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Notes

Tectonic evolution of the Northern Salinian Block, California, USA: Paleogene to Recent shortening in a transform fault-bounded continental fragment

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Abstract: The complex structural setting of the western margin of North America is interpreted to result from oblique convergence of the North American and Pacific plates, accommodated by both right-lateral slip along the San Andreas fault and shortening east and west of it. Strike-slip movements along the San Andreas fault led to the detachment of a continental fragment (the Salinian Block) from the North American margin during early Miocene, and its translation northwestwards for over 300 km. Structural analysis in the Northern Salinian Block, west of the San Andreas fault, reveals a NE–SW-directed shortening accommodated by NW–SE-trending folds and thrusts with a dip-slip kinematic character. The stratigraphic record of progressively younger unconformities affected by both folds and thrusts, as well as the overprinting relationships among these contractional structures, enables us to clarify the tectonic evolution of the region since Paleocene time. The Paleocene to Recent history of the Salinian Block was dominated by strike-slip along the San Andreas fault, and by shortening perpendicular to it. The partitioning between strike-slip and dip-slip movements appears to be controlled by a pre-existing tectonic feature. The results from structural analysis along the Salinian Block are integrated into a deformation model for the western margin of North America, providing additional constraints on the timing of deformation and helping to clarify the role of strain-partitioning processes in the obliquely convergent California margin.

The general parallelism between map- and outcrop-scale structures, known among geologists as *Pumpelly's rule* (see Price & Cosgrove 1990), renders mesoscopic analysis important for defining the kinematic history of deformed areas. Although outcrop-scale observations have long proven successful in inferring kinematic models (Wilson 1961; Cosgrove 1980), a limit of geodynamic reconstructions solely based on minor structures is that the latter are usually overprinted by later deformations, thus making tectonic inferences problematic. A well-defined geodynamic framework determined by means of independent methods, instead, makes structural analysis a reliable tool for relating detailed field information to larger-scale features.

The tectonic setting of the NE circum-Pacific subduction system is characterized by the juxtaposition of the North American plate, largely made of continental lithosphere, to the Pacific, Juan de Fuca and Cocos plates, almost entirely made of oceanic lithosphere. Well-defined seafloor magnetic isochrons, and the presence of two presumably fixed reference frames, the Hawaii and Yellowstone hot-spots, constrain both relative and absolute plate motions (Atwater 1970, 1989; Stock & Molnar 1988; Doglioni & Harabaglia 1996). In central–northern California, the Pacific and North American plates are separated by a continental fragment, the Salinian Block, where the record of Paleogene to Recent deformations is preserved along superb coastal exposures. These elements, in combination, make central–northern California an unusually favourable setting where mesoscopic data can tentatively be linked to plate-tectonic reconstructions.

This paper aims to unravel the deformation history of the Northern Salinian Block, bounded by the active San Andreas fault system to the east, and by the Pacific plate to the west. The results of a structural analysis provide the basis for discussing the role of strike-slip partitioning processes in the tectonic evolution of the North American ocean–continent transform margin.

Geological setting

The juxtaposition of the North American and Pacific plates occurs along a belt of anastomosing NW–SE-trending faults, the San Andreas fault system, which extends from the Gulf of California to Cape Mendocino for over 2500 km. Together with its northern continuation, i.e. the Queen Charlotte fault zone, the San Andreas fault system transfers extension produced at the East Pacific Rise to convergence and subduction in the Aleutian Trench with a dominantly right-lateral strike-slip, thus defining a major ocean–continent transform margin (Wilson

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1965; Atwater 1970). The inception of the transform regime is generally referred to the Late Oligocene (29–26 Ma: Stock & Molnar 1988; Atwater 1989). A diffuse seismicity associated with the San Andreas fault system, outlined by destructive historical and recent earthquakes (Hill *et al.* 1990), indicates that this regime is still tectonically active. In spite of a general agreement on the role of the San Andreas fault as a major tectonic boundary, controversy exists on the interpretation of its continuation at depth. Wilson (1965), Atwater (1970) and Namson & Davis (1988), among many others, considered it as a deep-rooted fault cutting the entire lithosphere, i.e. the stacked Pacific and North American plates, whereas Jones *et al.* (1994) and Holbrook *et al.* (1996) interpreted it as a shallow feature confined to the North American plate and emanating from a 20–25 km deep, gently NE-dipping décollement.

The tectonic history of California before activation of the San Andreas fault system was dominated by the Andean-type convergence with subduction of the Pacific plate under the North American continent, which had been initiated during Late Mesozoic time (Dickinson 1981). Continued subduction gave rise to an arc–trench system, with development of a frontal accretionary prism (the Franciscan Complex), a forearc basin (the seat of deposition of the Great Valley Sequence) floored by oceanic crust (i.e. the future Coast Ranges Ophiolites), and an igneous complex (the Sierra Nevada Magmatic Arc). Subduction-related shortening was probably accompanied by right-lateral slip along an ancestor lineament precursor of the San Andreas fault (the Proto-San Andreas fault: Nilsen 1981; Page 1990), which could have accommodated up to 300 km displacement in pre-Eocene time (Graham & Dickinson 1978).

The present-day San Andreas fault in central–northern California separates continental North America from a dominantly granitic fragment, the Salinian Block (Fig. 1). This fragment is thought to represent the former southern continuation of the Sierra Nevada batholith (Graham 1978; Ross 1983), or an exotic terrane accreted to North America during subduction of the Farallon plate (Vedder *et al.* 1983). Since early Miocene time, the Salinian Block has been detached from the North American margin and has been translated 300 km northwestwards along the San Andreas fault to its present position in western California (Graham & Dickinson 1978; Blake *et al.* 1984). Four smaller fragments are recognized within the Salinian Block: the Southeastern, Central, Western and Northern Blocks (Ross 1983). This study will focus on the structural evolution of the Northern Salinian Block, well exposed along the central–northwestern coast of California (Fig. 1).

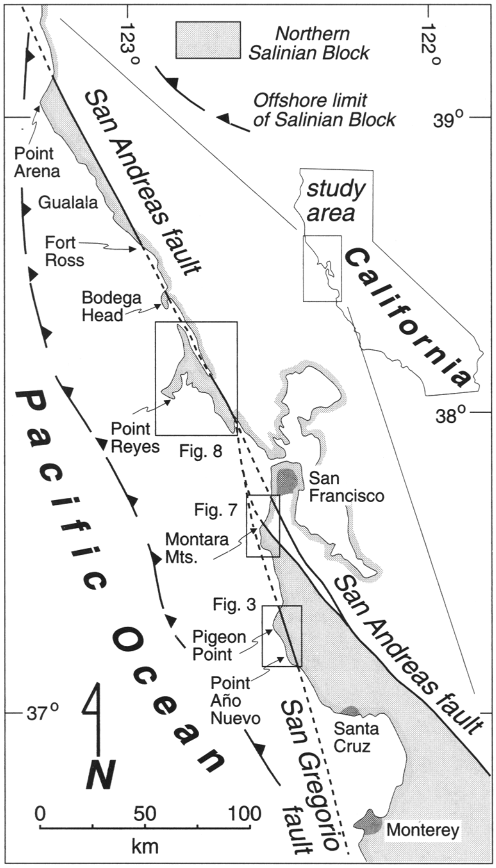


Fig. 1. Sketch map of the Northern Salinian Block, showing location of study areas.

Rocks of the region consist of Lower Cretaceous, mainly granitic and metamorphic basement, unconformably overlain by Upper Cretaceous to Recent sediments. Granitic rocks crop out extensively in the Montara Mountains, in the Point Reyes Peninsula, at Bodega Head, and, together with other igneous and metamorphic assemblages, are believed to underlie the sedimentary sequences of Point Arena and Pigeon Point (Fig. 2). The Upper Cretaceous to Recent mainly marine sequences show abrupt lateral stratigraphic differences over little horizontal distance, which reflect deposition in local, restricted basins, thus suggesting a complex history of continued synsedimentary deformation (Dickinson *et al.* 1979). Highly simplified

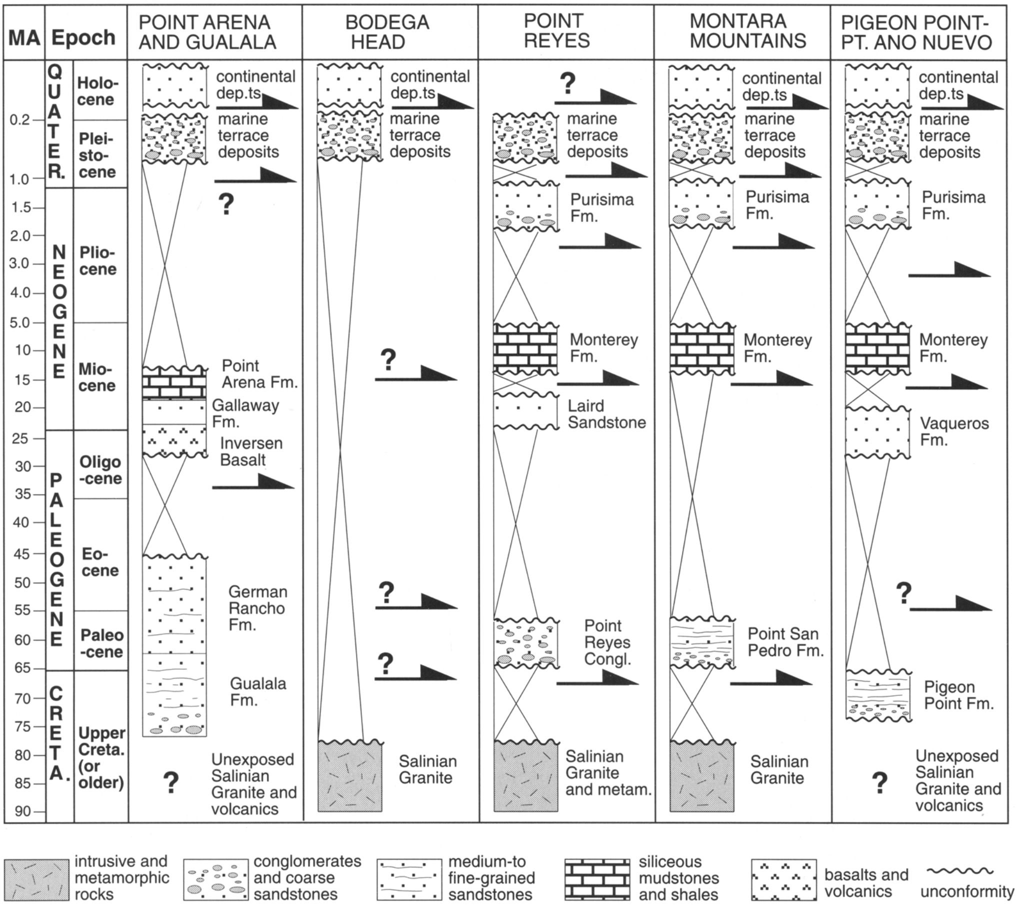


Fig. 2. Simplified composite stratigraphic columns of the outcrop locations of the Northern Salinian Block, based on Nilsen *et al.* (1981), Graham *et al.* (1989), and references therein. Arrows indicate the deformation episodes documented in this paper.

composite stratigraphic columns of the exposed sediments are summarized in Fig. 2.

General structure

Since inception of the transform regime, the deformation history of central–northern California was characterized by dominant right-lateral strike-slip along the San Andreas and attendant San Gregorio, Pilarcitos, Hayward and Calaveras faults (Johnson & Normark 1974; Graham & Dickinson 1978; McLaughlin *et al.* 1996). Right-lateral movements were accompanied by coeval SW–NE-directed shortening, mainly expressed by NW–SE-trending folds and thrusts, which are abundant east of the San Andreas fault (Aydin & Page 1984; Namson & Davis 1988; Bloch *et al.* 1993; Jones *et al.* 1994, and references therein). By contrast, the internal architecture of the Northern Salinian Block, west of the San Andreas fault, is poorly constrained and structural information is relatively rare, with important exceptions (Galloway 1977; Coppersmith & Griggs 1978; Joyce 1981; Duane Gibson 1983; Wiley & Moore 1983).

This section outlines the character, geometry and orientation of mesoscopic (outcrop-scale) and macroscopic (map-scale) contractional structures, i.e. folds and thrusts, which have affected the Northern Salinian Block since the (?)Late Cretaceous–Paleocene interval. Investigated anticlines and synclines range in both wavelength and amplitude from kilometres (i.e. first-order folds) to metres (i.e. third-order folds, according to the definition by Nickelsen (1963)). Deformation occurred under brittle to semi-brittle conditions at shallow crustal levels. Two separate tectonostratigraphic terranes are recognized in the Northern Salinian Block (Fig. 3): the La Honda Block, between the San Andreas, Pilarcitos and San Gregorio faults, and the Pigeon Point Block, west of the San Gregorio fault.

Pigeon Point Block

The structure of the Pigeon Point Block is characterized by both folds and thrusts. First-order folds range from open to isoclinal and their wavelengths vary from a few hundred metres to several kilometres. The major map-scale fold is represented by a syncline which affects the Upper Cretaceous Pigeon Point Formation and whose hinge line intersects the coast near Bolsa Point (Fig. 3). This fold trends 305° and plunges 17° towards the NW (Fig. 4a). Second- and third-order folds, parasitic to the Bolsa Point syncline, trend 308° and plunge 19° towards the NW (Fig. 4a). The Oligocene–Miocene Vaqueros Fm lies unconformably over the Pigeon Point Fm, post-dating the Bolsa Point syncline, which probably developed during the Paleocene–Eocene interval (see also Joyce 1981). Remnants of the Vaqueros Fm crop out between Franklin Point and Point Año Nuevo and at Pescadero Beach (Fig. 3), dipping homoclinally 30° towards the NNE (Duane Gibson 1983), and could represent a portion of a WNW-trending map-scale fold. The Vaqueros Fm is unconformably overlain by the Late Pliocene Purisima Fm, which is affected by a first-order anticline–syncline pair whose hinge lines intersect the coast at San Gregorio Beach and Pomponio Beach, respectively. These folds of probable late Pliocene–(?)Pleistocene age, trend NW–SE, subparallel to the Tertiary Bolsa Point syncline, and plunge gently towards the NW (Fig. 4b).

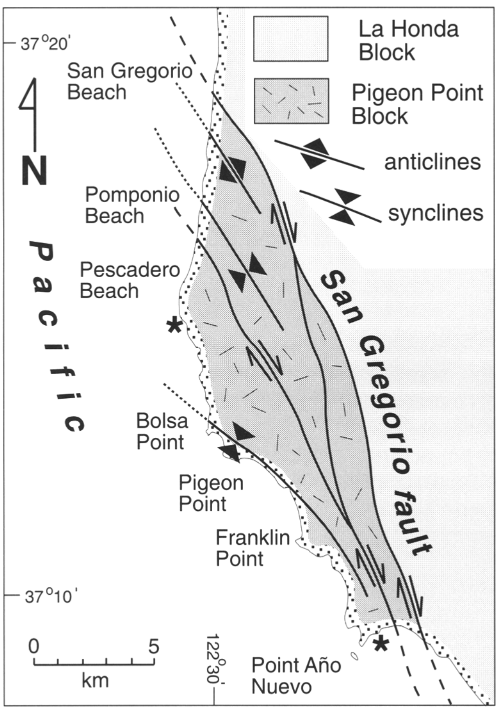


Fig. 3. Sketch map of the structure of Pigeon Point Block, west of the San Gregorio fault (see inset in Fig. 1); asterisks indicate the outcrop location of described structures.

The effects of reverse faulting are particularly evident near Point Año Nuevo, where mudstones and cherts of the upper Miocene Monterey Fm are thrust southwestwards over Quaternary marine and continental deposits. This fault, known as the Point Año Nuevo thrust (Coppersmith & Griggs 1978), strikes NW–SE and dips 35° towards the NE. Mechanical striae and grooves along the main thrust and attendant faults, a weak cleavage in the fault rock and rare synthetic (R) Riedel shears indicate a dip-slip kinematic character. Displacements are towards the SW with a 41° mean slip direction (Fig. 5a). The fault is parallel to bedding in the hanging wall, and makes angles of 20–35° with beds in the footwall, thus defining a hanging wall flat–footwall ramp geometry (Fig. 6a): this pattern indicates a minimum displacement of about 8 m.

Other mesoscopic reverse faults, along which the Upper Cretaceous Pigeon Point Fm is thrust over Pleistocene terrace deposits, cropout near Pescadero Beach (Fig. 3). These faults strike NW–SE and dip 20–45° towards both the SW and NE (Fig. 5b). Striae indicate a dip-slip kinematic character and define a 43° mean slip direction (Fig. 5b).

La Honda Block

Structural analysis in the northern part of the La Honda Block was carried out in the Montara Mountains, the Point Reyes Peninsula, Bodega Head and Point Arena areas (Fig. 1).

Montara Mountains

The main structure recognized in the Montara Mountains is a first-order, asymmetrical NNE-verging anticline that is well exposed in the cliffs between Shelter Cove and Devil's Slide (Fig.

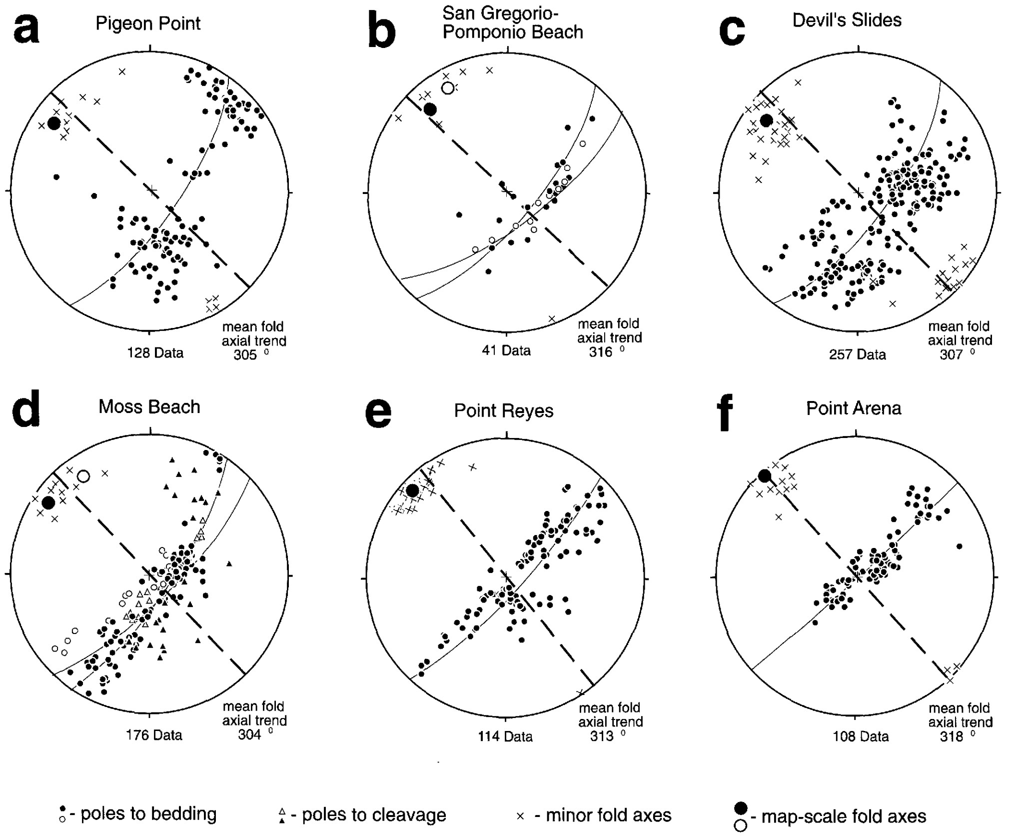


Fig. 4. Orientation of major and minor folds in the Northern Salinian Block (equal-area projection, lower hemisphere). The dashed line represents the local trend of the San Andreas fault. Filled and open circles in (**b**) refer to the Pescadero Beach syncline and the San Gregorio Beach anticline, respectively (see Fig. 3 for location). Filled and open circles in (**d**) refer to the northern and southern synclines at Moss Beach, respectively (see Fig. 7b for location).

7a). This structure affects the Cretaceous Montara Granodiorite and the unconformably overlying Paleocene Point San Pedro Fm; the fold trends 307° and plunges 21° towards the NW (Fig. 4c). Second- and third-order folds, parasitic to the major anticline, are well exposed along the California Highway 1 at Devil's Slide (Fig. 6b): their mean trend is 304° (Fig. 4c). This structure is post-dated by an unconformably overlying Pleistocene marine terrace (Fig. 7c).

Further to the south, at Moss Beach, a superb exposure in the Fitzgerald Marine Reserve allows for accurate definition of the local 3D structural geometry (Fig. 7b). The stratigraphy, and depositional and deformation history of the area were accurately defined by Wiley & Moore (1983), and further structural details are reported here. The Upper Pliocene Purisima Fm unconformably overlies the Cretaceous Montara Granodiorite, and is affected by two second-order asymmetrical synclines separated by a NE-verging anticline (Fig. 7b). The trends of these structures range between 302° and 307°, with plunges up to 24° towards the NW (Fig. 4d). These structures are post-dated by a Pleistocene marine terrace, which unconformably overlies both the granodiorite and the Purisima Fm (Fig. 7b).

Impressive structural relationships are observed along the northern cliffs of the nearby Montara Point, where mesoscopic reverse faults determine local stratigraphic repetitions, carrying the Cretaceous granodiorite over the Pleistocene marine deposits (Fig. 6c). These faults, which trend NW–SE to WNW–ESE and dip generally 35° towards NE, also affect Holocene deposits. Mechanical striae indicate a dip-slip kinematic character, with displacement of

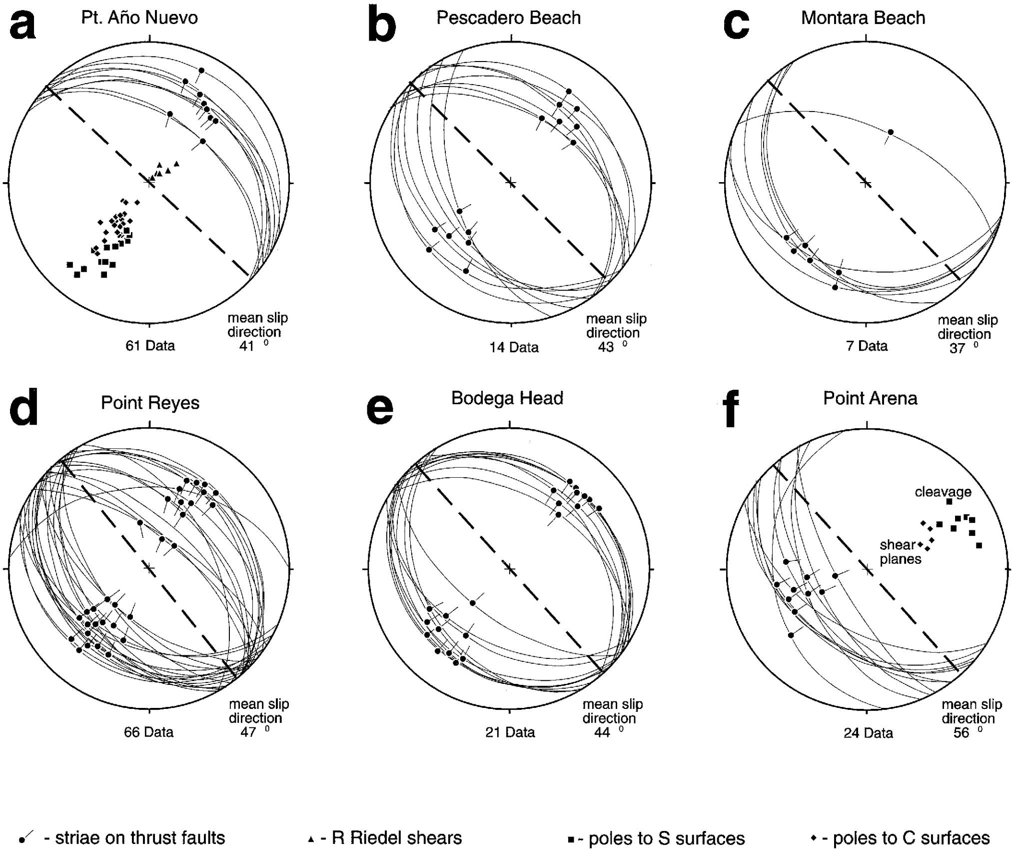
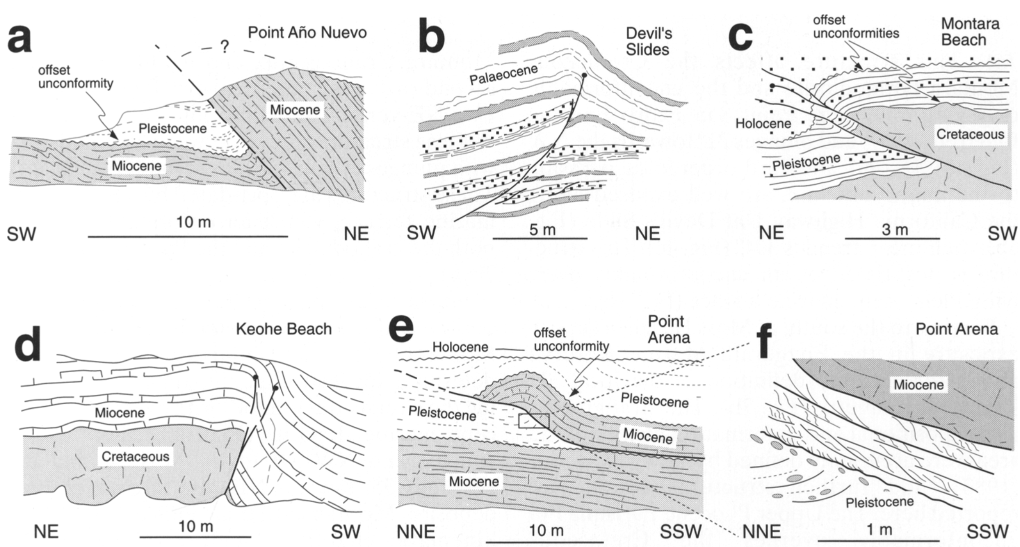


Fig. 5. Orientation and kinematics of mesoscopic thrusts and related shearing fabrics showing a dominantly dip-slip kinematic character (equal-area projection, lower hemisphere). The dashed line represents the local trend of the San Andreas fault.



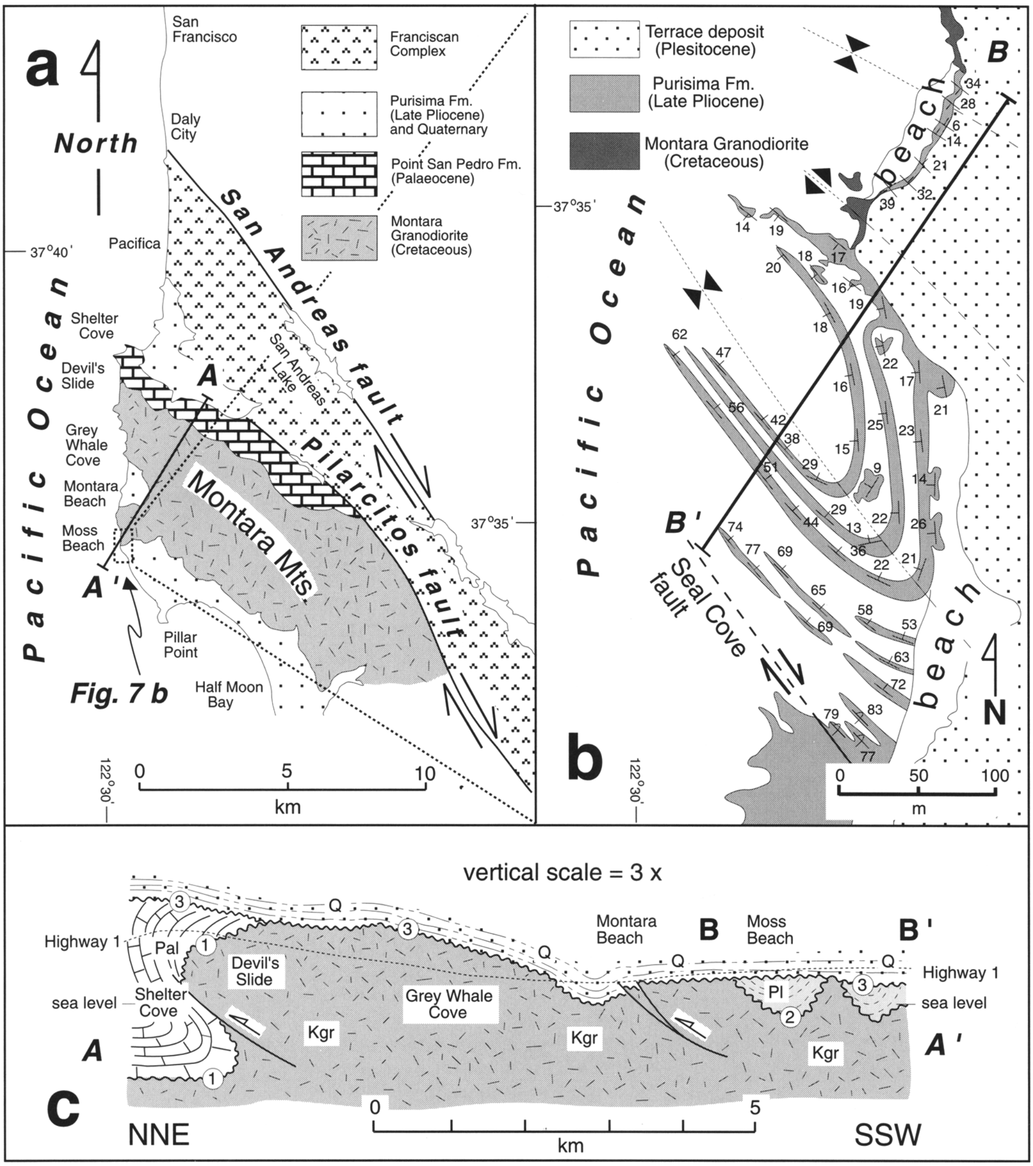


Fig. 7. Geological setting of the Montara Mountains (see Fig. 1 for location). (**a**) Simplified tectonic sketch map. (**b**) Detailed map of the Fitzgerald Marine Reserve at Moss Beach (partly based on mapping by Wiley & Moore (1983)) at low tide (see inset in (**a**) for location). (**c**) Simplified cross-section (trace A–A′ of (**a**)) showing unconformities of Paleogene (1), Pliocene (2) and Pleistocene (3) ages offset by progressively younger contractional structures. Kgr, Montara Granite (Cretaceous); Pal, Point San Pedro Fm (Paleocene); Pl, Purisima Fm (Late Pliocene); Q, marine terrace deposits (Pleistocene and Holocene).

Fig. 6. Mesoscopic reverse faults and related shearing fabrics from outcrops described in the paper (redrawn from photographs).

hanging wall blocks generally towards the SW (Fig. 5c).

Point Reyes Peninsula

The Point Reyes Peninsula is the only area where continuous outcrop along coastal exposures made it possible to reconstruct the general structure. This was done with map-analysis techniques, using the 1:48 000 map by Galloway (1977). The main structure is the Horse Ranch syncline, a broad first-order fold which affects the Cretaceous–Late Miocene sequence and underlying rocks. This fold, which approximately trends 140° (Fig. 8a), is post-dated by the unconformably overlying Late Pliocene Drake's Bay Fm (Fig. 8b). Another important structure is the Point Reyes syncline, an open first-order fold which affects both the Upper Pliocene Purisima Fm and the basal unconformity that separates it from the underlying Miocene sequence (Fig. 8a and b). This structure trends 313°, and plunges 7° towards the NW (Fig. 4e). Other mapped folds at Drake's Beach are a second-order anticline and syncline pair, parasitic to the Point Reyes syncline. Their hinge line trends range from 135° to 146° (Fig. 8a). Minor, asymmetrical folds parasitic to the Horse Ranch syncline are common in the upper Miocene Monterey Fm. Their average trend is 315° (Fig. 4e).

Mesoscopic thrust faults are abundant in the northernmost Peninsula. A reverse fault, along which the Early Miocene Laird Sandstone is overridden by Cretaceous granitic basement rocks, is exposed at Keohe Beach (Fig. 6d). This structure, and related minor thrusts, strike WNW–ESE and dips 70° towards the NNE. Mechanical striae on the fault surfaces indicate a dip-slip kinematic character, and displacement towards the SSW with a mean 47° slip direction (Fig. 5d).

Bodega Head

The Bodega Head Peninsula represents the northernmost exposure of the Salinian granitic basement rocks along the California coast, and is separated from the mainland by the 2–3 km wide San Andreas fault zone. The granitic basement, consisting of quartz diorite and diorite, is intruded by numerous pegmatite dykes (Ross 1983). These intrusive rocks are unconformably overlain by Quaternary marine terrace deposits, which were tilted towards the NE presumably as a result of slip along the San Andreas fault (Koenig 1963). At Horseshoe Cove, a sub-vertical NW–SE-trending fault juxtaposes the basement rocks, in the west, against Quaternary sediments, in the east. No kinematic indicators were found along the fault surface, which probably represents a strand of the San Andreas fault.

Evidence for recent shortening is found at Mussel Point, where small reverse faults truncate the unconformity which separates the marine terrace deposits from the underlying basement rocks. These faults strike NW–SE and dip 25–46° towards either the SW or NE. Mechanical striae on the fault surfaces indicate a dip-slip character, and a mean 44° slip direction (Fig. 5e). Other mesoscopic thrust faults occur at Windmill Beach, where the pegmatite dykes are offset with small (3–10 cm) displacements. These faults strike NW–SE and dip 20° towards the SW (Fig. 5e).

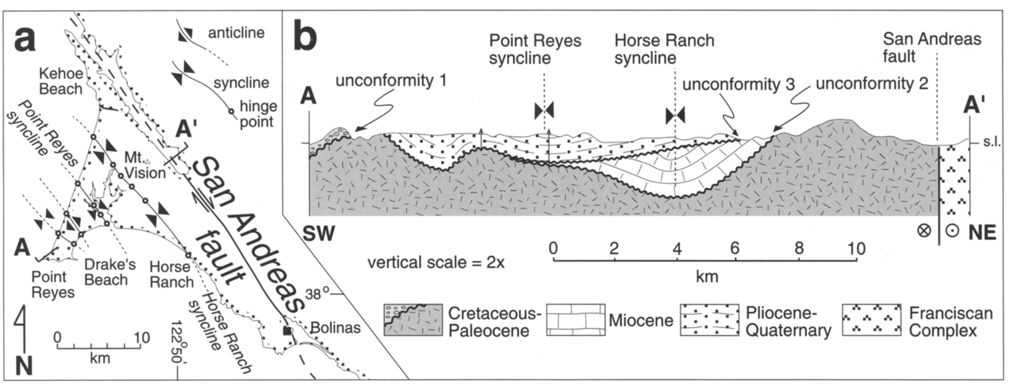


Fig. 8. Geological setting of the Point Reyes Peninsula (see inset in Fig. 1 for location). (**a**) Highly simplified hinge-point tie-line map. (**b**) Simplified cross-section showing unconformities of Paleogene (1), Miocene (2) and Pliocene (3) ages overprinted by progressively younger structures (modified after Galloway (1977)).

Point Arena

The northernmost portion west of the San Andreas fault, between Fort Ross and Point Arena, exposes three sedimentary sequences separated by two major unconformities (Fig. 2), which are believed to be underlain by the Salinian basement (McCulloch 1989). The oldest unit, represented by Upper Cretaceous to middle Eocene rocks deposited in the forearc Gualala basin (Loomis & Ingle 1994), is affected by tight to isoclinal, NW–SE-trending small folds. This sequence is unconformably overlain by an Oligo-Miocene unit which was deposited in the rapidly subsiding Point Arena basin. Siliceous strata of the Point Arena Fm are affected by gentle to tight, NW–SE-trending first-order folds (Fig. 4f). These folds are truncated by an erosional surface which represents the base of a Pleistocene marine terrace. This unconformity is truncated by three small thrust faults along which the Miocene Point Arena Fm overrides the Pleistocene terrace (Fig. 6e). The thrust contact is marked by a 1 m thick fault gouge with well-developed shearing fabrics (Fig. 6f). Mechanical striations along these structures indicate a dominant dip-slip character, with SW-directed thrust kinematics (Fig. 5f). Holocene terrace deposits post-date thrusting (Fig. 6e).

Tectonic significance of Paleogene to Recent shortening

The data presented above indicate that the Northern Salinian Block has experienced shortening since the (?)Paleocene, i.e. the proposed age for the Bolsa Point Syncline (Fig. 3), and that this deformation continued up to the Recent, as documented by faulted Holocene deposits at Montara Point (Fig. 6c). The recognized folds range in size from mesoscopic (outcrop-scale) to macroscopic (map-scale), the former being often parasitic to the latter; this suggests that contractional structures of different scales are geometrically and kinematically linked, and that the small strains inferred from minor structures reflect larger strains produced by plate-tectonic-scale features. Palaeomagnetic data show that folds and thrusts, although disrupted by the Neogene San Gregorio and Pilarcitos right-lateral strike-slip faults, did not significantly change orientation (Duane Gibson 1983). These combined lines of evidence can be used to test the existing plate-tectonic models for the western margin of continental North America. The NW–SE trend of Paleogene to Recent folds and thrusts, and the inferred mean SW–NE shortening direction, poses the question of how these structures relate to coeval right-lateral slip along the San Andreas and attendant faults. Sylvester & Smith (1976) and Aydin & Page (1984), among many others, ascribed compressional structures to wrench tectonics induced by the Neogene transform regime. Although this model accounts for contractional structures trending oblique to strike-slip faults (Wilcox *et al.* 1973), conventional wrench tectonics fails to explain the marked parallelism between the observed fold-thrust structures and the San Andreas fault (Figs 4 and 5).

Geodetic data show that the Pacific plate is at present moving toward N37°W with respect to North America, whereas the San Andreas fault south of the Mendocino triple junction strikes N41°W (Jordan & Minster 1988; Gripp & Gordon 1990; Doglioni & Harabaglia 1996); this discrepancy results in slightly oblique convergence, i.e. wrench-dominated transpression, between the Pacific and North American plates (Tikoff & Teyssier 1994). Geodynamic reconstructions for the past 5 Ma indicate that the relative motions of the Pacific and North American plates were also mainly characterized by right-lateral strike-slip accompanied by a minor component of convergence (Atwater 1989). As we go further back in time, the kinematic character of the Pacific–North America plate boundary becomes controversial, and the San Andreas fault is alternatively interpreted as a transpressional (Engebretson *et al.* 1985; Stock & Molnar 1988), or a transtensional (Atwater 1989; Bohannon & Parson 1995) feature. The reasons for these discrepancies originate in the different methods used to determine relative and absolute plate motions (Atwater 1989). Based on the present work, the reconstruction by Stock & Molnar (1988) for the 29–5 Ma interval, where the Pacific–North America relative movements are transpressional, is preferred because it accounts for the kinematic evidence in the Northern Salinian Block.

The coexistence of strike-slip and contractional deformations is best explained by strike-slip partitioning (*sensu* Teyssier *et al.* 1995) of oblique convergence at the North America–Pacific plate boundaries, where oblique movements produce a major component of right-lateral strike-slip parallel to the San Andreas fault, and a minor component of shortening perpendicular to it. A kinematic model for the western margin of California is illustrated in Fig. 9. As first proposed by Oldow *et al.* (1990), displacement compatibility suggests that thrusts and related folds, as well as strike-slip faults, share a common décollement. This is broadly consistent with the hypothesis of Jones *et al.*

(1994) for an active, low-angle subduction of the Pacific under the North American plate, and the consequent inference of a shallow San Andreas fault. The model closely recalls those by Jones *et al.* (1994) and Doglioni & Harabaglia (1996), yet differs as it incorporates structural evidence from the Northern Salinian Block. The model is also similar to those proposed for other transpressional orogens, such as the Caledonian belt of Greenland (Holdsworth & Strachan 1991) and Norway (Northrup & Burchfiel 1996), where deformation occurred at deeper crustal levels under dominantly ductile conditions, thus suggesting that *P–T* variations do not significantly influence kinematic strain-partitioning.

An interesting question concerns the factors influencing the proposed strike-slip partitioning processes. According to Zoback *et al.* (1987), the San Andreas fault is a mechanically weak structure and the stress field in central California is mainly controlled by fault properties. Tikoff & Teyssier (1994), on the other hand, have argued that lithospheric-scale deformation is primarily controlled by boundary conditions imposed by plate motion, and not by fault properties. Integrated field and geophysical evidence is consistent with both views. In addition to these influences, tectonic heritage can play an important role in strain-partitioning processes. It is widely agreed that, unlike oceanic lithosphere, continental crust accommodates much of its deformation by reactivation of pre-existing structures which can effectively act as loci for stress concentration during superimposed deformations (Schedl & Wiltschko 1987; Holdsworth *et al.* 1997 and references therein). Stratigraphic documentation of a Proto-San Andreas fault, subparallel to the present-day transform boundary, and active in the Late Cretaceous–Paleocene interval (Nilsen 1981; Page 1990), makes this feature an excellent candidate as an important mechanical anisotropy responsible for strike-slip partitioning during inception of wrench-dominated transpression. These elements suggest that the Paleocene to Recent evolution of the Northern Salinian Block and the inferred strain-partitioning along the San Andreas fault were controlled by a combination of relative plate motion, intrinsic fault properties and fault reactivation processes.

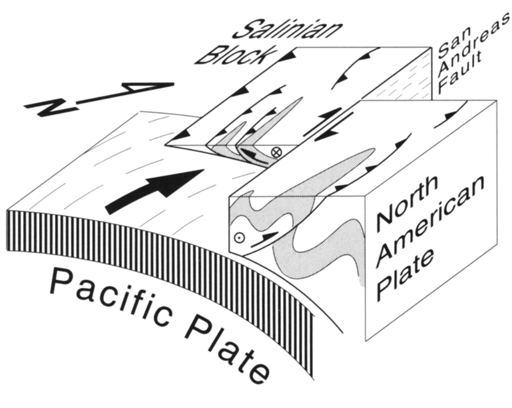


Fig. 9. Kinematic deformation model for western California, where contractional and strike-slip deformation result from strike-slip partitioning processes related to oblique subduction of the Pacific plate under North America.

Concluding remarks

The tectonic evolution of the Northern Salinian Block was dominated by SW–NE-directed shortening expressed by NW–SE-trending folds and thrusts. Structural data provide the analytical background to a kinematic deformation model, where coeval contractional and strike-slip deformations result from strike-slip partitioning of oblique convergent movements at the Pacific–North American plate boundary. In combination with other factors, such as boundary conditions imposed by plate motion and/or intrinsic fault properties, strain-partitioning processes could have been controlled by a major pre-existing tectonic feature, the Proto-San Andreas fault, active since Late Cretaceous time. Paleogene to Recent strike-slip deformations and coeval SW–NE-directed shortening support the hypothesis of a shallow San Andreas fault branching from a gently NE-dipping décollement. This view contrasts with the general notion of a conventional transform fault affecting the whole lithosphere, i.e. the stacked Pacific and North American plates. This study illustrates the effectiveness of mesoscopic analysis as a tool to ultimately test existing regional tectonic models.

This work was carried out while I was in receipt of a NATO–CNR Advanced Fellowship at the Department of Geology and Geophysics of the University of California, Berkeley, USA. I am indebted to W. Alvarez for introducing me to the fascinating geology of the Salinian Block. D. Jones, P. Claeys, D. Karner, A. Clymer and B. Fouke are also gratefully acknowledged for stimulating discussions in the field. Suggestions and comments by B. Tikoff, C. Teyssier and B. Holdsworth, along with critical reviews by Ian Alsop and an anonymous referee, greatly improved the original manuscript.

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