The Ore Bin

Volume 38, No. 8
August 1976

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon 97201
Telephone: [503] 229-5580

FIELD OFFICES

2033 First Street
Baker 97814

521 N.E. "E" Street
Grants Pass 97526

Subscription Rates
1 year, $3.00; 3 years, $8.00
Available back issues, $.25 at counter, $.35 mailed

Second class postage paid at Portland, Oregon

State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Bldg.
Portland Oregon 97201

The ORE BIN
Volume 38, No. 8
August 1976

BEACH EROSION ON SILETZ SPIT, OREGON

Paul D. Komar and C. Cary Rea
School of Oceanography, Estuarine and Coastal Research Program
Oregon State University

In the winter of 1972-73 severe erosion occurred on Siletz Spit on the central Oregon Coast (Figure 1). One partially constructed house was lost, and others were saved only by the immediate placement of riprap, large rocks installed at the base of the property to prevent wave erosion. This episode of erosion received widespread news coverage. For a time it was feared that the spit might breach, much as Bayocean Spit, on the northern Oregon Coast, had in 1952 (Terich and Komar, 1973, 1974). The erosion to Bayocean Spit resulted from the construction of a jetty at the entrance to Tillamook Bay. No jetties are present at the Siletz Bay inlet. Instead, the erosion is associated with rip currents, strong narrow currents that flow across the surf zone and out beyond the breakers. Rip currents erode embayments on the beach, at times cutting back into the dunes on which houses were built.

The purposes of this report are to document the erosion to Siletz Spit and to explain its causes. Similar processes occur elsewhere on the Oregon Coast, so we know that such episodes could be repeated. This paper is a summary of the unpublished reports of Rea and Komar (1975) and Komar and Rea (1975), which contain more of the details of the study.

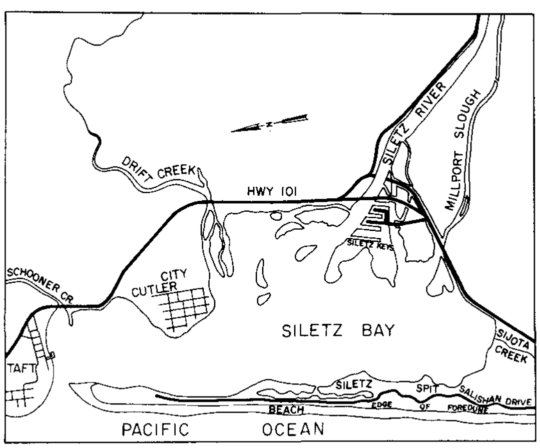


Figure 1. Site location for the Siletz Spit and Bay area, Oregon.

Recent Erosion

In 1972-73 the existing houses at Siletz Spit had been present for less than 10 years, and there had been no prior development. Little was known concerning the spit's erosional history. In 1970-71 erosion did occur along a 670-meter section of foredunes at the south end of the spit and a small stretch at the northern part of the developed section. Riprap placement prevented appreciable foredune losses, and no houses were seriously threatened. The maximum dune bluff recession, 15 meters, occurred in an unprotected park area.

No strong storms developed during the mild winter of 1971-72. Erosion was minor except in the park area, where the foredune retreated another 20 meters.

The severest episode of erosion occurred during the winter of 1972-73. One partially built home was destroyed (Figure 2), and others had to be protected by riprap on three sides (Figures 3 and 4). The worst erosion took place along a 650-meter stretch of the central spit, opposite the artificial lagoons cut into the bay side of the spit. Figure 5 diagrams the erosion to the base of the foredunes, the maximum recession amounting to 30 meters in a 3-week period. Individual homeowners placed riprap in front of their properties, but unprotected vacant lots continued to erode. Flank erosion in the empty lots made it necessary to protect the sides of houses so that the group of three houses ended on a promontory supported by riprap (Figures 3, 4, and 5).

Due to a disagreement between the developer, who owned the lots, and the individual leaseholders as to who should pay for the placement of the riprap, erosion to the empty lots was allowed to proceed until it threatened the road, at which time riprap was finally installed. The dispute is presently being settled in court.

Long Term Erosion

Erosion of the dunes of the spit exposed numerous drift logs, many of which had been sawed (Figure 6). This indicates that spit development was contemporaneous with logging along the Oregon Coast. The influx of settlers and logging started about 1895. Sawed logs within the spit indicate that the portion on which the houses had been built suffered previous erosion some time after 1895. The dunes must have then built back out, incorporating sawed logs in the process, and become re-established.

A detailed qualitative study of the spit erosion was conducted, using old and recent aerial photographs. Because Siletz Spit has been repeatedly photographed since 1939, 35 years of coverage was available. Study of the aerial photographs revealed cycles of erosion and reformation of the dunes. Periodically, sections of the dunes were eroded. Like the episodes of erosion in 1972-73, this erosion did not extend along the entire

Figure 2. Erosion and destruction of the house under construction on lot 226 of Siletz Spit.

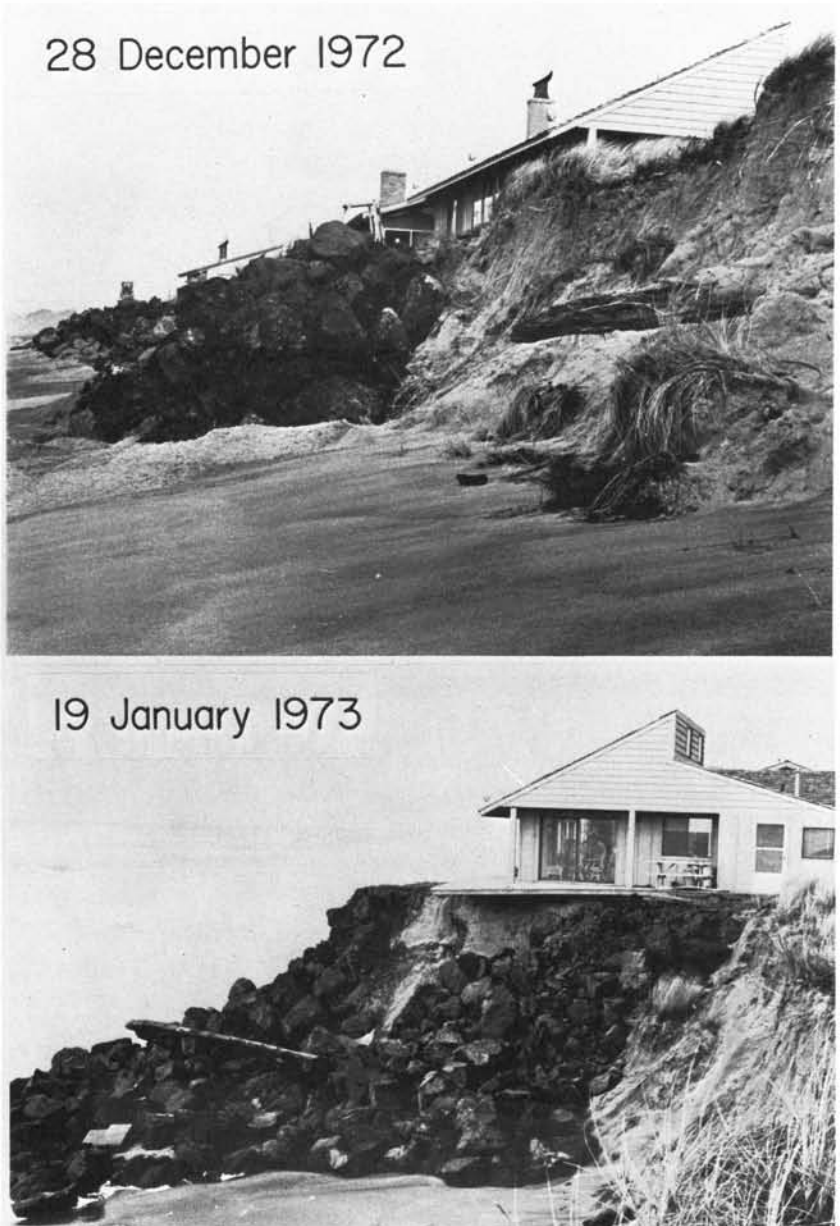


Figure 3. Erosion around the house on lot 229-A. Rapid erosion required placement of riprap fronting home in upper photo; but no riprap was installed in adjacent vacant lot, so erosion continued along the side as seen in lower photo.

Figure 4. View of both houses of Figures 2 and 3.

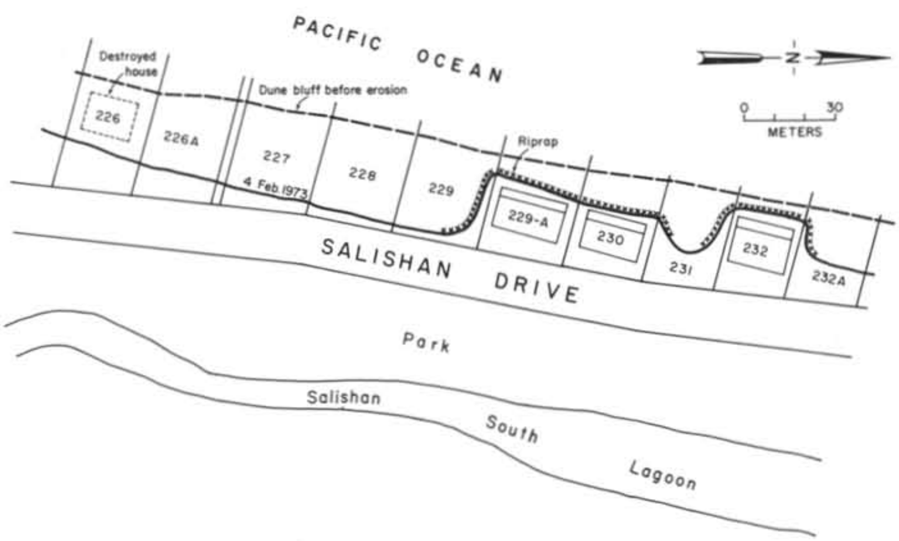


Figure 5. Successive surveys showing the retreat of the edge of the dune bluff. Riprap around lots 229-A through 232 prevented their erosion, but the erosion of the adjacent lots left them on a promontory extending out onto the beach.

length of the spit. Accretion of the dunes occurred in one area while another was eroding. In general, however, there appeared to be an overall predominance of either erosion or dune re-establishment at any given site. This is understandable since in a year of many storms on the coast there is a general predisposition toward erosion, but specific areas with wide beaches might still suffer no dune or property erosion.

The following sequence of events, as revealed by the aerial photographs, is typical of many cycles of erosion and accretion of the foredunes on Siletz Spit: (1) High waves eroded a vertical scarp in the seaward edge of the foredunes; (2) subsequent high tides deposited drift logs at the base of the scarp; (3) lower energy waves during the summer built a wide beach; (4) the logs behind the beach trapped sand that was either blown off the beach or washed there by the waves at high tide; (5) wind-blown sand continued to accumulate around the logs, sometimes aided by dune grasses, until the foredunes were re-established; (6) later erosion began a repetition of the cycle. Figure 7 illustrates the processes of dune reformation. One complete uninterrupted cycle takes 10 to 15 years.

Apparently such cycles of erosion and dune accretion have occurred repeatedly, the 1972-73 occurrence being the most recent episode of the erosion phase of the cycle. This last episode of erosion differed from earlier episodes mainly in that houses had been built along the landward edge of the reformed dunes. The seaward sides of many houses were on the crest of a healed erosion scarp that had formed as recently as 1962-64. Photographic coverage since 1939 indicates general advance of the foredunes through the early 1950's followed by erosion along most of the spit in the early 1960's. Rebuilding of the dunes began immediately and continued at least through 1967. Erosion since 1970 represents a renewal of the cycle.

Several lessons should be learned from the erosion to Siletz Spit. In sandy foredune areas of the coast, erosion can occur at any time, removing at least 50 meters of the foredunes. Later the foredunes may become re-established by natural processes. Man-made structures should not be built in areas subject to rapid wave erosion. Adequate setback lines should be established for such areas, preventing permanent construction. The areas should be left in their natural state, and riprap should not be installed when erosion does occur. Natural processes will repair the eroded area by re-establishing the foredunes: riprap is not needed to stop the erosion.

This study also demonstrates that drift logs play an important role in the natural rebuilding of the foredune areas on spits (Figure 7). Large-scale removal of logs from these areas may be harmful.

Causes of Erosion

The shoreline along Siletz Spit is typically very irregular (Figure 8) due to rip currents carrying sand offshore, hollowing out small bays on the beach with large cusps between them. At the time of erosion in 1972-73

Figure 6. Logs exposed within the eroded dune bluff, many of which had been sawed.

Figure 7. Logs deposited within small embayments eroded into the foredunes trap sands and help reestablish the foredunes.

a strong rip current was situated in one position for most of the winter. This rip current hollowed out a large embayment on the beach, entirely removing the portion of the beach above high tide level so that the wave swash was able to reach the dunes. The loose sand, offering no resistance to the waves, was easily eroded.

Severe erosion began during the last week of 1972 with the occurrence of large storm waves on the coast. A wave sensor at Newport, Oregon measured a deep-water wave height of 5.5 meters. Calculations indicate that the waves would have had a significant wave height of 7 meters when breaking on the beach. These are the highest storm waves that have been measured by the sensor since its installation in November 1971 (Komar and others, 1976).

A predisposition toward erosion on Siletz Spit occurs in winter when a series of storms removes most of the exposed beach, shifting the sand offshore. Actual erosion occurs when a rip current becomes stabilized in one position long enough to form an embayment that reaches up to the foredunes (Figure 8). Subsequent storm waves are then able to erode the dunes. This explains the periodic nature of erosion on the spit and why erosion shifts from one portion of the spit to another. The positions of the rip currents change from one year to the next. We are not able to predict yet where the rip currents will be positioned; however, once a strong rip current is positioned, we can predict that it is a potential site for severe dune erosion.

The level of the tides apparently did not play a major role in the erosion of Siletz Spit during the winter of 1972-73. During late December 1972 and early January 1973 high tides measured at Newport reached only a modest height of 2.3 meters above MLLW (mean low or lower water). Observed spring tides commonly reach as high as 3.4 meters MLLW. It is interesting to speculate how much greater the erosion to the spit would have been during this period of large storm waves had there been spring tides.

The erosion of 1972-73 cut farther back into the dunes than earlier episodes of erosion, at least since 1939. Sand mining operations on the beach to the south of the spit (Figure 9) may account for some of this (Rea and Komar, 1975). Some 84,500 cubic meters of sand were removed between 1965 and 1971. The beach is composed of coarse sand which has only a small long-term source, principally erosion of the sea cliffs behind the beach along this stretch of coast except on Siletz Spit itself. The Siletz River carries mainly finer sands unsuitable for the beach. In other Oregon Coast estuaries that have been studied, apparently most or all of this river sand remains in the estuaries and is not a source of beach sand. Analyses of beach sand confirm that it is derived from erosion of local sea cliffs (Rea and Komar, 1975). Rocky headlands to the north and south prevent sand movement alongshore from sources such as the Columbia River. Thus, Siletz Beach is a pocket beach, stretching from Cascade Head in the north to Government Point in the south, with only a small natural source of beach sand.

Figure 8. Irregular shoreline of bays and cusps are due to rip currents, one of which is shown in this photograph taken February 8, 1973.

Figure 9. Sand mining from the beach at School House Creek, south of Siletz Spit. Sand was removed from the beach at low tide (upper photo) and piled just inland (lower photo).

For these reasons, removal of the sand by mining operations probably disrupted the natural budget of beach sand, the balance of sand gains and losses on the beach. With decreased volume, the beach was less able to protect the coastal property from wave attack, and accelerated erosion resulted. Therefore, although cycles of erosion to Siletz Spit are natural and are known to have occurred prior to beach sand mining, the mining operations probably caused increased erosion. Beach sand mining has subsequently been stopped.

Present Status of Erosion on Siletz Spit

The winters of 1973-74 and 1974-75 were mild, and the few storms that did occur were not intense (Komar and others, 1976). Erosion is again occuring during this winter (1975-76), centered principally near the park and at the far north end of the spit, near the northernmost house on the spit. In both cases the erosion is again caused by rip currents hollowing out the beach. The erosion to the north spit area would have threatened one or two houses except that adequate riprap had been previously installed.

Some of the lots that were eroded in 1972-73 have been subsequently restored (Figure 10). These are either not protected or are inadequately protected: another winter of intense storms could bring renewed erosion. During this winter (1975-76) no rip current is located offshore from this area, and there is no erosion.

Some houses for which riprap was installed in 1972-73 could be endangered by future erosion because the riprap protection is inadequate. In some cases the riprap has partially eroded, exposing the dune sands (Figure 11). This riprap was installed hastily in order to save the houses at the time of severe erosion in 1972-73, and installation did not follow the established engineering procedures for riprap construction. Even more important, stones of inadequate size were used because of their availability: these are easily washed away by waves.

This illustrates another lesson to be learned from the erosion of Siletz Spit. When homes are constructed in sandy areas close to the ocean, there is a strong possibility that subsequent erosion may necessitate the installation of riprap at considerable expense. Some homeowners have already spent about $15,000 in their defense against the ocean, and more expense may be required.

It is now necessary that the area be uniformly protected with riprap. As we have seen from the experience at Siletz Spit, if one neighbor does not protect his property, the defense will be breached and the erosion may come from the side rather than from the ocean-front. When sand areas near the ocean are developed without adequate setback the entire area must be protected, perhaps by the developer.

The necessary placement of riprap acts to limit beach access from the homes. Riprap also interferes with the scenic aspects of the coast that draw

Figure 10. Restoration of the lots 228 and 229. Compare with Figures 3 and 4.

Figure 11. Erosion of the riprap fronting one of the homes, exposing some of the dune sands. Note small size of the rocks, which are easily removed by erosion.

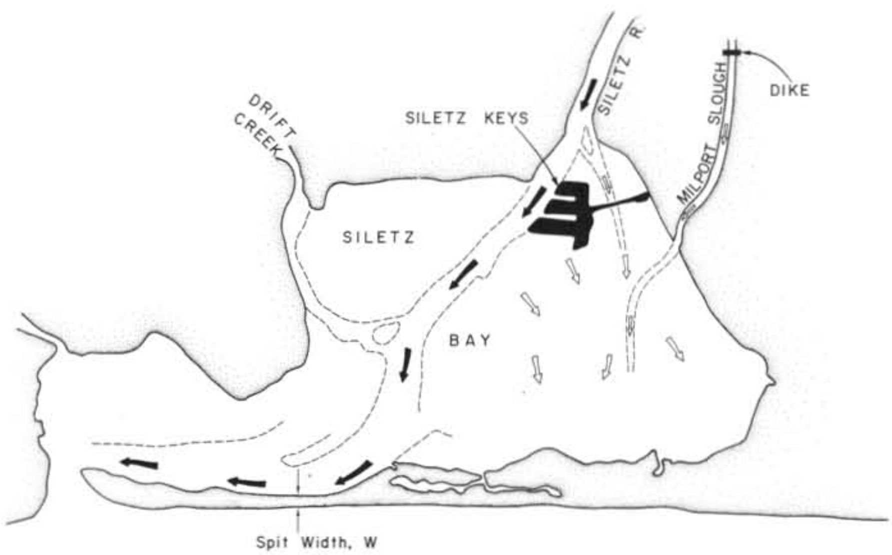
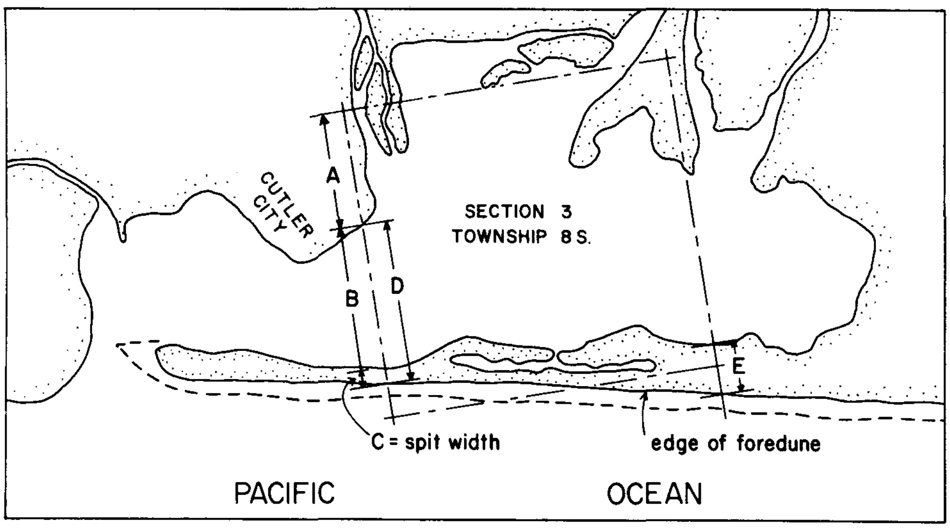


Figure 12. Siletz River flow through the estuary. Open arrows show how flood waters formerly spilled into the south bay, prior to diking of Milport Slough and to placement of Siletz Keys fill. Not shown is the fill for the new highway bridge, which also prevents spill in the Siletz Keys area. Now flood waters flow down main channel as shown by the black arrows, directed at back of spit.

people to the beach. With adequate setback lines established and observed, riprap is not needed.

Erosion to the Bay Side of the Spit

Erosion has been occurring on the bay side of the spit where the flow of the Siletz River through the bay impinges on the spit near its north end (Figure 12). The progress of this erosion was studied with aerial photographs and old surveys dating back to 1875, the original survey of this area. Fortunately, one of the section lines passed directly across the eroded area (Figure 13). This provided measurements of the distances A, B, C, D, and E in Figure 13. These distances were measured on the series of aerial photographs dating back to 1939. The results are shown in the graph of Figure 13.



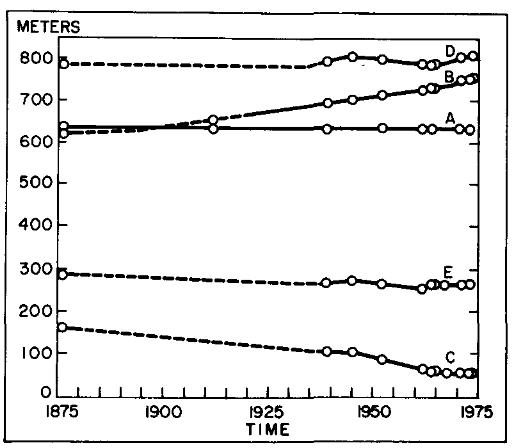


Figure 13. Data from old surveys and aerial photographs showing the progressive decrease in the spit width C due to erosion on the bay side.

In 1875 the width of the spit, C, was 163 meters. By 1939 it had decreased to 102 meters. Now it is only 52 meters wide. The progressive increase in the distance B across Siletz Bay shows that the 111-meter decrease in the spit width was due entirely to erosion on the bay side. The edge of the foredunes (taken as the seaward limit of the spit width) fluctuated somewhat in position due to the cycles of erosion and dune reformation discussed above but did not change its overall position in those 100 years. This is reflected in the irregularity of the distance D in Figure 13. The erosion on the bay side appears to have been fairly steady until recently when riprap was installed to stop the erosion (Figure 14).

It is difficult to determine exactly when this erosion began. If the rate of erosion from 1939 until the installation of riprapping is projected backward through time, it appears likely that erosion began about the turn of the century. Historical evidence such as settlers' comments on channel migrations and clam populations within the bay support this time as the beginning of the erosion (Rea and Komar, 1975). It may have been due to a natural meandering of the Siletz River channel within the bay. Occurring simultaneously with settling, logging, and farming in the drainage basins of the rivers, it may be that a sudden increase in siltation within the bay caused the channel migration. There is some evidence that a delta built by Drift Creek pushed the Siletz River against the spit (Rea and Komar,1975).

Recent landfills in Siletz Bay (Figures 12 and 15) have probably aggravated the erosion problem. Both the Siletz Keys fill and the dike on the Millport Slough prevent flood discharge spill into the south bay. Prior to these fills, flood waters flowed in part into the south bay, dissipating their energy. Now that the fills prevent this spill, the full flood discharge of the Siletz River is directed toward the back of the spit into the area that is eroding. Riprap has reduced the expected increase in erosion, but whether the riprap will continue to be effective is questionable.

Removal of the dike on the Millport Slough would partly eliminate this aggravation and would improve water circulation in the south part of the bay. Removal of the dike-entrance to Siletz Keys is no longer sufficient because the recent construction of a new bridge for Highway 101 over the Siletz River has also blocked that spill channel (Figure 15). A conduit under the approach to the bridge would also be necessary.

Landfills within bays and estuaries have an effect on the ecology of the area and change the water circulation, and changes in water flow may cause serious erosion of shorelines in the bay as seen at Siletz.

References

Komar, P.D., and Rea, C.C., 1975, The causes of erosion to Siletz Spit, Oregon: Oregon State Univ. Sea Grant College Program Publ. no. ORESU-T-75-001, 20 p.

Figure 14. Riprap placed on the bay side of the spit to prevent or decrease erosion.

Figure 15. Aerial view of the Siletz Keys fill and the approaches to the old and the new highway bridges. Note how the access road to the Siletz Keys and the approach to the new bridge both block the channel leading to the south bay.

Komar, P.D., Quinn, W., Creech, C., Rea, C.C., and Lizarraga-Arciniega, J.R., 1976, Oregon Coast wave conditions and beach erosion: Ore Bin, vol. 38, no. 7, p. 103-112.

Rea, C.C., and Komar, P.D., 1975, The erosion of Siletz Spit, Oregon: Oregon State Univ. Sea Grant College Program Publ. no. ORESU-T-75-001, Ref. 75-4, 105 p.

Terich, T.A., and Komar, P.D., 1973, Development and erosion history of Bayocean Spit, Tillamook, Oregon: Oregon State Univ. School of Oceanography, Ref. 73-16, 145 p.

Terich, T.A., and Komar, P.D., 1974, Bayocean Spit, Oregon: History of development and erosional destruction, in Shore and Beach, v. 42, no. 2, p. 3-10.

* * * * *

GEOTHERMAL LEASE SALE COMING IN SEPTEMBER

On Thursday, September 23, 1976 the U.S. Bureau of Land Management will hold a lease sale involving approximately 8,000 acres of Federal land within T. 33 S., Rs. 17 and 18 E. in the Summer Lake KGRA (Known Geothermal Resource Area). The sale will be through sealed bids which will be opened at 2:00 P.M. in the BLM conference room, 729 N.E. Oregon Street, Portland. Bids must be received by 1:00 P.M. on the day of the sale. Copies of the notice of the lease sale and stipulations may be obtained by writing BLM, P.O. Box 2965, Portland, OR 97208.

* * * * *

USGS REPORTS ON OPEN FILE

The U.S. Geological Survey has issued the following reports on areas in or adjacent to Oregon:

1. "Potential Hazards from Future Eruptions of Mt. St. Helens Volcano, Washington," by D.R. Crandell and D. R. Mullineaux. Open-file report 76-491. The 25-page report describes the products of eruption, potential hazards, and warning signs. Maps and charts emphasize the extent of past and possible future eruptions of this volcano, which the authors believe to be the most dangerous in the Cascade Range.
2. "Geology and Ore Deposits of the McDermitt Caldera, Nevada-Oregon," by James J. Rytuba. Open-file report 76-535. The 9-page report, illustrated by geologic and gravity maps, describes the structure, volcanic history, and ore deposits of this Miocene collapse feature. Ore deposits within the boundaries of Oregon are the Bretz and Opalite mercury mines.

Both reports can be consulted at the Department's library in Portland.

* * * * *

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed.)

BULLETINS

26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel.	$0.45
33.	Bibliography (1st suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1964: Baldwin	3.00
36.	Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 2	1.25
39.	Geology and mineralization of Morning mine region, 1948: Allen and Thayer	1.00
44.	Bibliography (2nd suppl.) geology and mineral resources of Oregon, 1953: Steere.	2.00
46.	Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	5.00
53.	Bibliography (3rd suppl.) geology and mineral resources of Oregon,1962:Steere,Owen	3.00
57.	Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors	3.50
60.	Engineering geology of Tualatin Valley region, 1967: Schlicker and Deacon	7.50
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	7.50
62.	Andesite Conference Guidebook, 1968: Dole	3.50
64.	Geology, mineral, and water resources of Oregon, 1969	3.00
65.	Proceedings of the Andesite Conference, 1969: McBirney, editor (photocopy)	10.00
66.	Geology and mineral resources of Klamath and Lake Counties, 1970.	6.50
67.	Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts	3.00
68.	Seventeenth biennial report of the Department, 1968-1970	1.00
69.	Geology of the southwestern Oregon Coast, 1971: Dott	4.00
70.	Geologic formations of western Oregon, 1971: Beaulieu	2.00
71.	Geology of selected lava tubes in the Bend area, 1971: Greeley	2.50
72.	Geology of Mitchell quadrangle, Wheeler County, 1972: Oles and Enlows	3.00
73.	Geologic formations of eastern Oregon, 1972: Beaulieu	2.00
75.	Geology, mineral resources of Douglas County, 1972: Ramp	3.00
76.	Eighteenth biennial report of the Department, 1970-1972	1.00
77.	Geologic field trips in northern Oregon and southern Washington, 1973.	5.00
78.	Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts and others	3.00
79.	Environmental geology inland Tillamook Clatsop Counties, 1973: Beaulieu.	7.00
80.	Geology and mineral resources of Coos County, 1973: Baldwin and others	6.00
81.	Environmental geology of Lincoln County, 1973: Schlicker and others	9.00
82.	Geol. Hazards of Bull Run Watershed, Mult. Clackamas Counties, 1974: Beaulieu	6.50
83.	Eocene stratigraphy of southwestern Oregon, 1974: Baldwin	4.00
84.	Environmental geology of western Linn Co., 1974: Beaulieu and others.	9.00
85.	Environmental geology of coastal Lane Co., 1974: Schlicker and others	9.00
86.	Nineteenth biennial report of the Department, 1972-1974	1.00
87.	Environmental geology of western Coos and Douglas Counties, Oregon, 1975	9.00
88.	Geology and mineral resources of upper Chetco River drainage, 1975: Ramp	4.00

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck $2.00; mailed -	2.50
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (from Bulletin 37)	1.00
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker	1.50
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	1.50
Geologic map of Bend quadrangle, and portion of High Cascade Mtns., 1957: Williams	1.50
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka	2.00
GMS-2: Geologic map, Mitchell Butte quadrangle, Oregon: 1962	2.00
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka	2.00
GMS-4: Gravity maps, Oregon onshore & offshore; [set only]: at counter $3.00, mailed	3.50
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess	2.00
GMS-6: Preliminary report, geology of part of Snake River Canyon, 1974: Vallier.	6.50

[Continued on back cover]

The ORE BIN
1069 State Office Bldg., Portland, Oregon 97201

Second Class Matter
POSTMASTER: Form 3579 requested

The Ore Bin

Available Publications, Continued:

SHORT PAPERS

18. Radioactive minerals prospectors should know, 1976: White, Schafer, Peterson	$0.75
19. Brick and tile industry in Oregon, 1949: Allen and Mason	0.20
21. Lightweight aggregate industry in Oregon, 1951: Mason	0.25
24. The Almeda mine, Josephine County, Oregon, 1967: Libbey	3.00
25. Petrography, type Rattlesnake Fm., central Oregon, 1976: Enlows	2.00

MISCELLANEOUS PAPERS

1. Description of some Oregon rocks and minerals, 1950: Dole	1.00
2. Oregon mineral deposits map (22 x 34 inches) and key (reprinted 1973):	1.00
5. Oregon's gold placers (reprints), 1954	0.50
6. Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton	3.00
7. Bibliography of theses on Oregon geology, 1959: Schlicker	0.50
(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts	0.50
8. Available well records of oil and gas exploration in Oregon, rev. 1973: Newton	1.00
11. A collection of articles on meteorites, 1968 (reprints from The ORE BIN)	1.50
12. Index to published geologic mapping in Oregon, 1968: Corcoran	0.50
13. Index to The ORE BIN, 1950-1974	1.50
14. Thermal springs and wells, 1970: Bowen and Peterson	1.50
15. Quicksilver deposits in Oregon, 1971: Brooks	1.50
16. Mosaic of Oregon from ERTS-1 imagery, 1973:	2.50
18. Proceedings of Citizens' Forum on potential future sources of energy, 1975	2.00

OIL AND GAS INVESTIGATIONS

1. Petroleum geology, western Snake River basin, 1963: Newton and Corcoran	3.50
2. Subsurface geology, lower Columbia and Willamette basins, 1969: Newton	3.50
3. Prelim. identifications of foraminifera, General Petroleum Long Bell No. 1 well	2.00
4. Prelim. identifications of foraminifera, E. M. Warren Coos Co. 1-7 well: Rau	2.00

MISCELLANEOUS PUBLICATIONS

Landforms of Oregon: 17" x 22" pictorial relief map	0.25
Mining claims (State laws governing quartz and placer claims)	0.50
Oregon base map (22" x 30")	0.50
Geologic time chart for Oregon, 1961	.10
Postcard - geology of Oregon, in color	10¢ each; 3 - 25¢; 7 - 50¢; 15 - 1.00
The ORE BIN - Annual subscription ($8.00 for 3 yrs.)	3.00
Available back issues, each	25¢; mailed 0.35
Accumulated index - see Misc. Paper 13	

GOLD AND MONEY SESSION PROCEEDINGS

Second Gold and Money Session, 1963 [G-2]	2.00
Third Gold and Money Session, 1967 [G-3]	2.00
G-4 Fifth Gold and Money Session, Gold Technical Session	5.00