

# QUATERNARY TECTONISM IN A COLLISION ZONE: THE CALAWAH FAULT

by

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with contributions from  
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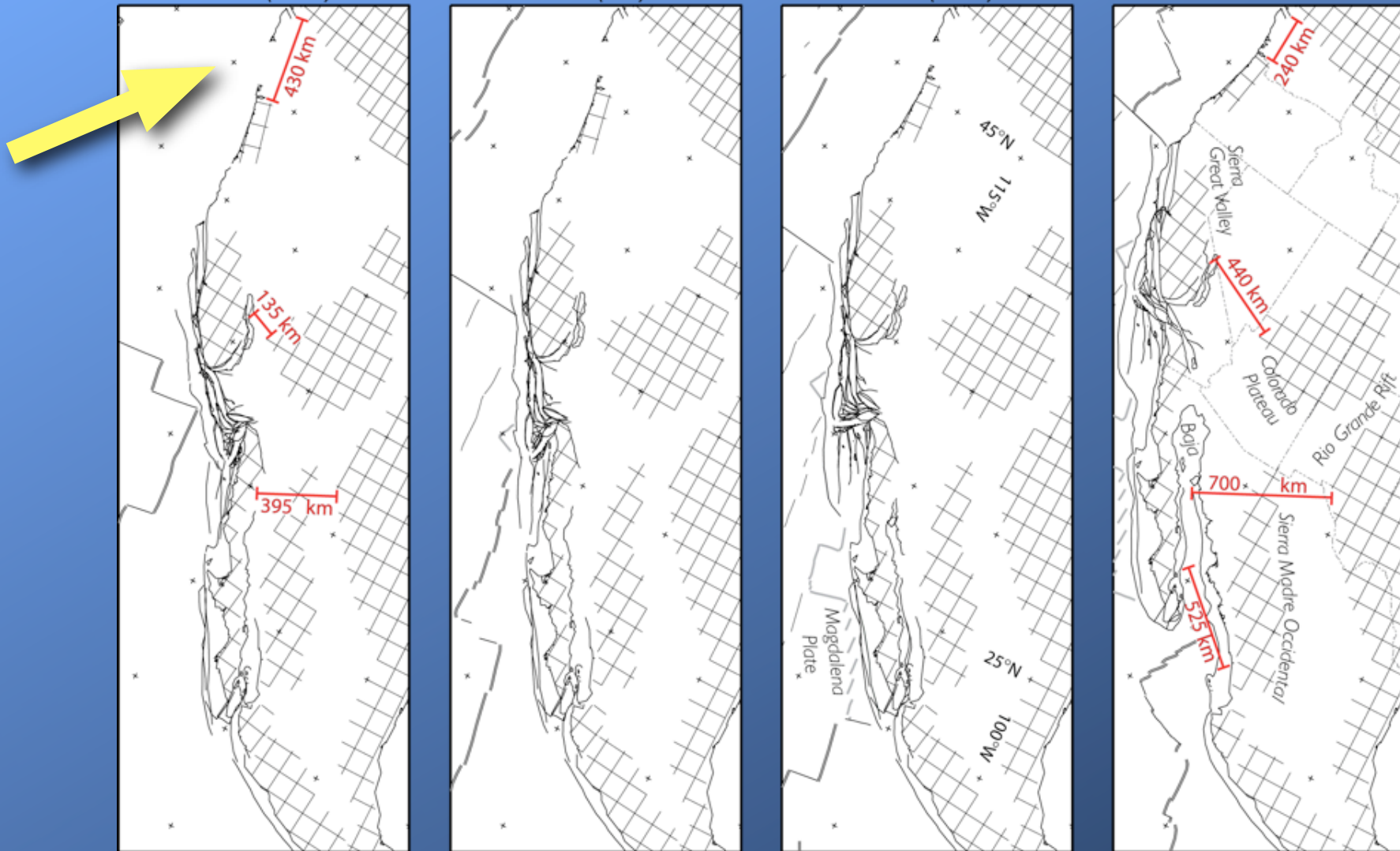


28.7 Ma (C10)

19.0 Ma (C6)

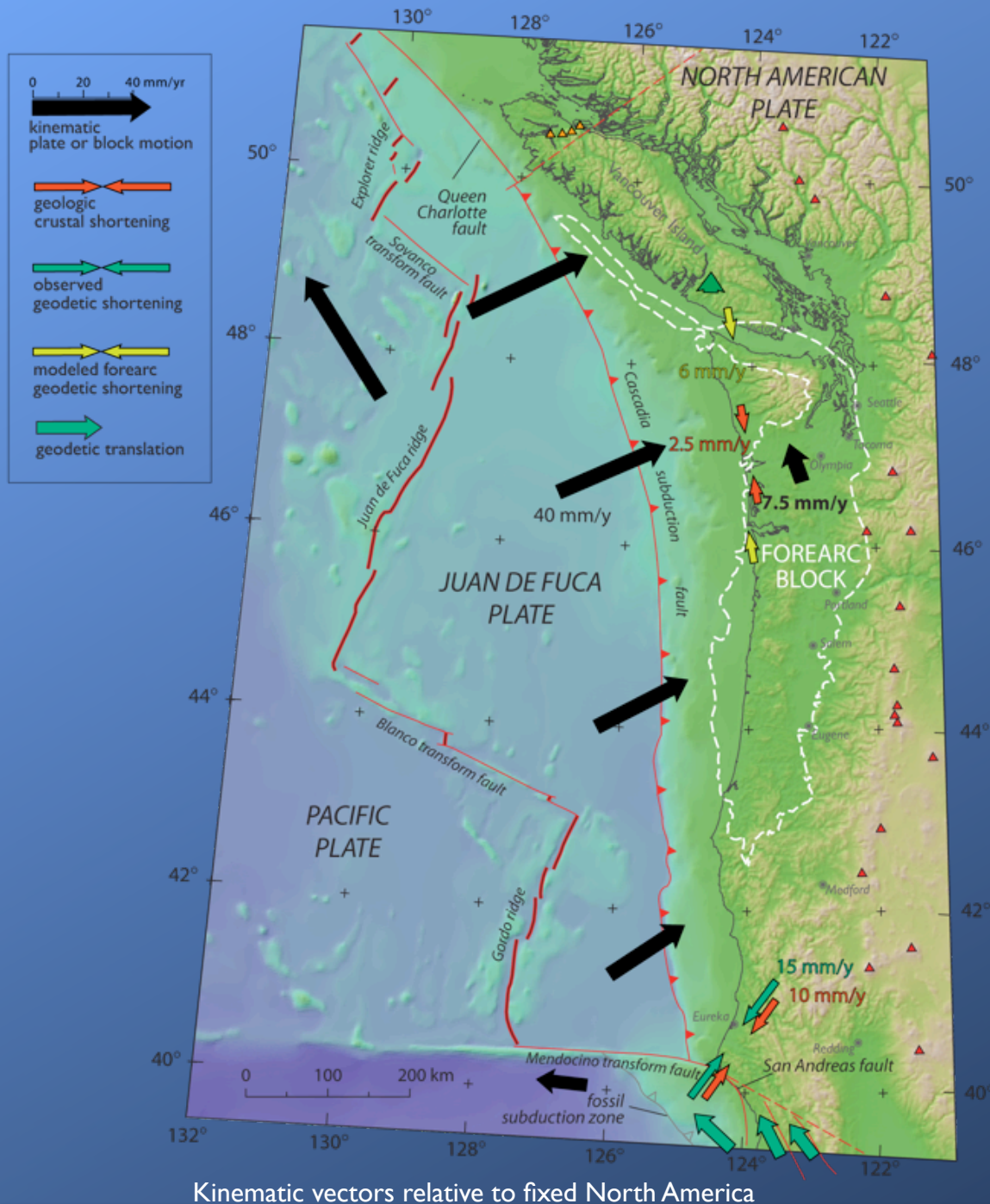
12.5 Ma (C5A)

0 Ma



Modified from Wilson, McCrory, & Stanley, 2005, *Tectonics*

TECTONIC EVOLUTION OF WESTERN NORTH AMERICA REQUIRES  
~ 110 KM OF CONTRACTION IN PACIFIC NORTHWEST



Kinematic vectors relative to fixed North America  
 [from McCrory, 2000, *Tectonics*; D. Wilson, 1998, *unpubl. data*]

## MODERN PLATE AND FORE-ARC BLOCK MOTION

## FORE-ARC CONTRACTION PARTIALLY ACCOMMODATED IN QUINAULT AREA

Modified from McCrory et al., 2004, *USGS DS-91*.  
 Observed geologic vectors from McCrory et al.,  
*USGS PP-1661A*, 2002. Observed geodetic vectors  
 from Murray & Lisowski, 1995, *Eos*; Freymueller et  
 al., 1999, *JGR*. Modeled geodetic vectors from  
 Mazzotti et al., 2002, *EPSL*

EFFORTS TO BETTER RESOLVE  
MODERN CONTRACTION INCLUDE:  
(I) CAMPAIGN GPS OBSERVATIONS






A photograph showing a grassy field in the foreground. In the lower right, a circular concrete benchmark is partially visible, surrounded by tall grass. In the middle ground, a person in a blue shirt stands in the field. In the background, there are several houses, including a large, multi-story house with a grey roof and white trim, and a smaller house to the right. Several cars are parked on a road in front of the houses. The sky is overcast.

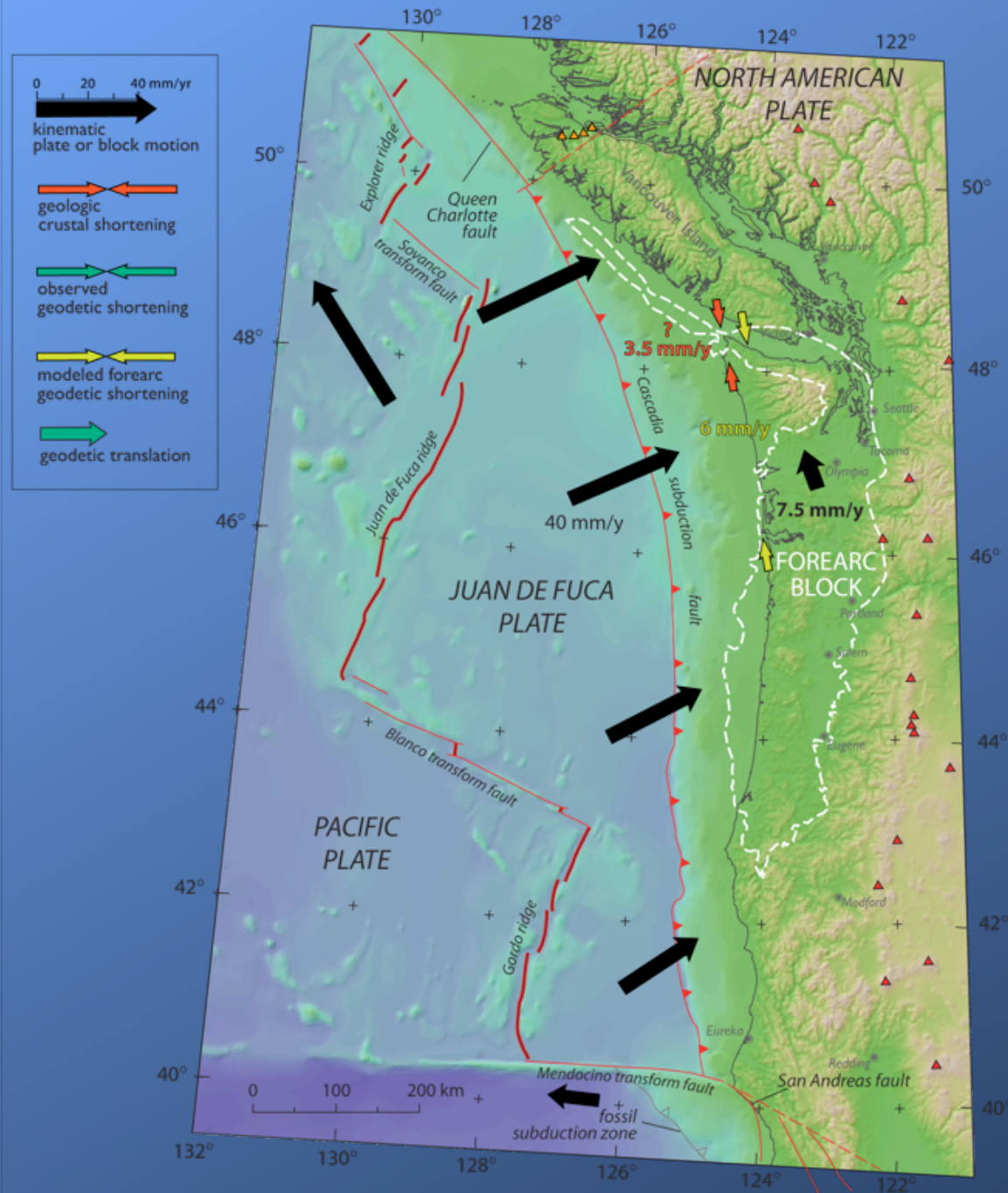
AND (2) RE-LEVELING  
ACROSS GRAYS HARBOR  
FAULT ZONE USING  
EXISTING BENCHMARKS



A photograph showing a surveyor in a dark jacket and light blue jeans standing on a concrete benchmark. The surveyor is holding a surveying instrument. In the background, there are two houses: a white one on the left and a darker one with a balcony decorated with colorful flags in the center. The area is surrounded by tall, dry grasses and a paved road with white arrows. Another person in a blue jacket is visible in the distance on the right. The sky is overcast with grey clouds.

AND (3) ESTABLISHING NEW  
LEVELING BENCHMARKS IN  
COLLABORATION WITH CVO  
AND THE SPATIAL REFERENCE  
CENTER OF WASHINGTON





IS REMAINING  
FORE-ARC  
CONTRACTION  
ACCOMMODATED IN  
MAKAH AREA?

Queried geologic vectors from  
McCrorry et al., 2002, USGS PP-1661-A



VERTICAL MOTION  
WITHIN FORE-ARC  
SUGGESTS MAKAH  
AREA HAS A  
RELATIVELY HIGH  
UPLIFT RATE

HORIZONTAL  
ROTATIONAL  
MOTION SUGGESTS  
CCW OR SINISTRAL  
ROTATION

Vertical geodetic observations from R. Weldon, 2005, *unpubl. data*;  
Horizontal rotations from F. Pollitz, 2006, *unpubl. data*



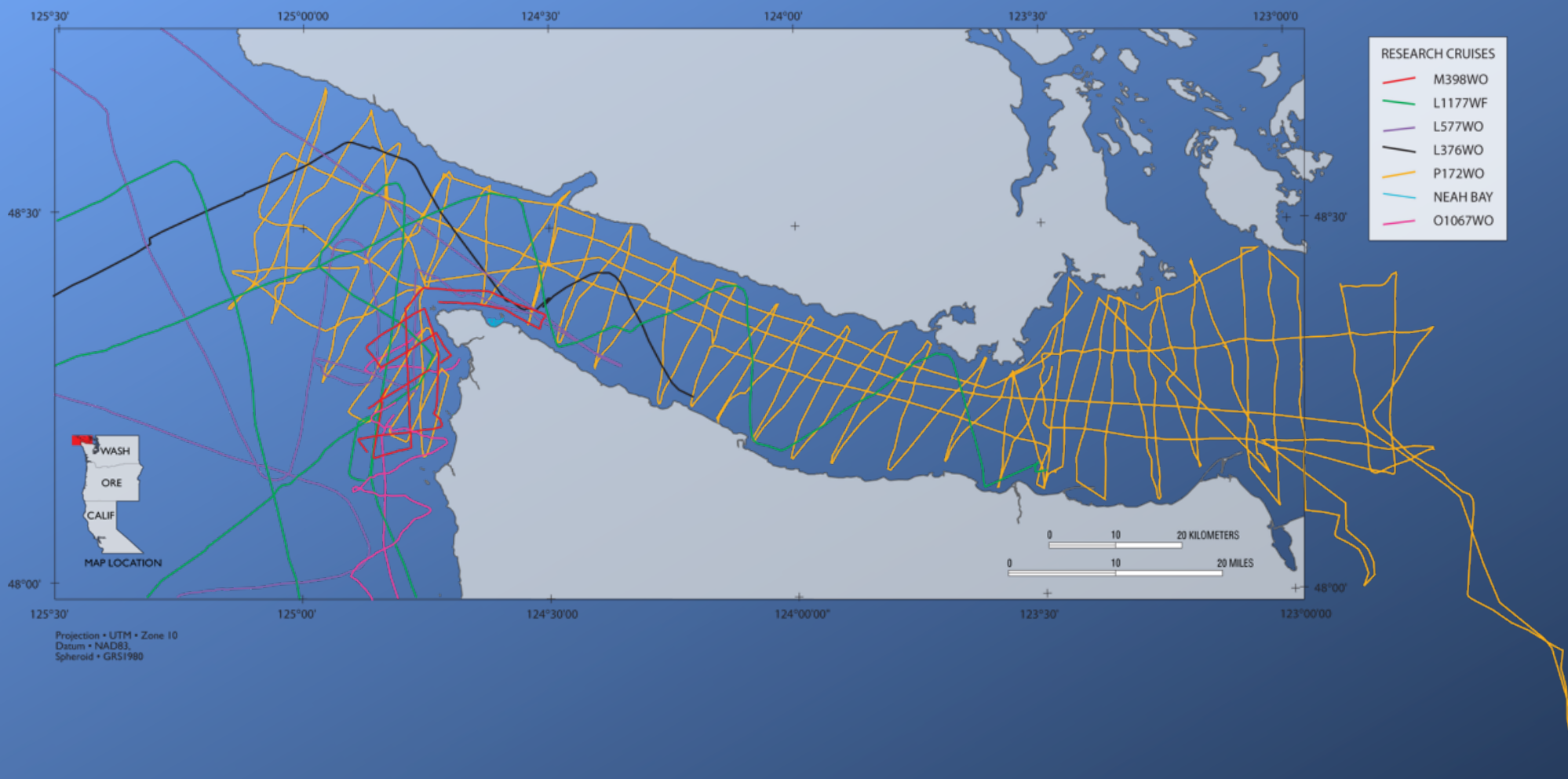


UPLIFT/  
SUBSIDENCE  
CONTOURS  
SUGGEST  
COMPLEXITY  
BEYOND  
SIMPLE PLATE  
INTERFACE  
LOCKING

Geodetic contours modified from  
Savage, Lisowski, and Prescott, 1991, *JGR*



# GEOPHYSICAL DATA COVERAGE IN STUDY AREA





# COMPLEX SET OF NW-SE TRENDING FAULTS & FOLDS MAPPED ADJACENT TO FORE-ARC BLOCK BOUNDARY



Onshore structures modified from Tabor & Cady, 1978; Snively *et al.*, 1993; Dragovich *et al.*, 2002



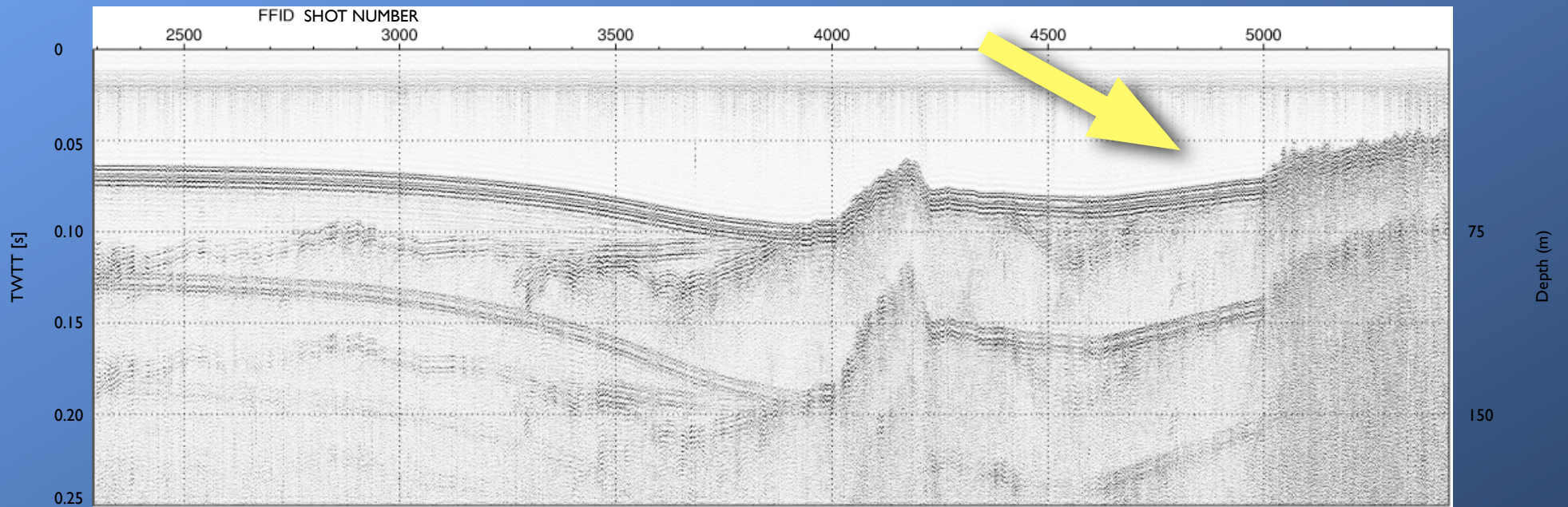


CALAWAH FAULT  
MARKED ON  
SEA FLOOR BY  
SCARP THAT  
SEPARATES SMOOTH  
SEA FLOOR FROM  
ROUGH SEA FLOOR

Multi-beam image from S. Intelmann, 2004, *unpubl. data*



# CALAWAH FAULT MARKED BY CHANGE IN ACOUSTIC CHARACTER



1998 - R/V McARTHUR - SPARKER - LINE 13

STREAM MORPHOLGY  
AND GEOMORPHOLOGY  
ADJACENT TO  
CALAWAH FAULT SHOW  
STRUCTURAL CONTROL







PHOTO OF GOWER SITE SHOWING  
OVERGROWTH OF EXPOSURE  
DOCUMENTING LATE QUATERNARY  
ACTIVITY ON CALAWAH FAULT



# CALAWAH FAULT EXPOSED IN STREAM BANK OF HOKO RIVER







PHOTO OF CALAWAH FAULT  
EXPOSED ALONG HOKO RIVER



CALAWAH FAULT EXPOSED IN STREAM BANK NEAR PARADISE LAKE  
AND ALONG LOGGED HILL SLOPE (?)







PHOTO OF CALAWAH FAULT EXPOSED  
ALONG STREAM NEAR PARADISE LAKE



PHOTO OF POSSIBLE CALAWAH FAULT SCARPS  
CROSSING LOGGED SLOPE





THESE QUERIED FAULT SCARPS WILL BE  
INVESTIGATED THIS SUMMER







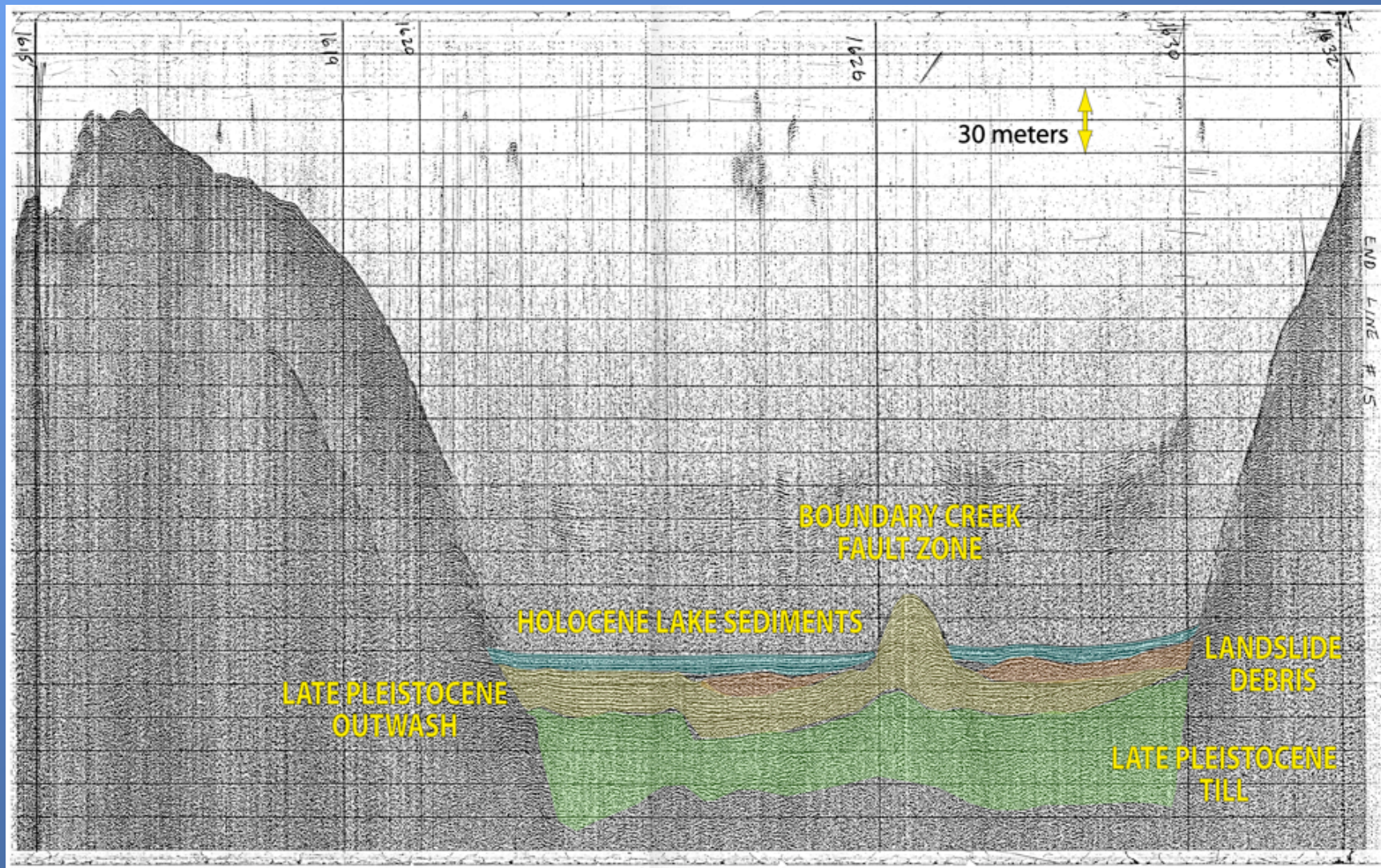
PHOTO OF GOWER'S  
CALAWAH FAULT CROSSING  
EAST OF PREVIOUS PHOTOS



# BOUNDARY CREEK FAULT DISRUPTS FLOOR OF CRESCENT LAKE



# LAKE CRESCENT SEISMIC LINE 15 (SLIDGEHAMMER TO SARATOGA)



P. Snively, 1984, *unpubl. data*



## SUMMARY

1. GEODETIC MODELS SUGGEST ~3.5 MM/Y CONTRACTION IN COASTAL WASHINGTON MAY BE CONCENTRATED IN MAKAH AREA
2. GEOLOGIC OBSERVATIONS SUGGEST THAT CONTRACTION IN MAKAH AREA IS ACCOMMODATED BY BOTH LEFT-LATERAL, STRIKE-SLIP FAULTING AND THRUST FAULTING
3. IF CORRECT -- THE CAPE FLATTERY AREA IS 'ESCAPING' SEAWARD AS THE COAST RANGE BLOCK TRANSLATES NORTHWARD TOWARD VANCOUVER ISLAND
4. FURTHER GEOLOGIC FIELD WORK IS NEEDED IN MAKAH AREA TO ESTABLISH RECENCY OF FAULTING AND SLIP RATE
5. FURTHER GEODETIC FIELD WORK IS NEEDED IN QUINAULT AREA TO ESTABLISH MODERN CONTRACTION RATE



