Appendix A—Updates to the California Reference Fault Parameter Database—Uniform California Earthquake Rupture Forecast, Version 3 Fault Models 3.1 and 3.2

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Introduction

This report describes revisions to the California Reference Fault Parameter Database. This database was originally developed for use in the Uniform California Earthquake Rupture Forecast, version 2 (UCERF2) by the 2007 Working Group on California Earthquake Probabilities (WGCEP, 2008). The databases used in UCERF2 were designed to be flexible and intended to serve as the foundation for future seismic hazard models, including updates to UCERF. To that end, Uniform California Earthquake Rupture Forecast, version 3 (UCERF3) has adopted the database structure and entries used by UCERF2. The purpose of this report is to document additions and edits to the database. For a description of how the database was designed and originally populated, see the UCERF2 report (Working Group on California Earthquake Probabilities, 2008) and Wills and others (2008). The reader also is referred to and encouraged to use the Southern California Earthquake Center-Virtual Display of Objects (SCEC-VDO), a visualization tool available to interactively view the UCERF2 and UCERF3 fault models. Within SCEC-VDO, the user can toggle between the UCERF2 and UCERF3 fault models, as well as two alternative UCERF3 fault models (Fault Model 3.1 [FM3.1] and Fault Model 3.2 [FM3.2]). SCEC-VDO and the UCERF fault models included within can be downloaded at *http://www.wgcep.org/tools*. An additional tool, the Fault Section graphical user interface, allows the user to query the Oracle® database and export the fault parameters and fault sections specific to each fault model. This java-based application is available at *http://www.wgcep.org/tools-fault_db*.

Two sources primarily were relied on for defining the fault geometry used in the UCERF2 fault model. The Community Fault Model (CFM) developed for southern California (Plesch and others, 2007) was used to provide much of the geometry for the major active faults in southern California, and the 2002 National Seismic Hazard Map (NSHM) fault model (Frankel and others, 2002) was used as the fault model source for the remainder of the State. The UCERF2 fault model also included additional revisions by WGCEP 2007 although the revisions to the fault geometries of the CFM and NSHM mostly were minor. Updates to the UCERF3 fault model focused primarily on the additions and revisions of fault sections based on new data and faults coincident with block boundaries in the geodetically based deformation models. Additional faults were added if they formed kinematic connections between larger faults in the model—important because fault-to-fault ruptures are allowed in UCERF3 and links between larger faults form pathways for these types of ruptures.

In UCERF2, two alternative fault models (Fault Model 2.1 [FM2.1] and Fault Model 2.2 [FM2.2]) were developed for a select number of fault sections with possible alternative geometries.

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For UCERF3, we retained this approach for the alternative models and developed fault models (FM3.1 and FM3.2). In addition to retaining the alternative geometries developed for UCERF2, we included alternative geometries developed in the Statewide Community Fault Model (SCFM) for several fault sections (described in table A1) and added alternatives based on feedback from two UCERF3-sponsored workshops held in April 2011.

Updates to the UCERF3 fault models included:

- Integration of the SCFM in the UCERF3 fault model,
- Integration of new faults and revision of existing faults from recent studies,
- Development of a geologically based block model for geodesy-based deformation models,
- Reevaluation of fault endpoints, and
- Development of a Geographic Information System (GIS) database in order to more easily integrate the UCERF3 fault parameter database with the NSHM database.

For UCERF3, models FM3.1 and FM3.2 were developed in coordination with the SCFM—an effort led by the developers of the CFM to create a California-wide representation of faults following the

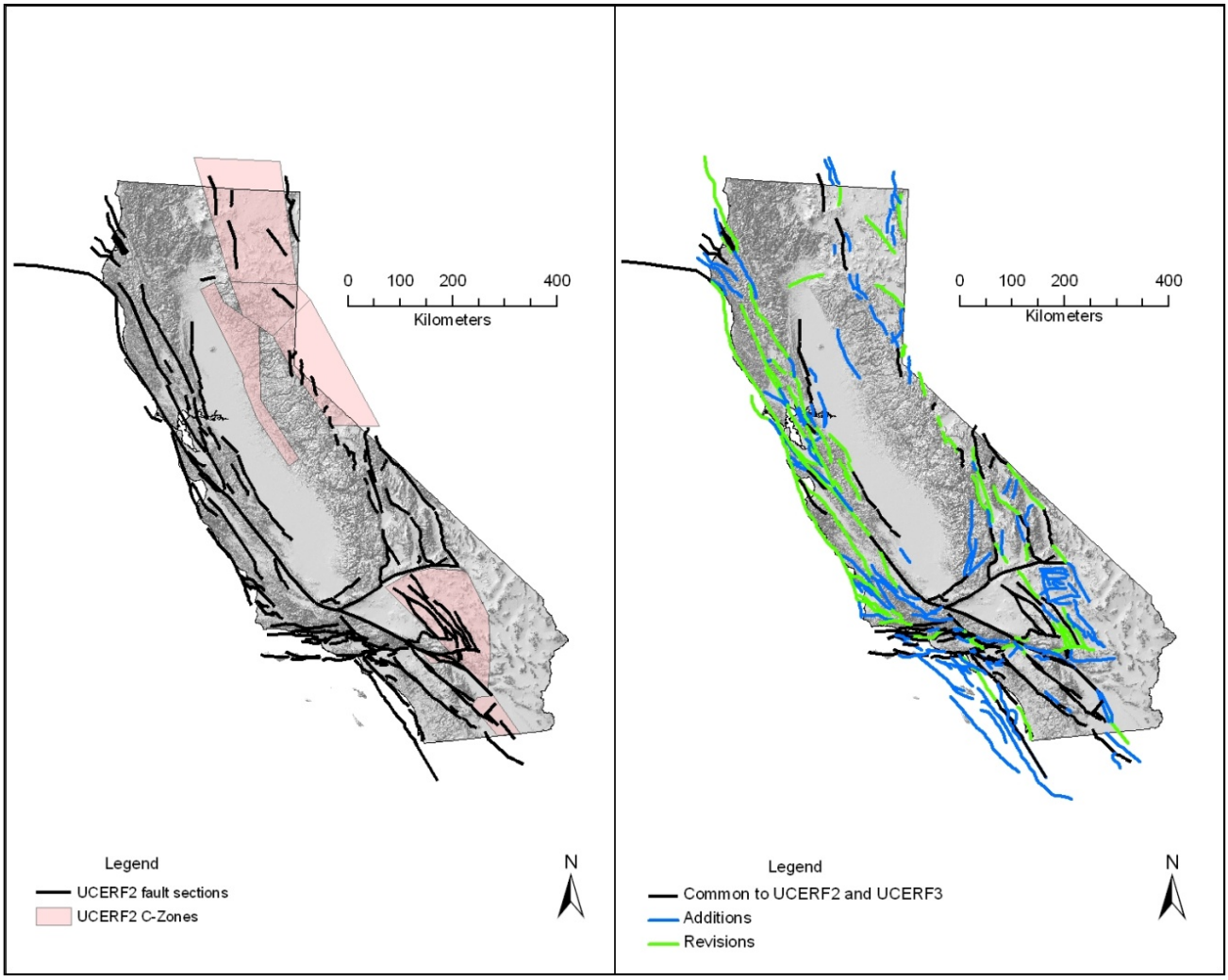

Figure A1. Maps showing comparison of fault sections and type C-Zones in Uniform California Earthquake Rupture Forecast, version 2 (UCERF2, left) to fault sections developed for Uniform California Earthquake Rupture Forecast, version 3 (UCERF3, right).

techniques used to develop the CFM, as described by Plesch and others (2007). The SCFM is currently in the evaluation phase, and a description of evaluation process is available at *http://structure.rc.fas.harvard.edu/cfm/themodel.html*. This effort has been focused on updating and augmenting the inventory of faults in northern California. Because of the many Quaternary-active faults in the northern California region, a prioritized list of faults, compiled by members of the WGCEP and UCERF3 geodetic modelers, was provided to the SCFM so that fault representations could be developed (fig. A1) for use in UCERF3. The prioritized list was based on identifying faults that potentially constitute block boundaries (for the geodetically based deformation models), faults that provide potential connections between faults included in the UCERF3 model, and faults with new data that warrant inclusion in the UCERF3 fault model. Faults from the UCERF2 fault model also were revised by the SCFM, using available data and a revised model of depth of seismicity based on the relocated seismicity catalog of Waldhauser and Schaff (2008). As a result, the latest SCFM model includes about 270 faults, more than 110 of which are located in central and northern California. Based on the priorities of UCERF3, the Bay Area and eastern California (Sierra Nevada, Modoc Plateau) fault systems were emphasized during SCFM development. New representations were provided to the Working Group for review and integration into the UCERF3 Fault Parameter Database. Most SCFM additions and revisions were accepted, with a few exceptions, such as where SCFM representations were less detailed than the existing UCERF2 fault model. An example is the Great Valley thrust system, which SCFM modeled as 2 continuous fault zones, in contrast to the 14 fault sections in the UCERF database. Other exceptions include dips for normal faults in eastern California, where SCFM generally assigned steeper dips than the UCERF2 model assigned. In this case, the UCERF2 default dip value of 50 degrees was retained for consistency with other normal faults in the U.S. Geological Survey (USGS) NSHM. As a result of this exercise, 153 fault sections were added to the UCERF3 fault model and the geometry of 95 fault sections were revised. Of the approximately 153 new fault sections, about one-half were fault sections developed for the CFM for UCERF2 and not used owing to those faults not having an assigned slip rate. The rest of the new fault sections were added for UCERF3 and are mostly in northern California. A detailed list of which faults were added and revised and comments for additional documentation are provided in table A1.

Table A1. Revisions and additions to Uniform California Earthquake Rupture Forecast fault model.

[CFM, Community Fault Model ; SCFM, Statewide Community Fault Model; UCERF2, Uniform California Earthquake Rupture Forecast, version 2; UCERF3, Uniform California Earthquake Rupture Forecast, version 3; USGS, U.S. Geological Survey; WGCEP, Working Group on California Earthquake Probabilities; km, kilometer]

Fault section	Change	Comments
Airport Lake	Addition	Added based on Jennings and Bryant (2010) trace. Assigned a 50-degree dip and a 90-degree rake based on description of Wills (1988) indicating that the fault zone is dominantly composed of normal faults.
Almanor 2011 CFM	Addition	Addition from SCFM.
Anaheim	Addition	Addition from SCFM.
Antelope Valley 2011	Addition	Not in UCERF2 earthquake rate model, but included in UCERF Fault Section Database. Used WGCEP (2008) parameters.
Ash Hill	Addition	Addition from Jennings and Bryant (2010).
Baker	Addition	Added based on Jennings and Bryant (2010) traces and as a boundary in block model.
Bartlett Springs 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Battle Creek 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM. Sense of motion changed from normal to reverse based on a new interpretation by Bill Page (Pacific Gas and Electric, written commun., 2011).
Bear River Fault zone	Addition	Added based on Jennings and Bryant (2010) mapped trace. Extension of the Garberville-Briceland Fault.
Bennett Valley 2011 CFM	Addition	Addition from SCFM.
Bicycle Lake	Addition	Addition from SCFM.
Big Lagoon-Bald Mountain	Revised	Revisions based on SCFM.
Big Pine (Central)	Addition	Addition from SCFM.
Big Pine (East)	Addition	Addition from SCFM.
Big Pine (West)	Addition	Addition from SCFM.
Birch Creek	Removed	Combined with Independence Fault based on misassigned slip rate and on strike continuity with Independence Fault.
Blackwater	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
Blue Cut	Addition	Addition from SCFM.
Brawley (Seismic Zone) alt 1	Addition	Originally an areal source in UCERF2, treated as a block boundary in UCERF3.
Brawley (Seismic Zone) alt 2	Addition	Originally an areal source in UCERF2, treated as a block boundary in UCERF3.
Breckenridge 2011	Addition	Added based on Jennings and Bryant (2010) traces. Part of Kern Canyon zone.
Bullion Mountains	Addition	Added based on Jennings and Bryant (2010) traces.
Butano 2011 CFM	Addition	Addition from SCFM.
Cady	Addition	Addition from SCFM. Trace modified to better match Jennings and Bryant (2010) traces. Trace extended west based on aeromagnetic interpretation of Schmidt and others (2010).
Calaveras (Central) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.

Fault section	Change	Comments
Calaveras (No) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Calaveras (So) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Calaveras (So) Paicines extension	Addition	Addition based on SCFM, part of Paicines Fault.
Camp Rock	Addition	Added based on Jennings and Bryant (2010) traces. Landers Fault section from UCERF2 disassembled into individual faults.
Canada David (Detachment)	Addition	Addition from SCFM.
Carlsbad	Addition	Addition from SCFM.
Carson Range (Genoa)	Addition	Used 2008 USGS National Seismic Hazard Map parameters.
Casmalia 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Cerro Prieto	Addition	Addition from SCFM.
Channel Islands Thrust	Addition	Addition from SCFM.
Channel Islands Western Deep Ramp	Addition	Addition from SCFM.
Clayton	Addition	Added based on Jennings and Bryant (2010) trace. Appears to be an extension of Greenville Fault.
Cleghorn	Revised	Modified western end to coincide with mapped western end shown on Jennings and Bryant (2010).
Cleghorn Lake	Addition	Added based on Jennings and Bryant (2010) traces.
Cleghorn Pass	Addition	Addition based on Jennings and Bryant (2010) traces.
Collayami 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Compton	Addition	Addition from SCFM.
Concord 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Contra Costa (Briones) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Dillon Pt) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Lafayette) 2011 CFM	Addition	Addition from SCFM. Common to models FM3.1 and FM3.2.
Contra Costa (Lake Chabot) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Larkey) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Ozal-Columbus) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Reliez Valley) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Southhampton) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa (Vallejo) 2011 CFM	Addition	Addition from SCFM. Unique to model FM3.1.
Contra Costa Shear Zone (connector) 2011 CFM	Addition	Addition from SCFM. Unique to FM 3.2, intended to represent a more connected fault zone than fault sections in FM3.1 would suggest. This is a boundary in the block models.
Coronado Bank (alt1)	Addition	Alternative of Coronado Bank Fault based on new mapping by USGS (presented by Holly Ryan (USGS) at UCERF3. Fault Model Workshop, April 2011).
Coyote Canyon	Addition	Addition from SCFM, trace modified to better match mapped traces (unpublished mapping provided by Dave Miller,

Fault section	Change	Comments
		USGS).
Coyote Lake	Addition	Addition from SCFM, trace modified to better match mapped traces (unpublished mapping provided by Dave Miller, USGS).
Cucamonga	Revised	Lower seismogenic depth revised from 7.8 to 13 km to match original 2002 USGS parameters.
Davis Creek	Addition	Addition based on Jennings and Bryant (2010).
Death Valley (No)	Revised	Extended to the south to better match mapped trace.
Death Valley (So)	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
Death Valley (Fish Lake Valley)	Revised name	Formerly known as Death Valley (No of Cucamonga). Name changed to be more consistent with USGS nomenclature.
Del Valle	Addition	Addition from SCFM
Dog Valley	Addition	Added based on Jennings and Bryant (2010); may form connection between Polaris and Last Chance Faults.
Dry Mountain	Addition	Added based on Jennings and Bryant (2010).
Earthquake Valley (N extension)	Addition	Addition from SCFM.
Earthquake Valley (S extension)	Addition	Addition from SCFM.
East Huasna 2011 CFM	Addition	Addition from SCFM.
Eaton Roughs 2011 CFM	Addition	Addition from SCFM.
Elysian Park (Lower CFM)	Addition	Addition from SCFM.
Emerson-Copper Mountain 2011	Revised	Landers fault section from UCERF2 disassembled into individual faults.
Fickle Hill (alt1)	Revised	Alternative model for Mad River Fault zone.
Fish Slough 2011 CFM	Revised	Modified trace from SCFM.
Fitzhugh Creek	Addition	Added based on Jennings and Bryant (2010).
Fontana (seismicity)	Addition	Addition from SCFM.
Franklin 2011 CFM	Addition	Addition from SCFM.
Garberville - Briceland 2011 CFM	Addition	Replaces Garberville portion of Maacama-Garberville in WGCEP (2008) model.
Garlic Springs	Addition	Addition from SCFM.
Gillem-Big Crack 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Goldstone Lake	Addition	Addition from SCFM; trace modified based on unpublished mapping provided by Dave Miller, USGS.
Goose Lake 2011 CFM	Addition	Addition from SCFM.
Great Valley 03a Dunnigan Hills	Addition	Addition using UCERF2 geometry (not assigned a slip rate in UCERF2).
Great Valley 05 Pittsburg-Kirby Hills alt1	Addition	Alternative representation from SCFM.
Great Valley 06 (Midland) 2011 CFM alt1	Addition	Addition from SCFM.
Great Valley 06 (Midland) alt2	Addition	Addition using UCERF2 geometry.
Great Valley 07 (Orestimba)	Revised	Modified based on Anderson and Piety (2001), reporting that

Fault section	Change	Comments
		there is no basis for the segment boundary between GV07 and GV08, used by WGCEP (2008).
Great Valley 08 (Quinto)	Revised	GV08 modified to be shorter and shallower than previously based on Anderson and Piety (2001).
Green Valley 2011 CFM	Revised	UCERF2 Green Valley (No) and (So) sections combined by CFM.
Greenville (No) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Greenville (So) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Hartley Springs 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Hayward (No) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Hayward (So) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Hayward (So) extension 2011 CFM	Addition	Addition from SCFM.
Hector Mine	Addition	Addition from SCFM.
Hilton Creek 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Holser, alt 1	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
Holser, alt 2	Addition	Addition from SCFM.
Homestead Valley 2011	Revised	Landers Fault section from UCERF2 disassembled into individual faults.
Honey Lake 2011 CFM	Revised	Replaced 2008 geometry with SCFM.
Hosgri	Revised	Bottom depth revised from 6.8 to 12 km based on Hardebeck (2010).
Hosgri (extension)	Addition	Addition from SCFM.
Hunter Mountain - Saline Valley	Revised	Extended to the south to better match mapped trace.
Hunting Creek - Bartlett Springs Connector 2011 CFM	Addition	Addition from SCFM.
Hunting Creek - Bartlett Springs 2011 CFM	Addition	Addition from SCFM.
Imperial	Revised	Trace extended south to better match 1941 rupture trace as shown in Jennings and Bryant (2010).
Incline Village 2011 CFM	Addition	Addition from SCFM.
Independence rev 2011	Revised	Combined fault section with Birch Creek Fault (part of the same range front).
Jess Valley	Addition	Added based on Jennings and Bryant (2010).
Johnson Valley (No) 2011 rev	Revised	2008 Landers Fault disassembled into individual faults.
Joshua Tree (seismicity)	Addition	Addition from SCFM.
Keddie Ridge 2011 CFM	Addition	Addition from SCFM.
Kern Canyon (Lake Isabella) 2011	Addition	Trace based on Jennings and Bryant (2010). Dip based on Amos and others (2010) and Keith Kelson (WLA-Fugro, written commun., 2011). Lower seismogenic depth based analogy to other faults in the region.
Kern Canyon (N. Kern) 2011	Addition	Trace based on Jennings and Bryant (2010). Dip based on Amos and others (2010) and Keith Kelson (WLA-Fugro, written commun., 2011). Lower seismogenic depth based analogy to other faults in the region.

Fault section	Change	Comments
Kern Canyon (S. Kern) 2011	Addition	Trace based on Jennings and Bryant (2010). Dip based on Amos and others (2010) and Keith Kelson (WLA-Fugro, written commun., 2011). Lower seismogenic depth based analogy to other faults in the region.
King Range 2011 CFM	Addition	Addition from SCFM
La Panza 2011 CFM	Addition	Addition from SCFM.
Lake Isabella (seismicity)	Addition	Addition from SCFM.
Landers 2011 rev	Revised	WGCEP (2008) Landers Fault section disassembled into individual faults.
Las Positas	Addition	Addition from SCFM.
Last Chance	Addition	Added based on Jennings and Bryant (2010).
Likely	Revised	Replaced WGCEP (2008) geometry with SCFM.
Lions Head 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Little Lake	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
Los Alamos 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Los Alamos extension	Addition	Added based on Jennings and Bryant (2010) trace that connects the Los Alamos and Santa Ynez Fault sections.
Los Medanos-Roe Island	Addition	Addition from SCFM.
Los Osos 2011	Revised	Modified to extend farther south along mapped trace.
Lost Hills	Addition	Addition from SCFM.
Ludlow	Addition	Addition from SCFM, trace modified to better match Jennings and Bryant (2010) traces.
Maacama 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Mad River-Trinidad (alt2)	Addition	Alternative geometry developed to combine individual faults into single seismic source.
Malibu Coast (Extension) alt 1	Addition	Addition from SCFM.
Malibu Coast (Extension) alt 2	Addition	Addition from SCFM.
Manix-Afton Hills	Addition	Addition from SCFM, trace modified to better match mapped traces (unpublished mapping provided by Dave Miller, USGS).
McLean Lake	Addition	Addition from SCFM.
Mendocino	Addition	New fault section.
Mission (connected) 2011 CFM	Addition	Addition from SCFM.
Mission Creek	Addition	Addition from SCFM.
Mission Hills 2011	Addition	Trace added based on source characterization developed by WLA-Fugro for Van Norman Dam Complex. Presented at 2011 UCERF3 Fault Model Workshop by Scott Lindvall (WLA-Fugro).
Mohawk Valley 2011 CFM	Addition	Addition from CFM.
Mono Lake 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Monte Vista-Shannon	Revised	Replaced WGCEP (2008) geometry with SCFM.

Fault section	Change	Comments
Morales (East)	Addition	Addition from SCFM.
Morales (West)	Addition	Addition from SCFM.
Mt Diablo Thrust North	Addition	Alternative representation from SCFM.
Mt Diablo Thrust South	Addition	Alternative representation from SCFM.
Nelson Lake	Addition	Addition from SCFM, trace modified to better match mapped traces (unpublished mapping provided by Dave Miller, USGS).
North Channel	Addition	Addition from SCFM.
North Frontal (East)	Revised	Trace modified to better match mapped traces of Jennings and Bryant (2010) at western end.
North Frontal (East)	Revised	Trace modified to better match mapped traces of Bryant and Jennings (2010) at western end.
North Salt Lake	Addition	Addition from SCFM.
North Tahoe 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
North Salt Lake	Addition	Addition from SCFM.
Northridge Hills	Addition	Addition from SCFM.
Oak Ridge (Offshore) west extension	Addition	Addition from SCFM.
Oceanic 2011 CFM	Addition	Addition from SCFM. SCFM trace modified to better match mapped traces.
Oceanside alt1	Addition	Addition from SCFM.
Oceanside alt2	Addition	Truncated alternative model developed for the Oceanside thrust based on new mapping by USGS. Truncation based on presentation by Holly Ryan (USGS) at the 2011 UCERF3 Fault Model Workshop.
Ortigilita (North)	Revised	Ortigilita split into north and south sections based on Anderson and Piety (2001). Geologic slip rates also adjusted based on Anderson and Piety (2001). Trace modified to better match Jennings and Bryant (2010) traces.
Ortigilita (South)	Revised	Ortigilita split into north and south sections based on Anderson and Piety (2001). Geologic slip rates also adjusted based on Anderson and Piety (2001). Trace modified to better match Jennings and Bryant (2010) traces.
Owens Valley	Revised	Extended to the south to better match mapped trace.
Owens Valley (Keough Hot Springs)	Addition	Added based on Jennings and Bryant (2010), may form connection between Owens Valley and Fish Slough faults.
Ozena	Addition	Added because it connects with South Cuyama. Boundary in block model
Paradise	Addition	Addition from SCFM, trace modified to better match mapped traces (unpublished mapping provided by Dave Miller, USGS).
Peralta Hills	Addition	Addition from SCFM.
Pilarcitos 2011 CFM	Addition	Addition from SCFM.
Pine Mountain	Addition	Addition from SCFM.
Pinto Mtn	Revised	Trace extended 9 km east to better match Jennings and Bryant (2010) traces.

Fault section	Change	Comments
Pisgah-Bullion Mtn-Mesquite Lk	Revised	Southernmost point modified to reflect mapped trace.
Pittville 2011 CFM	Addition	Addition from SCFM.
Point Reyes 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Point Reyes connector	Addition	Added based on Jennings and Bryant (2010) traces southeast of Point Reyes fault.
Polaris 2011 CFM	Addition	Addition from SCFM-Jennings and Bryant (2010).
Quien Sabe 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Red Pass	Addition	Addition from SCFM.
Redondo Canyon alt 1	Addition	Addition from SCFM.
Redondo Canyon alt 2	Addition	Addition from SCFM.
Reliz 2011 CFM	Revised	Replaced WGCEP (2008) geometry for Rinconada with SCFM.
Richfield	Addition	Addition from SCFM.
Rinconada 2011 CFM	Revised	Replaced WGCEP (2008) geometry for Rinconada with SCFM.
Rocky Ledge 2011 CFM	Addition	Addition from SCFM.
Rodgers Creek-Healdsburg 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM. Trace modified to better match mapped faults on Jennings and Bryant (2010).
Rose Canyon	Revised	Extended to the north to better match mapped trace.
Russ 2011CFM	Addition	Addition from SCFM.
San Andreas (Creeping Section) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
San Andreas (North Branch Mill Creek)	Addition	Addition from SCFM.
San Andreas (North Coast) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
San Andreas (Offshore) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
San Andreas (Peninsula) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
San Andreas (Santa Cruz Mts) 2011 CFM	Revised	Replaced 2008 geometry with SCFM. SCFM dip was not used owing to Loma Prieta seismicity making the SCFM representation dip more than the WGCEP (2008) model.
San Andreas (Banning)	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
San Clemente	Addition	Addition from SCFM.
San Diego Trough north alt1	Addition	Revised fault trace based on new work by Jamie Conrad and Holly Ryan (USGS) suggesting that the San Diego Trough Fault zone and the San Pedro Basin Fault are connected. Trace provided by Holly Ryan (USGS).
San Diego Trough north alt2	Addition	Addition from SCFM.
San Diego Trough (south)	Addition	Addition from SCFM.
San Gabriel Extension	Addition	Addition from SCFM.
San Gorgonio Pass	Addition	Addition from SCFM.
San Gregorio (North) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.

Fault section	Change	Comments
San Gregorio (South) 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
San Jacinto (Lytle Creek connector)	Addition	Added to follow Jennings and Bryant (2010) mapped traces.
San Jacinto (San Bernardino)	Revised	Northern part modified to better match Jennings and Bryant (2010) mapped traces.
San Juan	Revised	Extended to the north to better match mapped trace.
San Luis Bay 2011 CFM	Addition	Addition from SCFM.
San Luis Range– Oceano 2011 CFM	Addition	Addition from SCFM.
San Luis Range-Pecho 2011 CFM	Addition	Addition from SCFM.
San Luis Range (south margin)	Revised	Modified to extend farther south along mapped trace.
San Luis Range 2011 CFM	Addition	Addition from SCFM.
San Pedro Basin	Addition	Addition from SCFM.
San Pedro Escarpment	Addition	Addition from SCFM.
San Vicente	Addition	Addition from SCFM.
Santa Cruz Catalina Ridge alt1	Addition	Addition from SCFM.
Santa Cruz Catalina Ridge alt2	Addition	Alternative geometry to reflect new work by USGS, as presented by Holly Ryan at the 2011 UCERF3 fault model workshop. No active faults on south margin of Santa Catalina Island.
Santa Monica Bay	Addition	Addition from SCFM.
Santa Susana alt 2	Addition	Addition from SCFM.
Santa Susana East (connector)	Addition	Added to connect with San Fernando, based on source characterization developed by WLA-Fugro for Van Norman Dam Complex. Presented at 2011 UCERF3 Fault Model Workshop by Scott Lindvall (WLA-Fugro).
Santa Ynez (West)	Revised	Extended to the west to better match mapped trace.
Santa Ynez River	Addition	Added as a potential block boundary.
Sargent 2011 CFM	Addition	Addition using USGS 1996 National Seismic Hazard Map fault parameters.
Scodie Lineament	Addition	Addition from SCFM.
Sheephole	Addition	Based on Jennings and Bryant (2010).
Shoreline	Addition	Addition using 2011 Pacific Gas and Electric fault parameters.
Sierra Madre (San Fernando)	Revised	Trace modified to better follow location of 1971 surface rupture.
Sierra Nevada (No extension)	Addition	Addition from SCFM.
Silver Creek 2011 CFM	Addition	Addition from SCFM.
Sisar	Addition	Addition from SCFM.
Skinner Flat 2011 CFM	Addition	Addition from SCFM.
South Cuyama	Addition	Added from Jennings and Bryant (2010), connects with Rinconada. Boundary in block model.

Fault section	Change	Comments
South Klamath Lake East	Addition	Addition from SCFM.
South Klamath Lake West	Addition	Addition from SCFM.
Surprise Valley 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
Swain Ravine-Spenceville	Addition	Addition from SCFM.
Tank Canyon	Revised	Revision based on Jennings and Bryant (2010) and Walker and others (2005).
Thirty Mile Bank	Addition	Addition from SCFM.
Tin Mountain	Addition	Added based on Jennings and Bryant (2010), major range front fault.
Towne Pass	Addition	Added based on Jennings and Bryant (2010), major range front fault.
Ventura-Pitas Point	Revised	Trace modified to better match Jennings and Bryant (2010) traces.
Walker Spring 2011 CFM	Addition	Addition from SCFM.
West Napa 2011 CFM	Revised	Replaced WGCEP (2008) geometry with SCFM.
White Wolf (Extension)	Addition	Addition from SCFM.
Wight Way 2011 CFM	Addition	Addition from SCFM.
Yorba Linda	Addition	Addition from SCFM.
Zayante-Vergelis 2011 CFM	Addition	Alternative representation from SCFM.

Feedback from Fault Model Workshops

In April 2011, two regional workshops, convened by Tim Dawson, CGS;, Andreas Plesch, Harvard University; and Ray Weldon, University of Oregon, were held in Pomona and Menlo Park, California, to present the fault model and to solicit suggestions from the community to improve the model. Based on presentations and discussions at the southern California (Pomona) workshop, significant issues were raised regarding fault geometries for the Inner Borderlands Faults offshore, owing to new mapping by the USGS. Based on these presentations and addition discussions with Holly Ryan and Jamie Conrad (USGS), alternative fault models were developed based on this new data (some of which is still preliminary). The alternative fault models can be viewed in the SCEC-VDO, and a description of modifications is available in table A1. Revisions also were made to selected faults in the Transverse Ranges based on a presentation and discussion with Scott Lindvall (WLA-Fugro). These revisions also are noted in table A1.

At the northern California (Menlo Park) workshop, Jeff Unruh (WLA-Fugro) gave a presentation regarding segmentation of the Great Valley thrust system, with the main conclusion being that the system of faults is more segmented than the representation used by UCERF2 and adopted by UCERF3. With a few exceptions, little data are available to help better define the geometry of these faults. As currently modeled, most Great Valley fault sections are either adjacent to or in close proximity to another and, at this time there does not appear to be a way to make this system more segmented (larger gaps or steps) without additional geological data that would help define the actual locations of these structures.

Development of Geologically Based Boundaries for Block Models

The development of the UCERF3 block model (fig. A2) was done in consultation with the UCERF3 Geodetic Modeling Group, led by Kaj Johnson and Tom Parsons. The block geometry was developed by defining blocks bounded by significant faults and zones of deformation. Block boundaries were defined in a GIS platform, and the block boundaries follow the UCERF3 fault sections as much as possible so that block boundary rates can be mapped easily onto UCERF3 fault sections. Because some boundaries follow zones of faulting and other boundaries exist simply to connect blocks, each boundary is attributed in the GIS to one of three categories: (1) fault, (2) fault zone, or (3) connector. These designations will be used to guide the slip rate assignments to the fault sections once the deformation model results are available. The resulting block model is composed of 35 blocks, and about 50 block boundaries represent discrete fault sections, while another 50 or so block boundaries represent zones of faulting.

Fault Endpoints

One assumption of UCERF3 is that fault endpoints are reasonably well-constrained for purposes of quantifying multi-fault ruptures; therefore, an effort to examine the fault endpoints for faults in the fault model is a defined task for UCERF3. New fault representations generated by SCFM generally are more “connected” to other faults than they were in past models. We also have made an effort to examine other fault endpoints and to modify them as necessary. Typically, this involved examining the fault model trace and comparing it to the mapped trace as shown in the inventory of Quaternary-active faults in the USGS Quaternary Fault and Fold Database of the United States (*http://earthquake.usgs.gov/hazards/qfaults/)* and the 2010 Fault Activity Map of California (Jennings and Bryant, 2010). Compared to past models, UCERF3 fault sections generally are more connected

and better follow the traces of mapped Quaternary-active faults in the USGS/CGS Quaternary Fault and Fold Database. However, because the fault section database is a source model intended primarily to provide fault length and fault area, these traces do not correspond exactly to the mapped traces, although most traces are within 1 km of the mapped trace. The traces in the database should be considered simplified, and not appropriate for site-specific studies where a user might be concerned with issues such as hanging wall and footwall effects of ground motion, or surface rupture hazard.

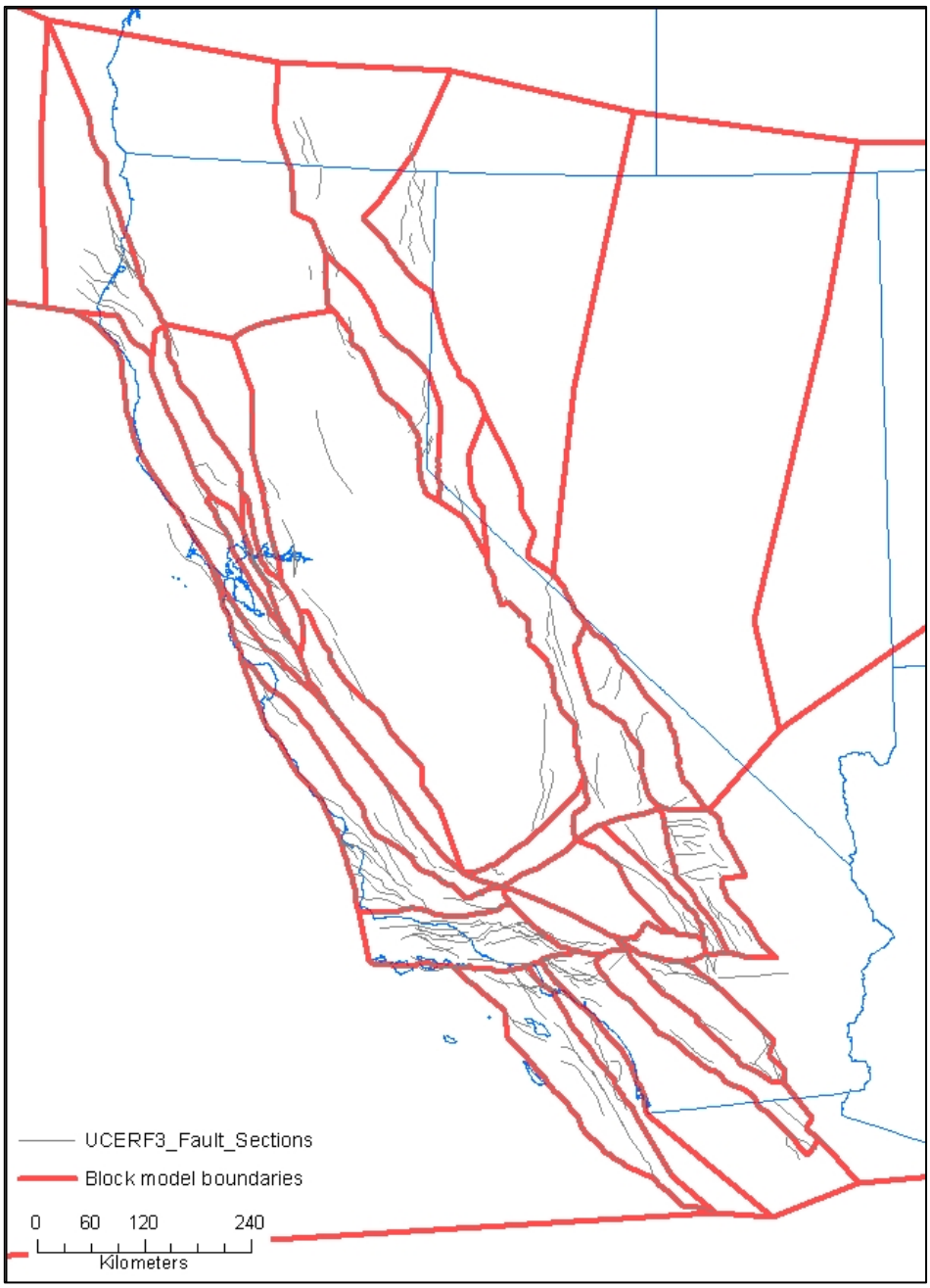

Figure A2. Map showing Uniform California Earthquake Rupture Forecast, version 3 (UCERF3) block model (colored polygons) and UCERF3 fault sections (red lines).

Fault-Zone Polygons

The Fault-Zone Polygon parameter is new to UCERF3. It specifies the region across which a slip rate in a deformation model pertains, and it is used to associate events with sources; that is, the parameter answers questions such as whether the 2010 El Mayor-Cucapah earthquake was an event on the Laguna Salada source or a background seismicity event. More specifically, a fault section is a proxy source for large ruptures that nucleate inside its fault-zone polygon (fig. A3).

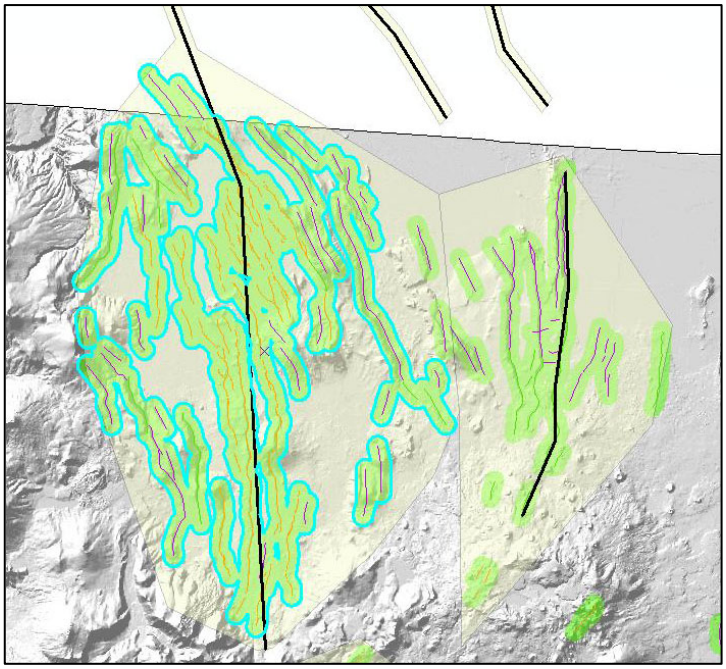

Figure A3. Map showing Quaternary faults (orange, green, and purple lines), Uniform California Earthquake Rupture Forecast, version 3 (UCERF3) fault sections (black lines), 1-kilometer fault zone buffers (green polygons), and fault-zone polygons (shaded yellow) for the Cedar Mountain-Mahogany (left) and Gillem-Big Crack (right) UCERF3 fault sections. Highlighted blue line around green buffers shows fault traces associated by distance, orientation, and fault name for the Cedar Mountain–Mahogany Fault zone. Fault-zone polygons are simplified areas drawn to associate faults into fault zones. Because the fault zones may overlap, the boundary between the two fault-zone polygons is shared and faults near this boundary may be associated with ruptures on either fault section.

In past WGCEPs and NSHMs, the association of a modeled fault section to a fault zone has been implied, but not explicitly defined. An example of this is the Cedar Mountain – Mahogany fault section shown in figure A3. Here, the modeled fault section follows no single mapped trace. Instead, the modeled fault section is intended to represent the dimensions of a seismogenic rupture across a zone of faults many kilometers wide.

The fault zone polygons, further described in the main report, as well as in appendix O (this report) are defined using three components: (1) A geologically based polygon defined by mapped faults, (2) a surface projection that accounts for fault dips, and (3) a default 12-km-wide buffer around the surface trace of the modeled fault. The geologically based polygons were developed using the USGS Quaternary Fault and Fold Database (QFFD) fault traces in conjunction with the UCERF3 fault model traces. In order to define fault zones, the QFFD fault traces were associated with each other

based on assigned fault name, orientation (within 30 degrees of the UCERF3 fault section trace orientation), and proximity. Another criterion considered for use in associating fault traces with each other was faulting style. The QFFD is not yet fully populated for this criterion to be useful. However, when drawing the simplified fault zone polygons, fault style was used qualitatively based on geomorphic expression or fault orientation.

In ArcMap, a commercially available GIS software package, a buffer was placed around each mapped fault trace in the QFFD and, for the individual buffers that touched or overlapped, the buffers were merged to produce larger polygons. Where a polygon overlapped a UCERF3 fault section, the individual fault traces within the polygon were assigned as part of the fault zone associated with that fault section.

Many buffer sizes were tried, and it was apparent that 5-km and wider buffers were too inclusive, essentially turning most of California into one large fault zone. A 1-km buffer size was selected because it appeared to associate many of the mapped fault traces without creating overly inclusive polygons. Because of the complexity of the buffers, a simplified areal polygon had to be defined by hand, guided by the merged buffer polygons, which included those fault traces that were within the buffer polygons. The simplified polygon was drawn to minimize the number of vertices, while including the associated fault traces as much as possible.

Because this is a mapped surface trace-based process, blind and dipping faults pose a special problem—Blind faults lack a surface map trace, and dipping faults can extend beyond the bounds of their surface-defined polygons at depth (in this case, the lower extent of the fault section at depth is projected to the surface to define an expanded fault zone polygon at the surface). This surface projection provides polygons for faults that have no surface trace defined, and also maintains consistency with the 2008 NSHM approach of using surface projections of dipping faults to minimize double counting of on- and off-fault seismicity. A description of this post-polygon generation processing to handle blind and dipping faults is included in appendix O (this report). The full set of polygons can be viewed in the SCEC-VDO.

Although the tools available in ArcMap are a powerful way to aggregate fault traces into fault zones, these tools had limitations, and there were many instances of fault traces that could be considered part of a fault zone that were outside the 1-km buffers. In these cases, judgment was used, often by comparing the 1-km buffers to the 5-km buffers and finding a compromise between the two, in order to aggregate faults where the slip rate might be shared with a UCERF3-modeled fault section. Although this approach is not ideal because it requires manual efforts, it still records many subparallel faults that likely share a slip rate in the deformation model, but that also could produce a large earthquake from the UCERF3-modeled fault trace. This methodology can be improved upon with more fully populated fault databases and better GIS-based tools.

Another result of this analysis is the identification of zones that are not yet modeled as UCERF3 fault sections. Because the Fault Zone Polygon concept is a late addition to the fault model, it was not possible to evaluate these additional possible zones for inclusion in UCERF3. However, the technique of associating mapped faults and aggregating them into fault zones may be a useful tool for developing future fault models that include a more complete inventory of active faults.

Database Integration

Because the results of UCERF3 will be integrated with the NSHM, coordination between the two projects is necessary to ensure integration between the databases used by the individual projects. A GIS-based geodatabase currently is being developed in parallel with the UCERF3 fault section database.

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