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Vertebrate Fossils from the Chuckanut Formation of Northwest Washington

Abstract

A single specimen containing a cast of a turtle carapace and a bone fragment from a larger animal are the first vertebrate fossils found in the Chuckanut Formation. The Clark Point outcrops (Whatcom Co., Wash.) where this specimen was collected also contain large calcareous concretions that superficially resemble bones or logs. These pseudofossils probably account for local tales of a fossil dinosaur reported from the Chuckanut Formation.

Introduction

Excavation of foundation trenches for a house built in 1960 near Bellingham, Whatcom Co., at Clark Point (T 37 N, R 2 E, SW corner Sec 13) uncovered a piece of siltstone that contains the first vertebrate fossils found in the Chuckanut Formation. The property owners, Mr. and Mrs. Douglas Clark, assumed the specimen to be a mollusc shell or leaf imprint, but their loan of the specimen to the Western Washington University Geology Department in the spring of 1981 led to recognition that the rock contains the cast of the interior surface of a turtle carapace and a bone fragment from a larger animal. Though carbonized leaves and log casts are abundant in the Chuckanut Formation, the only previously known animal fossils are fresh-water molluscans found at a few inland localities (Pabst 1966).

Previous Paleontology Studies

The Chuckanut Formation consists of a thick, strongly folded series of arkosic sandstone, shale, and conglomerate beds exposed on the western flanks of the North Cascades in Whatcom, Skagit, and northern Snohomish counties, Washington. Stratigraphic measurements by Glover (1935) and Weaver (1937) indicate a total thickness of about 3000 m along Chuckanut Drive, whereas Miller and Misch (1963) report 4600 m, and possibly 6100 m of section east of American Sumas Mountain near the U.S.-Canada border.

Paleontologic studies began in 1841, when James Dwight Dana of the Wilkes Exploring Expedition collected plant fossils from Bellingham Bay. Descriptions of plant species were published by Lesquereux (1859), Newberry (1863), and Knowlton (1902). Detailed paleobotany studies were made from 1948 to 1952 by Pabst, and a posthumous monograph (1966) contains a review of the paleobotany and paleoecology

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of these rocks. Ill health prevented Pabst from completing studies of the abundant angiosperm fossils, and her published work includes only the ferns, conifers, and rushes. Pabst believed the Chuckanut sediments were deposited in a continental basin having a warm-temperate to subtropical climate, with a flora similar to the lowland rain forests presently found in Mexico, Central America, and northern South America. Palynological investigation of the lower 1555 m of the type section (Griggs 1966) indicates the presence of more than a dozen species of flowering plants and generally confirms Pabst's interpretation of the paleoecology. Sediment characteristics indicate that deposition occurred mostly along meandering rivers and adjacent floodplains (Johnson 1981).

Chuckanut plant fossils are similar to early Tertiary floras from other western localities, particularly the Paleocene Fort Union Formation. Pabst believed the lowermost Chuckanut was very late Cretaceous, with the rocks being predominantly Paleocene. Radiometric dates suggest that the sediments are somewhat younger than previously recognized. Frizzel (1979) refers to the Chuckanut as being early to middle Eocene, based on a single fission track date of 50 my from the upper part of the stratigraphic section. Fission track dates of detrital zircon have recently been obtained at the University of Washington for about a dozen specimens of Chuckanut sediment and confirm that the formation is early to middle Eocene (Samuel Johnson, pers. comm.).

Vertebrate Remains

The turtle fossil (Fig. 1) was excavated from a thinly bedded siltstone layer within a series of beds which are predominately sandstone. The carapace is 12 cm long, 13 cm wide, and 2.5 cm deep, having a nearly circular outline and low arch. The cast represents the bony dermal shell, marked by 9 shallow corrugations on either side of the vertebral column. The specimen is somewhat eroded, but remnants of the original bone are present. X-ray fluorescence analysis shows that this material consists of calcium phosphate, and SEM examination reveals preservation of fibrous organic matrix (Fig. 2). Vertebral processes are preserved as a central line, representing dorsal vertebra 1-10, with faint indications of the first sacral vertebra. Nine pairs of free ribs attach to the vertebral column, fused to the dermal shell 0.5-1.0 cm from the vertebra, with the ribs forming the valleys of the shell corrugations.

The specimen lacks characteristics needed for complete identification, but general features place it in the Testudinoidea superfamily (Roemer 1968). Members of this group are known from late Cretaceous to Recent and include most living pond and swamp turtles. Two carapaces identified as *Baptemys* were reported from the Roslyn Formation (Wheeler 1955), a sedimentary unit from Eastern Washington similar in age and lithology to the Chuckanut. *Baptemys* belongs to the Dermatemydidae family, a primitive testudinoid group from the late Cretaceous and Eocene of North America.

One cm below the carapace the rock contains a fragment of bone too large to have come from the turtle (Fig. 3). The fragment is exposed in cross section and has a flattened assymetric 26 by 6 mm oval shape. A dense 0.5 mm cortical layer encloses the porous inner material. Though too incomplete to be identified, this bone indicates that the Chuckanut depositional basin was inhabited by some larger vertebrate.

Clark Point consists of steeply dipping beds of arkosic sandstone interlayered with lesser thicknesses of sandy shale and conglomerate. These beds are stratigraphically

Figure 1. Cast of the interior surface of turtle carapace from Clark Point, near Bellingham, Washington.

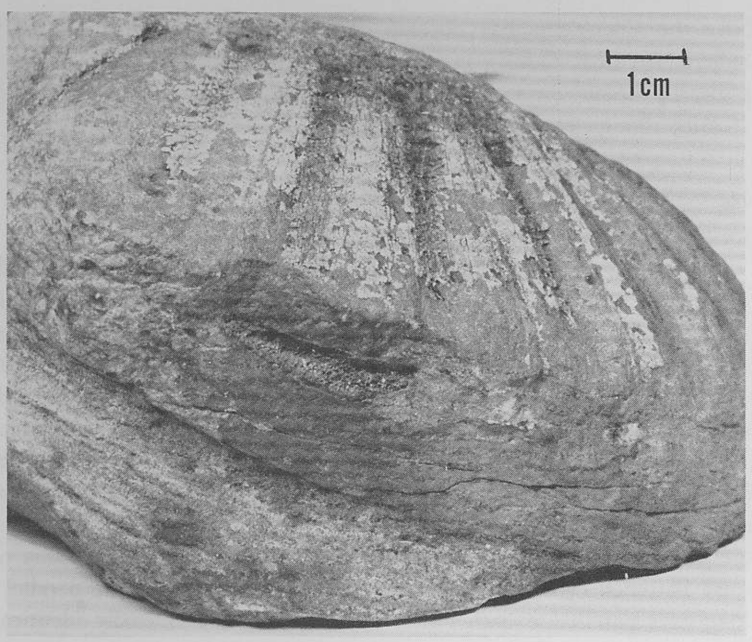

Figure 2. Side view of specimen, showing porous bone fragment, and remnants of original dermal shell.

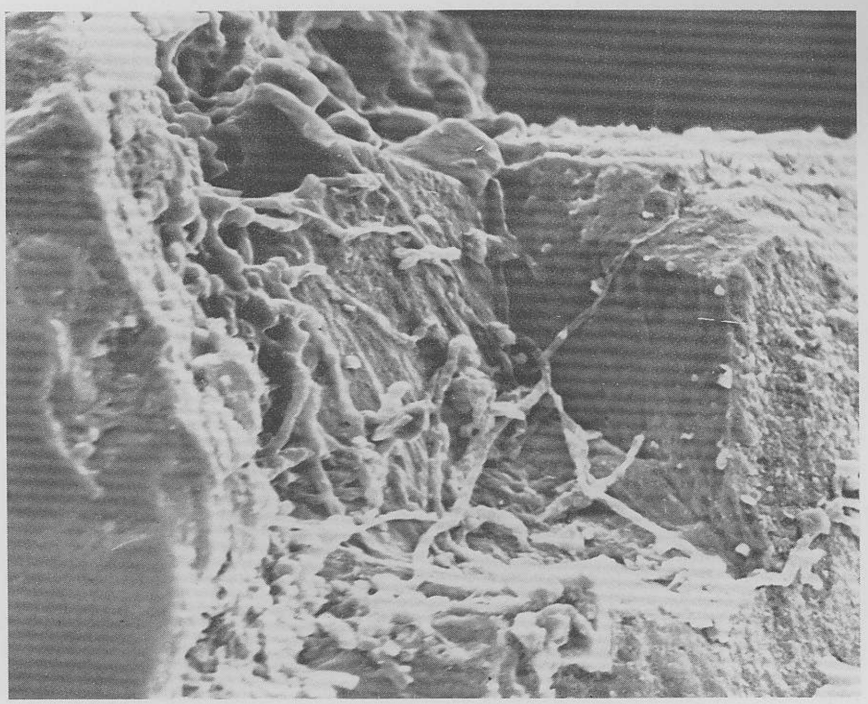

Figure 3. SEM photomicrograph of turtle shell material, showing organic matrix. 345X magnification.

slightly above the Chuckanut Bay outcrop dated at 50 my by Frizzel (1979). The exact site where the turtle fossil was found is no longer accessible, but this stratum is exposed in nearby beach cliffs. Examination of these rocks turned up no additional vertebrate fossils, though carbonized plant material is common.

Pseudofossils

About a dozen large objects resembling fossils are exposed near sea level at a small inlet near the tip of Clark Point. These occur in well-sorted, massively bedded arkosic sandstone and consist of elongate flattened-cylindrical masses typically divided into segments (Fig. 4) that bear a vertebra-like appearance. These objects may account for undocumented reports of fossil reptiles from the Chuckanut Bay area (Hopkins 1966, p. 20; W. H. Mathews, University of British Columbia, pers. comm.). Though superficially resembling vertebra, the objects are too large and lack such details as spinal processes, rib attachments, or articulating surfaces. They are similar in size and shape to casts of logs found throughout the Chuckanut Formation, but lack the carbonized outer layer present at other locations.

The objects are about 10-30 cm in diameter and have exposed lengths of up to 3 m. They are flattened cylinders oriented with the major axial plane parallel to bedding and long axes parallel to each other. These masses are textually identical to the surrounding sandstone but effervesce strongly in dilute HC1, showing that they contain large amounts of calcareous cement. In contrast, like most Chuckanut sediment

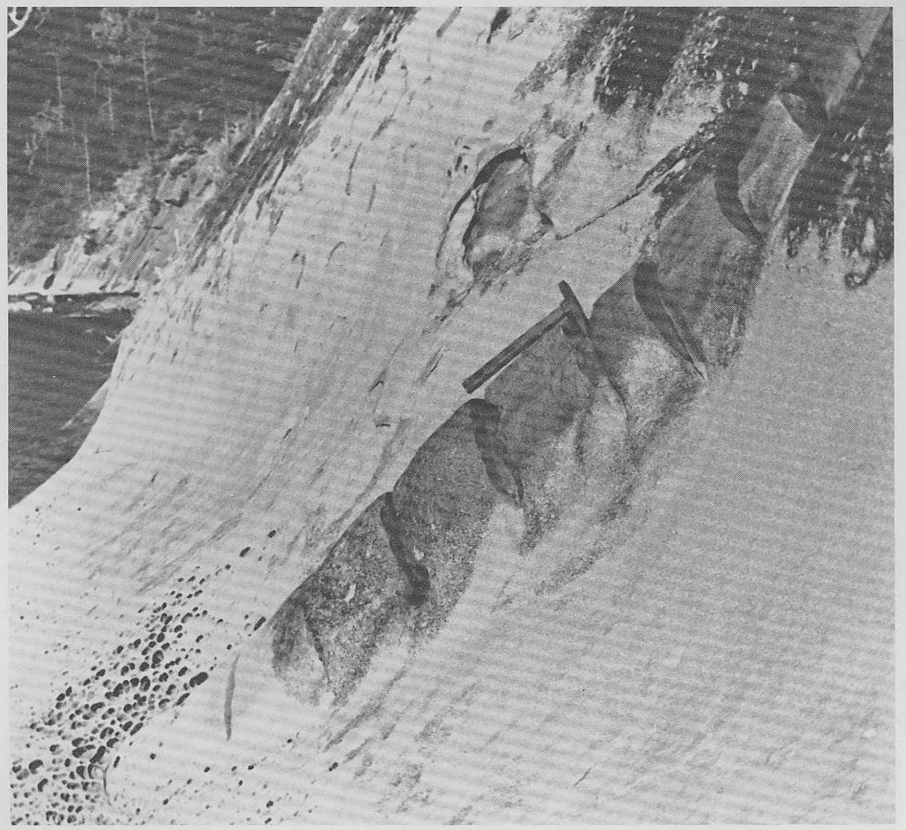

Figure 4. Weathered calcareous concretions exposed on beach cliff at Clark Point.

(Kelly 1970), the surrounding rock is cemented by phyllosilicates. The composition and shape of these objects suggests that they are calcareous concretions.

The segmented appearance results from dissolution of carbonate cement along joint planes that cut the concentrations perpendicular to their long axes. These joints are expressed only in the concretions and do not extend into the adjacent phylosilicate-cemented sandstone. In thin section an estimated 10-20 percent sparry calcite cement can be seen filling pores. Most of the Chuckanut sandstones have phyllosilicate pore fillings and low porosity. The concretions must have formed before the pores were filled with diagenetic phyllosilicates, indicating that their formation was an early event in the history of the rock. The joint fractures may have originated during folding; the fractures do not extend outside the concretions because either the sandstone was not cemented by phyllosilicates when folding took place, or the phyllosilicates behaved more plastically than the carbonate. Calkin (1959) observed "spine-like" calcareous concretions in coastal outcrops of Chuckanut sandstone on Lummi Island. These concretions are abundant but lack the segmented patterns present at Clark Point.

Literature Cited

Calkin, P. E. 1959. The Geology of Lummi and Eliza Islands, Whatcom County, Washington. Univ. British Columbia, Vancouver, M.S. thesis.

Frizzel, V. A., Jr. 1979. Petrology and Stratigraphy of Paleogene Nonmarine Sandstones, Cascade Range, Washington. Stanford Univ. Ph.D. thesis.
Glover, S. L. 1935. Oil and gas possibilities of western Whatcom County. Wash. Dept. Conserv. and Dev., Div. of Geol. Rept. No. 2
Griggs, P. H. 1966. Palynological interpretation of the type section, Chuckanut Formation, Northwestern Washington. Symposium on Palynology of the Late Cretaceous and Early Tertiary, R. M. Kosanke and A. T. Cross, eds., Geol. Soc. Amer. Spec. Paper 127: 169-212.
Hopkins, W. S. 1966. Palynology of Tertiary Rocks of the Whatcom Basin, Southwestern British Columbia and Northwestern Washington. Univ. British Columbia, Vancouver, Ph.D. thesis.
Johnson, S. Y. 1981. Sedimentation and tectonics of the Chuckanut Formation on Bellingham Bay, Washington (Abst.). Cordilleran Section Symposium, Geol. Assoc. of Canada: 25.
Kelly, J. M. 1970. Mineralogy and Petrography of the Basal Chuckanut Formation in the Vicinity of Lake Samish, Washington. Western Wash. State College, Bellingham, M.S. thesis.
Knowlton, F. H. 1902. Preliminary report on fossil plants collected by Henry Landes. Wash. Geol. Surv. Ann. Rept. for 1901, no. 1: 32-33.
Lesquereux, L. 1859. On fossil plants collected by Dr. John Evans at Vancouver Island and Bellingham Bay, Washington Territory. Am. Jour. Sci. 27: 85-89.
Miller, G. M., and Misch, P. 1963. Early Eocene angular unconformity at western front of northern Cascades, Whatcom County, Washington. Am. Assoc. Petroleum Geologists Bull. 46: 163-174.
Newberry, J. S. 1863. Descriptions of the fossil plants collected by Mr. George Gibbs, Geologist to the United States Northwest Boundary Commission. Boston Jour. Nat. Hist., 1859-1863, 7: 506-524.
Pabst, M. B. 1968. The Flora of the Chuckanut Formation of Northwestern Washington. Univ. of Calif. Press, Berkeley.
Roemer, A. S. 1968. Osteology of the Reptiles, Univ. of Chicago Press: 595-517.
Weaver, C. E. 1937. Tertiary Stratigraphy of Western Washington and Northwestern Oregon. Univ. of Wash. Publications in Geology, v. 4, Seattle.
Wheeler, H. E. 1955. Dermatemidid turtle from the Roslyn Formation of Washington (Abst.). Geol. Soc. Amer. Bull. 66: 1668-1669.

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