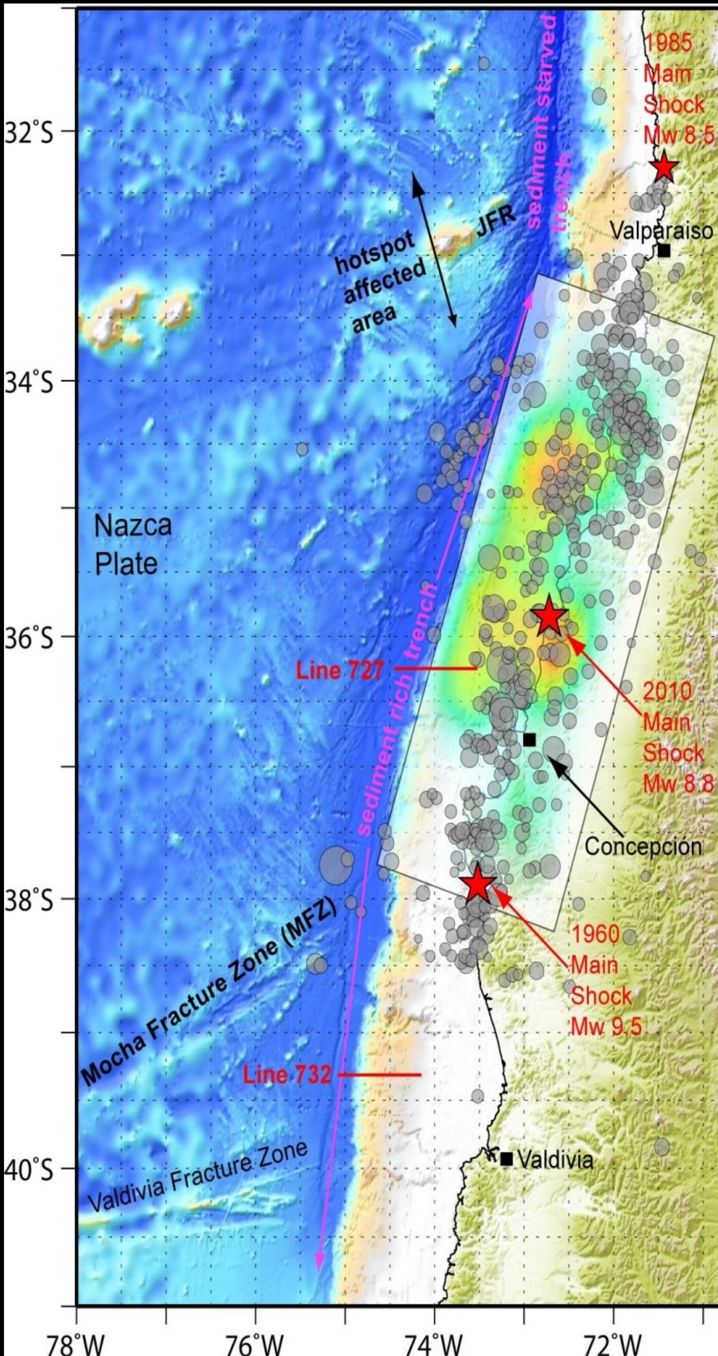
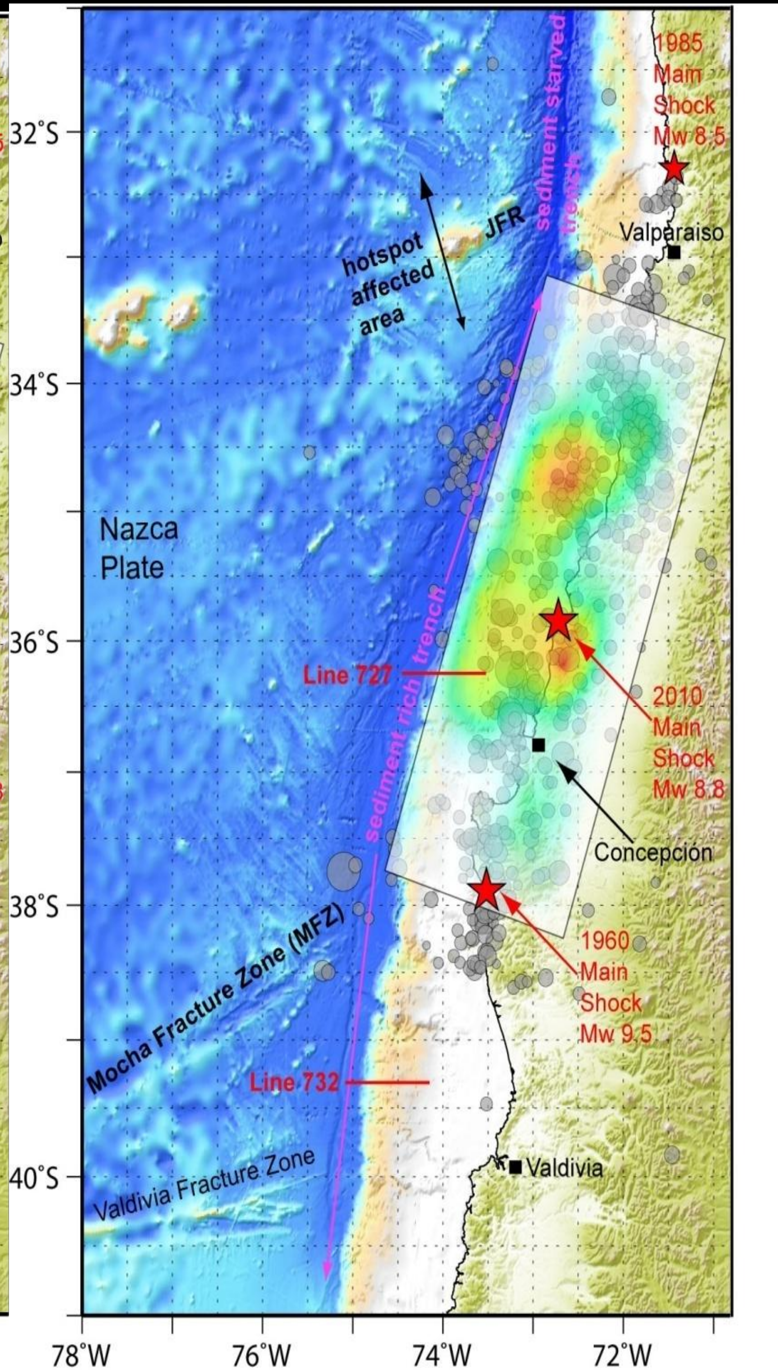
LOWER PLATE GEOLOGY AND EARTHQUAKE RUPTURE: 2010 CHILE AND 1964 ALASKA

Roland von Huene

with the help of many colleagues



1985
Main
Shock
Mw 8.5
sediment starved
trench
JFR
hotspot
affected
area
Valparaiso
Nazca
Plate
sediment rich trench
Line 727
2010
Main
Shock
Mw 8.8
Concepción
1960
Main
Shock
Mw 9.5
Mocha Fracture Zone (MFZ)
Line 732
Valdivia
Valdivia Fracture Zone
32°S
34°S
36°S
38°S
40°S
78°W
76°W
74°W
72°W



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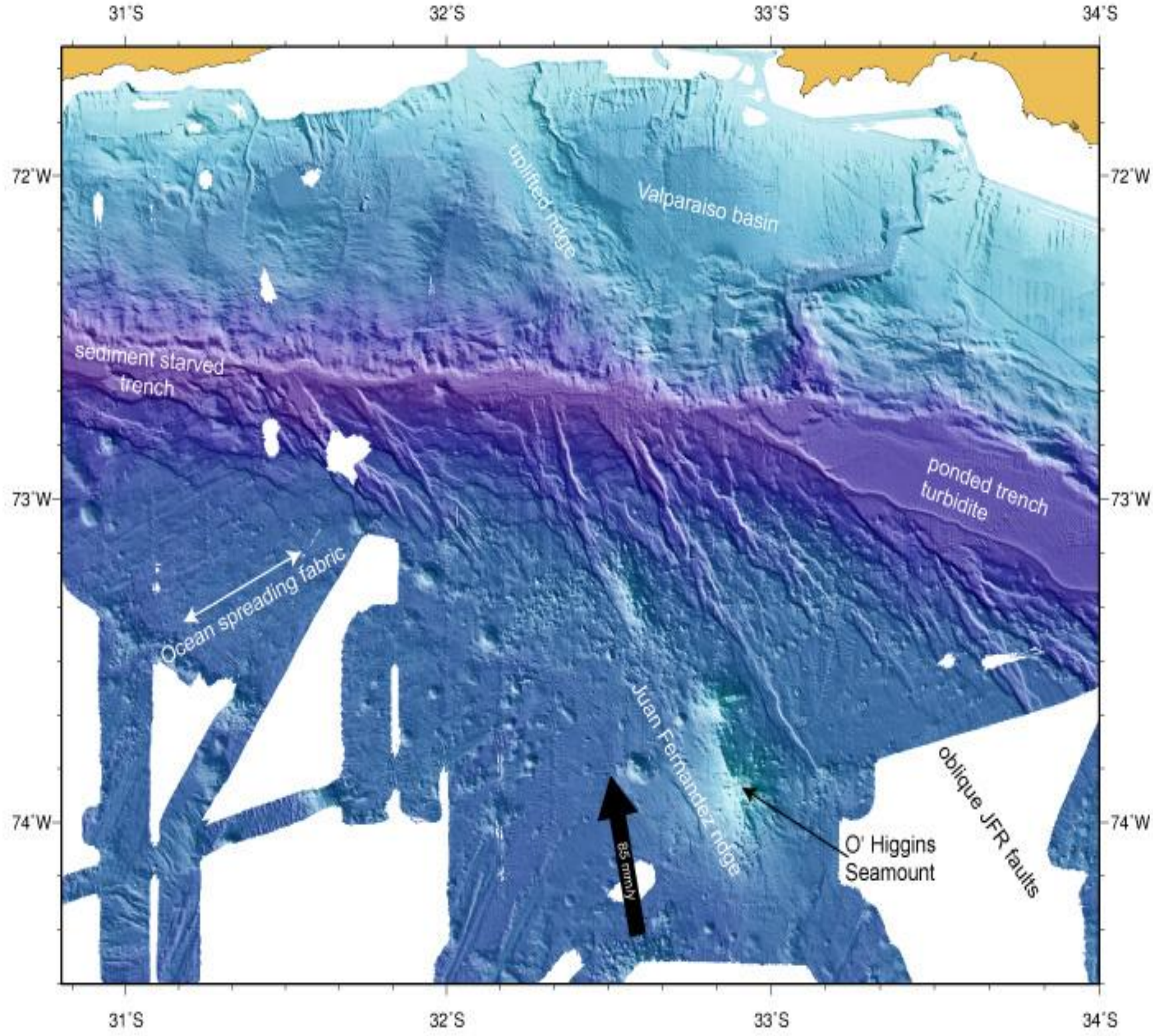
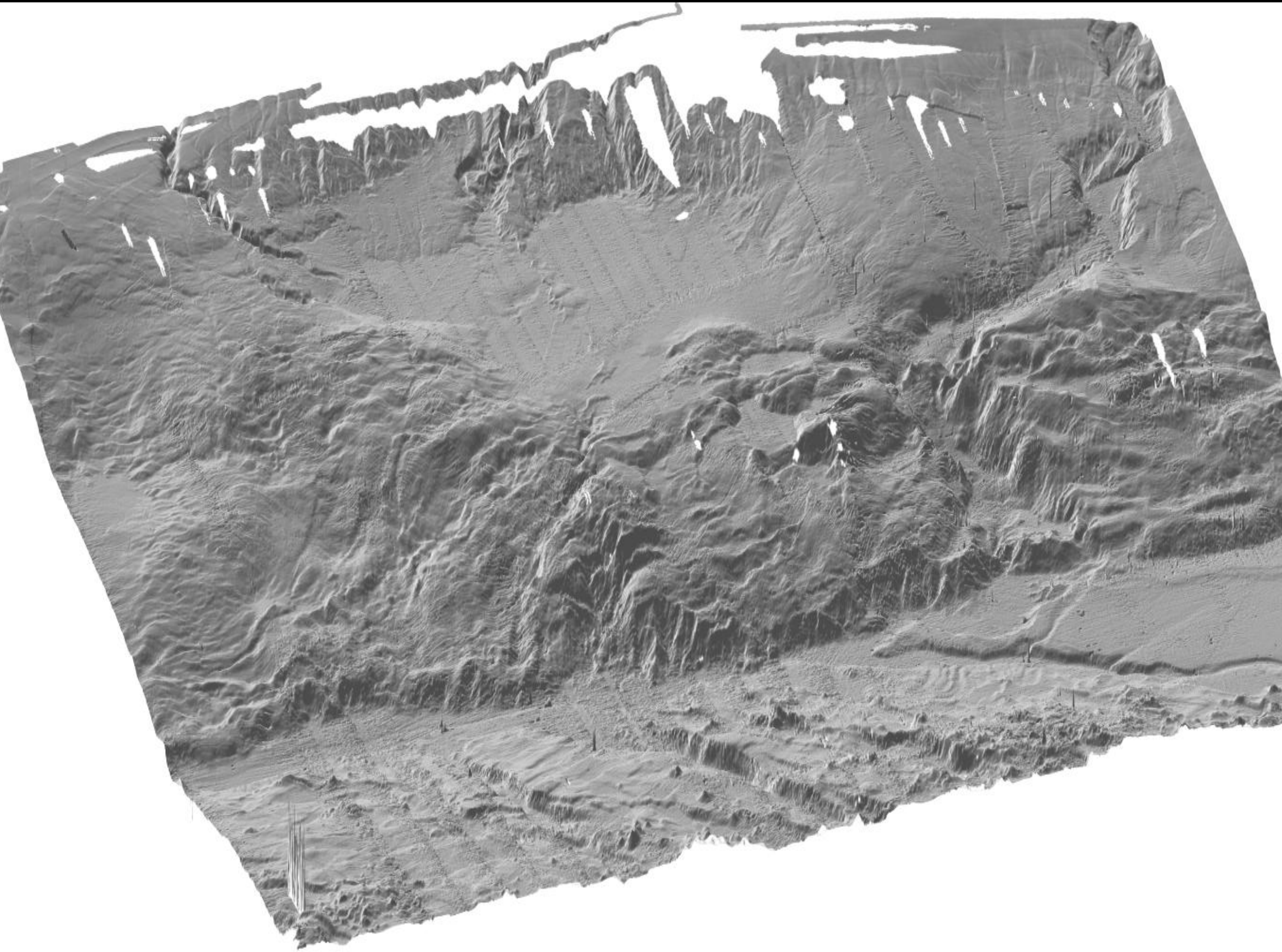
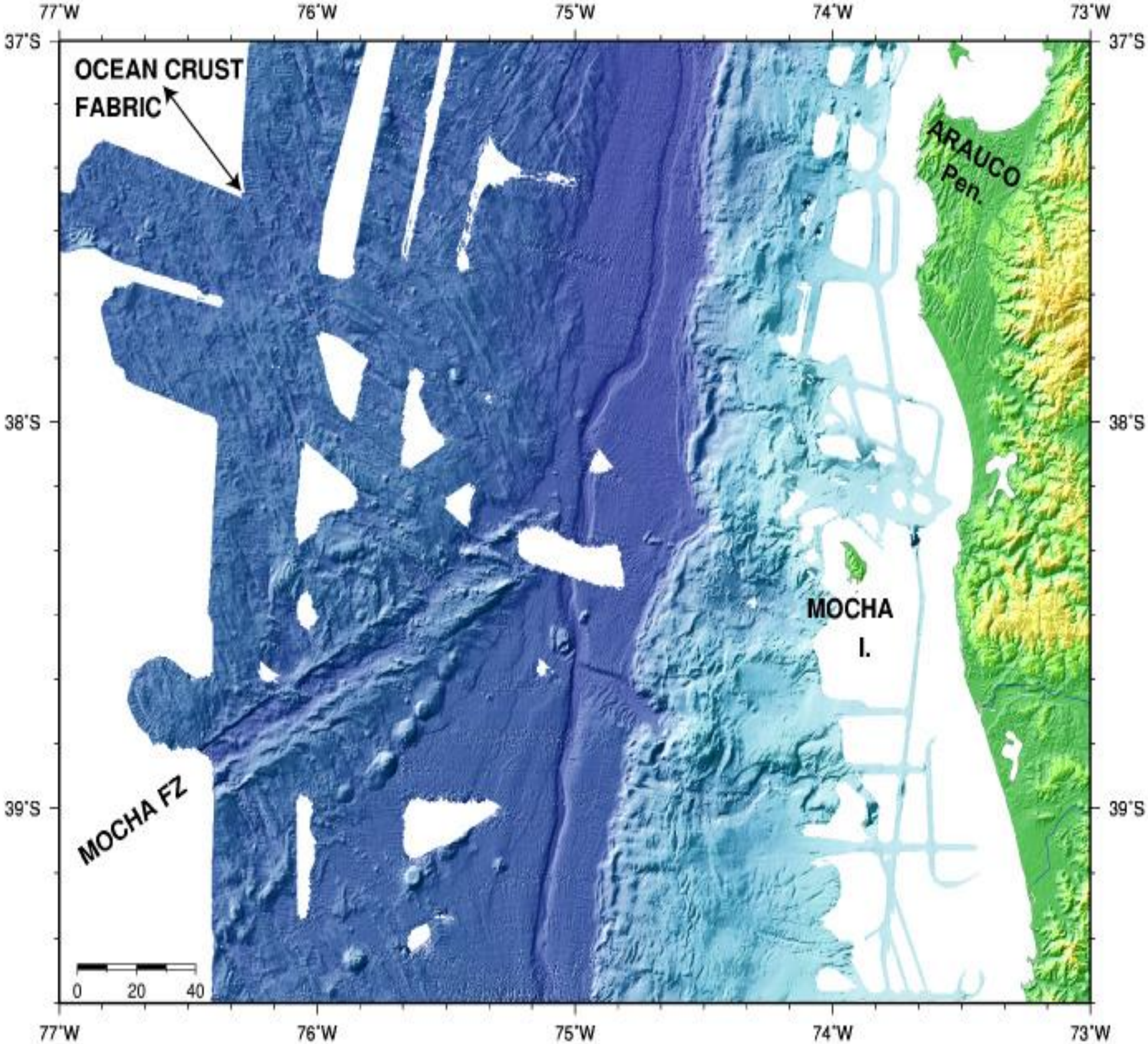
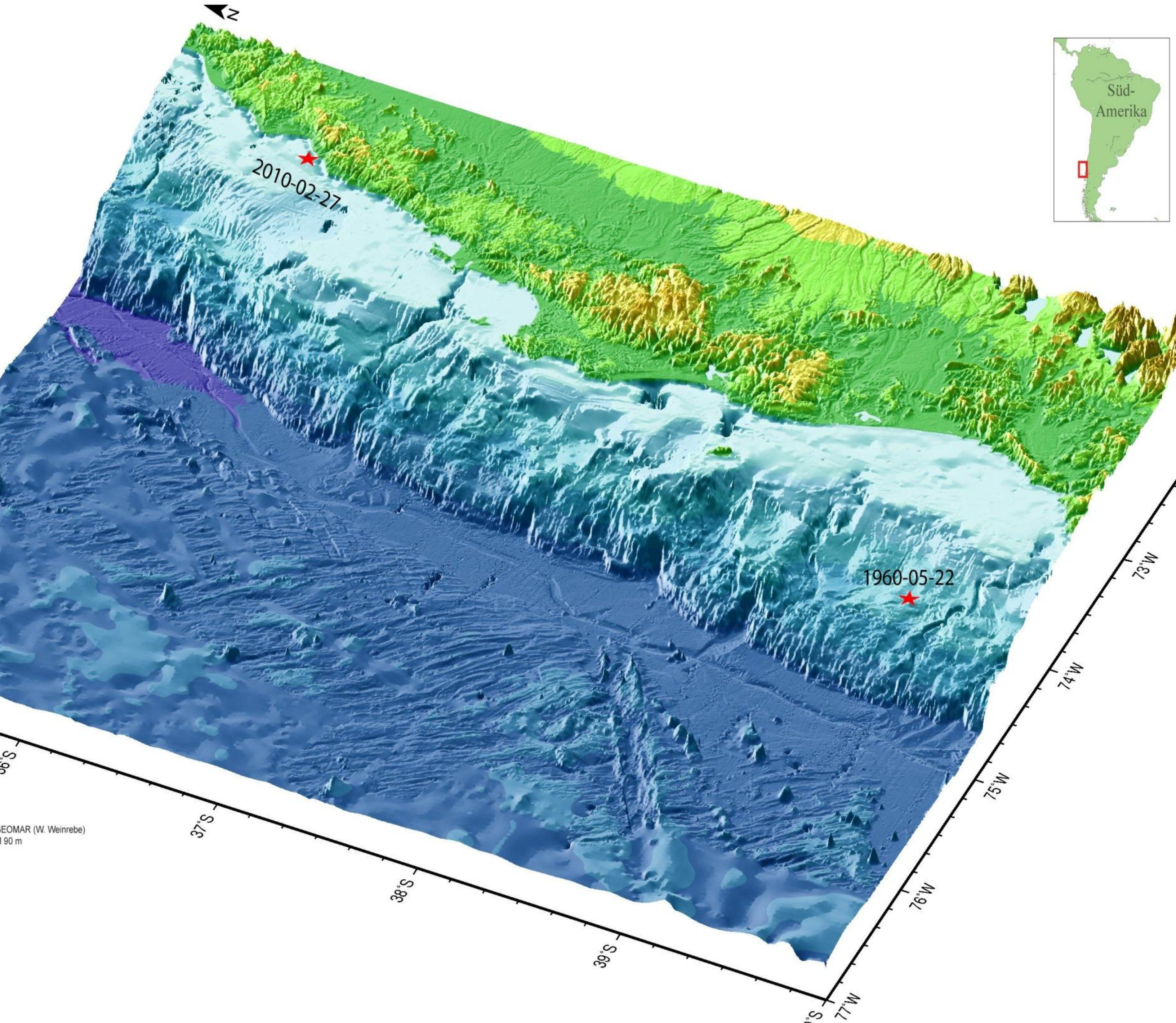


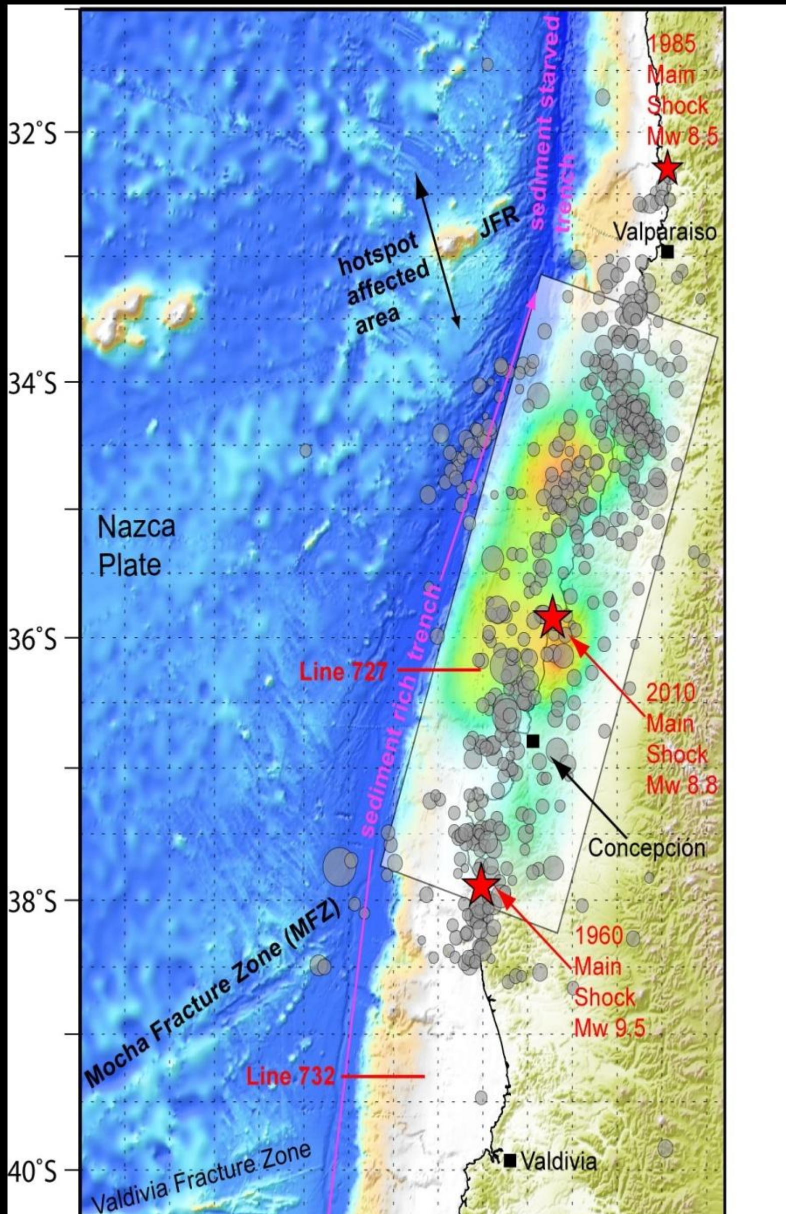
31˚S
32˚S
33˚S
34˚S
72˚W
73˚W
74˚W
uplifted ridge
Valparaiso basin
sediment starved trench
ponded trench turbidite
Ocean spreading fabric
Juan Fernandez ridge
oblique JFR faults
O' Higgins Seamount
85 mm/y




77°W
76°W
75°W
74°W
73°W
37°S
38°S
39°S
OCEAN CRUST
FABRIC
ARAUCO
Pen.
MOCHA
I.
MOCHA FZ
0
20
40



N
Süd-
Amerika
2010-02-27
1960-05-22
73°W
74°W
75°W
76°W
77°W
36°S
37°S
38°S
39°S
GEOMAR (W. Weinrebe)
90 m



32°S
34°S
36°S
38°S
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1985
Main
Shock
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Line 732
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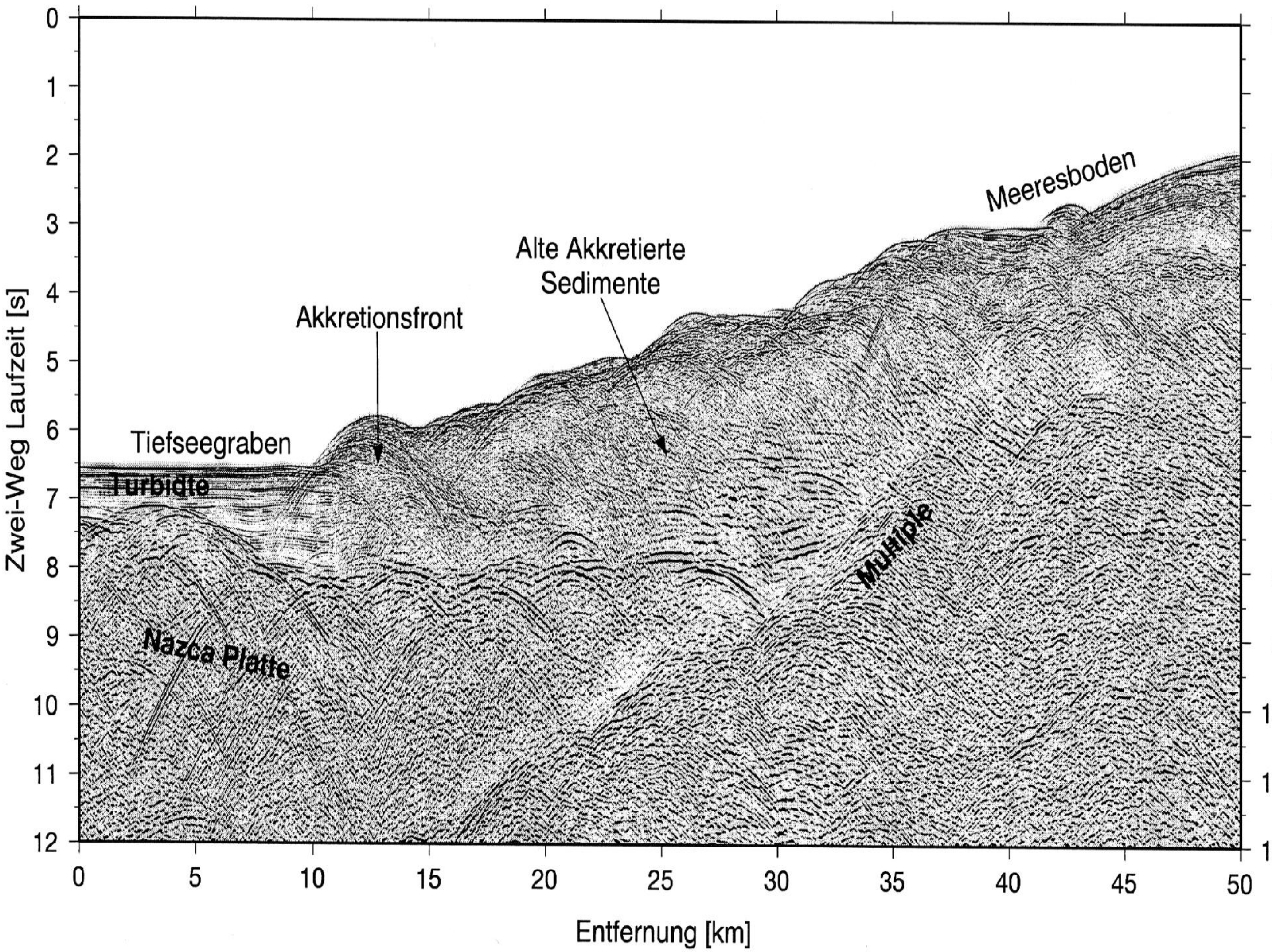
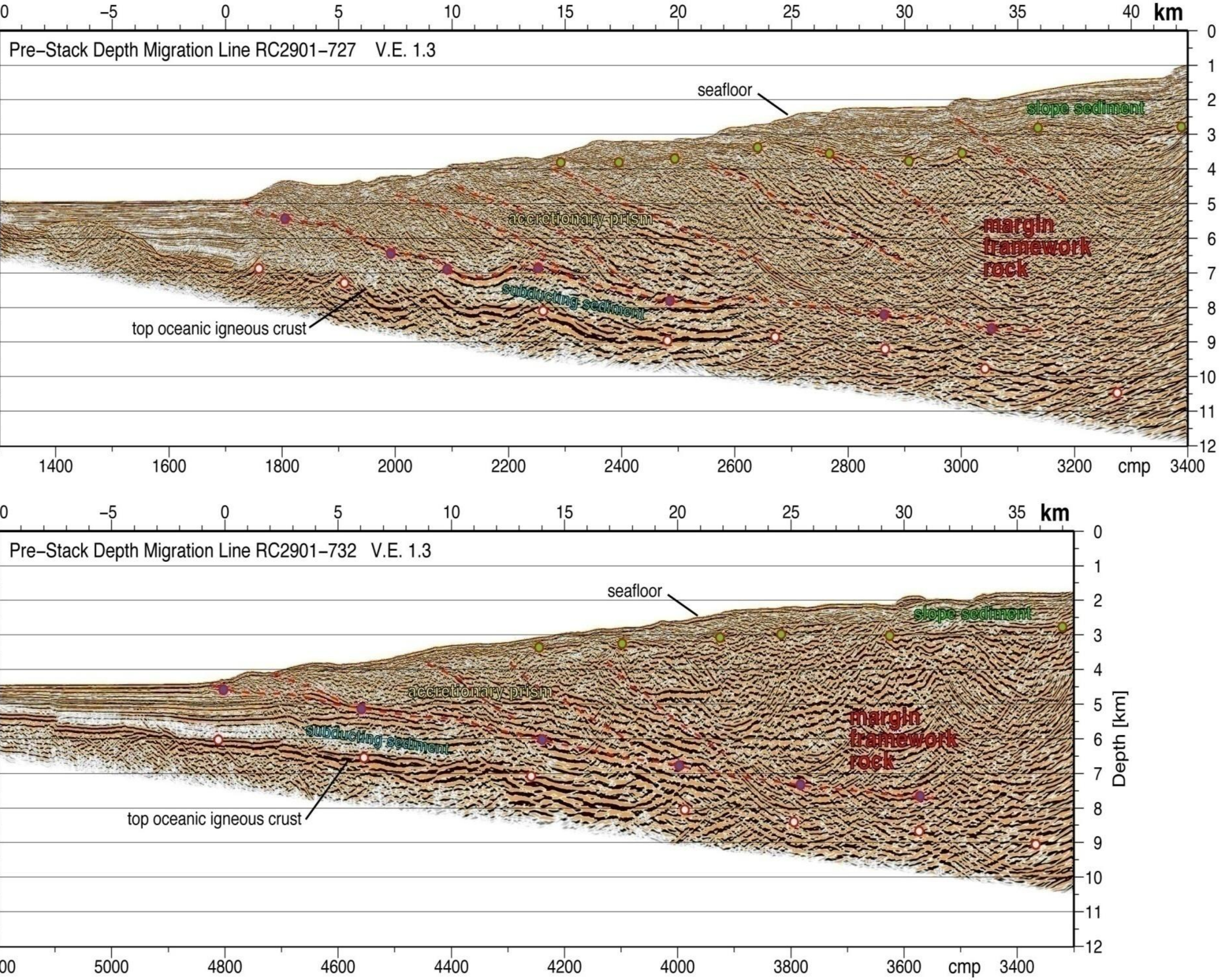
Valdivia Fracture Zone

Abb. 10: Linie Enap-2, CMP 1300-3300, Endstapelung

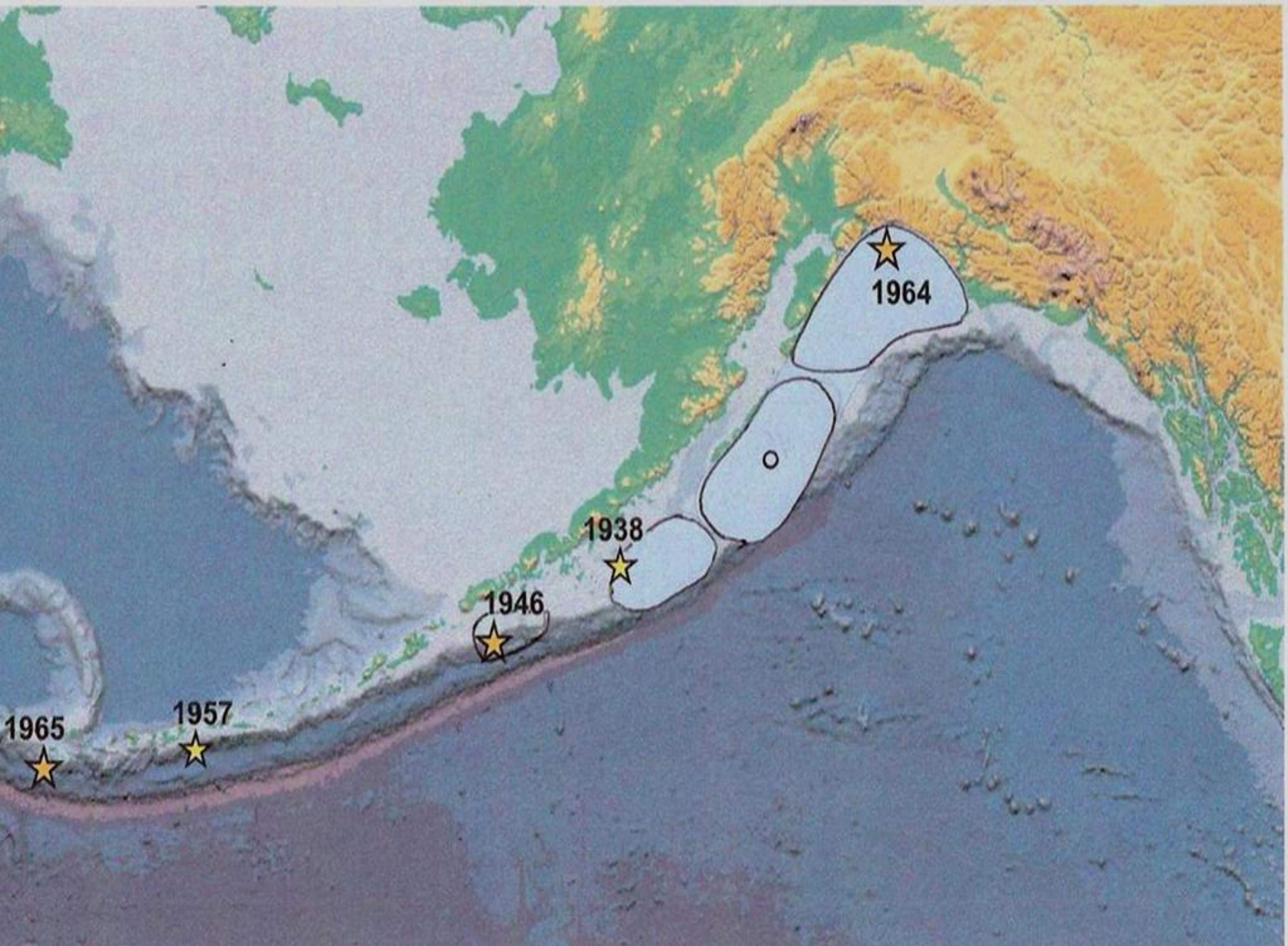



Pre–Stack Depth Migration Line RC2901–727 V.E. 1.3
km
seafloor
slope sediment
accretionary prism
margin framework rock
subducting sediment
top oceanic igneous crust
cmp
Pre–Stack Depth Migration Line RC2901–732 V.E. 1.3
km
seafloor
slope sediment
accretionary prism
margin framework rock
subducting sediment
top oceanic igneous crust
Depth [km]
cmp

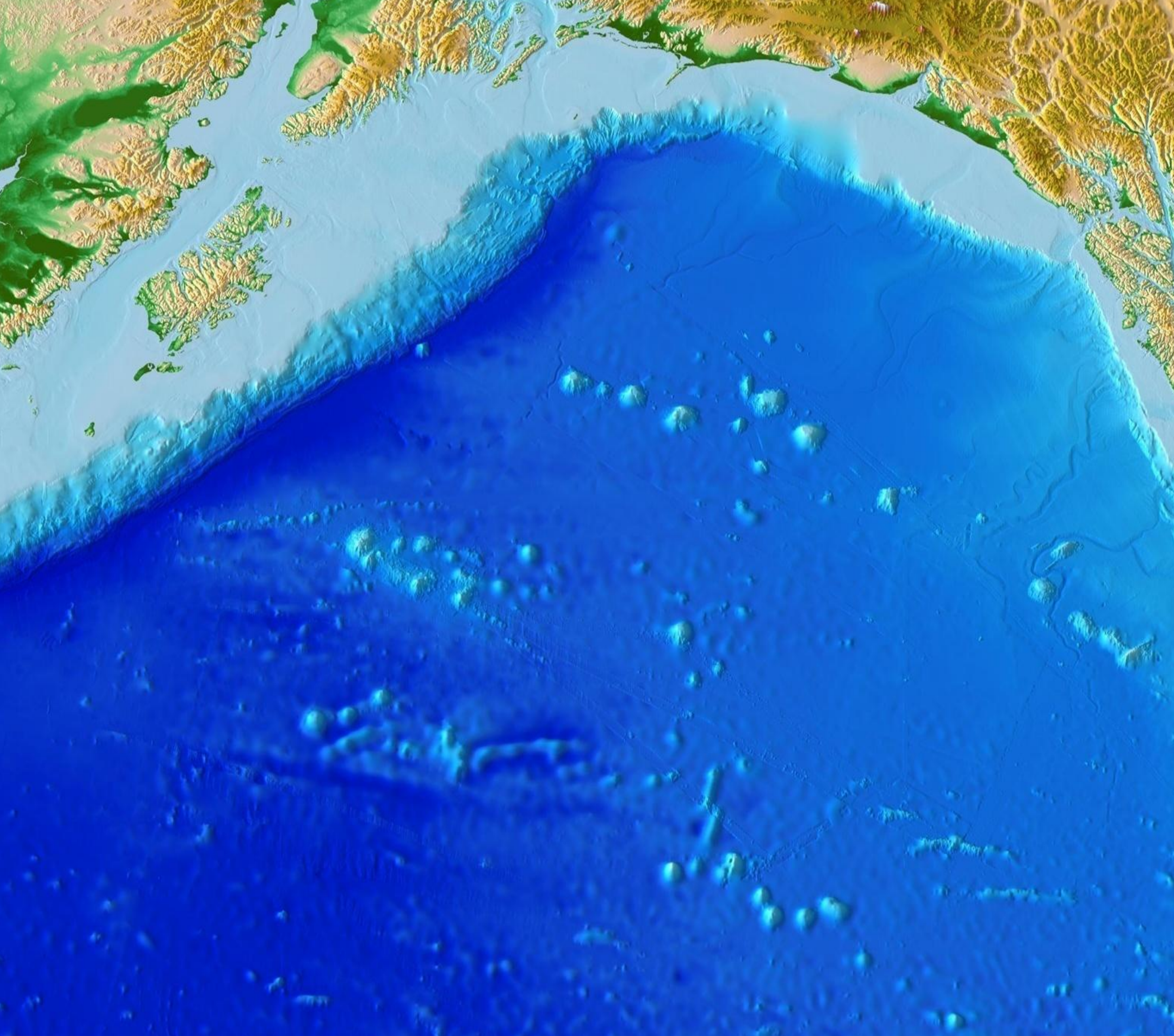
Rupture stopped at 1-3km high lower plate ridge in the north; in the south it ended at a 20 km wide subducted fracture zone with 1km high relief before subduction. Lower plate relief forms an asperity during one earthquake and a barrier during another.

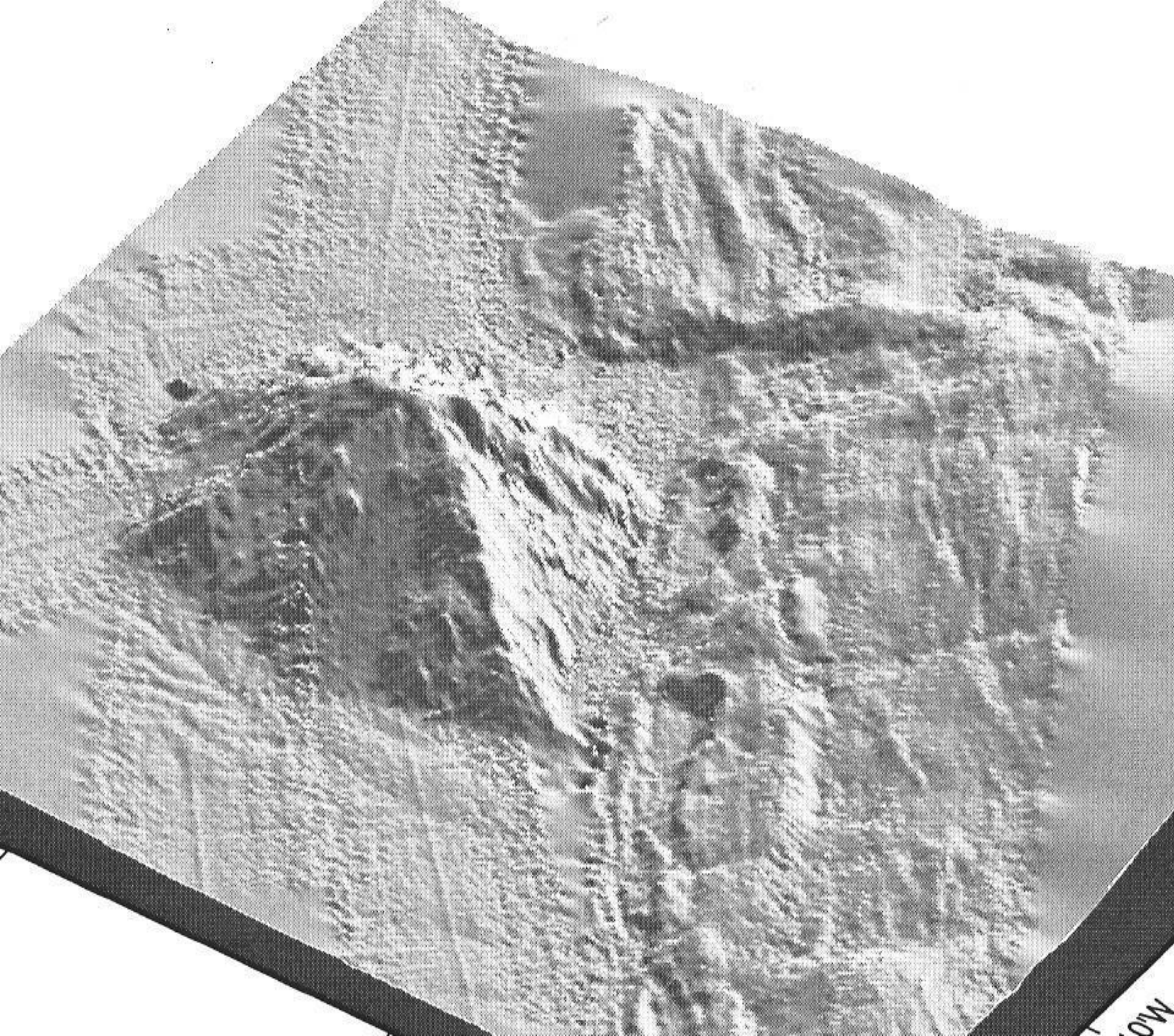
An upper plate transition from the frontal to middle prism probably arrested shear 10-20 km landward of the trench axis at a seismic velocity boundary. It limited the up-dip width of the rupture and the down-dip boundary is not constrained.

UPPER AND LOWER PLATE FEATURES FIT RUPTURE EXTENT



1964
1938
1946
1957
1965





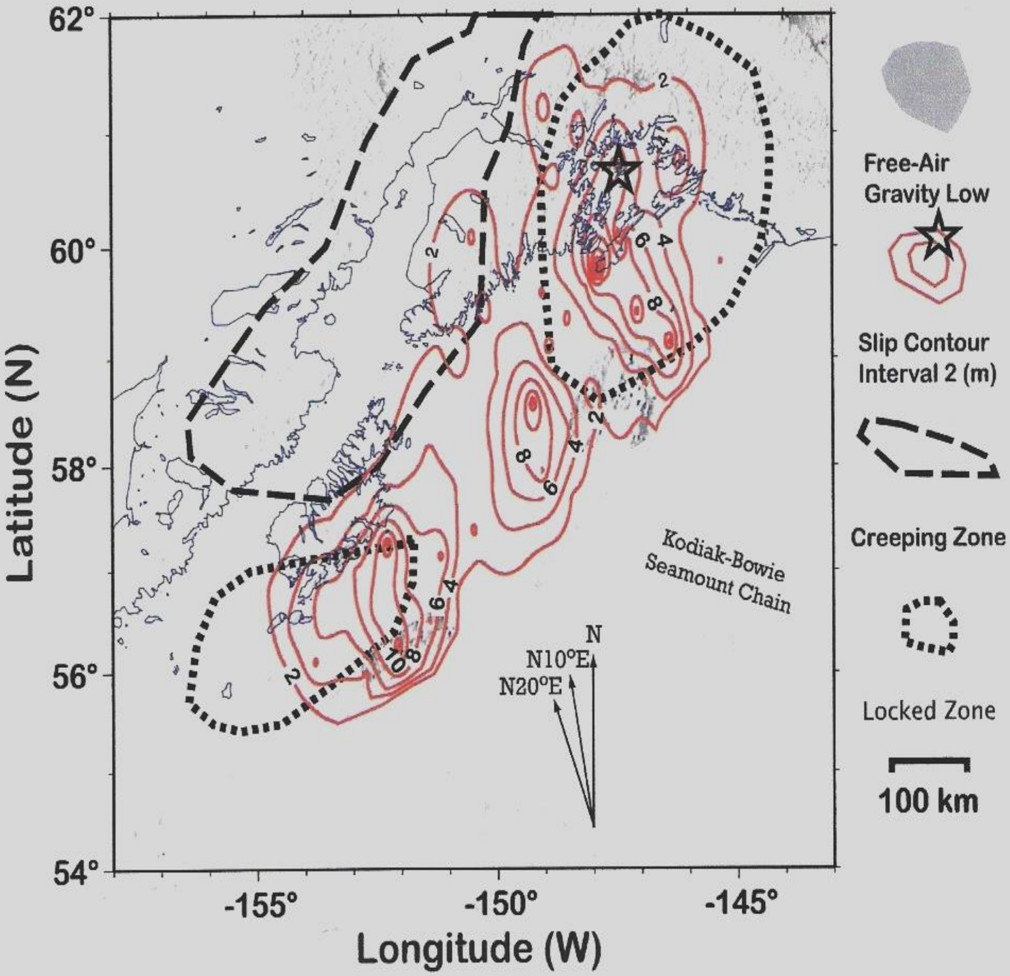
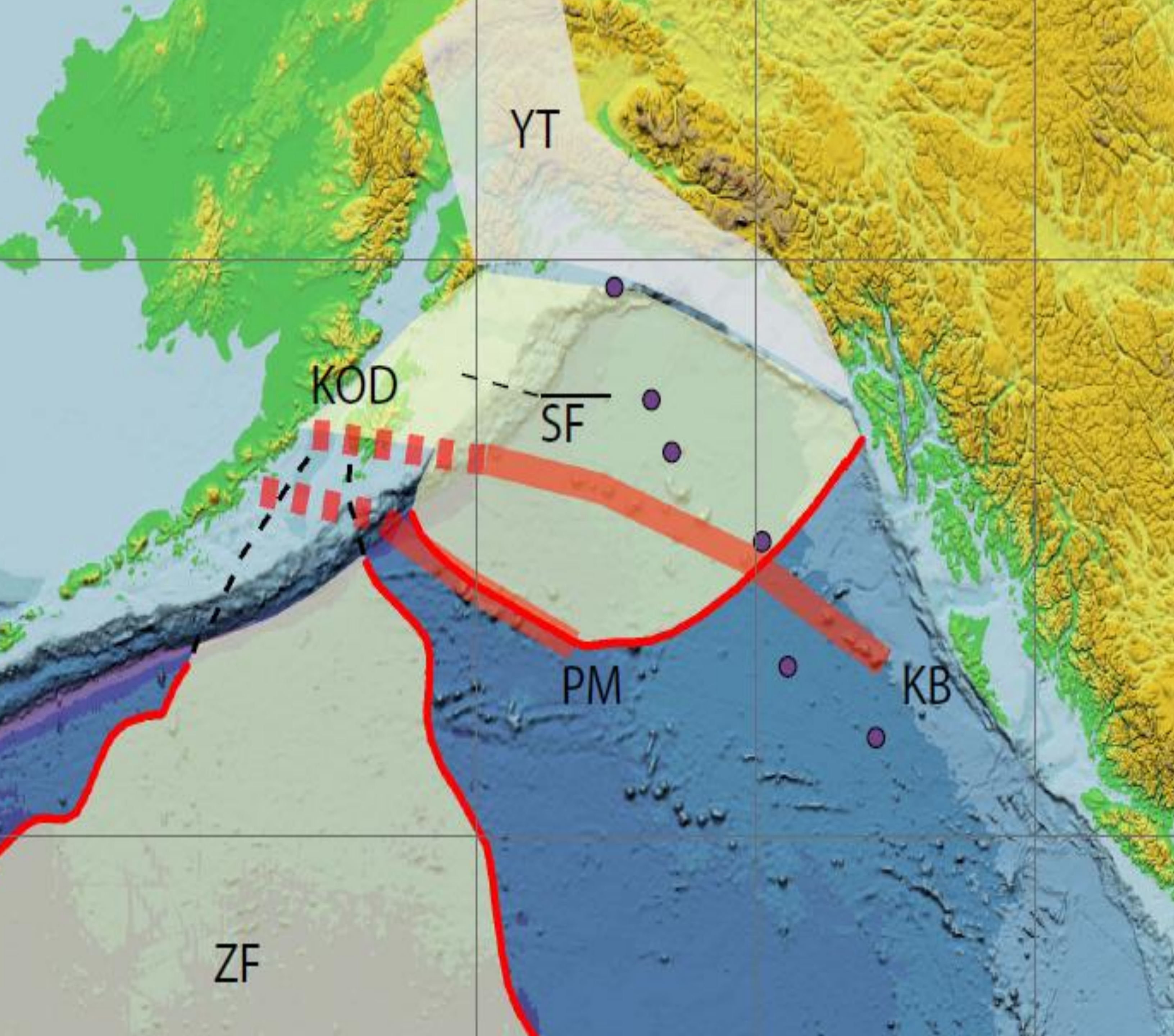
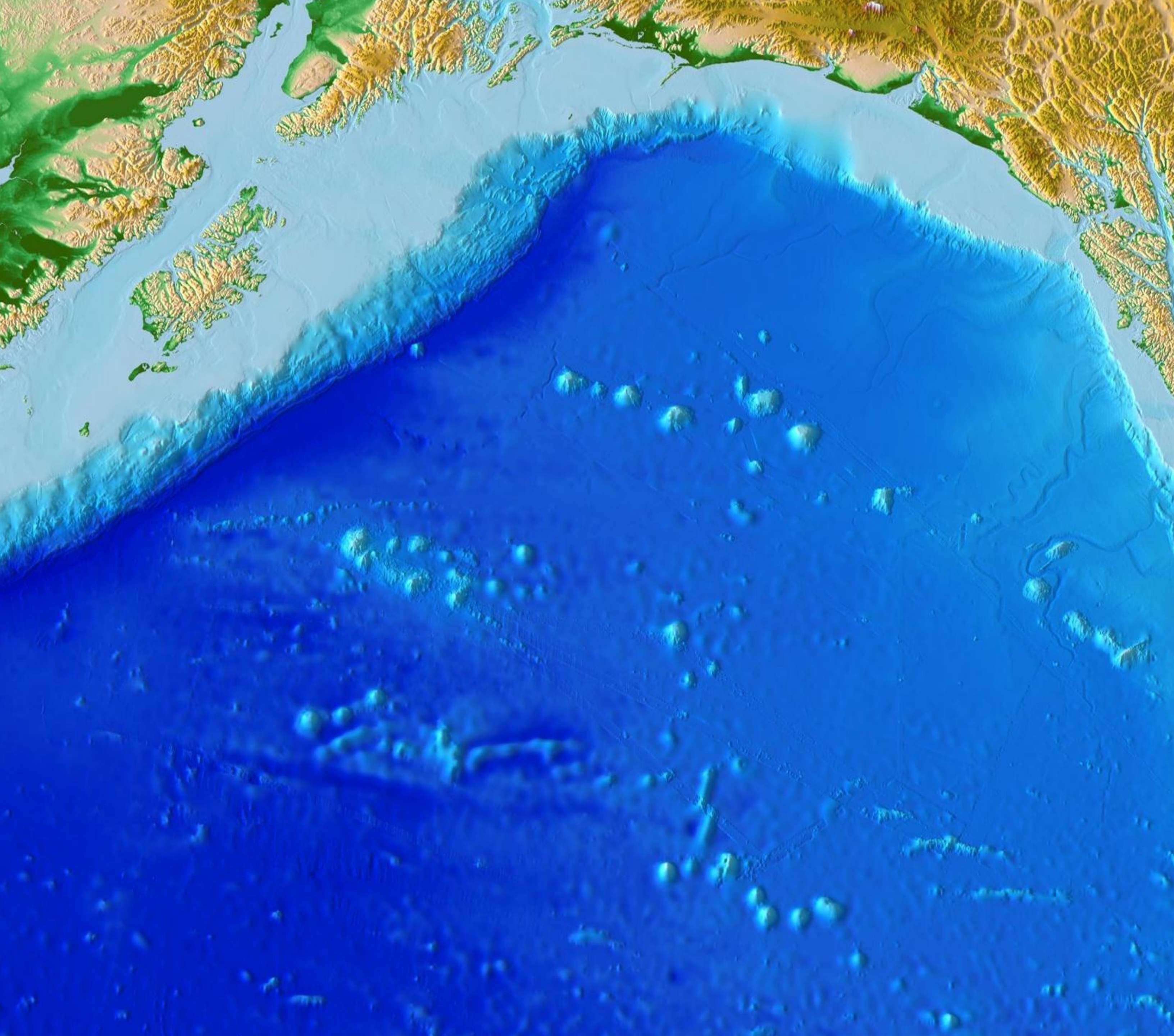
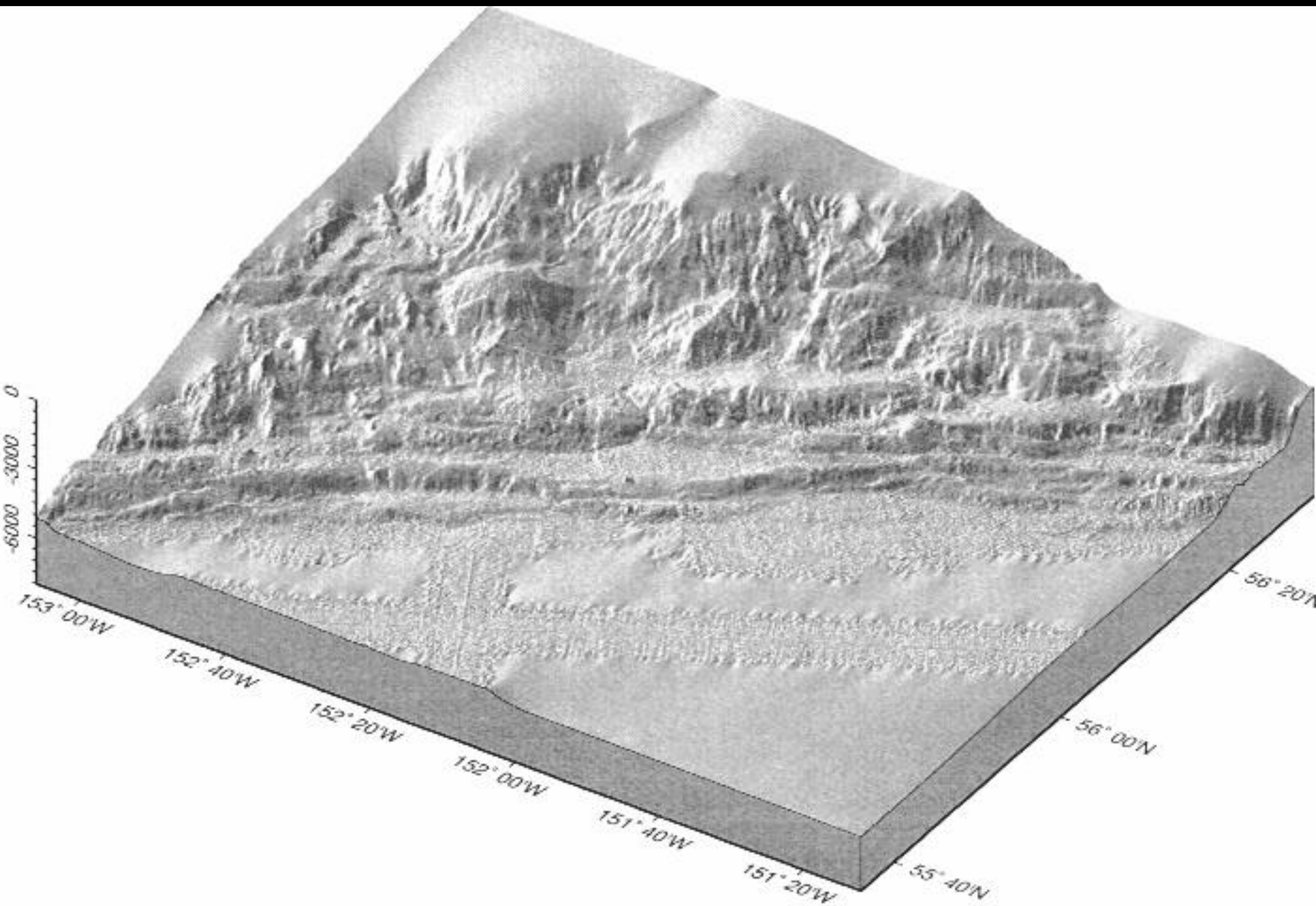


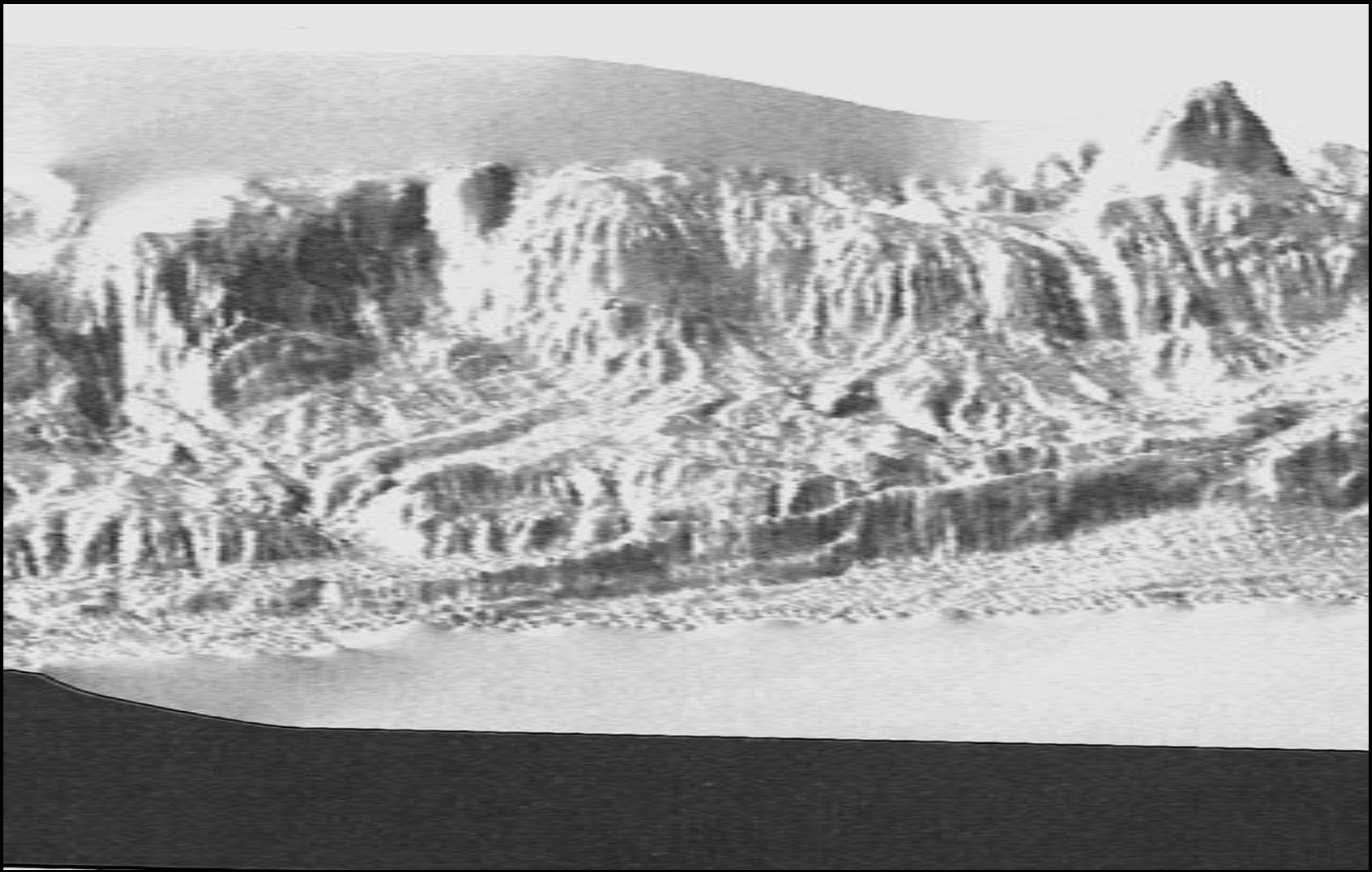
Figure 15. The 1964 seismic slip and geophysical characteristics map of the PWS subduction zone. Slip appears to occur outside of gravity anomalies and limited updip from the creeping zone. Creeping and locked zones estimated were from the inversion of GPS data [*Zweck et al.*, 2002]. The free-air gravity anomalies were derived from satellite data and calculated by *Song and Simons* [2003].

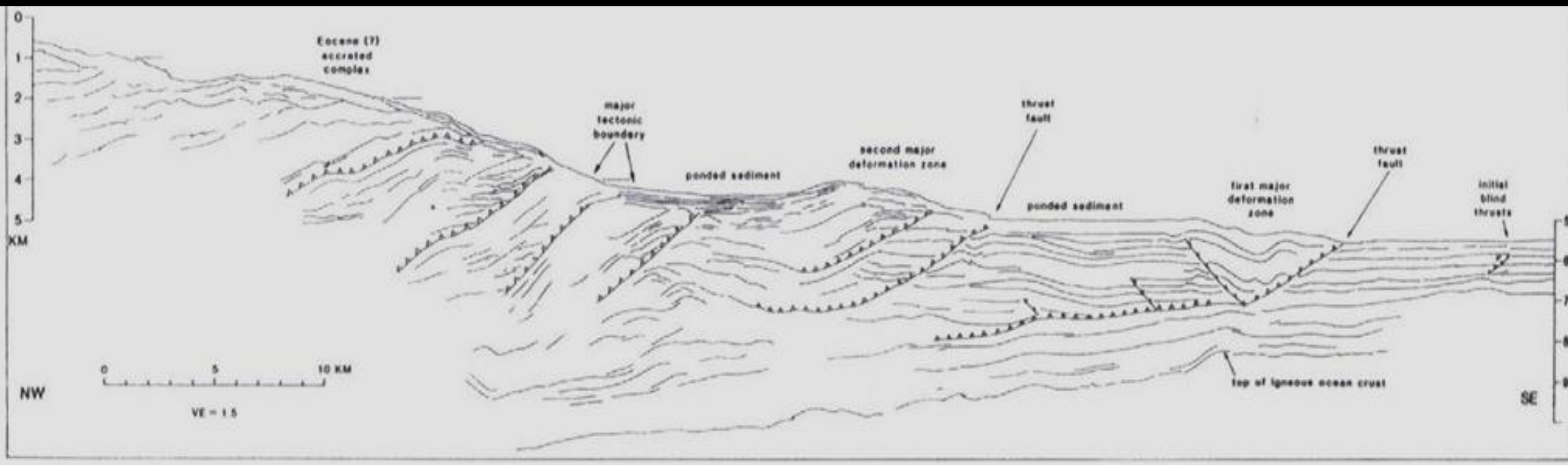


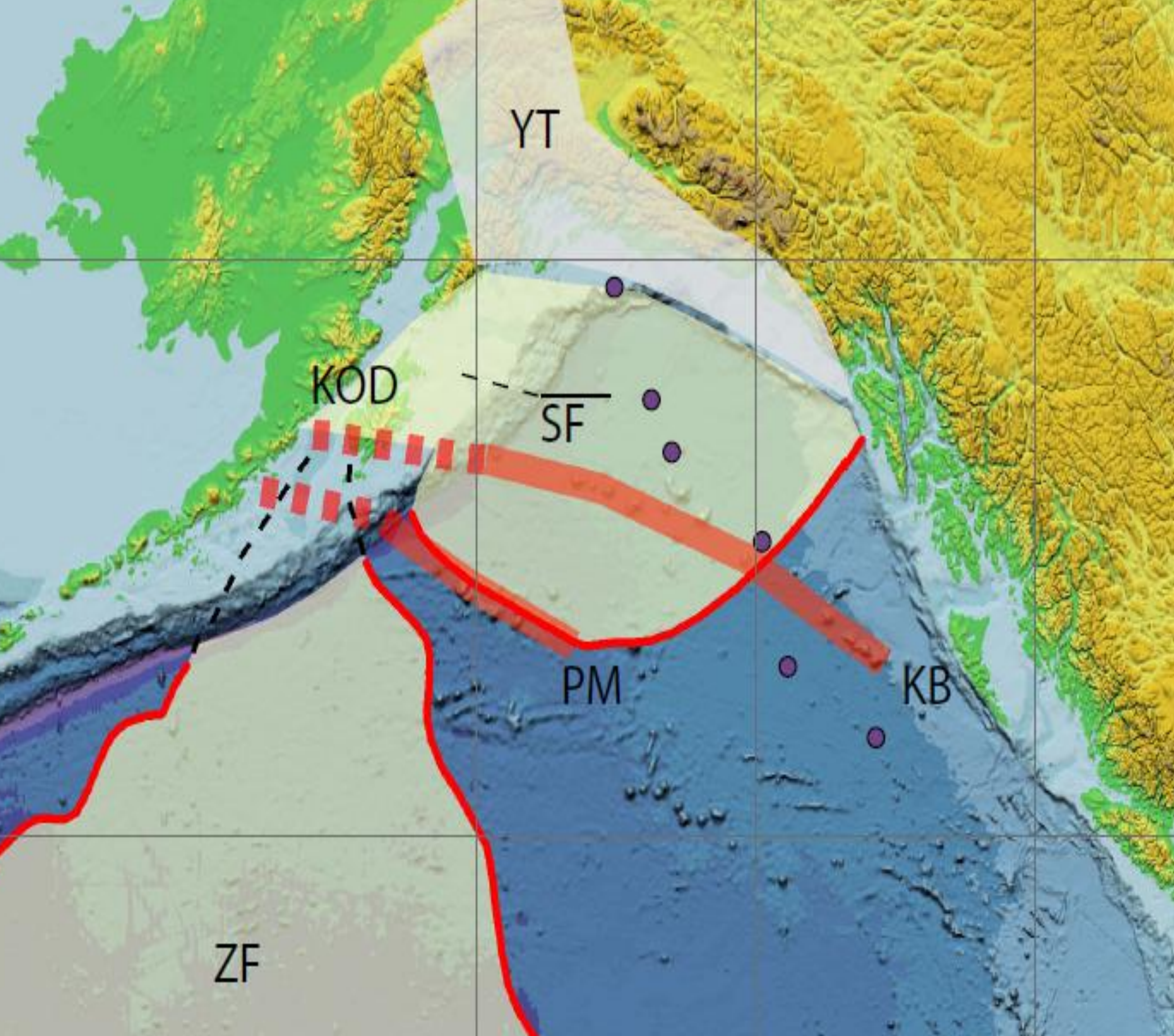
YT
KOD
SF
PM
KB
ZF

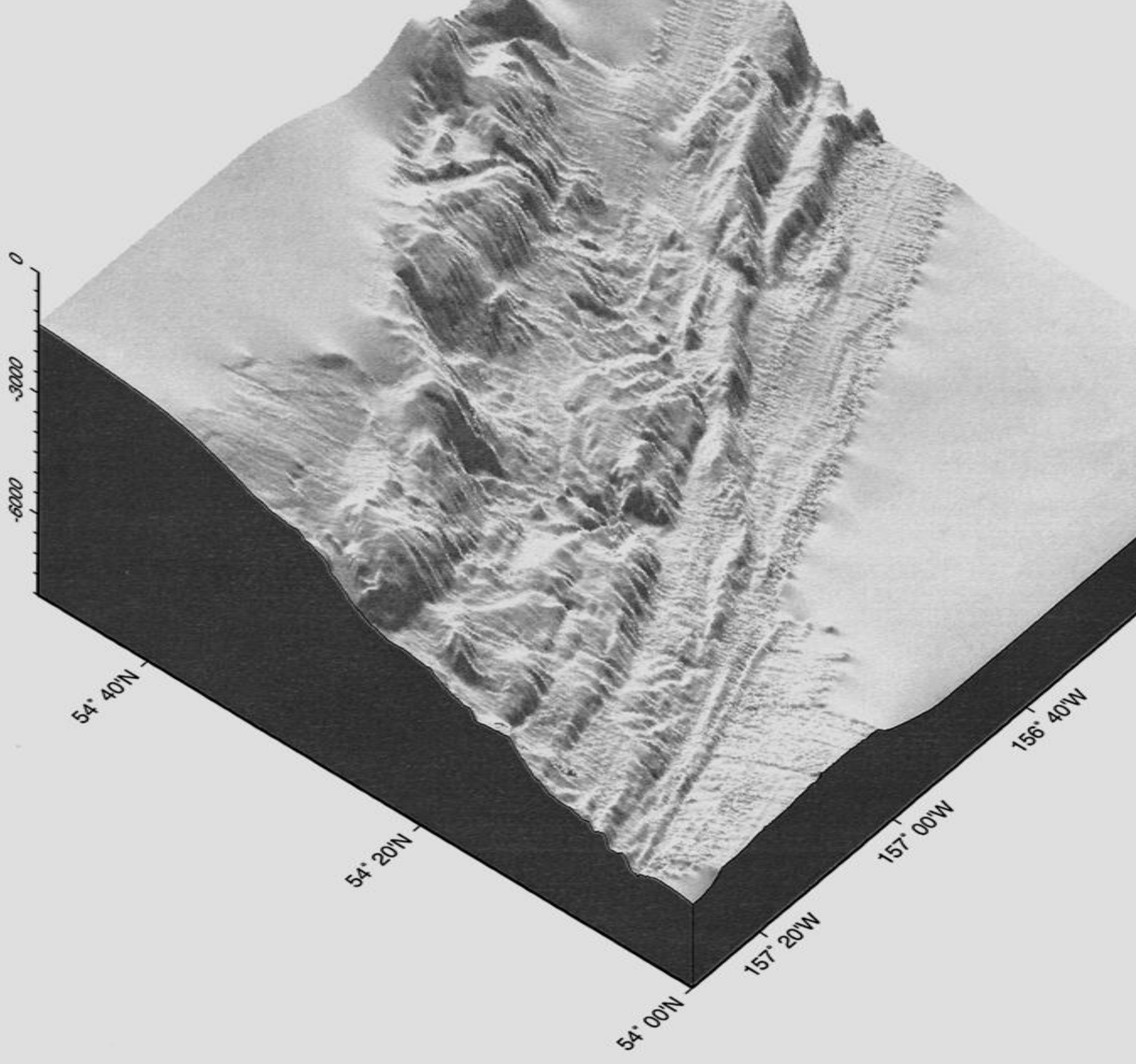



0
-3000
-6000
153° 00'W
152° 40'W
152° 20'W
152° 00'W
151° 40'W
151° 20'W
55° 40'N
56° 00'N
56° 20'N

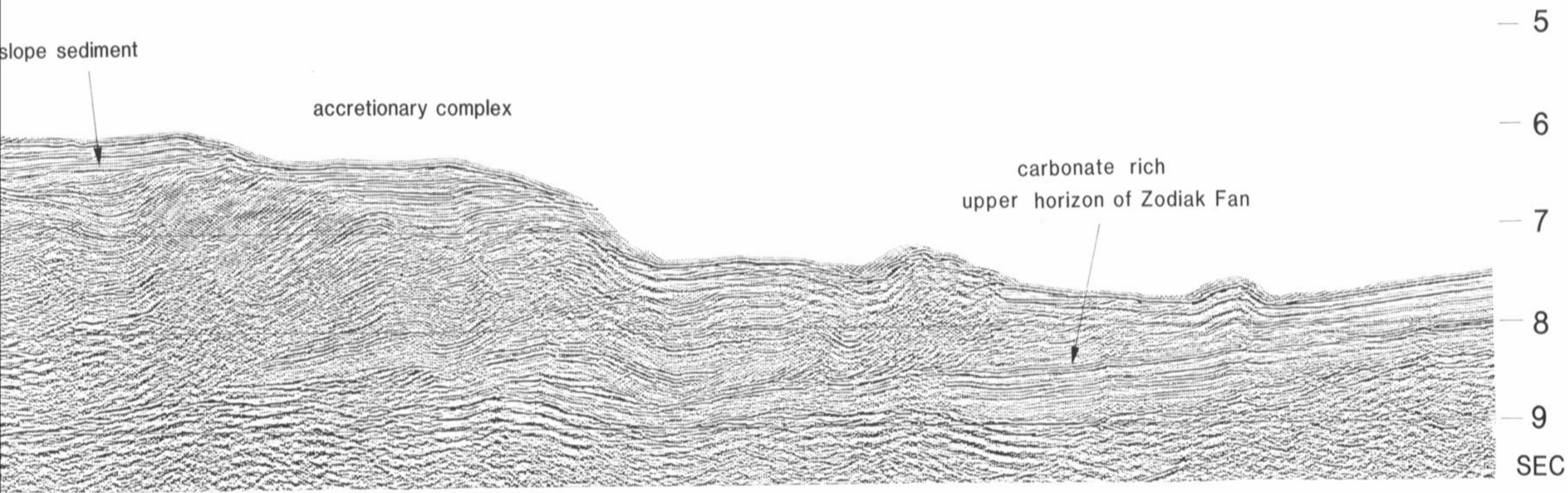


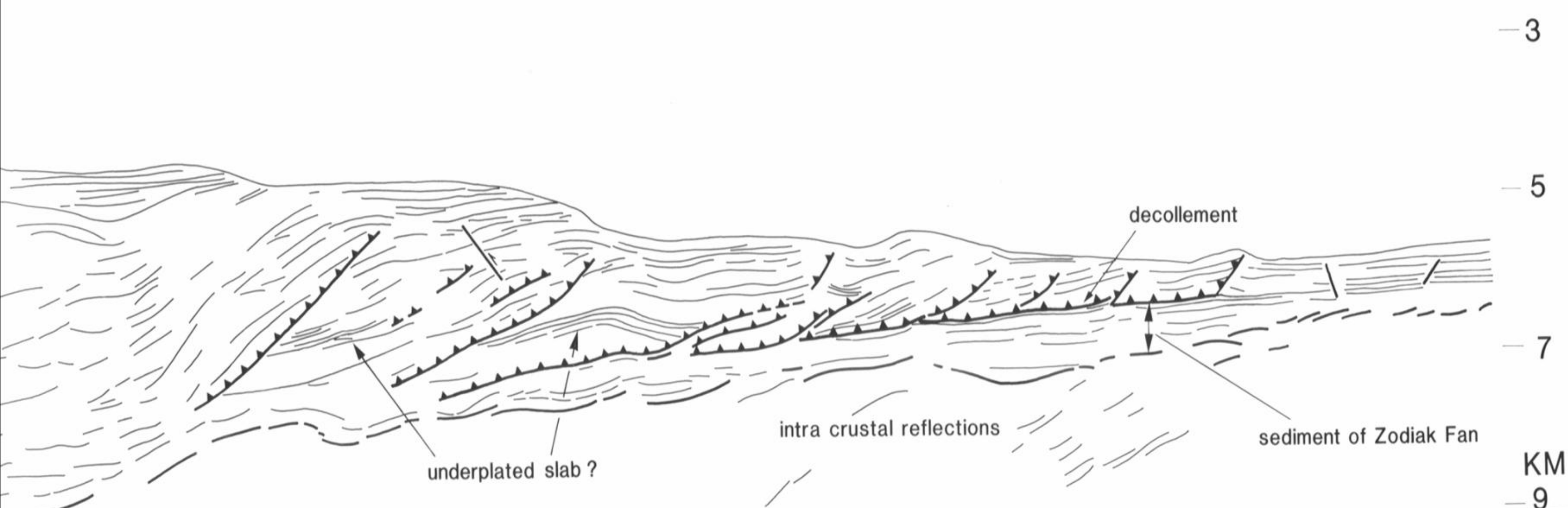

0
1
2
3
4
5
KM
Eocene (?) accreted complex
major tectonic boundary
ponded sediment
second major deformation zone
thrust fault
ponded sediment
first major deformation zone
thrust fault
initial blind thrusts
5
6
7
8
9
0
5
10 KM
NW
VE = 1.5
top of igneous ocean crust
SE


YT
KOD
SF
PM
KB
ZF



0
-3000
-6000
54° 40'N
54° 20'N
54° 00'N
157° 20'W
157° 00'W
156° 40'W


slope sediment
accretionary complex
carbonate rich
upper horizon of Zodiak Fan
5
6
7
8
9
SEC


3
5
decollement
7
intra crustal reflections
sediment of Zodiak Fan
underplated slab ?
KM
9

The Kodiak margin fault that ruptured in 1964 has subducted relief like the 2010 Chilean interplate fault rupture.

The 1938 earthquake rupture appears to have been constrained to Zodiak Fan. This may indicate a fault mechanics different from that on either side.

CONSIDERATIONS IN FUTURE HAZARDS STUDIES

The traditionally independent fields of fault geology/geophysics and seismology can be integrated better to understand earthquake rupture and interplate fault mechanics.

Modern Geophysical systems can now image subducted km scale lower plate relief to help assess seismic risk. Seismic data can yield physical properties across faults.

Lower plate relief can be a dominant asperity or barrier in the organization of great earthquake rupture. It indicates the spatial variability of plate interface friction.