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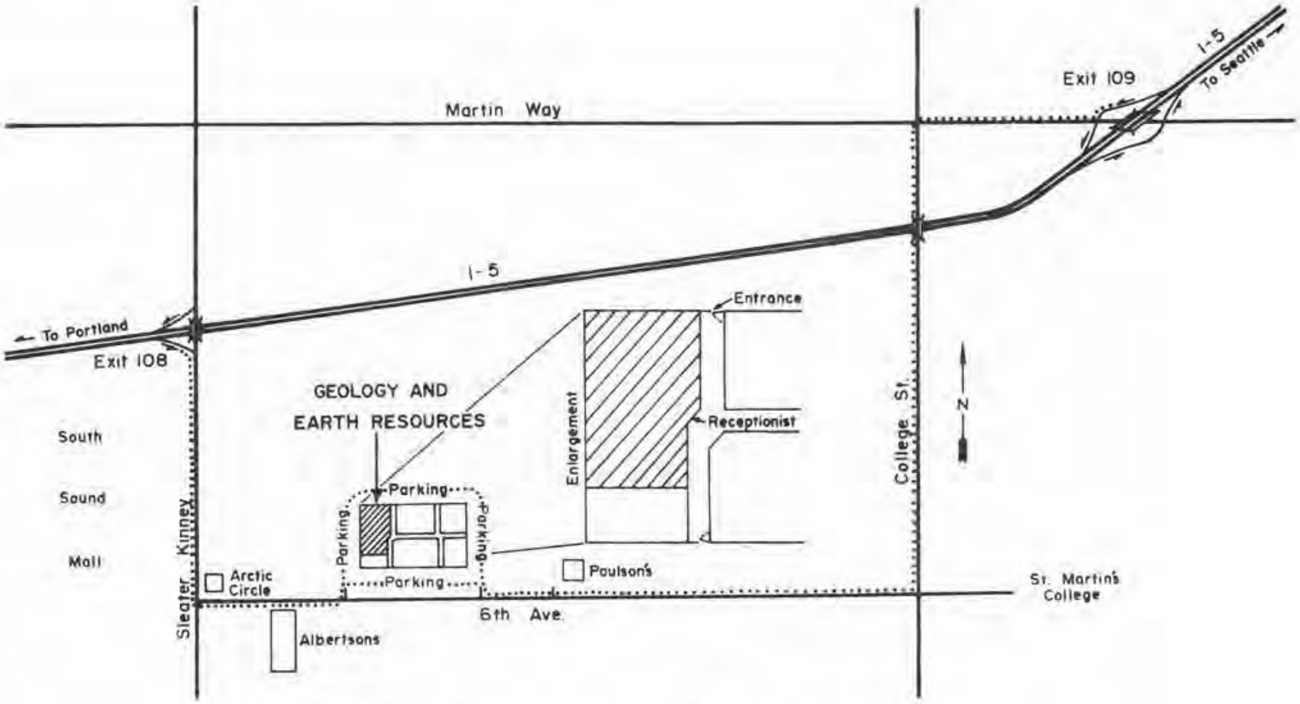

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The division also publishes bulletins, information circulars, and geologic maps. A list of these publications will be sent upon request.

NEW DEVELOPMENTS IN MINERALS AND ENERGY
WASHINGTON STATE
1980

by
Bonnie Butler Bunning[1/]

Metallic Mineral Exploration

The 1980 level of mining and exploration in Washington varied with each commodity. While 20 to 30 companies explored for uranium in 1979, only an estimated 16 were active in 1980, and of those, 50 percent were either seeking venture partners or pulling out of Washington entirely. Many have been discouraged by the relatively low U_3O_8 price and the uncertain political future of nuclear power generation. Gold and silver activity showed a dramatic increase both in new hard rock mining projects and prospector activity, including small dredging operations on the upper Columbia River and in streams of the Cascade Mountains. Substantial increase in recreational gold panning was noted also. Copper exploration attracted few newcomers this year and operations have been carried at the maintenance level on several projects since 1979. Some new molybdenum exploration was initiated and several molybdenum targets were drilled across the state. New zinc-lead exploration was moderate, while at several old mines, geologists drilled new extensions to buoy proven reserves while waiting optimistically for the zinc price to rise to a 50 cent minimum.

Okanogan County saw the most activity with 14 companies reported working in the area, followed by at least 13 in Stevens County, 9 in Ferry County, 6 in Pend Oreille County, 2 each in Chelan, Spokane, Skamania, Snohomish, and Whatcom Counties, and at least 1 in Pierce and King Counties (table 1). Many others worked generally in the Okanogan Highlands and north and south Cascade Mountains.

Washington Public Power Supply has permanently discontinued all exploration in the state. Reserve Oil and Minerals has left northeast Washington for Albuquerque, New Mexico, and Pathfinder Mines will be gone by 1981. Cyprus Mines, taken over by Amoco in 1979, is operating the Spokane office with a minimum staff. Rocky Mountain Energy has recently opened a Spokane office and is aggressively pursuing uranium targets in the northeastern part of the state. Nord, Inc. is another newcomer to the Spokane area.

Altogether a minimum of about 50 different companies were active in exploration and mining of metallic minerals in the 1980 season (table 2). This figure does not include the many small placer operations.

An estimated several hundred leases were held on state lands for mineral exploration. Hundreds more were committed to oil and gas efforts.

[1/] Geologist at Division of Geology and Earth Resources office in Cheney.

Table 1.—1980 county index of metallic mineral exploration and mining activity

County	Company	Commodity
Chelan	Bethex	Cu,Mo
	Cyprus Mines	Au
Ferry	Amax	Mo
	BurWest	Pb,Zn
	Day Mines, Inc.	Au,Ag
	Homestake Mining Co.	U
	Houston International	Au,Ag
	Mineral Associates	U
	Matt Obersbec	Au,Ag
	Rocky Mtn. Energy	U
	Ruby Mines, Inc.	Au,Ag
	Western Nuclear	U
King	Cominco American Inc.	Au
Lincoln	Rexcon	U
Okanogan	AFM Exploration	Mo
	Amax	Mo
	Bear Creek Mining Co.	Cu,Mo
	Bethex	Cu,Mo
	Chevron	U
	Cyprus	Au
	Denison Mines, Inc.	U
	Duval Corp.	Cu,Mo
	JNT-GPM Enterprises	Au,Ag,Pb,Zn
	Pathfinder	U
	Phillips Uranium	U
	Quintana	Cu,Mo
	Rocky Mines	Ag
	United Mines	Cu,Mo
Pend Oreille	BurWest	U
	Conoco	U
	Gulf Resources Corp.	Pb,Zn
	Homestake Mining Co.	U
	Joe McNamee	Pb,Zn,Cu,Ag
	Joy Mining Co.	Pb,Zn
Pierce	Amoco Minerals	Au,Ag,Cu,Mo
Skamania	Amoco Minerals	Cu,Mo
	Denison Mines, Inc.	Cu,Mo
Snohomish	Exxon	Cu,Mo
	Occidental	Cu,Mo
Spokane	Mineral Associates	U
	Westinghouse	U
Stevens	Arbor Resources Ltd.	Ag
	Charleston Resources	Ag
	Eagle Mountain Mining, Inc.	Cu
	Homestake Mining Co.	U
	Joe McNamee	Cu,W,Au
	Joy Mining	U
	Lowell Warner	Ag,Au,Pb,Sb,Cu
	Minatome	U
	Newmont	U
	Rocky Mountain Energy	U
	Sabine Products	U
	Toledo Resources Ltd.	Cu,Mo
	Western Nuclear Inc.	U
Whatcom	U.S. Borax	Ag
	Lions Mines	Au
Unidentified locations	Cominco American, Inc.	Au
	Minatome	U
	Teton Exploration	U

New activity in Pend Oreille County was dominated by lead and zinc exploration, both in the Belt Series and in Kootenay Arc carbonate rocks (fig. 1). Gulf Resources Co. ran a modest drilling program on potential extensions of the

Table 2.—Metallic mining - exploration companies active in Washington, 1980

AFM Exploration	Joy Mining Co.
Amax	Lions Mines Ltd.
Amoco	Midnite Mines, Inc.
Bear Creek Mining Co.	Minatome Corp.
Bethex	Mineral Associates
BurWest	Occidental Petroleum
Charleston Resources	Pathfinder Mines
Chevron	Phillips Uranium
Cominco American Inc.	Quintana Minerals Corp.
Conoco	Rexcon
Cyprus Mines	Rocky Mines
Dawn Mining Co.	Rocky Mountain Energy
Day Mines, Inc.	Sabine Products, Inc.
Denison Mines, Inc.	St. Joe American Corp.
Duval Corp.	Teton Exploration
Eagle Mountain Mining	Toledo Resources Ltd.
Energy Fuels	Union Carbide
Exxon	United Mines
Gulf Resources Co.	U.S. Borax
Homestake Mining Co.	Utah International
Houston International Minerals Corp.	Wallace Diamond Drilling
JNT-GPM Enterprises	Western Nuclear, Inc.
	Westinghouse

Pend Oreille mine workings. The mine remains closed primarily due to the low price of zinc.

Joe McNamee and others plan to open pit the Old Rocky Creek mine on Seldom Seen Mountain, 12 miles west of the Tiger Townsite. Two and a half million tons of lead-zinc and silver ore have been identified. Grade is unknown.

Joy Mining, among others, also conducted lead-zinc drilling programs in the county.

In Stevens County production at the Midnite mine continued at 960 tons per day of ore, grading .153 percent U_3O_8 in mine and stockpiles. Exploration drilling for extensions of known ore bodies was carried out on the Midnite holdings around the mine.

A few miles to the south, Western Nuclear's Sherwood mill maintained its 2,000 tons per day target capacity with mill feed grading .089 percent U_3O_8.

Interest in Stevens County uranium prospects waned dramatically, though some new projects were initiated (fig. 1). Sabine Products, a Texas firm, through Joy Mining made plans to heap leach a Flodelle Creek bog for uranium. Several other drilling, blasting, and mapping projects were carried out on hard rock uranium targets in the county by Rocky Mountain Energy, Western Nuclear, and others.

Arbor Resources has taken over the Melrose silver mine in the Northport area from Charleston Resources, both Vancouver corporations. An in-depth geologic study has begun there on the irregular polymetallic ore shoots in quartz veins, grading an average of 25 ounces per ton in silver.

Other activity in the Northport area included lead-zinc exploration on Flagstaff Mountain by Houston International Minerals, and geophysics by Toledo Resources on their Copperfind prospect, a bornite, chalcopyrite, and molybdenite occurrence. There was limited

Figure 1.—Mineral exploration and mining activity in Pend Oreille, Stevens, Ferry, Lincoln, and Spokane Counties, 1980.

production again from the Blue Grouse tungsten mine near Springdale.

Gold and copper exploration was reported near First Thought Mountain and Sand Creek in the Orient area. Geophysics and drilling for copper and tungsten were done on Mineral Mountain in the same vicinity. A small custom mill was built in Laurier to process local gold ore.

Significant progress is being made at the Mount Tolman project in Ferry County (fig. 1). Final agreement is imminent with the Colville Indian Tribal Council and the final Environmental Impact Statement will be submitted in December. Construction on the mine and mill complex is expected to begin in mid-1981 with production following in 1983-84. Production will be at the rate of 60,000 tons per day on this 900-million-ton ore body. Molybdenum grade is 0.10 percent with .09 percent copper.

The Knob Hill mine in Republic owned by Day Mines is enjoying the benefits of a general increase in precious metal prices. New reserves of 128,745 tons grading .43 ounce per ton in gold are nearly double the 70,000 figure of 1979. The grade in 1979, however, was .66 ounce per ton. The 1980 silver grade is listed as 1.63 ounces per ton.

Day Mines also explored potential extensions around the Knob Hill gold deposit. Competition in the area was presented by Houston International Minerals, who conducted extensive exploration and drilling in the Republic graben. Gold was produced at the Valley View mine (also called Golden Valley) near Curlew Lake. Ore from low-grade gold- and silver-bearing quartz veins was processed by a 100-ton cyanide plant run by Ruby Mines, Inc. Uranium, gold, and base metals prospects were also investigated in the county.

Matt Obersbee continued work at the Never-Fear mine where gold reportedly occurs in pyritic, graphitic greenstones veined by quartz.

Rexcon was active again drilling for uranium on Sand Flat (fig. 1) near Pitney Butte in Lincoln County.

Precious metal exploration highlighted activity in Okanogan County this year (fig. 2). Rocky Mines Co. of Republic began mining at the Silver Bell mine; the mineral values were 5.5 ounces per ton in silver and .02 ounce per ton in gold. It is the first major metal mine to begin production in Okanogan County in 25 years. One hundred and fifty thousand tons of ore have been blocked out in brecciated volcanics of the Klondike Mountain formation. Gangue consists of quartz, fluorite, and sanidine with pyrite and dustlike inclusions of silver. The ore is milled at the Dankoe mill north of Nighthawk and is smelted in Trail, B.C.

Exploration and development for gold was also carried out on the Gray Eagle and Reco vein north of Chesaw in the Meyers Creek-Wauconda

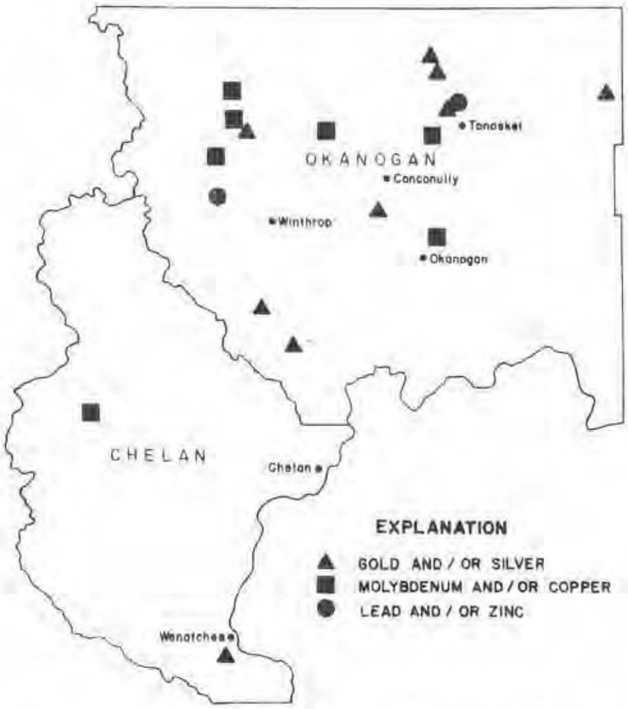


Figure 2.—Mineral exploration and mining activity in Okanogan and Chelan Counties, 1980.

district. Western Eagle Mining and Contracting, Inc., out of Oroville, is doing the work.

Geochemical studies and short core drilling were conducted at the Alder mine, a past producer in the Twisp district. Chalcopyrite, pyrite, sphalerite, pyrrhotite, and native copper were mined and milled in the 30's and 40's from sheared, silicified argillite.

Wallace Diamond Drilling pumped out the Ivanhoe mine shaft to sample the old workings for their silver potential, while Cyprus Mines investigated the American Rand gold mine.

Copper and molybdenum exploration continued at a modest pace with drilling at Bear Creek's Sherman property and at the Starr Molybdenum prospect. Work there was conducted by AFM Exploration of Canada.

Bethex worked on their Thunder Mountain claims, and United Mines worked at the Copper Glance prospect, while Cyprus, Duval, Amax, Quintana, among others, continued to explore for molybdenum and copper in the county.

At least four companies—Denison, Duval, Chevron, and Phillips—explored for uranium in Okanogan County this year.

The Slate Creek district of Whatcom County saw renewed activity in 1980, both in placer and hard rock gold mining (fig. 3). Lions Mines made plans to increase mill capacity at the Newlight mine from the present 100 tons per day to 200 tons per day. Limited processing of stockpiled ore accompanied mill development this year. Ore at the Newlight averages approximately .33 ounce per ton in gold in brecciated slate and argillite cemented by gold-bearing quartz and calcite veins. U.S. Borax continued work on the Excelsior mine, a silver mineralized breccia zone in Jurassic volcanics and sediments; and a western Washington concern, a past producer of gold in argillite, was active at the Lone Jack mine quartz vein system.

Figure 3.—Mineral exploration and mining activity in Whatcom, Skagit, and Snohomish Counties, 1980.

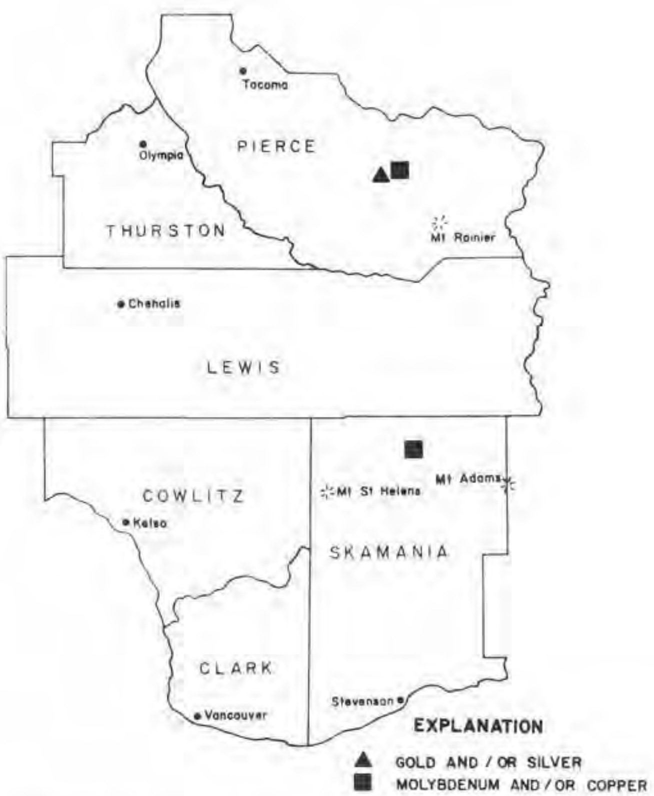


Figure 4.—Mineral exploration and mining activity in Pierce, Thurston, Lewis, Cowlitz, Clark, and Skamania Counties, 1980.

Modest drill programs and claim assessment work was conducted in Snohomish, Chelan, Skamania, and Pierce Counties, principally on Cascade porphyry copper deposits (fig. 4). No new discoveries were reported.

Placer Gold

Placer mining was predictably up this year with dragline and dozer operations in the Liberty and Blewett districts of Kittitas County.

Floating suction dredges in Stevens and Okanogan Counties on the Columbia and Similkameen Rivers recovered nuggets which were sold to local jewelers.

Small-scale sluicing and recreational panning was present throughout the Cascade Mountains and Okanogan Highlands.

Nonmetallics

The nonmetallics industry has been relatively constant over the past 5 years but is expected to show a decline when the 1980 figures are totaled. This is due to the effect of a depressed building industry on crushed rock, building stone, and some clay operations related to building projects. Dolomite mining was also off 20 percent in 1980, though levels of limestone and marble mining remained unchanged.

Production from two diatomite pits near George stayed steady this year, continuing to hold Washington's status as one of the top three producers nationwide.

Magnesium was produced from dolomite at the Alcoa plant in Addy at a rate constant with 1979 production. All magnesium produced there is consumed by Alcoa.

Silica sand, mined largely from quartzite and used for glass making and smelter flux, was produced by mill operators in Stevens, King, and Chelan Counties. Business in general was up in 1980.

Of the two olivine mining companies, one reported that business tripled this year. Olivine is mined from a massive dunite locality on Twin Sisters Mountain near Bellingham and is valuable for its refractory properties. The only nonmetallic commodity showing new activity was barite. Washington Barite Corp. shipped barite from their property on Flagstaff Mountain near Northport, to Montana for drilling additives. Along with this recently opened mine, the company has also been investigating barite potential in the O'Toole Mountain and Bruce Creek areas. Wallace Diamond Drilling investigated high-grade barite in the Eagle Mountain area.

Oil and Gas

The big news in oil and gas this year is the Shell Oil Co. well north of Yakima. Target depth of the hole is 15,000 to 20,000 feet. The hole has been drilled down to approximately 8,500 feet at present. No results are reported.

Shell's drilling has spurred a leasing rush in the Columbia Basin by the majors, small companies, and individual speculators. Leasing is heavy in Grant, Benton, Kittitas, Walla Walla, and Yakima Counties with participation by Shell, Gulf, Texaco, Union, Champion, and others. Private leases often go unrecorded and figures available refer to state and federal lands only. Because of considerable private land deals, these figures represent a bare minimum of activity. In the last week of October, 11 different companies filed 300 separate applications for 40,000 acres in Benton County alone.

Leasing interest is also picking up in Wahkiakum and Pacific Counties, across the Columbia River from the newly discovered Mist gas field in Oregon; and the oil and gas potential of Grays Harbor, Jefferson, and Whatcom Counties is also under scrutiny.

Coal

Interest in Washington coal resources remains high, though no new coal operations were started this year (table 3).

Production at WIDCO's mine in Centralia continued at about 5 million tons per year—all of which is used to generate power at the nearby thermo-electric plant. Reserves are estimated to be adequate for another 35 years.

Palmer Coking Coal produces 20,000 tons per year of bituminous coal from the mines near Ravensdale. Most of the coal is used by domestic and small institutional consumers.

Timber companies and Rocky Mountain and midwestern coal companies actively explored the state's reserves. Drilling was concentrated in the Chehalis, Green River, Wilkeson-Carbonado, and Fairfax-Ashford coal fields of King, Pierce, and Lewis Counties. Exploration was also carried out on the Grande Ronde lignite beds of Asotin County.

The State of Washington and Gulf Research and Development have jointly submitted a proposal to the Department of Energy for a cooperative underground coal gasification project on state land. Results of the grant request are expected in January.

Table 3.—Coal exploration companies active in Washington, 1980

ABCON Engineering (Luscar Ltd.)	Gulf Resources Exploration Corp.
Amax Coal	Kemmerer Coal Co.
AMCA Coal Leasing	Kimmer Coal Co.
ARCO Coal	Palmer Coking Coal
Bear Creek Mining	TRW Corp.
Burlington Northern Inc	Utah International
Exxon	Washington Irrigation & Development Corp.
Gulf Mineral Resources	
Gulf Research and Development Corp.	

Geothermal

The potential for geothermal development was eyed by several corporations. Companies showing interest without action in 1980 are expected to become more aggressive in 1981.

State Legislation Affecting Mining, Milling, and Exploration

Regulations adopted under Washington Administrative Code 402-52 pertain to the siting and maintenance of radioactive tailing piles and set fees for their licensing and inspection. Table 4 lists the fee schedule. The Department of Social and Health Services administers the regulations. Copies of WAC 402-52 can be obtained from the code revisers office in Olympia or the Division of Geology and Earth Resources offices in Cheney and Olympia.

HIGH BANK INSTEAD OF HIGH RISE—AN EARTH SHELTERED APPROACH TO MEDIUM DENSITY HOUSING[1/]

By Gerald W. Thorsen and Roger L. Rue[2/]

FOREWORD

The following paper was presented at an Earth Sheltered Housing Conference, held on April 9, 10, 11, 1980, sponsored by the Underground Space Center of the University of Minnesota, Minneapolis, Minnesota. Enthusiasm for the subject was attested to by the fact that more than 800 registrants and 54 commercial exhibitors attended the meeting. While earth sheltering hasn't yet really caught on in the State of Washington, it has many adherents in the central United States. As energy costs continue to soar, interest in earth sheltering is certain to mount, especially in areas of more severe climate, such as eastern Washington.

INTRODUCTION

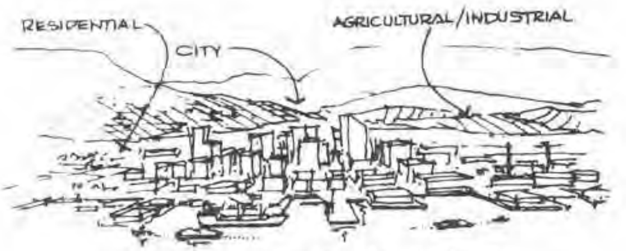
There are tens of thousands of kilometers of steep banks and bluffs in the United States, ranging from 30 to 70 degrees, with much of it in or near population centers. These bluffs commonly are as much as 100 meters or more in height and most are stable in their natural state or can be made so by relatively straightforward engineering techniques. Yet, because of their relief and slope, they make access and residential development by traditional methods difficult, expensive, and sometimes hazardous. The result is that slope surfaces commonly remain unused while wall-to-wall houses line the bluff tops and sprawl across the floodplains. Thus, the best agricultural land often disappears first, and industrial sites and natural resources such as gravel or quarry rock are zoned out of existence as a result of residential crowding.

Upon close analysis, residential use is probably one of the least critical land uses of all. Industry, waste disposal, raw materials extraction (to name a few) all have unique requirements—residential use has very few. Human ingenuity has coped with the elevation and slopes of Tibet and Bolivia, the foundation

1/ From Underground Space: Pergamon Press Ltd., New York City, New York, 1981 (in press).

2/ Gerald W. Thorsen, AIPG, division geologist; and Roger L. Rue, Rue and Butler, Architects, AIA ps, Tacoma, Washington.

conditions of Mexico City and Pisa, and the climate of Bangledesh and Siberia. As long as man recognizes the more violent natural processes of his particular local setting and designs accordingly, or stays out of the way, he can live safely practically anywhere on the planet. Modern materials and techniques can even make this existence comfortable and productive. We propose a closer look at steep slopes.



Land uses competing for flatland

TRADITIONAL SLOPE DEVELOPMENT

Medium and High Density

The conventional form of residential development of slopes in or near population centers is by a rectangular pattern of contour and slope streets. These street grids, and standard building design, permit flatland population densities but often provide a challenge for transportation systems on slopes approaching 15°. San Francisco's cable cars represent one area's solution for one period in history. One can find little evidence of a stampede in this direction in 1980, however. The automobile and bus have limitations in this kind of terrain, especially in areas of severe climate. A few inches of snow or icy conditions can paralyze traffic. Thus, on steeper slopes the grid is apt to be replaced by contour streets serving different levels of the same building. The architect must make his building "thinner" or be content with a considerable volume of the lower floors without daylight.

Steep gridded streets— like San Francisco

Low Density

Here also we commonly find the street grid, but lined with houses instead of larger buildings and confined to relatively low slope angles. The cut-and-fill construction sites, often with little or no engineering, present a wide range of foundation and erosion problems. In addition, the percentage of surface area in impermeable materials (roofs, driveways, and streets) creates peak runoff flows that many suburban storm drains are not designed to handle. For really steep slopes (those exceeding 30°) the cut-and-fill approach becomes impractical or even dangerous, so we find pole or cantilever-supported structures served by contour, or steep switchback, roads. In addition to the higher construction costs and difficulties of providing and maintaining transportation and utilities to such structures, there are additional energy losses from another exposed surface (the floor).

Only access to these slopes is via series of switchbacks

AN ALTERNATIVE

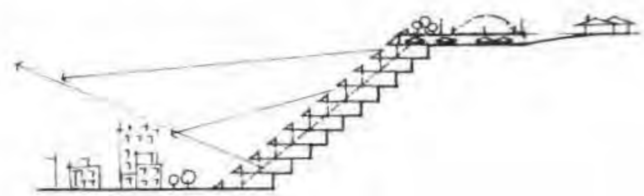
We propose that the steep slopes so common in and near many population centers could be most efficiently and responsibly used with dwelling units stacked stairfashion in a slot cut into the hillside. Such a complex would be accessible from either the top or bottom, or both, without roads on the slope face. Native vegetation would be left undisturbed on either side of the complex. Each unit would be earth sheltered but at the same time have a view; and there would be no intrusion on the natural skyline at the bluff top.

The essential points of the High Bank Residential Complex are utilization of steep (greater than 35°) slopes; continuous (unbroken) use of the full length of the slope; earth sheltering of the structure; and standardization of the units and complexes.

Some of these characteristics are, at least in part, present in existing custom designed complexes. In some instances, because a more desirable site was not available, the architect had to "design around" what he may have considered a difficult site. We propose seeking out such sites and using their physical characteristics as advantages rather than as obstacles to be overcome. While the following discussion is aimed largely at angle-of-repose slopes in soils (generally 35° to 45°) there is no reason that, with relatively minor modifications, such complexes could not be built into considerably steeper slopes, especially in dry cohesive sediments or bedrock.

Economics

Land costs for the High Bank Complex, other things being equal, should be less per residential unit than they would for most alternatives. As mentioned earlier, steep slopes even in population centers commonly remain unused (except as unauthorized refuse dumps). Thus, the development of an efficient use for these areas would, in effect, amount to the creation of new land. The stacked aspect of construction means that considerably less land would be used per dwelling unit than would be occupied even by densely packed single family residences. Flat land, potentially more valuable for other uses, would be conserved.

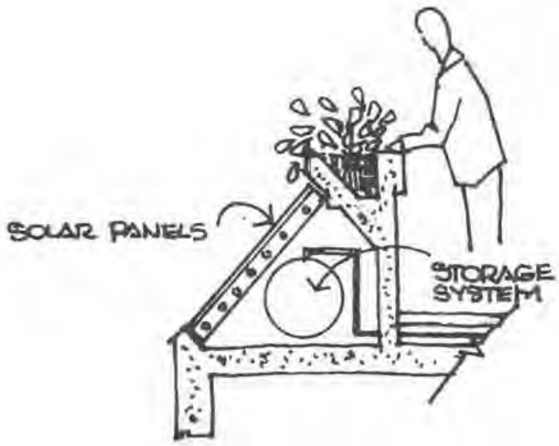


An uninterrupted view without disturbing others

In regard to structural costs, on a typical angle-of-repose slope, about a third of each "floor" of the High Bank Complex would be supported on its own foundation by virtue of the stairstep method of construction. The extra strength that is needed in the typical high rise to compensate for wind or seismic loading would be unnecessary. Thus, structural strengths could be minimized at no compromise in safety, and units could be made light and strong enough to be prefabricated and lowered one-by-one into place by gravity. Additional structural integrity could be provided for the complex as a whole, by pinning each unit to the walls of the excavation during construction.

Energy

As energy is no longer merely a question of economics, it seems to warrant separate consideration. The High Bank Complex lends itself to a variety of energy-related economies, not only in conservation but relating to collection as well. For example, at the latitude of the United States the slopes discussed provided more surface exposure to solar radiation than either horizontal or vertical surfaces. Complexes with any but a north orientation could, in almost any



Detail of balcony edge

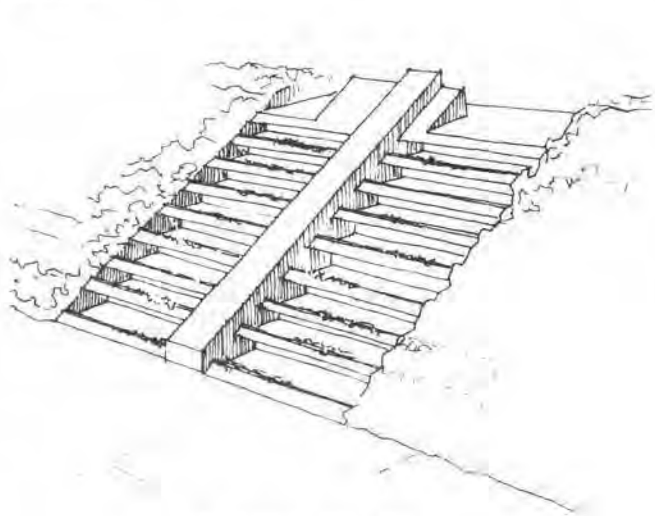
climate, get a boost from the sun. Heating-cooling costs would get the usual benefits of earth shelter, as little more than one edge of each dwelling unit would be exposed to the weather. The inclined shafts of counter-balanced elevators could be used for natural draft ventilation. The potential applications of gravity to other utilities are too numerous to discuss here. In addition, the proximity of the units to job centers would minimize energy consumption for transportation.

Safety

Safety should be nowhere near the concern it is in a conventional high rise building and, in some respects, less than in a free-standing single family residence. At no point could a person fall more than one floor. Escape from fire within structures built on angle-of-repose slopes would be by simply stepping onto the natural slopes flanking each unit. Hazard from brush fires would be considerably less than for above-ground units and could be even further reduced in susceptible areas by the use of appropriate shutters. Flood hazard, by the very design and location, would be nonexistent. As with all earth sheltered housing, hazard from wind, except a direct hit by tornado, would be negligible. Challenges to the structural engineer in coping with seismic hazards should be minimal in comparison with those related to free-standing multistory structures.

Esthetics

One of the greatest advantages of the High Bank Residential Complex over the more conventional type of development would be in the preservation of the natural terrain. From the lowland view, instead of a scalped skyline trimmed with wall-to-wall houses, one would see an unbroken skyline with natural vegetation. From the upland, residences set back from the edge of the bank would not have their views blocked. The scars of mid-slope access roads, with their cutbanks and sidecast slopes, would be totally avoided. Because the complexes would be designed to blend with the terrain and vegetation rather than to fight them, concerns about the proposed standardization producing an "institutional" appearance would be largely irrelevant. Such complexes, except for their solar panels, could be practically invisible from a few kilometers distance.



A 16-unit complex

Livability

Residential complexes such as described should be as pleasant to live in as to look at. The carefully designed terrace of each unit would not only ensure an unobstructed view but the privacy of the neighbors below. The panoramic view could make the transition to earth sheltered housing pass unnoticed, even by those with a tendency toward claustrophobia. Such amenities for residents as recreational facilities, covered parking, or even small shops, could be accommodated at the top or bottom of the complex with no compromises in the attributes discussed.

Other Applications

While this report is aimed specifically at earth sheltered residential applications, it seems appropriate to point out that the concept presented could be adapted to commercial, certain industrial, or even a mixture of these applications with residential in the same or an adjacent complex. Industries handling heavy bulk materials could benefit as much in energy and equipment savings from the thoughtful applications of gravity as from the insulation aspects of the High Bank Complex. Metallic ore mills, for example, have always had to cope with high energy costs; not so much because of the earlier costs of energy but because of the sheer weight of the rock and volume of process water that had to be handled. Thus, mill designers have long been masters at the applications of gravity to materials handling and would be horrified at the energy waste in the modern "flat land" plant where everything that moves requires new energy input.

Site Analysis

Any development of steep terrain requires a careful analysis of local site conditions, and the degree of detail required will, of course, vary from area to area. The average site in the Puget Lowland of Washington, for example, may require attention to factors such as highly erratic soil strength, perched ground water (in places under artesian pressure), overconsolidated glacial clays, prolonged seasonal rains, and moderate-to-strong seismic activity. The costs of such analyses, as well as site preparation techniques such as dewatering, can be much better supported by a multi-unit structure such as the High Bank Complex than they can be by individual residences perched in midbluff. Thus, there are many areas where the practical advantages and energy savings of this concept warrant careful consideration.

RECENT THESES ADDED TO DIVISION LIBRARY

The theses listed below were recently added to our division library and are available for reference work.

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Kilograms of ash per square meter, Washington and northern Idaho.

Depth of uncompacted ash, Pacific Northwest (isopach in centimeters).

Bulk density, Washington and northern Idaho (grams per cubic centimeter).

Depth of uncompacted ash, Pacific Northwest (isopach in inches).

Depth of rain-compacted ash, Washington and northern Idaho.

Time of first ash fall, Pacific Northwest.

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EOCENE CORRELATIONS—A COMMENT

In a recent article entitled, "Eocene Correlations in western Oregon-Washington," by R. G. McWilliams, an interpretation of Eocene stratigraphy for the Pacific Northwest is presented that differs greatly from the conventional model developed over the years and employed by many of my colleagues as well as myself. In order for the newly proposed interpretation of stratigraphy to appear creditable, its author claims that a number of generally accepted biostratigraphic concepts and correlations are not valid, largely because he believes that I have placed erroneous interpretations on foraminiferal assemblages. Furthermore, conclusions reached in the past on the age of certain foraminiferal faunas, as well as the identification of several specific taxa, are challenged.

The normal progression of science usually employs the examination and interpretation of all available data as well as an informal exchange of ideas with those having prior knowledge and experience in the subject under investigation. New concepts may develop from interpretations of these data and discussions, but these concepts must be based on sound judgment that takes into consideration all factors affecting the interpretation of these data. In the opinion of this writer, the newly proposed stratigraphic concept unfortunately has not undergone such a course of development.

It would be pointless as well as counter productive at this time to further argue in defense of my original conclusions. Furthermore, I will be the first to admit that foraminiferal biostratigraphy is frequently subject to varying interpretations. However, I believe that it is important to point out that my conclusions, as well as those reached collectively with my colleagues, were based on much data collected as an integral part of extensive geologic mapping in western Washington and Oregon. Such continuity between foraminiferal studies and field investigations provided a particularly sound base for biostratigraphic studies and conclusions founded on these studies.

As far as the identification of specific taxa is concerned, it would again be pointless to argue who is correct. Experienced paleontologists realize that, due to the interpretive nature of their science, they cannot expect to be in agreement on taxonomic nomenclature at all times. Thus, they have learned to relate to the interpretations of others. Continued study and extensive experience do help minimize taxonomic conflicts.

Nevertheless, the correctness of major stratigraphic conclusions based on my foraminiferal interpretations has been challenged. I find no reason to significantly alter these original interpretations. Therefore, it would seem that it is up to individual workers to make their own choice. In this regard, all assemblages studied by me over the years are on file in Olympia with the Washington State Division of Geology and Earth Resources. Most of them are available for examination upon request.

Weldon W. Rau
Biostratigrapher

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