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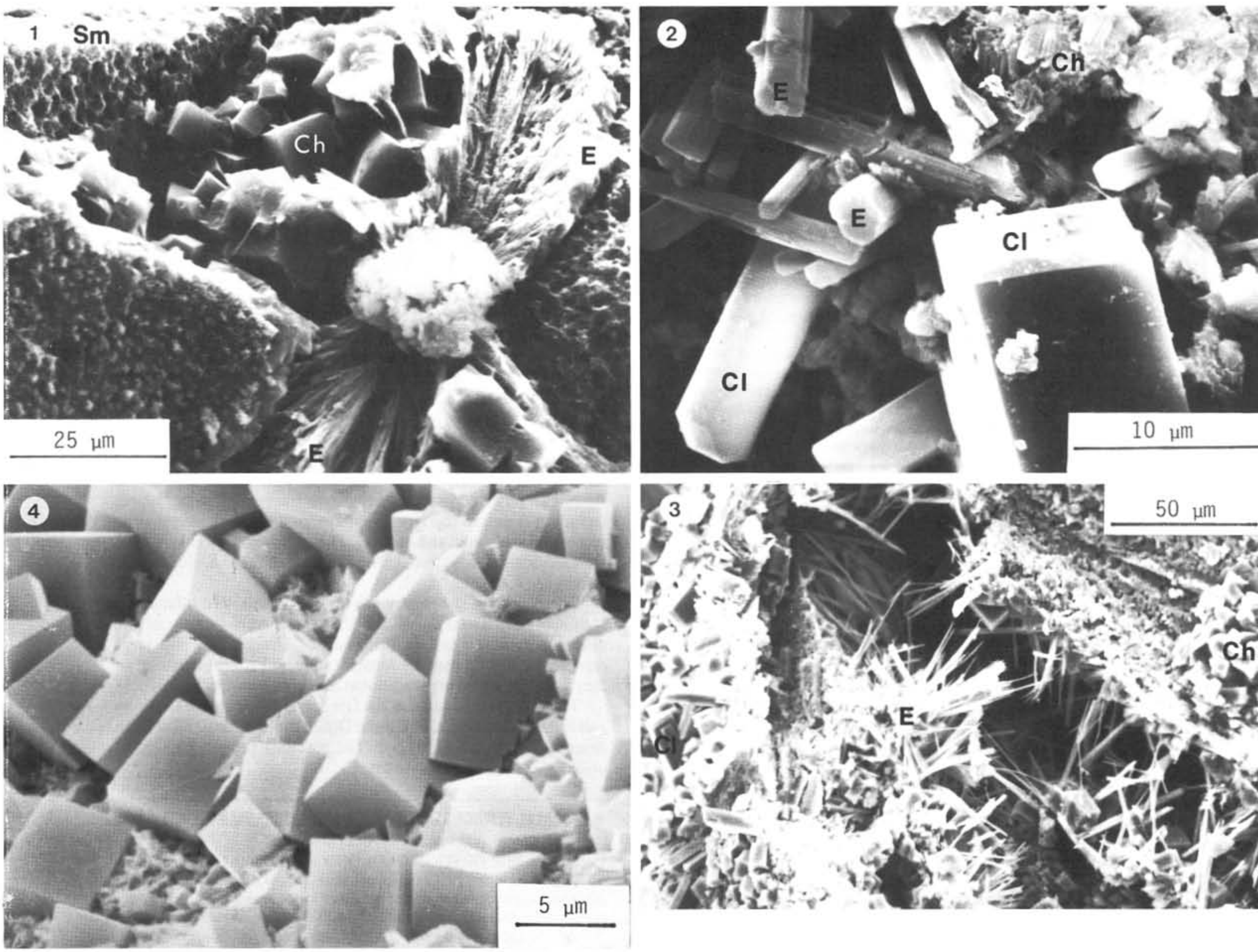

THIS MONTH:

DURKEE ZEOLITE DEPOSIT
SCENES FROM ANCIENT PORTLAND
MINING IN WILDERNESS

OREGON GEOLOGY
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Information for contributors

Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

The style to be followed is generally that of U.S. Geological Survey publications (see the USGS manual *Suggestions to Authors,* 6th ed., 1978). The bibliography should be limited to "References Cited." Authors are responsible for the accuracy of the bibliographic references. Names of reviewers should be included in the "Acknowledgments."

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of DOGAMI.

COVER PHOTOS

Four scanning electron micrographs of specimens from the Durkee zeolite deposit discussed in article beginning on next page. 1. Chabazite and erionite on a clay substrate in a cavity from unit 3GY. 2. Erionite and clinoptilolite from tuff bed at unit 11. 3. Cavity between platy shards preserved by clay coating, from tuff bed at unit 14B. 4. Chabazite rhombs and twinned (0001) rhombs on clay mat from tuff bed at unit 16. Letters on micrographs identify Ch=chabazite, CL=clinoptilolite, E=erionite, SM=smectite.

OIL AND GAS NEWS

ARCO continues Mist drilling program

With two successful wells in the summer, ARCO Oil and Gas Company continues its program of drilling at Mist. The company has drilled three wells since the last producer was completed and has about three more wells planned for 1986.

As reported last month, Cavenham Forest Industries (CFI) 33-9 was drilled to 3,242 ft and was plugged and abandoned. In addition, CFI 41-4 and a redrill 41-4 have been drilled to 2,584 ft and 1,935 ft, respectively, and plugged. Finally, CFI 12-12 was drilled in September to a total depth of 1,862 ft and was also plugged as a dry hole.

CFI 41-9 is the next well on ARCO's 1986 program.

Recent permits

Permit no.	Operator, well, API number	Location	Status, proposed total depth (ft)
377	ARCO Longview Fibre 11-31 009-00214	NW¼ sec. 31 T. 6 N., R. 4 W. Columbia County	Application; 2,300.

□

Survey describes map revision needs in Oregon

The Oregon Department of Geology and Mineral Industries (DOGAMI) has released results of a survey of State agency needs for map revisions. The findings have been published in DOGAMI Open-File Report 0-86-17 under the title *Map Revision Requirements of Oregon State Agencies.* The report was prepared for the State Map Advisory Committee by Glenn W. Ireland, State Resident Cartographer.

The survey addresses the needs of 14 State agencies, all of which coordinate their mapping through the State Map Advisory Committee. It investigates seven major map series used in the state, computerized maps as well as traditional paper maps, including standard topographic maps used for such purposes as recreation, camping, and hunting. The survey was a joint effort of DOGAMI and the National Map Division of the U.S. Geological Survey.

The results of the survey are intended mainly to inform the National Map Division of the U.S. Geological Survey of the mapping requirements in the State of Oregon. The 40-page report will also be used by local, State, and Federal agencies as they jointly plan future traditional and computerized maps.

The report is available at the Oregon Department of Geology and Mineral Industries, 910 State Office Building, 1400 SW Fifth Avenue, Portland, OR 97201. The purchase price is $5. Orders under $50 require prepayment. □

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Beverly F. Vogt, Publications Manager.

Field trip guide to the Durkee zeolite deposit, Durkee, Oregon

by R.A. Sheppard, U.S. Geological Survey, Denver Federal Center; and A.J. Gude, 3rd, U.S. Geological Survey, retired, Lakewood, Colorado

This article is a slightly modified reprint of "Field Trip Stop 1, Durkee Zeolite Deposit, Durkee, Oregon," which originally appeared in *Zeo-Trip '83*, a publication of the International Committee on Natural Zeolites that was used as guide for the organization's field trip held from July 7 to 10, 1983. The book, which was edited by F.A. Mumpton, State University College, Brockport, New York, and prepared by R.A. Sheppard, A.J. Gude, 3rd, and F.A. Mumpton, also contains trip logs to the Sheaville and Rome zeolite deposits in Oregon; the Castle Creek zeolite deposit in Oreana, Idaho; the Lovelock zeolite deposit in Lovelock, Nevada; and the Tahoe-Truckee water reclamation plant in Truckee, California. In addition, there is a section on the discovery and commercial uses of the zeolite deposits described in the book. Upcoming issues of *Oregon Geology* will contain reprints of the trip stops at Sheaville and Rome, both in Oregon. Copies of *Zeo-Trip '83* may be purchased prepaid for $12 from International Committee on Natural Zeolites, c/o Department of Earth Sciences, SUNY, College at Brockport, Brockport, New York 14420. Permission to reprint the Oregon trip stops in *Oregon Geology* is gratefully acknowledged.

— *Editor*

INTRODUCTION

The Durkee zeolite deposit is located about 5 km east of the hamlet of Durkee, Baker County, Oregon, and 145 km northwest of Boise, Idaho. Interstate Highway 84 transects the northwest-trending Durkee Valley, which is drained by the Burnt River and tributary streams. The field trip stop described in this article is in the SE¼ SE¼ sec. 23, T. 11 S., R. 43 E., and is easily accessible by Manning Creek Road from Interstate Exit 328. Figure 1 shows the geologic setting and other geographic features.

Nearly 100 m of zeolitic rocks is exposed at this locality in an amphitheater that has been produced by differential erosion (Figure 2). The steep cliff walls and pinnacles are formed by weathering-resistant zeolitic tuffs. Part of the light-colored lacustrine rocks present in Durkee Valley are visible in the distance from the amphitheater rim. The crudely elliptical area of the lacustrine Durkee basin is about 120 km². Within this area, authigenic zeolites are restricted to an irregular, nearly sinusoidal, 18-km² area in the southeastern part of the basin. Within the mapped area of Figure 1, the topographic relief is about 660 m; the low point on the Burnt River is at an elevation of about 780 m, and the highest point in the northeast corner of the mapped area is about 1,440 m above sea level.

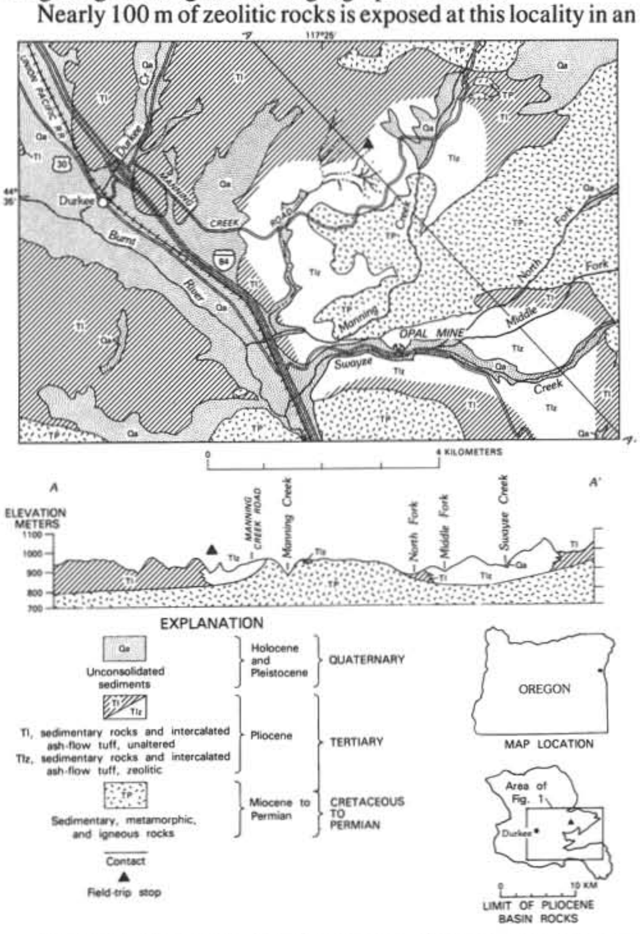


Figure 1. Generalized geologic map of the Durkee, Oregon, area, showing the location of the field trip stop discussed in this paper. Map is modified from Prostka (1967).

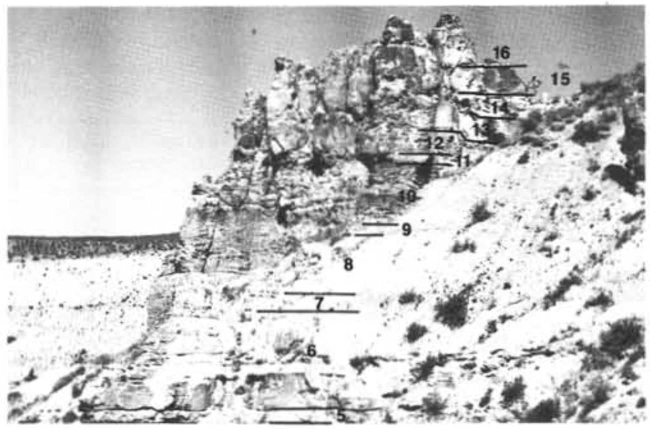


Figure 2. View looking northwest from the southeast rim of the amphitheater at the field trip stop. Person (1.8 m tall) is shown at upper right for scale. The numbers correspond to the lithologic units of Table 1.

Most of the 18-km² area of zeolite-bearing rocks is shown by symbol **Tlz** in Figure 1. A 1.8-km² part of the zeolitic area is beyond the southeast corner of the map. Pre-lacustrine sedimentary, metamorphic, and igneous rocks bound the margins of the larger lake basin. Unconsolidated alluvial and fluvial Holocene (recent) sediments fill most of the stream bottoms and form gravel benches on both the lacustrine formations and the surrounding older rocks. Figure 1 is adapted and modified from Prostka's (1967) geologic map of the Durkee 15-minute quadrangle. An unnamed Pliocene deposit of "tuffaceous lake and stream sediments," shown in Figure 1 by symbol **Tl**, crops out over a 120-km² area. The lake sediments are about 340 m thick and consist of mudstone, siltstone, sandstone, and diatomite with interbedded airfall tuffs and a welded ash-flow tuff near the

Table 1. Mineralogical composition of measured section at field trip Stop 1, Durkee zeolite deposit, Baker County, Oregon.

Unit	Lithology	Thickness (m)	Height above base of unit (m)	X-ray diffraction analysis[1] (in parts of ten) Ch	Cp	Er	Glass	C-T	Pl	Qtz	Sm
(Top of unit 16 not exposed)											
16	Tuff, yellow, coarse shard texture	3.96	2.45	10	-	tr	-	-	-	-	tr
15	Tuff, yellow-gray, pumice fragments as large as 5 cm	2.04	1.00	1	-	-	-	-	-	-	9
14B	Tuff, yellow to white, coarse shard texture	1.68	1.36	10	-	tr	-	-	-	-	-
14A	Tuff, yellow to white, coarse shard texture		0.91	4	tr	1	-	-	-	-	5
13	Tuff, yellow, coarse shard texture	1.68	0.85	7	3	-	-	-	-	-	tr
12	Tuffaceous mudstone, brown	1.40	0.70	tr	-	tr	-	-	-	2	8
11	Tuff, yellow	1.83	0.91	5	4	1	-	-	-	-	-
10	Tuffaceous mudstone, brown	3.81	1.90	tr	1	-	-	-	4	-	5
9	Tuff, yellow, pumice fragments up to 3 cm	0.79	0.40	3	1	-	-	-	2	-	4
8	Tuff, brown, punky, pumice in lower part	4.07	2.04	6	2	-	-	-	-	-	2
7	Tuff, brown, punky	0.70	0.35	2	3	-	-	-	-	-	5
6	Tuff, yellow, pumice fragments up to 1 cm	5.18	2.59	9	1	tr	-	-	-	-	-
5	Tuff, yellow, laminated, resistant	0.52	0.26	10	tr	tr	-	-	-	-	-
4	Mudstone, brown, poorly exposed	17.07	0.91	-	-	-	-	-	-	1	9
3G	Welded tuff, white, altered	1.22	1.20	9	-	tr	-	-	1	-	-
3GX	Welded tuff, gray, fresh		1.00	1	-	1	8	-	-	-	-
3GY	Tuff, altered along joint at GX		1.00	7	-	1	2	-	-	-	-
3F	Welded tuff, gray, platy, glassy	1.22	0.61	-	-	-	10	-	tr	-	-
3E	Welded tuff, gray, blocky fracture	2.44	0.30	-	-	-	-	5	5	-	-
3D	Welded tuff, greenish, blocky fracture	7.62	0.91	-	-	-	-	6	4	-	-
3C	Welded tuff, olive-green, blocky fracture	1.07	0.53	-	-	-	10	-	tr	-	-
3B	Welded tuff, gray, charcoal fragments	3.05	2.75	-	-	-	10	-	-	-	-
3A	Welded tuff, yellow, altered		0.15	-	-	-	-	-	-	-	10
2	Tuff, white, thin-bedded	0.91	0.45	10	-	-	-	-	-	-	-
1	Mudstone, yellow-brown	4.57	3.00	-	1	-	-	-	2	2	5
(base of unit 1 not exposed)											

[1]Ch = chabazite; Cp = clinoptilolite; Er = erionite; C-T = opal C-T; Pl = plagioclase; Qtz = quartz; Sm = smectite (14-Å clay mineral); tr = trace; - = looked for but not found.

bottom of the sequence. The enclosing rocks, shown by symbol **TP**, range in age from Permian to Tertiary. They include "greenschist," gabbro, the Nelson marble (which is being quarried southwest of Interstate Highway 84 near the southeast corner of the mapped area of Figure 1), quartz diorite, and patches of basalt of the Columbia River Basalt Group.

Small-scale faults, probably associated with a northwest-trending set of normal faults on Prostka's map (1967), have offset the tuff units visible in the amphitheater (Figure 2). One such fault has displaced the beds in the southwestern wall of the amphitheater. Similar displacement is found throughout the basin and makes mapping and correlation of the tuff units nearly impossible, except where the welded tuff is in an undisturbed sequence. In their report on the geology of the Oregon part of the Baker 1°x2° quadrangle, Brooks and others (1976) postulated that "The source of the ash ... may relate to the eruption of large volumes of silicic ash from vents in Harney Basin during Pliocene time." Harney Basin is 225 km southwest of Durkee.

The original discovery of erionite was made at the Opal Mine, along Swayze Creek, in the southeastern portion of Figure 1. A.S. Eakle (1898), a mineralogist at Harvard University, credited E. Porter Emerson for the discovery, but no further information is available on Emerson's identity. More than half a century passed before Staples (1957) relocated the Opal Mine and reexamined the type material (Staples and Gard, 1959). The Opal Mine quarry may have once had some underground workings, but the existing site is a chaotic pile of welded-tuff rubble that has been disturbed by construction of the present road that obliterated much of what may have been a waste dump. Frequent mineral collecting has removed most of the gemmy fire opal and all but tiny fragments of the woolly erionite. Since the original work by Eakle in 1898, the site has deteriorated to such an extent that no "type" erionite can be found in place, and collectible specimens in the form of fragments require hours of search to find.

Sheppard and Gude (1975) visited the Opal Mine quarry in 1970 to collect the type erionite and reported the existence of a lacustrine basin and authigenic minerals, including zeolites, in altered tuffs above and below the welded ash-flow tuff that is present in the mine area. Details on the mineralogy of the Durkee chabazite were given by Gude and Sheppard (1978), and the chemistry of other zeolites and zeolitic tuffs of the region was reported by Sheppard and Gude (1980). The Durkee deposit has not been commercially exploited for zeolites, although several companies have examined the area and prospected the deposit.

STRATIGRAPHY, LITHOLOGY, AND DEPOSITIONAL ENVIRONMENT OF THE BASIN DEPOSITS AT DURKEE

Information on the stratigraphy, lithology, and environments of deposition in the lacustrine basin at Durkee is scant. Prostka (1967) briefly noted the work done prior to his mapping, but since then, the only reported studies of this area have been made by the present authors. A composite, 340-m stratigraphic column through the deepest part of the basin as presented in Gude and

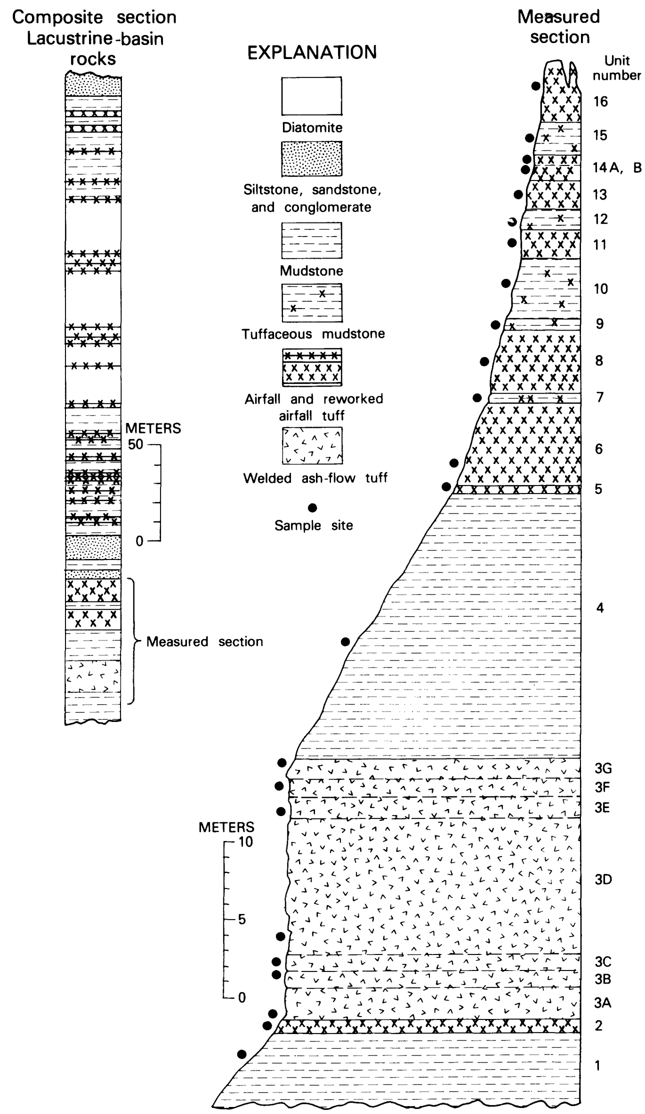


Figure 3. Composite columnar section of the lacustrine rocks in the Durkee basin and profile of the measured section at the field trip stop. The unit numbers correspond to the lithologic units of Table 1.

Sheppard (1978) is shown in Figure 3 along with a profile of the 67-m section measured at the field trip stop. Figure 4 is a view across the basin towards the northeast from a point on old U.S. Highway 30, about 2 km east of Durkee. The amphitheater and its pinnacles are visible on the right (arrow, Figure 4), and the enclosing unaltered rocks are visible in the light-colored hills in the middle of the photo. The cross section shown in Figure 1 along A-A′ depicts the possible subsurface relationships across the middle of the basin from northwest to southeast.

Figure 4. Panoramic view toward the northeast from a point about 1 km southeast of Durkee on U.S. Highway 30, showing the lacustrine beds exposed at the head of Durkee Creek and in the amphitheater at the field trip stop. Arrow indicates the amphitheater and pinnacles shown in Figure 2.

The composite columnar section contains about 45 percent mudstone, 35 percent diatomite, 15 percent volcaniclastic rocks (10 percent airfall tuffs, 5 percent welded ash-flow tuff), and 5 percent sandstone, siltstone, and conglomerate. At least 32 distinct tuff units are shown in Figure 3, including the welded ash-flow tuff. Scattered remnants of Mazama ash are present in perched channels in the Holocene basin-fill alluvium. This widespread ash layer originated from the great eruption of Mount Mazama at the site of present Crater Lake, Oregon, about 6,600 years ago. Basalt, older than the lacustrine rocks, occurs just below the lake beds in thin irregular flows and patches at several places across the basin. One such patch is visible across Manning Creek Road adjacent to the study area.

The 18-km^2 area of zeolitic alteration of the tuffaceous rocks denotes a closed soda-lake environment such as those described by Sheppard and Gude (1968, 1969, 1973) and Surdam and Eugster (1976). Siliceous, vitric volcaniclastic material deposited in the highly alkaline, saline water reacted during low-temperature, low-pressure diagenesis to form zeolites and associated authigenic silicate minerals. In the rest of the basin, the lake remained fresh or brackish from stream water entering from the surrounding terrain. Thus, the equivalent tuff units beyond the saline, alkaline-lake part of the basin are unaltered and still glassy.

During the ongoing history of the Durkee basin in early Pliocene time (2 to 5 million years before the present [m.y. B.P.]), the lake never again became a closed, soda-lake system. The environment was favorable for flourishing diatom growth as preserved in the thick diatomite units shown in Figures 3 and 4. Many thin, unaltered tuffs are interbedded in the diatomite.

MINERALOGY AND CHEMISTRY OF THE ZEOLITIC TUFFS

Chabazite, clinoptilolite, and erionite are present in the tuffs and tuffaceous rocks in the 67-m measured stratigraphic section (Figure 3), except in the massive, glassy, welded ash-flow tuff. No zeolites were found in the 17-m thick mudstone (unit 4) above the welded tuff. The measured section is in the bottom quarter of the complete lacustrine sequence. The base of the section and of the mudstone (unit 1) is not exposed in this location. Evidence from other localities in the basin, however, indicates that the welded tuff is less than 5-7 m above the bottom of the lake basin.

The mineralogy determined by X-ray powder diffraction (XRD) analysis of bulk samples is given in Table 1. About 10 percent of the measured section is comprised of nearly monomineralic beds of chabazite. Chabazite mixed with minor amounts of erionite, clinoptilolite, and detrital minerals is present in another 20 percent of the section. Glassy, unaltered, welded ash-flow tuff makes up about 23 percent, and mudstone and tuffaceous mudstone account for the remaining 45-47 percent. Gude and Sheppard (1978) estimated that several million tons of chabazite may be present in the Durkee basin.

Although chabazite is the predominant zeolite in the immediate area of this stop, several resistant tuff beds of nearly pure erionite occur stratigraphically higher elsewhere in the basin. Most of these tuffs are 25-35 cm thick, but beds of mixed mineralogy up to 1 m thick also occur. Clinoptilolite has rarely been found in monomineralic beds, except in thin units less than 5 cm thick. Analcime and potassium feldspar have been found at sites away from the stop; for example, analcime-rich tuff crops out in the cut for Manning Creek Road, near the letter "R" of "ROAD" in Figure 1. Correlation of tuffs containing analcime and potassium feldspar with units in the measured section has not been established.

Table 2. Chemical analyses of selected silicic glass and siliceous chabazite, Durkee, Oregon.

	Glass[1,2] 1	2	Chabazite[3,4] 3	4
SiO_2	73.35	71.67	57.91	58.65
Al_2O_3	12.31	11.78	14.25	13.51
Fe_2O_3	1.06	0.71	0.42	0.61
FeO	0.81	1.24	0.02	0.00
MgO	0.08	0.19	0.40	1.27
CaO	0.48	0.81	3.85	3.78
K_2O	3.73	5.04	1.33	1.76
Na_2O	3.83	2.21	2.46	0.77
TiO_2	0.14	0.38	0.15	0.02
P_2O_5	0.01	0.03	0.03	0.01
MnO_2	0.04	0.04	0.01	0.00
CO_2	-	-	0.04	0.02
H_2O+	3.43	5.42	10.58	11.77
H_2O-	0.57	0.17	7.80	7.19
Total	99.84	99.69	99.25	99.36

[1]Bulk sample of welded ash-flow tuff collected from unit 3B at field trip Stop 1. Conventional rock analysis by E. M. Brandt, U.S. Geological Survey, Denver, Colorado.
[2]Separate of platy, bubble-wall glass shards from fresh vitric tuff collected 0.5 km northwest of field trip Stop 1. Conventional rock analysis by E. M. Brandt, U.S. Geological Survey, Denver, Colorado.
[3]Separate of chabazite from unit 2, field trip Stop 1 (from Gude and Sheppard, 1978).
[4]Separate of chabazite from unit 16, field trip Stop 1 (from Gude and Sheppard, 1978).

Table 2 shows chemical analyses of two chabazites and two fresh glasses. The chabazites were collected from units 2 and 16 in the measured section, and the welded-tuff specimen was taken from unit 3B. An airfall tuff from a site about 0.5 km northwest of the field trip stop is a typical platy, bubble-wall vitric tuff, with a

*(Continued on page 132, **Field trip**)*

SCENES FROM ANCIENT PORTLAND

Sketches of major events in the city's geologic history

by Larry G. Hanson, Department of Geology, Portland State University, P.O. Box 751, Portland, Oregon 97207

INTRODUCTION

The landscape of Portland owes much of its form to three major episodes of geologic events during the last few millions of years. The sketches attempt to go beyond conventional geologic description to portray these events as they might have appeared during those momentous times.

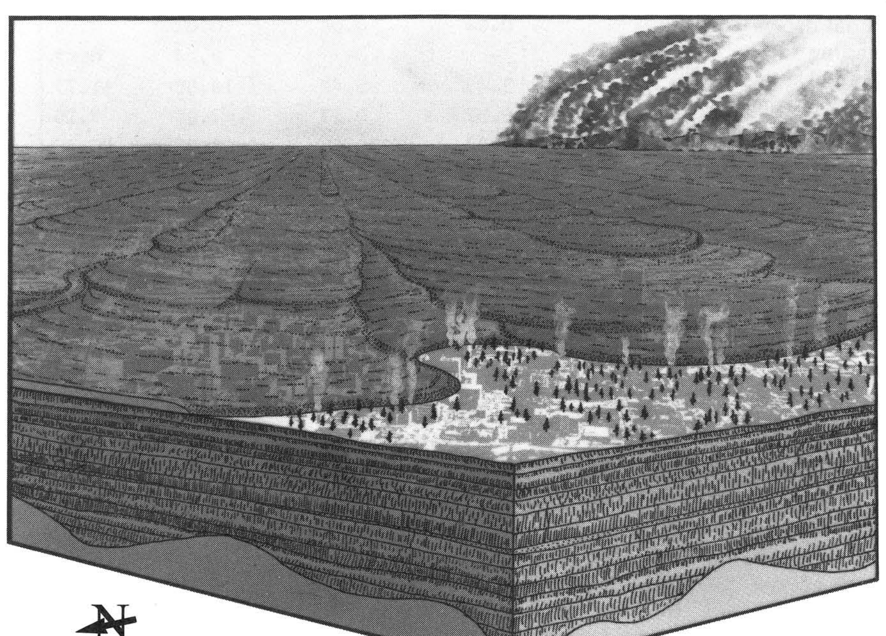
In each view, the drawing of the geologic event is superimposed on a photograph of the modern city to lend scale and relate the event to the present (in a "before/after" fashion). In the two older scenes, the modern city is intended to appear as a "ghost" of the future relative to the land-shaping event.

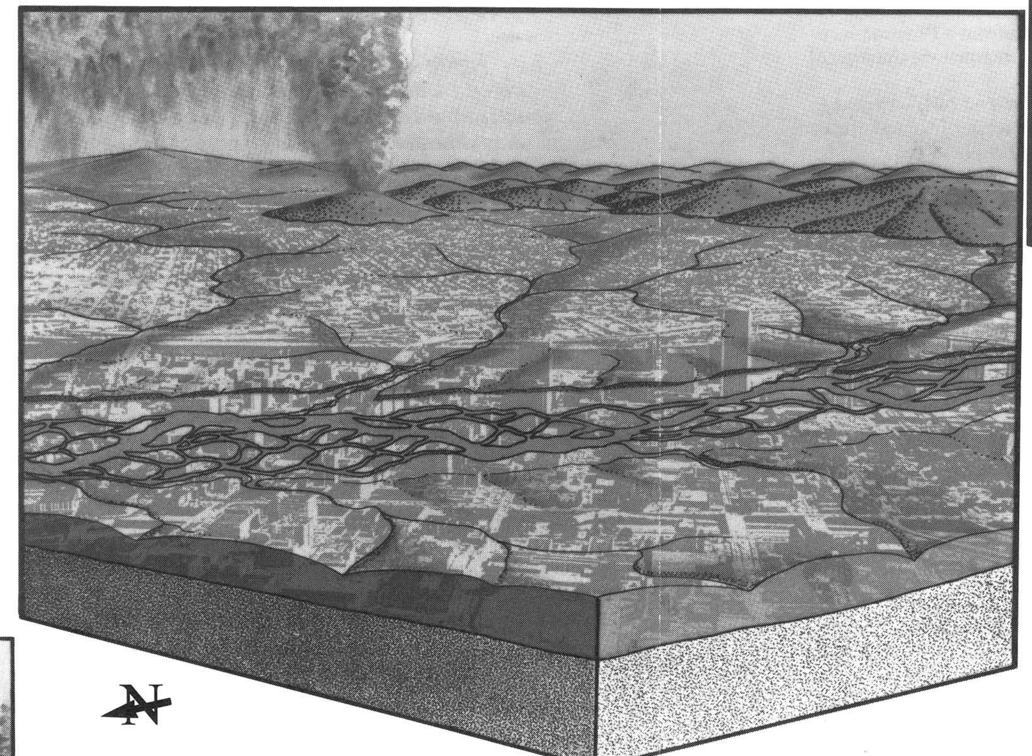
The author wishes to express his appreciation to John Allen, Marvin Beeson, and Paul Hammond, Portland State University, for their suggestions that helped guide this presentation. The photograph of Portland in 1974 is courtesy of the Oregon Historical Society.

16 MILLION YEARS AGO (below)

Lava of the remarkable flood volcanism spread across the city area (shown with the city image as a ghostlike background)

The lava was erupted from a long fissure, or crack in the ground, some 300 miles away in northeastern Oregon. The enormous volume and intense heat of this basaltic eruption enabled the lava to spread like molasses across this broad plain of the Northwest. The lava surged forth in vast lobes at speeds of up to 30 miles per hour. The rapid advance generally buried vegetation before it could ignite; however, in the foothills of the Cascades (background) along the flank of the lava field, forest fires raged. These mountains, with scattered volcanic peaks, were a subdued forerunner to the Cascades of today, and the flood basalt could spread across a wide tract in its westward course toward the sea. This was just one of more than a dozen flows that inundated the city area during this eruptive period. Thousands of years passed between some eruptions, and soils and vegetation developed on the tops of some of the flows. Although this scene was nearly flat, the Portland Hills formed a small anticlinal ridge (below and behind us) that diverted some of the flows. It was later that the major upwarp that lifted the hills to their present elevation was to occur. And similarly, it was after the event depicted in this scene that the flat volcanic layers shown here were bowed downward into a broad basin (the Portland syncline) that was then covered with ancient Columbia River gravels. This plain was to become the setting for the eruption of the Portland volcanoes shown in the next scene.

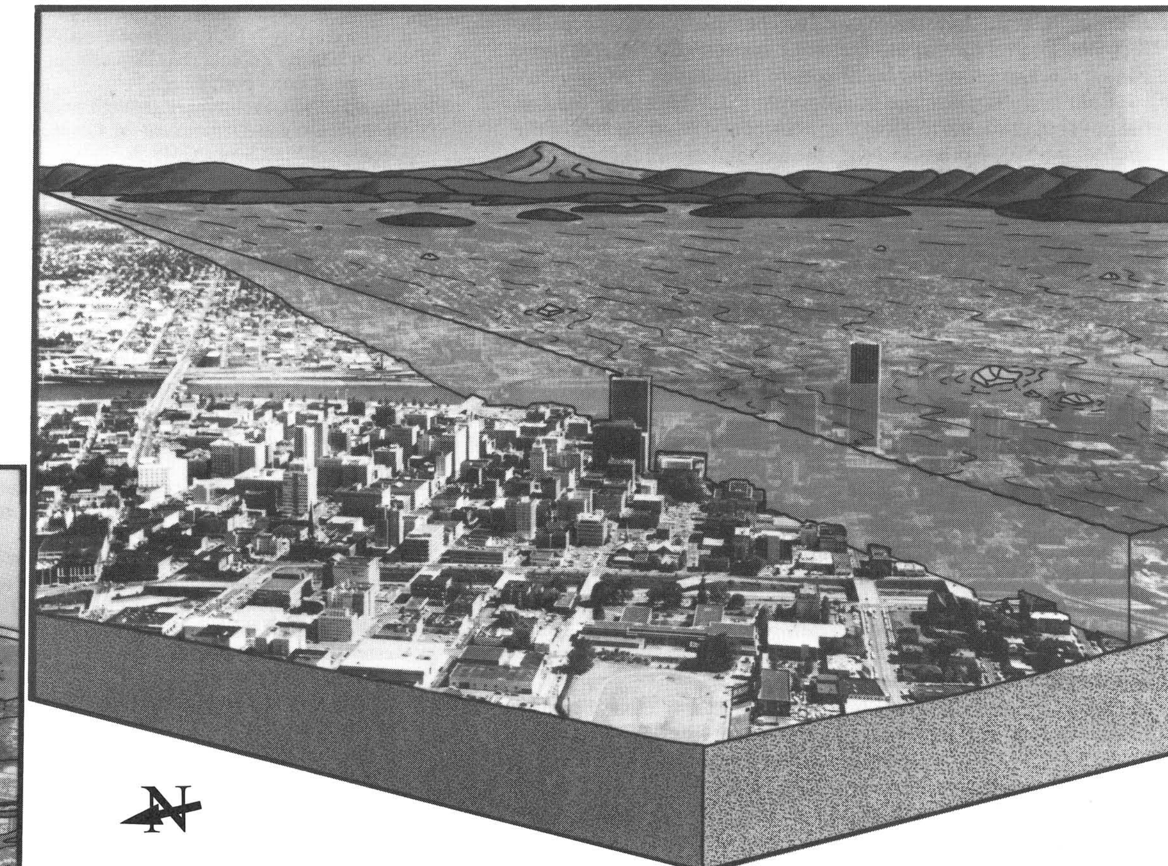




ONE MILLION YEARS AGO (?) (above)

An eruption of Mount Tabor scattered ash across the northeast Portland area (shown with the city image as a ghostlike background).

During the last few millions of years, Portland was the scene of hundreds of such eruptions. These nonviolent eruptions shaped the city area by building dozens of cinder and lava cones on the eroded surfaces of the more ancient plateau lavas and stream gravels. The hills of this city scene today represent extinct volcanoes or eroded remnants of volcanoes (such as Mount Tabor). Most of the volcanoes are cinder cones, although lava flows were erupted from the bases of many of them. The form of these volcanoes plus a few radiometric dates suggest that the oldest eruptions may have occurred several million years ago and the youngest, perhaps as recently as a few tens of thousands of years ago. The precise age of Mount Tabor, however, is undetermined. Collectively, the volcanic rocks produced during this eruptive period are mostly basaltic and are referred to by geologists as the Boring Lavas, named for the town of Boring where they were first described. They include numerous volcanic centers in the Portland Hills as well as south of the view area. The ancient landscape resembled the scene of today, although the exact location of the Willamette River at that time is not known; its location and nature as shown here are largely speculative.



14 THOUSAND YEARS AGO (above)

The Portland area was flooded by a catastrophic outburst from a glacial lake (shown in a cut-away section as it would have related to the modern city).

During the Ice Age, the site of Portland was swept by gigantic floods from the east. These were the immense "Spokane Floods," each of which resulted from the collapse of a glacier that had dammed a huge lake in Idaho-Montana (Glacial Lake Missoula). The released waters surged southwestward through the Columbia Gorge (upper left) to Portland. As indicated in the sketch, only tops of the higher buildings would have projected above the flood crest. Icebergs torn from the distant glaciers drifted across the flood surface. In the Portland area, the flood waters resembled a large turbulent lake that spread far to the south through the Willamette Valley. This flood endured for about two weeks and recurred roughly every century for more than a thousand years. The floods tore vigorously at the flanks of the volcanic hills and spread thick sheets of sand and gravel across the area to form a great "delta" — the upland plains of east Portland-Vancouver.

A LANDSCAPE MOLDED BY CATASTROPHE

The science of geology, in its quest to understand the patterns of earth evolution, has built its case on the principle of Uniformitarianism ("the present is the key to the past"). In the simplest of terms, this means that what we see at work on the land around us today represents the complex of processes that have worked to shape the land in the past. Although this principle has served the science admirably through the years, a rather unfortunate implication has strongly influenced its application. In this, the assumption has prevailed that the molding of most of the earth's surface has been governed by imperceptibly slow and sluggish processes (such as a creeping uplift of mountains and a grain-by-grain erosion of rivers), thereby taking thousands of years to produce significant changes in the landscape. More recently, however, the science has come to realize that the processes, such as the actions of streams, coastal waves, and tectonism, have frequently been so great that lands have been changed dramatically in mere days — in a "geologic instant." And so it is that geology is just beginning to recognize the importance of "catastrophe" within the concept of Uniformitarianism.

Although the 1980 eruption of Mount St. Helens is perhaps the most glaring demonstration of catastrophe in land shaping, virtually every piece of terrain in the Pacific Northwest has a heritage of geologic cataclysm built into its evolution. The site of Portland in the heart of the region is exemplary. Much of the modern land surface as well as the bedrock foundation and sediment blanket of greater Portland has been fashioned by cataclysms. The sketches are intended to depict three kinds of catastrophic events responsible for major changes in the Portland geologic history. It is hoped that these scenes will help geologists and nongeologists alike to better perceive events that are extreme and thereby difficult to comprehend. From this perhaps we can sense the remarkable magnitude and wonder of this awe-inspiring heritage. □

***(Field trip**, continued from page 129)*

texture similar to that seen in unit 16. The adsorption capacity for CO_2 and O_2 and the cation-exchange capacity for NH_4^+ of these chabazites were reported by Sheppard and Gude (1982).

Four scanning electron micrographs (SEM) are presented on the cover of this issue to show the textures and relationships of the zeolites with each other and with the associated authigenic smectite. SEM 1 (upper left) is an SEM from unit 3GY. The sample was taken from a cavity in a vertical fracture in the top of the welded tuff where the glass has been altered along the walls of the fracture. Radiating bundles of acicular erionite appear to have formed at the same time or shortly after the chabazite. The erionite coats some chabazite rhombs, but in the lower right corner of the SEM, the rhomb rests on the erionite. SEM 2 (upper right), an SEM of the tuff in unit 11, shows well-crystallized hexagonal rods of erionite present with clinoptilolite and more finely crystalline rhombs of chabazite. SEM 3 (lower left) is an SEM of material from a cavity in the tuff of unit 14B. Acicular erionite crystals have grown out into the cavity. Two size groups of chabazite crystals are visible; most are $<10\ \mu m$ on an edge, but some scattered rhombs are 15-20 μm in size. A few tabular clinoptilolite crystals are present with the chabazite. SEM 4 (lower right) is an SEM from unit 16 showing well-developed chabazite rhombs on a mat of fine-grained clay. Several of the chabazite crystals are interpenetrating twins on (0001).

ZEOLITE DIAGENESIS

The Pliocene Durkee basin is an example of a "closed-basin" zeolite deposit. A depositional environment existed in a constricted 18-20 km^2 pond at the south end of the valley when the outlet was dammed to form a shallow soda lake. Rapid deposition of siliceous vitric tuffs into the highly saline, alkaline water provided the kinetic and geochemical conditions required for a low-temperature, low-pressure diagenesis to alter the tuffaceous material to zeolites. Table 3 shows the paragenetic zeolite sequence established from optical and scanning electron microscopy and X-ray diffraction analysis.

Table 3. Paragenesis of authigenic minerals at the Durkee, Oregon, zeolite deposit.[1]

Glass, then:				
Phillipsite	-->	Clinoptilolite + Erionite		
Phillipsite	-->	Erionite		
Smectite	-->	Clinoptilolite		
Smectite	-->	Chabazite	-->	Clinoptilolite
Smectite	-->	Phillipsite	-->	Clinoptilolite
Smectite	-->	Erionite	-->	Clinoptilolite
Smectite	-->	Chabazite	-->	Erionite
Phillipsite	-->	Clinoptilolite		
Phillipsite	-->	Erionite + Chabazite		
Any of the above zeolites (but not glass or clay)	-->	Analcime + Potassium Feldspar		

[1]Adapted from Gude and Sheppard (1978).

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Governor creates Oregon Land Information Advisory Committee

A new Oregon Land Information Advisory Committee has been created by Governor Victor Atiyeh. Its goal, according to Kenneth J. Dueker, Committee Chair, is to help the State avoid the threat of seriously incompatible and duplicative land information data, caused by the increasing computerization of geographic mapping and inventory systems in Oregon State agencies, local governments, and public utilities.

Dueker, Director of the Center for Urban Studies in the School of Urban and Public Affairs at Portland State University, noted that the new committee will draw on the recent success of an interagency Strategic Water Management Group, which cooperated to share land and water data while building a new geographic information system for the John Day River Basin.

If the new committee can successfully promote data compatibility and sharing of information among the diverse entities across Oregon, Dueker predicted that "... this will lead to more timely and accurate answers to land information questions at all levels of government."

Governor Atiyeh also directed that three subcommittees be established to help the new committee carry out its work: a Standards and Base Mapping Subcommittee chaired by Deputy State Geologist John Beaulieu, Oregon Department of Geology and Mineral Industries; a Project Coordination and Technical Issues Subcommittee chaired by Gary Waltenbaugh, Manager of Special Programs, Oregon Department of Energy; and a Land Records Subcommittee chaired by Dueker. □

Mining in wilderness

by Daniel G. Avery, Area Mining Geologist, Wallowa-Whitman National Forest, Baker, Oregon

THE LAW

The General Mining Laws give a United States citizen the right to locate mining claims upon unreserved public domain lands, including the National Forests, to explore for or extract minerals. Although the Mining Laws have been supplemented and amended over the years, many of the key provisions remain intact. The general procedure for locating and holding mining claims involves (1) making a discovery of a valuable locatable mineral deposit (excluding leasables such as oil, gas, coal, phosphate, and sodium and salables such as common varieties of sand, gravel, and cinders); (2) recording the claim in the appropriate county courthouse and state office of the Bureau of Land Managment; and (3) performing at least $100 worth of annual assessment work for development of the mineral deposit on the claim.

Through this process, any number of claims may be located, subject to the following limitations: Lode claims (claims on minerals in solid rock), each with maximum dimensions of 600 by 1,500 ft or approximately 20 acres; and placer claims (generally, claims on heavy-mineral deposits concentrated in gravel), also limited to 20 acres. These per-person limits may be used by maximally eight individuals in association so that a single claim may be as large as 160 acres. No approval is required from the government to locate these claims, and no royalty payments are made for minerals produced from them.

The National Wilderness and Preservation Act of 1964 was passed to preserve and protect lands in a natural condition for present and future generations. As stated in the Act, "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Several criteria were given to further define wilderness. The areas were to be undeveloped Federal land retaining "primeval character and influence" and without permanent improvements or human habitation. The areas were to be primarily affected by nature, with human work substantially unnoticeable; they were to provide outstanding opportunities for solitude, or primitive, unconfined recreation; they should be 5,000 acres or larger, or of sufficient size for practical use and preservation in an unimpaired condition; and they could contain ecological, geological, or other features of scientific, educational, scenic, or historic value.

However, under the Act, entry under the Mining and Mineral Leasing Laws was to continue within the wildernesses created by the Act until December 31, 1983. Both the Wilderness Act and the subsequently enacted USDA Forest Service surface-use regulations allowed for mining activities to continue, with a goal of maintaining an unimpaired Wilderness Preservation System. This unimpaired condition was to remain while allowing location, exploration, development, and production of mineral deposits. Permitted activities could include construction of necessary water and power lines and use of mechanized transport and motorized equipment. Also, the U.S. Geological Survey and the U.S. Bureau of Mines were directed to conduct mineral studies of the areas. By keeping them open to mineral exploration and development by private industry for a period of 20 years, and by simultaneously conducting Federal mineral investigations, it was hoped that these lands would not be closed to development without a reasonably accurate knowledge of their mineral potential.

This apparent conflict between unimpaired wilderness preservation and allowance for mineral development was the result of a compromise reached between the Senate and the House of Representatives. The original House version of the Wilderness Bill provided for a 25-year period in which the Mining and Mineral Leasing Laws would continue to operate, while the original Senate version provided for immediate withdrawal. The compromise, which became the Wilderness Act of 1964, remained closer to the House version, providing for a 20-year period of operation under the Mining and Mineral Leasing Laws.

The General Mining Laws gave the public the right to enter the lands belonging to the United States, including the wildernesses through December 31, 1983, and the right to prospect for and mine valuable mineral deposits. In actual practice, many mining companies and individual prospectors appeared to be reluctant to pursue mineral exploration under the more rigid environmental constraints imposed on operations within wilderness. Additional perceived constraints were the general public sentiment against mineral development within wilderness and the question of whether development of a major mineral deposit would be allowed to take place. Given these factors, the major companies tended to ignore all but the most attractive targets within wilderness.

Critics have suggested that government studies of the mineral potential of wildernesses were limited by time, manpower, and funding. The inventories were to cover not only the areas created by the 1964 Act but also areas subsequently added to the system and areas recommended for wilderness or further study under the Forest Service Roadless Area Review (RARE and RARE II) processes. Since minerals are generally a hidden resource, it was not feasible to make a thorough evaluation of the mineral potential of much of the land under consideration.

VALID CLAIMS

The State of Oregon now has a total of 35 wildernesses, covering over two million acres. All 13 National Forests have at least one wilderness, and one Forest has eight. Most of these wildernesses were established by the 1964 act and automatically became closed to mineral entry on December 31, 1983. On June 26, 1984, the Oregon Wilderness Act of 1984 was signed by the President. The 849,300 acres of new wilderness established by this Act were added after the December 31, 1983, closure to mineral entry specified by the 1964 Act and were therefore instantly withdrawn. Included within the new additions to wilderness were well over a thousand mining claims, whose owners had not been operating under wilderness regulations. Holders of claims in the older wildernesses knew, or should have known, that their claims would have to be valid as of the December 31, 1983, closure in order to establish a right to any locatable minerals within the claim boundaries. Claimants in the new wildernesses may have been caught by surprise with the instant withdrawal from mineral entry and attendant requirement for validity.

In order for a claim to be valid, a claimant must (1) discover a valuable mineral deposit, (2) post the discovery on the ground, (3) do the discovery work (not required in Oregon), (4) monument the claim on the ground as required by State and Federal laws, (5) record the claim at the appropriate county courthouse, and (6) within 90 days of location, file a copy of the recorded claim notice with the state office of the Bureau of Land Management. Very often, the first element of validity is missing. The definition of a valid discovery was first made in 1894 in the case of *Castle* v. *Womble*, 19 LD 455 (1894), in which the Secretary of the Interior stated:

"... where minerals have been found and the evidence is of such a character that a person of ordinary prudence would be justified in the further expenditure of his labor and means, with a reasonable prospect of success, in developing a valuable mine, the requirements of the statutes have been met."

This definition, known as the "prudent person test," has since been reaffirmed in numerous cases before the Supreme Court of the United States and has withstood the test of time. In practice, this means that in order to be valid, a claim must show a mineral deposit which can be demonstrated to have a reasonable chance of being mined at a profit, based on current knowledge of the character of the deposit and the market condition available for the mineral to be extracted. A recent administrative decision [*In re Pacific Coast Molybdenum Co.*, 75 IBLA 16 (1983)] found that during depressed economic conditions, immediate profitability need not be shown. However, a potential for profit must exist given recent historic price/cost figures and reasonable expectations for a return to more normal market conditions.

It is common practice to locate a mining claim on the ground prior to making an actual discovery of a valuable mineral, as required under the General Mining Laws. As long as the locator physically occupies such a claim, excludes rival claimants, and diligently makes a good faith effort to perfect a discovery, he is protected from rival claimants by the doctrine of *Pedis Possessio*, or "foot-hold." However, he is given no rights against the government until a discovery is perfected. Many of the claims within the 1984 wilderness additions may not have discoveries, partly because the claimants had been operating in land open to the General Mining Laws and were not facing a definite date at which a discovery had to be made. Such claims will have acquired no rights against the government to minerals in the ground.

Validity will be determined by physical and economic conditions prevalent leading up to the date of the withdrawal. A discovery must have been present on the withdrawal date, and the possibility for extraction of minerals from the claim at a profit must be shown to have been reasonably likely. This precludes consideration of any subsequent radical price increases for mineral commodities that may take place after the withdrawal date. No work done after this date may be used to establish a discovery. Only existing surface exposures, verifiable drilling data, cuts, shafts, and adits may be considered in the validity process. Professionally prepared reports and analyses on the subject claim(s) dealing with quantity and quality of mineral to be extracted, along with records or estimates of production and recovery costs, will be extremely helpful to the claimant wishing to establish validity.

The rights accompanying a claim within wilderness depend upon the status of the land at the time of its location. Valid claims located on land prior to inclusion within the Wilderness System are under the General Mining Laws that were applicable to the land at the time. Claims located subsequent to wilderness designation and prior to withdrawal from mineral entry are under the General Mining Laws *and* the establishing legislation for the wilderness. One of the main differences between the two situations pertains to claims that are taken to patent (private ownership). All valid preexisting claims located in wildernesses that have been created after the December 31, 1983, closure date (such as the areas included within the 1984 Oregon Wilderness Act) and any claims validly established prior to the inclusion in the Wilderness System of the land on which they are located may be taken to full private ownership (mineral and surface estate). A claim that was located within an existing wilderness and validated prior to withdrawal from mineral entry may be patented only for its mineral estate. The surface remains with the Federal Government, subject to the rights of the claimant to the use of as much of the surface estate as is necessary to exercise his/her right to the minerals. Once validity is established, the claimant has a property right that cannot be extinguished without payment of just compensation.

Access to valid mining claims wholly within wilderness is to be permitted "by means consistent with the preservation of the National Forest Wilderness which have been or are being customarily used with respect to other such claims surrounded by National Forest Wilderness" [Code of Federal Regulations — 36 CFR 228.15 (c)]. This direction gives the Authorized Officer maximum latitude to determine what will be allowed. In practice, access is considered in relation to the need of the claimant. Requests for access may take into consideration (among other things) the claimant's proposal, distance from wilderness boundary, difficulty of terrain, impact on wilderness values, weight and complexity of materials to be transported, and existing access routes.

CONCLUSION

Mining in wilderness, a touchy subject during the 20-year period during which the General Mining Laws applied, may be even more controversial now that the date of withdrawal has passed. The administrative guidelines for handling mining proposals on those claims which prove to be valid, by necessity, leave room for interpretation. Efforts must be made to find creative solutions for developing a balance between the miners' desires to operate and the goal of preventing degradation of the National Forest wilderness environment.

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— *The editors*

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