Yonna Formation of the Klamath River Basin, Oregon

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THE PRE-QUATERNARY part of the rocks referred to by Callaghan and Buddington (1938) as the volcanic rocks of the High Cascades extends eastward through much of the Klamath River basin of Oregon. This extension of these rocks was recognized by Moore (1937, p. 37). The volcanic rocks of the High Cascades in the Klamath River basin consist of two sequences of basaltic lava flows and a medial zone of stratified tuff, agglomerate, shale, diatomite, sandstone, volcanic ash, and mixtures of these materials. The pre-Quaternary rocks as a whole are cut by andesitic and basaltic intrusives, which are especially plentiful in the lower lava sequence and in the medial sedimentary and volcanic-sedimentary zone. This zone ranges in thickness from 0 to 2,000 feet, and, with a thickness of 200 to 800 feet, extends over much of the Klamath River basin (and the adjacent Lost River basin) in Oregon. It crops out in large areas in the physiographic subunits known as Yonna, Swan Lake, Sprague River, Williamson River, Poe, and Klamath valleys. It is a definite lithologic unit and is here named the Yonna formation.

Type Locality and General Field Relations

The area of type exposure is along the west side of Yonna Valley in Township 38 South, Range 11½ East, of the Willamette meridian and baseline. There it crops out in the slopes and is exposed in road cuts and foundation excavations. From this area its outcrop extends in an irregular band, 1 to 2 miles wide, north across the divide into Sprague River valley, where it crops out in slopes and streambanks over large parts of the valley. It extends north up the tributary Sycan River into T. 33 S., R. 11 E., where, after passing for a few miles under the lavas near Taylor Butte, it crops out along the east side of Williamson River northward for 12 miles to the slopes of Yamsay Mountain. This is the farthest north that the Yonna formation has been observed.

To the east, the Yonna formation crops out at intervals beneath the capping lavas at least as far as the Klamath Basin drainage divide, and it has extensive exposure in Barnes Valley. The Yonna formation continues westward down Sprague River valley into the lower part of Williamson River valley, where the formation crops out in the vicinity of Chiloquin. There are ex-

cellent exposures in the road cuts for 7 miles north of Chiloquin to the Spring Hill grade on Highway 97.

South from Chiloquin the formation is exposed intermittently in the fault escarpments along the east side of Upper Klamath Lake and crops out extensively in Klamath Valley southward from Klamath Falls to the vicinity of Merrill. Additional outcrops are found along the west side of Swan Lake Valley, in the escarpments around Poe Valley, and in the pass south from Poe Valley into the mountain slopes around the north end of Tule Lake basin.

The contact between the Yonna formation and the underlying, or lower, lava rocks is exposed in several places. Among the best of these contact exposures are those in the bank north of Harpold Dam on Lost River, and in Sprague River canyon just below Braymill. At these places the lowest part of the Yonna formation lies upon the eroded top of the lower lava rocks.

The Yonna formation is overlain with minor erosional unconformity by the upper lava rocks (Pliocene?), by Quaternary lava, or by alluvium. The upper lava rocks form a relatively thin but extensive caprock over the Yonna formation in large areas of the Klamath River and Lost River basins. Many of the linear exposures of the Yonna in lava-capped bluffs could not be shown in Figure 1. The Yonna is cut by many dikes and sills of a generally basaltic composition. Larger intrusives, such as those forming masses like Bug Butte and Council Butte in Sprague River valley between Beatty and Sprague River (town), are formed of crystalline dioritic or gabbroid rock.

Through most of the Klamath River and Lost River basins the Yonna formation, as well as the rest of the pre-Quaternary part of the volcanic rocks of the High Cascades, is broken by an intricate system of block faulting. The fault breakage and displacement are greatest in the trenchlike structures known as the Klamath and Langell grabens. In those grabens the strata of the Yonna formation have dips as high as 30 or 40 degrees. In the larger blocks, outside the main grabens, the strata dip mostly at low angles over broad areas.

Lithologic Composition

The Yonna formation in the type area consists in general of two units: (1) A lower sedimentary (lacustrine) section consisting of ashy diatomite, stratified sandstone, laminated siltstone, waterlaid volcanic ash, pumice, and semiconsolidated gravel, and (2) a rather thick upper unit of basaltic lapilli tuff, part of which was deposited in water. In general, the lacustrine rocks are best exposed along the banks of Lost River, whereas the lapilli tuffs crop

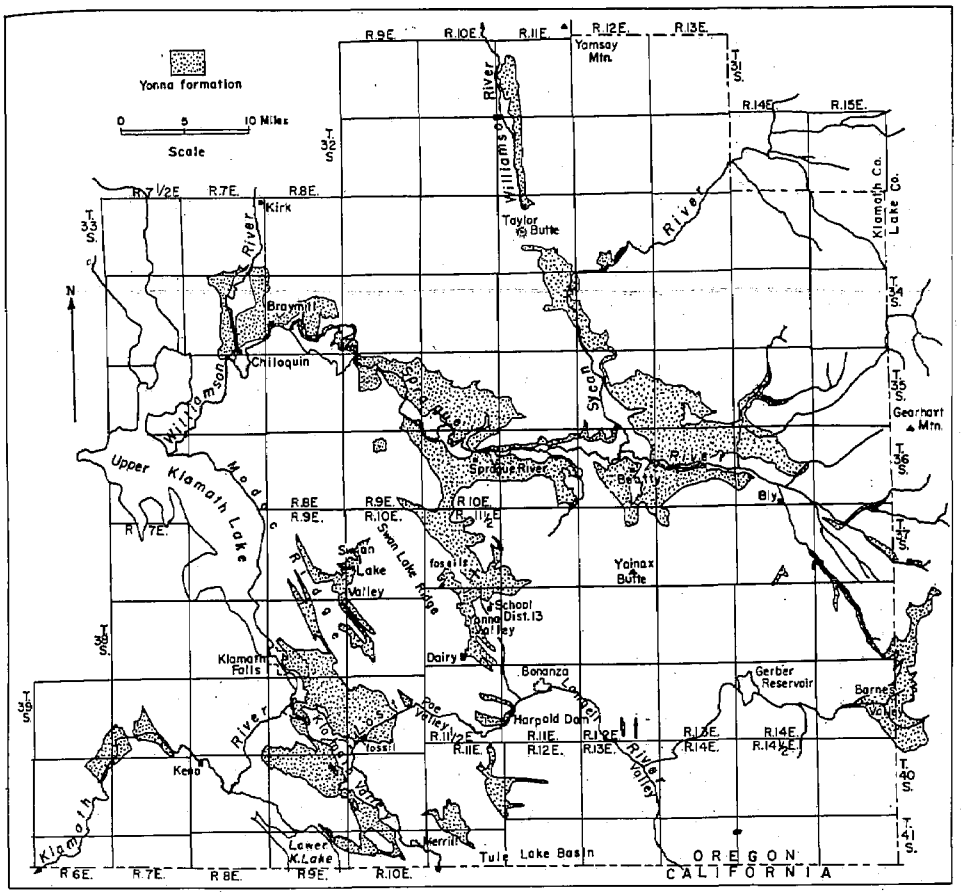

Figure 1. Map of the Oregon portion of the Klamath River basin showing the larger known areas of outcrop of the Yonna formation.

out more extensively in Yonna and Swan Lake valleys. Outside the type area there is much diatomite, waterlaid volcanic ash, and other sedimentary material in the upper part of the formation, and the relation of a sedimentary lower unit and a tuffaceous upper unit is not clearly established for the entire area of the Yonna formation.

Above the lower lava rocks at the site of the old Harpold Dam, and for about half a mile southwest of the dam, there are exposed in the right bank of Lost River small segments of the sedimentary rocks that there form the lower part of the sedimentary-rock unit of the Yonna formation. These segments have been cut by numerous small normal faults and tilted to the southwest. The section as described by Meyers and Newcomb (1952) is as follows:

	Feet
Top of section eroded	
Tuff, sandy black, fine-grained, laminated, friable	5
Ash, tan, fine-grained, laminated, consolidated	4
Tuff, sandy, black, fine-grained, laminated, friable	4
Ash, diatomaceous, white, and intercalated thin gray sandy laminae and one 4-inch bed of pumice	18
Lower lavas, base of section	
Total thickness of section	31

About 1.1 miles farther southwest, on the north side of the highway in the NW¼ sec. 30, T. 39 S., R. 11 E., a 15-foot-thick sheet of dense basalt rests on indurated brown tuff. Still farther west, on the north side of the road, sedimentary rocks crop out for a distance of 200 yards. Those rocks are faulted and tilted to the southwest. The following section was measured there:

	Feet
Top of section eroded	
Siltstone, grayish-green, laminated, indurated; breaks with a shaly fracture	5
Ash, diatomaceous, gray, laminated	20
Tuff, grayish-black, laminated, indurated	18
Siltstone, tuffaceous, brown, indurated; breaks with a shaly fracture	5
Basalt, sill, blue-black, dense, cubical jointing	15
Tuff, brown, indurated; contains angular fragments of basalt and glass of about 0.1-inch diameter in fine-grained matrix	10
Base not exposed	
Total thickness of section	73

In Yonna Valley there are extensive exposures of diatomite, diatomaceous volcanic ash, laminated siltstone, stratified sandstone, and volcanic ash. Those rocks crop out in the cuts of State Highway 66 and the O.C.&E. Railroad where they cross the long swells in the valley floor northeast of Dairy. The beds have been folded mildly and cut by numerous northwest-trending faults. In general, the siltstone and tuffaceous sandstone are comparatively firm and strong and are predominantly laminated, whereas the diatomaceous beds are friable and massive. A section measured in a railroad cut 1.5 miles northeast of Dairy is as follows:

	Feet
Top of section eroded	
Siltstone, gray-green, laminated, indurated; breaks with a shaly fracture	6
Lapilli, black, semiconsolidated, consisting of 1/10- to 1/4-inch subangular pebbles of basalt scoria, waterlaid, friable	.3
Siltstone, like the top unit	2
Sandstone, tuffaceous, brown, consolidated, fine-grained	1
Ash, diatomaceous, tan, friable	.1
Sandstone, black, laminated, fine-grained; waterlaid basaltic ash and lapilla, friable	1
Siltstone, like those units above	2
Sandstone, tuffaceous, brown, fine-grained and intercalated laminae of black basaltic tuff	3
Lapilli, black, semiconsolidated, consisting of 1/10- to 1/4-inch subangular pebbles of basalt scoria, waterlaid, friable	5
Siltstone, grayish-green, indurated, laminated in 1/4- to 1/2-inch-thick layers of black angular basaltic sands and minute tan and brown particles	12
Ash, diatomaceous, tan and buff, very light in weight, massive	15
Total thickness exposed	42.9

The lacustrine unit exposed in the southwestern part of Yonna Valley appears to interfinger with the upper, or lapilli-tuff, unit at the north end of the valley. At the north end of Yonna Valley, beneath the upper lava rocks that cap Swan Lake and Modoc Ridges, a rather thick unit of basaltic lapilli tuff occurs. A similar unit also occurs in Swan Lake, Poe, and Sprague River valleys. In general, the tuff is in thinly stratified layers and consists of scattered grains of black glassy lapilli within a matrix of tan to greenish-brown fine-grained angular ash and pumice. The greenish-brown ashy matrix of the thicker and more massive layers contains more basaltic fragments, lapilli, and glassy scoria than are commonly contained in more finely layered tuff. The basaltic fragments range in size from ⅛ to ½ inch. In the northern part of Yonna Valley, north of District School No. 13, there are several low swells made up of the edges of lapilli-tuff beds inclined outward in circular patterns that suggest truncated tuff cones. Those truncated cones probably represent old vents from which some of the tuffaceous material was thrown out. One of those beveled cones in the tuff forms Juniper Rock, a small eroded dome about 200 feet high in the SW¼ sec. 36, T. 37 S., R. 11½ E.

The thickness of the lapilli tuffs is more than 500 feet in the exposures in the northern part of Yonna Valley and in the northwestern part of Swan Lake Valley. The thickness of the lacustrine unit is nearly 500 feet in the

southern part of Yonna Valley and in the vicinity of the Harpold Dam. It is doubtful whether a complete section of both units is present at any single place. However, the Yonna formation reaches a thickness of more than 1,500 feet in wells at the northwest end of Swan Lake Valley and in Klamath Valley southeast of Klamath Falls. The thicknesses drilled in Yonna Valley range from 100 to 900 feet. Thicknesses of about 500 to 700 feet are penetrated commonly by deep wells in the Beatty area of Sprague River valley.

Age

Few fossils have been found in the Yonna formation. On the basis of the diatoms in samples examined for Moore (1937), K. E. Lohman (Geological Survey) assigns the deposits to the Pliocene (personal communication). In the NW¼NE¼ sec. 34, T. 37 S., R. 11½ E., numerous but poorly preserved fresh-water shells and a few fish bones were found by Meyers (Meyers and Newcomb, 1952, p. 39). Those fossils occur in a brown semiconsolidated tuffaceous sandstone, which apparently interfingers with the lapilli tuff. Specimens collected were identified by G. Dallas Hanna of the California Academy of Science as follows (Meyers and Newcomb, 1952):

> From a careful comparison with material from other western fresh-water deposits I am convinced that the age is Pliocene. It would be advantageous to date it closer, but I do not believe there is sufficient evidence available.
>
> The very large gastropod in your collection is *Carnifex* the species being the one I noted on page 6 'Univ. Oreg. Publ. vol. 1, no. 12, Aug. 1922.' It has not yet been described specifically because of lack of suitable well-preserved material.
>
> The abundant impressions of small gastropods are of a large high-spired *Amnicola* similar to the living *longinqua* (Gould). A few fragments of *Parapholyx* of *packardi* (Hanna) and a few internal impressions of bivalve *Sphaerium* are present.

Ten-Chien Yen of the U.S. Geological Survey examined a collection of specimens from the same site and identified the following forms of fresh-water mollusks:

Sphaerium	sp. undet.
Valvata	sp. undet.
Amnicola	sp. undet.
Laux cf. *L. klamathensis* Hannibal	
Physa	sp. undet.
Vorticifex binneyi (Meek)	
Lymnaea	sp. undet.

Yen concluded his analysis by stating that: "The occurrence of these related species seems to indicate a Pliocene age of its enclosing bed."

A peccary skull, reportedly found in the "Wilson's quarry pit" in the NW¼NW¼ sec. 32, T. 39 S., R. 10 E., was identified by Jean Hough of the U.S. Geological Survey as that of *Prosthennops oregonsis* Colbert, and its age placed as middle Pliocene (Meyers and Newcomb, 1952, p. 40). Although the exact position at which the fossil occurred in the pit is unknown, as it was found while excavation of the gravelly material was in progress, the reported find seemed to be authentic and the rock matrix enclosing the skull was a light-gray consolidated sandy tuff that appeared to be lithologically similar to the tuffs exposed in the sides of the quarry pit.

Just south of the quarry pit a ridge rises about 600 feet above the quarry. That ridge is made up of a thick sequence of lapilli tuff capped by the upper lava rocks. Those tuffs are lithologically similar to the ones exposed in Yonna Valley. The exact relationship of the two phases is not completely clear, but it is concluded that the diatomite and related sedimentary beds exposed in the quarry must represent the lacustrine phase and underlie the lapilli-tuff phase exposed in the ridge. Thus, the lacustrine phase of the Yonna formation is believed to be of middle Pliocene age, and the lapilli tuffs are of the same age or but slightly younger in the Pliocene.

Similar Rocks of the Region

To the north of Klamath Basin in the Deschutes River valley, a deposit of continental fluviatile deposits of great lithologic variety, The Dalles formation of Miocene or Pliocene age has been considered to be Pliocene in age by some authors (Chaney, 1941; Hodge, 1942). The principal area underlain by these deposits includes some of the valley and plateau areas between Bend and The Dalles, respectively 130 and 240 miles north of Klamath Falls. The topographic situation of the deposits—on the eastern flank of the Cascade Range—indicates a depositional environment similar to the basin to which the Yonna formation was deposited farther south. In Harney Lake basin, 160 miles northeast of Klamath Falls, two tuffaceous sedimentary and volcanic-sedimentary deposits, called the Harney (Pliocene?) and Danforth (Pliocene) formations by C. F. Park, Jr. (Piper, Robinson, and Park, 1939), are lithologically similar to the Yonna formation. In parts of Fort Rock Basin, which includes several subbasins—such as Silver Lake Basin and Christmas Lake Valley—and borders Klamath Basin on the northeast, there are extensive exposures of tuffaceous deposits of Tertiary age (Trauger, 1950). These deposits of Fort Rock Basin are lithologically similar to the Yonna formation and to parts of the Harney and Danforth formations.

No correlations with these similar formations or with unnamed deposits in these other basins of central Oregon are proposed at this time.

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