40, no. 11. In it, Dr. Allison outlined diverse interpretations, including his own of multiple late Pleistocene catastrophic floods, of the origins of sediments found in the Portland area, Tualatin Valley, Willamette Valley, and Willamette Lake.

Figure numbers in this issue resume from the November segment, beginning with Figure 16. The complete list of references for both articles appears at the end of this final installment.

Late Phase Erosion and Associated Deposits

The Spokane Flood produced many effects in the Willamette Valley. The erosional channels near Rocky Butte (Figure 2) are especially noteworthy. One, 20 to 50 ft deep, leaves the Columbia River trench near Fairview, Oregon, and separates the 360-ft Troutdale-Gresham terrace remnant from the 300-ft part of the terrace east of Rocky Butte. This channel continues southwestward nearly 10 mi across the Portland Gravels to the southwestern edge of the terrace. The Spokane Flood picked up gravel and sand en route and presumably deposited it in the Willamette and Clackamas River channelways, from which it was later largely removed, probably by ordinary stream erosion.

Below an erosional scarp along the northern edge of Mill Plain east of Vancouver is a long tract, called Fourth Plains, eroded by flood waters that poured from the Columbia River through the channel now occupied by Lackamas Lake (Figures 6 and 8). The flood removed at least 100 ft of gravel and sand from much of the Fourth Plains area. Lag boulders lie on the channel bottom.

In a belt 3 to 6 mi north-northeast from downtown Vancouver (Figure 8), where the terrace consisted mostly of sand, flood erosion produced a complex of multiple channels and elongate residual ridges (Allison, 1933, p. 717-718; Trimble, 1963, p. 62). The ridges are not bars, as Bretz once thought (1925, p. 254). This large Fourth Plains channel, however, may have been eroded by a flood later and lower than the Spokane Flood.

The Spokane Flood surged westward through the Tualatin River and Lake Oswego channels and, upon reaching the wide-open portion of the Tualatin Valley, deposited loose, poorly sorted, rubbly and bouldery gravel and sand (Figure 16). Direction of flow is indicated by westward-slanting foreset bedding in the rubbly gravel (Schlicker and Deacon, 1967, p. 32-35) and by channels in previous sand and silt deposits farther west (Lowry and Baldwin, 1952, p. 19-20).

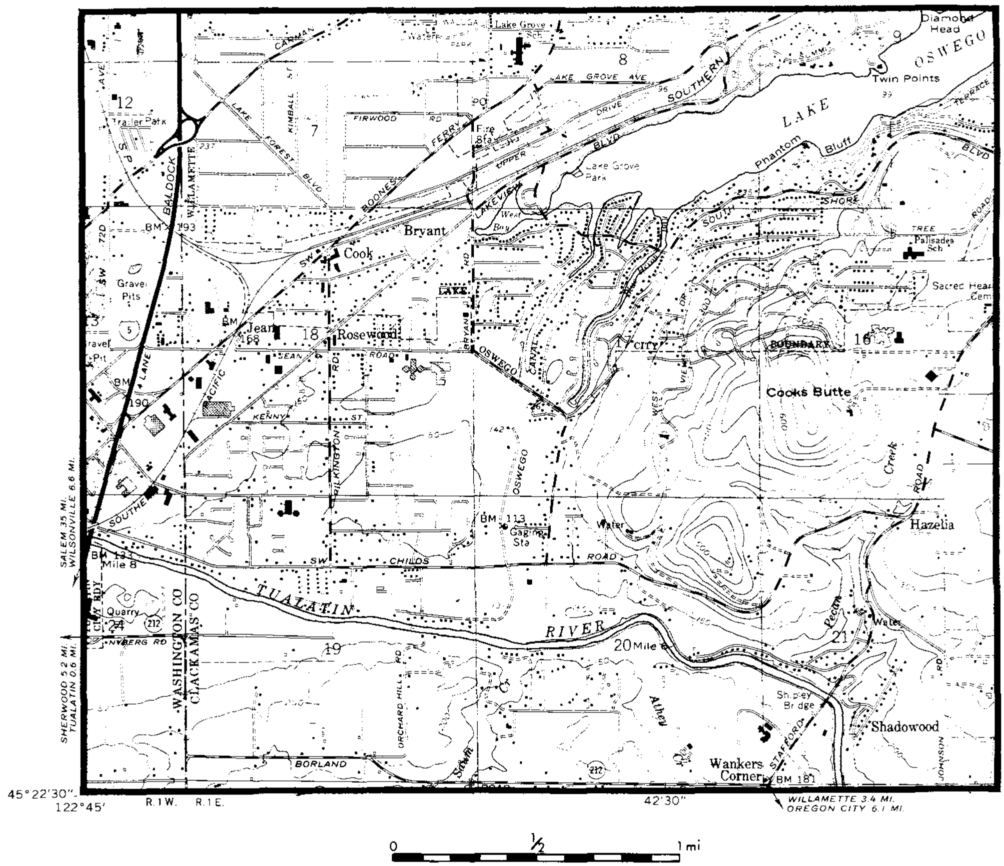

Figure 16. Southwest corner of Lake Oswego Quadrangle (contour interval 10 ft), showing Lake Oswego and Tualatin River routes used by Spokane Flood pouring into Tualatin Valley. Gravel pits along west edge of map are in ill-sorted, rubbly deposits which have west-slanting foresets.

The flood level in the Tualatin Valley rose high enough to spill with great force across the divide separating the Tualatin and Willamette drainage basins. This vigorous overflow southward across the divide scoured multiple channels in the basaltic bed rock, dug small rock-bound basins, and left rock knobs barren of soil (Allison, 1932; Glenn, 1965, p. 155), forming a topography in the Rock Creek-Tonquin area (Figure 17) that is a miniature replica of the well-known scabland in eastern Washington. The divide, of unknown preflood elevation, was lowered locally to a little less than 150 ft above sea level. The coarse products of erosion were dumped over the north side of the Willamette River channel at Wilsonville as poorly sorted, bouldery rubble with south-slanting foresets. Much of this material was removed and used locally in the construction of the I-5 freeway. The onrushing flood also eroded the northern edge of the early-phase terrace south of the Willamette River. Part of the sands and silts settled along the valley bottoms of the Willamette River and its tributaries.

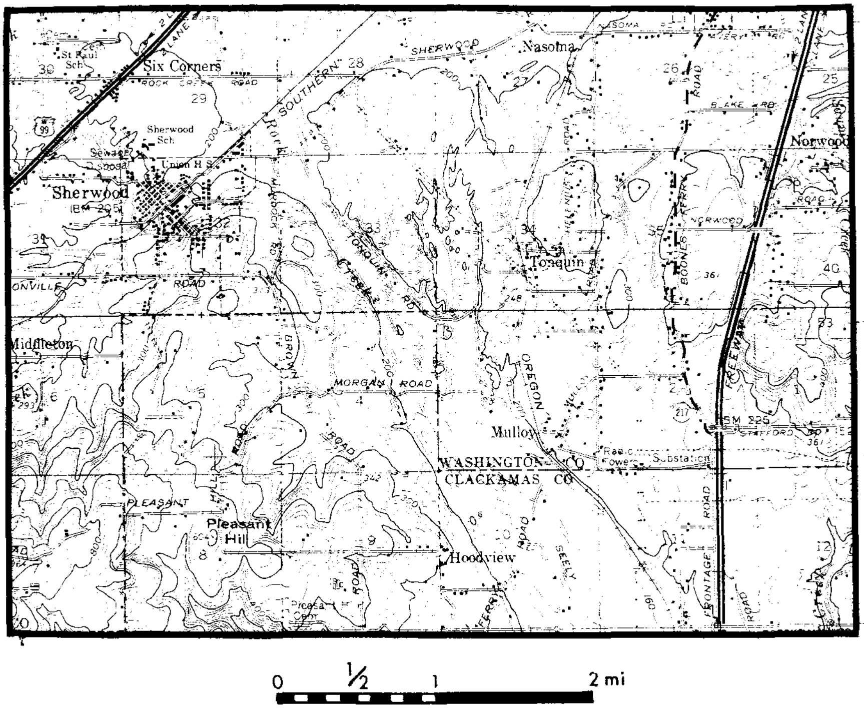

Figure 17. Scabland tract eroded by Spokane Flood across Tualatin-Willamette drainage divide in northern part of Sherwood Quadrangle (contour interval 10 ft). Channels end at Wilsonville (Figure 13).

A large flow of Spokane Flood water poured southward through the Oregon City water gap (Figures 18 and 19); at the north edge of the Mollala River trench near Canby it left southwest-slanting coarse, ill-sorted gravel beds that are no longer exposed. The flood also removed tens of feet of sand and silt from the terrace near Canby and from the northern part of French Prairie (Figures 13 and 19). Some of the sediments removed from the terraced valley fill were left in the then-entrenched channelways of the Pudding, Mollala, Yamhill, and Willamette Rivers and were later partly removed by these streams.

Portions of this late fill remain within the Willamette River trench and in its tributaries in the northern part of the Willamette Valley, occupying a second bottom terrace above the present flood plains. This fill of well-bedded silts and fine sands, whose mineral composition is similar to that of the Willamette Silt, forms a flat or gently rolling surface unlike the curving meander scars and point bars of the modern flood plains. The best examples are found along the Willamette, Yamhill, and Pudding Rivers and in the valleys of Champoeg, Mill, and Butte Creeks.

The inflow of flood water from the Columbia River temporarily raised the water level in the Willamette Valley to an elevation of 400 ft, forming a body of water named Lake Allison (Allen, in press). This 400-ft water level contrasts with the 1,100-ft level of the Spokane Flood east of the Columbia River Gorge, which cuts through the Cascades. Pebbly silts, a

Figure 18. Spokane Flood boulders from basement excavation in Canby.

few inches to a foot or two thick, containing iceberg-rafted erratics ranging in size from tiny particles to blocks several feet in diameter (Allison, 1935), were spread over the terraced Willamette lowland and its entrenched valleys and onto the lower slopes of adjacent hills. The erratics include granitic and metamorphic rocks foreign to the Willamette drainage basin, and some retain glacial striations.

Glenn (1965) found that these ubiquitous gray pebbly silts locally overlie oxidized Willamette Silt along the Willamette River bend exposure near Feasters Rocks, about 3 mi south-southwest of St. Paul, and at the Needy clay pit, approximately 4 mi east of Hubbard. A 50-ft bank of Willamette Silt and associated sand is exposed at the Needy site. The exposure at the bend of the Willamette River is somewhat thicker. Entrenchment of the streams and the surficial oxidation of the Willamette Silt indicate a time gap between its deposition and that of the disconformable gray pebbly silts deposited by the Spokane Flood. Lowry and Baldwin (1952, p. 20-21) also noted that a flood "long after the Portland Gravels" did some local scouring and left thin deposits of silt, gravel, and erratics elsewhere.

Trimble (1957, 1963) found deposits of fine sand and silt, both stratified and unstratified, disconformably overlying Portland Gravels at several places in Portland, notably, west of Mount Tabor and between Rocky Butte and Kelly Butte. At first he classified these fine-grained sediments as Pleistocene alluvium; later he called them "upper (?) Pleistocene sand and silt deposits." In places they occupy channels eroded into the earlier fill and may be slack-water deposits of the climactic flood waters that rose to their maximum level, held a short stillstand, and then continued down the Columbia River. This water was joined by Allison Lake water that reversed directions and flowed back out of the Tualatin and Willamette Valleys into the Columbia River.

The presence of late silts and fine sands in the Portland area and the thin sheet of Lake Allison pebbly silt over the Willamette Valley lowland means that the Spokane Flood waters were obstructed downstream from Portland, either by hydraulic damming of a tremendous volume of water (Trimble, 1963) or, in this author's view, by a combination of a huge volume of water and an ice jam. Some of the numerous icebergs were big enough to carry large tonnages of erratics. For example, a block of ice more than 75 ft on a side would have been required to carry one boulder found near Sheridan (Allen, in press). Groups of erratic boulders found elsewhere in the region affected by the flood would have also required icebergs of considerable size as carriers (Figure 20). The general prevalence of other smaller foreign particles in the pebbly silts is evidence of an abundance of ice in the flood water (Figures 11, 12, and 21). So the concept of ice in the Columbia River at that time is not farfetched.

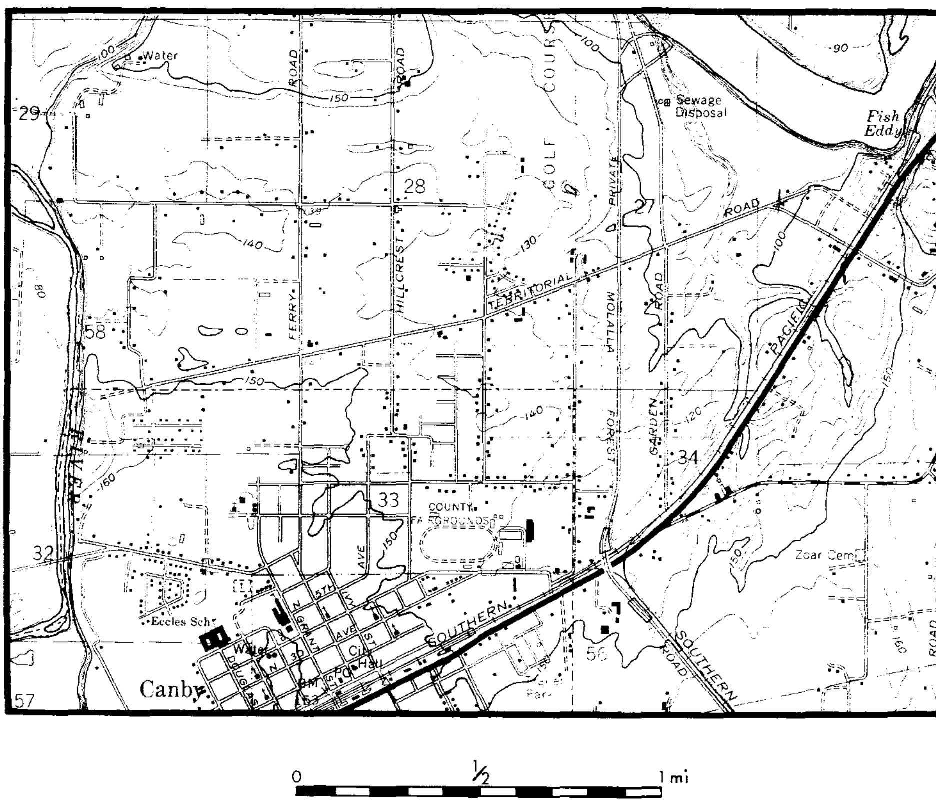

Figure 19. Spokane Flood-washed sandy terrace, correlative with Willamette Silt and Portland Gravels, near Canby (contour interval 10 ft). Flood currents coming out of Oregon City watergap (top right) crossed terrace from northeast and dumped their deposits southwesterly over side of already entrenched Mollala River and on valley bottoms generally. Large river in northeast corner of map is the Willamette. Flood topped ridge east of sharp turn of river at Fish Eddy.

Figure 20. Granitic erratics found at elevation of 310 ft near middle of sec. 32, T. 12 S., R. 2 W., south of Peterson Butte, Linn County. Other erratics are nearby.

The effect of ice is also seen in an analogous situation elsewhere. Waters (1933, p. 815-820) agreed with Bretz that the Okanogen ice lobe dammed the Columbia River west of the upper end of Grand Coulee, but he notes that as the ice melted, "This dam holding the lake became more and more unstable until eventually it collapsed, giving rise to a spectacular flood. The impounded water, charged with large blocks of ice from the broken dam, rushed through the Columbia Valley, jamming the bergs in great numbers behind every spur and projection." These grounded river-rafted icebergs melted and left a large number of kettle holes in the lowest outwash terrace in the Columbia River canyon. Waters stated, "Many of the kettles on the 'Great Terrace' are of such size that it would require a raging flood of water over 100 ft deep to carry the bergs that formed them."

A similar or even greater abundance of rafted ice should be expected from outbreaks of Glacial Lake Missoula. Evidence of large icebergs on the northeastern slopes of the Rattlesnake Hills between the Columbia River and lower Yakima Valley was recorded by Bretz (1930, p. 409-412) and Allison (1933, p. 678-681).

Geologic Ages

The Pleistocene was characterized by multiple stages of continental and montane glaciation, separated by long, warm, interglacial stages (Black

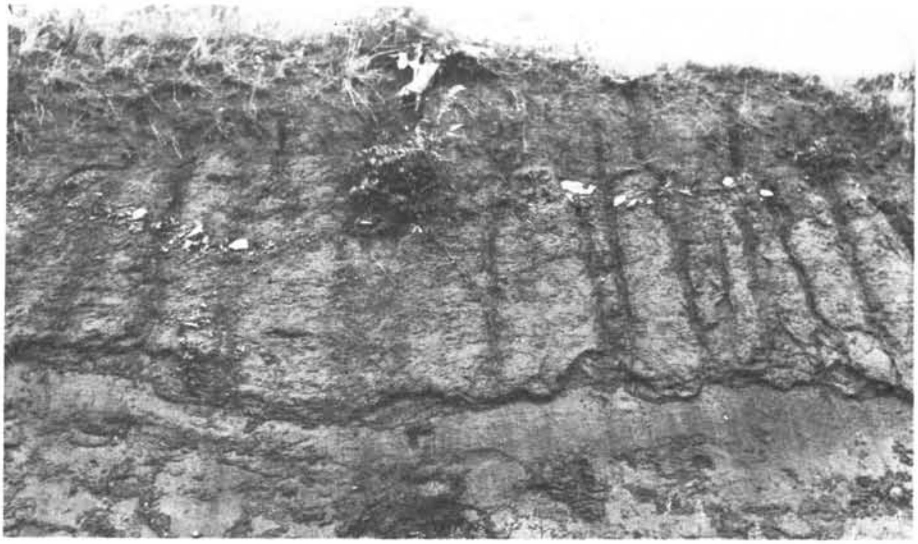

Figure 21. Roadcut at McNary, few miles southwest of Salem, showing streak of early-settling, ice-rafted erratics in valley fill.

and others, 1973). The last glacial stage was the Wisconsinan and its substages in the Great Lakes area (Frye and Willman, 1973); corresponding events in the northern Rocky Mountains area include two (locally three) stades of Bull Lake Glaciation and three stades of Pinedale Glaciation (Richmond, 1965). During the Bull Lake-Pinedale Interglacial Period, the Bull Lake deposits weathered to mature soil or, in dry areas, received considerable caliche.

Glenn (1965) believed that the main body of Willamette Silt is older than 19,000 years and younger than 34,000 years B.P. (before present). Glenn's 34,410 ± 3,450-year figure is based on the carbon-14 content of a log found at a depth of 20 ft in sec. 35, T. 2 S., R. 1 W., near Salem. The 19,000-year figure comes from an extrapolation beyond a radiocarbon date of 12,240 ± 330 years B.P. for peat 16 ft below the surface in Onion Flat, 3 mi west of Tualatin, assuming that the basal peat accumulated at a rate of 1 m/1,000 years.

Hansen's (1947) pollen diagrams for Onion Flat show a normal post-glacial forest succession, starting principally with lodgepole pine (a pioneer invader), Sitka spruce, and fir, giving way later to Douglas fir and Oregon oak, and still later to more Douglas fir and less Oregon oak. This sequence implies (1) prolonged, gradual warming and drying of a cool moist climate, (2) a pronounced warm stage about 4,000 to 6,000 years ago, and (3) return to a moister and cooler climate. There is no sign of intervention of a cold, wet, glacial climate; so the record appears to be entirely postglacial. Since no severe flood capable of excavating holes in solid rock, as did the Spokane Flood in the Tonquin area, could have passed the Onion Flat site without completely removing the peat, the Spokane Flood was unquestionably the last flood to pass through the area. Because of the common and contemporaneous origin of the Portland Gravels and the Willamette Silt, the Willamette Silt age determination applies to the Portland Gravels also.

The only Cordilleran glaciation occurring within the 19,000- to 34,000-year time span was the early and middle Pinedale Glaciation. Bull Lake Glaciation is estimated to have taken place more than 32,000 years B.P. The Portland Gravels and Willamette Silt are much less weathered than are the typical Bull Lake till and outwash deposits in Wyoming and elsewhere, despite a more favorable climate for chemical weathering in Oregon. A Pinedale and not a Bull Lake age assignment of the Portland Gravels-Willamette Silt seems therefore appropriate.

The last catastrophic outburst of Glacial Lake Missoula, the Spokane Flood, occurred near the end of early Pinedale Glaciation, according to Richmond and others (1965). In their words, "The youngest catastrophic flood, first recognized and described by Bretz (1923), scoured moraines and other deposits of early Pinedale age. Its deposits overlie early Pinedale glacial and lake deposits and are themselves overlain by moraines and other deposits of middle Pinedale age. Transported wood in the deposits at Vantage [Washington], but probably derived from older deposits, yields a radiocarbon date of 32,700 years."

Baker (1973, p. 65) says, "The last major scabland flood probably occurred during the early Pinedale Glaciation, about 22,000 years ago." The U.S. Geological Survey pamphlet, "The Channeled Scabland of Eastern Washington -- the Geologic Story of the Spokane Flood," uses a date of 18,000 to 20,000 years ago.

New radiocarbon dates and correlation of tephra in flood sediments with the Mount St. Helens "set S" tephra suggest a date as recent as 13,000 years B.P. for the Spokane Flood (Waitt, 1978).

Whether these age assignments or more recent age assignments allow enough time for the Columbia River and its tributaries to have entrenched themselves in early Pinedale outwash and valley-train deposits before the Spokane Flood is uncertain. Conceivably the overflow of several proglacial lakes in valleys dammed by the lobate front of the Cordilleran ice sheet may have shifted the regimen of certain streams, including the Columbia River, from deposition of valley trains to erosion and hence entrenchment.

One may speculate that the Spokane Flood deposits in the lower reaches of Pudding River valley may have caused the diversion of the Willamette River from its former northeastward course through the site of Lake Labish, now a peat bog, into its present northerly route and thence through the Pudding River valley. Peat near the base of the bog fill in Lake Labish, 20 ft below the surface, yielded a radiocarbon age of 11,000 ± 230 years B.P. (Glenn, 1965). This age date conforms with an age of 13,500 years B.P. for the last flood. Minor valley filling occurred in a time range of approximately 11,000 to 12,000 years ago. Or the Willamette River may merely have entered a more direct route northward from Salem via a former tributary of the Yamhill River as a result of stream piracy, regardless of any such intravalley deposits.

Although floods could have come from an Okanogan glacier-dammed Lake Columbia upriver from upper Grand Coulee (Richard and others, 1965, p. 237) or from other proglacial lakes, because of its great size, Glacial Lake Missoula seems to be the most likely source of the Spokane Flood. Presumably such a final flood from Glacial Lake Missoula used both the scabland routes on the Columbia Plateau and the Grand Coulee slot (Bretz, 1969; Richmond and others, 1965). No flood has crossed the plateau in the last 12,000 years.

Two later floods, smaller than the last great Spokane Flood, are thought to have used the route around the big bend of the Columbia River northwest of the plateau (Bretz, 1969, p. 506). These are attributed to successive failures of the dam created by the Okanogan glacier as it advanced into or across the Columbia River trench in middle Pinedale time downstream from Grand Coulee.

No evidence of a lesser flood later than the Spokane Flood has been recognized in the Portland environs, unless the eroded Fourth Plains channel east and northeast of Vancouver be attributed to such a subordinate flood or unless the "upper (?) Pleistocene sand and silt deposits" described by Trimble (1963, p. 58-71) can be assigned to it.

Of all the flood possibilities, the catastrophic Spokane Flood remains to many observers the best explanation for the very impressive Fourth Plains flood channel, the channeling of the Portland Gravels, and the array of flood-related features in the Tualatin and Willamette River Valleys.

References

Allen, J.E., 1979, The magnificent gateway, a guide to the geology of the Columbia River Gorge: Forest Grove, Oreg., The Timber Press [in press].

Allison, I.S., 1932, Spokane Flood south of Portland, Oregon [abs.]: Geological Society of America Bulletin, v. 43, p. 133-134.

_____ 1933, New version of the Spokane Flood: Geological Society of America Bulletin, v. 44, p. 675-722.

_____ 1935, Glacial erratics in Willamette Valley: Geological Society of America Bulletin, v. 46, p. 615-632.

_____ 1953, Geology of the Albany Quadrangle, Oregon: State Department of Geology and Mineral Industries Bulletin 37, 18 p., map.

Anonymous, 1973, The channeled scabland of eastern Washington--the geologic story of the Spokane Flood: U.S. Geological Survey pamphlet, 25 p., 23 figs.

Baker, V.R., 1973, Paleohydrology and sedimentology of Lake Missoula flooding in eastern Washington: Geological Society of America Special Paper 144, 79 p.

Black, R.F., Goldthwait, R.P., and Willman, H.B., eds., 1973, The Wisconsinan Stage, *in* Geological Society of America Memoir 136, 334 p.

Bretz, J.H., 1919, The late Pleistocene submergence in the Columbia Valley of Oregon and Washington: Journal of Geology, v. 27, p. 489-506.

_____ 1925, The Spokane Flood beyond the channeled scablands: Journal of Geology, v. 33, p. 97-115, 236-259.

_____ 1928, Bars of channeled scabland: Geological Society of America Bulletin, v. 39, p. 643-701.

_____ 1930, Valley deposits immediately west of the channeled scabland: Journal of Geology, v. 38, p. 385-422.

_____ 1932, The Grand Coulee: American Geographical Society Special Publication 15, 89 p.

_____ 1969, The Lake Missoula floods and the channeled scabland: Journal of Geology, v. 77, p. 505-543.

_____ Smith, H.T.U., and Neff, G.E., 1956, Channeled scabland of Washington, new data and interpretations: Geological Society of America Bulletin, v. 67, p. 957-1049.

Condon, T., 1871, The Willamette Sound: Overland Monthly, v. 7, p. 393-398.

Frye, J.C., and Willman, H.B., 1973, Wisconsinan climatic history interpreted from the Michigan Lobe deposits and soils, *in* Geological Society of America Memoir 136, p. 135-152.

Glenn, J.L., 1965, Late Quaternary sedimentation and geologic history of the north Willamette Valley, Oregon: Oregon State University doctoral dissertation.

Hansen, H.P., 1947, Postglacial forest succession, climate, and chronology in the Pacific Northwest: Transactions of the American Philosophical Society, v. 37, pt. 1, 130 p.

Lowry, W.D., and Baldwin, E.M., 1952, Late Cenozoic geology of the lower Columbia River Valley, Oregon and Washington: Geological Society of America Bulletin, v. 63. p. 1-24.

Price, Don, 1967, Geology and water resources of the French Prairie area, northern Willamette Valley, Oregon: U.S. Geological Survey Water Supply Paper 1833, 98 p.

Richmond, G.M., 1965, Glaciation of the Rocky Mountains, *in* Wright, H.E., and Frey, D.G., eds., The Quaternary of the United States: Princeton University Press, p. 217-230.

_____ Fryxell, R., Neff, G.E., and Weis, P.L., 1965, The Cordilleran ice sheet of the northern Rocky Mountains, and related Quaternary history of the Columbia Plateau, *in* Wright, H.E., and Frey, D.G., eds., The Quaternary of the United States: Princeton University Press, p. 231-242.

Schlicker, H.G., and Deacon, R.J., 1967, Engineering geology of the Tualatin Valley region, Oregon: State of Oregon Department of Geology and Mineral Industries Bulletin 60, 103 p.

Treasher, R.C., 1942, Geologic history of the Portland area: State of Oregon Department of Geology and Mineral Industries GMI Short Paper 7, 17 p.

Trimble, D.E., 1957, Geology of the Portland Quadrangle, Oregon-Washington: U.S. Geological Survey Quadrangle Map GQ 104, with text on back.

_____ 1963, Geology of Portland, Oregon, and adjacent areas: U.S. Geological Survey Bulletin 1119, 119 p. and map.

Waitt, R.B., Jr., 1978, Post-Miocene stratigraphy and tectonism of parts of the great Columbia Plain and adjacent Cascades, Washington, *in* Tectonics and Seismicity of the Columbia Plateau Workshop, Seattle, Washington, February 14-16, 1978, Proceedings: Rockwell Hanford Operations, Basalt Waste Isolation Program.

Waters, A.C., 1933, Terraces and coulees along the Columbia River near Lake Chelan, Washington: Geological Society of America Bulletin, v. 44, p. 783-820.

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Bidders will be required to negotiate a lease and agree to abide by all conditions and regulations set forth by the Coos County Board of Commissioners in the document entitled "Mineral Rights Lease Agreement and Requirements for Bidders," copies of which are available in the Commissioners' Office, Courthouse, Coquille, Oregon 97423. Telephone number is (503) 396-3121.

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