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# THE ORE BIN

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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The ORE BIN
Volume 40, No. 11
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# LATE PLEISTOCENE SEDIMENTS AND FLOODS IN THE WILLAMETTE VALLEY

Ira S. Allison
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Quaternary geologic units are assuming increasing significance in helping us understand the history of the land on which we live and the constraints we must consider in earthquake engineering, resource management, and land use planning.

Many Quaternary deposits of northern Oregon are associated with late Pleistocene catastrophic floods, events which further challenge our thinking. The following article represents Ira Allison's interpretations of some of the deposits.

This contribution will be, we hope, one of many from within the geologic community which will collectively lead to a more refined comprehension of the Quaternary of northern Oregon.

Because of its length, this article is being published in two parts. The bibliography for the entire article will appear in next month's ORE BIN. Readers will find the index map (Figure 1) on page 178 useful for determining locations of individual larger scale maps presented in both the November and December issues of the ORE BIN.

Editor

## Diverse Interpretations

The origin of certain unconsolidated sediments in the northern part of the Willamette Valley was attributed by Condon (1871) to a Willamette Sound. Sediments in the Portland-Vancouver area were called a delta in such a sound by Bretz (1919, p. 506), who later (1925, p. 252-257; 1928, p. 697-700) attributed them instead to river-bottom deposition by a huge Spokane Flood in a ponded drainage system. Allison (1932, 1935) assigned the Portland Gravels to a pre-Spokane Flood stage of alluviation by the Columbia River and named certain silts in the Willamette Valley the Willamette Silt (1953). Treasher (1924b, p. 13-15) noted that somehow ice-rafted erratics got into the Willamette Valley but said that there was little or no evidence for either the Spokane Flood or a Portland delta.

Lowry and Baldwin (1952, p. 17-21) recognized the Portland Gravels as dissected stream terrace deposits, considered the main bodies of silt in the Tualatin and Willamette Valleys to be a still-water facies of the Portland Gravels, accepted Allison's report of flooding via the Lake Oswego gap, and held that silt and erratics on the valley walls up to an elevation of 400 ft above sea level were deposited by a late flood long after the Portland Gravels stage of alluviation.

Bretz and others (1956) concluded that not just one flood but rather a whole series of floods came across the Columbia Plateau and on down the

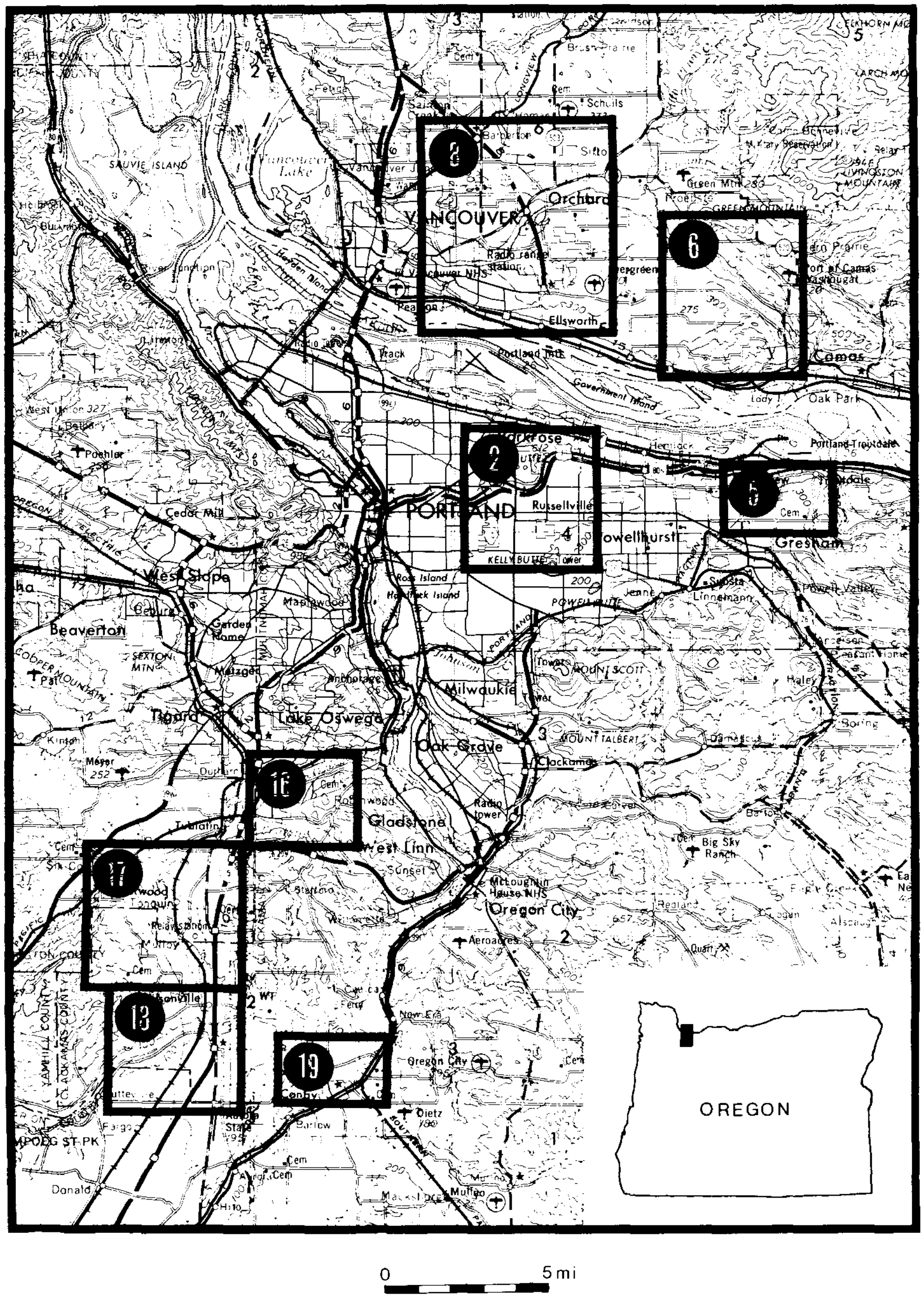


*Figure 1. Index map showing areas of Washington and Oregon discussed in this article. Boxes show areas covered by larger sale maps appearing in this and next month's segments. Numbers in boxes are figure numbers.*

Columbia River. Trimble (1957; 1963, p. 58-71) classified the sediments in the Portland area, largely on a textural basis, as lacustrine deposits in a ponded stream system, considering them to be products of Bretz-type flood waters of great volume and tremendous energy that were restricted by hydraulic damming of the Columbia River down-valley from Portland. Glenn (1965) concluded that the Willamette Silt was brought in by more than 40 surges of the Columbia River.

Schlicker and Deacon (1967, p. 29-35) described the Willamette Silt in or near Tualatin Valley and showed photographs of torrential bedding in sand and gravel deposited near Onion Flat and Durham, west of the Lake Oswego gap, by late flood currents. Ponding of the Willamette Valley was accepted by Price (1967, p. 27-32), who stated that alluvial deposits of the Columbia River impounded the Willamette Valley drainage in several inundations.

Bretz (1969) reviewed flood phenomena from northwestern Montana to Portland and determined that there were a total of seven or eight floods, five of which were caused by repeated failures of a glacier dam which once held back as much as 500 cu mi of water in a succession of Glacial Lake Missoulas. He gave special attention to scabland features, flood routes, divide crossings, flood gravels bearing gigantic current ripples, Grand Coulee, back-flooding of tributaries of the Columbia River, the Portland delta, the Rocky Butte fosse (long, narrow waterway) in Portland, and related matters.

## Twofold Deposits

This author considers the unconsolidated deposits in the Portland-Vancouver area and most of the Willamette Valley to be of two different ages: (1) early phase sediments deposited by the Columbia River in a ponded Willamette River drainage system over an extended period of time, and (2) a late phase resulting from short-lived catastrophic drainage of a proglacial lake. Two widely separated occasions of flooding are involved: The first is multiple and mainly depositional in northwestern Oregon; the second is single and strongly erosional. The early phase is attributed mainly to repeated failures of the glacier dam at Pend Oreille, Idaho, and many evacuations of Glacial Lake Missoula, although other proglacial lakes may have been involved by experiencing similar outbreaks. Stream entrenchment had converted the early phase deposits into alluvial terraces before the violent debacle of the Spokane Flood, resulting from the failure of the ice dam at Glacial Lake Missoula.

## Early Phase Deposits

### Portland area

The terrace surface over a broad area east of Rocky Butte and Mount Tabor and northeast of Kelly Butte has an elevation of about 300 ft or more above sea level (Figure 2). It rises to the east and was greatly channeled and modified by the Spokane Flood.

The early phase deposits, reaching from the vicinity of Troutdale into Portland, are still conveniently called the Portland Gravels, following earlier usage (Bretz, 1928a, p. 697-700; Lowry and Baldwin, 1952, p. 17-19). They consist mainly of well-rounded pebbles (mostly basalt) less than 3 in. in diameter and a generous fraction of sand. The beds generally are nearly parallel layers a few inches to a foot or two thick (Figure 3), with only minor fluvial cross-bedding or river-bar structure.

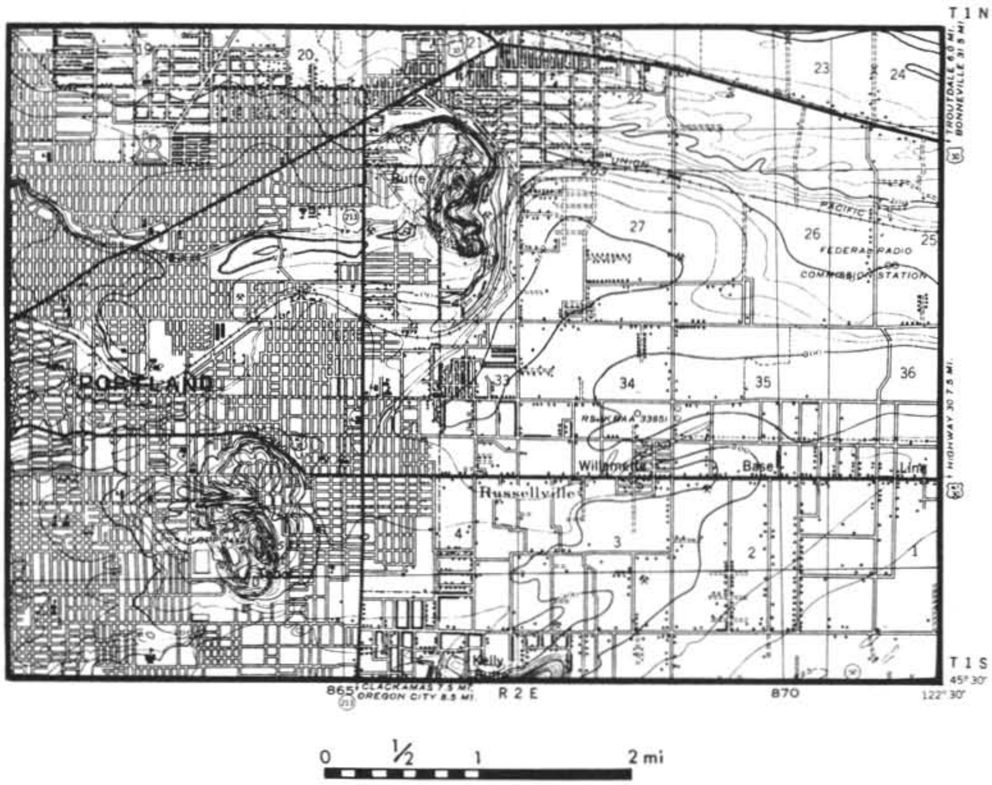


*Figure 2. Southeast part of Portland Quadrangle (contour interval 25 ft). Note channel depressions near Rocky and Kelly Buttes, modified 300-ft terrace, and northeast-to-southwest channel east of Kelly Butte.*

*Figure 3. Parallel-bedded, somewhat sandy Portland Gravels in pit beside S.E. Division Street just east of 106th Avenue in Portland.*

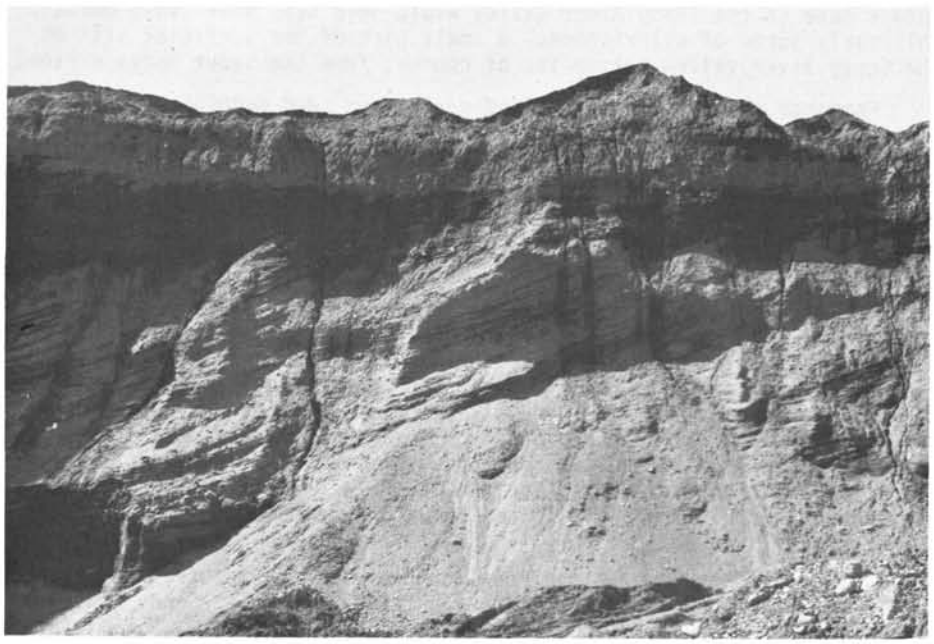

*Figure 4. Sandy phase of Portland Gravels in pit 1.5 mi south of Troutdale, showing extensive deltaic foreset bedding inclined toward Sandy River valley.*

They lack deltaic foresets except where Columbia River waters entered the mouths of tributaries which it had previously blockaded by alluviation.

One such exceptional deltaic structure occurs in a large exposure about a mile and a half south of Troutdale along the west side of the Sandy River valley, where a great deal of constructional material has been removed. Here long deltaic foresets slant east, southeast, and south (Figure 4). This site is at the eastern edge of a broad sand and gravel terrace remnant 3 mi long and 2 mi wide, at an elevation of more than 360 ft, between Troutdale and Gresham. A dry stony channel runs southwesterly along its southern edge. The northern and northwestern side of this terrace is an erosional scarp exhibiting basalt boulders and outcrops of basalt.

This gravel deposit grades into a silt-covered plain beside the Sandy River at an elevation of a little less than 200 ft (Figure 5). The easterly foresets apparently determine the eastward slope of the Troutdale-Gresham sand and gravel terrace. Similar foresets exposed at one time in a roadcut on Stark Street, half a mile to the south, were part of the reason Bretz called the deposit between Troutdale and Gresham a Spokane Flood eddy bar, supposedly favored by its position in the lee of a high rock shoulder east of the Sandy River.

In this author's opinion, the present terrace is part of a Portland Gravels fluvial deposit that once must have filled the adjacent Columbia River valley floor to an elevation of more than 360 ft at the mouth of the Columbia River Gorge. That deposit would have blocked the Sandy River drainage so that deltaic foresets directed by the Columbia River into a lake in the Sandy River valley would have been inevitable during this early stage of alluviation. A small part of the surficial silt on the Sandy River valley bottom is, of course, from the later Spokane Flood.

Remnants of similar early flood gravel and sand deposits showing foreset structures slanting up-valley also occur in the Willamette Valley and in the lower reaches of several tributaries of the Columbia River, such as Willow Creek, Old Lady Canyon, and Fifteenmile Creek, all east of the Cascade Mountains. Many gravels at the mouths of tributaries were later modified by the Spokane Flood into eddy bars. Silts antedating the climactic flood occupy the valley floors upstream in many of these tributaries as well as in the Willamette Valley. Bretz (1969, p. 514-515, 532-533) attributed them to back-flooding from a borelike flood front, but their origin remained unclear to him in 1969, notwithstanding his earlier statement (1956, p. 1034) that "perhaps two kinds of backwater episodes are recorded in these deposits, both with up-valley currents. The well-sorted, well-stratified valley bottom deposits may be the consequences of melt-water incursions from normal valley train building along the main scabland routes. Because, however, floods have all but destroyed any record of valley trains, survival of such bottom sediments seems anomalous." Floods did indeed scour the master channels but not the tributaries.

The present surface of the Portland Gravels descends from an elevation of more than 300 ft east of Rocky Butte to 260 ft at Sandy Boulevard, 1.5 mi west of the Butte, to 200 ft or less at Union Avenue, 2.5 mi farther west, and to still lower levels in the peninsula, or St. Johns area, some 4 mi farther on. This surface, however, has not only channels, such as those at the Rose City Golf Course and Sullivan Gulch (now the route of I-80N), but also has remnant ridges, such as those in the Alameda district of northeast Portland and in the St. Johns area, and a gradual slope toward the Columbia River. Apparently a considerable quantity of material

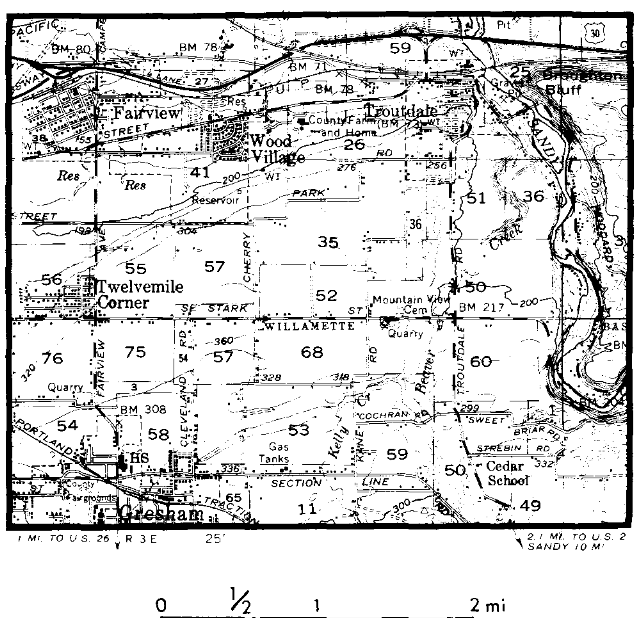


*Figure 5. Southwest part of Camas (Washington-Oregon) Quadrangle (contour interval 40 ft), showing Portland Gravels terrace between Troutdale and Gresham.*

has been eroded from this surface, presumably in large part by the Spokane Flood, whereas the corresponding surface of Mill Plain east of Vancouver, Washington, retains an approximate 300-ft level for many miles (Figure 6). So the present level of the Portland Gravels or equivalent sand and silt near the Willamette River in Portland cannot be used to find the precise level of the fill which diverted Columbia River water during flood seasons into the Willamette and Tualatin Valleys for the deposition of Willamette Silt.

Fluvial silt and fine sand (Figure 7) that now border the Willamette River in north Portland may be the downstream continuation of the Portland Gravels fill or perhaps, in part, products of the slow final outflow of previously ponded water of the last flood.

A terrace remnant, a correlative part of the Portland Gravels on the Washington side of the Columbia River, bears the local name of Mill Plain (Figure 8, middle right). It extends westward about 11 mi from the western part of T. 2 N., R. 3 E. to the eastern part of Vancouver, sec. 24, T. 2 N., R. 1 E. Its surface, nearly flat between elevations of 280 and 310 ft, may be at or near its original depositional level. A few shallow channels cross it. Its internal structure, well exposed in the English Pit (sec. 30, T. 2 N., R. 3 E.), reveals its fluvial, not deltaic nor catastrophic flood, origin (Figure 9). This internal structure is matched in several gravel pits on the Oregon side of the Columbia River (Figure 3) and is best ex-

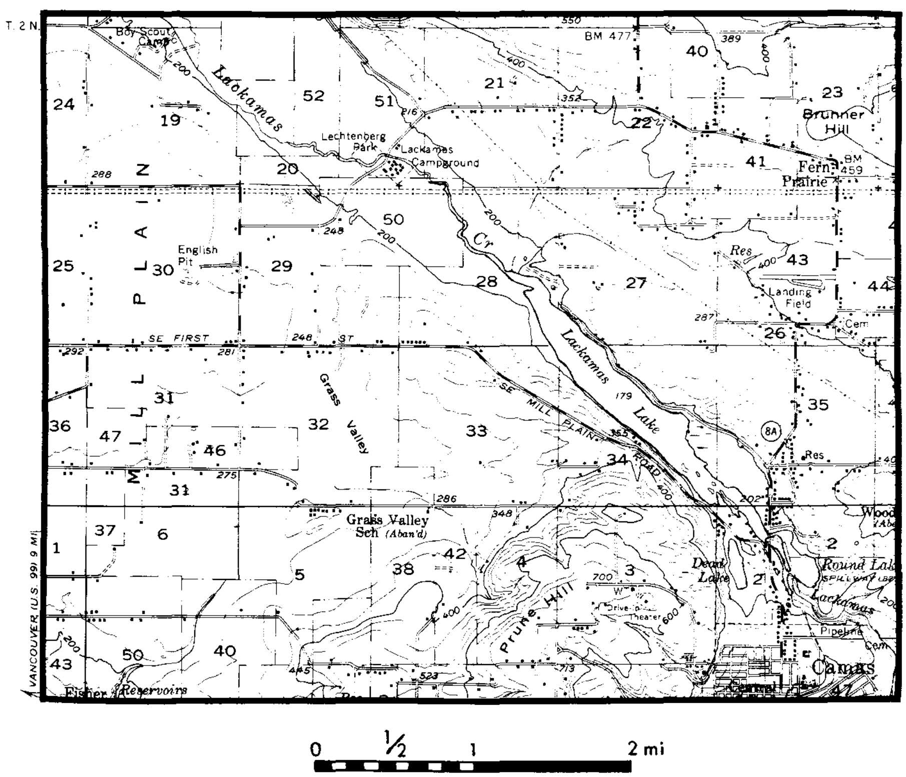


*Figure 6. Western part of Camas Quadrangle (contour interval 40 ft), showing Mill Plain terrace of Portland Gravels west of Prune Hill and northwest-oriented Lackamas Lake channel eroded by Spokane Flood.*

posed at present in pits: (1) 1.5 mi south of Troutdale, (2) at S.E. 195th Avenue and Division Street (Figure 10), (3) near S.E. 106th Avenue and Division Street, and (4) at N.E. 122nd Avenue and San Rafael Street. Figure 11 shows a former pit in which Portland Gravels are overlain by Spokane Flood deposits.

Tualatin Valley

A sandy extension of the Portland Gravels continues westward beyond the Tualatin River gap and the Lake Oswego lowland into the proximal part of the Tualatin River valley at a summit elevation of about 240 ft (Schlicker and Deacon, 1967, p. 30-32). These sands, which form uneven terraces on both the north and south sides of Tualatin Valley, at most places show channeling by the later Spokane Flood. Among the largest patches in the eastern part of Tualatin Valley are those: (1) at Six Corners (top greater than 210 ft), (2) northeast of Onion Flat (top greater than 190 ft), and (3) in secs. 19 and 20, T. 2 S., R. 1 E. (top greater than 210 ft).

These early sands in the Tualatin Valley afford an approximate measure of the maximum former height of the Portland Gravels (and sands) fill at the toe of the deposit along the present position of the Willamette River in Portland, now generally 50 to 150 ft above sea level. The original level clearly exceeded 210 ft, matching the graded level in the Tualatin Valley.

The reduction of level of the fill in Portland from approximately 250 ft or more and the abundance of later flood channels across the Portland Gravels testify to large-scale erosion of the fill, partly by the huge Spokane Flood and partly by ordinary stream activity both earlier and later.

The early sands in the Tualatin Valley give way up-valley to Willamette Silt deposits from a few feet to about 50 ft thick (Schlicker and Deacon, 1967, p. 30-32).

*Figure 7. Fine-grained fluvial deposits at N. Greeley Avenue and N. Going Street, Portland.*

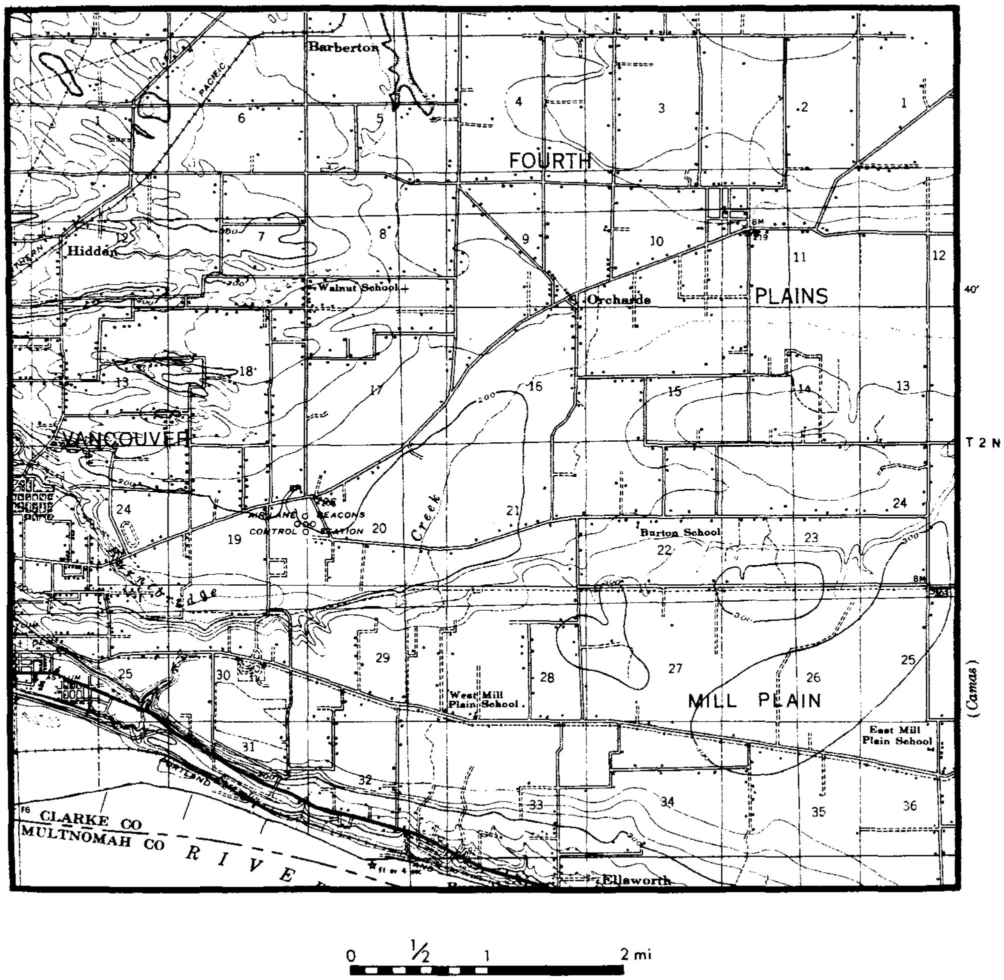


*Figure 8. East-central part of Portland Quadrangle (contour interval 25 ft), showing western part of Mill Plain 300-ft terrace of Portland Gravels, flood-swept Fourth Plains channel, and eroded sand hills (terrace remnants) north-northeast of Vancouver.*

*Figure 9. Texture and fluvial, not deltaic, structure of Portland Gravels in English Pit, 5 mi northwest of Camas, Washington. Deposit here includes considerable sand.*

*Figure 10. Bouldery Spokane Flood deposits in western part of gravel pit 1.5 mi west of Gresham, showing poor sorting and wide range of textures.*

*Figure 11. Portland Gravels in former pit at southwest edge of terrace near northern Clackamas County line, with foresets toward southwest. Few-feet-thick sheet of Spokane Flood deposits, including erratics of various sizes, overlies older gravel. Range pole is 8 ft long.*

*Figure 12. Roadcut on U.S. Highway 99E, just across Pudding River from Aurora. Material at base is sand of early phase of Willamette Valley filling, overlain by Spokane Flood mixture of gravel, sand, silt, and erratics (light-colored stones). Note small cut-out at right side of roadcut at contact.*

Willamette Valley

Similar sands and silts were washed southward in large volume through the Oregon City watergap into the open part of the Willamette Valley. Near Canby and Aurora (Figure 12), sand predominates. These sands are overlain by or give way laterally to tens of feet of Willamette Silt, which continues up-valley southward as far as Harrisburg, Oregon, about 90 mi from Portland. South of Harrisburg, the valley fill of equivalent or greater age consists of gravel and sand from the headwaters of the Willamette and McKenzie Rivers.

In the northern part of French Prairie (Figure 13), portions of the partly dissected Willamette Valley fill south of the bend of the Willamette River have nearly flat surfaces with maximum elevations of a little more than 190 ft above sea level; and 170- to 190-ft levels extend for many miles into other nearby areas.

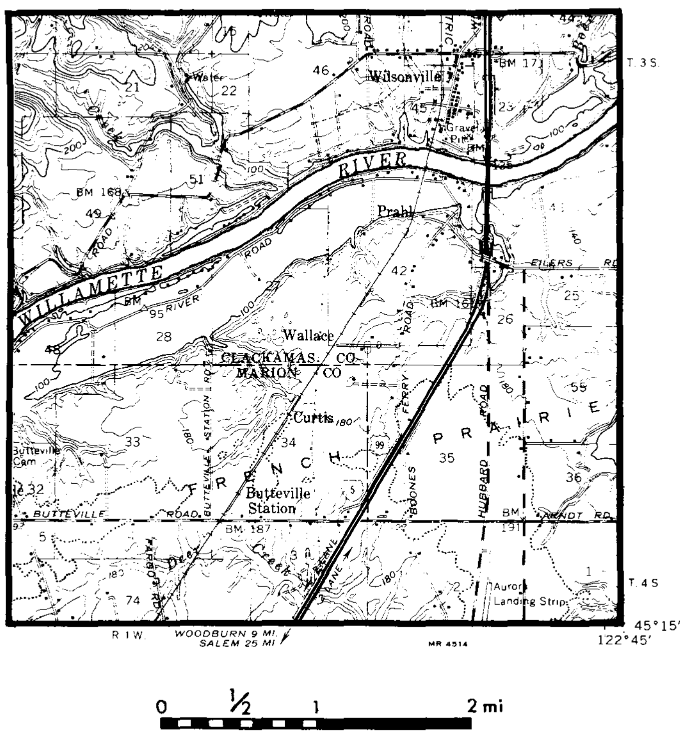


*Figure 13. Southeastern part of Sherwood Quadrangle (contour interval 20 ft), showing part of Spokane Flood-modified French Prairie; a 190-ft Willamette Silt terrace (dotted contour lines, lower part of map), correlative and consanguineous with Portland Gravels;· and site of Portland Flood rubble deposit over edge of Willamette River trench at Wilsonville.*

Willamette Lake

The lake in the Willamette Valley in which Willamette Silt and correlative deposits were laid down is here named the Willamette Lake. It was caused by upbuilding of the Portland Gravels fill at Portland above the grade of the Willamette River, presumably as part of a glacial Columbia River valley train. Its highest level, as recorded by silts near Harrisburg, was about 300 ft above sea level. Whatever may have been the elevation of the toe of the Portland Gravels deposit in Portland, the original summit of the valley fill south of the Oregon City narrows may not have been much more than 200 ft. In that case, the depth of Willamette Lake in the northern Willamette Valley above the present top of the fill at times may have approached 100 ft and was probably much greater when the filling began. The level of the lake must have fluctuated through a wide range because of repeated surging and ebbing of water from the Columbia River.

As laboratory tests of Willamette Silt show almost complete sedimentation within a few minutes, one may wonder how the nearly clay-free silt was kept in suspension long enough to reach the 300-ft level, 90 mi upvalley. After passing through the Oregon City gap, the heavily loaded, roily, inrushing Columbia River water evidently deposited its basaltic sand in the Canby-Aurora area, leaving the silt and fine sand to flow along the lake bottom as turbidity currents. A steep front on the incoming surge of water would have helped keep material in suspension, but the main requirement was a rapid rise of a large volume of turbid water.

Unlike the later Spokane Flood, the Willamette Lake may have been intermittent over a considerable span of time. The repetitively banded structure and graded bedding of the Willamette Silt indicate the occur-

*Figure 14. Roadcut at edge of Willamette River trench, about 5 mi south-southeast of St. Paul, Oregon, showing stratification of Willamette Silt (and fine sand) deposited in Lake Willamette. Note characteristically uneven sands (dark when moist) at base of each bed. Structure, including graded bedding, is attributed to turbidity or density currents flowing along bottom of Lake Willamette.*

rence of many surges of silt-laden Columbia River water into the valley. Faint laminations appear within many of the beds, but evaluation of the time significance of these layers is difficult.

Each layer of Willamette Silt in the northern and central parts of the valley typically has an uneven sandy base under a thicker band of silt (Figure 14). Some beds show reverse grading or compound grading. The prevailing structure is somewhat like that of varves in glacial lakes, as though each layer were the result of an annual Columbia River freshet. A year-by-year origin may be questioned, however, because each layer seems to be too voluminous for an annual increment from a single flood season, even from one lasting several spring and early summer months as experienced by the Columbia River at present. If the layers were annual and repeated in successive years, the whole record would require only decades of time. On the other hand, if there are time gaps in the sequence, the time scale may run to centuries--still a very short fraction of geologic time.

At Irish Bend, its type locality in the Willamette River bank about 7 mi north of Harrisburg (Figure 15), the Willamette Silt contains little fine sand, so beds are somewhat indistinct, and each one is only a few inches thick. Perhaps the River Bend section (Glenn, 1965) should be considered a co-type, as it is representative of the northern facies. The silt consists mainly of quartz, feldspar, and mica, but a great variety of other minerals are present in small quantities.

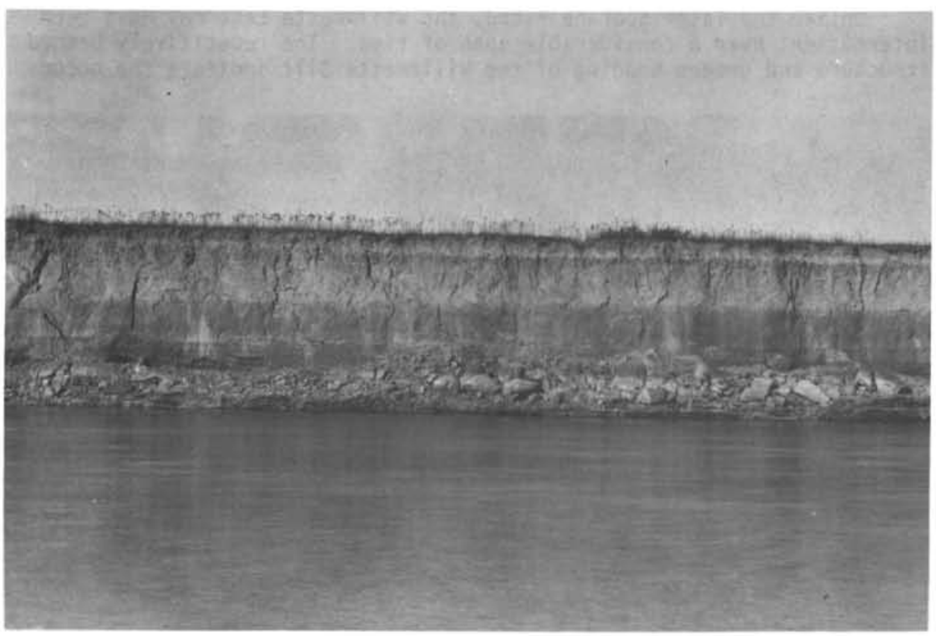

*Figure 15. Willamette Silt (wide upper gray band) in bank of Willamette River at Irish Bend, southeastern Linn County, Oregon, overlying deeply weathered, semiconsolidated river deposits and underlying thin sheet of silt from Spokane Flood. Somewhat weathered top of Willamette Silt ranges in color from pale yellowish gray when wet to dark reddish brown.*

The Willamette Valley fill is thought to have been formed by multiple extraordinary Columbia River floods caused by the repeated deterioration of the Pend Oreille glacier that dammed Glacial Lake Missoula. In a setting where glacial ice and proglacial lake water are in a contest, we may visualize each of them having mastery of the lake outlet from time to time, first one and then the other. Any weakening of the glacier would allow the lake to burst out. Judged by the number of sediment beds in the valley fill in northern Willamette Valley, several tens of floods must have occurred during the early phase of alluviation. Bretz (1969) deduced a total of seven or eight floods from the scabland record in eastern Washington.

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Next month: A discussion of late phase erosion and deposits of the Spokane Flood will complete this two-part article.

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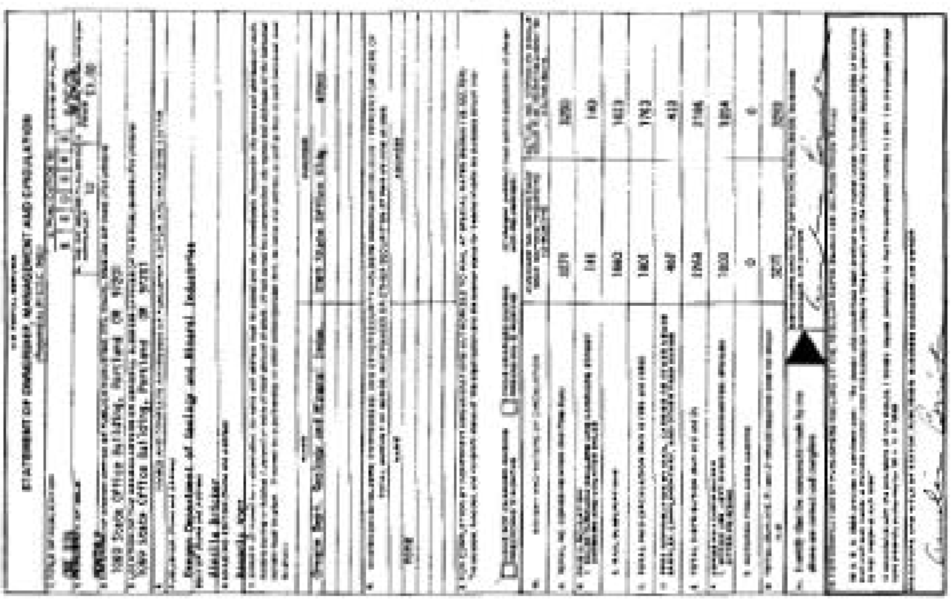

## SUNOCO OBTAINS FOUR GEOTHERMAL TRACTS

Sunoco Energy Development Company of Dallas, Texas, was the only bidder on four tracts of land near Breitenbush Hot Springs offered for geothermal development.

The successful bidding allows Sunoco to proceed with geothermal development plans, pending approval of the bids by the U.S. Geological Survey and the Bureau of Land Management's issuance of leases.

The lands are located about 12 mi northeast of Detroit, Oregon, and are managed by the U.S. Forest Service. A fifth tract received no bids. The Bureau of Land Management conducted the sale.

Acreage and bids are as follows:

| Tract | Acres | Bid |
|---|---|---|
| 1. | 2,133.4 | $27,734.20 |
| 2. | 1,280 | $22,592.00 |
| 3. | 1,365 | $32,459.70 |
| 4. | 1,040 | $ 3,796.00 |
| 5. | 1,029 | No bids received |

* * * * *

## NORTHWEST MINERS TO HOST

The Northwest Mining Association's 84th Annual Convention is expected to draw more than 1,600 miners from around the world. The meetings will be held at the Davenport Hotel, Spokane, from November 30 through December 2.

John B. Hite, General Chairman, said the convention theme, "The Great Northwest - Resources for Tomorrow," was chosen to emphasize the known and potential mineral and energy sources in the Northwest. "In these days of energy and mineral shortage and increasing uncertainty of foreign supplies, every effort must be made in the energy-rich Northwest United States to discover and produce the enormous reserves that nature has provided," Hite said.

Details and registration materials are available at the association offices at 1020 Riverside Avenue, Spokane, Washington.

* * * * *

## WESTERN STATES RECOVER FROM DROUGHT

Streamflow measurements made by USGS hydrologists indicate that heavy snow and rains brought to years of drought in most western states to an end. The scientists have been compiling records of the 1978 water year, which was from October 30 through September 30.

Throughout the water year, Oregon's streamflow fluctuated, but amounts were generally normal or above average. The Columbia River streamflow was above average in December for the first time since September 1976. The drought experienced in the season preceding the 1978 water year was the most severe on record for the State of Oregon.

In neighboring California, Idaho, and Washington it may be years before ground-water supplies are recovered, although the drought appears to be over.

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