Map Restoration

We use map restoration to produce a balanced surface-area restoration. The details of this method are published and only a general overview is presented here (see, Gratier and others, 1991; Gratier and Guillier, 1993; Gratier and others, in press). First, the outline and the contours of the depth-contoured surface are digitized in each fault block or artificially limited fold block and then gridded. The program UNFOLD organizes the grid into triangles that are then laid flat and a misfit between the rotated triangle and the hole defined by its neighbors is minimized by translation and rotation in an automatic iterative process (Gratier and others, 1991). The program also calculates the percent of shortening for each individual fault block; the local shortening direction will be perpendicular to the fold trend. One edge of the map is chosen as a reference line, and an interactive graphics program is used to sequentially fit the unfolded surfaces to this line and to their neighbors across faults (Gratier and Guillier, 1993). Comparison between the restored and present state allows the finite displacement field to be drawn with respect to the fixed reference line, in this case, the western boundary of the map (Fig. 2). Estimates of local block rotations with respect to the reference line are obtained by rotating the flattened block outlines to achieve a best fit between neighbors, and then comparing the orientation of a block boundary in the restored map to the orientation in the present-day deformed map. Slip, including strike-slip, is inferred by comparing displacement across a fault. The results are local estimates of shortening for each block and a regional displacement field derived from fitting all blocks.

RESULTS

Ocean drilling program site 893 was drilled to 200 m depth beneath western Santa Barbara Channel. Careful dating shows that the oldest sampled strata are 160 ka (Kennett, 1995). We correlated a reflection dated at 110 ka (+/- 10%) (depending on the velocity used for depth-travel time conversion; see also Elliot and Kamerling, 1995), a reflection extrapolated to be ~200 ka (+20%-10%), and one interpolated to be 250 ka (+60%/-20%) throughout dense grids of single-channel and 12 fold multichannel seismic reflection data in central Santa Barbara Channel. The age of the ~250 ka reflection was estimated by interpolation between the dated ~110 ka and a dated 1 Ma reflection in the deeper basins of central Santa Barbara Channel, where the depths of the 110 ka, 200 ka, and 1 Ma horizons indicate relatively constant sedimentation rates.

Results also include the completion of the map of the ~1 Ma horizon (975 +/-75 ka; Huftile and Yeats, 1995). The onshore part of the map was constructed from Yeats (1981 and 1989), and slightly modified by interpolation of additional contours. Depths from the offshore map and cross sections of Yeats (1981, 1983) were converted to travel time using velocity surveys in wells, and then correlated through a grid of 1970s-vintage multichannel industry seismic reflection data loaned to the project by Occidental Oil and Gas. Velocity surveys in numerous wells were used to convert the travel times back to depth. These depths were combined with the depth contours of Yeats (1981), and a new, more detailed map created. This map shows folding and reverse faulting along the Mid Channel and Oak Ridge trends, folding of the Ventura Avenue anticline, the steep fold limb above the blind San Cayetano fault, and the large vertical motions across the onshore Oak Ridge fault. This ~1 Ma map has been digitized and restored. The digitized grid is being provided to the USGS as part of this report and should be available for download by the USGS or eventually at our own web site (http://quake.crustal.ucsb.edu/vbmrp).