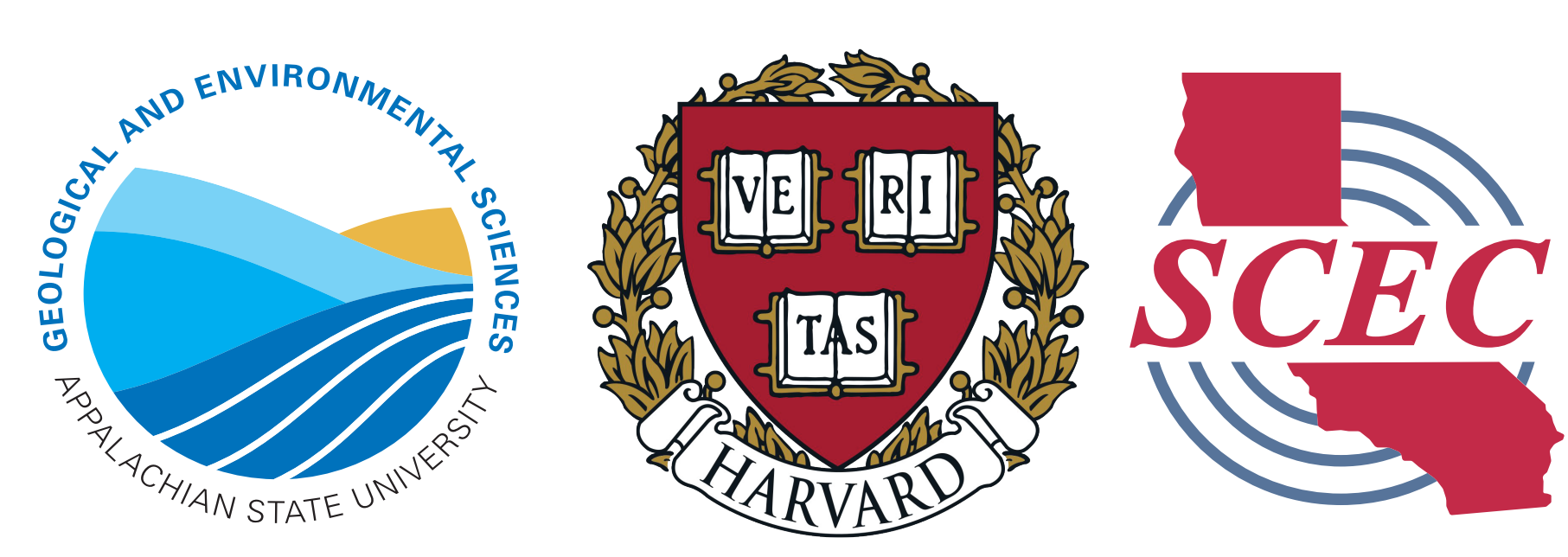


Earthquake-to-Fault Associations Across Northern California

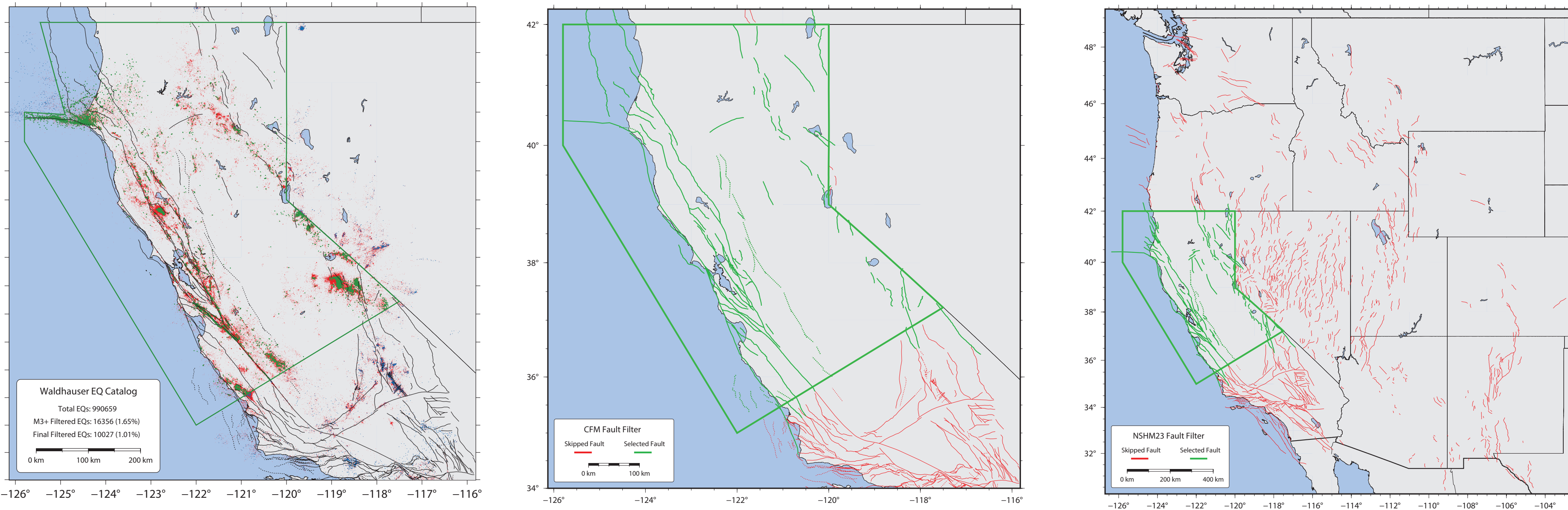
Esmeralda Callejas¹, Scott T. Marshall¹, Andreas Plesch², Walker S. Evans³, John H. Shaw²

¹Department of Geological and Environmental Sciences, Appalachian State University
²Department of Earth and Planetary Sciences, Harvard University, ³Unaffiliated Reasearcher



1. INTRODUCTION

The Evans et al. (2020) earthquake-to-fault (E2F) association algorithm statistically associates earthquakes to their most probable sources out of a set of 3D fault surfaces, therefore the E2F algorithm can be used to quantify a fault model’s completeness. Here, we present results from the E2F associations across the nascent northern California portion of the SCEC Community Fault Model (CFM). Our preliminary analyses use relocated earthquake hypocenters from 1984 to 2026 in the Northern California Seismic Network’s Real-Time Double-Difference (DD-RT) earthquake catalog (Waldhauser & Schaff, 2008) and filter it to exclusively M3+ events in northern California. To compare model performance, we ran the E2F algorithm on the SCEC CFM 7.0 and a 3D mesh of the Fault Sections Database of the USGS National Seismic Hazard Model (NSHM).

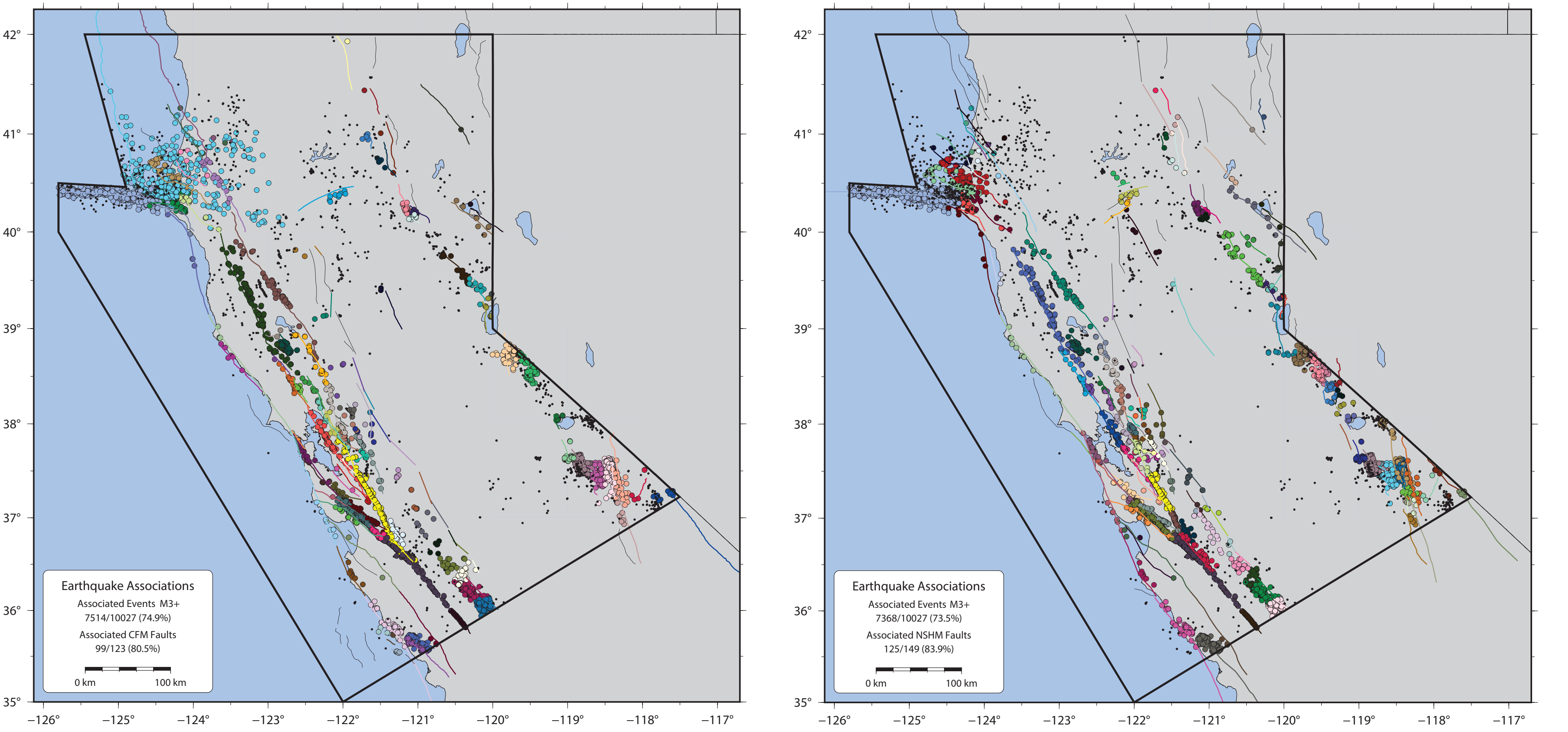


Above: The DD-RT earthquake catalog plotted on a map of Northern California. The red dots represent the raw earthquake data, the blue dots represent the M3+ events, and the green dots represent the M3+ events that occurred within the region of Northern California outlined in green.

Above: The CFM7.0 fault traces filtered to Northern California. The green polygon outlines the region that the fault model is filtered to. All of the green faults have been selected for this analysis, and all of the red faults have been omitted.

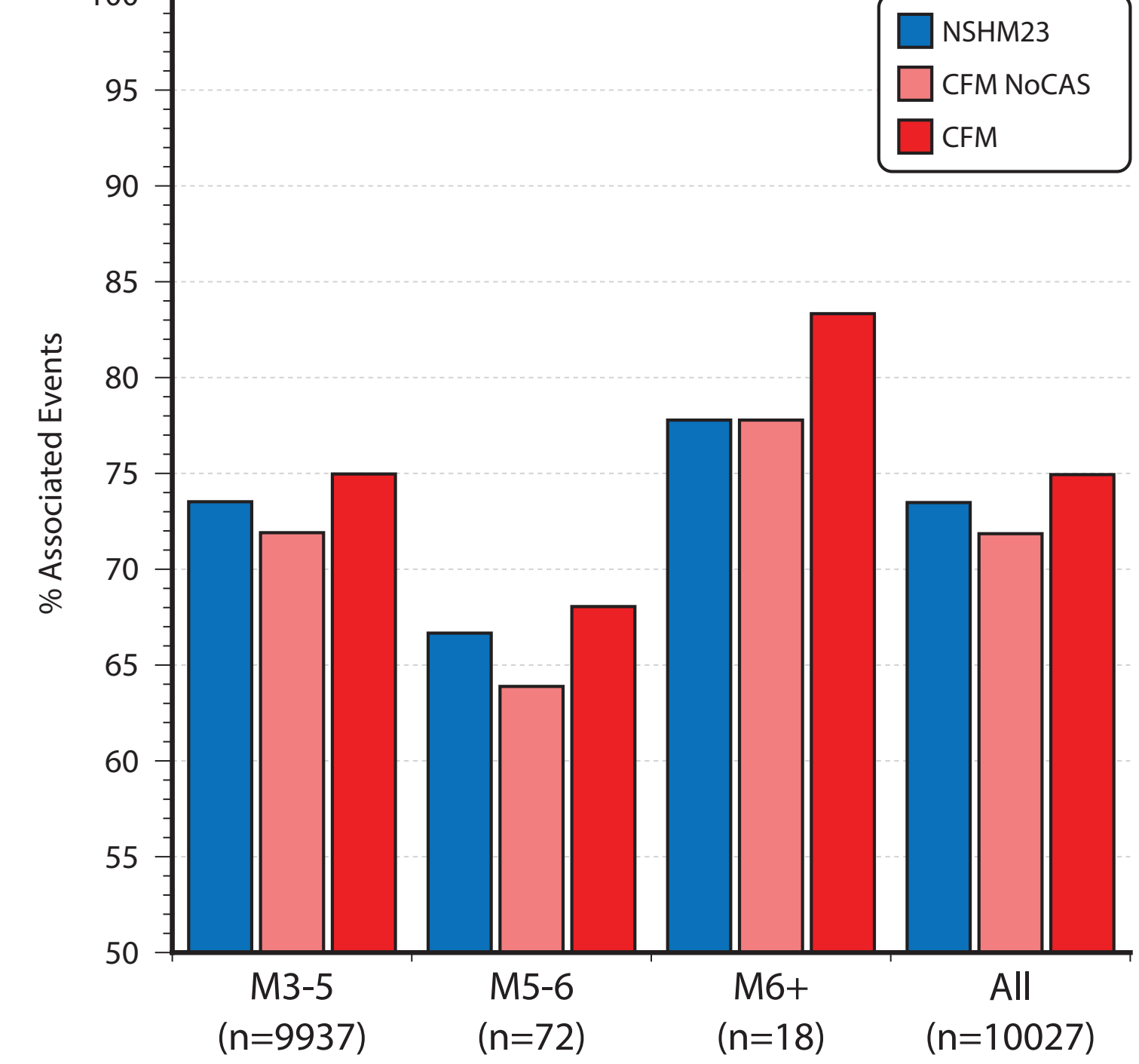
Above: The NSHM23 fault traces filtered to Northern California. The green polygon outlines the region that the fault model is filtered to. All of the green faults have been selected for this analysis, and all of the red faults have been omitted.

2. E2F ASSOCIATIONS IN NORTHERN CALIFORNIA



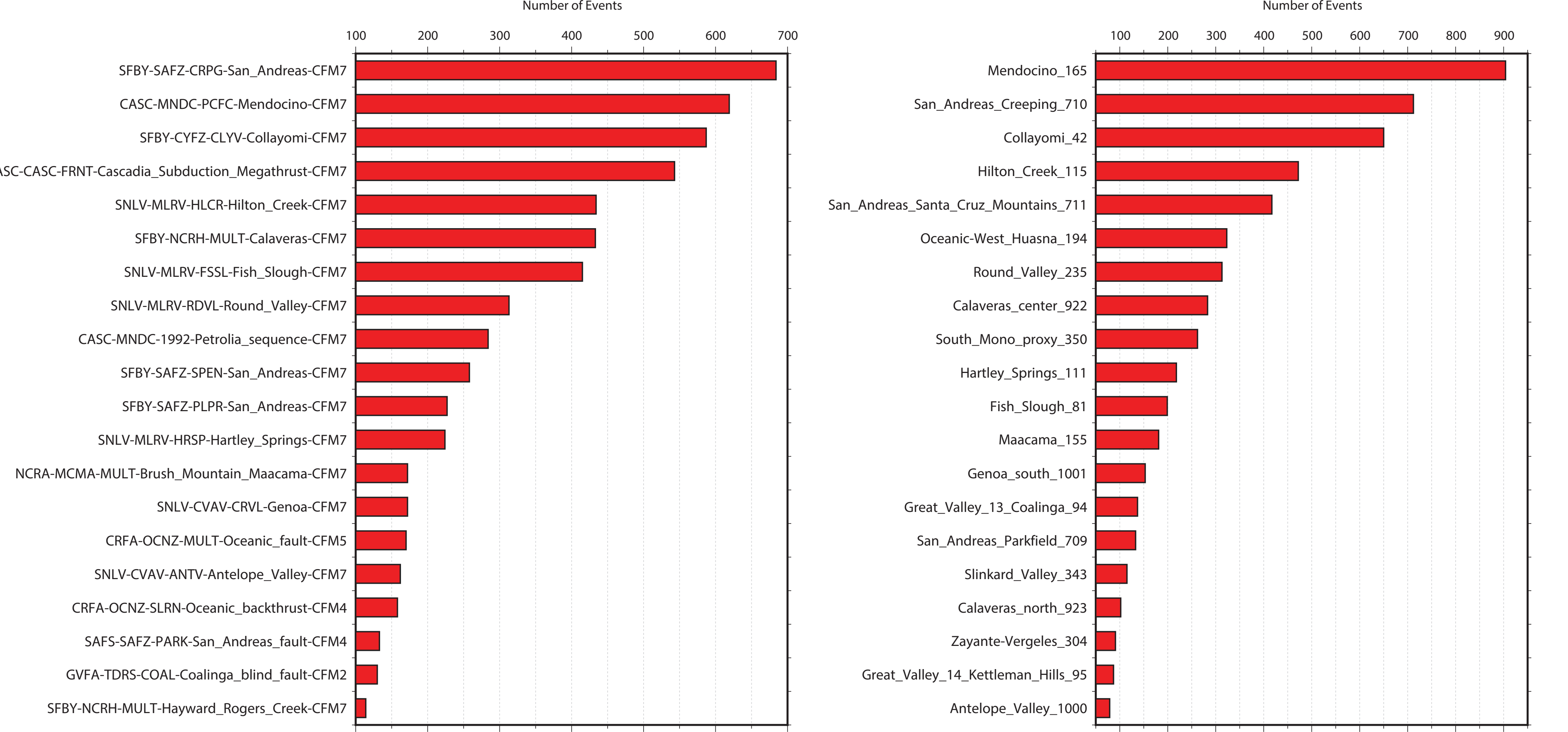
Above: A plot of events that associate to a fault in the CFM7.0. The color of the events matches the respective fault. The black dots represent the unassociated events.

Above: A plot of the events that associate to a fault in the NSHM. The color of the events matches the respective fault. The black dots represent the unassociated events.



Left: We find that 74.9% and 73.5% of all M3+ northern California events are associated with a fault in the CFM7.0 and NSHM, respectively. Although the CFM and the NSHM have a similar percentage of associated events, the NSHM does not contain a Cascadia Subduction Zone fault representation, which more than 300 events associate to in the CFM. To better compare the two models, we removed the Cascadia Subduction Zone from the CFM analysis and find that 71.9% of events then associate to a CFM fault.

3. MOST ASSOCIATED FAULTS

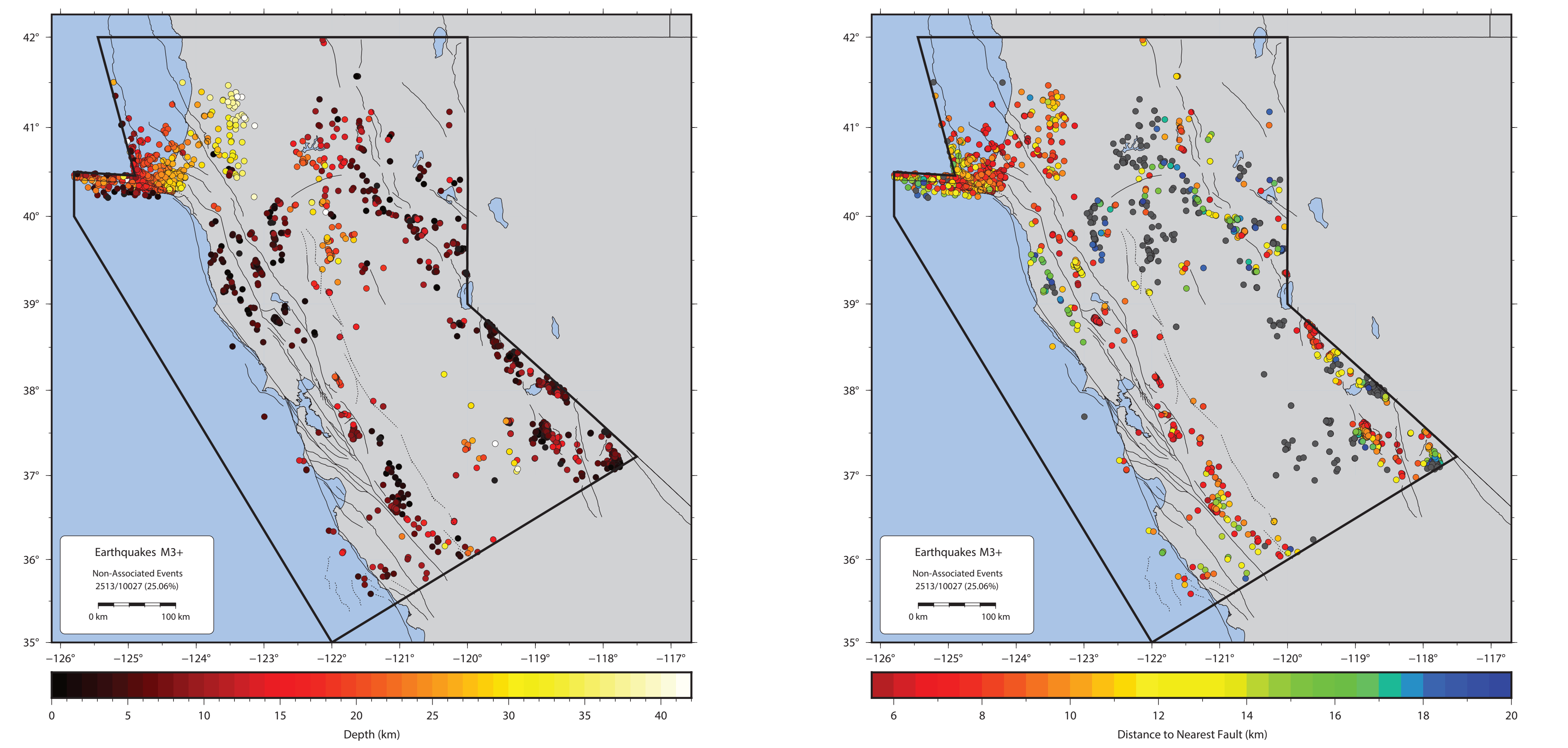


Above: A histogram with the top 20 most associated faults in the CFM 7.0 and the number of events that were associated to each.

Above: A histogram with the top 20 most associated faults in the NSHM and the number of events that were associated to each.

4. ANALYSIS OF UNASSOCIATED EARTHQUAKES

We find that 25.06% of all M3+ northern California events do not associate to a fault in the CFM 7.0.

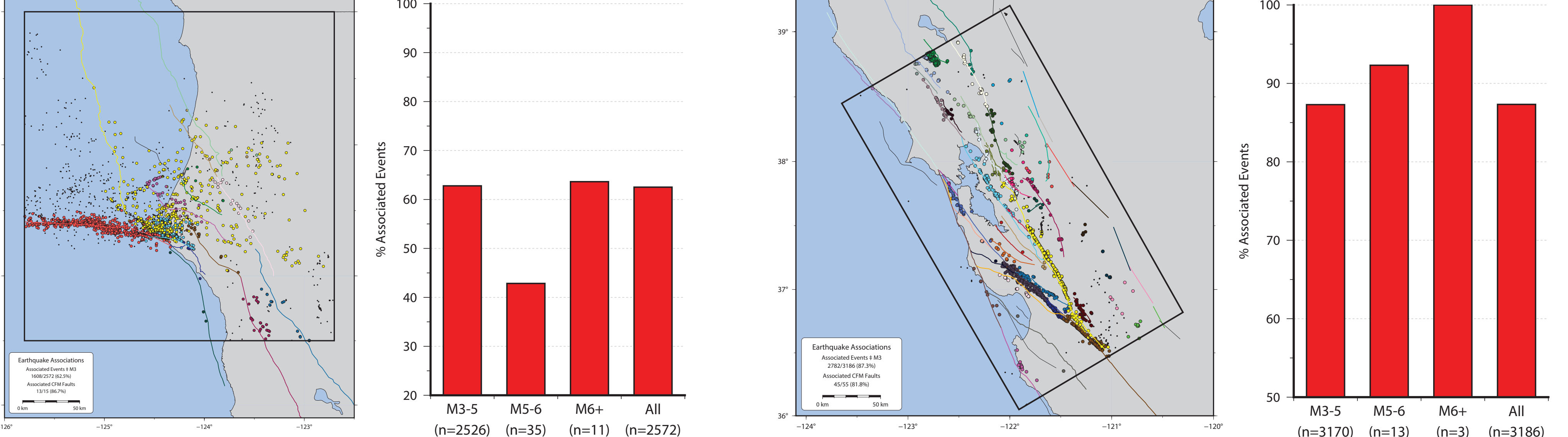


Above: A plot of all of the events that did not associate to a fault in the CFM 7.0 colored by depth (km). Note: There are a few anomalously deep events (>42 km).

Above: A plot of events that did not associate to a CFM 7.0 fault colored by distance to the nearest fault (km). All events >20km from a fault are colored dark gray.

5. ANALYSIS OF SUBREGIONS

The Mendocino triple junction (MTJ) region has lowest percentage of associated events with 45.8% associated to NSHM faults and 62.5% and 50.3% associated to the CFM with and without the Cascadia subduction zone included, respectively. E2F associations in the San Francisco Bay region show 87.3% and 90.0% of events associating to a CFM and NSHM fault, respectively.



Above: A plot of events that associate to a fault in the MTJ (left) and San Francisco Bay (right) regions of the CFM 7.0. The color of the events matches the respective fault. The black dots represent unassociated events.