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WAVE CONDITIONS AND BEACH EROSION ON THE OREGON COAST

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Ocean wave conditions have been measured daily at Newport, Oregon by a unique seismic recording system that detects microseisms produced by the waves. This yields a measure of the significant wave height and period every 6 hours. Data from November 1971 through June 1975 have been analyzed, and the expected breaking wave conditions have been determined. This wave data set is the longest and most complete available for wave conditions on the Oregon Coast.

Wave heights and energies are important in beach and coastal erosion. One of the more dramatic examples of this on the Oregon Coast occurred on Siletz Spit in the winter of 1972-73 (Komar and Rea, in press). This episode of erosion will be discussed in light of the wave measurements. The wave measurements also have application to the prediction of hazardous navigation at the many harbor entrances on the Oregon Coast (Enfield, 1973).

Wave Conditions and Measurements

Waves reaching the Oregon Coast play an important role in eroding beaches, sea cliffs, and headlands. Large waves can also cause the closure of port entrances. Unfortunately, until recently only scattered measurements had been made of waves off Oregon and no method was available for routine daily measurements. O'Brien (1951) reported on visual observations made on the Columbia River lightship. National Marine Consultants (1961) provided wave hindcast data of sea and swell but made no actual measurements. Rogers (1966) obtained wave data from an oil rig off the Oregon coast and reported seas with waves of 50 feet (15 m) height occurring under winds gusting up to 150 mph (67 m/sec). Similarly, from observations on an oil rig, Watts and Faulkner (1968) reported waves up to 58 feet (18 m) with one wave 95 feet (29 m) high generated by two separate storms. The measurements of both Rogers (1966) and Watts and Faulkner (1968) do not represent average wave conditions during the severe storms, but exceptional waves produced by the chance constructive summation of several large waves. However impressive these studies are in reporting exceptional waves off the Oregon Coast, they do not provide measurements of daily wave heights and periods that are required in coastal erosion studies or other applications.

As part of an attempt to better define Oregon Coast wave conditions, W. Quinn, D. Zopf, and C. Creech installed a seismic recording system at the Marine Science Center, Newport, which went into operation in November 1971. This system is described in Enfield (1973), Quinn and others (1974), and in Bodvarsson (1975), so it will be discussed only briefly here.

Early investigators noted that microseisms could be produced by high surf conditions. Microseisms are small vibrations of the earth's surface of periods 4 to 10 seconds, with amplitudes up to 20 microns. It was noted that the microseisms at some locations were recorded before the swell had actually reached the surf zone, suggesting that wave energy is somehow transmitted to the deeper water sea floor, causing the microseisms. Longuet-Higgins (1950) developed a consistent theory to explain the development of microseisms from offshore waves and predicted the relationship between the period of the ocean waves and the period of the microseism oscillations. His predictions have been substantiated by the recordings at Newport. Darbyshire (1962) gives a complete review of the theories and observations relating microseisms to sea-wave conditions.

The seismometer at the Newport Marine Science Center senses the vertical velocity of the ground motion. An oscillating trace is thus recorded from the seismometer. A series of calibrations was performed by comparing these recordings to direct observations of wave heights and periods causing the microseisms. This led to an empirical equation relating the ocean wave heights to amplitudes of oscillation of the seismometer recording. Figure 1 gives scatter diagrams of seismometer-predicted wave heights versus visually observed or pressure-sensor recorded wave heights. It is seen that there is good agreement. Direct measurements of the wave periods showed that the period of oscillation of the seismic record is half the period of the waves. This confirms the prediction of the relationship made by Longuet-Higgins (1950).

The visual and pressure-sensor records of ocean waves to which the seismic system is empirically related were obtained offshore in a water depth of 12 meters (40 feet). Thus the wave conditions evaluated with the seismic system refer to that water depth and do not directly yield a measure of the breaking wave. For periods less than about 5.5 seconds a water depth of 12 meters can be considered deep water: that is, the ratio of the water depth to wave length is greater than 1/4 (Komar, in press). Computations of wave length, velocity, and energy are greatly simplified in deep water over those calculations in shallower water depths. Unfortunately, most of the measured waves at Newport have periods longer than 5.5 seconds, making them intermediate depth waves (Komar, in press) rather than deep-water waves. However, in the calculations all waves were still treated as if they

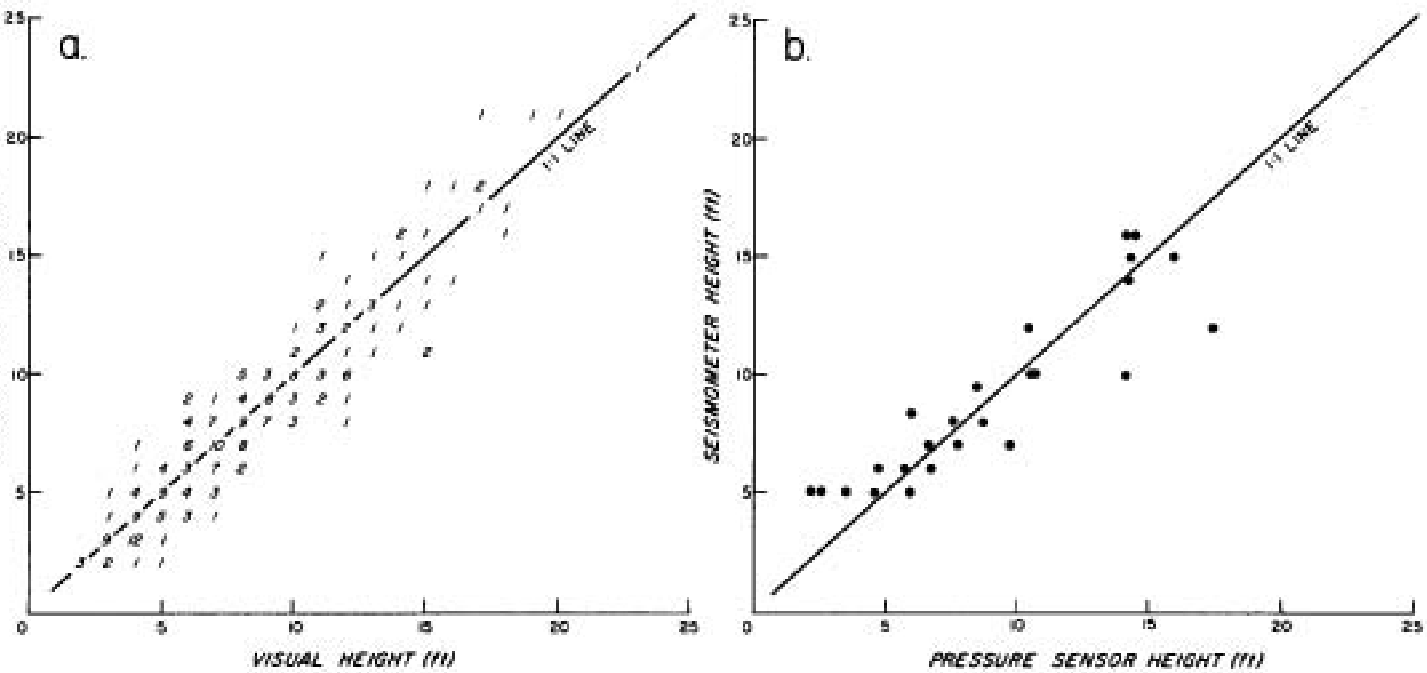


Figure 1. Scatter diagrams of seismometer-predicted wave heights versus (a) visually observed heights and (b) pressure-sensor wave heights. (After Enfield, 1973).

were in deep water. This introduced some error, but the error never amounted to more than 9 percent and was generally considerably less. The uncertainties in the basic measurements are well above this introduced error, and the simplifications introduced by treating them as deep-water waves were sufficient to warrant such an approximation.

The expected breaker heights can be calculated from the deep-water wave height H_∞ and period T provided by the seismic system. This is done with the equation

$$H_b = 0.39\, g^{1/5} (T H_\infty^2)^{2/5}$$

of Komar and Gaughan (1973), wherein H_b is the breaker height and g is the acceleration of gravity (981 cm/sec^2).

The seismic system at Newport is set to obtain a 10-minute record every 6 hours. Thus we ar e provided with a measure of the significant wave height and period every 6 hours. In our analysis the four daily measurements were averaged to obtain an average significant wave breaker height and period for each day. Averaging reduced the immense amount of data provided by the system and yielded a daily estimate of the wave conditions with smaller measurement error than inherent in any single estimate.

Such an analysis was performed for data obtained during the period November 1971 through June 1975. Figures 2 through 5 show the results, presented as averages for each 1/3 month. Also given are the maximum and minimum wave breaker heights that occurred during the 1/3-month durations.

It is seen that larger breaker heights prevail during the winter months, reaching on the average about 4.5 meters. However, individual storms are seen to produce maximum daily waves with significant breaking heights of some 7 meters (23 feet). It will be recalled that the "significant wave height" is defined as the average of the highest one-third of the waves measured over a span of time. This means that there will be individual breaking waves much higher than the significant wave height estimated in this analysis.

During the summer months of June through September the breaker heights are seen in Figures 2 through 5 to average only a little over 1 meter; individual storms can produce breakers of significant wave height of 4 meters (13 feet) even during the summer.

Also shown in the figures is a plot of the wave period, again measured over 1/3-month increments. Each year the wave periods tend to be higher during the winter months of storms, the periods being mainly 10 to 13 seconds, then drop to around 7 to 9 seconds during the quieter summer months.

Applications of Wave Data

Observations obtained at Newport are useful in several studies. Among these is charting beach and coast erosion. It is well known that the increase in wave heights and energy during the storm months of November

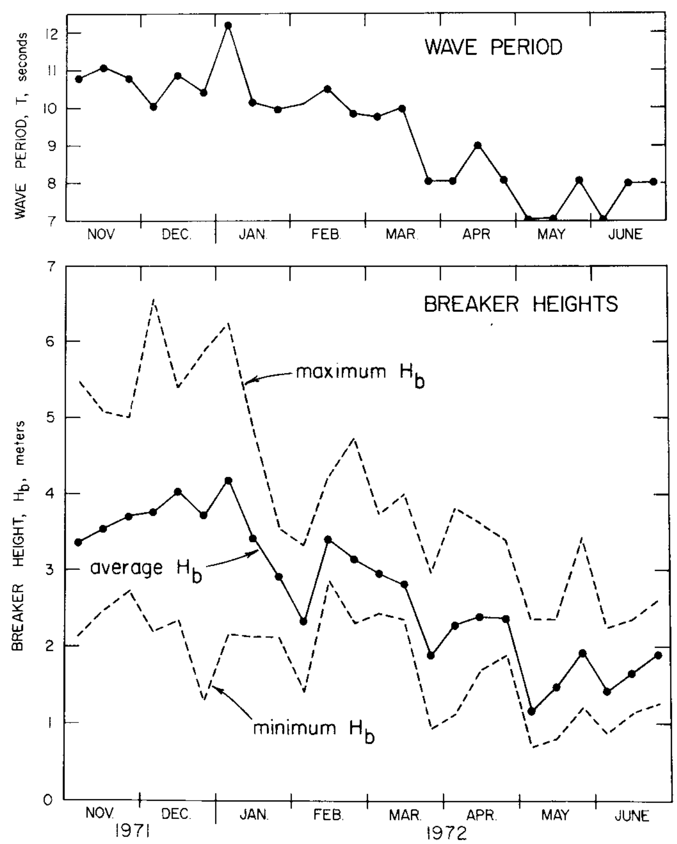


Figure 2. Significant wave breaker heights and periods calculated from measurements obtained with the seismometer system at Newport, Oregon. Given are the average H_b, which are average breaker heights for each 1/3 month and the highest and lowest breakers determined for that 1/3 month.

and December progressively shift more and more beach sand to the offshore. There is general transformation of the beach profile from a "swell profile" to a "storm profile" as shown in Figure 6. These profile types are sometimes also referred to as the "summer profile" and the "winter profile" because of their general agreement with those seasons. The sand shifted offshore during the storms of winter months is returned to the beach during the lower wave conditions of April through September. In general, from late December through January the beaches have the least amount of sand. It is during these months that the Oregon Coast experiences nearly all of its sea-cliff and property erosion. This is because, as seen in Figure 6, the swash of the incoming waves can reach the coastal property.

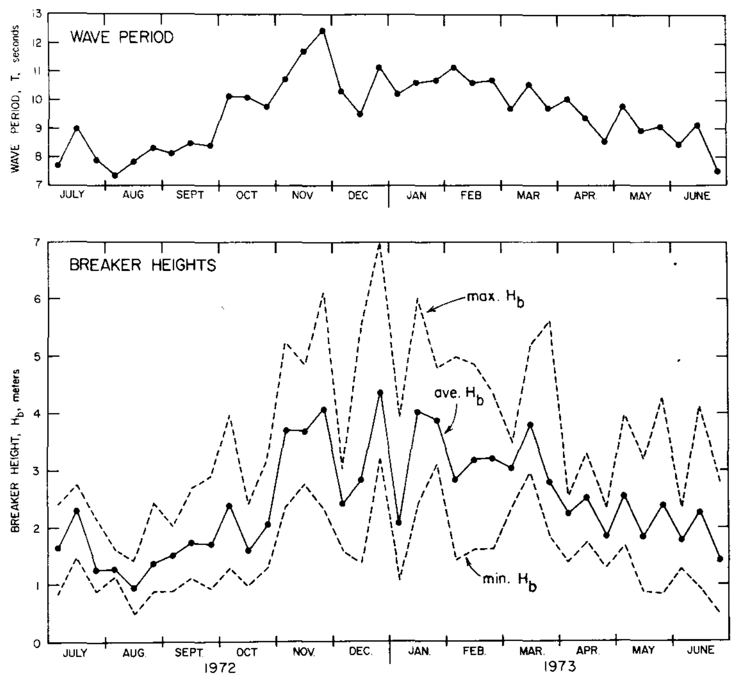


Figure 3. Significant wave breaker heights and periods at Newport for July 1972 through June 1973.

The beach acts as a buffer between the ocean waves and the coastal sea cliffs. During the summer months, when there is a wide berm, the flat portion of the beach (Figure 6), the waves break far offshore and their swash energy is expended before reaching the shoreline. Even at highest tide levels, a wide berm prevents the waves from reaching the coastal sea cliffs and dunes to cause erosion. In contrast, during the winter months, when sand is removed from the beach berm and shifted offshore, the wave swash can reach the coastal property and cause erosion.

The wave data obtained at Newport could be used to better understand these onshore-offshore shifts of beach sand. This would require establishing a series of beach profiles so that the quantities of sand moved could be correlated with the causative wave conditions. Such a study was undertaken on the Oregon Coast by Fox and Davis (1974), who mapped three beaches by series of profiles obtained at low tide. These maps show the positions of bars, troughs, and rip channels. Successive maps show changes in the beaches, shifts in these features, and quantities of sand moved onshore or offshore. The study of Fox and Davis demonstrated that beach erosion and sand bar migration can be related to the weather and wave conditions. The study extended only over a time of 45 days, but if expanded over an entire year it would relate the changing wave conditions measured at Newport to the seasonal beach profile shifts discussed above.

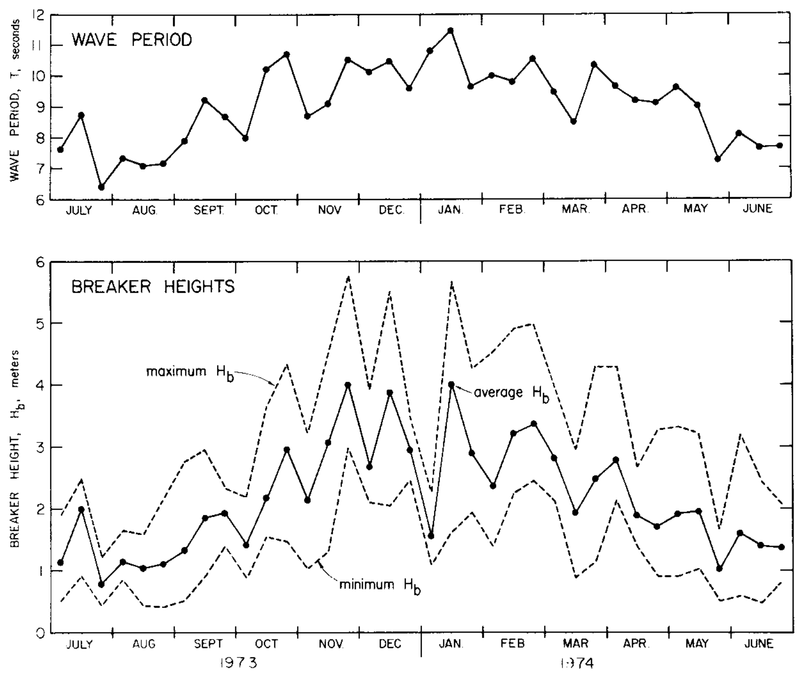
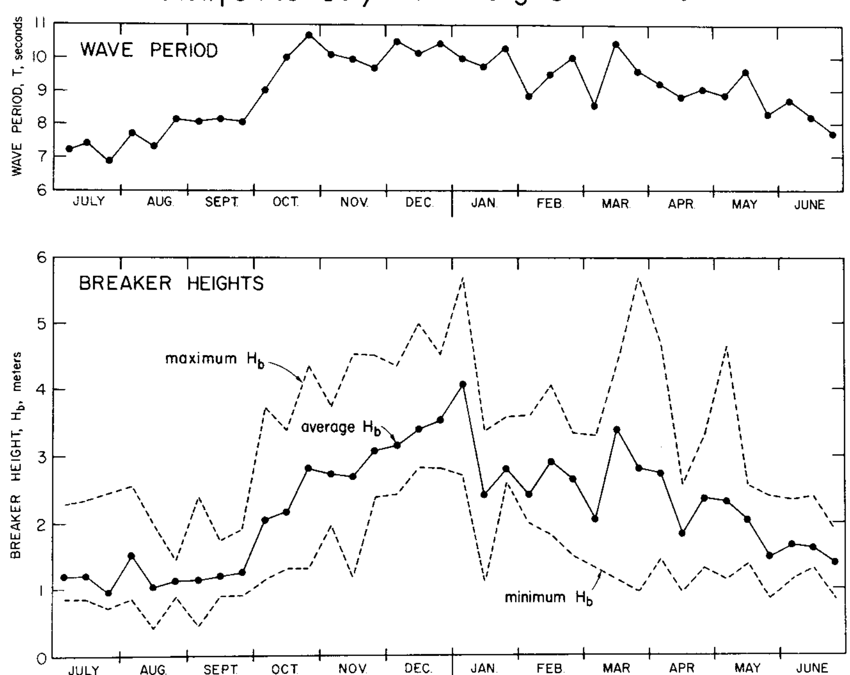


Figure 4. Significant wave breaker heights and periods at Newport for July 1973 through June 1974.

Figure 5. Significant wave breaker heights and periods at Newport for July 1974 through June 1975.



Such a study for an entire year might provide the ability to determine critical wave conditions (height and period) for causing beach sand shifts onshore or offshore and the quantities that are shifted. In this way we could better understand, and perhaps predict, seasonal shifts in the beach profile and when episodes of property erosion are liable to occur on the Oregon Coast.

In general, during November and early December on the Oregon Coast, sand is progressively shifted offshore; but some berm still remains from the previous summer, so that little property damage occurs in spite of intense wave action (Figures 2 through 5). By mid-December most of the berm has been washed away and sand has been shifted offshore. Now wave swash can reach the cliffs and dunes, so property is damaged by waves smaller than the earlier waves, which could not reach the cliffs. For this reason, episodes of sea-cliff and dune erosion on the Oregon Coast generally occur in late December through February. By March the wave heights and energy are reduced so that sand is shifted onshore and the berm is restored. Even during the summer months, however, a storm can occur which shifts sand offshore. Similarly, during the winter months a period of low waves may prevail for a time with beach sand shifted back onto the berm. In this way beach changes can be closely tied to the varying wave conditions. By monitoring the waves arriving at the Oregon Coast, we may eventually be able to anticipate beach changes and predict when property erosion might be severe.

The relationship between the wave conditions and coastal erosion is demonstrated by the erosion that has occurred at Siletz Spit during the past 5 years. The erosion has been discussed in detail in Rea and Komar (1975) and by Komar and Rea (in press), so only the relationship to the wave conditions will be examined here.

Only minor erosion of the dunes occurred on Siletz Spit during the winter of 1971-72. Figure 2 shows that in early December wave breakers reached 6.6 meters, and a storm during the first week of January 1972 produced breakers of 6.1 meters. The December storm may have been too early to produce dune erosion, some of the previous summer's berm offering protection.

The principal erosion to Siletz Spit occurred during the winter of 1972-73. Severe erosion took place in the last week of December 1972 when significant wave breaker heights of 7.0 meters were measured by the Newport seismic system. These are the highest breakers that have been measured by the system since its installation in November 1971. As discussed in Rea and Komar (1975) and Komar and Rea (in press), there are many factors other than just the wave height and energy that account for the erosion. Of importance, at that time strong rip currents had remained constant and had removed most of the berm, enabling wave swash to reach the dunes. The erosion continued through January and into February 1972. It would have eroded still more of the spit if riprap had not been placed to protect the dunes.

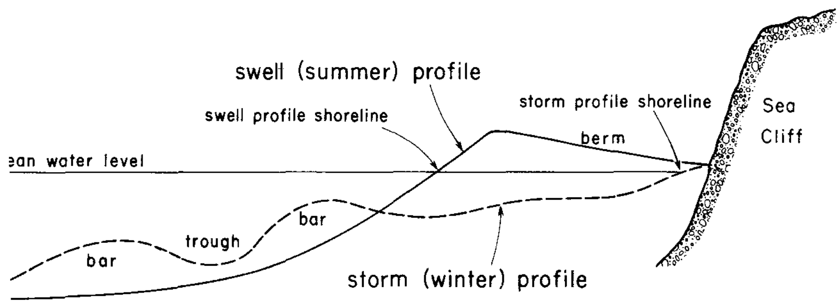


Figure 6. Beach profile typical of swell waves that occur during the summer, characterized by a wide berm exposed above the mean water level, versus a storm (winter) profile where sand has been shifted offshore from the berm to form a series of bars. (After Komar, in press).

During the winters of 1973-74 (Figure 4) and 1974-75 (Figure 5), when no storms produced breaker waves over 6 meters, very little erosion occurred to the property on Siletz Spit. It was observed that during those winters a protective berm existed along the entire length of the spit.

Although coastal erosion at some site such as Siletz Spit is a complex function, it is apparent that the height and energy level of the incoming waves is important. It is no coincidence that the severest erosion at Siletz occurred when the waves reached their greatest heights during the 44 months of observation.

Conclusion

In this report only one application was discussed for the wave data collected by the seismic recording system at the Marine Science Center, Newport. There are other obvious applications, such as the prediction of wave and bar conditions at harbor entrances. For example, Enfield (1975) has developed a computerized forecasting method and a hazard index for the mouth of the Columbia River.

The scope of applications may increase. Seismic systems similar to that at Newport are presently being installed at other sites on the Oregon Coast. Systems are now in operation at the Chetco River mouth and at Coos Bay. In Washington, systems have been installed at Cape Disappointment, at Quillayute, and at Westport. With these several systems in operation, we can expect to be better able to define the wave conditions on the coast of the Pacific Northwest.

Acknowledgements

This work is a result of research sponsored by the Oregon State University Sea Grant Program, supported by the National Oceanographic and Atmospheric Administration, under grant number 04-6-158-44004. We would like to thank Dave Zopf for his suggestions during the preparation of the manuscript.

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PETRIFIED BED ROLL?

This flow roll in the lower Coaledo Formation at Sunset Bay was formed during the deposition of the enclosing sediments and prior to cementation or uplift. As the overlying beds were laid down the thin layer of sand became mobilized and moved gently downslope. Friction against the enclosing beds generated the roll structure seen here. Later cementation by calcite accounts for the relative resistance to erosion. Preconsolidation structures such as this are easily recognized because they are restricted to individual beds and lack direct relationship to regional tectonic structures. The lower Coaledo Formation is an upper Eocene shallow-water deltaic deposit restricted to the Coos Bay area.

A similar feature, occurring in an outcrop of Cretaceous sandstone on Highway I-5 South of Medford, was described by Boggs and Swanson in the February 1970 issue of The ORE BIN.

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THE ART OF UNASSEMBLING

Ralph S. Mason, Deputy State Geologist
Oregon Department of Geology and Mineral Industries

A century ago mechanical devices were relatively few, were composed of a limited number of different materials--and were built to last. Today the exact opposite is true. Even our simplest machines often have a dozen or more metals and plastics assembled so inextricably that not even death will do them apart.

Once is was possible to unbolt worn-out parts of a machine and bolt on replacements. Now many such repairs are either impossible or economically unfeasible. When the weakest part fails, the whole machine is discarded. The U.S. Bureau of Mines has documented the complexity of the problem in the table opposite.

Each year approximately eight million cars are junked to recover their iron and steel. Half of these are shredded by huge machines into fist-sized pieces which are then treated electromagnetically to recover the iron and steel. The other half of the cars are dismantled by hand and the ferrous scrap is salvaged. The wasted non-ferrous material resulting from all this recycling amounts to 1.5 million tons annually. A total of 300,000 tons of this material consists of various metals having an estimated value of $120 million.

The U.S. Bureau of Mines has been working on the recycling problem for several years and has developed a smokeless incinerator for the preliminary burning of the car bodies, and more recently a water and air separation technique which separates the non-ferrous from the ferrous scrap. Further refinements to the process will, we hope, result in the separation of the three principal non-ferrous metals: aluminum, copper, and zinc.

1975 CAPRICE ESTATE WAGON — Photo courtesy of GM Corp.

Components of a 1975 Chevrolet Caprice Station Wagon

Group Number	Component Material		Weight lb	Weight pct
1	Polyurethane foam		46.6	0.93
2	Polypropylene		37.6	.75
3	Acrylonitrile butadiene & styrene (ABS)		30.0	.60
4	Vinylized fabric		27.0	.54
5	Nylon rug		13.9	.28
6	Plated ABS		4.1	.08
7	Vinyl		6.9	.14
8	Tar-like backed felt		46.5	.93
9	Polyethylene		4.7	.09
10	Acrylic		2.2	.04
11	Nylon fabric		2.3	.05
12	Styrene		.2	.01
13	Phenolic		.3	.01
14	Bakelite		1.7	.03
15	Nylon		2.6	.05
16	Polyvinyl acetyl		.3	.01
17	Fiber		.2	.01
18	Polyester		.3	.01
19	Teflon		.1	.01
20	Mastic		5.7	.11
21	Tygon		1.4	.03
22	Cotton fabric		3.7	.07
23	Fiberglas		2.7	.05
24	Tin		.1	.01
25	Lead		1.7	.03
26	Asbestos		2.2	.04
27	Clay		6.3	.13
28	Carbon		1.7	.03
29	Pressed paper/cardboard		8.7	.18
30	Felt		5.1	.10
31	Cotton mat		34.0	.68
32	Paper-cork		2.0	.04
33	Glass & ceramic	(Glass)	135.0	2.69
		(Ceramics)	1.4	.03
34	Light steel (< 1/8 inch thickness)		1,804.2	35.98
35	Chrome-plated steel		191.5	3.82
36	Spring steel		29.5	.59
37	Heavy iron & steel (> 1/8 inch thickness)		1,334.6	26.61
38	Cast iron		776.1	15.48
39	Aluminum		75.4	1.50
40	Zinc die cast		55.8	1.11
41	Stainless steel		5.6	.11
42	Copper & brass		51.2	1.02
43	Rubberized fabric		.8	.02
44	Rubber		208.9	4.17
45	Battery		42.2	.84
	TOTAL		5,015.0	100.00

What we really need, for cars and a host of other domestic and commercial machines, is an entirely new approach, as efficient as possible, to assembly, use, and disassembly. Quite possibly the method of assembly should be contingent upon eventual disassembly. We are experts at assembling but rather unskilled at taking things apart. Unfortunately our society looks upon the ability to assemble with favor and on those who tear up,down, or apart with disdain. When these attitudes change, our dependence on foreign ores will diminish greatly and our entire economy will be improved.

* * * * *

FLUSH TOILETS AND REMBRANDTS

Lawrence F. Rooney

If 100 people were polled as to whether they would rather live out their lives in a house equipped with modern plumbing or in a house decorated by Rembrandts, 75 would choose the plumbing. Of the other 25, 20 would choose the Rembrandts because the question is hypothetical and they would not have to live with their choice. The other five would be crazy.

The moral to this story is that something may be exquisite and complex and require immense talent to produce, yet have lower priority in the business of living than something gross, simple, and amenable to mass production.

A parallel can be drawn in geology. For the past few decades theoretical geology has been given much more emphasis than applied geology, especially in the universities. A master's thesis on the provenance of a sandstone has been much preferred over the geologic mapping of a $7\frac{1}{2}$-minute quadrangle. Economic geology has received cursory attention. A project that did not require backup by a million dollars worth of equipment, especially computers, was suspect.

In the geological surveys, state and national, comparatively little effort and money were spent during those decades in determining the location, size, and grade of our mineral reserves and resources. Even now, I question that governmental geology has emerged from the never-never land of the sixties in response to the national crisis.

Meanwhile, the oil was being pumped, bigger tankers were being built, machines were digging holes large almost beyond imagination--all for minerals to support our affluence, which in turn supported our geological Rembrandts.

And society benefitted. Perhaps one of every hundred research projects provides us with new insights, and it seems that society must support a large number of researchers. . . to ensure those few who make one step forward. Those new insights, for example plate tectonics, are sometimes of fundamental and far-reaching significance to applied geology.

But perspective was lost, not only in geology, but in the whole country. One has learned to expect distorted perspective, even to the point of insanity, from the nation's economists. They have yet to discover that the earth is the fundamental source of our wealth and that it is finite. But geologists should know better, and mining geologists should know best of all, a point I will return to later.

Perspective was lost in that the geological profession did not stress one fact: we needed to find more raw materials--energy, minerals, and water--to sustain the affluence that supports theoretical research. (We rely upon the agronomists to stress conservation of productive land.) That emphasis was not given in geology departments in universities during the past decades. Yet all of us to a certain degree are molded by schools we attend, and our perspectives are set there. To correct this imbalance, universities need not adopt a whole set of new courses, but they need to set a new tone, that survival of the human species has first priority and that all other priorities devolve from that. Theoretical research, even more than art, is predicated on a stable economy with surplus production.

Industrial geologists and engineers, therefore, bear a great responsibility beyond that to their companies, a responsibility to the country and to mankind. They do much to affect public policy. They must go beyond their day-to-day duties in whatever aspect of the mining industry they are employed and see it in the context of the nation's supply and demand and the implications of ever-increasing production. They must read. A good place to start is "Potential Sources of U.S. Mineral Supplies," by Brobst and Tooker, published in the February issue of the Mining Congress Journal. All is not right, Jack. . . .

(From Mining Engineering, v. 28, no. 2, February 1976, p. 89)

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DOTY APPOINTED TO DEPARTMENT BOARD

July 1, Governor Bob Straub announced the appointment of Robert W. Doty to the three-member Governing Board of the Department of Geology and Mineral Industries. Doty fills the vacancy created when Lyle Van Gordon's term expired on March 15.

Doty, 43, is a former member of the Jackson County Planning Commission and a current member of the Southwest Regional Forest Practices Committee. He holds a B.S. degree in Chemistry from Eureka College, in Illinois, and an M.A. in Sedimentary Petrology from the University of Missouri. Currently he is working on a Ph.D. in Modern Geological Processes.

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OREGON COAST BOOK REPRINTED

Fifteen years ago Samuel N. Dicken (now Professor Emeritus of Geography at the University of Oregon), assisted by Emily Dicken, Carol Johannessen, and Bill Hanneson, produced a 151-page report, "Some Recent Changes of the Oregon Coast," for the Office of Naval Research. Government policy at that time was to produce only a few copies, so the report went out of print shortly after it appeared.

Recently the Lane County Geographical Society and the Eugene Register Guard reprinted this classic study. Copies are available from the University of Oregon Bookstore, 13th and Kincaid, Eugene OR 97403 at $2.95 over the counter or $3.60 mailed. Checks and money orders are payable to the store.

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PITTSBURG BLUFF FOSSILS DESCRIBED

"Oligocene Marine Mollusks from the Pittsburg Bluff Formation in Oregon," by Ellen James Moore, is a recent Professional Paper (No. 922) issued by the U.S. Geological Survey. The author describes 48 species of Oligocene mollusks of which five species and one subspecies are new. A geologic sketch map of the Vernonia area shows locations of collecting sites and measured sections; 17 plates illustrate the fossils.

Professional Paper 922 is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. The stock number is 024-001-02775-5. The price is $2.00.

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RATTLESNAKE FORMATION STUDY PUBLISHED

"Petrography of the Rattlesnake Formation at the Type Area, Central Oregon," is the title of Short Paper 25, the latest publication issued by the Oregon Department of Geology and Mineral Industries. The author is Dr. Harold E. Enlows, Department of Geology, Oregon State University.

The Rattlesnake Formation is a Pliocene fluviatile deposit interrupted by a prominent ignimbrite flow which had its source in the Harney basin area. Outcrops of the Formation lie within the drainage of the John Day River, with the type area situated near Picture Gorge.

The 34-page publication is illustrated with photographs of outcrops and thin-sections of the ignimbrite. An index map shows the distribution of the formation.

Short Paper 25 is for sale by the Oregon Department of Geology and Mineral Industries at its Portland, Baker, and Grants Pass offices.

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SUMMER LAKE ENVIRONMENTAL STUDY RELEASED

An environmental analysis record for the Summer Lake Basin Geothermal Interest Area has been released by the Bureau of Land Management. The Bureau prepared the study in response to the interest shown by energy companies in geothermal development in central Lake County. If leases are issued, environmental stipulations will govern the development.

The analysis report describes the environment of the 260-square-mile area and details the anticipated effects of geothermal leasing. Copies are available for public inspection at all Oregon Bureau of Land Management offices as well as in selected public libraries. The BLM Lakeview district office, P.O. Box 151, Lakeview OR 97630 has a few copies for public distribution.

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AVAILABLE PUBLICATIONS

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BULLETINS

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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
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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
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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
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GMS-4: Gravity maps, Oregon onshore & offshore; [set only]: at counter $3.00, mailed	3.50
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