TABLE 2-1

SOURCE MODEL PARAMETERS

SONGS Seismic Study

Model 1-Strike Slip Model

In this model, the Oceanside detachment is not considered to be an active seismogenic source. The characterization of the NI-SCOZD-RC as a strike-slip fault system follows the IPEEE source characterization (Risk Engineering , 1995, Appendix A). The San Joaquin Hills Blind fault is included as a potential seismogenic fault source with a probability of activity (P_A) of 0.5. Thrust faults west of the SCZOD are interpreted to be non-seismogenic because they are linked with the strike-slip fault at depth (i.e., local strain partitioning) or they do not extend to seismogenic depth.

Fault Name [Model (Weight)]	Total Length (km)	Rupture Length (km)	Depth (km)	Downdip Geometry	Slip Rate (mm/yr)
Newport-Inglewood-Offshore Zone of Deformation (NI/SCOZD) [IPEEE Model A (0.50]	148	32 (0.3) 43 (0.4) 75 (0.2) 116 (0.1)	12 (0.6) 15 (0.4)	90°	0.8 (0.2) 1.5 (0.6) 2.1 (0.2)
Rose Canyon (RC) [IPEEE Model A (0.50]	52	18 (0.2) 34 (0.5) 52 (0.3)	10 (0.6) 15 (0.4)	90°	1.0 (0.2) 1.5 (0.6) 3.0 (0.2)
Newport-Inglewood (NI) [IPEEE Model B (0.5)]	70	30 (0.4) 40 (0.5) 70 (0.1)	12 (0.6) 15 (0.4)	90°	0.1 (0.3) 0.8 (0.5) 1.5 (0.2)
Offshore Zone of Deformation-Rose Canyon (RC/SCOZD) [IPEEE Model B (0.5)]	115	32 (0.3) 43 (0.4) 52 (0.1) 75 (0.1) 115 (0.1)	10 (0.6) 15 (0.4)	90°	1.0 (0.2) 1.5 (0.6) 2.1 (0.1) 3.0 (0.1)
San Joaquin Hills Blind Fault (SJBF) [P_A = 0.5]	37	25 (0.7) 37 (0.3)	Top 1 (1.0) Bottom intersection with NI	30°W (0.3) 40°W (0.4) 50°W (0.3)	Based on fault dip and corrected uplift rate[1] (minus regional component) of 0.11 (0.2) 0.15 (0.6) 0.17 (0.2)

1 The corrected uplift rate equals the late Pleistocene uplift rate of (0.21-0.27 m/kyr) based on uplifted marine terraces in the San Joaquin Hills minus a regional background rate (0.1 m/kyr) that may be due to other processes (e.g., rift shoulder thermal isostasy)

TABLE 2-1

SOURCE MODEL PARAMETERS

SONGS Seismic Study

Model 2- Independent OBT and Strike Slip Faults

In this model, the Oceanside blind thrust (OBT) is considered to be an active seismogenic source. Two alternatives are considered, depending on whether or not the San Joaquin Hills blind fault (SJBF) is linked (i.e., is a backthrust) to the OBT. If the SJBF is modeled as a backthrust forming a wedge structure with the OBT (i.e., linked), it is not considered as an independent seismic source because it intersects the OBT at a depth of 5 km (i.e., does not extend to seismogenic depth). In this case the OBT is extended north to Newport Beach (OBT-long) resulting in a shorter NI (NI-short). When the SJHBF is not linked with the OBT, the NI is extended to south of Dana Point (NI-long) and the SJBF is considered an independent seismogenic source (P_A = 0.5) that is bounded on the west by the NI. The RC is modeled as a strike-slip fault following the characterization presented in Risk Engineering (1995, Appendix A).

Fault Name [Model (Weight)]	**Total Length (km)**	**Rupture Length (km)**	**Depth (km)**	**Downdip Geometry**	**Slip Rate (mm/yr)**
Oceanside Blind Thrust (OBT)	See Logic Tree (Figure 2-19)				
Newport-Inglewood Onshore (NI)	65 (0.2) NI (Short) 97 (0.8) NI (Long)	NI(Short) 30 (0.4) 40 (0.5) 65 (0.1) NI (Long) 30 (0.3) 40 (0.5) 65 (0.1) 97 (0.1)	12 (0.6) 15 (0.4)	90°	0.1 (0.3) 0.8 (0.5) 1.5 (0.2)
Rose Canyon (RC)	52	18 (0.2) 34 (0.5) 52 (0.3)	10 (0.6) 15 (0.4)	90°	1.0 (0.2) 1.5 (0.6) 3.0 (0.2)

TABLE 2-1

SOURCE MODEL PARAMETERS
SONGS Seismic Study

Model 3-OBT Oblique

In this model, the OBT and SCOZD-RC represent strain partitioning in the upper crust above an oblique fault plane (OBT-OBL) at depth (Alternative D, Rivero and others, 2000). The NI is modeled as an independent strike-slip fault. A simplified fault plane based on the location and dip of the northern segment of the Oceanside blind thrust as provided by Rivero (written communication, October 3, 2001) is used to model the fault source in the vicinity of SONGS. Following Rivero and others (2000) a maximum magnitude of M_W=7.6 is used. In addition to the range of slip rate values (1.19 to 2.91) given by Rivero and others (2000) an intermediate slip rate value of 1.7 mm/yr with a rake angle of 22° (calculated from the weighted average strike-slip and contractional rates) is used.

Fault Name [Model (Weight)]	Total Length (km)	Rupture Length (km)	Depth (km)	Downdip Geometry	Slip Rate (mm/yr)
Newport-Inglewood (NI) [IPEEE Model B (0.5)]	70	30 (0.4) 40 (0.5) 70 (0.1)	12 (0.6) 15 (0.4)	90°	0.1 (0.3) 0.8 (0.5) 1.5 (0.2)
Oceanside Blind Oblique OBT (OBL) (Maximum magnitude M_W=7.6)	117	N/A	Tip 2.8 km Base 17 km	14°	1.19 [0.2] 1.7 [0.6] 2.91 [0.2]

TABLE 3-1 SELECTION OF SCIGN GPS STATIONS

Station	Installation Date	Considerations	Used in Evaluation
cat1	6/25/95	Stable displacement rate values, long duration, a good candidate for the offshore reference site for OBT	Yes
cat2	6/14/00	Moving east wrt cat 1, short duration	No
corx	11/15/00	Too far south, missing data for a period of time	No
ecfs	7/12/01	Recent station	No
fvpk	7/30/98	Seasonal fluctuation due to ground water pumping, ground water basin edge effect	No
lbc1	8/25/98	Too far north, pronounced seasonal fluctuation	No
lbc2	8/25/98	Too far north, possible fluctuation (Long Beach area)	No
mjpk	7/12/01	Recent station	No
monp	4/1/94	"Behind" OBT, and west of Elsinore, long duration	Yes
nsss	7/6/00	"Behind" OBT, somewhat short duration, a possible southernmost choice	Yes
oghs	6/2/99	"Behind" OBT, and west of Elsinore, somewhat short duration	Yes
sacy	5/26/99	Too north, seasonal fluctuation, and gaps	No
sbcc	11/8/99	Relatively short duration, gap between 2000.1 & 2001.8	No
scip	9/23/97	West of San Clemente, gap after 2000	No
scms	8/11/98	Gap before 1999.5, slight seasonal fluctuation	No
sio3	3/18/93	Seasonal fluctuation, gap	No
trak	6/2/94	Long duration, the northernmost station of interest	Yes
vtis	10/24/98	Too far north, gap before 2000	No

Note: It is desirable to choose GPS stations with long recording duration, no fluctuation, no gaps, behind OBT, not separated with too many faults, and within the area of interest.

TABLE 4-1
Mean Horizontal Ground Motions (g) at Various Probabilities of Exceedance
SONGS IPEEE

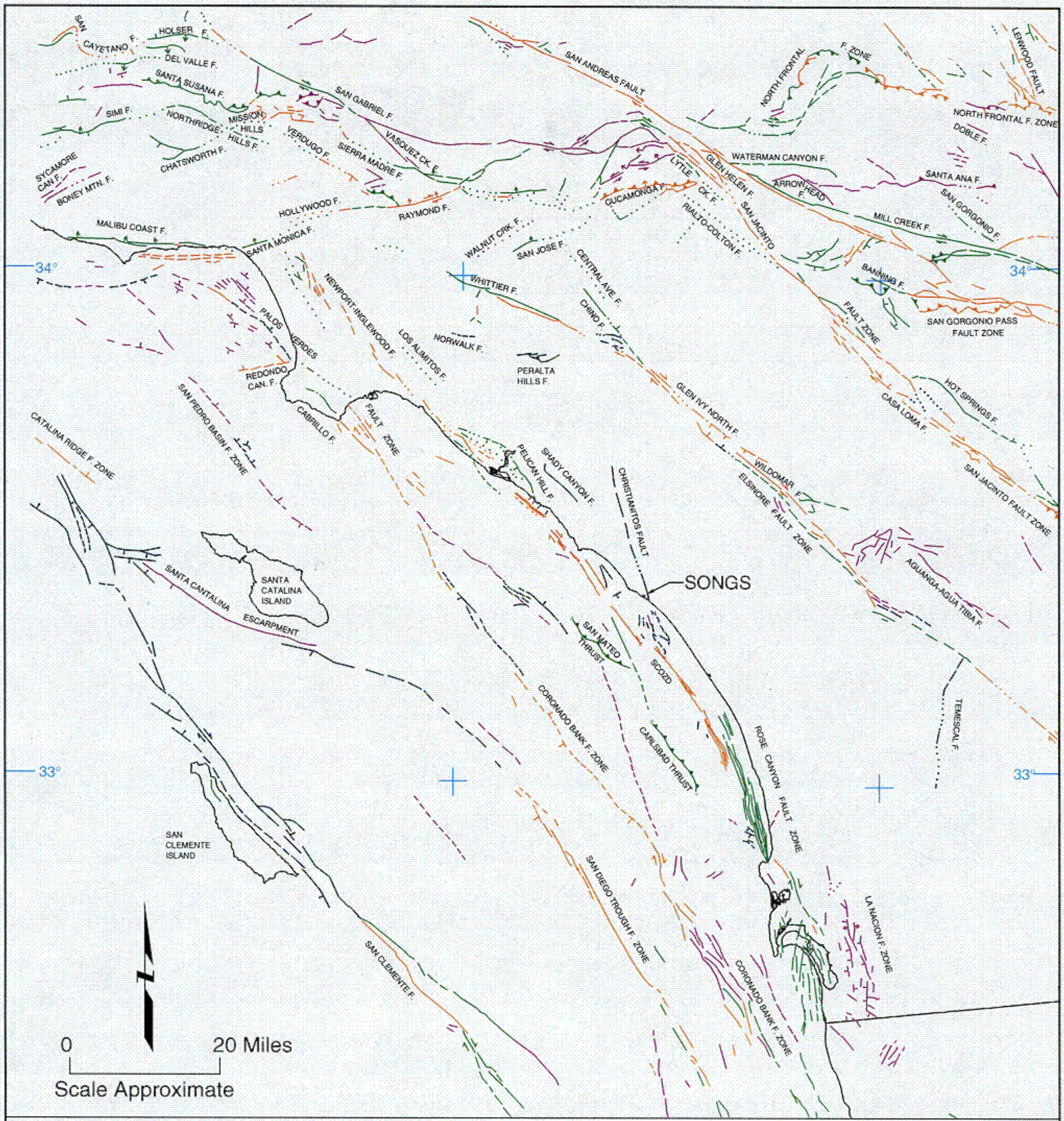
Probability	Spectral Acceleration - g						
	25Hz	**10Hz**	**5Hz**	**2.5Hz**	**1Hz**	**0.5Hz**	**Weighted***
1.00E-08	2.712	5.315	6.962	6.816	4.938	2.109	6.302
1.72E-06	1.516	2.813	3.972	3.461	2.060	1.128	3.290
1.00E-05	1.198	2.157	3.044	2.714	1.550	0.858	2.537
2.00E-05	1.071	1.919	2.696	2.443	1.376	0.758	2.262
1.00E-04	0.795	1.402	1.964	1.799	1.007	0.543	1.656
1.39E-04	0.735	1.301	1.810	1.673	0.934	0.504	1.534
2.00E-04	0.674	1.195	1.652	1.542	0.857	0.458	1.407
1.00E-03	0.423	0.729	1.029	0.985	0.544	0.283	0.884
2.00E-03	0.334	0.552	0.783	0.755	0.423	0.221	0.675
6.00E-03	0.197	0.323	0.462	0.454	0.261	0.136	0.403
1.00E-02	0.154	0.248	0.355	0.350	0.203	0.106	0.310

Note: * Weighted spectral acceleration is computed as follows:
Weighted $Sa=(1/2\ Sa_{10Hz}+Sa_{5Hz}+Sa_{2.5Hz}+1/2\ Sa_{1Hz})/3$
where, Sa_{xHz} is the spectral acceleration for x Hz.

TABLE 4-2
Mean Horizontal Ground Motions (g) at Various Probabilities of Exceedance
2001

Probability	Spectral Acceleration - g																				
	25Hz			10Hz			5Hz			2.5Hz			1Hz			0.5Hz			Weighted*		
		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling		w/ Dir.	w/ Dir. & Fling
1.00E-08	3.029	3.029	3.029	4.517	4.517	4.517	5.785	5.785	5.785	7.918	7.918	7.918	5.784	6.048	6.115	2.683	3.600	3.672	6.285	6.329	6.340
4.70E-06	1.605	1.605	1.605	2.413	2.413	2.413	3.263	3.263	3.263	3.575	3.575	3.575	2.467	2.508	2.536	1.311	1.509	1.542	3.093	3.100	3.104
1.00E-05	1.409	1.409	1.409	2.159	2.159	2.159	2.926	2.926	2.926	3.122	3.122	3.122	2.164	2.198	2.222	1.134	1.288	1.314	2.737	2.742	2.746
2.00E-05	1.245	1.245	1.245	1.927	1.927	1.927	2.599	2.599	2.599	2.723	2.723	2.723	1.885	1.915	1.936	0.976	1.085	1.107	2.409	2.414	2.418
1.00E-04	0.886	0.886	0.886	1.404	1.404	1.404	1.873	1.873	1.873	1.874	1.874	1.874	1.238	1.258	1.272	0.669	0.722	0.756	1.689	1.693	1.695
1.74E-04	0.777	0.777	0.777	1.234	1.234	1.234	1.624	1.624	1.624	1.590	1.590	1.590	1.015	1.032	1.043	0.563	0.606	0.645	1.446	1.449	1.451
2.00E-04	0.749	0.749	0.749	1.191	1.191	1.191	1.562	1.562	1.562	1.519	1.519	1.519	0.974	0.984	0.995	0.536	0.576	0.606	1.387	1.389	1.391
1.00E-03	0.453	0.453	0.453	0.744	0.744	0.744	0.949	0.949	0.949	0.894	0.894	0.894	0.559	0.566	0.572	0.359	0.371	0.406	0.831	0.833	0.834
2.00E-03	0.361	0.361	0.361	0.564	0.564	0.564	0.751	0.751	0.751	0.695	0.695	0.695	0.445	0.447	0.452	0.290	0.299	0.328	0.650	0.651	0.651
6.00E-03	0.214	0.214	0.214	0.399	0.399	0.399	0.472	0.472	0.472	0.447	0.447	0.447	0.314	0.315	0.318	0.181	0.185	0.205	0.425	0.425	0.426
1.00E-02	0.174	0.174	0.174	0.339	0.339	0.339	0.407	0.407	0.407	0.381	0.381	0.381	0.253	0.254	0.257	0.130	0.132	0.147	0.361	0.361	0.362

Note: * Weighted spectral acceleration is computed as follows:
Weighted $Sa=(1/2\ Sa_{10Hz}+Sa_{5Hz}+Sa_{2.5Hz}+1/2\ Sa_{1Hz})/3$
where, Sa_{xHz} is the spectral acceleration for x Hz.



FAULT RECENCY CLASSIFICATION

- Faults that displace Holocene (~ 10 ka) or latest Pleistocene (~ 20 ka) deposits or geomorphic surfaces
- Faults that displace late Quaternary (~ 780 ka) deposits or geomorphic surfaces
- Quaternary faults (1.8 Ma)
- Faults that displace pre-Quaternary deposits. Receny of last displacement for offshore faults generally not known. Only selected faults from Jennings (1992) are shown.

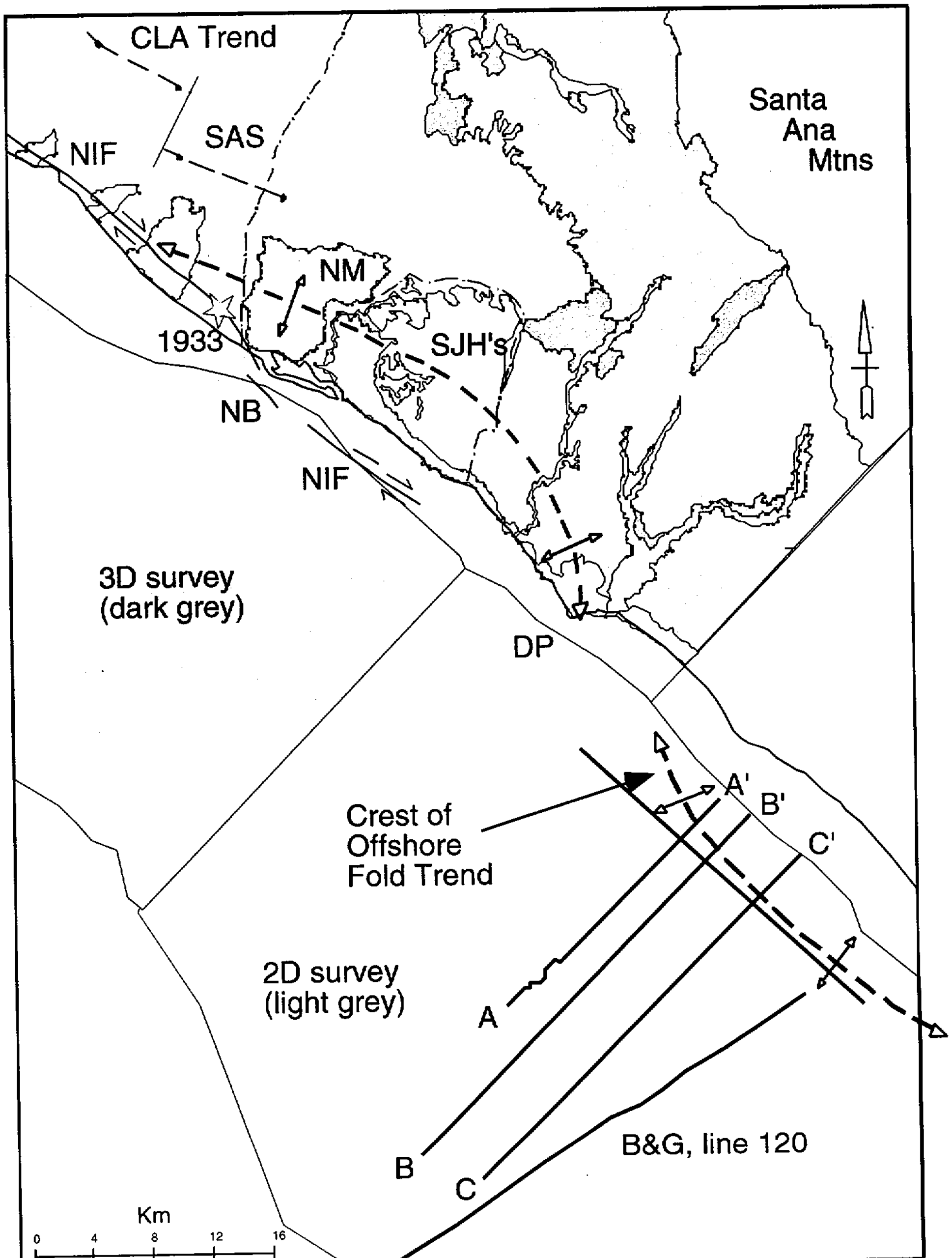
From Risk Engineering (1995): Sources of data include Fischer and Mills (1991), Jennings (1992), and Legg and Kennedy (1991).

QUATERNARY FAULT MAP, SOUTHERN CALIFORNIA
SONGS Seismic Issues

Figure
2-1

S:\5300\5388\001\task_04\ssc_0110_fig_2-01.ai

C01



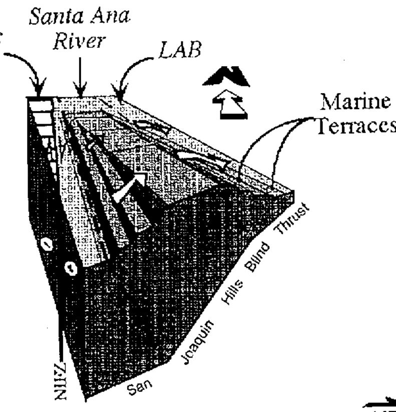
CLA - Compton-Los Alamitos trend; SAS - Santa Ana segment; NIF - Newport-Inglewood Fault; NM - Newport Mesa; SJH - San Joaquin Hills; NB - Newport Beach; DP - Dana Point; B&G - Bohannon and Geist line 120; A-A', B-B', C-C'; selected profiles from Harvard dataset. Profile C-C' shown as Figure 3C. (From Mueller and others, 1998b)

MAP OF SIMPLIFIED ONSHORE GEOLOGY OF ORANGE COUNTY SHOWING LOCATIONS OF SAN JOAQUIN HILLS AND OFFSHORE FOLD AXES
SONGS Seismic Issues

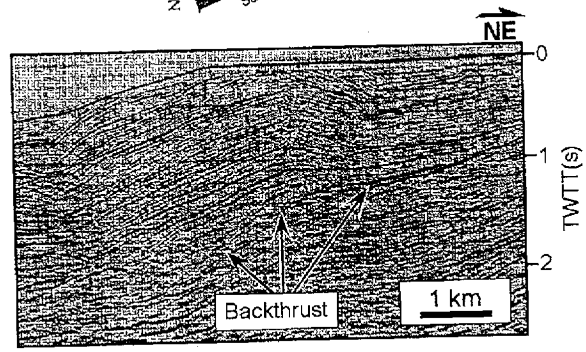
Figure
2-2

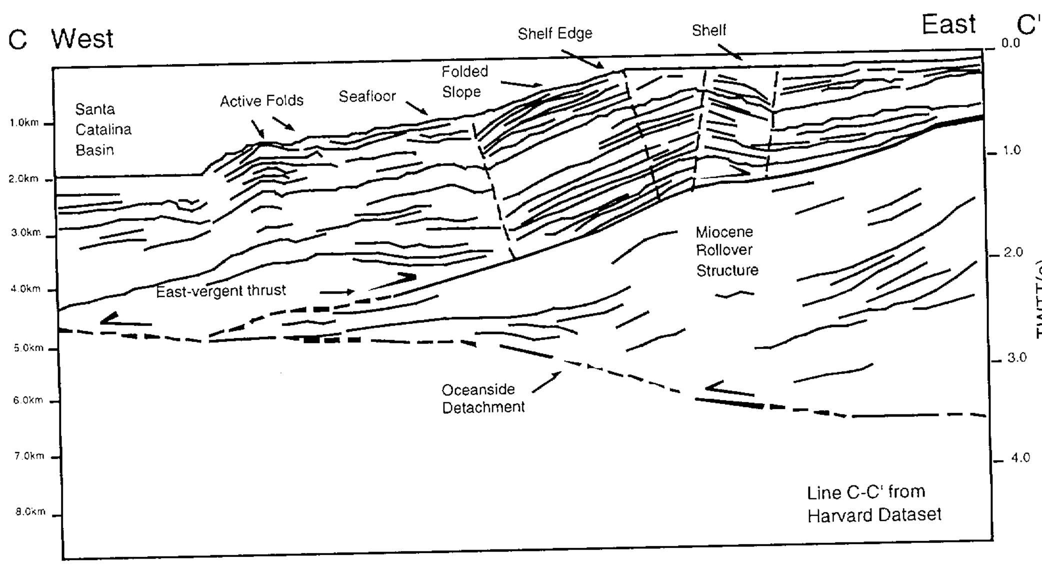
S:\5300\5388\001\task_04\ssc_0110_fig_2-2.ai

A. Kinematic model of blind thrust faulting and terrace uplift beneath San Joaquin Hills (Grant et al., 1999). (From Rivero and others, 2000.) LAB - Los Angeles basin; NIFZ - Newport-Inglewood fault zone.



B. Migrated seismic reflection profile imaging offshore extension of this fold system, which has developed above west-dipping back-thrust. TWTT - two-way traveltime; s - seconds. (From Rivero and others, 2000.)



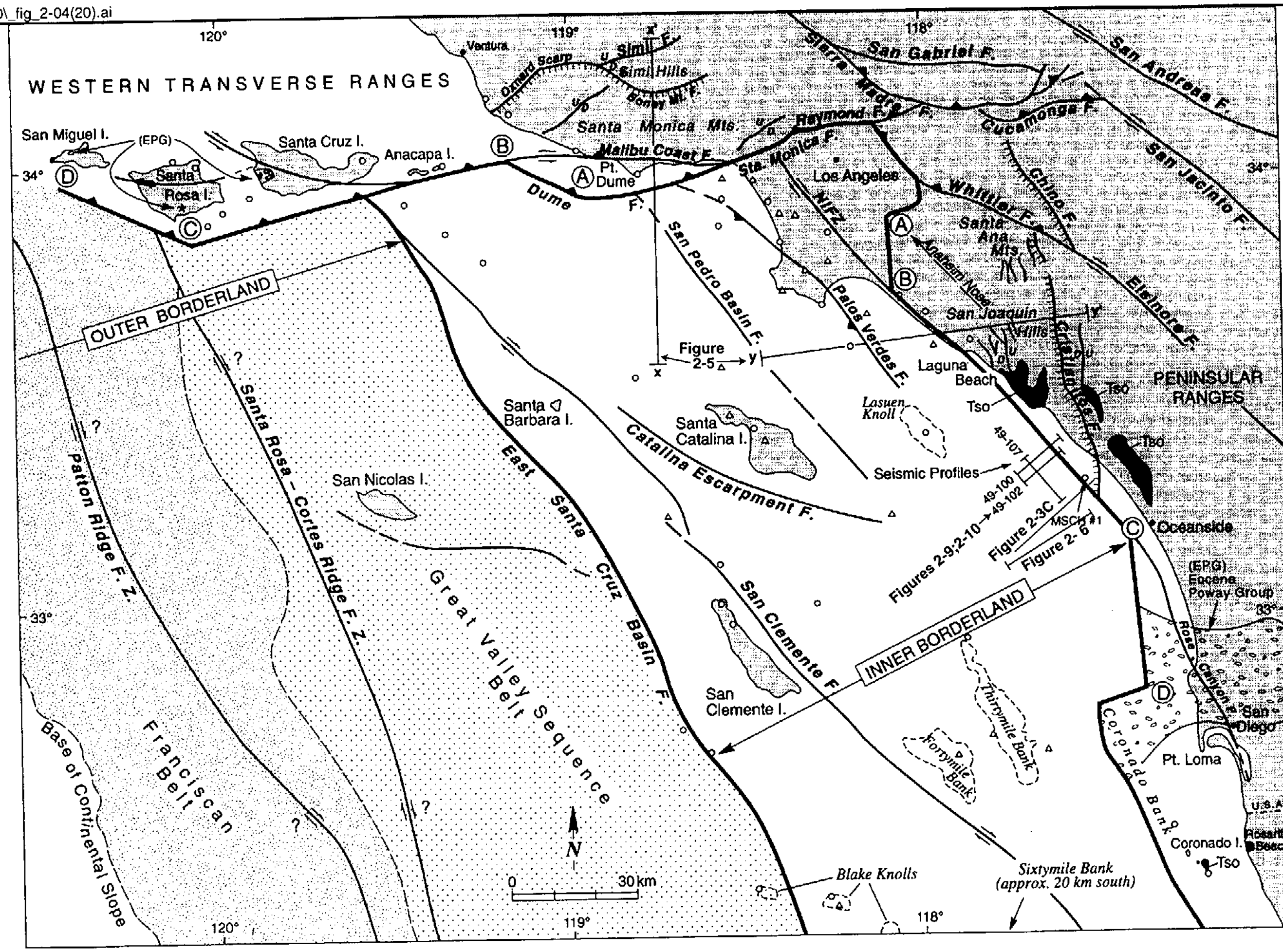


C. Interpreted seismic line C-C' from Harvard dataset. Note the Oceanside detachment and the blind thrust in its hanging wall which we interpret to be related to the southern extension of the San Joaquin Hills anticline. These form a wedge-thrust structure which is formed by west vergent slip on the detachment. Note the narrow east-facing forelimb formed above the upper blind thrust; underlying reflectors define fold geometry related to rollover on the detachment and compressive fault-related folding. Note also where the continental slope appears folded by the back limb of the upper fold, which we interpet to indicate its currently active nature. Erosion during sea level low stands may have eroded the crest of the fold on the shelf. (From Mueller and others, 1998b)

POSTULATED STRUCTURAL INTERPRETATION OF
SAN JOAQUIN HILLS BLIND THRUST
SONGS Seismic Issues

Figure
2-3

S:\5300\5388\001\task_04\ssc_0110_fig_2-04(20).ai

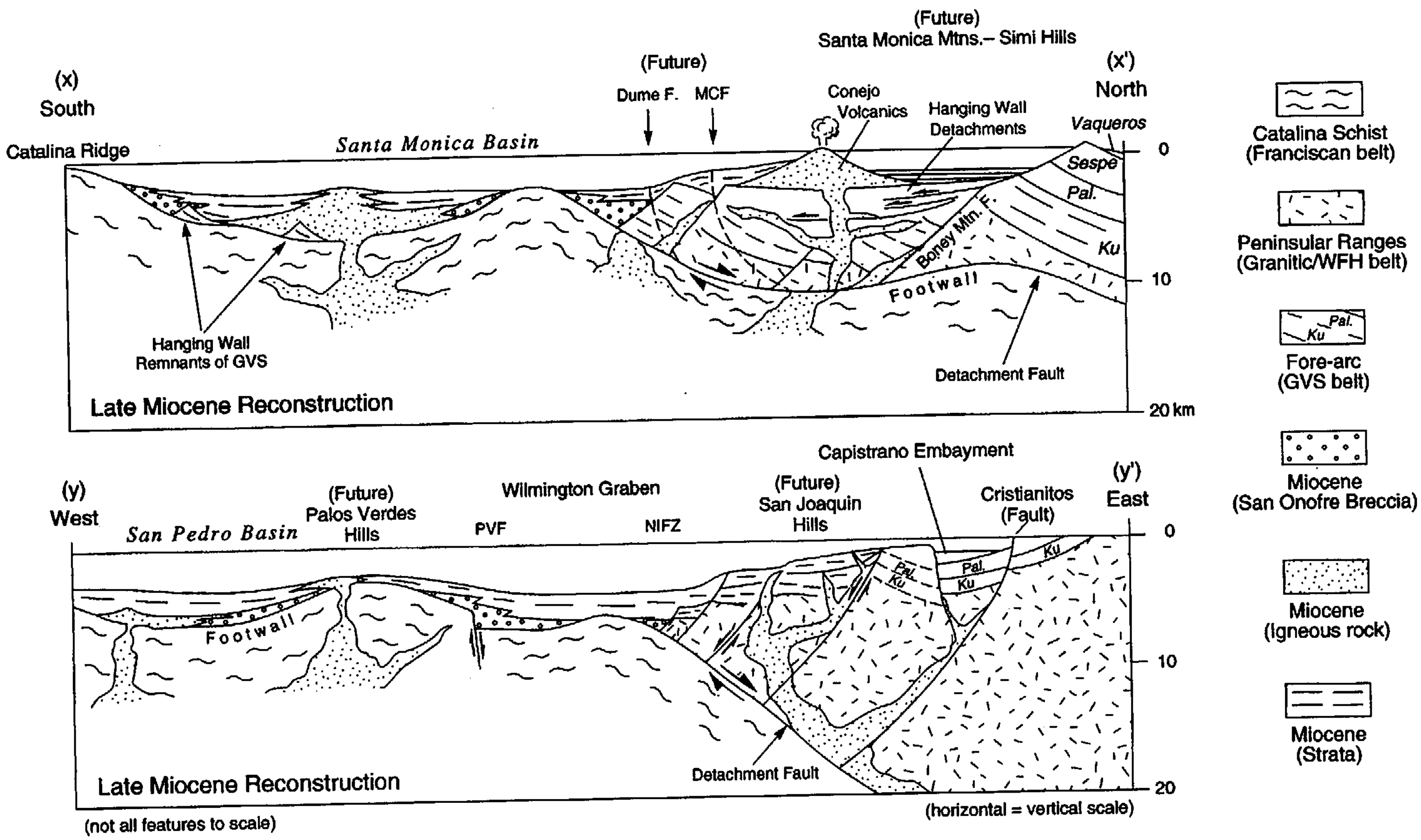


Fault and geographic map of onshore and offshore southern California showing detailed location of inferred LAB-IB rift boundaries (heavy lines), principal onshore late Cenozoic hanging-wall listric normal faults along margins of rift (thin hachured lines), locations of known and inferred surface and subsurface occurrences of Miocene San Onofre Breccia (small open circles), Catalina Schist basement (open triangles), and major San Onofre Breccia outcrops (blackened Tso); adapted from Vedder and Howell (1976) and Stuart (1979a, 1979b). Teeth on selected faults indicate sense of Pliocene and younger shortening. A, B, C, and D on rift boundary indicate inferred join points for rift restoration. MSCH No. 1 - Mobil San Clemente Core Hole No. 1; EPG - Eocene Poway Group. (Modified from Crouch and Suppe, 1993)

MAP SHOWING LOCATION OF CROSS SECTIONS AND SEISMIC PROFILES
SONGS Seismic Issues

Figure
2-4

S:\5300\5388\001\task_04\ssc_0110_fig_2-05(11).ai



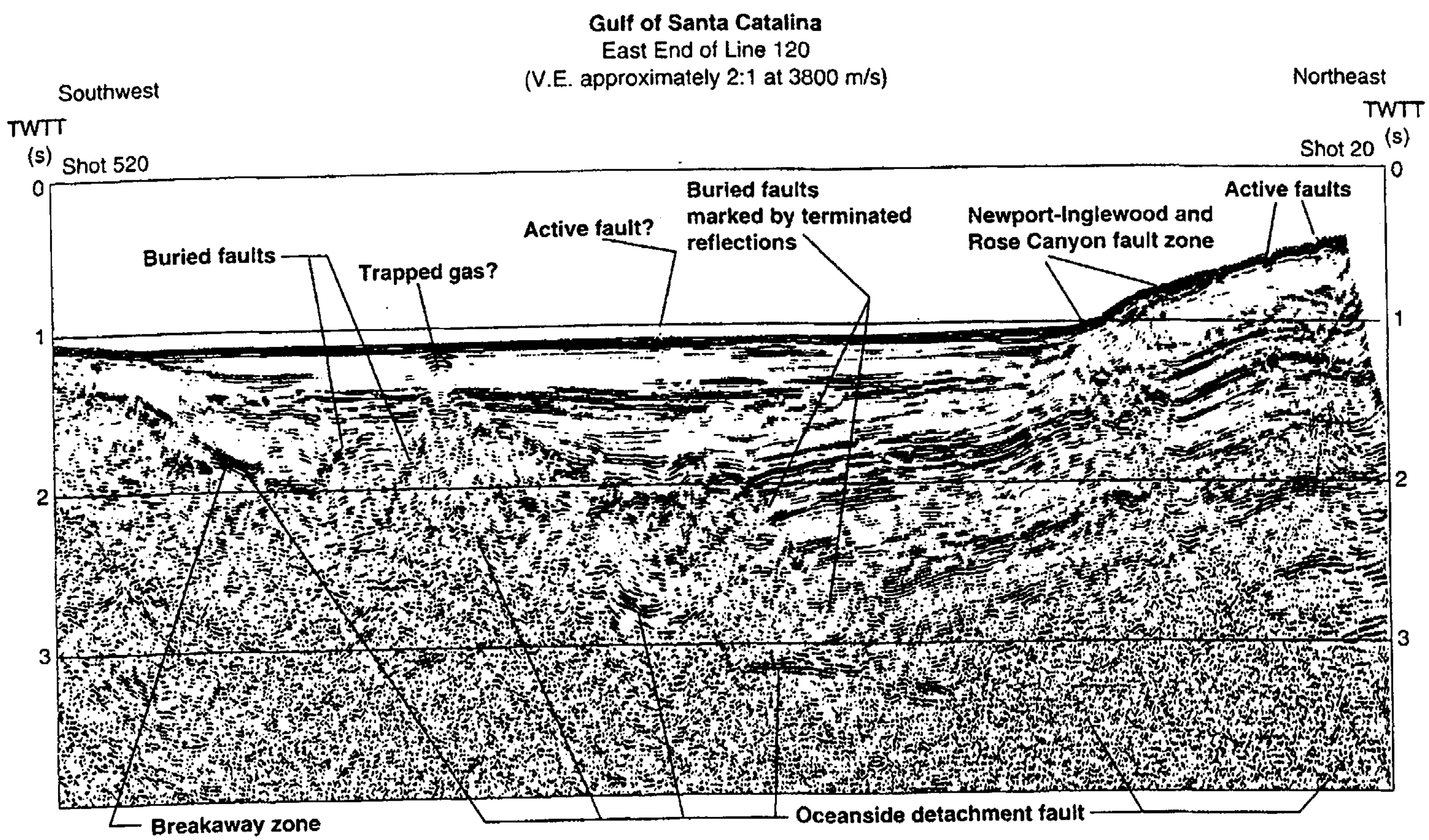
(See Figure 2-4 for locations)

Note high-angle normal and low-angle detachment faults in hanging wall, Catalina Schist metamorphic core in footwall, and extrusion and intrusion of Miocene volcanic and igneous rocks; structure inferred at about early-late Miocene (lower Mohnian) time. North-south section through Simi Hills-Santa Monica Mountains and east-west section through San Joaquin Hills (modified, in part, from Campbell and Yerkes, 1976; Yeats, 1987). MCF - Malibu Coast fault; PVF - Palos Verdes fault; NIFZ - Newport-Inglewood fault zone; WFH - Western Foothills belt; Ku - Upper Cretaceous strata; Pal - Paleogene strata; GVS - Great Valley strata. (From Crouch and Suppe, 1993.)

GENERALIZED SCHEMATIC SECTIONS ILLUSTRATING THE SUGGESTED STYLE OF CRUSTAL EXTENSIONS WITHIN THE LAB-LB RIFT
SONGS Seismic Issues

Figure
2-5

S:\5300\5388\001\task_04\ssc_0110_fig_06(12).ai

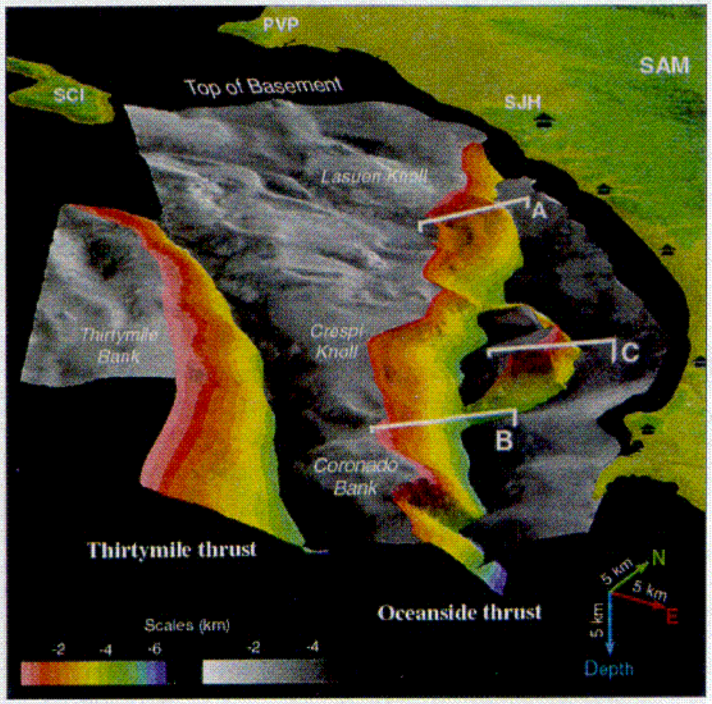


From Bohannon and Geist (1998)
(See Figure 2-4 for location.)

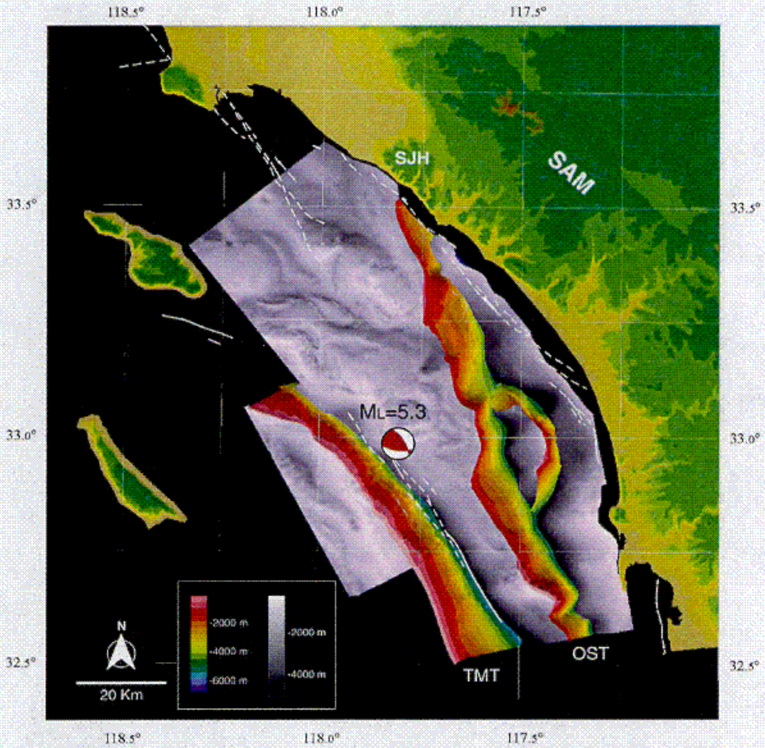
DETAILED PART OF EAST END OF LINE 120 (MIGRATED SECTION) SHOWING OCEANSIDE DETACHMENT
SONGS Seismic Issues

Figure
2-6

S:\5300\5388\001\task_04\ssc_0110_fig_2-07(04).ai



A. Perspective view of three-dimensional model of Oceanside and Thirtymile Bank blind thrusts. Gray surface is top of basement (Catalina Schist). Small triangles indicate areas of recent uplift (Lajoie et al., 1979, 1992; Barrie and Gath 1992; Kern and Rockwell, 1992; Grant et al., 1999; Kier and Mueller, 1999). Digital shaded relief map of southern California topography was derived from digital elevation data provided by U.S. Geological Survey. SAM - Santa Ana Mountains; SJH - San Joaquin Hills; PVP - Palos Verdes Peninsula; SCI - Santa Catalina Islands. (From Rivero and others, 2000)



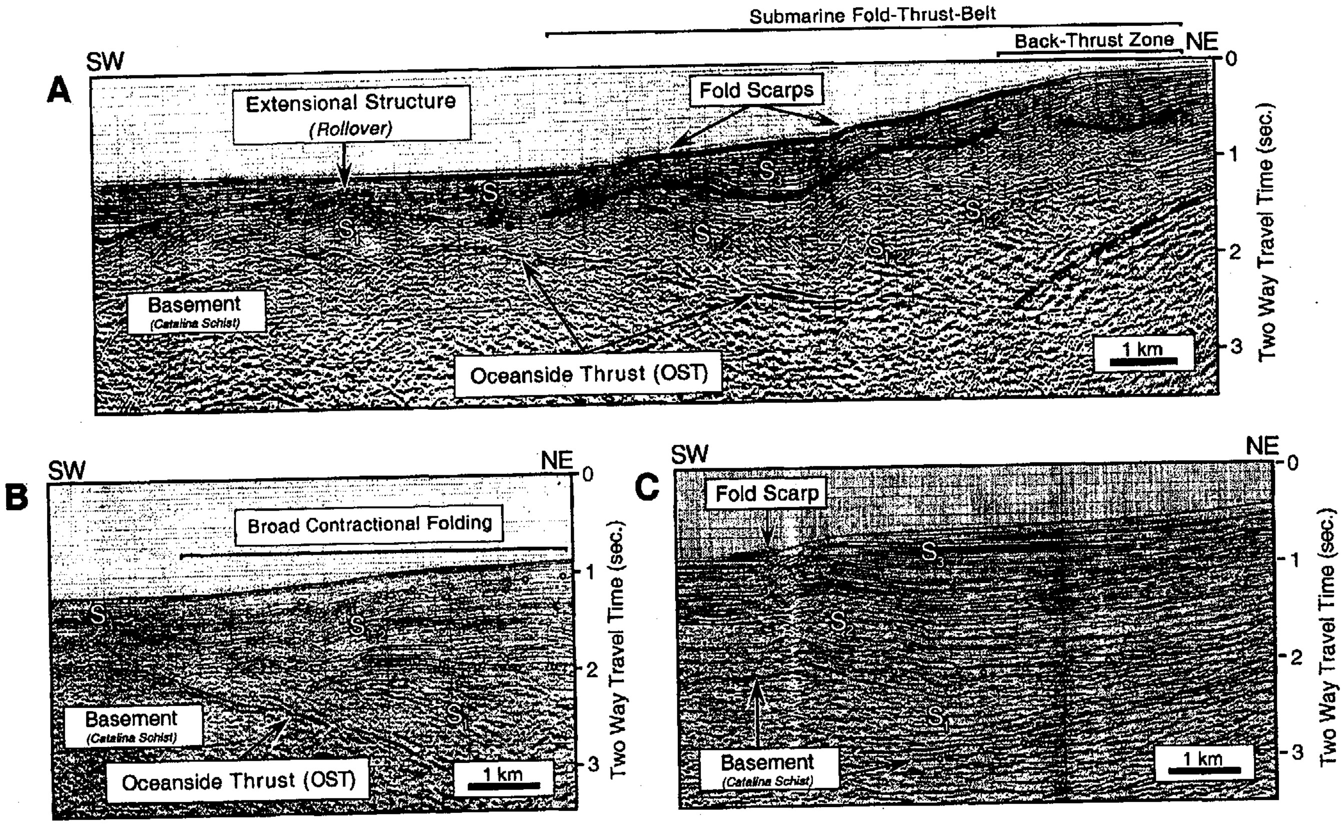
B. Plan view map showing relocated epicenter of 1986 Oceanside earthquake (Asitz and Shearer, 2000). (Map coutesy of Carlos Rivero, 2001)

MAPS SHOWING LOCATIONS OF OCEANSIDE AND THIRTYMILE BANK THRUST FAULTS
SONGS Seismic Issues

Figure
2-7

C02

S:\5300\5388\001\task_04\ssc_0110_fig_2-08(05).ai

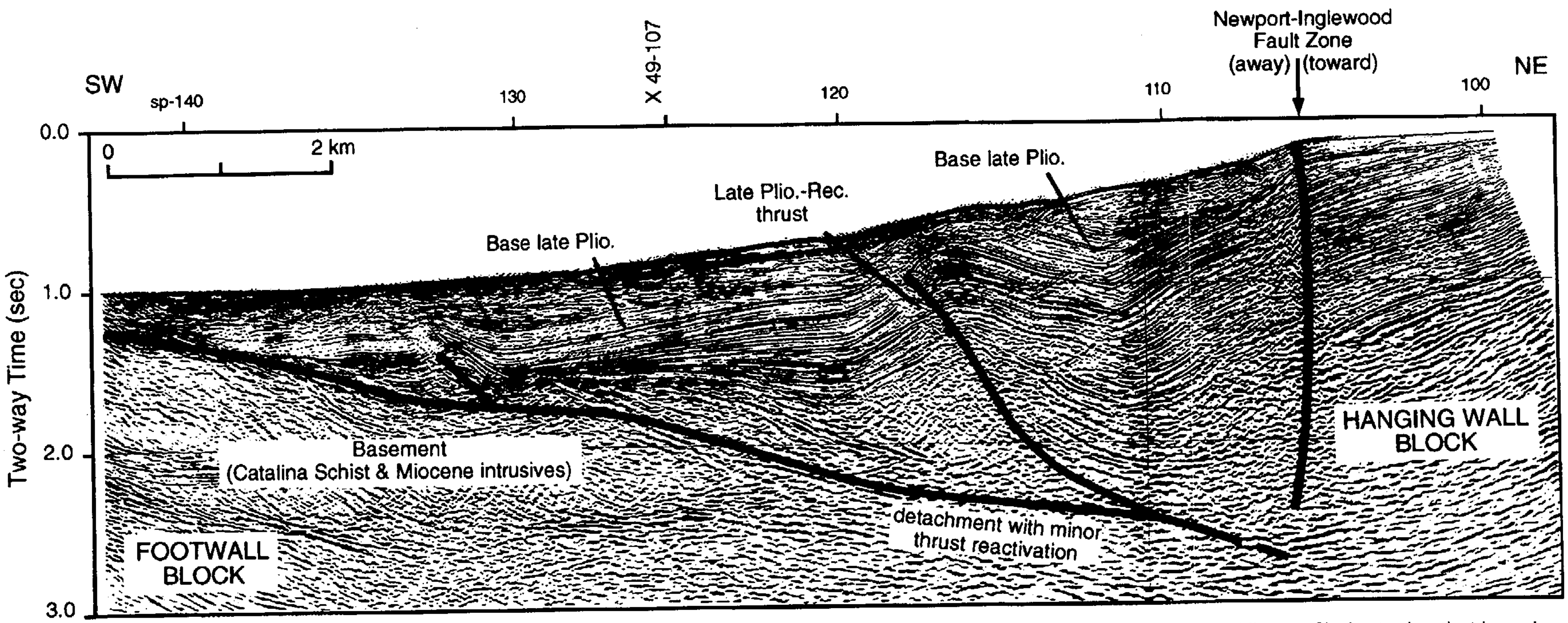


A: Migrated seismic reflection profile imaging segment of thrust south of Lasuen Knoll. Sharp and continuous reflections dipping to east define location of thrust. Note shallow fold-and-thrust belt above Oceanside thrust that produces seafloor fold scarps. This contractional deformation does not affect thrust; thus, we interpret Oceanside as basal thrust of sequence. Note old (Neogene) extensional rollover structure buried by Pliocene and younger strata preserved on west end of section. B: Migrated seismic image of Oceanside thrust northeast of Coronado Banks. Oceanside thrust motion is reflected by broad, contractional fold involving shallow sedimentary units and forming broad seafloor slope. C: Migrated seismic reflection profile across Carlsbad thrust, which resides in hanging wall of Oceanside thrust east of Crespi Knoll. Fault is defined by offset of top basement reflection, and produces contractional fold with pronounced seafloor scarp. Unit S_1 is Miocene and Oligocene(?) synextensional strata. S_1 and S_2 are grouped where undifferentiated. Vertical scale is ~1.1; datum is sea level; s - seconds. Section traces are shown in Figure 2-7A. (From Rivero and others, 2000)

GEOMETRY OF OCEANSIDE THRUST AS IMAGED IN SEISMIC REFLECTION PROFILES
SONGS Seismic Issues

Figure
2-8

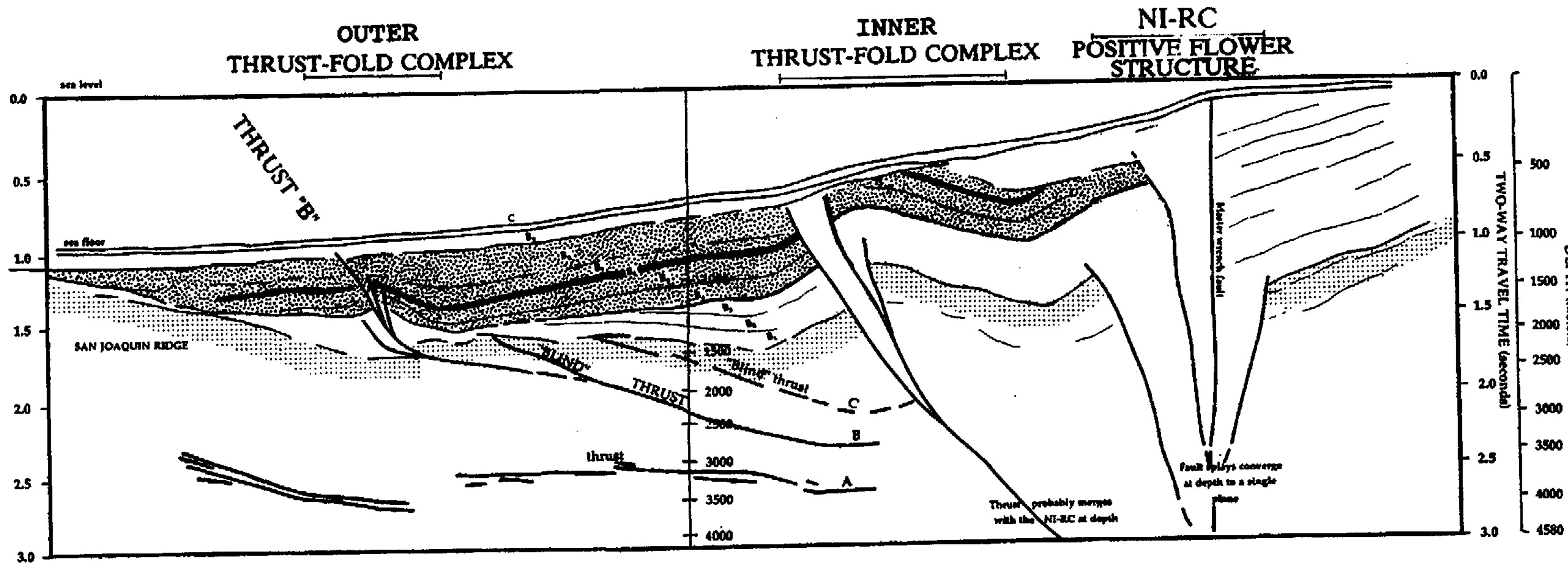
S:\5300\5388\001\task_04\ssc_0110_fig_2-09(06).ai



Migrated CDP seismic reflection 49-102. V.E. = 2.0 at sea floor. Note reactivation of detachment fault by younger (post-early Pliocene?) shortening that has also produced an overlying fold and thrust belt. Also note both eastward and westward thickening of Miocene-Pliocene strata into Newport-Inglewood trough and structural inversion of these strata; see Figure 2-4 for location. (From Crouch and Suppe, 1993)

INTERPRETED SEISMIC LINE 49-102
SONGS Seismic Issues

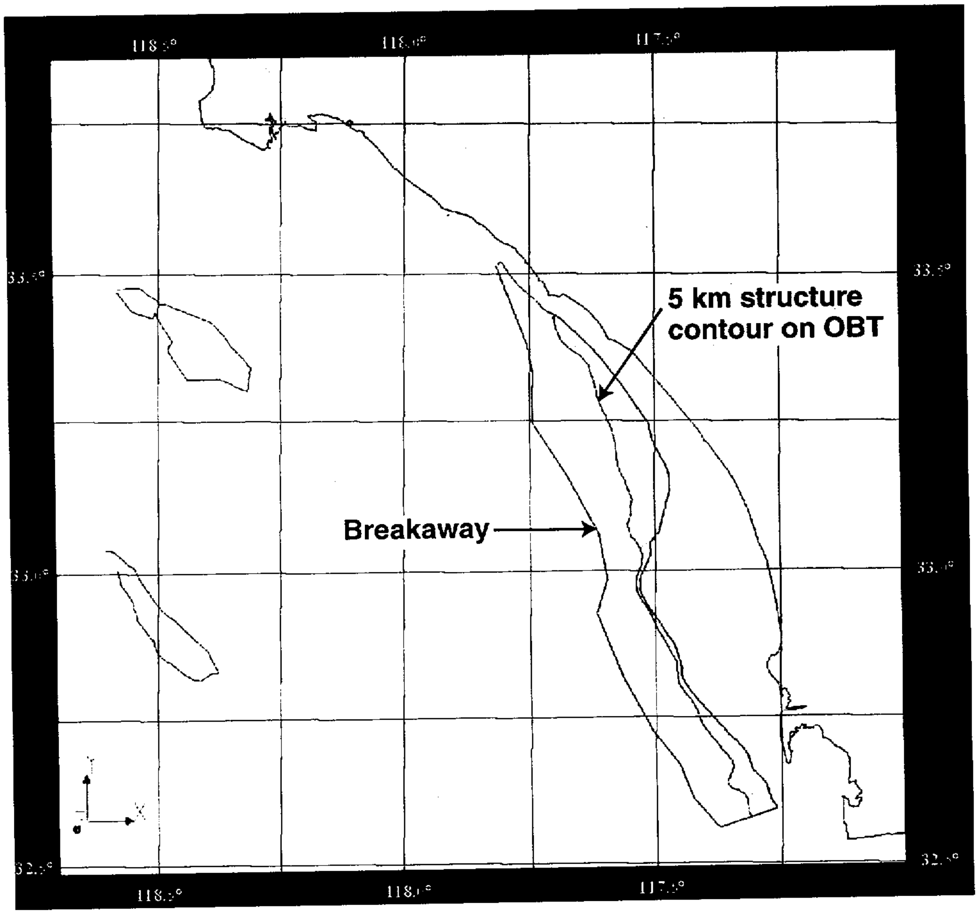
Figure
2-9



(From Fischer and Mills, 1991)

CROSS SECTION ALONG JEBCO LINE 49-102 OFF SAN MATEO POINT
SONGS Seismic Issues

Figure
2-10

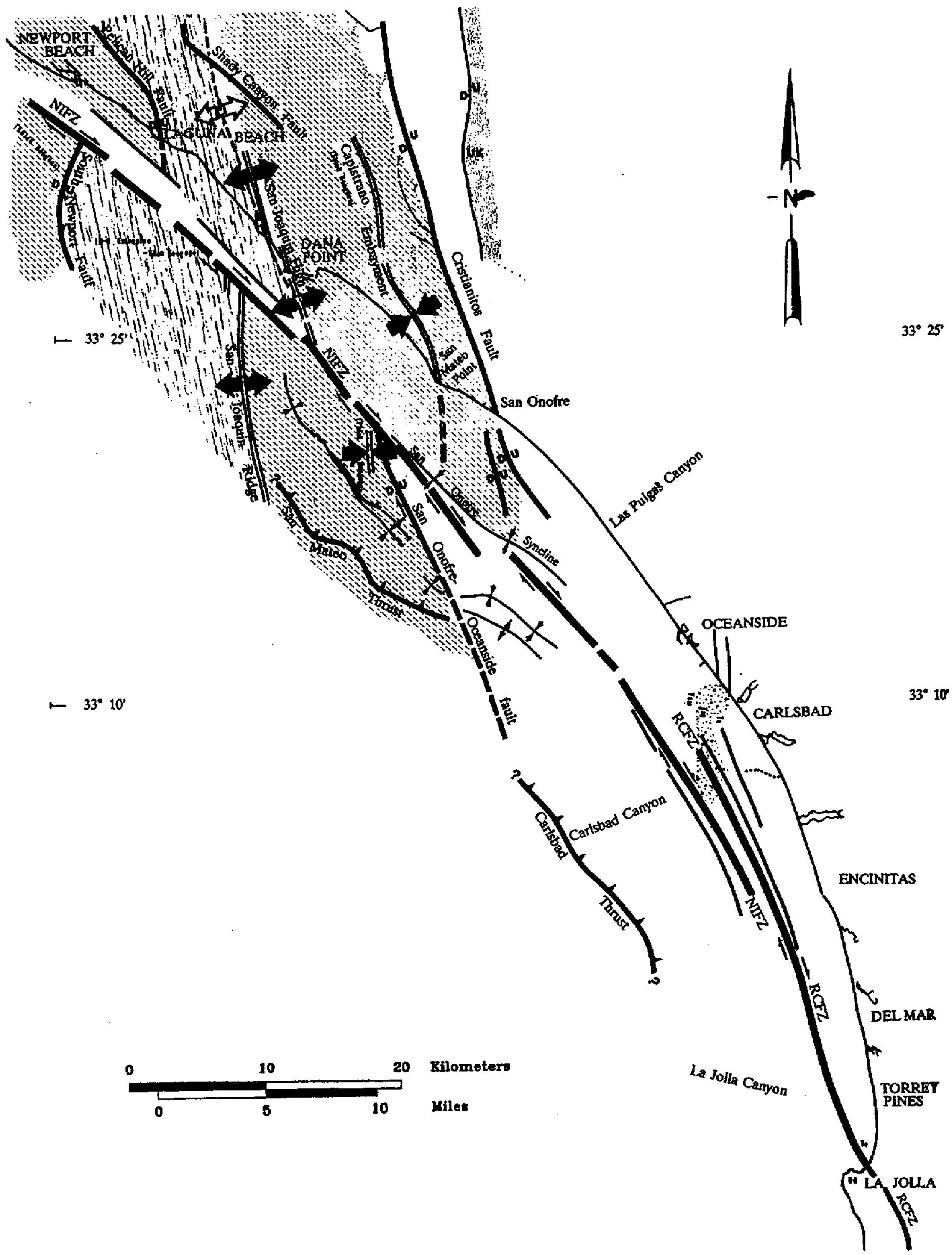


(Map courtesy of Carlos Rivero, October 2001)

LIMITS OF OCEANSIDE DETACHMENT AS IMAGED IN SEISMIC DATA
SONGS Seismic Issues

Figure
2-11

S:\5300\5388\001\task_04\ssc_0110_fig_2-11(18).ai



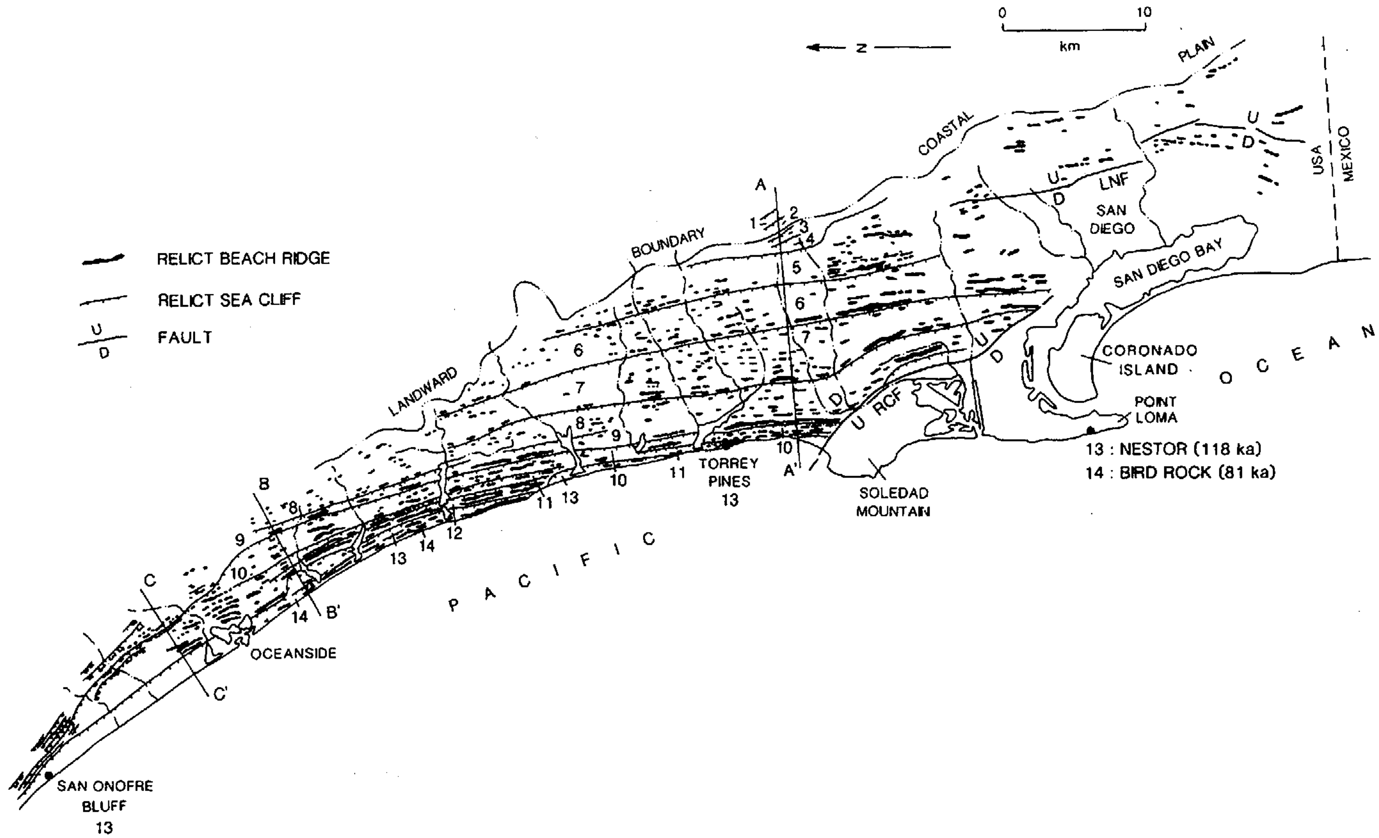
(From Fischer and Mills, 1991)

GEOLOGIC SETTING OF THE INNER MARGIN FROM THE PALOS VERDES PENINSULA TO THE SILVER STRAND
SONGS Seismic Issues

Figure 2-12

S:\5300\5388\001\task_04\ssc_0110_fig_2-12(07).ai

S:\5300\5388\001\task_04\ssc_0110_fig_2-13(19).ai

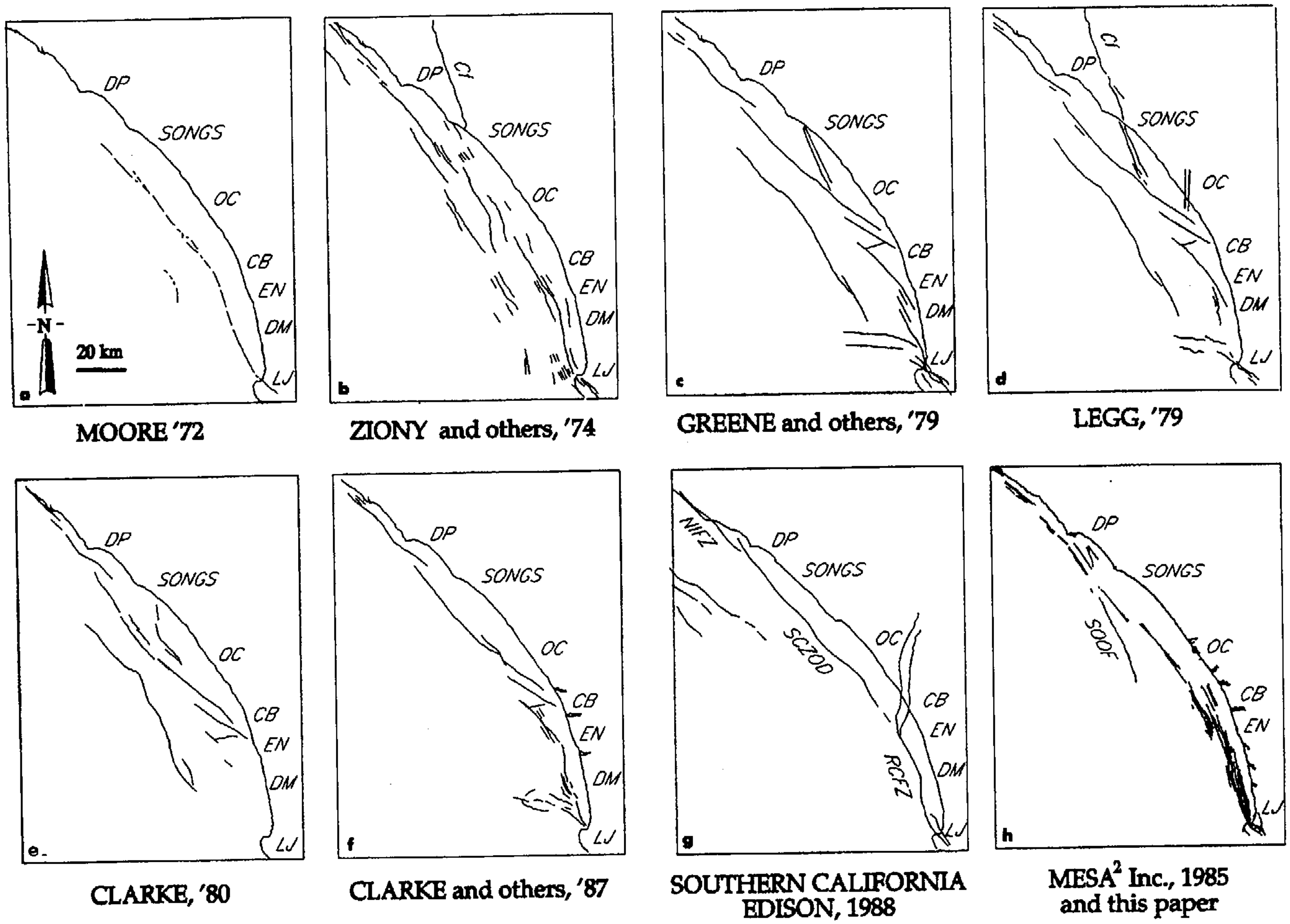


Map showing emergent Pleistocene strandline terraces (from oldest to youngest numbered 1 through 15) and beach ridges in coastal San Diego County. Strandlines 3 through 10 lie on an elevated coastal plain, and strandlines 11 through 14 are cut into the steep escarpment along the seaward edge of the plain. The relict beach ridges are part of the accretionary marine deposits that overlie the terrace platforms. An extrapolated uplift rate of 0.21 m/k.y. derived from strandline 14 at Torrey Pines yields tentative ages of 920 ka and 520 ka respectively. Several of the terraces are offset across the Rose Canyon fault (RCF) and the La Nacion fault (LNF) (Kennedy, 1975; Kennedy and others, 1975). Strandline data northwest of San Onofre from Ehlig (1977). (From Lajoie and others, 1992)

MAP SHOWING MARINE TERRACES IN COASTAL SAN DIEGO COUNTY
SONGS Seismic Issues

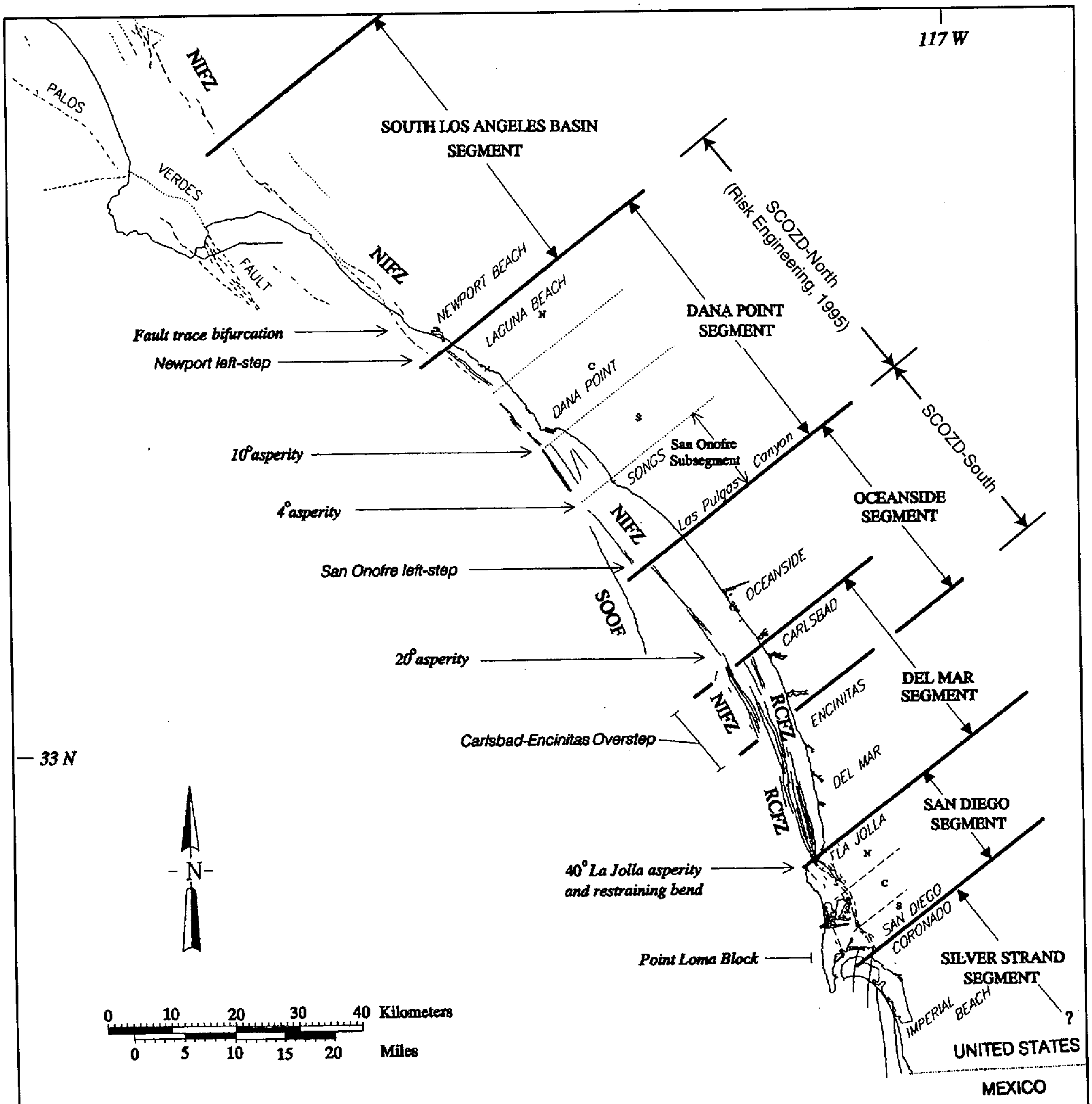
Figure
2-13

S:\5300\5388\001\task_04\ssc_0110_fig_2-14(13).ai



Location abbreviations are as follows: DP - Dana Point; SONGS, San Onofre Nuclear Generating Station; OC - Oceanside; CB - Carlsbad; EN - Encinitas; DM - Del Mar; LJ - La Jolla; CF - Cristianitos fault; NIFZ - Newport-Inglewood Fault Zone; SCZOD - South Coast Zone of Deformation; RCFZ - Rose Canyon Fault Zone; SOOF - San Onofre-Oceanside Fault. (From Fischer and Mills, 1991)

PREVIOUS INTERPRETATIONS OF THE NEWPORT-INGLEWOOD FAULT ZONE FROM 1972 - 1988 SONGS Seismic Issues	Figure **2-14**



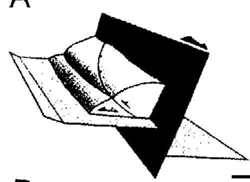
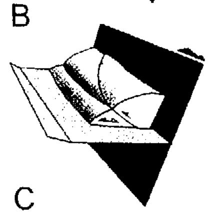
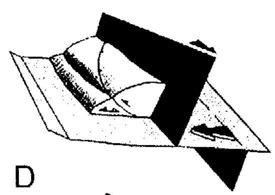
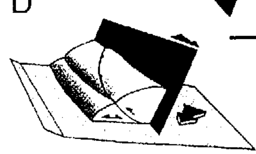
(Modified from Fischer and Mills, 1991)

THE NEWPORT-INGLEWOOD - SCOZD-ROSE CANYON FAULT ZONE, SHOWING MAJOR FAULT SEGMENTS AS CHARACTERIZED IN RISK ENGINEERING (1995)
SONGS Seismic Issues

Figure
2-15

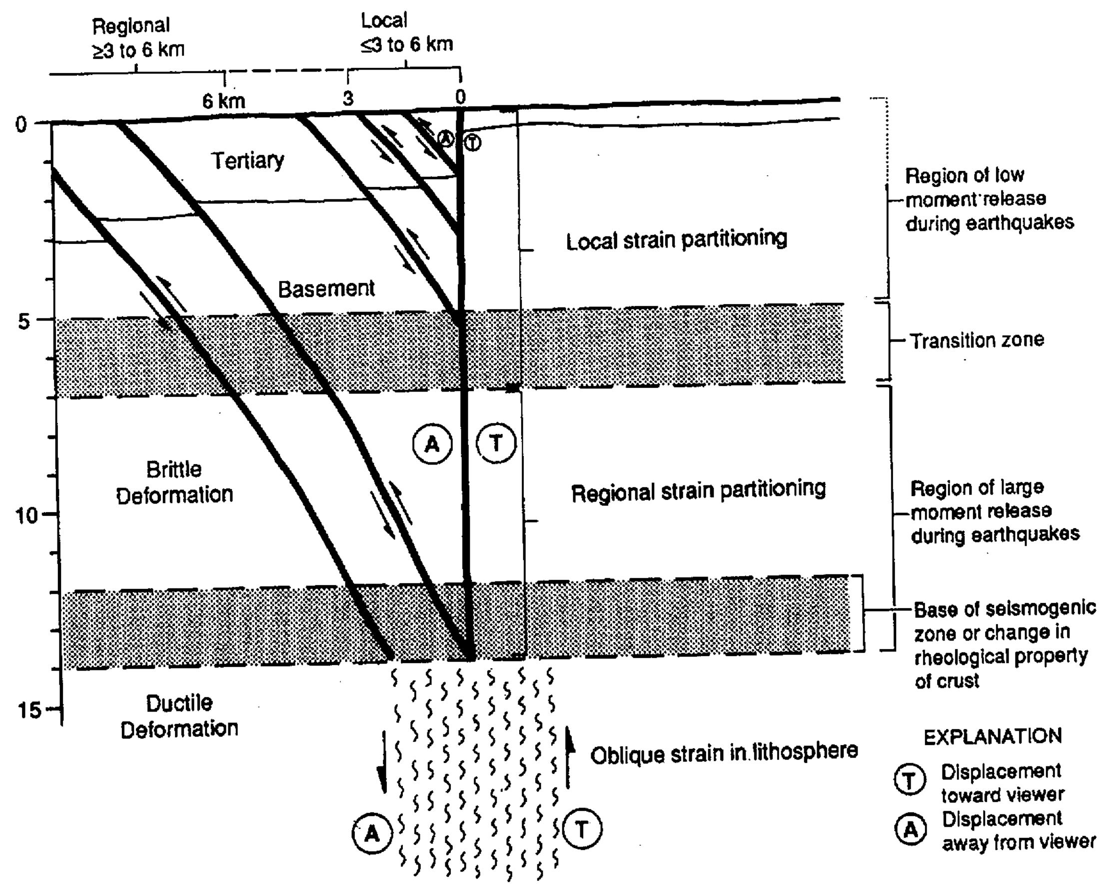
S:\5300\5388\001\task_04\ssc_0110_fig_2-15(14).ai

S:\5300\5388\001\task_04\ssc_0110_fig_2-16(10).ai

CONFIGURATIONS (Rivero and others, 2000)		ALTERNATIVE SSC MODELS (This Study)
A 	Model 1	Strike-slip fault sources (NI/SCOZD/RC) and San Joaquin Hills blind fault source (SJBF).
B 	–	Not modeled based on shallow depth (<5-6 km) of the northern segment of the OBT west of SCOZD and lack of direct evidence for activity (link to coastal uplift) for southern segment.
C 	Model 2	Independent strike-slip faults (NI and RC) and blind thrust (OBT).
D 	Model 3	Oblique Slip Model (OBT and RC/SCOZD modeled as a single oblique slip fault). NI is an independent strike-slip fault.

POTENTIAL CONFIGURATIONS FOR THRUST AND STRIKE-SLIP FAULT INTERACTIONS
SONGS Seismic Issues

Figure
2-16



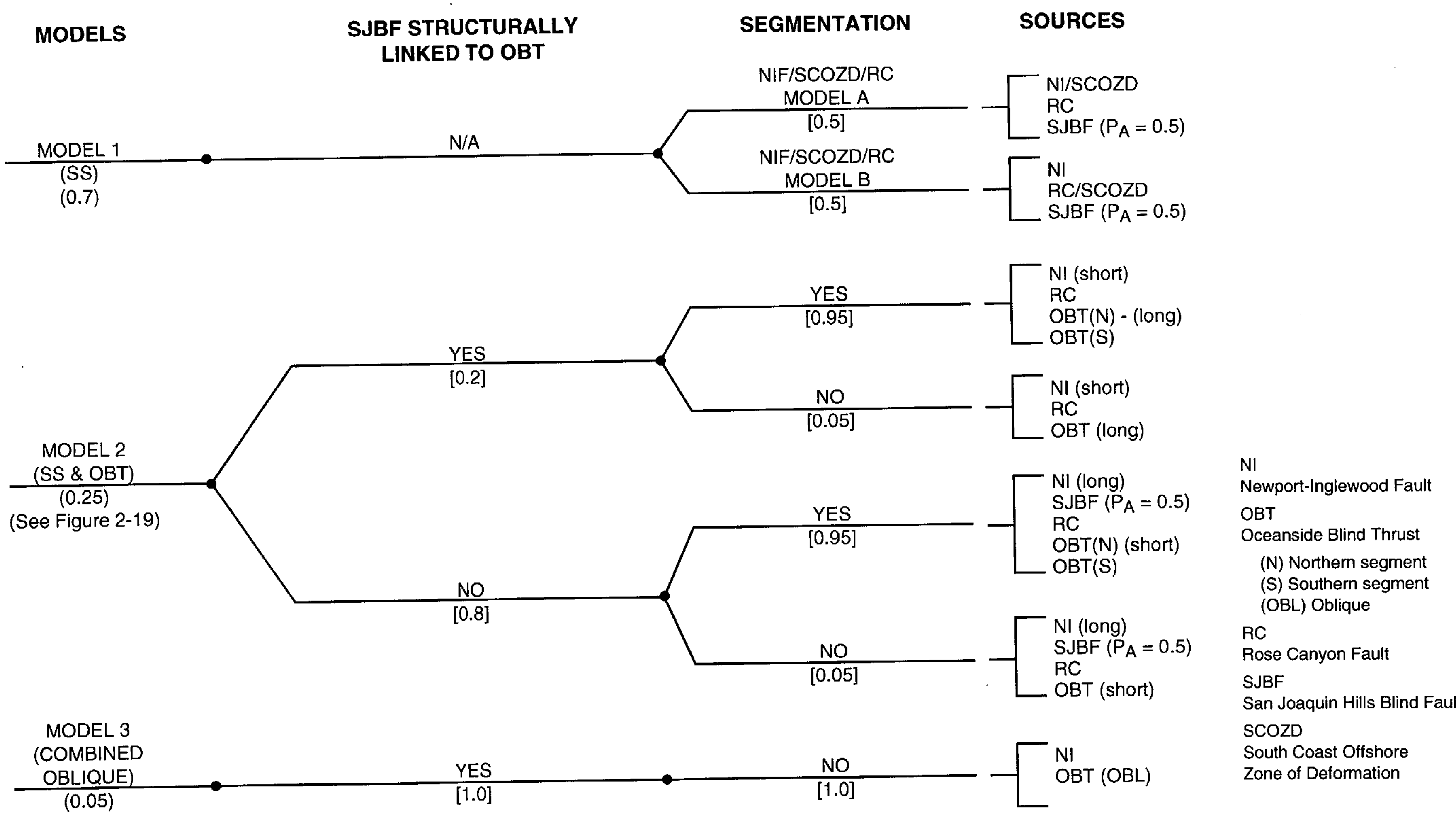
Idealized section of upper lithosphere, illustrating features of regional and local strain partitioning. Regionally partitioned structures originate at crustal depths where large-moment-release earthquakes nucleate and should be characterized independently as separate seismic sources. Locally partitioned structures are not necessarily separate seismic sources and should be characterized collectively to assess underlying seismic sources. (From Lettis and Hanson, 1991)

SCHEMATIC SHOWING REGIONAL AND LOCAL STRAIN PARTITIONING
SONGS Seismic Issues

Figure
2-17

S:\5300\5388\001\task_04\ssc_0110_fig_2-17(17).ai

S:\5300\5388\001\task_04\ssc_0110_fig_2-18.ai

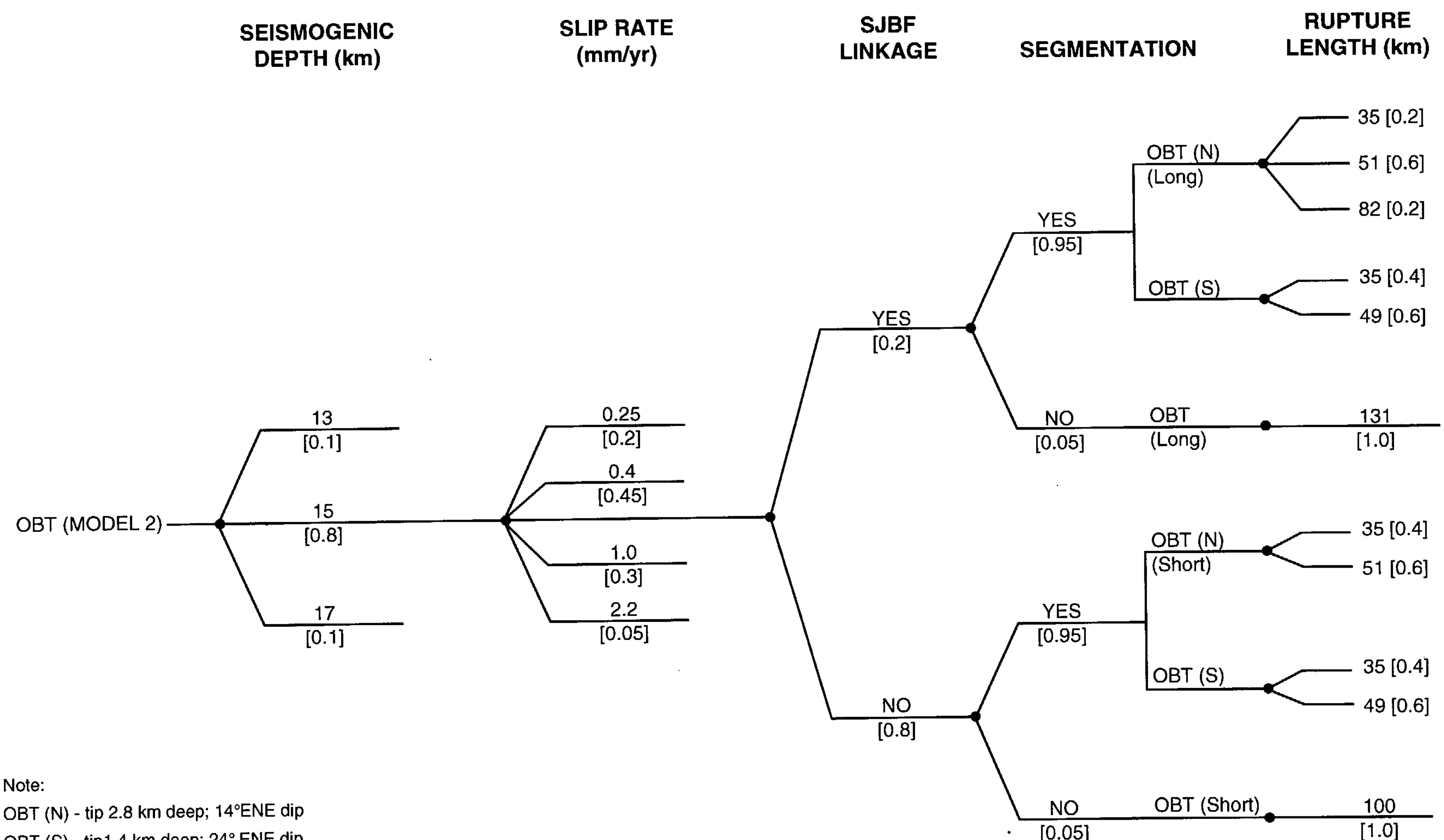


Note: See Table 2-1 for summary of source parameters.

SEISMIC CHARACTERIZATION LOGIC TREE
SONGS Seismic Issues

Figure
2-18

S:\5300\5388\001\task_04\ssc_0110_fig_2-23.ai



Note:

OBT (N) - tip 2.8 km deep; 14°ENE dip

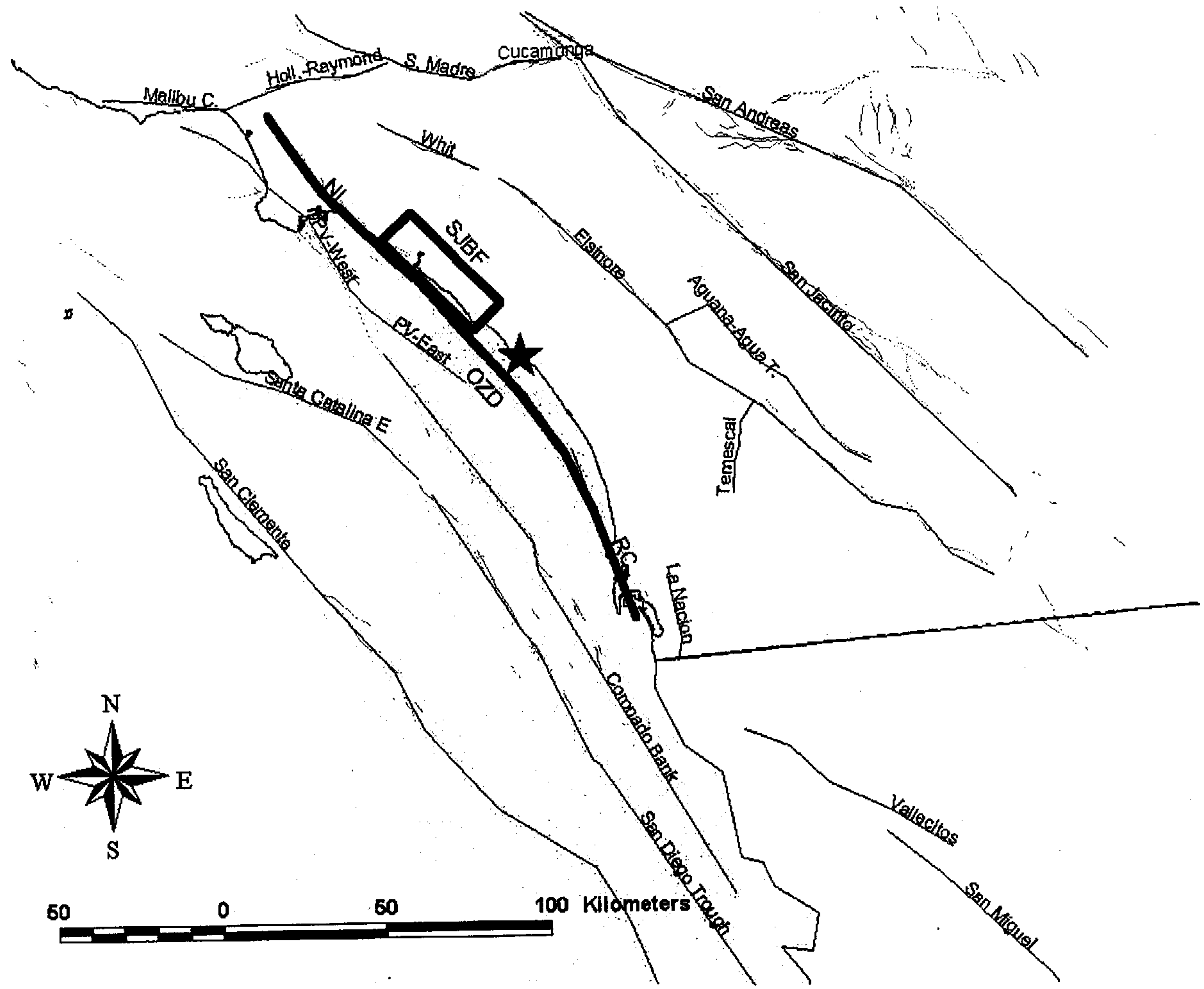
OBT (S) - tip1.4 km deep; 24° ENE dip

Unsegmented OBT - geometry from OBT (N) segment adjacent to SONGS

OCEANSIDE BLIND THRUST (MODEL 2) SOURCE CHARACTERIZATION LOGIC TREE
SONGS Seismic Issues

Figure
2-19

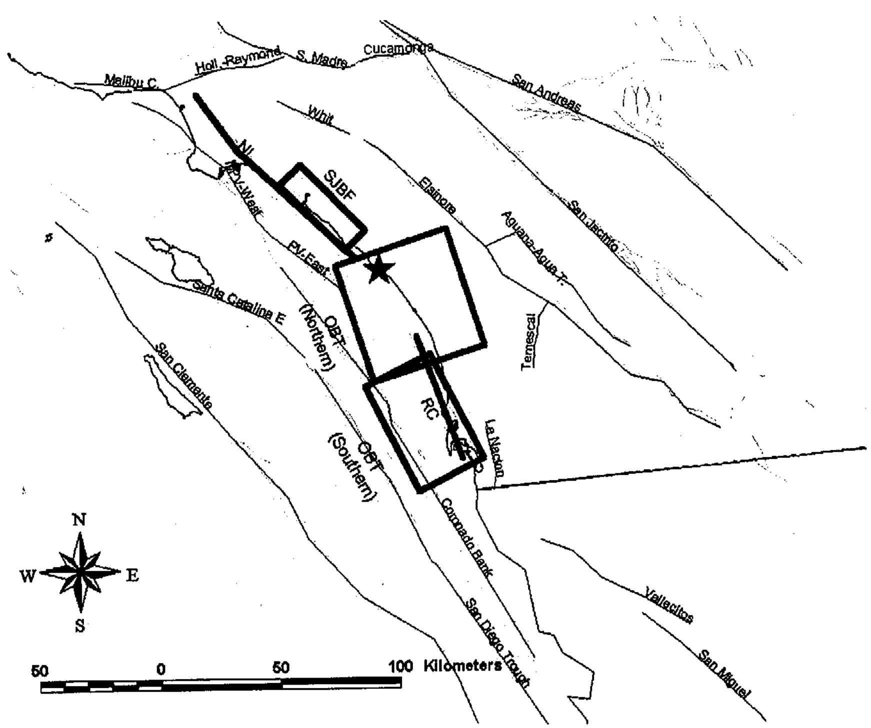
S:\5300\5388\001\task_04\ssc_0110_fig_2-20(21).ai



MAP SHOWING MODEL 1 FAULT SOURCES
SONGS Seismic Issues

Figure
2-20

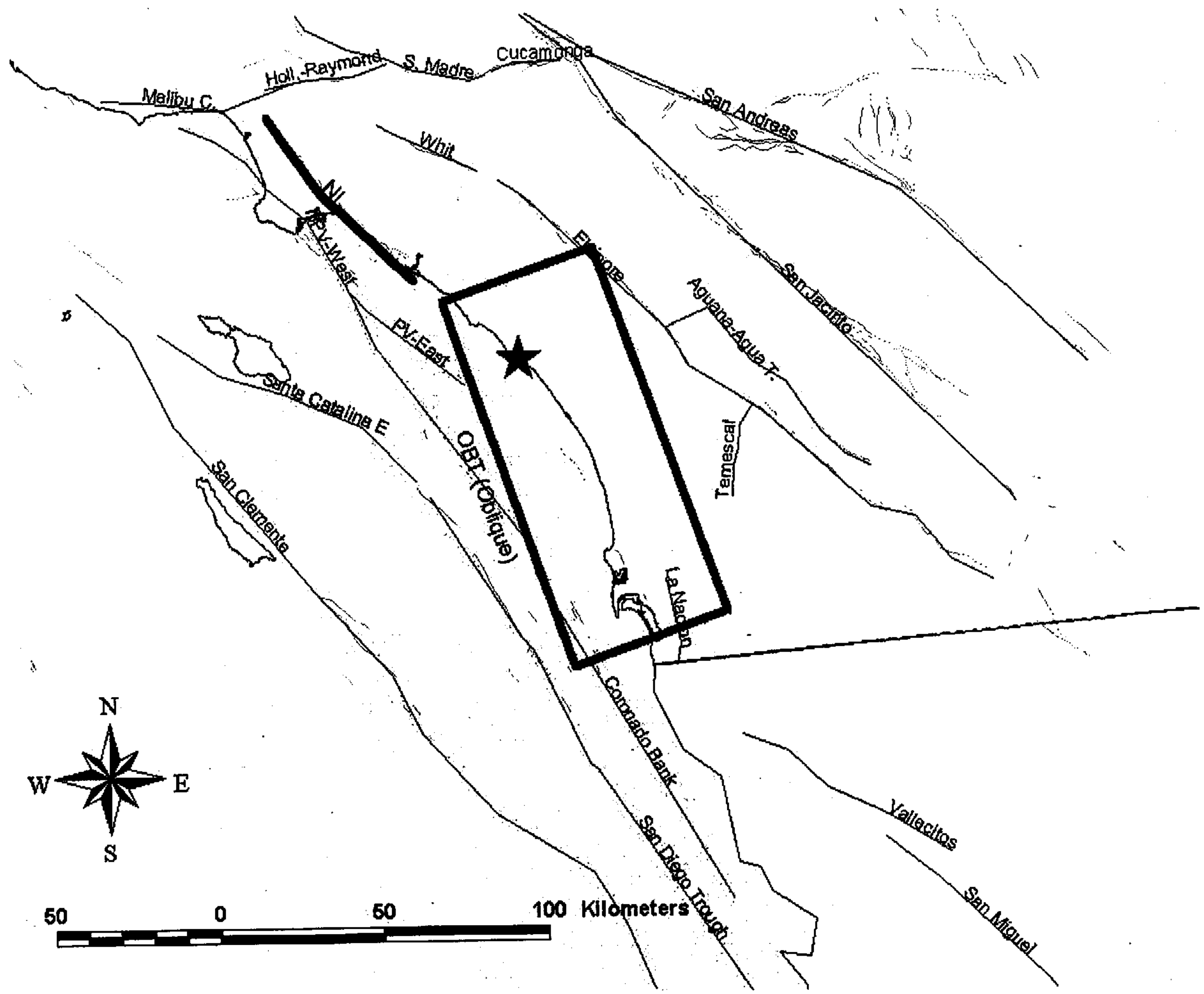
S:\5300\5388\001\task_04\ssc_0110_fig_2-21(22,23).ai



MAP SHOWING MODEL 2 FAULT SOURCES
SONGS Seismic Issues

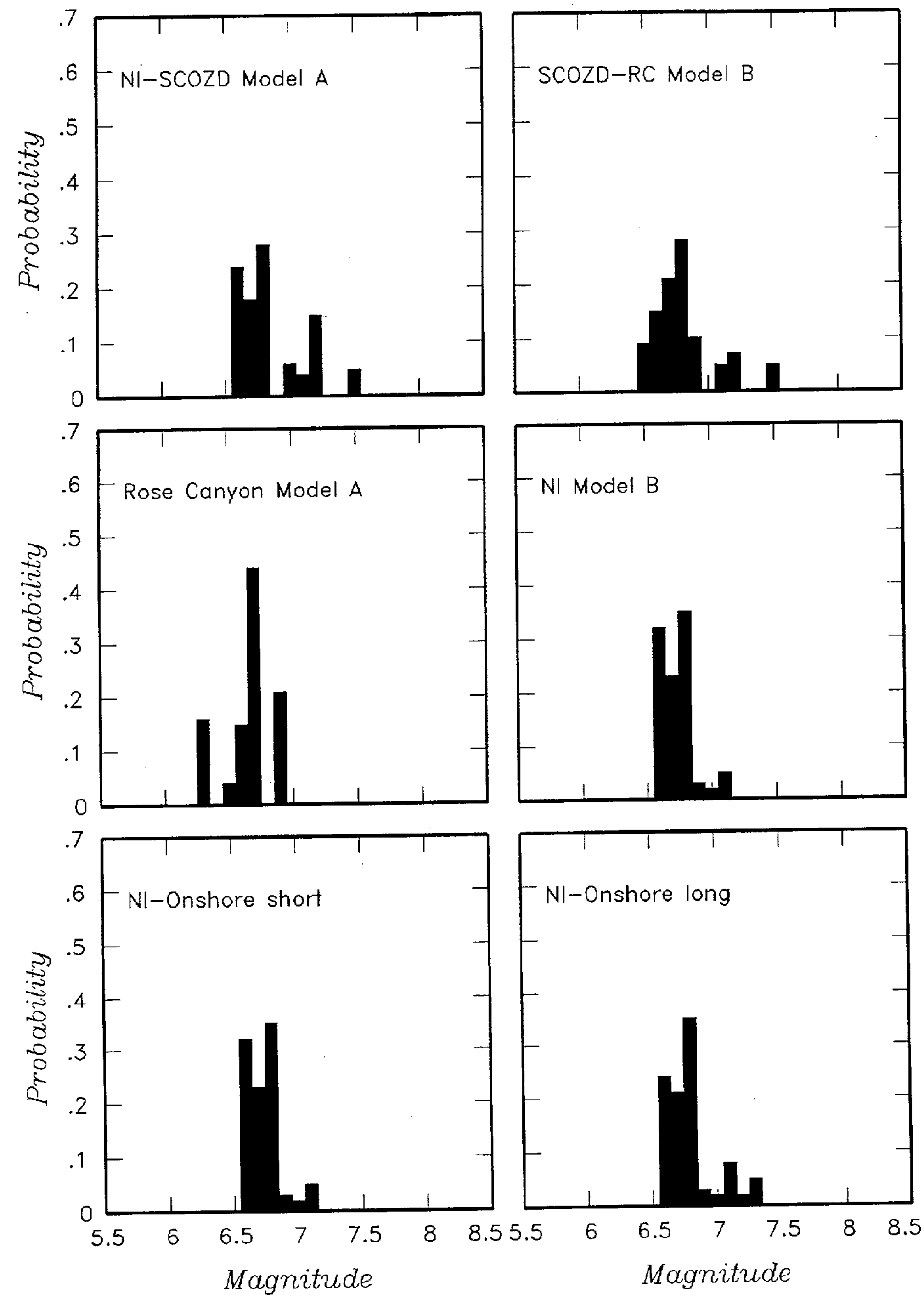
Figure
2-21

S:\5300\5388\001\task_04\ssc_0110_fig_2-22(24).ai



MAP SHOWING MODEL 3 FAULT SOURCES
SONGS Seismic Issues

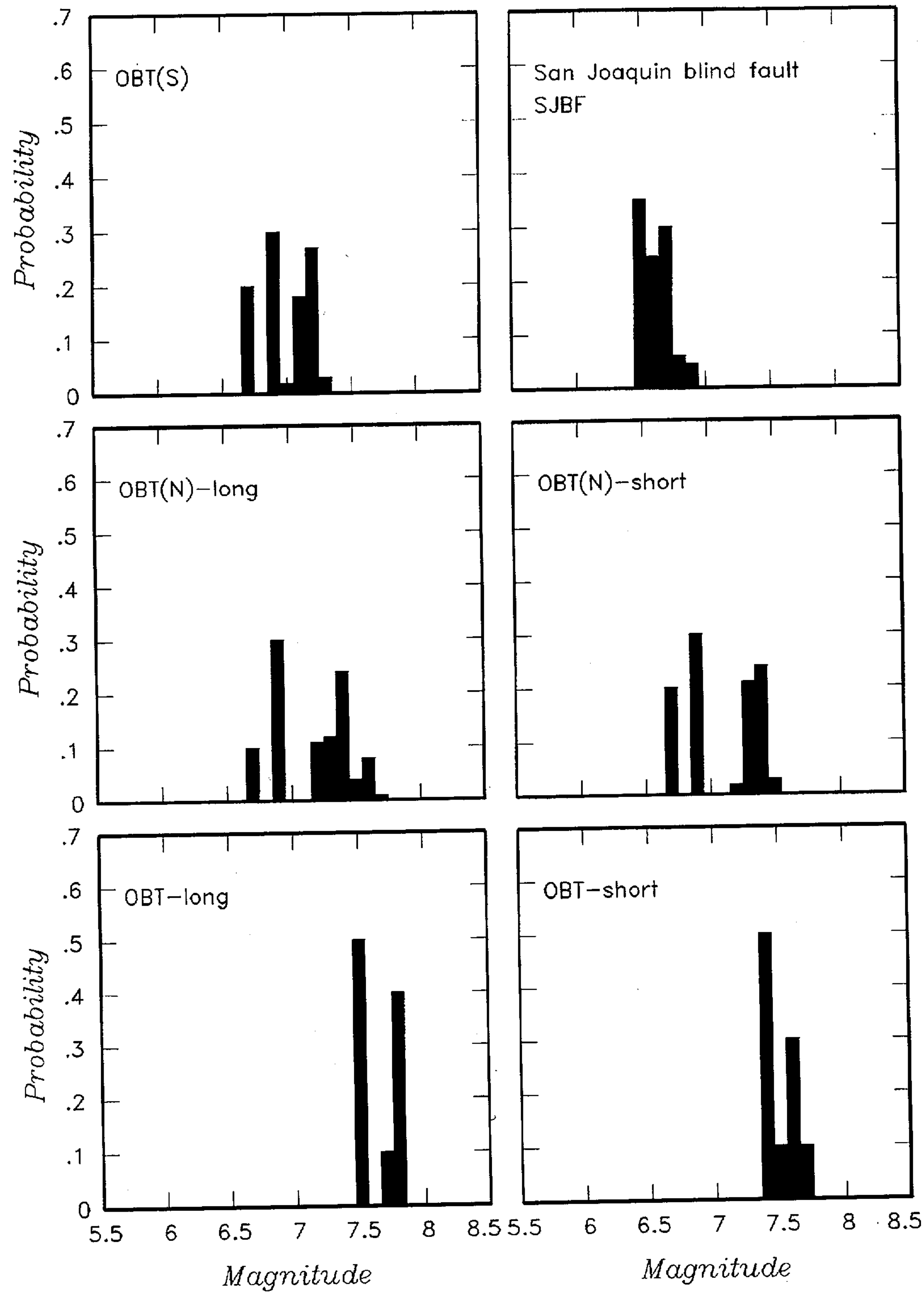
Figure
2-22



S:\5300\5388\001\task_04\ssc_0110_fig_2-23.ai

MAXIMUM MAGNITUDE DISTRIBUTION PLOTS
SONGS Seismic Issues

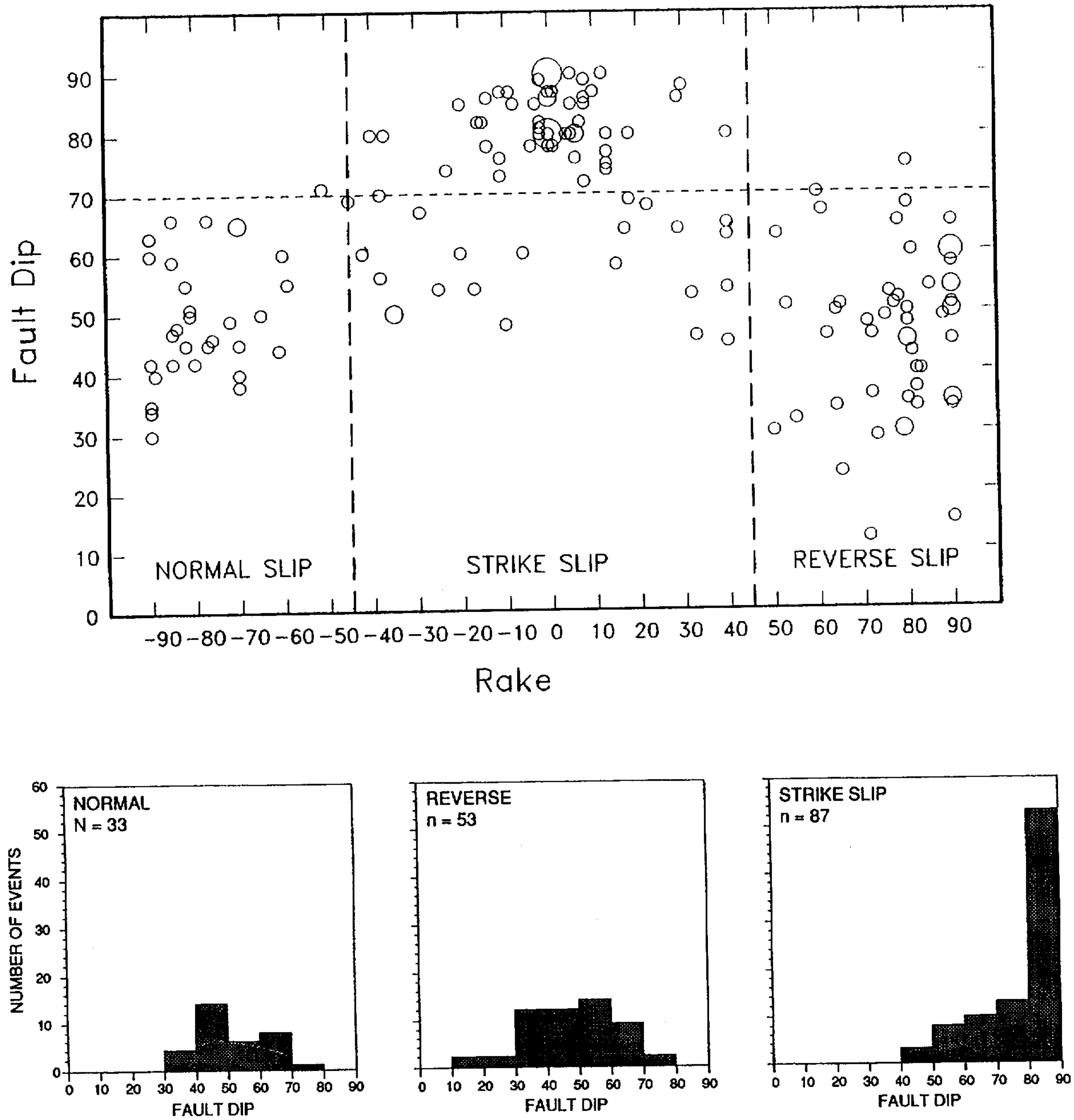
Figure
2-23



MAXIMUM MAGNITUDE DISTRIBUTION PLOTS
SONGS Seismic Issues

Figure
2-23 (cont.)

S:\5300\5388\001\task_04\ssc_0110_fig_2-23c.ai



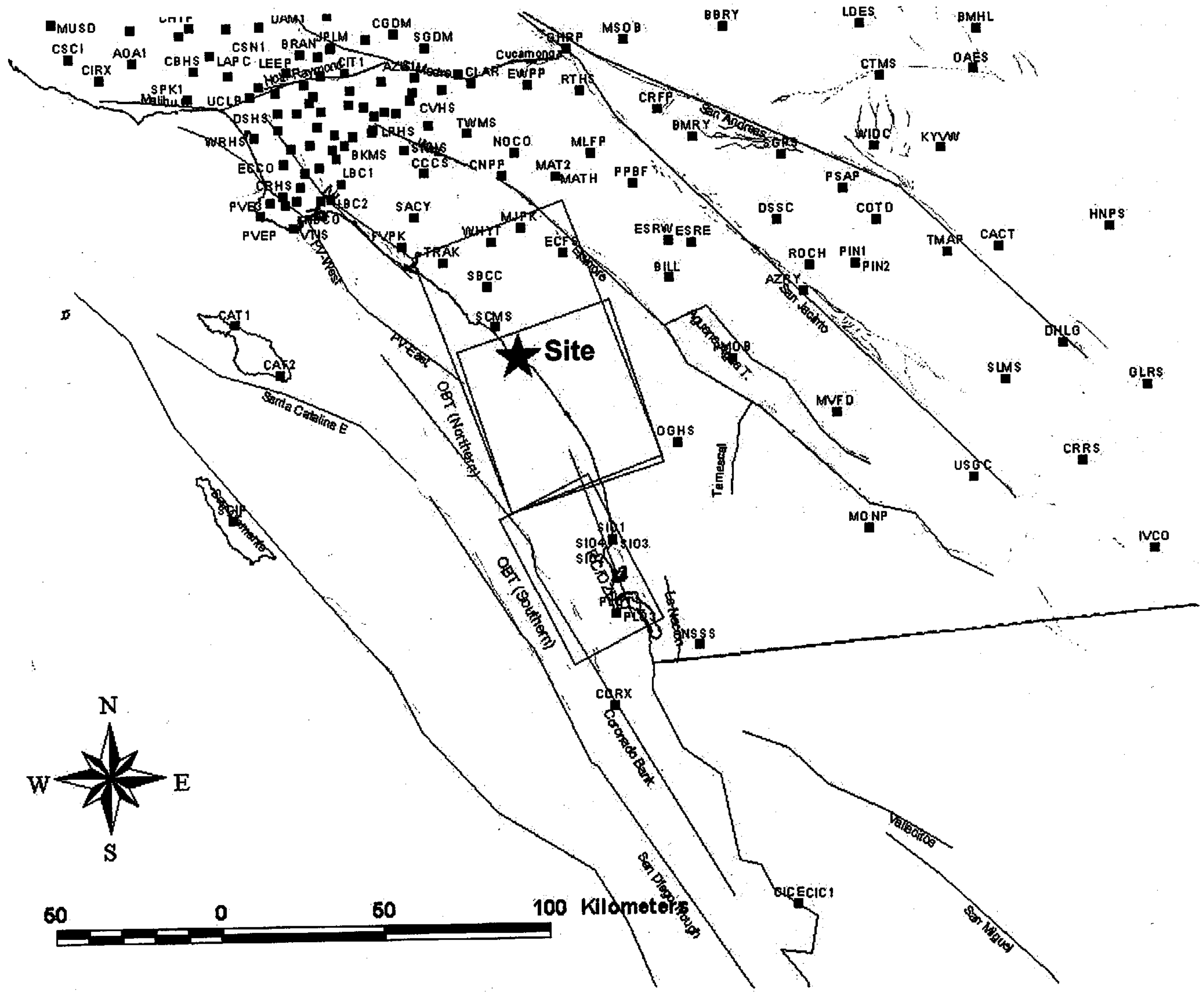
Plot of fault dip versus rake angle for 173 earthquakes. Frequency distributions show the number of earthquakes having particular dips, as a function of sense of slip. (From PGandE, 1990; Wells and Coppersmith, 1991)

S:\5300\5388\001\task_04\ssc_0110_fig_2-24(15,16).ai

PLOT OF FAULT DIP VERSUS RAKE ANGLE FOR HISTORICAL EARTHQUAKES
SONGS Seismic Issues

Figure
2-24

_2001 Projects\01050B ...\Figures\Fig3-1.CDR

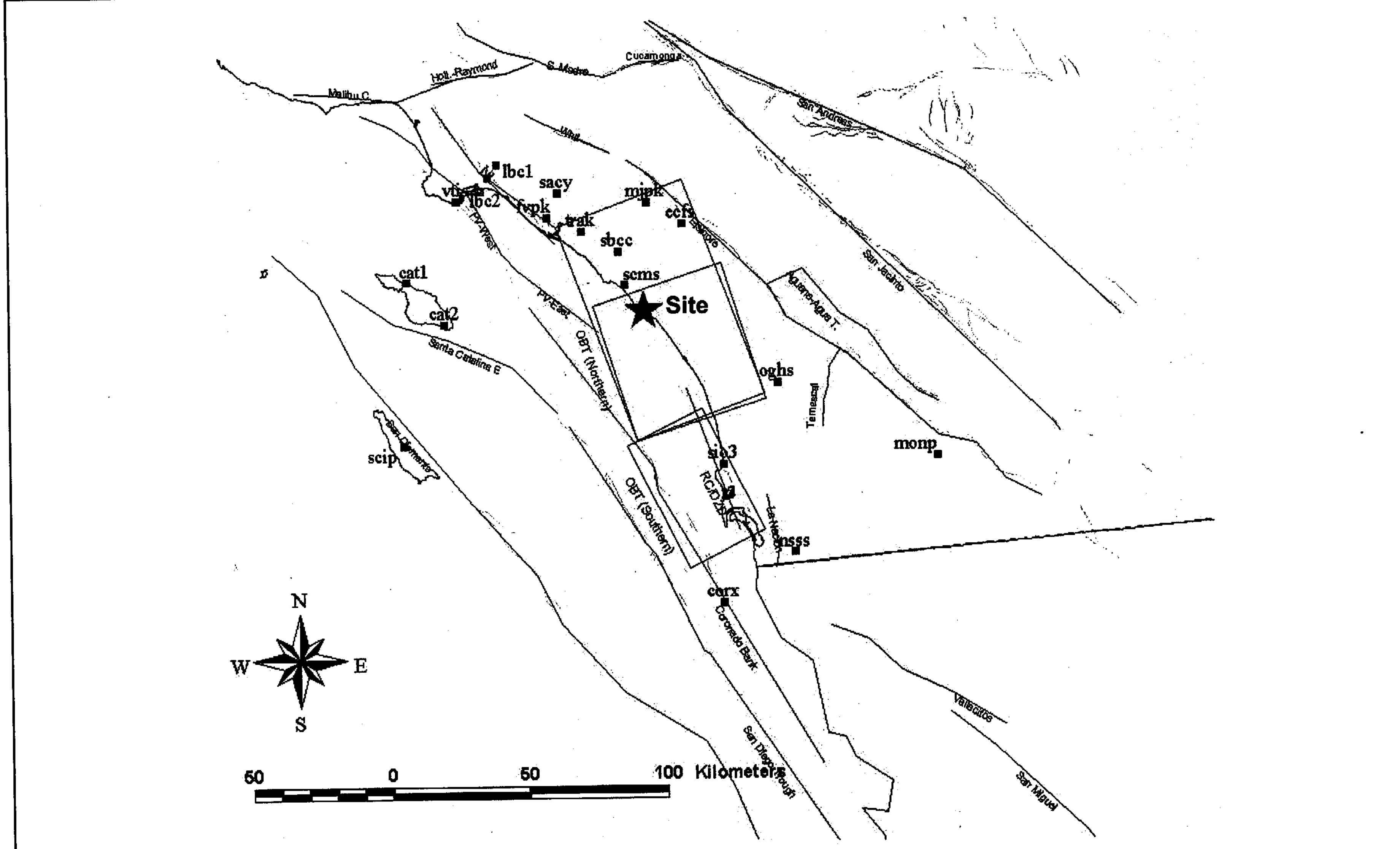


SCIGN GPS LOCATIONS

SONGS Seismic Study

Figure
3-1

_2001 Projects\01050B ...\Figures\Fig3-2.CDR

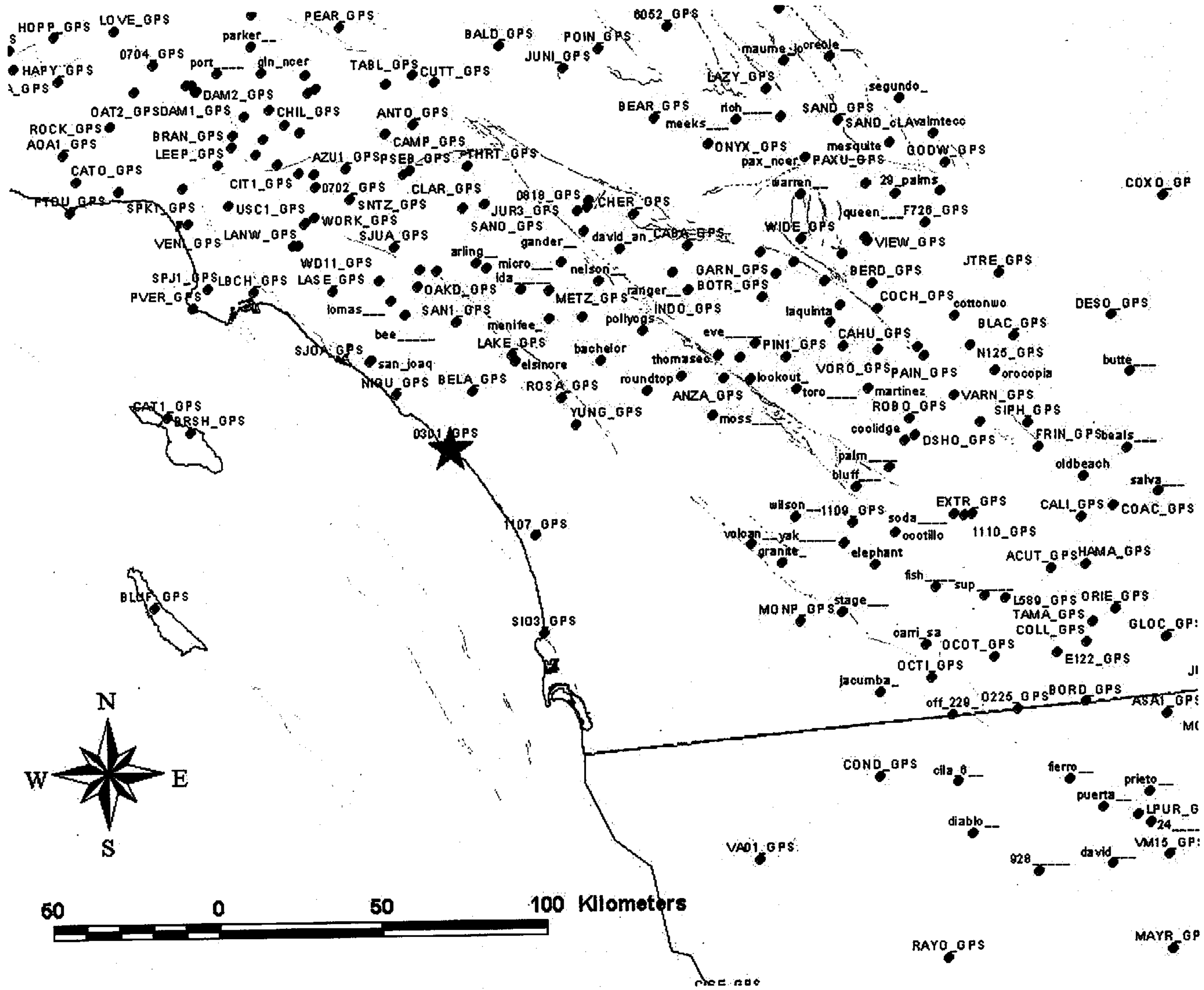


SCIGN GPS LOCATIONS NEAR SONGS SITE

SONGS Seismic Study

Figure
3-2

_2001 Projects\01050B ...\Figures\Fig3-3.CDR

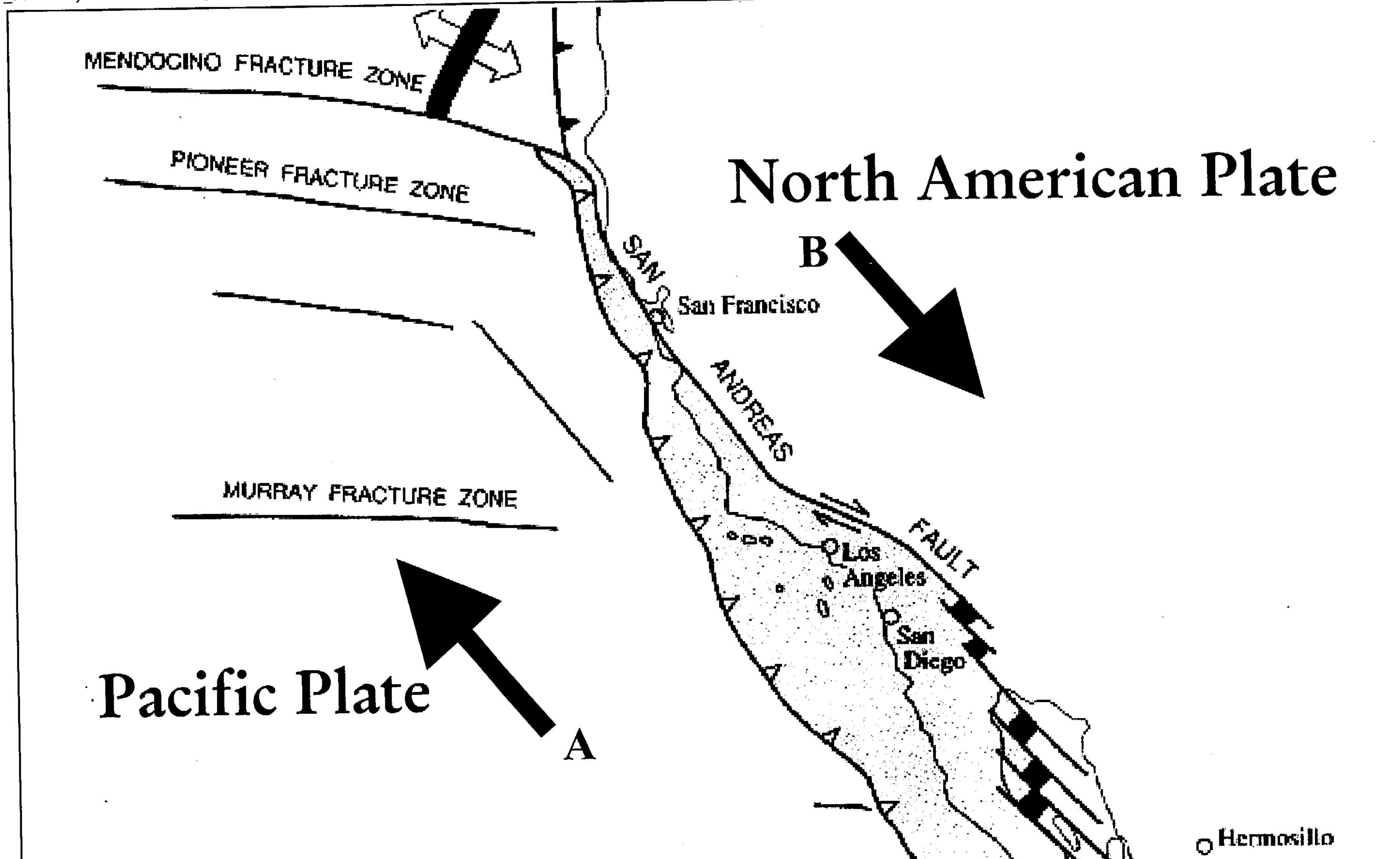


SCEC (VERSION 2) GPS LOCATIONS

SONGS Seismic Study

Figure
3-3

_2001 Projects\01050B ...\Figures\Fig3-4.CDR

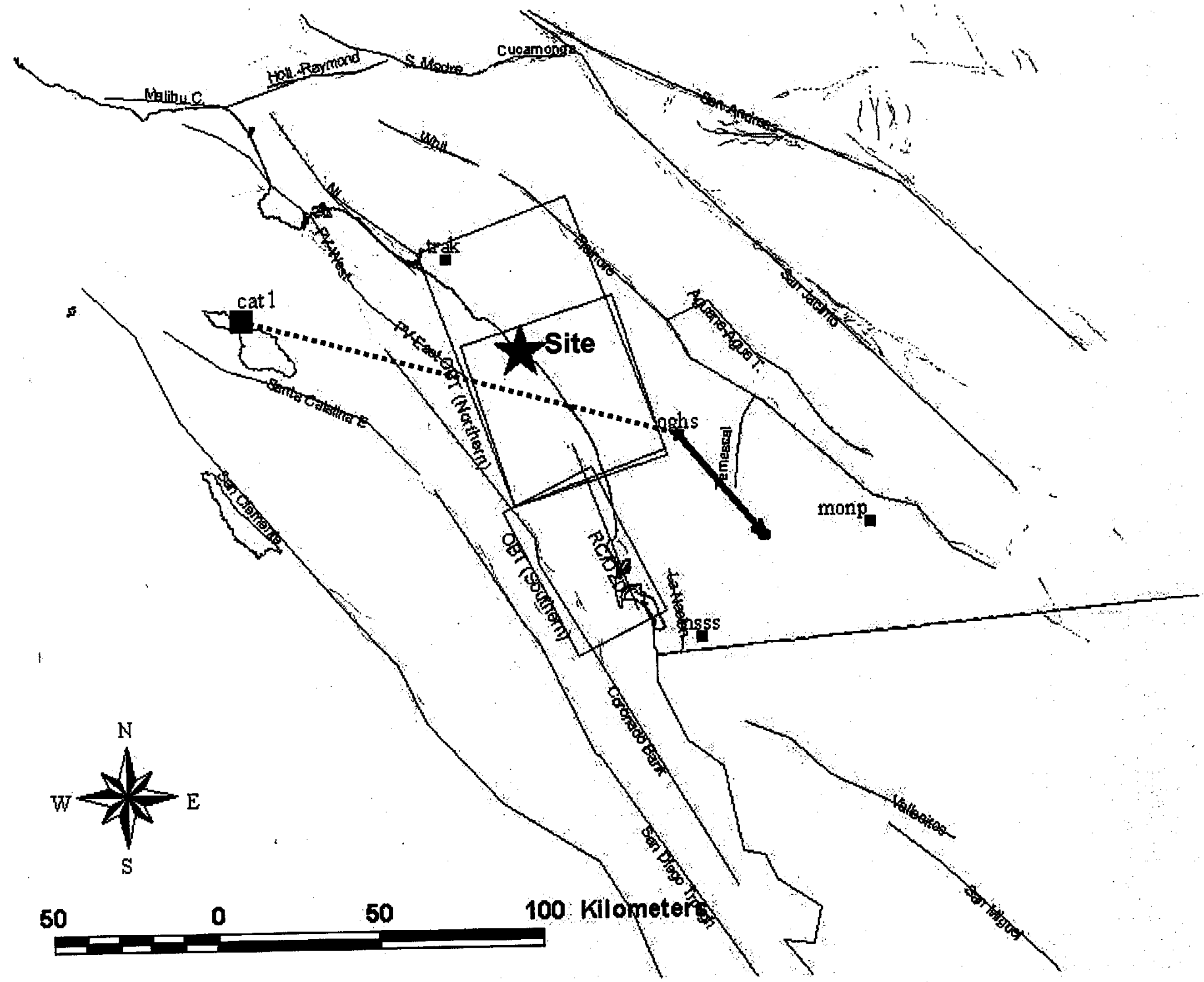


TECTONIC PLATES AND RELATIVE DISPLACEMENT RATES

SONGS Seismic Study

Figure 3-4

_2001 Projects\01050B ...\Figures\Fig3-5.CDR

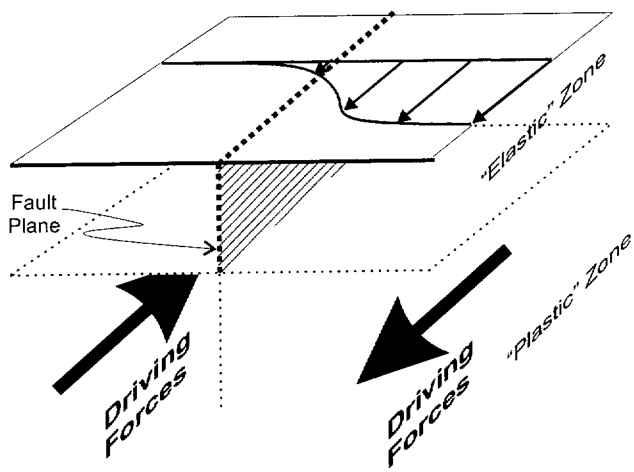


RELATIVE DISPLACEMENT OF OGHS WITH RESPECT TO CAT1

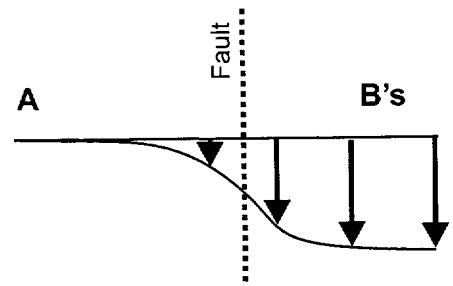
SONGS Seismic Study

Figure
3-5

a) Schematic Illustration of Strike-Slip Fault

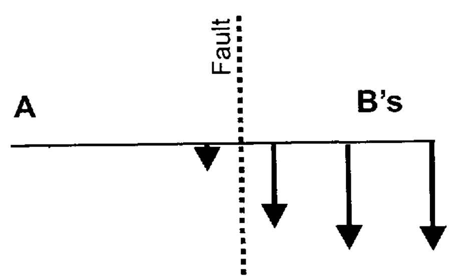


Perspective View



Plan View

b) Likely Relative Displacement Rates for Strike-Slip Fault



Plan View

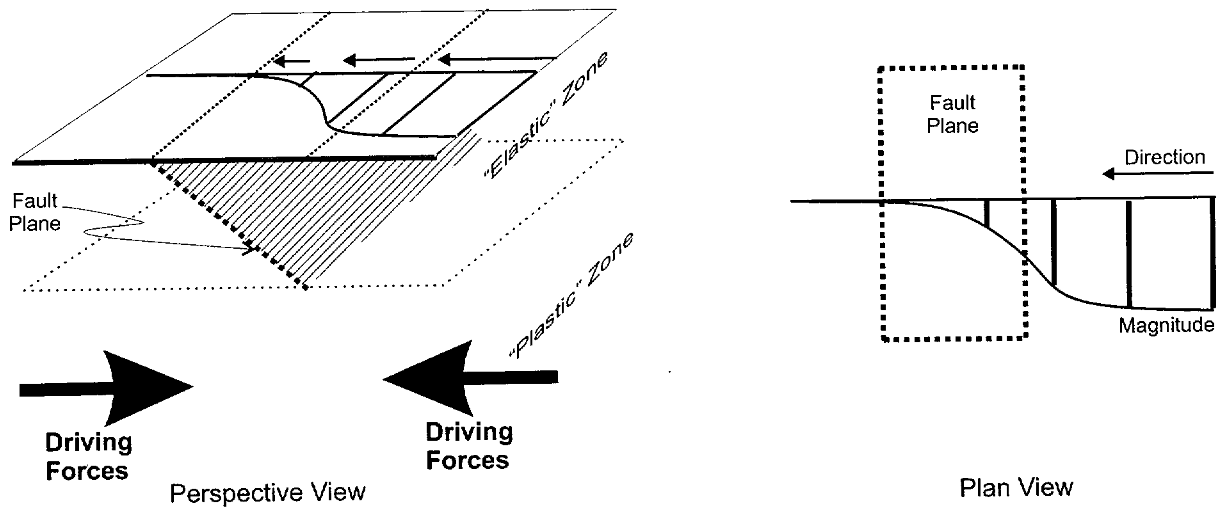
ILLUSTRATION OF RELATIVE DISPLACEMENT RATES FOR STRIKE-SLIP FAULT

SONGS Seismic Study

Figure 3-6

2001 Projects\01050B ...\Figures\Fig3-6.CDR

a) Schematic Illustration of Thrust Fault



b) Likely Relative Displacement Rates for Thrust Fault

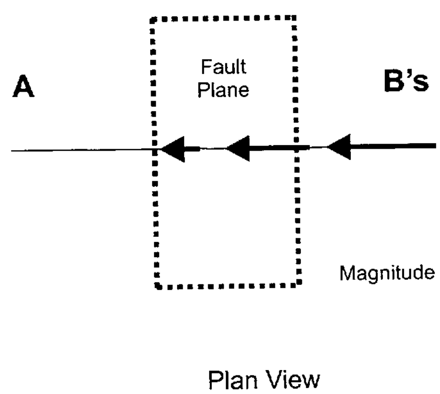


ILLUSTRATION OF RELATIVE DISPLACEMENT RATES FOR THRUST FAULT

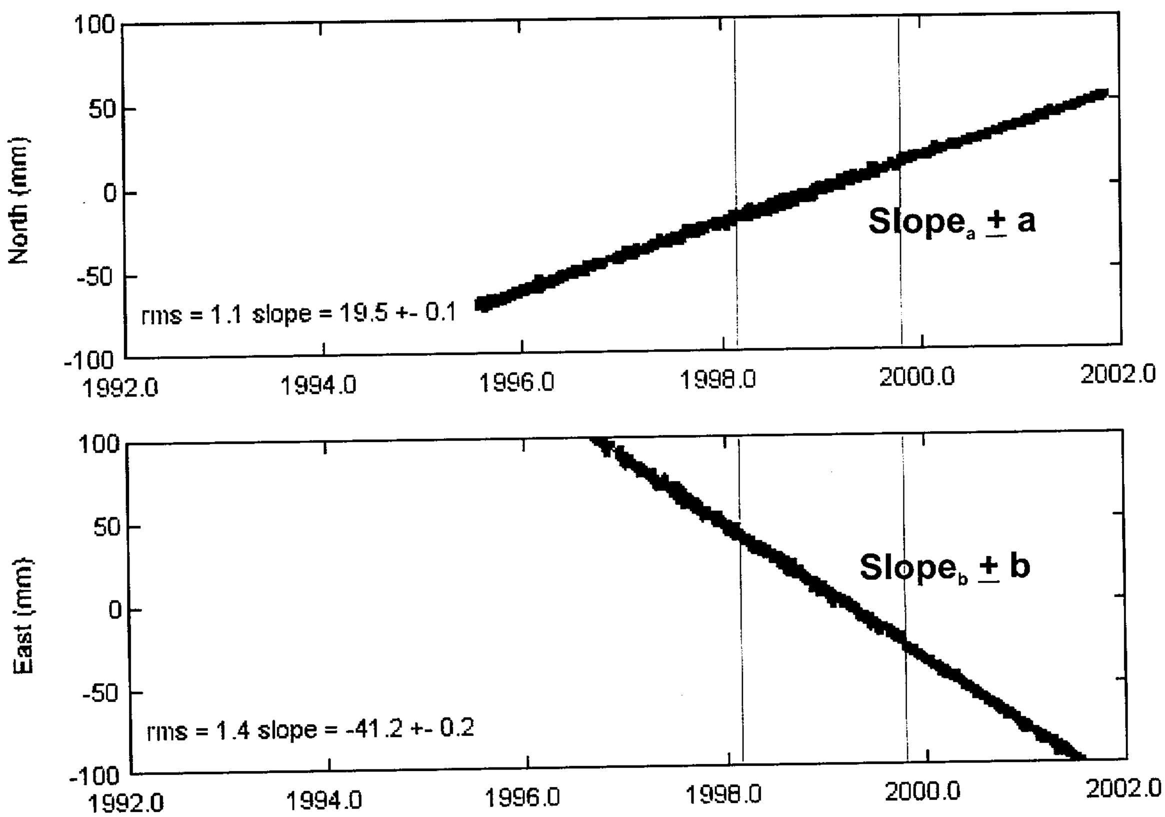
SONGS Seismic Study

Figure 3-7

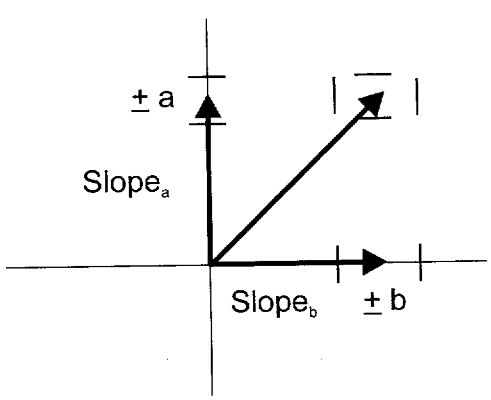
2001 Projects\01050B ...\Figures\Fig3-7.CDR

a) Example of Reported Displacement Rates and Associated Errors

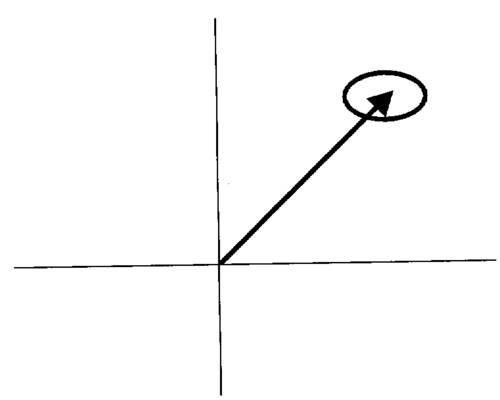
cat1 position time series (filtered)



b) Displacement Rate Vector and Error



c) Reported Error Ellipse

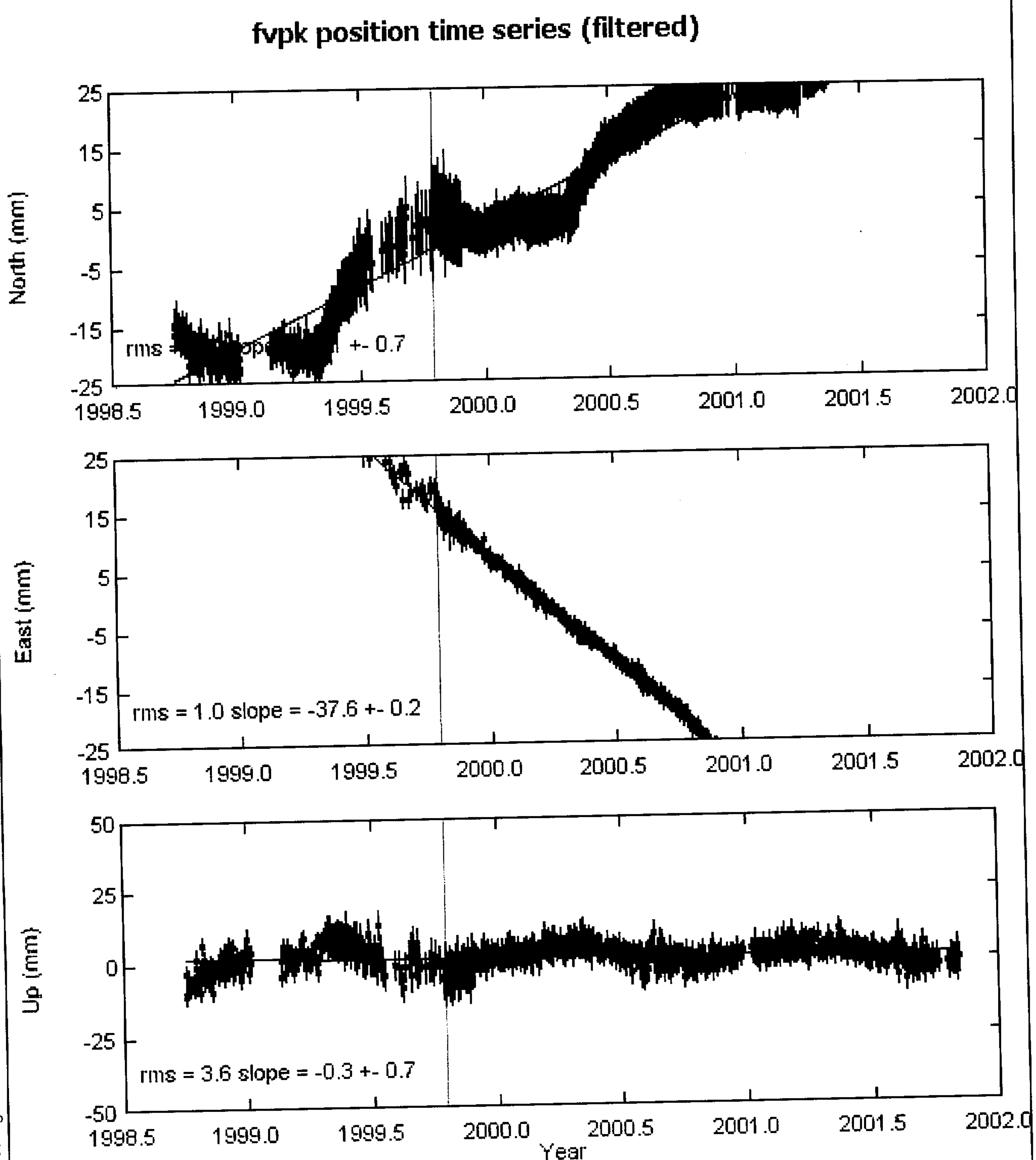


REPORTED DISPLACEMENT RATES &
ASSOCIATED ERRORS

SONGS Seismic Study

Figure
3-8

2001 Projects\01050B ...\Figures\Fig3-8.CDR



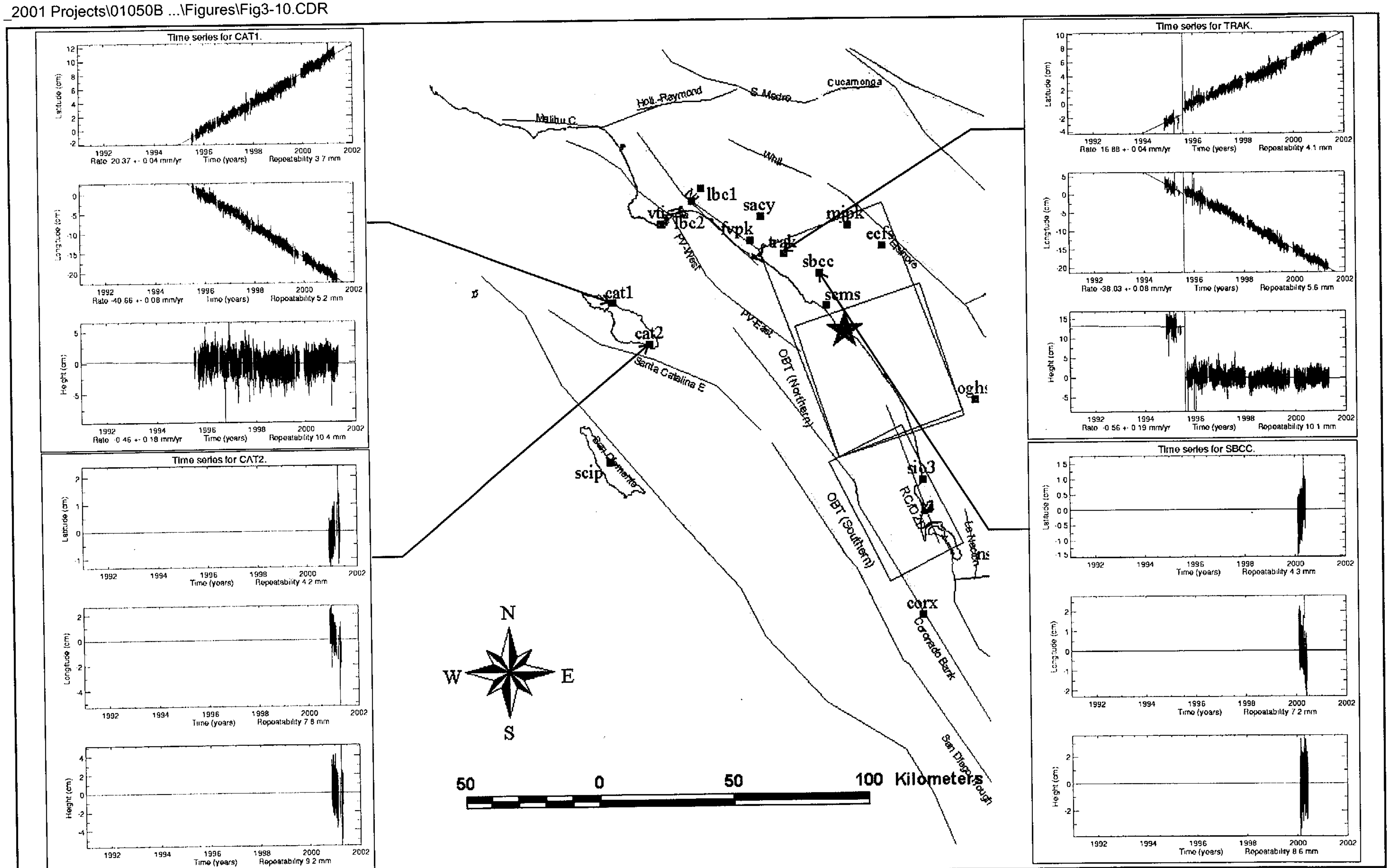
GPS DATA CONTAMINATED BY NON-TECTONIC GROUND MOVEMENTS

SONGS Seismic Study

Figure
3-9

2001 Projects\01050B ...\Figures\Fig3-9.CDR

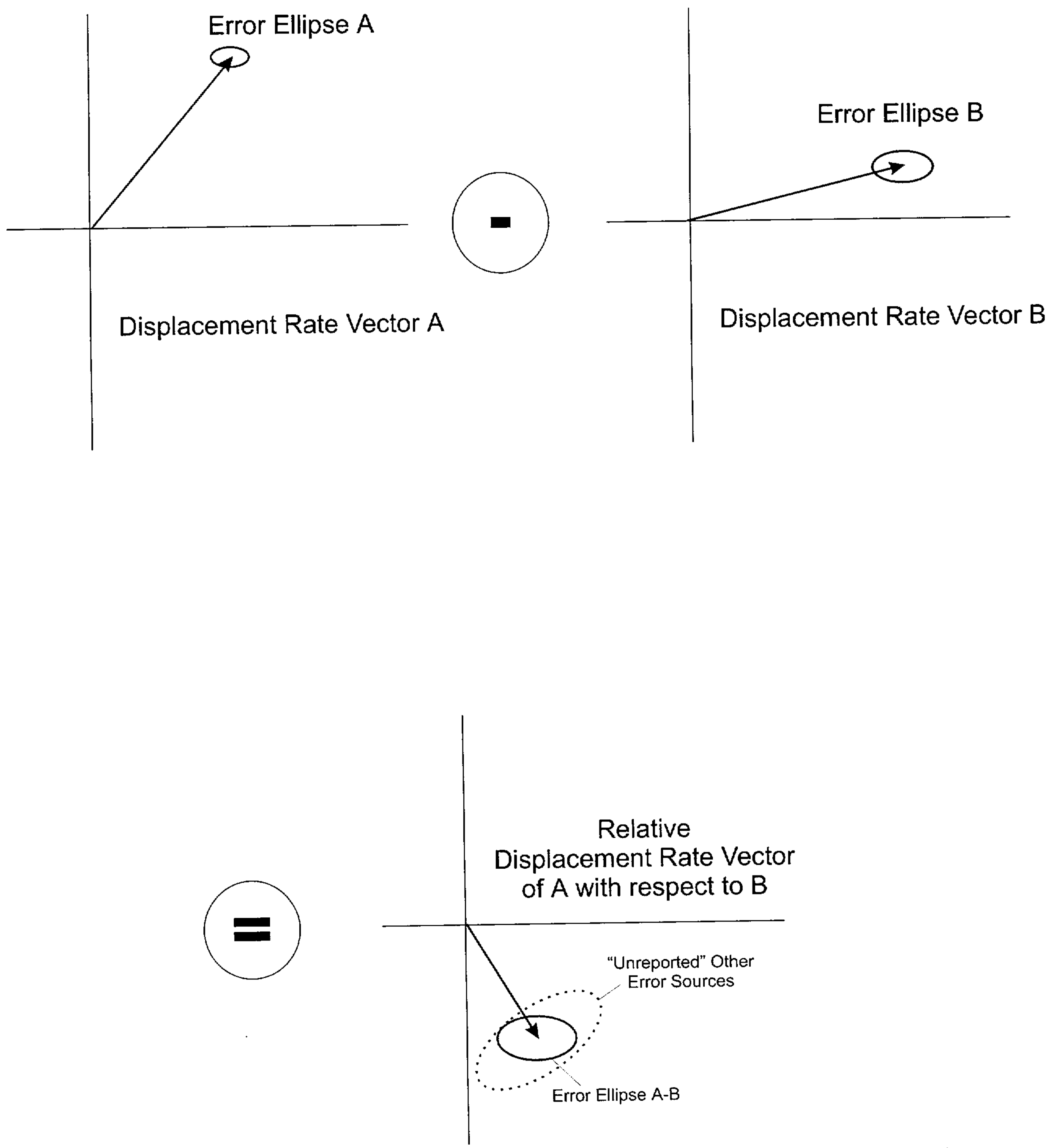
_2001 Projects\01050B ...\Figures\Fig3-10.CDR



DIFFERING DURATIONS OF GPS MEASUREMENTS

SONGS Seismic Study

Figure
3-10

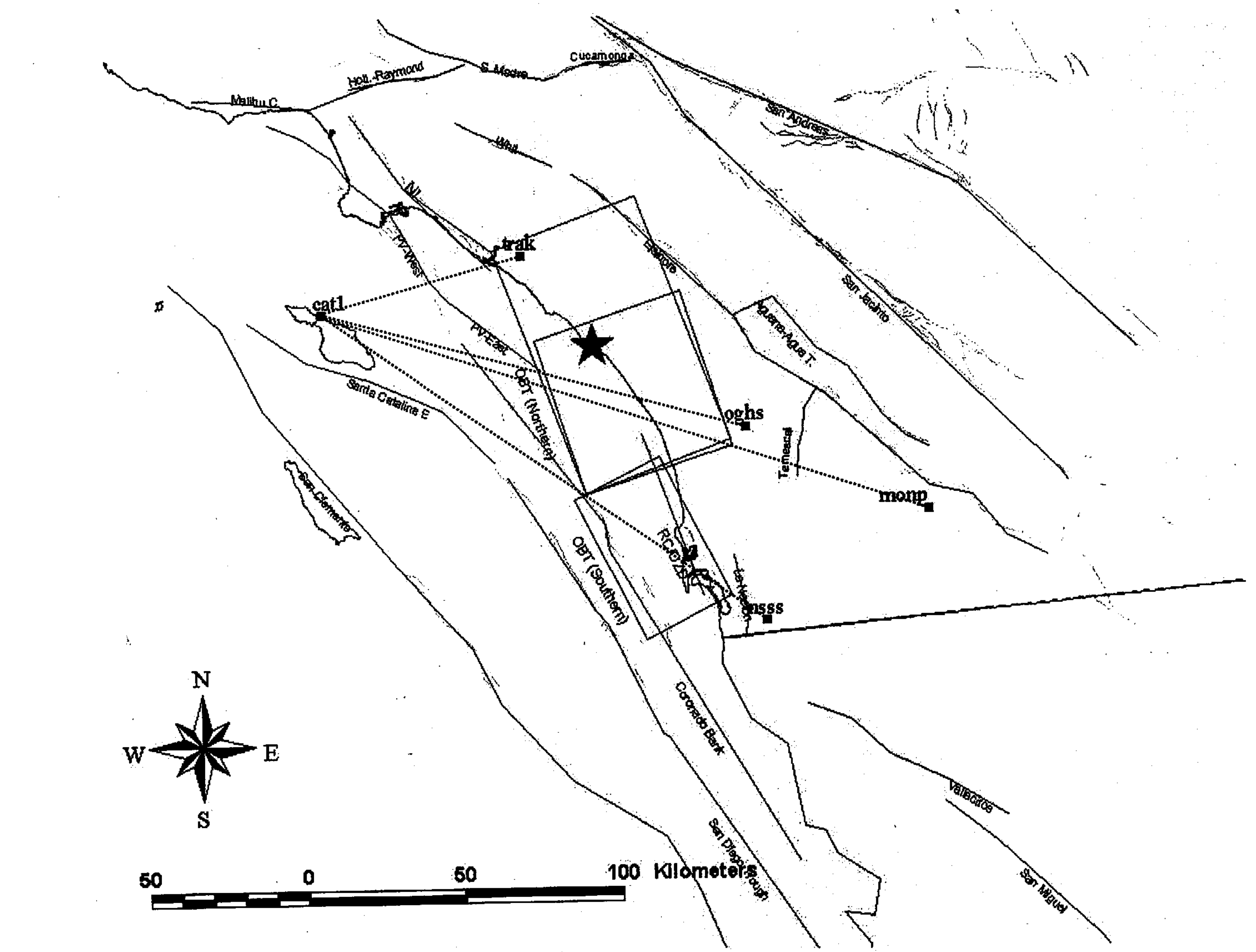


ERROR ELLIPSES ASSOCIATED WITH
RELATIVE DISPLACEMENT RATE VECTOR

SONGS Seismic Study

Figure
3-11

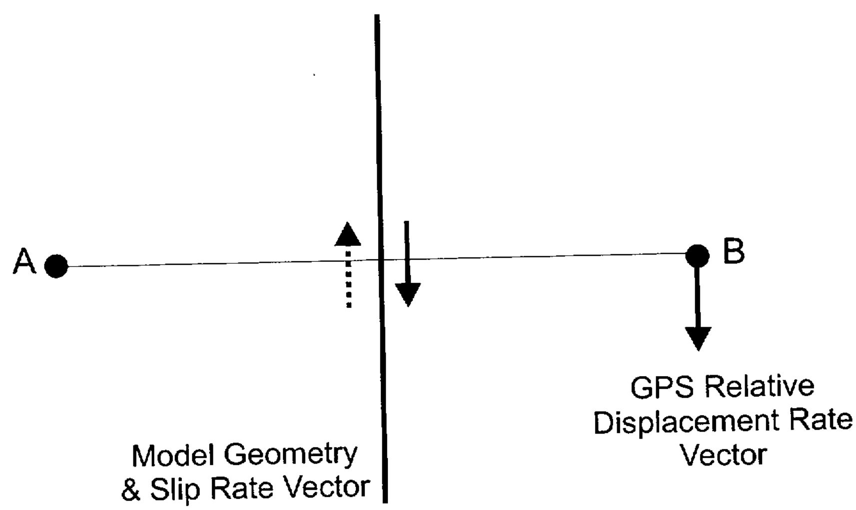
_2001 Projects\01050B ...\Figures\Fig3-11.CDR



SELECTED SCIGN GPS STATIONS & PAIRS

SONGS Seismic Study

Figure 3-12

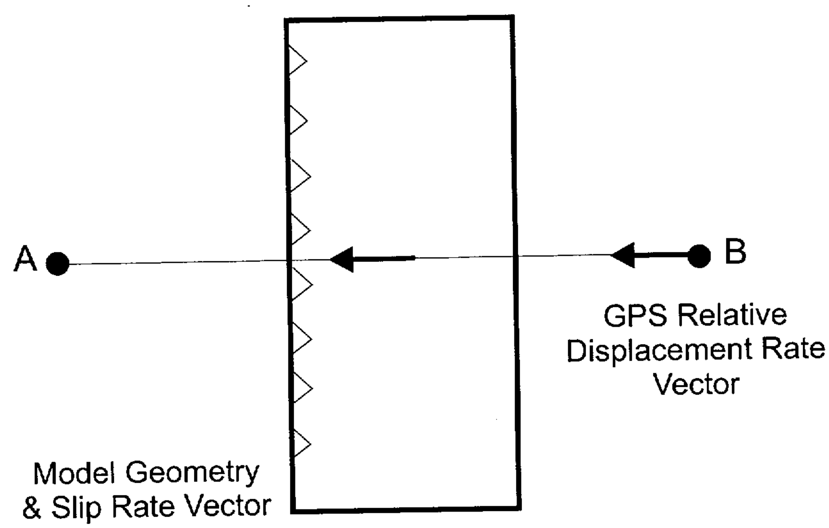


RELATIVE DISPLACEMENT RATE VECTOR AND SLIP RATE VECTOR
STRIKE-SLIP FAULT

SONGS Seismic Study

Figure
3-13

2001 Projects\01050B ...\Figures\Fig3-13.CDR

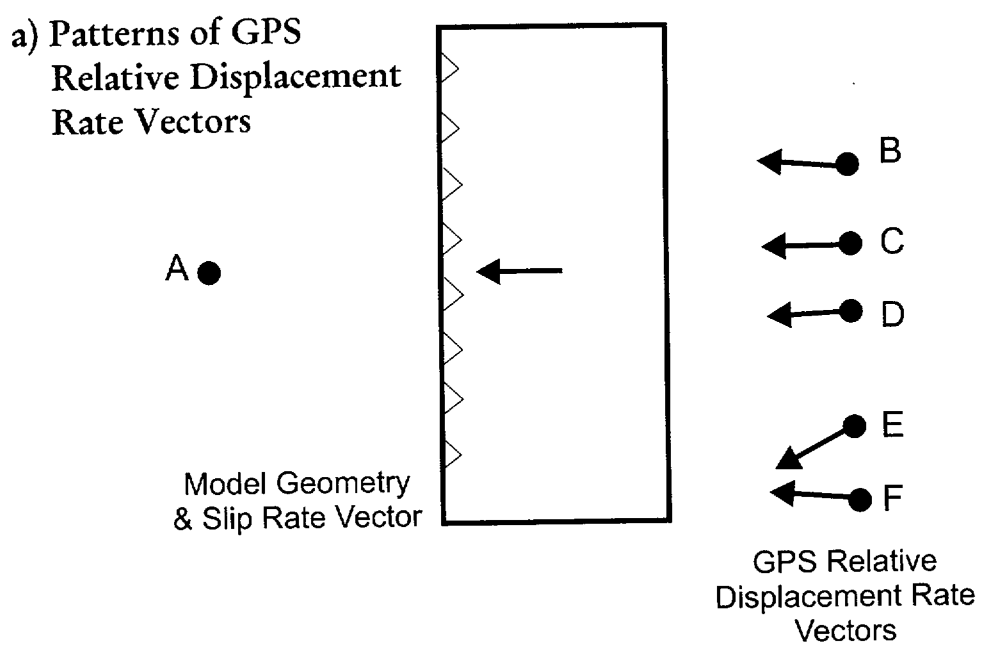


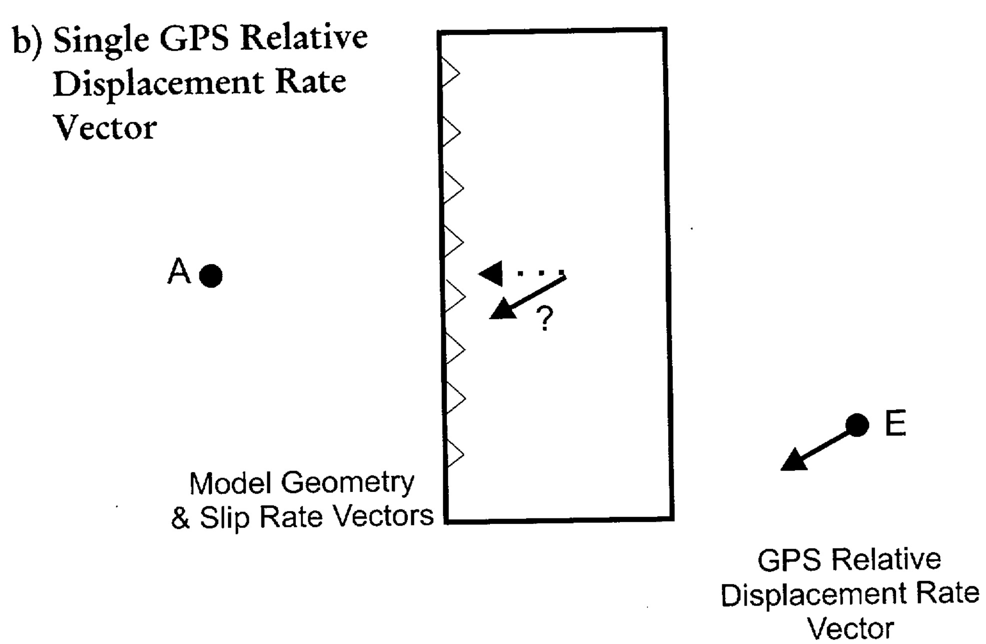
RELATIVE DISPLACEMENT RATE VECTOR AND SLIP RAT VECTOR
THRUST FAULT

SONGS Seismic Study

Figure
3-14

2001 Projects\01050B ...\Figures\Fig3-14.CDR



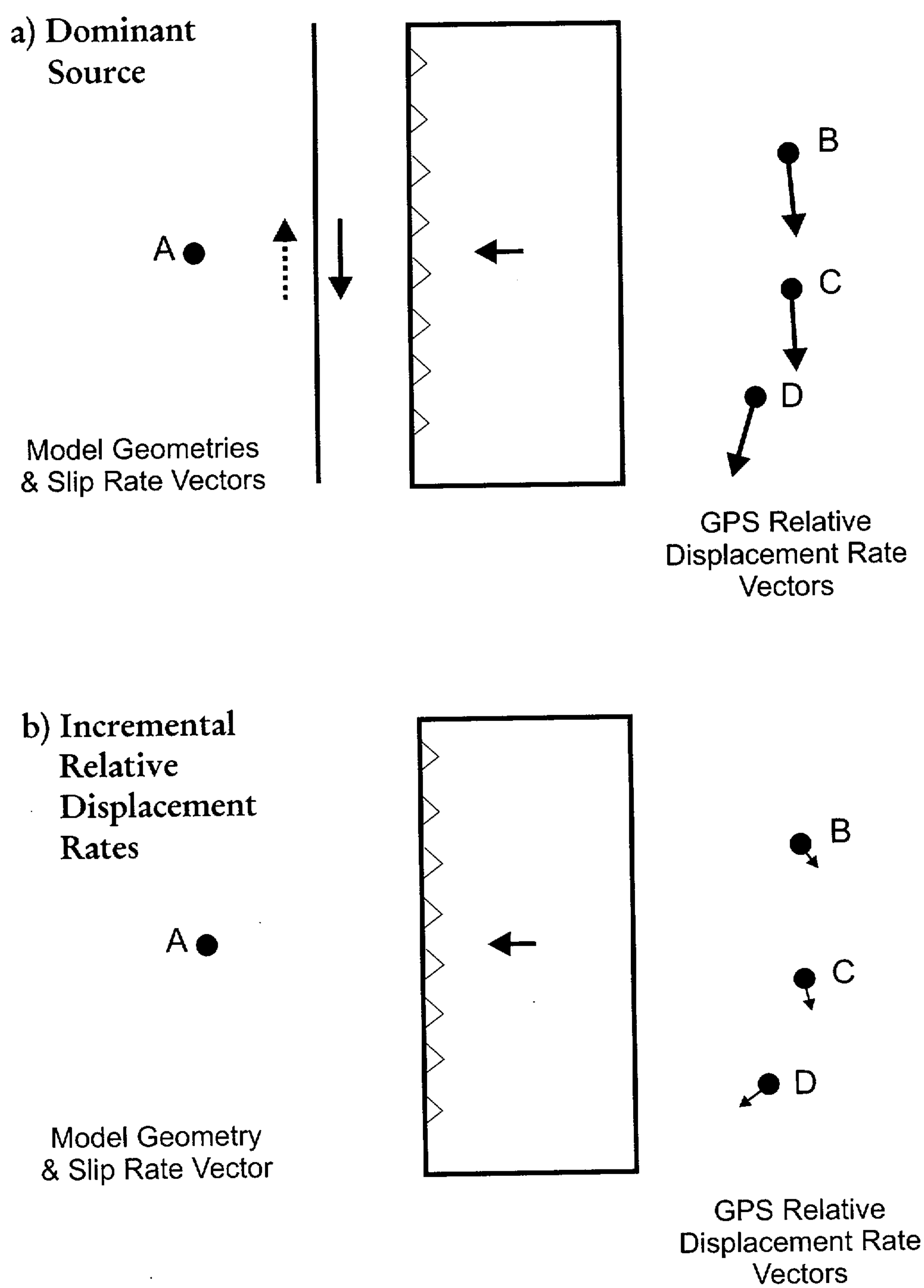


PATTERNS OF MULTIPLE GPS VECTORS VERSUS SINGLE GPS VECTOR

SONGS Seismic Study

Figure 3-15

_2001 Projects\01050B ...\Figures\Fig3-15.CDR



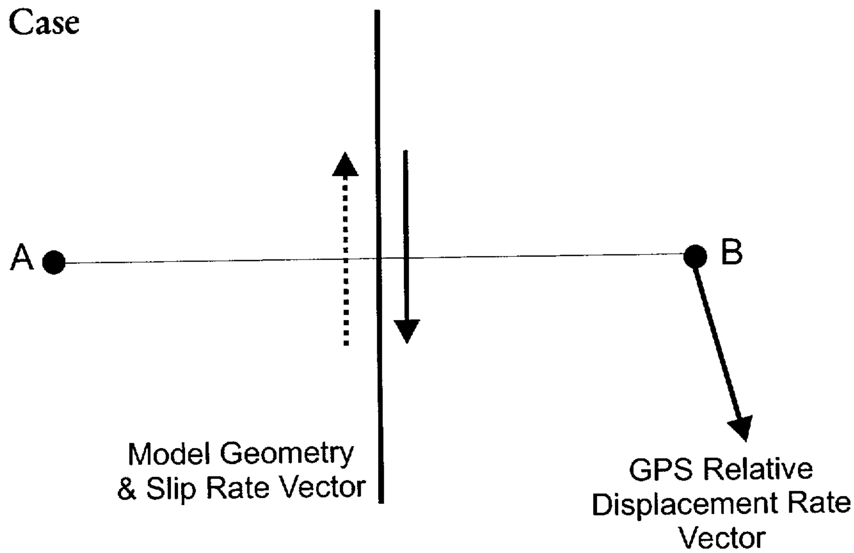
INCREMENTAL RELATIVE DISPLACEMENT RATES

SONGS Seismic Study

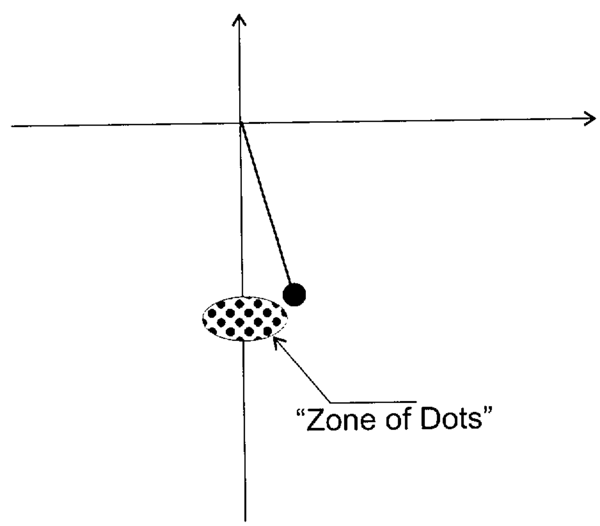
Figure
3-16

2001 Projects\01050B ...\Figures\Fig3-16.CDR

a) Actual Case



b) Summary Plot



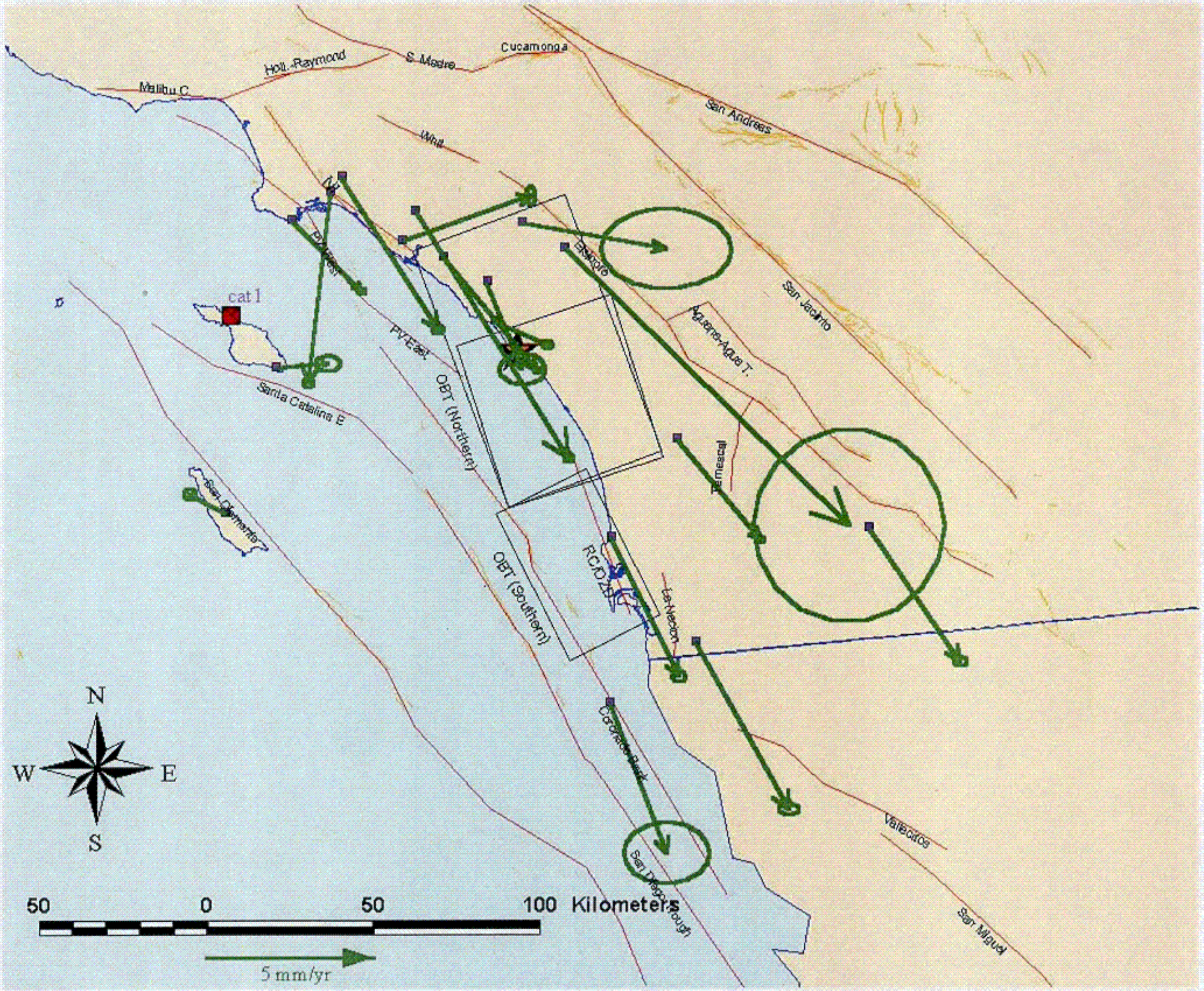
2001 Projects\01050B ...\Figures\Fig3-17.CDR

SUMMARY PLOT

SONGS Seismic Study

Figure
3-17

_2001 Projects\01050B ...\Figures\Fig3-18.CDR



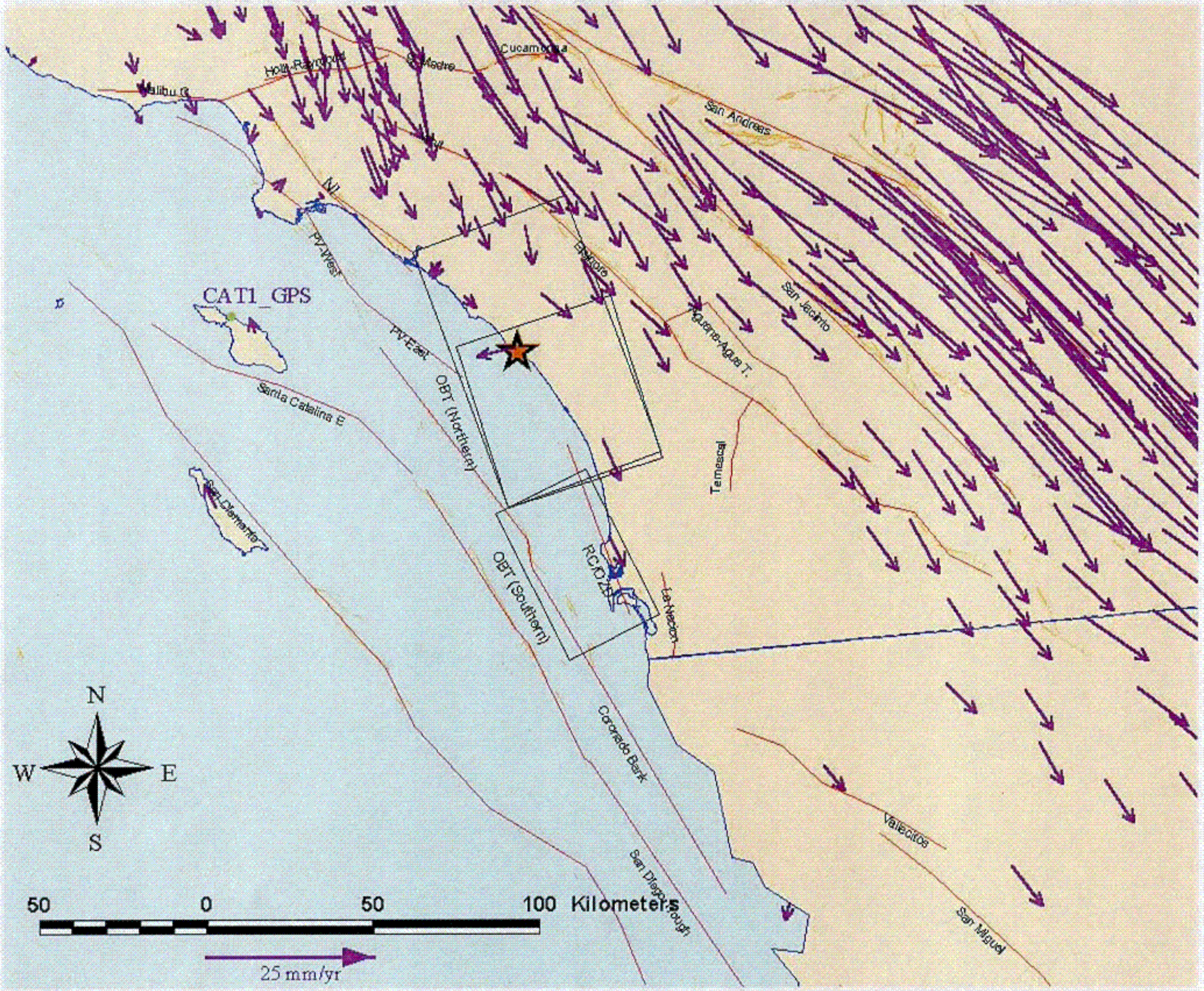
GENERAL PATTERN OF GPS RELATIVE DISPLACEMENT RATE VECTORS WITH RESPECT TO CAT1
(SCIGN GPS STATIONS)

SONGS Seismic Study

Figure
3-18

C03

_2001 Projects\01050B ...\Figures\Fig3-19a.CDR



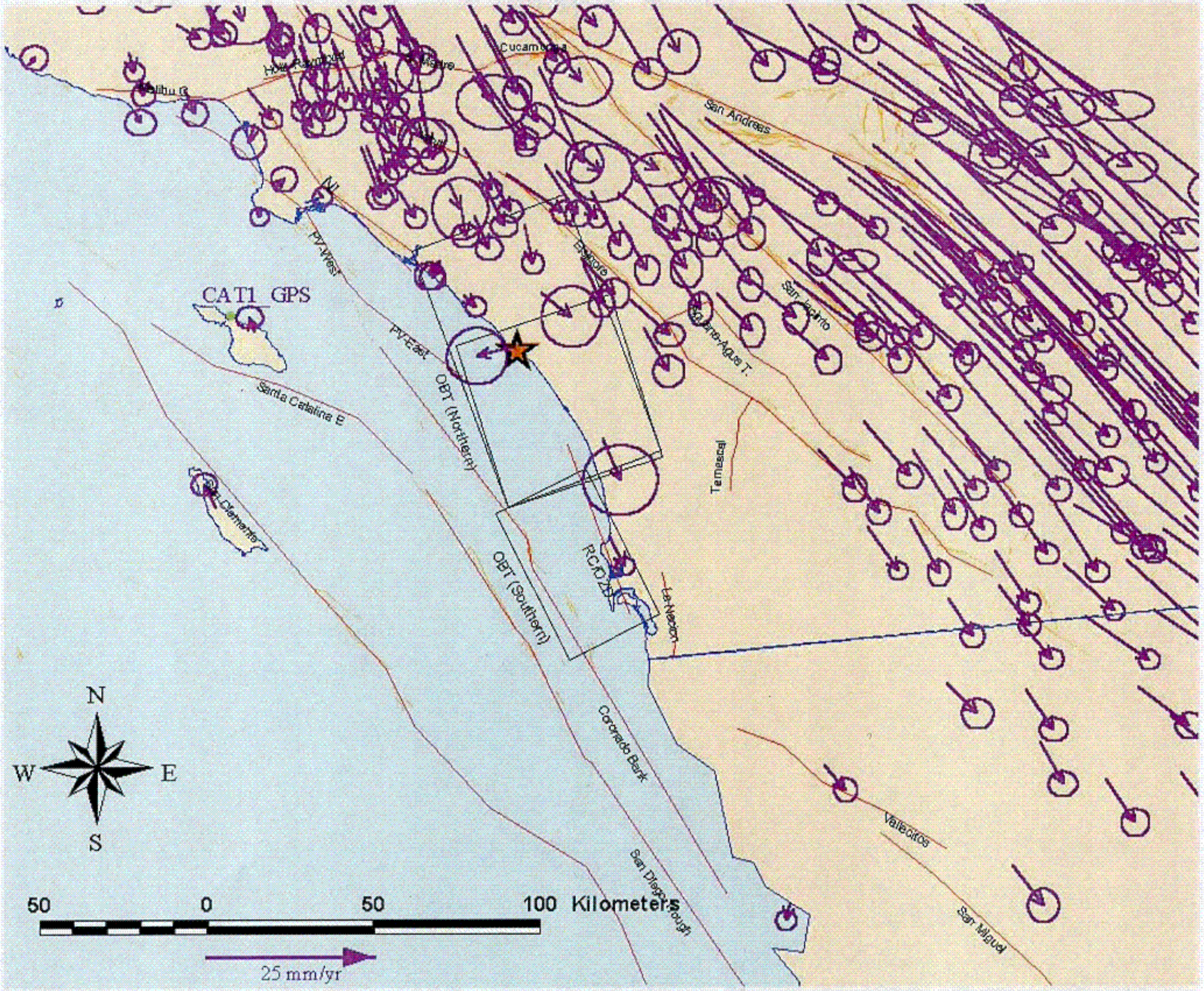
GENERAL PATTERN OF GPS RELATIVE DISPLACEMENT RATE VECTORS WITH RESPECT TO CAT1
(SCEC VERSION 2 STATIONS)

SONGS Seismic Study

Figure
3-19a

c04

_2001 Projects\01050B ...\Figures\Fig3-19b.CDR



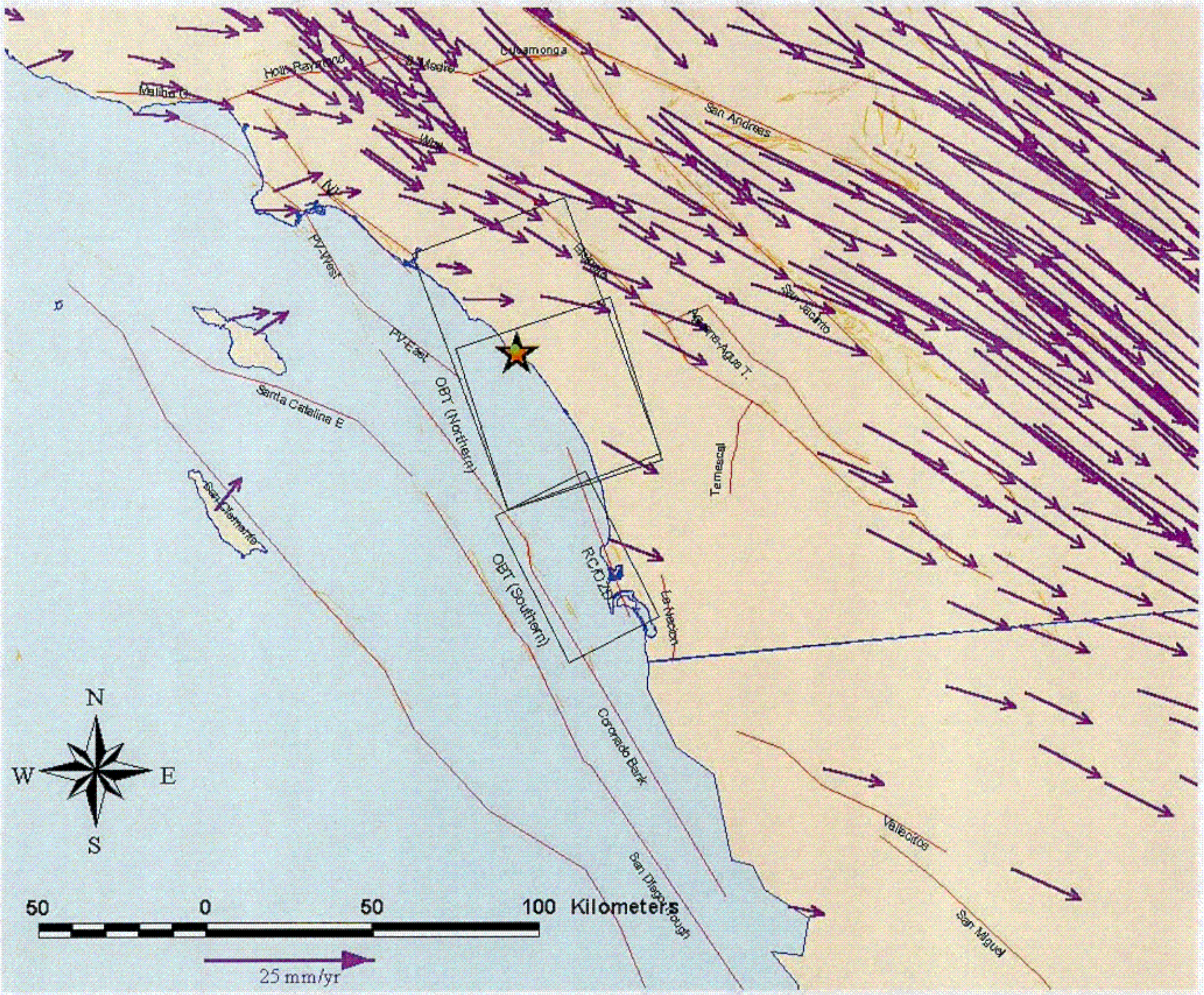
GENERAL PATTERN OF GPS RELATIVE DISPLACEMENT RATE VECTORS WITH ERROR ELLIPSES WITH RESPECT TO CAT1
(SCEC VERSION 2 STATIONS)

SONGS Seismic Study

Figure
3-19b

C05

_2001 Projects\01050B ...\Figures\Fig3-20a.CDR



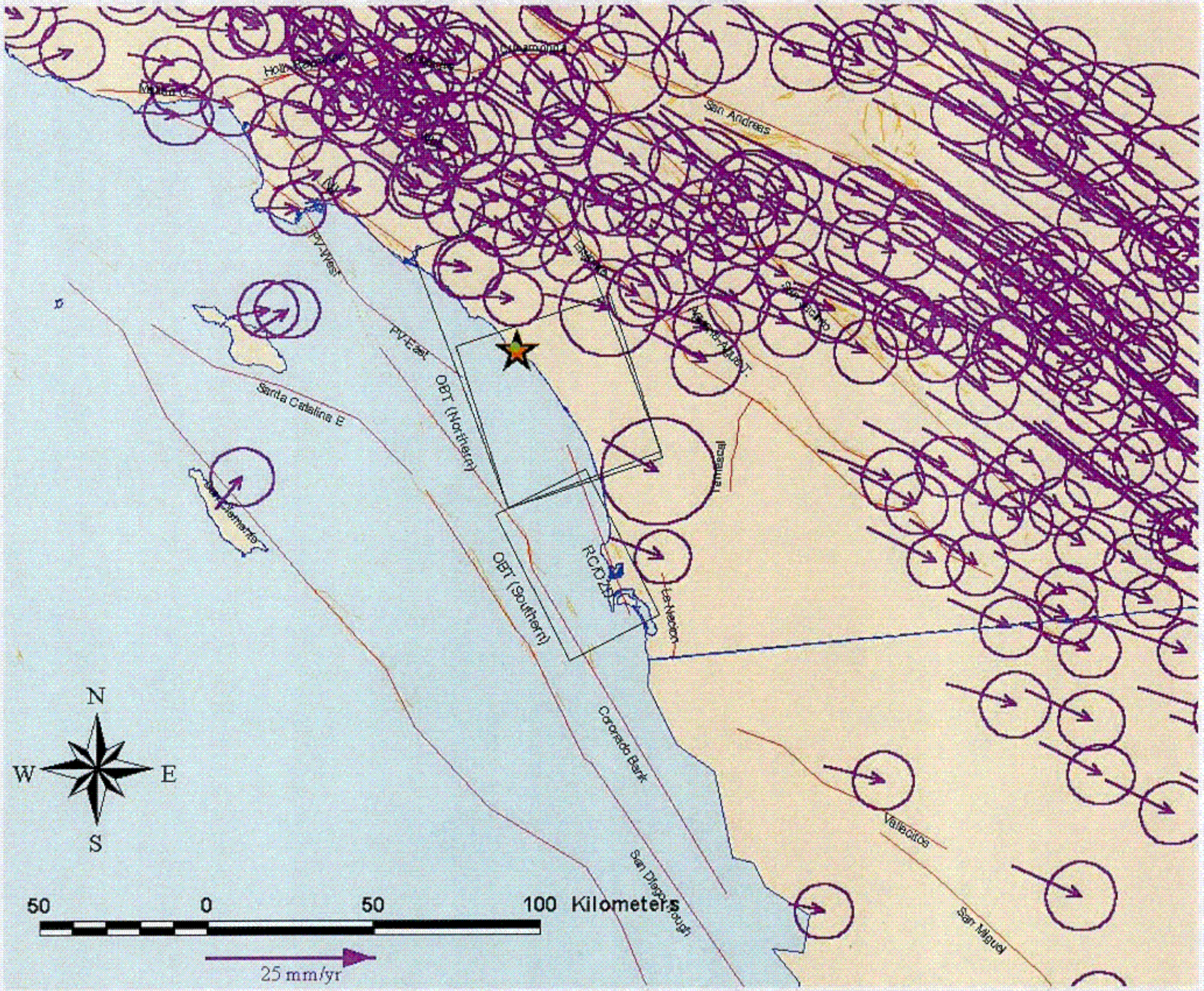
GENERAL PATTERN OF GPS RELATIVE DISPLACEMENT RATE VECTORS WITH RESPECT TO SONGS STATION
(SCEC VERSION 2 STATIONS)

SONGS Seismic Study

Figure
3-20a

C04

_2001 Projects\01050B ...\Figures\Fig3-20b.CDR



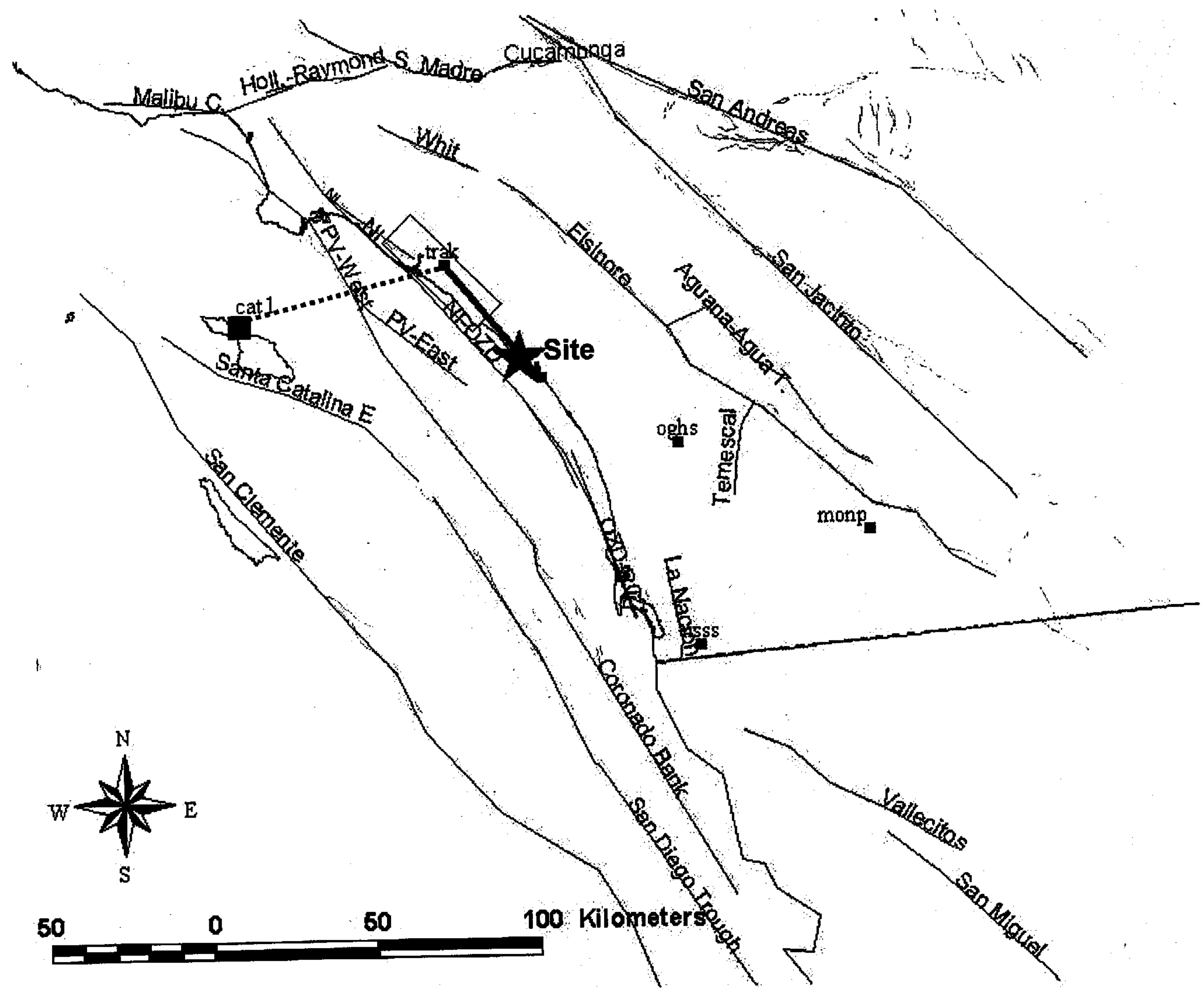
GENERAL PATTERN OF GPS RELATIVE DISPLACEMENT RATE VECTORS WITH ERROR ELLIPSES WITH RESPECT TO SONGS STATION (SCEC VERSION 2 STATIONS)

SONGS Seismic Study

Figure
3-20b

C07

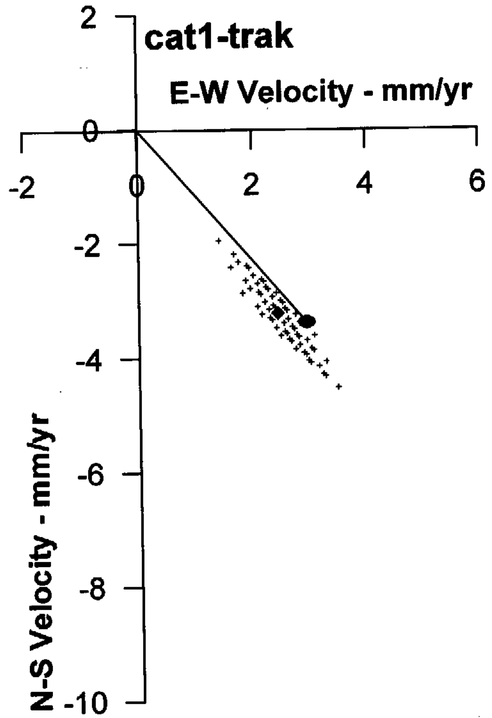
_2001 Projects\01050B ...\Figures\Fig3-21.CDR



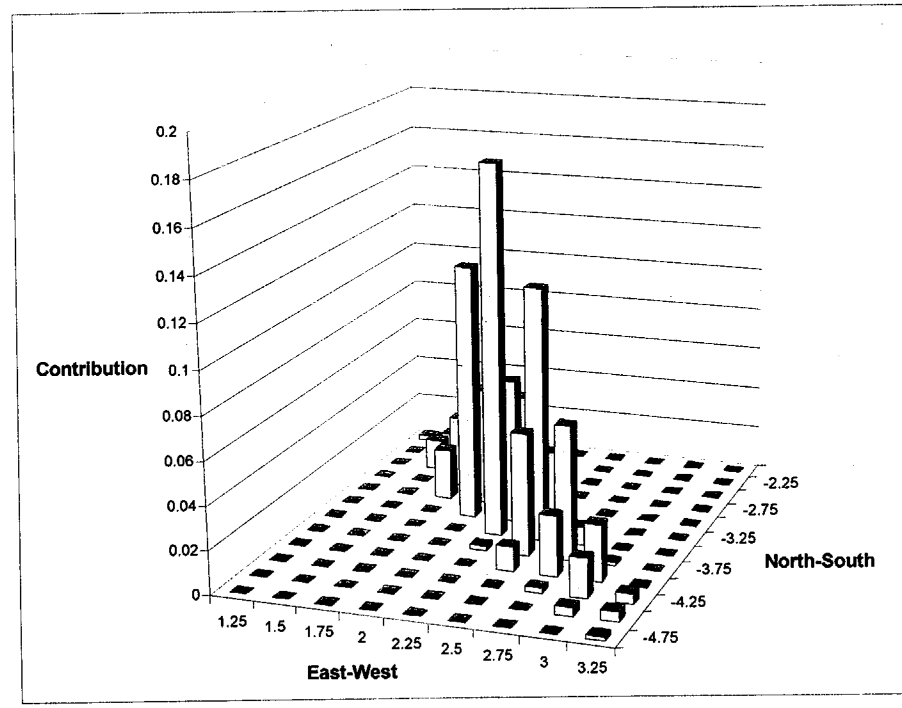
SCIGN GPS STATIONS - CAT1 & TRAK

SONGS Seismic Study

Figure
3-21



a) Summary Plot



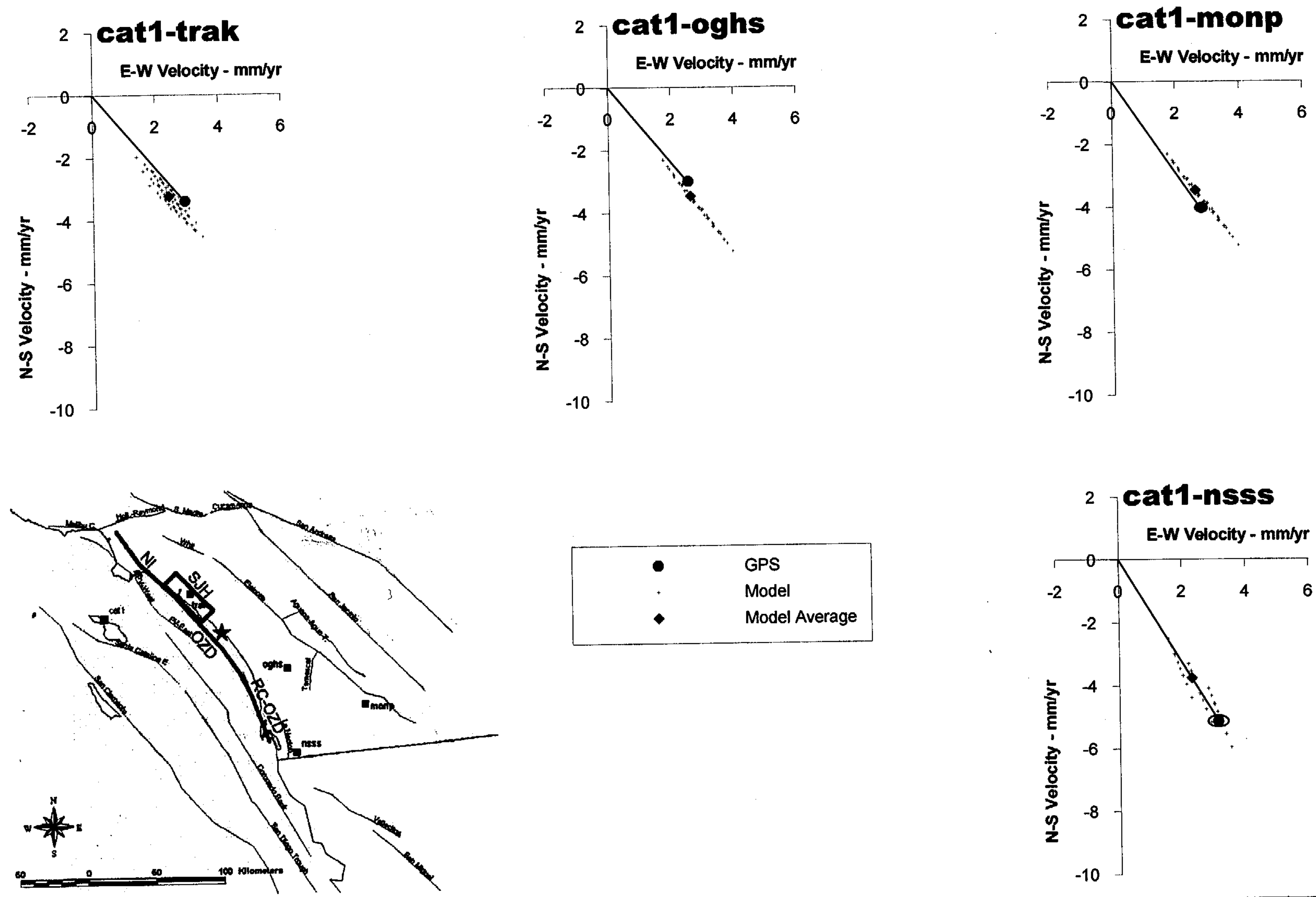
b) Associated Histogram of Slip Rate Vector Tips

SUMMARY PLOT FOR CAT1-TRAK &
ASSOCIATED HISTOGRAM OF SLIP RATE VECTOR TIPS

SONGS Seismic Study

Figure
3-22

2001 Projects\01050B SONGS...\Figures\Fig3-23.grf

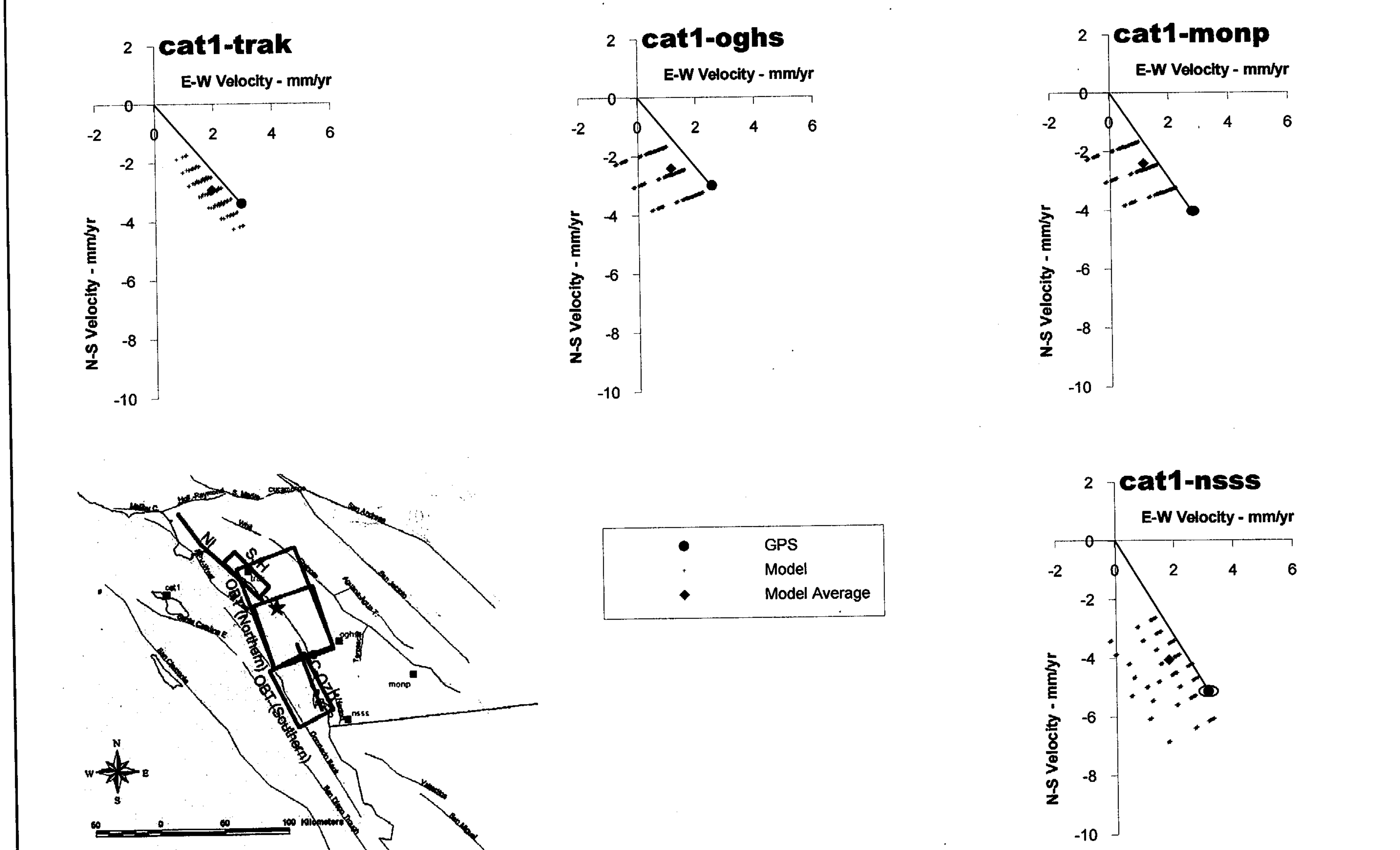


SUMMARY PLOT OF TOTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 1

SONGS Seismic Study

Figure
3-23

2001 Projects\01050B SONGS...\Figures\Fig3-24.grf

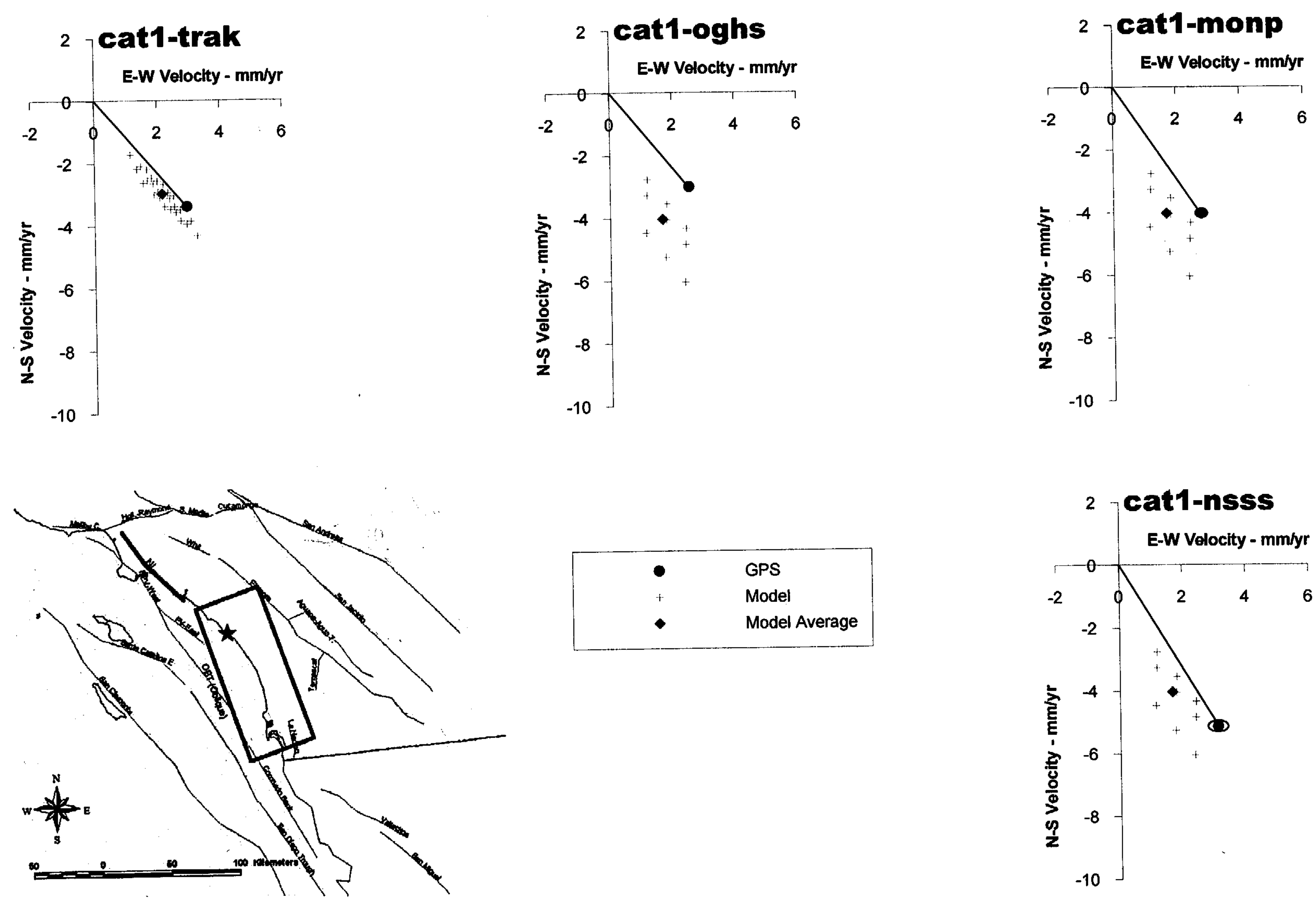


SUMMARY PLOT OF TOTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 2

SONGS Seismic Study

Figure
3-24

2001 Projects\01050B SONGS...\Figures\Fig3-24.grf

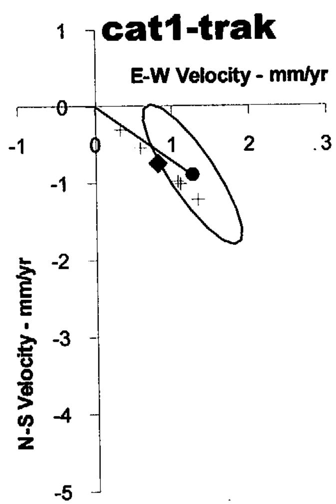


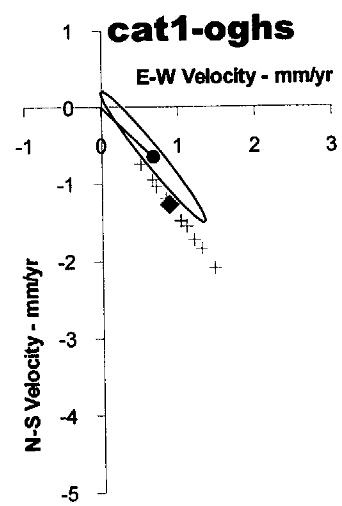
SUMMARY PLOT OF TOTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 3

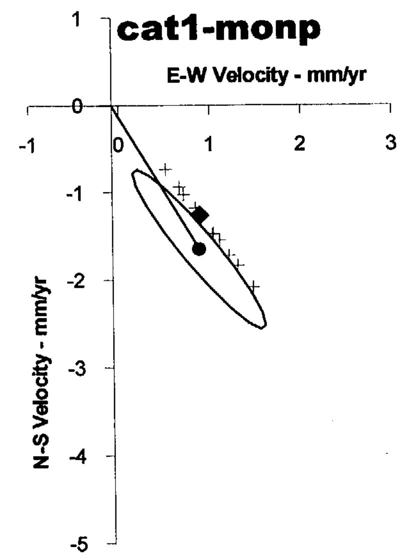
SONGS Seismic Study

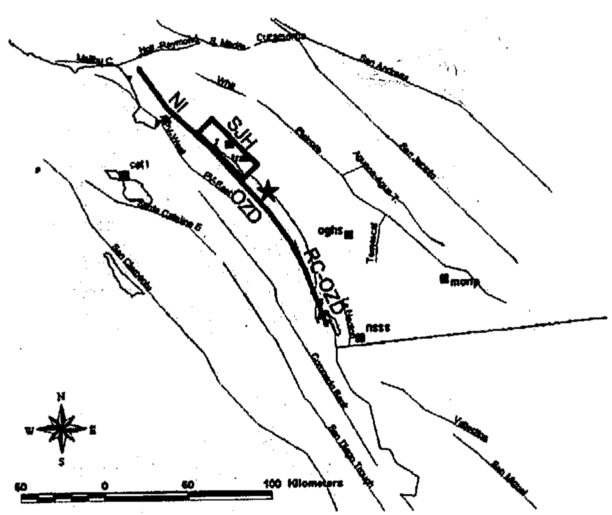
Figure
3-25

2001 Projects\01050B SONGS...\Figures\Fig3-26.grf

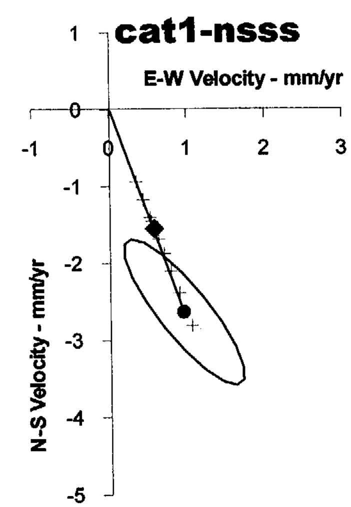








● GPS
+ Model
◆ Model Average

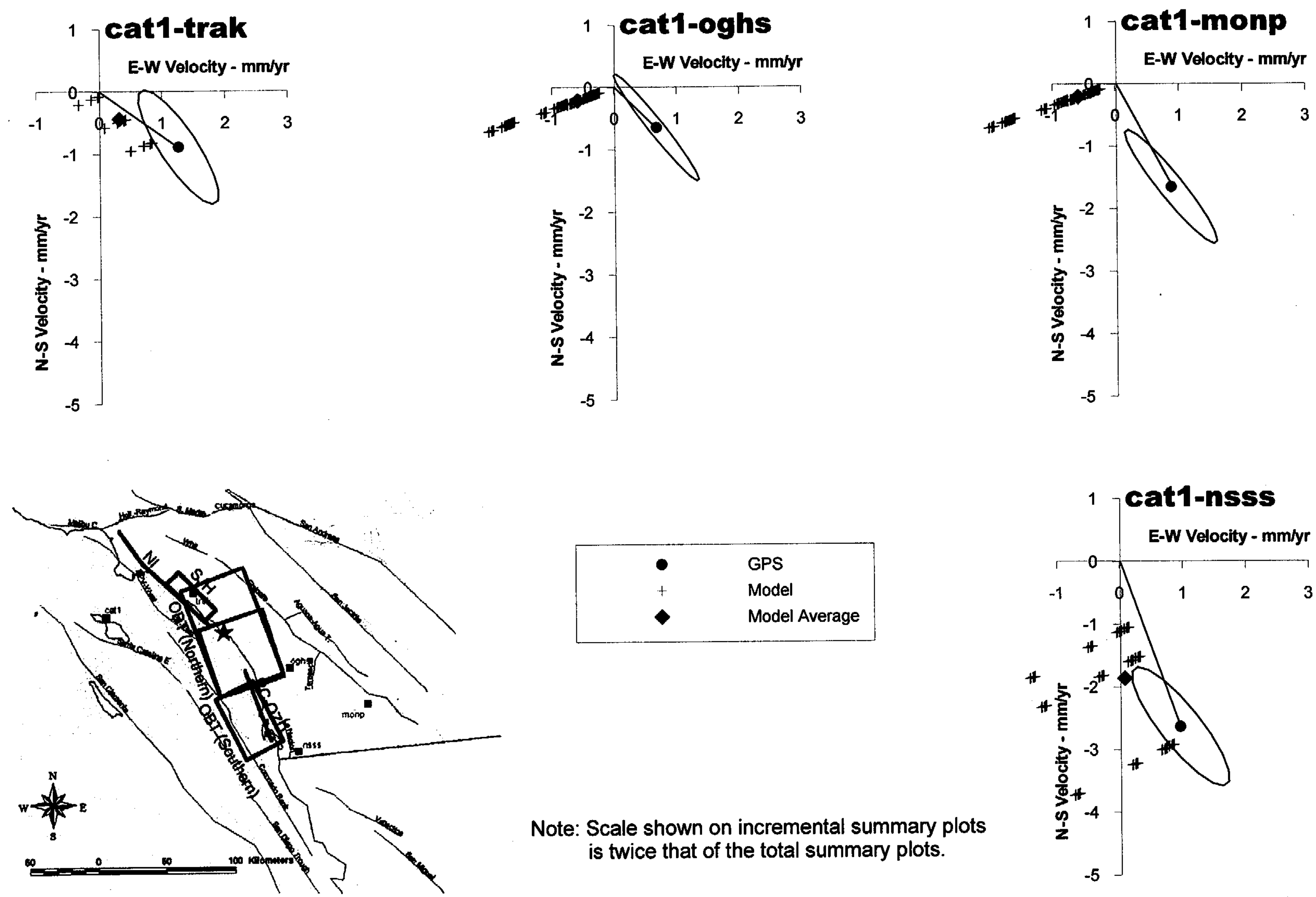


Note: Scale shown on incremental summary plots is twice that of the total summary plots.

SUMMARY PLOT OF INCREMENTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 1

SONGS Seismic Study

Figure
3-26

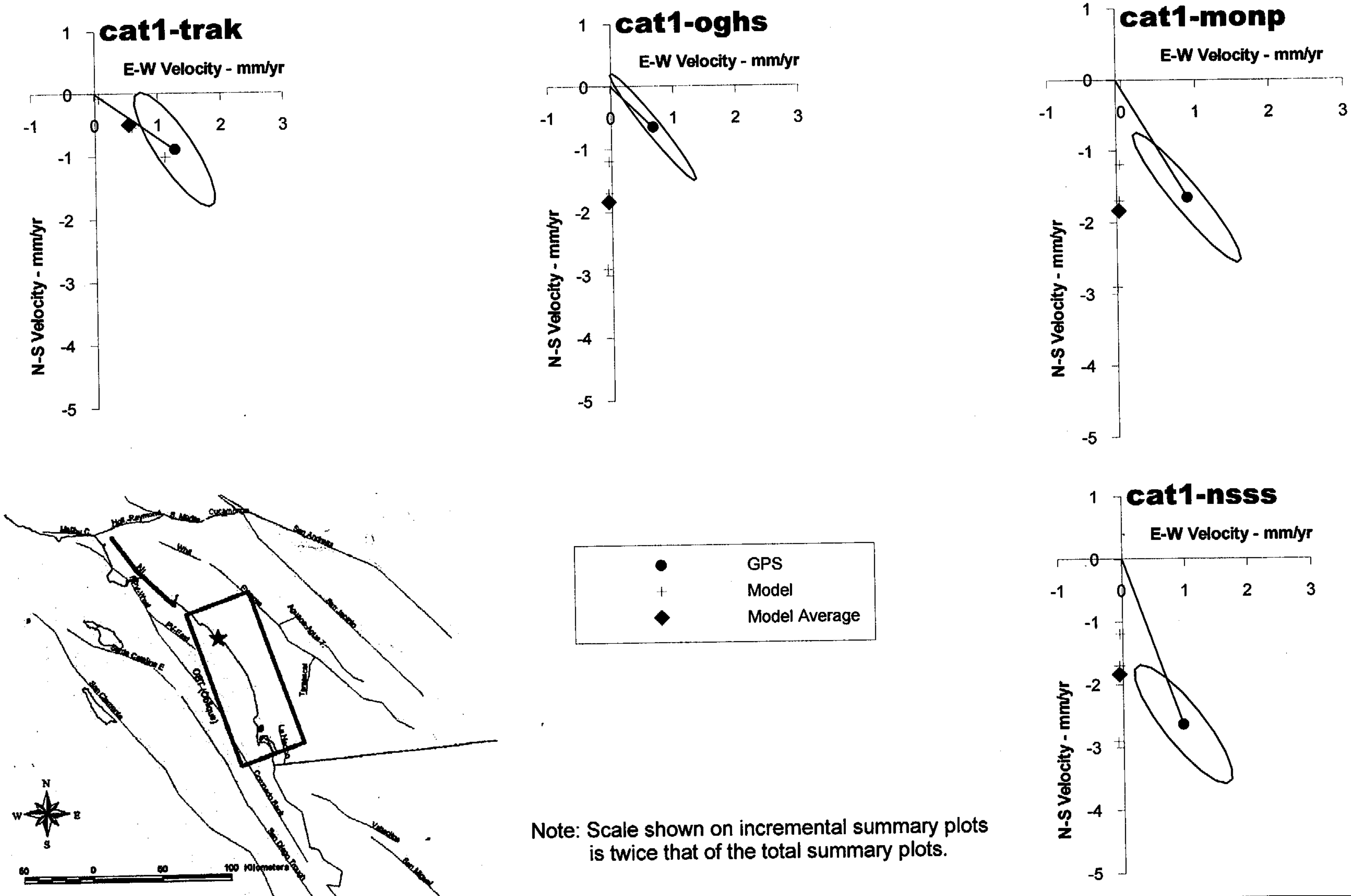


SUMMARY PLOT OF INCREMENTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 2

SONGS Seismic Study

Figure
3-27

2001 Projects\01050B SONGS...\Figures\Fig3-28.grf

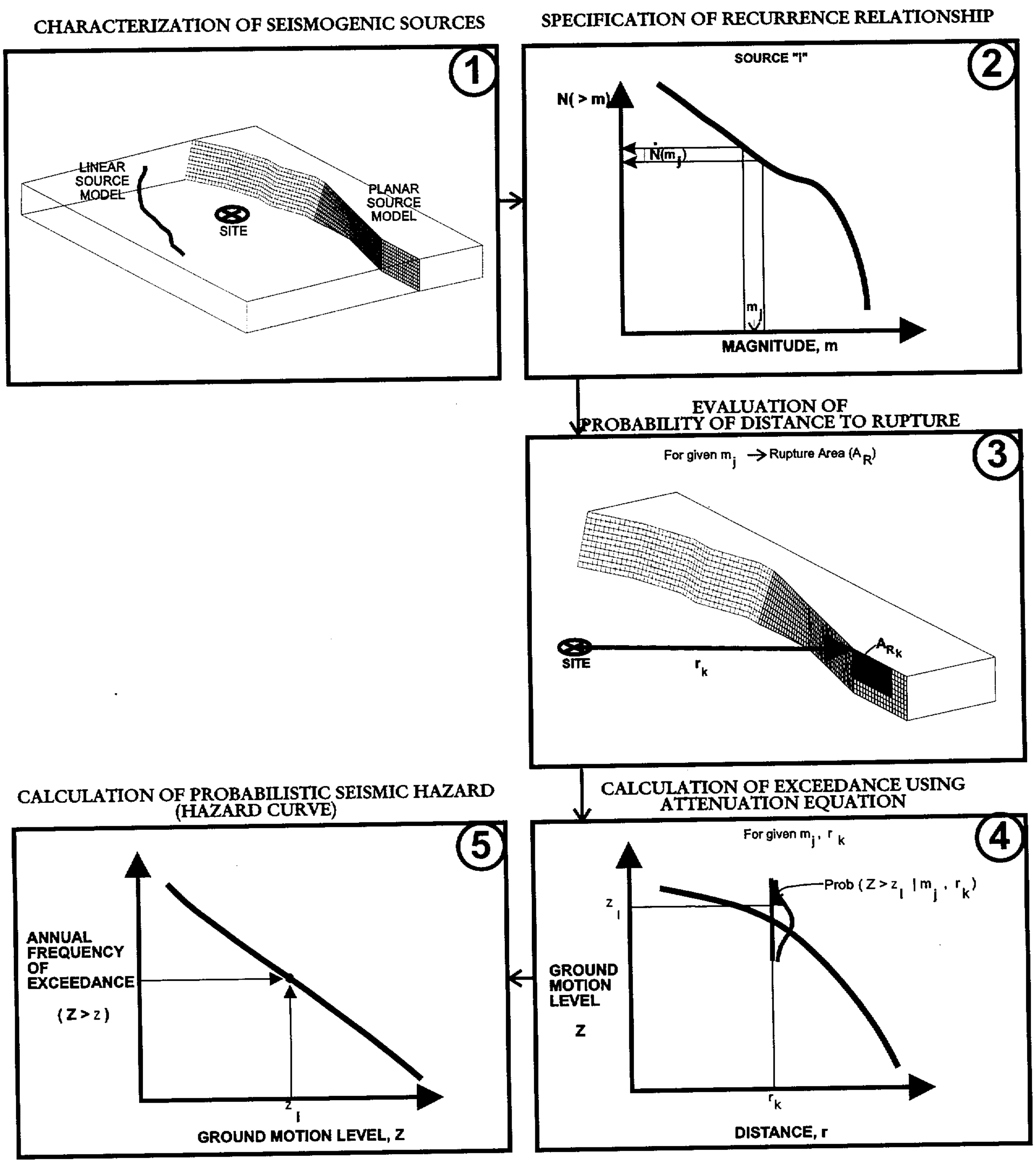


Note: Scale shown on incremental summary plots is twice that of the total summary plots.

SUMMARY PLOT OF INCREMENTAL RELATIVE DISPLACEMENT RATE VECTOR TIPS & SLIP RATES
MODEL 3

SONGS Seismic Study

Figure
3-28

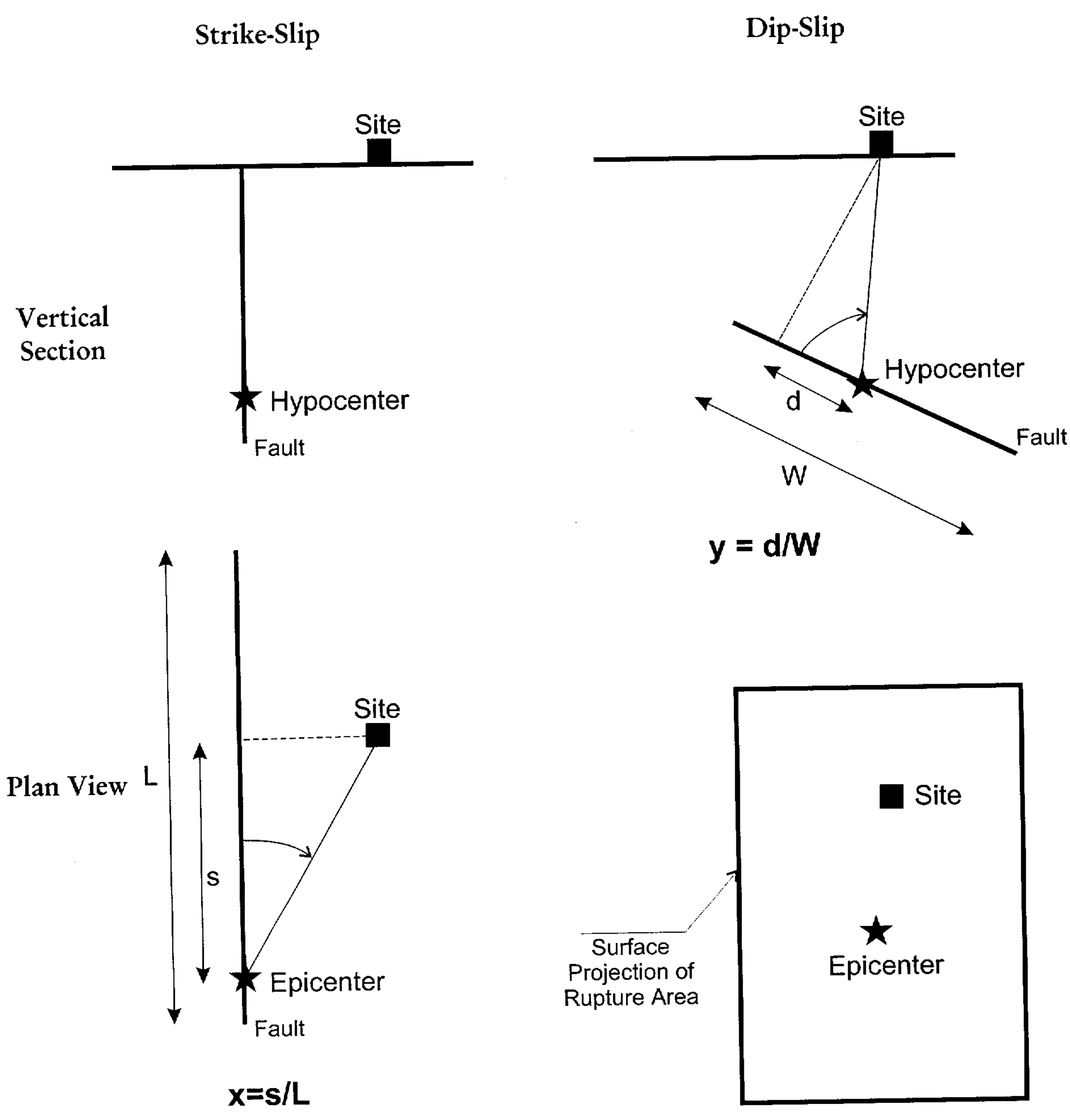


PROBABILISTIC SEISMIC HAZARD ANALYSIS (PSHA) METHODOLOGY

SONGS Seismic Study

Figure 4-1

2001 Projects\01050B ...\Figures\Fig4-1.CDR



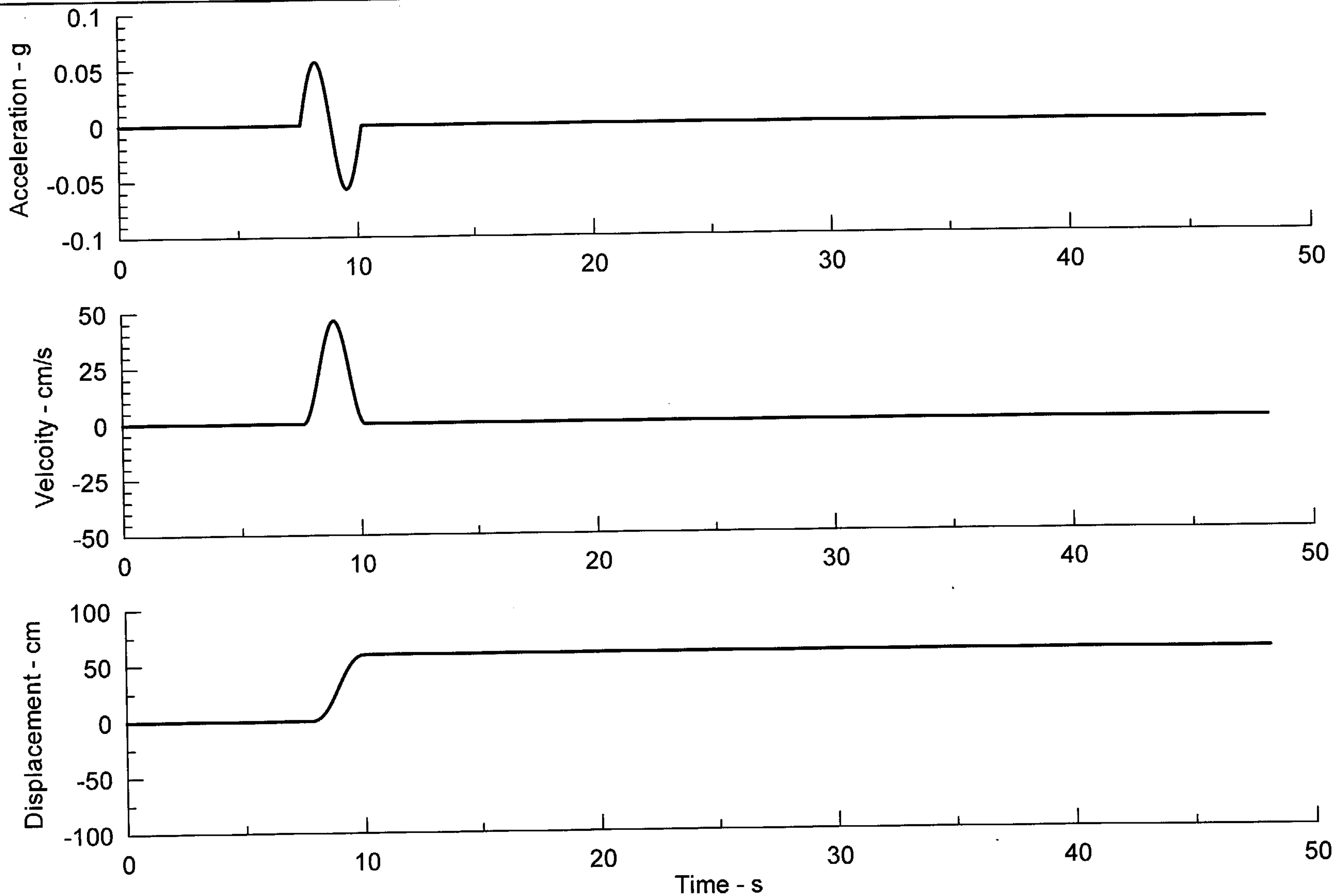
2001 Projects\01050B ...\Figures\Fig4-2.CDR

DEFINITION OF RUPTURE DIRECTIVITY PARAMETERS
STRIKE-SLIP & DIP-SLIP

SONGS Seismic Study

Figure
4-2

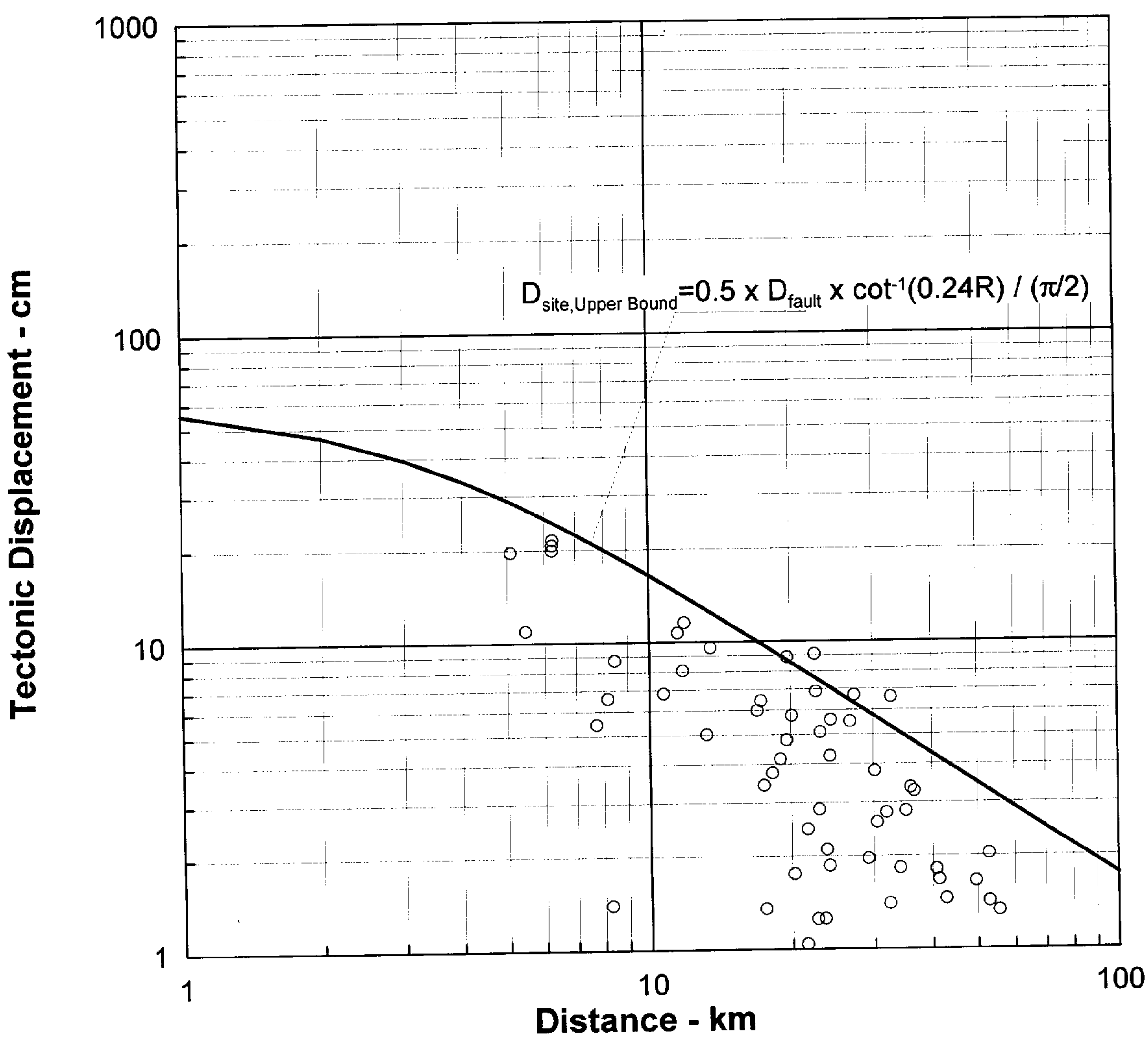
c:\project\songs\fling\Lucerne\fling\fig4-3.grf



FLING FUNCTIONAL FORM
ACCELERATION, VELOCITY, & DISPLACEMENT TIME HISTORIES

SONGS Seismic Study

Figure
4-3



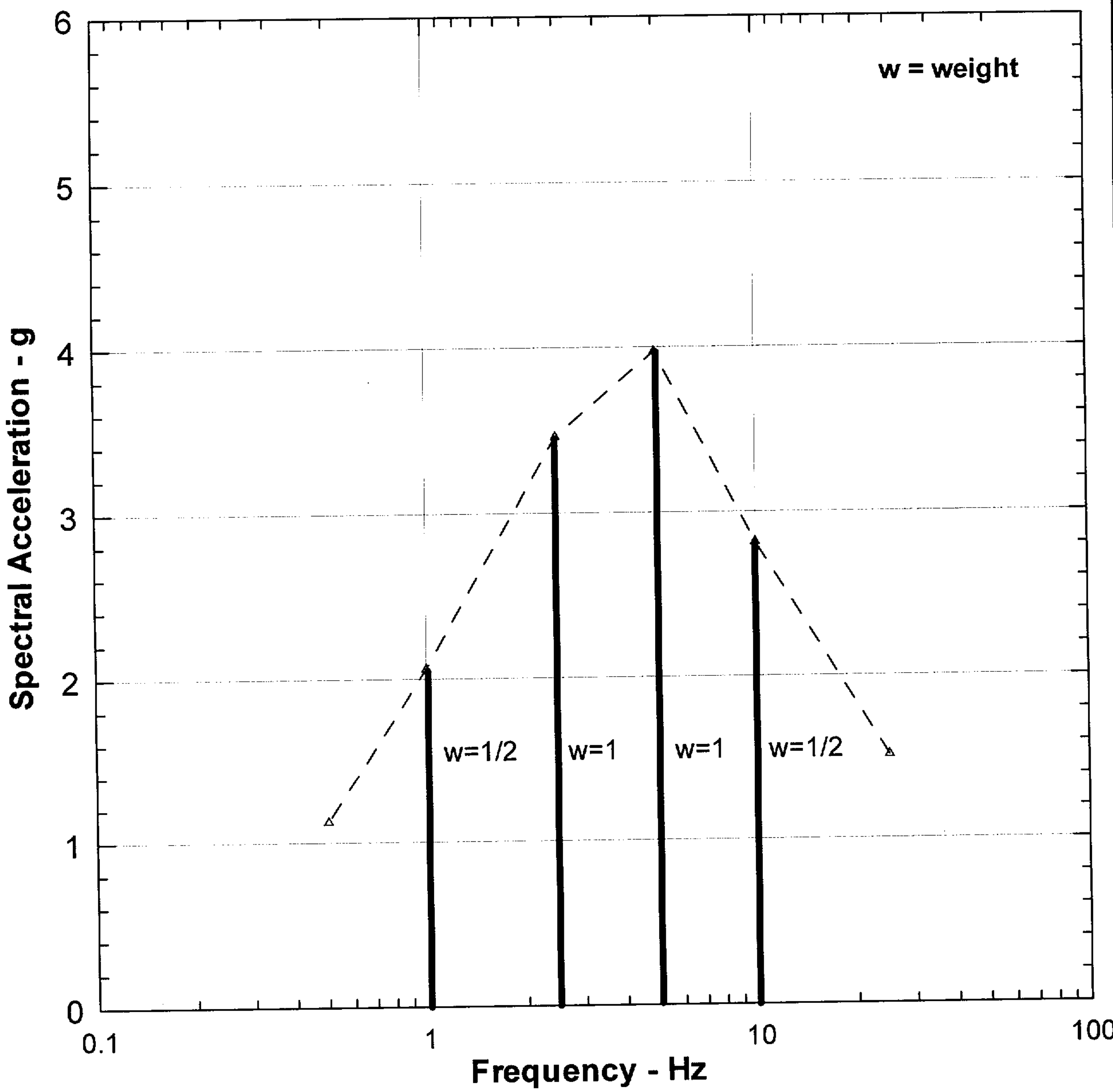
c:\project\songs\Northridge\map\Fig4-4

TECTONIC DISPLACEMENT
1994 NORTHRIDGE EARTHQUAKE

SONGS Seismic Study

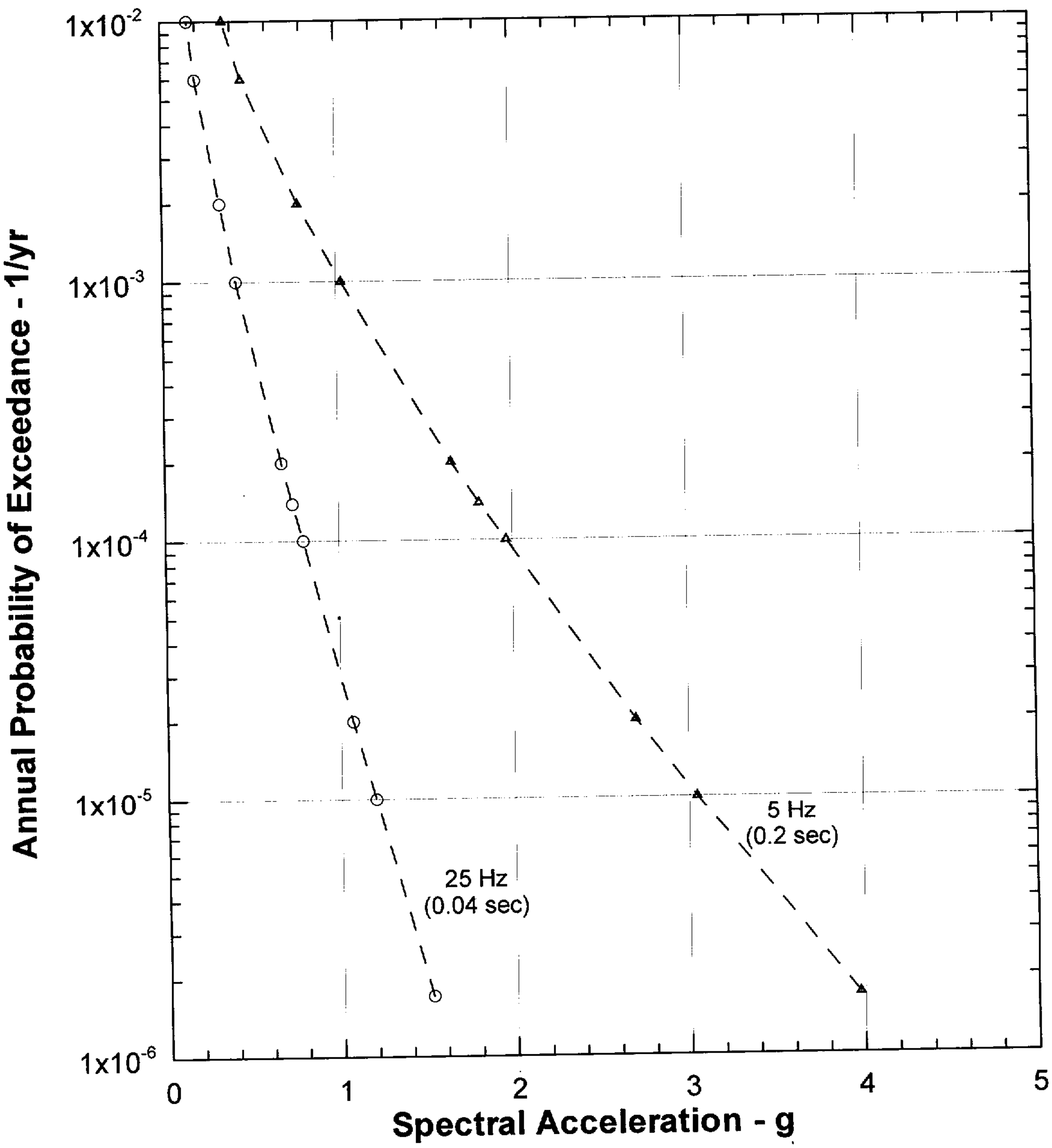
Figure
4-4

$$Sa_w = (1/2\ Sa_{10Hz} + Sa_{5Hz} + Sa_{2.5Hz} + 1/2\ Sa_{1Hz}) / 3$$



c:\project\songs\colleen\sum\suma\Fig4-5

WEIGHTED HAZARD CALCULATION SONGS Seismic Study	Figure **4-5**



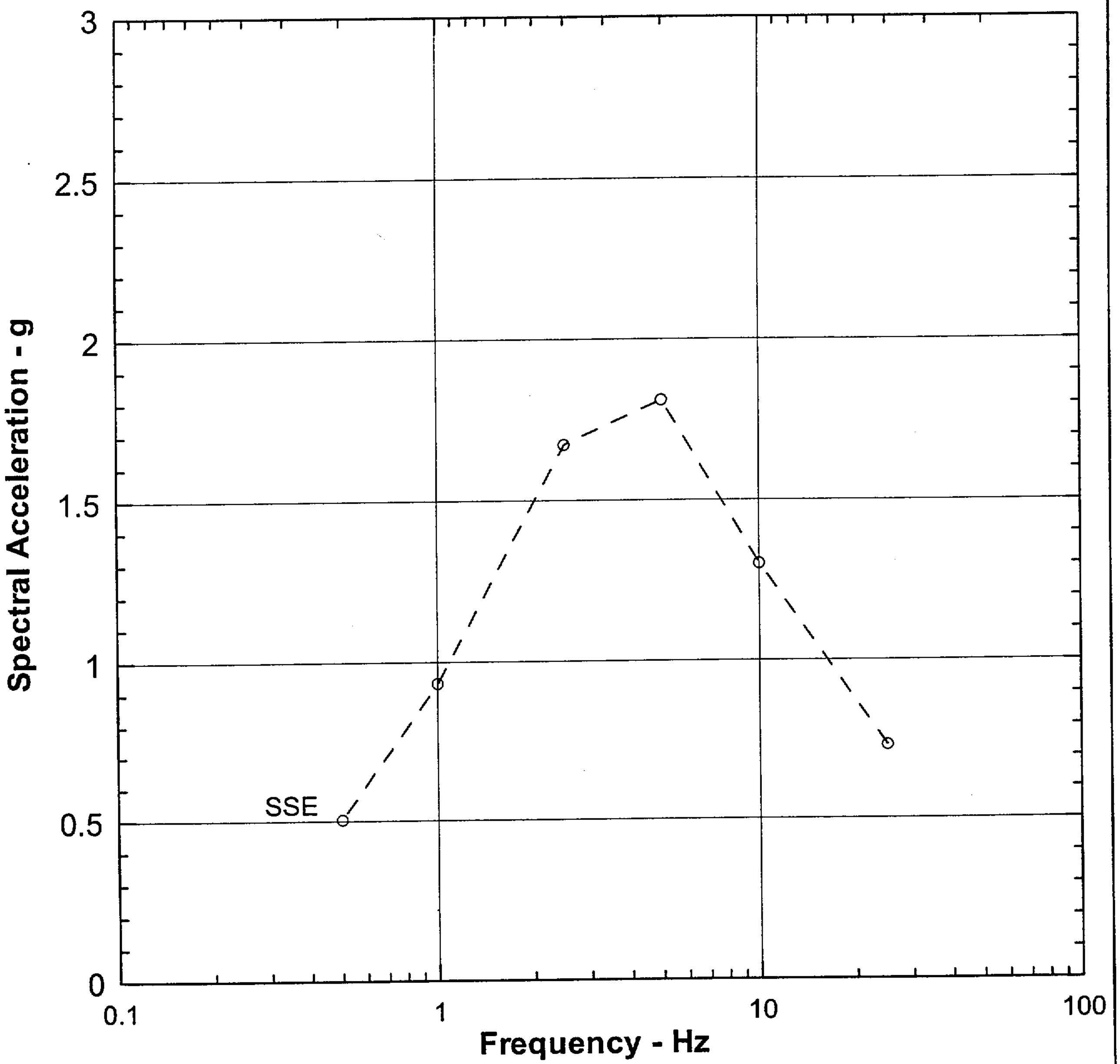
2001 projects\01050B SONGS...\PSHA\REI-1994\Fig4-6.grf

SONGS IPEEE HAZARD CURVES

SONGS Seismic Study

Figure 4-6

Shaking Level	Annual Probablitiy of Exceedance
	SONGS IPEEE
SSE	1.39×10^{-4}

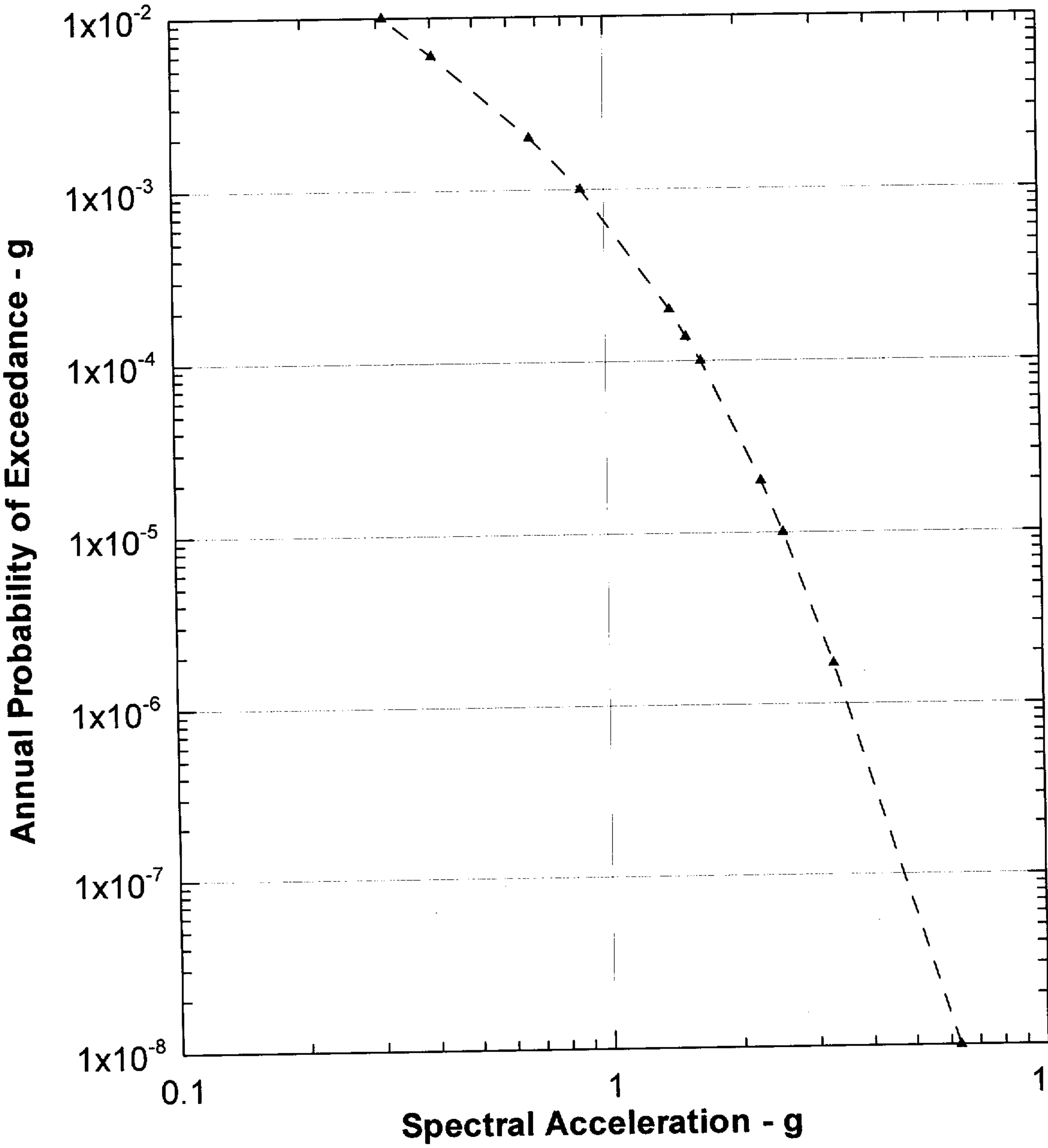


SONGS IPEEE RESPONSE SPECTRUM

SONGS Seismic Study

Figure
4-7

c:\project\songs\colleen\sum\suma\Fig4-7 (SSE)

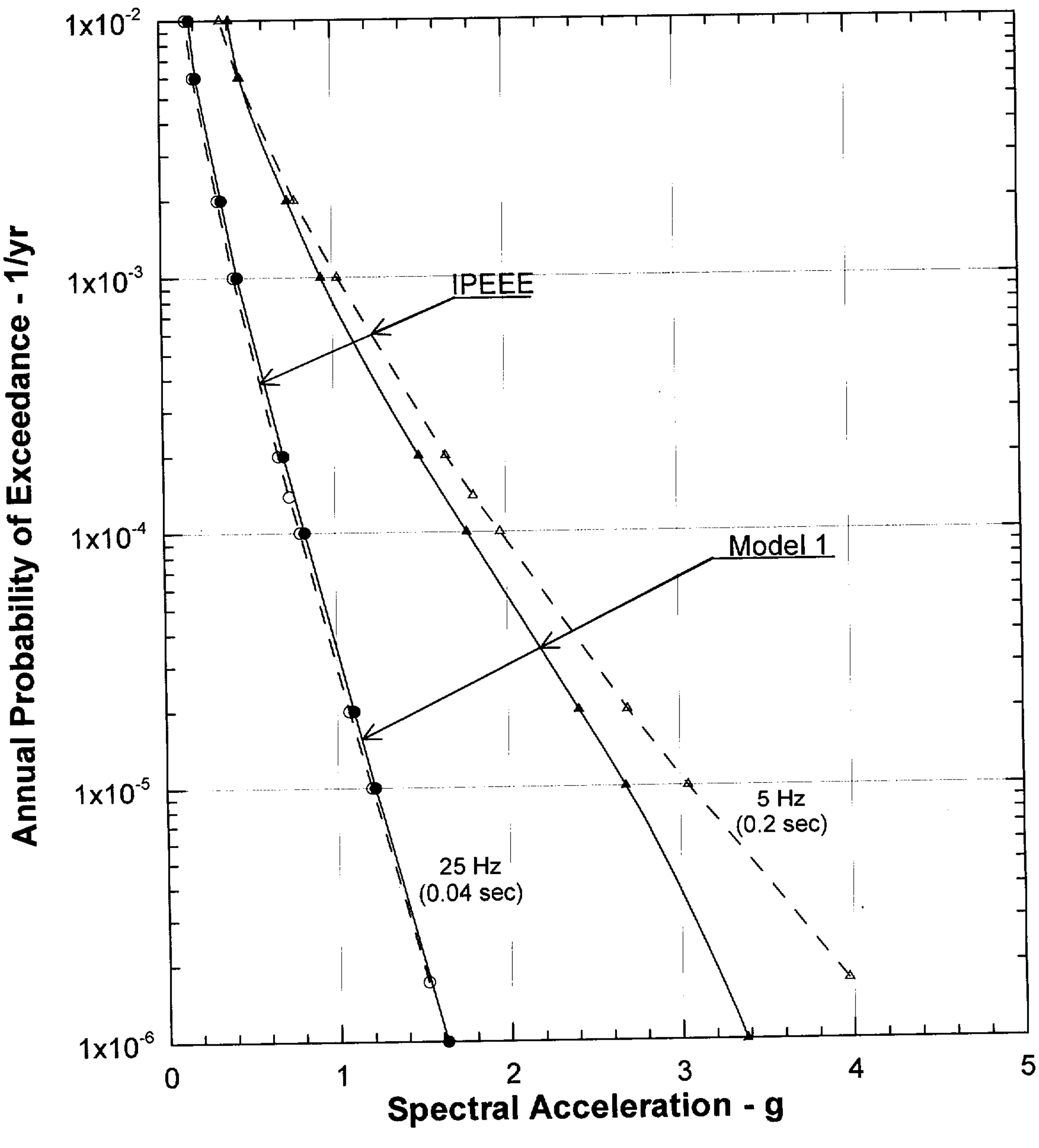


c:\project\songs\colleen\sum\suma\Fig4-8

SONGS IPEEE WEIGHTED HAZARD CURVE

.SONGS Seismic Study

Figure
4-8



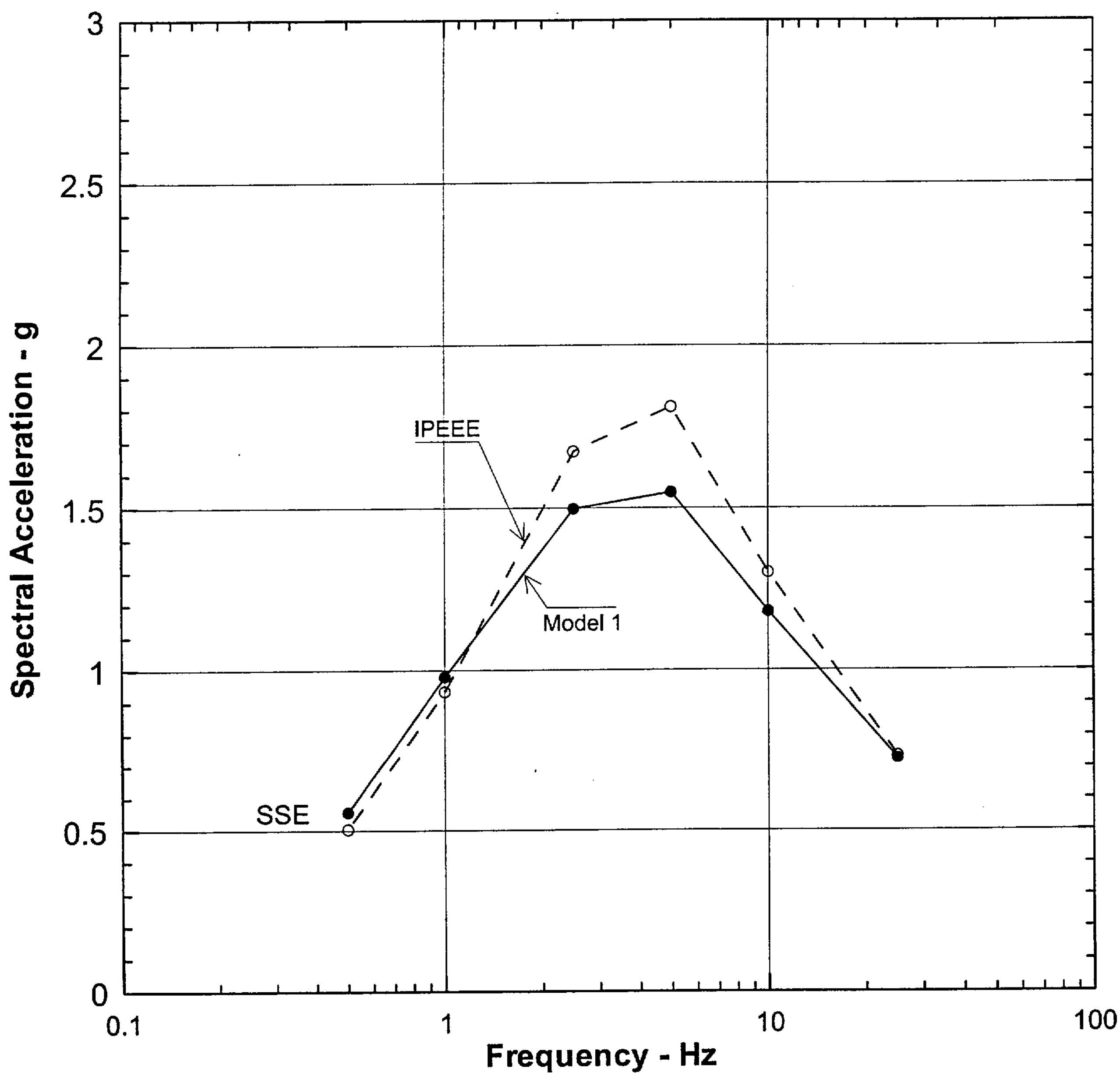
COMPARISON OF SONGS IPEEE & 2001 MODEL 1 HAZARD CURVES

SONGS Seismic Study

Figure
4-9

2001 projects\01050B SONGS...\PSHA\SUM\SumA\Fig4-9.grf

Shaking Level	Annual Probablitiy of Exceedance	
	SONGS IPEEE	2001
SSE	1.39x10^{-4}	1.74x10^{-4}

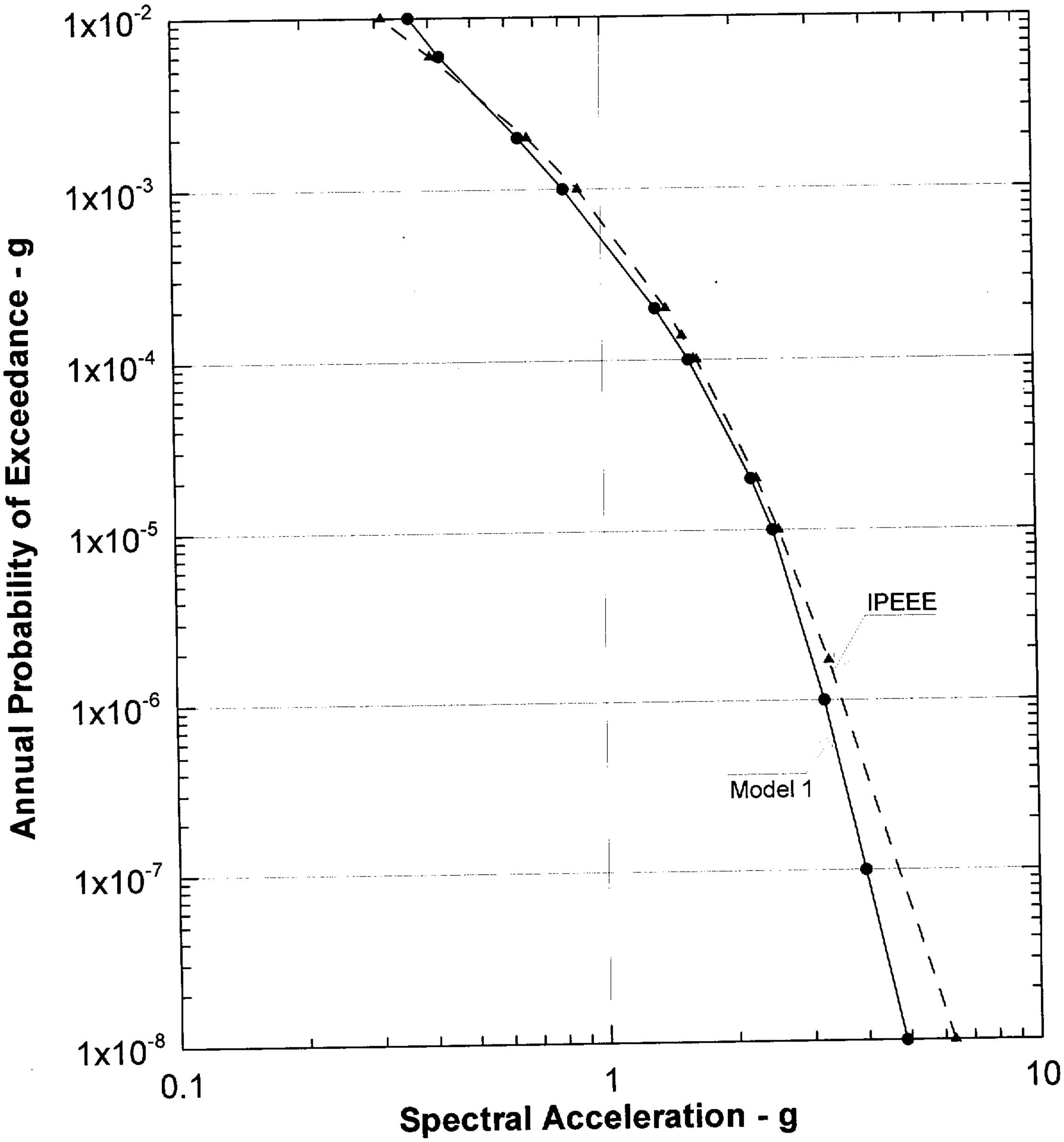


c:\project\songs\colleen\sum\suma\Fig4-10 (SSE)

COMPARISON OF SONGS IPEEE & 2001 MODEL 1 RESPONSE SPECTRA

SONGS Seismic Study

Figure
4-10

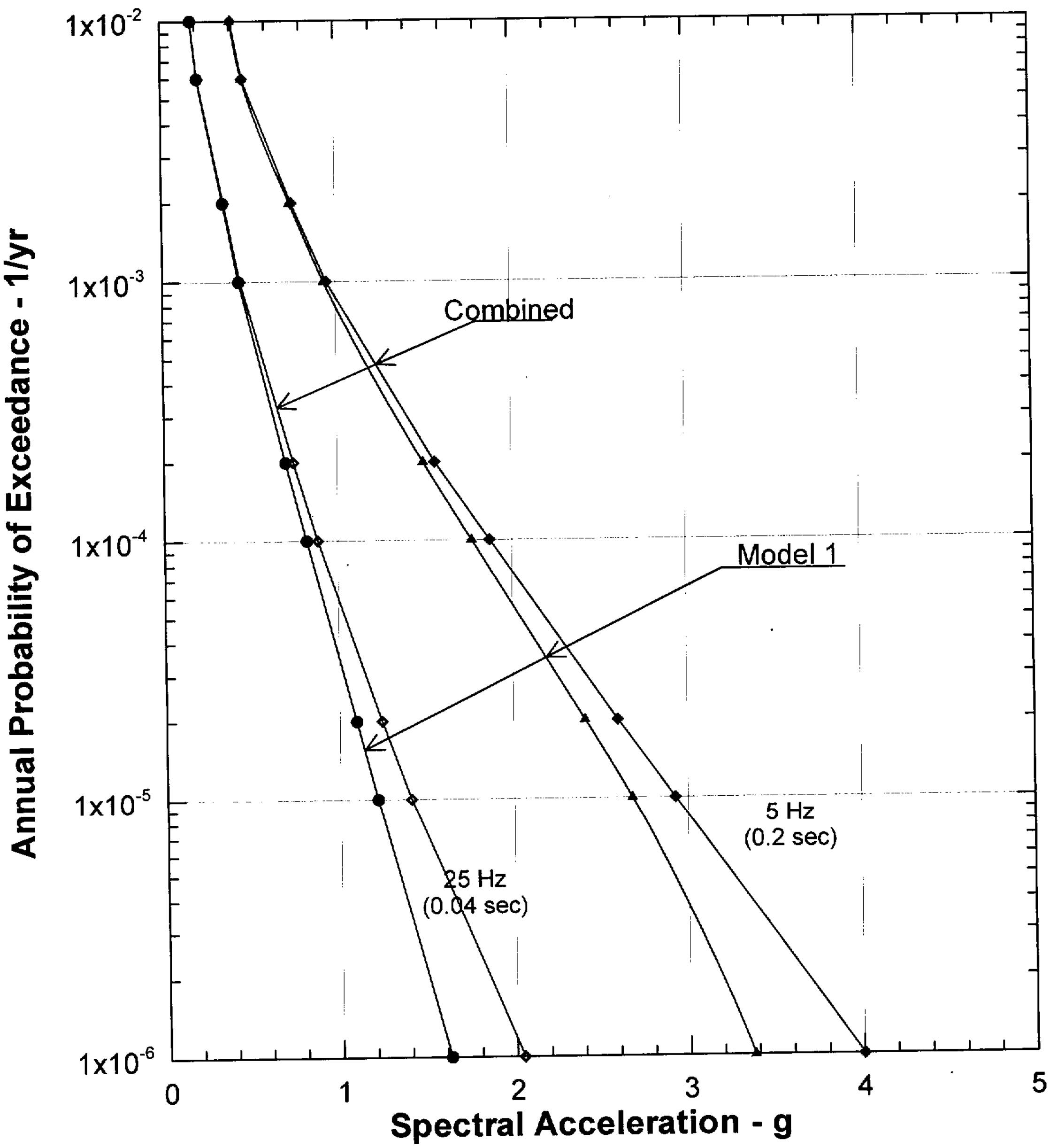


c:\project\songs\colleen\sum\suma\Fig4-11

COMPARISON OF SONGS IPEEE & 2001 MODEL 1 WEIGHTED HAZARD CURVES

SONGS Seismic Study

Figure
4-11



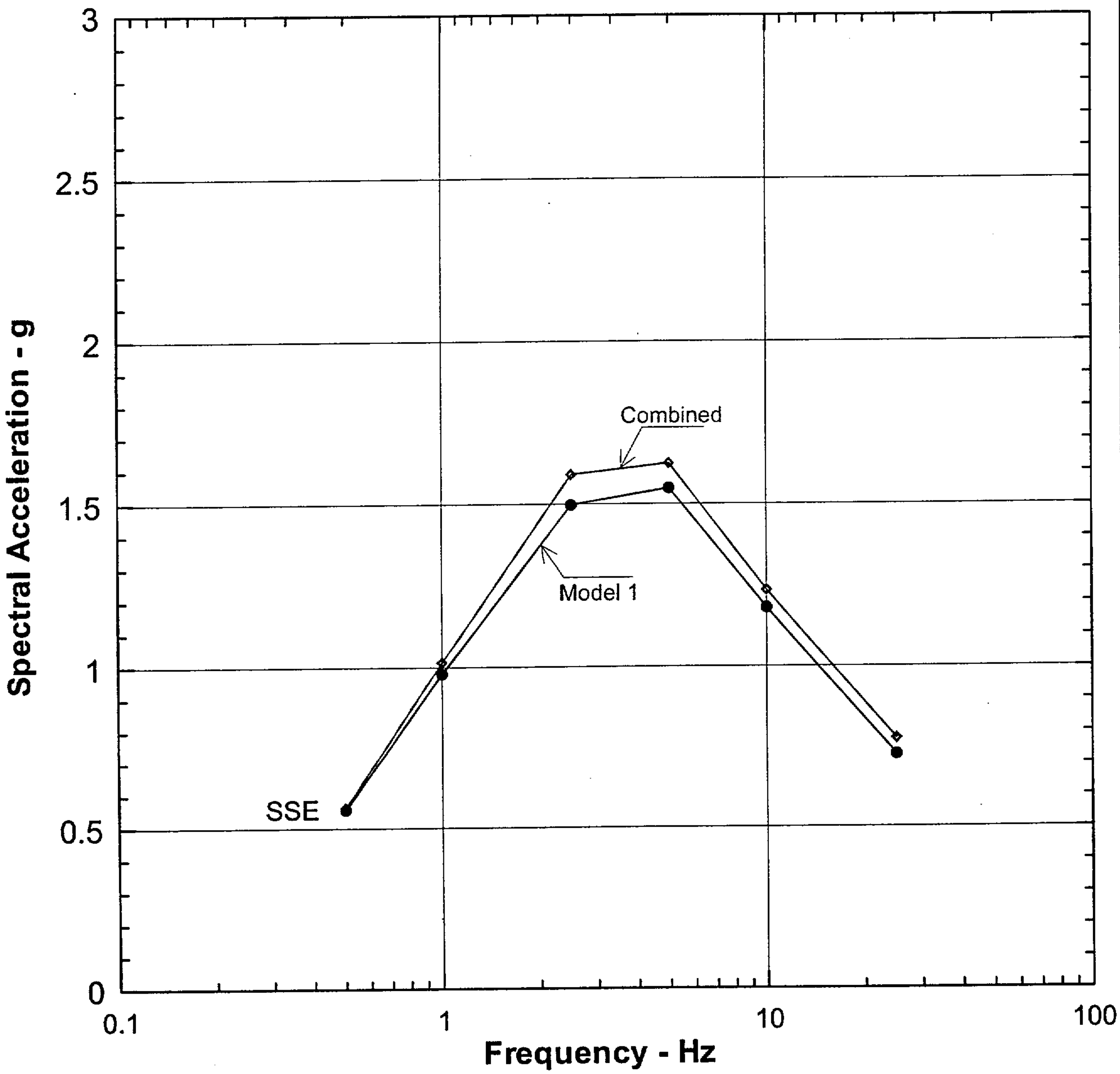
_2001 projects\01050B SONGS...\PSHA\SUM\SumA\Fig4-12.grf

EFFECTS OF OBT ON HAZARD CURVES

SONGS Seismic Study

Figure
4-12

Shaking Level	Annual Probablitiy of Exceedance
	2001
SSE	$1.74x10^{-4}$

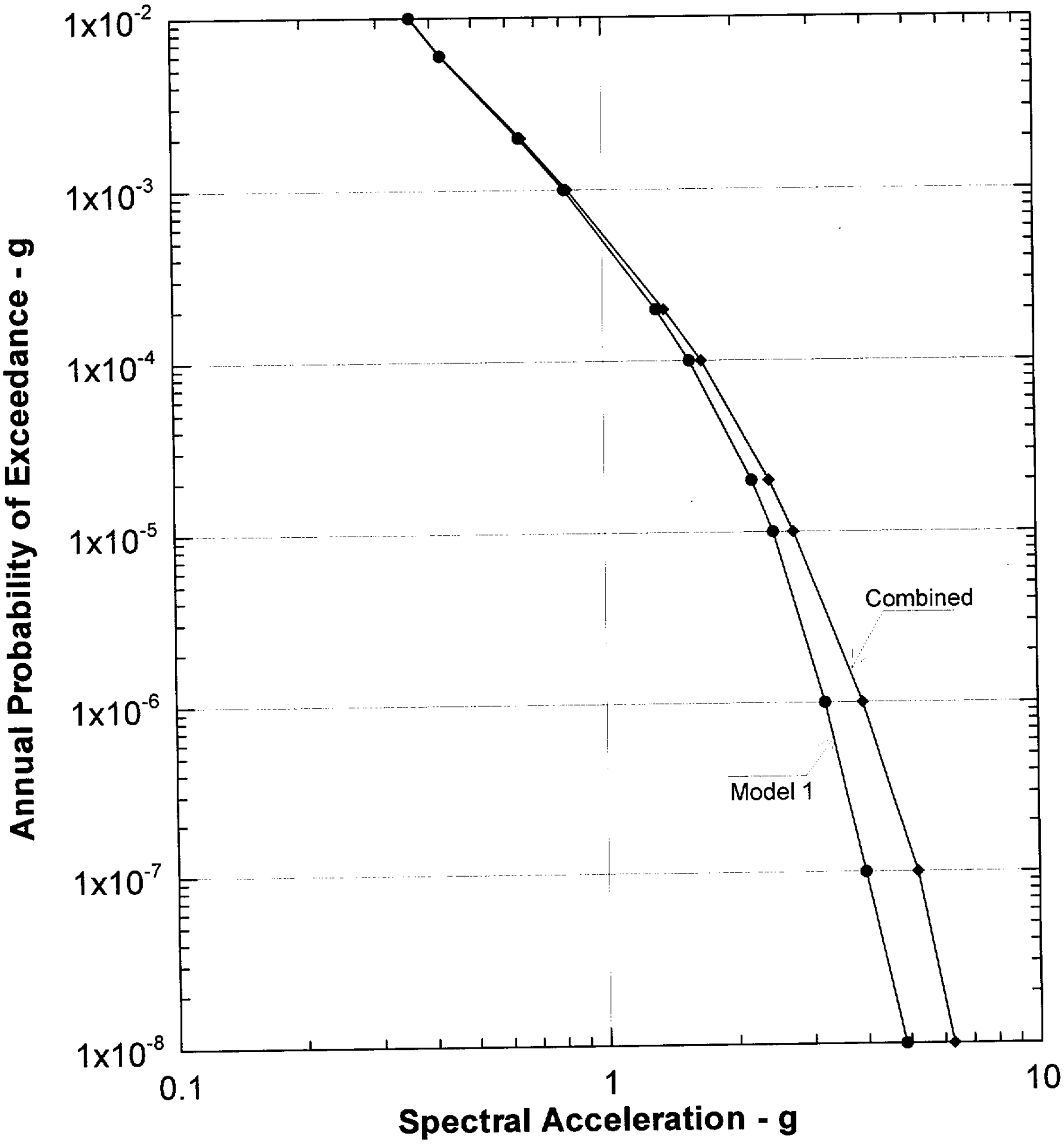


c:\project\songs\colleen\sum\suma\Fig4-13 (SSE)

EFFECTS OF OBT ON RESPONSE SPECTRA

SONGS Seismic Study

Figure 4-13

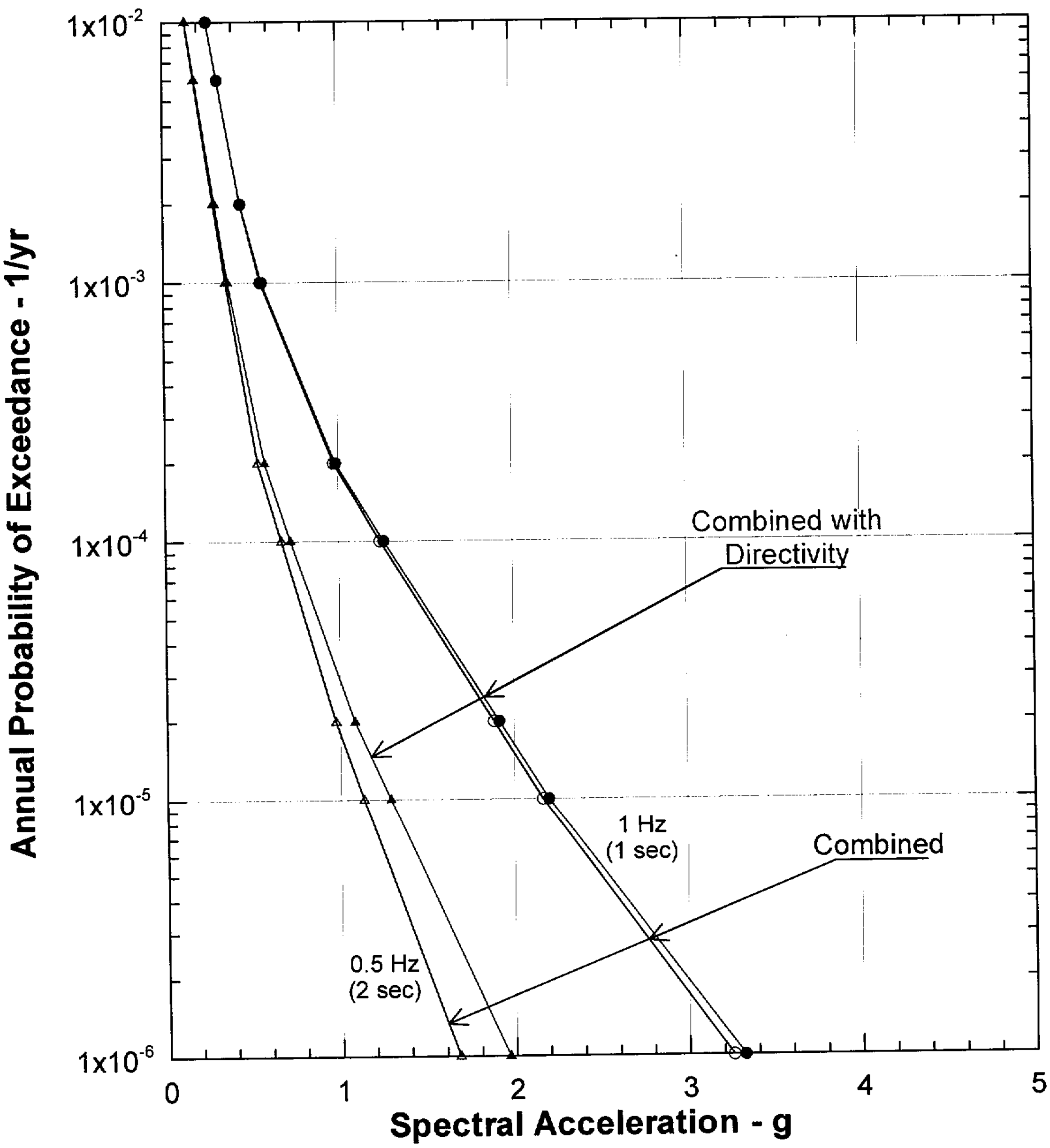


c:\project\songs\colleen\sum\suma\Fig4-14

EFFECTS OF OBT ON WEIGHTED HAZARD CURVES

SONGS Seismic Study

Figure
4-14



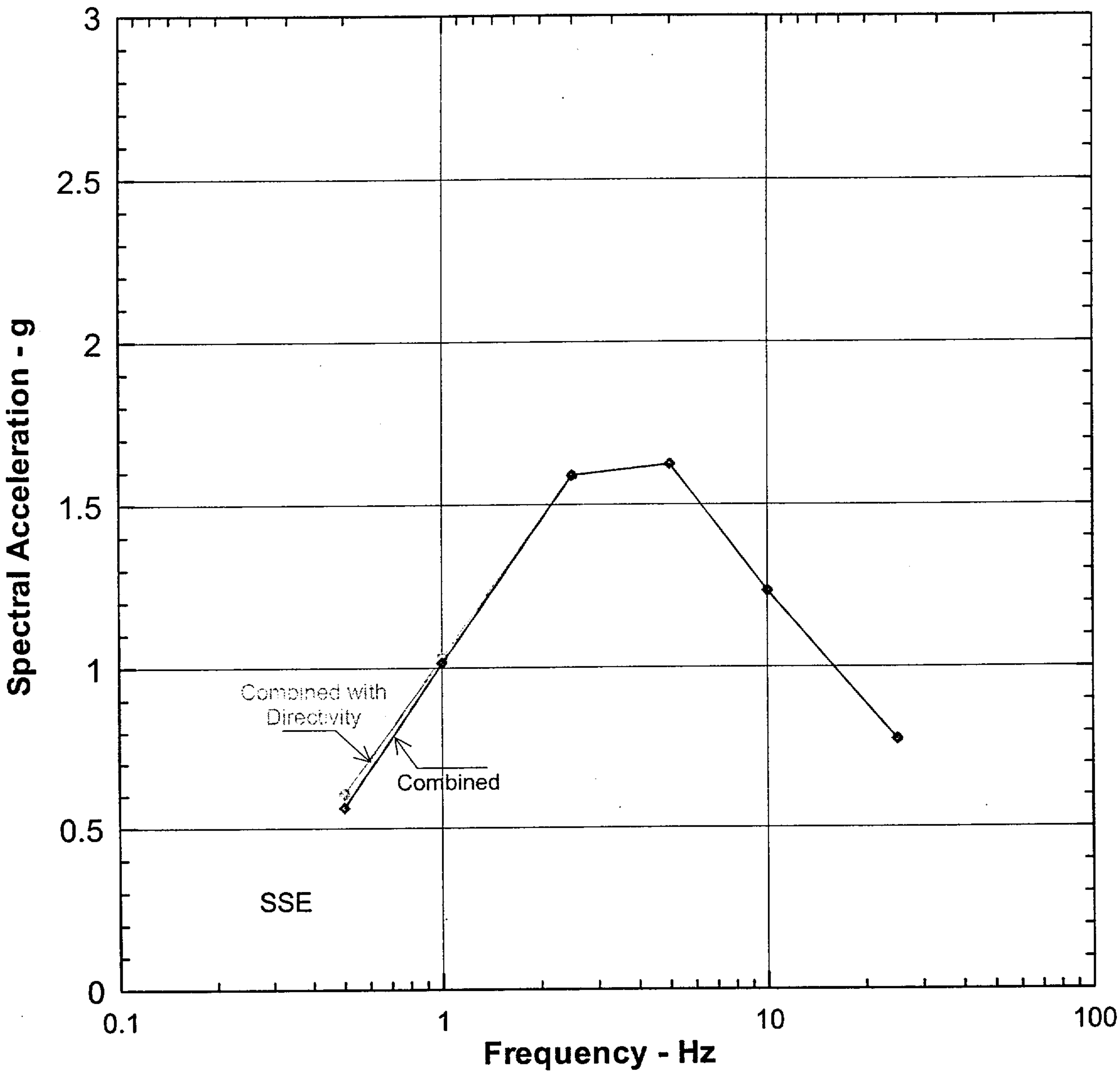
EFFECTS OF DIRECTIVITY ON HAZARD CURVES

SONGS Seismic Study

Figure 4-15

_2001 projects\01050B SONGS...\PSHA\SUM\SumA\Fig4-15.grf

Shaking Level	Annual Probablitiy of Exceedance
	2001
SSE	1.74×10^{-4}

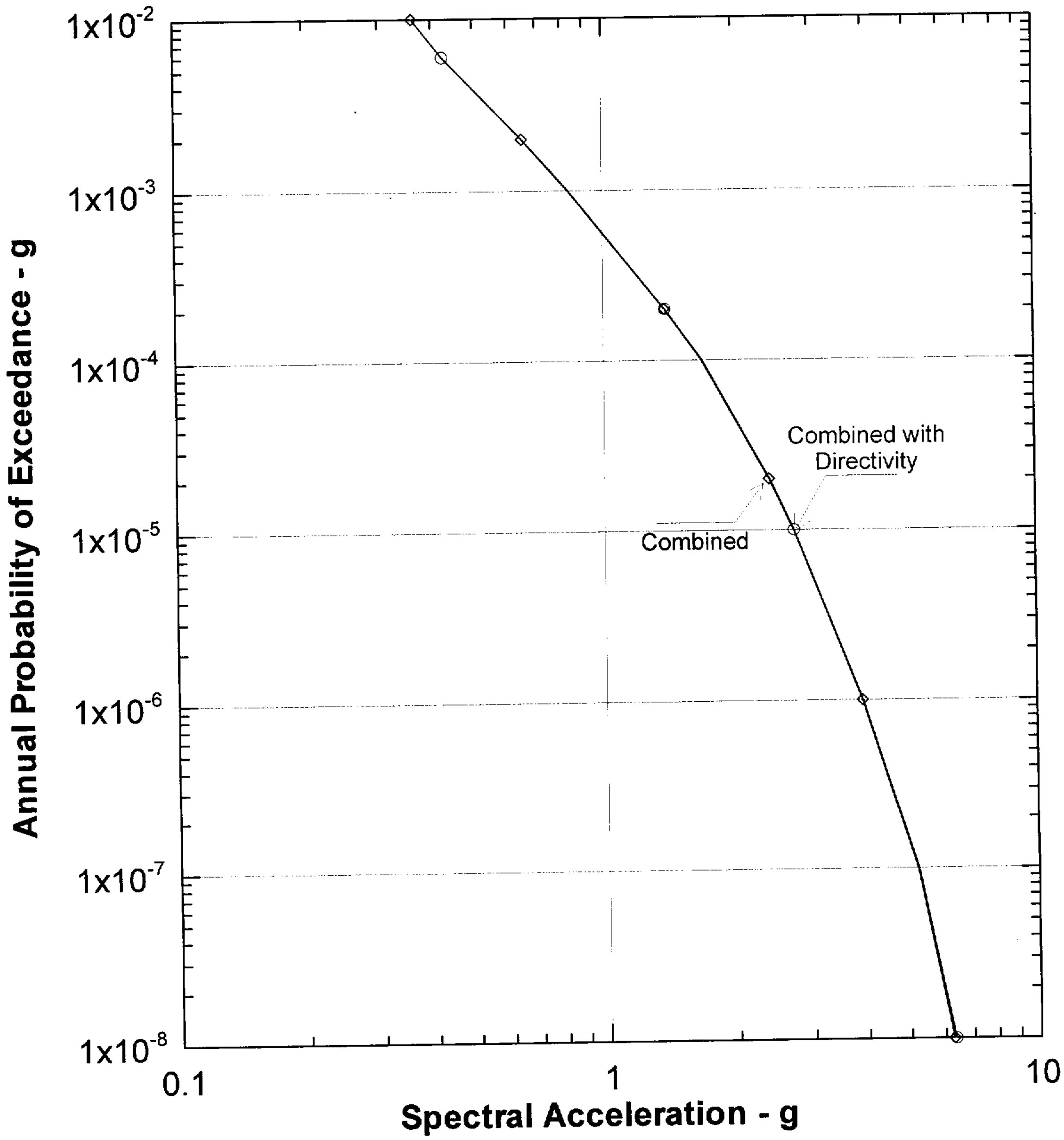


EFFECTS OF DIRECTIVITY ON RESPONSE SPECTRA

SONGS Seismic Study

Figure 4-16

c:\project\songs\colleen\sum\suma\Fig4-16 (SSE)



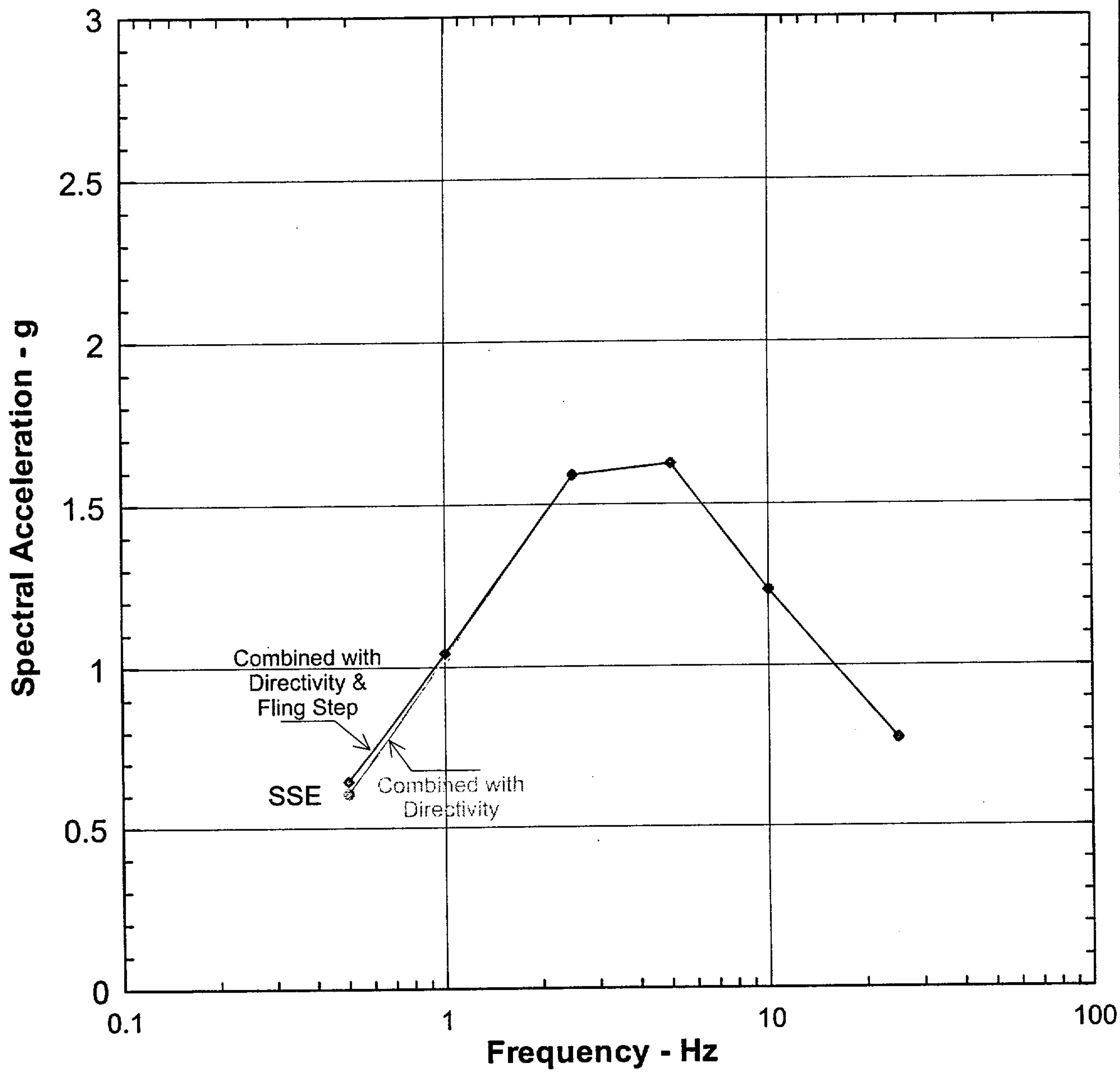
EFFECTS OF DIRECTIVITY ON WEIGHTED HAZARD CURVES

SONGS Seismic Study

Figure 4-17

c:\project\songs\colleen\sum\suma\Fig4-17

Shaking Level	Annual Probablitiy of Exceedance
	2001
SSE	1.74×10^{-4}

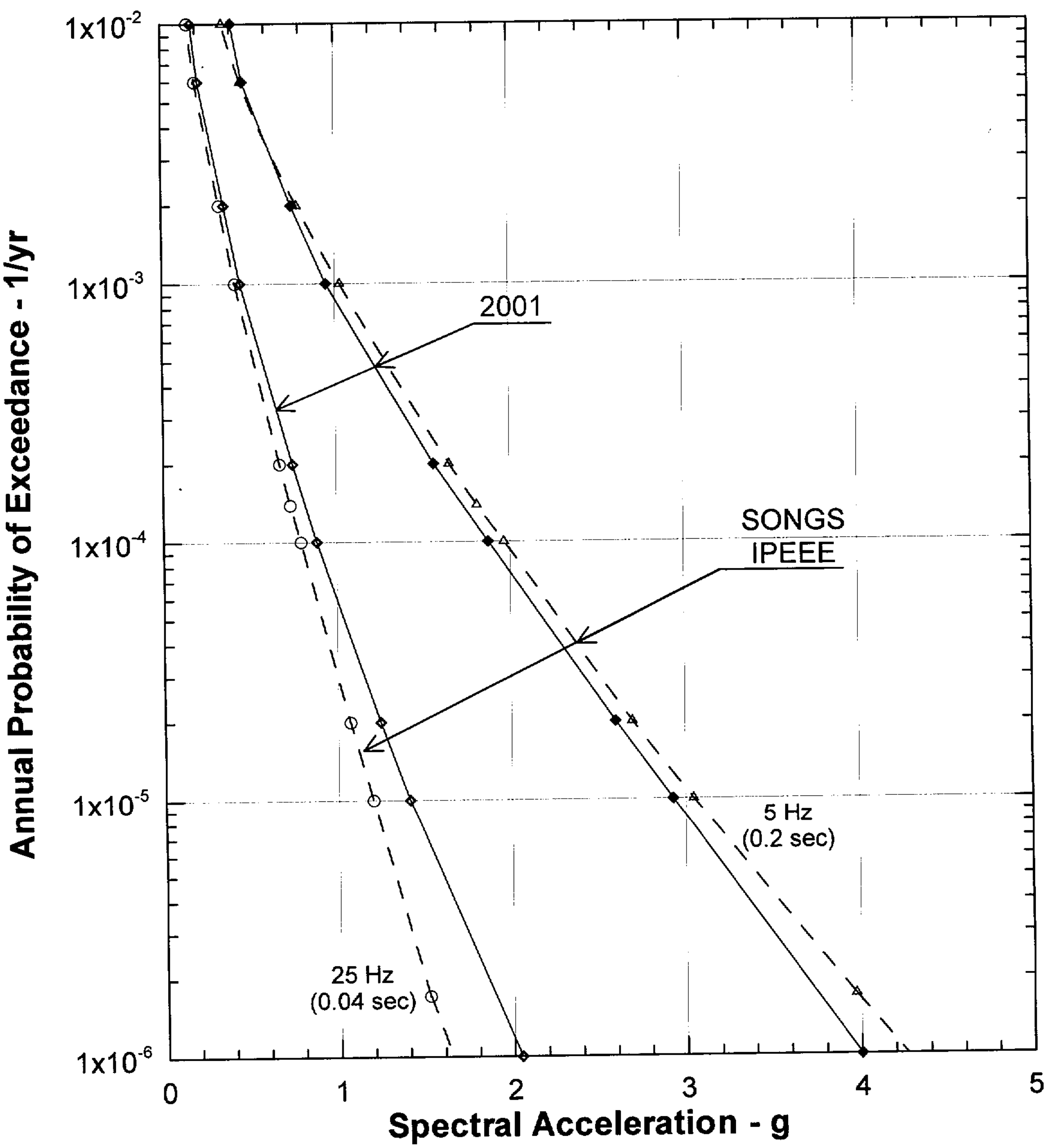


EFFECTS OF FLING STEP ON RESPONSE SPECTRA

SONGS Seismic Study

Figure 4-18

c:\project\songs\colleen\sum\suma\Fig4-18 (SSE)

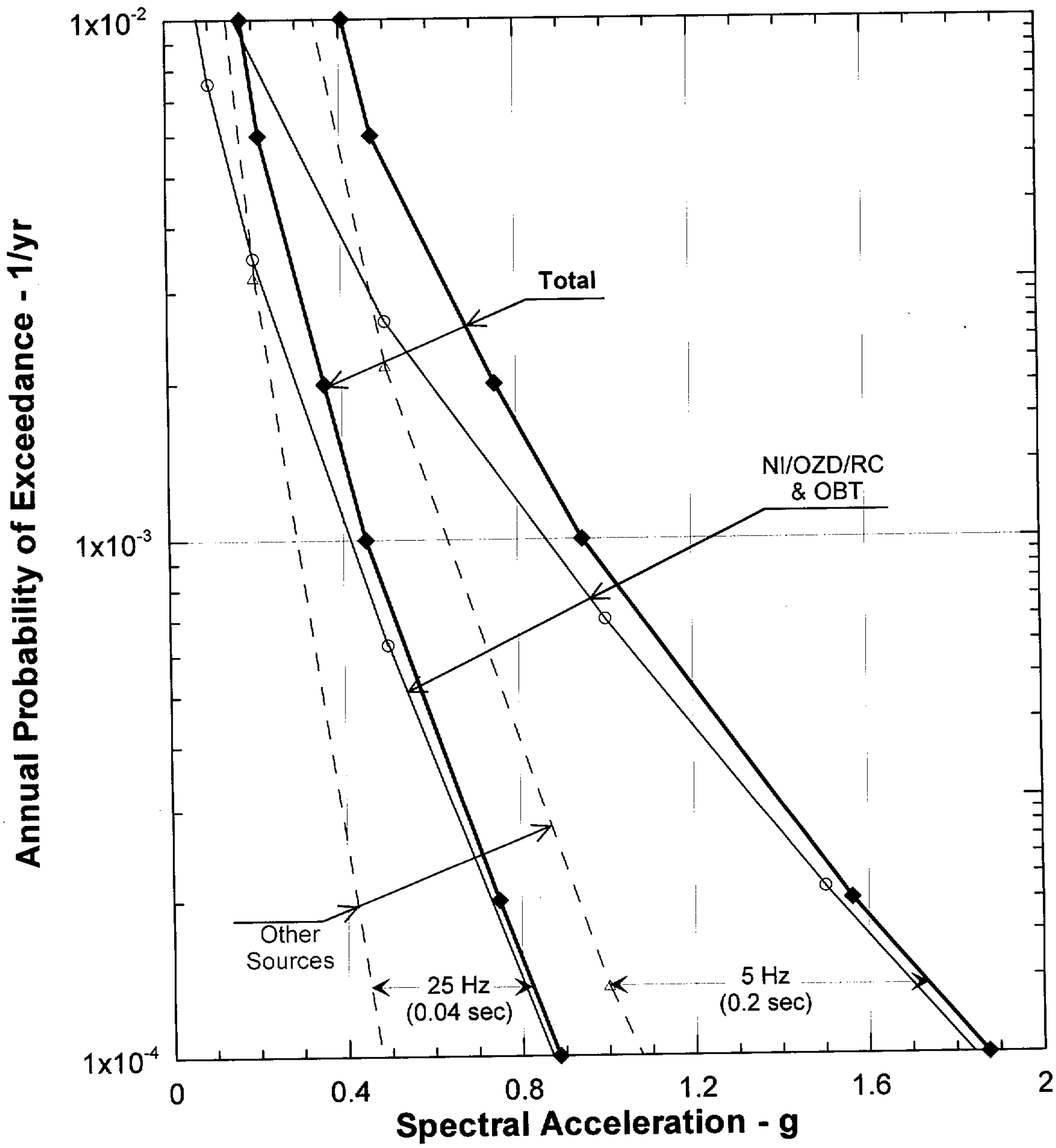


COMPARISON OF HAZARD CURVES -
SONGS IPEEE & 2001

SONGS Seismic Study

Figure
4-19

_2001 projects\01050B SONGS...\PSHA\SUM\SumA\Fig4-19.grf

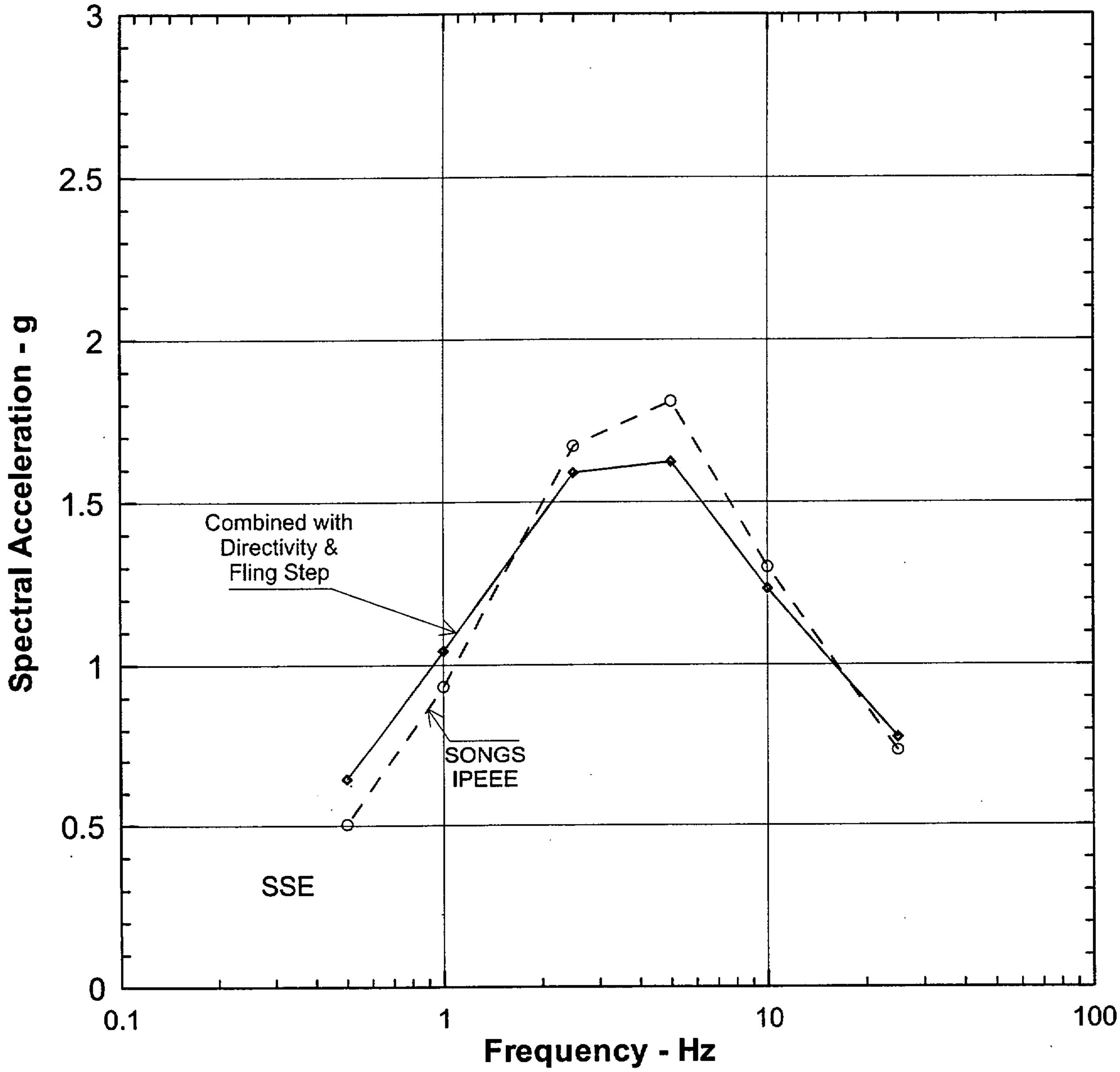


2001 projects\01050B SONGS...\PSHA\SUM\SumA\Fig4-20.grf

CONTRIBUTION OF SEISMIC SOURCES TO
2001 HAZARD CURVES
SONGS Seismic Study

Figure
4-20

Shaking Level	Annual Probablitiy of Exceedance	
	SONGS IPEEE	2001
SSE	1.39×10^{-4}	1.74×10^{-4}

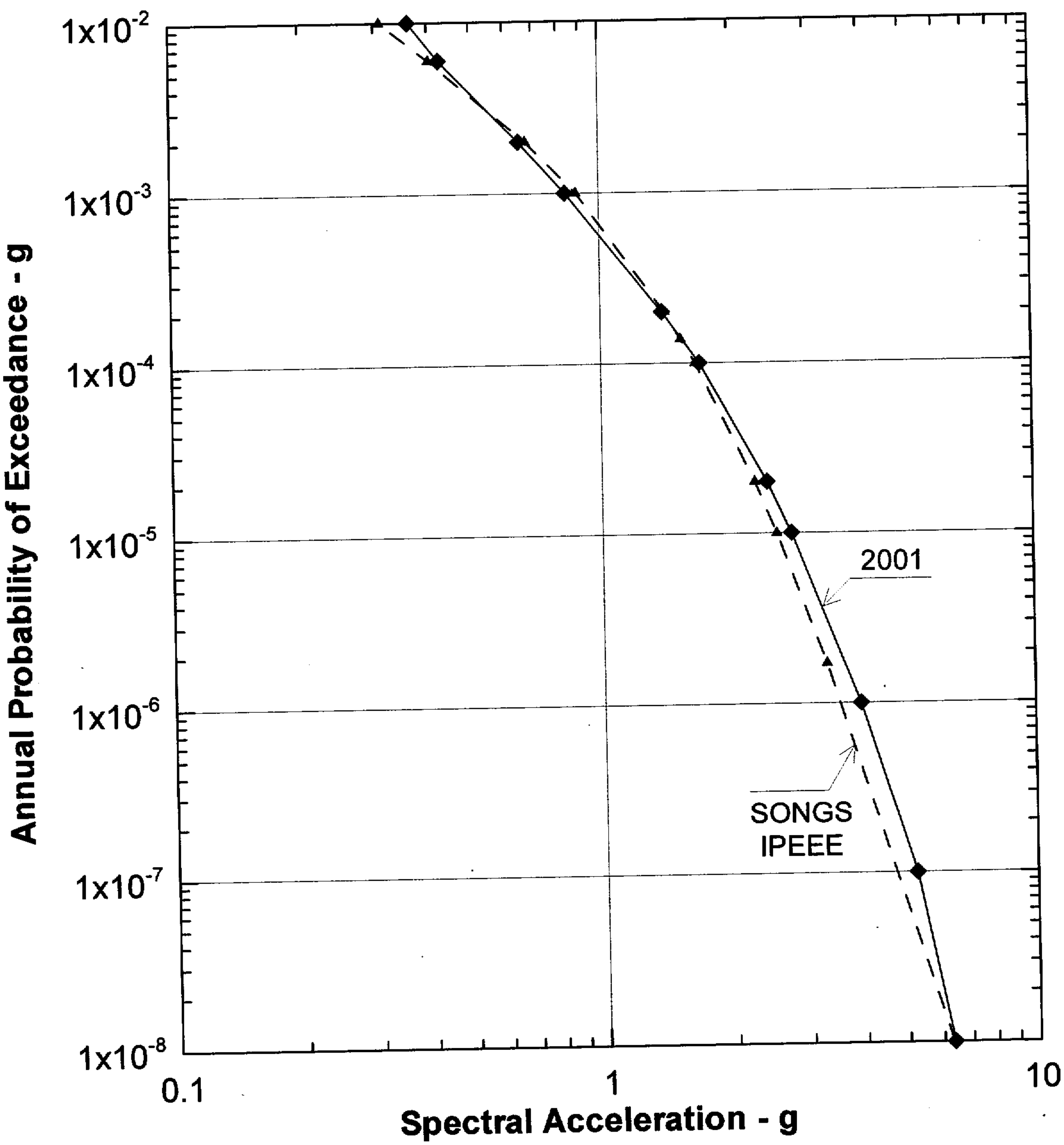


c:\project\songs\colleen\sum\suma\Fig4-21 (SSE)

COMPARISON OF RESPONSE SPECTRA - SONGS IPEEE & 2001

SONGS Seismic Study

Figure 4-21



COMPARISON OF WEIGHTED HAZARD CURVES
SONGS IPEEE & 2001

SONGS Seismic Study

Figure
4-22

c:\project\songs\colleen\sum\suma\Fig4-22

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: PLATE 2-1 REGIONAL STRUCTURE MAPS- BASEMENT SONGS SEISMIC REPORT WITHIN THIS PACKAGE

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

D-1

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: PLATE 2-2 REGIONAL STRUCTURE MAPS-SEDIMENTS SONGS SEISMIC ISSUES WITHIN THIS PACKAGE

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

D-2

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: PLATE 2-3 SOUTH COAST OFFSHORE ZONE OF DEFORMATION (SCOZD) SAN MATEO POINT TO SAN ONOFRE SONGS SEISMIC ISSUES

WITHIN THIS PACKAGE

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

D-3