Extensions of the Ringold Formation[1]

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Just a little more than twenty years ago Merriam and Buwalda made an examination of the sedimentary rocks exposed in the White Bluffs on Columbia River. After measuring and describing the section there exposed, they determined the fossils it contained and gave the formation the name Ringold, from the type locality near Ringold Post Office.

It is worth while for us to note that Merriam and Buwalda were especially concerned with the relation of these beds to the Ellensburg formation. A correlation had been suggested by Russell in 1893, and followed by others, including George Otis Smith, who noted the fluvial origin for the Ellensburg near Yakima and the apparent lacustrine origin for the beds at White Bluffs. Calkins, who described the type section of Ellensburg, noted in 1906 that there were some points of contrast between the two, but that some parts of the White Bluffs beds were probably of fluviatile origin.

It will be recalled that a tooth of the genus Hipparion had been reported from the type Ellensburg. According to Merriam and Buwalda, such poorly preserved bones of representatives of the horse family as were found in the White Bluffs beds indicated that they were not only distinct from, but considerably later than the type Ellensburg beds. Teeth from the Ringold area are "at least as advanced as those of Equus occidentalis from the Pleistocene of Rancho La Brea, and may be even more specialized."[2] Bones of camel, deer, ground sloth, and equid types, while possibly late Tertiary in age, "seem more advanced than any fauna known heretofore in the Miocene of the Pacific Coast and Great Basin provinces."[3] And further: "the collection from near Ringold School taken by itself would be considered to represent Pleistocene."[4]

A section totaling 503 feet of light-colored muddy sandstones and sandy clays, with minor parts of fine gravels, volcanic ash and calcareous strata, was measured by Merriam and Buwalda. It is well to note that they observed and recorded several features of importance:

1. The material is not thoroughly classified nor sharply stratified;
2. The coarser materials are water-worn;
3. The strata lack induration and are notably softer than most exposures of the Ellensburg;
4. The remarkably even surface extending several miles eastward is probably a surface of aggradation;
5. The apparent absence of freshwater molluscan remains, together with the mammalian fossils, indicates the deposits to be flood-plain sediments;
6. Occasionally beds of coarse angular materials, chiefly basaltic, are found at the top of the Bluffs, evidently laid in channels cut in the Ringold.

No attempt was made to determine the areal limits of the formation, but it was thought to have originally extended from the Saddle Mountains on the north and the Yakima Range on the west, to the "lava plateaus on the east and south."[5]

An eastward extension of the Ringold from the type locus was implied in the original article by Merriam and Buwalda. Hence it is not surprising to find that it is readily traced to Esquatzel Coulee in the vicinity of Eltopia and northward near Connell. This is the southern portion of the area mapped by Bretz as "Channeled sedimentary rocks above the basalt."[6] Northeast of Connell it is exposed in many places along the highway, but is

generally concealed beneath wind-blown sands and silts. It can certainly be recognized north of Ritzville, but studies have not been carried much beyond there, so its full extent is not determined. East of Connell the Ringold is well exposed at McChesney Springs where erosion by both stream and wind has provided the loose sand of the picturesque dunes. It is interesting to note that silicified fossils representing most if not all of the forms found in the type locality of the Ringold have been collected from these beds. There would seem to be no doubt that these beds and those of the type Ringold occupy identical stratigraphic positions.

Although these McChesney Springs beds were not recognized by Bretz as "channelized sediments above the basalt," he has mapped several interesting exposures of such beds nearly as far east as LaCrosse in Whitman County. In addition many of the "prow-pointed hills"[7] of Bretz can be shown to comprise at least two distinct stratigraphic units, a top of wind-blown silt or sand, the "palouse soil" of many writers, and an underlying siliceous silt, clay, or sandstone, distinctly more resistant than the overburden. There seems to be no reason for not considering the possibility of this lower member being the eastern representative of the Ringold formation. Several other angles of this correlation have been under study for the past decade, but it suffices here to say that essentially all data point to this conclusion.

The northward extension of this formation is quite different from that suggested by Merriam and Buwalda. Not only do these beds lie on the north slope of Saddle Mountain, but clearly extend farther west. The close structural similarity of the Ringold beds and the basalt, both on the Saddle Mountain uplift and in the surrounding tracts, makes it difficult to follow the original idea of Merriam and Buwalda that this formation "originally extended up through the gap which the Columbia has cut across the Saddle Mountains, and that it was deposited over areas north of that range."[8] Instead it seems clear that this deposition took place prior to the Saddle Mountains uplift and extended northward past Othello and beyond Moses Lake, spreading westward to cover the now upwarped tract of Frenchman Hills. Field studies have not yet been carried far enough north to even suggest the limit in this direction, but preliminary observation of the region suggests that it may be north of Columbia River.

On the south the extension is less carefully studied to date. There seems no reason to believe that the beds did not originally extend over the present crest of the Rattlesnake Hills just as they did over the Saddle Mountains and Frenchman Hills. Certainly remnants can be found along the south slopes near the Sunnyside gap, and other exposures of similar beds seem to fit in with this idea. On the south side of the downwarped and eroded Yakima Valley are still other exposures of Ringold-like sediments, even on the south slopes of the Horseheaven Hills. In view of the similarity in structural history of these uplifted tracts it is evident that an original extension to some point south of the Horseheaven Hills uplift can be postulated safely. How much farther is not clear on present data.

The westward extension is even more interesting than those in other directions. This has been suggested previously in a paper on the Ellensburg formation presented in Seattle last June.[9] In this direction, instead of being confined by the rocks of Yakima Range, the deposits, as traced by remnants still discernible, appear to have originally extended beyond the Yakima in the Selah region. A large part of the formation originally defined as Ellensburg seems in truth to be distinctly later in origin than that formation. There is no doubt that some post-basalt beds of true Ellensburg type and relations were originally laid down in this area,

for remnants of them are readily observable today. Still it appears likely that much of the clastic material designated as Ellensburg in the Selah area is in reality stratigraphically and structurally referable to a later time than the true or type Ellensburg. If this be so, much of the overlying series of sands and gravels would appear to be part of the widespread Ringold formation.

In support of this idea are two significant facts. First, the fossils by which the type Ellensburg formation was identified as Miocene were found in but two places. The tooth assigned to the genus Hipparion was sent from the Yakima region to Doctor Condon in Oregon, but the exact locus of its discovery remains in doubt. Careful examination of possible sources by our Secretary, Mr. Thompson, has led him to the conclusion that the tooth was probably found in the sandstone quarry near Thorp, about five miles south of the city of Ellensburg. These beds of sandstone are like the true Ellensburg rather than the less indurated and less well stratified Ringold. The plant fossils, on which more reliance as to age has been placed, came from Kelly Hollow, where undoubted Ellensburg beds only are exposed. No fossils have been found in that portion of the "Ellensburg" here assigned to the Ringold.

Field examination of the beds of both formations leads to the conclusion that there are recognizable structural differences between them. While both formations have been deformed by warping, only the Ellensburg beds have suffered marked deformation. In several places near Selah the two series appear to be unharmonious in structure. Insufficient work makes it impracticable to state with certainty that this is a feature by which the two series can always be distinguished or can be separated in all places. Indeed this would seem to be improbable in view of the deformation which has affected the later Ringold formation. Yet it is certainly significant that where comparison is possible, the distinction seems t hold.

These extensions of the area on whic the Ringold was formed justify recor sideration of its stratigraphic features.

The lithologic and sedimentation character of the component parts serve to reaffirm the idea brought forward b Merriam and Buwalda that the Ringol is a sort of flood-plain deposit. That could not have been the deposit of any or stream, such as the Columbia, is clea from the extent of the area over whic it was formed. Rather it seems to sugge a general and widespread filling of th Columbia Basin from a number of dire tions and by several agencies. Under th concept, the Ringold would be expected t show the varied character which it e hibits, both as to materials and as to oth stratigraphic features. There would b expected, locally, current embedded san and gravels, deposits made upon mud flat local pond or lake deposits, and witho doubt deposits referable to wind actio All these types are recognized.

As to age, several factors may be co sidered. It is clearly post-basalt, and sin no beds other than Ellensburg have be recognized between the Ringold and t basalt, the Ringold must be called po Ellensburg. Until more decisive data a discovered the later basalts of the C lumbia series and the Ellensburg must left in the late Miocene. As yet there no reported correlation between the Ri gold and the recently recognized Plioce of northern Oregon.

The strongest evidence as to age is course that of the fossils recorded Merriam and Buwalda previously not But in addition, there is the relative la of induration, which in spite of its a parent insecurity, comes to be looked up by experienced workers as a valua guide to stratigraphic position. There also the prominent trenching of the up surface, locally resulting in the compl elimination of the Ringold, a feature no

by practically every worker in the field. It is clear that later glacial waters, at least, have been operative after the deposition and warping of this formation.

Post-Ringold structural changes clearly involve the uplift of the Frenchman Hills tract and that of the Saddle Mountains, Rattlesnake Hills and Horseheaven Hills probably should be included. In the Saddle Mountains not only has the Ringold participated in the warping, but the extensive faulting of the lavas has affected these sediments also.

Post-Ringold sedimentation history appears simpler, on the whole, than the Ringold history itself. It is largely a record of general erosion with some local continental deposition. Without doubt most of the so-called "Palouse soil" of Whitman County is not only post-Ringold, but derived from that formation in large part. Farther west the surficial sediments are generally more sandy than in the Palouse region as would be expected from the generally coarser character of the Ringold beneath them there.

In a recent article, Professor Beck, of the Ellensburg Normal College has suggested that the calcareous layer at or near the top of some of the Ringold exposures was either "a hardpan subsoil zone" or, as he thought more likely, "the result of leaching from one of the earlier Pleistocene loess mantles."[10] Probably every careful student of this interesting calcareous zone has noted its obvious secondary nature. It is clearly a cementation zone in which lime carbonate has been concentrated. But in the original White Bluffs section, as noted by Merriam and Buwalda, the lime layer lies some 85 feet below the top of the Ringold section. If this be true, it may be necessary to modify the concept set forth by Professor Beck so as to bring out more clearly the relation of the lime zone to the fluctuation of the water table.

It is obvious that the problems of the Ellensburg, the Ringold, and the Palouse are inextricably intermingled. Little progress on any one has been possible without giving a good deal of consideration to the others. For purposes of presentation, however, it has seemed advisable to discuss each formation separately, and in chronologic order. I hope to complete the preliminary paper on the Palouse at an early date, so as to bring out the interesting inter-relations which are indicated.

By way of summary it may be said that the Ringold can be looked upon as extending much more widely than first suggested by Merriam and Buwalda. It appears to have been a rather general filling of the Columbia Basin. Sedimentary materials appear to have come from all sides with the recently uplifted rocks along the west margin furnishing the major portion. The usual continental agencies of erosion and deposition appear to have been operative. The Ringold deposition certainly preceded the uplift of the Frenchman Hills and the Saddle Mountains, but the formation has subsequently been trenched by streams of late glacial time, probably those related by Bretz to his Scabland Flood. Still later, and continuing even today, the original Ringold deposits appear to have been furnishing most of the material making up the substance of the Palouse soil.

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[1] Presented at the annual meeting of the Northwest Scientific Association, Spokane, Washington, December 29-30, 1936.
[2] Merriam, J. C., and Buwalda, J. P., Age of strata referred to the Ellensburg formation in the White Bluffs of the Columbia River: Univ. of California (Geol.), Vol. 10, No. 15, 1917, p. 259.
[3] Ibid., p. 259.
[4] Ibid., p. 259.
[5] Op. cit., p. 263.
[6] Bretz, J. H., Geog. Rev., Vol. XVIII., Pl. V., 1928.
[7] Bretz, J. H., Channeled scablands of the Columbia Plateau: Jour. Geol., Vol. XXI., 1923, p. 625.
[8] Op. cit., p. 265.
[9] Special meeting, Geol. Soc. America, Cordilleran Sec.
[10] Lime-rock zone of Columbia Basin: The Mineralogist, Nov. 1936 (Portland, Ore.).

Notes on Vashon Stage Glaciation of the South Fork of the Skykomish River Valley, Washington[1]

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Two distinct glacial stages[1] have been recognized in the Pleistocene history of the Puget Sound lowland, an earlier Admiralty Stage and a later Vashon Stage. The Vashon glacier, which filled the lowland as far south as the Chehalis River, left on retreat a partly drowned topography of parallel valleys and drumloidal hills composed of Vashon till molded around cores of fluvial and lacustrine sediments which had been deposited in the preceding interglacial stage. The consistent north-south alignment of these features shows clearly that they were formed by a great glacier moving southward from British Columbia. Flanking the lowland are high mountain ranges, the Cascades on the east and the Olympics on the west, which bear evidence of severe local glaciation in their serrated ridges, many cirques and broad, straight, U-shaped valleys. A few small glaciers, probably remnants of the mightier alpine glaciers of the Vashon Stage, still occupy protected cirques in the mountains. The relations of these local glaciers of the Vashon Stage to the main ice sheet in the Puget Sound lowland presents an interesting problem.

Bailey Willis[2] and J. Harlan Bretz,[3] who have made the most important contributions to the glacial history of the Puget Sound region, have expressed somewhat different views on this problem. Willis, whose investigations were confined largely to the region just west of Mt. Rainier, believed that the main sheet of northern ice received considerable contribution from the local Cascade glaciers, while Bretz, whose reconnaisance studies extended all along the mountain front, held that the local glaciers had contributed little or no ice to the main sheet.

The writers have recently studied the glacial deposits in the valley of the South Fork of the Skykomish River, which is located on the west slope of the Cascades about midway between the Canadian boundary and the terminal moraine of the Vashon ice in the Puget Sound lowland. The work was undertaken as part of a general program of research on the Pleistocene glaciation of the Puget Sound region, under the direction of Professor J. Hoover Mackin of the University of Washington. Absence of critical lines of evidence makes a complete statement of the history of the valley impossible but it is felt that certain general conclusions, which bear on the problem outlined above, are worthy of note.

Rising in the high Cascades, the South Fork of the Skykomish River flows through a broad, straight, U-shaped valley before leaving the mountains to flow across the Puget Sound lowland. At the point where the river issues from the mountains its valley is constricted by a high ridge of till and outwash material. On the north side of the stream the ridge has the form of an ice-contact terrace with a pitted ice-contact slope resembling a huge amphitheatre, facing to the west or toward the lowland. The general level of the terrace is about 1850 feet above tide or 1450 feet above the river. Excellent sections in the cut made by the stream across the constricting ridge disclose south-dipping, delta-bedded silt, sand, and gravel, interstratified with lake clay and till sheets. The coarser sediments of the delta grade eastward into warved and laminated lake clays, 600 feet in maximum thickness, which extend several miles up the mountain valley. No glacial till has been found overlying or underlying the up-valley extension of the clays. Farther up-stream, in the main valley and its tributaries, there are glacial moraines of local