3D GEOLOGIC MAP OF THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA; A PROGRESS REPORT

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Main Points

To improve estimates of expected earthquake shaking in the Delta and associated hazards (eg. levee failure), we are developing a geology-based 3D seismic velocity model. The first step is creation of a 3D geologic map. We have combined surface geologic mapping, petroleum well, gravity and aeromagnetic, and limited reflection seismic data, to generate a 3D framework of major faults and surfaces marking the base of the Neogene (<23 million years old) and Paleogene (23-65 million years old) sedimentary rocks, horizons that form distinct breaks in the seismic velocity model. The complexity revealed may have an important impact on earthquake shaking.

Study Area

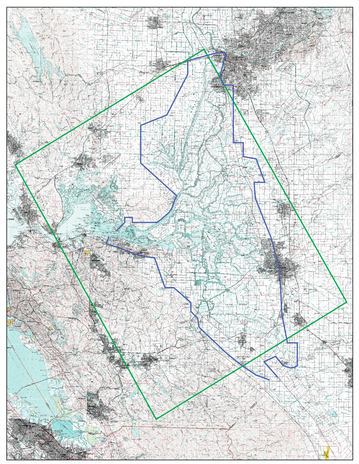

Figure 1. Mosaic of USGS 1:100,000 scale topographic maps of the Delta region showing the extent of the 3D geologic map as a green rectangle and a simplified outline of the legal Delta in blue.

Input Data Sets

1. Surface geologic maps

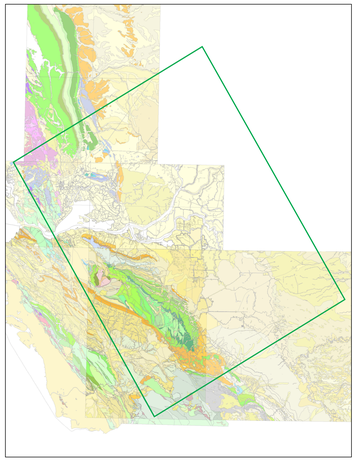

Figure 2. Simplified mosaic of surface geologic maps of the west Delta region and surrounding area to the south and west (from Graymer et al., 1994; 1996; 2002; Delattre et al., in prep.)

2. Oil- and gas-well data

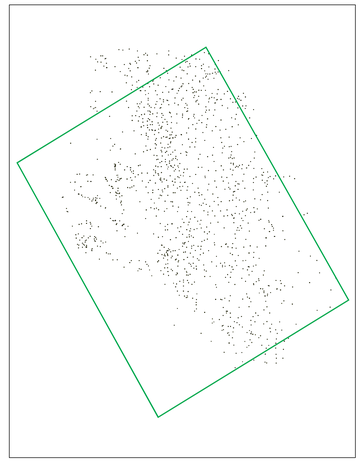

Figure 3. Map showing distribution of oil- and gas-wells used to construct the 3D geologic map (compiled from California DOGGR top file, DOGGR well data files and e-logs, and from Brabb et al., 2011)

3. Gravity data

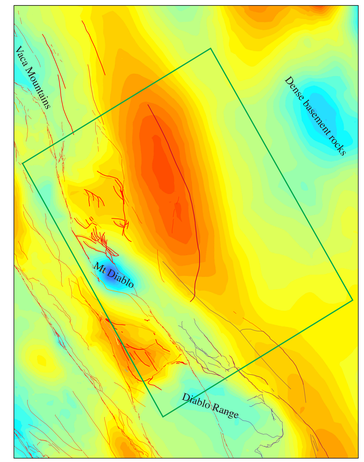

Figure 4. Isostatic gravity map of the Delta region (high=blue, low=red) overlain by faults (see Figure 6). Note the prominent gravity highs related to uplifted basement in the Diablo Range, Mt Diablo, and the Vaca Mountains (west), and dense crystalline basement under the Great Valley (east), as well as the prominent low associated with thick sedimentary rocks along the west side of the Great Valley. Data from V. Langenheim, USGS.

4. Aeromagnetic data

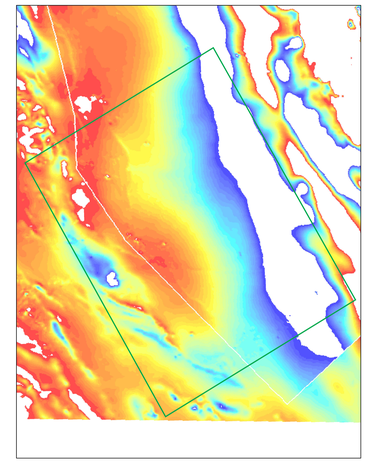

Figure 5. Aeromagnetic map of the Delta region, color spectrum adjusted to emphasize smaller anomalies in the study area (very high and very low values not colored, high=blue, low=red). Data from V. Langenheim, USGS.

5. Fault maps

Figure 6. Fault map of the Delta region (thin red lines from USGS-CGS Quaternary fold and fault database; thin purple lines from Unruh and Krug, 2007; thick red (fault) and orange (fold axes) lines from Unruh and Sundermann, 2006)

Complex areas require an interpretive step

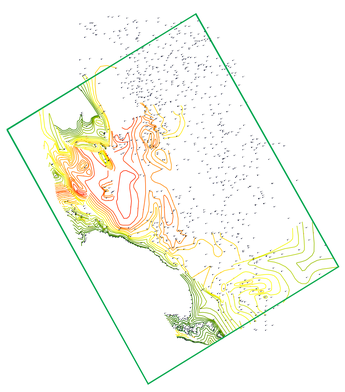

Figure 7. Map showing well and geologic map data (tiny numbered dots) and hand-drawn structure contours on the top of Cretaceous and older rocks (>65 million years old). Computer interpolation could not adequately handle the complexity revealed by the multiple data sets. Note that the northeast part of the study area is not hand-contoured because there is less data.

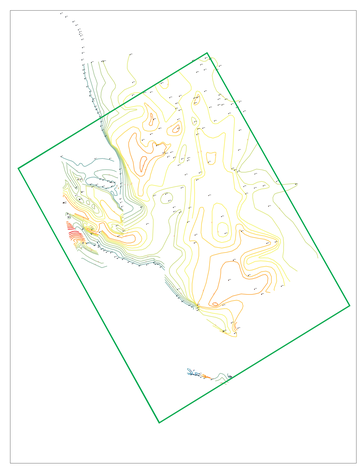

Figure 8. Map showing well and geologic map data (tiny numbered dots) and hand-drawn structure contours on the top of Paleogene rocks (23-65 million years old). Computer interpolation could not adequately handle the complexity revealed by the multiple data sets, so the whole surface was hand-contoured.

Preliminary 3D geologic map - version 0.1

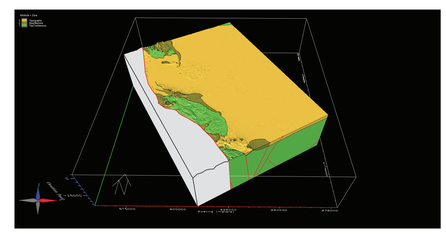

Figure 9. Preliminary 3D geologic map, showing the volumes of Neogene (<23 million years old, orange), Paleogene (23-65 million years old, olive) and older (green) rocks. Gray volume west of Delta, previously modeled, not part of present work.

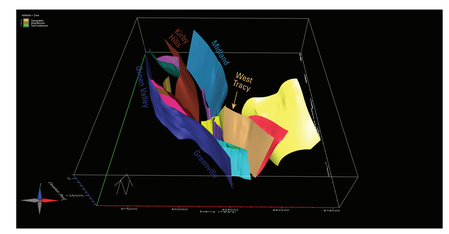

Figure 10. 3D fault surfaces. Only faults with significant offset on mapped horizons included. Some fault surfaces were created by linking multiple on-strike faults to make a continuous bounding surface (eg. Green Valley-Concord-Diablo-Greenville)

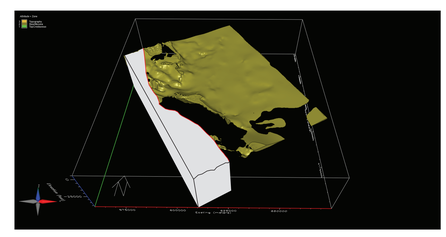

Figure 11. Preliminary upper surface of Paleogene rocks (compare to Figure 8). Note the complex structure in the northwest part of the study volume.

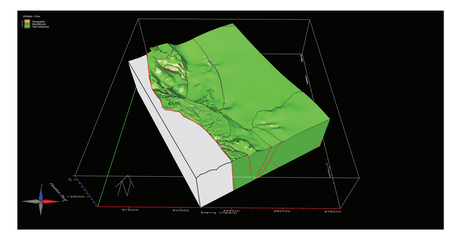

Figure 12. Preliminary upper surface of Cretaceous and older rocks (>65 million years old). Northeast part not yet modeled. Note large folding and faulting in the northwest part of the model

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