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" Sixth Workshop on Non-Linear Dynamics and Earthquake Prediction"

15 - 27 October 2001

Neotectonics and Earthquake Generation along Complex Fault Systems

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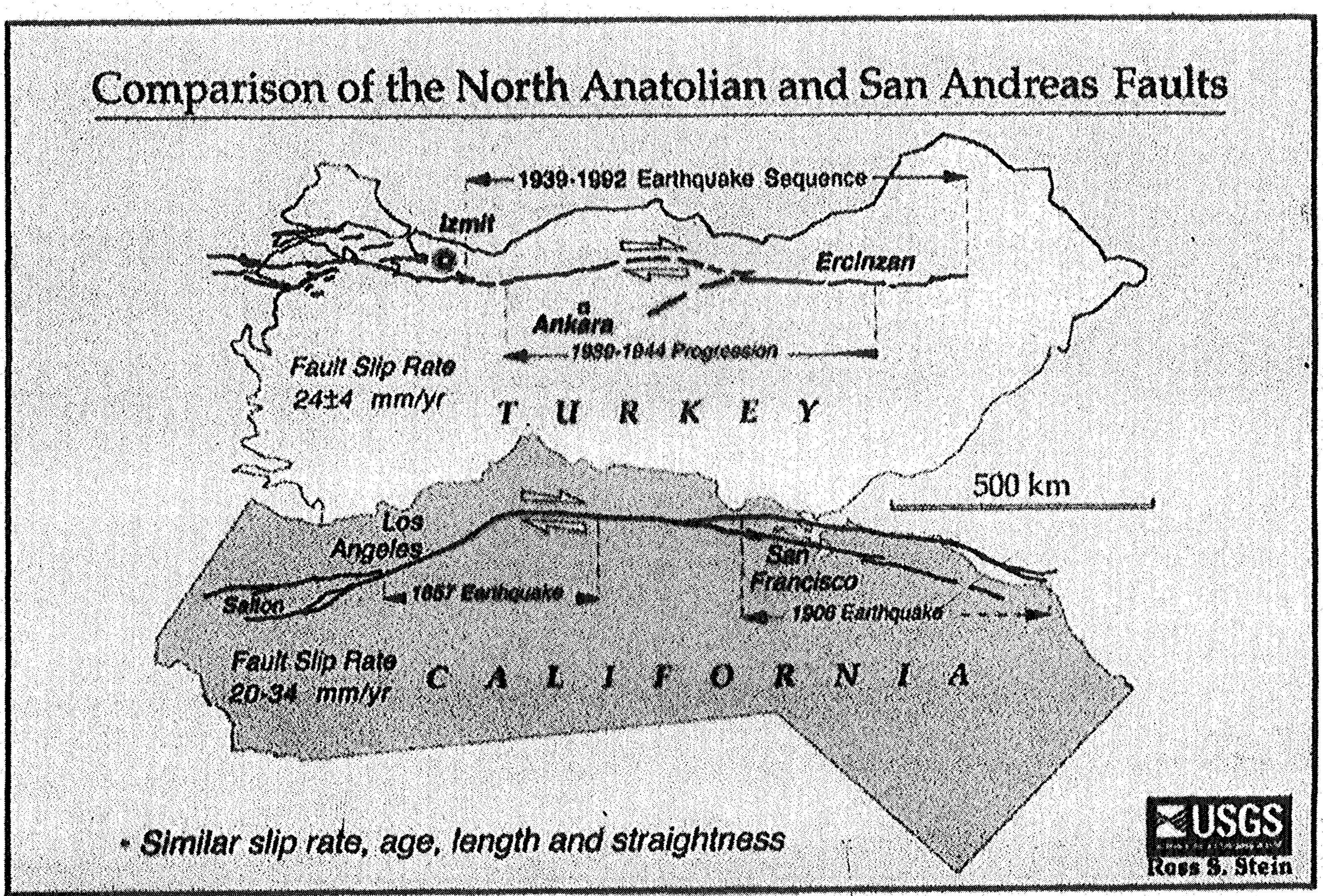
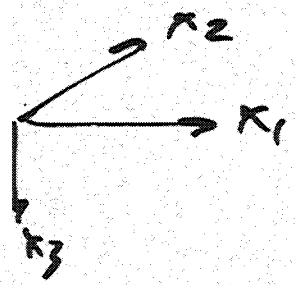

Comparison of the North Anatolian and San Andreas Faults
1939-1992 Earthquake Sequence
Izmit
Erclnzan
Ankara
1939-1944 Progression
Fault Slip Rate
24±4 mm/yr
T U R K E Y
500 km
Los Angeles
San Francisco
1857 Earthquake
1906 Earthquake
Salton
Fault Slip Rate
20-34 mm/yr
C A L I F O R N I A
• Similar slip rate, age, length and straightness
USGS
Ross S. Stein


x2
x1
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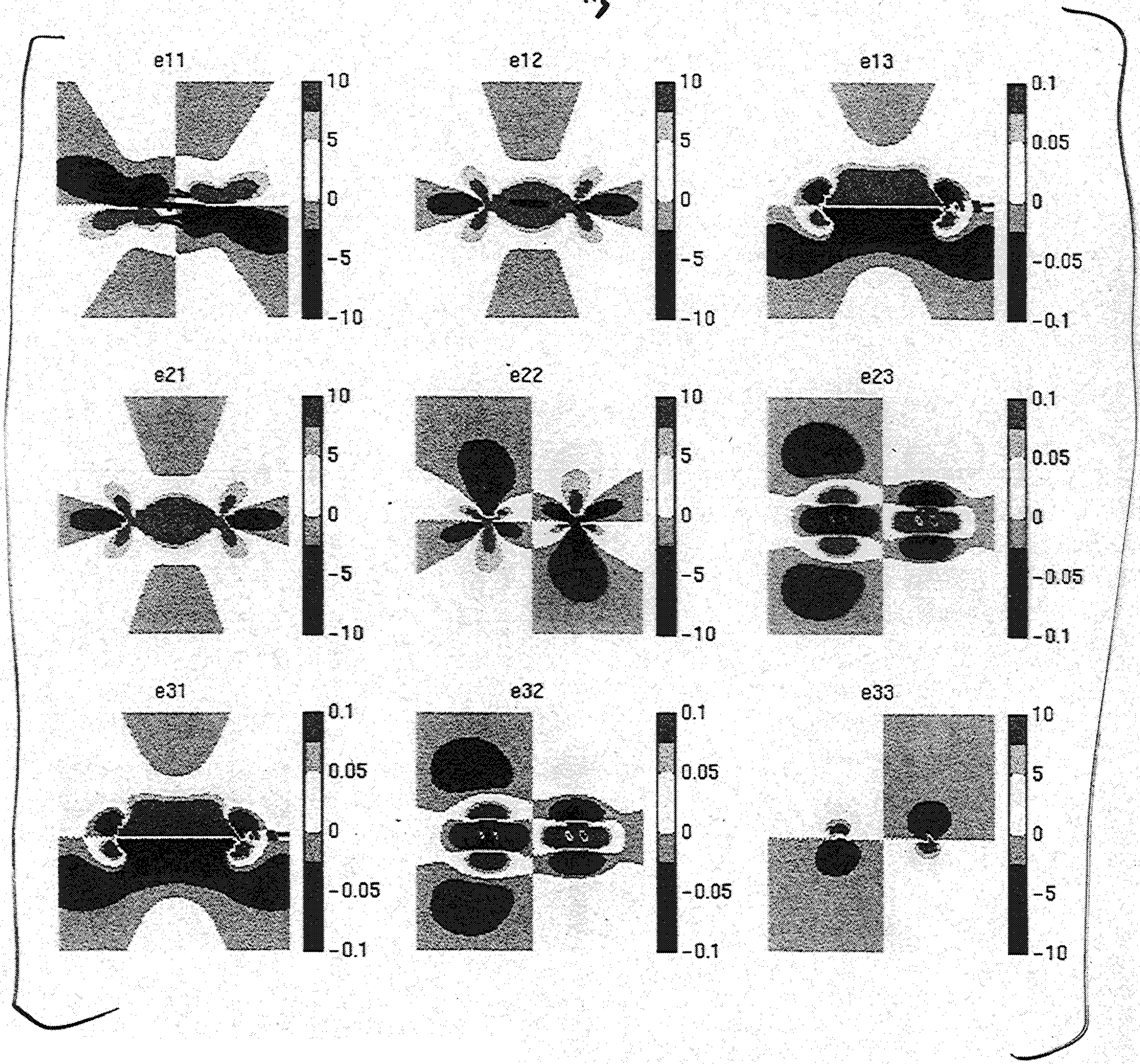
e11
10
5
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e12
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e13
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-0.1
e21
10
5
0
-5
-10
e22
10
5
0
-5
-10
e23
0.1
0.05
0
-0.05
-0.1
e31
0.1
0.05
0
-0.05
-0.1
e32
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0.05
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-0.05
-0.1
e33
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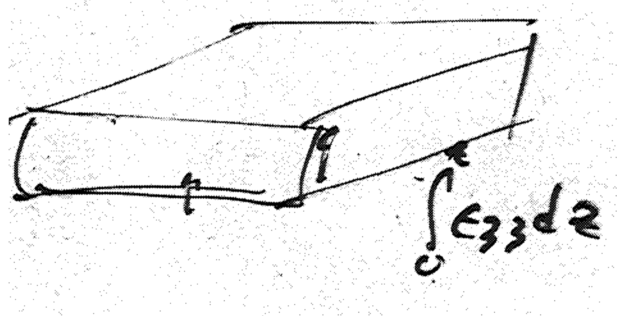
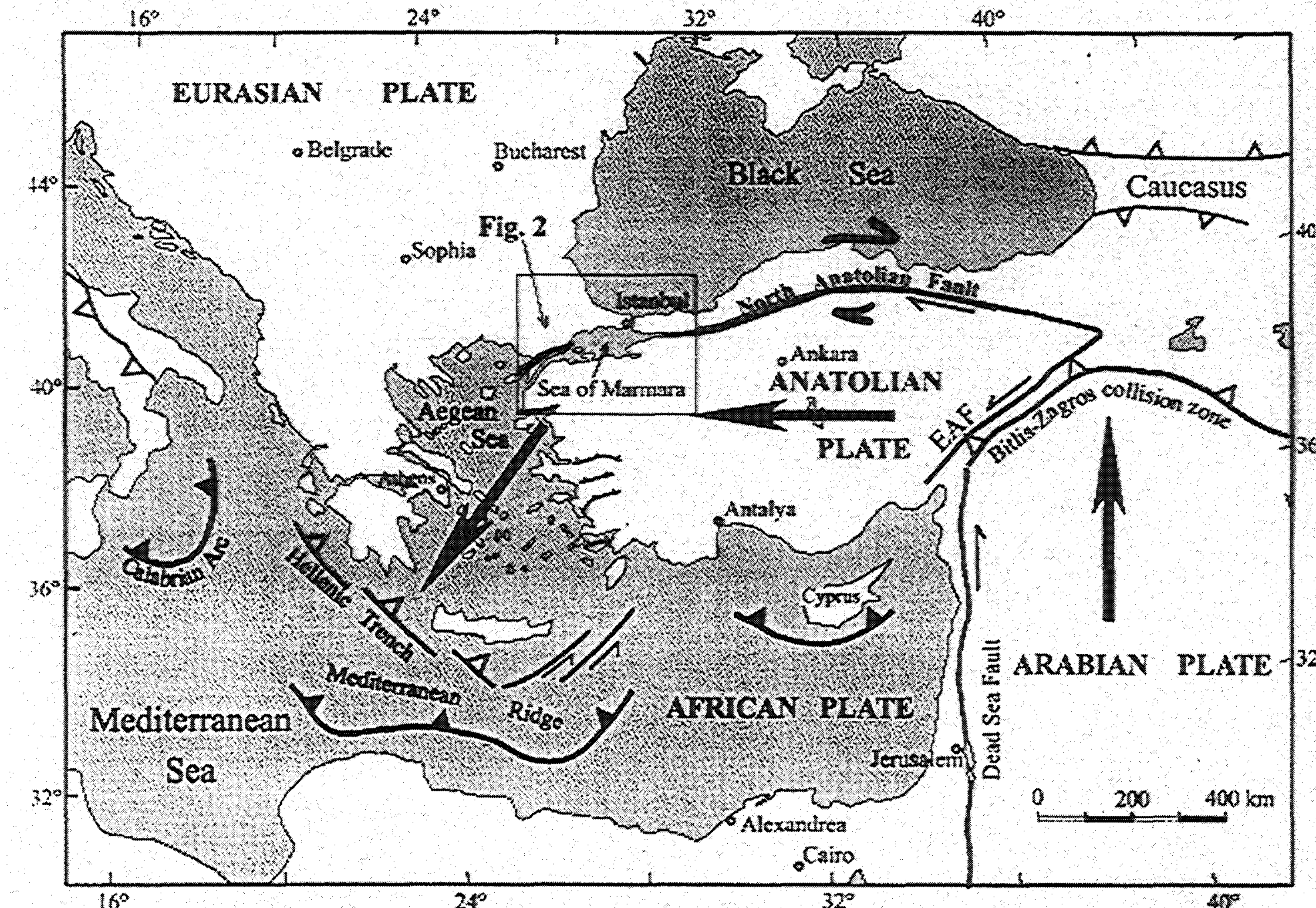
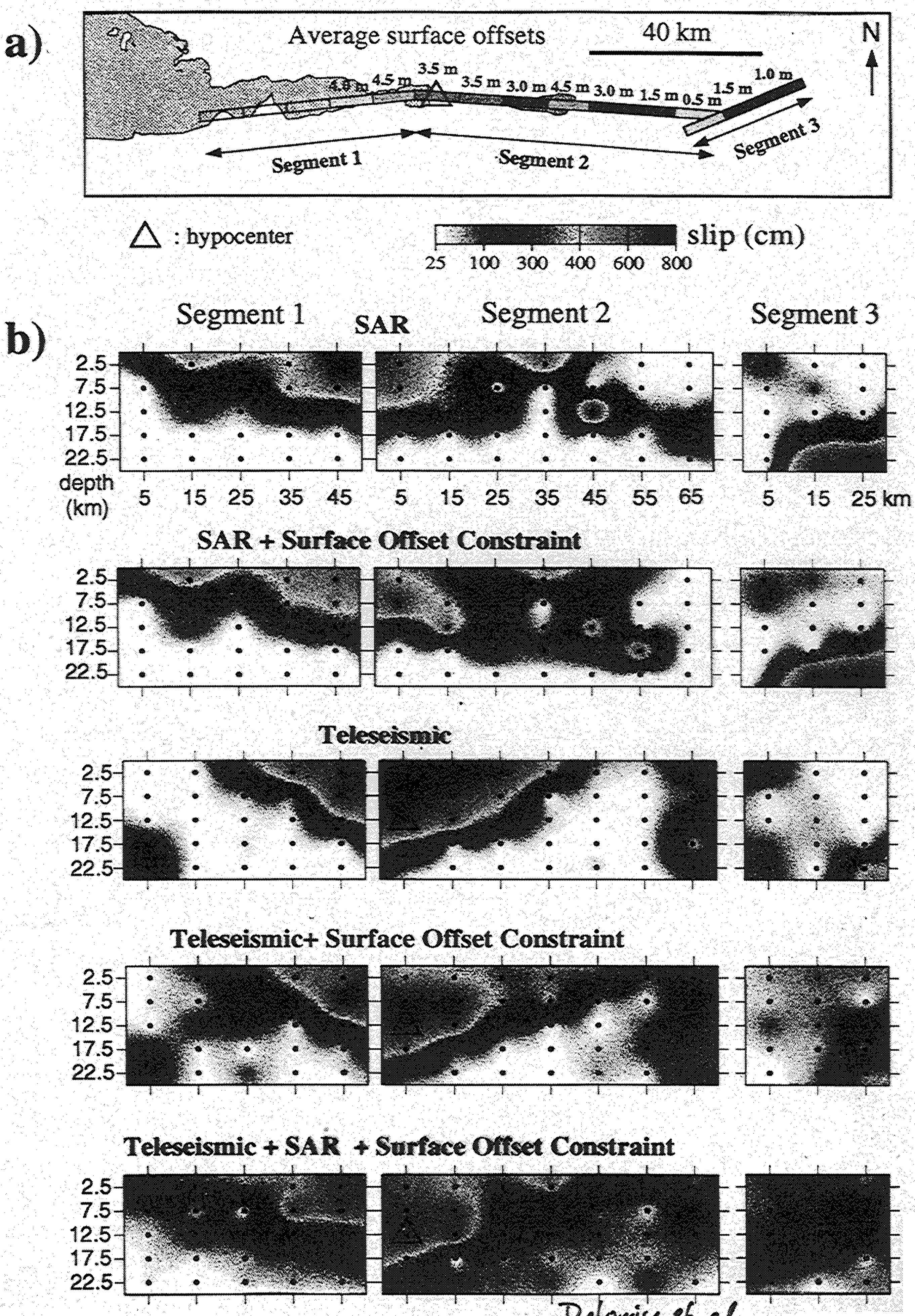
-5
-10


t
$\int_0^t \epsilon_{33} dz$



16°
24°
32°
40°
EURASIAN PLATE
Belgrade
Bucharest
Black Sea
Caucasus
44°
Fig. 2
Sophia
Istanbul
North Anatolian Fault
Ankara
ANATOLIAN
PLATE
Sea of Marmara
40°
Aegean
Sea
EAF
Bitlis-Zagros collision zone
36
Athens
Antalya
Calabrian Arc
Hellenic Trench
36°
Cyprus
Mediterranean
Ridge
ARABIAN PLATE
32
AFRICAN PLATE
Mediterranean
Sea
Dead Sea Fault
Jerusalem
0
200
400 km
32°
Alexandrea
Cairo

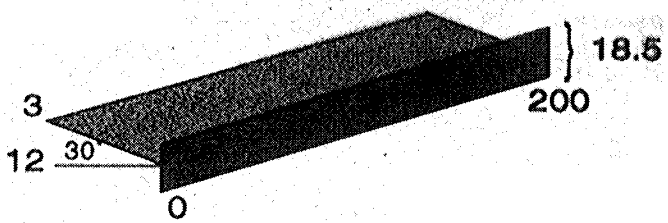
Okay. 90

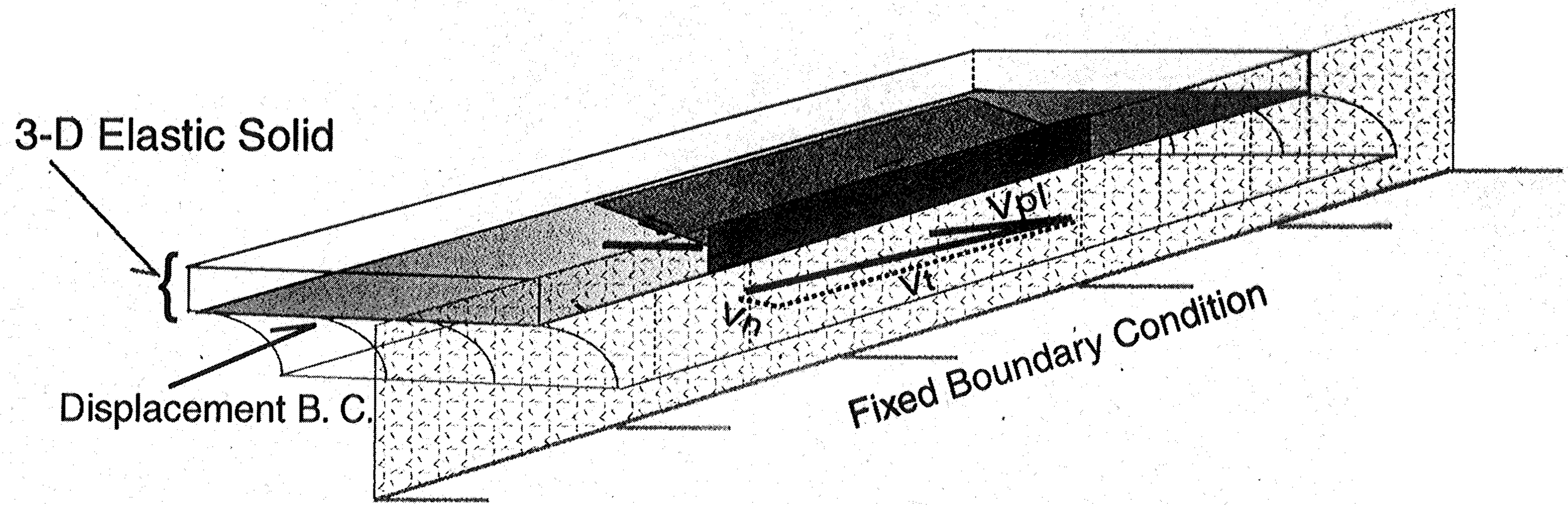


Delouis et. al (99)

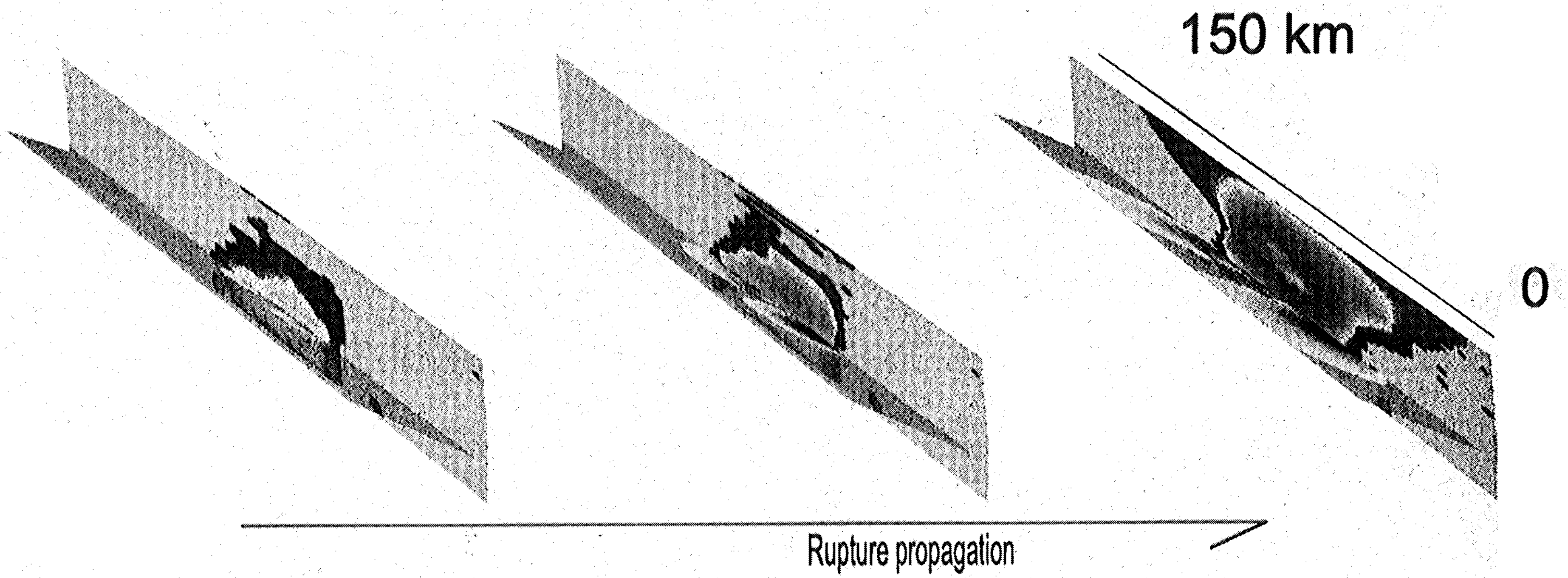
BIG BEND, Ca. USA

Coupled blind-thrust, strike-slip fault system model



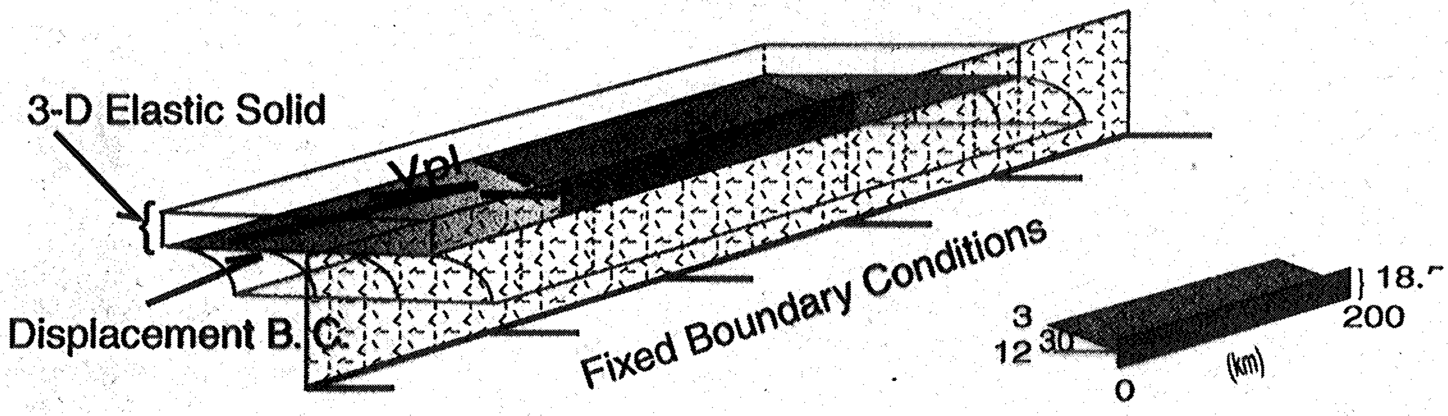


Poroelastic Effect on the Thrust Fault due to Slip on the Strike-Slip Fault.

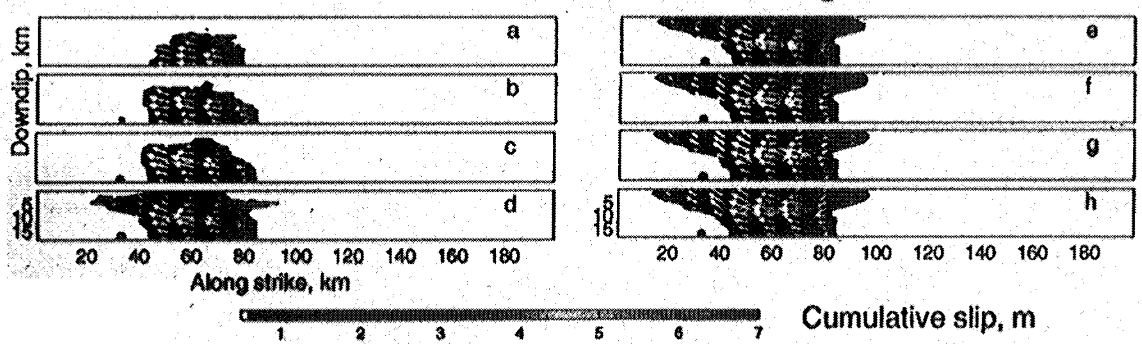


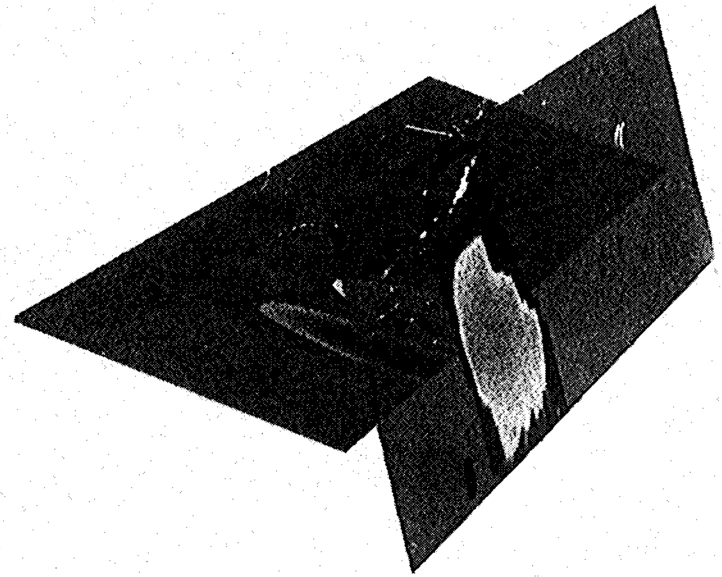
7

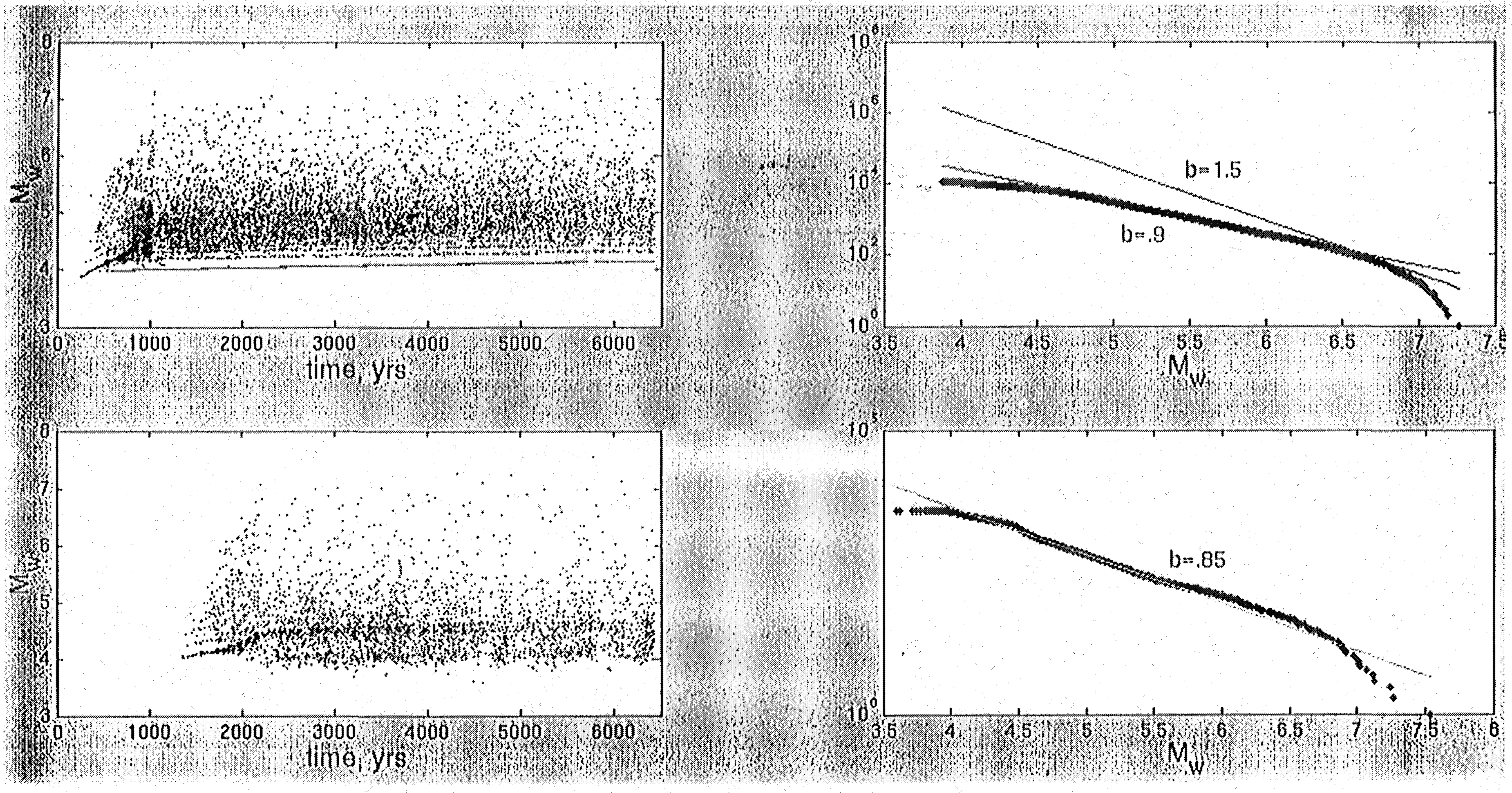
Coupled blind-thrust, strike-slip fault system



Rupture Propagation on the Strike-Slip Fault (t=970 years): Cumulative slip and rake angle







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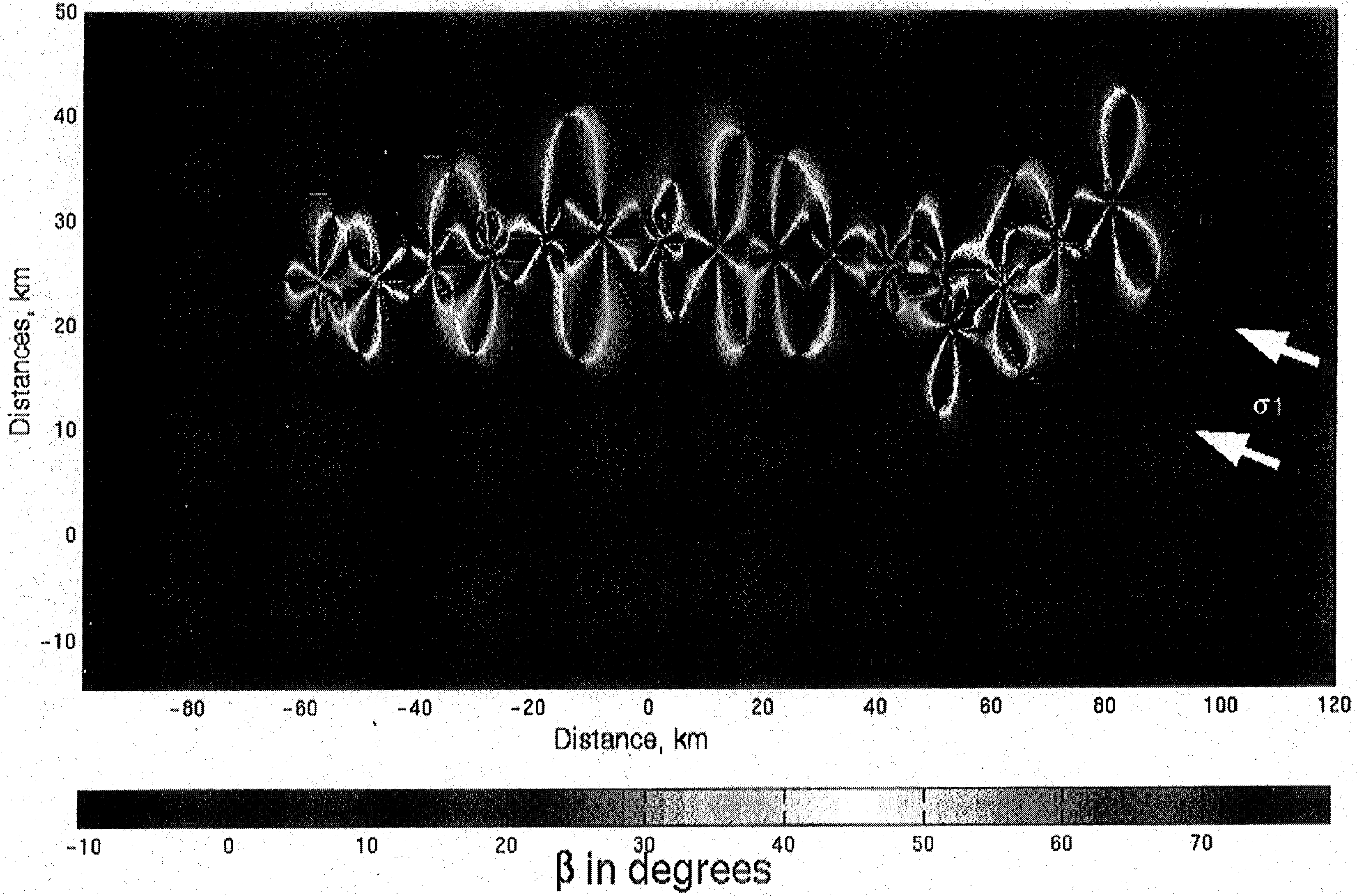
Optimal orientation for slip (in degrees) after the Izmit earthquake, μ'=0.4, z=−12km



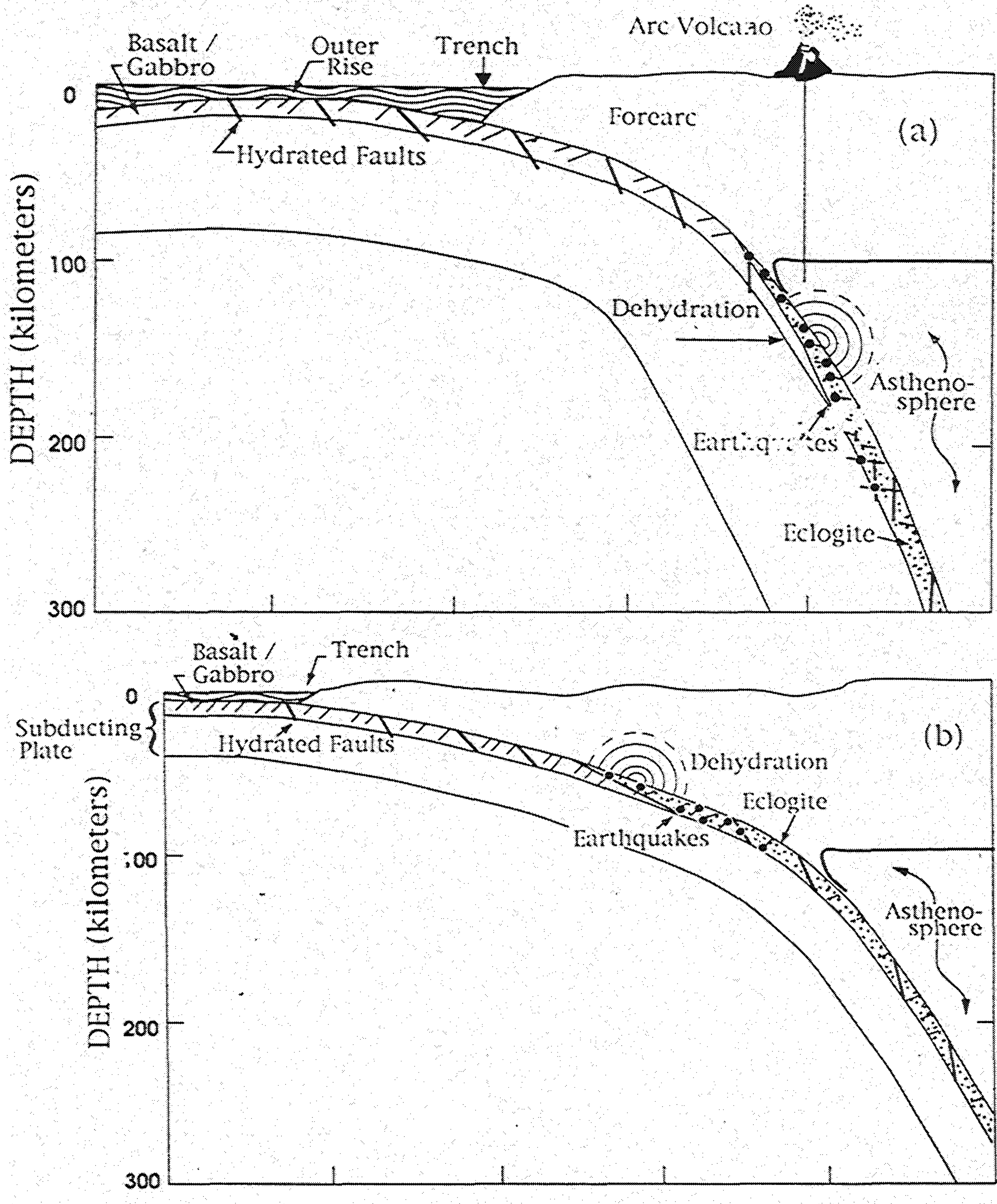
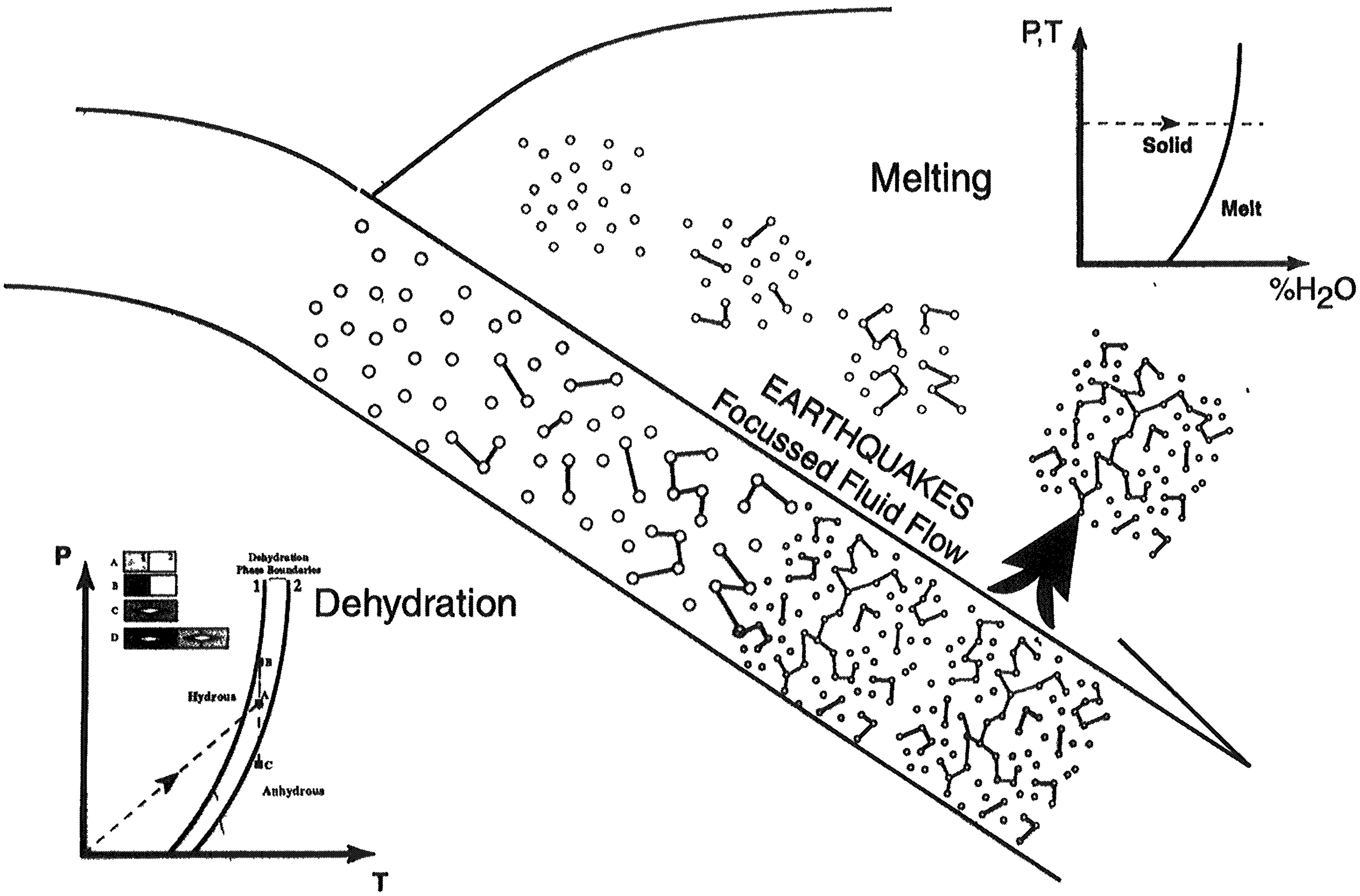
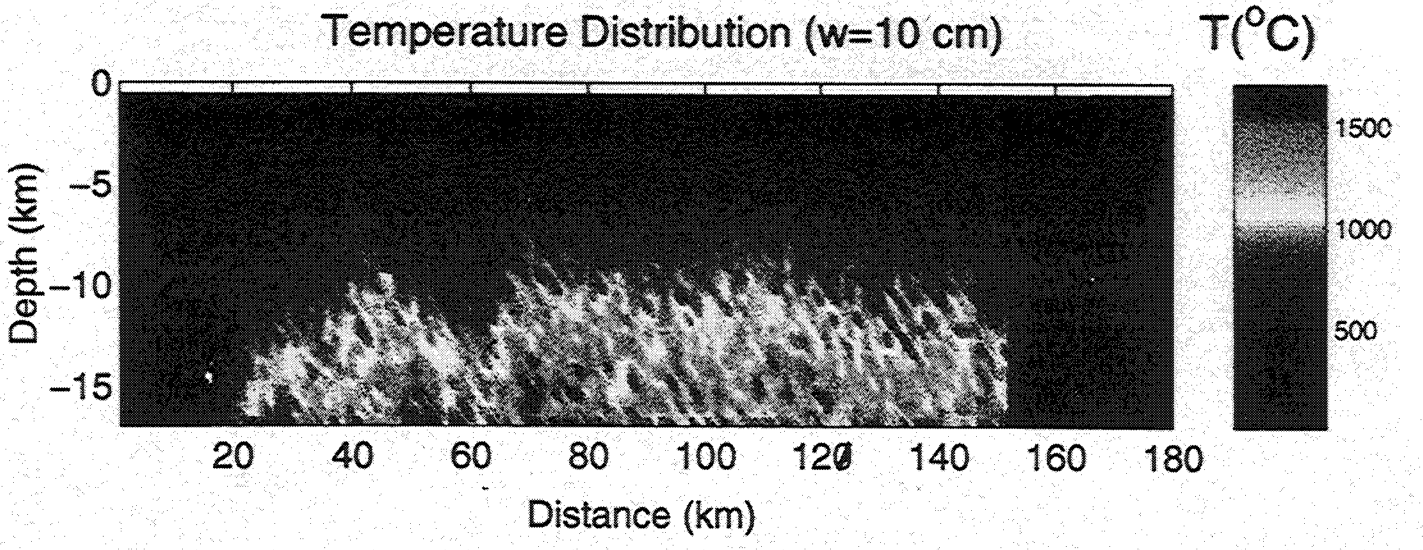
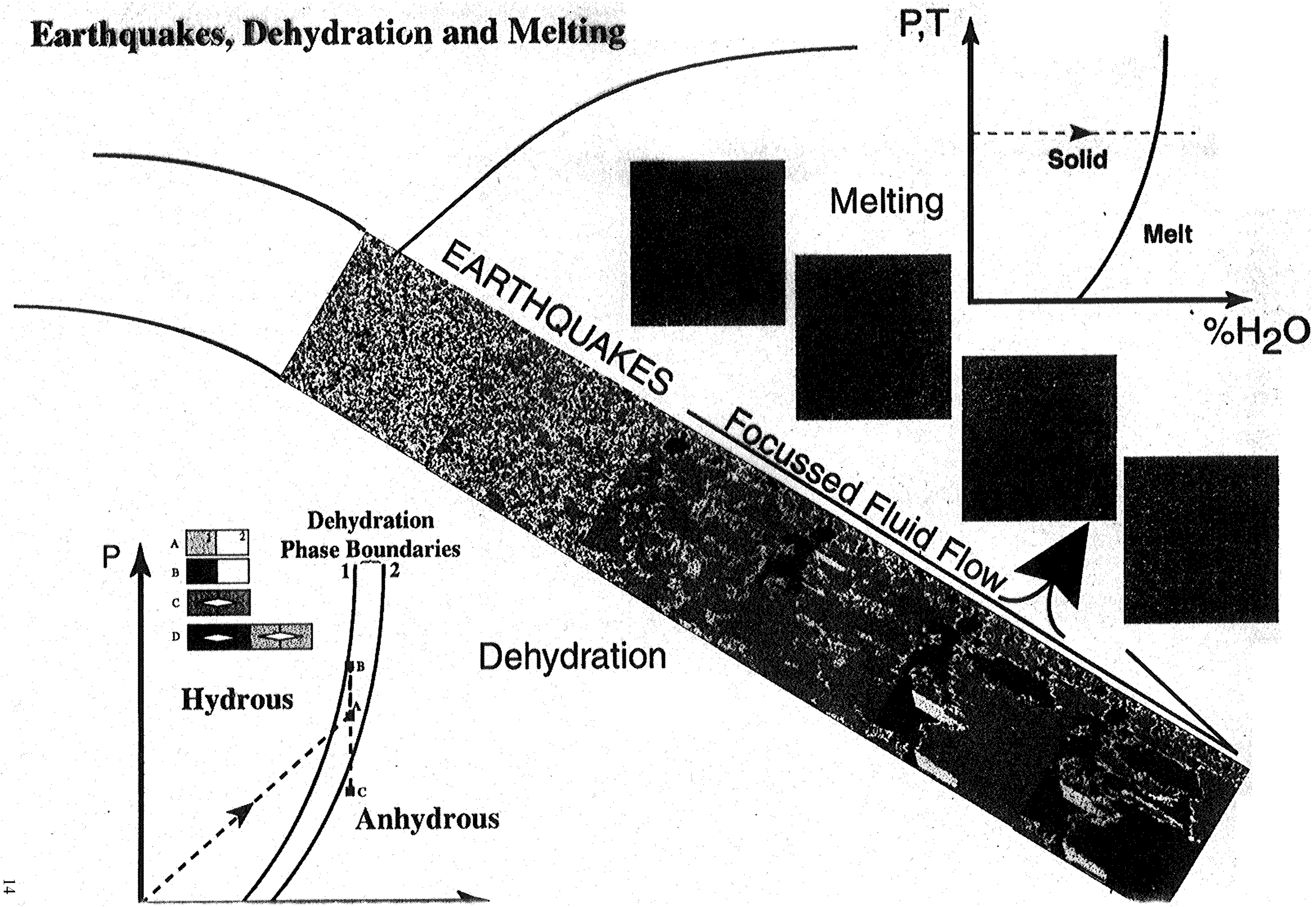


Fig. 1. Schematic diagrams of slab metamorphism associated earthquakes and arc magmatism (a) Thermally-mature slabs [after *Kirby*, 1995]. Oceanic lithosphere layered in mineralogy and flawed principally by hydrated normal faults descends to the depths near the roots of arc volcanoes where it dehydrates and densifies to ecolgite, becomes prone to reactivation of fossil faults by dehydration embrittlement and produces earthquakes. Slab dehydration also fluxes melting in the asthenospheric mantle wedge, producing arc magmas. (b) Young and/or slowly sinking slabs that are warm sustain similar processes as in (a) but largely at shallow depths beneath the forearc, a condition causing shallow intraslab earthquakes and feeble or absent arc volcanism.


P,T
Solid
Melt
%H2O
Melting
EARTHQUAKES
Focussed Fluid Flow
Dehydration
P
T
Dehydration
Phase Boundaries
1
2
A
B
C
D
Hydrous
Anhydrous


Temperature Distribution (w=10 cm)
T(°C)
0
−5
−10
−15
Depth (km)
20
40
60
80
100
120
140
160
180
Distance (km)
1500
1000
500


Earthquakes, Dehydration and Melting
P,T
Solid
Melting
Melt
%H2O
EARTHQUAKES
Focussed Fluid Flow
Dehydration
Dehydration
Phase Boundaries
1
2
A
B
C
D
P
Hydrous
Anhydrous

Conclusions and Future Directions

- Fluid pressure controls fault strength
- Can determine λ by measuring M_o, L and W for large earthquakes
- Quantify frictional heating→Dehydration→Melt
- Numerous new directions for research

1. General Faulting Model
2. Quantify fluid sources (How much? where did it come from? where did it go?)
3. Frictional heating and dehydration/melt
4. Damage (increased permeability)
5. Global maps of fault strength
6. Earthquake source physics
7. etc. etc.

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