Modeling Prehistoric Landscapes Along the Pacific Coastline: Two Case Studies from Oregon and Baja California

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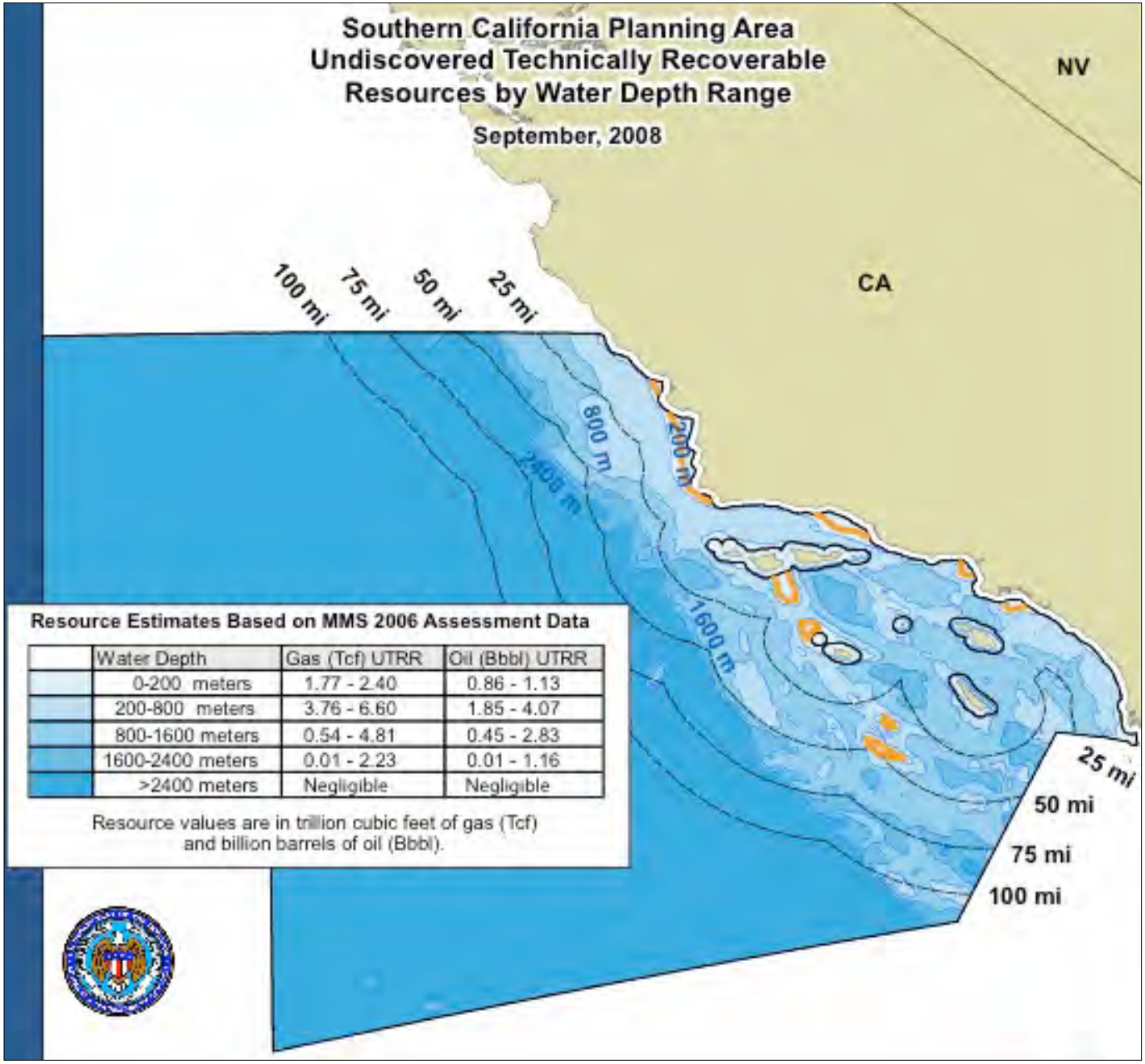
1. Introduction

- What we know
- What we can model
- What we don’t know
- Ways to move forward

2. What we know

- Nearshore bathymetry
- Eustatic marine transgression history
- Coastal and pericoastal adaptations are not New World inventions



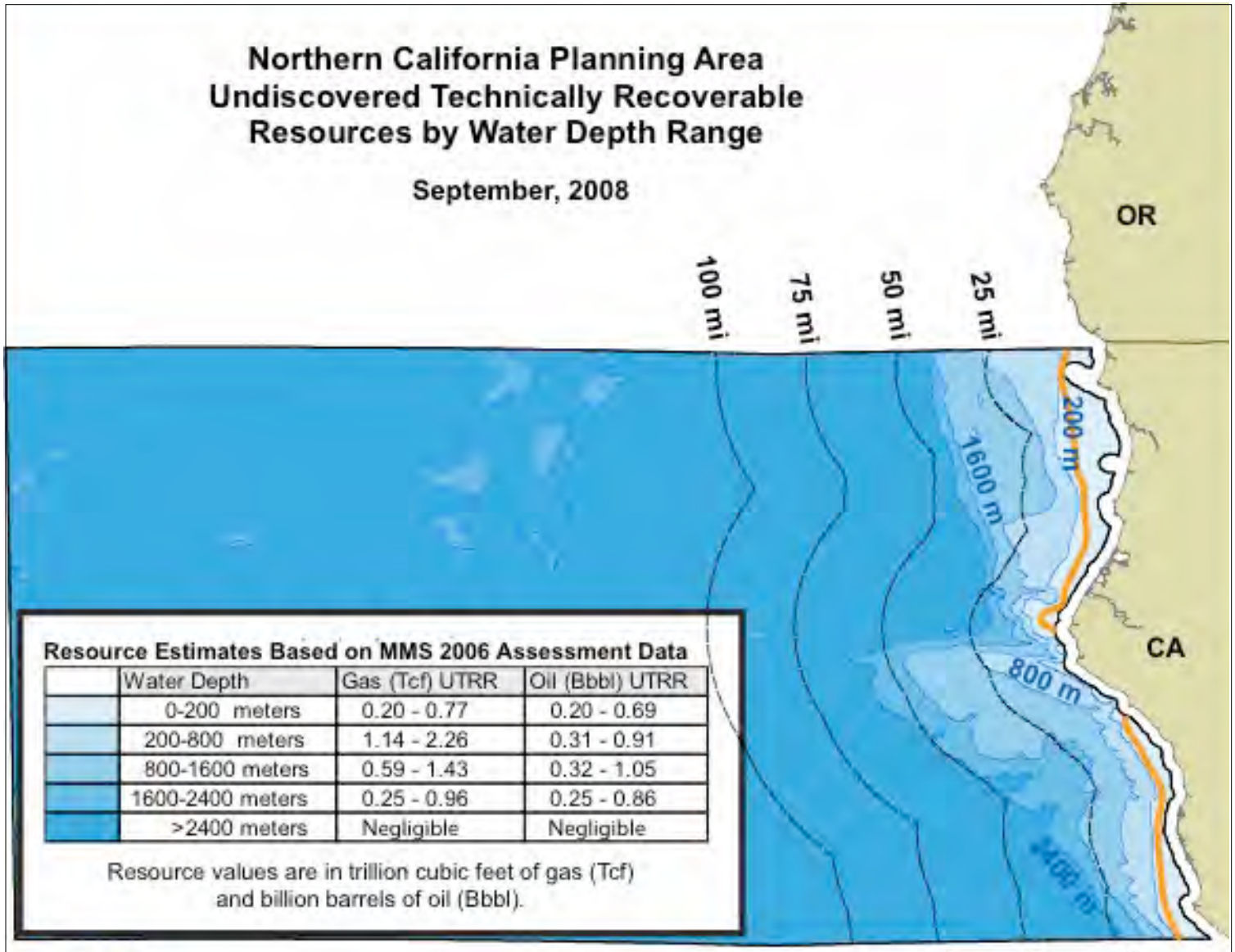
Resource Estimates Based on MMS 2006 Assessment Data

	Water Depth	Gas (Tcf) UTRR	Oil (Bbbl) UTRR
	0-200 meters	1.77 - 2.40	0.86 - 1.13
	200-800 meters	3.76 - 6.60	1.85 - 4.07
	800-1600 meters	0.54 - 4.81	0.45 - 2.83
	1600-2400 meters	0.01 - 2.23	0.01 - 1.16
	>2400 meters	Negligible	Negligible

Resource values are in trillion cubic feet of gas (Tcf) and billion barrels of oil (Bbbl).

Northern California Planning Area Undiscovered Technically Recoverable Resources by Water Depth Range

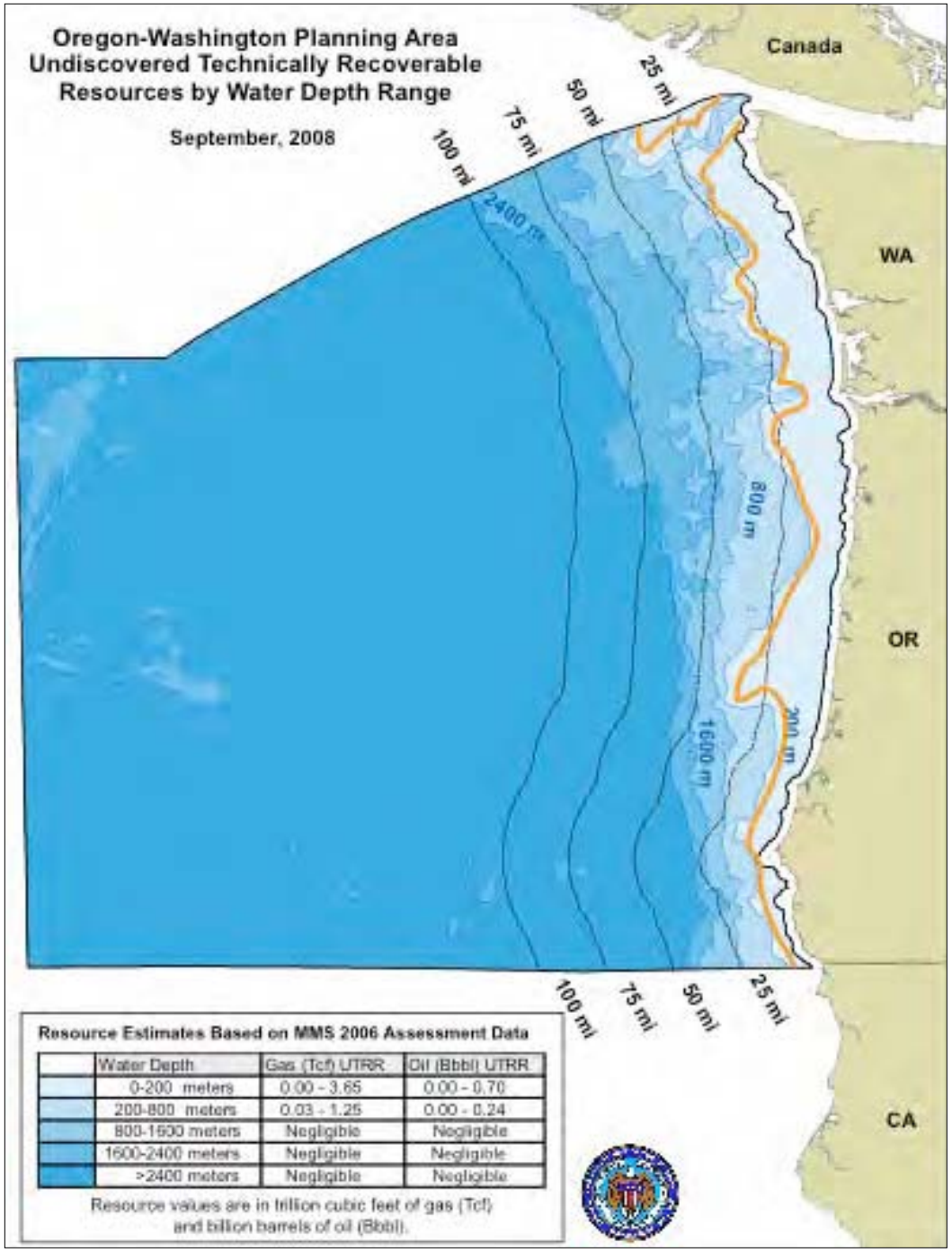
September, 2008



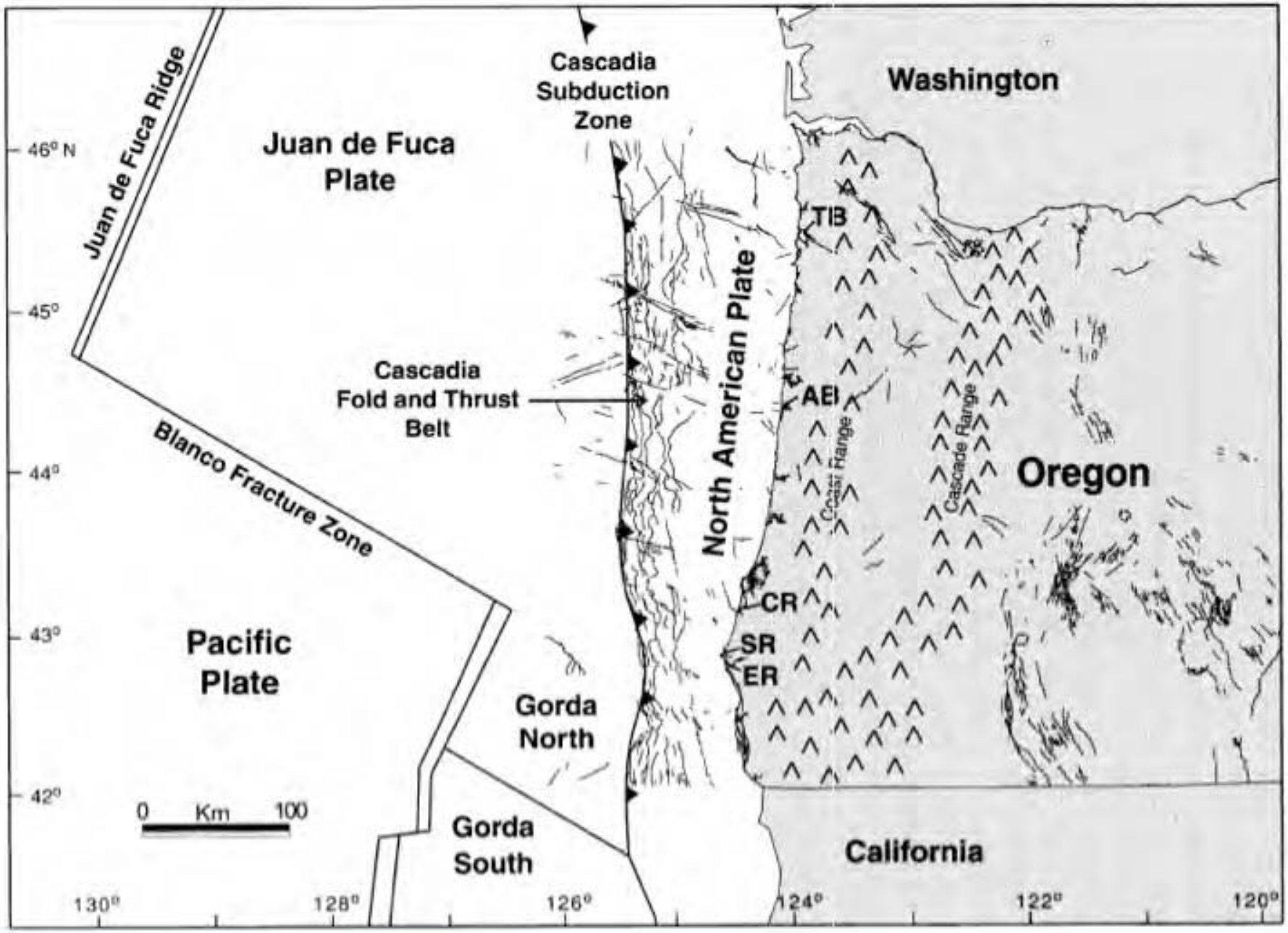
Resource Estimates Based on MMS 2006 Assessment Data

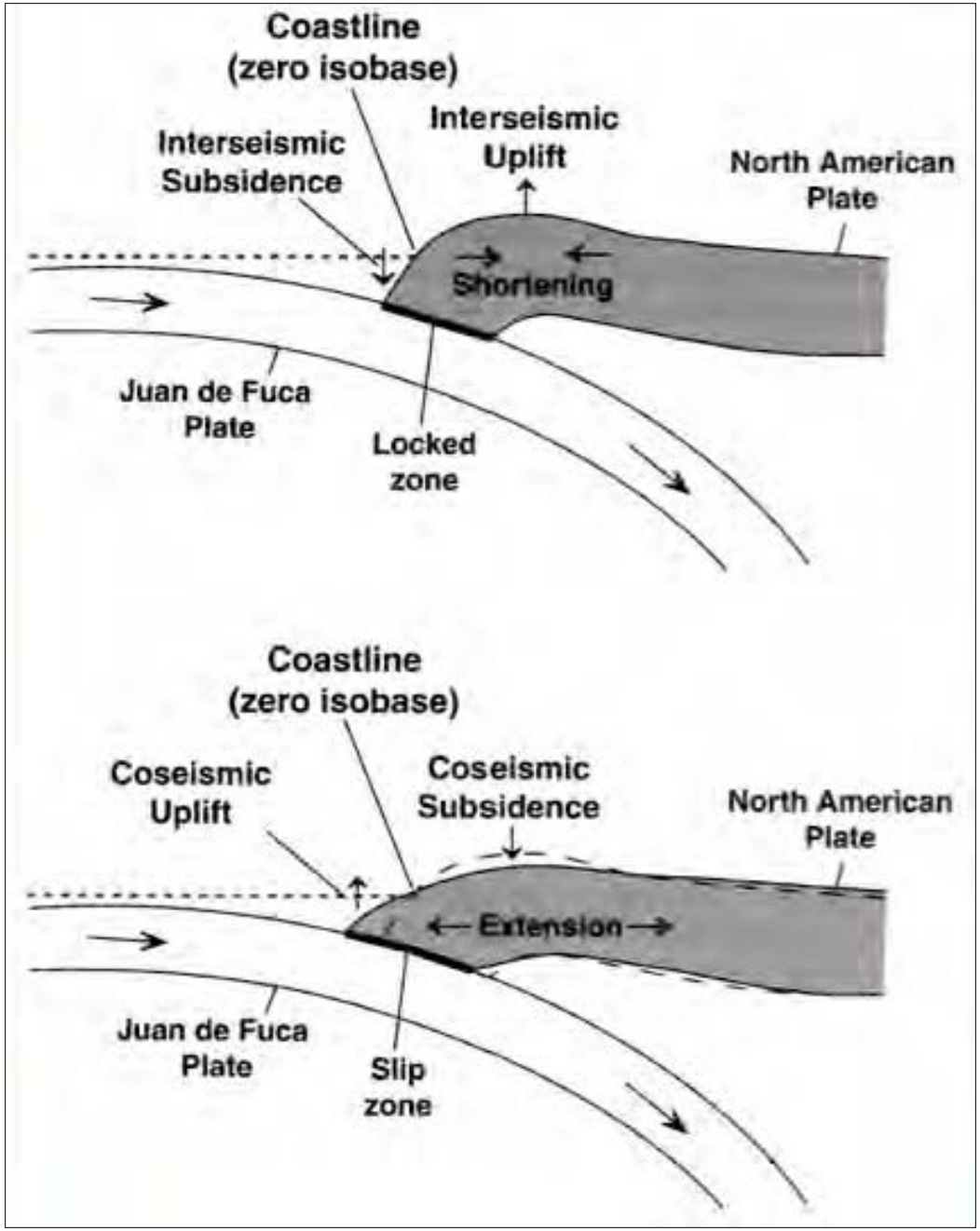
	Water Depth	Gas (Tcf) UTRR	Oil (Bbbl) UTRR
	0-200 meters	0.20 - 0.77	0.20 - 0.69
	200-800 meters	1.14 - 2.26	0.31 - 0.91
	800-1600 meters	0.59 - 1.43	0.32 - 1.05
	1600-2400 meters	0.25 - 0.96	0.25 - 0.86
	>2400 meters	Negligible	Negligible

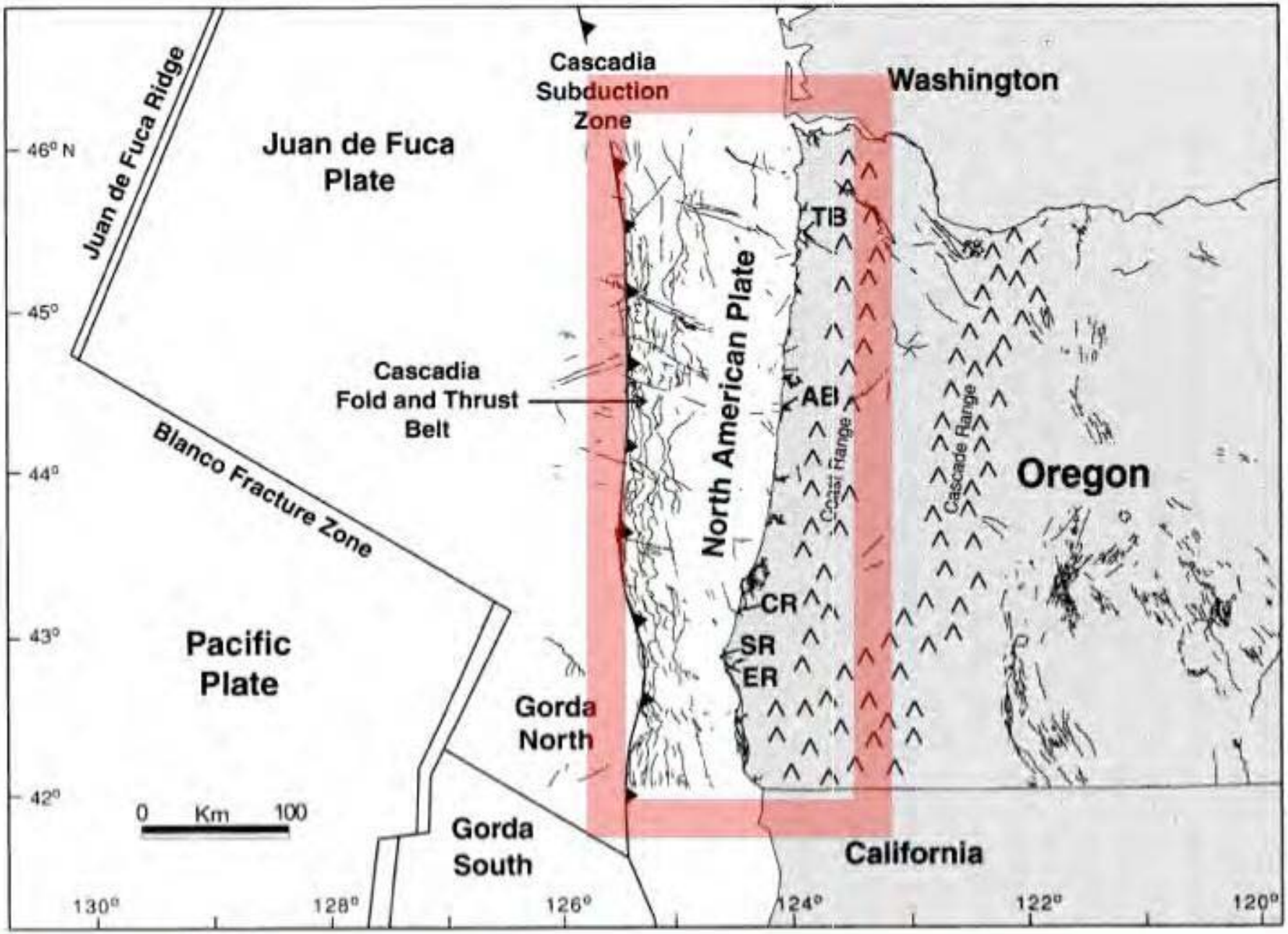
Resource values are in trillion cubic feet of gas (Tcf) and billion barrels of oil (Bbbl).



Water Depth	Gas (Tcf) UTRR	Oil (Bbbl) UTRR
0-200 meters	0.00 - 3.65	0.00 - 0.70
200-800 meters	0.03 - 1.25	0.00 - 0.24
800-1600 meters	Negligible	Negligible
1600-2400 meters	Negligible	Negligible
>2400 meters	Negligible	Negligible


Juan de Fuca Ridge
Cascadia Subduction Zone
Washington
Juan de Fuca Plate
46° N
45°
44°
43°
42°
TIB
North American Plate
Cascadia Fold and Thrust Belt
AEI
Coast Range
Cascade Range
Oregon
Blanco Fracture Zone
CR
SR
ER
Pacific Plate
Gorda North
0 Km 100
Gorda South
California
130°
128°
126°
124°
122°
120°


Coastline
(zero isobase)
Interseismic
Subsidence
Interseismic
Uplift
North American
Plate
Shortening
Juan de Fuca
Plate
Locked
zone
Coastline
(zero isobase)
Coseismic
Uplift
Coseismic
Subsidence
North American
Plate
Extension
Juan de Fuca
Plate
Slip
zone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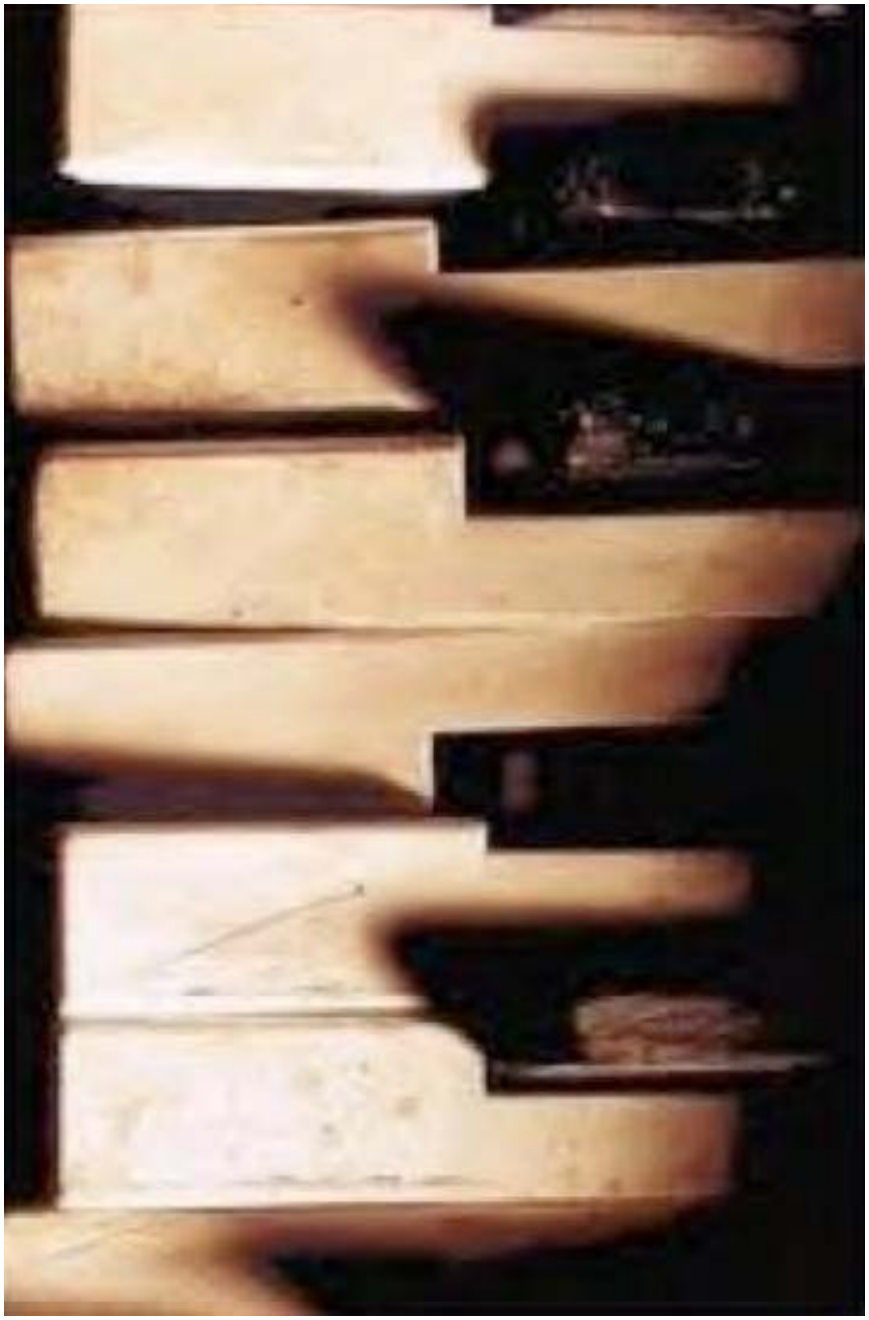
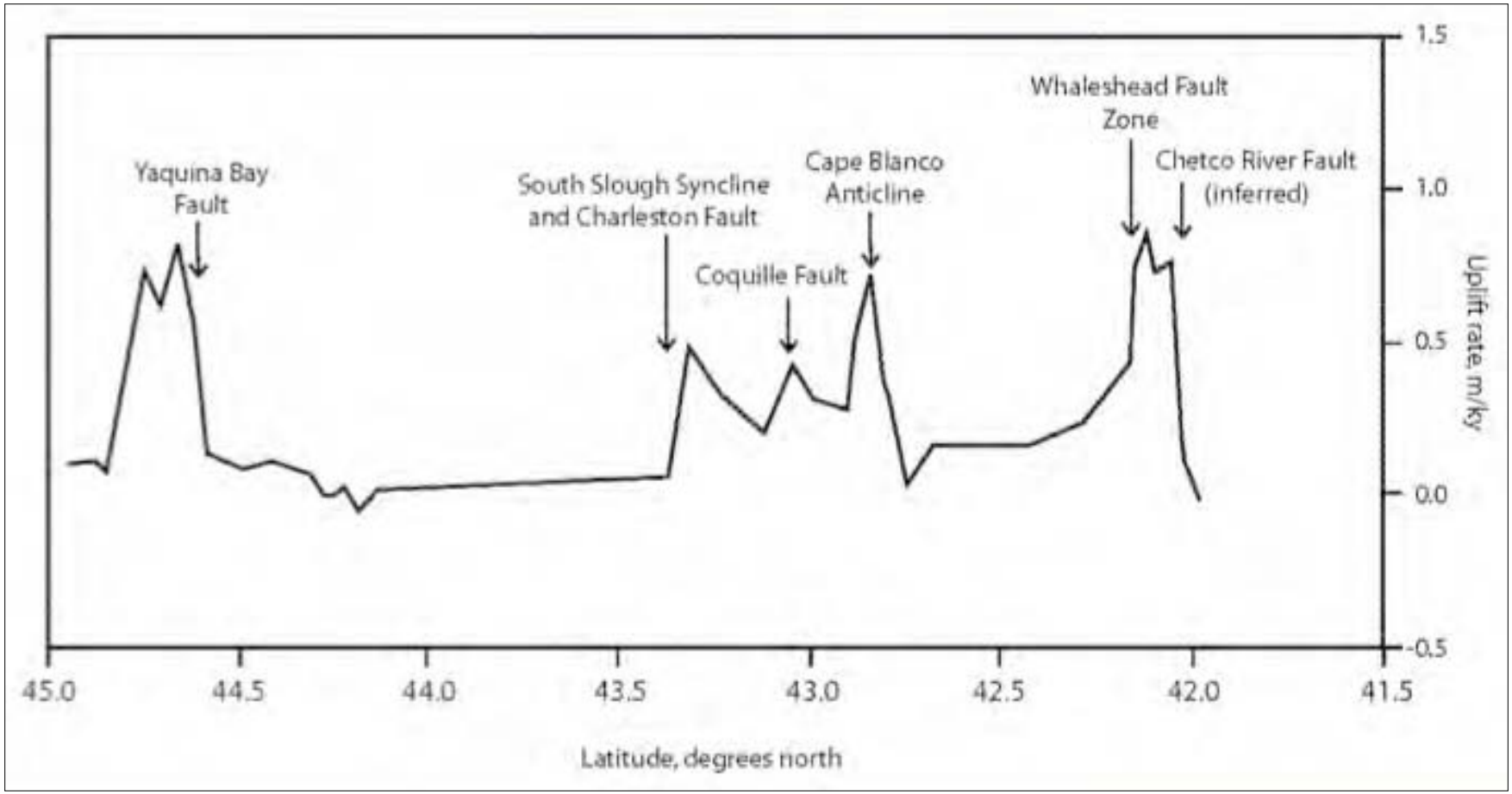
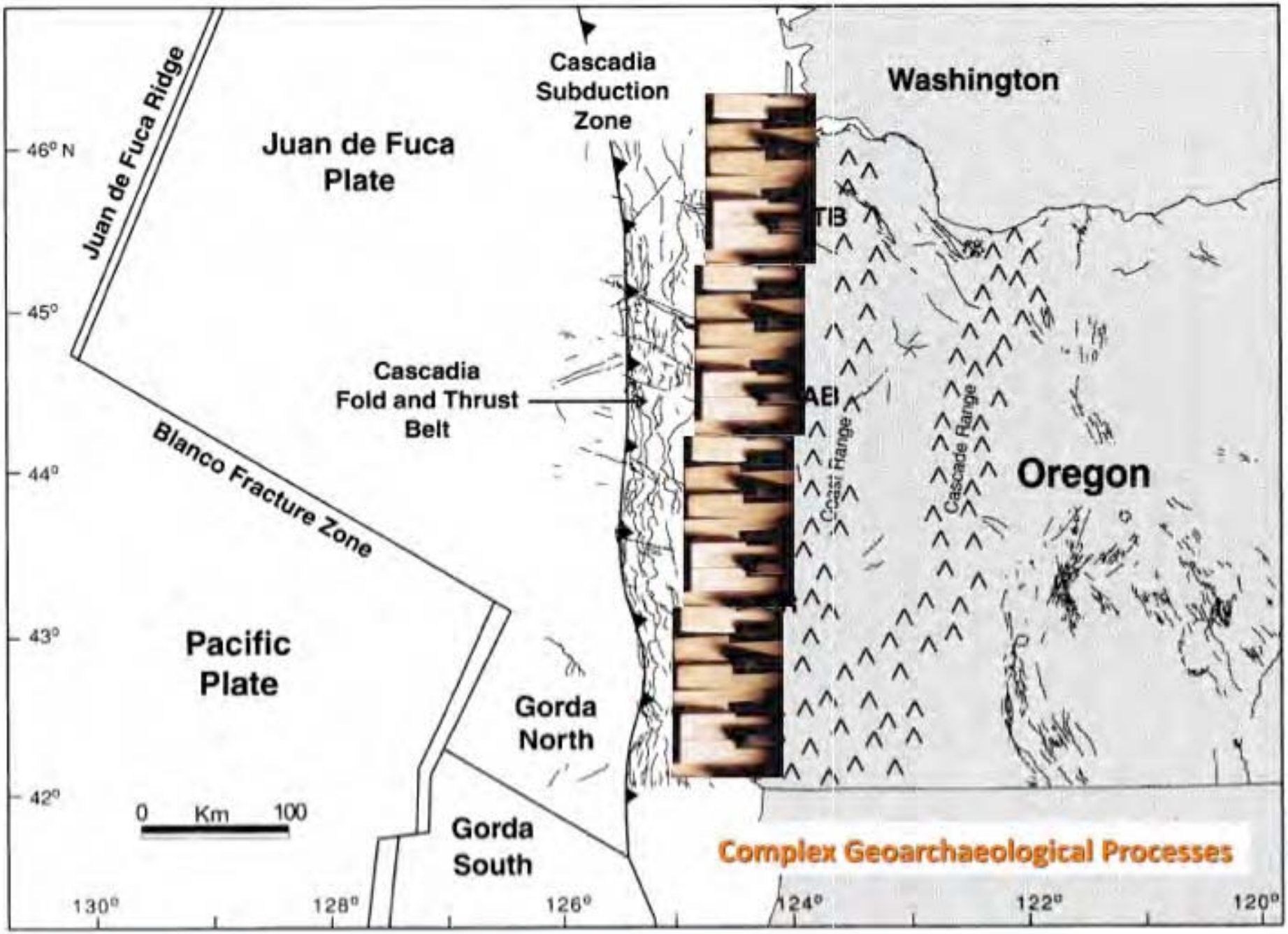


Broken Piano Model

- Stress and strain of CSZdrives neotectonic actions along upper crustal deformation structures
- Produced diverse geomorphic histories across small spatial scales

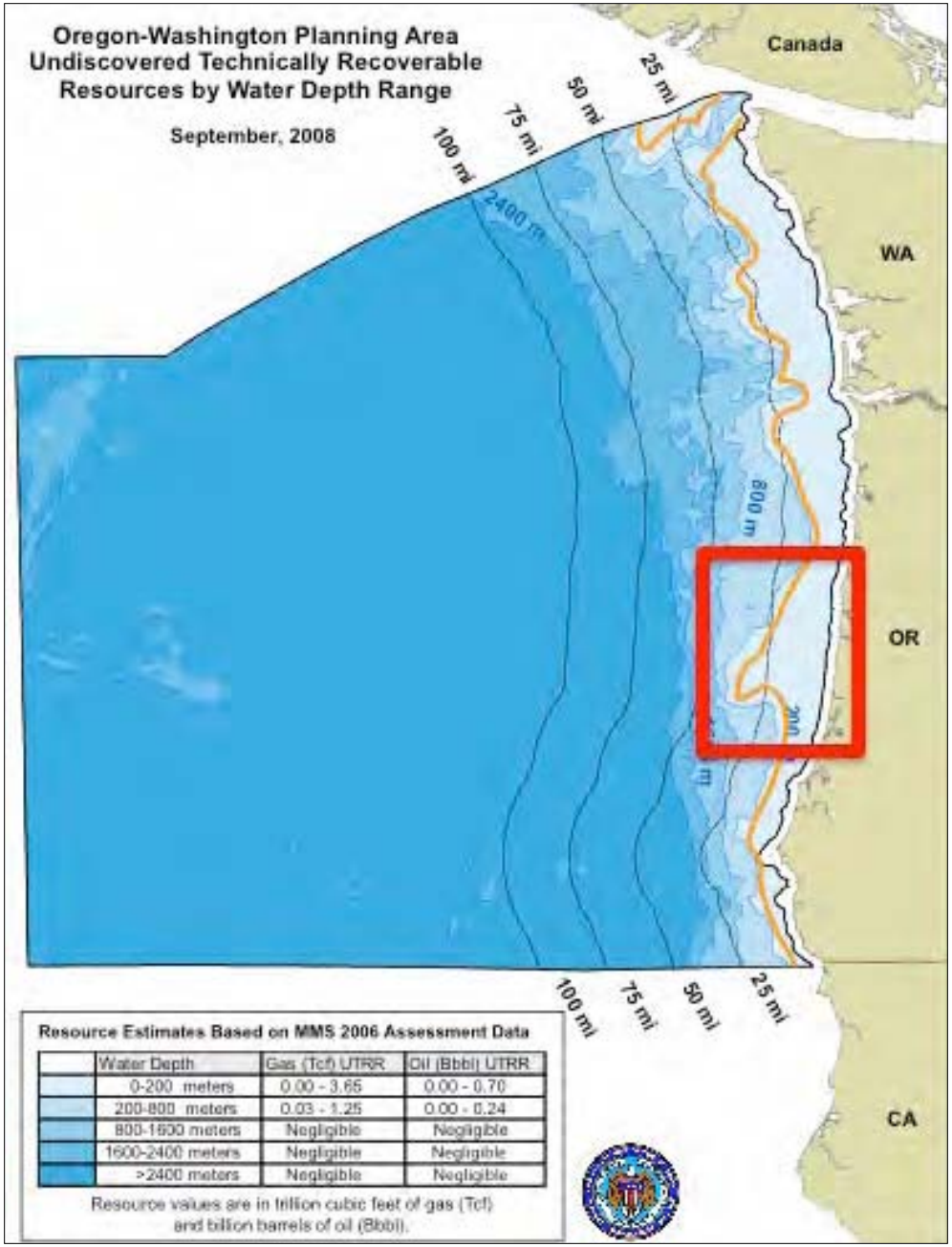
Neotectonic Actions: Central Oregon Coast




Cascadia
Subduction
Zone
Washington
Juan de Fuca Ridge
Juan de Fuca
Plate
46° N
45°
44°
43°
42°
TIB
AEI
Cascadia
Fold and Thrust
Belt
Blanco Fracture Zone
Coast Range
Cascade Range
Oregon
Pacific
Plate
Gorda
North
Gorda
South
0 Km 100
Complex Geoarchaeological Processes
130°
128°
126°
124°
122°
120°

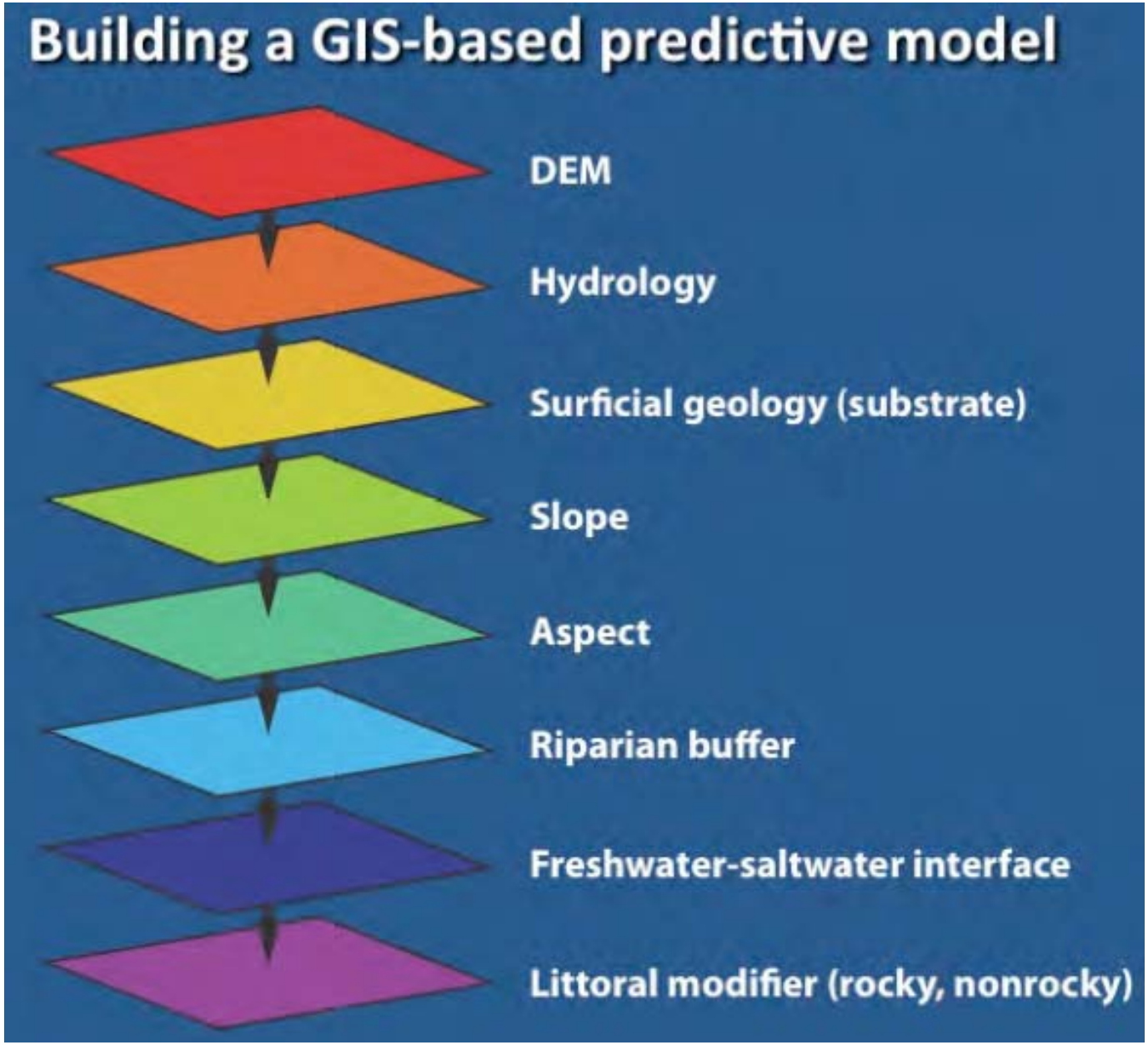
3. What we can model

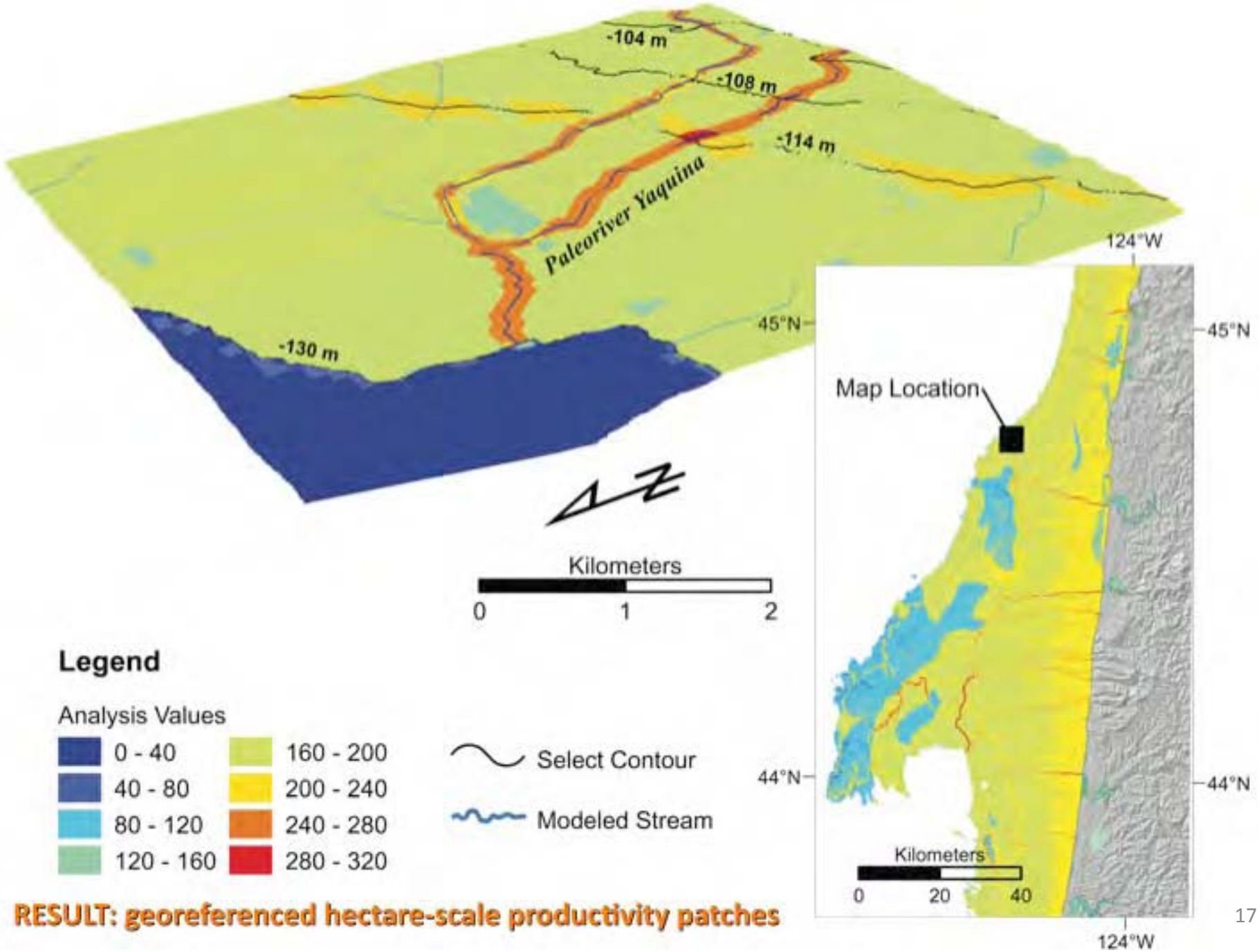
- Ancient coastal landscapes
- Site locations based on:
  - Patch productivity in paleoenvironmental context
  - Ideal free distribution of foragers


Oregon-Washington Planning Area
Undiscovered Technically Recoverable
Resources by Water Depth Range
September, 2008
Canada
WA
OR
CA
25 mi
50 mi
75 mi
100 mi
2400 m
800 m
200 m
Resource Estimates Based on MMS 2006 Assessment Data
Water Depth | Gas (Tcf) UTRR | Oil (Bbbl) UTRR
0-200 meters | 0.00 - 3.65 | 0.00 - 0.70
200-800 meters | 0.03 - 1.25 | 0.00 - 0.24
800-1600 meters | Negligible | Negligible
1600-2400 meters | Negligible | Negligible
>2400 meters | Negligible | Negligible
Resource values are in trillion cubic feet of gas (Tcf) and billion barrels of oil (Bbbl).

Pacific Ocean
Highlight of -114 to -104 contour
Paleoriver Alsea
Paleoriver Siuslaw
Kilometers
0
10
20
ELEVATION IN METERS

Highlight of -114 to -104 contour
Stonewall Bank
Paleoriver Alsea
Perpetua Bank
Heceta Bank
Paleoriver Siuslaw


Building a GIS-based predictive model
DEM
Hydrology
Surficial geology (substrate)
Slope
Aspect
Riparian buffer
Freshwater-saltwater interface
Littoral modifier (rocky, nonrocky)



RESULT: georeferenced hectare-scale productivity patches

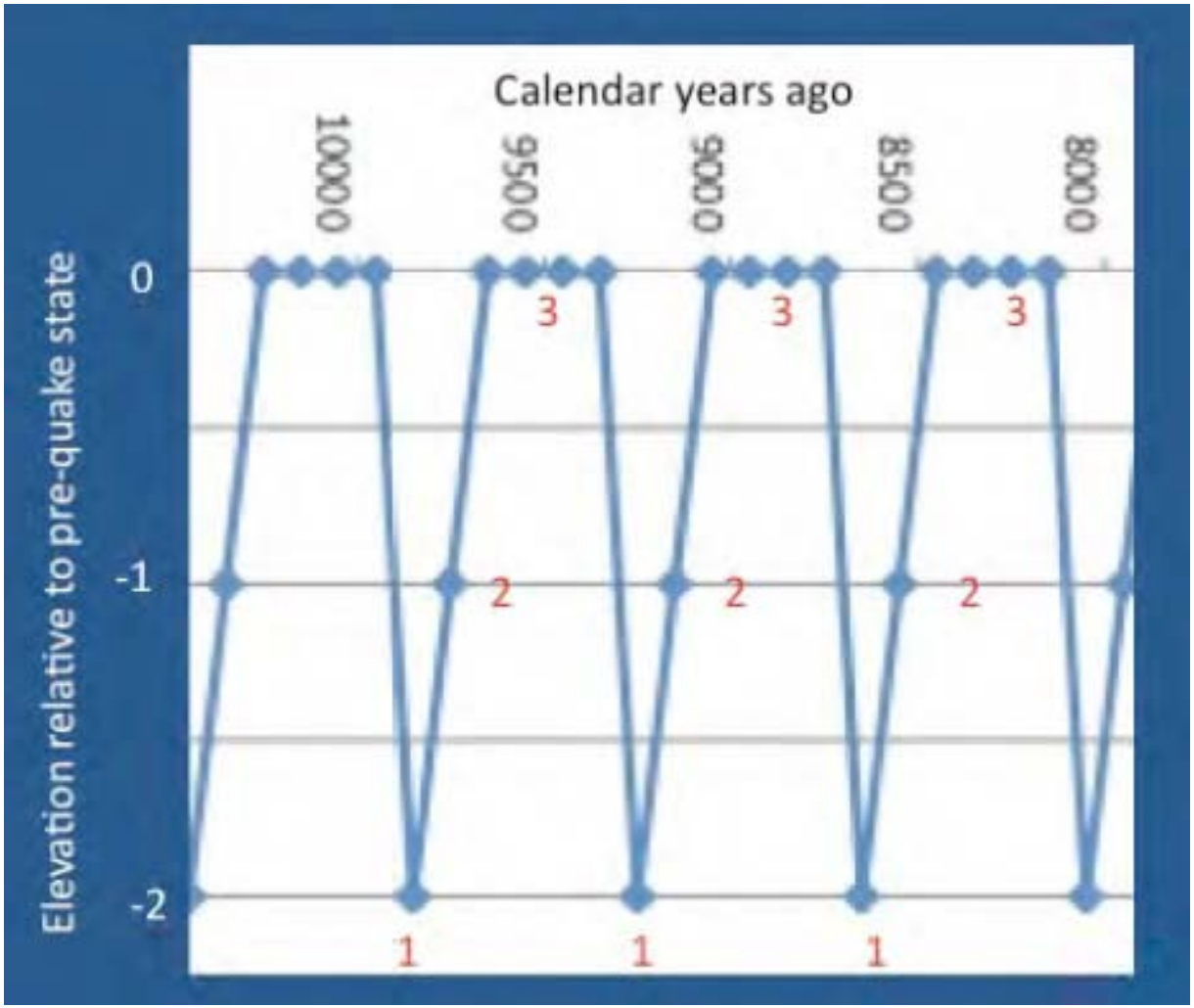
4. What we don’t know

- Neotonic deformation history along CSZ
- State of terrestrial stratigraphic record in post-inundation context
- Potential for site preservation in buried contexts

Did the CSZ help to preserve archaeological sites in offshore settings?

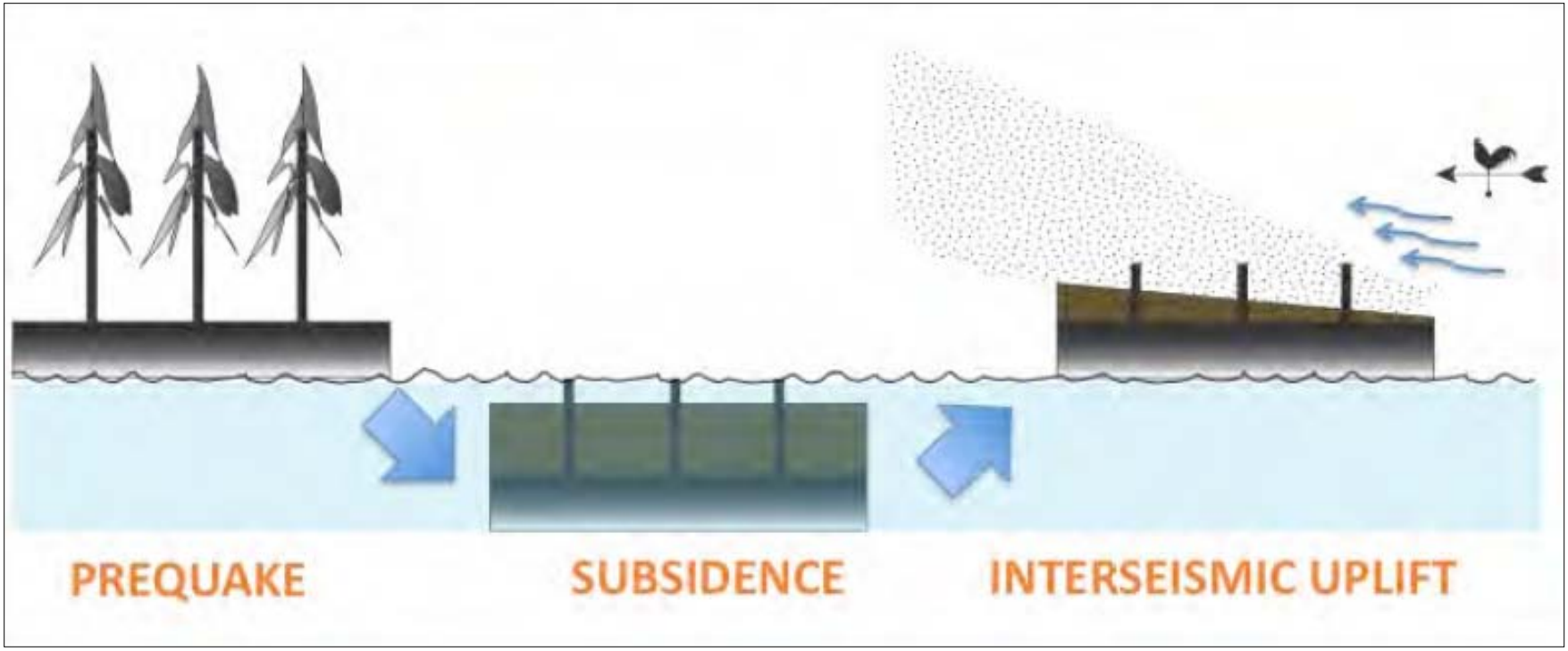
- Tectonic uplift will not keep pace with eustatic sea level rise
  - 1 m/1,000 yrs = fast tectonics
  - Eustatic sea level rose an average of 1 m/136 yrs since 15.5k.
- Coseismic subsidence creates accommodation space for marine sedimentation
- Rapid eustatic sea level rise inundates, buries, and preserves ancient landscapes and sites they might contain

1. CSZ quake-induced co-seismic subsidence drops coast up to 2 m
2. Interseismic loading of CSZ plates creates strain that uplifts coastline back to pre-quake state
3. Interseismic stability/slow uplift

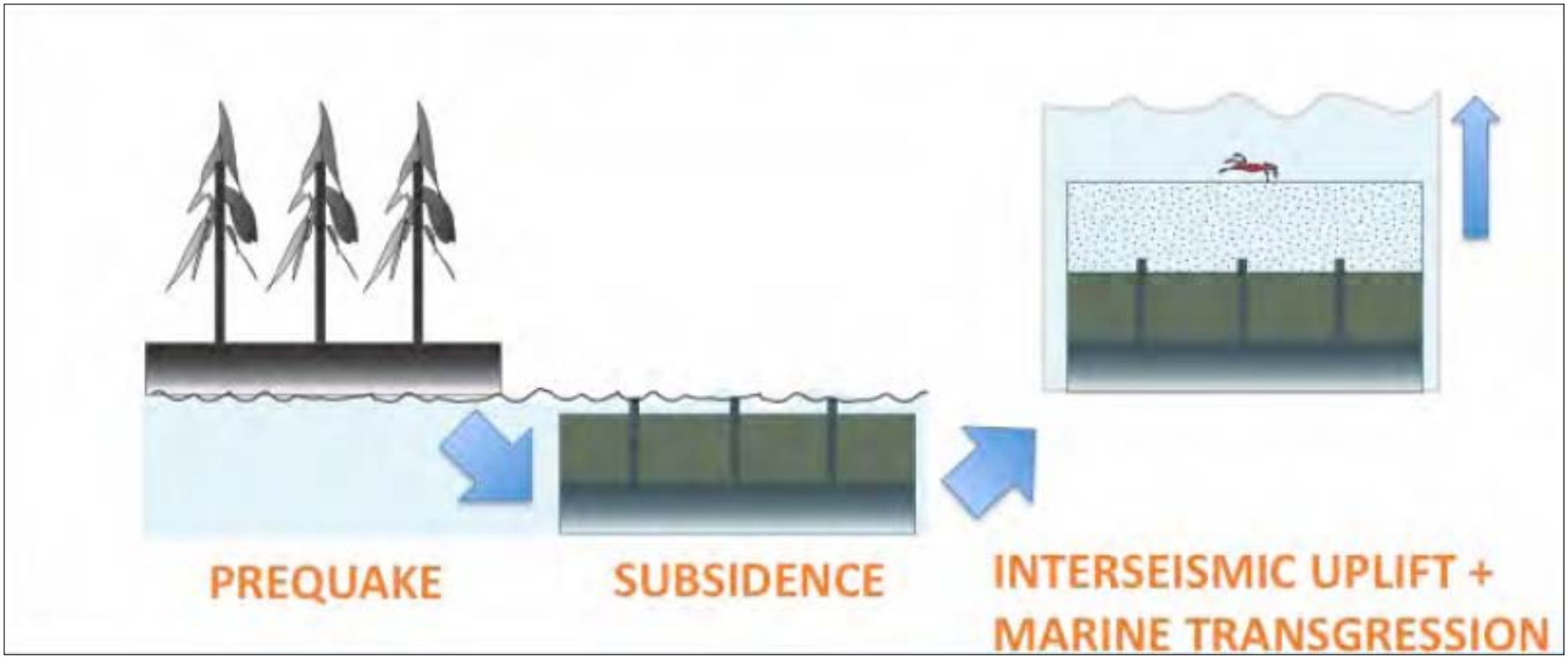


"Ghost Forest" at Neskowin Beach, Near Depot Bay, Oregon

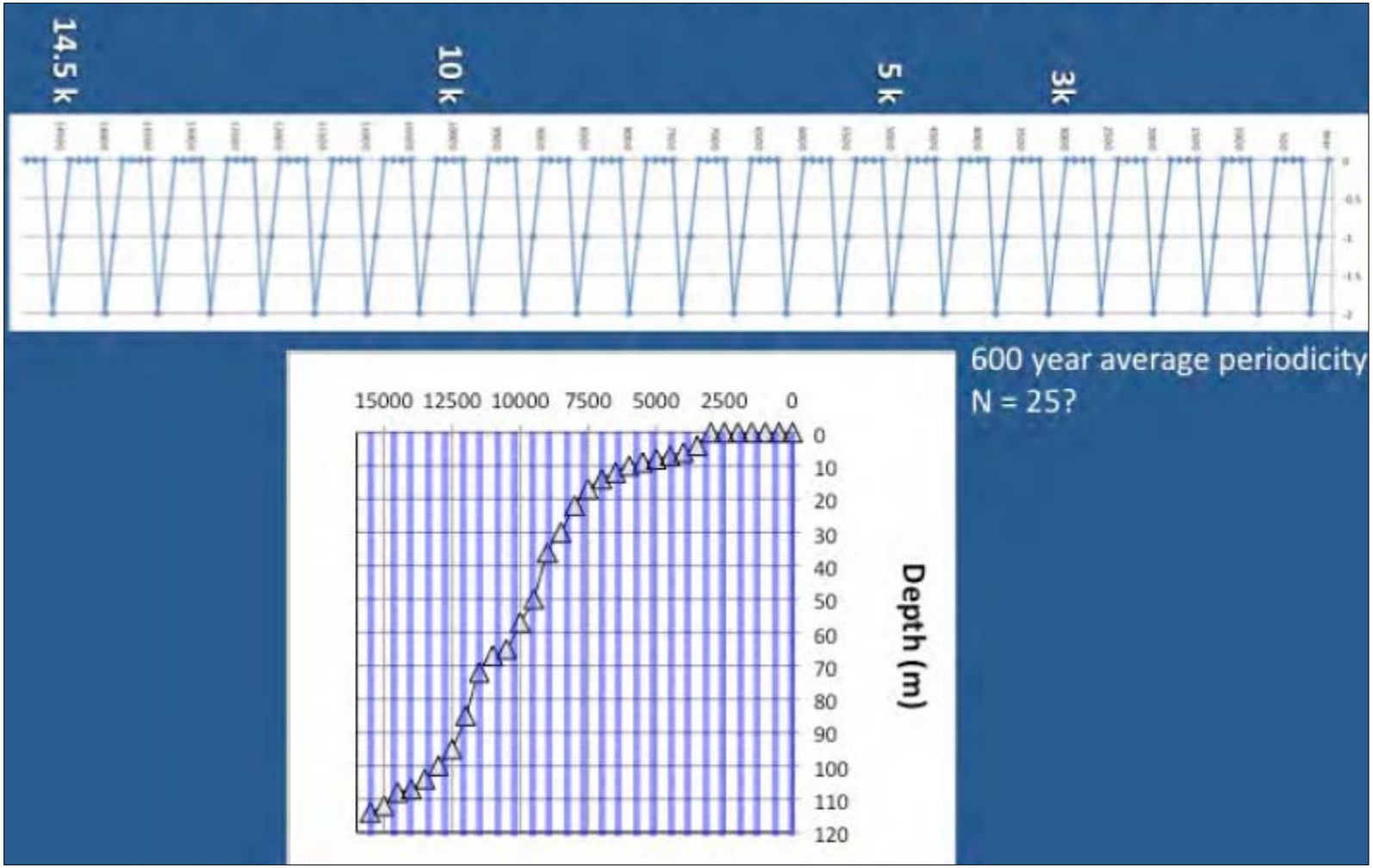
Coseismic-Interseismic Geomorphic Cycle (post-3,000 RYPB)

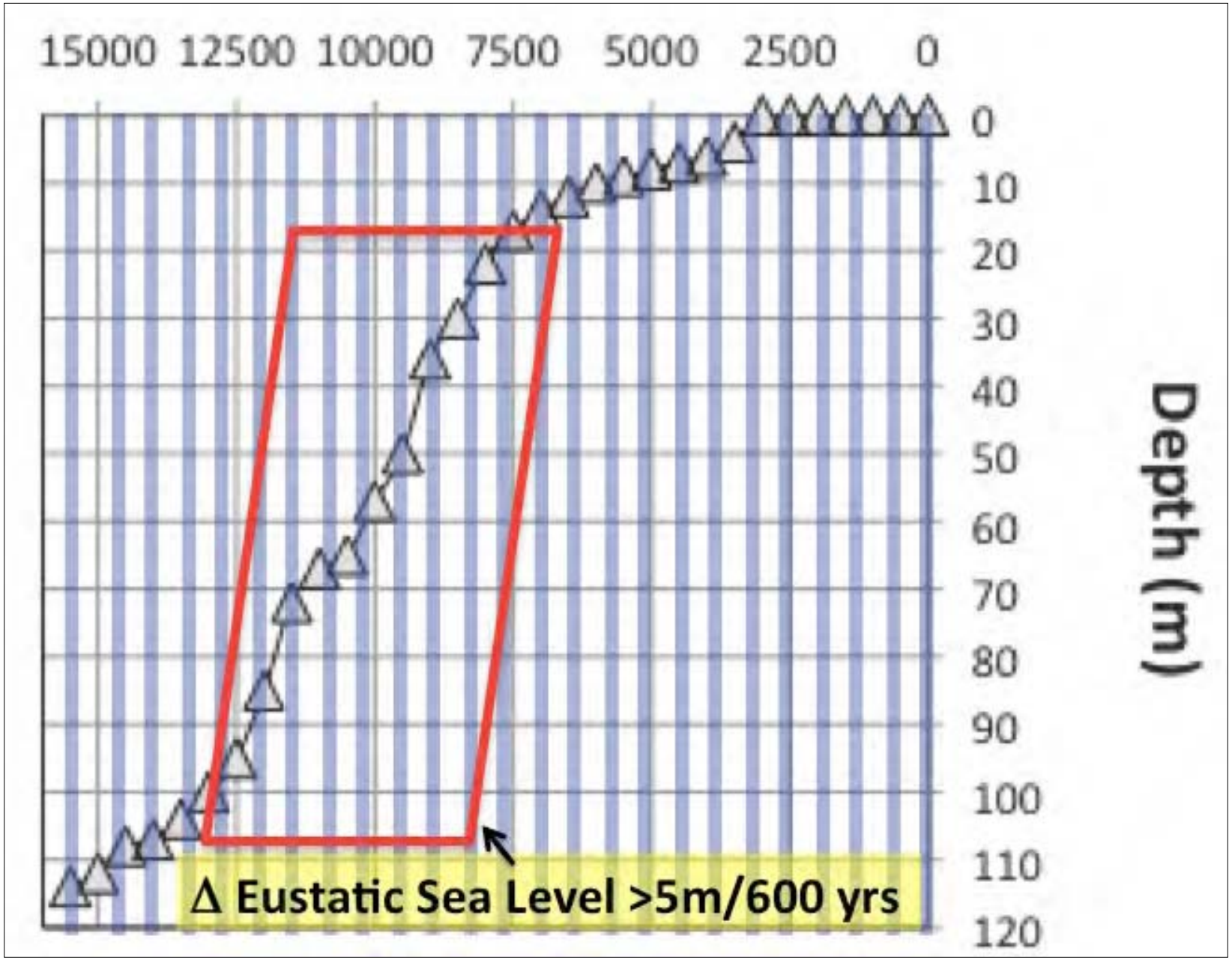


Coseismic-Interseismic Geomorphic Cycle (pre-3,000 RYPB)



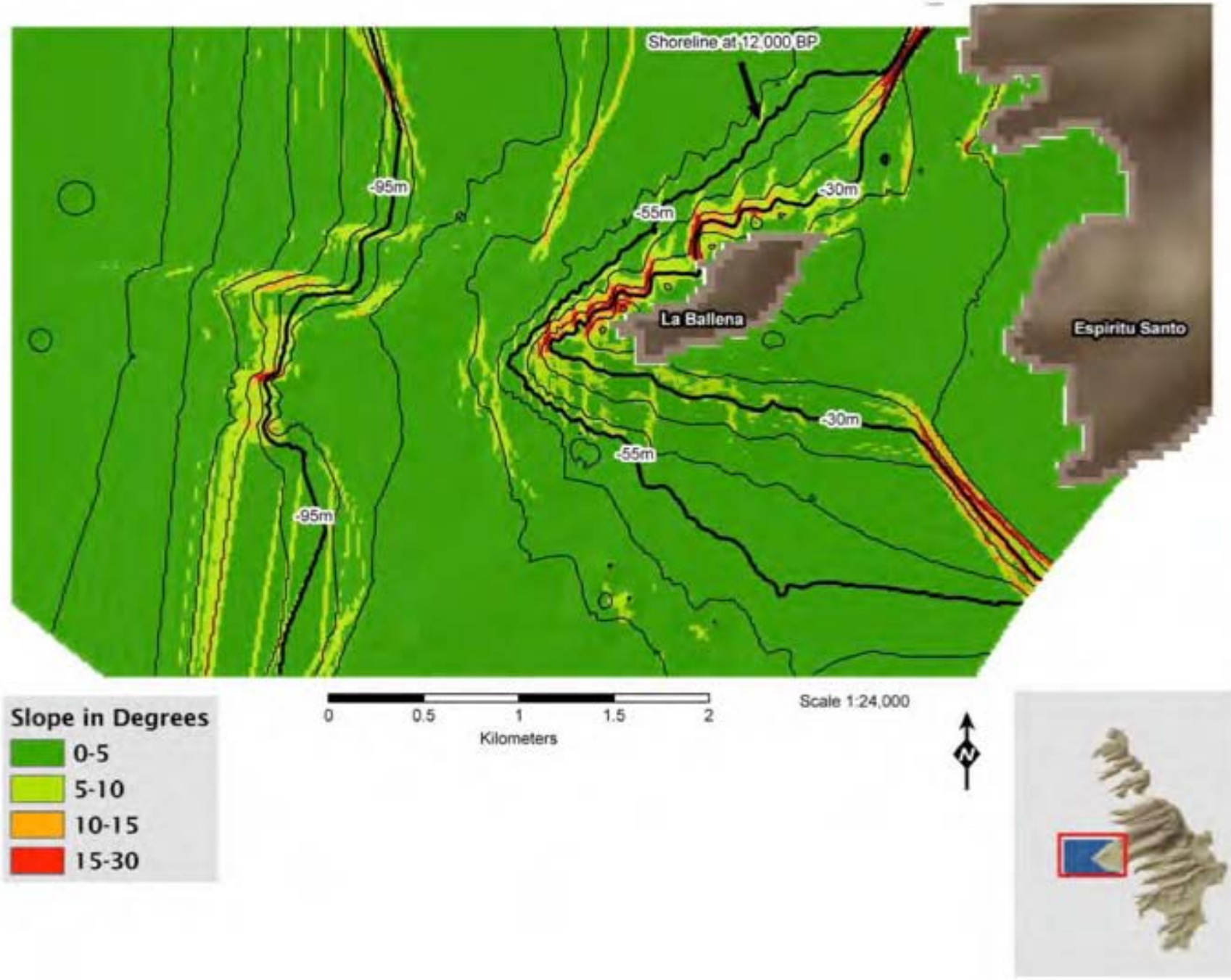
CSZ Quakes Since the Late Pleistocene




15000 12500 10000 7500 5000 2500 0
0
10
20
30
40
50
60
70
80
90
100
110
120
Depth (m)
Δ Eustatic Sea Level >5m/600 yrs

Baja California

2010 NOAA-funded project to survey Espiritu Santo Island


Shoreline at 12,000 BP
-95m
-55m
-30m
La Ballena
Espiritu Santo
-30m
-55m
-95m
Slope in Degrees
0-5
5-10
10-15
15-30
0
0.5
1
1.5
2
Kilometers
Scale 1:24,000
N

The Trouble with Rhodoliths

Photo: Konar and Iken
http://www.sfos.uaf.edu/news/story/?ni=66 (2004)

Bad news for tectonically stable shorelines … ?

5. Ways to move forward

- **Good**: Assume all parts of U.S. Pacific Shelf above LGM shoreline hold archaeological sites
- **Better**: Develop and impement GIS-based paleolandscape-scale site predictive models using foraging potential or resource patches
- **Best**: Develop GIS model and conduct offshore groundtruthing tests to address unknowns and improve archaeological site predictive model

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