

REVISIONS IN THE TERTIARY STRATIGRAPHY OF THE EAST FLANK OF THE DIABLO RANGE, CENTRAL CALIFORNIA

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Abstract

The San Pablo Formation is geographically restricted from the area south of Hospital Creek on the east flank of the Diablo Range. Strata previously assigned to the basal part of the San Pablo Formation and lower previously unnamed strata are herein reassigned to the Poverty Flat Sandstone (new) of late middle and late Eocene age. The Valley Springs Formation (upper Oligocene and lower Miocene) is extended from the east side of the northern San Joaquin Valley to include part of the original San Pablo Formation. The remainder of the strata previously assigned to the San Pablo Formation are reassigned to the Neroly Sandstone (upper Miocene).

INTRODUCTION

Recent geologic mapping and stratigraphic studies of Cenozoic strata bordering the northern San Joaquin Valley, together with study of subsurface data from strata under the valley, have provided new information about the regional stratigraphic relations that require revisions in the Tertiary stratigraphy. Lithologic similarities between upper Eocene to upper Miocene sequences exposed on the east side of the northern San Joaquin Valley and on the west side between Hospital and Garzas Creeks (fig. 1) strongly suggest a one-to-one correlation of units. Lithologic equivalents of the east-side units—the Lone, Valley Springs, and Mehrten Formations—are recognized on the west side of the valley, mostly as part of what had been previously mapped as the San Pablo Formation of Anderson and Pack (1915). The San Pablo Formation is here geographically restricted from the area south of Hospital Creek on the east flank of the Diablo Range, and its rocks are here reassigned to the Poverty Flat Sandstone (new), the Valley Springs Formation, and the Neroly Sandstone.

POVERTY FLAT SANDSTONE

A predominantly sandstone sequence, above the Kreyenhagen Shale and below the Valley Springs Formation, that is exposed for 4 to 5 km along the California Aqueduct south of Orestimba Creek (fig. 1) is here named the Poverty Flat Sandstone, a name taken from the shallow, broad valley just east of the aqueduct. The Poverty Flat includes the "undifferentiated Miocene between Garzas and Crow Creeks" of Anderson and Pack (1915, p. 89, 90) and the basal conglomerate and conglomeratic sandstone of the overlying San Pablo Formation of Anderson and Pack (1915, p. 99) (fig. 2). The Poverty Flat comprises units 15, 16, and 17 in the stratigraphic section from near Crow Creek described by Anderson and Pack (1915, p. 99, 100). Subsequent

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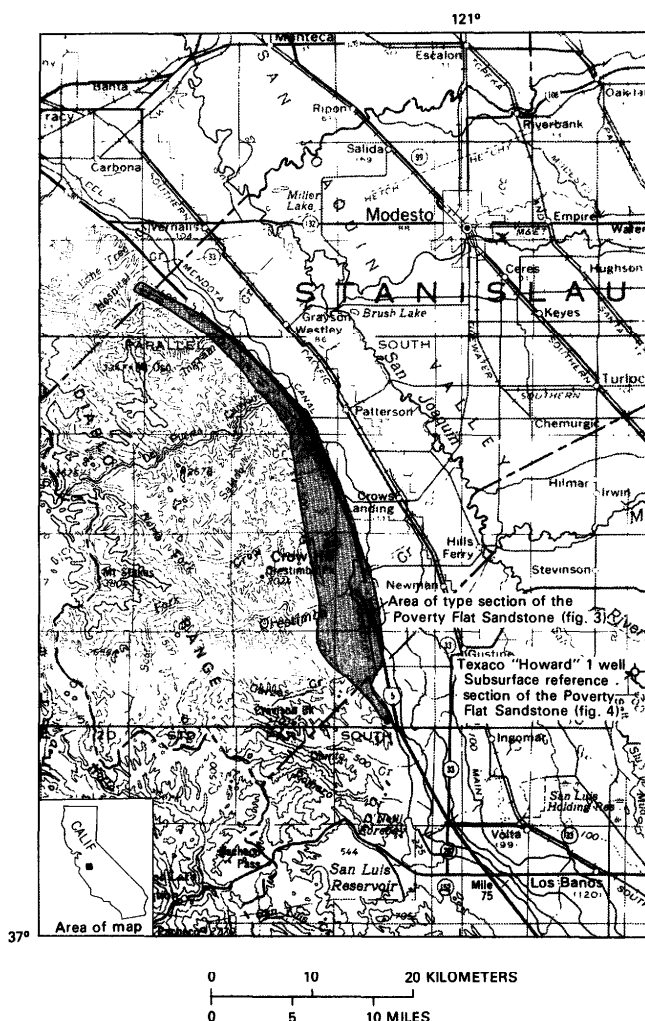


Figure 1. Index map of eastern flank of the Diablo Range and adjacent San Joaquin Valley showing the generalized outcrop area of the Tertiary strata (shaded area) and the locations of the type and subsurface reference sections of the Poverty Flat Sandstone.

workers have followed the Anderson and Pack definitions, although an Oligocene age was proposed for the "undifferentiated Miocene" of Anderson and Pack (1915) in a 1922 University of California student report by H. O. Elftman (cited in Jenkins, 1931). The name "Poverty Flat" was first used for the undifferentiated unit by Collins (1950), who also considered it to be Oligocene (fig. 2).

The Poverty Flat Sandstone, at its type section along the California Aqueduct in secs. 20, 29, and 32, T. 7 S., R. 8 E., Newman 7 1/2-minute quadrangle (fig. 3) and in the subsurface reference section in the Texaco "Howard" 1 well about 25 km to the east (figs. 1, 4), is mostly sandstone with subordinate amounts of siltstone or claystone. The lower part of the formation is composed

Anderson and Pack (1915)	Collins (1950)	THIS REPORT
Tulare(?) Formation	Tulare(?) Formation	Miocene and Pliocene(?) fanglomerate
San Pablo Formation	San Pablo Formation	Neroly Sandstone
		Valley Springs Formation
Undifferentiated Miocene [rocks]	Poverty Flat Siltstone	Poverty Flat Sandstone
Kreyenhagen Shale	Kreyenhagen Formation	Kreyenhagen Shale Domengine Sandstone
Tejon Formation	Tesla Formation	Tesla Formation

Figure 2. Correlation chart showing the development of the stratigraphic nomenclature for Tertiary units of the east-central Diablo Range.

mostly of gray or blue-gray lithic sandstone, and the upper part of interbedded light-gray to white kaolinitic quartzose sandstone and siltstone, carbonaceous shale, and kaolinitic claystone. Relative proportions of these lithologies are variable, especially in the upper part of the unit. A characteristic of the formation is the red or orange mottling in the upper part. A conglomerate at the top of the formation south of Crow Hill and north of Orestimba Creek is composed principally of red radiolarian-chert pebbles derived from the Franciscan Complex together with a few badly weathered pebbles of other Franciscan and ophiolite lithologies (diabase, gabbro, blueschist) (fig. 5). Just north of Crow Creek, pebbly sandstone with a similar clast composition is heavily cemented with hematite.

Previous workers (Anderson and Pack, 1915; Collins, 1950) have stated that the unit, here named the Poverty Flat Sandstone, unconformably overlies the Kreyenhagen Shale. Their evidence for this was the large clasts of white diatomaceous claystone included in the basal part of the sandstone that were inferred to have been eroded from the underlying Kreyenhagen Shale. However, as shown in the type section (fig. 3), claystone of the same lithology as the clasts is actually interbedded with the sandstone at the base of the Poverty Flat as well as occurring at the top of the Kreyenhagen. Both the Kreyenhagen diatomite and the claystone interbeds in the basal part of the Poverty Flat contain late middle Eocene diatoms (J. A. Barron, written commun., 1981). It therefore seems likely that the claystone clasts resulted from local scouring by currents during deposition of the basal Poverty Flat sand and do not indicate a significant unconformity.

The Poverty Flat Sandstone is unconformably overlain by the Valley Springs Formation, which truncates both the Poverty Flat and the Kreyenhagen Shale a short distance north of Crow Creek. No definite outcrops of the Poverty Flat are known south of the type area, but a red- and white-mottled quartzose sandstone that occurs locally between the Kreyenhagen Shale and a Tertiary laterite developed on top of the Kreyenhagen near Laguna Seca Creek, about 50 km to the southeast (Lettis, 1982), may be correlative with the Poverty Flat. The Poverty Flat can be recognized in many well cores and logs in the San Joaquin Valley from the Merced area, east

of the type locality, at least as far south as Madera on the east and Los Banos on the west.

Diatoms from claystone at the base of the Poverty Flat Sandstone indicate a late middle Eocene age. A sparse molluscan assemblage from the same beds indicates an age of late Eocene or early Oligocene (E. J. Moore, written commun., 1981). The upper part of the formation is apparently nonfossiliferous; however, the prevailing quartz-kaolinite mineralogy of the sandstone and conglomerate, together with the red or orange mottles and concentrations of hematite cement, indicates subaerial weathering under a warm wet (tropical) climate. An early Paleogene tropical climate was followed by a well-documented climatic deterioration at the end of the Eocene (Wolfe, 1971; Frakes, 1979). Warmer climates returned during the late Oligocene to middle Miocene, but they were drier and not fully tropical (Wolfe, 1971; Frakes, 1979). Thus the deposition and weathering of the sand and gravel must have been completed before the terminal Eocene climatic deterioration. The age of the Poverty Flat, then, is late middle and late Eocene.

The Poverty Flat Sandstone is approximately correlative with the uppermost or late Eocene part of the Kreyenhagen Shale of the central part of the San Joaquin Valley and is probably correlative with the Wagonwheel Formation (Dibblee, 1973) of the southwestern San Joaquin Valley.² The Poverty Flat is probably partly correlative with the Ione Formation of the Sierra Nevada foothills to the east, but the age range of the Ione is not known well enough to make a definite correlation.

The Poverty Flat Sandstone represents a shallowing-upward sequence of depositional environments. The sandstone in the lower part of the formation is probably a marine shelf deposit overlying the upper-slope diatomite and diatomaceous claystone of the uppermost part of the Kreyenhagen Shale. Sandstone near the top of the Poverty Flat appears to have been deposited in a fluvial environment. A more thorough sedimentologic study is needed before the depositional environments can be described in any more detail. The formation represents the final regressive phase of the middle and late Eocene transgressive-regressive cycle that began with the deposition of the Domengine Sandstone and lower part of the Kreyenhagen Shale.

VALLEY SPRINGS FORMATION

The Valley Springs Formation was originally named and described in the Sierra Nevada foothills, where it lies above the Ione Formation and below the Mehrten Formation (Piper and others, 1939). The distinctive lithology of the Valley Springs Formation, which consists of crudely bedded yellowish-gray and tan clayey sandstone, sandy tuffaceous claystone, and vitric tuff, can be recognized in well cores throughout the northern San Joaquin Valley

²Dibblee originally assigned the Wagonwheel Formation to the Oligocene because he considered the Refugian Stage to be Oligocene. The Refugian, at the time this report was written, was considered to be late Eocene (Poore, 1980).

AGE		THICK- NESS, IN METERS	FOR- MATION	LITHOLOGY	DESCRIPTION
TERTIARY	Oligocene		Valley Springs Fm. (part)		Interbedded very clayey sandstone, claystone, sandy claystone, and tuffaceous claystone, tan to pale-greenish-gray Crudely bedded; common prismatic joints
		120			Sandstone with thin claystone interbeds, tan or gray, fine- to medium-grained, lenticular
	Eocene				Sandstone, gray, locally mottled with red or orange
					Kaolinitic claystone, greenish-gray, sandy
		110			Kaolinitic claystone, mottled greenish-gray and red. Grades into overlying unit
					Sandstone, light-gray to white and tan, medium-grained, quartzose, kaolinitic. Massive to locally crossbedded in lower part, large-scale crossbedding near top. Finer grained and very clayey at top; grades into overlying unit
		100			
					Sandstone, light-gray to white and tan, very fine-grained. Mostly massive, locally laminated
		90			Siltstone, light-gray, laminated or cross-laminated, anauxitic
					Carbonaceous shale, brown, sandy
		80	Poverty Flat Sandstone		
		70			
TERTIARY	Eocene				Covered. Probably mostly fine- or medium-grained friable sandstone
		20			
		10			
					Lithic sandstone, gray, medium-grained, micaceous. Clasts of light-gray claystone near base
					← Diatomaceous claystone, light-gray, fossiliferous. Thin lithic sandstone interbed. Mf-6323 (late middle Eocene)
		0			Lithic sandstone, gray, medium- to coarse-grained, micaceous. Clasts of fossiliferous, light-gray, diatomaceous claystone
TERTIARY	Eocene		Kreyenhagen Shale (part)		Shale, brown, diatomaceous in part. Thin clayey sandstone interbed
					Interbedded diatomaceous shale, clay shale, and diatomite, light-brown to white
					← Diatomite, laminated, pinkish-gray to white. Thin light-brown clay shale interbeds. Mf-6324 (late middle Eocene)

Figure 3. Type section of the Poverty Flat Sandstone along the California Aqueduct south of Orestimba Creek, secs. 20, 29, and 32, T. 7 S., R. 8 E. Arrows indicate location of U.S. Geological Survey diatom localities (Mf-6323, Mf-6324).

and is now recognized in Diablo Range outcrops. Correlation of the Diablo Range outcrops with the Valley Springs in its type area is based on similar lithology, relative stratigraphic position, and trace- and minor-

element chemistry of the glass in vitric tuff interbeds (A. M. Sarna-Wojcicki, written commun., 1981).

In the Diablo Range, the Valley Springs Formation was originally included in the San Pablo Formation of

TEXACO "Howard" 1
NE 1/4 SW 1/4 sec. 6, T.8S., R.11E.
Elevation 278.9m (85 ft)

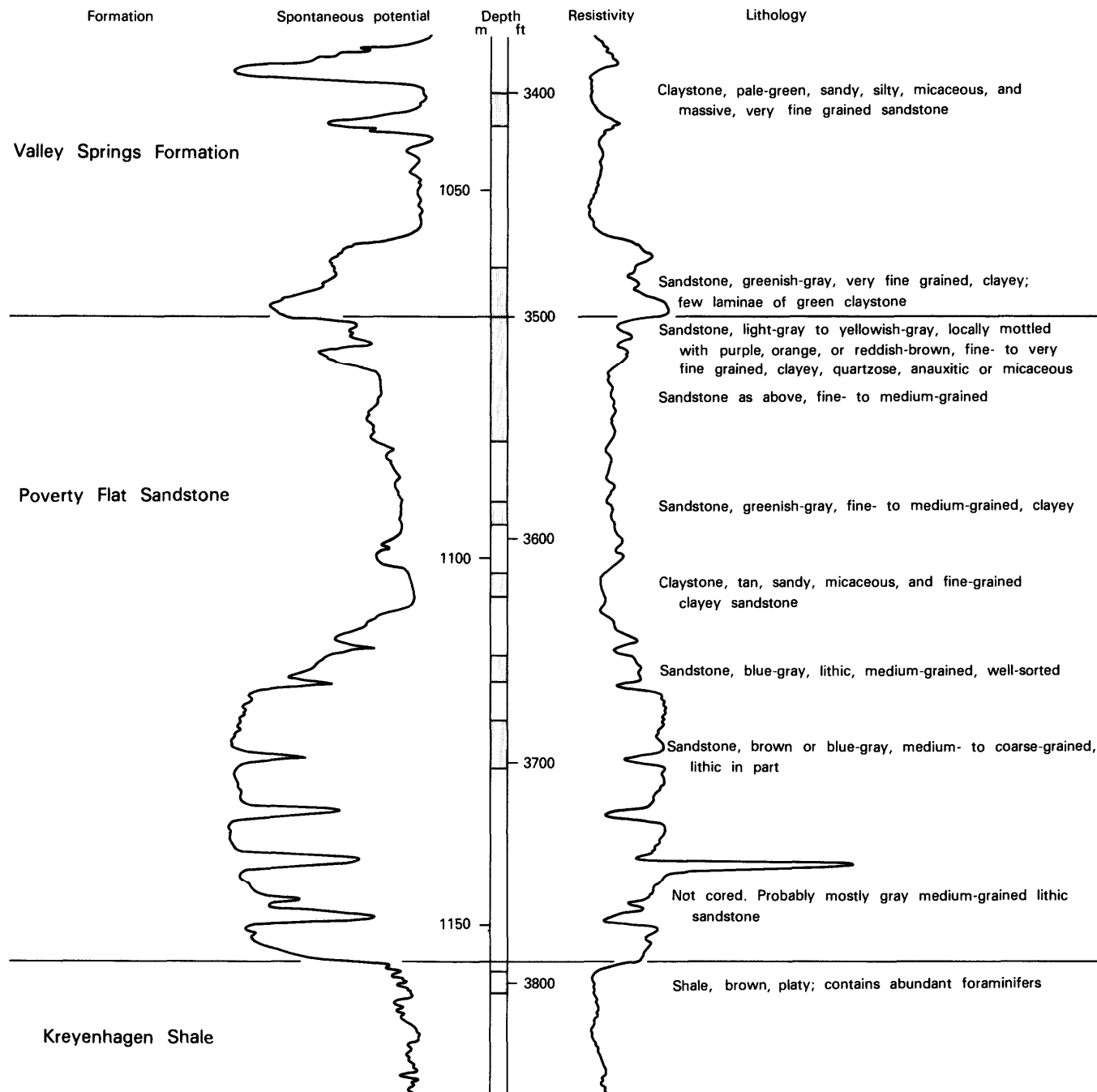


Figure 4. Subsurface reference section of the Poverty Flat Sandstone between the depths of 1,067 m (3,500 ft) and 1,155 m (3,790 ft) in the Texaco "Howard" 1 well. Shaded parts of column indicate cored intervals.

Anderson and Pack (1915) and comprises units 3 through 14 of their measured section near Crow Hill (1915, p. 99, 100). As they pointed out, the lithology of the strata that they assigned to the San Pablo Formation changes markedly near Ingram Creek. The blue-gray sandstone that makes up their San Pablo north of Ingram Creek overlaps strata of Valley Springs lithology for 1 to 2 km south of Ingram Creek but is absent farther south. All of the original San Pablo south of the overlap near Ingram

Creek, exclusive of the conglomerate and sandstone that is herein reassigned to the Poverty Flat Sandstone, is here reassigned to the Valley Springs Formation.

The strata herein reassigned to the Valley Springs Formation were originally, as part of the San Pablo Formation, considered to be late Miocene in age. No new information bearing on the age of the Valley Springs was obtained from the Diablo Range outcrops, and, on the basis of K-Ar ages for tuff interbeds in the type area

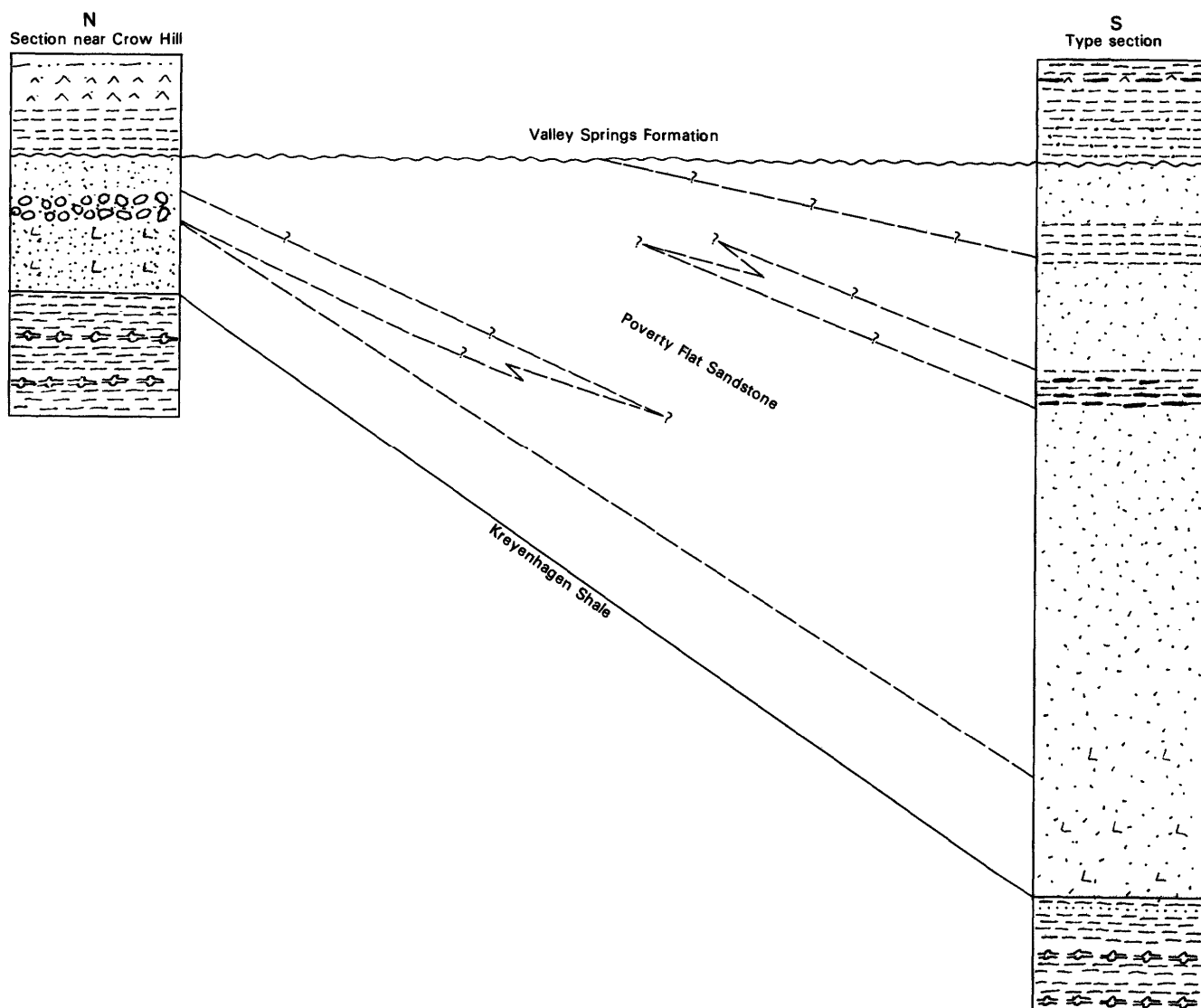


Figure 5. Diagram showing inferred relations of Poverty Flat Sandstone sections north and south of Orestimba Creek. Section near Crow Hill from Anderson and Pack (1915) section of San Pablo Formation (units 15, 16, and 17); type section generalized from figure 3.

(Dalrymple, 1963, 1964), it is considered to be late Oligocene and early Miocene in age.

NEROLY SANDSTONE

Blue-gray andesitic sandstone that unconformably overlies the Valley Springs Formation or older units and is conformably overlain by upper Miocene and lower Pliocene(?) conglomerate is assigned to the Neroly Sandstone. The Neroly was included in the San Pablo Formation by Anderson and Pack (1915) and was assigned to the Neroly Formation of the San Pablo Group in the

Tesla quadrangle a few kilometers to the northwest by Huey (1948). In the area south of Hospital Creek, the Neroly is much thinner than it is in the Tesla area and is composed entirely of sandstone and pebbly sandstone. It pinches out just south of Ingram Creek.

Sandstone and conglomeratic sandstone of the Neroly Sandstone are virtually identical petrologically to sandstone and conglomerate of the Mehrten Formation in the Sierra Nevada foothills; the volcanic detritus in both units was derived from andesitic eruptions farther east, near the crest of the Sierra Nevada. The Neroly and the Mehrten are at least partly correlative, although the Mehrten probably represents a somewhat longer span of time. Clarendonian age vertebrates from the Neroly (Raymond, 1969) indicate a late Miocene age.

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