The Ore Bin

Vol. 35, No. 11
November 1973

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon - 97201
Telephone: 229 - 5580

FIELD OFFICES

2033 First Street
Baker 97814

521 N. E. "E" Street
Grants Pass 97526

Subscription rate - $2.00 per calendar year
Available back issues $.25 each

Second class postage paid
at Portland, Oregon

State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Bldg.
Portland Oregon 97201

The ORE BIN
Volume 35, no. 11
November 1973

STRATIGRAPHIC AND BIOSTRATIGRAPHIC RELATIONSHIPS OF THE TYEE AND YAMHILL FORMATIONS IN CENTRAL-WESTERN OREGON

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Introduction

The Yamhill Formation was defined by Baldwin and others (1955) as the "sequence of marine sedimentary rocks that overlies the Siletz River Volcanic Series." The type area was designated as the exposures of mudstone and siltstone along Mill Creek, south of Sheridan in northwestern Oregon. The name Yamhill has since been applied to the succession of black mudstone and siltstone interbedded with minor sandstone overlying the Tyee Formation and the Siletz River Volcanics in central-western Oregon and the volcanics and sediments undifferentiated" (Schlicker and Deacon, 1967) in the hills bordering the west edge of the Willamette Valley. Baldwin (1964b, p. 19) defined the Rickreall Limestone in the type area near Buell as a lower member of the Yamhill Formation He interpreted it to lie above the contact with the Siletz River Volcanics.

The lower part of the Yamhill Formation has been generally interpreted as equivalent to the upper Tyee and to interfinger with the Tyee where the two formations are in contact (Snavely and Wagner, 1964, p. 9; Baldwin, 1964a, p. 7). This interpretation is based on four considerations: (1) The mudstone and siltstone interbeds of the Tyee and the dominantly siltstone upper members of the Tyee (Lorane Siltstone, Elkton Siltstone, and Sacchi Beach) closely resemble rocks of the Yamhill Formation. (2) The Yamhill Formation is said to interfinger with the Tyee near Falls City (Baldwin, 1964a, p. 12). (3) Foraminifera from the type Yamhill Formation were used (Baldwin and others, 1955; Stewart, 1957) to correlate the Yamhill Formation with the Sacchi Beach member of the Tyee. (4) The stratigraphic position of the Yamhill above the Siletz River Volcanics in northwestern Oregon is similar to that of the Tyee Formation in southwestern Oregon.

Previous Work

Portions of the area shown in the geologic map (Figure 5) have been mapped by Baldwin (1947, rev. 1964b), Baldwin and Roberts (1952), Baldwin

and others (1955), and MacLeod (1969). Owing to the exploratory nature and geographic separation of their work, the Yamhill and Tyee Formations were not continuously distinguished and mapped throughout this area. Therefore, the primary concern of the writer in remapping the geology and studying the foraminifera of this area was to produce a consistent regional map and to determine the stratigraphic relationship between the Yamhill Formation and Tyee Formation. The writer recognizes the essential accuracy of most of the earlier work and strongly recommends them to the reader for comparison and particularly for additional structural and petrologic details.

Lithologic Discrimination of the Tyee and Yamhill Formations

The Tyee Formation was distinguished from the Yamhill Formation in the map area by the presence of sandstone interbeds greater than 6 inches thick and by the more fissile siltstone and mudstone (Figures 1 and 2).

The sandstone beds of the Tyee range from 6 inches to 10 feet thick, consist of lithic to arkosic micaceous wacke, and are rhythmically interbedded with shale. The sandstone beds contain current markings and sedimentary structures described in detail by Snavely and others (1964).

The mudstone and siltstone layers of both Tyee and Yamhill contain abundant mica and carbonized fragments of fossil plants. Sandstone interbeds are scarce in the Yamhill but where present include arkosic and basaltic wackes.

Although defined as a member of the Yamhill Formation, the Rickreall Limestone is characteristic of neither the Yamhill nor the Tyee Formations. In the area studied, the Rickreall Limestone occurs within or at the top of the Siletz River Volcanics. In addition, the foraminifera and other fossils of the Rickreall Limestone are known to occur in the Siletz River Volcanics but not in the Tyee or Yamhill Formations. Therefore, the Rickreall Limestone is shown as part of the Siletz River Volcanics on the map.

Stratigraphic Relationships of Tyee and Yamhill Formations

The geologic map shows that where the Yamhill occurs in depositional contact, as for example in the area 4 miles south of Grand Ronde, it overlies the Tyee. In most cases, however, the contact is located at normal and reverse faults and the Tyee and Yamhill are restricted to separate fault blocks. This indicates a layer-cake rather than interfingering relationship between the formations (Figure 3). Where the contact occurs along a fault, the Yamhill is always found on the downthrown block and the Tyee on the upthrown block, indicating the Yamhill is younger than the Tyee. This is particularly significant at the long east-west trending fault located 2 miles south of Grand Ronde. There the sense of displacement of the fault has been

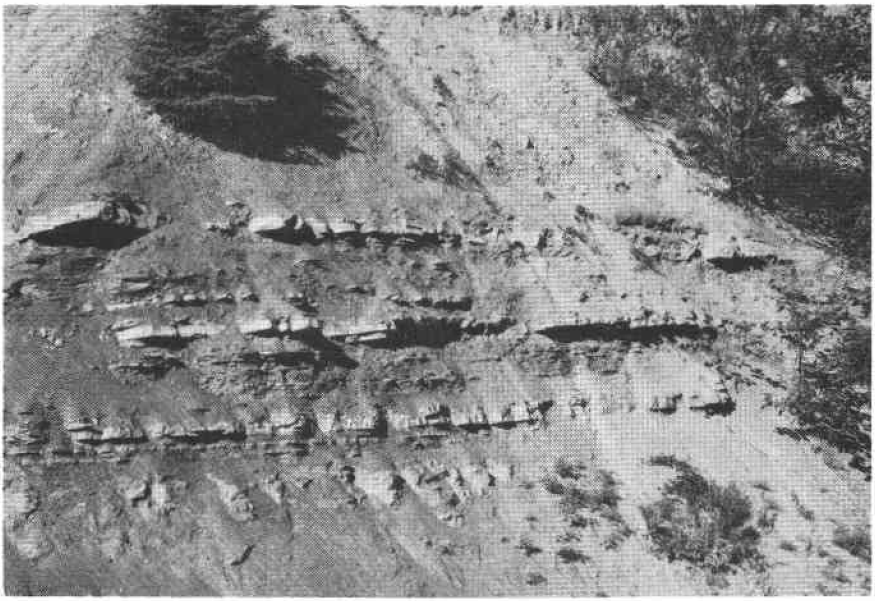


Figure 1. Typical weathered exposure of Tyee Formation showing resistant character of outcrops and the presence of sandstone beds 6 inches thick and greater. Hammer in lower center provides scale. Located center sec. 2, T7S, R8W, Valsetz quad.

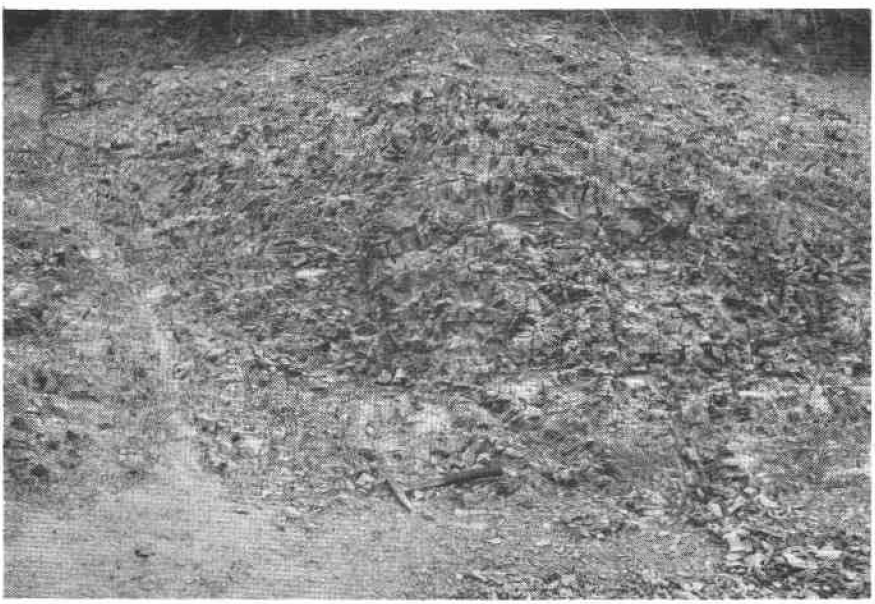


Figure 2. Typical weathered exposure of Yamhill Formation showing generally non-resistant character of outcrops and the absence of sandstone beds greater than 6 inches thick. Hammer in lower center provides scale. Located sec. 35, T6S, R8W, Grand Ronde quad.

independently determined by Baldwin and Roberts (1952) and MacLeod (1969), and the Yamhill side is downfaulted. The apparent interfingering reported by Baldwin (1964a) near Falls City was not observed. In a later publication, Baldwin (1964b) indicates, as does the map accompanying this article, (Figure 5), that the contact is located 3 to 4 miles south of Falls City. There the Yamhill overlies the Tyee Formation and is separated from it by a sill.

Biostratigraphic Relationships of the Tyee and Yamhill Formations

Fossil mollusks from the type Yamhill (Baldwin and others, 1955) indicate a Tejon age or what has been long regarded as upper Eocene age on the West Coast (Weaver, 1944). Fossil mollusks of the Tyee outside of the map area indicate a Domengine or middle Eocene age (Turner, 1938).

In apparent contradiction with this age distinction, Stewart (1957, p. 11; Baldwin and others, 1955) correlated the type Yamhill Formation and the Sacchi Beach member of the Tyee with Laiming's B-1A zone. Stewart (1957, p. 11) stated:

> ...the Yamhill-Sacchi Beach-lower McIntosh fauna is distinguished by the common and restricted occurrence of Amphimorphina californica Cushman and McMasters, which is Laiming's marker for the upper Domengine B-1A zone in California.... It appears to mark the upper range limits of a few middle Eocene species including Nodosaria latejugata Gumbel and probably [italics mine] Amphistegina californica Cushman and M. A. Hanna, A. simiensis (Cushman and McMasters) and Pseudophragmina psila (Woodring).

More recent information shows this correlation to be in error, however. Although Amphimorphina californica and Nodosaria latejugata are present in the Yamhill, the other species are not reported in Stewart's check lists (in Baldwin and others, 1955) and are not present in my collections of the Yamhill Formation along Mill Creek and elsewhere in the map area (Tables 1-5 and 7).

Amphimorphina californica and Nodosaria latejugata have recently been reported in definite Narizian assemblages by Rau (1964, p. 4, 7; 1966, Fig. 5) and with other species restricted to the Narizian in the type Yamhill by Stewart himself (Baldwin and others, 1955) and this author (Table 2). Therefore, these species can no longer be considered to be restricted to the Ulatisian or the B-1A zone.

The Tyee does not contain foraminifera diagnostic of age in the map area. Available data from the Tyee elsewhere in Oregon indicate it is no younger than Ulatisian (Stewart, 1957, p. 13; Snavely and others, 1964, p. 465; Thoms, 1965; and Bird, 1967). The Siletz River Volcanics (including

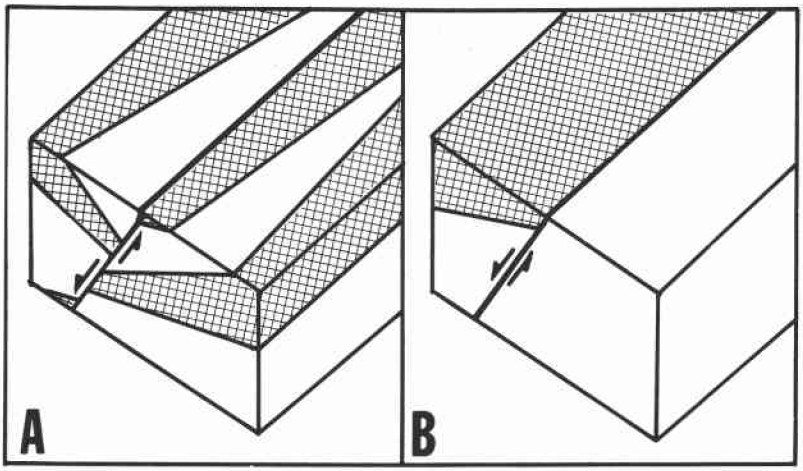


Figure 3. A. Effect of block faulting and erosion on interfingering stratigraphy. Note each facies, denoted by pattern, is found on each side of the fault.

B. Effect of block faulting and erosion on layer-cake stratigraphy. Note upper layer found only on down-thrown block.

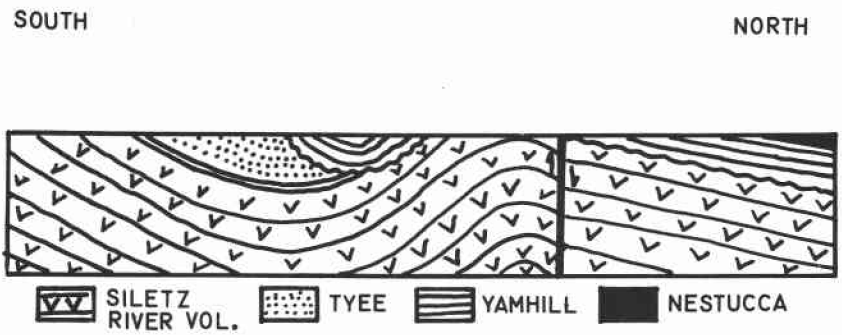


Figure 4. Generalized cross section showing angular unconformity between Yamhill and older formations. South end of section located near intersection of the southern boundary of the geologic map (Figure 5) and the Luckiamute River. North end of section located near Sheridan.

the Rickreall Limestone member) contains species indicative of the Ulatisian stage (Tables 1, 2, 5, 6, 8). In summary, present knowledge of the range of benthonic foraminifera indicate the Yamhill is Narizian and therefore younger than any of the Tyee and that correlation or interfingering of the two formations is not possible.

Stratigraphic Relationships of the Siletz River Volcanics and Yamhill Formation

The Yamhill Formation overlies the Tyee Formation in the southern and western portions of the map. Elsewhere in the map area it overlies volcanics mapped as Siletz River. This relationship is depicted in the cross section (Figure 4) as an angular unconformity. This interpretation requires deformation, uplift, and erosion of both the Tyee Formation and the Siletz River Volcanics prior to deposition of the Yamhill Formation. The type Siletz River Volcanics was defined by Snavely and Baldwin (1948) as underlying the Tyee and is lower Eocene in age. The Siletz River Volcanics underlying the Tyee south of the map area in the vicinity of Marys Peak contains fossils in the upper part indicative of Capay or lower Eocene age (Baldwin, 1955).

The rocks mapped as "Siletz River" underlying the type Yamhill along Mill Creek in the northern part of the map contain foraminifera whose joint occurrence indicate an upper middle Eocene age (at the Ulatisian-Narizian boundary). Elsewhere in the map area in the sub-Yamhill "Siletz River" is Ulatisian or middle Eocene (Tables 1, 2, 5, 6, 8). Apparently two volcanic units are involved although they have not been shown separately on the map. The type "Siletz River Volcanic Series" is one unit, and a younger volcanic sequence beneath the Yamhill Formation is the other. In addition, available biostratigraphic data suggest the sub-Yamhill "Siletz River" may even be young enough to be post-Tyee in age. Because of these and other difficulties, the writer has proposed to explain the relationship of the Yamhill to the underlying rocks in terms of the plate tectonics model (McWilliams, 1972, 1973).

Conclusions

(1) Field mapping and biostratigraphic data indicate that the Yamhill Formation overlies and is younger than the Tyee Formation; interfingering of the two formations is not indicated. (2) Stewart's correlation of the Yamhill Formation with the Sacchi Beach member of the Tyee was based on incomplete knowledge of the range in time of key species. Presently available information rules out age equivalence of the two units. (3) Available biostratigraphic data suggest that the sub-Yamhill "Siletz River" is younger than the sub-Tyee Siletz River and may even be post-Tyee in age.

Fossil localities indicated by number in Tables 1-8 are shown on the geologic map (Figure 5) and described in the "Register of Localities."

Table 1. Check list of foraminifera from the Rickreall Creek section

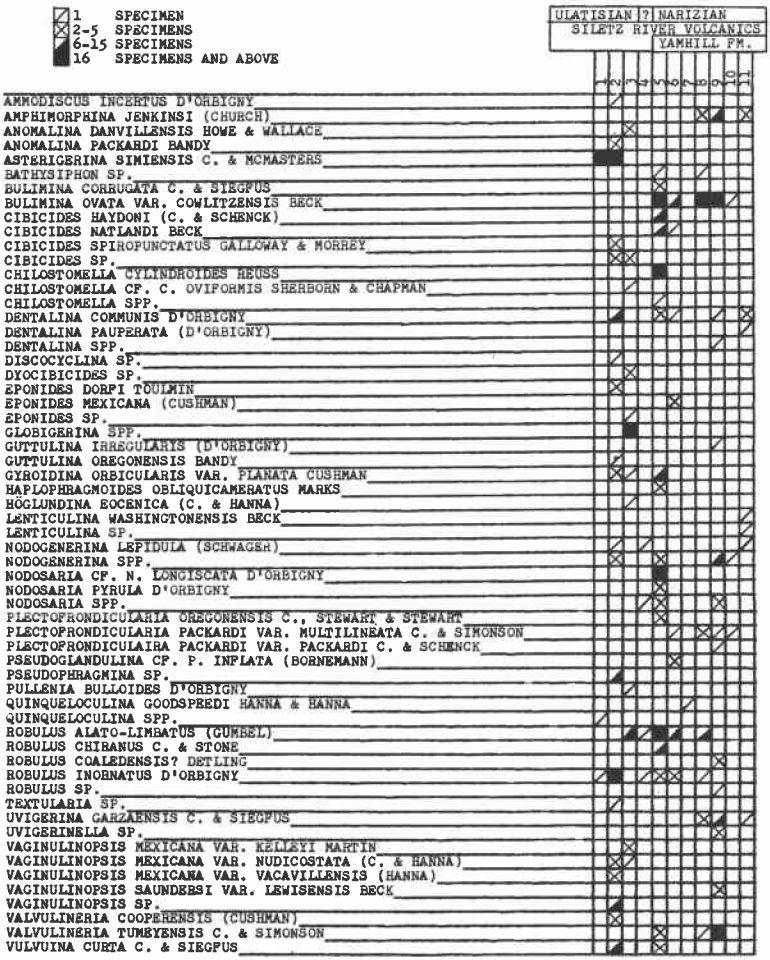


Table 2. Check list of foraminifera from the Mill Creek section

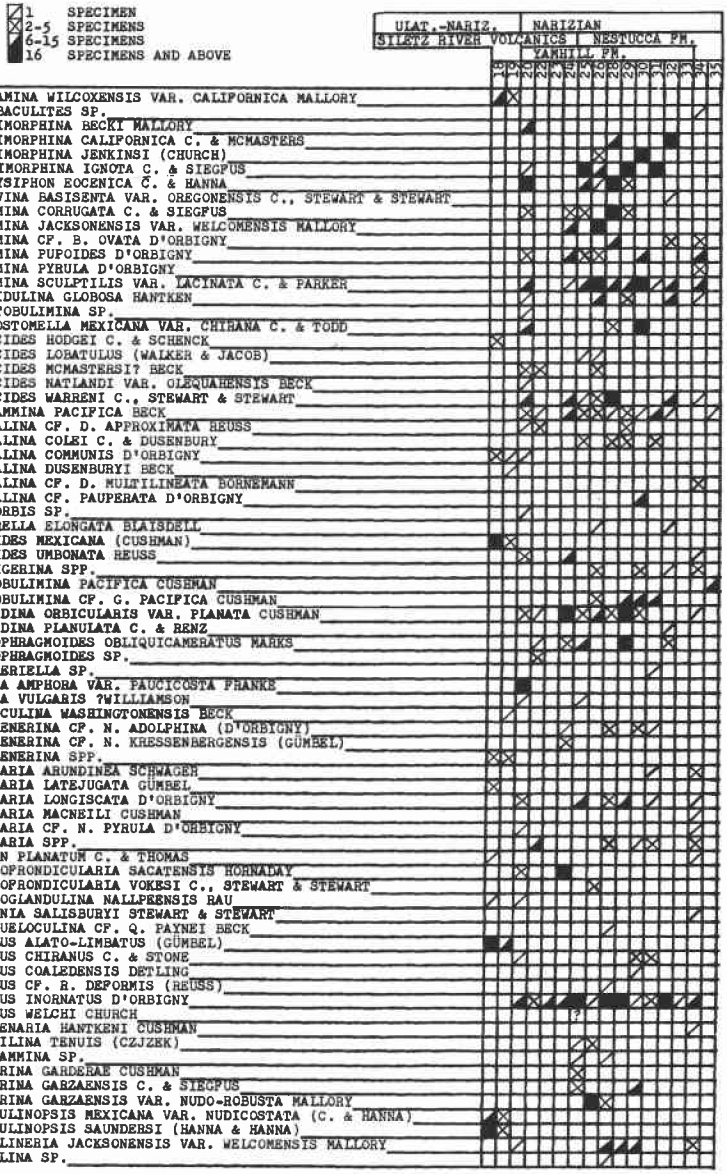


Table 3. Check list of foraminifera from the Rowell Creek section

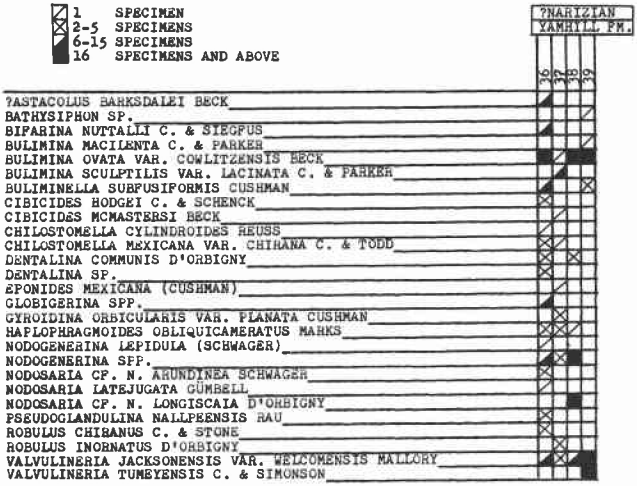
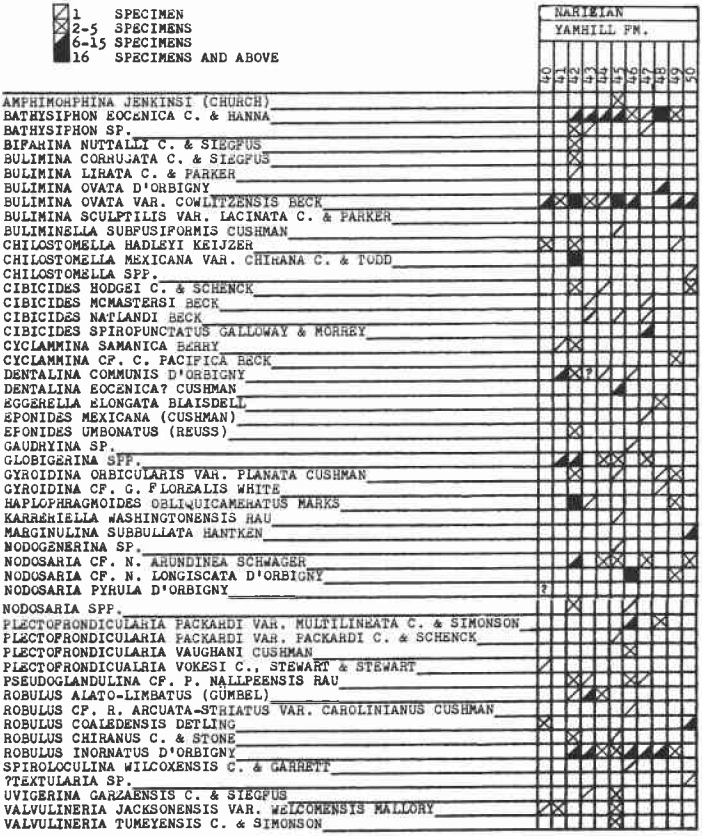
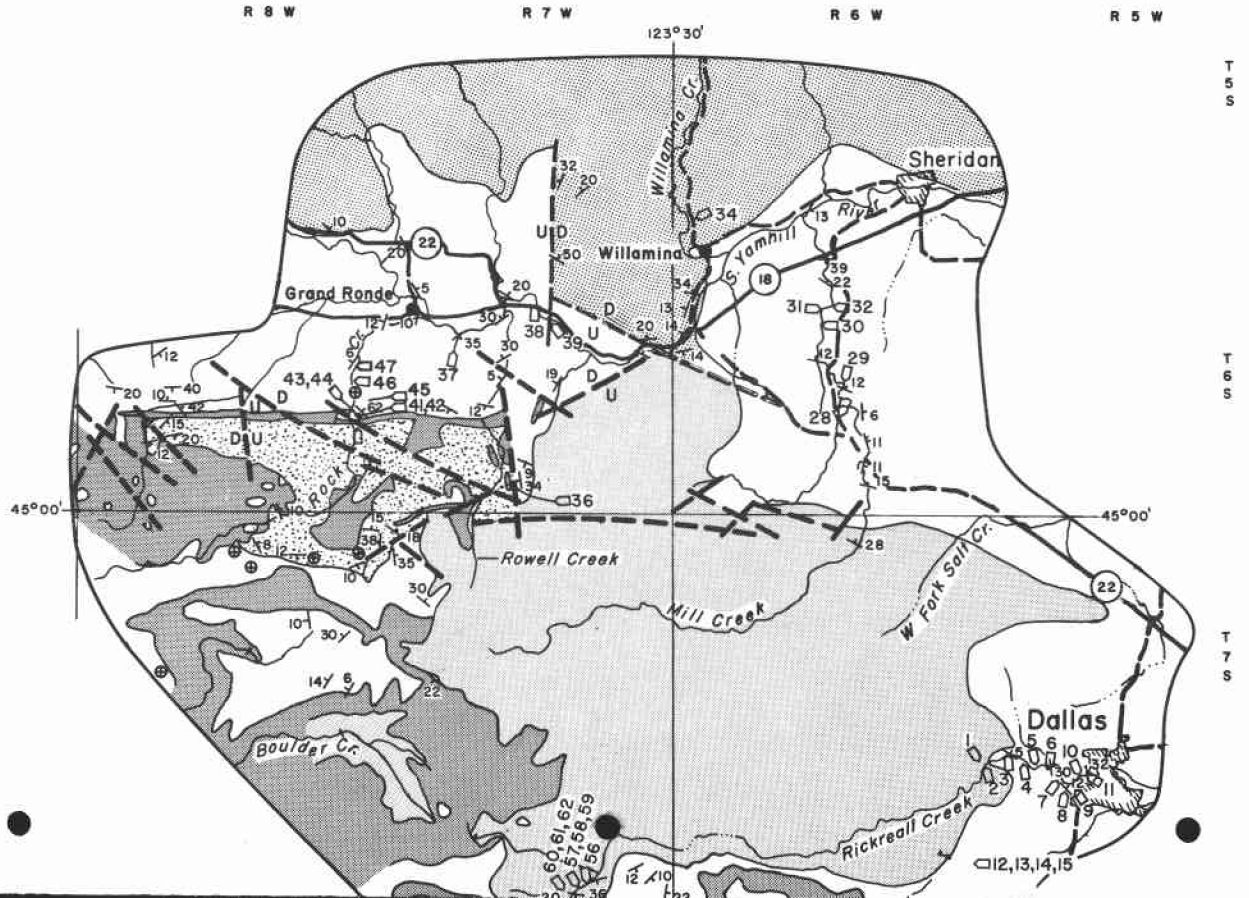


Table 4. Check list of foraminifera from the Rock Creek section




R 8 W
R 7 W
R 6 W
R 5 W
123°30'
T 5 S
T 6 S
T 7 S
45°00'
45°00'
Sheridan
Willamina
Grand Ronde
Willamina Cr.
S. Yamhill River
Rock Creek
Rowell Creek
Mill Creek
W. Fork Salt Cr.
Boulder Cr.
Rickreall Creek
Dallas
22
18
43,44
46
45
41,42
47
36
28
12,13,14,15
60,61,62
57,58,59
56

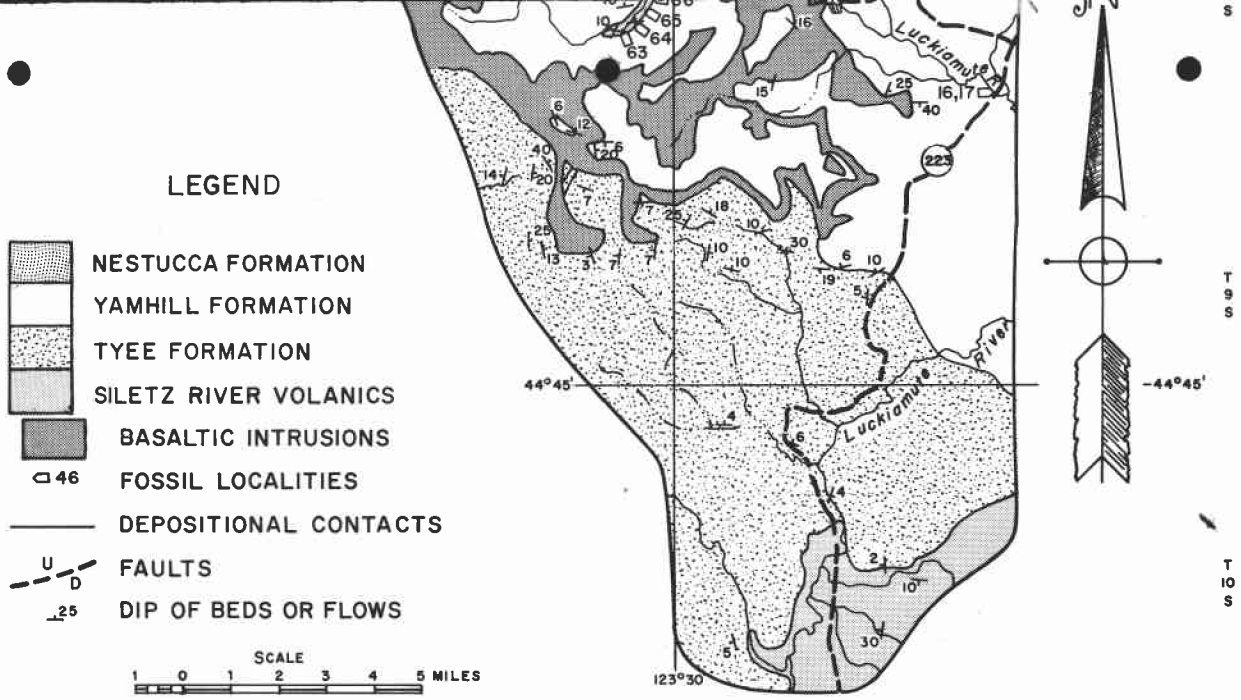


Figure 5. Geologic Map of the Dallas - Grand Ronde, Oregon

Table 5. Check list of foraminifera from the Oakdale School section

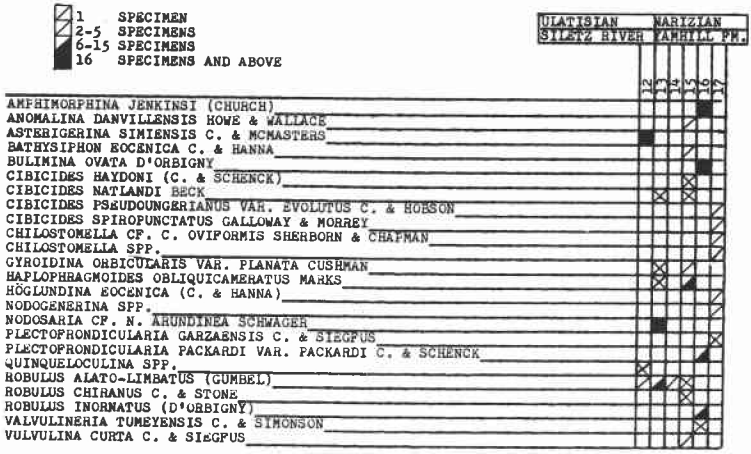


Table 6. Check list of foraminifera from the South Fork Rickreall Creek section

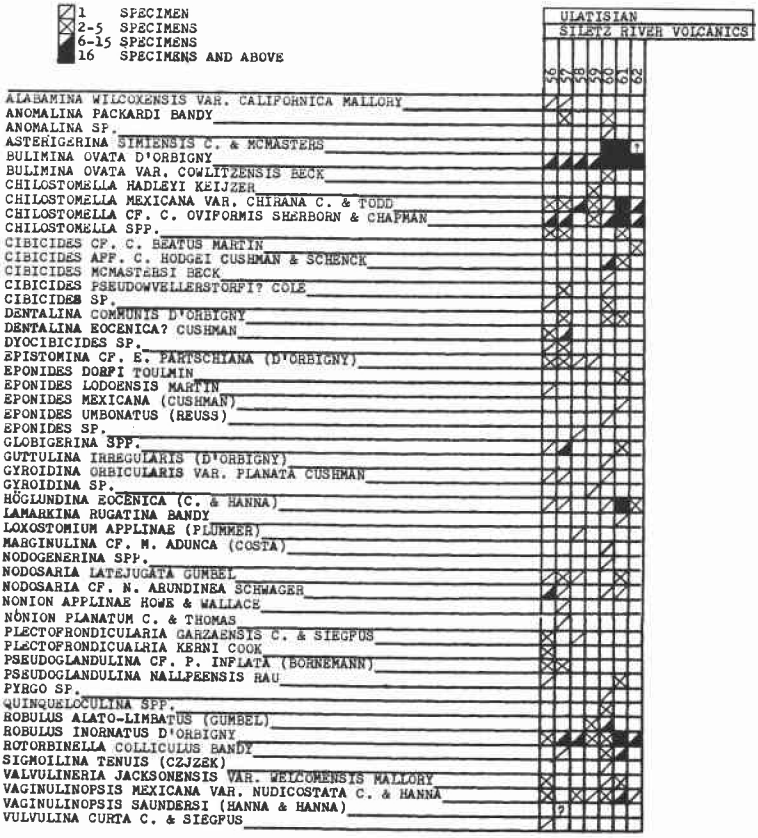
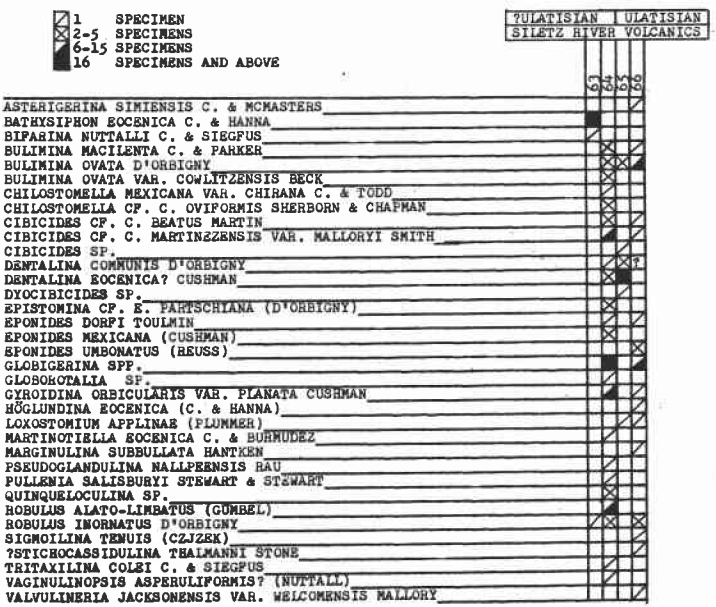


Table 7. Check list of foraminifera from the Salmon Creek section

Table 8. Check list of foraminifera from the Little Luckiamute River section



Register of Localities*

Locality No.

1. Ellendale quarry, NW¼ sec. 36, T7S, R6W, Dallas 15' quad. Sample collected at top of quarry in basaltic ss. on south side.
2. North bank Rickreall Cr. about 400 feet south of north boundary sec. 36, near Ellendale quarry, T7S, R6W, Dallas 15' quad.
3. Intersection of sec. 25 and 30 and Rickreall Cr. T7S, R5 and 6W, Dallas 15' quad.
4. Intersection of Rickreall Cr. and second "l" in "Ellendale" SW¼ SW¼ sec. 30, T7S, R5W, Dallas 15' quad.
5. In Rickreall Cr., immediately below the "i" in "Rickreall" SE¼ NW¼ sec. 31, T7S, R5W, Dallas 15' quad.
6. In Rickreall Cr. immediately below second "l" in "Rickreall", NE½ NE¼ sec. 31, T7S, R5W, Dallas 15' quad.
7. Just inside sec. 31 near boundary with sec. 32 in Rickreall Cr., T7S, R5W, Dallas 15' quad.
8. In Rickreall Cr. about 400 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
9. In Rickreall Cr. about 1,200 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
10. In Rickreall Cr. about 2,000 feet east of west boundary of section in SE¼ NW¼ sec. 32, T7S, R5W, Dallas 15' quad.
11. In Rickreall Cr. about 3,000 feet east of west boundary of sec. 32, T7S, R5W, Dallas 15' quad.
12. In quarry floor NW¼ NW¼ sec. 12, T8S, R6W, Dallas 15' quad.
13. In black mudstone 6 feet above contact with underlying basalt at north end of quarry NW¼NW¼ sec. 12, T8S, R6W, Dallas 15' quad.
14. In black mudstone 12 feet above contact with underlying basalt at north end of quarry in NW¼ NW¼ sec. 12, T8S, R6W, Dallas 15' quad.
15. In black mudstone 18 feet above contact with underlying basalt at north end of quarry in NW¼ NW¼ sec. 12, T8S, R6W, Dallas 15' quad.
16. In Luckiamute River about 500 feet SE of State Highway 223 in NW¼ NE¼ sec. 36, T8S, R6W, Dallas 15' quad.
17. NW side of bridge on Little Luckiamute River NE¼ sec. 36,T8S, R6W, Dallas 15' quad.
18. On east side Mill Cr. next to NE support of bridge NE¼ sec. 4, T7S, R6W, Dallas 15' quad.

* Localities are shown on the geologic map (Figure 5).

19. In Mill Cr. at east footing of bridge in NE¼ sec. 4, T7S, R6W, Dallas 15' quad.
20. On west bank of Mill Cr. about 200 feet north of bridge NE¼ NE¼ sec. 4, T7S, R6W, Dallas quad.
21. No fossils collected.
22. On east bank of Mill Cr. approximately 400 feet south of section line, NE¼ NE¼ sec. 4, T7S, R6W, Dallas quad.
23. On west side of Mill Cr. about 600 feet north of section line SE¼ sec. 75, T6S, R6W, Sheridan quad.
24. In Mill Cr. about 600 feet west of section line SE¼ sec. 52, T6S, R6W, Sheridan quad.
25. On NW bank of Mill Cr. about 200 feet west of section line NE¼ sec. 52, T6S, R6W, Sheridan quad.
26. 800 feet north of section line in Mill Cr. SW¼ sec. 54, T6S, R6W, Sheridan quad.
27. No fossils collected.
28. In middle of Mill Cr. about 200 feet upstream from intersection of 320-foot contour and stream, NE¼ sec. 43, T6S, R6W, Sheridan quad.
29. 100 feet north of section line in Mill Cr. SE¼ SE¼ sec. 41, T6S, R6W, Sheridan quad.
30. 600 feet south of section line in Mill Cr. NW¼ NW¼ sec. 41, T6S, R6W, Sheridan quad.
31. 300 feet north of south section line on west bank of Mill Cr. S½ sec. 39, T6S, R6W, Sheridan quad.
32. 1,000 feet north of section line in Mill Cr. SE¼ SE¼ sec. 39, T6S, R6W, Sheridan quad.
33. 100 feet south of section line in Mill Cr. NW¼ NW¼ sec. 38, T6S, R6W, Sheridan quad.
34. On east side of road in quarry about 75 feet north of road intersection sec. 36, T6S, R6W, Sheridan quad.
35. In quarry on east side of road, 300 feet east of section line sec. 1, T6S, R6W, Sheridan quad.
36. In Rowell Cr. at bend about 1,900 feet south of north boundary sec. 32, T6S, R7W, Grand Ronde 15' quad.
37. In South Yamhill River at south extremity of bend in river near south corner of sec. 57, T6S, R7W, Grand Ronde 15' quad.
38. On east bank South Yamhill River about 500 feet south of fork in E½ sec. 9, T6S, R7W, Grand Ronde 15' quad.
39. In South Yamhill River on north bank, about 2,500 feet NW of BM 272 in sec. 46, T6S, R7W, Grand Ronde 15' quad.
40. In Rock Cr. about 500 feet south of fork in creek, in N½ sec. 26, T6S, R8W, Grand Ronde 15' quad.
41. In Rock Cr. 75 feet north of locality 40, N½ sec. 26, T6S, R8W, Grand Ronde 15' quad.

42. In Rock Cr. 125 feet north of locality 40, N½ sec. 26, T6S, R8W, Grand Ronde 15' quad.
43. In Rock Cr. located 50 feet north of Siletz River outcrop in Yamhill Fm. at bend in creek, about 250 feet north of south boundary, sec. 23, T6S, R8W, Grand Ronde 15' quad.
44. In Rock Cr. at west extremity of bend in creek, about 600 feet north of south boundary, sec. 23, T6S, R8W, Grand Ronde 15' quad.
45. In Rock Cr. about 100 feet SW of right angle turn in creek near center S½ sec. 23, T6S, R8W, Grand Ronde 15' quad.
46. In Rock Cr. about 1,900 feet south of north boundary sec. 23, T6S, R8W, Grand Ronde 15' quad.
47. In Rock Cr. at boundary between sec. 14 and sec. 23, T6S, R8W, Grand Ronde 15' quad.
48. In Rock Cr. NE¼ sec. 14, T6S, R8W, at north extremity of bend in creek about 1,000 feet south Salmon River Highway, Grand Ronde quad.
49. In Rock Cr. extreme NW¼ NW¼ sec. 13, T6S, R8W, about 500 feet west of road crossing Rock Creek, Grand Ronde 15' quad.
50. In Agency Cr. beneath bridge along state route 22, NW¼ sec. 1, T6S, R8W, Grand Ronde 15' quad.
51. In Salmon River 1,200 feet north of south boundary, sec. 24, T6S, R9W, Grand Ronde 15' quad.
52. In Salmon River about 1,600 feet SE of fork in NE¼ SE¼ sec. 24, T6S, R9W, Grand Ronde 15' quad.
53. In Salmon River about 1,200 feet SE of fork in sec. 24, T6S, R9W, Grand Ronde 15' quad.
54. In Salmon River at fork near center sec. 24, T6S, R9W, Grand Ronde 15' quad.
55. In Salmon River about 1,500 feet NW of fork in N½ sec. 24, T6S, R9W, Grand Ronde 15' quad.
56. In South Fork Rickreall Cr. in NW¼ SW¼ sec. 10, T8S, R7W, Valsetz 15' quad. about 1,000 feet east of west boundary sec. 10.
57. In South Fork Rickreall Cr. about 985 feet east of west boundary of sec. 10, T8S, R7W, Valsetz 15' quad. 15 feet south of locality 56.
58. In South Fork Rickreall Cr. about 965 feet east of west boundary sec. 10, T8S, R7W, Valsetz 15' quad. 25 feet south of locality 56.
59. In South Fork Rickreall Cr. about 805 feet east of west boundary sec. 10, T8S, R7W, Valsetz 15' quad. 195 feet south of locality 56.
60. In South Fork Rickreall Cr. about 635 feet west of east section boundary in SE¼ sec. 9, T8W, R7W, Valsetz 15' quad.
61. In South Fork of Rickreall Cr. about 425 feet west of east section boundary in SE¼ sec. 9, T8S, R7W, Valsetz 15' quad.
62. In South Fork Rickreall Cr. at intersection with south boundary of sec. 9, T8S, R7W, Valsetz 15' quad.

63. In Luckiamute River about 1,100 feet west of east boundary sec. 22, T8S, R7W, Valsetz 15' quad.
64. In Luckiamute River at intersection of boundary between secs. 22 and 23, T8S, R7W, Valsetz 15' quad.
65. In Luckiamute River at intersection with creek SW¼NW¼ sec. 23, T8S, R7W, Valsetz 15' quad.
66. In Luckiamute River about 1,100 feet south of north boundary sec. 23, T8S, R7W, Valsetz 15' quad.

Acknowledgments

I wish to recognize the help of Professor V. S. Mallory of the Department of Geology and the Burke Museum, University of Washington, under whose guidance and with whose help this work was begun in 1967. I am also greatly indebted to Dr. John Beaulieu, Oregon Department of Geology and Mineral Industries, for sharing with me his extensive knowledge of the stratigraphy of the Pacific Northwest. Financial support for this work was provided by the Miami University Faculty Research Committee and by a Penrose Grant from the Geological Society of America. I accept full responsibility, however, for the data and interpretations proposed.

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GEOTHERMAL DEVELOPMENTS OUTSIDE THE UNITED STATES

Many countries of the world are recognizing the usefulness of geothermal resources for supplementing, and in some cases surplanting, the conventional energy systems. The following notes from various journals give an indication of these activities.

Italy

In March 1973, the total generating capacity of geothermal plants in Italy was increased to 405.6 MW. The average production per plant was 2.5 billion kw hr/yr. Drilling activity has been fruitful in the Travale-Radiocondoli area 20 km east-southeast of Larderello. Well 22, completed this year, produced 326,000 kg/hr of 180°C steam; shut-in pressure is 60 bars.

Monti Volsini is a new field 80 km northwest of Rome. A well completed in August produced steam at 300,000 kg/hr and had a shut-in pressure of 33 bars. Two wells have been drilled in the Viterbo-Monti Cimino hot-water system 50 km northwest of Rome. The wells are now being tested for production and reinjection in a zone below 700 m.

Exploration for geothermal resources is continuing in a 30,000 km^2 area along the west coast of Italy and on the islands of Sicily and Sardinia. The geothermal prospect area represents 10 percent of the Italian territory. (P. Ceron, Geothermal Hot Line Newsletter)

New Zealand

Development drilling has begun at the Broadlands field in New Zealand after several years of delay. The discovery of large reserves of natural gas in offshore fields caused delay in the development of the Broadlands field as new power plants utilizing the natural gas were considered. The government energy policy now is to utilize the geothermal resources more extensively and to reserve natural gas for higher quality uses than boiler fuel. (Geothermal Hot Line Newsletter and Electrical World)

Iceland

Considerable exploration and drilling has taken place in Iceland during the last 3 or 4 years. Most of this has concentrated on developing new sources of hot water and steam for space and process heating in order to reduce the island's dependency on imported oil. (Geothermics)

Japan

The Japan National Natural Resources Committee reported on May 5, 1973 that Japanese scientists and experts have estimated that it is possible

to develop geothermal energy in Japan in a range between 30,000-50,000 MW and perhaps up to 60,000-140,000 MW.

In addition to the presently operating fields at Matsukawa and Otake, four other fields are under development. Near Hachimantai-Onuma, a 10 MW turbine-generator set is now being installed and is expected to be in operation in December 1973. At Onikobe, ten successful dry-steam wells have been drilled, and construction of an initial 25 MW plant is underway. At Katsukonda, construction is underway, with initial plans to install 200 MW in increments of 50 MW each. At Hatchobaru, Kyushu Electric Power Co. is developing an initial 50 MW geothermal unit scheduled for operation in 1975, with possible expansion to 200 MW. (Geothermics)

Phillipine Islands

Three successful geothermal wells have been drilled in the Tiwi area of southern Luzon and developmental drilling is continuing. The United States has just announced a loan of $4.2 million to the Phillipine National Power Corporation for the construction of a 10 MW electric generating plant and necessary transmission facilities. (Geothermal Hot Line Newsletter)

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5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS (Not printers): 1069 State Office Bldg., Portland, Multnomah, Oregon 97201
6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER (Name and address): Oregon Dept. of Geology and Min. Indus., 1069 State Office Bldg., Portland, OR 97201

EDITOR (Name and address): R. E. Corcoran, State Geologist, 1069 State Office Bldg., Portland, OR 97201

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