

USGS 3D Seismic Velocity Model 08.3.0

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March 21, 2018



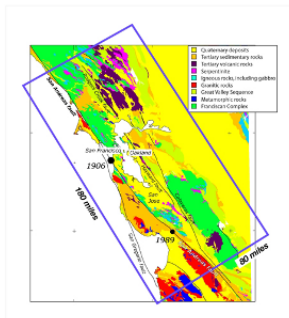
3-D Geologic and Seismic Velocity Models of the San Francisco Bay Region

The USGS 3-D Geologic and Seismic Velocity Models of the San Francisco Bay region provide a three-dimensional view of the geologic structure and physical properties of the region down to a depth of 45 km (28 miles). Construction of this 3D Bay Area model has been a joint effort of the [USGS Earthquake Hazards Program](#) and the [USGS National Cooperative Geologic Mapping Program](#).

Previous work by the USGS and others has shown that the 3-D structure of the earth has a significant impact on how strongly an earthquake is felt at different locations and on the duration of the shaking. Because seismic waves propagate through different rock types with differing speeds that depend on the rock properties, the waves can be reflected and refracted as they travel through various rock types. These effects need to be understood in order to predict the shaking in future large earthquakes.

The 3-D models combine 100 years of surface geologic mapping by the USGS, the California Geological Survey, and many other institutions together with decades of research into the seismic properties of the rocks in the Bay Area. They also include information from boreholes and variations in Earth's gravity and magnetic fields. Traditional two-dimensional geologic maps show only the distribution of rock units at Earth's surface.

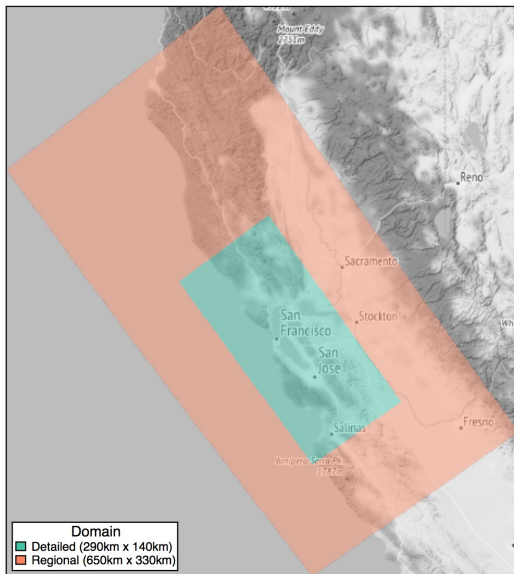
The geologic model is a fault block model - that is, the upper 45 km (28 miles) of Earth's crust has been broken up into irregular shaped blocks, bounded by faults. The model also includes the subsurface shape of basins that underlie the Santa Clara Valley, Livermore Valley, and Santa



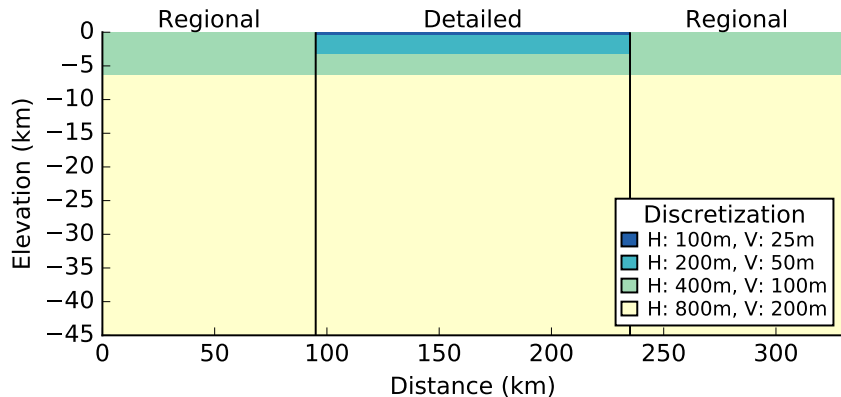
Traditional two-dimensional geologic map of the San Francisco Bay region. The blue rectangle outlines the region covered by the 3-D geologic and seismic velocity models. Black dots show the epicenters of the 1906 San Francisco earthquake and the 1989 Loma Prieta event. Different colors correspond to different rock types found in the region.

Model Domain: Map View

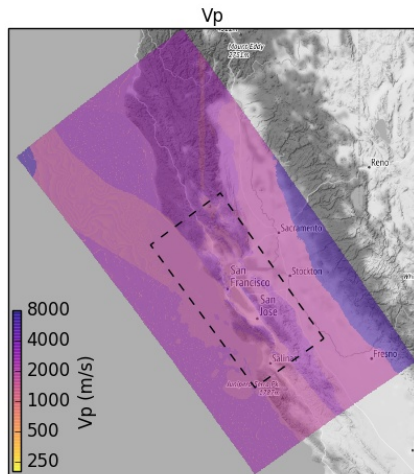
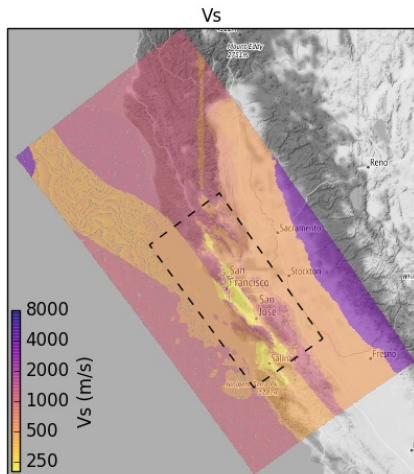
Detailed domain surrounded by coarser regional domain



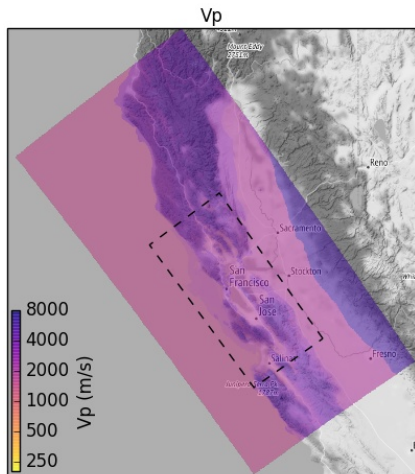
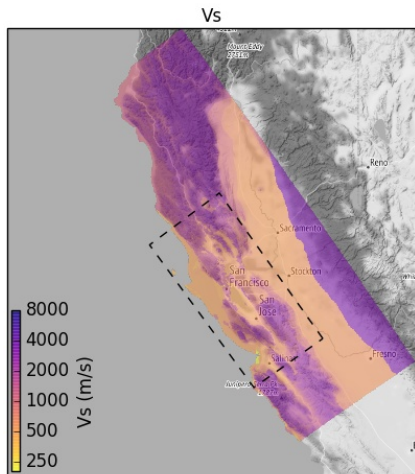
Model Domain: Profile View



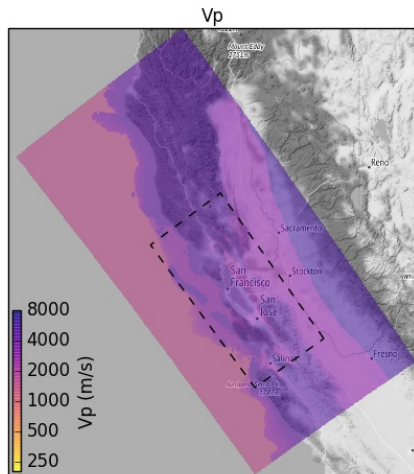
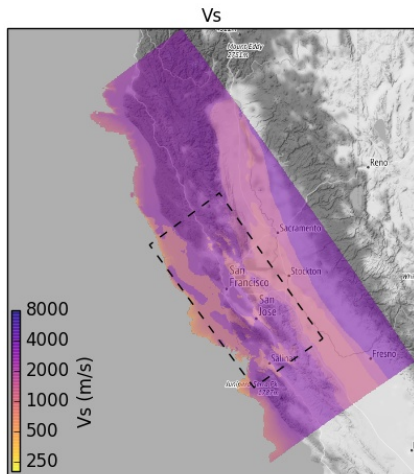
Regional+Detailed, Horizontal Slice: Ground Surface



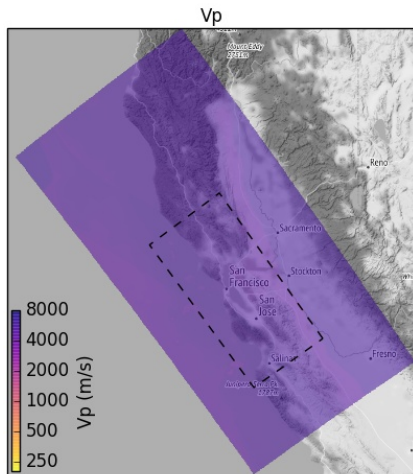
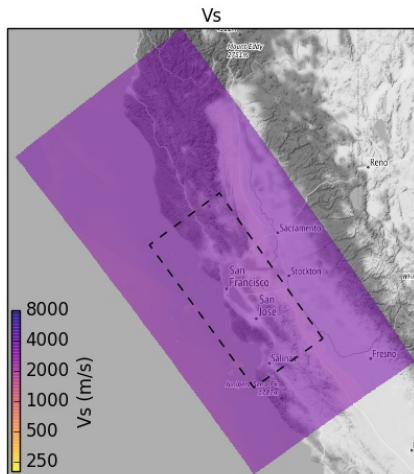
Regional+Detailed, Horizontal Slice: -100m Elevation



Regional+Detailed, Horizontal Slice: -1km Elevation

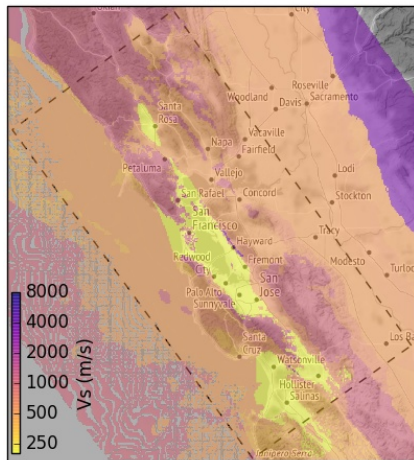


Regional+Detailed, Horizontal Slice: -5km Elevation

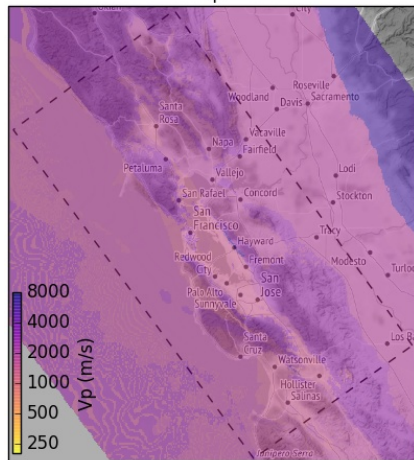


Detailed, Horizontal Slice: Ground Surface

Vs

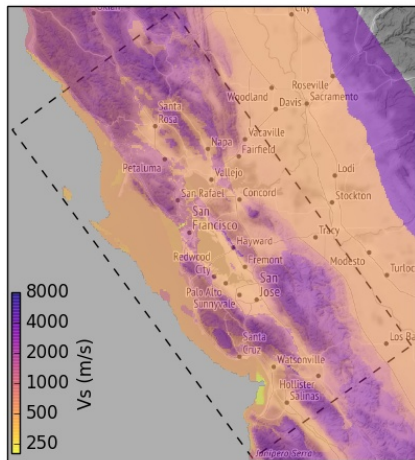


Vp

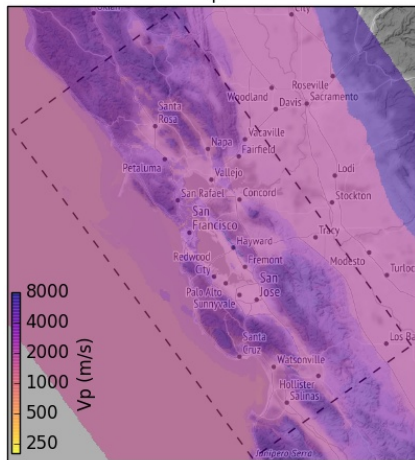


Detailed, Horizontal Slice: -100m Elevation

Vs

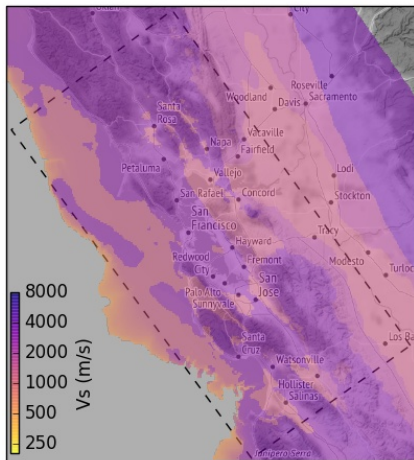


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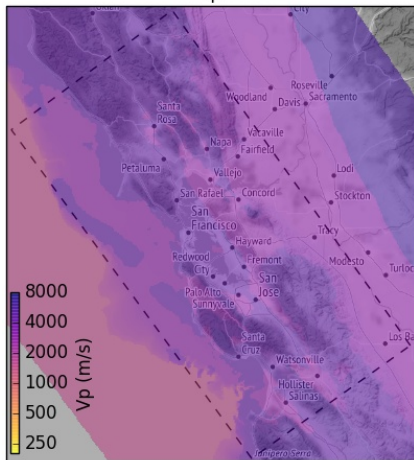


Detailed, Horizontal Slice: -1km Elevation

Vs

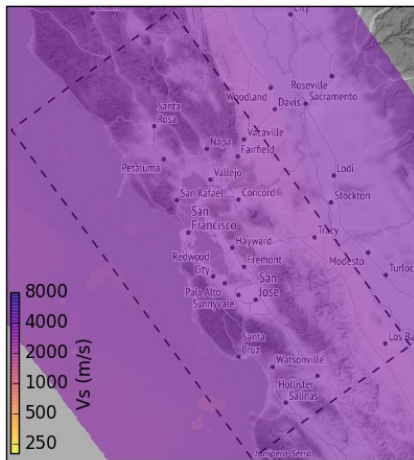


Vp

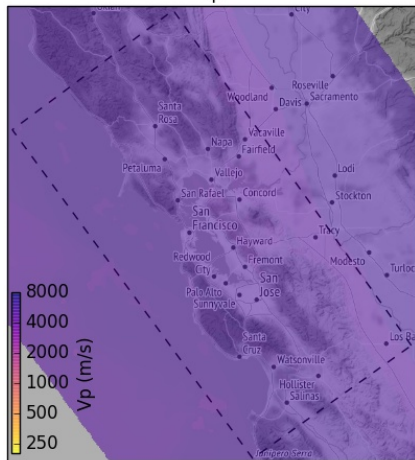


Detailed, Horizontal Slice: -5km Elevation

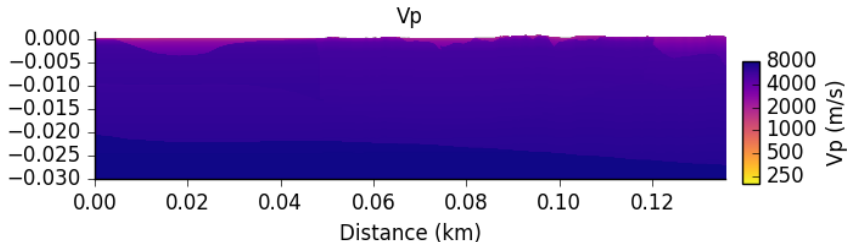
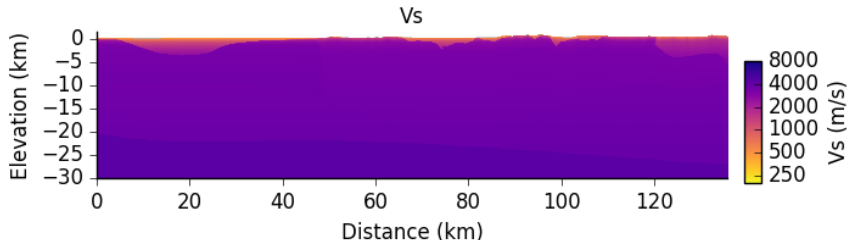
Vs



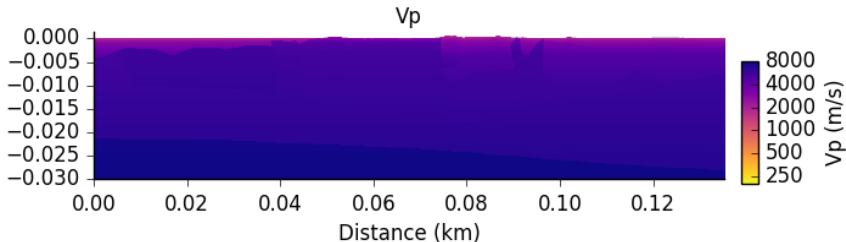
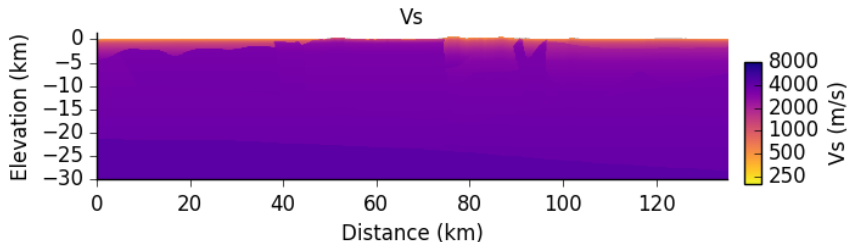
Vp



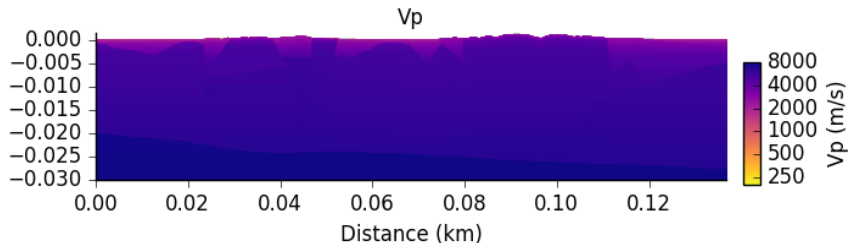
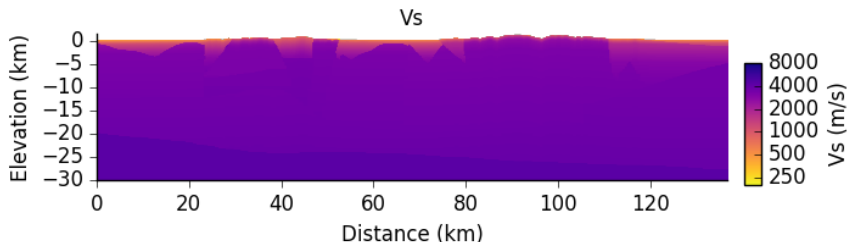
Detailed, Vertical Slice: Santa Rosa



Detailed, Vertical Slice: San Francisco

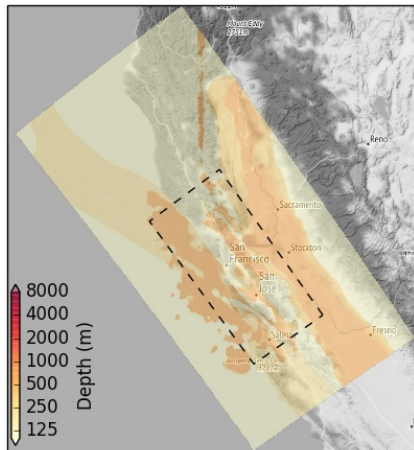


Detailed, Vertical Slice: San Jose

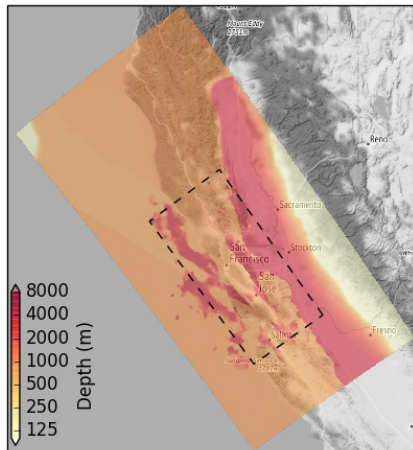


Regional+Detailed: Z1.0 and Z2.5

Z1.0

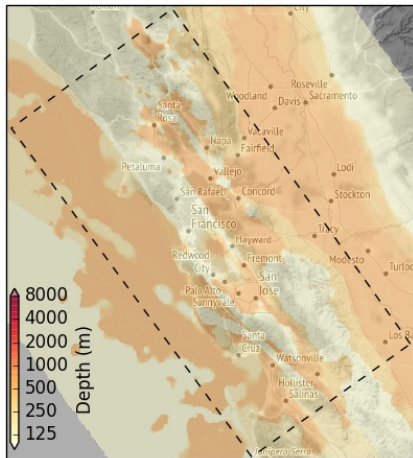


Z2.5

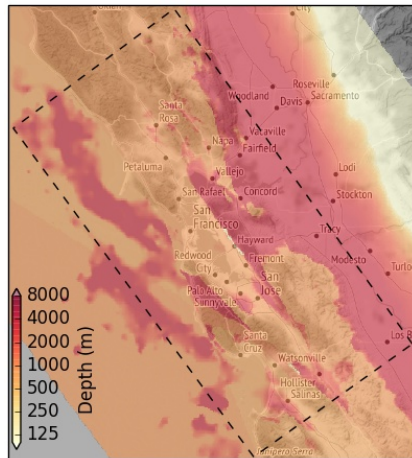


Detailed: Z1.0 and Z2.5

Z1.0



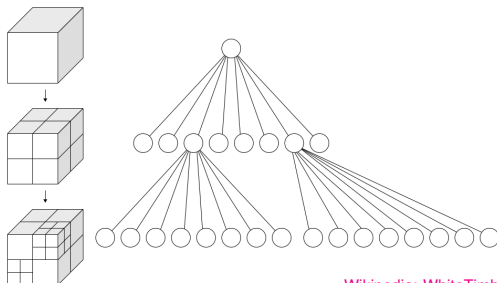
Z2.5



Storage Scheme and Query Interface

Detailed model: 8.9 GB; Regional model: 6.5 GB

- **Storage scheme:** Etree format from CMU based on octrees



Wikipedia: WhiteTimberwolf, CC BY-SA 3.0

- **Query library**
 - Custom C/C++/Fortran API on top of CMU Euclid/Etree C library
 - Only part of model is loaded into memory (user-specified cache size)
 - File format is opaque to user
 - Problems with portability of CMU Euclid library on LLNL clusters