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Predictive model: Late Cretaceous to Early Miocene paleogeography of the San Andreas fault system derived from detailed multidisciplinary conglomerate correlations

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ABSTRACT

Paleogeographic reconstruction of the San Andreas fault system in western California, USA, was hampered for over thirty years by the apparent incompatibility of lithologic correlations, especially those indicating larger offset for younger features than for older features across the same fault. Disparate estimates of offsets across the San Andreas fault have varied from 563 km for Cretaceous features, to 315 km for Jurassic-Miocene features, to 30 km for Cretaceous-Pliocene features. Estimates of total slip on the San Gregorio fault have ranged from 5 km to 185 km. Sixteen upper Cretaceous and Paleogene conglomerates of California have been included in a multidisciplinary study to evaluate total displacements. Detailed analysis, including microscopic petrography, geochemistry, and SHRIMP U/Pb dating, centered on identification of matching unique clast varieties, rather than on simply counting general clast types, and included analyses of matrices, paleocurrents, diagenesis, fossils, adjacent rocks, and stratigraphy. From conglomerate correlations, a late Cretaceous to Early Oligocene paleogeography of the San Andreas fault system was constructed that reconciles apparent disparities and has proved predictive. Since its first introduction, in 1998, other authors have reported seven subsequently identified correlative pairs of geological and geophysical features consistent with the model. The paleogeography now incorporates at least 58 pairs of documented correlatives (far more than any other model), covers the period from 70 Ma to 23.1 Ma, extends from the Pelona and Orocopia schists to the Mendocino triple junction, and indicates that the San Andreas fault is a temporary assemblage of separate segments, and is not the primary fault of the transform system.

INTRODUCTION

Paleogeographic reconstruction of the region of the San Andreas fault was hampered for more than thirty years by the apparent incompatibility of authoritative lithologic correlations, notably 315 km between ~23.5 Ma Pinnacles and Neenach Volcanics (Matthews, 1976), versus 563 km between upper Cretaceous sediments of Anchor Bay and a proposed gabbroic source at Eagle Rest Peak (Ross et al., 1973; Fig. 1). This gabbro at Eagle Rest Peak was correlated with Logan Gabbro by Ross (1984). In addition, six pairs of Cretaceous-Pliocene features had been proposed to demonstrate ~30 km offset (Dibblee, 1966a) across the San Andreas fault section between Pinnacles and Point Reyes, and four Oligocene-Miocene pairs of features were proposed (Addicott, 1968; Clarke, 1973; Nilsen and Clarke, 1975; Stanley, 1987; Graham et al., 1989) which were separated ~315 km across that same section. The most serious problem with these apparently conflicting interpretations is that certain younger features showed greater fault offset distance than older features on the same fault segment. Furthermore, estimates of total dextral slip on the San Gregorio fault have ranged from 5 km (Underwood et al., 1995) to 185 km (Bachman and Abbott, 1988; Burnham and Anderson, 1994; Hall et al., 1995).

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CONGLOMERATE STUDIES

Sixteen upper Cretaceous and Paleogene conglomerates of the California Coast Ranges, from Anchor Bay to Simi Valley (near Los Angeles), have been included in a study that centered on identification of matching unique clast varieties, rather than on simply counting general clast types, and included analyses of matrices, paleocurrents, diagenesis, fossils, adjacent rocks, and stratigraphy (Fig. 2). Promising correlatives were subjected to detailed analysis, including microscopic petrography (69 to 135 characteristics), microprobe geochemistry, and SHRIMP U/Pb zircon dating. This study verified Seiders and Cox's (1992) and Wentworth's (1996) correlation of the upper Cretaceous strata of Anchor Bay at Anchor Bay with a then-unnamed conglomerate on the San Francisco Peninsula at the intersection of Skyline Road with Highway 92 [previously designated the Pilarcitos site by Burnham (1998b, 1998c, 1998d)], and verified that the Paleocene or Eocene Point Reyes Conglomerate at Point Reyes is a tectonically displaced segment of the Carmelo Formation of Point Lobos south of Monterey (Burnham, 1998a, 2005; Fig. 2). The Cretaceous conglomerate at Skyline Road/Highway 92 was later named "Anchor Bay conglomerate" by Brabb, et al. (1998). These two pairs of conglomerates do not match any others in this study. The work also led to three new correlations: the Point Reyes Conglomerate with granitic source rock at Point Lobos; a magnetic anomaly at Black Point (near Sea Ranch) with a magnetic anomaly near San Gregorio; and the strata of Anchor Bay with previously established source rock, the potassium-poor Logan Gabbro (Ross et al., 1973) at a more recently recognized location (Brabb and Hanna, 1981; McLaughlin et al., 1996) just east of the San Gregorio fault, south of San Gregorio (Burnham, 1998b, 1998c, 1998d; Fig. 2).

TECTONIC IMPLICATIONS

180 km resolves 315 km vs. 563 km

Juxtaposition of Anchor Bay and the Skyline/Highway 92 site (#3; Figs. 3, 4, 6; Burnham, 1998c) places the strata of Anchor Bay (#4; Burnham, 1998c) near Logan Gabbro just east of the San Gregorio fault, south of San Gregorio (#4; Fig. 6). This body of Logan Gabbro was not recognized earlier because it is buried, with only small exposures just west of the San Andreas fault between Logan and the Butano fault. Its extent was discovered by magnetic studies (Brabb and Hanna, 1981). Burnham's (1998b, 1998c) proposed correlation of the strata of Anchor Bay with Logan Gabbro source rock near San Gregorio (#4), instead of Logan Gabbro source at Eagle Rest Peak, resolves the apparent discrepancy between Ross's strata of Anchor Bay-Logan Gabbro correlation (Ross et al., 1973) and Matthews's (1976) correlation of Pinnacles-Neenach volcanics. The Burnham model, as the Figure 6 map shows, leaves no unresolved offset distances.

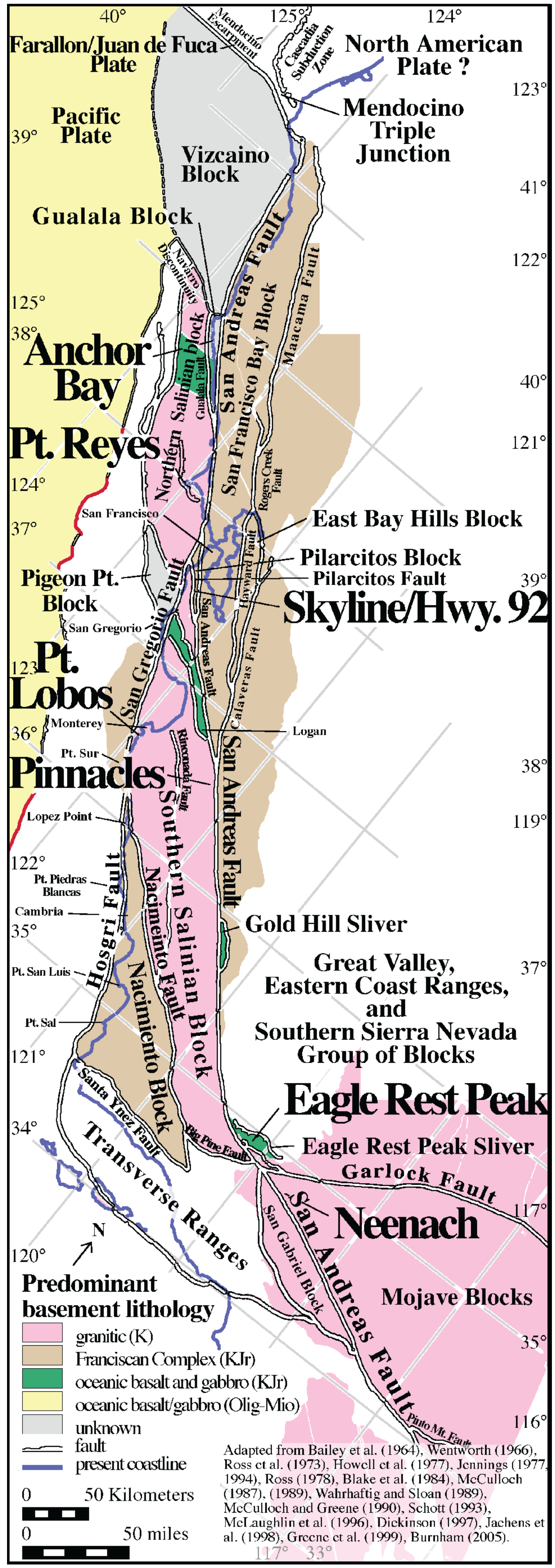


Figure 1. Regional basement, faults and tectonic blocks.

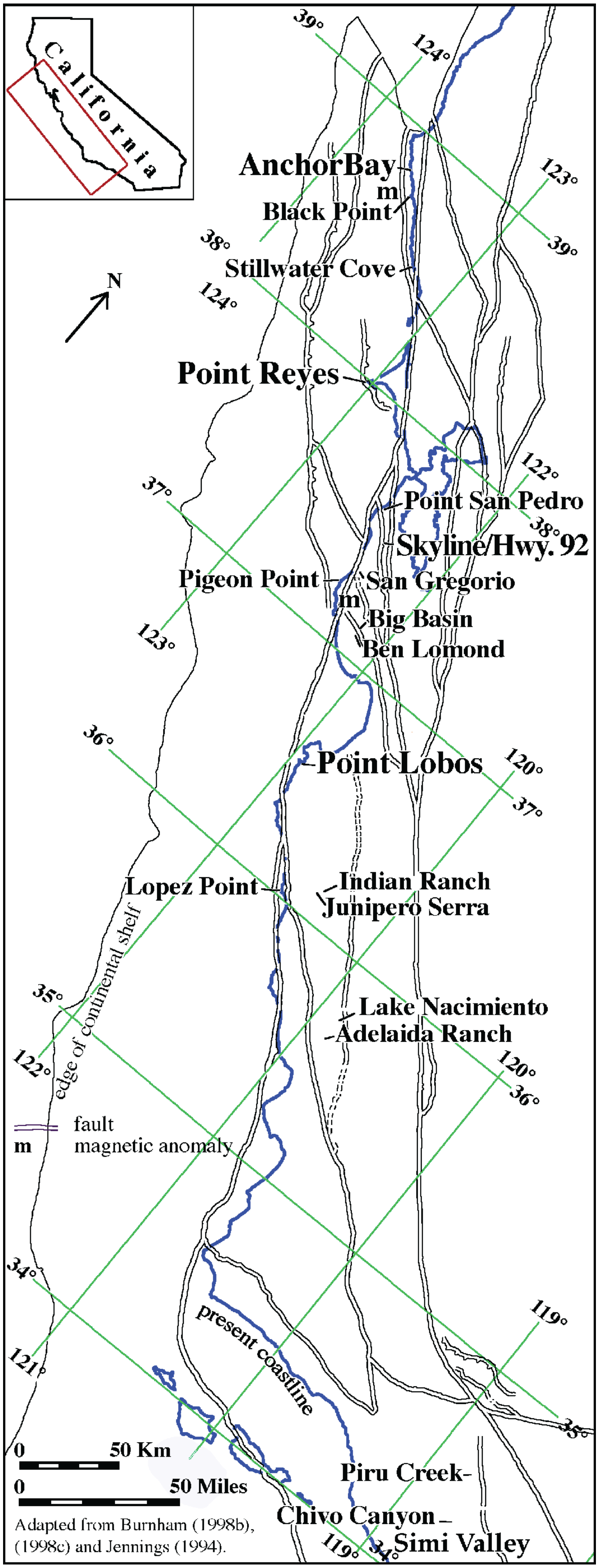


Figure 2. Conglomerate sites studied.

San Gregorio fault paleogeography

Thirteen pairs of correlative geological and geophysical features occur entirely west of the San Andreas fault (red in Fig. 3). The southeastern half of each of these pairs of correlatives occurs between the San Gregorio fault (yellow in Figure 3) and the San Andreas fault (red). Restoration of a single post-Early Miocene dextral offset of 180±5 km on the combined San Gregorio (yellow) – northern San Andreas (red) fault juxtaposes at least 13 pairs of correlative features (Figs. 4 and 5). The Figure 6 map is updated from Figure 18 of Burnham (1998c) only by more detailed representation of the Butano Sandstone, by correction of the position of the well at Castroville, and by addition of five pairs of correlative features (designated “post-thesis”, in bold) later documented by other authors.

Wentworth (1966) reported simultaneous upper Cretaceous sedimentation of contrasting rock types in the Gualala block – the mafic gabbro-rich Anchor Bay Member of the Gualala Formation (strata of Anchor Bay) and the felsic granite-rich Stewarts Point Member of the Gualala Formation (strata of Stewarts Point). James (1986) provided new paleocurrent data indicating that both of these sediments were derived from easterly sources. Schott (1993) proposed adjacent sediment sources, gabbro north of granite, such as is found just north of the Garlock fault where the Pastoria-Rand fault separates Logan Gabbro at Eagle Rest Peak from granitic rock to the south. The Burnham (1998c) reconstruction is consistent with James’ and Schott’s sedimentological interpretations, but suggests the strata of Anchor Bay was derived from Logan Gabbro near the San Gregorio fault (#4), and that the strata of Stewarts Point was derived from granitic rock of Ben Lomond Mountain on the south side of the Zayante-Vergeles fault (#70; Fig. 6).

The 150 km offset proposed by Clark et al. (1984) and Clark (1997) is currently the most widely accepted offset model for the San Gregorio fault, and is certainly a possible minimum offset distance for their correlation of granitic rocks and conglomerates of Point Reyes and Point Lobos (#8, 10-12). Their proposal has recently been refined to 156±4 km (Dickinson et al., 2005). However, other correlations (#1, 3, 4, 7; Graham and Dickinson, 1978; Hall et al., 1995; Burnham, 1998b, 1998c, 1998d; Jachens et al., 1998; Wentworth et al., 1998) and the upper Oligocene-lower Miocene Iversen-Mindego Basalt correlation (#2; Springer, 2002; age per Clark and Brabb, 1978; Brabb et al., 1998) cannot have been offset less than 175 km (Burnham, 1998b, 1998c, 2006). These correlated pairs of features constrain the post-Early Miocene offset to ≥175 km. A single post-Early Miocene dextral offset of 180±5 km of the San Gregorio and northern San Andreas faults comprises the simplest paleogeographic reconstruction, accommodates the greatest number of correlative features, and juxtaposes correlative features more directly across the fault (Figs. 3-6).

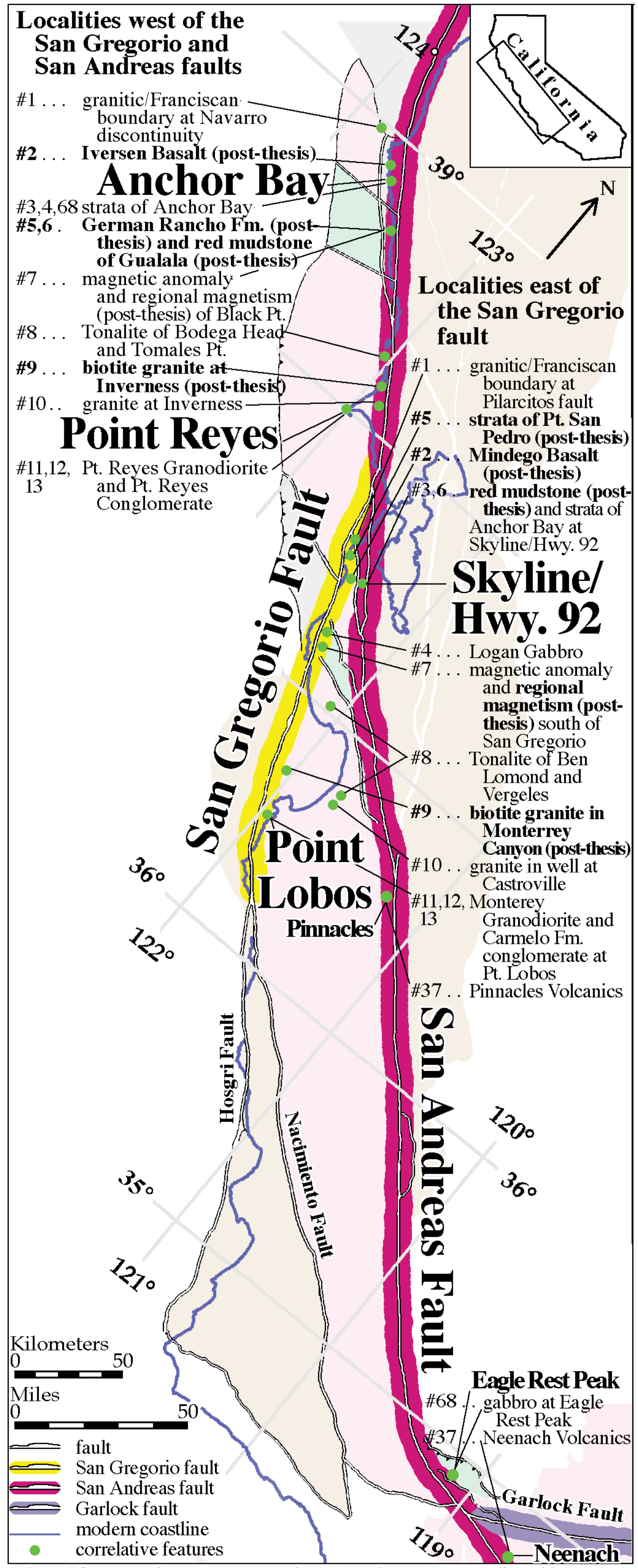
San Andreas fault system paleogeography

Construction of the model. The paleogeographic model was first constructed using only a few pairs of localities (Burnham, 1988c; Figs. 7-9): Matthews' (1976) Pinnacles-Neenach Volcanics tie (#37); the Anchor Bay and the Skyline/ Highway 92 conglomerates (#3; Seiders and Cox, 1992; C.M. Wentworth, oral commun., 1996; Burnham, 1998c); granodiorite and conglomerate at Point Reyes and Point Lobos (#11, 12, 13; Clark et al., 1984; Ross, 1984; Bachman and Abbott, 1988; Clark, 1997; Hilton, 1997; Burnham, 1998c); Permanente terrane melange at Skyline/Highway 92 and Permanente Quarry (# 23; McLaughlin et al., 1996); Pine Creek stratigraphy (#20; Vedder et al., 1991); correlation of Cretaceous limestone at Gavilan College and at Gold Hill (#47; McLaughlin et al., 1996); and the Zayante-Vergeles and Pastoria-Rand faults (#35; Ross, 1984; Schott, 1993). Other correlatives then fell into place, confirming the essential correctness of the model (Figures 7-9). In bold are localities subsequently correlated by other authors, including two pairs of correlatives which prompted expansion of the model to include areas that extend from the Orocopia and Pelona schists to the modern position of the Mendocino triple junction.

The present shape of tectonic blocks was used for paleogeographic reconstruction, despite compression and extension internal to several blocks, because at this stage in our knowledge, their present shape offers the most rigorous constraint for fit, distance, and fault geometry. This model treats tectonic blocks of solid lithosphere as roughly coherent entities through time, sometimes divided, stretched, or compressed, but still recognizable. Faults, however, are considered as merely transient interstices between blocks, evolving radically as the blocks move. The different colors juxtaposed on opposite sides of faults in Figures 8-9 indicate that the faults have been drastically re-combined. For example, the eastern side of the central San Andreas fault (red) and the eastern side of the Calaveras fault (blue) are juxtaposed against the western sides of the Calaveras (blue), Hayward (tan), Rogers Creek (pink) and Maacama (pink) faults; thus comprising the San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault.

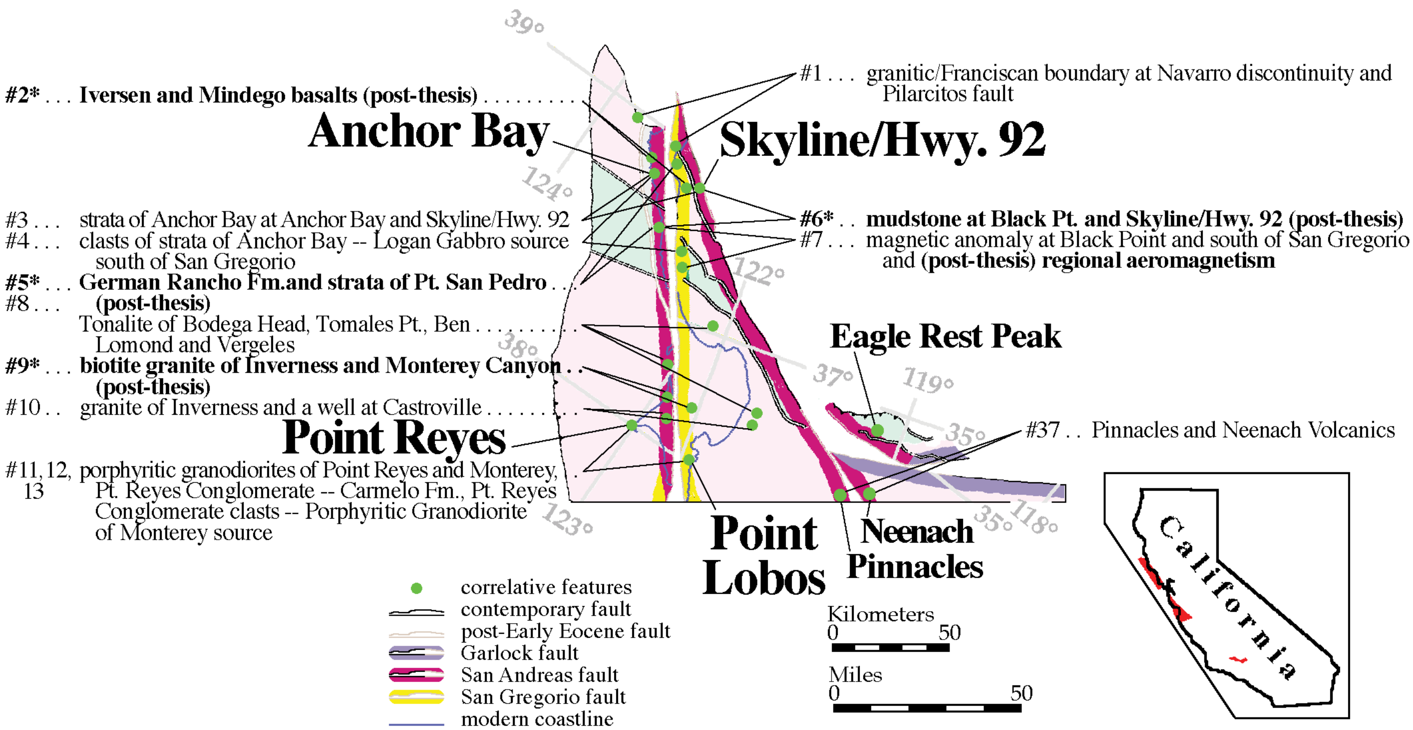
Predictivity of the 1998 model

The 315±5 km offset of the San Andreas fault south of the intersection with the Calaveras fault is partitioned between the Calaveras fault and the section of the San Andreas fault north of that intersection. Restoring 30±5 km offset (Dibblee, 1966a, Cummings, 1968; McLaughlin et al., 1996) on the section of the San Andreas fault between its intersections with the Calaveras and San Gregorio faults reveals an offset of 285±5 km across the San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault (Figs. 7-10; Burnham, 1998c). Figures 9 and 10 show the Skaggs Springs Schist (#54; Wakabayashi, 1999) and Healdsburg terrane (#73, potential; Graymer et al., 2002) pairs fall into place on the model, juxtaposed across the



Adapted from Jennings (1994), Burnham (2006b). See Appendix TableA1.

Figure 3. San Andreas and San Gregorio faults at present. ("Post-thesis" indicates correlatives documented by other authors after publication of the Burnham (1998c) thesis model. See Appendix Table A1 for citations of specific features.)



Adapted from Burnham (2006). See Appendix Table A1.

Figure 4. Restoration of 181 km post-early Miocene (<16.2 Ma) offset of the San Gregorio (yellow)-northern San Andreas (red) fault.

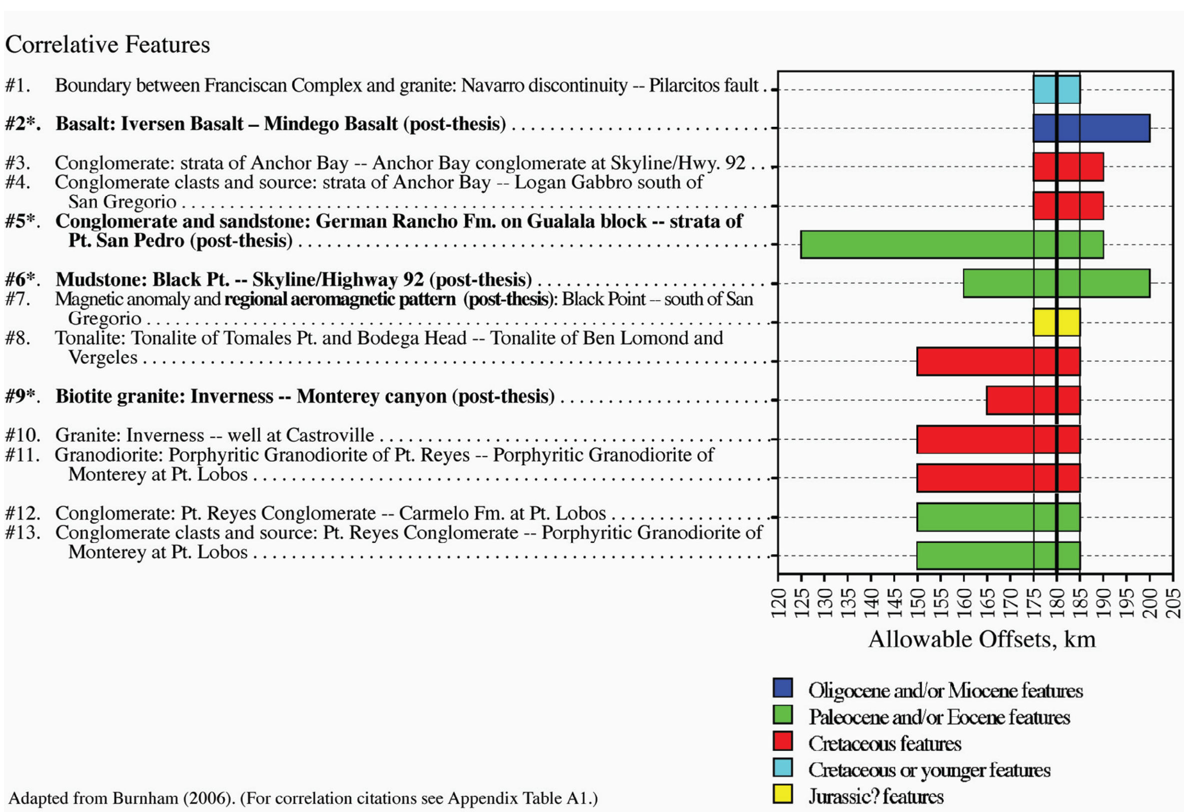
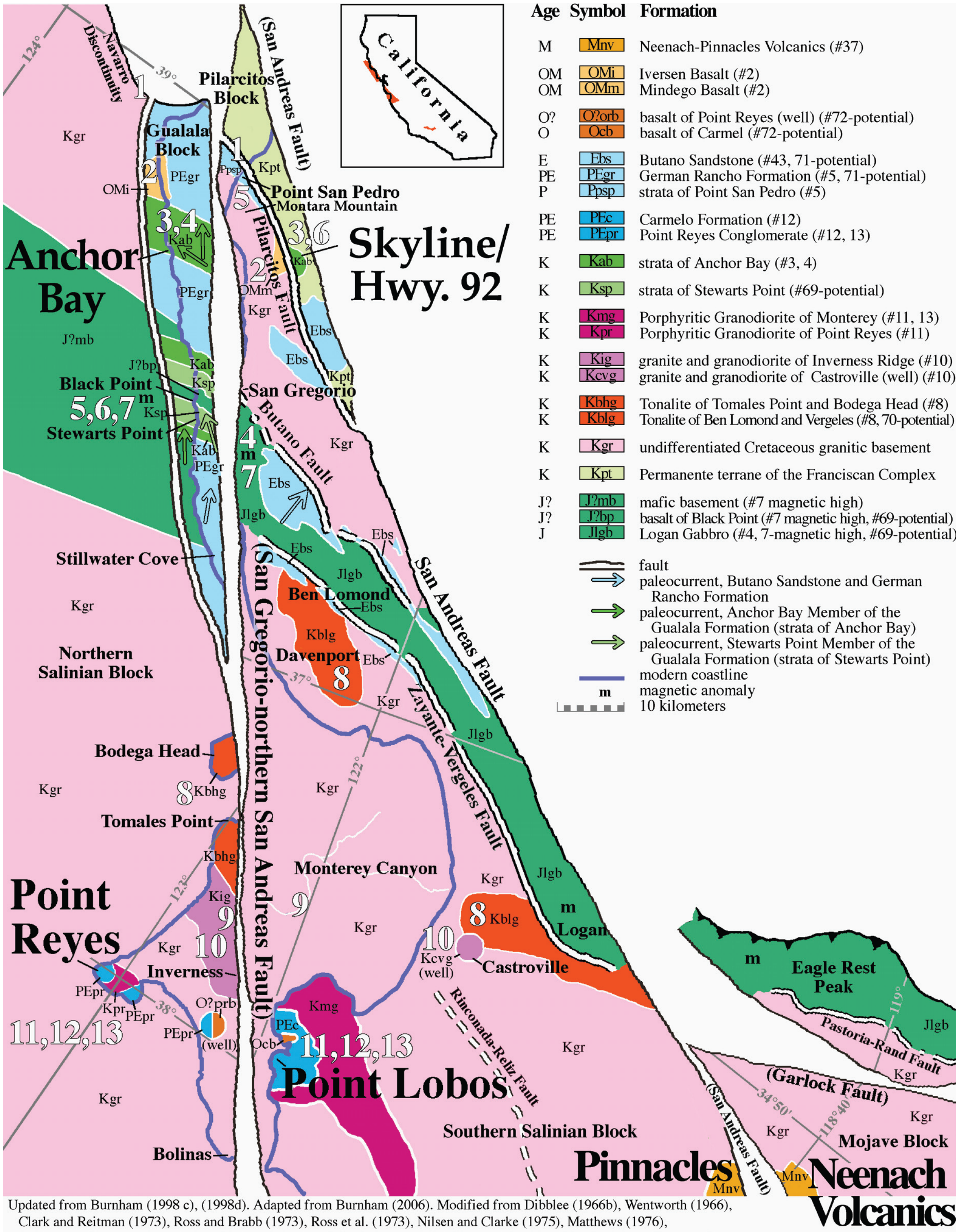


Figure 5. Allowable offsets of correlative features across the San Gregorio-northern San Andreas fault. All of the thirteen pairs of correlative features fit within a single offset distance of 180±5 km.



Updated from Burnham (1998 c), (1998d). Adapted from Burnham (2006). Modified from Dibblee (1966b), Wentworth (1966), Clark and Reitman (1973), Ross and Brabb (1973), Ross et al. (1973), Nilsen and Clarke (1975), Matthews (1976), Galloway (1977), Jennings (1977), Clark and Brabb (1978), Nilsen (1979), Nilsen and Brabb (1979), Brabb and Hanna (1981) Brabb and Pampeyan (1983), Blake et al. (1984), Clark et al. (1984), Ross (1984), Graham et al. (1989), Griscom and Jachens (1990), Schott (1993), Jennings (1994), Hall et al. (1995), McLaughlin et al. (1996), Clark (1997), Brabb et al. (1998), Elder et al. (1998), Jachens et al. (1998), Stakes et al. (1998), Wentworth et al. (1998), Greene et al. (1999), Wakabayashi (1999a), Kistler and Champion (2001), Springer (2002). For specific correlation citations see Appendix Table A1.

Figure 6. Late Cretaceous to early Miocene (~70-23.5 Ma) paleogeographic features of the San Gregorio-San Andreas fault.

San Andreas (red)-Calaveras (blue)-Hayward (tan)-Rogers Creek-Maacama (pink) fault. The juxtaposition of these pairs of features in an area beyond the original Burnham (1998c) paleogeographic map confirms the accuracy of the ~285 km offset of the Burnham (1998c) model across the San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault.

New post-thesis additions beyond the San Gregorio fault include the correlation of Middle Miocene? to Pliocene? Wilson Grove Formation on the San Francisco Bay block with the Delgada fan on the Vizcaino block (#14; Allen and Holland, 1999; McLaughlin et al., 2005). These features are offset ~205 km across the far-northern segment of the San Andreas fault. This ~205 km offset is the result of merger of the ~180 km offset of the San Gregorio fault with the ~30 km offset of the San Francisco peninsula segment of the San Andreas fault (Figures 7-10).

The paleogeographic model is validated by the fact that new correlations can be added (Fig. 8) by simple regional extension of the maps, with no change in the shapes or position of the tectonic blocks of the original model. Predictivity of a paleogeographic model of the San Andreas fault system on branching faults beyond the scope of the original model is unprecedented.

SUMMARY

The Burnham (1998c) paleogeographic model has not been substantially modified except by additions to incorporate new correlations. It accords with proposals of no post-Cretaceous strike-slip of the San Andreas fault system before 27 Ma (Atwater, 1998). It synthesizes formerly apparently disparate fault-offset correlations, i.e.: ~315 km San Andreas fault offset between Pinnacles and Neenach Volcanics (#37; Matthews, 1976), strata of Anchor Bay-Logan Gabbro (#4, 68; Ross et al., 1973), Dibblee's (1966a) six pairs of correlatives (#21-22, 25-28) showing ~30 km offset across the San Francisco Peninsula section of the San Andreas fault, and the four pairs of features (Addicott, 1968; Clarke, 1973; Nilsen and Clarke, 1975; Stanley, 1987; Graham et al., 1989) measuring ~315 km separation across that same section of the San Andreas fault (Figs. 3-10; Table 1). The model does this within the constraints of using the present shape of tectonic blocks, and without any "leftover" large offset requiring assignment of large (or any) post-Cretaceous slip to the Pilarcitos fault or to a hypothetical proto-San Andreas fault.

The model improves resolution of complex spatial-temporal distribution of slip along this evolving tectonic margin and accords with suggestions the San Andreas fault is not the plate boundary (Page, 1990). However, because a central section of the San Andreas fault has offset less and began dextral motion later (~30 km since 3 or 4 Ma) than the San Gregorio-northern San Andreas fault (~180 km since before ~11 Ma) or the San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault (285 km since before ~11 Ma), this model suggests the San Andreas fault is a young temporary configuration, and is not the primary fault of the transform system. The model has passed the fundamental scientific test of predictivity seven-fold.

ACKNOWLEDGMENTS

I thank my advisor, Simon Klemperer, and committee members, Steve Graham, Bob McLaughlin, and Mike McWilliams, numerous other geologists, the National Park Service, the State of California, landowners, my late husband William L. Moultrie, Stanford University, PEO, the National Academy of Sciences through Sigma Xi, the National Science Foundation, Dr. C. Healy Burnham, and Ms. Elizabeth Freitag. I am delighted to be able to contribute a "conglomerates as clues to tectonics" paper to the symposium honoring Bill Dickinson, who invented the use of sandstones as tectonic evidence, and greatly expanded and refined the repertoire of tectonic sedimentology. I thank him for a helpful review of my study,

TABLE 1. POST-CRETACEOUS FAULT-OFFSET DISTANCE RANGES AND TIME CONSTRAINTS OF EACH FAULT SEGMENT.

Fault	Dextral offsets shown in figures (km)	Allowed range of dextral offset (km)	Time of initial lateral motion
Far-northern San Andreas fault (north of the Navarro Discontinuity and the Pilarcitos fault)	204	205±30	not before Middle Miocene (<16.6 Ma)
San Gregorio-northern (between Bolinas and the Navarro Discontinuity) San Andreas fault	181	180±5	not before Early Miocene (<23.7 Ma)
San Gregorio-Hosgri fault	93	90±10	Late Miocene (<11.2 Ma)
San Gregorio-Nacimiento fault	90	90±10	Middle Oligocene (<30.0 Ma)
San Francisco peninsula segment of the San Andreas fault (between the intersections with the San Gregorio and Calaveras faults)	31	30±5	3-4 Ma (Early Pliocene)
Southern San Andreas fault (south of Logan and Eagle Rest Peak, north of Pelona and Orocopia)	315	315±5	after 21.3 Ma (Early Miocene)
San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault (north of Eagle Rest Peak)	284	285± 5	after 21.3 Ma, before ~ 11 Ma (between Early and Late Miocene)
Hayward-Rogers Creek fault	36	35±5	after ~10 Ma (Late Miocene)
Pinto Mountain fault	16 sinistral	16±2 sinistral	after 21.3 Ma (Early Miocene)

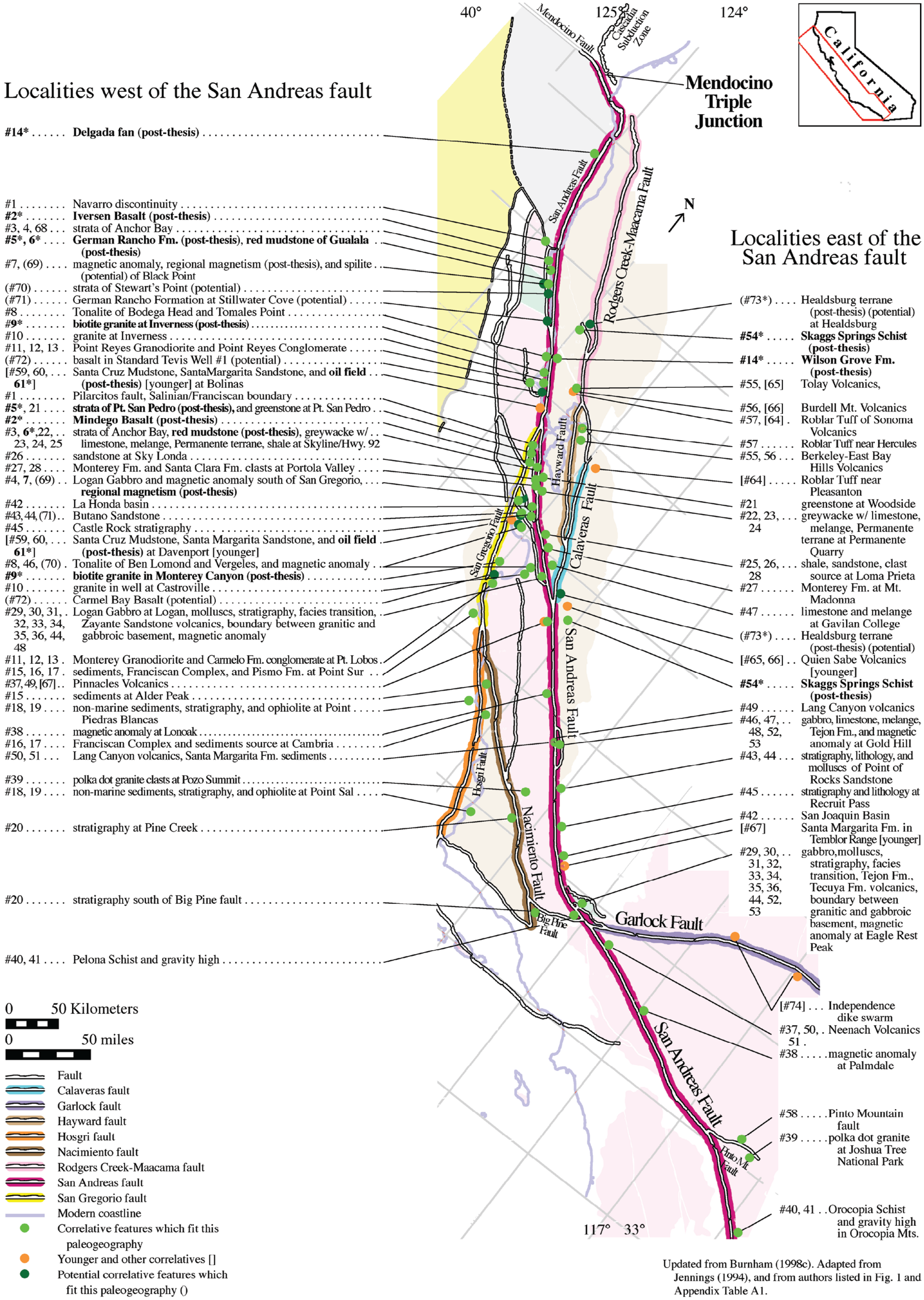


Figure 7. Correlated localities and potential correlatives of the San Andreas fault system, consistent with the paleogeography of Burnham (1998c; 1998d). This model now incorporates at least 58 pairs of correlative features, seven of which (bold) were later proposals by other authors.

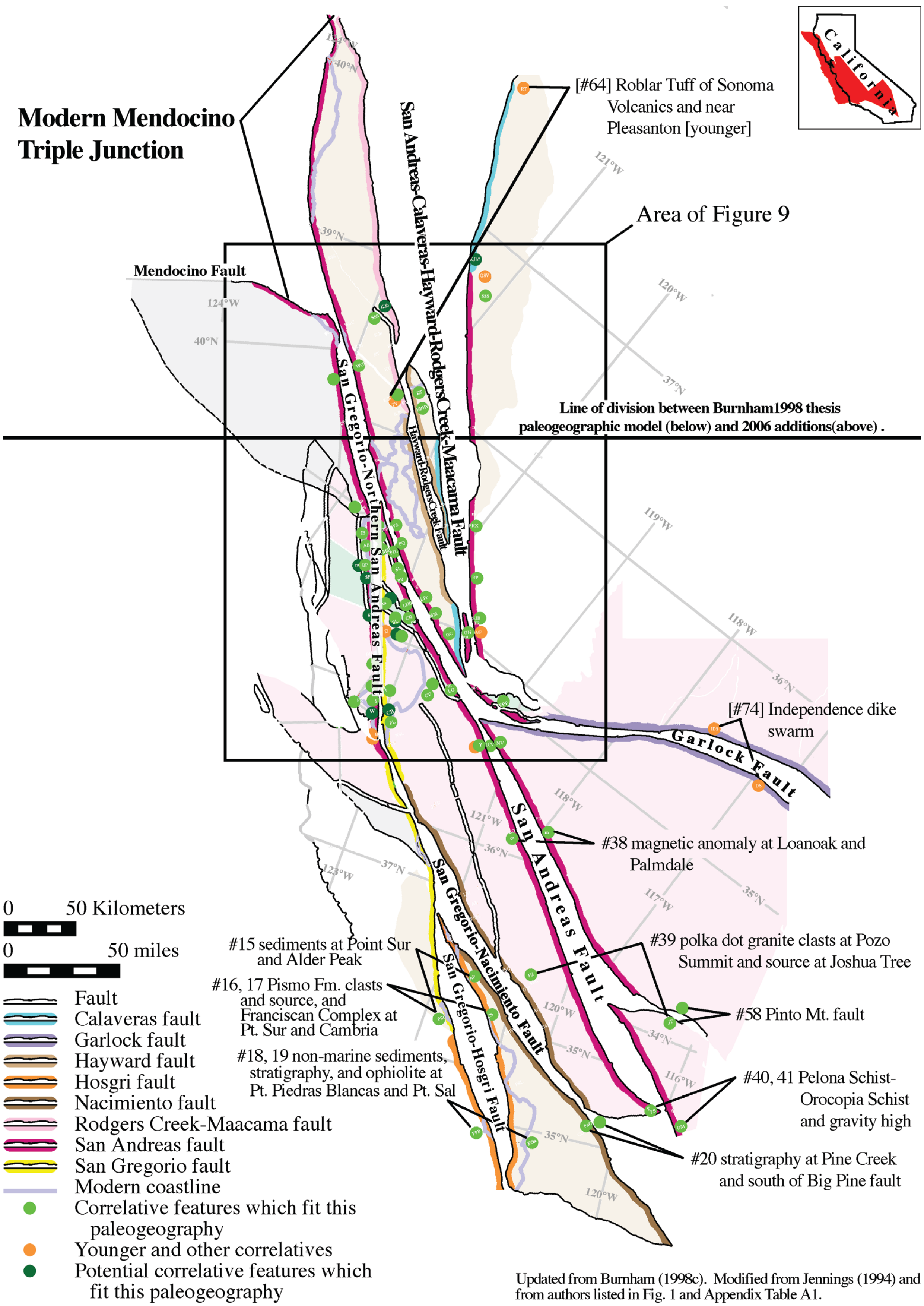


Figure 8. Late Cretaceous (Campanian) to Oligocene (~70 to ~30 Ma) paleogeography of the San Andreas fault system.

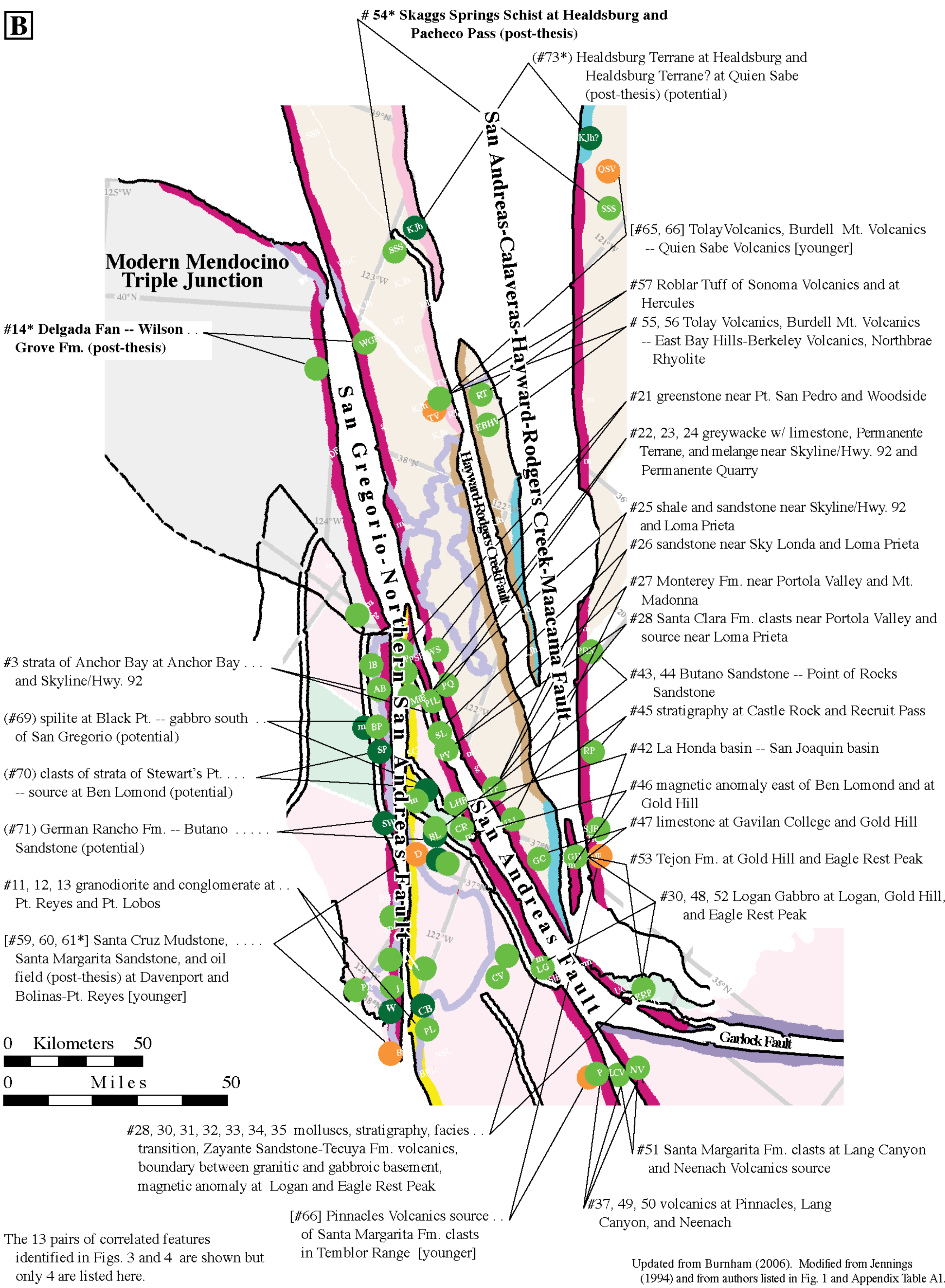


Figure 9. Detail of paleogeography.

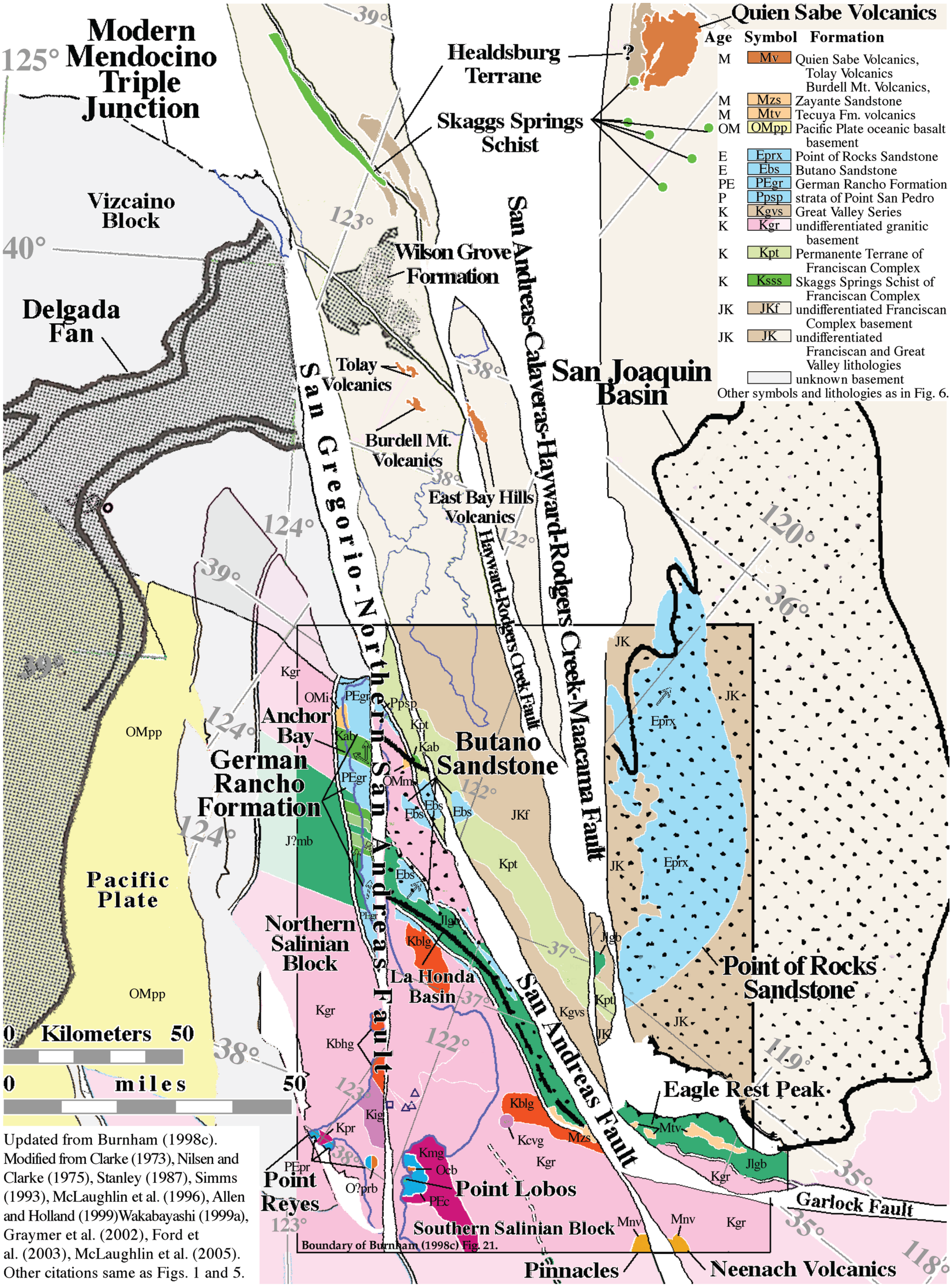


Figure 10. Selected geologic features of San Andreas fault system paleogeography, Late Cretaceous Campanian to Early Miocene (~70-21.3 Ma). Certain younger features which constrain initial strike-slip are included.

APPENDIX

TABLE A1. FAULT-OFFSET CORRELATIONS CONSISTENT WITH BURNHAM (1998C, FIGURES 3-10) THESIS PALEOGEOGRAPHY.

*correlated features pair #	western correlated feature, locality	eastern correlated feature, locality	reference
San Gregorio-northern San Andreas fault-offset correlatives juxtaposed by restoration of 180±5 km post-Early Miocene dextral offset:			
1	Navarro Discontinuity or fault at Bodega	Pilarcitos fault	Graham and Dickinson (1978)
	Navarro Discontinuity	Pilarcitos fault	Hall et al. (1995)
2* post-thesis	Iversen Basalt	Mindego Basalt	Springer (2002); age per Clark & Brabb (1978), Brabb et al. (1998), Wentworth et al. (1998)
3	Anchor Bay Member of the Gualala Fm. (strata of Anchor Bay)	Anchor Bay conglomerate at Skyline/Hwy. 92	Brabb et al. (1998), Burnham (1998b, 1998c), Elder et al. (1998),, Wentworth et al. (1998), E. Brabb, (written communication (2007)
4	strata of Anchor Bay	Logan Gabbro south of San Gregorio	Burnham (1998b), (1998c)
5* post-thesis	German Rancho Fm.	strata of Pt. San Pedro	Elder et al. (1998), Wentworth et al. (1998)
6* post-thesis	red mudstone at Gualala block	red mudstone at Skyline/Hwy. 92	Wakabayashi (1999)
7	magnetic anomaly at Black Point	magnetic anomaly south of San Gregorio	Burnham (1998c), (1998d)
(*part post-thesis)		magnetic anomaly south of San Gregorio and regional magnetism	Jachens et al. (1998)
8	tonalite of Bodega Head & Tomales Pt.	tonalite of Ben Lomond & Vergeles	Clark et al. (1984), Clark (1997)
9* post-thesis	biotite granite at Inverness	biotite granite in Monterey canyon	Stakes et al. (1998), Kistler and Champion (2001)
10	granite at Inverness	granite in well at Castroville	Clark et al. (1984); age per Ross (1978)
11	Porphyritic Granodiorite of Point Reyes	Porphyritic Granodiorite of Monterey	Clark et al. (1984), Ross (1984); age per Clark (1997)
		Monterey granodiorite at south bank of Monterey Canyon	Clark (1997)
		Porphyritic Granodiorite of Monterey at Pt. Lobos	Burnham (1998a), (2005)
12	Pt. Reyes Conglomerate	Carmelo Fm. at Pt. Lobos	Clark et al. (1984), Bachman and Abbott (1988), Burnham and Anderson (1994), Clark (1997), Hilton (1997), Burnham (1998a, 2005)
13	Pt. Reyes Conglomerate	Porphyritic Granodiorite of Monterey at Pt. Lobos	Burnham (1998a), (2005)
Far-northern San Andreas fault-offset correlatives juxtaposed by restoration of 200-235 km post-Middle Miocene dextral offset:			
14* post-thesis	Delgada fan	Wilson Grove Fm	Allen and Holland (1999), McLaughlin et al. (2005)
San Gregorio - Hosgri fault-offset correlatives juxtaposed by restoration of 90±10 km post-Miocene dextral offset:			
15	Point Sur	Alder Peak	Graham and Dickinson (1978)
16	Point Sur	Cambria	Graham and Dickinson (1978)

*Listed north to south by western locality, within categories.
"Post-thesis" indicates published after the Burnham (1998c) thesis paleogeographic model.

Continued on next page.

Table A1., continued.

*correlated features pair #	western correlated feature, locality	eastern correlated feature, locality	reference
17-18	Point Sur	Cambria	Hall et al. (1995)
18	Point Piedras Blancas	Pt. Sal	correlation of Dickinson (1983); sediments reported by Anderson (1980)
18-19			Hall et al. (1995)
19	San Simeon	Pt. Sal	Graham and Dickinson (1978)
San Gregorio-Nacimiento fault-offset correlatives juxtaposed by restoration of 90±10 km post-Middle Oligocene dextral offset:			
20	Pine Creek	(Big Pine fault or farther)	Vedder et al. (1991)
San Andreas fault-offset correlatives juxtaposed by restoration of 30±5 km post-4 Ma dextral offset:			
21	Franciscan Complex greenstone near Pt. San Pedro	Franciscan Complex greenstone near Woodside and Permanente Quarry	Dibblee (1966a); age per Murchey and Jones (1984)
22	Franciscan greywacke sandstone w/ limestone lenses near Skyline/Hwy 92	Franciscan greywacke sandstone w/ limestone lenses near Permanente Quarry	Dibblee (1966a); ages per Murchey and Jones (1984) and Sliter (1984)
23	Franciscan mélange near Skyline/Hwy 92	Franciscan mélange at Cupertino (near Permanente Quarry)	McLaughlin et al. (1996); age per Murchey and Jones (1984)
24	Permanente Terrane near Skyline/Hwy 92	Permanente Terrane near Permanente Quarry	Wakabayashi and Hengesh (1995)
25	shale and sandstone near Skyline/Hwy 92	shale and sandstone near Loma Prieta	Dibblee (1966a)
26	sandstone near Sky Londa	sandstone near Loma Prieta	Dibblee (1966a)
27	Monterey Shale near Portola Valley	Monterey Shale near Mt. Madonna	Dibblee (1966a)
28	Corte Madera facies of Santa Clara Fm. gravel near Portola Valley	Great Valley Series conglomerate near Loma Prieta	Dibblee (1966a), Cummings (1968)
San Andreas fault-offset correlatives juxtaposed by restoration of 315±5 km post-21.3 Ma dextral offset:			
29	Logan	Eagle Rest Peak	Addicott (1968)
30	Logan, Mt. Pajaro	Eagle Rest Peak	Ross et al. (1973)
31	San Juan Bautista (near Logan)	San Emigdio Mountains (near Eagle Rest Peak)	Nilsen (1984)
32	Zayante Sandstone or San Lorenzo Fm. volcanics (near Logan)	Tecuya Fm. At Eagle Rest Peak	Simms (1993)
33	Gabilan Range east-west shoreline (south of Logan)	San Emigdio Mountains (near Eagle Rest Peak)	Nilsen and Link (1975)
34	magnetic anomaly at Logan	magnetic anomaly at Eagle Rest Peak	Griscom and Jachens (1990)
35	Zayante-Vergeles fault	Pastoria-Rand fault	Ross (1984), Schott (1993)
36	N. Santa Lucia & Gabilan Ranges (between Monterey and Logan)	Eagle Rest Peak	Nilsen and Link (1975)
37	Pinnacles Volcanics	Neenach Volcanics	Turner et al. (1970), Matthews (1976)
38	magnetic anomaly at Lonoak	magnetic anomaly at Palmdale	Griscom and Jachens (1990)
39	polka dot granite clasts at Pozo Summit	polka dot granite clasts and source at Joshua Tree National Park	Ehlig and Joseph (1977)
40	Pelona Schist in San Emigdio Mts.	Orocopia Schist in Orocopia Mts.	Crowell (1973); age per Jacobson et al. (2000)
41	gravity high at Pelona Schist	gravity high at Orocopia Mts.	Griscom and Jachens (1990)
San Andreas-Calaveras fault-offset correlatives juxtaposed by the Burnham (1998c) paleogeography:			
42	La Honda basin	San Joaquin basin	Stanley (1987)
43	Butano Sandstone	Point of Rocks Sandstone	Clarke (1973), Nilsen and Clarke (1975)
44	molluscan assemblage from Butano fault to Logan	molluscan assemblage from Point of Rocks to Garlock Fault	Addicott (1968)
45	stratigraphy & lithology at Castle Rock State Park	stratigraphy & lithology at Recruit Pass	Graham et al. (1989)

Continued on next page.

Table A1., continued.

*correlated features pair #	western correlated feature, locality	eastern correlated feature, locality	reference
46	magnetic anomaly east of Ben Lomond	magnetic anomaly at Gold Hill	Griscom and Jachens (1990)
47	limestone at Gavilan College to Sargent Oil Field	limestone at Stone Corral Canyon near Gold Hill	McLaughlin et al. (1996); age per Sliter (1984)
48	Logan Gabbro	gabbro at Gold Hill	Ross (1970); age per Schott (1993)
49	Pinnacles Volcanics	Lang Canyon volcanics (near Gold Hill)	Turner et al. (1970), Simms (1993)
50	Lang Canyon volcanics (near Gold Hill)	Neenach Volcanics	Simms (1993)
51	Santa Margarita Fm. sandstone and conglomerate at Lang Canyon (near Gold Hill)	Neenach Volcanics	Simms (1993)
52	Logan Gabbro at Gold Hill	Logan Gabbro at Eagle Rest Peak	Ross (1970); age per Schott (1993)
53	Tejon Fm. At Gold Hill	Tejon Fm. In San Emigdio Mt.s, near Eagle Rest Peak	Simms (1993)
San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault-offset correlatives juxtaposed by restoration of 285±5 km post-21.3 Ma dextral offset:			
54* post-thesis	Skaggs Spring Schist near Healdsburg	Skaggs Spring Schist at Pacheco Pass, south of Quien Sabe Volcanics	Wakabayashi (1999a); age per Wakabayashi and Dumitru, in press
Hayward-Rogers Creek fault-offset correlatives juxtaposed by reversal of 35±5 km post-10 Ma dextral offset:			
55	Tolay Volcanics	Oakland-Berkeley Hills Volcanics	McLaughlin et al. (1996)
	Tolay Volcanics, Donnell Ranch Volcanics	Berkeley Hills Volcanics	Wagner et al. (2005)
55-56	Burdell Mt Volcanics, Tolay Volcanics	Northbrae Rhyolite in Berkeley Hills	Ford et al. (2003)
57	Roblar Tuff of Sonoma Volcanics, near Tolay Volcanics	Roblar Tuff near Hercules, near EBHV	McLaughlin et al. (1996), Wagner et al. (2005)
Pinto Mountain fault-offset consistent with the Burnham (1998c) paleogeography:			
58	Pinto Mt.	Pinto Mt.	Crowell and Ramirez (1979)
Younger San Gregorio fault-offset correlations compatible with the Burnham (1998c) paleogeography:			
59	Santa Cruz Mudstone at Pt. Reyes	Santa Cruz Mudstone in Santa Cruz Mountains	Clark et al. (1984)
60	Santa Margarita Sandstone at Pt. Reyes	Santa Margarita Sandstone in Santa Cruz Mountains	Clark (1997)
61	Santa Cruz Mudstone at Pt. Reyes	Santa Cruz Mudstone at Davenport	Stanley and Lillis (1999)
62	Purisima Fm. at Seal Cove (near Moss Beach)	Purisima Fm. 16 - 19 km southeast of Seal Cove	Clark (1997)
63	Upper Purisima Fm. at Ano Nuevo (south of Pigeon Point)	Upper Purisima Fm. at Capitola State Park (near Santa Cruz)	Clark (1997)
Younger San Andreas-Calaveras-Hayward-Rogers Creek-Maacama fault-offset correlatives compatible with the Burnham (1998c) paleogeography:			
64	Roblar Tuff of Sonoma Volcanics, near Tolay Volcanics	Roblar Tuff east of faults (near Pleasanton)	McLaughlin et al. (1996)
65	Tolay Volcanics	Quien Sabe Volcanics	McLaughlin et al. (1996)

Continued on next page.

Table A1., continued.

*correlated features pair #		western correlated feature, locality	eastern correlated feature, locality	reference
66		Burdell Mt Volcanics	Quien Sabe Volcanics	McLaughlin et al. (1996), Ford et al. (2003)
67		Pinnacles Volcanics	Santa Margarita Fm. Member C in south Temblor Range	Turner et al. (1970), Simms (1993)
Lithologic correlation compatible with the Burnham (1998c) paleogeography:				
68		Strata of Anchor Bay	Logan Gabbro of Eagle Rest Peak (utilized Logan Gabbro source location near San Gregorio per Burnham, 1998c)	Ross et al. (1973), Schott (1993)
Potential correlatives proposed for investigation by Burnham (1998c):				
69		spilite of Black Point	Logan Gabbro south of San Gregorio	Burnham (1998c)
70		strata of Stewart's Point	granitic rock at Ben Lomond	Burnham (1998b), (1998c)
71		German Rancho Formation at Stillwater Cove	Butano Sandstone	Burnham (1998b), (1998c)
Potential correlatives, consistent with the Burnham (1998c) paleogeography, proposed for investigation by other authors:				
72		basalt in Standard Tevis well at Pt. Reyes	Carmel Bay basalt (near Pt. Lobos)	Clark (1997)
73*	post-thesis	Healdsburg terrane of Great Valley Sequence near Healdsburg	?Healdsburg terrane? of Great Valley Sequence near Quien Sabe Volcanics	Graymer et al. (2002)
Previously published tie which probably correlates when this paleogeography is modified by reversal of syn-tectonic compression and extension:				
74		Independence dike swarm	dike swarm	Correlation by Wernicke et al. (1982); dikes reported by Smith (1962)

For a more extensive table with additional categories of information – overlapping age of features, evidence for correlation, distance and timing of offset per original author, and faults offset per original author– see Burnham (2006b).

for miscellaneous assistance through the years, and for kindly thinking to send to me his hot-off-the-press publications pertaining to my own work. All sedimentary tectonicists and tectonic sedimentologists follow in his giant pioneering footsteps.

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