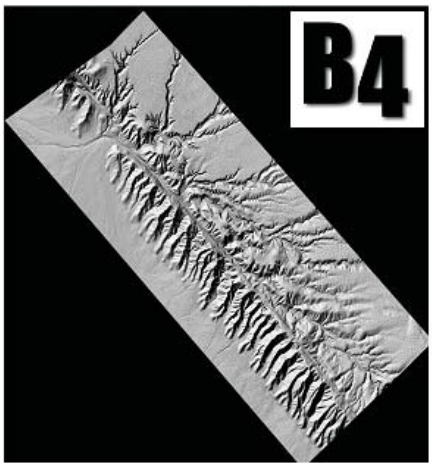
High Resolution Mapping of the Southern San Andreas Fault System Using Airborne Laser Swath Mapping

Mike Bevis » Ohio State University
Ken Hudnut » U.S. Geological Survey

NCALM and UNAVCO supported the NSF-funded B4 project led by Ohio State University and the USGS. This project used Airborne Laser Swath Mapping (ALSM), also known as LiDAR, to produce very high-resolution digital elevation models (DEMs) of the near-field of the southern and central San Andreas fault system, including the San Jacinto fault. B4's laser point clouds can support DEMs with a horizontal resolution of 0.25 to 0.5 meters, and provide vertical accuracy approaching 10 cm. The total length of the faults imaged by B4 exceeds 1,200 km. This survey differed from previous ALSM surveys by using far more GPS control on the ground, in order to understand and mitigate the height errors associated with GPS positioning of the aircraft. UNAVCO fielded 15 GPS systems and an engineer to make this 'GPS Heavy' approach possible.

The primary motivation of the B4 project was to image the fault before the next 'Big One' occurs (hence 'B4'), so that by performing a second survey immediately following a great earthquake, it will be possible to capture the near-field deformation with unprecedented accuracy and thereby help resolve several long standing problems in earthquake source physics. The secondary motivation was to support a wide range of applications (in structural geology, geomorphology, paleoseismology, etc.) that require only the present day morphology, but captured with very high resolution. Accordingly, the B4 project has an open data policy, and is structured as an 'open collaboration.' For example, the LiDAR point clouds and customized DEMs are being distributed by the GEON web portal at Arizona State University, and DEMs are also being made available in a Google Earth and Fledermaus formats by Scripps Institute of Oceanography. As of February 2007, B4 data are being used by at least one dozen university research groups, and by the USGS, as well as by professional geologists involved in fault zone mapping to ensure safe development of housing tracts along these faults, as regulated by the State of California. FEMA has expressed interest in using the B4 DEMs for flood plain mapping and modeling. The section of the San Andreas fault in the Carrizo Plain (below) is perhaps the best-studied fault in the world; the site is a superb 'laboratory' for understanding fault behavior in great earthquakes. During the recent sesquicentennial commemoration of the 1857 event, the Southern California Earthquake Center (SCEC), which is supported by NSF and USGS, announced formation of its new special project, the Southern San Andreas Fault Evaluation (SoSAFE) Project. The first scientific workshop of the SoSAFE group initiated a large-scale team effort that will make systematic use of the B4 data by paleoseismologists along the entire southern San Andreas and San Jacinto (throughout the B4 coverage area). The SoSAFE Project will furthermore link with NSF's GeoEarthScope and its funding of geochronological support, using radiocarbon and other new dating facilities and methods to better define the past 2000 years of earthquake history, as well as slip rates along the fault system. This information is expected to enhance our ability to forecast the occurrence of future destructive earthquakes along the fault system.



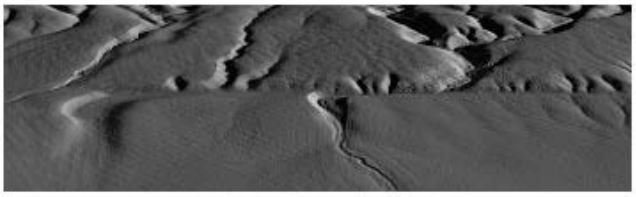


Figure 1. Oblique view of Wallace Creek, the classic San Andreas slip rate site in central California, as imaged by the B4 Project and gridded at 0.25 m resolution. The 1857 Fort Tejon earthquake (MW 7.9) produced the most recent ~9 m of slip at this location. Note the offset stream channels.

This work was supported by NSF EAR 0409045.