

The dissertation of Sergio Chávez-Pérez is approved:

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To my parents, María Lucrecia and Alfredo,  
sister, Sara, and wife, María Teresa,  
who convinced me I could do it  
and supported me all  
the way through.

## Acknowledgments

“I give this record of my journey  
not as a contribution to human knowledge,  
because my knowledge is small and of little account,  
but as a contribution to human experience.”

Henry Miller

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I love you China!

## Abstract

This dissertation focuses on processing and migration techniques to enhance the seismic images of two types of faults that are difficult to map in the subsurface: normal and blind thrust. Motivated by the need to image faults to test Cenozoic extension models for the Death Valley region of the western Basin and Range province, an area of strong lateral velocity variations, I examine the geometry of normal faulting by seismic depth imaging of a portion of COCORP (Consortium for Continental Reflection Profiling) Death Valley Line 9. Previous workers used standard seismic processing to infer normal faults from bed truncations, displacement of horizontal reflectors, and diffractions. I use a detailed velocity model obtained by nonlinear optimization of first-arrival times, examine the unprocessed data for fault reflections, and use a Kirchhoff prestack depth imaging procedure to properly handle lateral velocity variations and arbitrary dips. Fault-plane reflections reveal the listric true-depth geometry of the normal fault at the Black Mountains range front in southern Death Valley. This is consistent with the concept of low-angle extension in this region and strengthens its association with crustal-scale magmatic plumbing.

An inexpensive means to understand further the geometry of active faults in southern California arises from the use of aftershock recordings at regional seismic networks to image crustal structures. I show it is feasible to image fault structure using three-dimensional, wide-angle prestack Kirchhoff migration using aftershock traces recorded on the short-period vertical stations of the Southern California

Seismic Network. This work complements seismicity and focal mechanism work by imaging reflectivity volumes and cross sections rather than having to associate events with certain faults. Further, it can image below the seismogenic zone to resolve current geologic controversies on how proposed faults extend below focal depths. Work with data from the 1991 Sierra Madre earthquake sequence images the prominent lower crustal reflective zone observed beneath most of the San Gabriel Mountains by the Los Angeles Region Seismic Experiment Line 1. Aftershocks of the 1994 Northridge earthquake allow me to image a north-dipping structure that may represent the fault plane of a crustal-penetrating blind thrust. The images serve as a test for the existence and geometry of thrust ramps and detachments proposed from balanced-section reconstructions of shallow-crustal profiles and borehole data. My results are more consistent with a thick-skinned tectonic regime in the vicinity of the Northridge earthquake, rather than a thin-skinned model.