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ART. XXXIX. — *The Mesozoic Sediments of Southwestern Oregon;* by J. S. DILLER.

The Mesozoic Sediments of Southwest Oregon.

Introduction.

The Klamath Mountains of southwest Oregon and the adjacent portion of California, like the Sierra Nevada, are composed in large part of Paleozoic sediments associated with masses of intrusive and effusive rocks of various ages. Mesozoic sediments are of less amount than the Paleozoic and have their most extensive development along the mountain borders, from which they overlap and by deformation are so involved with the older rocks as to form an important structural element of the Klamath mountain mass.

The peripheral portion of the Klamath Mountains has been surveyed in the Lassen Peak and Redding quadrangles of California and the Roseburg, Coos Bay and Port Orford quadrangles of Oregon. The remaining peripheral portion, as well as the mountains themselves, has been covered by reconnaissance, and the general results in areal distribution are shown upon the geological map of North America, published by the International Geological Congress for the meeting in Mexico, 1906.

The study of the Mesozoic in southwest Oregon is far from complete, but the publication of the map referred to above and the general interest in the region, as shown by Mr. Louderback's article in the Journal of Geology for September, 1905, p. 514, call for additional data, which this paper is intended to partly supply. It will, however, be limited to the consideration of the sedimentary rocks only, since they alone contain the records of geologic age to which the others must be referred.

Subdivisions Discriminated.

The Mesozoic, as far as known in southwest Oregon, belongs to the Cretaceous and Late Jurassic. The bottom of the latter has not yet been determined, and what may lie between it and the Paleozoic rocks of the same region is a matter for further investigation. The bodies of strata thus far discriminated are as follows:

Cretaceous

- Chico formation
- Myrtle "

Jurassic

- Dothan formation
- Galice "

Galice Formation (Jurassic).

Definition.—The Galice formation is composed chiefly of fine dark to black sediments with a well-marked slaty cleavage. Subordinate amounts of sandstone and conglomerate occur and the whole is characterized by an upper Jurassic fauna. It is named from Galice Creek, where the rocks are well exposed.

Lithology.—The slates are generally black and weather gray. A well-developed slaty cleavage prevails, but locally they may be shaly or on the other hand so sheared as to break up into small slickensided fragments. Where massive, their stratification is shown only by occasional thin beds of sandstone.

The sandstones are light-gray, hard and siliceous, and though much less abundant than slate form occasional heavy beds, but more commonly are not a foot in thickness.

The conglomerates, much less abundant than sandstone, are composed chiefly of cherty quartz pebbles with some fragments of sandstone or rarely of limestone. Igneous material is for the most part absent, though sometimes abundant in tufaceous rocks interstratified with the others. One bed of moderately fine conglomerate is 30 feet in thickness. The others were all less than ten feet, with pebbles smaller than marbles.

Quartz veinlets are locally abundant in the slates parallel to their cleavage and may fill numerous small irregular fractures in the sandstone, but they are neither a conspicuous nor a regular feature.

The stratification of the Galice formation is in most places plainly marked. The strata have been greatly compressed and folded but not crushed to small fragments. Incipient schistose structure occurs locally with very little recrystallization along lines of special disturbance, but it is neither a prominent nor common feature.

Distribution and thickness.—The Galice formation is distributed at intervals along a line running northeast from the boundary of California to the South Fork of the Umpqua River, a direct distance of nearly 100 miles. The most important area extends from Galice on Rogue River in a slightly irregular course northeast for 20 miles across Grave Creek to Cow Creek, 2 miles below Glendale. This belt is from 2 to 3 miles in width, and continuous throughout, but is completely surrounded by igneous rocks. It is the small Jurassic area noted along Rogue River on the map of North America. The strata, with but little variation, dip S.E. at an angle ranging from 30° to 50°, and have a thickness of not less than 2,000 feet. Grave Creek affords an excellent section across the belt, distributed approximately as follows:

30	feet.	Conglomerate locally overlain by a few feet of black slates greatly sheared.
300	"	Dark sandstones with some heavy layers and a small proportion of interbedded slates.
1000	"	Black slates.
500	"	Sandstones and conglomerates with a smaller proportion of slates.
200	"	Slates, black and gray.

Within the Galice area to the northeast of Grave Creek the proportion of dark sandy slates increases and to the southwest along Galice Creek and Rogue River it is slightly diminished. Along the eastern border tufaceous rocks play a considerable part.

Sixteen miles northeast of Glendale the Galice slates reappear on the slope of Canyon Creek and form a narrow belt extending northeast between volcanic rocks to the forks of Beal Creek and beyond, where it merges into a great thickness of black slates exposed along the South Fork of the Umpqua.

To the southwest of Galice the slates are interrupted by igneous rocks but reappear 35 miles beyond in California, where the conglomerates and slates cover a large area. They are well exposed near the Oregon line about the head of Shelly and Monkey creeks, which are tributaries of Smith River.

Fossils and age.—The first fossils discovered in this formation were obtained on Galice Creek by Prof. J. N. Hyde, of the State University of Oregon, who through Chester W. Washburne kindly loaned his collection for determination. Dr. T. W. Stanton, who has examined all the fossils, reports the following forms:

Along Galice Creek and Rogue River, *Aucella erringtoni* occurs at many points. Is well preserved at Almeda mine, where *Perisphinctes* was obtained through the superintendent, H. B. Perks. In a conglomerate at the mouth of Anderson Gulch, *Trigonia*, *Amberleya*, and *Belemnites* were found with *Aucella*, and Dr. Stanton remarks that "the state of preservation of this lot is too poor for specific determination. Many of the Aucellae cannot be distinguished in form from *A. piochi*, but a few fragmentary imprints of the surface indicate that they were striated like *A. erringtoni*."

Along Grave Creek, *Aucella erringtoni* was found at numerous horizons throughout the section. Belemnites is common, and at one point Pecten ? was found.

On Cow Creek, near the mouth of Rattlesnake, one-fourth mile below Reuben Spur, the largest collection was obtained, and Dr. Stanton recognizes "Aucella erringtoni, Ctenostreon ? sp., Pecten ? sp.—may be a Lima, Turbo ? sp., Perisphinctes ? sp.—same as that from Anderson's ditch on Galice Creek."

On O'Shea Creek only *Aucella erringtoni* was found. The same form occurs with Belemnites by the stage road from Grant's Pass to Crescent City, on Shelly and Monkey Creeks.

In the field, the three areas of the Galice formation noted above were regarded as Jurassic, and Dr. Stanton remarks that "the examination of the fossils has confirmed this view, although the evidence is not as strong as might be desired. In most cases the determination is based on the occurrence of a form of Aucella with numerous distinct radiating striae which I have identified with *Aucella erringtoni*, a common species of the Mariposa slates in California. The Aucellae of the Lower Cretaceous Knoxville beds often have nearly the same outlines, but they never show the distinctive surface sculpture above mentioned. So far as our present knowledge goes, therefore, we are justified in assigning all beds containing Aucellae with numerous fine radiating striae to the Jurassic. In two of the lots, 6682 (Anderson's ditch) and 6687 (Almeda mine), this reference is strengthened by the presence of Ammonites of Jurassic type. This is especially true of 6687, which contains a Perisphinctes very closely related to or possibly identical with the Mariposa species doubtfully referred by Hyatt to *P. filiplex*. The Perisphinctes (?) in lot 6682 is of a different group which also resembles European Jurassic forms."

Four lots from Galice, Grave and Rattlesnake creeks "all contain poorly preserved specimens of Aucella that do not show the surface features well enough for specific identification, though from the character of the matrix and from their relations with the lots containing *Aucella erringtoni*, it is probable they are Jurassic.

Four lots from Shelly and Monkey creeks "are probably also Jurassic as the Aucellae though not very well preserved seem to have the striated surface in most of the lots."

Structure of Galice area.—Notwithstanding the fact that there are three good sections of the Galice area afforded by Rattlesnake Creek, Grave Creek and Rogue River, its structure and relation to the associated volcanic rocks are not clearly understood. Along the main stream and East Fork of Rattlesnake the position of the strata suggests a synclinal structure for the belt, with the western arm well marked but the eastern one less regular and indefinite. This is due at least in some measure to the fact that in the eastern arm the slaty cleavage makes a large angle with the stratification and tends to obscure it. Where the strata strike N. 45° W. and dip 50° S.W., the slaty cleavage strikes N. 55° E. and dips 50° S.E. The slaty cleavage throughout the area with but few doubtful exceptions dips to the S.E. more or less steeply, and is generally much more distinctly marked than the stratification.

The section so well exposed along Grave Creek dips, with rare exceptions, to the S.E., and it is evident that if the general structure of the Galice area is synclinal the southeast arm must have been overturned towards the northwest so as to give the strata a monoclinal attitude. Strong evidence against the synclinal view is afforded by a comparison of the two halves of the Grave Creek section, for they are not repetitive but supplemental.

The narrow V-shaped valley of Rogue River affords a good section of the Galice area. Just above the mouth of Galice Creek the beds are much twisted and sometimes vertical, but farther up the river the dip is from 25° to 50° S.E., and this agrees with their position on Galice and Taylor creeks. The slaty structure has the same position, and approaching the eastern border of the area the fine sediments become so decidedly slickensided as to suggest displacement. Below the mouth of Galice Creek the strata with few exceptions dip to the N.W. at a high angle ranging from 65° to 80°, and at the Almeda mine along the northwest limit of the area the slates are practically vertical.

Though the section of the Galice area along Rattlesnake Creek suggests a synclinal structure, the view is not supported by the Grave Creek and Rogue River sections, and overlooking minor displacements within the mass it appears to be essentially monoclinal and a continuous series with general dip to the S.E.

Limits of Galice formation.—The limits of the Galice formation are not fully determined. In the Galice area the outlines are marked by the adjoining igneous rocks, but it is believed that the full development of the Galice series is not represented in that area. On the South Fork of the Umpqua a greater thickness of vertical black slate occurs. They closely resemble those of the Galice series but are not yet known to be fossiliferous.

Relation to the igneous rocks bordering the Galice area.—The igneous rocks bordering the Galice area northeast of Rogue River are chiefly if not wholly volcanic, and the general dip of the flows is to the S.E., approximately parallel to the general position of the stratification in the enclosed Galice area. This accordance would be expected if the Galice beds of the Galice area are interstratified with the volcanics, a view which may be favored also by the following consideration: On Rogue River, east of the mouth of Galice Creek, some tufaceous sediments and sheets of basic igneous rocks appear interstratified with the fossiliferous sediments of the Galice series, suggesting contemporaneous volcanic activity; others

appear to be intrusive, but the contacts are obscure and the exact relations a matter of doubt.

The borders of the Galice area are generally lines of displacement. Along the eastern border of the area, on Rogue River, a short distance below Massie's ferry, the slates are so greatly sheared in the plane of general slaty cleavage dipping to the southeast as to indicate decided displacement.

On Grave Creek, near Anderson's, 5 miles below Leland, the eastern border is an irregular fault which is locally exposed and at least in part vertical. The general dip of the Galice strata of that vicinity is to the southeast, and the topmost slates are greatly sheared in the same direction as if volcanics were overthrust from the southeast.

On Cow Creek, near the mouth of Rattlesnake, the contact of the Galice slates and the volcanics is exposed within a few square rods on three lines, all of which run approximately northeast and southwest parallel to the strike of the slaty cleavage. Two of the contacts are clearly fault planes, straight and smooth with slickensides and local polish. These two lines of evident displacement can be traced only about a score of feet and run out into the volcanics. The third line of contact which lies between the other two is much less regular. Though the projecting portions of the volcanics along the line are rounded as if by some form of attrition, it is not so clearly a line of faulting. Wherever the contact of the Galice formation and the volcanics is exposed about the Galice area it shows displacement, but the amount of the displacement and its full meaning are not yet fully comprehended. It seems certain, however, that the Galice formation in its present position stratigraphically overlies a great portion of the associated volcanics.

Dothan Formation (Jurassic).

Definition.—The Dothan formation is an extensive succession of conformable Jurassic sandstones and shales in which the strata though often thin-bedded frequently range from 10 to over 100 feet in thickness. The sandstones predominate and locally there are thin beds of fine conglomerate and small lentils of radiolarian chert. The name is adopted from Dothan post-office on Cow Creek, in the midst of one of the best sections of the formation.

Lithological features. The shales are gray, dark within, rarely black. For the most part they are not slaty. At other places they may be slickensided parallel to cleavage. The sandstones are gray, weathering yellowish brown. They are in the main firmly lithified with silica, and in some places so squeezed as to give rise to a schistose structure with numerous

veinlets of quartz. Many of the sandstones, however, are less firmly lithified and break with a rough surface due to the fact that the grains are stronger than the cement and the fracture passes between them instead of through them. The thin beds of conglomerate are made up largely of siliceous pebbles. The chert is of various colors, gray to red. It is sometimes massive but more frequently banded with thin films of brown shale.

Occurrence.—The Dothan formation occupies a broad belt running southwest from Cow Creek across Rogue River and the Illinois, reaching the coast near the southern border of the state. The larger area of Jurassic in southwest Oregon, as outlined on the Geological Map of North America, is chiefly Dothan. It lies northwest of the Galice area, from which it is separated generally by a belt of volcanic rocks. The most accessible and the best cross section of the series is on Cow Creek and West Fork, where it may be seen along the railroad in continuous exposures for nearly a dozen miles.

The section begins nearly 4 miles southeast of Dothan, where the rocks are mainly sandstone with less shale and a few thin beds of siliceous conglomerate. Sandstones occasionally massive attain a thickness of 100 feet, but most of the beds are much thinner and with the shales clearly mark the position of the strata dipping to the southeast beneath the sheets of lava which limit their outcrop in that direction. Near the border lava flows and tuffs occasional masses of chert are found interbedded with the other sedimentary rocks.

Farther down Cow Creek about Dothan and beyond on the main stream to the limit of the Dothan formation near Nichols Station, the proportion of shales is somewhat increased so that in some places shale is more abundant than sandstone. In the same portion of the section on West Fork, sandstones are decidedly the most abundant. The beds range from 2 to 30 feet in thickness and the stratification is conspicuous. As the northwest side of the area is approached, the attitude of the strata becomes more variable. Dips to the northwest become more frequent though the general dip may remain to the southeast. Quartz veinlets are abundant anywhere in cross fractures but are never conspicuous. Those of calcite become more abundant to the northwest near the Cretaceous, and lie mainly in the plane of slaty cleavage as well as in the fault planes which cut the earlier veins of quartz.

Rogue River between Howard and Mule Creek, for a distance of over a dozen miles, has cut a rugged canyon directly across the Dothan series and exposed an almost continuous section. The principal difference between the Cow Creek and Rogue River sections of the series is the presence of a large

mass of conglomerate in the latter near the middle, forming prominent outcrops for several miles along Rogue River between Ditch and Kelsey creeks. The conglomerate is made up in part of limestone fragments and is so crushed as to obscure its folding. The rest of the section is made up of alternating sandstone and shales in variable but on the whole nearly equal proportions. They are greatly compressed and often sheared so that the sandstones appear as small lenses in the shales. Their dip is variable but generally southeast at a high angle.

Southwest of Rogue River the belt of Dothan is narrowed by the advance of the overlapping Cretaceous and Eocene formations. Beyond the Illinois, although traversed at a number of points to the coast, the country has not been sufficiently studied for mapping.

The thickness of the Dothan formation is difficult to determine owing to its disturbed condition, but it is certainly more than a mile and perhaps more nearly 2 miles. The belt is about a dozen miles wide where greatest, and no definite evidence could be obtained tending to show a repetition of any horizon. The faulting, as will be noted presently, tends to decrease rather than increase the apparent thickness.

Fossils and age.—Fossils have been looked for with care at many places on the Dothan formation and their general scarcity or absence contrasts this series with the Galice (Jurassic) on the one hand and the Myrtle (Cretaceous) on the other. Excepting the radiolaria of the chert and problematical wormtracks and leaf fragments which have been found at various horizons, definite fossils are known to occur only near the northwestern border of the main area in the vicinity of Nichols Station or in a small area on Doe Creek and Thompson Creek, 11 miles farther northeast.

The Nichols Station localities are in the sandstone and fine conglomerate of a small gulch about half a mile northwest of the post-office and on Table Creek near Logsden's place. A collection made by Mr. Will Q. Brown last summer at the last-named locality contains forms which are distinctly striated and leave no doubt concerning their specific determination as *Aucella erringtoni*. The rocks containing them are twisted and crushed but not silicified, and contain only veins of calcite.

On Doe Creek and Thompson Creek, Aucella have been found at a number of points but chiefly near Lost Prairie, a mile and a half northwest of Nickel Mountain, where they occur in a sandstone which is decidedly sheared and shows incipient schistosity cut by veins of quartz.

Associated with the fossiliferous silicified sandstone on Doe Creek is a considerable thickness of black slate. These rocks are

cut off by a mass of greenstone about the head of Thompson and Judd creeks but reappear on the Umpqua River by the fording 3 miles northwest of Myrtle Creek post-office, where an example of *Aucella* was found. This is apparently the same horizon that occurs on Johnson Creek in the Port Orford quadrangle, where striated Aucella have been found in loose fragments but not in place.

It thus appears that the only characteristic fossil yet found in the Dothan formation is *Aucella erringtoni*, but that is so well marked and so distinctive as to leave scarcely a doubt concerning the Jurassic age of the formation. This reference is strongly supported when we come to consider its relations to adjacent terranes.

Relation to adjacent volcanic rocks.—The relation of the Dothan formation to the volcanic rocks which bound it for many miles upon the southeast has already been indicated in considering the Cow Creek section whose contemporaneous lavas and tuffs are found interbedded with the marginal portion of the Dothan strata. The general dip of the Dothan formation near the border is to the southeast beneath the great mass of lavas.

The contact of the Dothan formation with the overlying volcanics along the eastern border of the main area is everywhere a zone of decided shearing, affecting both the sediments and volcanics and producing not only slaty structure and slickensides but entailing the local development of talcose and chloritic schist-like material and considerable ore deposits. The displacement, however, has not changed the apparent stratigraphic succession, and the facts observed clearly indicate that the Dothan formation at present is stratigraphically beneath the mass of volcanics.

Relation to adjacent Galice formation.—The mass of volcanics which overlies the Dothan series is the same that has been shown to lie beneath the Galice series, and there seems no doubt that the two series in their regular order of succession are for the most part separated by an interval of volcanic rocks. This succession illustrates their order of age unless they have been overturned, a condition which is suggested by the planes of displacement.

At a number of points along Cow Creek and elsewhere striated fault planes were found rising to the northwest, generally at a high angle but sometimes horizontal as though there was an overthrust from the southeast.

A suggestion that the Galice is older than the Dothan may be found in the fact that the area occupied by the Galice lies between that of the Dothan and the nearest Paleozoic on the southeast. The most common dip among all the rocks is to

the southeast, as if the Jurassic passed beneath the Paleozoic as a result of an overturn. However, the structure has not yet been resolved and the faunal differences between the Dothan and the Galice are not sufficiently great for age distinction.

Myrtle Formation (*Cretaceous*).

Characterization.—The Myrtle formation is a succession of shales, sandstones and conglomerates in which the alternating shales and sandstones, often thin-bedded, are of approximately the same volume but the conglomerates, generally fine, are of much smaller mass. Lentils of chert and limestone occur locally and the whole assemblage of beds is characterized by such a lower Cretaceous fauna as demonstrates its essential equivalence to the Shasta series of California.

Lithification.—The greater portion of the rocks of this formation are somewhat less firmly lithified than the majority of those belonging to the Galice and Dothan formations, but this is not the case everywhere. In the Myrtle, carbonate of lime as cementing material and in veinlets is widely distributed though siliceous cement and quartz veinlets are common in some areas. In the two Jurassic formations silica is the more common and widely distributed cementing material and quartz veinlets are locally abundant. Carbonate of lime is often present in them, but in both cement and veinlets it plays a much less extensive rôle than silica.

On lithological grounds, therefore, the Myrtle and Dothan are not always easily distinguished. The higher degree and more extensive silicification of the Dothan affords presumptive evidence, but it is only by means of fossils or definite stratigraphic data having reference to fossiliferous horizons that affords a satisfactory basis for separating the Dothan and Myrtle in the field.

Distribution.—The Myrtle formation lies north and northwest of the Dothan. Its largest area is along the coast about the mouth of Rogue River and as far north as the Sixes, where it passes beneath Eocene. This area mapped in the Port Orford folio as Myrtle certainly contains some Jurassic rocks for they have locally yielded *Aucella erringtoni* in the stream gravel of Johnson Creek, but as the fossils could not be found in place, and the rocks thus distinguished from similar rocks containing Knoxville fossils in the same region, they could not be mapped separately.

East of the Coast Range beyond the Eocene the Myrtle formation reappears along Myrtle Creek from which the formation was named and also a short distance farther northwest about the post-office of Dillard. All three areas are indicated

upon the Geological Map of North America and are shown in detail in the Roseburg, Coos Bay and Port Orford folios, where a more extended account of the Myrtle formation may be found.

Relation of the Myrtle formation to the Dothan.—The actual contact of the Knoxville (Cretaceous) and the Dothan (Jurassic) has not been observed though it has been followed throughout the greater part of a distance of 50 miles and mapped in detail for nearly 30 miles. From Rogue River below the mouth of Mule Creek northeast to West Fork the Knoxville follows the border of the Dothan series, but near that point it turns abruptly east by way of Nichols Station to Canyonville, unconformably overlapping the broad belt of Dothan. Although the contact could not be found exposed, the strike of the Dothan carries it directly beneath the Knoxville; it is for the most part more disturbed and more firmly lithified than the Knoxville and there can be no reasonable doubt that the unconformity is generally great. The Dothan and Knoxville where exposed within a few rods of each other are generally in strong contrast, the Knoxville strata having calcareous veins and cement while those of the Dothan are siliceous bespeaking a decided discordance, but this is not always true, for the Dothan, as near Nichols, well characterized by *Aucella erringtoni*, is locally calcareous and the Knoxville, in places equally well characterized, is locally siliceous.

Plant beds.—Plant beds containing a flora which according to Ward,* Fontaine and Knowlton has a decidedly Jurassic facies, occur in southwestern Oregon and northern California. In Oregon and more especially at Big Bar, Cal., some of the plants of Jurassic facies are clearly associated with shells which are regarded as characteristic of the Knoxville, but near Oroville, Cal., the plant beds contain an assemblage of shells which Dr. Stanton reports as having "a decided Jurassic aspect," in his opinion "older than the aucella-bearing Mariposa formation." The plant beds with "Jurassic flora" will be considered in a separate paper.

The Dillard Series of Louderback.

Introduction.

Louderback's general results.—"The Mesozoic of Southwestern Oregon" is the title of a paper† in which Prof. G. D. Louderback considers particularly the Myrtle formation of the Roseburg, Coos Bay and Port Orford folios. The results of his studies, to use his own language (p. 521), "are to the effect

* 20th Ann. Rept., pt. 2, pp. 368–377, and Monograph LVIII.

†Journal of Geology, vol. xiii, No. 6, pp. 514–555, Sept.–Oct., 1905.

that the formations mapped as Myrtle *senso stricto* may be separated into two chief groups or series (upper and lower), each representing quite an extent of geological history, and separated from each other by a distinct interval during which there were intrusions of igneous rocks and a period of considerable erosion."

Lower series.—The lower series, according to Louderback, is composed principally of gray sandstone so firmly lithified by siliceous cement that when the rock is broken the fresh fracture surface is smooth, traversing the grains. Besides this characteristic sandstone the lower series contains some shale, occasionally slaty, as well as foraminiferal limestone and radiolarian chert, the last being very characteristic. For the lower series Louderback proposes the name "Dillard", after a village situated on the railroad and south fork of the Umpqua River in the midst of the largest area of this series in the Roseburg quadrangle.

Upper group.—Louderback states that in the upper group the most abundant and characteristic rock type is shale, then sandstone and conglomerate. No trace of radiolarian cherts or cherts of any type occurs in this group, nor do foraminiferal limestones corresponding to the Whitsett lenses, although there are calcareous shales. For this division Louderback proposes to retain the name *Myrtle group.*

Comparison.—Comparing his Dillard series and the Myrtle group, Louderback remarks that their most striking general difference is the markedly inferior lithification of the Myrtle group, in which the sandstones (p. 525) "are commonly brown, sometimes buff or greenish, and never show the peculiar gray compact facies so often seen in the sandstones of the lower series." In describing (p. 343) the strong contrast between the close-lying areas of Myrtle and Dillard he points out that the change from one to the other is abrupt and not gradational. The only locality referred to where this contrast may be seen is a few miles southwest of Dodson Mountain, but unfortunately for that locality the two contrasted series are separated by a belt of serpentine. The general impression conveyed in Mr. Louderback's lengthy paper is that the two series are "well defined and distinctly separable" lithologically and readily discriminated in the field, epecially by one who is familar with the Franciscan of California.

Dillard Area of Dillard Series.

Defined.—The largest area of the Myrtle formation outlined on the map of the Roseburg quadrangle centers about the village of Dillard, where it crosses the Umpqua River and is conveniently referred to by both Louderback and the writer

as the Dillard area. The lentils of limestone (Whitsett) and the larger masses of radiolarian chert, amphibole schist, and igneous rocks within the area are separately outlined and the great predominance of the other sediments is apparent at a glance.

Rocks considered.—Igneous rocks play a very important rôle in the geologic records of southwestern Oregon. Many of the rocks are of types found elsewhere in the Klamath Mountains at various horizons in the Paleozoic and Mesozoic. Since their ages are determined by reference to associated sedimentary rocks they will not be considered in this paper, which will be devoted to the consideration of the sedimentary rocks only.

Different views.—The Myrtle formation of the Dillard area was described in the Roseburg folio as Cretaceous and regarded as having its equivalence in the Knoxville and Horsetown of the Shasta group in California. Mr. Louderback designated the rocks of the same area as the "Dillard series," and regarded them as stratigraphically below and older than the Knoxville and equivalent to the Franciscan of California.

Locality of Louderback's observations.—Mr. Louderback states (p. 540) that "a large part of the Dillard area was studied by the writer, with the result that everywhere formations characteristic of the Dillard series were found, while no representative of the Myrtle group was recognized. It is probable that this whole area belongs to the lower series, although a more complete study may show subordinate patches or infoldings of the lower members of the Myrtle group. All of the members of the sedimentary series, all of the main types of igneous rocks, and the peculiar schists, described as characteristic of the Dillard series, occur within this area. The Whitsett foraminiferal limestone lentils crop out at intervals from about four miles directly east of Dillard to the northeast extremity of the area."

Expecting to have an opportunity to re-examine the "Dillard area" in connection with the survey of the Riddles quadrangle, which adjoins the Roseburg upon the south, I wrote to Mr. Louderback, enclosing a geological map of the Roseburg quadrangle and asked him to indicate by shading or otherwise "the large part of the Dillard area" he had studied, so that in the field I would have a lithological standard of comparison in endeavoring to discriminate between his "Dillard series" and "Myrtle group." In reply he stated: "I examined the country along *all* of the roads of that area northeast of the Umpqua River, and furthermore I visited those areas mapped as amphibole schist and as limestone which lie off the roads. To the southwest of the river I went over the

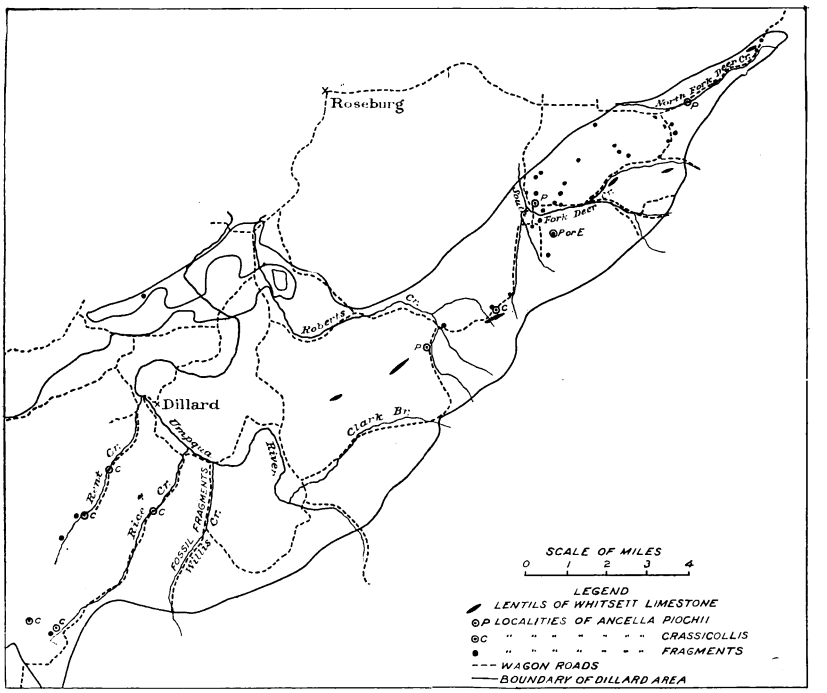
area north of Winston and Brockway where cherts and schists are shown and also made a trip into the hills across from Dillard, but not far from the river road. I also went the full length of the three disconnected areas between the Dillard and the Myrtle Creek areas and believe them to be entirely Franciscan (Dillard)."

Points of agreement.—Before considering the differences of opinion attention should be called to points of agreement. Mr. Louderback and the writer agree in regarding the conglomerates, sandstones, shales and limestones of the Dillard area as forming but one series. Along *all* the roads east of the river and over whatever routes he traveled to examine the various small areas outlined within the Myrtle area, Mr. Louderback reports "everywhere formations characteristic of the Dillard (Franciscan) series were found." The writer, reviewing his own work in that portion of the Roseburg quadrangle last September, re-examined many and perhaps most of the localities studied by Louderback and found, as did Louderback, no sufficient reason for considering the sedimentary rocks in question as belonging definitely to more than one series.

The writer's views.—While surveying the Dillard area for the Roseburg folio in 1895–6 Knoxville fossils were found at four widely separated localities in the sandstones, and this furnished the reason for including this area in the Myrtle formation. When I read Mr. Louderback's paper his confident statements greatly surprised me that I should have overlooked so important an unconformity or break in the series in relegating the whole to the Knoxville. My surprise was lessened, however, when I remembered the Dothan that lies unconformably beneath the Knoxville in the Riddles quadrangle. Upon returning to the Dillard area I was expecting to find it composed in large part of the Dothan, containing Jurassic fossils, but in this I was disappointed, for all the determinable fossils found at over forty localities are Knoxville.

Knoxville fossils in the Dillard area.—The general distribution of Knoxville fossils collected in the Dillard area is shown upon the accompanying outline sketch (fig. 1), which indicates their position with reference to the roads, principal lines of drainage and the lentils of limestone, outlined within the area. The search for fossils was made chiefly in the northeast and southwest portions. In the former because it contains all the lenses of limestone and some of other rocks examined most particularly by Mr. Louderback, and in the latter because sedimentary rocks known to belong at the bottom of the Knoxville (plant beds), and next beneath it (Dothan) lie in that direction.

Northeast portion: From the head of Roberts Creek northeast along the road for over a dozen miles fossils occur at frequent intervals. In some places the fossils are well preserved but in others they are small fragments of aucellae, and it is only by careful search that specimens can be found complete enough to permit specific determination. Such specimens have been found, however, at a number of places and Dr.



Stanton has determined without question *Aucella piochii* and *Aucella crassicollis*, both of which are characteristic Knoxville forms. From one locality he reports a form that "may be either *A. piochii* or *A. erringtoni*," but from its field relation I have no hesitation in calling it *A. piochii*.

Fossils were not found at every outcrop nor could this reasonably be expected, for where best exposed in California the Knoxville strata are not all fossiliferous. There is no doubt, however, that further search would greatly extend the localities. The fossils were found most common along the central and northwest side of this portion of the Dillard area but some were found upon the southeast side, and lithologi-

cally the strata upon that side are the same as those containing fossils.

In the sandstone within 300 feet of the type area of Whitsett limestone, 1¼ miles northwest of Dodson Mountain, well preserved specimens of *Aucella crassicollis* were found. The sandstone very near or in contact with the limestone upon both sides appears to be identical with that which is fossiliferous.

Aucella occurs in the sandstone adjoining the northeastern lentil of limestone in Section 14, as well as near the mass of basic eruptive in Section 21 as shown in the Redding folio and near both of the border areas of amphibole schists a few miles farther southwest.

Southwest portion:—Some years ago *Aucella* was found in a conglomerate several miles north of Brockway in the immediate vicinity of the outcrops of chert and amphibole schist of that region, but the greater number of observed localities are about Kent, Rice, and Willis creeks.

On Kent Creek, fragments of shale, sandstone and conglomerate containing *Aucella crassicollis* occur throughout its course. Those in calcareous shale are in place within two miles of its mouth; the others come from higher up, where they occur more frequently in rocks that are locally well-veined with quartz.

Rice Creek has a gentle grade and a few rock outcrops in its bed as compared with Kent Creek. *Aucella crassicollis* was sought for at only two points and found at both. At Rice's Ranch, nearly 2 miles above the mouth of the creek, Aucella was found in fragments like those of Kent Creek. Near the head of the creek in Sec. 25, T. 29, R. 7, Mr. Storrs, to whose skill as a collector I have so often testified, recently found *Aucella crassicollis* in conglomerate shale and sandstone that is in part traversed by distinct veins of quartz. This locality is within a short distance of the intrusive which forms Big Baldy and occupies so large an area on the southern border of the Roseburg quadrangle.

On Willis Creek fossiliferous fragments of sandstone and conglomerate are common, especially above the forks in the neighborhood of a mass of red chert. Sufficient time was not devoted to this locality to find them in place, but the rocks are of the same character as those on Kent and Rice creeks. They must occur in place before reaching the limit of the area within a mile south of the mass of red chert.

Dr. Stanton's report on the fossils.—The fossils collected in the Dillard area were not made the subject of a special report by Dr. Stanton but included in his general report upon all the

Mesozoic fossils collected during the season in Douglas County. He says:

"In the Douglas County area the discrimination between the Jurassic and Cretaceous rests on the same slender basis as in the case of previous collections from the same region, that is, most of the localities in question contain no determinable fossils except Aucella, and when these are marked with numerous, distinct, radiating striae they are referred to the Jurassic species *Aucella erringtoni*. The Cretaceous species *Aucella piochii* has very nearly the same form, but lacsk the radiating striae.

It is evident, therefore, that the paleontologic separation of Jurassic and Cretaceous cannot be very positively made, especially when the surface features of the fossils are not very well preserved. It is true, however, that all of the specimens in this collection that can be referred to *A. erringtoni* came from the area that had previously been determined as Jurassic, and was so classified in Mr. Diller's list. This species was recognized in the lots from Thompson Creek, Table Creek, O' Shea Creek, and doubtfully in those from the South Fork of Beal Creek. The other lots from the supposed Jurassic area usually contain only fragmentary specimens of Aucella that cannot be specifically determined, or, in a few cases, some other fossil which is not diagnostic."

"The lots that were classified in the field as Cretaceous (including those of the Dillard area) apparently all belong to that system, although a few of them do not contain enough to distinguish between Jurassic and Cretaceous."

Quartz veining.—A considerable portion of the rocks of the Dillard area contain veinlets of quartz and in some cases the veinlets are abundant, though their distribution is very irregular. They occur most frequently in compact gray sandstone and are mere films, a small fraction of an inch in thickness and but a few inches in extent. Some irregular masses occur of a few feet in length.

A good exposure of this siliceous sandstone occurs in the immediate vicinity of the limestone lentil at the Marble Works in the eastern part of Sec. 19, T. 27, R. 4, and in the hills within 2 miles to the westward, where some of the beds containing quartz veins have calcareous cement and in others such veins are entirely absent.

Southwest of the Umpqua River among the rocks of the Dillard area a somewhat larger proportion is veined with quartz generally associated with those of calcite. Where quartz veinlets are most abundant calcite is often wanting. Towards the heads of Kent and Rice creeks, such rocks contain *Aucella crassicollis*, affording definite evidence of their Knoxville age,

and yet it should be noted that specifically determinable fossils were not found in the ledges richest in quartz veins.

Limestone.—There are six lentils of Whitsett limestone scattered at intervals along the axis of the northeast portion of the Dillard area. They all contain the same foraminiferal remains, lie approximately in line, and are interstratified with the same series of sediments throughout so that there is good reason to suppose they represent but one geological horizon and that they belong to the same horizon as the strata with which they are associated. The limestone lentil near Whitsetts at the northwest base of Dodson Mountain has yielded a few fossils concerning which Dr. Stanton reports as follows:

"The collection from the Whitsett limestone is not as satisfactory as those previously obtained at the same place. When all of these are put together the evidence is not conclusive for the Cretaceous age of the bed, though there is nothing definitely opposed to this reference. The lot No. 6939 which was collected only 100 yards from the Whitsett limestone is certainly of Knoxville age."

The occurrence of limestone in the upper part of the Knoxville of the Dillard area is now holly exceptional, for it occurs at that horizon in several places along the western side of the Sacramento Valley in California.

Chert.—Lenses and irregular masses of radiolarian chert are mentioned by Louderback as very characteristic of the Dillard (Franciscan) as though the mere occurrence of chert were sufficiently distinctive. It is well to remember that in the Klamath Mountains radiolarian chert is widely distributed in some of the Paleozoic formations and occurs at intervals in later formations. In the Shasta group of Tehama County, Cal., where it attains perhaps its greatest known thickness, no cherts were observed as far as the writer is aware, but this cannot be considered a valid reason for excluding them from its equivalent series in Oregon. Nor, on the other hand, can it be reasonably claimed that because some of the chert belong to the Dothan formation of Oregon and is Jurassic, all of it in that region belongs to the same horizon.

In the Roseburg folio radiolarian chert is mapped as "Juratrias?" The intimate association of the chert with the Myrtle formation was recognized as tending to show that the chert is Cretaceous, but greater weight was given to the fact "that the sandstones and conglomerates of the Myrtle formation contain veined fragments of chert, suggesting an age for much of the chert clearly earlier than the Myrtle formation, which was itself probably laid down during the early portion of the Cretaceous period."

While still holding to the view that much of the chert is earlier than the Knoxville, I see no sufficient reason for concluding that it is *all* older. As pointed out elsewhere, the intimate association of chert with Knoxville strata furnishes strong evidence of its Knoxville age. At this time I shall refer to but one of the cherts in the Dillard area and that is the one at several points associated with the Whitsett limestone. It is distinctly radiolarial and so involved with the limestone that both must belong to the same horizon.

Nomenclature.—Primarily upon lithological evidence the name "Dillard series" was proposed for the sediments of the Dillard area under the impression that they were older than the Knoxville. The presence of Knoxville fossils at so many points throughout the area demonstrates conclusively that the great part if not the whole mass of sediments within the Dillard area are really Knoxville and were properly included in the Myrtle formation as originally defined and since unchanged. The Myrtle formation has always been regarded as practically equivalent to the Shasta group of California.

As stated in this paper, the writer is of the opinion that the equivalent of what is called "Franciscan" in California is most likely in the Dothan and not the prevailing rocks of the Dillard area. The fossils clearly show that the bulk of the rocks in the Dillard area are Knoxville. No definite trace of Dothan fossils or of the plant beds with "Jurassic flora" were found in the Dillard area, as might reasonably be expected if they occur there, for their nearest outcrops a few miles to the southwest have distinctive fossils.

It is possible that rocks of the Dothan series may yet be identified in the Dillard area, but as it now stands our failure to find within the area any fossils definitely older than the Knoxville leaves a decided objection to adopting Louderback's term Dillard for the strata here included under the Dothan. If striated Aucellae are yet discovered in the strata at Dillard station proving it a type locality for strata older than the Knoxville, the name Dillard should supplant Dothan as a formation name.

Résumé.

The Mesozoic sediments of southwestern Oregon may be, for the present, most conveniently considered under four heads as follows: Galice formation, Dothan formation, Myrtle formation, and Chico formation.

The Galice formation is composed mainly of dark slates and is characterized by a late Jurassic fauna.

In the Dothan formation sandstone predominates though there is much interbedded shale. Its Jurassic age is indicated by the presence of *Aucella erringtoni.*

Both formations where best developed dip to the southeast and the Galice beds overlie the Dothan. They are generally separated by a belt of volcanics. Both series and the associated volcanics are locally sheared by thrust from the southeast.

The prevalence of shearing from the direction of the dip suggests that the strata are overturned and that the Galice is really older than the Dothan.

From its lithology and fauna the Galice may be correlated to the Mariposa.

The Dothan lies unconformably beneath the Knoxville and with its occasional beds of chart may be the equivalent in part of the Franciscan in California, which is said to occupy a corresponding position. If so, the Franciscan is Jurassic.

The Dillard of the type area of Louderback is characterized in large part by the presence of Knoxville fossils and therefore belongs chiefly if not wholly to the Myrtle formation.