

CFM 7.0 updates: peer review, web enhancements, and CRESCENT interoperability

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Abstract

We conducted a full peer evaluation of the central and northern California portions of CFM 7.0, which was released in the fall of 2024. For this evaluation, we subdivided these previously unreviewed portions of the model into five areas following the CFM naming hierarchy (KLMT-GVFA; SNLV; SFBY; CASC; OCCA). Each region included between 18 and 38 faults. For each area, we designated an evaluation leader who assembled a team of regional experts. The expert groups utilized updated 2D and 3D tools provided by the CFM Explorer and were guided in their evaluation by a set of questions both for each individual fault and for the overall fault area. In total, 132 faults were reviewed, and with significant feedback provided. A large majority of the faults received detailed suggestions for updates and 45 faults were recommended to be added to the model.

In collaboration with the SCEC IT group, we have updated the CFM Explorer to add an important and widely requested functionality: visualization of near real time and historic earthquake hypocenters along with faults in 2D and 3D and the ability to generate a direct hyperlink to preselected 2D or 3D views with preselected faults and recent USGS ComCat earthquakes.

Further, we are working to update the earthquake-to-fault association service that is widely used by the SCEC community when discussing near real time events. This service sends near real-time email notifications with the probabilities of which faults are most likely associated with earthquakes > M3 in southern California. The new earthquake-to-fault association service runs on the CFM 7.0 faults, providing the foundation for covering the entire state of California. The service will directly link to the CFM Explorer showing the most likely fault source and the hypocenter in 2D and 3D views. The updated service is in the testing phase but will be accessible to all SCEC account holders soon.

Finally, in collaboration with the Cascadia Region Seismic Center (CRESCENT), we reassessed the CFM representation of ten CA-OR border crossing faults based on available legacy industry seismic reflection data, detailed fault trace mapping, earthquake hypocenters and focal mechanism nodal planes. These updates partially address review comments and will be part of the next CFM release, along with a SLAB 2.0 based megathrust representation and CFM consistent statewide surfaces for seismogenic depth and topography.

1. The Community Fault Model 7.0

The Community Fault Model (CFM) 7.0 is the first 3D fault model with a scope of covering the State of California completely. The model comprises more than 550 fault objects (figure 1) which are organized in a self-consistent manner with a system-level hierarchy. This organization required defining and updating metadata for all of the 113 fault objects which were added to an existing database of faults in the central and southern portion of the state. The metadata includes information on four levels of hierarchy, source data, estimated sense of slip, average strike and dip, fault size and noteworthy features. The model is released under 10.5281/zenodo.13685611, is available for download in multiple resolutions and can be explored interactively.

2. Peer evaluation of central and northern California

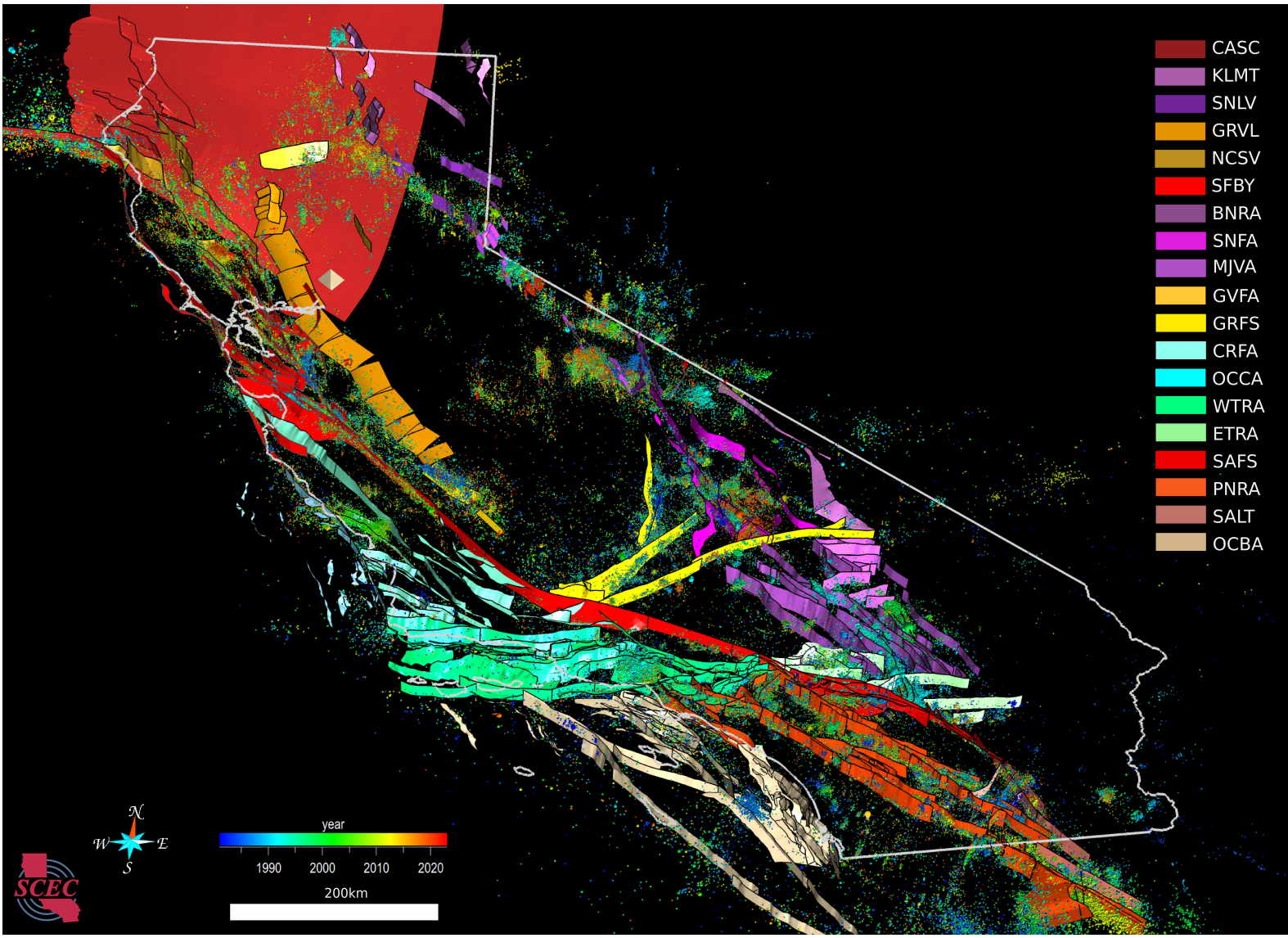


Fig. 1: Perspective view of the integrated statewide model for Northern, Central and Southern California, CFM 7.0. Small dots are relocated hypocenters (Hauksson et al., 2012, and updates, Waldhauser et al., 2018) which are colored by their time of occurrence. Faults are colored by fault area, the top level in the fault hierarchy. The hierarchy is preliminary and subject of active research. CASC: Cascadia, KLMT: Klamath Mountains, SNLV: Sierra Nevada-Long Valley-Mammoth, GRVL: Great Valley, Sacramento and San Joaquin Valley, SFBY: San Francisco Bay, Delta, BNRA: Basin and Range, SNFA: Sierra Nevada, MJVA: Mojave, GVFA: Great Valley, GRFS: Garlock Fault, CRFA: Coast Ranges, OCCA: Offshore Central California, WTRA: Western Transverse Ranges, ETRA: Eastern Transverse Ranges, SAFS: San Andreas Fault, PNRA: Peninsular Ranges, SALT: Salton Sea, OCBA: Offshore Continental Borderland

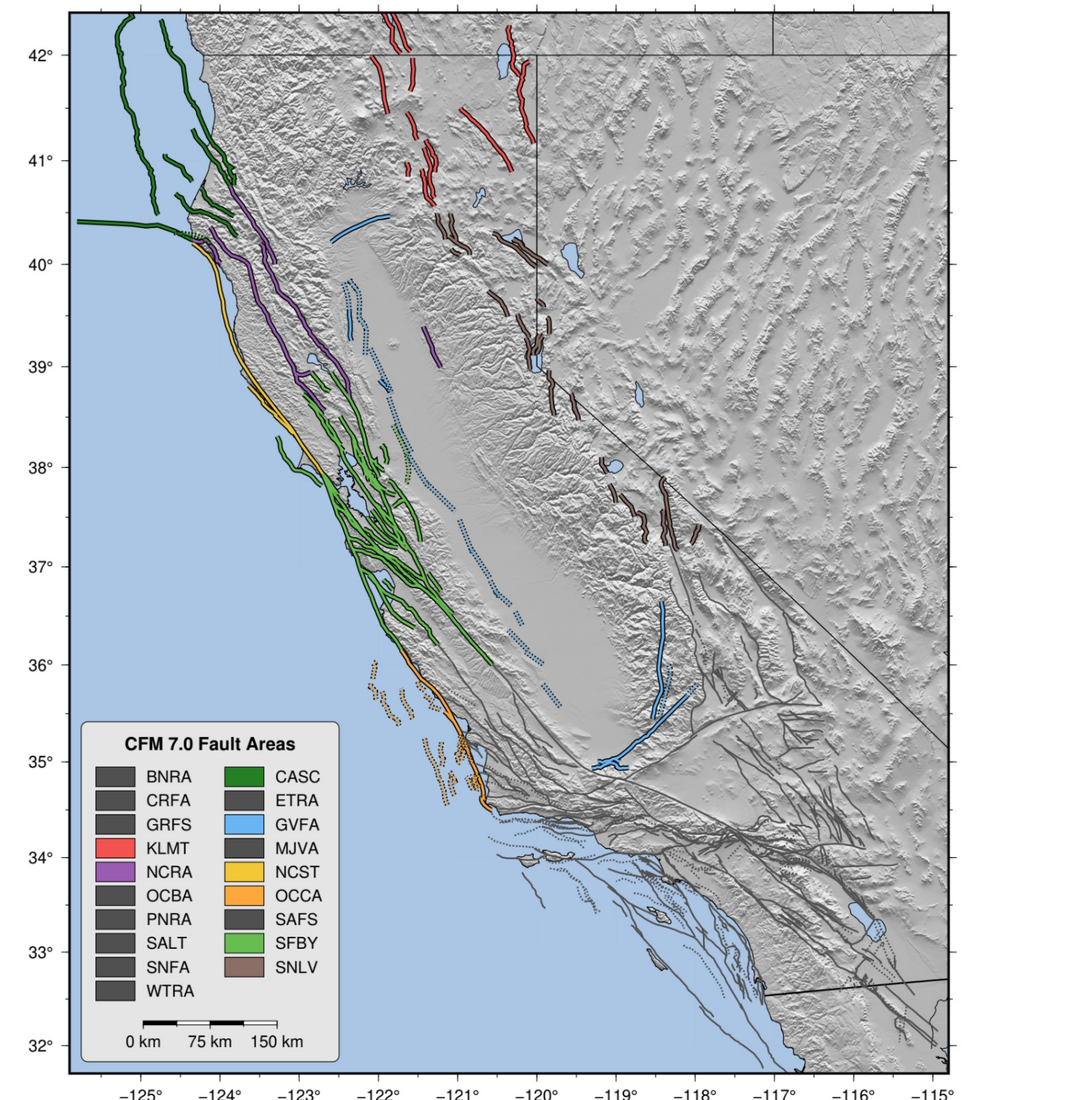


Fig. 2: Map of the evaluated faults colored by fault area. Each fault area was evaluated by a dedicated team of the CFM Evaluation Working Group.

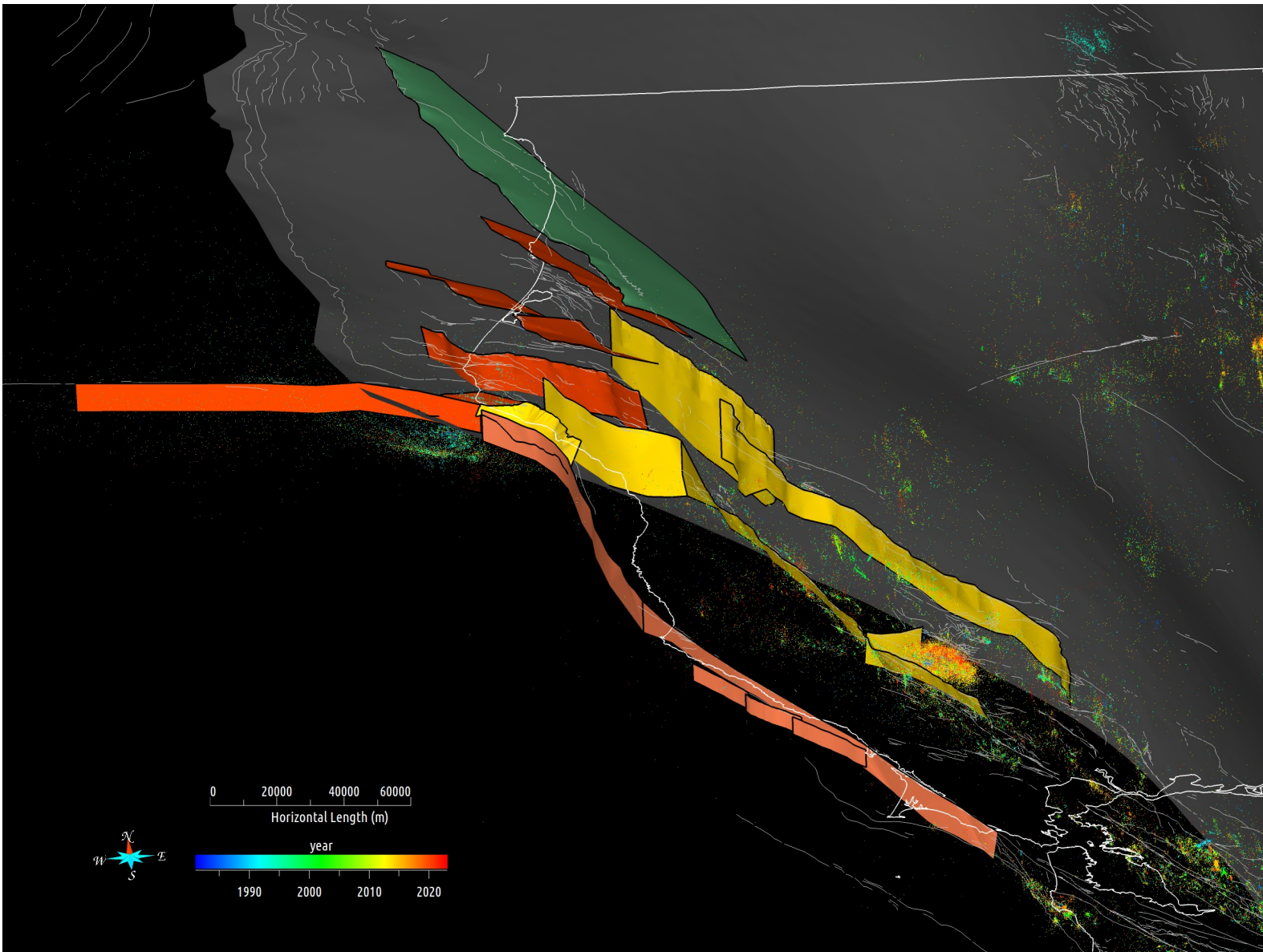


Fig. 3: CASC, NCRA, NCST evaluation areas: 11 specific suggestion, 6 faults candidates for additions

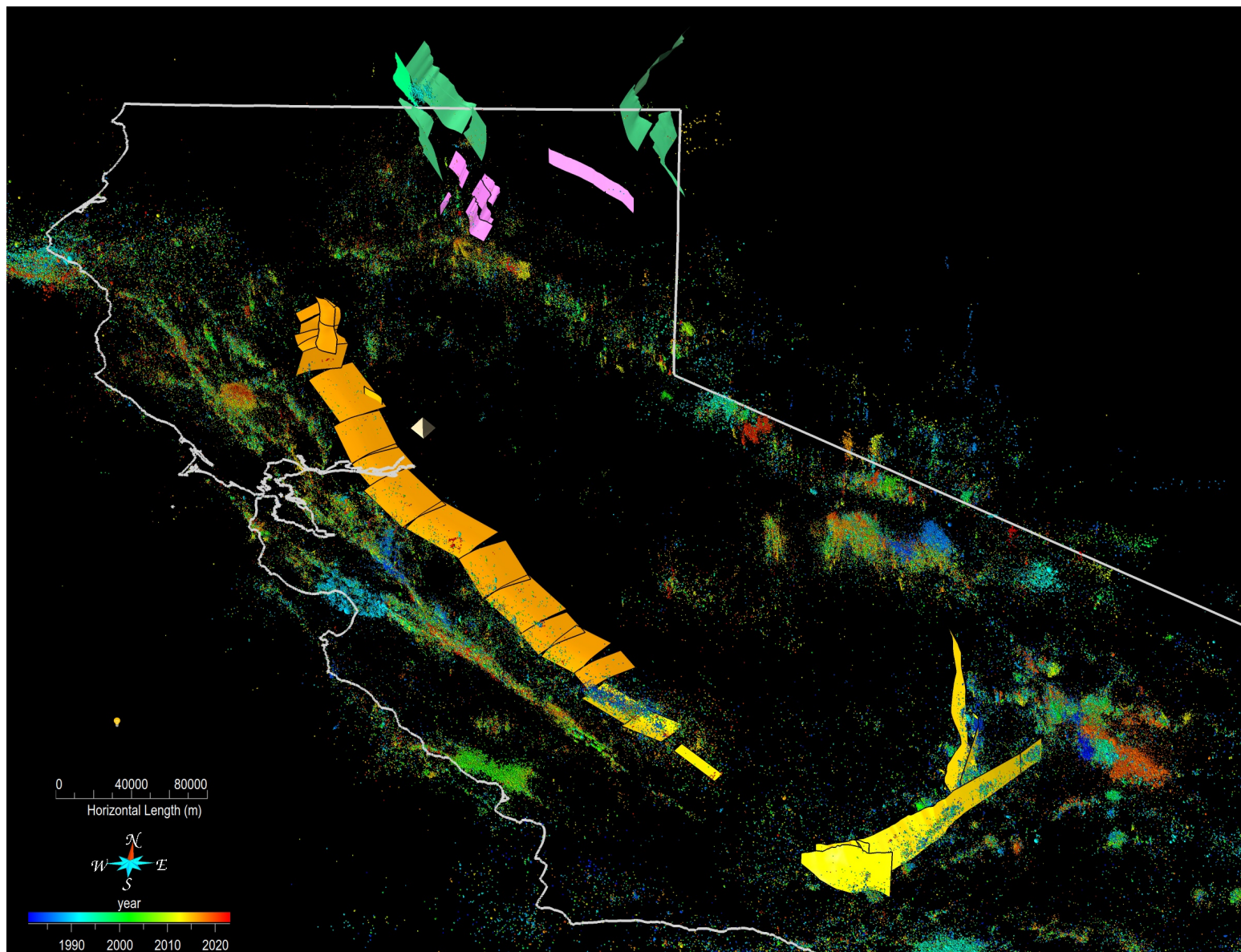
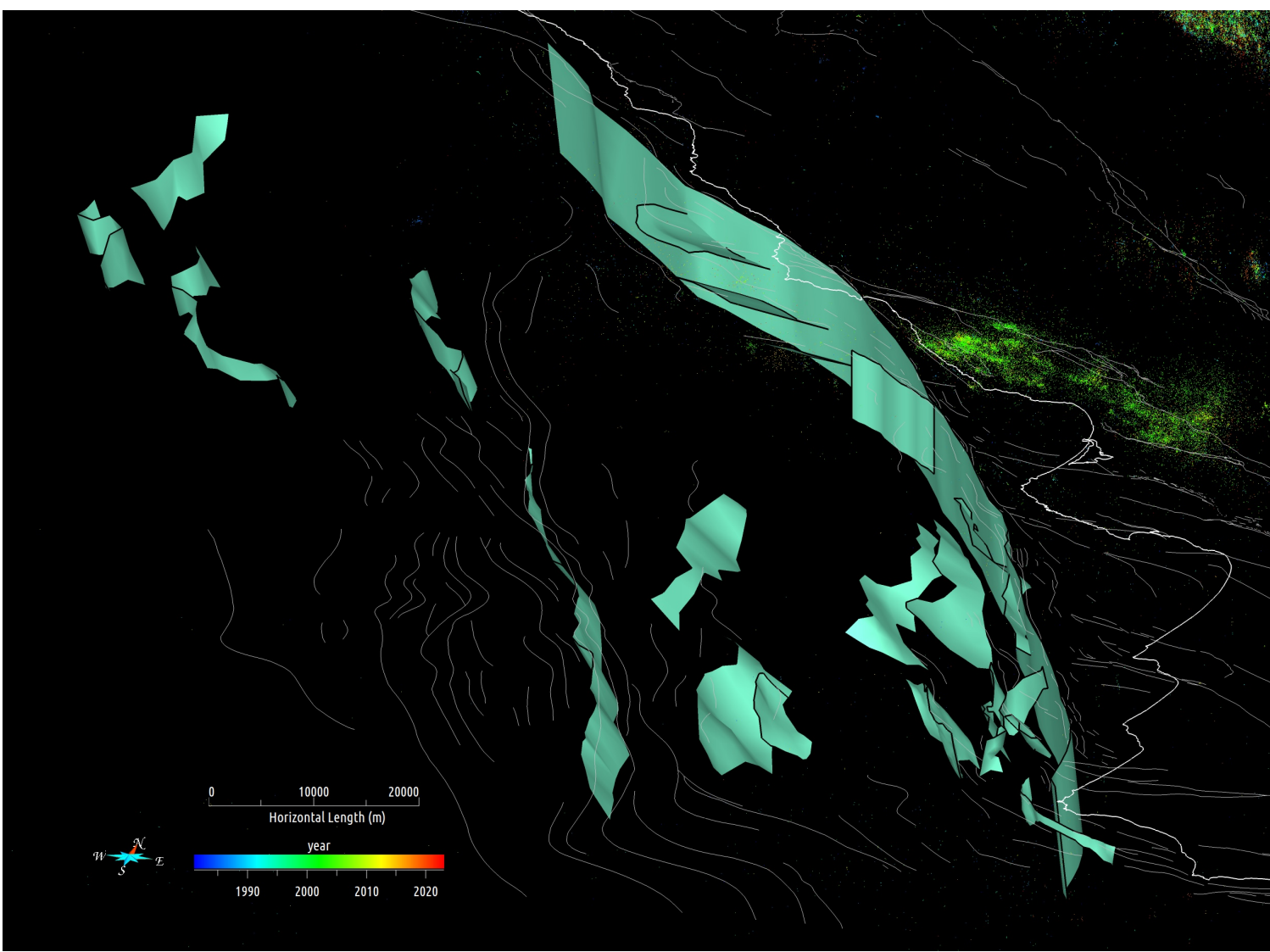
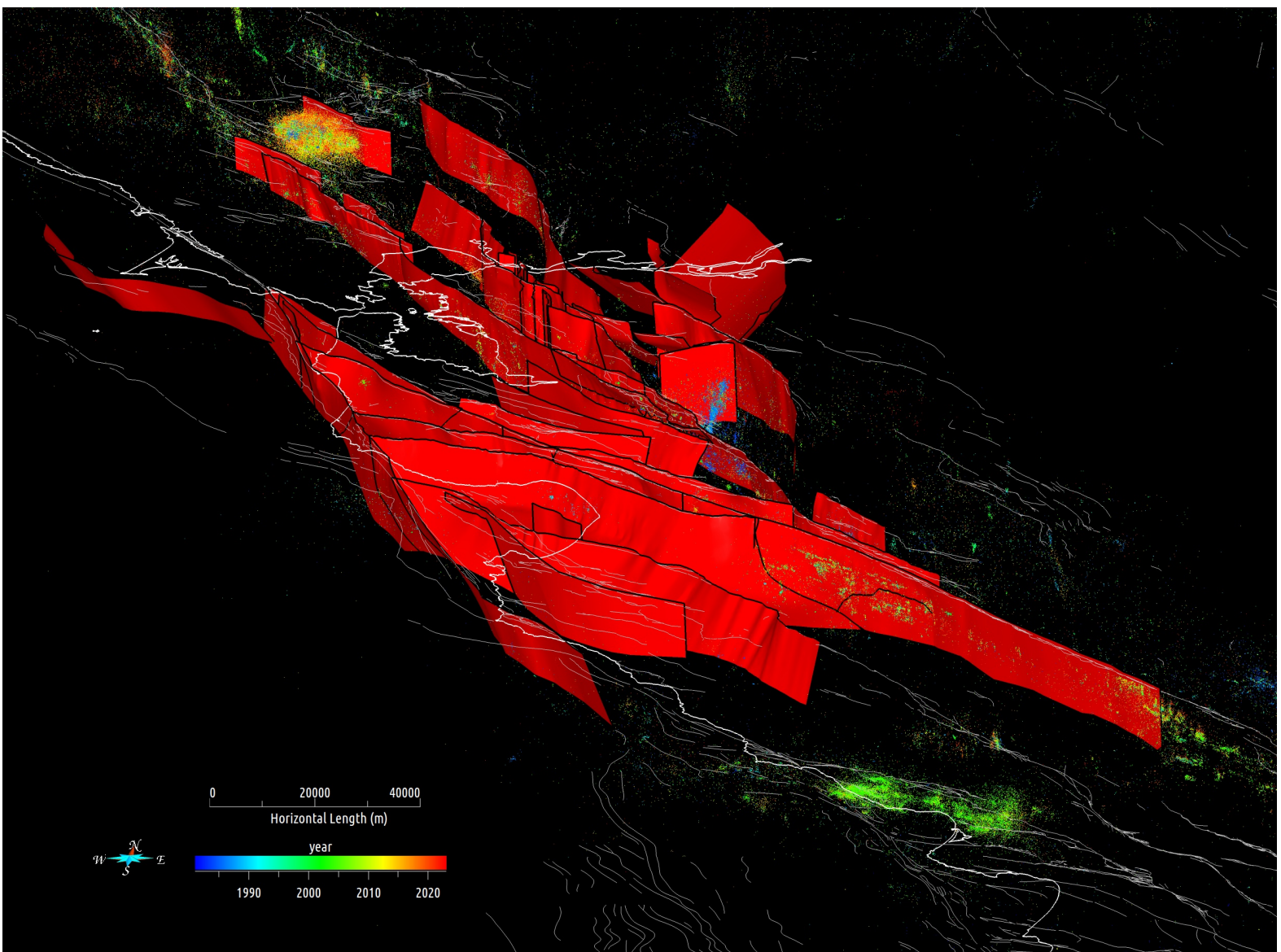


Fig. 6: SNLV evaluation area: ca. 30 specific suggestions, 27 candidates for addition (some in Nevada)

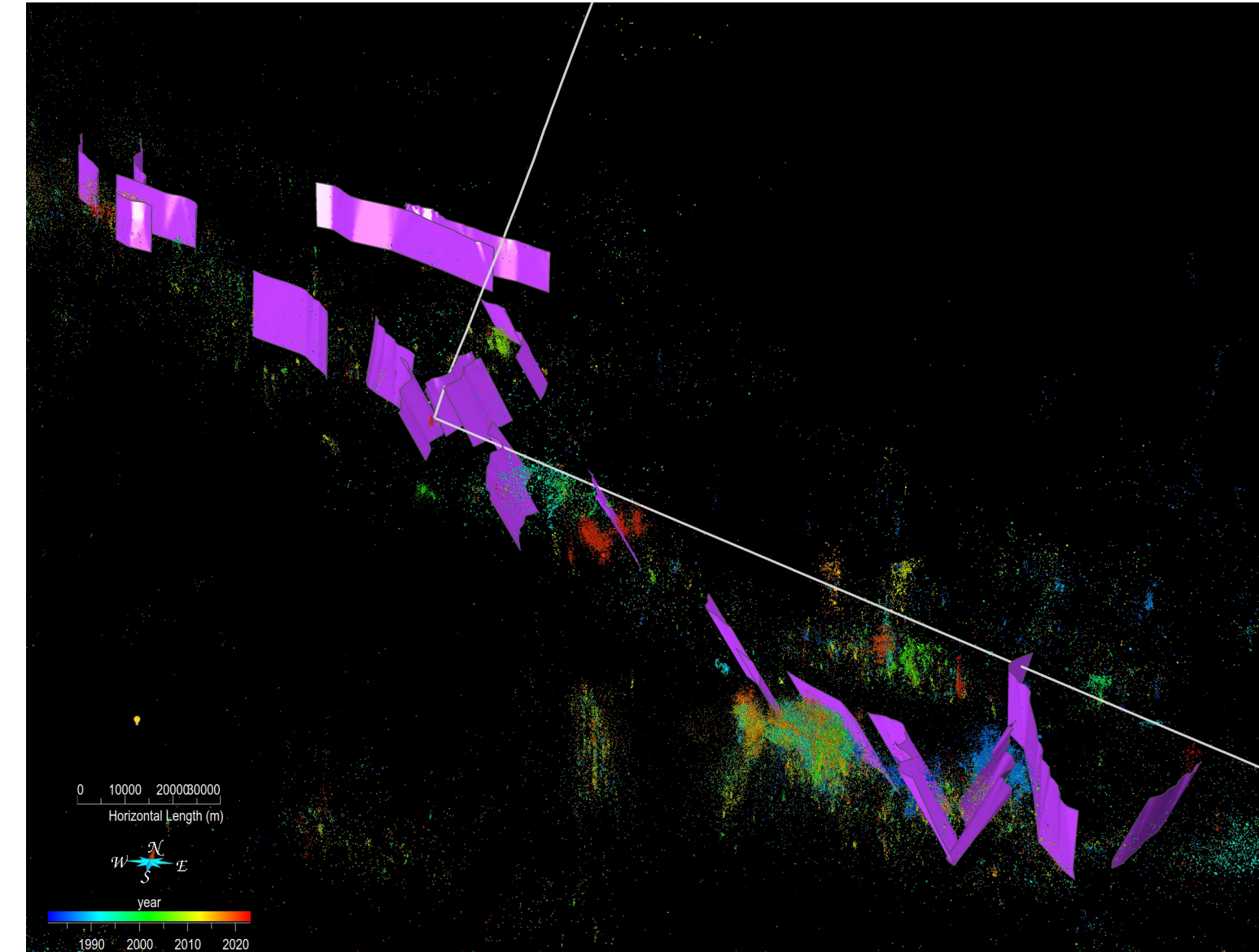


Fig. 7: OCCA evaluation area: 8 specific suggestions

3. CFM 7.0 Explorer Update: Recent Seismicity

In collaboration with the SCEC IT group, we have updated the CFM Explorer (fig. 8) to add an important and widely requested functionality: visualization of near real time and historic earthquake hypocenters along with faults in 2D (fig. 9) and 3D (fig. 10) and the ability to generate a direct hyperlink to preselected 2D or 3D views with preselected faults and recent USGS ComCat earthquakes (see fig. 11).

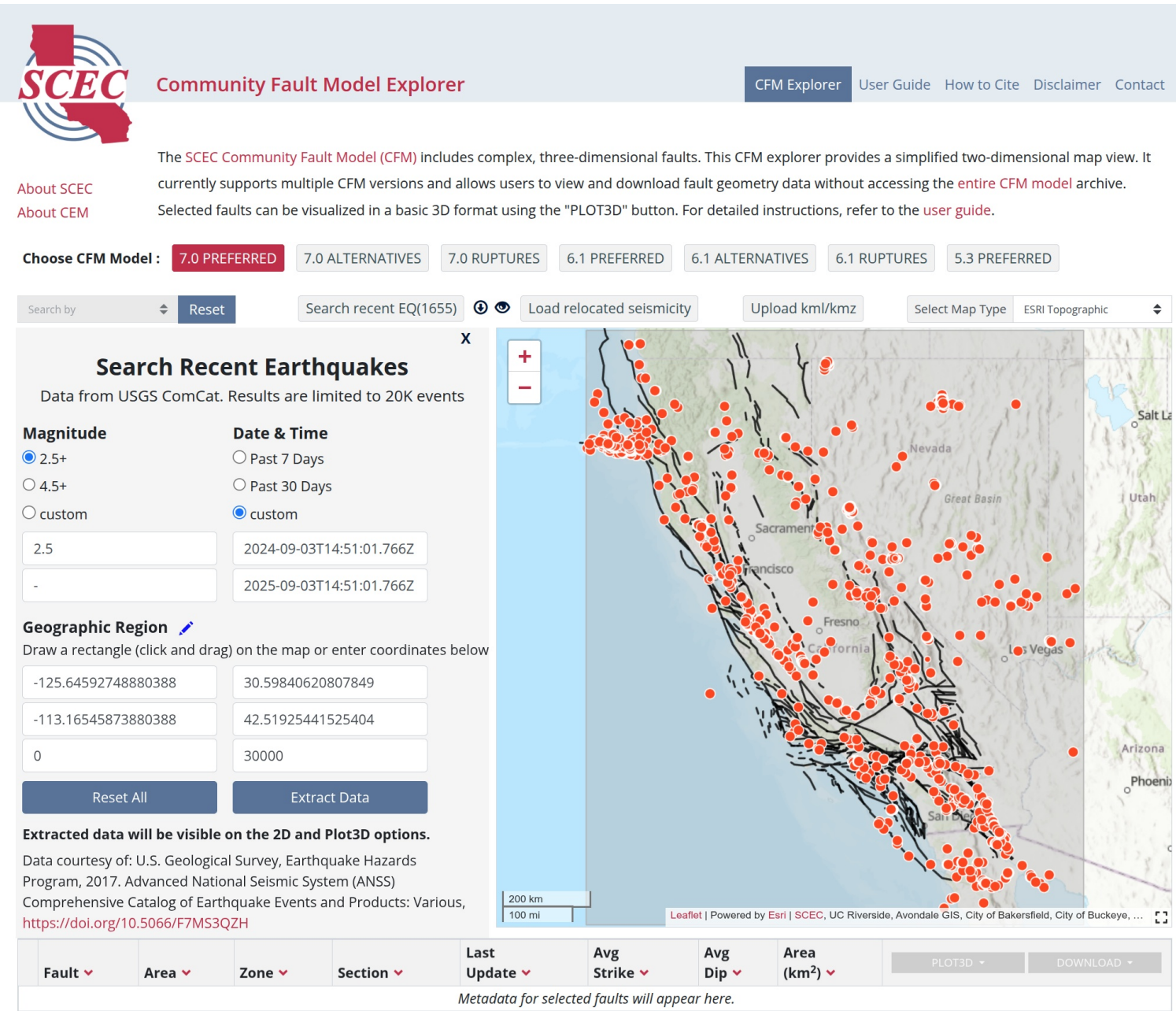


Fig. 8: Interface for Recent Seismicity in the CFM web explorer. Selection criteria include magnitude and date range, and area. Map shows seismicity M>2.5 for the past year.

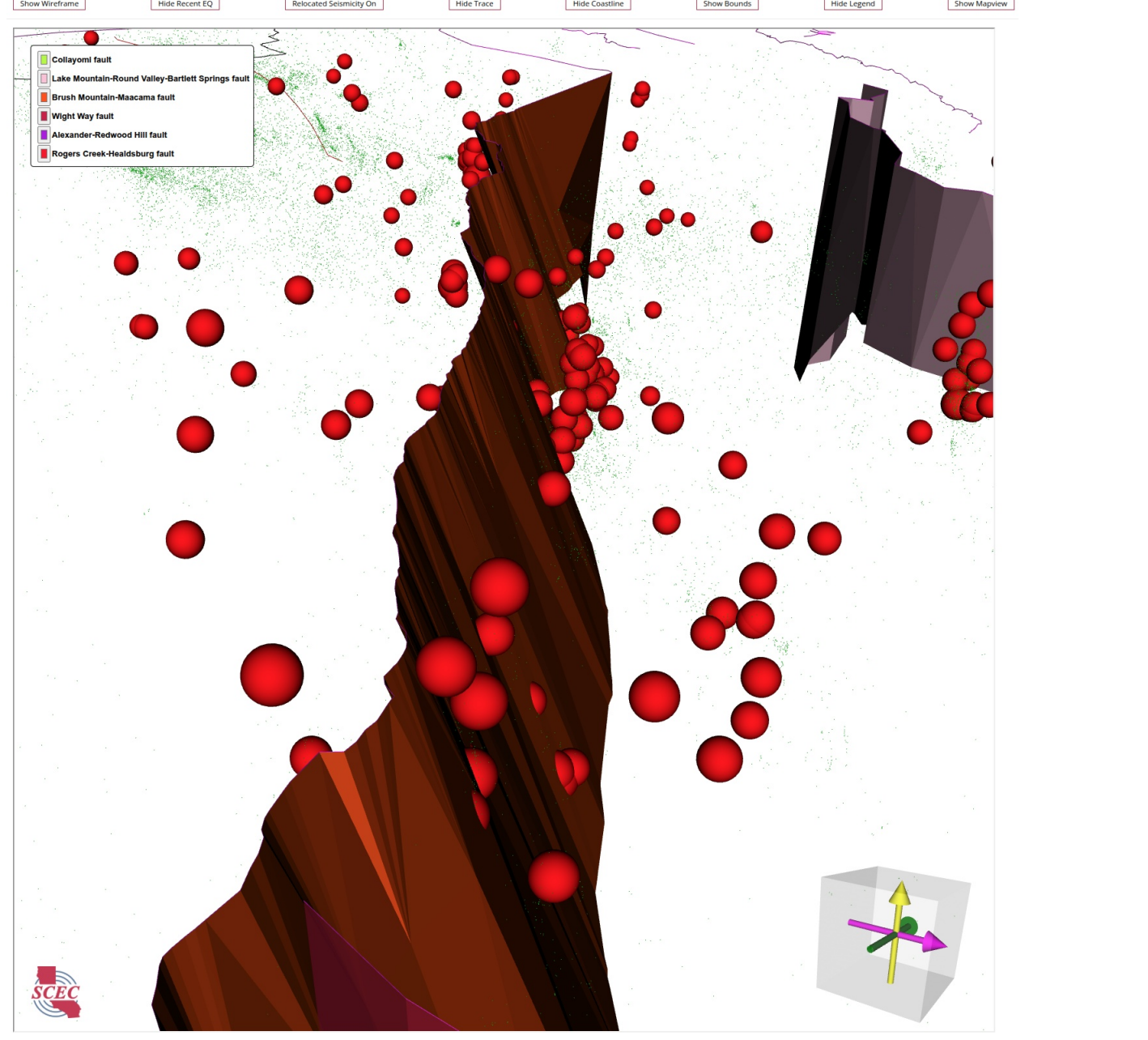


Fig. 9: Perspective view along the NE dipping Maacama fault and associated seismicity M>2 since 1981.

4. Update of Earthquake-Fault Association service: CFM 7.0, linked to CFM Explorer

The service is available to all sec.org account holders. It sends near real-time email notifications with the probabilities of which faults are most likely associated with earthquakes > M3 in southern California. The new earthquake-to-fault association service utilizes CFM 7.0, providing the foundation for covering the entire state of California. The service notifications (fig. 11) directly link to the CFM Explorer showing the most likely fault source and the hypocenter in 2D (fig. 10) and 3D views (fig. 12) for immediate inspection, near real-time.

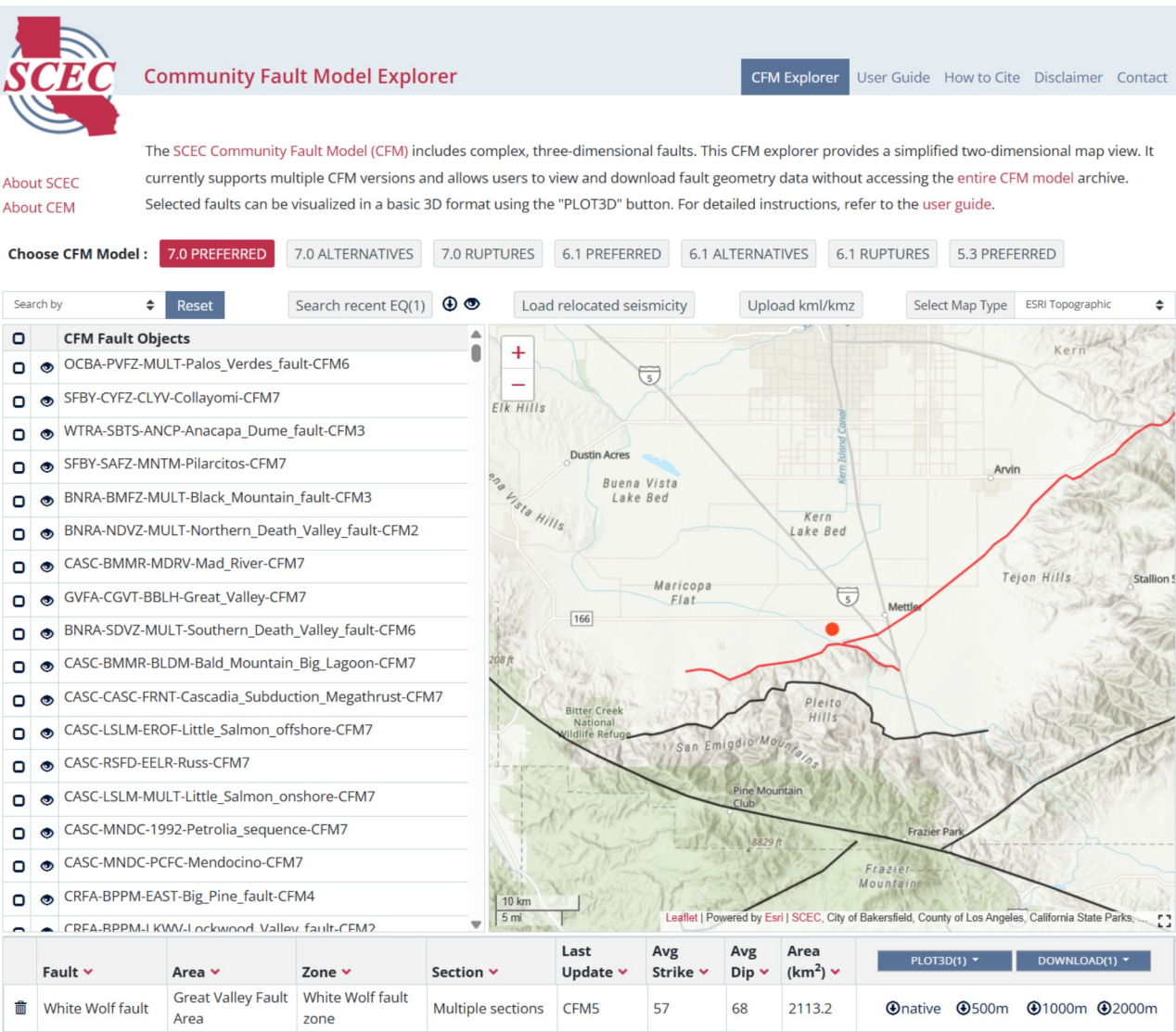


Fig. 10: map view of fault with the highest probability of association with event, here a M 3.8 event in the southern San Joaquin Valley.



Fig. 11: notification received near real time with details on event, links to USGS event page, links to the SCEC CFM explorer, and a table of the three faults with the highest probabilities of association.

5. CA-OR border crossing faults

In collaboration with the Cascadia Region Seismic Center (CRESCENT), we reassessed the CFM representation of ten CA-OR border crossing faults (fig. 13) based on available legacy industry seismic reflection data, detailed fault trace mapping, earthquake hypocenters and focal mechanism nodal planes. These updates partially address review comments and will be part of the next CFM release.

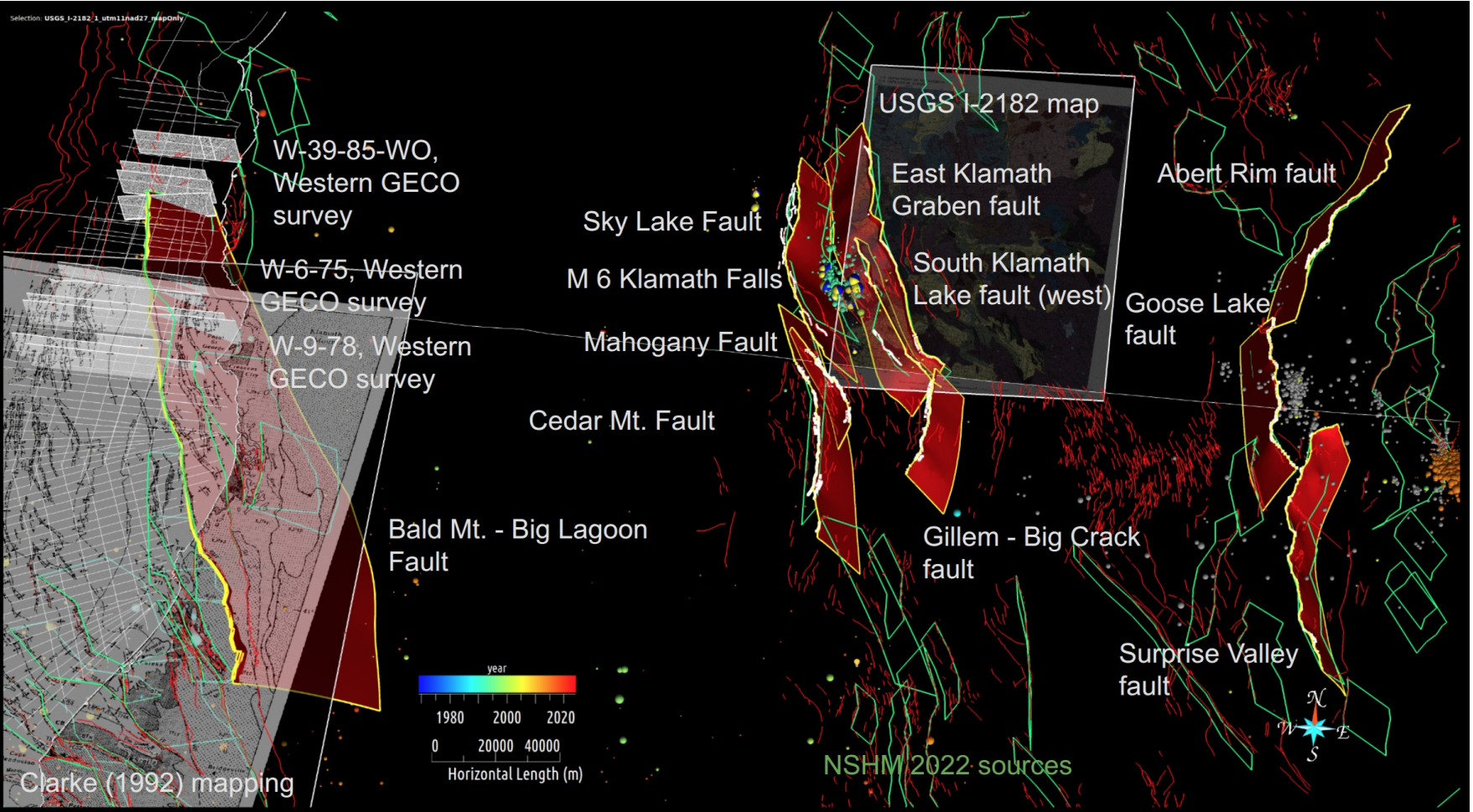


Fig. 12: interactive 3d view of event at located depth and full fault, here the White Wolf fault.

Fig. 13: perspective view looking to N across CA-OR border. Ten fault have been updated based on all available data in collaboration with CRESCENT. Red updated 3d fault surfaces, qfault traces (red), hypocenters, focal mechanism, maps and seismic reflection profiles are shown.

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