

ZEOLITE-RICH BEDS of the JOHN DAY FORMATION,
GRANT and WHEELER COUNTIES, OREGON

By Richard V. Fisher*

General Statement

This report, prepared for the purpose of locating zeolitized tuff beds, is, essentially, an extension of a report by the author (1962) on the Deep Creek Tuff, a zeolite-rich layer in the central portion of the Picture Gorge quadrangle, eastern Oregon. The John Day Formation within six 15-minute quadrangles and a large part of the 30-minute Mitchell quadrangle (Plate I) was the only formation included in this search. Relatively thick (greater than 5 feet) deposits of zeolite-rich tuff were located in only 4 of the quadrangles within the mapped area -- Picture Gorge, Kimberly, Richmond, and Mitchell -- and most extensively within the Picture Gorge quadrangle.

The variety of zeolite that prompted this survey is clinoptilolite which has the ability to capture radioactive cesium (Brown, 1962). Detailed tests to determine the chemical and physical variabilities of clinoptilolite (or its relationship to the close relative, heulandite) within a single bed have not been made. It would not be surprising, however, to find that zones of clinoptilolite-altered tuff are laterally equivalent to those altered to heulandite or other closely related zeolites. Thus, even though there are huge tonnages of zeolite-rich layers reported here, the amount of clinoptilolite cannot be accurately predicted. The origin of the zeolites of the John Day Formation has been discussed by Hay (1963).

Stratigraphy

The John Day Formation in parts of the present area has been described previously by other workers, including Merriam (1901), Coleman (1949), Fisher and Wilcox (1960), and Hay (1962, 1963). The formation attains 2,000 feet or more in thickness, but usually not in any one place, and has been divided into a lower, middle, and upper part (see accompanying

*Assistant Professor of Geology, University of California at Santa Barbara, University, California.

columnar section). In the area under discussion, the John Day Formation unconformably lies above the Clarno Formation (Eocene), and, where Clarno rocks are absent, above conglomerate, sandstone, and shale of probable Cretaceous age or above pre-Cretaceous quartzite and marble. A thick sequence of basalt flows (middle Miocene) called the Picture Gorge Basalt* (Waters, 1961), unconformably covers the John Day Formation.

The lower member of the John Day Formation is composed of deep red to red-brown volcanic claystones and siltstones. These rocks, described by Hay (1962) from near Mitchell, are poor in clinoptilolite. The middle member of the formation is composed of green, buff, and light red or light red-brown volcanic siltstones and sandstones. This member contains an ignimbrite (welded tuff) layer that occurs throughout much of the area under discussion, and forms an excellent stratigraphic reference horizon. The upper member is unzeolitized and light gray to buff in color in most areas.

The middle member, therefore, contains the clinoptilolite-rich zeolite beds at several horizons. One rather persistent zeolitized bed is the Deep Creek Tuff that occurs about 100 feet above the ignimbrite layer. In some areas, an ashfall layer that lies in contact with the basal part of the ignimbrite layer and a zeolite-rich bed (or beds) 150 to 200 feet below the ignimbrite are thick enough to form important deposits.

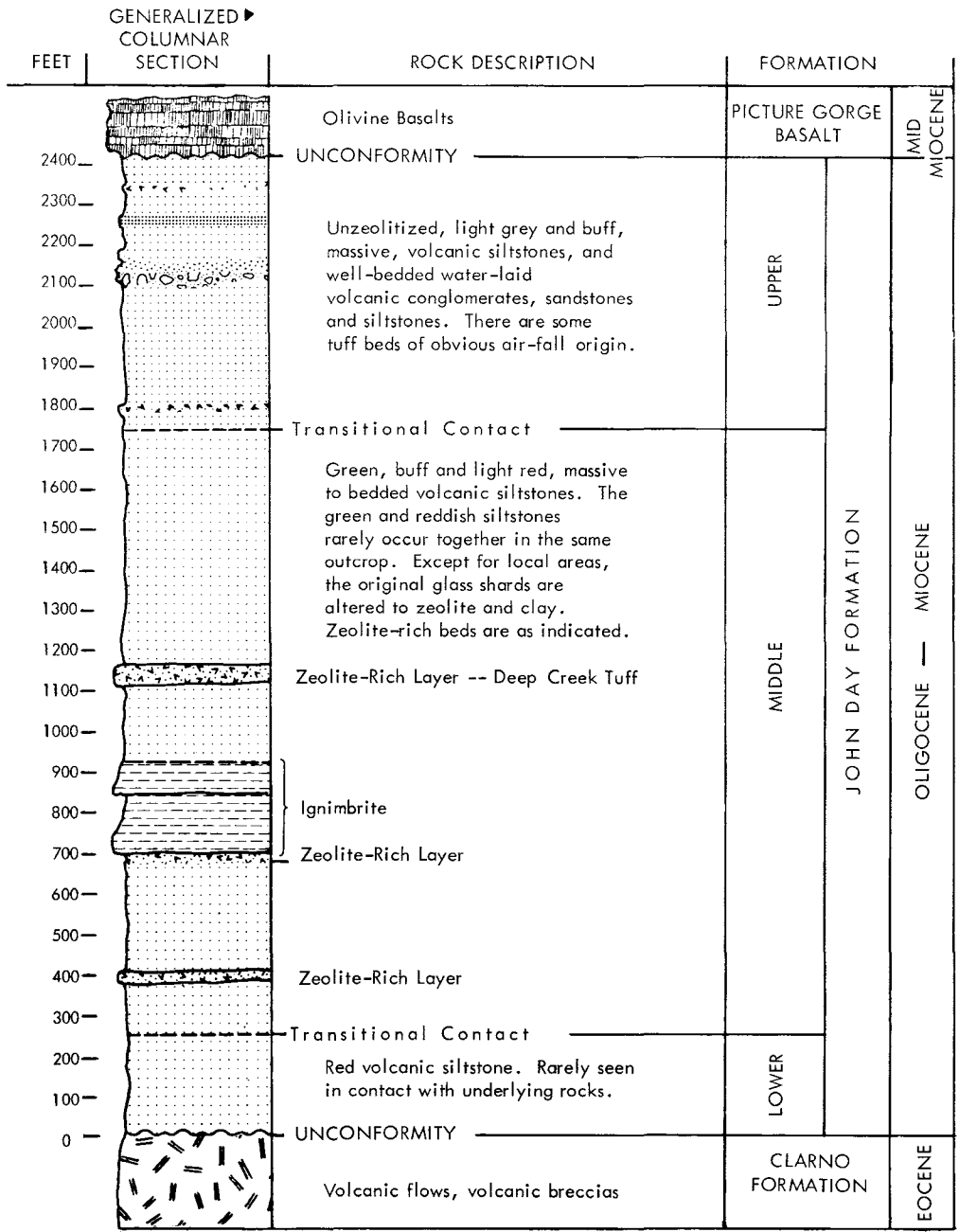
Rocks rich in clinoptilolite or related zeolites are composed almost exclusively of altered sand-size shards. These coarse-grained tuffs are usually poor in pyrogenic crystals, especially ferromagnesian and magnetite. Where they are thick, the beds generally form orange- or cream-colored cliffs and thus may be relatively easy to locate. Where the beds are thin (less than 5 feet thick), they weather to white or light-gray colors similar to layers containing abundant clay. Invariably, the John Day rocks that are colored green or red on fresh surfaces contain more clay than is desirable for a good quality clinoptilolite deposit. The formation of a zeolite-rich layer is dependent upon the coarseness and abundance of glass shards, because the fine-grained particles (original glass?) alter to clay, whereas the coarse-grained particles alter mainly to zeolite.

Zeolite-Rich Beds

Introduction

Thick and conspicuous deposits of coarse-grained zeolite-altered tuff

* Lower part of Columbia River Basalt.



▶ Only maximum thickness is shown for units of the John Day Formation

Generalized geologic column showing relative position of the zeolite-rich tuff beds in the John Day Formation.

beds in the mapped area are relatively rare, occurring in a few scattered localities. The thickest and most accessible deposits occur within the Picture Gorge quadrangle in an area described previously by the author (1962), and in the Squaw Creek and Sheep Rock exposures (figure 1). These deposits are part of the Deep Creek Tuff, which has also been observed in the Kimberly quadrangle in Haystack Valley (sec. 21, T. 8 S., R. 25 E.) and in Kahler Basin (figure 2). Similar deposits occur in Parrish Creek (figure 3) and about a mile south of Dutch Flat (figure 4), although these layers may be greatly thinned, lateral equivalents of the ignimbrite layer.

Deep Creek Tuff

The Deep Creek Tuff, named for its thick exposures in Deep Creek (secs. 35 and 36, T. 10 S., R. 25 E.), has been identified in many places within the Picture Gorge quadrangle about 100 feet above the ignimbrite. No other layer of comparable coarseness and purity of zeolite has been found within the section above the ignimbrite. Thin (less than 5 feet thick) exposures of the Deep Creek Tuff have been mapped or observed throughout the Picture Gorge quadrangle, but the tuff is exceptionally thick in only two places outside those described earlier by the author; one is in sec. 5, T. 12 S., R. 26 E., about one mile northeast of Sheep Rock, and one is in sec. 14, T. 11 S., R. 25 E., in Squaw Creek (figure 1).

The exposure north of Sheep Rock is a composite ashfall layer about 30 feet thick that shows graded laminae and some coarse platy layers near its central part. It is easily visible from Oregon State Highway 19 as a cream-colored outcrop. The layer, which dips about 20° south, forms a dip slope near the 3,200-foot contour line about 1,000 feet above the John Day River. The tuff thins rapidly to the north and south, although it can still be identified around the west face of Sheep Rock, where it is lenticular and not more than 10 feet thick.

The Deep Creek Tuff in Squaw Creek is about 30 feet thick. There are at least three zones of graded laminae and a 1- to 2-foot zone of coarse platy tuff near its central portion. Some layers contain pink felsitic lithic fragments up to 3 mm in longest dimension that form nearly 5 percent of the rock. Even though the bed is about 3 miles west of State Highway 19, it is easily accessible by the unpaved Squaw Creek road.

The Deep Creek Tuff has been recognized in Haystack Valley, where it is thin and lenticular, and farther north in Kahler Basin (figure 2) in the Kimberly quadrangle. The exposure in Kahler Basin is about 10 feet thick and occurs in two easily accessible areas about 1 mile apart.

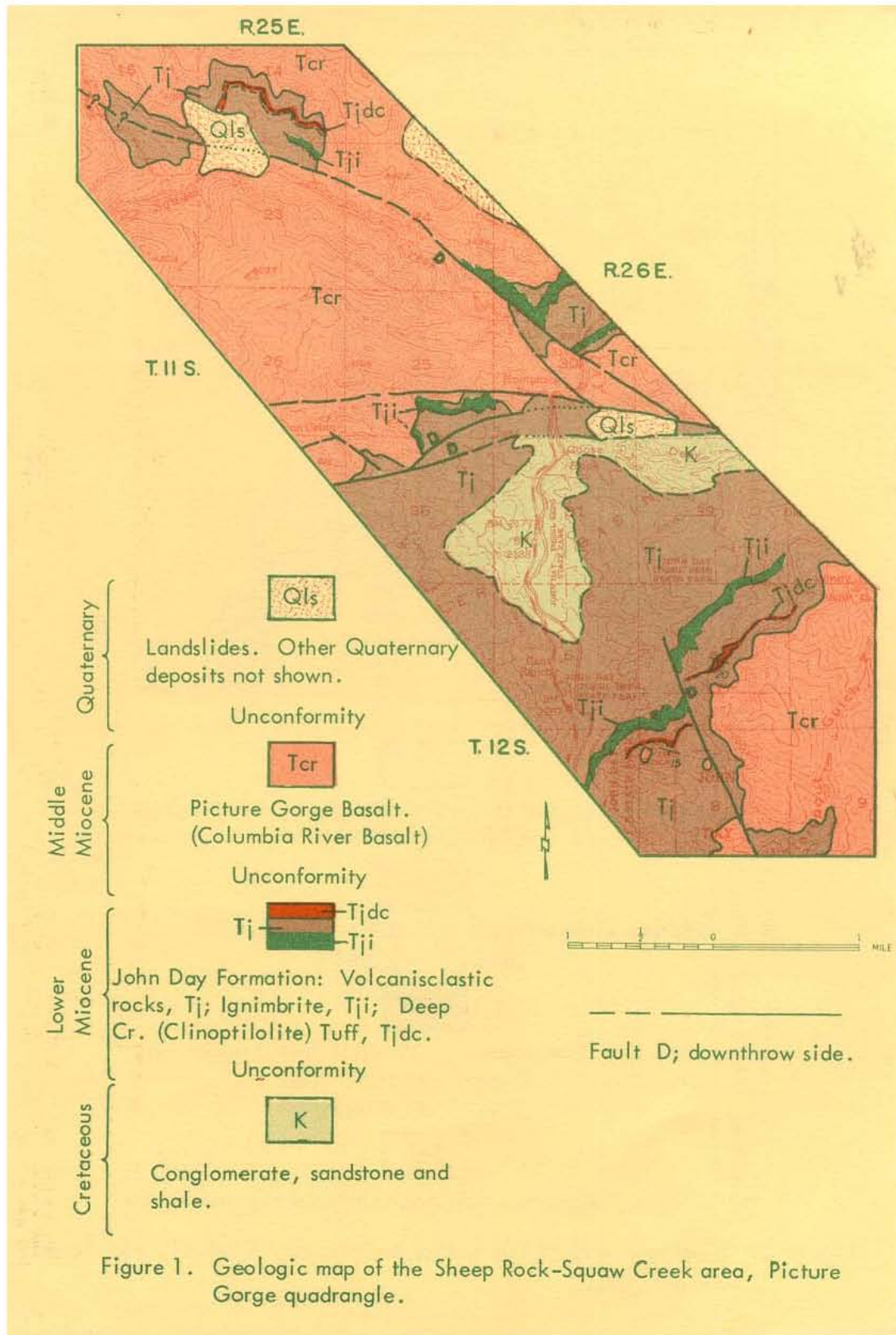


Figure 1. Geologic map of the Sheep Rock-Squaw Creek area, Picture Gorge quadrangle.

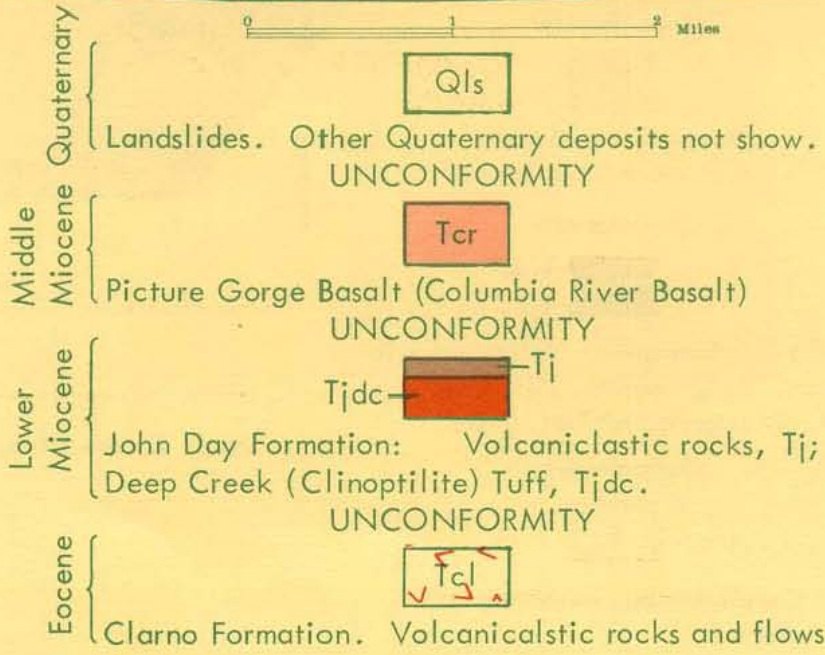
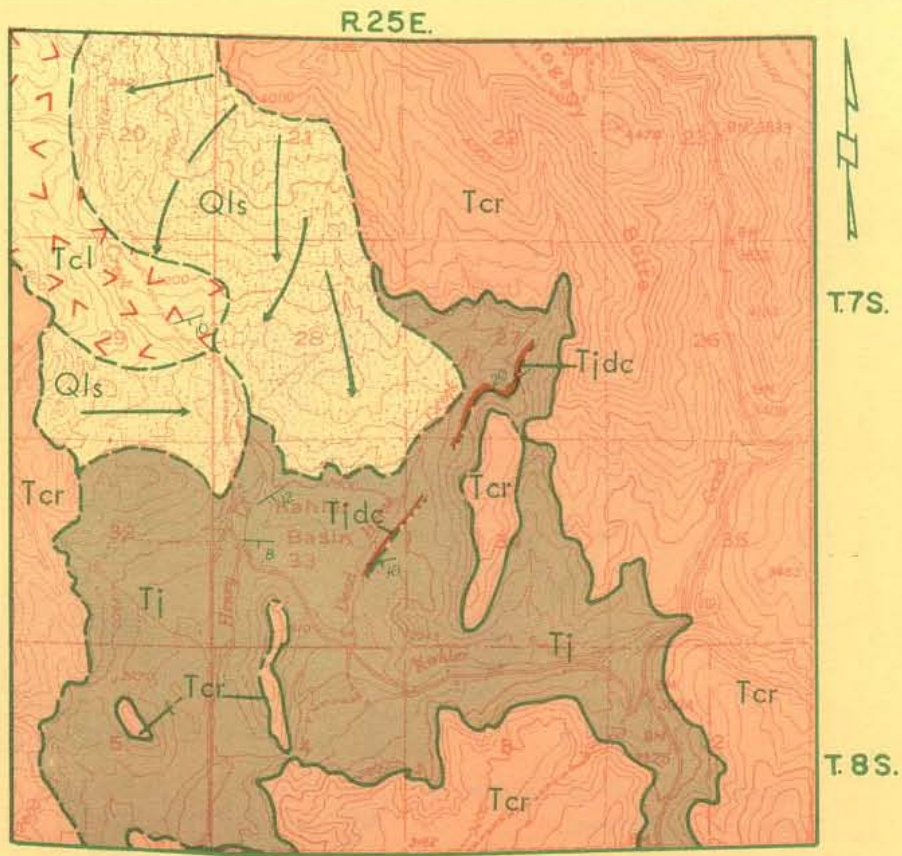


Figure 2. Geologic map of the Kahler Basin area, Kimberly and Spray quadrangles.

Ignimbrite layer and zeolitic tuffs

The ignimbrite layer is composed of two cooling units (as defined by Smith, 1960, p. 157) in some places, and only one cooling unit in others. It is underlain by a section approximately 10 feet thick of primary ashfall tuff showing graded bedding, and massive to fissile tuff that is gradational upward with the lower welded base of the ignimbrite. The welded base shows flattening of pumice and glass fragments and is either obsidian-like in appearance or is a hard lithic material with conchoidal fracture. The laminated and fissile tuff is commonly altered to zeolite, but is usually poorly exposed because it lies beneath the talus of the overlying pyroclastic flow. This tuff is as coarse and generally appears to be as rich in zeolite as the Deep Creek Tuff, but is less accessible because it lies beneath the usually well indurated welded tuff. Occasionally, it is absent or very thin. One of the thicker exposures of this basal tuff occurs in secs. 29 and 30, T. 10 S., R. 24 E. (figure 3) in the Richmond quadrangle.

At two rather widely separated localities are relatively thick deposits of coarse, zeolitized tuff that are lithologically similar to the Deep Creek Tuff. These may be stratigraphically equivalent to the ignimbrite layer. One area (figure 3) lies along the unpaved road between Spray and Waterman Flats in Parrish Creek (sec. 21, T. 10 S., R. 24 E.) in the Richmond quadrangle; the other deposit (figure 4) is just south of Dutch Flat (sec. 22, T. 8 S., R. 22 E.) in the Mitchell quadrangle.

The Parrish Creek deposit (figure 3), about 10 feet thick, is formed of at least 3 or more successive ashfalls. Its upper part, 3 feet thick, has green patchy areas that are caused by the alteration of pumice fragments to the blue-green clay, celadonite. About two miles farther south in secs. 29 and 30, T. 10 S., R. 24 E., the ignimbrite layer is exposed in what may be the same stratigraphic horizon.

The zeolitized tuff (figure 4) near Dutch Flat in the Mitchell quadrangle is 35 to 40 feet thick and forms the dip slope of a small knoll. This deposit is a little more than 2 miles from State Highway 19, but is easily accessible by a logging road requiring some repair. If the zeolite is all clinoptilolite, this deposit may prove to be important because of its thickness. The tuff is lithologically similar to the Deep Creek Tuff, but appears to occupy the same stratigraphic horizon as the ignimbrite that is exposed farther south in the Mitchell quadrangle along the west slope of Rock Mountain. Further mapping is required to clarify this stratigraphic relationship.

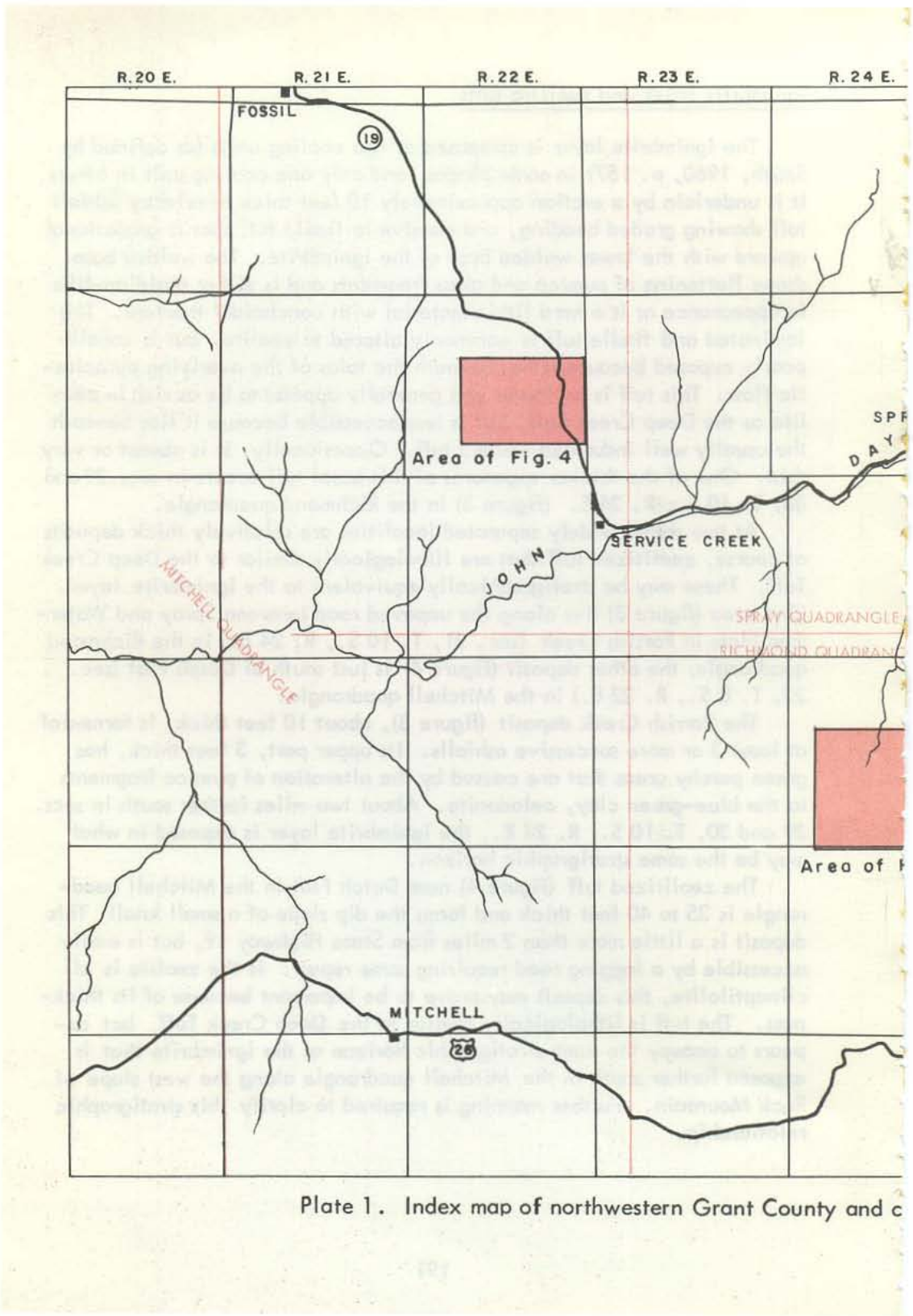
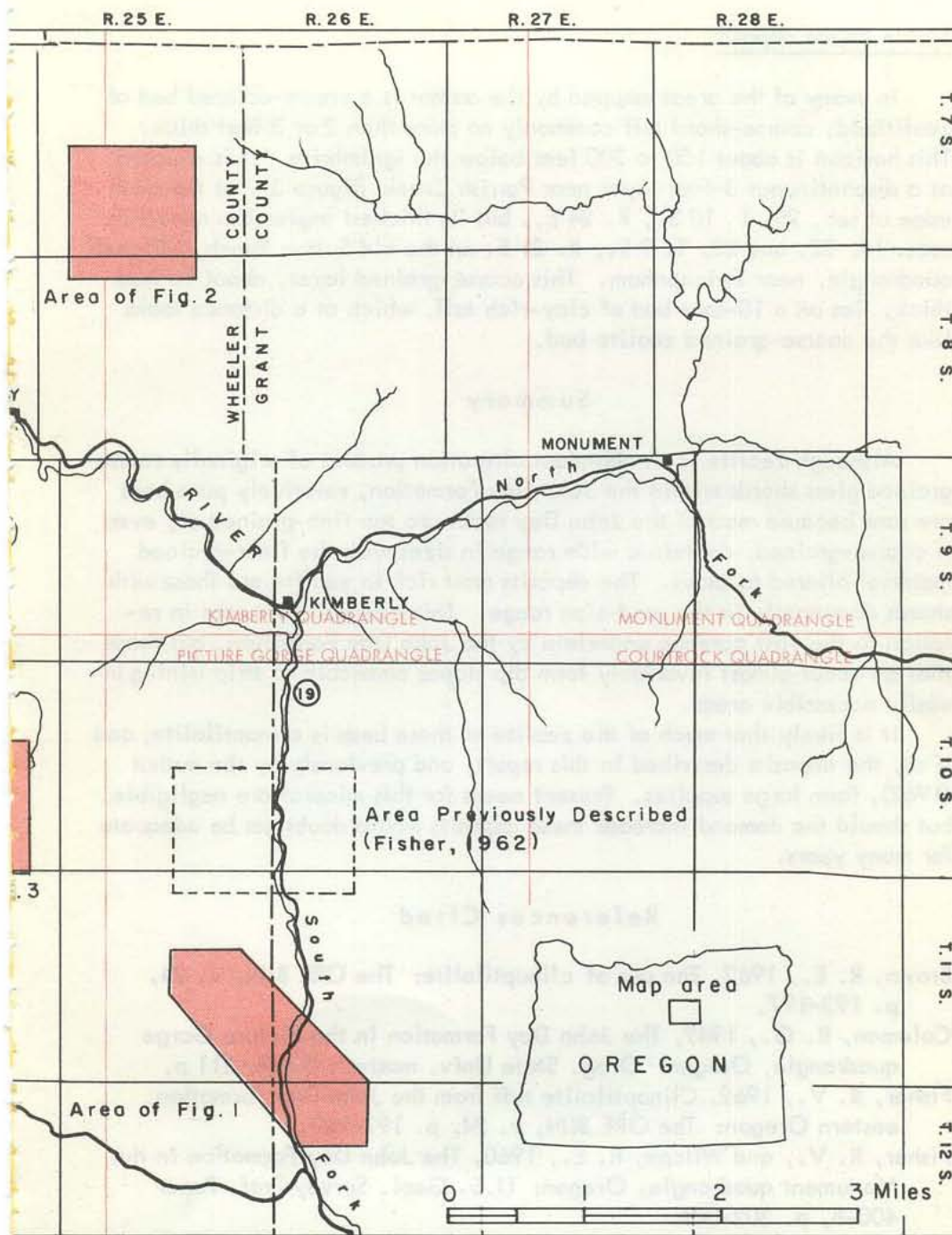


Plate 1. Index map of northwestern Grant County and c



Map of Wheeler County showing location of five zeolite areas.

Sutton Ranch deposit

In many of the areas mapped by the author is a cream-colored bed of zeolitized, coarse-shard tuff commonly no more than 2 or 3 feet thick. This horizon is about 150 to 200 feet below the ignimbrite. It is exposed as a discontinuous 3-foot layer near Parrish Creek (figure 3), at the south edge of sec. 29, T. 10 S., R. 24 E., but its thickest expression occurs in secs. 14, 22, and 23, T. 9 S., R. 21 E. on the old Sutton Ranch, Mitchell quadrangle, near Twickenham. This coarse-grained layer, about 10 feet thick, lies on a 10-foot bed of clay-rich tuff, which at a distance looks like the coarse-grained zeolite bed.

Summary

Although zeolite is an abundant alteration product of originally coarse-grained glass shards within the John Day Formation, relatively pure beds are rare because most of the John Day rocks are too fine-grained or, even if coarse-grained, contain a wide range in sizes with the finer-grained material altered to clays. The deposits most rich in zeolite are those with shards dominantly in the sand-size range. Thick deposits are rare in relation to the vast acreage underlain by the John Day Formation, but those that do occur almost invariably form dip slopes amenable to strip mining in easily accessible areas.

It is likely that much of the zeolite of these beds is clinoptilolite, and if so, the deposits described in this report, and previously by the author (1962), form large supplies. Present needs for this mineral are negligible, but should the demand increase these deposits would doubtless be adequate for many years.

References Cited

- Brown, R. E., 1962, The use of clinoptilolite: The ORE BIN, v. 24, p. 193-197.
- Coleman, R. G., 1949, The John Day Formation in the Picture Gorge quadrangle, Oregon: *Oreg. State Univ. master's thesis*, 211 p.
- Fisher, R. V., 1962, Clinoptilolite tuff from the John Day Formation, eastern Oregon: The ORE BIN, v. 24, p. 197-203.
- Fisher, R. V., and Wilcox, R. E., 1960, The John Day Formation in the Monument quadrangle, Oregon: *U.S. Geol. Survey Prof. Paper* 400-B, p. 302-304.
- Hay, R. L., 1962, Origin and diagenetic alteration of the lower part of the John Day Formation near Mitchell, Oregon: *Geol. Soc. America*,

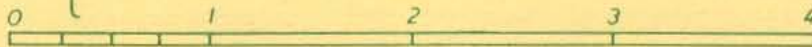
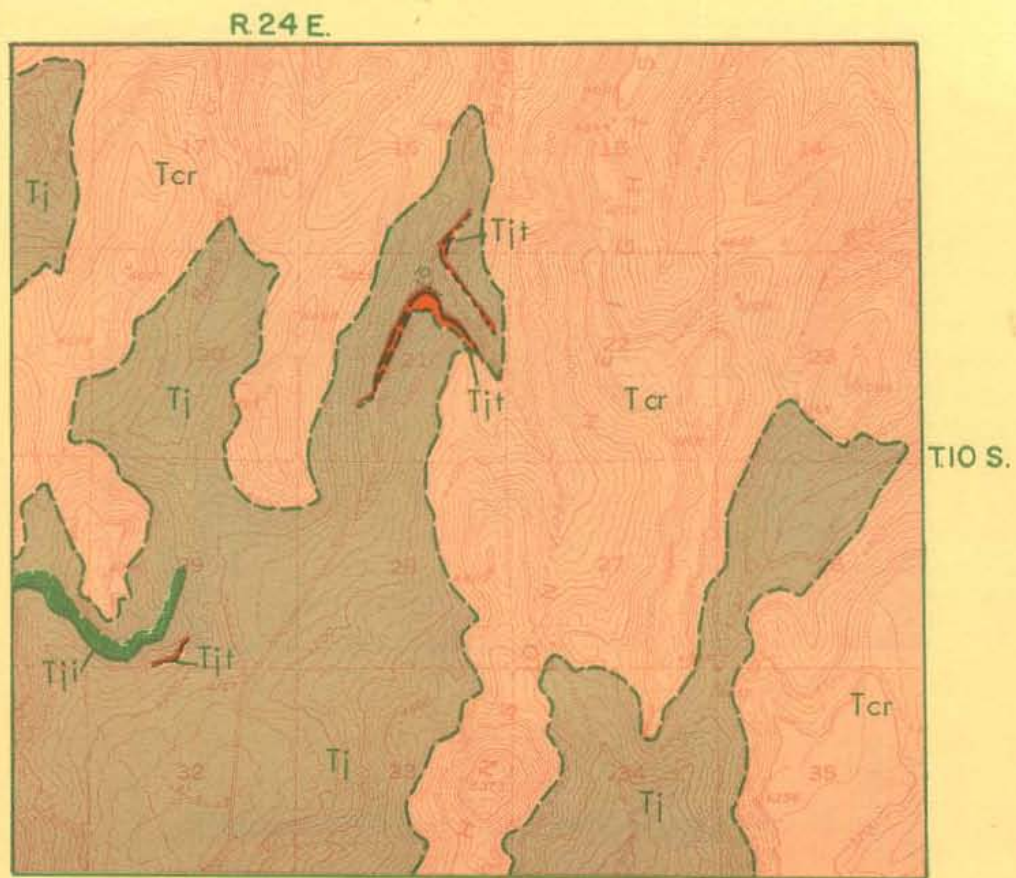


Figure 3. Geologic map of the Parrish Creek area, Richmond quadrangle.

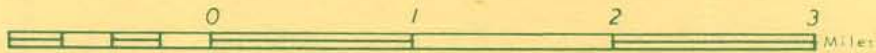
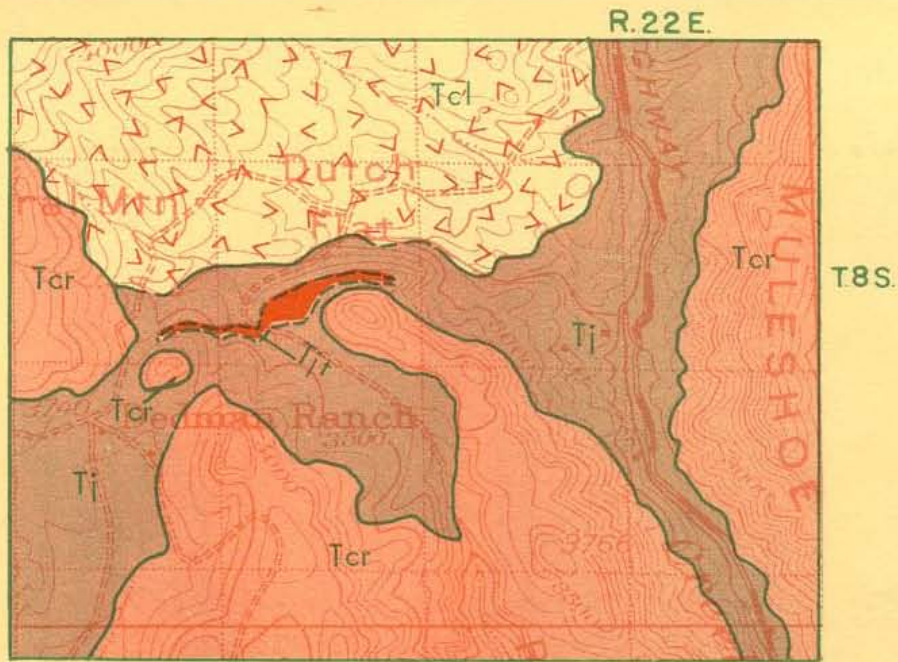


Figure 4. Geologic map of the Dutch Flat area, Mitchell quadrangle

- Buddington Volume, p. 191-216.
- Hay, R. L., 1963, Stratigraphy and zeolitic diagenesis of the John Day Formation of Oregon: Univ. Calif. Pub. Geol. Sci., v. 42, p. 199-262.
- Merriam, J. C., 1901, A contribution to the geology of the John Day Basin, Oregon: Univ. Calif. Pub. Geol. Sci., v. 2, p. 269-314.
- Smith, R. L., 1960, Zones and zonal variations in welded ash flows: U.S. Geol. Survey Prof. Paper 354-F, p. 149-159.
- Waters, Aaron, 1961, Stratigraphic and lithologic variations in the Columbia River Basalt: Am. Jour. Sci., v. 259, p. 583-611.

* * * * *

WILLAMETTE VALLEY GROUND WATER UNDER STUDY

Two preliminary reports on ground-water resources in the northern Willamette Valley have been issued by the Oregon State Engineer in cooperation with the Ground-Water Branch of the U.S. Geological Survey. Recently made available is "Records of Wells, Water Levels, and Chemical Quality of Ground Water in the Molalla-Salem Slope Area," by E. R. Hampton. A similar report covering the French Prairie area adjacent to and west of the Molalla-Salem area was compiled by Don Price in 1961. The two reports present existing well data as an aid to location and development of ground-water resources in this region and are preliminary to a more comprehensive study to be published later by the U.S. Geological Survey. Persons having a use for these reports may obtain them free of charge from the Oregon State Engineer, Salem, Oregon.

* * * * *

PORTLAND BULLETIN AVAILABLE

"Geology of the Portland, Oregon, and adjacent areas," U. S. Geological Survey Bulletin 1119, by Donald E. Trimble (described in the August 1963 ORE BIN) is now for sale by this department at its Portland office. The price is \$2.00 postpaid. It may also be obtained for the same price from the Government Printing Office, Washington 25, D. C.

* * * * *

NORTHWEST MINING ASSOCIATION ANNUAL CONVENTION SPOKANE, WASHINGTON, DECEMBER 6 AND 7

* * * * *