*2003 SCEC Annual Report*

# A community block model (CBM) for southern California, and progress toward a Unified Structural Representation

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| Proposal Categories: | Science |
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| Primary Discipline Group: | Geology |
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## TECHNICAL REPORT

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**Summary**
We are developing a new Community Block Model (CBM) of southern California, which consists of closed, triangulated surface (t-surf) representations of fault-bounded blocks. The model includes 52 faults that, combined with topography and a regional base-of-seismicity surface, define more than 100 fault blocks. Fault representations are based on the new Community Fault Model (CFM) (http://structure.harvard.edu/cfm). In collaboration with SCEC's crustal deformation modeling group, we are exploring alternative approaches for meshing the CBM, using a prototype model in the northern Los Angeles basin. The completed CBM will be available by the end of current funding cycle (1/31/04).

In addition, we have also updated the top of crystalline basement surface in the Los Angeles basin to incorporate fault offsets that are specified by the CFM. Once this and other geologic surfaces are made compatible with the CFM, they can be incorporated into the Community Block Model to facilitate its use as a framework for the Unified Structural Representation (USR).

### Community Block Model (CBM)

*Composition:*

Elements of SCEC's fault systems studies require a three dimensional description of major fault blocks in southern California, which we are providing as a Community Block Model (CBM). The CBM will be meshed and used by 3D quasi-static codes for simulating crustal motions, and by codes that simulate earthquake catalogs over multiple rupture cycles. Unlike the community fault model (CFM) where faults can terminate laterally or at depth in free space, "fault surfaces" in the CBM must extend to connect with other faults or the model boundaries. Extending fault surfaces requires careful consideration of geology in order to produce meaningful block representations. Moreover, care must be taken to ensure that block topologies are not so highly complex that they cannot be effectively meshed.

The CBM includes 52 faults selected from the more than 120 faults currently comprising the CFM. In coordination with Brad Hager (MIT), faults were selected based on size, slip rate, and continuity. Blocks are bounded by these faults and other surfaces, including topography and base of seismicity surfaces extracted from the CFM. The completed blocks are defined by closed traingulated surfaces (t-surfs) that must precisely fit together without gaps or overlaps.

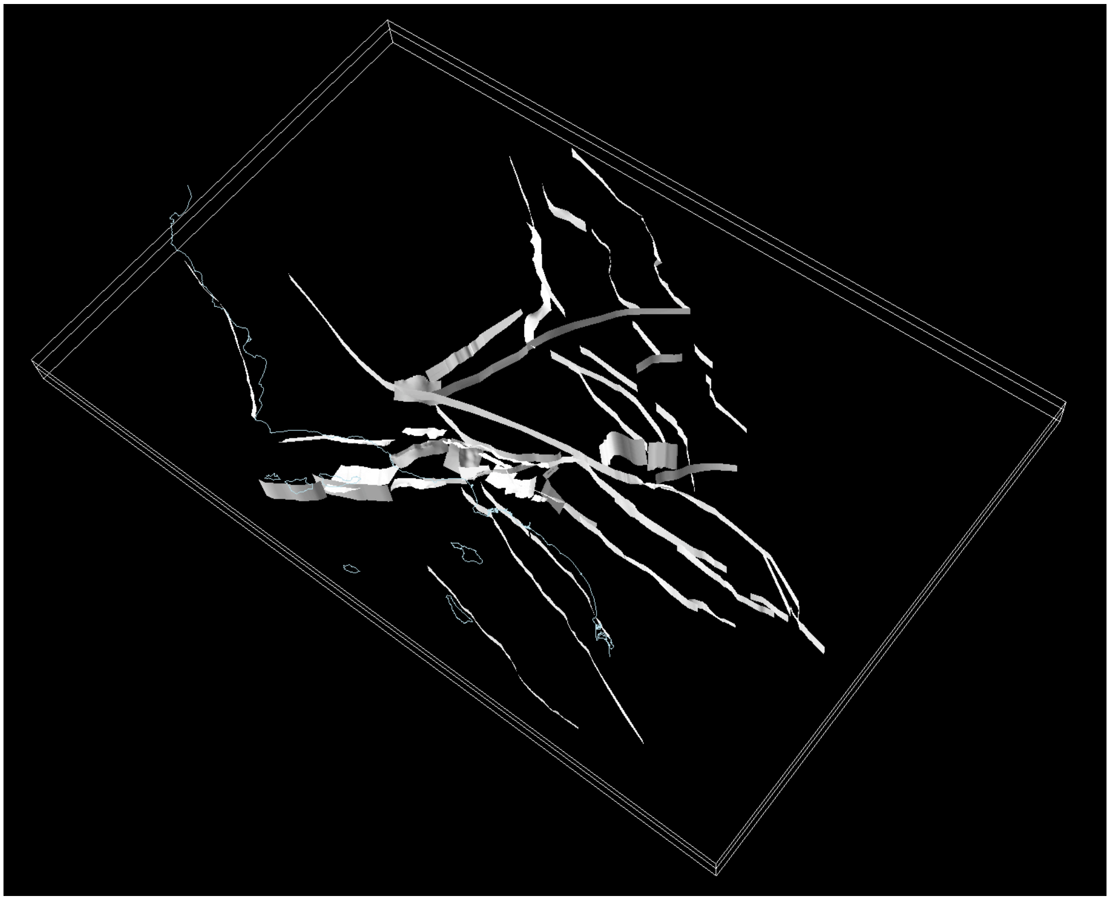

**Figure 1**: Perspective view of the faults that define the blocks in CBM, including: Channel Islands, Garlock, Cucamonga, Death Valley, Hollywood, Hosgri, San Simeon, Imperial, Julian, Elsinore, Landers Rupture, Newport Inglewood, Palos Verdes, Owens Valley, Panamint Valley, Puente Hills, Raymond, Pinto Mountain, Santa Monica, Sierra Madre, Verdugo, Whittier, San Gabriel, Brawley Seismic Zone, Goldstone Lake, Gravel Hills, Harper Lake, Red Mountain, Santa Rosa Island, Santa Cruz, Dume, Malibu Coast, Northridge, Santa Susana, San Cayetano, Chino, Upland, Peralta Hills, Alhambra, Rose Canyon, Coronado Banks, San Clemente, Ludlow, Lenwood, Lockhart, Old Woman Springs, Coyote Lake, Red Pass, Burnt Mountain, Helendale, South Lockhart, East North Frontal Zone, West North Frontal Zone, Little Lake Sierra, Nevada, Hunter Mountain, Furnace Creek, White Wolf, Pleito, Oakridge Onshore, Elsinore (Glen Ivy, Coyote Mountain, Temecula, San Jacinto (San Jacinto Valley, Superstition Hills, Superstition Mountain, San Bernardino Valley, Coyote Creek, Borrego, Anza), San Andreas (1857 Rupture, Cholame, Coachella, San Bernardino).

*Block construction and meshing*

Initial attempts at block generation involved collecting surfaces that bounded a desired block, then extending those surfaces to such an extent that they mutually cross-cut or intersected one another. This process generally resulted in satisfactory block geometries. The blocks enclose completely a volume, and neighboring blocks shared faces. In addition to geometry, we also needed to specify node connectivity and the topology of the triangles which comprise a given block surface in order to address the requirements of various volume meshing and modeling software.

Concurrent with building of the CBM, we worked with various members of the SCEC crustal deformation modeling group to evaluate different ways of meshing the CBM. These tests were performed using the microblock model we developed in 2002, which is a prototype CBM of the northern Los Angeles basin. It was quickly noted that blocks should have no unconnected edges, a topology equivalent to a (deformed) sphere. Repeated cross-cutting of surfaces using Gocad modeling software had created small miss-matches between surfaces bounding the blocks. (Fig. 2). The unconnected nodes in these surfaces were found difficult to connect or eliminate without completely regenerating the block using available gridding software (Carl Gable, pers. comm.). As a result, the Gocad block generation process was modified in such a way that it would determine an optimal cross-cutting sequence between surfaces, which dictated the way the surfaces were combined to envelope the blocks. The modified process was much more successful in producing improved, albeit not perfect triangle connectivity (Fig. 2). Only minor manual editing was required for remaining problem areas. This approach to block model construction has already been adopted in building the complete CBM.

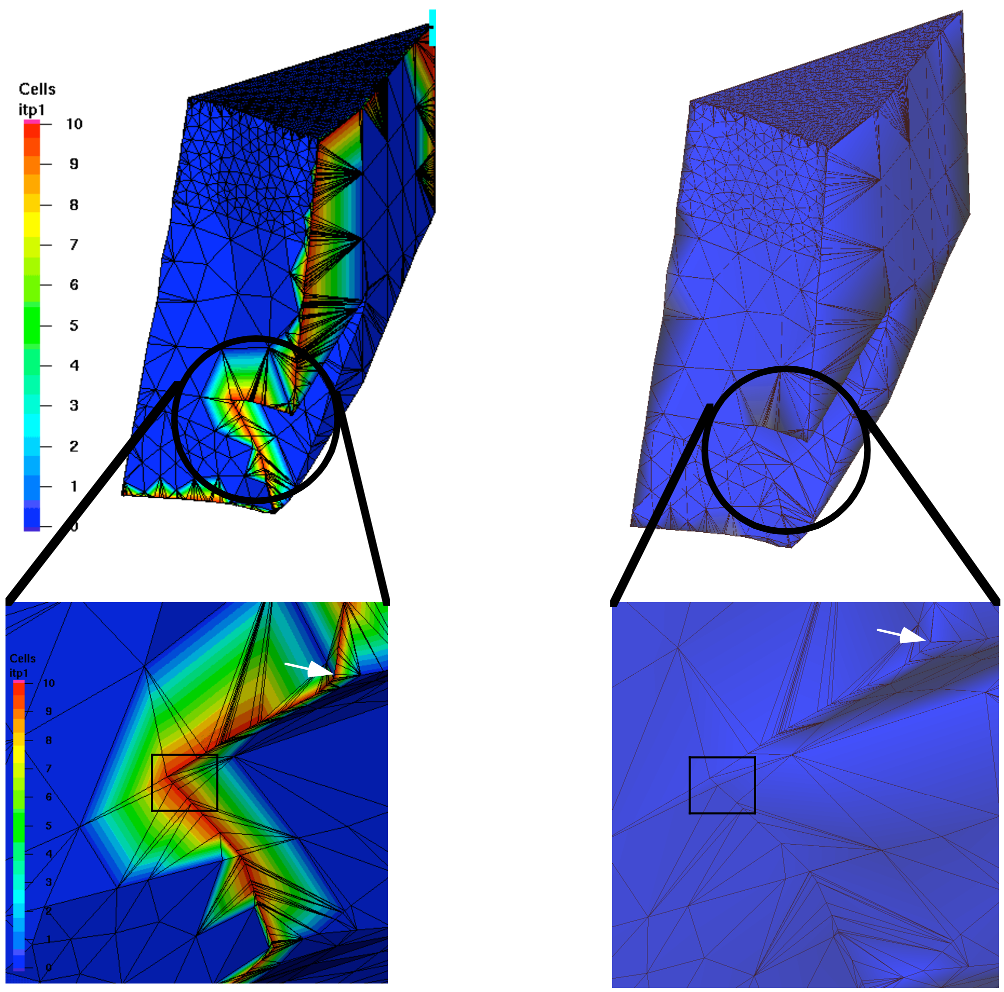


**Figure 2:** An example of a problem in block shape and topology in the prototype CBM that is resolved by a new block generation procedure. (left) The initial process resulted in appropriately complex block shapes, but faulty topology along edges. The most obvious effect is that some nodes on edges are part of only one

triangle and not shared by a triangle on the adjacent side of the edge. Color 10 (red) indicates nodes that are not connected (courtesy Carl Gable, LANL), an example of which is shown in the close-up. (right) An improved block generation method, now adopted for the CBM, produces somewhat simplified edges that are properly connected. The box in the close-up shows the improved topology. Also note the simplified corner in the upper right (arrow).

## Updating geologic surfaces

In order to facilitate the use of the CBM as a framework for property modeling (e.g., as in the CVM), we need to incorporate geologic surfaces that are used to specify property boundaries. For these surfaces to be properly represented in the CBM, however, they must first be made compatible with the Community Fault Model (CFM). This involves local re-mapping and refinement of horizons such that they are made consistent with the positions of faults and the fault displacements. In 2003, we began this process by refining the top basement surface in the Los Angeles basin (Figure 3), as it is known to represent an abrupt change in compressional and shear wave velocities, as well as density and rheologic properties. The refined basement surface now incorporates offsets of the major faults in the basin, including both blind thrust and strike-slip faults. This refined surface has been made available to SCEC investigators for local wave-propagation studies. Completion of the faulted surfaces for the basement and other important stratigraphic horizons will allow their inclusion as block boundaries in the CBM.

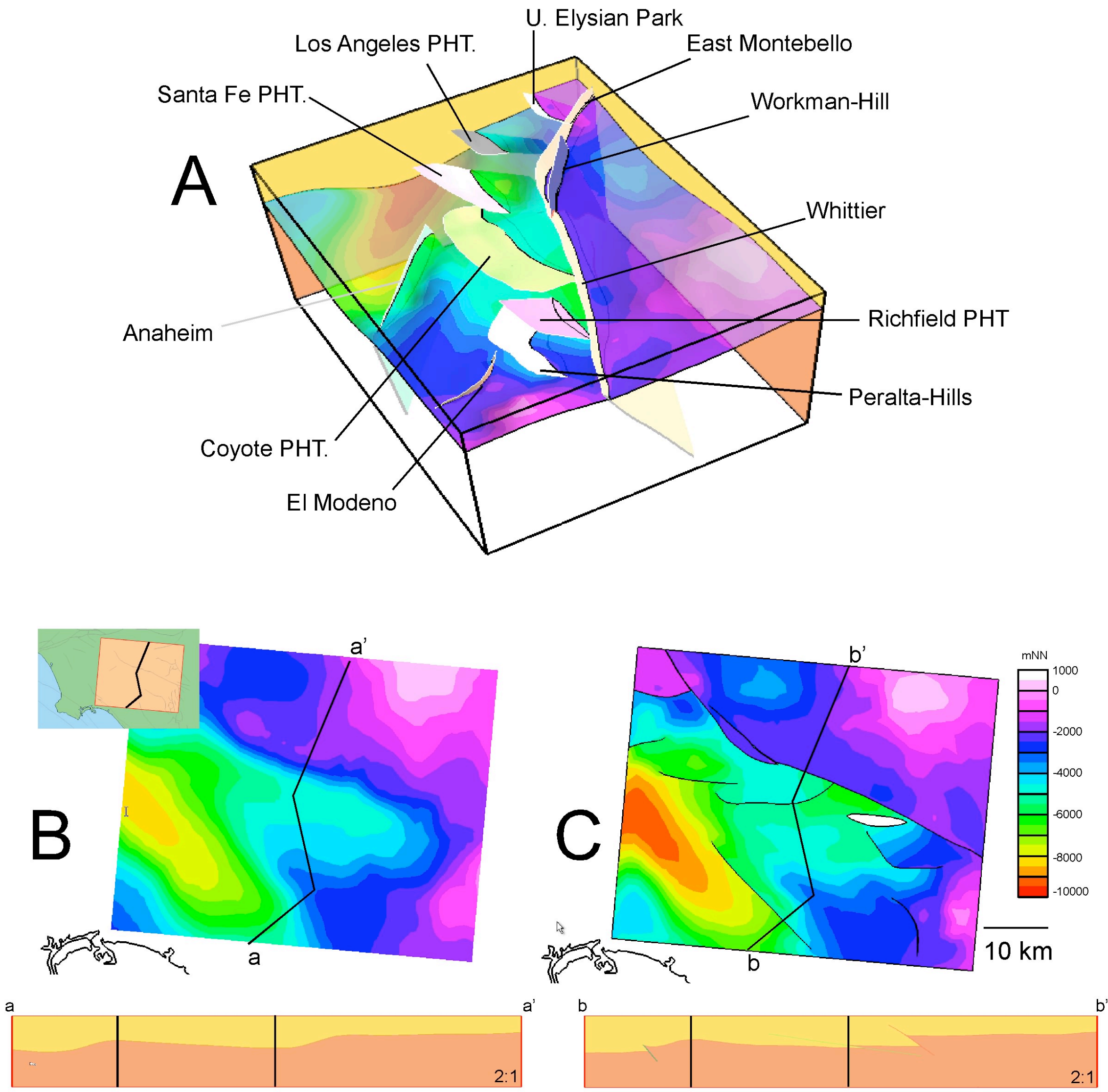


**Figure 3:** A) Perspective view of the refined top basement surface in the northeastern Los Angeles basin. The surface is offset by faults derived from the SCEC Community fault Model (CFM). B) Map view and cross section of the basement surface before remapping. Note that the basement surface is continuous, without any fault offsets. C) Map view and cross section of the basement surface after remapping.