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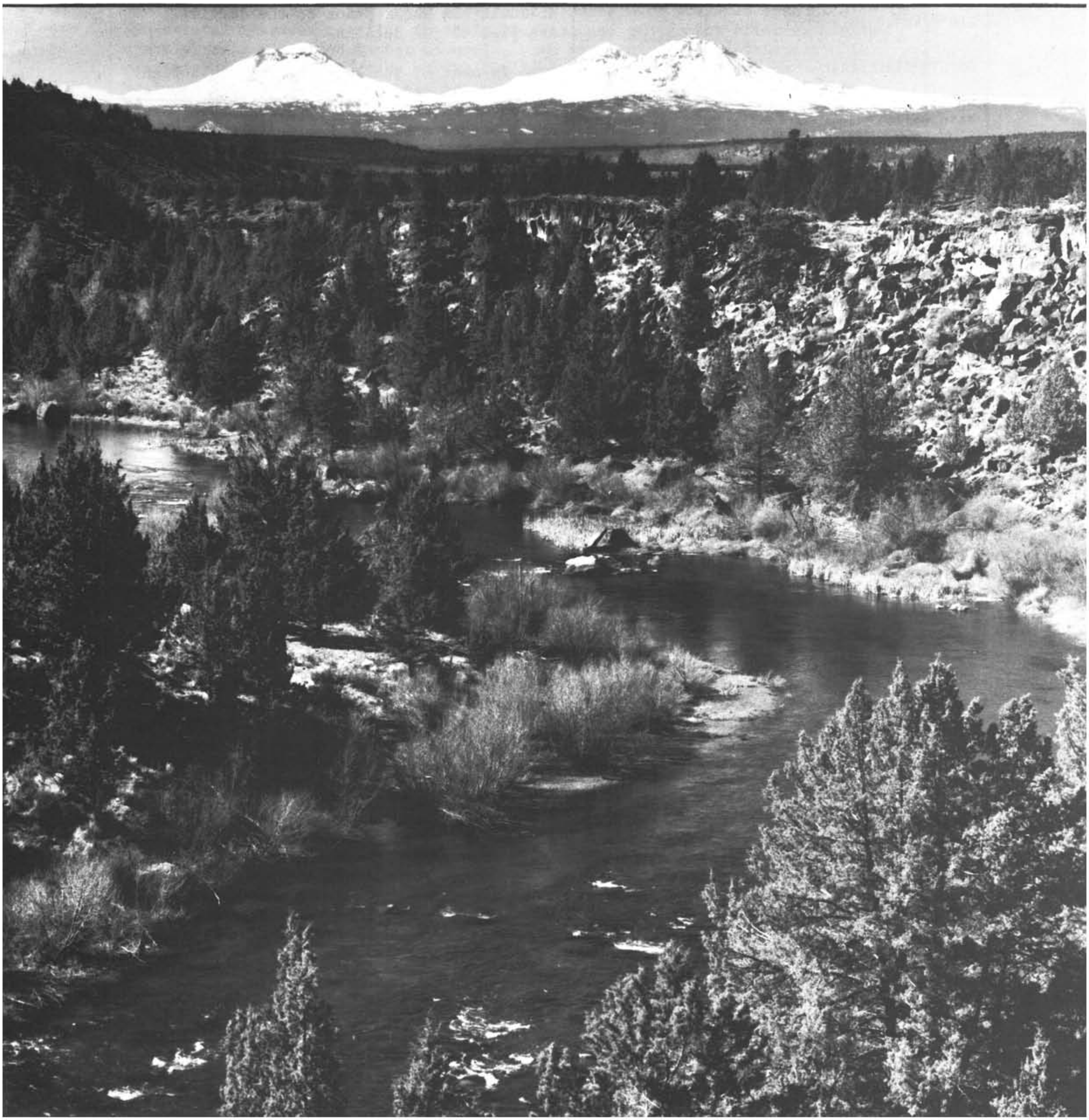

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To our readers:

Response to our new format has been enthusiastic, and we thank you all for your interest. This month we are including upcoming meeting announcements on page 32. If you want your geology or mineral-industry meeting announced, we need the information at least six weeks prior to the meeting. See page 32 for details.

As most of you know, geology is a highly interpretive science, and all of you may not agree with all of what our authors say about Oregon geology. We invite written discussion about geologic interpretations printed in OREGON GEOLOGY and from time to time plan to print these letters. We will also give our authors the opportunity to respond in writing.

Next month, OREGON GEOLOGY will contain the annual summaries of Oregon's mineral and metallurgical industry; oil, gas, and geothermal exploration; and mined land reclamation.

The Department has several current projects that are part of our ongoing survey of the State's geology and mineral resources: Josephine County mineral inventory, Blue Mountains mapping, economic demand model of sand and gravel, Mt. Hood geothermal assessment, statewide low temperature geothermal inventory, Coos Basin oil and gas, waste disposal, Clackamas County geologic hazards, and Benton County geologic hazards. These projects will be discussed individually in detail in future issues of OREGON GEOLOGY.

COVER PHOTO

Three Sisters form backdrop for Deschutes River, one of Northwest's best known trout fishing streams, near Redmond, central Oregon. Concepts presented in article beginning on page 19 represent significant step toward development of unified interpretative framework for maintaining fishable and swimmable waters in Oregon. (Oreg. Dept. Transportation photo)

CONTENTS

The assessment of nonpoint source pollution in Oregon

by Gary L. Beach, Geographer, Oregon Department of Environmental Quality

The following article describes a recent effort to assess nonpoint source pollution in Oregon. It is an excellent illustration of the way various agencies and disciplines can focus on a complex problem. No single discipline was dominant; each was essential to the successful completion of the project. From the discussion it is evident that geologic processes commonly viewed as geologic hazards have relevance to a wide variety of land and resource management concerns.

The Statewide and Basinwide Assessment reports were prepared specifically to aid natural resource agencies in their planning and management efforts. Consequently, only a limited number of copies were printed. Persons interested in obtaining further information on the 208 Assessment Project or on the locations where these two publications can be examined should write to Oregon Department of Environmental Quality, Water Quality Division, P.O. Box 1760, Portland, Oregon 97207.

INTRODUCTION

THE PROBLEM

Water is one of Oregon's most important natural resources. For many years now, Oregonians have met the challenge of maintaining a desirable natural environment and improving the quality of its water. But as urbanization and man's intensified use of rural land continues to increase, the deterioration of our valued waters is inevitable without specified planning and adequate management tools to guide decision-makers.

Recognizing the need to control accelerated land erosion and to restore the quality of the streams to acceptable levels, Congress in 1972 passed Public Law 92-500, the Federal Water Pollution Control Act Amendments. According to this law, by 1983 each state will determine ways to achieve "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water." In Section 208 of the Act, Congress further recognized that the proposed 1983 goal of fishable and swimmable waters could not be met by controls on point sources alone (e.g., end-of-pipe discharges from municipal waste treatment plants and industrial effluents). For the first time, the control of water pollution from more subtle and less obvious nonpoint sources will have been required by federal law.

Nonpoint source (NPS) pollution can be defined as adverse water quality conditions generated by the introduction of materials from diffuse origins, caused by man's planned or accidental activities on the land and in the stream. Erosion of the land surface that produces sediment in the streams is an example of a nonpoint source pollution problem.

THE SOLUTION

In Oregon, the Department of Environmental Quality (DEQ) was assigned the task of developing a water-quality management planning program to meet the ambitious objectives of Public Law 92-500 (Mullane and Beach, 1977, p. 15). These objectives require each state to:

(1) Identify and evaluate the nature and extent of present or potential NPS problems; and

(2) Develop and initiate processes, procedures, and methods to control, to the extent feasible, identified NPS problems.

Several aspects make this planning process unique:

(1) The emphasis on finding solutions that involve prevention rather than correction of NPS problems;
(2) The emphasis on state and local interagency planning rather than national planning;
(3) The emphasis on combating water pollution where it is most serious;
(4) The emphasis on public involvement throughout the entire planning process; and
(5) The emphasis on consideration of the quality of all stream segments, including small tributaries.

As a result of this mandate, DEQ's 208 Assessment Project, in cooperation with the Oregon Department of Geology and Mineral Industries and other natural resource agencies, developed several significant and far-reaching planning and management products and procedures. For the first time, a statewide inventory of NPS problems in Oregon has been completed. Also for the first time, a basinwide procedure that relates the dynamic natural processes on land and in streams to man's land management activities is available. The maps, guidelines, and resource tools developed represent the application of geo-based information specifically designed for aiding the control of erosion-related NPS problems, thereby improving the quality of Oregon's waters.

STATEWIDE ASSESSMENT

OBJECTIVES

The first phase of the Assessment Project was concerned with gathering all available information on the location, type, and severity of known or potential NPS problem areas throughout the State. This information could be used to prioritize management planning efforts aimed at understanding and controlling NPS problems and to provide other resource agencies with a means of designing their long-range planning goals as they relate to stream and water quality.

QUALIFICATIONS

Several important decisions were made by the assembled interdisciplinary team prior to data collection.

Stream quality versus water quality

First, focus was placed on the broader context of stream quality in preference to water quality. The inventory was concerned with the physical condition of the stream channel and surrounding banks as well as the quality of the water because many highly prized fish, such as trout and salmon, require stable bottom conditions for spawning, and all fish require suitable cover conditions for rearing. Geologic input is particularly significant in this kind of analysis.

Natural or man-caused pollution

Second, because of the statewide nature of the Assessment Project and severe time constraints imposed on data collection and analysis, it was impossible to determine the degree to which identified problems were natural or were man-caused. Therefore, much of the information presented in the report pinpoints the types and locations of problems without making the judgment as to whether nature or man is responsible for the adverse condition (Rickert and others, 1978b, p. 9).

Cause-and-effect relationship

Third, it was not the intent of the statewide assessment to show a cause-and-effect relationship between man's activities on the land surface and the subsequent impacts on stream quality. Because land use patterns and practices largely determine the degree of pollution in streams, generalized land use information was put on the problems maps to illustrate the relationship between man's use of the land (i.e., urban, agriculture, forest, and range) and the distribution and concentrations of identified NPS problem areas.

PROCEDURES

The information used in the statewide assessment was gathered from a technical questionnaire sent to federal, State, and local resource management agencies and from the public at meetings in each of Oregon's 36 counties. The information initially collected was validated through compilation, analysis, and review by local agency respondents and private citizens (Figure 1). The completed inventory maps were further reviewed by an Interagency Task Force, a Policy Advisory Committee, county water-quality committees, and DEQ water-quality specialists. The intent was to obtain a consensus of the known problem areas and develop confidence in the results.

RESULTS

The products of the statewide assessment are presented on a series of Oregon maps (scale 1:500,000), on two tables, and in a summary report. The maps are entitled:

(1) Stream-Bank Erosion,
(2) Sedimentation,
(3) Excessive Debris,
(4) Water Withdrawals Causing Stream-Quality Problems,
(5) Elevated Water Temperatures,
(6) Nuisance Algae or Aquatic Plant Growths,
(7) Composite Nonpoint Source Problems, and
(8) Erosion Potential-Sediment Yield.

The two tables summarize streams, stream segments, or water bodies in the state that have:

(1) Low-dissolved oxygen
(2) Excessive nutrients.

For the purposes of this paper, only the results of stream-bank erosion, sedimentation, and erosion potential-sediment yield are presented. The summary report by Rickert and others (1978b) contains detailed discussion of all the maps and tables.

Sedimentation

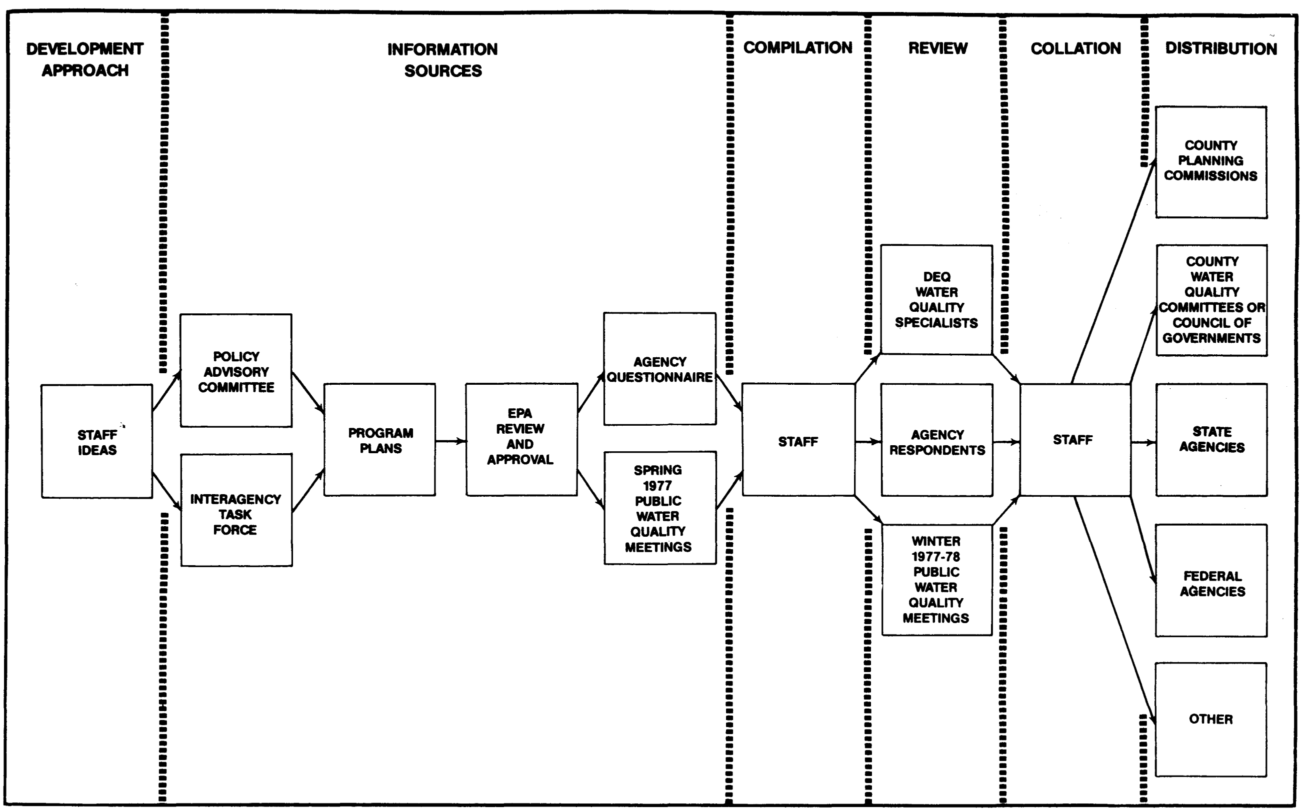
In this paper, sedimentation is defined as the presence in water of suspended or settled solids which interfere with its beneficial uses. Excessive sedimentation can adversely affect water supplies, irrigation, fish and aquatic species habitats, recreation, and aesthetics. Deposited sediment may also create a problem in maintaining navigation channels or may shorten the life and utility of lakes and reservoirs. The study clearly illustrated that excessive sedimentation is the most widespread and pervasive NPS problem in Oregon (Figure 2). Regional areas identified as having large concentrations of severe sedimentation problems include:

(1) Southwestern part of the North Coast Basin (largely centered in the Tillamook Burn area),
(2) Southeastern part of the Willamette Basin,
(3) Siuslaw River part of the Mid-Coast Basin,
(4) Main Stem and South Fork parts of the Umpqua Basin,
(5) Central part of the Rogue Basin,
(6) Southern part of Goose and Summer Lakes Basin,
(7) Crooked River part of the Deschutes Basin,
(8) Malheur Basin,
(9) Southern part of the John Day Basin, and
(10) Hood Basin.

Stream-bank erosion

Stream-bank erosion results from the movement and cutting of streams. This process involves the collapse of earth material and vegetation directly into streams. The potential for stream-bank erosion is determined primarily by bedrock characteristics,

Figure 1. Process used to develop Oregon's inventory of nonpoint source pollution problems.



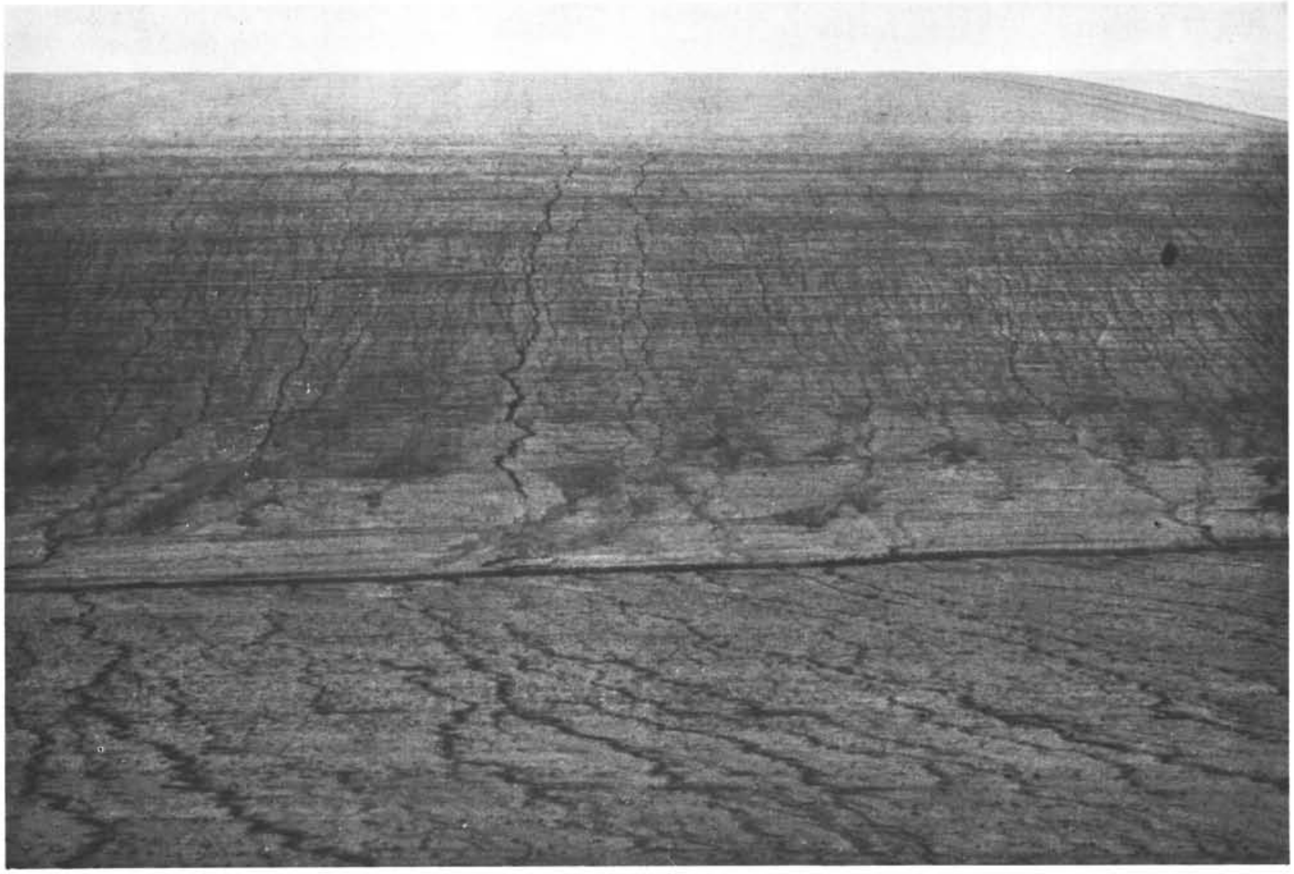


Figure 2. Sheet and rill erosion on exposed dryland wheat farm near Pendleton. Sediment derived from these loessal soils moves progressively downslope, entering intermittent and perennial stream channels. On land, sedimentation removes valuable topsoil and may lead to severe gully erosion unless prompt conservation practices are applied. In streams, sediment can change natural equilibrium and thereby destroy fish and aquatic specie habitats. (Photo courtesy John E. Jackson)

soil properties, and the degree of vegetation cover. When excessive or accelerated by man's activities, stream-bank erosion can destroy productive land and affect several beneficial uses of streams. Stream corridor activities that remove protective vegetation are prime causes of stream-bank erosion. This type of fluvial erosion may also be initiated by deflection of debris or sediment on the outside bends of streams and by mass wasting resulting from stream cutting (Figure 3). Regional areas of large concentrations of severe stream-bank erosion are:

(1) Southwestern part of the North Coast Basin,
(2) Yamhill River part of the Willamette Basin,
(3) South Fork part of the Umpqua Basin,
(4) Central part of the Rogue Basin,
(5) Southern part of Goose and Summer Lakes Basin,
(6) Crooked River part of the Deschutes Basin,
(7) Northern part of the Malheur Lake Basin,
(8) Malheur Basin,
(9) Umatilla Basin,
(10) Northern part of the John Day Basin, and
(11) Hood Basin.

Erosion potential-sediment yield

The purposes for producing an erosion potential-sediment yield map within this inventory phase were to:

(1) Identify general source areas for erosion-related NPS problems presented in the stream-bank erosion and sedimentation maps; and
(2) Show land management agencies where to focus their preventive and corrective programs for water-quality protection or improvement.

The Oregon sediment yield areas were taken directly from a map prepared by the U.S.D.A. Soil Conservation Service (1975), which protrays high, medium, and low sediment yield areas of the State.

The erosion-potential component of the DEQ map is a composite of data on three major types of erosion: surface erosion, gully erosion, and mass wasting. Thirteen erosion-potential units ranked in terms of the susceptibility of land to erode were interpreted through the procedure shown in Figure 4.

The first step in developing the map was the utilization of a land use map of Oregon (Pacific Northwest Regional Commission, 1975). The working hypothesis assumed agricultural land and rangeland (<20 percent slope) is dominated by surface erosion and forest land and rangeland (>20 percent slope) is dominated by mass wasting and gully erosion. Although almost all types of erosion will occur somewhere on land included within any one general type of land use category, at the statewide mapping scale used, the above assumptions about types of erosion are generally correct.

Surface erosion: Surface erosion categories were determined by combining generalized slope steepness with available data on the *R* (rainfall intensity) and *K* (soil texture) factors from the Universal Soil Loss Equation (U.S.D.A. Soil Conservation Service, 1976). By combining statewide information on these three factors, it was possible to define and rank seven categories of surface erosion potential for Oregon.

Mass wasting and gully erosion: The areas designated as being dominated by mass wasting and gully erosion were grouped and ranked into four mass-wasting and two gully-erosion categories, by using statewide overlay maps of climate (Loy, 1976) and geology (Walker, 1977; Wells and Peck, 1961). The

Figure 3. Nearly continuous stream-bank failure on Vester Creek, tributary to South Fork John Day River. Natural meadow in which stream flows has been disturbed by man's activities. Willows along stream channel have been disturbed, and the meadow has been drained, resulting in active downcutting by stream as it attempts to regain its dynamic equilibrium. This situation could have been avoided. (Photo courtesy David M. Anderson)

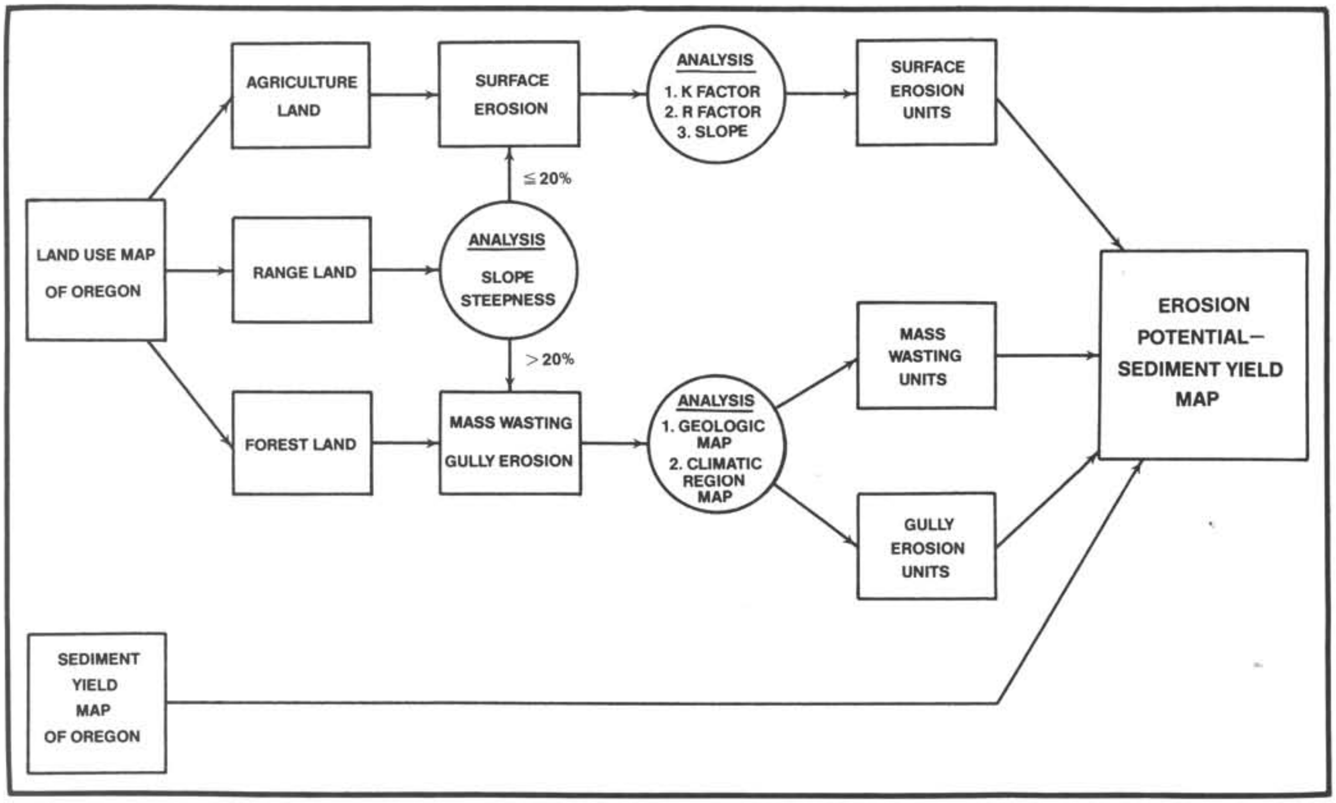


Figure 4. Procedure for producing erosion potential-sediment yield map of Oregon.

Oregon Department of Geology and Mineral Industries provided guidance on the mass-movement properties of various geologic units.

The relationship of climate to geologic bed rock accounts largely for the areal variation of specific landforms and geomorphic processes. The atmosphere provides energy and agents such as water, ice, and wind necessary for most weathering of the earth's surface. The bed rock provides material to be sculptured. As this interrelationship continues over time, distinctive landforms evolve. Under a certain set of climatic conditions, particular geomorphic processes predominate and give a regional character to the land surface, distinguishing it from other areas developed under different conditions. This explains, to a considerable degree, the type and distribution of mass wasting and fluvial erosional processes.

→

Figure 5. Massive landslide near headwaters of Molalla River, tributary to Willamette River. Landslide occurred on lower slope during winter of 1973-1974, following building of two log-hauling dirt roads. Debris from toe of landslide has directly impacted stream channel. (Photo courtesy U.S. Geological Survey)

The completed erosion potential-sediment yield map of Oregon shows a good correlation between areas having a high sediment yield and areas dominated by soils and rocks having a high potential for erosion.

BASINWIDE ASSESSMENT

OBJECTIVES

The Oregon 208 Basinwide Assessment Project is concerned with procedures for relating stream quality to natural terrain characteristics and land management activities. Unlike the statewide assessment, which was concerned with identifying the existing effects of NPS pollution, this phase of the Assessment Project involves the development of a logical framework for determining the link between the causes of erosion (terrain-land management interactions) and the resultant stream-quality effects (Rickert and Beach, 1978). The map, matrices, and text have been designed specifically to minimize stream-quality impacts from problems associated with erosion and sedimentation.

THE PROBLEM

Erosion and sedimentation are naturally and continually occurring geologic processes that over long periods of time have reshaped the earth's surface. Erosion is the process by which soil and bedrock material are detached and transported, principally by water, wind, and gravity (Figure 5). Sedimentation results when eroded soil particles reach a drainage system and are carried downstream (Figure 6). Every stream has a unique capability to transport certain amounts of sediment. However, when sediment in a stream exceeds the amounts produced by natural erosion, the result is a form of man-caused pollution.

The effects of man-related erosion and sedimentation are dramatic and at times catastrophic. These processes deplete the soil resources of the land from which the sediment is derived, impair the quality of water in which it is transported, and reduce the productivity of lakes and estuaries where it is deposited. Sediment eliminates fish spawning and rearing areas, destroys insect larvae used by fish for food, shortens reservoir life, and affects the channel morphology of the transporting stream.

Sediment can also serve as an indicator of deficiencies in land and water management which allow sediment to reach the stream instead of remaining in the field, forest, range land, roads, or construction sites. Further, if soil is moving into a water course, other pollutants such as fertilizers, pesticides, salts, bacteria, and toxic metals, which often are attached to sediment, are also likely to be moving into the streams.

The problem is complex. Within any given basin in the State, many closely interrelated variables combine in varying degrees to cause NPS pollution of varying types and severities. The amount and spatial variation of sediment, for example, are strongly dependent upon the magnitude and characteristics of climatic events. In addition, close relationships exist between physical properties of the land surface (e.g., soils, geology, slope, runoff, and vegetal cover), geomorphological processes

Figure 6. Stream-bed deposits in lower reach of Molalla River, near town of Molalla. As river enters flood plain, it begins to meander, shifting its channel and depositing sediment as sand and gravel bars. (Photo courtesy U.S. Geological Survey) →

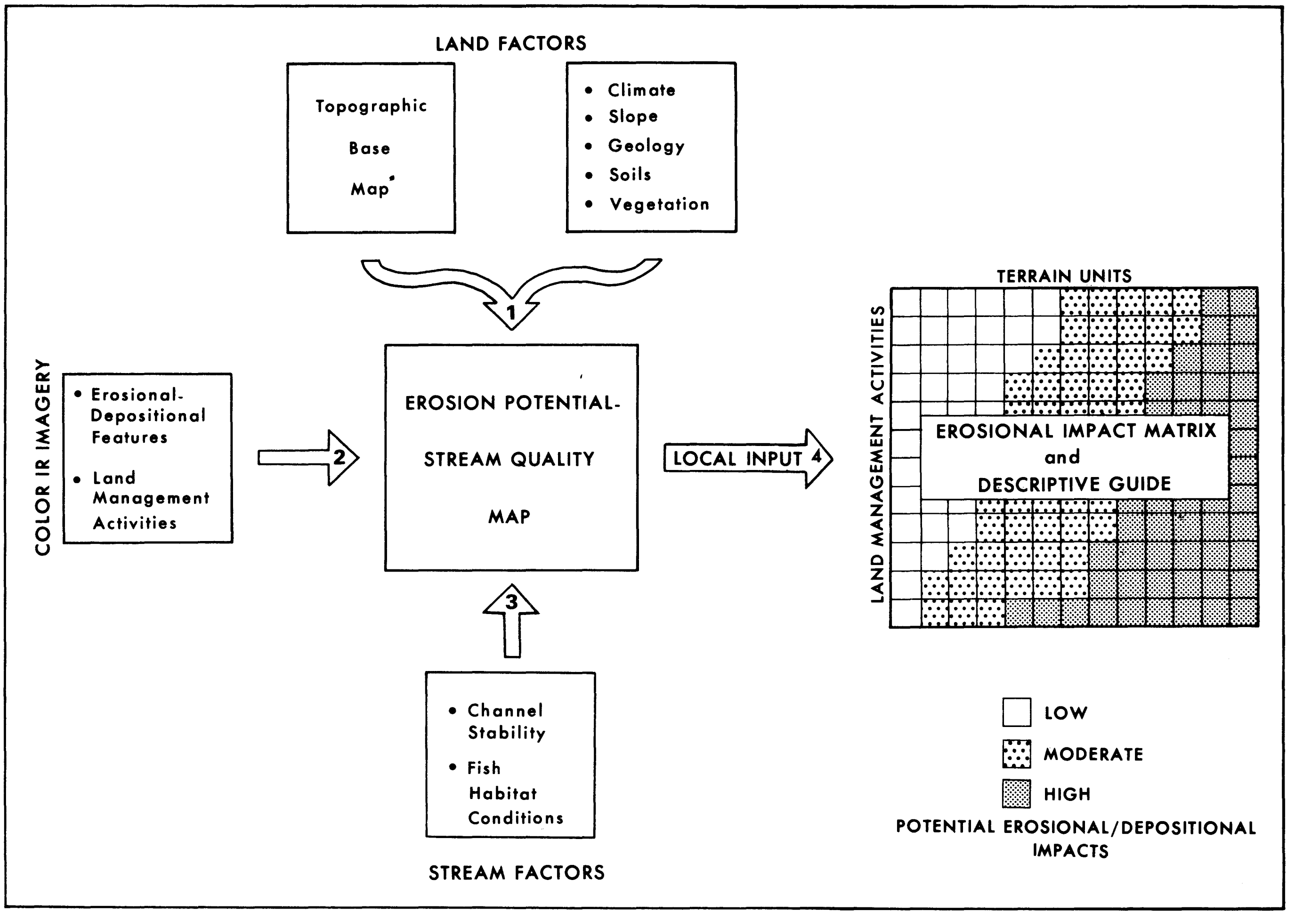


Figure 7. Oregon's process for determining suitability of rural land management activities. Process assesses relative erosional and sediment impacts on streams resulting from application of various land management activities on different types of terrain.

at work (e.g., rates of weathering, erosion, transport mechanisms, and deposition), and characteristics of land management activities (e.g., agriculture, grazing, forestry, mining, and urban/rural construction). The solution that addresses all of these environmental factors must also be systematic, reproducible, and readily usable by governmental agencies.

PROCEDURES

The basic procedure adopted for the basinwide assessment was initially developed by the U.S. Geological Survey (Rickert and others, 1976; Brown and others, 1979) and modified for Oregon's 208 Assessment Project. It consists of four steps (Figure 7) (Rickert and Beach, 1978; Rickert and others, 1978a).

Step 1

Information on climate, slope, geology, soils, natural vegetation, and generalized land use is collated. Only those factors that combine to explain the potential of the land to erode and that are compatible with the base-map scale (in this case 1:62,500) are selected for final analysis. See Brown and others, 1979, and Rickert and others, 1978a, for a complete discussion of this process.

Individual overlays of each important factor are prepared and composited to form an erosion-potential map that delineates distinctly different terrain types in the basin. These maps are useful because different terrains have different types and degrees of natural instability that must be recognized. For example, areas within a basin consisting of steep slopes, slide-prone bed rock, and poorly drained soils have a far greater erosion potential than do areas consisting of gentle slopes, competent bed rock, and well-drained soils (Figure 8). This kind of information must be systematically developed for all land in each basin to provide a sound basis for resource management.

Step 2

Land management activities are determined, and existing land and stream features caused by erosion and sedimentation are mapped. The various activities and preselected features are determined largely from color-infrared (IR) imagery; verification is made from published information, field and low-altitude aerial reconnaissance, and discussion with landowners and local agency personnel.

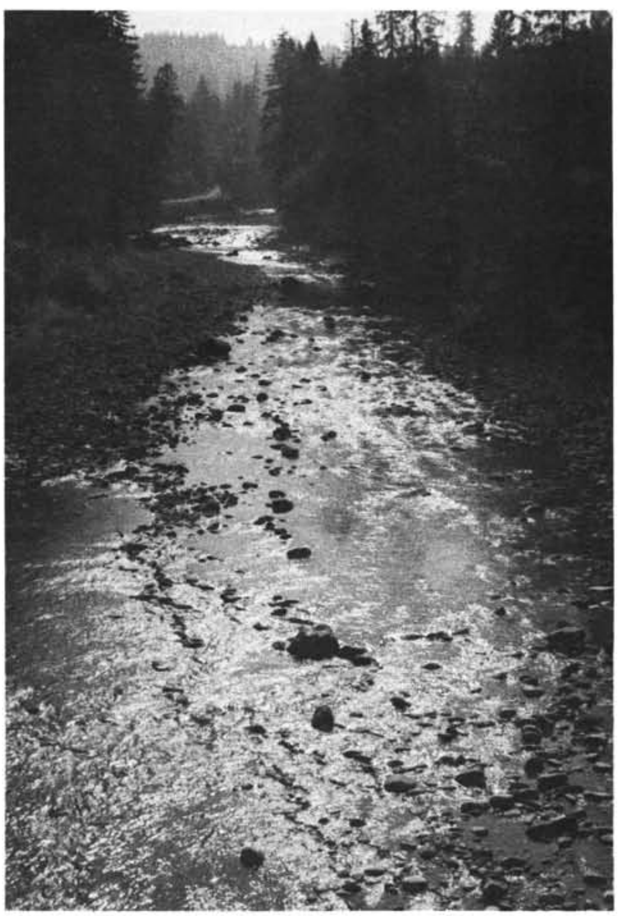
These erosion- and sedimentation-produced features are mapped to demonstrate relationships between the type and number of changes resulting from erosion, the natural potential of land to erode (as defined by the erosion-potential maps), and the type of management activities man imposes on the land.

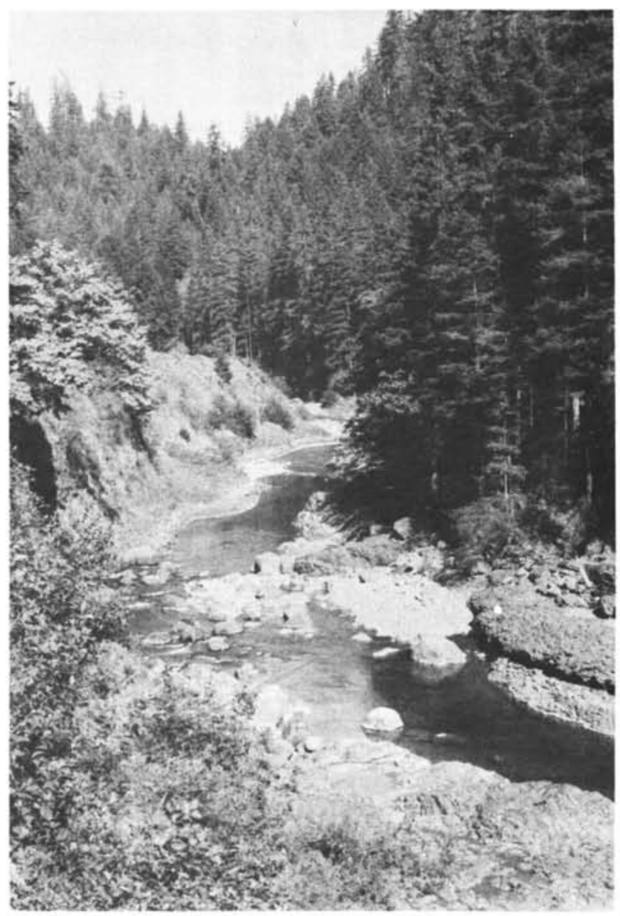
Step 3

Erosion-related stream-quality problems are assessed, using reconnaissance field surveys of channel stability and fish-habitat conditions. The channel-stability evaluation was modified from a stream survey developed by the U.S.D.A. Forest Service (1975); the fish condition evaluation was developed by biologists of the DEQ Assessment Team.

A variety of information, including location and type of fish occurrences; flow records used to determine the best time period for conducting the surveys; and assessments of land management activities, types of terrain, and types and uses of the

Figure 8. Examples of differences in channel morphology in Molalla River Basin. These two photos were taken within a few miles of each other. (Left) Molalla River, as it flows through easily eroded bed rock. (Right) Same river as it flows through more erosion-resistant basaltic rock.





streams, is needed to plan and conduct stream-quality surveys. Comprehensive survey forms are then used by the field teams as they walk selected segments of all major tributary streams within each study basin.

At the conclusion of field work, the collected data on channel stability, fish habitats, and, where there is intense stream-side management, riparian vegetation conditions are segregated into stream-quality ratings for each investigated segment. The results from these stream reconnaissance surveys are combined with information derived from air photo interpretation, terrain analysis of erosion-potential units, and land management activities to define impacts on streams from erosion/sedimentation-related non-point source pollution. For a detailed discussion of this stream-survey procedure, consult Rickert and others (1978a, Chapter V).

The results of these first three steps, depicted graphically on a regional map (scale 1:62,500), present a unique synoptic overview of (1) the erosion-potential units (terrain types), (2) all erosional-depositional features observable from the color IR imagery, and (3) the relative stream quality as determined from the field reconnaissance surveys. This completed map presents a dynamic picture of the land and stream processes within the identified basin. Because of its dynamic qualities, it can be used to predict where various types and magnitudes of erosional processes are likely to occur under varying conditions.

Step 4

The final and most important step is the development of a management tool for portraying the land and stream-quality effects of the various combinations of land erosion potentials and land management activities. The tool is a matrix (Figure 7) that lists the previously delineated terrain types on one axis and identified land management activities on the other.

Each terrain-activity combination is rated as having a high, medium, or low potential for erosion/sedimentation-related problems in nearby streams. The ratings are based on knowledge and experience of the assessment team, available and collected information, and input from a matrix committee of experts familiar with the basin. The matrix is utilized primarily for determining the regional suitability of various proposed activities or land uses of different types of terrain.

PRODUCTS

The maps and matrix are designed for both resource planning and management. For planning, they provide a screening mechanism for regional resource evaluation and suggest alternative activities for a given terrain unit that will minimize stream-quality degradation. For land management, the maps and matrix can be used to determine immediately areas where upgrading of land activities or application of conservation practices are necessary. In addition, they provide the basis for prioritizing site specific investigations of land management activities for critical terrain units.

SUMMARY

The concepts presented in this paper represent a significant step toward the development of a unified interpretive framework that can be used to control NPS and related problems in Oregon or throughout the nation. Emphasis has been placed on identifying existing stream- and water-quality problems and on establishing a means of analyzing the relationship between natural processes and man's activities on land and in streams.

STATEWIDE ASSESSMENT

In the statewide assessment phase of the project, the generalized locations of NPS pollution problems are identified. This geographical information will allow agencies to determine the distribution of problems that need investigation or remedial action. On a statewide or regional basis, the assessment provides information for prioritizing future programs for the study, remedy, and prevention of NPS pollution.

BASINWIDE ASSESSMENT

The basinwide assessment interrelates land management activities, the natural susceptibility of land to erode, and erosional effects on streams. The procedure can thus be used to (1) determine the suitability of various land management activities on different types of terrain, (2) monitor the success of land management guidelines and regulations, and (3) prioritize the need for site specific studies of land management activities.

Figure 9. Example of NASA high-altitude imagery of upper Molalla River Basin. By using stereo and high magnification, one can distinguish such erosional features as slump/earthflows, debris avalanches, talus, road failures, stream-bank failures, mining excavations, and large gullies; depositional features such as streambed deposits and debris jams; and various land management methods and practices. Lighter areas represent recent clear-cut harvesting, while darker areas show old-growth timber. (Photo courtesy National Aeronautics and Space Administration)

The procedure may also be used as a guide to the design of water-quality data-collection programs. In this context, the map and matrix show areas where erosional and depositional problems are most prevalent and where new problems are most likely to occur. Such areas will tend to be prominent sources of sediment. Thus, by using an erosion potential-stream quality map and impact matrix, data programs can be spatially designed to better define the cause-effect relationships of land and water quality.

ACKNOWLEDGMENTS

The author would like to acknowledge the many individuals and agencies who contributed to the development of this procedure. The project was directed by David A. Rickert, hydrologist, on loan to DEQ from the U.S. Geological Survey. The stream surveys were conducted by John E. Jackson and David M. Anderson, with assistance from James Sachet and Paul Krupin. Hank Hazen, a forester on loan from the U.S. Forest Service, helped coordinate agency cooperation and provided valuable information on land management activities. The talented cartographic skills of Elizabeth Suwijn greatly added to the graphic portrayal of the accumulated information.

In particular, John Beaulieu of the Oregon Department of Geology and Mineral Industries contributed on numerous occasions important new perspectives on the complex land-water processes and interrelationships. His many ideas and helpful suggestions can be found throughout the final report.

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Speculations on Oregon calderas, known and unknown

by John E. Allen, Professor Emeritus, Portland State University

Two spectacular calderas, Crater Lake and Newberry, have long been known and adequately mapped. One other, Harney Lake, has been suggested but not proven. Casual inspection of the ERTS photographs and the plastic relief maps of the 1:125,000 map series suggests that field work in relatively unstudied areas might prove the presence of several others. The following circular features appear to be particularly promising:

(1) The 4-mi-wide circular high basin with Bald Mountain, Wart Peak, and Wickiup Butte on its rim, located 9 mi south of Big Hole;
(2) The 3-mi-wide circular basin northeast of Yamsay Butte, 25 mi west of Summer Lake;
(3) The 6-mi-wide circular flat north of Diablo Mountain, 10 mi northeast of Summer Lake; and
(4) The 6-mi-plus-wide North Alkali Lakes basin, bounded on the east by a semicircular escarpment.

The payoff for an outrageous hypothesis is to find that it exhibits some regularity that permits one to extrapolate and predict (Allen and Beaulieu, 1976). The intervals between Crater Lake and the last three suggested calderas are very close to 35 mi; to Harney Caldera the interval is a bit longer. The circular features all lie on an almost straight east-west line which, if extended westward from Crater Lake, lies exactly on the Canyonville fault zone in the basement rocks mapped by Perttu (1976). The suggested Bald Mountain and Diablo calderas lie upon Lawrence's (1976) Eugene-Denio lineament. The intervals between Newberry Caldera and the suggested Bald Mountain and Yamsay Butte calderas are nearly 30 mi in a north-south line.

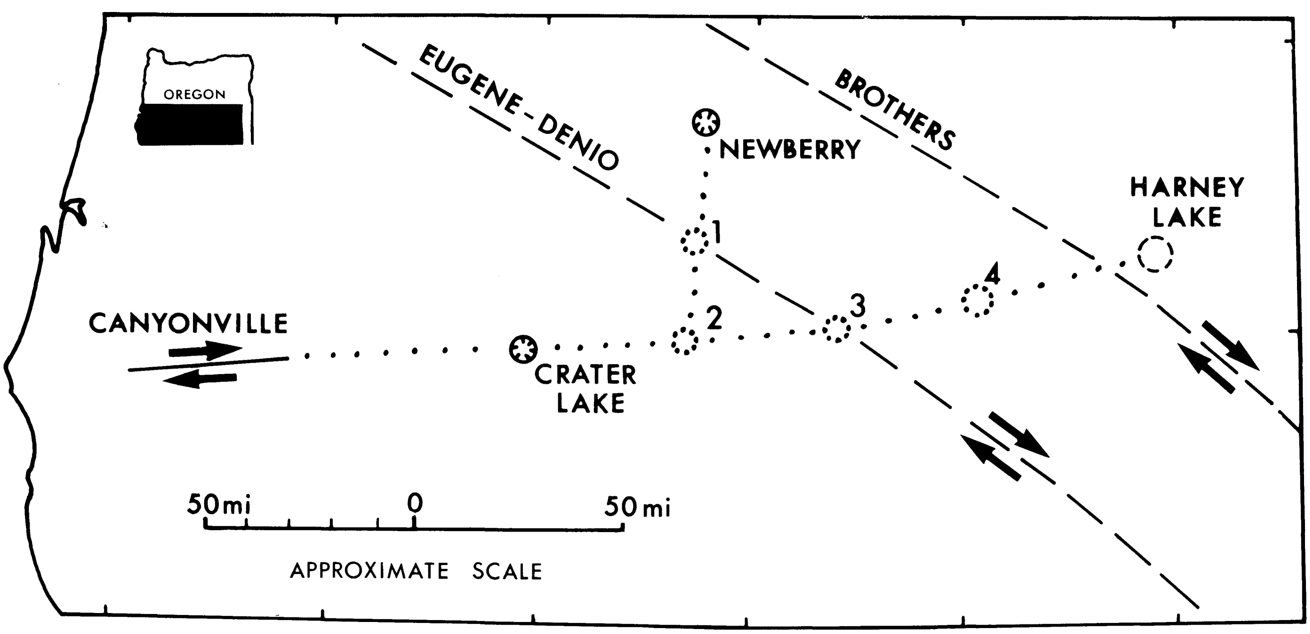
Nineteen years ago I suggested that there might be a volcano-tectonic graben beneath the High Cascades (Allen, 1965). Do you suppose that future field work will show more than three calderas in Oregon?

References

Allen, J.E., 1965, The Cascade Range volcano-tectonic depression of Oregon, *in* Transactions of the Lunar Geological Field Conference: Oregon Department of Geology and Mineral Industries, p. 21-23.

Allen, J.E., and Beaulieu, J.D., 1976, Plate tectonic structures in Oregon: Oregon

(see **CALDERAS** *, p. 32)*



meeting announcements

Each month, space permitting, upcoming meetings will be announced in this column. Information should reach our office no later than six weeks before a meeting. Please be specific and give full name of the organization; exact subject, location, and time of the meeting; and the name, address, and phone number of person to contact for questions or reservations.

AIME PLANS FEBRUARY MEETING

The Oregon section of the American Institute of Mining, Metallurgical, and Petroleum Engineers will meet Feb. 16, 1979, at the International Dunes Motel, at the Beltline exit of I-5 in Eugene. Len Ramp, Oregon Department of Geology and Mineral Industries, will speak on "Oregon Nickel Deposits." Ramp wrote the Department's recent publication, "Investigations of Nickel in Oregon."

Social hour is slated for 6:00 p.m.; dinner, 7:00 p.m.; speaker, 8:00 p.m. For additional program information, contact Rick Kent, 19443 Wilderness Drive, West Linn, Oregon 97068. His phone numbers are: (503) 243-4897 (days), and (503) 636-4146 (evenings). Reservations should be phoned or mailed to Vern Newton, Oregon Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon 97201. Phone: (503) 229-5580.

ANNUAL OAS MEETING ANNOUNCED

The Oregon Academy of Science (OAS) will hold its annual meeting Feb. 24, 1979, at Mt. Hood Community College, in Gresham. In addition to the regular presentation of papers, there will be a symposium on geothermal energy in Oregon. Main speakers at the symposium will be Gordon Reistad, Associate Professor of Mechanical Engineering, Oregon State University, and Joseph Riccio, Geothermal Specialist, Oregon Department of Geology and Mineral Industries.

This meeting is open to the public. Persons wishing to eat lunch at the college should send reservations to Donald White, Department of Natural Sciences and Mathematics, Oregon College of Education, Monmouth, Oregon 97361. Tickets will be sold at the door. The approximate charge for the luncheon will be $2.00 to $2.50.

METALS AND MINERALS CONFERENCE SET FOR APRIL

The Pacific Northwest Metals and Minerals Conference, "Exploring '79," will convene at the Ridpath Hotel, Spokane, Washington. Dates for the conference are April 26-28. The conference will cover exploration, mining, metallurgy, and regulations. Forty-one presentations will be made. Chairman Thor Kiilsgaard said four field trips are scheduled during the conference.

For more information, contact Thor Kiilsgaard, AIME, American Society for Metals, 656 U.S. Court House, Spokane, Washington 99201. Phone: (509) 456-4677. □

USGS: Spotting the age of the Spotted Ridge Formation

The Spotted Ridge Formation occurs in a restricted area in east-central Oregon. It has been dated as Pennsylvanian and possibly Early Pennsylvanian on the basis of fossil plants. Marine fossils were recently obtained from conglomerate beds in the formation by Ewart Baldwin of the University of Oregon and have been studied by Mackenzie Gordon, Jr. This fauna includes the ammonoid genus *Cancelloceras*, which occurs in latest Namurian beds in northwest Europe. In the United States, this genus has been found elsewhere only in the upper part of the Hale Formation of northwest Arkansas. Deposition of the Spotted Ridge Formation during the late Hale (Early Pennsylvanian) is assured. □

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(**CALDERAS**, *from p. 31)*

Department of Geology and Mineral Industries, Ore Bin, v. 38, no. 6, p. 87-99.

Lawrence, R.D., 1976, Strike-slip faulting terminates the Basin and Range province in Oregon: Geological Society of America Bulletin, v. 87, no. 6, p. 846-850.

Perttu, R.K., 1976, Structural geology of the northeast quarter of the Dutchman Butte Quadrangle, southwestern Oregon: Portland State University master's thesis, 60 p. □

Waterfall alcoves in the Columbia Gorge

by John E. Allen, Professor Emeritus, Portland State University

I have not seen in print any explanation of the origin of the waterfalls in the Columbia River Gorge.

Nearly all of the higher falls lie in the centers of alcoves, cut back several hundred feet into the cliff faces that form much of the lower walls along the south side of the Gorge. These alcoves are generally from 150 to 300 ft wide, 10 to 40 times as wide as the falls themselves.

Waterfalls, like lakes, are ephemeral geological features, rarely lasting more than a few tens of thousands of years. Those in the Gorge must have been formed during or since the late Pleistocene by processes no longer active. It is not possible that a glacier ever occupied the Gorge to widen the normal V-shaped canyon, faceting the spurs between the tributary canyons to produce hanging valleys and waterfalls, as was the case in Yosemite Valley. No evidence indicates uplift of the south wall by faulting of the Gorge to produce the lower escarpments. Convincing evidence, however, has been found in recent years to substantiate Bretz' long-neglected Spokane or Missoula catastrophic flood*, along with indications of several such floods, at least one in pre-Wisconsin time. A six- to nine-hundred-ft-high flood, sweeping several times through the Gorge at speeds estimated to be over 30 mi per hour, could

*For an up-to-date bibliography, see Baker, V.R., and Nummedal, Dag, 1978, The channeled scabland, a guide to the geomorphology of the Columbia Basin, Washington, prepared for the Comparative Planetology Geology Field Conference, sponsored by the Planetary Geology Program, Office of Space Science, National Aeronautics and Space Administration, Washington, D.C. 20546.

Multnomah Falls, Columbia Gorge. (Photo courtesy Oregon Department of Transportation)

easily account for the lower near-vertical walls cut in the thick entablatures of massive brickbat jointed basalt flows which underlie most of the dozen or so highest waterfalls.

Waterfalls are almost lacking on the Washington side, due to the gentle south and southeastward dips in the Yakima Basalt, which have in most places brought the massive cliff-forming flows on the north side of the river high above flood levels. Any falls originally present would have been mostly destroyed by the extensive landslides which characterize so much of the Washington side of the river.

The alcoves in which the major falls lie could not have been formed by normal water erosion, by undercutting of the massive flows in less resistant interbeds, or by zones of weakness in the rocks.

I propose that the large alcoves resulted from the lateral spray from the falls seeping into the joint cracks during thousands of winter seasons, especially in the finely-spaced brickbat joints of the entablatures, and freezing and popping out the small blocks of basalt. Stream transport at the bases of the alcoves during spring freshets would remove the debris. The rate of alcove retreat, then, is a function of the number of freeze-thaw cycles since the original widening of the Gorge by the Missoula floods. Five hundred ft of retreat, as at Multnomah Falls, during the 13,000 years since the last catastrophic flood represents an average rate of a little over one-half in. per year. Oneonta Falls, 900 ft from the outer cliffs, retreated (along a weak fracture zone?) at nearly double this rate, perhaps so rapidly that an alcove did not have time to form. □

Mt. Hood geothermal research meeting held

Geoscience researchers engaged in the joint U.S. Geological Survey (USGS), U.S. Department of Energy (DOE), U.S. Forest Service (USFS), and Oregon Department of Geology and Mineral Industries (DOGAMI) project on the Geothermal Resource Assessment of Mt. Hood met in Portland on January 9-10, 1979. Fifteen individual research papers on various aspects of the assessment effort were informally presented. Discussion of the research followed the presentations.

From the USGS, D.L. Williams spoke on self-potential studies and remote sensing; H.D. Ackerman described refraction seismic studies; Jack Healy gave a presentation on reflection seismic studies; Guy Flanagan discussed aeromagnetic studies; Craig Weaver spoke on microseismicity; and J.H. Robison gave a paper on hydrology.

M.H. Beeson, Portland State University, detailed the stratigraphy and structure of the Columbia River Basalt Group in the Mt. Hood area. D.D. Blackwell, Southern Methodist University, talked on the heat flow modeling aspects of Mt. Hood Volcano. Results of the telluric-magnetotelluric survey of Mt. Hood were presented by N.F. Goldstein, Lawrence Berkeley Laboratory, and Edward Mozley, University of California.

The geochemistry of fumaroles and hot springs on Mt. Hood was the subject of a three-part presentation by H.A. Wollenberg, Lawrence Berkeley Laboratory; R.G. Bowen, consultant to DOGAMI; and J.H. Robison, USGS.

Craig White, University of Oregon, discussed the geology and geochemistry of young andesite lava flows on Mt. Hood. Richard Couch, Oregon State University (OSU), presented gravity data of Mt. Hood. Gunnar Bodvarsson, OSU, discussed the rheological aspects of the volcano. J.F. Riccio, DOGAMI, described the exploratory and heat-flow drilling recently completed in the Mt. Hood area. John Geyer explained the role of the USFS in the overall geothermal assessment.

State Geologist D.A. Hull chaired the meeting, and Hull and Williams presented opening and closing remarks.

Others attending the meeting included C.R. Bacon, USGS; J.C. Eichelberger, Los Alamos Scientific Laboratory, University of California; and Michael Korosec, Washington Department of Natural Resources.

Formal presentation of the papers may be given at an undetermined national meeting as part of a symposium on geothermal energy later this year or as a published effort in a geophysical or geological journal, probably as one complete monthly issue. □

J.F. Riccio, Geothermal Specialist
Oregon Dept. of Geology and Mineral Industries.

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