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The Ore Bin

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Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 229 - 5580

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WRIGHT'S POINT, HARNEY COUNTY, OREGON
AN EXAMPLE OF INVERTED TOPOGRAPHY

Alan R. Niem
Department of Geology, Oregon State University

Abstract

Wright's Point, a 250-foot-high, sinuous, flat-topped ridge, projects eastward into Harney Basin, Harney County, Oregon. This 6-mile-long feature ranges from 200 to 600 yards wide and merges with a broad mesa at its western end. The nearest topographic highs are Dog Mountain, 2 miles southwest, and foothills of the Blue Mountains near Burns, 12 miles northwest. The point is composed of a fluvial* sequence of tuffaceous channel sandstones, mudstones, and conglomerates (Pliocene-Pleistocene Harney Formation) capped by two thin, early Pleistocene diktytaxitic olivine basalt flows. The configuration of the ridge and the paleocurrent pattern, sedimentary structures, fossils, and stratigraphic relations of the rocks to nearby topographic highs suggest that the fluvial sequence and capping basalts were deposited in a narrow valley of an eastward flowing meandering stream(s). The basalts acted as a protective cap while the less-resistant valley walls were eroded away to produce an inverted topography.

Remnants of the valley walls consist of a Plio-Pleistocene palagonite tuff ring at Dog Mountain and ignimbrites and tuffaceous sediments of the middle Pliocene Danforth Formation in the Blue Mountain foothills. Reworked palagonite tuff, pumice sands, and Danforth ignimbrite pebbles compose the sandstone and conglomerates of Wright's Point. Measured elevation differences at the base of the lower flow, orientations of filled and open lava tubes, and increasing number of flows to the west suggest that the basalt flowed from west to east down the stream valley. Probable sources of the basalts are several vents 6 miles west of Wright's Point near the Palomino Buttes.

*Definitions of terms in glossary at end of article

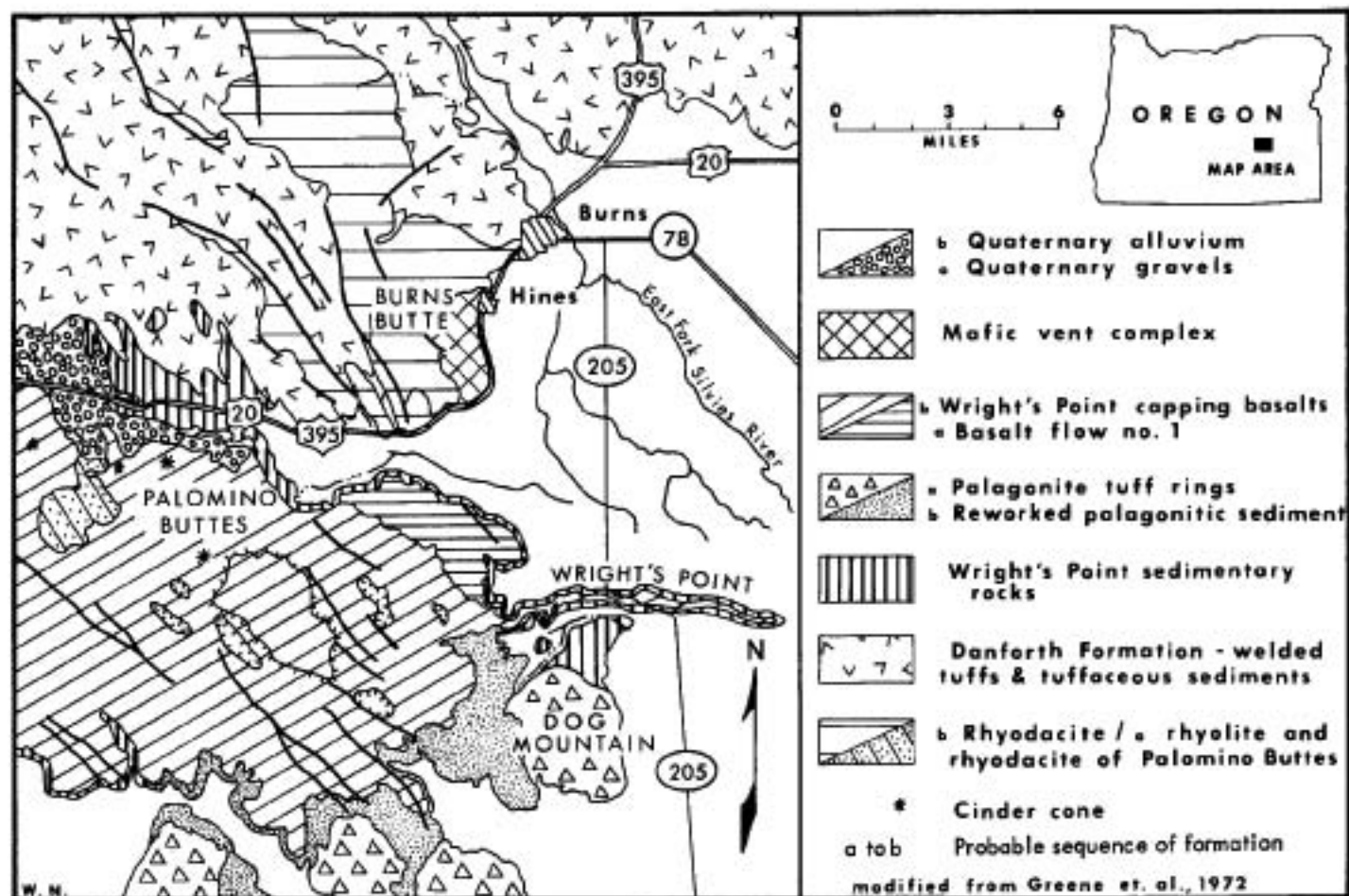


Figure 1. Geologic map of northwestern part of Harney Basin.

Introduction

Intracanyon lava flows are a familiar sight on the high lava plateaus of eastern Oregon. Equally familiar are the elongate sinuous basalt-capped ridges produced when "softer" canyon walls are eroded away, leaving an erosion-resistant, narrow, high-standing ridge composed of stream valley fill with an intracanyon basalt cap. Yet this familiar topographic feature, commonly referred to as inverted topography (Thornbury, 1969, p. 217), has received little more than brief mention in general geomorphology texts. A perusal of the geologic literature indicates that little is reported about the anatomy or origin of inverted topography. According to Aaron Waters (1960), western North America contains hundreds of examples of this distinctive landform.

An easily accessible classical example of inverted topography occurs at Wright's Point in southeastern Oregon. Wright's Point is a long, narrow finger-shaped ridge approximately 12 miles south-southeast of Burns, Oregon (Figure 1). It appears on the U.S. Geological Survey Dog Mountain and Lawen 15-minute topographic maps. This sinuous flat-topped ridge is 6 miles long, 200 to 600 yards wide, and rises 250 feet above the surrounding basin floor (Figure 2). The point merges with a broad basalt-capped mesa at its western end. The nearest topographic highs are Dog Mountain, 2 miles to the southwest, and the foothills of the Blue Mountains, which include Burns Butte near the city of Burns.

Oregon State Highway 205 crosses Wright's Point and provides a series of nearly continuous roadcuts from the basin floor to the top of the ridge. Although the roadcuts on the north side of the ridge have slumped extensively, those on the southern margin are relatively fresh and undisturbed. Two thin basalt flows overlie a well-exposed, nearly horizontal sedimentary section approximately 200 feet thick (Figure 3).

General Geologic Setting

Wright's Point is located in the northwestern part of the Harney Basin. The Harney Basin is approximately 50 miles in diameter and is bounded on the east by the continuation of the fault-block Steens Mountains and on the west by the high lava plateaus of central Oregon. The Blue Mountains form the northern boundary. Streams flowing into the basin empty into the shallow ephemeral Malheur and Harney Lakes. The basin is floored with lake sediments and alluvium. Although marsh and wet ranch lands cover much of the area, sand dunes are locally developed along the eastern shore of Harney Lake.

The geology of the Wright's Point area is varied. North of Burns, ignimbrites, tuffaceous and pumiceous sandstones, and mudstones of the middle Pliocene Danforth Formation crop out in the foothills of the Blue Mountains (Figure 1). The ignimbrites form thick resistant ledges which dip gently southward into the basin.



Figure 2. Oblique aerial view of Wright's Point looking westward.



Figure 3. Roadcuts on south side of Wright's Point expose dark basalts capping light-colored sedimentary section.

A flow-banded rhyodacitic mass (7.82 ± 0.26 m.y., Greene and others, 1972) with abundant obsidian at the surface, a Quaternary mafic vent complex, and Pliocene pumiceous strata comprise Burns Butte immediately west of Burns and Hines.

Dog Mountain, 2 miles southwest of Wright's Point, is a 520-foot-high palagonite tuff ring (Figure 1). From the air, it appears as a roughly circular topographic high with a central depression. The orange-brown palagonite is easily eroded, and the slopes of Dog Mountain have a distinctive "badlands" topography that is strewn with a variety of basalt boulders from fist size to 8 feet in diameter. The tuff ring is massive to well-bedded, commonly consisting of alternating thin beds of ash falls and base-surge deposits similar in appearance, composition, and structures to the palagonite tuff rings at Fort Rock, Oregon, and Diamond Head, Hawaii.

The flat surface of the basalt mesa at the western end of Wright's Point is interrupted by several partly eroded cinder cones, irregular to circular and elongate depressions infilled with thin recent playa deposits, and a 300-foot-high rhyolitic and rhyodacitic domal mass that forms the Palomino Buttes. A thin mantle of gravels and tuffaceous sandstones overlies the northern part of the mesa. The broad mesa, the nearby Blue Mountain foothills, and Burns Butte are cut by numerous northwest-trending normal faults with minor displacements.

Stratigraphy

The sedimentary rocks of Wright's Point were mapped by Piper and others (1939) as part of the Harney Formation, which they named for a section measured on the east face of Dog Mountain, 4 miles south of Wright's Point. Their work preceded the construction of State Highway 205 in its present position; and, therefore, the exposures available to this writer were not in existence at that time. The correlation of Piper and others (1939) from Dog Mountain to Wright's Point was based on a 5-foot-thick basaltic scoria which they considered to be equivalent to the basalt cap of Wright's Point. Although this unit occurs approximately at the same elevation as the Wright's Point basalt, these two units apparently are not equivalent. The basaltic scoria feathers out along the north-northeast flank of Dog Mountain, whereas the Wright's Point basalt actually consists of two separate flows that can be traced westward. In addition, the Dog Mountain section bears little resemblance to the section along Highway 205. The former is composed of dark black scoria and yellowish-brown palagonite tuff and breccia, a typical tuff ring assemblage; the latter contains cross-bedded pale olive-gray ignimbrite pebble conglomerates, yellow-gray tuffaceous channel sandstones and mudstones with abundant plant rootlets, and a 6-inch-thick white tuff bed. Therefore, the name Harney Formation is not used in this paper. Greene and others (1972) refer to the Wright's Point strata on the Burns quadrangle geologic map as tuffaceous sedimentary rocks and differentiate these strata from the palagonite tuff at Dog Mountain.



Figure 4. Roadcut on Oregon State Highway 205 exposes a large light-colored mudstone-filled channel truncating darker tuffaceous strata. Several smaller channels also occur in this roadcut. Bar scale is 5 feet high.

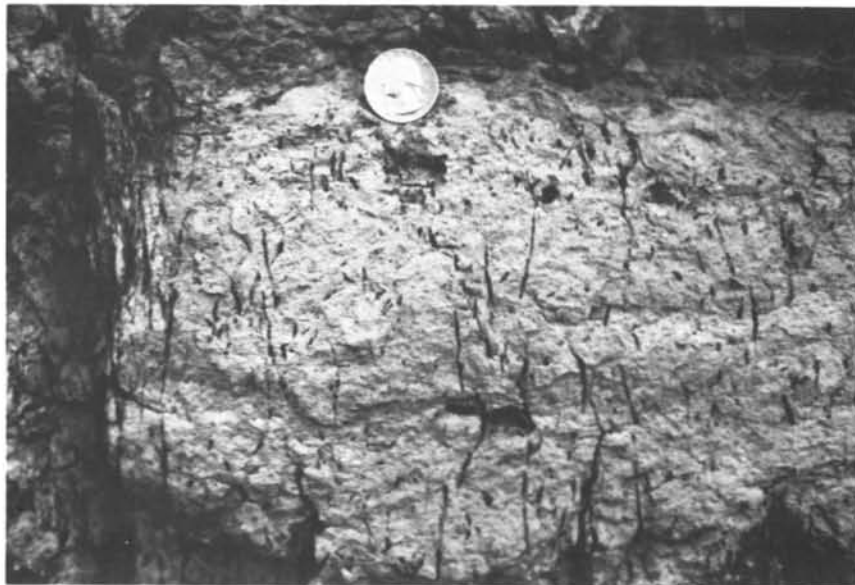


Figure 5. Fossil plant rootlet impressions in tuffaceous mudstones exposed in roadcut on Wright's Point.

Semi-consolidated yellowish-gray mudstone-filled channels and planar to trough cross-bedded conglomerate and tuffaceous sandstone lenses are abundant in the sedimentary sequence of Wright's Point. Relief of the channels ranges from 1 foot to 9 feet; the width ranges from 3 feet to 42 feet (Figure 4). Commonly the base of a channel is filled with cross-bedded conglomerate that grades abruptly upward into buff mudstone with abundant plant rootlet impressions. The impressions are less than 1/8 inch in diameter, up to 2½ inches long, and are stained black. They are in growth position and closely resemble the rootlets of reeds found in the mud and silt banks of the modern Silvies and Donner und Blitzen Rivers that flow into the Harney Basin (Figure 5).

Fairly well-sorted to poorly sorted fine- to medium-grained tuffaceous sandstone beds are faintly laminated or contain well-developed trough cross-lamination (Figure 6), and many grade laterally over 40 to 150 feet into conglomerate or mudstone units. The sandstone beds are generally 1 foot to 3 feet thick although lenses and 2- to 3-inch beds are present. Several fossil fish bones, including vertebrae and ribs, were collected from some of the coarser-grained sandstone beds. Thin, uniform sandstone beds contain ripple marks and some carbonaceous plant fragments. The upper few inches of several sandstone beds contain concentrically filled burrows that may have been produced by worms or mollusks. Extensive burrowing has obliterated internal stratification in many mudstone beds. The semi-consolidated sandstones consist of mixtures of glass shards, pumice, plagioclase grains, subangular basalt fragments, minor quartz, and rare ignimbrite and palagonite clasts.

The volcanic conglomeratic units of Wright's Point are a distinctive pale olive-green color. They are cross-bedded, poorly sorted, and many units are lens-shaped. The subangular to subrounded pebble- to cobble-sized clasts range in composition from obsidian to ripped-up clasts of the underlying tuffaceous mudstones. The most common clasts are very irregular, knobbly, "vuggy" pale olive-green ignimbrite fragments (Figure 7). Rounded white to yellow pumice, basalt, and sandstone clasts also are present. Numerous fossilized fish bones are oriented along the cross-beds in the conglomerates. The tooth of a large Plio-Pleistocene camelid (identification by Charles Repenning, U.S. Geological Survey) and a fresh-water pelecypod were collected from a conglomerate bed.

Approximately 25 to 50 feet of bedded yellow-brown palagonite tuff and breccia underlie the two capping basalt flows and overlie the yellow-gray channel sandstones, cross-bedded sandstones, and mudstones in the extreme southwestern part of Wright's Point (Figure 8). It is not clear if this material is current-reworked palagonite tuff derived from Dog Mountain or if this is an original part of the palagonite tuff ring. The occurrence of bedding sags (Figure 9) and antidune structures suggests a primary base-surge origin. This suggestion is further supported by the fact that this palagonite deposit can be traced continuously beneath the broad mesa of Wright's Point basalts to the palagonite rims of Dog Mountain, where it thickens to 200 to 400 feet.



Figure 6. Trough cross-bedded pebbly sandstone of Wright's Point.



Figure 7. Irregular, "vuggy," caliche-encased ignimbrite pebbles from conglomerate of Wright's Point strata.

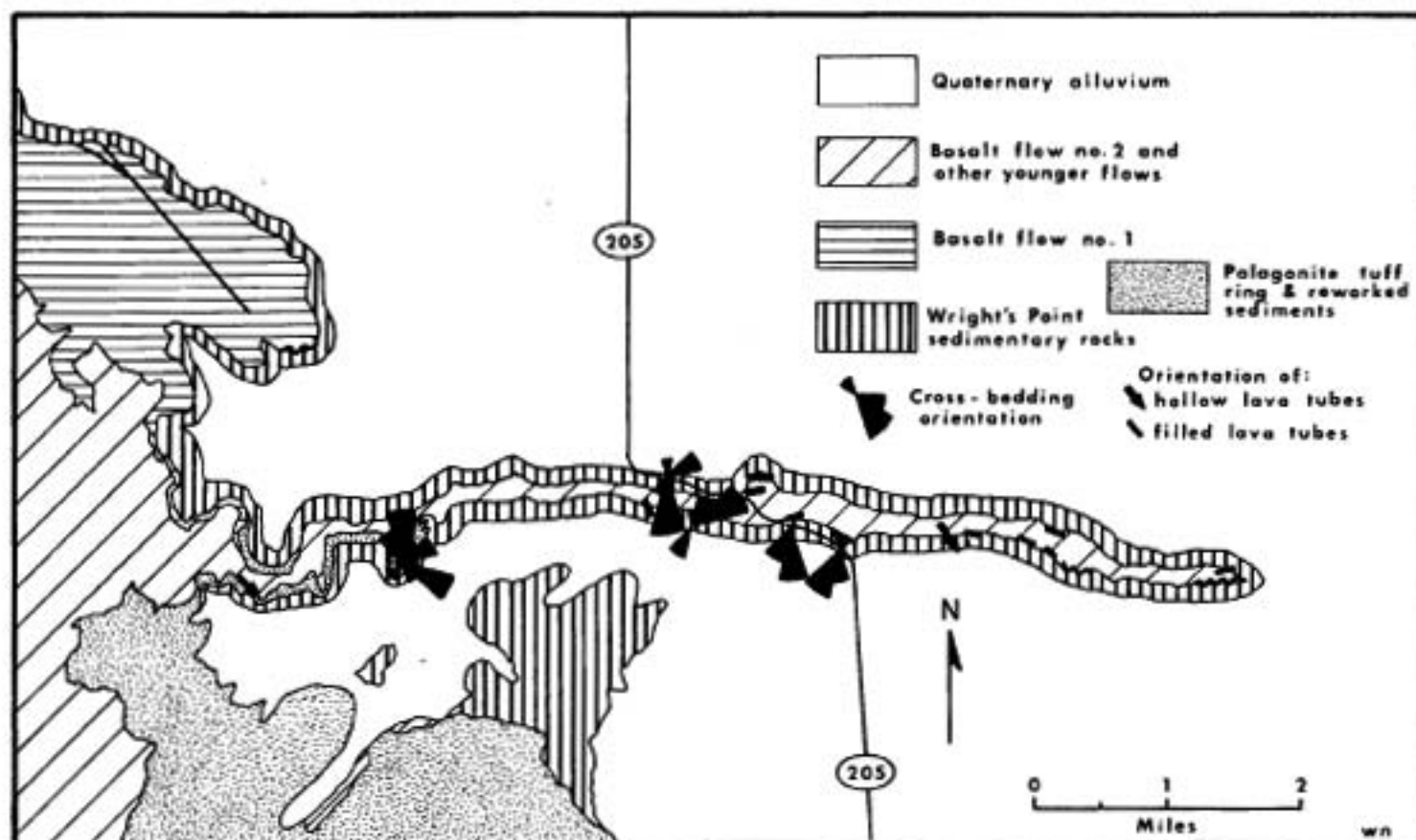


Figure 8. Geologic map of Wright's Point.

Paleocurrent directions indicated by cross-beds are bimodal to the north-northeast and south-southwest and were probably produced by a meandering or braided stream (Figure 8). The directions of the channel axes are in a similar bimodal pattern.

Basalts

Wright's Point is capped by two thin (10 to 30 feet thick), diktytaxitic olivine basalt flows of Pleistocene age (2.4 m.y. according to Greene and others, 1972). A thin baked zone occurs at the contact of the basalt with the underlying sedimentary rocks. Both flows are vesicular, locally dense or platy, and display well-developed columnar jointing. Where the upper surfaces of the flows are exposed, the polygonal pattern of the jointing is apparent. A third basalt flow, 15 feet thick, occurs some 55 to 75 feet below the two capping flows of Wright's Point at the extreme northwestern side of Wright's Point and forms a cap in the northeastern part of the broad mesa that joins Wright's Point (Figure 8). This flow contains abundant small plagioclase phenocrysts.

The upper surface of the youngest flow capping Wright's Point is covered with a thin soil, ant hills, and sage brush. Locally the two capping flows of Wright's Point are separated by 4 to 6 feet of thinly bedded white tuff. In general, however, the younger flow rests directly on the red rubbly undulating upper surface of the older flow with a relief of 1 to 4 feet. Both filled and open lava tubes occur near the base of both flows. Filled lava tubes were recognized by the distinctive "war bonnet" radiating pattern of columnar jointing described by Waters (1960, p. 354). Individual "war bonnets" are 15 to 20 feet in diameter (Figure 10). Curving platy joints and bands of vesicles in concentric zones (Waters, 1960, p. 354) locally form arcs suggesting filled lava tubes in which columnar jointing did not form.

In general, the sinuous filled lava tubes are oriented parallel to the edge of the east-west ridge, and in many places their margins form the resistant edge of the ridge. Most of the open lava tubes also have a west to east orientation (Figure 8). The elevation of three widely separated points at the base of the older flow were measured with plane table and alidade from a bench mark on Wright's Point. Using the three-point method of Billings (1954), the paleoslope of the base of the older flow was determined to be 12 feet per mile eastward.

Source of capping basalts

The broad mesa that lies to the west of Wright's Point most probably contains the source of the Wright's Point lavas. A western source is suggested by the orientation of filled and open lava tubes and increasing number of flows in that direction. Several possible sources on the mesa were

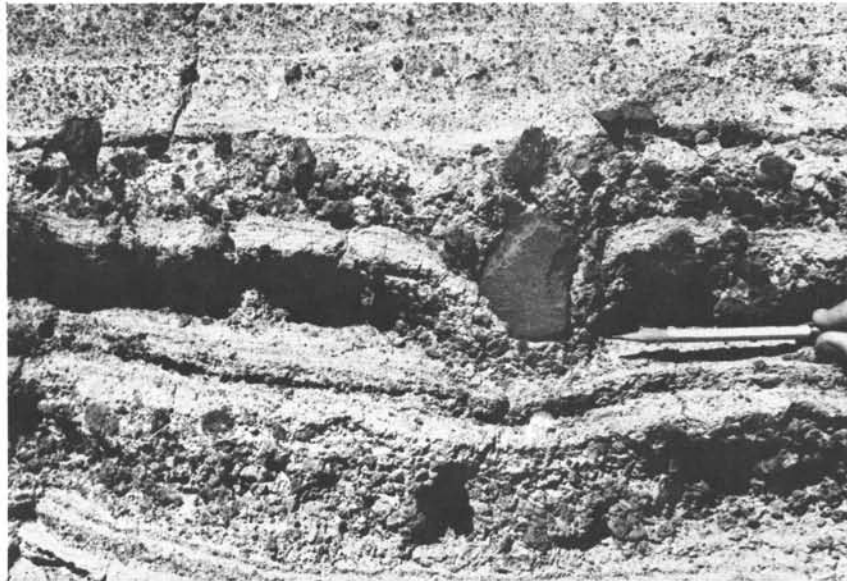


Figure 9. Bedding sag structure in palagonite tuff 10 feet below capping basalts of Wright's Point.



Figure 10. Filled lava tube with "war bonnet" pattern of columnar jointing, south side of Wright's Point.

investigated. Northeast of the Palomino Buttes, two old eroded cinder cones rest on the lower capping basalt of Wright's Point (Figure 1). Other cones occur northwest and southeast of the buttes. Five miles southeast of Palomino Buttes, several lava flows form a broad, local topographic high. This mound, $1\frac{1}{2}$ miles wide, 4 miles long, and rising 200 feet above the mesa, is another possible source of the Wright's Point lava flows.

Circular to elongate depressions on the basaltic surface of the broad mesa may be surface expressions of collapse features such as grabens produced by draining of underlying lava tubes or, as interpreted by George Walker (U.S. Geological Survey, personal communication, 1972), may be deflation basins. Islands of fine tuffaceous sediment surrounded by lava were later more rapidly eroded (by wind?) than the basalt, thereby producing a depression. More recently these shallow depressions have acted as catchment basins for rain water and have been partly infilled with mud.

Geologic Interpretations

The abundance of channels, trough and planar cross-bedding, poor sorting, and subrounded nature of the clasts in the conglomerates, lens-like shape of the conglomerates and sandstones, and rapid lateral grading of conglomerate-sandstone-mudstone facies in the Wright's Point strata indicate that the sedimentary rocks were deposited in a fluvial environment. Fossilized fish bones, a fresh-water pelecypod, and the tooth of a camelid are further evidence for a stream depositional environment. The repeated reduction in grain size in the channels from cross-bedded conglomerates to mudstone is the typical sequence observed in modern meandering river deposits (Selley, 1970).

The channels and ripped-up sandstone and mudstone clasts in the channel conglomerates were probably produced during erosive flood stages. The planar and trough cross-bedded conglomerates and sandstones at the base of the channels represent high-flow regime deposition with migrating mega-ripples and sand waves. The gradation upward into finer sandstone and tuffaceous mudstone, which are the major constituents of the channel fill, possibly reflects settlement of finer sediment from suspension during a period of diminished stream velocity, as in low-river stage. More probably it represents the gradual infilling of abandoned channel meanders (e.g., oxbow lakes) during periods of overbank flow of the active channels. The abundance of reed-like plant rootlet impressions in the mudstones and abundant burrows in the sandstones also suggest a flood-plain environment similar to that observed in the nearby modern Silvies River.

The laminated and rippled sandstones are probably the coarser flood-plain deposits. The rapid lateral facies changes in the deposit, channel truncations, and ripped-up clasts of sandstone and mudstone in the conglomerates may be attributed to erosion and deposition during lateral channel migration. Some of the conglomerate and sandstone lenses in channels

appear to be point bars. The bimodal cross-bedding orientations and the somewhat sinuous shape of Wright's Point ridge also suggest that the stream meandered. The Silvies River, just north of Wright's Point, shows a meandering river pattern (Figure 11) similar to the hypothetical stream that deposited the Wright's Point strata. The valley fill accumulated to at least 200 feet as the streams meandered laterally and inundated the flood-plain periodically.

The source areas of the Wright's Point strata as indicated by thin-section petrography were nearby and ranged from welded ash-flow tuff (ignimbrite) to obsidian to palagonite tuff. The ignimbrite clasts have distinctive hollowed shapes indicating an origin from the weathering of a lithophysal zone of an ignimbrite, probably from the older middle Pliocene Danforth ignimbrites. Near Burns the Danforth ignimbrites contain abundant lithophysae. Abundant glass shards and pumice in the tuffaceous sandstones were probably derived from the thick, older, pumiceous and shard-rich lacustrine, fluvial,



Figure 11. Aerial view looking eastward down the meandering course of the Silvies River, a quarter of a mile north of Wright's Point.

and ash-fall interbeds of the Danforth Formation in the foothills of the Blue Mountains to the northwest of Wright's Point. The nearest sources of obsidian occur in the rhyodacitic domes (middle Pliocene) at Burns Butte to the northwest and Palomino Buttes to the west. The palagonite tuff ring at Dog Mountain contributed palagonite, scoria, and a variety of basalt clasts to the sediment, particularly to the western part of Wright's Point.

Erosional remnants of these potential source areas are still exposed in sharp contact with the Wright's Point strata and capping basalts (Figure 1), suggesting that they may have acted in part as source areas and as valley walls for the streams that flowed down the Wright's Point paleoslope. The palagonite tuff ring is Pliocene-Pleistocene in age based on a fossilized horse's tooth (identification by Repenning), and the palagonite tuff may have been erupted just before or contemporaneously with the Wright's Point lava because the tuff underlies the capping basalts at the western end of Wright's Point and overlies most Wright's Point stream-deposited strata. Orientation of cross-bedding and channels and slope of the base of the older lava flow suggest that the paleoslope of Wright's Point valley was from west to east.

Early Pleistocene lavas flowed down the ancient stream valley from the west, as evidenced by the dip of the base of the older flow, orientation of lava tubes, and increased number of flows to the west. The flows may have been partly funneled down a stream channel within the flood plain. As the "softer" valley walls and flood-plain deposits were stripped away in the last 2.5 million years (age of Wright's Point flows), the erosion-resistant basalt-capped ridge remained to produce an example of inverted topography.

Acknowledgments

The writer gratefully acknowledges help from his wife, Wendy Niem, for field assistance, drafting, and typing of the manuscript. Also thanks are extended to George Walker, U.S. Geological Survey, and to Donald Parker, Oregon State University, for helpful discussions concerning Wright's Point, and to Charles Repenning, U.S. Geological Survey, for identifications of vertebrate fossils. Research was supported by grants from the Oregon State University Graduate School General Research Fund.

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Glossary

Antidune structure: a form of cross-bedded ripple that appears to have moved up-current rather than with the current.

Base-surge deposits: volcanic material which spreads outward at hurricane speeds from the base of vertical eruption clouds; commonly deposited in very thin layers.

Bimodal: grain size distribution in which there are two maxima.

Bimodal pattern: On a paleocurrent diagram, the two most frequently occurring directions of flow.

Breccia: a rock composed of angular fragments.

Camelid: a camel-like animal.

Channel truncations: abrupt ends of sedimentary layers due to erosion by stream channels.

Clasts: transported fragments of any size in a sedimentary rock.

Cross-bedding and cross-lamination: the arrangement of layers of sediment within a sedimentary bed at an angle to the upper and lower surfaces of the bed.

Diktytaxitic: a descriptive term for basalt with numerous very small angular cavities.

Fluvial: deposited by a stream or river.

Grabens: depressions formed by downdropping of a block of earth between two faults.

Ignimbrite: rock composed of small volcanic fragments erupted in dense fiery clouds; as the deposit cooled, some fragments were "welded" together, hence the name commonly used, "welded tuff."

Lacustrine: deposited in a lake.

Lithophysae: large hollows infilled with aggregates of minerals found in volcanic rocks.

Lithophysal zone: the portion of an ignimbrite that contains lithophysae.

Palagonite: yellow to orange mineraloid formed when lava flows into water.

Palagonite tuff ring: a volcanic cone composed of tuff (fine-grained volcanic rock) containing yellowish brown palagonite, commonly well bedded.

Paleocurrent: direction of flow of water, air, lava, etc in geologic past.

Paleoslope: the direction of the slope of the land in the geologic past.

Phenocrysts: crystals in igneous rocks.

Planar cross-bedding: sedimentary cross-bedding in which the layers lie more or less parallel [as opposed to curved (trough cross-bedding) layers] and are inclined from the top to the bottom of a sedimentary bed.

Playa deposits: very fine-grained sediment deposited in the lowest portions of basins.

Pleistocene: the period of geologic time between approximately 3 million years ago and 10,000 years ago – popularly called "The Ice Age."

Pliocene: the period of geologic time extending from approximately 10 million years ago to approximately 3 million years ago.

Quaternary mafic vent complex: an area of numerous small volcanic cones composed of dark igneous material that was erupted sometime during the last 3 million years.

Rhyodacitic mass: a fine-grained light-colored igneous rock body, commonly showing flow structures.

Scoria: a dark-colored porous volcanic rock composed of cinders.

Shard: a curved fragment of volcanic glass, usually sand-sized or smaller.

Thin section petrography: a detailed study with a microscope of rocks cut in thin slices.

Tuffaceous: formed of volcanic fragments.

Tuff ring: a type of maar; a circular, shallow, flat-floored crater usually less than a half mile in diameter surrounded by a rampart of volcanic ejecta containing abundant palagonite.

Vesicular: containing many small cavities.

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WALKING TOURS TO SEE ROCKS AND MINERALS

Walking tours around Portland and its environs are becoming increasingly popular as a way to conserve gas, get some exercise, and learn some interesting facts about the city.

One type of walking tour recommended by the Department is to see the unusual variety of rocks and mineral products that constitute the exteriors of Portland's buildings. The following pamphlets provide self-conducting tours and describe these decorative building materials; they are available at the Department's Portland office in the State Office Building:

"The Lloyd Center Collection of Fine Stones," by R. S. Mason 35¢
"Portland State University - Park Blocks Area Tour of Walls,"
by R. S. Mason Free; by mail 10¢
"Walls of Portland," by R. S. Mason (ORE BIN, April 1965) 25¢

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CONGRESS SHOWS CONCERN OVER MINERALS SHORTAGES

Concern over impending shortages of domestically produced minerals is being evidenced in the U.S. Congress. Two bills have been introduced in the House. Rep. Elwood H. Hillis introduced H. Res. 907 with 17 co-sponsors creating a select committee of seven House members named by the Speaker "to conduct a full and complete investigation and study of the shortages of materials and natural resources." A bill by Rep. Edward R. Madigan (H.R. 13202) would create a National Commission on Raw Materials to study and recommend programs to prevent shortages of raw materials in the U.S.

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GEOHERMAL FIELD TRIP IN JUNE 1974

The Oregon Department of Geology and Mineral Industries will conduct a field trip through parts of Oregon and Washington to show the relationship of thermal manifestations to regional and local geology.

Present plans are to make this a 6-day trip, starting in Portland on June 24 and returning on June 29. Participating in the organization and leading segments of the trip will be Paul Hammond, Portland State University; Oregon Department of Geology staff members R. G. Bowen, Howard Brooks, R. E. Corcoran, and N. V. Peterson; and Washington Division of Geology and Earth Resources staff members Ted Livingston and Eric Schuster.

The planned itinerary is as follows:

- Day 1. Start from Portland. Proceed into area of Pleistocene to Holocene volcanism between Mount St. Helens and Mount Adams; overnight in Pendleton, Oregon.
- Day 2. Pendleton through Blue Mountain belt to La Grande-Baker area; overnight at Ontario.
- Day 3. Vale-Owyhee Uplands to north side of Harney Basin; overnight in Burns.
- Day 4. Southern Harney Basin, Alvord Valley, Fields, Denio to Warner Valley-Crump Lake area via Highway 140; overnight in Lakeview.
- Day 5. Lakeview thermal area, Klamath Falls thermal areas with stops at Oregon Institute of Technology and other heating installations; overnight at Bend.
- Day 6. Holocene geology of High Cascades, volcanic stratigraphy, and structural geology of Western Cascades thermal spring area; return to Portland.

This trip will be limited to the first 35 persons applying. Cost will be about \$250, to include bus transportation, lodging away from Portland, and noon lunches. A \$25 non-refundable fee, which will be applied to total cost, is required with each application.

Send application and fee to Geothermal Trip, Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon, 97201.

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MINED LAND RULES AND REGULATIONS

Copies of the Rules and Regulations for the Mined Land Reclamation Act are now available from the Department. All known operators of open pits in the State are being supplied with copies, but others interested in obtaining this information may get copies from any of the Department's offices for \$1.50.

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GEOHERMAL REPORT ON OPEN FILE

The U.S. Geological Survey has just released an open-file report on chemical analyses of thermal springs in Oregon. The 27-page report, entitled "The Chemical Composition and Estimated Minimum Thermal Reservoir Temperatures of Selected Hot Springs in Oregon," is by R. H. Mariner, J. B. Rapp, L. M. Willey, T. S. Presser. The report describes 32 hot springs in the State, detailing their major element composition, geologic setting, and probable reservoir temperatures.

Copies of the report are available from the Oregon Department of Geology and Mineral Industries for \$2.70.

* * * * *

SLOSSON NAMED HEAD OF CALIFORNIA DIVISION OF MINES

James E. Slosson has been named State Geologist and Chief of the California Division of Mines and Geology, under the Department of Conservation. He succeeds Wesley Bruer.

Slosson joined the California Division of Mines and Geology in 1973. He is a graduate of the University of Southern California and holds master's and doctorate degrees from U.S.C. He has worked for the U.S. Geological Survey, the Department of Water Resources, and Gulf Oil Corporation. Before entering the state service, he formed his own consulting geological firm. He was recently appointed to the scientific panel of the Earthquake Engineering Research Institute and to the landslide mitigation panel by the National Academy of Science.

* * * * *

FALKIE NAMED BUREAU OF MINES DIRECTOR

Interior Secretary Rogers Morton administered the oath of office to Thomas V. Falkie, 39, newly confirmed by the Senate as Director of the Bureau of Mines, at a ceremony February 28 in the Secretary's office.

Dr. Falkie, a professor of mining engineering, headed the Department of Mineral Engineering at Penn State University from 1969 until his nomination by President Nixon as head of the Bureau of Mines on January 25. At Penn State he was also chairman of the inter-disciplinary graduate program in mineral engineering management. Since 1971 he has been a consultant to the United Nations on mining economics and mine management, with recent assignments in Chile.

From 1961 to 1969 he was employed by International Minerals and Chemical Corporation, holding various managerial and technical positions.

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SECOND GEOTHERMAL LEASE OPENING HELD

The U.S. Bureau of Land Management opened, on March 1, 242 geothermal lease offers from 43 companies in the second geothermal lease opening in the state since Federal regulations became effective January 1.

The applications were for more than a half million acres in Oregon and Washington. Oregon offers totaled 460,121 acres. In Washington the applications were for 68,981 acres.

Greatest interest was for lands in southern Lake County, Oregon, where almost 100 applications were filed. Members of the Dallas, Texas based Hunt Oil Company, filing as individuals, had 96 applications in Oregon, most of which were in Lake and Klamath Counties.

Applications in both states generally followed patterns of offers filed in February. There was some increase in activity in Marion and Clackamas Counties in the vicinity of Breitenbush Hot Springs.

In Washington, most filings were in Skamania County.

About a third of the applications were for land within national forests.

BLM is processing these applications, many of which overlap with ones filed in February. It is expected to be several months before the first leases are offered and actual development of geothermal energy begins.

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GOLD MINE PRODUCING IN BAKER COUNTY

The Bald Mountain gold mine near Sumpter in Baker County recently began shipping crude ore to the American Smelting and Refining Company smelter in Tacoma. Shipments are at the rate of about 50 tons per day. Renovation and new development work at the old mine began in 1970, and rehabilitation of 2700 feet of haulage adit and construction of new surface facilities has been done to Federal safety standards.

The mine property incorporates workings of the Bald Mountain and Ibex mines, which were first operated prior to 1900. The vein, which is 5 to 25 feet wide, dips steeply and is in argillite near the contact with younger quartz diorite of the Bald Mountain batholith. Haulage level is about 900 feet below surface outcrops of the vein, and present mining widths are 6 to 8 feet. The ore is highly siliceous; values are about 65 percent gold and 35 percent silver.

Owner of the mine is Tony Brandenthaler, and the present work force of 15 men includes Mirko Skripsy, mine manager, and Vern Jacobson, engineer.

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