THE GEOLOGICAL NEWSLETTER

GSOC

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

GEOLOGICAL SOCIETY
OF THE OREGON COUNTRY
P.O BOX 907
PORTLAND, OR 97207

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

SINCE 1935

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GEOLOGICAL SOCIETY OF THE OREGON COUNTRY
1998-1999 ADMINISTRATION
BOARD OF DIRECTORS

President:		Directors:		
Beverly Vogt	292-6939	Richard Donelson	(3 years)	654-1098
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Carol Hasenberg	282-0547	Ray Crowe	(1 year)	640-6581
Secretary-Treasurer:		Immediate Past Presidents:		
Phyllis Thorne	292-6134	Dr. Paul Brown		227-2136
		Richard Bartels		292-6939

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THE GEOLOGICAL NEWSLETTER
[e-mail: barrd15@uswest.net

Editor:		Business Manager:	
Donald Barr		Rosemary Kenney	221-0757
Calendar:		Assistant Business Manager:	
Evelyn Pratt	223-2601	Cecelia Crater	235-5158

ACTIVITIES:

ANNUAL EVENTS: President's Field Trip--Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS**: Usually one per month, private car, caravan, or chartered bus. **GEOLOGY SEMINAR**: Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. GSOC Library: Rm. S7, Open 7:30 p.m. prior to meetings.
PROGRAMS: EVENING: Second Friday Evening each month, 8:00 p.m., Rm 383, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually First Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP**: per year from January 1: Individual-$20.00; Family-$30.00; Junior (under 18)/Student-$10.00
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State: _______ Zip: ___________ PHONE: ____________________

Geological Interests and Hobbies: ____

Please Indicate Membership Type and Include Check for Appropriate Amount:

Individual ($20.00): ______ Family ($30.00): ______

Junior (Under Age 18) or Student (Not Included with Family Membership) ($10.00): ______

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P.O. BOX 907, PORTLAND, OR 97207

VISITORS WELCOME AT ALL MEETINGS
INFORMATION: Beverly Vogt, 503-292-6939
Evelyn Pratt, 503-223-2601

VOL. 65, No. 1
JANUARY 1999

JANUARY ACTIVITIES

(*Weather-watch season:* If schools are closed, meetings are postponed to a later date.)

Wed. Jan. 6,12-1:30 PM: Oregon's Spectacular Southeast Corner
Presenter: Evelyn Pratt, past president, GSOC
Central Library, 801 SW 10th

Fri. Jan. 8, 8:00 PM: Recent Rock Avalanches on Mt. Adams
Presenter: Dick Iverson, Cascade Volcano Observatory, USGS
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

FIELD TRIP Mon. Jan. 18: Tour of ESCO, demonstrating various aspects of metallurgy and steelmaking. Call Evelyn Pratt, 223-2601 for details.

Wed. Jan. 27, 8:00 PM: This year's Seminar Series: "Topics in Physical Geology"
4. Igneous Rocks and Plate Tectonics
Richard Bartels, geology instructor and past GSOC president
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

We need a Geology Field Trip chairperson. Several field trip leaders-to-be have been contacted, and just need follow-ups. Spring and summer are good times for field trips. PLEASE TELL BEV (503-292-6939) if you can do this. Thanks!

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PREVIEW OF COMING ATTRACTIONS: **FEBRUARY**

Fri. Feb. 5, 12-1:30 PM, Central Library: Natural History of Steens Mountain
Presenter: Don Barr, past GSOC president

Fri. Feb. 12, 8:00 PM, Rm. 371 Cramer Hall: Prehistoric and Historic Eruptions of Mt. St. Helens Presenter: Ed Klimasauskas, Cascade Volcano Observatory, USGS

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Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

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NOMINATION AND ELECTION OF OFFICERS

The report of the Nominating Committee for officers for the 1999-2000 year was announced at the November and December 1998 meetings and reported in the November 1998 Newsletter. No further nominations have been received. In accordance with Article XI of the Bylaws revised as of July 1, 1998, the following nominees will be submitted for approval by vote of the membership at the Annual Meeting February 12, 1999:

President	Carol Hasenberg
Vice President	Ray Crowe
Secretary-Treasurer	Phyllis Thorne
Director, 3 years	Archie Strong
Director, 2 years	Richard Donelson
Director, 1 year	Robert E. Richmond

ANNUAL MEETING

The annual meeting is February 12, 1999. Officers for the coming year will be approved by vote of the membership. Current Officers and Committee Chairmen are requested to submit written reports for filing in the Society's records.

DUES

Dues for 1999 are due January 1, 1999. Members whose dues are received prior to April 1, 1999 will be included in the 1999-2000 Membership Directory. We anticipate mailing a new Directory in the May Newsletter.

ANNUAL BANQUET

Plans for the Sixty-fourth Annual Banquet are progressing. It will be held again at the Terwilliger Plaza. Doors open at 5:30, with dinner at 6:30 p.m. We are pleased to announce our speaker will be Alex Bourdeau, Archeologist with the U.S. Fish & Wildlife Service. His topic will be "GEO-ARCHEOLOGY OF THE WILLAMETTE VALLEY." We would appreciate receiving your reservation as soon as possible so a final count can be submitted to the Chef by February 28, 1999. The Menu is similar to last year, but with a couple variations.

BANQUET RESERVATION

GSOC ANNUAL BANQUET   March 12, 1999   Terwilliger Plaza
Speaker: Alex Bourdeau   Amount: $19.50

Menu: Salad Fresh Greens & Julienne Beets with Ranch Dressing
Choice of Roast Sirloin with horseradish sauce, or
Salmon Wellington with chablis butter sauce
Fresh Green Beans with nutmeg; Roasted Red Potatoes;
Yeast Rolls and Butter; Beverage
Double Chocolate Fudge Cake with Raspberry Sauce

Name/s______________________________________

Dinner Choice/s______________________________Amount Paid______

Volcano Hazards in the Mount Adams Region, Washington

From: Scott, et.al., 1995, USGS Open-File Report 95-492.

Mount Adams, one of the largest volcanoes in the Cascade Range, dominates the Mount Adams volcanic field in Skamania, Yakima, Klickitat, and Lewis counties and the Yakima Indian Reservation of south-central Washington. The nearby Indian Heaven and Simcoe Mountains volcanic fields lie west and southeast, respectively, of the 1,250 square kilometers (500 square miles) Adams field.

Even though Mount Adams has been less active during the past few thousand years than neighboring Mounts St. Helens, Rainier, and Hood, it assuredly will erupt again. Future eruptions will probably occur more frequently from vents on the summit and upper flanks of Mount Adams than from vents scattered in the volcanic fields beyond. Large landslides and lahars that need not be related to eruptions probably pose the most destructive, far-reaching hazard of Mount Adams.

From: Hoblitt, et.al., 1987, Volcanic Hazards with Regard to Siting Nuclear-Power Plants in the Pacific Northwest: USGS Open-File Report 87-297

Mount Adams is composed of lava flows and fragmental rocks of basaltic andesite and andesite; numerous satellitic vents on the flanks of the volcano have erupted rocks ranging from basalt to dacite. Most of the main cone is younger than 220,000 years. Seven postglacial lava flows issued from flank vents, the youngest of which is between 6,850 and 3,500 years old. Debris avalanches and lahars affected several valleys around the volcano during postglacial time; the longest lahar extended at least 52 kilometers from the volcano. A large amount of hydrothermally altered material in this and one other lahar and in one debris avalanche implies they originated as avalanches of wet, altered, clay-rich debris from near the summit. The youngest such event was a debris avalanche that descended the southwest flank in 1921. Numerous debris flows generated by glacial and meteorologic processes occur frequently at Mount Adams, but typically affect areas within only a few kilometers of the volcano. Postglacial eruptions and weak, diffuse fumarolic emissions in the summit area suggest that the volcano is capable of erupting again.

From: Wood and Kienle, (eds.), 1990, Volcanoes of North America - United States and Canada: Cambridge University Press, p.164-165, Contribution by Wes Hildreth

Mount Adams stands astride the Cascade Crest some 50 kilometers due east of Mount St. Helens. The towering stratovolcano is marked by a dozen glaciers, most of which are fed radially from its summit icecap. In the High Cascades, Mount Adams is second in eruptivevolume only to Mount Shasta, and it far surpasses its loftier neighbor Mount Rainier (which is perched on a pedestal of Miocene granodiorite). Adams's main cone exceeds 200 cubic kilometers, and at least half as much more was eroded during late Pleistocene time form earlier high-standing components of the compund edifice: peripheral basalt adds another 70 cubic kilometers or so.

Nearly all the high cone above 2,300 meters in elevation was constructed during latest Pleistocene time, probably between 20 and 10 thousand years ago, explaining the abundance of late-glacial till and the scarcity of older till. Products of this eruptive episode range from 54% to 62% SiO_2 on the main cone. ...

There have been no recorded eruptions of Mount Adams, and, of the 11 Holocene vents, none is known certainly to have erupted products younger than 3,500 years. Seven of the Holocene eruptions took place at flank vents 2,000-2,500 meters in elevation and produced a wide variety of compositions (49-61% SiO_2); the other four vents are peripheral to the main cone at 1,100-1,600 meters and 48-54% SiO_2. ...

Weak H_2S-bearing fumaroles still rise from crevasses in the summit icecap. Subjected to this solfataric flux, the breccia-and-scoria core of the stratovolcano has suffered severe acid-sulfate leaching and deposition of alunite, kaolinite, silica, gypsum, sulfur, and iron oxides. Where exposed in glacial headwalls, the 4-square-kilometer rotten core is a persistent source of avalanches and debris flows; the longest traveled 40 kilometers after breaking loose approximately 5,000 years ago, creating the southwest notch and shelf for the perched White Salmon Glacier.

Fifty kilometers north of the Columbia River, Mount Adams is reached most rapidly from Trout Lake, which is two hours drive from Portland, Oregon, by paved road. U.S.Forest Service roads from Trout Lake, Glenwood, or Randle, Washington, lead toward the volcano.

TABULATION OF QUESTIONNAIRE ON ANNUAL CAMPOUT, November 1998

(41 responses. Some people gave more than one answer per question. This is a simple tabulation of all responses)

1. What kind of transportation for campout do you prefer?
a. Commercial bus—15
b. Private car—12
c. Rented vans—14
d. Other School bus—1
Carpooling—1
My own motor home—1

2. What time of year do you prefer to go on campouts?
a. Spring—3 (total of all spring votes—13)
April—3
May—7
b. Summer—7 (total of summer votes—37)
June—4
July—10
August—15
No preference—1
c. Fall—5 (total of fall votes—31)

3. How long do you want the campout to last?
a. Several days—1 (total of all several days votes—4)
4 days—1
6 days—1
10 days--1
b. A few days including a weekend—14 (total of 17 votes)
5-7 days—1
5-8 days—1
7-10 days—1
c. A weekend—9
d. One week—25
e. Two weeks—1
f. Other
1 day—1

4. Do you think GSOC should continue to sponsor campouts? Yes—35; yes only if led by professional geologists who have done work in the area they are covering—1
If yes, would you attend? Yes—25; if possible—1; maybe—1; no—1
If yes, where would you like to go? Nevada, southern Oregon, British Columbia, Oregon, Washington, Idaho, northern Idaho, northern California, eastern Oregon, southeast Oregon, Oregon Basin and Range, Klamath Mountains, Missoula Floods, Lake Chelan, Malheur area, Steens Mountain, Death Valley, Sierras, Grand Coulee, Quartzville and other Or and WA mining districts, Snake River, Siskiyous, Vancouver Island, Olympic Peninsula, Owyhees, Train from Sandpoint ID to Montana Rockies, Oregon coast, Mount Hood and Mount St Helens and Mount Adams and Mount Jefferson, Jordan Valley, anywhere (4), anywhere the leader wants to go—1.

5. Where do you want to stay during a campout?
a. Motels—26
b. Campground—5 (one mentioned group campsites in USFS and State Park campgrounds)
c. Mixture of both—16

6. How much are you willing to spend on a campout?
a. $100-200-8
b. $300-400-13
c. $500-600-14
d. More than $600-3
e. Specified sums: $750-2, $800-1, $1000-1
f. Could be more-1
g. Any reasonable amount-3

7 . Do you think a prepared field trip guide is essential to a good campout? Yes-31, no-3, helpful but not required-3, not essential but nice-1, good but skip it if too expensive-1, don't know-1, make photocopies of sheets-1, yes but only if preparer is paid to do it-1, yes but consider previously prepared field trip guides (post 1980) without the necessity of upgrading -1

8. Have you ever attended a GCOC campout? Yes-18, no-8. How many? 1 campout-1, 2 campouts-2, 3 campouts-5, 6 campouts-1, 8 campouts-1, 10 campouts-1, 12 campouts-2, 15 campouts-2, 20 campouts-5. Where were the campouts? Oregon coast, Washington northwest, Washington northeast, North Cascades, Clympics, Baker, John Day, Perkins Lake ID, Newberry Crater, Mount St. Helens, Vancouver Island, Idaho, So. Oregon, Wallowas, Central Oregon, Hancock area, Mt. Rainier to Yakima WA, NW Cascades to Methow Basin to Wenatchee WA, Red Fish ID, Jordan Valley, Canada, Todd Lake, Ochoco, Wallowa Lake, Crater Lake, Bend, Delintment Lake, Montana

9. How far do you wish to walk per day?
a. easy, 1-2 miles, level ground-12
b. Moderate, 3-4 miles, some up and down-22 (one added with rest periods and raspberries and homemade bread 3 times a day)
c. Strenuous, 5-6 miles, up and down-6
d. Other: not much distance-1, whatever is necessary-1

10. Additional comments
a. Professionally prepared field trip guides are common. DOGAMI, Wash. Dept of Natural Resources, professional meetings in the Pacific Northwest all have wonderful trips that can be used as is.
b. Tying campout to President's position keeps capable people from agreeing to be president. Why not call it the annual field trip and appoint a committee to make arrangements?
c. Good place to stay is Bar M Ranch, Adams, OR-good meals, banquet space in huge barn, hot swimming pool (springs), and Forest Service camp nearby.
d. While camping is probably least expensive, it nearly always requires some caravaning. Bus travel minimizes the parking problems at points of interest and has the considerable advantage of access to a speaker system en route. It also keeps the group together more readily and may minimize the need for pit stops
e. Some three-day trips would be nice for our group
f. How about asking GSOC members to answer 3 places I would be interested is seeing /studying, 3 places I've been to enough that I would NOT be interested in going to again. Old time GSOCers have been going to Camp Hancock for many years and may feel that they know this area very well. Same applies to coast. On the other hand, maybe going to either of these places or to Malheur Field Station and or SE Oregon could be a way to attract newcomers to president's field trips. I do feel that calling them "campouts" gives a misleading impression of what they really are.
g. I would be interested in field collecting of minerals and fossils.

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MISCELLANEOUS

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1998
compiled by Rosemary Kenney

ARTICLES and REPORTS

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NAME: ______________________________ SPOUSE: ______________________

Children Under Age 18: ____

ADDRESS: ____________________________________ City: ____________________

State: ________ Zip: ____________ PHONE: ____________________

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INFORMATION: Beverly Vogt, 503-292-6939
Evelyn Pratt, 503-223-2601

VOL. 65, No. 2
FEBRUARY 1999

FEBRUARY ACTIVITIES

(*Weather-watch season:* If schools are closed, meetings are postponed to a later date.)

Fri. Feb. 5, 12-1:30 PM, Central Library: Natural History of Steens Mountain
Presenter: Don Barr, past GSOC president
Central Library, 801 SW 10th

Fri. Feb. 12, 8:00 PM, Rm. 371 Cramer Hall: Prehistoric and Historic Eruptions of Mt. St. Helens Presenter: Ed Klimasauskas, Cascade Volcano Observatory, USGS. Rm. 371 Cramer Hall, PSU, 1721 SW Broadway. Short business meeting to elect officers & submit annual reports. Cookie-provider: Phyllis Thorne

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Can you coordinate the field trip from The Dalles to Sunriver (1/98 Oregon Geology) in March or April? If so, please tell Bev (503-292-6939) or Ev (503-223-2601) . Thanks!

FIELD TRIP Fri. 2/19: To tour new Hillsboro Joint Water Treatment Plant, call Clyde Kelley, 245-3945. Plus bring binocs to see eagles, ruddy ducks, teal at adjacent ponds.

Wed. Feb. 24, 8:00 PM: This year's Seminar Series: "Topics in Physical Geology"
Sedimentary Rocks and Plate Tectonics
Richard Bartels, geology instructor and past GSOC president
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

DUES ARE DUE! DUES ARE DUE! DUES ARE DUE!

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PREVIEW OF COMING ATTRACTIONS: MARCH

Monday March 1, noon to 1:30 PM, Central Library: Mexico's Copper Canyon presented by GSOC past president Rosemary Kenney

Friday March 12, 8:00 PM, ANNUAL BANQUET. **Alex Bourdeau**, US Fish and Wildlife Service, discusses **Geoarcheology of the Willamette Valley.** Terwilliger Plaza.

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Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

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GEOTOURING IN HAWAII

by
Carol Hasenberg

Hawaii, as most of you probably know, is a chain of islands which have been manufactured from a hot spot in the mid-Pacific Ocean. At least this is the current geological model for the islands. The hot spot does not move with the overriding Pacific plate - therefore, as the plate moves, the upwelling of the magma occurs on a slightly different spot on the plate. In this manner a sort of conveyor belt island forming operation occurs. The island chain formed by this action actually stretches for thousands of miles along the Pacific plate, terminating in the Aleutian trench between Siberia and Alaska. Most of this chain has eroded back below the ocean surface, and the Hawaiian islands are the largest and youngest land masses in this chain. The oldest of the main islands is Kauai, and as one travels southeast, the islands are progressively younger until one reaches the island of Hawaii, the Big Island.

The Life of a Hawaiian Volcano

In the early stages of the life of a Hawaiian volcano, basalts are erupted from the plume of magma arising from the hot spot to create a subterranean mountain. The common basalt in the early stage eruptions is called tholeiite, and contains crystals of the mineral olivine. The mountain gets larger and larger until it appears above the water, after many thousands of years. It continues to erupt, and forms a regular shape. Hawaiian volcanoes tend to erupt "quietly", or with non-explosive outpourings of molten rock which roll down the slopes and into the sea. The slope of the mountain is very shallow compared to mainland volcanoes, because the hot thin lava flows cannot maintain a steep slope. This type of volcano is called a **shield volcano**.

Shield volcanoes have a characteristic shape. With the accumulation of heavy, fractured rock, the massive mound begins to settle and crack. The upwelling magma then forces its way up through fractures that radiate from the central cauldera, which lies just above the magma chamber. These fractures are called **rift zones**. The spacing between rift zones tends to be about 120^0, so that a shield volcano by itself will have three rift zones. If the volcano develops alongside an older one (such as Kilauea and Mauna Loa), the older volcano will act as a bolster and only two rift zones will develop.

As this mountain building process is unfolding, the weight of the volcano gets greater and greater, depressing the ocean floor in its vicinity. All around the Hawaiian islands is a depression in the ocean floor called **the Hawaiian deep**. The deep is greatest around the island of Hawaii, with the great masses of Mauna Kea and Mauna Loa, the two tallest peaks in the islands. It can be argued that if measured from tip to base, the Hawaiian volcanoes are the world's largest mountains. For example, the volcano Mauna Kea is more than 31,000 feet from base (18,000 feet below sea level) to tip (13, 796 feet above sea level).

Another thing that characterizes shield volcanoes is slump faulting and landslides. As the volcano becomes massive and begins to age, large and small slump blocks form on its sides. You can see lots of fault scarps all over the islands. **Giant landslides**, where a large portion of the mountain can slide into the deeps, can occur. Evidence of these landslides is found on almost all of the Hawaiian islands. Lanai (massive slide deposits in ocean), Kauai (Na Pali cliffs), Molokai (3000+ foot cliffs on north side of island plus half-moon shape), Oahu (massive slide scarp bisects the Koolau Volcano), and Niihau (most of original island gone) all show evidence of these slides. These giant slides tend to form scarps at the rift zones, which are weak points in the mountain's structure.

As the volcano ages it gets carried away from the hot spot. Eruptions become less frequent. Landslides and erosion transform the once smooth shield shape into something craggier. The erosional sediment can form coastal and inter-mountain plains. The chemistry of the lava changes to alkalic basalt, which is rich in the element sodium. These **late stage eruptions** riddle the tops and sides of the mountain with widely scattered cinder cones and lava flows. In general the eruptions follow the plumbing of the original eruptions, and occur in the same locations. After many thousands of years the volcano gets quiet.

Erosion and landslides continue as the volcano ages. On the older islands there is also evidence of a **rejuvenated stage of eruption** which produces cinder cones, lava flows, and ash cones. Plumbing in the rejuvenated phase does not generally follow the original plumbing; these eruptions can occur anywhere on the island or even on the sea floor. The products of this eruption phase are even more enriched in sodium than the late stage eruptions, and are lighter in color. Eventually this last gasp of the dying volcano ceases, and the island continues eroding until it lies below the sea once more.

Geo-Touring in Hawaii

No matter where you travel in the Hawaiian islands, you are aware of the rich geologic backdrop. What would the beach at Waikiki be without the famous profile of Diamond Head, a half-million year old ash cone, looming in the background? Many of the tourist areas exist because of some unique geologic feature: Waimea Canyon on Kauai, dubbed the "Grand Canyon of Hawaii", or Molokini Crater off the island of Maui, famed for its sea life and a favorite of snorkelers and scuba divers. Every island has quite a few remarkable geologic features to see.

My travels last summer took me to two of the most geologically exciting of the islands: Maui and the big island of Hawaii. The rest of this paper focuses on the geologic features, both large and small, which I observed on that tour. The features will be presented in the order which they were observed.

Maui Tour

The first island that I visited was Maui. Maui is the second youngest of the larger Hawaiian islands; the oldest exposed lava to be found on the island is 2 million years old. Looking at a map of the island, one sees a land mass consisting of two lobes or humps, with a flat plain connecting the two. The northwestern lobe is a volcano known as West Maui (I have not seen a reference to its Hawaiian name). West Maui is rather egg-shaped, with two rift zones trending just a little northwest of due north. The rift zones are almost exactly 180^0 apart, which is somewhat unusual. The eroded cauldera of West Maui exists as a deep circular valley in the center called the Iao Valley.

The early stage lava in West Maui is called the Wailuku basalts, which erupted until about 1.3 million years ago. The late stage is the Honolua formation, composed of alkalic basalt and trachyte, a more sodium-enriched rock which is lighter in hue. Most of the rocks of the Honolua formation are located on the north half of the volcano. The youngest of these are about 0.5 million years in age. For this reason the northern section of the volcano appears to be less eroded than the southern, even though it is exposed to more rainfall.

The youngest rocks on West Maui occur towards the western shore near the town of Lahaina, where a cinder cone rises just east of the town. These rocks are highly alkalic in composition.

The town of Lahaina and the shoreline road for several miles to the north have probably the largest concentration of tourists on the island. This area is located on a broad swath of alluvial fans which accumulated on the leeward side of the island from sediment washed down from the gulches in the volcano. Such plains generally do not exist on the rainier windward sides of the islands, towards the northeast, since there is enough water to wash the sediment into the sea.

North of the resort at Kapalua the plain ends, and the tourists rapidly thin out. This is good area for a drive and observation of some interesting geologic features. The terrain becomes much more rugged, and the road gets steadily worse. My husband and I drove until we were able to observe the prominence of Puu Koae (two late-stage trachyte domes) in the distance; then we turned around, and drove to Nakalele Point, of the famed "blowhole" in the tourist guide books.

The article Geotouring in Hawaii part one is in this February Newsletter. Part 2 will appear in the March 1999. Geological Newsletter

What are Volcano Hazards?

--Bobbie Myers, Steven R. Brautley, Peter Stauffer, and James W Hendley H, 1997, What are Volcano Hazards?: USGS Fact Sheet 002-97

Volcanoes give rise to numerous geologic and hydrologic hazards. U.S. Geological Survey (USGS) scientists are assessing hazards at many of the almost 70 active and potentially active volcanoes in the United States. They are closely monitoring activity at the most dangerous of these volcanoes and are prepared to issue warnings of impending eruptions or other hazardous events.

More than 5O volcanoes in the United States have erupted one or more times in the past 200 years. The most. volcanically active regions of the Nation are in Alaska, Hawaii, Caifornia, Oregon, and Washington. Volcanoes produce a wide variety of hazards that can kill people and destroy property. Large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Some of the volcano hazards described below, such as landslides. can occur even when a volcano is not erupting.

Eruption Columns and Clouds

An explosive eruption blasts solid and molten rock fragments (tephra) and volcanic gases into the air with tremendous force. The largest rock fragments (bombs) usually fall back to the ground within 2 miles of the vent. Small fragments (less than about 0.1 inch across) of volcanic glass, minerals, and rock (ash) rise high into the air forming a huge billowing eruption column.

Eruption columns can grow rapidly and reach more than 12 miles above a volcano in less than 30 minutes, forming an eruption cloud. The volcanic ash in the cloud can pose a serious hazard to aviation. During the past 15 years, commercial jets have been damaged by inadvertently flying into ash clouds, and several have nearly crashed because of engine failure. Large eruption clouds can extend hundreds of miles downwind, resulting in ash fall over enormous areas; the wind carries the smallest ash particles the farthest. Ash from the May 18, 1980, eruption of Mount St. Helens, Washington, fell over an area of 22,000 square miles in the Western United States. Heavy ash fall can collapse buildings, and even minor ash falls can damage crops, electronics, and machinery. Other common volcanic gases are carbon dioxide, sulfur dioxide, hydrogen sulfide, hydrogen, and fluorine. Sulfur dioxide gas can react with water droplets in the atmosphere to create acid rain, which causes corrosion and harms vegetation. Carbon dioxide is heavier than air and can be trapped in low areas in concentrations that are deadly to people and animals. Fluorine which in high concentrations is toxic and can be adsorbed onto volcanic ash particles that later fall to the ground. The fluorine on the particles can poison livestock grazing on ash-coated grass and also contaminate domestic water supplies.

Volcanic Gases

Volcanoes emit gases during eruptions. Even when a volcano is not erupting, cracks in the ground allow gases to reach the surface through small openings called fumaroles. Ninety percent of all gas emitted by volcanoes is water vapor (steam), most of which is heated ground water (underground water from rain fall and streams). Other common volcanic gases are carbon dioxide, sulfur dioxide, hydrogen sulfide, hydrogen, and fluorine, Sulfur dioxide as can react with water droplets in the atmosphere to create acid rain, which causes corrosion and harms vegetation. Carbon dioxide is heavier than air and can be trapped in low areas in concentrations that are deadly to crops and animals. Fluorine, which in high concentrations is toxic, can be adsorbed onto volcanic ash particles that later fall to the ground. The fluorine on the particles can poison livestock grazing on ash-coated grass and also contaminate domestic water supplies. Cataclysmic eruptions, such as the June 15 1991, eruption of Mount Pinatubo (Philippines), inject huge amounts of sulfur dioxide gas into the stratosphere, where it combines with water to form an aerosol (mist) of sulfuric acid. By reflecting solar radiation, such aerosols can lower the Earth's average surface temperature for extended periods of time by several degrees Fahrenheit. These sulfuric acid aerosols also contribute to the destruction of the ozone layer by altering chlorine and nitrogen compounds in the upper atmosphere.

Lava Flows and Domes

Molten rock (magma) that pours or oozes onto the Earth's surface is called lava and forms lava flows. The higher a lava's content of silica (silicon dioxide, Si02), the less easily it flows. For example, low-silica basalt lava can form fast-moving (10 to 30 miles per hour) streams or can spread out in broad thin sheets up to several miles wide. Since 1983, Kilauea volcano on the Island of Hawaii has erupted basalt lava flows that have destroyed more than 200 houses and severed the nearby coastal highway.

In contrast, flows of higher-silica andesite and dacite lava tend to be thick. and sluggish, traveling only short distances from a vent. Dacite and rhyolite lavas often squeeze out of a vent to form irregular mounds called lava domes. Between 1980 and 1986, a dacite lava dome at Mount St. Helens grew to about 1,000 feet high and 3,500 feet across.

Pyroclastic Flows

High-speed avalanches of hot ash, rock fragments, and gas can move down the sides of a volcano during explosive eruptions or when the steep side of a growing lava dome collapses and breaks apart. These pyroclastic flows can be as hot as 1,5OO F and move at speeds of 100 to 1 50 miles per hour. Such flows tend to follow valleys and are capable of knocking down and burning everything in their paths. Lower-density pyroclastic flows, called pyroclastic surges, can easily overflow ridges hundreds of feet high.

The climactic eruption of Mount St. Helens on May 18, 1980, generated a series of explosions that formed a huge pyroclastic surge. This so-called "lateral blast" destroyed an area of 230 square miles. Trees 6 feet in diameter were mowed down like blades of grass as far as 15 miles from the volcano.

Volcano Landslides

A landslide or debris avalanche is a rapid downhill movement of rocky material, snow, and (or) ice. Volcano landslides range in size from small movements of loose debris on the surface of a volcano to massive collapses of the entire summit or sides of a volcano. Steep volcanoes are susceptible to landslides because they are built up partly of layers of loose volcanic rock fragments. Some rocks on volcanoes have also been altered to soft, slippery clay minerals by circulating hot, acidic ground water. Landslides on volcano slopes are triggered when eruptions, heavy rainfall, or large earthquakes cause these materials to break free and move downhill.

At least five large landslides have swept down the slopes of Mount Rainier, Washington, during the past 6,000 years. The largest volcano landslide in historical time occurred at the start of the May 18, 1980, Mount St. Helens eruption.

Lahars

Mudflows or debris flows composed mostly of volcanic materials on the flanks of a volcano are called lahars. These flows of mud, rock, and water can rush down valleys and stream channels at speeds of 20 to 40 miles per hour and can travel more than 50 miles. Some lahars contain so much rock debris (60 to 90% by weight) that they look like fast-moving rivers of wet concrete. Close to their source, these flows are powerful enough to rip up and carry trees, houses, and huge boulders miles down streamstream. Farther downstream they entomb everything in their path in mud.

Historically, lahars have been one of the deadliest volcano hazards. They can occur both during an eruption and when a volcano is quiet. The water that creates lahars can come from melting snow and ice (especially water from a glacier melted by a pyroctastic flow or surge), intense rainfall, or the breakout of a summit crater lake. Large lahars are a potential hazard to many communities downstream from glacier-clad volcanoes, such as Mount Rainier.

SIXTY-FOURTH ANNUAL BANQUET

The 1999 Annual Banquet will be held at Terwilliger Plaza, 2545 S.W. Terwilliger Boulevard, in the Auditorium, on Friday, March 12th. For its planning, Terwilliger needs a count by February 27, so please make your reservations as soon as possible. We can take no reservations after March 5, 1999.

TIME: 5:30 p.m. The Auditorium will be open for viewing exhibits, purchasing items from the sales tables, greeting old friends, meeting new members and picking up your dinner tickets. Dinner will be served at 6:30 p.m.

SPEAKER: Alex Bourdeau, Archaeologist with the U.S. Fish & Wildlife Service, will speak on "GEO-ARCHAEOLOGY OF THE WILLAMETTE VALLEY."

PARKING: There are four places to park at Terwilliger: (1) front of building; (2) behind the building--go through passageway in middle of Terwilliger Plaza; (3) just north of location (2) in the Parkview Center lot and (4) across the street to north, between yellow house and corner house.

****

BANQUET RESERVATION

MENU

Salad of Fresh Greens and Julienne Beets
with Ranch Dressing
Choice of
Roast Sirloin with horseradish cream sauce, or
Salmon Wellington with chablis butter sauce
Fresh Green Beans with nutmeg; Roasted Red Potatoes
Yeast Rolls and Butter; Beverage
Double Chocolate Fudge Cake with Raspberry Sauce

_______ Number of tickets at $19.50 each. Please indicate choice of entree. If you have a table preference, please indicate on the reservation.

Name/Names ______________________________

____

Choice of Entree ______________________________

____

_______ Amount enclosed.

Send to: Geological Society of the Oregon Country
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Portland, Oregon 97207

In Memmoriam: Frank I. Dennis

Frank I. Demnis, a long time member of GSOC, passed away December 31, at age 90. He was born in 1908 in Dallas and moved to Portland about 1925 to attend the Oregon Institute of Technology. He was an engineering inspector for Union Pacific Railroad for 44 years and was instrumental in the relocation of the railroad when the new water-grade Columbia River Highway was built. He retired in 1971.

He was an authority on the geology of the Columbia River Gorge, gave programs about the Gorge and led many GSOC field trips to the Gorge. He was very interested in trains, especially steam trains and had traveled on many steam trains throughout the world. He is survived by his wife Beulah, daughter Barbara Barrie, sister Ruth Anderson, and many friends from GSOC.

by Rosemary Kenney and Don Turner

MAR 99

THE GEOLOGICAL NEWSLETTER

GSOC

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ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00.

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INFORMATION: Beverly Vogt, 503-292-6939
Evelyn Pratt, 503-223-2601

VOL. 65, No.3
March 1999

MARCH ACTIVITIES

Mon. March 1, 12-1:30 PM: Mexico's Copper Canyon
Presenter: Rosemary Kenney, past GSOC president
Central Library, 801 SW 10th, Portland

****
Friday March 12 ANNUAL BANQUET. Call Phyllis Thorne, 292-6134, for reservations. Doors open at 5:30 PM for visiting, sales table. Dinner is served at 6:30 PM. After the banquet, Alex Bourdeau, US Fish and Wildlife Service, will give a presentation on Geoarcheology of the Willamette Valley.

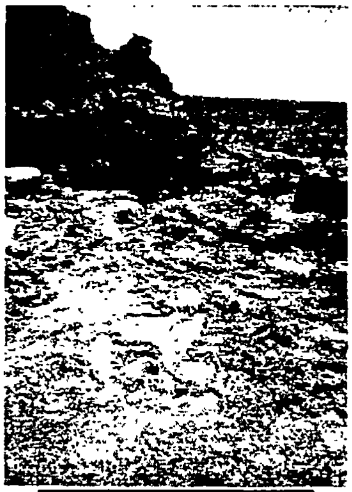
****
FIELD TRIP: Drive from The Dalles south to Smith Rock, following part of trip outlined in 1/2/98 *Oregon Geology*. Meet at TROUTDALE in Lewis & Clark State Park's main parking lot, March 20 at 8:30 AM. Leader: Evelyn Pratt, 503-223-2601.
****

Wed. March 24, 8:00 PM: This year's Seminar Series: "Topics in Physical Geology"
Metamorphic Rocks and Plate Tectonics
Richard Bartels, geology instructor and past GSOC president
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

****
PREVIEW OF COMING ATTRACTIONS: APRIL
Fri. Apr. 2, 12:00-1:30 PM: Owyhee Country: Succor Creek and Leslie Gulch, Don Barr, Central Library
****

Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

GEOTOURING IN HAWAII Part II By Carol Hassenberg



Salt Pool at Nakalele Point

On the bluff overlooking the ocean between Kanounou Point and Nakalele Point is an ancient terrace, the surface of which is a pahoehoe flow of lava. Indeed the lava in this area is from the Wailuku basalts, part of the earlier shield building stage of eruptions. Above the terrace rises a bluff consisting of thick layers of red lateritic soil, perhaps an ancient shoreline?

Lacework Patterns in the Lava

Walking down the trail towards the blowhole at Nakalele point is interesting because as one nears the point, one travels through a large exposure of lava that has been intensely eroded by the salt spray and wind. This erosion has taken the form of intricate lace-like patterns of ridges separated by hollows in the surface of the stone. Salt could be observed crystallizing in little pools close to the shoreline.

Pillow Basalt

As we drove along in the vicinity of Nakalele point, we observed an outcrop of pillow basalts, red paleosols sandwiched between lava flows, and around one hill was a mass of the reddest soil that I have ever seen. Erosion had formed little hoodoos at its base, and the vertical jointing pattern was still clearly visible.

Of course, no trip to Maui would be complete without a visit to the summit of Haleakala, which is a dormant volcano in the late-stage of activity forming the eastern lobe of the island. Haleakala last erupted in 1790, on its southwest rift zone. This rift zone and the east rift zone are still active; the northwest rift zone is dead. The presence of three rift zones gives a triangular shape to the east part of the island. The volcano still has its original shape; erosion and faulting have not altered its profile to a great extent.

The largest valleys on Haleakala are the Keanae Gap to the north and the Kaupo Gap to the south. Both of these valleys cut through the summit and the original cauldera has eroded away. In its place is a moonscape of gray and red cinder cones with the occasional lava flow. Volcanic bombs are scattered over the surface, along with an alien-looking, rare plant called silversword, or ahinahina.

Silversword Plant on Haleakala

From the summit road, one can hike on the Sliding Sands Trail into the "cauldera". The view along the trail truly is breathtaking; at least, I was quite out of breath as I trudged back up the trail towards the parking lot at the 9000+ foot elevation. Still, the unearthly beauty of the cauldera made the hike worth the pain.

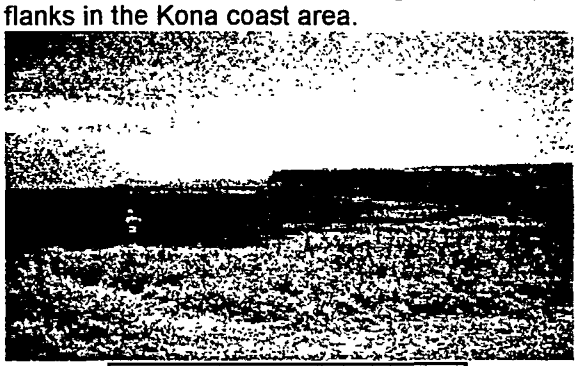
One last interesting geologic feature I visited on Maui was the Kipahulu area of Haleakala National Park, on the southeast side of the mountain. To get there you must drive around the north side of the volcano, on about 40 miles of the most narrow, twisted, tortuous road that you can imagine. An overnight stay in the little town of Hana, about 10 miles north of the park, is recommended.

Here in the Kipahulu area a stream has cut its path into the layers of the basalt flows. Each hard layer of basalt colonnades forms the lip of a waterfall whose pool sits atop the next hard layer below. In between the softer layers get washed away. The canyon formed by the many pools is called the Oheo Gulch.

Basalt Lip in Oheo Gulch

Hawaii Tour

Everyone interested in seeing Hawaii geology in action goes to the Big Island, as the island of Hawaii is known. Hawaii is bigger than all the other islands combined, so it deserves this moniker. There are 5 volcanoes on the Big Island; only one of those, Kohala on the northwest side of the island, is thought to be extinct. The largest volcano is Mauna Loa, which occupies most of the southern half of the island, and is 13,677 feet tall. Extremely active Kilauea is located on the southeast flank of Mauna Loa, and is just over 4000 foot elevation. Older Mauna Kea at 13, 796 feet, is the tallest mountain in the chain, but has experienced more erosion including glacial erosion during the ice ages. Hualalai on the west side is in the late stage of activity and is a threat to the many people living on its flanks in the Kona coast area.



Paliomamalu Scarp

I stayed in the Kona coast area while visiting the Big Island and drove over to the Kilauea volcano for an overnight trip. The drive around the southern tip of the island up to Kilauea is very interesting for both geology and scenery. As one travels south from the crowded Kona coast villages, perched on the side of Hualalai, one travels through alternating stands of Macadamia nut trees and lava flows, many of which are less than 150 years old. As you approach the turnoff for the south point road you see a large, uneroded fault scarp, about 400 feet high at its highest point, and about 12 miles long. This is the Paliomamalu scarp, a slump scarp on the southwest rift zone of Mauna Loa.

About 20 miles up the road, you are traveling on the east flank of Mauna Loa, up the hill towards the cauldera of Kilauea. Some blocky looking hills to the left are remnants of a slide scarp on an earlier version of Mauna Loa, which has been mostly covered by younger lavas. The landscape becomes drier as you travel upward until you are traveling through a virtual desert paved with ash and pahoehoe flows dotted with an occasional tree. To me, one of the most striking aspects of visiting Kilauea is climatic change you witness as you reach the cauldera. As you get to the top you drive into a cloud and the vegetation quickly thickens into a rainforest complete with giant ferns. It's generally cool and rainy at the Volcano house on the northeast rim of the cauldera.

Halemaumau Crater in Kilauea Cauldera

The Volcano House and the village of Volcano beyond is now shielded by a 400 foot cliff along the north and northeast side of the cauldera, although nothing on a volcano this active is really safe. Currently the action is happening on the eastern rift zone of Kilauea, in the Puu Oo vent. As you drive down the slope towards the fresh lava at the shore on the Chain of Craters road, you arrive at the top of a 1500 foot slump scarp, the Holei Pali. You are driving through lavas erupted in the 1970's from Mauna Ulu on the eastern rift zone. The surface of recent pahoehoe lava has an oily sheen that is reminiscent of the surface of a brownie. On the Holei Pali these shiny pahoehoe flows drape down the scarp alternating with black a'a flows.

Holei Pali - View South towards the South Point

After having driven down the face of Holei Pali you cross a plain of lava to the end of the road, passing through clouds of "vog" or volcano smog. The fresh lava has obliterated the highway that once took you to Hilo. The lava is pouring from Puu Oo to the tune of 400,000 cubic yards per day. It is best viewed at night, so rent a room nearby to be on hand for this event.

Carol Hasenberg, 1998

Membership News

Cecelia Crater Honored

"In recognition of service to the Geological Society of the Oregon Country by virtue of meritorious service, the society in accordance with by-laws and amendments thereto hereby designates Cecelia Crater a fellow of the Society with all the rights and privileges thereof; given at Portland, Oregon this day of February 12 year of 1999." So reads the plaque awarded to Cecelia Crater at the February business meeting. Cecelia is honored for her dedication in overseeing the noon meetings held at the Multnomah County Library. She executes her duties of finding speakers, arranging the facilities, and chairing the meeting with admirable skill. Thank you Cecelia!

New Members

The following new members have joined the society between November 1998 and February 1999:

Carrie Brugger, Tom Burnett, Victoria and Ronald Cummings, Peter Griffen, Clyde Kellay, Thomas and Ingrid Palm, Diane Stafford, David Steinbrugge, Robert Strebin, Jr., Jay Van Nice, Lyle Gross.

In Memorium

Dorothy Barr a member of GSOC since 1962 passed away on January 27, 1999. She was born 1914 in Vancouver, British Columbia. She graduated from Teacher's College in Vancouver and then took a teaching position in a small coal-mining town in central British Columbia. Later she became secretary to the Dean of the History Department at the University of British Columbia. Dorothy was a member of the Canadian Alpine Club of Canada, a mountain climbing group. She climbed many mountains in the Canadian Rockies and was featured in several films produced by the Canadian Film board. She and her husband came to Oregon in 1948. Dot became secretary to the Dean of Women at Lewis and Clark College.

Dorothy was interested in all aspects of natural history. She became involved in activities of the GSOCs, Native Plant Society and Oregon Agate and Mineral Society. She carried her interest in natural history to her many gardens where she could be found with her cat, Penney, and Ralph her dog beside her while working in the garden. Her great interest in the fossil leaves of the John Day and Clarno Formations in central Oregon took a lot of her time during the period from 1958 through 1996. Dorothy's collection is museum quality.

She is survived by her husband, Donald, daughter, Heather Alane, son, Alan, two grandchildren, Ian and Crissy, and her many friends

Events Around the Area

June 18, 19, 20, 1999 Northwest Federation of Mineralogical Societies will have their annual meeting/show in Hillsboro, Oregon at the Washington County Fair Complex, Cornell Road across from the airport. All rockhounds are invited. For more information please contact: Lew Birdsall, 2912 Watercrest Dr., Forest Grove, OR 97116, (503) 359-4855.

March 6, 20, April 3, 17, May 1, 15, 29 Special Saturday Programs in Earth Science at Rice Northwest Museum of Rocks and Minerals, 26385 NW Groveland Dr., Hillsboro, OR 97124, Phone (503) 647-2418. Programs are conducted by Taylor Hunt from 1-4 pm. For more information, contact Taylor Hunt, (503) 662-4790

Mt. Adams Landslides

*The following is a summary of a talk by **Dr. Richard Iverson**, hydrologist & mass movement specialist, CVO, Vancouver.. The talk was given at the GSOC monthly evening program on January 8, 1999 and is here summarized by **Evelyn Pratt***

Mt. Adams, unlike Mt. St. Helens, is not an explosive mountain. Tephra on its slopes usually comes from Mt. St. Helens. The only high-elevation - at a mere 5000' - long term record of debris flows is at Paradise on Mt. Rainier.

We've had two wet winters, in which glaciers in the high Cascades have really been broken up and are moving fast. Both of these flows happened at the end of the thaw season - one in August, the other 7 weeks later in September. These rock avalanches were, with the exception of the beginning of Mt. St. Helens' 1980 eruption, the largest in the Cascades since the big one on Little Tahoma in 1963. If they'd taken place at Mts. Hood or Rainier, geologists would be swarming all over them. But because of the low population around Mt. Adams there hasn't been as much interest. Darryl Lloyd and Jim Balance are two Mt. Adams specialists. I'm not, although I've been up there aa couple of times to study the debris flows.

During the last 4000 years Mt. Adams has had some small lava flows, but no major eruptions. The last 15,000 years have seen scattered vent eruptions, the largest on the north side. But during this time the major force here has been erosion. The Trout Lake lowland down to Husum has been inundated by a rock avalanche.

In general the mountain's north-south axis of relatively young, compact rocks holds it together. From east to west, glacial erosion and rock avalanche activity expose 2 to 3 km of rotten rock at the volcano's core. This rock is weak due to hydrothermic action which has turned feldspar to clay and water. Where you see yellow debris, it usually indicates hydrothermically altered material.

The first debris flow removed the upper part of White Salmon Glacier on the southwest side, and a lot of rock. It followed the path of a similar one in 1983. These events do tend to recur over and over again in the same place. [Something to be aware of when climbing!] Fluid material went down one tributary of Salt Creek. There'd been an avalanche [here] in the spring of 1921. Both these avalanches had a high snow and ice content. A thin veneer of sandy stuff, 10-20 cm thick, and some huge boulders were left on top of what had been mostly snow and ice. The photos taken a year apart show what a large amount of debris had been frozen and subsequently melted. This could be pretty puzzling to a geologist who didn't know what had happened - how could such different size products be laid down at the same time?

When sandy debris dries on the surface, heat can't get through. The ice core underneath gets insulated, and a year later some of it is still there, mantled by rock. But in a few years it'll be gone. The glacier's already beginning to rebuild.

Seven weeks later, at the top of Klickitat Glacier on the southeast side, an avalanche took away part of a rock formation called the Castle. In both the 1998 avalanches, about 5 million cubic meters of material moved. But the one on the southwest side was 90% snow and ice, and left practically no seismic record. The avalanche on the southeast side was half ice and half rock, and registered a seismic impact as far away as Corvallis. It went into the valley of Big Muddy Creek. Both avalanches descended 5000 vertical feet, and 3 miles horizontally. The surface of Klickitat Glacier was planed off. 'Glacial striations' on rocks alongside the avalanches were probably created in seconds by fast-moving debris.

To get a good view of these avalanches, go up to the Ridge of Wonders. It's a short hike, not difficult.

Everyone wants to know when the next avalanche will happen. One possible way of predicting is by AVRIS - [Airborne Visible/InfraRed Imaging Spectrometer.] This shows hydrothermal alteration products in red. These areas are most likely to fail.

We're studying the travel times, impacts, etc., of avalanches at the H. G. Anders Experimental Station, 40 miles east of Eugene. Here we have a chute down which we can release measured amounts and types of debris and catalog the results. A good time to visit it would be this coming August.

Q&A

In the Dodson slide in the Gorge, trees were transported long distances. In both of the debris flows on Mt. Adams, where trees were affected, they were just pushed over.

No seismic activity preceded either of the Mt. Adams slides.

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VISITORS WELCOME AT ALL MEETINGS
INFORMATION: www.gsoc.org
or Carol Hasenberg, 503-282-0547 or Evelyn Pratt, 503-223-2601

VOL. 65, No. 4
APRIL 1999

APRIL ACTIVITIES

Fri. Apr. 2, 12:00-1:30 PM: Owyhee Country: Succor Creek and Leslie Gulch
Don Barr, GSOC Past President
Central Library, 801 SW 10th

Fri. Apr. 9, 8:00 PM: Watershed Disturbance, Response, and Recovery Following Volcanic Eruptions Jon Major, Cascades Volcano Observatory, USGS
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

****

Field Trip: April 17, Erratic Rock State Park and Other Reminders of the Bretz Floods
Ray Crowe, leader. (The casino nearby has a great lunch for $6.)

****

Wed. April 28, 8:00 PM: This year's Seminar Series: "Topics in Physical Geology"
Rocks and Plate Tectonics
Richard Bartels, geology instructor and past GSOC president
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

****

PREVIEW OF COMING ATTRACTIONS: MAY

May 3, 12-1:30 PM: Recent Studies in the Columbia South Shore Well Field Area, and Bull Run Ground Water Exploration
Jeff Leighton, Ground Water Specialist, Portland Water Bureau

Field Trip: May 22: Central Oregon's Lavalands: Smith Rock to Lava Cast Forest

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>A special thank-you to Clay Kelleher<, who so ably led the March 20 field trip from Lewis & Clark St. Pk. to the Dalles & south to Cove Palisades when I couldn't do it! EP

(PS: L&C St. Pk. parking lot closes *promptly at 7 PM*. Cars are quickly towed away, & towing fee is NOT CHEAP. Park in factory store mall across the Sandy River instead.)

Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

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FIELD TRIP REPORT: GSOC tour of ESCO Mon., 1/18/99, 10 AM; Rod Staben, guide.
BY Evelyn Pratt

We met at the gatehouse on Wilson St. (1 block N of NW Vaughn) to tour a mini-Dante's Inferno. The exterior gives no hint that electric-arc furnaces inside are heating steel white-hot and tram-size buckets of molten metal are being moved by overhead cranes to where alloys can be poured into sand molds. ESCO's succeeded, by spending millions, in controlling external emissions and sound. But inside the plant the noise is ear-splitting.

The firm recycles metal which scrap dealers have graded by chemical content. When scrap metal is dumped into huge vats of melt, or when the melt is poured, a fireworks display of sparks rises 20 to 30 feet in the air.

The 86-year-old company makes steel products from football-size to larger than a city bus. Major items are dragline buckets for strip mining, such as those used in the Centralia coal mine.

Laboratories are small but impressive. A blob of 3000-degree metal can be pulled out of the furnace on a long rod, water-cooled, sent by vacuum tube to the chemical lab, and tested in four minutes. If the steel's ready, aluminum- clad furnace tenders quickly ready it for pouring. We were properly respectful of the product testing lab's resistance strain gauge, which has 16 megabytes of memory, costs $20,000, and is about the size of a box of teabags. It can be mounted on, and measure strains on, anything from tennis racquets to dragline bucket teeth to buildings.

The sand molds must be chemically inert to whatever alloys are poured into them. ESCO generally uses four kinds: 99+% pure silica sand from Minn. (Bev & Bart knew the source formation) at $85/ton, zircon sand at $450/ton, black chromite sand from Rhodesia, and olivine sand for melts with manganese in them. Binders vary from sodium silicate to phenolic [resin?] to bentonite clay + water. Sand is recycled and used for backing later molds. ESCO also uses a process involving compression of sand molds in a vacuum - environmentally-friendly, but expensive.

Bob Richmond, who retired from ESCO 20 years ago, compared notes with our knowledgeable and enthusiastic guide about then and now. Afterwards we adjourned for a welcome lunch at McMenamin's. Tour participants: Bev Vogt, Richard Bartels, Rosemary Kenney, Bob Richmond, Cecelia Crater, Mary Grafton- Kirkendall, Clyde Kellay, Robert Strebin, Elizabeth Horne, & Ralph & Evelyn Pratt.

Events Around the Area

June 18, 19, 20, 1999 Northwest Federation of Mineralogical Societies will have their annual meeting/show in Hillsboro, Oregon at the Washington County Fair Complex, Cornell Road across from the airport. All rockhounds are invited. For more information please contact: Lew Birdsall, 2912 Watercrest Dr., Forest Grove, OR 97116, (503) 359-4855.

April 3, 17, May 1, 15, 29 Special Saturday Programs in Earth Science at Rice Northwest Museum of Rocks and Minerals, 26385 NW Groveland Dr., Hillsboro, OR 97124, Phone (503) 647-2418. Programs are conducted by Taylor Hunt from 1-4 pm. For more information, contact Taylor Hunt, (503) 662-4790

COMPLETELY FRACTURED GEOLOGY
Ralph & Evelyn Pratt

1. **cohesion**: what happens when someone spills Elmer's glue on the workbench
2. **angulation**: the process of fishing with worms
3. **weathering correction**: what TV weather predictors in Portland have to do a lot of
4. **confluence**: (1) more than one lobbyist working on the same politician (2) a prisoner with a lot of pull
5. **accelerometer**: instrument for precisely measuring the length of celery
6. **benthal**: as in, "I deed to take sub cough drops with benthal id them, for this biserable code."
7. **adhesion**: describes how well TV commercials stick in consumers' minds
8. **Cordillera**: a luxury car Detroit will produce one of these days
9. **chatoyant**: a person who sees things beyond normal vision and talks about them a lot
10. **autoclastic**: has to do with an instrument dentists and lab technicians use to clean their tools

GSOC Website – Up and Running

New president, Carol Hasenberg has created a website for GSOC. The attractive and user friendly site can be accessed at **gsoc.org**. One feature is a set of links to other interesting geological sites. One such link is to the USGS Cascades Volcano Observatory (CVO) site. The following public domain material is printed from the CVO site.

Glacial Hazards

From: Driedger, 1986, A Visitor's Guide to Mount Rainier Glaciers: Pacific Northwest National Parks and Forests Association

Rockfalls occur on unstable slopes high upon the mountain and in valleys near glacier termini. Sometimes the rising dust of rockfalls startles local residents by mimicking steam vents and volcanic eruptions. Glaciers undercut headwalls and valley walls, making slopes steep and unstable. Some moraines and debris-covered slopes have cores of slowly melting ice. Rocks often tumble from these unstable slopes. ...

Some smaller lahars may be triggered by the sudden release of water from cavities within or beneath the ice. We call these events glacial outburst floods, or JOKULHLAUPS (an Icelandic term pronounced Yo-kul-hloips). They have occurred an numerous glaciers on the mountain (Mount Rainier). Jokulhlaups often become lahars when they incorporate the rock debris that lies within their path. ...

Because outburst floods are unpredictable, you should be alert when visiting valleys with glacier-fed streams, particularly on unusually hot or rainy days. If you are near a stream and hear a roaring sound coming from upvalley, or note a rapid rise in water level, move quickly up the stream embankment, away from the stream channel and to higher ground. Do not try to escape by moving downstream; debris flows move faster than you can run. ...

From: Hoblitt, et.al., 1995, Volcano Hazards from Mount Rainier, Washington: USGS Open-File Report 95-273

Non-magmatic debris avalanches are especially dangerous, because they can occur spontaneously, without any warning. Earthquakes, steam explosions, and intense rainstorms can trigger debris avalanches from parts of a volcano that have already been weakened by glacial erosion or hydrothermal activity. ...

... debris avalanches commonly contain enough water or incorporate enough water, snow, or ice to transform into debris flows. Debris flows are slurries of water and sediment (60 percent or more by volume) that look and behave much like flowing concrete. ... During the past 10,000 years, at least 60 debris flows of various sizes have moved down valleys that head at Mount Rainier. All these can be grouped into two categories, called cohesive and non-cohesive debris flows. Cohesive debris flows form when debris avalanches originate from water-rich, hydrothermally altered parts of the volcano. They are cohesive because they contain relatively large amounts of clay derived from chemically altered rocks. Non-cohesive debris flows, in contrast, contain relatively little clay. Mount Rainier's non-cohesive debris flows are triggered whenever water mixes with loose rock debris, such as the mixing of pyroclastic flows or pyroclastic surges with snow or ice; relatively small debris avalanches; unusually heavy rain; or abrupt release of water stored within glaciers. ...

Glacial outburst floods at Mount Rainier result from sudden release of water stored within or at the base of glaciers. Outburst floods and the debris flows they often trigger pose a serious hazard in river valleys on the volcano. The peak discharge of an outburst flood may be greater than that of an extreme meteorological flood (such as the 100-year flood commonly considered in engineering practice) for any given stream valley. At least three dozen outburst floods have occurred during the 20th century. Bridges, roads, and National Park visitor facilities have been destroyed or damaged on about ten occasions since 1926. However, the effects of outburst floods are rarely noticeable outside the boundaries of Mount Rainier National Park. Because they commonly transform downvalley to debris flows, outburst floods are included with debris flows for purposes of hazard zonation. ... Glacial outburst floods at Mount Rainier are unrelated to volcanic activity. The best-studied outbursts those from South Tahoma Glacier are correlated with periods of unusually high temperatures or unusually heavy rain in summer or early autumn. The exact timing of outbursts is unpredictable, however.

From: Walder and Driedger, 1993, Volcano Fact Sheet: Glacier-generated debris flows at Mount Rainier: USGS Open-File Report 93-124

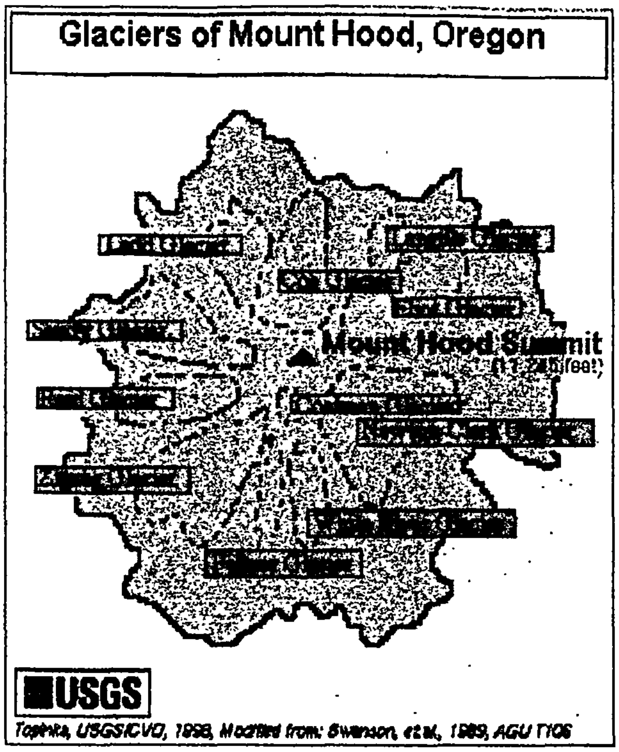
The smallest, but most frequent, debris flows at Mount Rainier begin as glacial outburst floods, also called by the Icelandic term "jokulhlaup" (pronounced "yo-kul-h-loip"). Outburst floods at Mount Rainier form from sudden release of water stored at the base of glaciers or within the glacier ice. Outburst floods have been recorded from four glaciers on Mount Rainier: the Nisqually, Kautz, South Tahoma, and Winthrop glaciers. ...

Outburst floods become debris flows by incorporating large quantities of sediment from valley floors and walls, often by triggering landslides that mix with the flood waters. The transformation from water flood to debris flow occurs in areas where streams have eroded glacially derived sediments and sediment-rich, stagnant glacier ice that was stranded in valleys as glaciers thinned and retreated earlier in this century. As the stagnant ice melts over the next several decades, it will release its charge of sediment into the stream valleys. That sediment will potentially be incorporated into more debris flows if it is mobilized by outburst floods. ...

Because outburst floods are unpredictable, you should be alert when visiting valleys with glacier-fed streams, particularly on unusually hot or rainy days. If you are near a stream and hear a roaring sound coming from upvalley, or note a rapid rise in water level, move quickly up the stream embankment, away from the stream channel and to higher ground. Do not try to escape by moving downstream; debris flows move faster than you can run. Observe Park Service regulations, especially those provided for your safety in areas prone to debris flows. Here, as in most areas in other national parks, natural processes such as floods and debris flows are allowed to occur without human intervention.

From: Swanson, et.al., 1989, IGC Field Trip T106: Cenozoic Volcanism in the Cascade Range and Columbia Plateau, Southern Washington and Northernmost Oregon: American Geophysical Union Field Trip Guidebook T106, p.20.

(At Mount Hood) ... Jokulhlaups (glacial-outburst floods) have been recorded from the Zigzag, Ladd, Coe, and White River Glaciers. In 1922, a dark debris flow issued from a crevasse high on Zigzag Glacier and moved 650 meters over the ice before entering another crevasse; this event initiated a scare that Mount Hood was erupting. The Ladd Glacier jokulhlaup in 1961 destroyed sections of the road around the west side of the mountain and partly undermined a tower of a major powerline. The Coe Glacier outburst occurred around 1963, causing a section of trail to be abandoned and the "round-the-mountain" trail to be rerouted farther from the glacier. Jokulhlaups from White River Glacier were reported in 1926, 1931, 1946, 1949, 1959, and 1968; the Highway 35 bridge over the White River was destroyed during each episode. The more frequent outbursts from White River Glacier may be due in part to an increase in size of the fumarole field at the head of the glacier at Crater Rock.



From: Scott, et.al., 1997, Geologic History of Mount Hood Volcano, Oregon -- A Field-Trip Guidebook: USGS Open-File Report 97-263

Outburst floods from White River Glacier (Mount Hood) have taken out numerous, lesser versions of the highway bridge. The aggrading valley floor downstream displays several surfaces formed during this century that can be differentiated by the size (age) of the trees growing on them. The sediment sources for the aggradation are White River Glacier and the canyons that are being cut into diamicts of Polallie and Old Maid age downstream from White River Glacier

From: Waitt, 1985, Case for periodic, colossal jokulhlaups from Pleistocene glacial Lake Missoula: GSA Bulletin, v.96

Two classes of field evidence firmly establish that late Wisconsin glacial Lake Missoula drained periodically as scores of colossal jokulhlaups (glacier-outburst floods). ...

Correct definitions for **COMPLETELY FRACTURED GEOLOGY**, adapted from AGI Dictionary of Geological Terms, 3rd Ed., Bates & Jackson, by E. Pratt

1. **cohesion**: shear strength of a rock, not related to interparticle attraction
2. **angulation**: an angular position or formation (Random House Dictionary)
3. **weathering correction**: in seismic exploration, a correction allowing for variations in reflections and refractions due to irregularities in a weathered layer near the surface
4. **confluence**: the point where two streams or two glaciers meet
5. **accelerometer**: a seismograph designed to measure how fast earth particles accelerate
6. **benthal**: having to do with the bottom of a lake, sea, or ocean (R. H. Dict.)
7. **adhesion**: the molecular attraction between surfaces next to each other
8. **Cordillera**: an extensive series of more or less parallel ranges of mountains with their associated valleys, rivers, etc.: esp. the Andes or western North America from the Rockies to the Pacific Ocean
9. **chatoyant**: said of a mineral having a changeable luster, or color marked by a narrow band of light
10. **autoclastic**: applies to rocks which have been brecciated in place by faulting, shrinkage, etc.

Here is a picture you might recall from R. Iverson's talk about Mt Adams. This shows the 1998 Mt Adams landslides near the Klickitat Glacier. The picture is from the USGS Cascades Volcano Observatory website.

President's Annual Field Trip – 1999 STEEN'S MOUNTAIN

This year the week-long field trip will be **September 3rd to the 9th**. Malheur Field Station will be the base of operations with daily field trips launched from there. The cost is estimated to be about $500 per person. Please call the society president, Carol Hasenberg at **503-282-0547** if you are interested. *Early registration would be greatly appreciated since a deposit is needed to reserve the field station.* Refunds can be fully made up to a month before the trip.

The Annual Banquet: A Success

The Sixty-Fourth Annual Banquet of the Geological Society of the Oregon Country was held on March 12th at Terwilliger Plaza. Richard Bartels emceed the event introducing past presidents including immediate past president, Bev Vogt. Bev gave gracious thanks to the board and all who helped her last year. She encourage everyone to recall the highlights of the year: speakers from the Cascades Volcanic Observatory, field trips, Wednesday evening lectures on rocks/minerals and plate tectonics, the noon meetings, and GSOC's new website. All of these events were much appreciated for their quality. She did not fail to mention the members who passed on last year and how we will miss them and to welcome many new members who have joined in the last year.

Richard Bartels then introduced the new officers for the coming year: President Carol Hasenberg, Vice President Ray Crowe, Secretary-Treasurer Phyllis Thorne, and the directors: Archie Strong, Richard Donelson, and Bob Richmond. Carol Hasenberg gave her inaugural address in which she described the upcoming president's field trip, future Friday evening programs focused on planetary geology, and her plans for the website. Carol encouraged those who go on any GSOC field trips to take pictures and write a synopsis so that she can incorporate these onto the website. The new president received from the former president a 1902 book describing all that was known of the geology of Oregon at the time, a gavel (a tradition since 1943), and a pick-ax with all the GSOC presidents' names engraved.

The evening concluded with a lecture on *Geo-Archeology of the Willamette Valley* by Alex Bourdeau. This fine lecture will be summarized in the May newsletter and we will also have pictures from the banquet then.

All who attended and enjoyed the banquet want to thank the banquet committee for a great time: Esther Kennedy, chairperson, Phyllis Thorne, Charlene Holzwarth, Archie Strong, Rosemary Kenney, Art Springer, Susy Sudbrock, John and Elizabeth King, Robert Richmond, Evelyn Pratt, and Gale Rankin.

MAY 99

THE GEOLOGICAL NEWSLETTER

GSOC

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

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OF THE OREGON COUNTRY
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1999-2000 ADMINISTRATION
BOARD OF DIRECTORS

THE GEOLOGICAL NEWSLETTER

ACTIVITIES:

ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00.

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Geological Society of the Oregon Country, P.O. Box 907, Portland, Oregon 97207

TRIP LOGS: Write to the same address for names and price list.

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Name______________________________ **Spouse**____________________

Children under age 18____________________________________

Address ____

City ____________________ **State** _____ **Zip**__________

Phone ______________ **Email address**____________________

Geologic Interests and Hobbies__________________________________

____

Please indicate Membership type and include check for appropriate amount:
Individual $20.00 __________ **Family $30.00** __________ **Student $10.00** __________
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GEOLOGICAL NEWSLETTER

THE GEOLOGICAL SOCIETY OF THE OREGON COUNTRY
P.O. BOX 907, PORTLAND, OR 97207

VISITORS WELCOME AT ALL MEETINGS | VOL. 65, No. 5
INFORMATION: www.gsoc.org | MAY 1999
or Carol Hasenberg, 503-282-0547 or Evelyn Pratt, 503-223-2601

MAY ACTIVITIES

Mon., May 3, 12:00-1:30 PM: Recent Studies in the Columbia South Shore Well Field Area and Bull Run Groundwater Exploration
Jeff Leighton, Groundwater Specialist, Portland Water Bureau
Central Library, 801 SW 10th

Fri. May 14, 8:00 PM: Living With Earthquakes in the Pacific Northwest
Robert Yeats, geology Professor Emeritus, OSU; Sr. Consultant, Earth Consultants International
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

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NEW FIELD TRIP CO-CHAIR and **May 22 Field Trip** leader **Taylor Hunt, 662-4790,** conducts Central Oregon's Lavalands with Cecelia Crater. Call either; meet at Zoo Max station at 8 AM or Salem waterfront, 9-9:15 AM to carpool. Can be 1- or 2-day trip.

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Wed. May 26, 8:00 PM: Last of 1998-9 "Topics in Physical Geology" Seminar Series:
Plate Tectonics: Subduction Zone and Forearc Basin Rocks
Richard Bartels, geology instructor and past GSOC president
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

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PREVIEW OF COMING ATTRACTIONS: JUNE

Fri. June 11, 8:00 PM: Oregon Fossils
Dr. William Orr, U of O, premier authority on Oregon's fossil record

June 26 **Field Trip,** led by Taylor Hunt, to varied and easily-accessible volcanic features on the SOUTH side of Mt. St. Helens

No noon meetings or seminars will be held during the summer.

****

Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

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President's Annual Field Trip – 1999 STEEN'S MOUNTAIN

This year the week-long field trip will be **September 3rd to the 9th**. Malheur Field Station will be the base of operations with daily field trips launched from there. The cost is estimated to be about $500 per person. Please call the society president, Carol Hasenberg at **503-282-0547** if you are interested. *Early registration would be greatly appreciated since a deposit is needed to reserve the field station.* Refunds can be fully made up to a month before the trip.

To help you start thinking about the President's field trip to southeast Oregon, here is an article printed in *The Geological Newsletter*, July 1995. For another interesting article about the area, see the August 1997 *National Geographic* article on "Oregon's Outback."

There is Just Something Magnetic about the Steen's Mountains: Magnetite in the lava of the southeastern Oregon landmark show rapid changes in the Earth's poles. By Richard L. Hill of *The Oregonian* Staff

Boy scouts on a long hike find themselves lost, their trusty pocket compasses going haywire. Magnetic north seems to be on the move, heading south.

This bizarre scenario isn't implausible as it sounds. A new study indicates the earth's magnetic field may make very rapid direction changes.

Studying ancient lava flows on stark 9,670-foot-high Steen's Mountain in southeastern Oregon, scientists have found that the planet's magnetic field quickly shifted its direction 16 million years ago at a rate of about 6 degrees per day.

Earth's north and south magnetic poles have flip-flopped hundreds of times in the past. The planet's magnetic field probably has been reversing at irregular intervals for as long as it has existed, at least 3 billion years. The reasons for the switch aren't known.

It usually takes about 5000 years for a total reversal. The new findings reported in the April [1995] issue of the journal *Nature*, suggest that the long process can be punctuated by brief episodes of very rapid change.

"You guys in Oregon can really be proud of your mountain," said Robert S. Coe, a professor of earth sciences at the University of California at Santa Cruz, who co-authored the study with researchers from the University of Montpellier in France. "It's the best record of a reversal recorded by lava flows that have been studied anywhere".

"Steen's Mountain happened to be erupting lava flows quite rapidly in geologic terms when the field started to reverse. And it's the best anyone has found so far."

As lava cools, the magnetite it contains aligns itself with the magnetic field. The researchers found sites on Steen's Mountain where changes in the magnetic direction existed with a single lava flow.

"This is one special place in the reversal where it looked like the field may have moved very, very quickly," Coe said. "But you should think of it as an erratic process with the field sometimes staying relatively still sometimes moving very rapidly, perhaps, sometimes moving slowly. The whole process from beginning to end...probably takes a thousand or a few thousand years."

Coe, a paleomagnetist, said the earth's magnetic field probably will shift again just as it has hundreds of times in the past. On average, the field reverses about four or five times every million years, he said.

"We've gone about 780,000 years since the last reversal, so it's been longer than usual since we've had one, " Coe said.

What would the effect on humans be? "Well, we know that species have lived right on through magnetic reversals," Coe said. "We know that many species seem to be more capable than we of detecting the magnetic field, and some of them use it as one of the many systems of staying oriented.

"It doesn't seem like most species are so dependent on it that they die out when the field reverses."

Coe said some scientists have speculated that a reversal of the magnetic field could cause the aurora borealis to be seen in lower latitudes. And magnetic compasses may go awry, but airplanes and ships use more sophisticated navigation aids now.

The article "There's just something magnetic about Steen's Mountain" appeared in *The Oregonian*, Saturday, April 22, 1995. Permission was grated by the author, Richard L. Hill to publish the article in the *Geological Newsletter*.

Lecture Notes from "Geoarcheology of the Willamette Valley" by Alex Bourdeau given at the GSOC banquet March 12,1999

A marsh site, the National Historic Preservation Act of 1966, and the need for economy were factors that came together to provide a lesson in geology. Someone wanted to build a dike on top of a marsh site and under the National Historic Preservation Act (1966), it needed to be determined whether or not the site had significant archeological value to be preserved. Mr. Bourdeau, asked to evaluate the site for significance, needed to do an efficient evaluation in terms of time and cost. To that end Mr. Bordeaux used a magnetometer to limit the area of excavation.

One geology lesson learned in this excavation related to the extent of the Missoula Flood in the Willamette Basin and materials from this flood. Another lesson was about point-bars on Muddy Creek.

Muddy Creek is a small creek in a heavily wooded area of McFadden Marsh. It is a young tributary that is flowing on lacustrine sediments from the Missoula flood. Once dried out, these sediments became very resistant. The Willamette River even has trouble moving this fine grained sediment.

In the archeological site, Alex looked for evidence of fire ovens. When curie point (>670^{o}) is reached in the sediment, the iron bearing minerals in the sediment line up with earth's magnetic field and adds to it – creating a magnetic anomaly. The magnetometer was used to look for subsurface fire ovens. Bourdeau came up with all kinds of magnetic anomalies. Readings were taken at regular intervals were plotted out on a surface map. The anomalies then needed to be tested to see if these were human-caused anomalies.

A backhoe was used to dig along high anomaly tracks. Alex found evidence of pyrogenic features. He found charcoal but he did not find the usual rocks used in ovens. This absence raised the question: what were they roasting? Could these have been warming fires? These features also were not the normal lens shape that was expected. Alex noted that the shape was due to the nature of sediments.

In general, few artifacts were found. The features were radiocarbon dated and it was decided the site was not national register material.

That still left some interesting geological questions that arose during the study. What is the sedimentary nature of this area? how did this stuff get buried? why stratified? The sediment was 35 to 55% clay with the rest being silt. Could there be a point bar made out of clay? The sediments were stratified and formed very rapidly i.e. not from slow moving materials. So here was a classic point bar made out of non-classic material. The material was stratified horizontally as well as vertically. First clay settled out then silt settled out and finally some sand. The bar was built laterally rather than vertically which is why the features have an odd shape.

Another geological question surrounded some pockets of cobbles found. The cobbles were quartzites which means they were deposited by the Missoula floods. It was curious that the orientation of the cobbles was vertical. It turns out that the clay, montmorillonite (smectite), shrinks and swells with the seasons. This caused the orientation of the cobbles. Cobbles were forced up. The shrink/swell process also caused the fire features to have an unusual shape. The process does not seem to be happening at present since now the clays are buried rather deep.

One other geological question concerned the point bar composed of odd materials. Point bars are usually composed of at least sand-sized particles deposited in swift moving streams often at flood times. Clays are not large enough particles to accumulate in such a pattern. It seems that here clays were transported as aggregates of clay in sand size particles. The cycle of rain/drought in the region provides potential for a shrinking/swelling process, which causes the sand size particles to meld back together again. Point bars were popular places to be--an inviting place due to lack of vegetation, hence the evidence of fire ovens.

-Jeralynne Hawthorne-- Interesting geology lessons can come from unexpected directions.

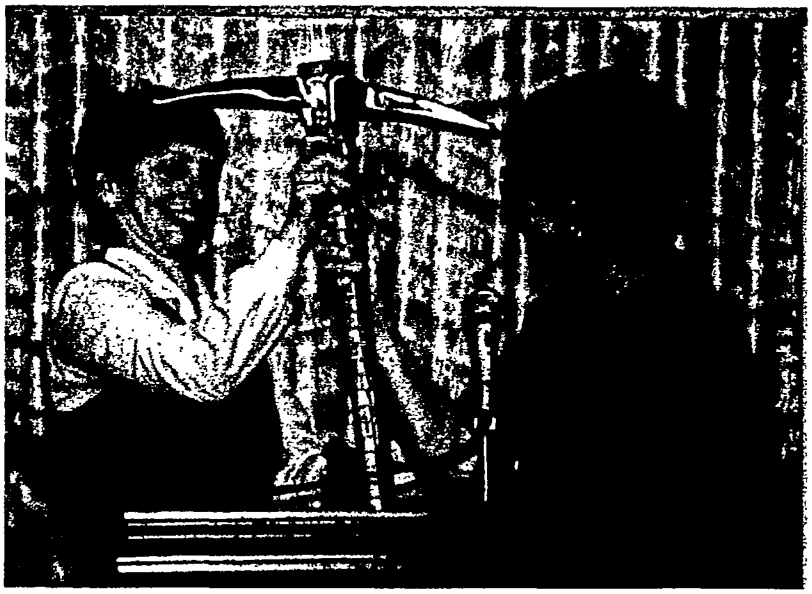
GSOC Banquet March 12, 1999

Special thanks to Robert Richmond for the great pictures.

At the banquet, Richard Bartels, master of ceremonies, presents immediate past president, Beverly Vogt with a certificate and rock hammer in appreciation of her service.

Bev Vogt thanks the banquet speaker, Alex Bourdeau, for his talk 'Geo-archeology of the Willamette Valley '.

Mildred Phillips – a founding member of the society.



New president Carol Hasenberg (left) receives the tools of the office of president from Bev Vogt. The tools included: a book, published in 1902, which described all the then known geology of Oregon; a gavel – a tradition since 1943; and a pick-ax with all the presidents' names engraved on the handle.

Past presidents of GSOC--front row (l. to r.): Rosemary Kenney, Evelyn Pratt, Esther Kennedy; middle row: Archie Strong, Beverly Vogt; back row: Clay Kelleher, Don Barr, Walter Sunderland, Richard Bartels.

COMPLETELY FRACTURED GEOLOGY

Evelyn Pratt

1. **drusy:** as in 'Zat is where I drew ze line!'
2. **potamology:** the study of (1) kitchen utensils or (2) marijuana
3. **dumpy level:** that part of human anatomy where the fat content is the highest
4. **orocratic:** describes a clerk working in a government that is ruled by mining interests
5. **aiguille** (ai-gwee): baby-talk for 'I say yes.'
6. **idioblast:** what Macbeth bellowed about life – "It is a tale told by an idiot, signifying nothing."
7. **point bar:** in the South, a big shaggy carnivore that's been trained to hunt game birds
8. **Tectonite:** where and when to meet for a date in Beaverton
9. **triclinic system:** a very small HMO
10. **fiducial:** someone taking care of someone else's money, stock, valuables, etc.

Events Around the Area

June 18, 19, 20, 1999 Northwest Federation of Mineralogical Societies will have their annual meeting/show in Hillsboro, Oregon at the Washington County Fair Complex, Cornell Road across from the airport. All rockhounds are invited. For more information please contact: Lew Birdsall, 2912 Watercrest Dr., Forest Grove, OR 97116, (503) 359-4855.

May 1, 15, 29 Special Saturday Programs in Earth Science at Rice Northwest Museum of Rocks and Minerals, 26385 NW Groveland Dr., Hillsboro, OR 97124, Phone (503) 647-2418. Programs are conducted by Taylor Hunt from 1-4 pm. For more information, contact Taylor Hunt, (503) 662-4790

Correct definitions for COMPLETELY FRACTURED GEOLOGY, adapted from AGI Dictionary of Geological Terms, 3rd Ed., Bates & Jackson, by E. Pratt

1. **drusy:** pertains to an irregular cavity in a vein or rock with its inner surface covered with small projecting crystals
2. **potamology:** the study of rivers
3. **dumpy level:** an instrument with a telescope attached; the telescope can only rotate horizontally
4. **orocratic:** referring to a time when there is a lot of movement of the earth's crust
5. **aiguille:** a needle-like rock mass or mountain peak
6. **idioblast:** in a metamorphic rock, a mineral which has recrystallized and is bounded by its own crystal faces
7. **point bar:** one of a series of low, crescent-shaped ridges of sand and gravel developed on the inside of a river or stream meander
8. **tectonite:** any rock whose fabric reflects the way it got deformed
9. **triclinic system:** the most asymmetrical of 6 crystal systems (EP)
10. **fiducial:** something accepted as a fixed basis of reference; as on an earthquake record, where a set fiducial time can be used to synchronize with other earthquake records

Looking for Book Reviews from Members of GSOC

As a regular feature of the newsletter, we would like to include book reviews and/or recommendations about geology or related fields. Please send your review to GSOC, PO Box 907, Portland, OR 97207.

Here is a book recommendation from the editor: **Brian Greene, *The Elegant Universe*, W.W. Norton & Company, Inc., 1999.** This book is about superstring theory – a theory enjoying a lot of attention right now as a grand unifying theory in physics. The book came to my attention on *Talk of the Nation—Science Friday* with Ira Flatow. He had high praises for the book as very readable; one of the best he has read in 25 years of science reporting.

SURVEY OF THE MEMBERSHIP

The purpose of this survey is to determine whether or not to continue to have the annual banquet and an annual picnic. We ask all members to respond and would appreciate return of the survey by May 15, 1999.

Will you attend the Banquet? ______ Maximum amount you would pay $_______
Will you serve on the Banquet Committee? Yes _____ No _____
(A member of the Board telephoned various restaurants in the area and found the least expensive was $18.00 for a sit down dinner, including gratuity and room rent. We can anticipate an increase next year.)

Is Friday night satisfactory? Yes ______ No ______
Would you prefer a Saturday or Sunday lunch? Yes ____(Circle one) No _____
Prefer: Sit Down Dinner ___ Buffet ___ Order individually from menu_____

Do you want to continue with a Speaker at the Banquet? Yes ____ No____

Location:	On MAX Line	Yes _____	No _____	
	Downtown Portland	Yes _____	No _____	
	Outlying Area	Yes _____	No _____	Where________________

COMMENTS AND IDEAS:

Since the officers are formally elected at the February business meeting, the Board discussed having the formalities of "passing the gavel" take place at the February meeting and having a longer social hour rather than a speaker. We are anticipating doing this at the February 2000 meeting. What are your thoughts on this?

The picnic. The August meeting has always been scheduled for the annual picnic which is on the evening of the second Friday.

Will you attend a potluck picnic? Yes _____ No _____
Is Friday evening a good time? Yes _____ No _____
Would you prefer a Saturday or Sunday? Yes _____(Circle one) No _____

COMMENTS AND IDEAS:

____
Member/s

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY
P. O. BOX 907
PORTLAND, OREGON 97207-0907

JUN 99

THE GEOLOGICAL NEWSLETTER

GSOC

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

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1999-2000 ADMINISTRATION
BOARD OF DIRECTORS

THE GEOLOGICAL NEWSLETTER

ACTIVITIES:

ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00.

PUBLICATIONS: THE GEOLOGICAL NEWSLETTER (ISSN 02705451), published monthly and mailed to each member. Subscriptions available to libraries and organizations at $10.00 per year. Individual Subscriptions $13.00 per year. Single Copies: $1.00. Order from:

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TRIP LOGS: Write to the same address for names and price list.

APPLICATION FOR MEMBERSHIP-
THE GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

Name________________________ **Spouse**________________

Children under age 18________________________

Address ____________________________

City ________________ **State** ____ **Zip**________

Phone ____________ **Email address**________________

Geologic Interests and Hobbies________________________

____

Please indicate Membership type and include check for appropriate amount:
Individual $20.00 ________ **Family $30.00** ________ **Student $10.00** ________
Make Check Payable to: The Geological Society of the Oregon Country
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VISITORS WELCOME AT ALL MEETINGS | VOL. 65, No. 6
INFORMATION: www.gsoc.org *or* gsoc@teleport.com | JUNE 1999
Carol Hasenberg, 503-282-0547 or Evelyn Pratt, 503-223-2601

JUNE ACTIVITIES

Fri. June 11, 8:00 PM: Oregon Fossils
Dr. William Orr, U of O, premier authority on Oregon's fossil record
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

June 26 **Mt. St. Helens Field Trip** to varied, interesting, and easily-accessible volcanic features on the SOUTH side of Mt. St. Helens. Call Taylor Hunt, 662-4790, and meet at 8:15 AM by PSU's Cramer Hall to carpool. Parking building *should* be free.

****

PREVIEW OF COMING ATTRACTIONS: JULY

July 17 Field Trip: **Silver Falls State Park**, led by Clay Kelleher. Meet at 9:30 AM at Silver Falls Historic Lodge, near South Falls (**NOT** Park Headquarters). Field trip guide provided and/or see March 1998 Geological Newsletter guide. Wear water-repellent footgear; bring sack lunch, water, also optionals such as hand lens, hammer, camera. Repeat of March 1998 field trip without all the rain. . .

****

!!

SEE THE OLD WEST! INCREDIBLE VOLCANIC ACTIVITY! PLENTY OF SUNSHINE AND SPECTACULAR WILDFLOWERS! A ONE-MILE DROP FROM GLACIAL CIRQUES TO SALTY DESERT FLOOR! Come to the President's Campout at Malheur Field Station Sept. 3-10, and you'll experience all these and more. We'll be guided by Dr. Mike Cummings, PSU's southeast Oregon expert, and others. For more information call Carol Hasenberg, 503-282-0547, or e-mail www.gsoc.org *or* gsoc@teleport.com.

!!

No noon meetings or seminars will be held during the summer.

Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

---

President's Annual Field Trip – 1999
STEEN'S MOUNTAIN
September 3rd to the 9th

Leader: Carol Hasenberg **503-282-0547**

Cost: TBA (The cost is estimated to be no more than $500 per person.)

Field Trip Headquarters: Malheur Field Station will be the base of operations with daily field trips launched from there.

Lodging: At Malheur Field Station, in dormitories or trailers, depending on preference.

Transportation: Will depend on personal vehicles to get to Malheur Field Station. Day trips will be made in vans from the station.

If you are interested in attending, please send Carol Hasenberg the following information at GSOC, PO Box 97, Portland, OR 97207 along with a deposit.

Name ____________________ Names of others attending with you
Address ____________________ ____________________
Phone # ____________________ ____________________
Transportation: _____ I will be needing a ride.
_____ I am providing my own transportation
_____ I am willing to take _____ (number) of passengers.
Lodging: Indicate preference
_____ Dormitory
_____ Trailer

Refunds can be fully made up to a month before the trip.
If you have any questions, please call Carol Hasenberg **503-282-0547**

U.S. Geological Survey

Assessment of the Water Resources of the Grand Ronde Area, Oregon *By* K.A. McCarthy, J.C. Risley, R.R. Caldwell, *and* W.D. McFarland **USGS Water-Resources Investigations Report 97-4040, 27 pages, 1 plate, 4 figures, 10 tables**

Abstract

Stream hydrographs show that throughout the Grand Ronde area, most precipitation follows surface or shallow subsurface pathways to streams, resulting in rapid runoff and little natural water storage within the basin. Limited storage and low aquifer permeability restrict base flow to streams, and streamflows therefore decline rapidly once precipitation ceases. Shallow ground water and springs occur throughout the area, but because of the low permeability of aquifer materials, nearly all wells and springs have low yields. Water quality in streams, wells, and springs is generally good, but saline ground water has been reported on a number of drillers' logs for the study area and in several previous investigations of nearby areas. Further development of water resources in the Grand Ronde area is likely to be constrained by existing downstream water rights, the low permeability of geologic materials throughout the area,

and possibly the intrusion of saline water. However, construction of facilities to store available water and thus compensate for low yields could provide a reliable, sustainable water supply for the Grand Ronde area.

GLACIAL ERRATIC FIELD TRIP April 17, 1999 Led by Ray Crowe

Objective: To view evidence of the Bretz-Missoula Flood
Trip Log: (These notes were taken on the trip and supplemented from the field trip guide. Extra copies of the field trip guide are available from Ray Crowe.)

Start -- We met at Shari's at the 10th Street/West Linn exit on 205 and started by turning left on 10th out of the Shari's parking lot. We then turned right on Willamette Falls Drive and continued to 14th Street.

Stop 1 -- Corner of 14th Street and Willamette Falls Drive by the Willamette United Methodist Church. Here lies a replica of a meteorite. The meteorite, discovered in 1902, currently is in the Hayden Planetarium in New York. The meteorite is believed to have been rafted into the area in an iceberg during the Missoula floods. The lack of an impact crater and the nearby granite erratics prove that the meteorite is itself an erratic. (Dick Pugh and John Allen wrote a report on the site in Oregon Geology about 1989?). The meteorite is composed of nickel and iron and is the sixth largest in the world. It was found in 1902 by Alex Hughes.

Back on Willamette Falls Drive go north about 2 miles to Sunset Avenue. Turn left on Sunset Ave and then left on Chestnut and right to Walnut Street. At the end of Walnut Street is the Camassia Nature Preserve.

Stop 2 -- Camassia Nature Preserve. The preserve shows outcrops of basalt and has kolk lakes -- areas scoured by the Missoula floods. Kolk lakes are potholes with no inflow or outflow of water. An erratic is evidently in the quarry that is part of the preserve. At the time of the floods this area was under about 100 feet of water. The hills of the surrounding area are covered by Portland Hills Silt. The silt is a light brown color and ranges from 25 to 100 feet thick. The silt was deposited by strong winds during the Pleistocene. Three soil horizons separate four distinct layers of silt. This represents the interglacial warm intervals.

Return to Willamette Falls Drive and go back to 10th to 205. Take 205 south around to Tualitin. Turn north on I-5 and then immediately take the Sherwood-Tualitin Road exit. Watch for the library sign on the right. Follow to the Tualitin Library next to the Safeway store.

Stop 3 -- In the library's lobby is the skeleton of the body of a Mastodon found nearby in April 1962. "Tu Tu Tuala" is the name given to the female mastodon. Radiocarbon dating puts the age of the skeleton at 11,300 years. Growth rings on her tusk indicate the mastodon was 27 or 28 years old at the time of death. (The Missoula-Bretz floods occurred between 12,000 and 16,000 years ago.)

Erratic Rock – north of Highway 18 between McMinnville and Sheridan

Cammasia Nature Preserve

At the replica of Meteorite -- Lyle Groves, Michael Stuart-Champion, Frank Poundstone, Carol Hasenberg, John Hawthorne, Jeralynne Hawthorne

Stop 4 -- Just a drive by the place of the Mastodon's discovery -- the parking lot of the Tualitin Fred Meyer just across the Sherwood-Tualitin Road.

Back on the Sherwood Tualitin Road head west through Tualitin and on to Sherwood. At the intersection of Sherwood Tualitin Road and 99W. Turn south on 99W. About 4 miles down the road you will see a sign indicating Parrott Mountain on left. Parrott Mountain at the westernmost edge end of the Columbia River Plateau, lavas coming from northeast Oregon down the Columbia River during the Miocene.

Continue on 99W through Newberg and on to Dundee. Note the red soils in the Dundee area. "The red soils are the Eola surface of old Columbia River basalt that has weathered and decomposed. The soil is great for grape growing." (Field trip guide.)

Continue on 99W to hwy 18 bypassing McMinnville. On out Hwy 18 several miles (don't give up) go past the first small brown glacial rock sign, to the geology marker.

Stop 5 -- Geology Marker -- is a description of the flood and how the glacial erratics arrived. You can see the large glacial rock from here.

Continuing on Hwy 18 for about .5 to 1 mile is the second turn off for the Erratic State Park. Follow the signs.

Stop 6 -- Erratic State Park. The rock is called the Belleview erratic and is the largest such erratic found in the Willamette Valley so far. It is at an elevation of 306 feet. In 1950, the rock was found to weigh about 160 tons. Over the years, people have taken souveniers from the rocks amounting to about 70 tons. (Cataclysms on the Columbia, J.E. Allen and M.Burns)

Stop 7 - "Terraces along Hy. 18 in the Yamhill Valley and west, past Erratic Rock Wayside, dip to the next flat surface where the current flood plain exists. North and west of McMinnville is seafloor basalt which crops out past the Willaminia-Salem intersection. Prior to Willamina, watch for seafloor sandstones. A roadcut at the Sheridan exit has exposures of basalt pillows." (field trip guide)

Stop 8 -- Spirit Mountain Casino for lunch. Grand Ronde. "To the south are shale, sandstones, and basalts. During the Pliocene, continued subduction of the Juan de Fuca plate and growth of an offshore accretionary wedge has renewed the uplift and tilting of the Coast Rnage and folding of Willamette Valley rocks." (field trip guide)

Stop 9 - Stewart-Grenfell County Park. "North of here a low rise of 500 feet may have let some of the flood waters spill over to the ocean via the Little Nestucca River." At this stop, people looked for cobbles containing fossils and for cobbles composed of quartzite.

Members on this field trip: Ray Crowe, Leader, Carol Hasenberg, Lyle Groves, Michael Stuart-Champion, Frank Poundstone, John Schriever, David Schriever, Dick Cheadle, John Hawthorne, Jeralynne Hawthorne.
Report by Jeralynne Hawthorne

Ray Crowe at the Glacial Erratic

Ray posing with the Mastodon skeleton in the Tualitin Library lobby.

Flowers at Camassia Nature Preserve.

News Release U.S. Department of the Interior U.S. Geological Survey

Seismic Profiling Reveals Ancient River Valley and Prehistoric Faulting Beneath Portland, Ore.

An ancient river valley a mile wide and 250 feet deep, as well as breaks in geologic strata beneath two suspected fault zones have been revealed beneath Portland, Ore., by a team of scientists from the U.S. Geological Survey, the University of Washington and Portland State University.

This new data was presented by USGS researcher, Tom Pratt, at the annual meeting of the Seismological Society of America, meeting in Seattle May 3-5.

Pratt explained how he and fellow researchers used an echo-sounding method called seismic reflection profiling to produce images that revealed the underground features. Seismic profiling is similar to the ultrasound commonly used in medical imaging, but it is applied to the earth on a much larger scale. The technique uses computer-processed echoes returned from the subsurface after the ground was struck or a special energy source produced a loud 'click' in the water.

The scientists looked as much as 500 feet into the earth, using equipment towed behind a small boat on the Columbia and Willamette Rivers. In a separate effort they used equipment on land to look beneath three of Portland's residential streets; Rex Street, Berkeley Street and Monteith Street.

The ancient river valley is believed to have formed about 15,000 years ago, possibly when an ice dam east of the Cascades broke and released huge volumes of water into the Columbia River. The valley was carved into the rocks beneath and just south of the modern Columbia River. The flood waters also left as much as 250 feet of silt and mud covering the 15,000 year-old ground surface beneath much of the Portland area. The thickness of these soft sediments, which may amplify ground shaking during large earthquakes, were also mapped by the scientists.

Pratt said the 15,000 year old ground surface appears to be broken by prehistoric earthquakes on two suspected fault zones near the Willamette River. "The East Bank fault is suspected, from tiny changes in the earth's magnetic field and differences in the depth of rocks in drill holes, to lie along the north side of the Willamette River. The Portland Hills fault is believed to lie at the base of the Portland Hills and to cause the hillside near downtown Portland to be a long, straight feature," Pratt said.

Profiles near the mouth of the Willamette River, near the university, and near Ross Island, southeast of downtown Portland, show abrupt, 3-to 30-foot changes in the depth to the 15,000 year old ground surface at the faults. Pratt said changes such as these are expected, if the faults have moved.

Although Pratt and his fellow scientists say they cannot rule out other processes, such as erosion, as a cause of these changes, their location beneath suspected fault zones suggests that earthquakes have ruptured the surface in the past 15,000 years and that the faults are active. He said it is not known how often earthquakes could occur on the faults. "Earthquakes are thought to be infrequent on these faults because few modern earthquakes have occurred near them," Pratt said, "but our work raises the possibility that past earthquakes are more frequent than previously assumed. Our study is a first test to see whether the faults are active, but it is not definitive. Follow-up studies will be needed to verify the results."

Seismic profiles across another suspected fault zone, the Frontal fault, that crosses the Columbia River near the east end of Reed Island, did not show clear evidence for past earthquakes. Pratt said this could imply that the fault is not active, but he cautioned that the location of this fault is not well known and small amounts of motion may go undetected by the seismic profiling technique.

As the nation's largest water, earth and biological science, and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial scientific information to resource managers, planners, and other customers. This information is gathered in every state by USGS scientists to minimize the loss of life and property from natural disasters, contribute to the sound conservation and the economic and physical development of the nation's natural resources, and enhance the quality of life by monitoring water, biological, energy, and mineral resources.

* * * USGS * * *

A Special Thank You

A big thank you to **Mary Kirkendall** for volunteering to take care of the cookie supply at our Friday evening meetings. She takes over for long term refreshment providers **Gale Rankin** and **Archie Strong.** We thank Gale and Archie for their work during the past many years.

Mary needs your help to supply cookies for the Friday evening meetings. Either call her at 286-1700 and tell her what you can bring or sign up at the next meeting. Thanks.

Field Trip March 20, 1999 From The Dalles to Smith Rock
Report by Arthur Springer

On Saturday, March 20th, eleven geo-trippers met on a sunny brisk morning at a highway 197 pulloff at the east end of The Dalles. Here the road cuts through pillow basalts formed when lava poured into an ancient lake. Clay Kelleher was the delegated speaker and Evelyn Pratt the group leader on the first part of a two part tour of the geology of Central Oregon between The Dalles and Newberry Crater.

The Miocene basalts range in color from almost black to brown, with orange-yellow palagonite the lightest colored mineral. These rocks are exposed for 12 miles in roadcuts on the way to Dufur.

A few miles south of Dufur, at Butler Canyon, we stopped at a quarry where several dozen basalt flows were visible. Surface oxidation of silicates showed as light tan. Frost action on the columnar basalts left recent debris piles from the hundred foot high cliff face. Picking through the fallen material we found black boulders and bubble gas filled rocks.

We stopped for lunch at a highway rest stop near the Criterion Summit. The day was pleasantly mild though hazy, so we didn't have a clear view of the major Cascades peaks, which are for the most part andesite stratovolcanoes.

After lunch we stopped on Hay Creek Road at a deposit of red tuff which has been quarried for building stone. The quarry was inaccessible this day but a friendly local ranch hand who happened to be feeding horses nearby gave us samples of the fairly dense red rock, some uncut and others apparently sawn into brick sized pieces.

The last stop was Lake Billy Chinook, formed by damming of the Deschutes, Metolius and Crooked Rivers when the Round Butte Dam was built forty years ago. We drove down a switchback road, past a boat dock and over a suspension bridge to the Ship, a wedge of layered basalt, ash flow tuff and gravel towering 500 feet over the lake. Many layers of color – grays, black, green, and pink – shown in the afternoon sunlight. We walked over a shoulder of the formation and looked back across the lake at the ash beds underlying the road we had just traveled. Landslide debris showed above and below the road in several places as scallops in the canyon wall. As we returned to the main highway for the trip back to Portland we crossed over a recently repaired section of the road about 100 yards wide, which was already showing renewed downhill movement of the poorly consolidated beds.

(See pictures of the field trip at the Website: www.gsoc.org)

Books of Interest

Dr. Yeats

If you were not at the Friday evening lecture for May, you missed an excellent time. Dr. Robert Yeats gave a very interesting lecture on "Living with Earthquakes in the Pacific Northwest". Dr. Yeats is geology professor emeritus from Oregon State University and is a senior consultant with Earth Consultants International.

You can still learn about what Dr. Yeats had to say by reading his book: ***Living with Earthquakes in the Pacific Northwest***, published by Oregon State University Press, 1998.

Dr. Orr

Our next speaker will be Dr. William Orr from the University of Oregon. He will be speaking on Oregon fossils. You might like to look up his book: ***Oregon Fossils*** published by Kendall/Hunt Publishing Company, 1998

If you have recently read a geology or geo-related book, please send in book recommendations and/or reviews to share with your fellow GSOC members. Either e-mail to gsoc@teleport.com or write to GSOC, PO Box 907, Portland, OR 97207.

JUL 99

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Calendar:		**Assistant Business Manager:**	
Evelyn Pratt	223-2601	Cecelia Crater	235-5158

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Children under age 18____________________________________

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Phone ______________ **Email address**__________________

Geologic Interests and Hobbies__________________________________

____

Please indicate Membership type and include check for appropriate amount:
Individual $20.00 ________ **Family $30.00** ________ **Student $10.00** ________

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VISITORS WELCOME AT ALL MEETINGS — VOL. 65, No. 7
INFORMATION: www.gsoc.org *or* gsoc@teleport.com — JULY 1999
Carol Hasenberg, 503-282-0547 or Evelyn Pratt, 503-223-2601

JULY ACTIVITIES

Fri. July 9, 8:00 PM: Origins of the Planet Venus
Melinda Hutson, PhD, U. of AZ; Professor of Geology & Astronomy, PCC
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

****

July 17 Field Trip: **Silver Falls State Park**, led by Clay Kelleher. Meet at 9:30 AM at Silver Falls Historic Lodge, near South Falls (**NOT** Park Headquarters). Field trip guide provided and/or see March 1998 Geological Newsletter guide. Wear water-repellent footgear; bring sack lunch, water, also optionals such as hand lens, hammer, camera. Repeat of March 1998 field trip without all the rain. . .

If you're carpooling, park free in Structure 3 on 12th on other side of campus, or pay $2 and park in Structure 2 across from Cramer Hall.

****

SEE THE OLD WEST! INCREDIBLE VOLCANIC ACTIVITY! PLENTY OF SUNSHINE AND SPECTACULAR WILDFLOWERS! A ONE-MILE DROP FROM GLACIAL CIRQUES TO SALTY DESERT FLOOR! Come to the President's Campout at Malheur Field Station Sept. 3-10, and you'll experience all these and more. We'll be guided by Dr. Mike Cummings, PSU's southeast Oregon expert, and others. For more information call Carol Hasenberg, 503-282-0547, or e-mail www.gsoc.org *or* gsoc@teleport.com.

No noon meetings or seminars will be held during the summer. August picnic has been canceled due to lack of interest.

Give calendar items to Evelyn by 15TH of the month. 503-223-2601; ralf70@aol.com

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Steens Mountain

The following information is from a website called *The Unofficial Guides to National Parks and Wildlife Areas of the Pacific Northwest* (used with permission) **www.halycon.com/rdpayne**

Steens Mountain Recreation Lands constitute an unusual mountain country. Steens Mountain, often called "The Steens" for short, is a 30-mile-long fault block, thrust a mile upward 15 million years ago when layers of basalt gave way under the terrible pressures caused by the earth's cooling and contracting. The tilting of the fault block to the west resulted in a rugged eastern face rising to the escarpment at 9,773 feet, one vertical mile above the Alvord Desert in a horizontal distance of approximately three miles.

Then, 14 million years later, glaciers carved the mountain, moving down the Blitzen, Wildhorse Kiger and Indian Creek valleys, resulting in the present U-shaped gorges. Complete erosion took place at one location between the western and eastern faces. This big "nick," called Kiger Gap, is northeast of Kiger Viewpoint. The rugged eastern face of the Steens contrasts with the gentle western slope that gradually descends into the Blitzen and Catlow valleys.

The Steens climate is semi-arid, characterized by moderate summers and cold winters. Most of the moisture falls as snow during the winter. Access to the higher elevations is usually limited to mid-July through late October because of the heavy snowpack.

In summer, the higher elevations are quite comfortable and a welcome change from the hot lower country. However, because of the high elevation, severe thunderstorms accompanied by lightning, wind, and hail or snow are quite common. Many visitors have found it necessary to retreat to lower elevations for protective cover when a storm approaches.

Steens Mountain Recreation Lands consists of 147,773 acres managed by the Bureau of Land Management, 41,577 acres of private lands, and 4,506 acres of State lands. Several organizations are working to have this area re-designated as a National Park to preserve this outstanding national treasure.

Diamond Loop National BackCountry Byways
Points of Interest in the Steens Mountain Area

Steens Mountain Southeastern Oregon's highest mountain is a fault block 30 miles long. Fifteen million years ago when layers of basalt gave way under massive pressure caused by the earth's cooling and contracting, the tilting of the fault block resulted in a rugged east face that climbs one vertical mile from the Alvord Desert floor to an elevation of 9,773 feet and slopes gently to the valley floor on the west. The Steens Mountain Recreation lands are managed by the Bureau of Land Management to maintain ecological diversity, scenic values and natural environment. Steens Mountain National Backcountry Byway (Steens Loop Road), the highest improved road open to vehicles in Oregon, takes the traveler to views of magnificent glacier-formed gorges and wide vistas of surrounding high desert. The Alvord Desert can be seen from the East Rim overlook.

East Rim The east rim of the High Steens dramatizes the power of the volcanic and earth-shifting activity of pre-historic ages. The summit at 9,733 feet elevation, rises about 4,100 feet above the floor of the Alvord Desert to the east and provides a breathtaking view of Great Basin high desert country which reaches beyond the Oregon border into Nevada and Idaho.

The lava layers which cap Steens Mountain are several thousand feet thick and the individual flows are layers 10 to 200 feet thick. About 15 million years ago, lava erupted from cracks in the ground and spread rapidly across a level plain. Several million years later, Steens Mountain fault block began to lift up along a fault below the east rim and along the edge of Catlow Valley on the west. The uplift was faster at the east rim, tilting the mountain so that once level lava flows now form the gentle slope to the west. The eroded face of the tilted block forms the steep slope to the east. The east rim has been eroded almost a mile and a half from its estimated original position, and glaciers have sculpted its face.

Big Indian Gorge While Indians used all of Steens Mountain, the Big Indian Gorge must have been the most popular place of all. Walt Riddle, who settled on the Little Blitzen River in 1884, said that Indians came in large numbers each summer to camp in the Big Indian. They fished and hunted deer and sheep. They liked to race their ponies and gamble. The bottom of Big Indian was their race track.

Kiger Gorge From the top of the cirque, looking north down the steep walled sweep made by the glacier as it carved Kiger Gorge, this viewpoint is one of the most spectacular spots on the Steens. A stream flows nearly half mile below where beavers live and deer can be seen feeding in the meadows and along the canyon face. Nowhere in America is there such a clear picture of the wide swinging U-shape of the path left by a glacier.

Wildhorse Lake The lake can be seen to the south from the top of the bowl-shaped basin, and is like a blue jewel in appearance. The shallow lake is a result of glacial action. The bowl-shaped basin, or cirque, was gouged and eroded from the rock by ice. Glaciers once extended almost halfway down the east face of the mountain.

Lily Lake Approximately 13 miles from Page Springs on the Steens Loop Road, Lily Lake provides a beautiful setting for a picnic. The lake, with water lilies, is shallow and has no fish, but does have an abundance of aquatic organisms, boreal toads and Pacific treefrogs. Some waterfowl nest here and many song birds can be found in the aspen grove on the south side of the lake. The lake is an example of a natural process called plant succession. As the present vegetation dies it contributes to a gradual filling of the lake. Someday, less than a thousand years from now, Lily Lake will become a mountain meadow.

Fish Lake Fish Lake is a moraine lake, a natural body of water ponded behind a dam of earth and rocks deposited at the lower end of a glacier. During the Pleistocene, the prehistoric period of 10,000 to 100,000 years ago, the ice cap on Steens Mountain covered as much as 115 square miles. Glacial advances during the Pleistocene era formed many small lake basins on the High Steens. Fish Lake has a developed campground with drinking water and sanitation facilities for twenty family camps. Trout fishing during the summer season usually is very good. Wild flowers are abundant.

Diamond Craters Diamond Craters is the scene of one of the most recent volcanic eruptions in Harney County. Perhaps 25,000 years ago, lava oozed out of the cracks in the ground to form a large pool about six miles in diameter. As this lava hardened, more molten rock was injected at a shallow depth, lifting up the overlying rock to form the low hills, or domes, near the center of the first flows. More eruptions followed. Some were quiet outpourings of lava forming small shield volcanoes like those found in Hawaii, or more violent eruptions which formed cinder cones. Other eruptions were violent enough to blow the tops off of some of the domes and spread rock fragments for several miles.

The area has been designated as an Outstanding Natural Resource Area by the Bureau of Land Management and rock collecting is forbidden within this 17,000 acres area. Geologists have called the Diamond Craters a museum of volcanic activity because of its diverse formations.

Malheur National Wildlife Refuge Managed by the U.S. Fish and Wildlife Service, this wildlife refuge was dedicated by President Theodore Roosevelt in 1908. The upper Blitzen Valley section. including the P Ranch, was added in 1935. The refuge is a favorite destination for bird watchers throughout the western United States. Approximately 220 species of birds including migrating waterfowl, wading birds, and shorebirds can be found on and adjacent to the refuge during various times of the year. Stop at refuge headquarters for more detailed information.

The Alvord Desert This wide expanse of alkali, is a seasonal lakebed, is dry most of the time but is covered by very shallow water in wet years. During the Pleistocene Epoch, tens of thousands of years ago, a lake almost 200 feet deep covered the Alvord Desert and extended southward into Nevada. The old shoreline forms terraces along the edge of the valley. Deep under the floor of the Alvord Desert are the same lava flows which form the top of Steens Mountain. The valley floor sank as the mountain was uplifted, forming a "graben". Many types of sand dunes occur along the southern and eastern edge of the desert.

Mann Lake Named for an early rancher, Mann Lake is a favorite fishing spot for the rainbow and cutthroat trout that live there. Antelope, chukar, quail, and sage grouse are also found in this area. Rockhounds search for thundereggs, agates and other rocks and minerals in the area.

Recommended Reading

Oregon's Great Basin Country, Denzel & Nancy Ferguson, Maverick Publications.

The Oregon Desert, E.R. Jackman and R.A. Long, The Caxton Printers, Ltd.

Oregon's Outback: An Auto Tour Guide to Southeast Oregon, Donna Lynn Ikenberry, Frank Amato Publications, Inc.

GSOC NOTES

--Phyllis Thorn would like to remind everyone to turn in their responses to the survey about the annual banquet, etc. Please send your responses to the attention of Phyllis Thorn, **Geological Society of the Oregon Country, P.O. Box 907, Portland, Oregon 97207,** or fill out the survey at the next Friday evening meeting, July 9th. Thanks!

--For all going on the July 17th field trip to Silver Falls... you can read ahead by either looking up your copy of the March 1998 GSOC Newsletter or by buying a special reprint of the 5-page article about the geology of Silver Falls. To order in advance send a $1.00 check (pay to GSOC) to **Geological Society of the Oregon Country, P.O. Box 907, Portland, Oregon 97207** . A reprint may also be purchased on the day of the field trip.

Welcome to the following new members!

Sandra Adamson
Joy Brinda
Dick Cheadle
Taylor and Jean Hunt
Gary Jesky
Jett Karlson
Douglas Norseth
Michael Stuart-Champion
George and Marilou Waldmann

Malheur Field Station

Malheur Field Station will be the base of operations with daily field trips launched from there. Here is some further information about the field station.

Malheur Field Station is located in the northern part of the Great Basin and presents a unique combination of extensive marshlands, desert basins of alkali playas (4,000 ft elevation), uplands of desert scrub steppe, volcanic and glacial land forms and fault-block mountains, especially Steens Mountain (9,700 ft elevation). Five physiographic areas meet in this Harney Basin and visible paleoecological information for the past 12,000 years is available. The 20-acre building site is located on the 1,136 acre Coyote Butte Environmental Research Area and is part of the 185,000-acre Malheur National Wildlife Refuge. The entire Refuge and surrounding Bureau of Land Management land is available for use by the Station which is on a major migratory flyway, plus this area has a large variety of resident bird populations. MFS has cooperative agreements with the USFWS, the BLM and USFS for use and research on the Federal lands which comprise over 3/4 of the county.

RESEARCH Although Malheur Field Station was established primarily for educational purposes, investigators in the past have pursued research programs such as: 22 years of ongoing greater sandhill crane ecology; 12 years of small mammal studies; regional plant ecology studies ranging from the effects of domestic grazing; snow cover, and wild fires on grasslands at 4,000 ft to above 9,500 ft elevation; multiple-site studies of breeding bird populations in upland habitats; R 8 E plant species propagation and ecology; invertebrate studies such as desert thatch ant ecology; lichen-invertebrate inaction above 9,000 ft elevation; l5-year studies of cave-dwelling invertebrates; vernal pool invertebrate inventories; 10-year study on food foraging practices by the contemporary Burns Paiute tribe; long-term archaeological surveys and studies; over 10 years of paleoenvironmental studies; recently initiated plant studies related to hot springs and marsh recovery from flooding; as well as sagebrush lizard dynamics. Within a day's drive of the Station, students utilize a vast variety of ecosystems such as marshlands, riparian systems at different elevations, desert playas and dune systems, hot springs, alpine vegetation, volcanic areas, upland desert shrubsteppe, and coniferous forests.

GSOC NOTES

-- **Ray Crowe writes "Dr. Melinda Hutson will speak** on the Geology of Venus, and has, 'lots of neat slides,' she says. Dr. Hutson is an instructor in Geology and Astronomy at Portland Community College, Sylvnia Campus. We're really looking forward to this talk."

GSOC NOTES

--**Dr. Ruth Keen Donation** by Ray Crowe

The December, 1998, newsletter carried the obituary of Dr. Ruth H. Keen, but failed to mention that she had donated her extensive mineral and rock collection to the Rice Museum. Dr. Keen passed away in October last year, having been born in 1906 in Oklahoma. Her Ph.D. was from Cornell in geology, and Rosemary Kenny commented it was on Oregon geology...something the Easterners were unfamiliar with...so the degree was granted with no contest. She moved to Oregon and spent many years teaching geology, natural history and conservation, becoming a professor at Portland State College. And, of course, she was GSOC president in 1982 and 1990.

At a recent board meeting, I was asked to inquire about the status of her collection, and met Saturday afternoon, June 5th, with curator Sharleen Harvey at the Rice Museum. She indicted they were overwhelmed with the collection...boxes stacked in storage and even outside (agates and such). Dr. Keen had indicated to her that they should do as they wanted with the collection, "whatever was best for the museum."

Thus, about half of the collection will be, or has been sold, and the other half retained (there is a nice gift shop at the museum). Dr. Keen had a particular interest in only three items; a marvelous piece of stibnite about a foot long, a beautiful pseudomorph of malachite after azurite, and a four foot slab of Arizona petrified wood (this was offered to the Smithsonian, but they didn't want it...their loss) that had been made into a coffee table (some repairs now being done to the base, so not on display).

Other items will be worked into displays...a new one, Minerals Of The Northwest to open soon at the museum in time for visitors to come over from the NW Federation Show at the Hillsboro Fairgrounds, Jun 17-18-19 (no admission at this time at Rice Museum).

Come by and ask curator Harvey or another guide to point out the copper ore and the antimony specimen. More information from the museum at: (503) 647-5207.

Sharleen K. Harvey, Curator, Rice Museum, is holding a quartz crystal from Dr. Keens' collection.

Geological Society of the Oregon Country
PO Box 907
Portland, OR 97207-0907

President's Annual Field Trip - 1999
MALHEUR FIELD STATION/STEEN'S MOUNTAIN
Official Registration Form

Leader: ....Carol Hasenberg, 1999-2000 GSOC President

Dates for Trip:..................July 30, 1999, - Registration and Payment DUE
September 3, 1999 - Carpool to Malheur Field Station (MFS). Scheduled activities will commence with dinner at MFS at 6pm. Plan to arrive about an hour before dinner.
September 3-9, 1999 - Nights we will be staying at MFS.
September 10, 1999 - Carpool back to Portland after breakfast at the station. Attend the GSOC meeting that evening.

Cost for the Trip: ....$500. This is the estimated maximum cost. Any moneys not spent on the field trip will be divided amongst the participants as a refund. Price includes lodging in the dormitories at MFS, all meals and transportation during the scheduled activities. Price does NOT include transportation to and from the station.

Lodging:...........................Standard lodging is the MFS dormitories. Those participants wishing to stay in one of the MFS trailers at the station will have to pay an additional $12 per night ($84 total) and notify Carol of their intention by July 15, 1999.

Refunds:...........................Last date to notify Carol for a full refund is August 1, 1999. After that the refund will be prorated depending on the refund we can obtain from MFS.

Name Additional Participant Names
Address Total Number of Persons Registering
Phone # Total Cost
LodgingIndicate preference
Dormitory
Trailer

Transportation
I will need a ride to and from MFS
I am providing my own transportation
I am willing to take ___ (number) of passengers

Geological Society of the Oregon Country
PO Box 907
Portland, OR 97207-0907

President's Annual Field Trip - 1999
MALHEUR FIELD STATION/STEEN'S MOUNTAIN
Waiver

In consideration of the Geological Society of the Oregon Country providing this trip, I,

______________________________________,

hereby waive any claim that I might have against the Geological Society of the Oregon Country, its Board of Directors and trip leaders, jointly and individually, for injuries or loss to me as a result of any accident or incident which may occur on this trip.

Dated:______________________________________

Signed:______________________________________

Please sign and return with your final payment

MEDICAL INFORMATION

Name:______________________________________

Telephone Number: ______________________________

Name of Physician: ______________________________

Telephone Number: ______________________________

Allergies: ____________________________________

Special Medications: _____________________________

Special Medical Conditions: _________________________

In Case of an Emergency Call:________________________

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THE GEOLOGICAL NEWSLETTER

GSOC

GEOLOGICAL SOCIETY OF THE OREGON COUNTRY

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THE GEOLOGICAL NEWSLETTER

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Calendar:		**Assistant Business Manager:**	
Evelyn Pratt	223-2601	Cecelia Crater	235-5158

ACTIVITIES:

ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00.

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Address __________________________________ **City** ____________ **State** ___ **Zip**______

Phone _______________ **Email address**____________________

Geologic Interests and Hobbies____

____

Please indicate Membership type and include check for appropriate amount:
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GEOLOGICAL NEWSLETTER

THE GEOLOGICAL SOCIETY OF THE OREGON COUNTRY
P.O. BOX 907, PORTLAND, OR 97207

VISITORS WELCOME AT ALL MEETINGS — VOL. 65, No. 8
INFORMATION: www.gsoc.org *or* gsoc@teleport.com — AUGUST 1999
Carol Hasenberg, 503-282-0547 or Evelyn Pratt, 503-223-2601

AUGUST ACTIVITIES

****

Sat. August 21 Field Trip: Columbia Gorge, Portland to Hood River. Meet at 8:30 AM, Troutdale Factory Outlet Mall by Mikasa's. Evelyn Pratt, leader. Bring a sack lunch, wear footgear appropriate for mini-hikes, and *ignore* 5-day weather forecasts - prepare for rain or shine! 223-2601 or ralf70@aol.com

****

No August picnic this year.

SEPTEMBER'S COMING ATTRACTIONS:

****

Sept. 3-10: PRESIDENT'S TRIP, MALHEUR FIELD STATION. GEOLOGY OF OREGON, Orr, Orr, & Baldwin, has good sections on Steens Mt., the Alvord Desert, and Diamond Craters. For a detailed look at Harney Basin, check "Field guide to the Rattlesnake Tuff and High Lava Plains near Burns, OR," in May/June 1998 OREGON GEOLOGY. For more information call Carol Hasenberg, 503-282-0547, or e-mail www.gsoc.org *or* gsoc@teleport.com.

****

Fri. Sept. 10 8:00 PM: Charlene K. Harvey, Curator of the Rice Museum, will give an illustrated talk about the museum and about Dr. Ruth Keen's huge collection of specimens. Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

Fri. Sept. 17 12:30-2 PM: Willamette Valley at the End of the Ice Age: Extinct Mammals and Survivors Alison Stenger, PhD, Director of Research, Inst. for Archaeological Studies. Central Library, 801 SW 10th St.

Wed. Sept. 22 8:00 PM: First of seminar series Life's Travel Through Time, E. Pratt
1. Today's scientific speculations on how - and where - life began. Sources to refer to: March 1998 Nat. Geographic's "Rise of Life on Earth"; Internet; Scientific American, Science News; or bring *scientifically-validated* articles. Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

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Calendar items must be received by 15TH of preceding month. Evelyn at 503-223-2601; ralf70@aol.com

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Geology of the Portland Area, Oregon
by R. E. Corcoran

[Here is a reprint of an article last published in The Geological Newsletter in August 1994 with a few editorial changes shown in italics. This reprint was requested by a member for the benefit of some of the newer members of the society. The article was originally prepared for GSOC Earth Science Studies MAP PROJECT – March 15, 1984]

Introduction

The Portland area has had a most interesting geologic history. The basaltic hills of west Portland, the Boring Hills to the southeast, and the little cinder cone on the flank of Mt. Tabor give our city a character not seen elsewhere in a metropolitan area of this size. Portland has the distinction of having the only volcanoes within its city boundaries.

Fortunately the geology of this area is not so complex that it cannot be reasonably understood by the interested layman as well as the professional geoscientist. A number of geologic reports have been written on the area over the past 90 years beginning with a report by Thomas Condon the latter part of the 19th century. Many of these reports are now out of print however, so this brief summary has been prepared to assist you in developing your geologic map. The following descriptions of the geology of the Portland area are taken largely from the U.S. Geological Bulletin by Trimble (1963) because it is the most recent detailed survey.

***Skamania Volcanics* (Tsv)**

The oldest rocks in the area are altered basalt and basaltic andesite flows and associated pyroclastics that are exposed extensively in the Cascade Mountains north of the Columbia River. The name is taken from the type locality in Skamania County, Washington. Other names for these volcanic rocks are: Goble Volcanics and Ohanapecosh Formation. In the Portland area the Skamania Volcanics are exposed only in the vicinity of Lackamas Lake, Washington .... Altered lavas that probably are a part of the Skamania Volcanics crop out in the Willamette River near New Era.... The volcanic formation is probably several thousand feet thick.

The age of the Skamania Volcanics has not been determined precisely by radioactive age dating, but is probably late Eocene to Oligocene. Fossil floras of both Eocene and Oligocene age have been found in water-laid sediments associated with the Skamania Volcanics at two localities in southern Washington.

***Columbia River Basalt* (Tcr)**

In the Portland area the Skamania Volcanics are overlain mainly by Columbia River Basalt. These lavas constitute a thick series of flows that originated from fissures several hundred miles to the east in Washington and Oregon. During a two-million-year period they covered more than 50,000 square miles in these two states plus Idaho. A number of reports and articles have been written about this tremendous flood of basaltic lava flows because they are so extensively exposed along the Columbia River, the type area. One result of these studies has been to raise the unit to "Group" status and subdivide it into a number of new formations and members.

The Columbia River Basalt underlies most of the Portland Hills (called "Tualatin Mountains" by Trimble) as well as several other ridges both to the west and south. The flows dip beneath Portland and lie at depth of about 1,000 feet east of the Willamette River. They rise again farther east and appear at the surface a few miles east of Troutdale along the Columbia River. The "Group" has an aggregate thickness of about 5,000 feet near its source; it is probably less than 1,000 feet thick in the Portland area.

Radioactive age dates determined for these lava flows range from about 14 to 16 million years. This means that the lavas are early to middle Miocene in age.

Troutdale Formation **(Tt)**

The Troutdale Formation, including the Sandy River Mudstone, lies unconformably on the older lavas of the Columbia River Basalt. The best exposures of the Troutdale are along the Sandy River upstream from the town that gave it its name. The Formations consists of mudstone, siltstone, claystone, sandstone, and conglomerate. This wide variety of sedimentary rock types indicates a great variation in depositional environment in this part of Oregon during Pliocene time. In addition to outcrops along the Sandy River, the Troutdale Formation is also well exposed on both sides of the Columbia River east of Washougal and Troutdale. Another locality is an old gravel quarry on northwest Cornell Road above downtown Portland where one can collect representative samples of the pebbles and cobbles that make up the conglomerate facies of the Formation. Of particular interest are the quartzite pebbles. Quartzite beds do not occur in Oregon, so these "foreign" rocks must have been brought down and deposited by the ancestral Columbia River from quartzite outcrops somewhere in northeastern Washington or Canada.

A Pliocene age for the Troutdale Formations (and Sandy River mudstone is based on the identification of fossil flora found in some of the finer-grained sedimentary strata within this unit. The formation is believed to be approximately 1,000 to 1,500 feet thick.

Boring Lava (Qtb)

In late Tertiary and early Quaternary time scores of volcanoes erupted in the Portland area. The products of this volcanic episode were named the Boring Lava for their occurrence near the town of Boring. All of the basaltic flows and minor pyroclastic rocks are of local origin, and none of the lava spread far from its eruptive source. The source areas are still visible around the Portland area because there has been little erosion or alteration to destroy them. Mt. Scott, Mt Tabor (in part), and Mt. Sylvania are a few examples of the Boring Lava Volcanoes.

Quaternary deposits mantle about 50 percent of the Portland area. The material is mostly water-deposited sediments. The rivers that transported this material must have had a fairly high carrying capacity because the sediments are predominantly bouldery cobble gravel with lesser amounts of sand, silt, and clay. The three stratigraphic units which Trimble named Springwater, Estacada, and Gresham Formations (from their respective type localities) are grouped as one sedimentary unit for this exercise and are referred to as "Terrace deposits". In the area of your map they occur along and between the Sandy and Clackamas Rivers. Their similar genesis and lithology make it difficult to distinguish them in the field.

Portland Hills Silt

The blanket of yellowish-brown clayey sandy silt that covers a large part of west Portland is believed to be mainly of loessial (wind-deposited) origin. Although it can be found east of the Willamette River on some of the higher areas, it is most extensive on the Portland Hills west of downtown Portland at elevations between 300 and 1,500 feet. Thickness is estimated to be 55 feet and it thins away from the Columbia River flood plain.

The Portland Hills Silt is essentially structureless and shows no stratification typical of water-laid deposits. Pebbles found locally in the silt are believed to represent slope-wash material introduced from nearby outcrops of the Troutdale Formation.

In past years, a considerable amount has been written on the origin of the Portland Hills Silt as to whether it is a loess deposit, a water-laid deposit, a residual weathering product of basalt, or a combination of all three. The general consensus today is that the silt is mostly, if not all, wind-laid material; and that it was blown in from the Columbia River Basin. Trimble shows it on his map by means of an overprint pattern.

Spokane Flood Gravel (Qlg) and (Qs)

The valley floors of the Lower Columbia, Willamette, and Tualatin Rivers are almost covered by unconsolidated gravel, sand, silt, and clay that are interpreted as deposits of late Pleistocene (?) age. Many years ago J. Harlan Bretz proposed that these water-laid deposits were brought in by a [*sequence of floods*] of far greater proportions than any in historic times. [*At some time called the Spokane Flood*] These have] come to be referred to as the [*Bretz Floods based on the multiple occurrences*] or [*Missoula Floods based on place of* *origin. Dr. J. E. Allen and Marjorie Burns have described these events in their 1986 book, Cataclysms on the Columbia.*] It is recommended that everyone read this book in order to obtain a better understanding of how these floods originated and the dramatic erosional and depositional effects that resulted.

Recent Alluvium (Qal)

Alluvial deposits of sand, silt, and gravel of Holocene (Recent) age cover the flood plains of the Columbia and Willamette Rivers and some of their tributaries. The upper limit of the alluvium in the vicinity of Portland is at about 50 feet above sea level along the larger rivers, and it rises to higher elevations along the tributaries.

Lecture Notes July 9, 1999

Portland Community College professor, Dr. Melinda Hutson spoke on the "Origins of the Planet Venus" at the society's Friday evening lecture. The following is a summary of her remarks.

Venus' cloud cover has made it very difficult for astronomers to know much about the planet. It was assumed that since Venus had the same size, same bulk, and same density as earth that it had the same contents and thus the same heat budget. In the past, Venus was thought "earth's twin." However, current research shows that Venus is " earth's *evil* twin."

The atmosphere of Venus is 96% carbon dioxide and 3% nitrogen with sulfuric acid clouds. Its rotation is 255 days and surface temperatures rise to 900° F. The atmosphere is very much denser than earth's. It is dense creating a pressure like what would be felt in the deep ocean. This is why previous attempts at landing a craft on the surface have not worked.

The Russians did land a craft, *Venera*, using brute force in 1982. Dr. Hutson showed a slide of a photograph taken by the ship that revealed a barren rocky landscape in dim light. The dim light was the result of the sulfuric acid clouds. The rocks appear to be basalt.

The Pioneer Venus spacecraft survived long enough to measure the atmosphere. The measurements indicated that the atmosphere is bone dry – there is no hint of water. The expectation is that Venus, Mars, and Earth would have all started with the same materials in the atmosphere. This implies that the earth's atmosphere is seriously altered. Carbon dioxide on the earth is mostly locked up in carbonate rocks, e.g. limestone.

Water on Venus would have stayed as vapor. However the planet is very hot and this would have driven off the hydrogen from the atmosphere and forced the oxygen to combine with rocks. The result would be an atmosphere with more than 90% carbon dioxide.

The Magellan spacecraft used radar to map the surface. Dr. Hutson showed maps composed of radar images of the surface. Radar images are based on reflections. If the surface is rough, the amount of reflection is great and the image is good. Smooth surfaces reflect less well.

As a result of the mapping, it is believed that Venus is different compared to the rest of the solar system in regard to impact craters. All other solar bodies are calibrated by the nature of impact craters on our moon. The more craters a surface has the older the surface. Older craters are crossed by lava flows or altered by other means. Earth's freshest crater is Meteor Crater outside Flagstaff in Arizona. Meteor Crater is about 1.2 km in diameter.

One characteristic of impact craters on Venus is that there are none less than 3 km in diameter. This is believed to be due to the thick atmosphere: no meteor can get through that will create a crater smaller than 3 km in diameter. Another characteristic is that the craters are distributed randomly. A third characteristic is that none are modified by any other processes, with a few exceptions.

That the number of craters is uniform around the planet implies that they are all the same age. The age of impact craters around earth vary from 0 to 3.6 billion years in age with an average age of about 500 million years. The age of impact craters on Venus vary from 400 to 600 million years with an average age of 500 million years. Why? There is a conflict of theories about why based on whether the proponent is a catastrophist or a uniformitarian.

The craters do not themselves indicate whether Venus is active geologically. One exception is from data acquired in 1978. At that point in time there was much too much sulfuric acid vapor in the atmosphere and there were low frequency radio emissions over volcanoes such as from lightning. In 1983 data showed a much lower level of sulfuric acid. These clues suggest volcanic eruptions.

Venus' terrain is dominated by volcanoes and volcanic plateaus. The most common feature is small shield volcanoes. Another feature is lava channels. Some of these appear normal (i.e. such as they would appear on earth). Others take the form called "canali". These are channels the length of the United States. Basalt could not be that runny so as to flow that distance and create such a feature. Therefore canali must be formed of some other substance. One suggestion is ultramafic lava which would be hot enough to flow over such a distance. Another suggestion is carbonate lava.

Other features are volcanic domes and landslides. In one area there is a series of domes suggesting a moving source. To get a volcanic dome one needs a siliceous lava like rhyolite or dacite. There are some large shield volcanoes – very large. One is called Sif Mons which is 600 kilometers across and 1 mile tall.

There are also features called "coronas." Coronas are so called due to circumferential faulting which are associated with volcanoes and giant laccolithes.

Eighty-five percent of the surface is lowlands and the rest are highlands. Some of the highlands have large gravity anomalies which means the crust is not in isostatic equilibrium. It is believed that some upwelling mantle is pushing these highlands up. Some of the highlands have low gravity anomalies. These areas have slightly more craters and are slightly older. They are "messy" with some fractures showing stress from pushing together and some from pulling apart. There seem to be ridge belts and what look like folded mountain belts (like plate boundaries). A third type of highlands are a combination of the other two.

On Venus there are no linear features (spreading boundaries) and the terrain goes from low lands to highlands very gradually. On Earth there is a jump from low areas to high abruptly (like ocean plate to continental plate?). Conclusion: there is no plate tectonics evident on Venus.

Earth and Venus started with the same material but proceeded along different evolutionary paths. Venus is probably the way it is because it is too close to the sun. Earth is "just right."

"Deep Impact" in Chesapeake Bay

In the next few months we will be treated to lectures on planetary geology. An important facet of planetary geology is the study of impact craters. Studying craters on earth help us understand craters on the planets and vice versa. Here is a recent press release from USGS about an impact crater on the East Coast.

No, not another meteor disaster movie, but something left a big impression in the Chesapeake Bay.

"About 35 million years ago a huge rock or chunk of ice slammed into the Atlantic Ocean and blasted a 56-mile-wide hole in the shallow ocean floor near what is now the mouth of the Chesapeake Bay," David Powars, hydrologist with the U.S. Geological Survey (USGS) said. "The force of the impact ejected huge amounts of debris into the atmosphere and spawned a train of gigantic tsunamis that probably reached as far as the Blue Ridge Mountains. This impact left behind a crater that is now buried under 400 to1,200 feet of sand, silt, and clay."

Scientists with the USGS and the Virginia Department of Environmental Quality have recently discovered the Chesapeake Bay impact crater. The USGS, in cooperation with the Hampton Roads Planning District Commission, has just released the first of a series of planned reports describing the effects of the impact crater on the geology and hydrogeology in the region.

"Ongoing analysis of this impact crater will yield a wealth of information," Powars said. "It's the largest crater discovered so far in the United States, and it's one of only a few oceanic impact craters that have been documented worldwide. The Chesapeake Bay impact crater is shallower and more accessible than the much larger and older one off the coast of Mexico that most scientists believe led to the extinction of the dinosaurs."

The discovery of the Chesapeake Bay impact crater helps explain a number of unusual features that have been noted in the region, including salty ground water, earthquakes around the crater's perimeter, and an unusual rate of sea-level rise.

"The object from outer space that hit the Earth millions of years ago appears to be responsible for the salty ground water that we find at depth over a large area in the bay region," Powars explained.

Virginia's "inland saltwater wedge" is a well-known but previously unexplained phenomenon. The impact of the comet or meteorite deformed and broke up the "layer cake" stack of aquifers (water-bearing rocks) and confining units, which restrict the flow of ground water. The outer rim of the crater seems to coincide with the boundary separating salty and fresh ground water. Salty ground water is found inside the crater. Fresh ground water is found outside of the crater. The report documents the location of the outer rim, which can be used to determine where fresh ground water is likely to be found.

The report presents a reinterpretation of the lower York-James Peninsula geologic framework and is the first step in understanding the ground-water flow system. "In other words," said Powars, "first you have to describe the container and the material holding the water before you can begin to describe how the water flows. The next step will be revising existing computer ground-water flow models."

The computer models are used to guide the management of Virginia's ground-water resources, such as the permitting of large ground-water withdrawals.

Copies of U.S. Geological Survey Professional Paper 1612 "The Effects of the Chesapeake Bay Impact Crater on the Geological Framework and Correlation of Hydrogeologic Units of the Lower York-James Peninsula, Virginia" by David S. Powars and T. Scott Bruce, are available for viewing at university, state, and government depository libraries and at the USGS Virginia District office, 1730 East Parham Road, Richmond, VA 23228 (804)261-2600. Copies may be purchased from the USGS, Branch of Information Services, Box 25286, Federal Center, Denver, CO 80225.

This press release, along with a picture of the report cover showing a satellite image of the impact crater site, may be found on the Virginia District home page: http://va.water.usgs.gov/ .

As the nation's largest water, earth and biological science and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial scientific information to resource managers, planners, and other users. This information is gathered in every state by USGS scientists to minimize the loss of life and property from natural disasters, contribute to the sound conservation, economic and physical development of the nation's natural resources, and enhance the quality of life by monitoring water, biological, energy, and mineral resources. ***USGS***

SEP 99

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INFORMATION: www.gsoc.org *or* gsoc@teleport.com — SEPTEMBER 1999
Carol Hasenberg, 503-282-0547 or
Evelyn Pratt, 503-223-2601

SEPTEMBER ACTIVITIES

Sept. 3-10: PRESIDENT'S TRIP, MALHEUR FIELD STATION. Good information on Steens Mt., the Alvord Desert, and Diamond Craters can be found in GEOLOGY OF OREGON, Orr, Orr, & Baldwin. For a detailed look at Harney Basin, check "Field guide to the Rattlesnake Tuff and High Lava Plains near Burns, OR," in May/June 1999 OREGON GEOLOGY. As of 8/15, all roads are open, & wildflowers are spectacular. For more information call Carol Hasenberg, 503-282-0547, or e-mail www.gsoc.org *or* gsoc@teleport.com.

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Fri. Sept. 10 8:00 PM: Charlene K. Harvey, Curator of the Rice Museum, will give an illustrated talk about the museum and about Dr. Ruth Keen's huge collection of specimens. Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

Fri. Sept. 17 12:30-2 PM: Willamette Valley at the End of the Ice Age: Extinct Mammals and Survivors Alison Stenger, PhD, Director of Research, Inst. for Archaeological Studies. Central Library, 801 SW 10th St.

Wed. Sept. 22 8:00 PM: First of seminar series Life's Travel Through Time, E. Pratt

1. Today's scientific speculations on how - and where - life began. Popular sources to refer to: March 1998 Nat. Geographic's "Rise of Life on Earth"; Internet; Scientific American, Science News; or articles from reputable scientific journals.
   Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

****

PREVIEW OF COMING ATTRACTIONS:

Oct. 1, 12-1:30 PM: The Roadside Geology of Oregon Past President Don Barr
Central Library, 801 SW 10th St.

****

Calendar items must be received by 15TH of preceding month. Evelyn at 503-223-2601; ralf70@aol.com

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The Planet Mercury

During the fall we will be treated to lectures on the geology of the planets. Here is some background in anticipation of those lectures. ***This material comes from the NASA website.***

Smallest planet of them all, Mercury is also closest to the Sun. It is heavily cratered, showing impact scars from countless bombardments by meteoroids. Old lava flows and quake faults also mark its crust. Mercury has no atmosphere, but surprisingly, scientists have found evidence for a polar ice cap on this hot little globe. Mercury was explored in three flybys by the Mariner 10 spacecraft in 1974 and 1975.

HOW MERCURY WAS DISCOVERED

(Bill Yenne, "The Atlas of the Solar System," Brompton Books Corp., Greenwich, 1987, p. 23.)

Johann Hieronymus Schroeter was the first to observe the planet Mercury and record detailed drawings of Mercury's surface features. Schroeter lived from 1745 to 1816. Unfortunately, his sketches were not very accurate. Streaks similar to the so-called "Martian Canals" were also seen on Mercury by Schiaparellit and Percival Lowell (1855-1916). An astronomer by the name of Eugenios Antoniadi (1870-1944) charted the surface of Mercury in great detail. His maps were used for almost 50 years. He used one of the stronger telescopes of his time and found the canals to be optical illusions. Mariner 10 provided a close look at Mercury which redrew earlier telescope charts and maps.

FACTS ABOUT MERCURY

(Bevan M. French and Stephen P. Maran, eds., "A Meeting with the Universe," NASA EP-177, U.S. Government Printing Office, 1981.)

Mercury Ground-based radar measurements determined (1965) that the rotation period is 59 days, not 88 days as had long been believed.

Mariner 10 made the first spacecraft flyby of Mercury in 1974 (in fact, it flew past Mercury three times), and obtained several thousand photographs. Among the results of the Mariner 10 investigations were the following: The mass of Mercury was accurately determined. Any residual atmosphere has less than a million- billionths the pressure of the Earth's atmosphere at sea level. However, a trace of helium, perhaps derived by outgassing from Mercury's interior, was found. It was discovered that Mercury has an internal magnetic field, similar to but weaker than that of Earth.

Mercury's surface is heavily cratered and resembles that of the Moon. * A huge circular impact basin (Mare Caloris), about 1300 kilometers (810 miles) in diameter, was discovered. A planetary feature unique to Mercury was found, consisting of long scarps, or cliffs, that apparently were produced by compression in a major shrinkage of the planet.

Flat plains, perhaps lava flows, were found. Mercury was found to be closer to a perfect sphere than is the Earth.

(The following is from "The Solar System" NASA/ASEP, 1989, p. 2.)

* This planet has no moon.
* Mercury's gravity is about one-third of the Earth's gravity.
* Mercury's diameter is 3,025 miles.
* Mercury's orbit is more elliptical than any other planet except Pluto.

(NASA, Jet Propulsion Laboratory, "Our Solar System at a Glance," NASA Information Summaries, PMS 010-A (JPL), June 1991.)

Obtaining the first close-up views of Mercury was the primary objective of the Mariner 10 spacecraft, launched on November 3, 1973, from Kennedy Space Center in Florida. After a journey of nearly five months, including a flyby of Venus, the spacecraft passed within 703 kilometers (437 miles) of the solar system's innermost planet on March 29, 1974.

Until Mariner 10, little was known about Mercury. Even the best telescopic views from Earth showed Mercury as an indistinct object lacking any surface detail. The planet is so close to the Sun that it is usually lost in solar glare. When the planet is visible on Earth's horizon just after sunset or before dawn, it is obscured by the haze and dust in our atmosphere. Only radar telescopes gave any hint of Mercury's surface conditions prior to the voyage of Mariner 10.

The photographs Mariner 10 radioed back to Earth revealed an ancient, heavily cratered surface, closely resembling our own Moon. The pictures also showed huge cliffs crisscrossing the planet. These apparently were created when Mercury's interior cooled and shrank, buckling the planet's crust. The cliffs are as high as 3 kilometers (2 miles) and as long as 500 kilometers (310 miles).

Instruments on Mariner 10 discovered that Mercury has a weak magnetic field and a trace of atmosphere - a trillionth the density of Earth's atmosphere and composed chiefly of argon, neon and helium. When the planet's orbit takes it closest to the Sun, surface temperatures range from 467 degrees Celsius (872 degrees Fahrenheit) on Mercury's sunlit side to -183 degrees Celsius (-298 degrees Fahrenheit) on the dark side. This range in surface temperature - 650 degrees Celsius (1,170 degrees Fahrenheit) - is the largest for a single body in the solar system. Mercury literally bakes and freezes at the same time.

Days and nights are long on Mercury. The combination of a slow rotation relative to the stars (59 Earth days) and a rapid revolution around the Sun (88 Earth days) means that one Mercury solar day takes 176 Earth days or two Mercury years – the time it takes the innermost planet to complete two orbits around the Sun!

Mercury appears to have a crust of light silicate rock like that of Earth. Scientists believe Mercury has a heavy iron rich core making up slightly less than half of its volume. That would make Mercury's core larger, proportionally, than the Moon's core or those of any of the planets.

After the initial Mercury encounter, Mariner 10 made two additional flybys - on September 21, 1974, and March 16, 1975 - before control gas used to orient the spacecraft was exhausted and the mission was concluded. Each flyby took place at the same local Mercury time when the identical half of the planet was illuminated; as a result, we still have not seen one-half of the planet's surface.

Mercury would seem to be one of the least likely places in the solar system to find ice. The closest planet to the Sun has temperatures which can reach over 700 K. The local day on the surface of Mercury is 176 earth-days, so the surface is slowly rotating under a relentless assault from the Sun. Nonetheless, Earth-based radar imaging of Mercury has revealed areas of high radar reflectivity near the north and south poles, which could be indicative of the presence of ice in these regions (1-3). There appear to be dozens of these areas with generally circular shapes. Presumably, the ice is located within permanently shadowed craters near the poles, where it may be cold enough for ice to exist over long periods of time. The discovery of ice on the Earth's moon can only serve to strengthen the arguments for ice on Mercury.

HOW WAS THE EVIDENCE FOR ICE FOUND?

Investigations of Mercury were done from Earth using the Arecibo radio telescope, the Goldstone antenna, and the Very Large Array (VLA). The Goldstone/VLA study (1) used the NASA Deep Space Network 70-m Goldstone dish antenna to transmit 8.51 GHz, 460 kW, right circularly polarized radar waves towards Mercury. The reflections were received by the National Radio Astronomy Observatories 26 VLA antennas. Calibration and processing of the radar returns showed radar-bright (high radar reflectivity) with depolarized signatures at the north pole. The Arecibo observations (2,3) were made by transmitting an S-band (2.4 GHz), 420-kW, circularly polarized coded radar wave at Mercury. The wave reflects off Mercury back to Earth. The wave is both transmitted and received by the Arecibo radio telescope. Filtering and processing the return signal gives a radar reflectivity map of Mercury's surface with a resolution of approximately 15 km. About 20 anomalously reflective and highly depolarized features were observed at the north and south poles.

WHY ARE THESE RADAR-BRIGHT AREAS THOUGHT TO BE ICE?

Ice is highly radar reflective and the radar reflections off ice tend to be highly depolarized, unlike typical silicate rock which comprises the bulk of Mercury's surface. While not as highly reflective as other icy solar system objects, such as Europa, Ganymede, and Callisto, these areas are still significantly more reflective than silicate material. Moreover, the depolarized nature of the reflections is also an indicator of water ice. The Arecibo results show that the radar reflective areas are concentrated in crater-sized spots. At the south pole, the location of the largest area appears coincident with the large crater Chao Meng-Fu and the smaller areas with other identified craters. At the north pole, much of the area containing the radar bright spots was not imaged, and so cannot be correlated with known craters. However, for the imaged areas at both poles most of the areas have been loosely correlated with known craters (3).

Craters near the poles could provide the permanent, or near-permanent (see 5), shading required for ice to exist on Mercury. The radar results indicate the reflective areas are probably relatively uncontaminated ice. However, the lower reflectivity compared to pure ice features indicates the ice may be covered by a thin layer of dust or soil or else does not completely cover the crater floor (6). Note that no direct unequivocal detection of ice has been made. The coincidence of the radar bright areas with large, possibly permanently shadowed, polar craters is strong circumstantial evidence for ice. However, the radar reflections could be explained by an enhancement of some other radar reflective material, such as metal sulphides or other metallic condensates, or precipitated sodium ions.

HOW CAN ICE SURVIVE ON MERCURY?

As mentioned above, all provinces on Mercury are exposed to the Sun for almost 90 earth-days at a time, and can reach temperatures over 700 K. Additionally, Mercury has no ambient atmosphere and very low gravity. Water ice on the surface of Mercury is exposed directly to vacuum, and will rapidly sublime and escape into space unless it is kept cold at all times. This implies that the ice can never be exposed to direct sunlight. The only locations on the surface of Mercury where this is possible would seem to be near the poles, where the floors of some craters might be deep enough to afford permanent shading. Whether such permanently shadowed craters exist on Mercury is still problematic. The only close-up images we have of Mercury were taken by the Mariner 10 spacecraft on three close passes in 1974 and 1975. The same hemisphere of Mercury was sunlit on each of these passes, so nearly half the planet has never been imaged, and no determination can be made of what polar areas, if any, are permanently shadowed. However, theoretical studies assuming typical crater dimensions show that craters near the poles should have areas which never rise above about 102 K (4) and that even flat surfaces at the poles would not exceed about 167 K (5). Other studies (6-7) also indicate that water ice in polar craters on Mercury could be stable over the age of the solar system.

HOW DID THE ICE GET THERE ORIGINALLY?

There are only two significant sources for ice on Mercury: meteorite bombardment and planetary outgassing. Meteorites, especially in the past, potentially carried large amounts of water to Mercury's surface. Outgassing of water from the planet's interior could also provide a non-negligible flux of water to the surface, although this is speculative. The permanently shadowed regions near Mercury's poles should act as "cold-traps" so that any water which found its way to these regions would freeze on the surface and remain. (The possibility that the ice is relatively uncontaminated may indicate that each deposit was laid down in one or a small number of rapid events (6), such as a large comet impact.) Meteorites which impacted near the poles and water which outgassed in that region could have been easily trapped. Water originating away from the poles would behave as individual, randomly moving molecules, some of which could migrate to the poles and be come trapped there (6). There are mechanisms for potential loss of ice, however. These include photodissociation, solar wind sputtering, and micrometeoroid gardening. The effects of these processes are not well-understood.

HOW CAN THIS DISCOVERY BE TESTED?

Direct observations of Mercury from Earth are difficult because Mercury is so close to the Sun. The only effective way to study the polar regions beyond radar observations is to send a space probe equipped with an imager and spectrometry instruments. Missions to Mercury are difficult because the planet is deep in the Sun's gravitational well. No such mission is currently planned. The only mission to visit Mercury was Mariner 10 which had three flybys in 1974 and 1975. Each of these flybys occurred when the same portion of the planet was lit by the Sun, so only about half the planet was imaged. By their very nature, the interiors of shadowed craters are too dark to image, so these pictures do not shed any light on whether or not ice exists inside these craters.

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7) Near-surface ice on Mercury and the Moon: A topographic thermal model, Salvail and Finale, Icarus, v. 111, p. 441, 1994

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NSSDC, Mail Code 633, NASA/Goddard Space Flight Center, Greenbelt, MD 20771

In Memory of Vivian Wynkoop

Vivian A. Wynkoop died July 26, 1999, at age 80. No services were held.

Mrs. Wynkoop was born September 1, 1918 in Delight Valley. She moved to Portland in the late 1930's after attending the University of Oregon. She was a clarinetist for the Gresham Senior Vancouver Pops Orchestra for the past 20 years and had also played with the Gresham Senior Orchestra. She married Victor R. Wynkoop in 1948.

Both she and Victor were active members of Oregon Agate and Mineral Society and Geological Society of the Oregon Country.

Survivors include her husband Victor, daughters Leslie Voight of Florence and Shelley Pennington of Tigard, son Michael Coates of Tigard; several grandchildren and great-grandchildren.

Press release from the Oregon Department of Geology & Mineral Industries

New State Geologist to Guide Oregon Activities

Earthquakes, Ecosystems, Landslides, Floods, Tsunamies, Volcanic eruptions.

Oregon's new chief geologist wants to provide information Oregonians need about these events and process. "It's simple," says Dr. John Beaulieu, "the more we know about areas at risk and the mechanisms of these geologic processes, the safer we can be and the better managers we can be of natural systems."

Beaulieu also wants to provide more and better information aimed at other problems in Oregon's future including ground water supply, watershed health, and resource development.

Beaulieu is uniquely qualified to be the new State Geologist and director of the state's Geology and Mineral Industries Department. Since becoming Deputy Director in 1977, he has helped fashion the department's current programs, but knows where he'd like to make a few changes. "We're the people who gather the information. We need to make sure that local governments, other state agencies, businesses, volunteer assistance organizations like the Red Cross, and everybody else has the balanced information they need to solve geology related problems in Oregon. That should result in keeping Oregonians reasonably safe."

Years of researching Oregon's geology, lobbying the Legislature, working with other state and federal agencies, and developing the current staff give him the tools he needs to be effective. "Twenty years ago we didn't really appreciate how geologically active Oregon was; we didn't know, for example, that part of Oregon was at risk of a magnitude 9 earthquake. Now that we know it's a huge potential problem, we're able to work with a variety of public and private organizations to get ready for it.

"The purposes of the department are clear," says Beaulieu. "We're the centralized source of geology information for Oregon that people need to make wise decisions. In addition, we are expected to provide informed and creative regulation and voluntary problem-solving for earth resources, like aggregate and natural gas."

With a world class reputation, and dozens of maps and research papers bearing his name, Beaulieu has been invited to speak at conferences in Paris, Kobe, and Cyprus as well as various places in the United States. He is one of the authors of a recent United Nations publication describing the use of geologic data to prepare for earthquakes.

Much of his earlier research has involved landslides, an especially important topic to Oregonians these days. "We're building in riskier places in much higher densities than we ever have before. Put that together with wetter winters than we're used to, and a lot of places are seeing landslides," he explains. "Unfortunately, the loss of an entire neighborhood to a landslide as in places like Kelso, has happened in the past in Oregon and could happen again."

Along with developing applied geologic information and partnering to reduce the risk from natural hazards, Beaulieu will guide regulatory functions in mining and energy resources. "We have an exceptional staff here; that's one of the great benefits of this job. For example, one of our staff members was named the Best Reclamationist in the nation a couple of years ago. With the level of commitment and creativity of the staff, we will continue to improve our research and application of geologic information in serving Oregonians."

Family life is also important to Beaulieu. He and Kathy, his wife for 32 years, have raised three sons: Mike, Pat, and Matt. "You're a better worker and a better person when you have a challenging job and a rewarding life outside the office. I'm fortunate to have both," he said.

Beaulieu became State Geologist on August 1.

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Evelyn Pratt, 503-223-2601

VOL. 65, No. 10
OCTOBER 1999

OCTOBER ACTIVITIES

Fri. Oct. 1, 12-1:30 PM: The Roadside Geology of Oregon Past President Don Barr.
Central Library, 801 SW 10th St.

Fri. Oct. 8, 8:00 PM: Meteorites and the Early Solar System O. Richard Norton.
author, astronomy instructor at Cent. OR Comm. Coll., pres. of Science Graphics
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

Wed. Oct. 20, 8:00 PM: Second seminar Life's Travel Through Time, led by E. Pratt
2. Arguments for & against the most widely-held speculations on how life began - "warm soup?" Mars? intergalactic space? clay? "black smokers?" or?
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

FIELD TRIP: Sat. Oct. 9 Trip to Trout Lake Ice Caves will feature a natural bridge, ice pool, Crystal Grotto, slide, twin lava tubes, & more. For departure time and meeting place call Taylor Hunt, 503-662-4790.

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PREVIEW OF COMING ATTRACTIONS:
Fri. Nov. 5, 1:30-3:00 PM Diamond Craters - A Volcanic Gem Evelyn Pratt, past pres.
Central Library, 801 SW 10th St.
Fri. Nov. 12, 8:00 PM: Dry Valleys of Antarctica presented by Andrew Fountain, PSU
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway
Seminars resume in ***January*** with Oxygen, Sex, and the Single Cell, led by E. Pratt
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

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Calendar items must be received by 15TH of preceding month. Evelyn at 503-223-2601; ralf70@aol.com

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This month's speaker, O. Richard Norton, will have his book, ***Rocks from Space***, for sale after the meeting and those wishing to purchase it must pay by check. The Montana press (www.montana.com/mtnpress/) description of the book is as follows: ***Rocks from Space: Meteorites and Meteorite Hunters***, second edition, O. Richard Norton, Mountain Press Publishing Company, Inc., ISBN 0-87842-373-7, (paperback) $30.00

RAFTING - AND GEOLOGIZING - ON THE KLICKITAT RIVER

6/5/99 E. Pratt

The short but scenic Klickitat River runs along the dry east side of the southern Washington Cascades, between high rolling hills and steep cliffs. It empties into the Columbia at the town of Lyle, directly across river from Oregon's Tom McCall State Park. My friend Fran and I signed up to raft down the Klickitat during the first week in June.

This has not been one of the Northwest's drier years. Predictably, cold mist and rain followed us as we drove up the Gorge, but gave way to fitful sunshine at Lyle. The meeting place turned out to be a long way from Lyle - winding 20 or 30 miles upriver from the town of Klickitat, climbing up onto a plateau, then dropping back down through andesite, basalt, and landslide slopes to the river by Leidl Bridge. The write-up about driving time was a bit inaccurate (2 hours to go 130 miles!?!), and we nearly creamed a wild turkey on our way up.

At the campground we donned wet suits, climbed into a couple of vans, and left around 10 AM. We were taken 16 miles upriver, mostly on dirt roads in the Klickitat Wildlife Area, to the put-in spot. I figured later that it was in the Goat Rocks Wilderness Area, east of Mt. Adams and a few miles north of Glenwood.

The Klickitat River was full of snowmelt from Mt. Adams glaciers and Goat Rocks snowdrifts. The water was running at 3600 cfs (cubic feet per second), which is a lot for a river this size. There's just a small window of time in late spring and early summer when rivers such as the Klickitat are raftable. High water had postponed a trip two weeks earlier, so we had a good-sized group of 35 on five rafts. The wet suits were for warmth, and we were issued helmets and life jackets for safety.

Dave McCann, owner of Northwest River Guides, steered our raft and told us six paddlers when to do what. We sat with one buttock on the raft gunwale and one on a rubber "bolster seat" with our toes tucked under the bolster in front of us. Dave has guided for 15 years, and knows the locations of all the rocks, holes, and strainers (low hanging trees that strain folks out of the raft). He had us paddling just enough to steer between them and the banks and into the most exciting standing waves in this rather narrow river.

We started with two men in front, two women in the middle, Fran and me in back, and Dave behind us on the stern, using his oar as a rudder. In rafting, the front two paddlers set the pace. The men had never paddled a raft, and had a few first-timer challenges. One woman was quite experienced, but this was her 20-something daughter's first time.

The upper river was very scenic, with curves, fir trees leaning out over the water, cut-into banks, and high cliffs. Lupines and balsamroot were blooming, and once a gray stub-tailed dipper flew upstream inches above the water.

Soon after launching we stopped at the point of a mid-river gravel bar between two big logjams. This was where we were to portage over the bar and put in farther downstream. All five rafts were to land on one small point of gravel, and each had to be carried forward so the next could land. The last one almost missed. For a minute or two it looked as though raft and crew would be hurled right down into the logs. Paddlers jumped into the shallow water or were dragged out and a bunch of us grabbed the side strap of the nearly runaway raft and pulled it in.

For the first few miles we ran into - almost literally, at one spot! - magnificent light-tan (where fresh) slanted columns, mostly on the east side of the river, topped by blocky and platy entablatures. According to the SW Washington geology map, these 2- or 3-story-high columns are most likely Mt. Adams andesite lava, 200,000 years old or so. Mt. Adams is probably less than 20-odd miles from where we put in.

The most thrilling ride of the day was a wild 3-mile roller coaster called Christmas Rapids. Everyone got soaked on that one! I suspect, from the straightness of the channel, that the river follows a fault line here. Afterwards Fran and I changed places with the two men. Up to then the wet suits had kept us warm. But in front we really caught the waves, and a couple of times we were drenched from head to toe. Dave said that because of the high water the river would probably be raftable later in the year than usual.

At one place he pointed out a lovely Ramona-Falls-type waterfall tumbling down over the rocks. Near here we passed Indian Ford Springs, where dozens of seeps, which seemed to originate from the toe of a very large landslide, trickled down over mossy boulders into the river.

Near the Klickitat Fish Hatchery dozens of small gulls were circling and landing on the water. We guessed that schools of tiny fish were providing them with lunch. And three vultures circled right over our heads. On a rafting trip that can make one a bit nervous - what do they know about the river that we don't?

Watching the birds made us aware that lunchtime had come and gone. Shortly before 2:00 we saw high rounded lumps and spires of 16-17 million year old Grande Ronde basalt, very similar to that at Cape Horn on the Columbia, rising above the river's east bank. We took out on the west side around 2:00. One outcrop across from there was practically a needle.

By then I was shivering so violently I couldn't make a sandwich. After Fran put one together for me I still shook hard enough that bits of lettuce and tomato flew hither and yon. Another woman had the same problem. But after eating lunch and lying on the grass in the sunshine we all felt a lot better. Thank goodness there was no poison oak!

Back in the rafts the other two women switched seats with us. I saw dogwood, cow parsnip, and osier pass by, but even though the water was not as wild as it had been farther upstream, the raft traveled fast enough to make other spots of color unidentifiable. Farther downstream Doug firs on the hillsides gave way to oak groves and dry slopes.

We reached takeout around 3. Modesty was thrown to the winds as everyone hurried to strip off wet clothes. Fran's daughter-in-law had offered us a substitute trip - we could stand in her back yard and she'd squirt icy water from the hose on us for a while, then we could pop into their hot tub and be served lunch. Coming downstream we did think about that offer a couple of times. 'Twas a great trip, but next time we'll opt for a warmer river!

HIGHLIGHT: Remember the GSOC Library is located in Room S7, Cramer Hall, PSU and is open from 7:30 to 8:00 just prior to Friday evening programs. You are welcome to browse.

Completely Fractured Geology from Southeast Oregon President's Trip

Definitions 1-5 by Carol Hasenberg; definitions 6-10 by Fran Pearson

1. **plagioclase:** a group of students who cheat on their writing assignments
2. **spatter wall:** what's next to my kitchen stove
3. **pahoehoe:** what Dad does in the garden-garden
4. **vesicle:** frozen blood conduit
5. **plug dome:** a group of geologists sharing a common restroom for more than two days
6. **sinter:** the middle of a circle
7. **foliation:** what deciduous trees do in the spring
8. **tholeiitic:** having to do with a religious credo
9. **solifluction:** a respectful bow or curtsey made in the direction of the sun
10. **thermophilic:** term used to describe the middle layer of Phil's heavy winter underwear

Notes from the Friday evening program, September 10th :

Rice Northwest Museum of Rocks and Minerals

Sharleen Harvey presented the history and collection of the Rice Northwest Museum of Rocks and Minerals at the Friday evening program on September 10th. She showed many beautiful slides depicting some of the treasures of the collections and described the history of the acquisitions. Helen and Richard Rice, parents of Sharleen Harvey, acquired their collection over a lifetime. At the time of their death, the process of becoming a non-profit foundation was already in the works. It was this tax-exempt status that allowed the family to preserve the collection and create the museum. In the last year, the museum inherited the collection of the late Ruth H. Keen.

The museum is located west of Portland, off Highway 26 West, Exit 61 North, then the first turn west onto Groveland Drive. The museum is at 26385 NW Groveland Drive. The website is at www.ricenwmuseum.org. The museum building was originally the Rice's home built of timber from the site and of Arizona flagstone (Coconino sandstone). The sandstone was selected personally by Mr. Rice and shipped up to Portland by train. The display of the exhibits is primarily in the basement of the house. A new gallery has been opened upstairs in one of the former bedrooms. Other rooms are available as meeting rooms for small groups. The grounds are available for weddings in a beautiful setting.

Part of the story of how the collections both grew and came together is the friendship between Al Keen and the Rice's. When the Rice's would return with a new group of specimens, Al Keen would be given the chance to buy some of them. In many particulars the collections resemble each other due to this. Al later in life married Ruth and so the four became good friends sharing a strong interest in minerals and collecting.

Sharleen shared slides of some of the most spectacular pieces. Just to list a few: 1) a slide of her father collecting palm stumps in the 1950's in Smithville, Texas, 2) an Oregon thunderegg which is in the Northwest Gallery, a display of specimens from Oregon up to Alaska, 3) aragonite pseudomorphed to quartz with calcite, 4) an Antelope Creek geode, 5) petrified wood displaying a green color unique to Hampton Butte area of Oregon, 6) Uranium ore from Spokane area, 7) a sample of chrysocolla covered by drusy quartz, 8) fluorite from Illinois, 9) a malachite from Zaire (polished by Mr. Rice), 10) Malachite pseudomorph after azurite, 11) stibnite from Japan (the Keen collection also contains a stibnite encased with quartz and is lustrous), 12) sulfur from Sicily, 13) a 104 pound quartz from Brazil showing several generations of growth with a limonite inclusion, 14) a Sperrylite that has been shown on the cover of *Mineralogic Record* and is the finest specimen of Sperrylite in the world.

Sharleen told the story of Ruth Keen's decision to leave her collection to the museum. The museum is fortunate to have the vast collection with no strings attached.

Ice Age Floods Institute

The National Park Service is attempting to create a "trail" for the public to follow the evidence of ice age floods. The service has contracted with a company to find the most appropriate sites and develop information regarding such sites. Reed Jarvis from this company has contacted Carol Hassenberg and Ray Crowe about how GSOC can be involved in this project. Further information about the project can be seen at the website: www.uidaho.edu/igs/iafi/iafihome.html. If you want to know more about being involved talk to Ray Crowe, vice president of GSOC, 640-6581. To contact Mr. Jarvis, write the Ice Age Alternatives Study, c/o Jones & Jones, 105 South Main Street, Seattle, WA 98104-2578.

Correct definitions for COMPLETELY FRACTURED GEOLOGY, adapted from AGI Dictionary of Geological Terms, 3rd Ed., Bates & Jackson, by E. Pratt

1. **plagioclase:** refers to a group of feldspars with a fairly high percentage of sodium and/or calcium in them; among the most common rock-forming minerals
2. **spatter wall:** side of a fissure, formed as small soft globs of molten basalt erupted a short distance and fell back down [from Ellen Benedict's Guide to Diamond Craters]
3. **pahoehoe:** basaltic lava flow with smooth, billowy, or ropy surface
4. **vesicle:** a small cavity in an extrusive igneous rock, formed by the expansion of a bubble of gas or steam when the rock was hardening
5. **plug dome:** a circular volcanic uplift in which an upheaved, hardened mass has filled the original conduit
6. **sinter [siliceous]:** the lightweight porous opaline variety of silica, white or nearly white, deposited as crusty material by precipitation from hot springs or geysers
7. **foliation:** the structure that results from flattening the grains of a metamorphic rock
8. **tholeiitic:** refers to a basalt rock that has one or more pyroxene minerals in it
9. **solifluction:** the slow downhill motion of waterlogged soil, especially in areas which are frozen underneath
10. **thermophilic:** refers to bacteria and other living things that grow best in a warm environment

MEMBERS – HAVE YOU TRAVELED LATELY OR HAVE A SPECIAL GEOLOGICAL INTEREST? DO YOU HAVE OR ARE YOU WILLING TO PUT TOGETHER A SLIDE SHOW OR TALK? WE WOULD ENJOY HEARING ABOUT YOUR INTERESTS OR YOUR TRAVELS DURING THE NOON PROGRAM AT THE LIBRARY. FOR FURTHER INFORMATION CALL CECELIA CRATER AT 503-235-5158.

Central Oregon's Lavalands Part 1 by Taylor Hunt, Field Trip Leader

May 22 and 23 Field Trip to Central Oregon's Lavalands

Eight members met at the Salem waterfront at 9:00 AM to carpool. Our goal was the Newberry National Volcanic Monument. Why? Because Newberry Volcano is one of the largest shield volcanos in the lower 48 states. Covering over 500 square miles, the area was named after J. S. Newberry, a scientist attached to the 1853 railroad survey party. The complex geologic history of the volcano suggests that it has been formed over the last million years. Several types of eruptions have contributed to Newberry's great size; passive flows of basalt magma are found interlayered with explosive rhyolite eruption deposits.

The volcano's summit contains a seventeen square mile caldera, formed as the top of the volcano collapsed when the magma chamber beneath the volcano emptied out. The caldera, also referred to as Newberry Crater, may have once contained one deep lake, much like Crater Lake. However, more recent eruptions have divided the crater into two crystal clear lakes, Pauline Lake and East Lake, separated by pumice, ash and lava flows. Paulina Peak, the highest point in the monument, stands at 7,984 feet on the edge of the crater rim, and offers a stunning view of the caldera and the surrounding geologic landscape of central Oregon.

The flanks of Newberry are dotted with over 400 cinder cones, also called parasite cones. Many such cones are found along the northwest rift zone, a line of fissures running from Newberry to Lava Butte.

The last major caldera-forming eruption probably occurred about 2000,000 YBP. Since then, the caldera floor has gradually been filled with ash, pumice and lava. Found within the caldera, the Big Obsidian Flow formed 1300 YBP making it the youngest geologic feature in central Oregon.

Obsidian is a natural volcanic glass remarkably similar to the glass in your windows. It is not made of crystals as other rocks are, but has the disordered internal structure of a liquid. When lava is especially rich in silica (SiO2), it has the stiff consistency of taffy. This is because the silicon (Si) and the oxygen (O) atoms stick together, forming a three-dimensional "web" that hinders movement inside the liquid. Because the lava cools fairly quickly above ground, it hardens to rock before its atoms have time to move about and organize themselves into the symmetrical closely packed structures of crystals.

Native Americans have populated the area almost continuously for the last ten thousand years and have fashioned knives, arrowheads and other sharp tools from obsidian. The high quality obsidian from Newberry Crater was traded through out the Northwest. Because obsidian blades are sharper than steel, they cause little scarring. Some doctors use them today for delicate operations such as eye surgery.

Based on geophysical and geological evidence, a magma changer of molten rock probably lies 2 to 3 miles below the floor of the crater. Fissures containing a series of vents extended almost seven miles in a northwesterly direction. This line of weakness in the earth' crust originates at East Lake in the caldera of Newberry Volcano. Fissures should not be confused with cooling cracks that are clearly visible. Part way down the mountain, Lava Cast Forest was created from these fissures. This area over 6000 YBP looked very similar to what we see today. The northwest fissure zone erupted along a series of pahoehoe lava onto the surface through many vents located along this fissure zone. Lava surged through the ancient forest, engulfing everything it encountered. The area preserved by the USDA Forest Service envelops an area of approximately five square miles. Here you can see that a major lava flow moved a clump of trees into a jumbled pattern. Lava, reheated by the burning trees, dribbled into the space between the original mold and charred wood. This pattern is often mistaken for bark impressions. Liquid pahoehoe lava poured out of a series of vents beyond the tree line. Supply exceeded drainage, and a large lake formed. As the eruption subsided downflow drainage occurred, decreasing the lake depth to 10-15 feet. When lava surged through the stands of pines, some trees were pushed over by its force. Trees that were snapped off were carried away. Others remained, anchored by their roots. Horizontal molds show this now. In one area 3 trees came from a single base stump and the holes join at the base. Proof that two trees once grew together remains in the half-molds. Generally the open side faces downhill and indicates lava flow direction. The holes extend 10-15 feet under the lava into soil which once supported the vanished forest. Tree molds were formed as lava spilled through the pine forest, flowing against the upstream side of the tree trunks. Lava cast Forest derives its name from the concentration of these features. A more accurate explanation, however, defines a cast as having filled a mold, while a mold is formed around an object such as a tree.

Unfortunately all these areas were covered by a record snow pack, which raised river levels and much drainage along the road to eastern Oregon. Our first stop was a large gravel bar in the Idenha River, where we collected agates, igneous intrusive and extrusive rock along with some metamorphic rock which showed us the diversity in this growing mountain chain. Our second stop was for lunch at Powell Butte, where we picked up a potential new member, Constance Albrecht, who really helped us out by getting the permit and key for Lavacicle Cave for our Sunday excursion (more on this later).

Our next stop on Saturday was at Lava Butte and the visitor center, with a very knowledgeable guide named Andy. Lava Butte formed 7000 YBP when highly gas-charged magmas erupted along a zone of weakness, the northwest rift zone. Cinders and Ash were thrown high into the air as the first magma reached the surface, much like opening a bottle of soda pop after shaking it. These cinders both red and black are found on Lava Butte, a curiosity noticed by visitors. The first cinders formed during the eruption were black. When they fell to the ground, some landed back in the crater and were hurled out again and again. This repeated exposure to oxygen caused the black cinders to turn read as the cinders oxidized or rusted. These cinders accumulated in a cinder cone, which was shaped by the prevailing southwest winds. As the eruption proceeded the wind carried more cinders to the northeast side of the cone, forming a crater 180 feet deep from the highest side. The Butte, elevation 5000 feet above sea level, is 500 feet higher than the visitor center. After the highly gas-charged lava foam was expelled, liquid lava broke through the thinner south side of the cone, spreading over 5 miles to the north and west. Numerous overlapping flows contributed over 9 square miles of lava before the eruptions ceased. The lava flows dammed the Deschutes River in many places, permanently altering the river's course. A 50 foot dam in the Benham Falls area created a lake which extended south to Sunriver and LaPine and lasted for almost 4000 years. The numerous lava-formed dams are responsible for the many rapids and waterfalls found along the Deschutes.

The volume of rock in the Lava Butte flow is 380 million cubic yards. Assuming a paved road 24 feet wide and 6 inches thick, there is enough rock in this flow to pave 160,000 miles of road, equivalent to a paved road circling the earth 6 ½ times. Only 10% erupted in the form of airborne cinders, while 90% erupted as fluid magma.

The age of the eruption was determined by carbon-14 dating a piece of charcoal found near the edge of the flow. The road to the top was completed in 1933. We also walked along the Trail of the Molten Land and the Trail of the Whispering Pines. These encompassed 1 ¼ miles of paved interpretive trail over lava flows and lava gutters to the Phil Brogan viewpoint, then looped through the cool pine forest along the edge of the lava flow. The Gift Center was well stocked with videos, maps, and books where we took some time to shop.

Our last stop on Saturday was Lava River Cave, Oregon's longest uncollapsed lava tube, 5200 feet long as a main downslope chamber. The upslope tube, running southeast, is 1560 feet long for a total of 6760 feet. The upper area is closed due to loose and dangerous rocks.

Lava tubes are formed in flows of pahoehoe basalt. This type of lava is very fluid and moves readily downslope. Lava tubes are crusted-over channels which conduct lava to the advancing front of the lows. This crusting-over starts near the vent where the lava spews from the earth, then gradually progresses downslope along the lava stream. The crust first is a thin ledge-like protrusion extending inward from the sides of the lava channel. Eventually the ledges meet to form a roof across the channel. The roof gradually thickens as surges of lava break through the roof and spread out as thin layers over the newly formed roof. Additional lava linings to the underside of the roof provide still more support. When the molten river of lava stops, the tube drains leaving the empty tube that we walked through. If it were not for cooling and shrinkage of the lava at the end of the flow and freezing and thawing of winter rains (which dislodge rocks causing the roof to cave in and expose this underground cavern) it would be missed by all.

To be continued

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THE GEOLOGICAL NEWSLETTER

GSOC

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THE GEOLOGICAL NEWSLETTER

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ACTIVITIES:

ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00. **PUBLICATIONS: THE GEOLOGICAL NEWSLETTER (ISSN 02705451),** published monthly and mailed to each member. Subscriptions available to libraries and organizations at $10.00 per year. Individual Subscriptions $13.00 per year. Single Copies: $1.00. Order from:

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Evelyn Pratt, 503-223-2601

VOL. 65, No. 11
NOVEMBER 1999

NOVEMBER ACTIVITIES

Fri. Nov. 5, 1:30-3:00 PM Diamond Craters - A Volcanic Gem Past presidents Clay Kelleher and Evelyn Pratt
Central Library, 801 SW 10th St.

Fri. Nov. 12, 8:00 PM: Dry Valleys of Antarctica presented by Andrew Fountain, PSU
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

FIELD TRIPS will resume in January.

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PREVIEW OF COMING ATTRACTIONS:

Friday Dec. 3, 1-2:30 PM Geology of the Steens Mts. and the Malheur Area
Carol Hasenberg, GSOC President, Central Library, 801 SW 10th St.

Friday Dec. 10, 8:00 PM Missoula Floods Ray Crowe, GSOC Vice President
Rm. 371 Cramer Hall, PSU, 1721 SW Broadway

Seminars resume in ***January*** with Oxygen, Sex, and the Single Cell, led by E. Pratt
Rm. S-17 Cramer Hall, PSU, 1721 SW Broadway

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Calendar items must be received by 15TH of preceding month. Evelyn at 503-223-2601; ralf70@aol.com

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A Journal of the President's Field Trip 1999

The trip to Malheur field station and Steens Mountain and the surrounding area was from September 1st to the 8th. The following are accounts of some of the days' proceedings. The remaining days will be included in next month's newsletter.

President's Trip, Day 1 - Evelyn Pratt

Diamond Craters is deep in the sagebrush of Harney County, about 55 miles SE of Burns. To reach it we left Malheur and drove past the Blitzen River and a lot of reddish rimrock made of 9.7 Ma Devine Canyon Ashflow Tuff.

We followed Ellen Benedict's excellent guide, available free at the BLM office in Hines.

Diamond Craters is a bumpy pancake only 550' high, with many varied volcanic features in its 22-square mile radius. They were formed when molten basalt spilled out of fissures, then flooded in a thin layer over a relatively dry lake bed. Before this layer cooled completely, more basalt magma intruded underneath, creating six arching structural domes. The area has been dated to 17,000-15,000 years, though Dr. Cummings says some of it may be as young as 4000 years.

At one stop we walked along pressure ridges, peered down into deep ragged fissures, and watched lizards skittering across the pahoehoe. When lava squeezed out low on the flanks of Graben Dome the flows emptied the magma chamber, which led to the collapse of the dome. Most of us hiked up to its graben. This is an impressive trench over a mile long, a quarter of a mile wide, and 100 feet deep, which with two accessory grabens forms a shallow Y.

South Dome is made of four craters; we saw three. Big Bomb Crater is a source of cored bombs - blobs of basalt that shot up a short distance, then rolled back down the crater's slopes, growing pea-size to two feet in diameter as they acquired more layers. Lava Pit Crater, a small shield volcano with pahoehoe, shows features such as mini-tubes and benches, indicating a lava lake which repeatedly filled and drained. Red Bomb Crater formed as hot basalt magma rose through layers saturated with cold ground water from Steens Mt. This water changed to high pressure steam, and blew fine tephra out to form a scoria cone.

West Dome did not collapse or fracture. It holds six maars. A maar is a broad volcanic crater that is formed by steam under pressure, but from which no magma is erupted. Only broken rocks are hurled into the air. East Twin Crater and West Twin Crater are two dry maars a couple of hundred feet wide.

Calm water and lush marsh reeds were a welcome sight at Malheur Maar. According to the pollen record in its 50 feet of sediment, it has contained a small lake for the last 7000 years.

We saw Northeast Dome from a distance. It extruded flows that were cooler and more brittle than the other domes. The top has fissures similar to the crust of cornbread when it cracks. One fissure is 40' deep, 8' wide, and 250' long.

Most of the tephra scattered under and around the nearby sagebrush is from Central Dome. This caldera is a mile long, 2/3 of a mile wide, and more than 200' deep. Ruptured Raven Ridge (named by some cowpoke with imagination?) forms one side of the caldera. The floor has more than 30 vents similar to Red Bomb Crater. Although the group didn't get up to Central Dome, Clay Kelleher returned later and did a lot of observing and picture-taking.

The flank flows from Graben Dome held some of the day's most interesting features, including spatter cones, spatter ramparts, more pahoehoe and a small ex-lava lake. From Diamond Craters we toured Pete French's Round Barn, then headed back to Malheur for a delicious supper. EP

President's Trip Day 3 – Thomas Gordon

Tourmaline! Epidot! Malachite!

We found them all! Though not of gem grade, the samples we picked up were fascinating and the metamorphic zone they were in was spectacular.

On the third day of our field trip, Dr. Michael Cummings of Portland State University led us to a site south of Fields, Oregon, on Highway 205. Four miles north of the Nevada border, we turned right at the Colony Ranch sign onto a dirt road next to Colony Creek.

Driving a few hundred yards, as far as our two vans could safely go, we parked at the base of the Pueblo Mountain. Within a few feet of the vans, close to the creek, we found metamorphic schist with a vein of lime-green epidot with the darker green of malachite. The schist here is chlorite, not biotite. We walked along the creek, going up the steep grade for about one-quarter mile, with the shear zone on the right becoming more exposed. The range here is tilted at 35 degrees; otherwise the metamorphic rocks would be vertical. The zone continued up the mountain side for several hundred yards up to 30 to 40 feet thick in places.

Boudins, sausage-shaped rock segments, formed when the parallel schist broke during later stages of formation. Deformation planes were hard to find in the twisted mass of glittering rock before us. Crennulation, a herring bone pattern in the rock, alternated back and forth in orientation, testifying further to the incredible stresses endured by the rocks here. Super-saturated solutions of water under high pressure, with mineral content varying over time, forced their way through the cracks, leaving epidot, malachite and tourmaline.

There are several theories on how this area formed, according to Dr. Michael Cummings. Once claims this area is where the original continent to east, the North American craton, and the area to the west, island arcs created by a subducting plate being forced under the craton, smashed together some 200 million years ago. This area was far under ground. Some geologists claim this is part of the Idaho suture zone.

But Dr. Cummings said this is only one theory of several and that much more investigation needs to be done in the area before any one theory can be given credence.

Loaded down with samples, we made our way back to the vans, marveling at the beauty of the area and the processes that created it.

President's Trip Day 5 – Beverly Vogt

On Wednesday, September 8, GSOC members Richard Bartels and Beverly Vogt led the GSOCers on a half-day trip to look at Wright's Point and welded ash-flow tuffs, particularly the Rattlesnake Ash-Flow Tuff.

After going north on State Highway 205, the group made its first stop partway up Wright's Point, a 250-foot-high, east-west trending, flat-topped ridge that extends into the Harney Basin. Wright's Point is all that remains of an old river valley covered by two thin eastward-flowing diktytaxitic olivine basalt lava flows about 2.4 million years ago. The source of the flows was somewhere on the broad volcanic highlands west of Wright's Point. After the flows solidified, erosion of the Harney Basin removed the softer surrounding sediments, leaving the lava-protected valley high in the air as a classic example of what geologists call "inverted topography." The GSOC group examined the underlying sediments, consisting of tuffaceous pebble conglomerates, sandstone, and mudstone, with plant rootlets, numerous sedimentary structures, and a tuff bed. A brief stop at the top to look at the basalt also showed quite vividly how much of the surrounding Harney Basin sediments had been removed by erosion. (Reference: 1974, Niem, Alan R., Wright's Point, Harney County, Oregon, An Example of Inverted Topography: Ore Bin, v. 36, no. 3, p. 33-49.)

The group then headed north, going 6.5 miles north of Burns on Highway 395 to a cliff where they could see the Rattlesnake Ash-Flow Tuff, which in this location overlies pale-orange to buff-colored tuffaceous sediments of the Harney Basin. This wonderful outcrop shows all the classic features of a welded ash-flow tuff, starting at the base with a light-colored base-surge deposit of glass shards, then continuing upsection with a nonwelded glass shard and pumice zone, a partially welded zone, a black glassy-looking vitrophyre, and then the thick lithophysal section consisting of a perlitic zone, a zone of spherulites, and a thick vuggy-looking lithophysal section capped by a devititrified tuff. As the Rattlesnake Ash-Flow Tuff is a great cliff-forming unit, the outcrop was very steep, and leader Bart and van driver Shawn Zinsli risked life and limb to collect samples from the section and throw them down onto the side of the highway for the rest of the eagerly waiting GSOC members. (References: 1999, Streck, M.J., Johnson, J.A., and Grunder, A.L., Field Guide to the Rattlesnake Tuff and the High Lava Plains near Burns, Oregon: Oregon Geology, v. 61, no. 3, p. 64-76; and 1981, Walker, G.W., and Nolf, B., High Lava Plains, Brothers Fault Zone to Harney Basin, p. 105-118, in 1981, Johnston D.A., and Donnelly-Nolan, J., eds., Guides to Some Volcanic Terranes in Washington, Idaho, Oregon, and Northern California: US Geological Survey Circular 838, 189 p.)

The group continued north to Idlewild Campground in Malheur National Forest for lunch and then turned around to head back to the field station. There was a brief picture stop at milepost 61 on Highway 395 north of Burns to see where three ash-flow tuffs are exposed on top of each other along the highway: 1) the Devine Canyon Tuff, age 9.68 million years, 2) the Prater Creek Tuff, age 8.48 million years, and 3) the Rattlesnake Tuff, age 7.05 million years. The tuffs form cliffs and are separated by slope-forming tuffaceous sediments.

Once the GSOCers arrived back at the field station, after a brief break, most of them piled back into the vans to head about five miles west to go rockhounding. They arrived back at the field station a few hours later, hot, dusty, happy, and loaded with a variety of pieces of chert and agate. A few others went separate ways, one to Diamond Craters, others to discover more of the wonders of the Harney Basin. Everyone eventually got back safely for another splendid Malheur Field Station dinner, followed by conversation, showers, sample sorting, and other Field Station evening activities.

Open Letter to Members:

"As people gather together to discuss the nature of things they are empowering wisdom." (This must include the PSU Geology headquarters after GSOC lectures.)

Cheers to all who have donated GSOC cookies. Now you know to what goodness you are contributing: nourishment and wisdom!

And many thanks to Rosemary Kenney who nobly continues to fresh freeze the cookie extras.

In appreciation of the GSOC Newsletter staff for their good work also,

Mary Grafton Kirkendall

Central Oregon's Lavalands Part 2 *by Taylor Hunt, Field Trip Leader*

(Part 1 begins in October's newsletter page 61)

We started in the "collapsed corridor", the cave's entrance, hardly more than a hole in the ground. At the mouth the trail drops suddenly over volcanic rocks bridged by stairs, bringing us to the floor of a large cool chamber where winter-born ice stalactites and stalagmites were still present. The piles of volcanic rock fell from the roof and sides slowly each year from the action of ice freezing in the cracks. Very few rocks have dislodged and fallen past here.

Stairs lead upward from the collapsed corridor to the main section of the tunnel and after a short walk we were amazed at the proportions of nature's handiwork. The ceiling reached above us at least 58 feet, and was at least 50 feet wide. Conversations echo in far recesses and voices return as eerie sounds in absolute darkness. I am sure that is why they named it Echo Hall. We also noticed remnants of the ancient stony current clinging to tunnel walls. The lava flowed through the tube with varying currents much as a river has currents. As this came through, the currents left deposits. They appeared as slaggy crusts and as rounded overhanging shelves. In other locations, the walls are etched with lateral markings showing the varying levels of the old volcanic floor. At the end of this hall a 1500-foot marker-post also marks the overhead passage of Hwy 97. The highway was 80 feet above us.

Almost immediately the roof seemed to meet the floor, a real 'low bridge' at only 5 ½ feet high. Here we were able to observe two forms of 'lavacicles'; the hollow cylindrically shaped 'soda straws' formed by escaping gases, and the cone-shaped drip pendants formed by remelted lava dripping from ceilings and walls. The remelting occurred when the lava drained out and hot gases reheated the lining of the cave walls and ceilings. Between the 'lavacicles' the remelting formed a unique shiny and glazed form of lava resembling slumped grey toffee that thinly coats the tube.

As the ceiling rose, we noticed lava shelves extending across the width of the tunnel. Here we found two caves, one on top of the other, intermittently connecting the passage. The lava flowed in both tubes. As the lava level fell, the flow surface again roofed over, forming a second lower and smaller tube within the larger main tube, a 'cave within a cave'.

The last 2000 foot of the cave has a sand floor. Years ago people thought an ancient river flowed through the cave, thus the name Lava River Cave. However the only water to bring in the sandy ash was drop by drop from rain and melting snow, chipping through cracks and openings of the lava flow. The constant dripping of water in one large area has carved a garden of spires and pinnacles. It took hundreds of years to do this and is very delicate and has been fenced off the protect it. Eventually the sand reaches the ceiling and no one knows how much farther the cave goes on past this sand plug.

After exiting the cave, three people headed back to Portland and six of us stayed to meet again on Sunday.

After Sunday breakfast, we headed East. Our first stop was at Dry Canyon, an old river channel that drained the ancient Pleistocene lakes. It must have been quit a site with lots of rapids and white water. The interpretive sign described the finding of sea-run fish bones, indicating the old lakes flowed to the sea with a consistent flow enough for migrating salmon to spawn and make a return trip.

The next stop found us driving across grassy prairie where we paralleled an immense lava flow covered with trees. Apparently the jagged surface holds enough snow to allow Ponderosa pines to flourish where the prairie can only support grasses. The ground was so flat in this area that it was hard to imagine our next stop was a cave.

Firefighting crews first discovered Lavacicle Cave in 1958 when a crew leader noticed a column of clean air rising through the smoke and discovered a small entrance. First named Plot Butte Cave for the Butte directly south of it, but commonly called Pilot Butte Cave, its location was often confused with Pilot Butte on Bend's city limits. It was later renamed Lavacicle for its impressive formations and a gate was put in the entrance to protect its exceptional and fragile nature.

To get the key, a $25 deposit was needed and only 8 people are allowed inside at any one time. Thank you, Constance, for helping me with this timely task. The only entrance (if one could call it that) was through the tiny opening of the gate and a tiny passage down through a maze of large boulders from a collapsed lava flow, so tiny only three of us dared enter. This entrance and passage actually entered the side of the cave instead of the normal hole in the ceiling. We entered about midway with 1802 feet going north and 2429 feet leading south. The cave had a 60 foot maximum width and maximum height of 15 feet. Because of its broad arched shape it would appear a second flow filled this tube about half way up. The post-flow conditions were such that a considerable amount of lava was extruded from the roof. Most of it detached and fell to the floor where it formed 'lava roses' and stalagmites. There were considerable stalactites as drip stone on the ceiling, some as large as 6 inches. Covering many areas of the cave floor was the typical sandy ash and the constantly dripping water has created delicate gardens of spires and pinnacles. Pathways were designated to minimize accidental damage.

The age of the cave was indicated by the very large cracks in the floor and sides and sometimes across the ceiling. Most were so deep we could not see bottom, but sometimes saw water! Apparently early exploration found a considerable amount of water near the north end, a condition not noted since. Also found was a skeleton of a small mammal later identified as a river otter, odd since the nearest body of water is over 25 miles away.

After departing the cave, we split up and 5 of us met again on the way home at Black Butte. Its thought to be the world's largest cinder cone. But as the late Dr Ruth Hops Keen mentioned in her 1982 President Campout handbook, "one could hardly call the huge blocks of basalt or basaltic andesite that are exposed along the road that goes….to the summit "cinders". The butte is 3200 feet high and 4 miles in diameter. No cinder cone is that large." Its location at the south end of the Green Ridge fault escarpment is also the source of the Metolius River. At the northern base several springs emerge as a full-blown river. The source of the springs is a spongy aquifer known as the Black Butte Swamp, located on the southwest side 300 feet higher than the springs, so serves as a hydraulic head that insures a constant flow of the springs. This is a most beautiful area, a must-see on your next trip to the Bend area.

Respectfully submitted.

Taylor Hunt
Field Trip Leader

The End

DEC 99

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THE GEOLOGICAL NEWSLETTER

GSOC

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THE GEOLOGICAL NEWSLETTER

email address: gsoc@teleport.com

ACTIVITIES:

ANNUAL EVENTS: President's Field Trip—Summer or Fall; Picnic—August; Banquet—March; Annual Meeting—February. **FIELD TRIPS:** Usually one per month, by private car, caravan, or chartered bus. **GEOLOGY SEMINAR:** Fourth Wednesday, excluding June, July, August, and holidays, 8:00 p.m., Rm. S17, Cramer Hall, PSU. **GSOC LIBRARY:** Rm. S7, Open 7:30 p.m. prior to meetings. **PROGRAMS:** EVENING: Second Friday Evening each month, 8:00 p.m., Rm. 371, Cramer Hall, PSU, SW Broadway at SW Mill St., Portland, Oregon. NOON: Usually first Friday monthly except June, July, August, and holidays, usually at noon, Multnomah County Library, 801 SW 10th Ave., Portland. Suggest time and date be verified by phone: 235-5158 or 221-0757. **MEMBERSHIP:** per year from January 1. Individual--$20.00, Family--$30.00, Junior (under 18)/Student--$10.00. **PUBLICATIONS: THE GEOLOGICAL NEWSLETTER (ISSN 02705451)** published monthly and mailed to each member. Subscriptions available to libraries and organizations at $10.00 per year. Individual Subscriptions $13.00 per year. Single Copies: $1.00. Order from:

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Earthquake History of Oregon (The following article is taken from the USGS website.)

A strong earthquake in Del Norte County, California, on November 22, 1873, caused chimney damage in many places as far north as Port Orford, Oregon, and east to Jacksonville, California. The tremor was felt from Portland to San Francisco and onboard ships at sea. Chimneys were damaged (intensity VII) in the Portland area from an October 12, 1877, earthquake apparently centered in the Cascade Mountains.

Another severe shock affected Portland on February 3, 1892. Buildings swayed, and terrified people rushed into the street (VI). The earthquake was felt strongly at Astoria and Salem; the total area affected covered about 26,000 square kilometers. Some damage to buildings at Umatilla (VI-VII) resulted from a March 6, 1893, earthquake. Details on this shock are lacking.

On April 2, 1896, three shocks in succession awakened everyone in McMinnville (VI). The main shock was felt at Portland and Salem. A similar occurrence on April 19, 1906, awakened people at Paisley (V). Three additional shocks followed within 1 1/2 hours. A strong earthquake on October 4, 1913, in the Seven Devils Mountains of western Idaho broke windows and dishes (V) in the area. On May 18, 1915, a sharp local earthquake rattled dishes, rocked chairs, and caused some fright (V) at Portland; three shocks were reported.

Three shocks were felt at Fort Klamath (V) on April 14, 1920. The center was probably in the vicinity of Crater Lake. People in a small area around Cascadia felt an earthquake on February 25, 1921 (V). A shock that was probably rather strong in an unsettled region of southern Oregon occurred on January 10, 1923. Plaster fell at Alturas, California, and the tremor was felt strongly (V) at Lakeview, Oregon. The felt area extended to Klamath Falls. Another earthquake was felt widely over a sparsely settled area in eastern Oregon on April 8, 1927. The center was apparently in eastern Baker County; the maximum intensity (V) was noticed at Halfway and Richland.

A damaging earthquake occurred at 11:08 PM PST on July 15, 1936, near the State line between Milton-Freewater, Oregon, and Walla Walla, Washington. The magnitude 5.75 shock affected an area of about 272,000 square kilometers in the two States and adjacent Idaho. Ground cracking was observed about 6.5 kilometers west of Freewater, and there were marked changes in the flow of well water (VII). Many chimneys were damaged at the roof level in Freewater; in addition, plaster was broken, and walls cracked. Similar damage was reported from Umapine. Total damage amounted to $100,000. There were numerous aftershocks up to November 17; more than 20 moderate shocks occurred during the night, and stronger ones were felt (V) on July 18 and August 4 and 27.

A shock of intensity VI affected about 13,000 square kilometers in the vicinity of Portland on December 29, 1941. A downtown display window was shattered, and a few other windows were broken in other parts of Portland. The earthquake was also felt strongly at Hillsboro, Sherwood (where many were frightened), and Yamhill. The felt region extended into Washington; Vancouver and Woodland experienced minor damage.

On April 13, a major earthquake (magnitude 7.0) caused eight deaths and an estimated $25 million damage at Olympia, Washington, and a broad area around the capital city. The depth of focus was estimated to be slightly greater than normal, which, in part, accounted for the large felt area - 388,000 square kilometers in the United States. In Oregon, widespread damage was observed, several injuries occurred at Astoria and Portland. A maximum intensity of VIII was experienced at Clatskanie and Rainier, where many chimneys twisted and fell, and there was considerable damage to brick and masonry.

Minor damage in the Portland area resulted from a December 15, 1953, shock. There was one report of a cracked chimney and slight damage to fireplace tile (VI). Additional reports of plaster cracking were received from Portland and Roy, Oregon, and Vancouver, Washington. The total felt area covered about 7,700 square kilometers.

Similar damage occurred at Salem on November 16, 1957, from an earthquake felt over a land area of 11,600 square kilometers in northwestern Oregon. The tremor frightened all in the city (VI) and caused some cracked plaster in West Salem.

On August 18, 1961, another earthquake caused minor damage at Albany and Lebanon, south of the 1957 center. The magnitude 4.5 shock was felt (VI) by all in the two cities. Two house chimneys were toppled, and plaster cracked. The felt region extended into Cowlitz County, Washington; the total area was about 18,000 square kilometers. Portland experienced another moderately strong shock on November 6, 1961. Slight plaster cracking (VI) was the principal damage reported. Also, part of a chimney fell, and windows and lights broke. The earthquake was felt over a large area (about [illegible],000 square kilometers) of northwestern Oregon and southwestern Washington.

A series of earthquakes near the Oregon-California border began on May 26, 1968, and continued daily through June 11. At Adel, old chimneys fell or were cracked, and part of an old rock cellar wall fell (VI) from a magnitude 4.7 tremor on June 3. Some ground fissures were noted in Bidwell Creek Canyon, near Fort Bidwell, California. The total felt area in the two States covered 18,000 square kilometers.

Numerous other shocks located in California, Idaho, Nevada, Washington, and offshore points affected places i. Oregon. The 1959 Hebgen Lake, Montana, earthquake was also felt in the State; slight damage was reported at Richland.

Abridged from *Earthquake Information Bulletin, Volume 8, Number 3, May-June 1976,* by Carl A. von Hake.

The following are the two strongest earthquakes the second occuring since the article was written:

Time		Latitude	Longitude	----- Magnitude -----------		Intensity
Year Mo Da	hh:mm:ss	(deg.)	(deg.)	USGS	MS	Mercalli
1910 08 05	01:31:36	42.0 N	127.0 W	6.80	MS	Felt
1993 09 21	03:28:55.4	42.314N	122.012W	5.7 5.8 5.9	ML 6.0	VII

Most recent notable earthquake in the Northwest is:

1999 08 31	23:03:7.08 Z	45.1863N	120.0908W	3.5	Mc	

Earthquake Word Search Puzzle – Fun from USGS

Instructions: The words in the puzzle may be hidden horizontally, vertically, diagonally, forward, or backward.

Topic: Tsunami

P	T	Y	G	B	R	T	E	D	A	N	G	E	R	O	U	S	D
W	S	I	E	M	H	E	V	A	W	M	B	D	P	Z	P	E	D
V	U	R	F	K	J	U	E	G	E	O	I	D	O	I	S	E	Z
K	N	N	J	N	A	P	C	T	N	U	S	L	T	T	C	C	Z
W	A	O	K	J	S	U	E	C	L	I	K	I	R	C	I	L	D
O	M	C	S	T	Y	O	Q	T	B	R	N	U	O	F	E	U	H
S	I	E	K	R	R	G	T	H	Q	C	C	R	I	O	T	F	U
P	K	A	I	I	E	K	R	K	T	T	Q	C	A	S	L	R	D
I	C	N	T	H	T	D	O	E	I	R	A	X	A	W	A	E	R
D	F	E	G	X	A	K	I	V	N	P	A	O	Z	B	N	W	O
C	I	K	G	E	W	A	E	T	A	E	C	E	Q	O	D	O	T
L	H	S	P	L	C	E	G	A	M	A	D	X	N	T	S	P	I
Z	Z	E	A	J	D	C	N	S	G	P	L	A	B	K	L	K	N
W	Y	J	L	S	V	Y	S	H	X	U	C	O	O	G	I	V	O
B	Z	B	T	S	T	D	R	K	G	L	C	T	W	Q	D	X	M
I	W	O	W	S	J	E	R	T	O	Z	M	N	L	K	E	P	M
O	Y	F	L	Y	I	Z	R	V	K	Q	V	L	M	V	D	Q	F
K	F	W	D	V	R	V	B	I	N	M	Z	F	F	U	Q	T	E

COAST	DAMAGE	DANGEROUS	DESTRUCTIVE	DISASTER
EARTHQUAKE	ENERGY	LANDSLIDE	METERORITE	MONITOR
OCEAN	PACIFIC	POWERFUL	TSUNAMI	VOLCANO
WARNING	WATER	WAVE		