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Eocene Megafossils from the Needles–Gray Wolf Lithic Assemblage of the Eastern "Core Rocks", Olympic Peninsula, Washington

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INTRODUCTION

The central part of the Olympic Mountains, Washington, contains several lithic assemblages that collectively make up what is known as the "core rocks", a term that stems from usage in the 1970s by U.S. Geological Survey mappers. These core rocks have had a complex tectonic history, and it is generally accepted that they are a collage of several imbricated thrust slices consisting of subduction-related mélange and turbidite units that accreted to North America during the Tertiary (Heller and others, 1992; Suczek and others, 1994). Due primarily to the scarcity of fossils, the ages of the core rocks are not well constrained (Heller and others, 1992), but they are generally accepted to be younger than the lower part of the so-called "peripheral rock" (that is, lower part of the Crescent terrane) that border them to the north, east, and south in a horseshoe outcrop pattern.

Fossils are rare within the core rocks (Danner, 1955b; Tabor, 1975). Reasons for this scarcity are that many of the core rocks are turbidites, originally deposited in deep water as the result of turbidity flows. Turbidity flows are, in most instances, not conducive to the preservation of fossils. Many turbidites in the core rocks have also been sheared or otherwise deformed, and some are metamorphosed, destroying any fossils that may have been present.

The Needles–Gray Wolf lithic assemblage, the easternmost of the core rocks, consists of an approximately 6.5 km-thick thrust slice containing sandstone, siltstone, slaty mudstone, and pillow basalt. The dip of this thrust slice is nearly vertical, and the unit is also chiefly eastward and northeastward topping (Cady and others, 1972a) and is one of the structurally highest thrust slices in the accretionary prism that makes up the Olympic core. The Needles–Gray Wolf lithic assemblage is one of the oldest thrust slices, yet it is younger than the lower to middle Eocene pre-subduction zone rocks in the lower part of the Crescent terrane. The Needles–Gray Wolf unit was originally reported (see Previous Work) as ranging in age from late Paleocene to late Eocene, on the basis of scarce megafossil remains. Fission-track studies of detrital zircons in sandstones (Brandon and Vance, 1992a,b) now place the age range from 39 to 33 Ma (late Eocene to early Oligocene). The stratigraphic positions of these detrital-zircon samples versus those of the megafossils are discussed under Previous Work.

This is the first detailed report about the megafossil species in the Needles–Gray Wolf unit. We offer comments regarding provenance, geologic age, and photographic documentation of the species collected. The molluscan stages used in this report stem from Clark and Vokes (1938), who proposed five informal molluscan-based provincial Eocene stages: Meganos, Capay, Domengine, Transition, and Tejon.

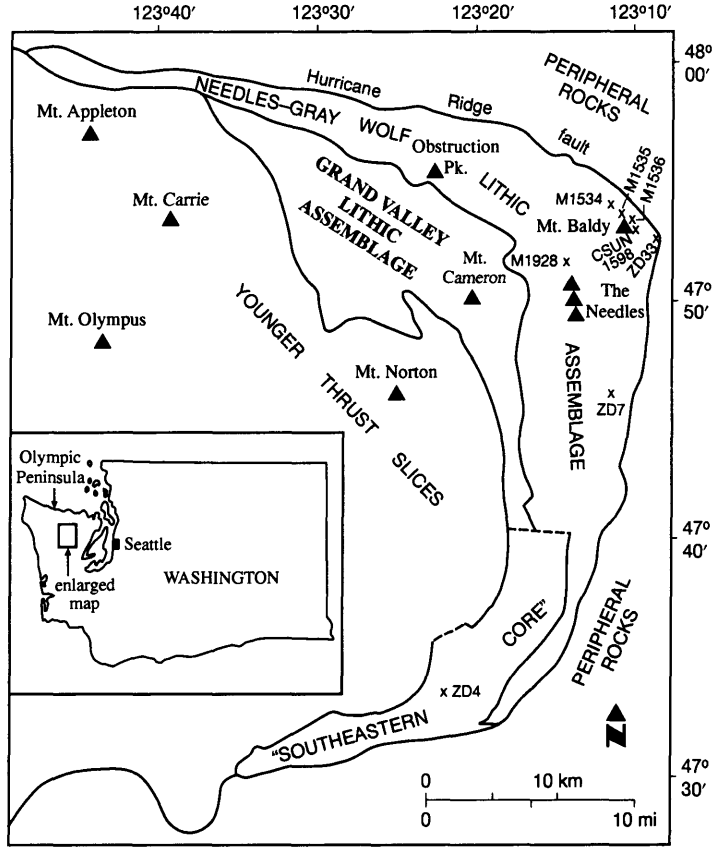

Figure 1. Index map showing the megafossil localities and selected detrital-zircon localities of Brandon and Vance (1992a,b). Modified from Tabor and Cady (1978a, fig. 2).

Abbreviations used are: CSUN, California State University, Northridge; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; USGS, U.S. Geological Survey; and USNM, National Museum of Natural History, Washington, D.C.

PROCEDURE

The Needles–Gray Wolf megafossils we studied are from five localities. Four of these localities (USGS locs. M1534, M1535, M1536, and M1928) were found and collected by W. M. Cady and his colleagues while mapping for their report on the Tyler Peak quadrangle (Cady and others, 1972a). Localities M1534–1536 are from near Mount Baldy in the upper part of the Needles–Gray Wolf lithic assemblage (Fig. 1).

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Locality M1928 is about 6.5 km southwest of the other localities and is north of The Needles, which is a high, steep-sided ridge where rocks of the Needles–Gray Wolf lithic assemblage are prominently exposed. We did not visit the Cady localities; they are remote and extremely difficult to reach. We borrowed the collections of megafossils, which number about 100 specimens, from the USGS at Menlo Park, Calif.

The fifth locality (CSUN loc. 1598) was found by the junior author in 1992. A blizzard in August allowed for only a short visit, but seven fossil specimens were collected.

Preservation of all the fossils from the Needles–Gray Wolf unit is poor, and many specimens are preserved as molds. Latex peels of external molds (made by workers at the USGS and by us) were used to identify the gastropods and some of the bivalves.

The specimens illustrated in this report are deposited at USNM, and the rest of the collection is stored at the USGS (Menlo Park).

PREVIOUS WORK

Cady and MacLeod (1963) reported fragments of megafossils from a fossiliferous horizon in the core of the Olympic Mountains. The interval is 150 to 300 m thick and crops out locally for about 34 km along strike. They also mentioned the presence of the gastropod *Gemmula*? sp. and the bivalves *Acila* cf. *A. decisa* (Conrad, 1855) and *Crassatella?* sp. They further mentioned that W. O. Addicott, who was a molluscan paleontologist with the USGS at that time, had examined the megafossils and considered them to be of early Tertiary (Paleocene to Eocene) age. These fossil molds and casts of fragmentary remains are from three USGS localities (M1534, M1535, M1536) that were plotted within the Needles–Gray Wolf lithic assemblage by Cady and others (1972a) on their geologic map. The localities are in a thin zone of microbreccia in the Mount Baldy area. Cady and others (1972a) also indicated megafossils from the microbreccia at about 5.5 km and about 8.5 km south of Mount Baldy but gave no locality numbers.

Cady and others (1972a) reported planktonic microfossils from a microfossil locality (USGS 3816) 3 km southeast of locality M1928. The reported age of the microfossils as "not older than Tertiary" is not very informative and makes any information gained from megafossils more important. Cady and others (1972a) assigned a minimum age of 42.6 ±0.7 Ma. (late Eocene) to the Needles–Gray Wolf lithic assemblage on the basis of a K-Ar age from a dike that cuts the assemblage about 45 km southwest of the Mount Baldy area.

Cady and others (1972b), Tabor and others (1972), and Tabor and Cady (1978a) reviewed the probable geologic age of the Needles–Gray Wolf rocks but added no new megafossil information. Tabor (1975, fig. 22) provided generalized line drawings of unnamed species of the bivalve *Venericardia* and the gastropod *Turritella* from near locality M1928. He reported that W. O. Addicott considered these fossils to be probably late Eocene in age. Tabor and Cady (1978b) plotted the four above-mentioned USGS mega- fossil localities on their geologic map of the Olympic Peninsula, but they did not list or discuss the megafossil species, nor did they give a precise geologic age. They assigned the Needles–Gray Wolf unit an undifferentiated Eocene age.

Brandon and Vance (1992a,b) reported fission-track ages in the range of 39 to 33 Ma (late Eocene to late Oligocene) for the youngest detrital zircons in two sandstone samples (ZD7 and ZD33) (Fig. 1) from the Needles–Gray Wolf unit. Sample ZD7 was collected about 10.5 km (6.5 mi) south of USGS loc. M1928 and might be stratigraphically higher. Sample ZD33 is 3.2 km (2 mi) southeast of localities USGS M1536 and CSUN 1598 and is from the stratigraphically highest (youngest) part of the Needles–Gray Wolf unit.

Brandon and others (1988) reported a fission-track age of 39 ±4.5 Ma (late Eocene) for the youngest detrital zircons in a sandstone sample (ZD4) (Fig. 1) collected from the Southeastern core rocks (map unit Tsc of Tabor and Cady, 1978b) along the North Fork Skokomish River. The northernmost outcrops of the Southeastern core rocks are about 21 km (13 mi) south of the southernmost megafossil locality in the Needles–Gray Wolf unit. The stratigraphic relations of the Southeastern core rocks and the Needles–Gray Wolf unit are complex and need further study.

The only other megascopic fossils reported from the Needles–Gray Wolf lithic assemblage are large (as much as 8.5 mm diameter) siliceous tubes of a foraminiferid. Danner (1955a,b) reported the tubes as present near Obstruction Peak [his Obstruction Point], which is about 15 km northwest of Mount Baldy (Fig. 1). Obstruction Peak is underlain by rocks of the Needles–Gray Wolf lithic assemblage (Tabor and Cady, 1978b). In 1975, Danner referred to the fossils as the agglutinated tube fossil *Terebellina* and noted that they indicate relatively deep offshore waters. Miller (1995) confirmed that the tubes are actually remains of the siliceous, large foraminiferid *Bathysiphon* and that the genus name *Terebellina* is a junior synonym. However, remains of this foraminiferid, which are also present in the peripheral rocks surrounding the core rocks, are not age diagnostic.

LITHOLOGIES AND PALEONTOLOGY

Rocks from USGS loc. M1928 are dark-gray, well-cemented, very fine grained and well-sorted micaceous sandstone that is brown when weathered. The rock is slightly metamorphosed and contains some deformed gastropods and bivalves. Some of the hand specimens contain localized concentrations of disarticulated bivalve shells that show both concave-up and concave-down positions. The shells are matrix supported and were deposited by grain-flow processes associated with turbidites, which make up most of this rock assemblage.

Seventy-six fossil specimens were collected at locality M1928, and the taxonomic composition of this fauna is listed in Table 1. Taxa identifiable to genus level or lower are illustrated in Figure 2. The dominant faunal components are the gastropod *Turritella uvasana* cf. *T. uvasana uvasana* Conrad, 1855, and the bivalve ?*Callista andersoni* (Dickerson, 1915). Most of the gastropods are preserved as external molds, and the *Turritella uvasana* cf. *T. uvasana uvasana* remains consist

Table 1. Megafossils from USGS loc. M1928 in the western part of the Needles–Gray Wolf lithic assemblage, eastern core of the Olympic Mountains. The number of specimens of each species is given in parentheses

Gastropods
Turritella uvasana cf. *T. uvasana uvasana* Conrad (11)
Crepidula? sp. (1)
naticid (1)
unidentifiable gastropods (11)
Bivalves
Glycymeris sp. (3)
Venericardia sp. indet. (1)
?*Callista andersoni* (Dickerson) (16)
?*Callista conradiana* (Gabb) (5)

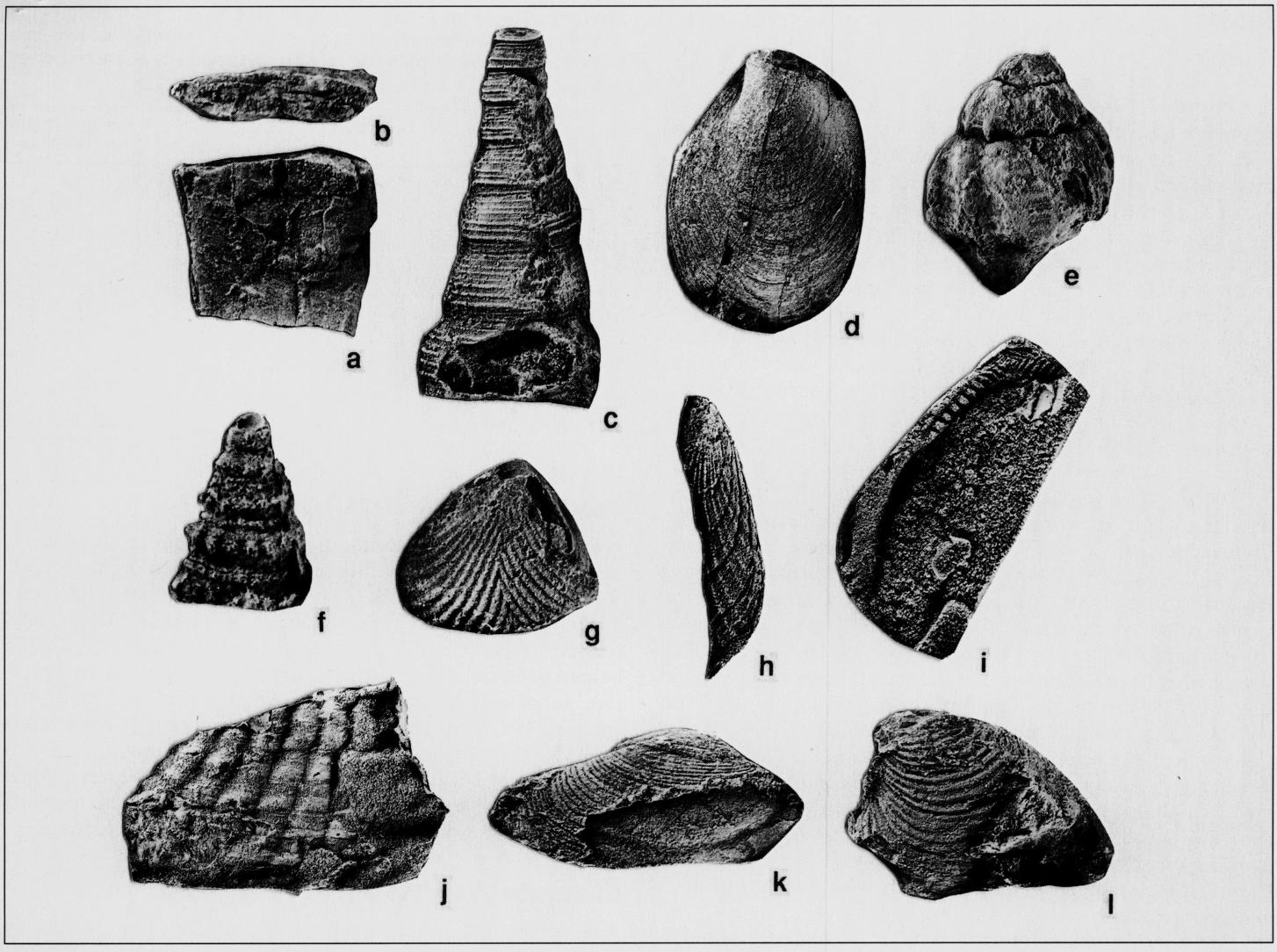

Figure 2. Needles–Gray Wolf lithic assemblage megafossils identifiable to genus or species. All latex casts and specimens coated with ammonium chloride. **a,b.** *Bathysiphon* sp., hypotype LACMIP 7950, CSUN loc. 1598, length 8.5 mm, diameter 8.5 mm, total thickness 2.3 mm, x3.3. **a**, lateral view; **b**, cross-section view. **c.** *Turritella uvasana* cf. *T. uvasana uvasana* Conrad, 1855, USNM hypotype 487983, USGS loc. M1928, latex cast, side view, length 16 mm, x7.3. **d.** *Crepidula*? sp., USNM hypotype 487984, USGS loc. M1928, dorsal view, length 37.6 mm, x1.2. **e.** *Whitneyella*? sp., USNM hypotype 487985, USGS loc. M1535, latex cast, side view, length 16 mm, x2.3. **f.** Gemmula sp., USNM hypotype 487986, USGS loc. M1535, latex cast, side view, length 3.2 mm, x9.7. **g.** *Acila* (*Truncacila*) *decisa* (Conrad, 1855), USNM hypotype 489787, USGS loc. M1535, latex cast, right? valve, height 6 mm, x4.7. **h,i.** *Glycymeris* sp., USNM hypotype 489788, USGS loc. M1928, latex cast of partial specimen, height 23 mm. **h**, exterior view, x1.9; **i**, partial hinge view, x2.2. **j.** *Venericardia* sp. indet., USNM hypotype 487989, USGS loc. M1928, latex cast of fragment of shell, maximum dimension 40 mm, x1.3. **k.** ?*Callista andersoni* (Dickerson, 1915), USNM hypotype 487990, USGS loc. M1928, right-valve exterior, height 7 mm, x3.1. **l.** ?*Callista conradiana* (Gabb, 1864), USNM hypotype 487991, USGS loc. M1928, left-valve exterior, height 10 mm, x2.7.

only of the apical whorls (that is, juvenile whorls). Some of the bivalves are preserved as recrystallized shell calcite, but many are internal molds. Nearly all the bivalves are single valves, and the only articulated ones are three juvenile specimens. All the megafossil taxa found at this locality are found elsewhere along the Pacific coast of North America in shallow-marine (shelf depths) rocks.

The *Crassatella*? sp. reported by Cady and MacLeod (1963) from locality M1928 is a fragmental specimen whose hinge teeth are missing. Positive identification to even the familial level is not possible.

At USGS locs. M1534–1536, as well as at CSUN loc. 1598, the rocks consist of gray to black micaceous siltstone with abundant rip-up clasts and scattered granules and small pebbles that reach 6.5 mm in diameter. Fewer than ten specimens were found at each of these localities. The taxonomic composition at each locality is given in Table 2. Taxa identifiable to genus level or lower are illustrated in Figure 2. Most specimens are preserved as molds. The dominant faunal component at these localities is the bivalve *Acila (Truncacila) decisa* Conrad, 1855, a widespread species found elsewhere along the Pacific coast of North America in shallow-marine rocks (Squires, 1984; Squires and Goedert, 1994).

At CSUN loc. 1598, a thick-walled fragment of the tubular, siliceous foraminiferid *Bathysiphon* sp. was found. At USGS loc. M1536, an external mold of this foraminiferid was also found.

GEOLOGIC AGES

Turritella uvasana cf. *T. uvasana uvasana*, ?*Callista andersoni* (Dickerson, 1915), and ?*Callista conradiana* (Gabb,

1864) provide the best indication of geologic age of any of the megafossils found in the Needles–Gray Wolf lithic assemblage. These taxa were found only at USGS loc. M1928. The specimens of *Turritella uvasana* cf. *T. uvasana uvasana* can be only tentatively identified to subspecies because the specimens consist only of the apical whorls. Nevertheless, a comparison with all the known subspecies of *Turritella uvasana* showed that the locality M1928 specimens are most similar to *Turritella uvasana uvasana*. The similarity concerns the whorl profile and the relatively close spacing of the three to four secondary spiral ribs on the posterior half of the juvenile whorls. The anterior half of the juvenile whorls is occupied by three primary spiral ribs. *Turritella uvasana uvasana* is confined to the Tejon Stage, which spans a considerable interval of time from middle middle Eocene through late Eocene (Squires, 1994). *Turritella uvasana uvasana* is a common subspecies in southern and central California (Merriam, 1941), and its geographic range can now be extended tentatively to Washington.

The *Turritella* specimens at USGS loc. M1928 are also similar to certain specimens of *Turritella uvasana chehalisensis* Merriam, 1941. These particular specimens were considered by Merriam (1941) to be "extreme variants" that have the characteristics of *T. uvasana uvasana*. One of these extreme-variant specimens is a paratype of *T. uvasana chehalisensis* and is figured by Merriam (1941, pl. 16, fig. 14). That specimen is from exposures that Pease and Hoover (1957) and Logan (1987) mapped as Skookumchuck Formation just south of Oakville near Balch in the Chehalis Valley, Grays Harbor County, western Washington. This formation is of late middle Eocene age (Armentrout and others, 1983) and correlative to the Tejon Stage. Although it is not possible to resolve whether the USGS loc. M1928 specimens are *Turritella uvasana uvasana* or extreme variants of look-alike *T. uvasana chehalisensis*, the geologic age of the latter is within the range of *T. uvasana uvasana*.

The *Turritella* specimens at USGS loc. M1928 superficially resemble *Turritella porterensis* Weaver (1912), a species known (Armentrout, 1975) from lower Oligocene strata in western Washington. The whorl profile of the *Turritella* specimens at USGS loc. M1928 differs from that of *T. porterensis* by having much weaker and much less well developed spiral ribs on the posterior half of the whorls.

The specimens of *?Callista andersoni* and *?Callista conradiana* from USGS loc. M1928 cannot be positively identified because of poor preservation. Both bivalve species are widespread on the Pacific coast of North America, and *Callista conradiana*, like *Turritella uvasana uvasana*, is confined to the Tejon Stage. *Callista andersoni* ranges from the Transition Stage to Tejon Stage (Squires, 1994). Therefore, the geologic age of the megafossils at USGS loc. M1928 is most likely middle middle Eocene to late Eocene (Tejon Stage).

The single specimen of *Crepidula*? sp. found at USGS loc. M1928 is a large specimen (37.6 mm long) embedded in matrix, but cleaning this specimen to make a positive generic and specific identification would destroy it.

The bivalve *Acila (Truncacila) decisa* is the dominant faunal component at the localities in the vicinity of Mount Baldy. The geologic range of this species is late Paleocene through the late Eocene (Squires and Goedert, 1994). The specimens in the Mount Baldy area must be either the same age as or younger than the middle middle Eocene to late Eocene rocks at USGS locality M1928 in the lower part of the unit because the specimens are from near the top of the Needles–Gray Wolf unit.

Table 2. Megafossils from localities in the Mount Baldy area in the eastern part of the Needles–Gray Wolf lithic assemblage, eastern core of the Olympic Mountains. The number of specimens of each species is also given

Taxa \ Localities:	USGS M1534	USGS M1535	USGS M1536	CSUN 1598
Foraminiferid				
Bathysiphon sp.			1	1
Gastropods				
Whitneyella? sp.	–	1		–
Gemmula sp.	–	1	–	–
unidentifiable gastropods	1	2	–	1
Bivalves				
Acila (Truncacila) decisa (Conrad)	3	7	1	4
Echinoderms				
unidentifiable fragments	–	–	2	–

ACKNOWLEDGMENTS

We thank Steven R. Benham (Pacific Lutheran University, Tacoma) for suggesting this project and reviewing the paper. Rowland W. Tabor (USGS, retired) provided us with background information. Charles L. Powell II (USGS, Menlo Park) loaned us the USGS specimens. LouElla Saul (LACMIP) helped us in obtaining various *Turritella* species for comparative purposes and shared her knowledge of fossil mollusks. Lindsey T. Groves (LACMIP) helped us obtain obscure references and provided a catalog number. Mark Florence (USNM) provided other catalog numbers. Daniel H. Goedert helped collect fossils from the Mount Baldy area. We thank the staff of Olympic National Park for permits allowing collecting.

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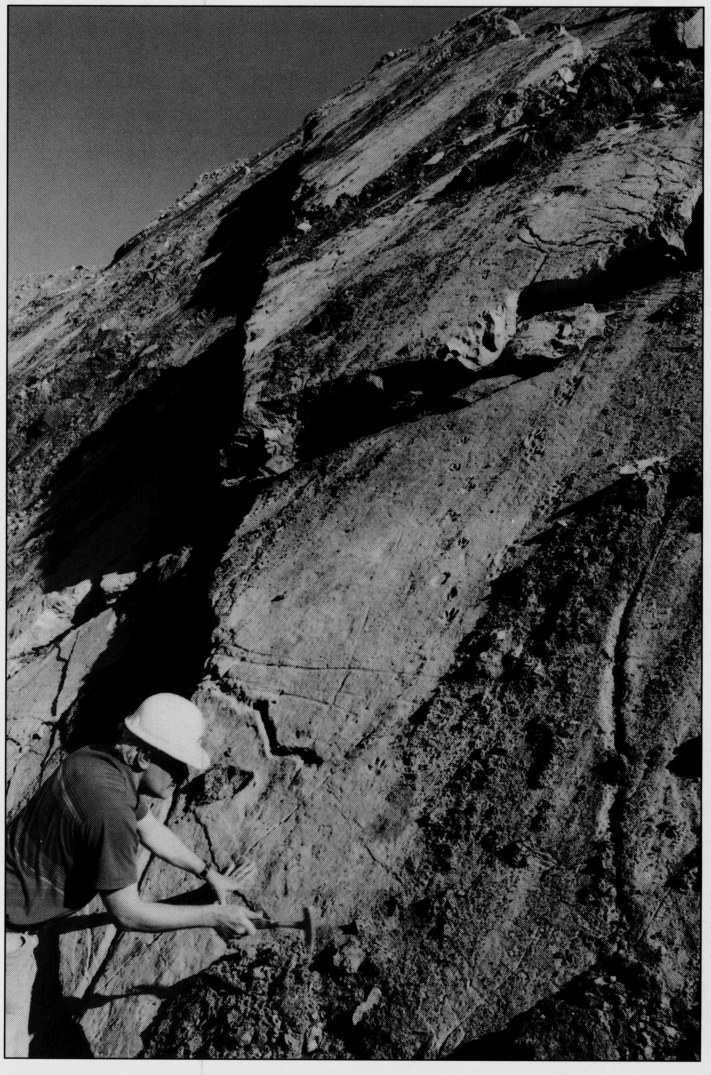
Erratum

In the article about the Chuckanut Formation in the previous issue, there is a spurious reference to a Clark Point on the north end of Guemes Island. The Clark Point in question is the one that borders Chuckanut Bay, near Bellingham's southwestern city limits.

EOCENE FOOTPRINTS DISCOVERED



Footprints of several kinds of middle Eocene animals were recently discovered in the Black Diamond coal mine, owned by Pacific Coast Coal Company. The company has offered to help the Burke Museum geologic staff make casts or to collect some of these or similar prints. (We do not know who took this photo. If you recognize it as one of yours, let us know and we'll give you credit in the next issue.)