DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

Lithofacies in Part of the Type Merced Formation in Sea Cliff Exposures between Thornton Beach and Woods Gulch, Daly City, California

by

H. E. Clifton[1] and Joseph Stagg[1]

OPEN-FILE REPORT 86-91

[1]U. S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

The type section of the Merced Formation occurs in sea cliff exposures between Mussel Rock and Fort Funston on the western side of the San Francisco Peninsula (Lawson, 1893). This section and the associated overlying Pleistocene beds have been scrutinized by a number of geologists (e.g., Lawson, 1893; Ashley, 1895; Glen, 1959; Hall 1965 and 1966). The most recent examination has focused on the depositional facies that exist within this sediment (Hunter and Clifton, 1982; Hunter et al., 1984).

This report extends the lithofacies analysis of the Merced Formation in its sea cliff exposures south of San Francisco from the bottom of the section (base of sequence J) described by Hunter et al (1984) to the north side of Woods Gulch. The stratigraphic column is shown in Fig. 1 (A and B) and a cross-section of the sea cliff exposures from Thornton Beach is shown in Fig. 2. We follow the designation system of Hunter et al. (1984) whereby "sequences" (mostly bounded by unconformities) are designated with capital letters. The sequences comprise a set of relatively homogeneous lithologic units that are designated by subscript number. As noted in Hunter et al. (1984), the sequences are lettered in a stratigraphic-downward direction in reverse alphabetical order.

LITHOFACIES

Sequence C. Progradational shoreline sequence (shelf to backshore facies).

Basal contact: abrupt change to fine-grained sand, transgressive lag of coarse sand and fine gravel, shell fragments.

Unit C_1. Shelf facies. Very fine-grained muddy sand coarsening upward to fine sand; bioturbated; abundant shells.

Unit C_2. Nearshore facies. Coarse sand and gravel; cross-beds.

Unit C_3. Backshore facies. Medium-fine sand; root structure at base of lignitic beds. May include foreshore facies in lower part.

Sequence D. Series of thin (2-4 m) embayment deposits.

Basal contact: sharp, with local interfingering with underlying backshore sands.

Unit D_1. Embayment facies. Texturally variable (gravel to mud). Basal mudstone is indurated; has benthic marine microfossils, ostracods, possible fish remains. Upper 4 m seems to be fining-upward (gravel to mud) tidal channel deposit that contains probable neap-spring bundles of tidal laminae in middle part.

Sequence E. Prograding nearshore deposit.

Basal contact: Abrupt; sharp change to sand; no lag deposit.

Unit E_1. Nearshore facies. Sand and gravel, coarsening upward; well-sorted into beds in upper part; crossbedding; abundant shells.

Sequence F. Very thick, initially transgressive, subsequently progradational (shelf to backshore) sequence.

Basal contact: Abrupt; probable transgressive lag.

Unit F_1. Shelf facies. Coarse to fine sand; planar lamination; abundant shell fragments, smaller ones predominantly concave-up (implying migrating ripples); large bivalves in growth position.

Unit F_2. Shelf facies. Fine to very fine well-sorted light-colored sand; bioturbated; shells common.

Unit F_3. Shelf facies. Coarsening upward from very fine muddy sand to fine well-sorted; pebbly sand at top; mostly bioturbated; some deformed beds; shells common throughout; shell lags in upper part.

Unit F_4. Nearshore facies. Sand and gravel; well sorted into beds; crossbedded; abundant shell fragments. Macaronichnus in upper part.

Unit F_5. Backshore facies. Medium- to fine-grained sand; sporadic muddy sand layers (paleosols) and thin (1-2 cm) mud layers; root structures below some inferred paleosols. May include foreshore facies in lower part where weathering and fracturing obscure stratification.

Sequence G. Embayment deposit.

Basal contact: Fairly abrupt, approximately 1 cm of muddy sand separates mud from underlying clean sand. Actual contact may be cryptic sand/sand contact a few tens of cm below obvious mud/sand contact (as suggested by the fact that the sand immediately below the muddy sediment contains mollusks).

Unit G_1. Embayment facies. Sandy mud; bioturbated; sandy layer in upper part has sand-filled burrows extending into underlying mud; shell detritus abundantly scattered throughout unit.

Sequence H. Prograding shelf to nearshore sequence.

Basal contact: Abrupt; transgressive lag present.

Unit H_1. Shelf facies. Fines upward in lower 15 m from fine sand to very fine muddy sand, then coarsens upward to fine sand; fine gravel in uppermost part; bivalves common.

Unit H_2. Nearshore facies. Sand and gravel; crossbedded; well sorted into beds; Macaronichnus; abundant shell fragments. Uppermost part of unit (1.5 m of fining-upward planar-bedded gravel) may be foreshore facies.

Sequence I. Thick prograding shelf to backshore sequence.

Basal contact; abrupt, transgressive lag present.

Unit I_1. Shelf facies. Fining upward in lower part, then coarsening-upward very fine muddy sand to fine sand with scattered small pebbles near top; abundant bivalves; middle part laminated; some soft sediment deformation and sheared intervals; possible hummocky cross-stratification.

Unit I_2. Nearshore facies. Sand and gravel; well sorted into beds; cross-bedded; Macaronichnus; abundant shell fragments.

Unit I_3. Backshore facies. Well-sorted fine-grained sand with several lignitic beds in central part; root structures present beneath lowermost lignitic bed. Lowermost part of unit may include foreshore facies.

Sequence J. Described in Hunter et al (1984).

REFERENCES

Ashley, G. H., 1895, The Neocene [sic] of the Santa Cruz Mountains. I-Stratigraphy: California Academy of Science Proc., Ser. 2, v. 5, pt. 1, p. 273-367 (reprinted in Stanford University Publs. Geol. Paleontol., no. 1).

Glen, William, 1959, Pliocene and lower Pleistocene of the western part of the San Francisco Peninsula: Univ. California Publs. Geol. Sci., v. 36, p. 147-198.

Hall, N. T., 1965, Petrology of the type Merced Group, San Francisco Peninsula, California: unpublished M.A. thesis, University of California, Berkeley, 126 p.

Hall, N. T., 1966, Fleishhacker Zoo to Mussel Rock (Merced Formation)--A Plio-Pleistocene nature walk: California Division of Mines and Geology Mineral Information Service, v. 19, no. 11, p. S22-S25.

Hunter, R. E., and Clifton, H. E., 1982, Description of beds exposed at Fort Funston, Golden Gate National Recreation Area, northwestern San Francisco Peninsula, California: U.S. Geological Survey Open-File Report 82-1055, 30 p.

Hunter, R. E., Clifton, H. E., Hall, N. T., Czaszar, G., Richmond, B. M., and Chin, J. L., 1984, Pliocene and Pleistocene coastal and shelf deposits of the Merced Formation and associated beds, northwestern San Francisco Peninsula, California: SEPM Midyear Meeting Field Trip Guide Book No. 3, p. 1-29.

Lawson, A. C., 1895, Sketch of the geology of the San Francisco Peninsula: U.S. Geological Survey Yearbook 15, 1893-94, p. 405-476.

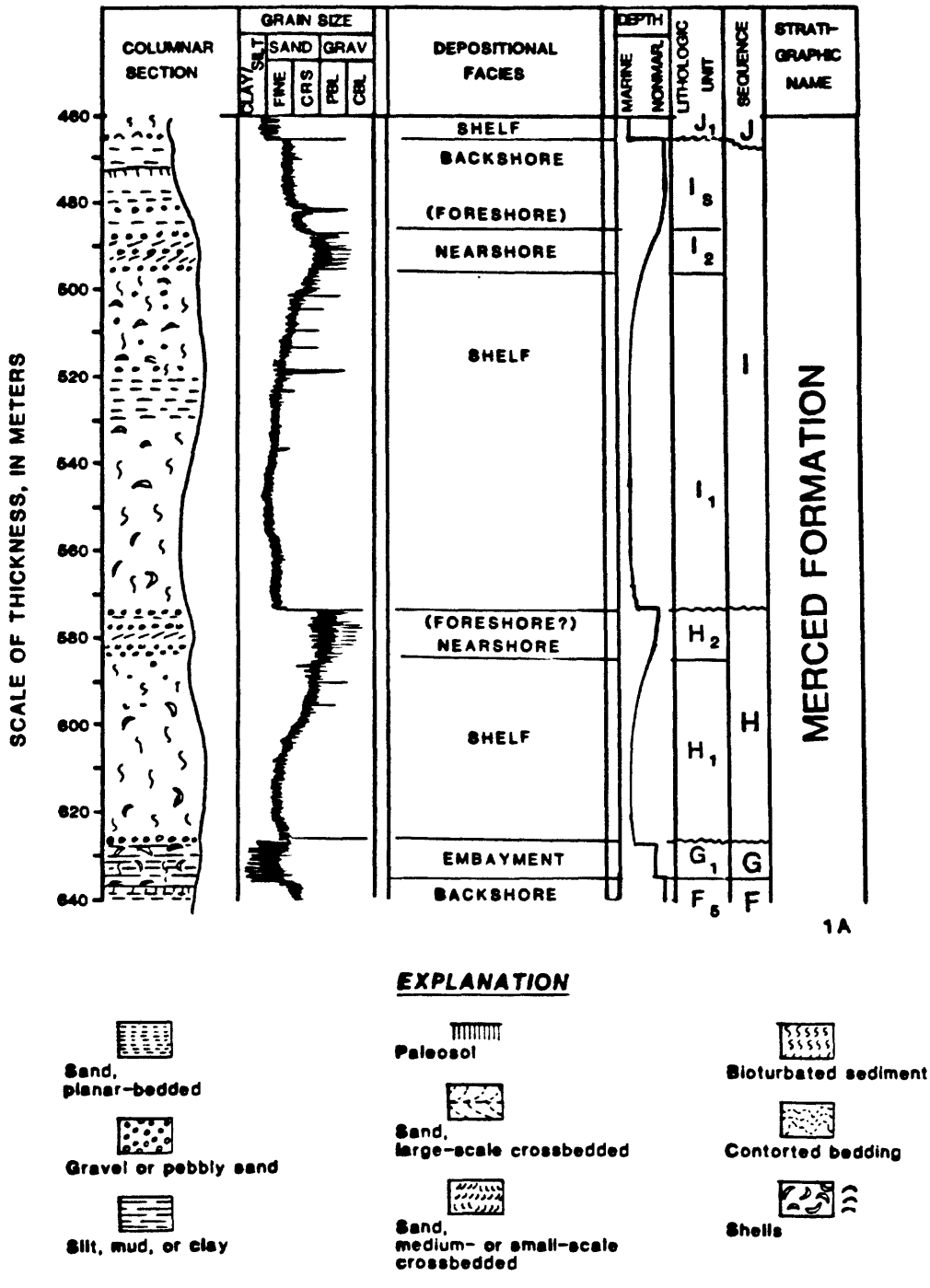
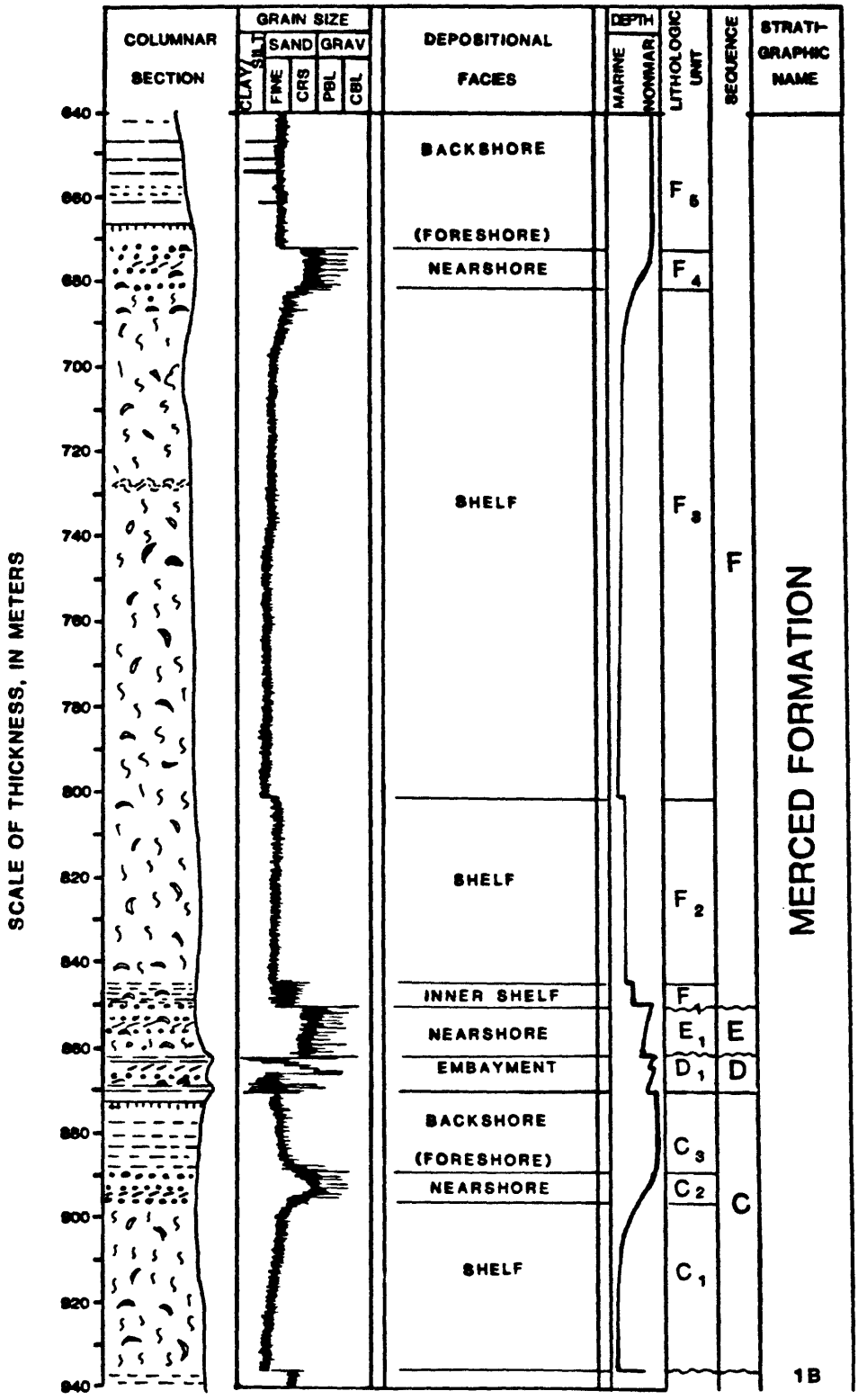


Fig. 1. Stratigraphic column of the Merced Fm. immediately north of Woods Gulch.


COLUMNAR SECTION
GRAIN SIZE
CLAY
SILT
SAND
FINE
CRS
GRAV
PBL
CBL
DEPOSITIONAL FACIES
DEPTH
MARINE
NONMAR
LITHOLOGIC UNIT
SEQUENCE
STRATI-GRAPHIC NAME
SCALE OF THICKNESS, IN METERS
640
660
680
700
720
740
760
780
800
820
840
860
880
900
920
940
BACKSHORE
(FORESHORE)
NEARSHORE
SHELF
SHELF
INNER SHELF
NEARSHORE
EMBAYMENT
BACKSHORE
(FORESHORE)
NEARSHORE
SHELF
F6
F4
F3
F2
F1
E1
D1
C3
C2
C1
F
E
D
C
MERCED FORMATION
1B

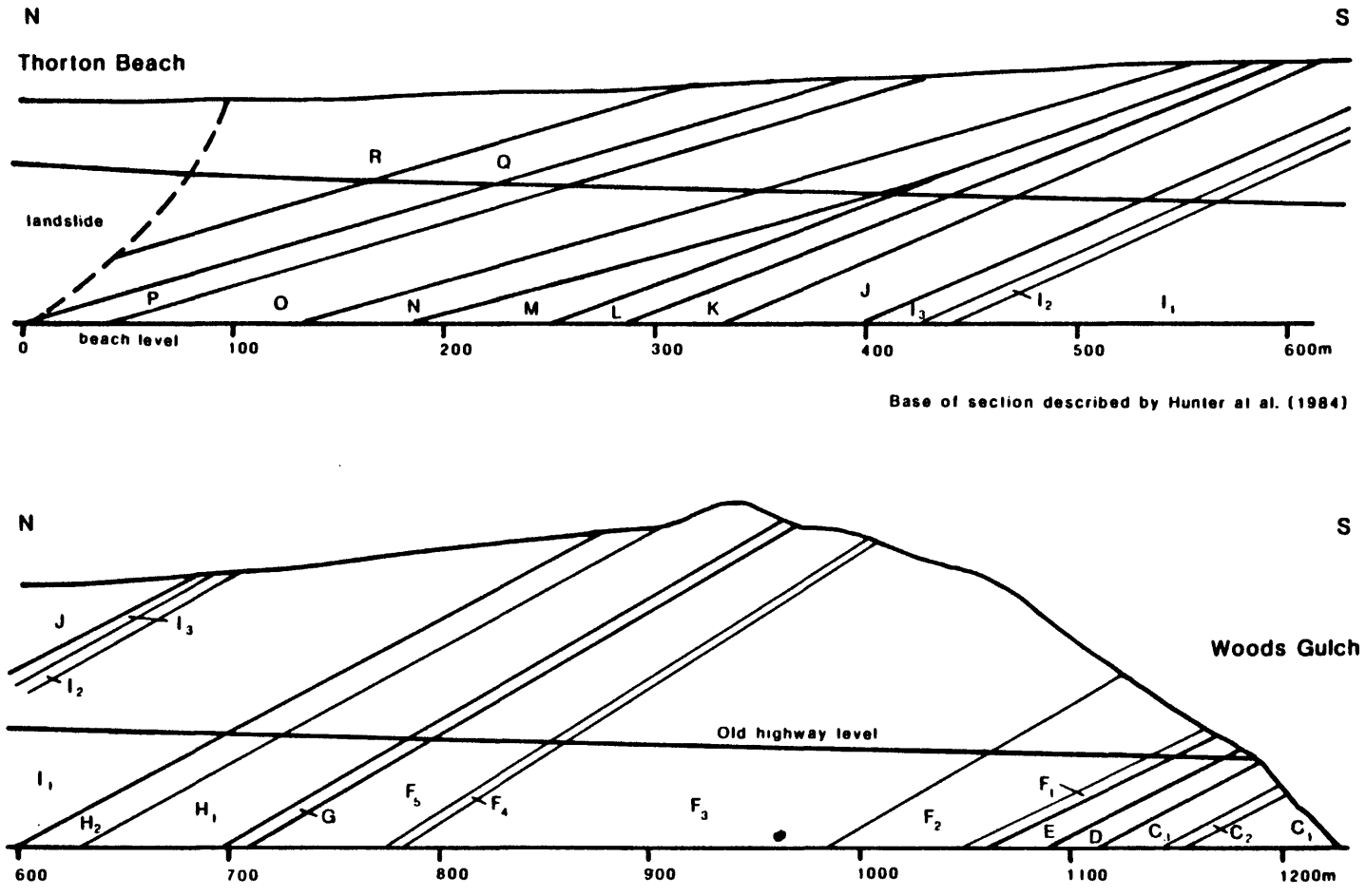


FIG. 2. Generalized seacliff section, Thorton Beach to Woods Gulch