Tectonic Characterization of the THUMS-Huntington Beach Fault, Offshore Southern California*

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Abstract

This project is aimed at detailed mapping of the THUMS-Huntington Beach Fault based on the integration of high resolution 2D and 3D seismic data with wireline log data acquired offshore Southern California. Correlation of the seismic and well data provides a basis for tectonic characterization of the THUMS-Huntington Beach Fault and estimation of its structural relation to neighboring faults and petroleum traps by developing a 3D geological model.

The THUMS-Huntington Beach Fault branches from the Palos Verdes Fault Zone and from that point south forms the southwestern border of the Wilmington Anticline, where the 2 billion barrel Wilmington Field is located. The timing and trapping mechanisms in this field are closely related to the evolution of the continental margin from subduction to transform tectonics. The Inner Borderland, where the faults and oil field are located, is a rift zone between the main continental block and small detached, rotated blocks such as the Western Transverse Ranges, with probable changes in stress fields affecting fault motion. Newly acquired 2D images and existing 2D and 3D data will make it possible to more accurately map the THUMS-Huntington Beach Fault and shed light on the character of fault separation. This project’s results will provide insights on the true nature of the THUMS-Huntington Beach Fault, including precise determination of dip and strike orientations and displacement components, and reveal important implications on the Palos Verdes Fault Zone and tectonic history of the California Continental Borderland.
TECTONIC CHARACTERIZATION OF THE THUMS–HUNTINGTON BEACH FAULT, OFFSHORE SOUTHERN CALIFORNIA

SERGEY ISHUTOV

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OUTLINE

- Introduction
- Significance and objectives
- Regional context
- Previous investigations
- Methods and techniques
- Models of T-HBF
- Future research
The THUMS–Huntington Beach fault (T–HBF):

- discovered in 1969 by Oil City survey as a SE–striking fault;
- extends offshore from the PVFZ along the SW flank of the Wilmington Anticline;
- parallel to NIFZ and steps (?) towards Newport Beach;
- 10–15 miles long but discontinuous;
- poorly expressed and based on limited and sparse data.
California Continental Borderland: T-HBF tectonic history and implications on the PVFZ and NIFZ.

Earthquakes: active faults within large restraining bends may pose potential hazards.

HC exploration: timing and trapping mechanisms along T-HBF.
Detailed mapping of the THUMS–Huntington Beach Fault using 2D and 3D seismic and well data.

Reconstruction of the T–HBF tectonic history.

Estimation of the structural relation to neighboring faults (PVFZ and NIFZ).
Regional Context

California Inner Borderland (CIB):

- series of N-NW-trending ridges and basins;
- unconformity between Catalina schist and Miocene strata;
- PVFZ, T-HBF, and NIFZ;
- San Pedro shelf;
- Wilmington Graben;
- Wilmington Anticline;
- Huntington Beach anticline.

Crouch and Suppe (1993)
REGIONAL CONTEXT

- **Middle Oligocene**: subduction–transform, uplift, regression
- **Early Miocene**: rifting and rafting
- **Middle Miocene**: transrotation, major volcanism and subsidence
- **Mio–Pliocene**: transtension
- **Late Pliocene**: transpression

Wright (1991)

Legg (1991)
Truex (1974) and Wright (1991):

- a high-angle normal fault;
- dips NE into the Wilmington Anticline;
- T-HBF converges with NIFZ (south of Huntington Beach)?
PREVIOUS INVESTIGATIONS

Davis and Namson (1998)
Earth Mechanics Report:

- T–HBF: a low-angle thrust fault;
- Displacement of Catalina schist basement (A–A’);
- Displacement decreases to NW and T–HBF dies out in the western area of the Long Beach Harbor, with no basement offset (B–B’);
- No evidence for convergence with PVFZ and/or NIFZ.
Representative northeast/southwest seismic/geologic cross-section showing bedrock highs near- and offshore separated by a basin filled with multiple sequences of sedimentary deposits which are generally flat-lying. A thin veneer of unconsolidated (?) sediment (yellow) overlies the basin fill.
METHODS AND TECHNIQUES

- 2D and 3D seismic interpretation
- New 2D seismic data collection
- Well logs correlation (DOGGR)
- Seismic and well tie
- Structural and tectonic framework

Base map from Kingdom project

www.conservation.ca.gov/dog
# SEISMIC DATA

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<th>Survey details</th>
<th>Source, receiver</th>
<th>Year</th>
<th>Data type</th>
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Base map from Kingdom project
WELL CORRELATION

Fisher et al. (2004)

ROCK VELOCITY, IN METERS PER SECOND

DEPTH, IN METERS

Age (Ma)

Epoch  Stage

Pliocene Early Late

Miocene Late Middle

Mioene

Mahnian

Delmontian

Reptilian

Pico

Pico

Teasdale

White-Huntington #1 SIGNAL WELL CL #1

Paleo Results of sidewall samples.

6.0-6.9 Pliocene, Upper Pico.

5.7-5.8 Lower Pliocene, Middle Pico.

5.4-5.6 Lower Pliocene, Upper Repetet.

5.5-5.7 Lower Pliocene, Middle to lower Repetet.

4.7-4.18 Upper Miocene, Delmontian.

3.3-2 Upper Miocene, Mohnian.

3.3-3.6 Miocene, Lower Miocene.

3.6-3.8 Miocene, Upper Miocene.

3.5-3.7 Possibly lower Mohnian.

No faunal evidence for Miocene.
SEISMIC INTERPRETATION

Wright (1991)

- Pico Formation
- Repetto Formation

PVF
T-HBF
NIFZ
SEISMIC INTERPRETATION

Wright (1991)

- Pico Formation
- Repetto Formation
- Catalina schist
- PVF
- T-HBF
- NIFZ
SEISMIC INTERPRETATION

Wright (1991)

- Pico Formation
- Repetto Formation
- T-HBF splay
- Catalina schist
- Shallow penetration of seismic problems with interpretation.
- The upper tip of T–HBF at Pico Formaton.
- Evidence for basement rocks offset.
SEISMIC INTERPRETATION

USGS Geologic and bathymetric reconnaissance overview of the San Pedro shelf region

Wolf et al. (2004)
Fault surfaces in 3D cube, Kingdom suite.

- PVF
- T–HBF
Right-stepping right-lateral strike-slip fault

McClay (2002)

Fault propagation fold

Fault bend fold
T-HBF MODELS

North American plate relative motion

Pacific plate relative motion

WA Wilmington Anticline

HBA Huntington Beach anticline

Harding (1974)
Reprocessing of seismic data to attenuate noise.

Acquiring more well and seismic data to refine deep stratigraphy and T–HBF offset.

PVFZ, NIFZ, and THBF: timing and trapping mechanisms in the neighboring oil fields.

Earthquakes studies.

Fisher et al. (2004)
QUESTIONS?

ACKNOWLEDGEMENTS

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Occidental Oil and Gas Corporation
Dr. R.D. Francis
Dr. M.R. Legg
M. Barth
REFERENCES

- Shot point interval – 3 sec.
- Receiver interval – 6.25 m
- # receivers in streamer – 16
- line length – 118.75 m
- Seismic length line – c.4.5 km
- Source – 2kj Sparker
- Acquisition – Oct. 31, 2012
- Data ownership – CSULB

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