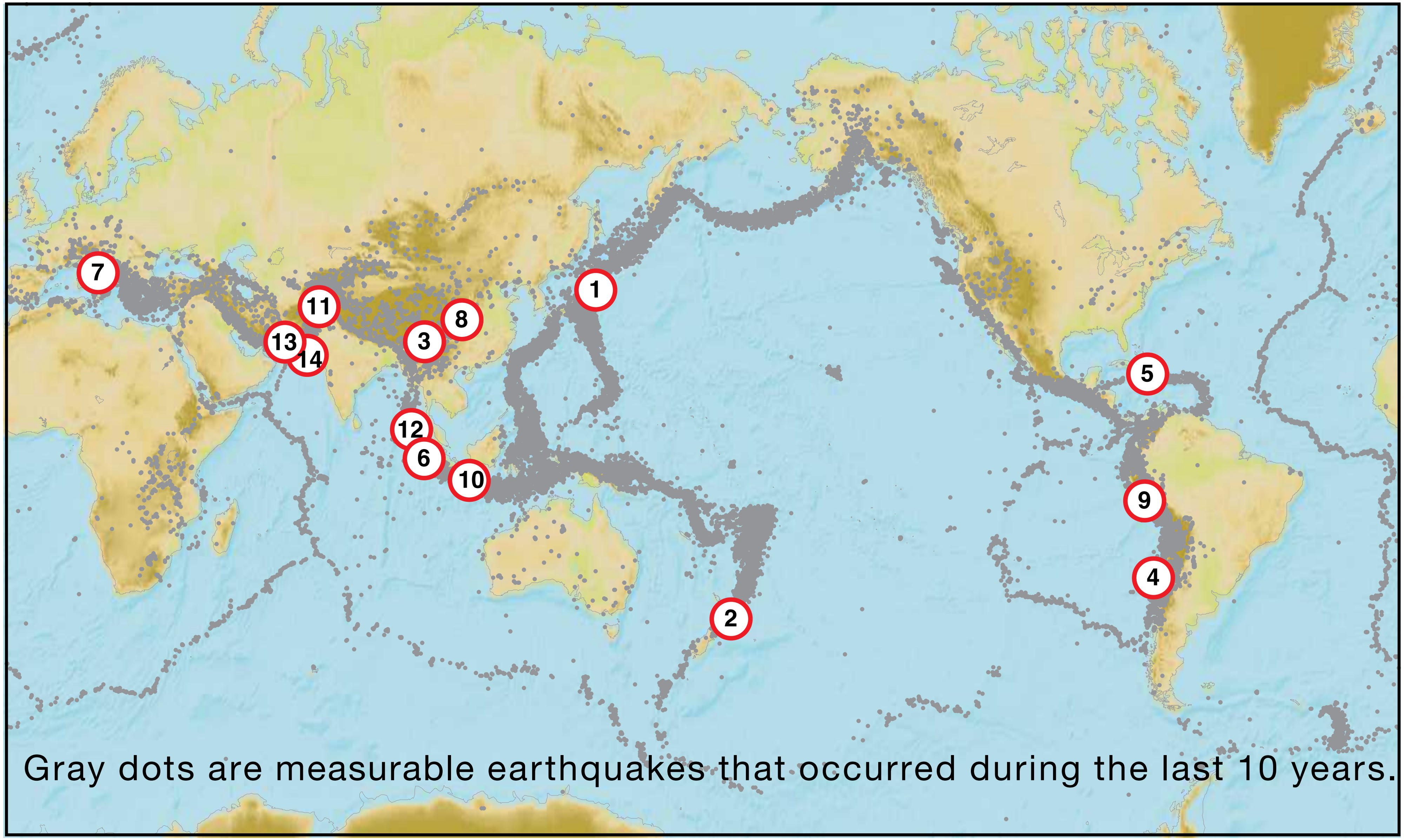
Tatort
Plattengrenze
Fokus Erdbeben (6)

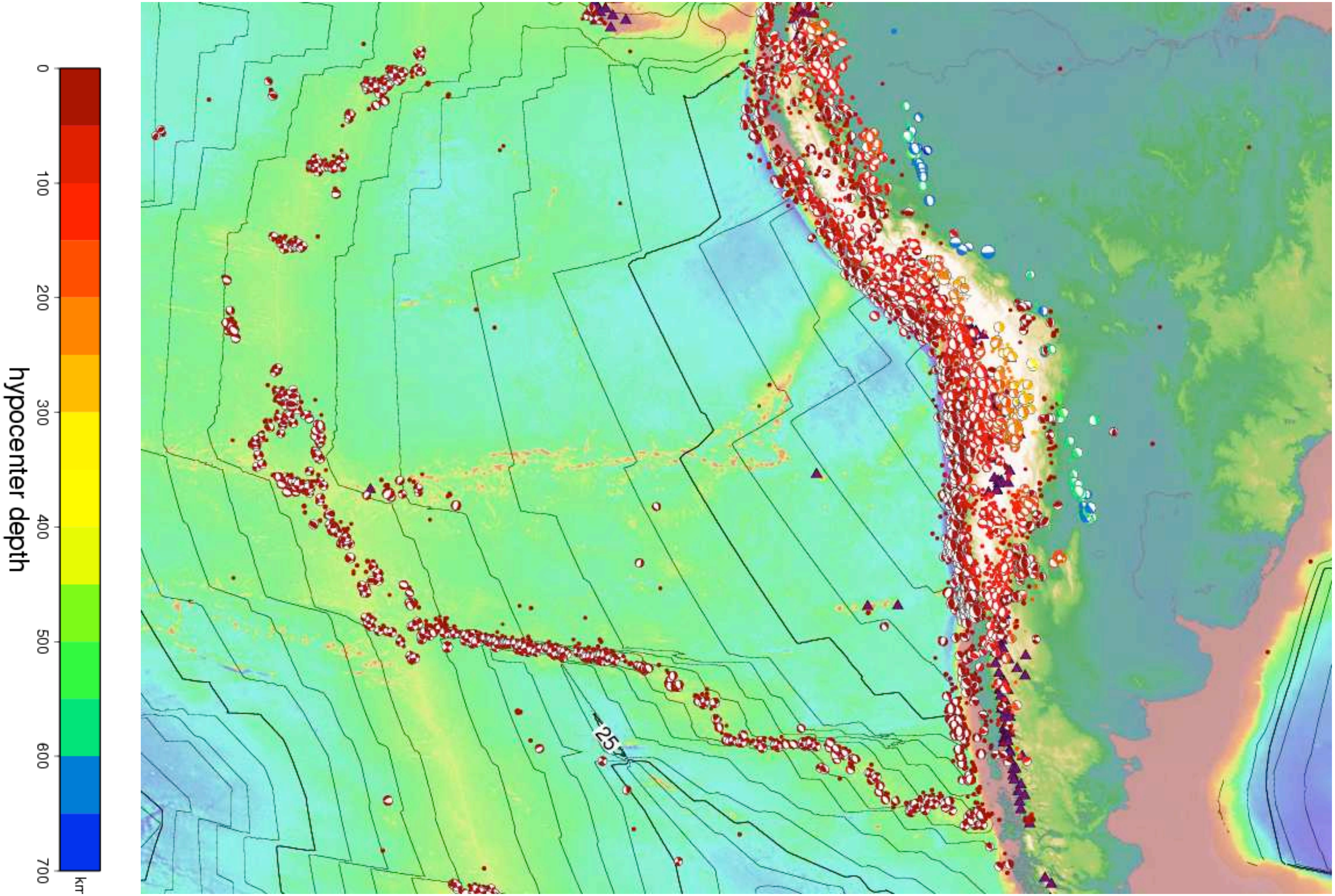
10 grösste Erdbeben 2001-2011



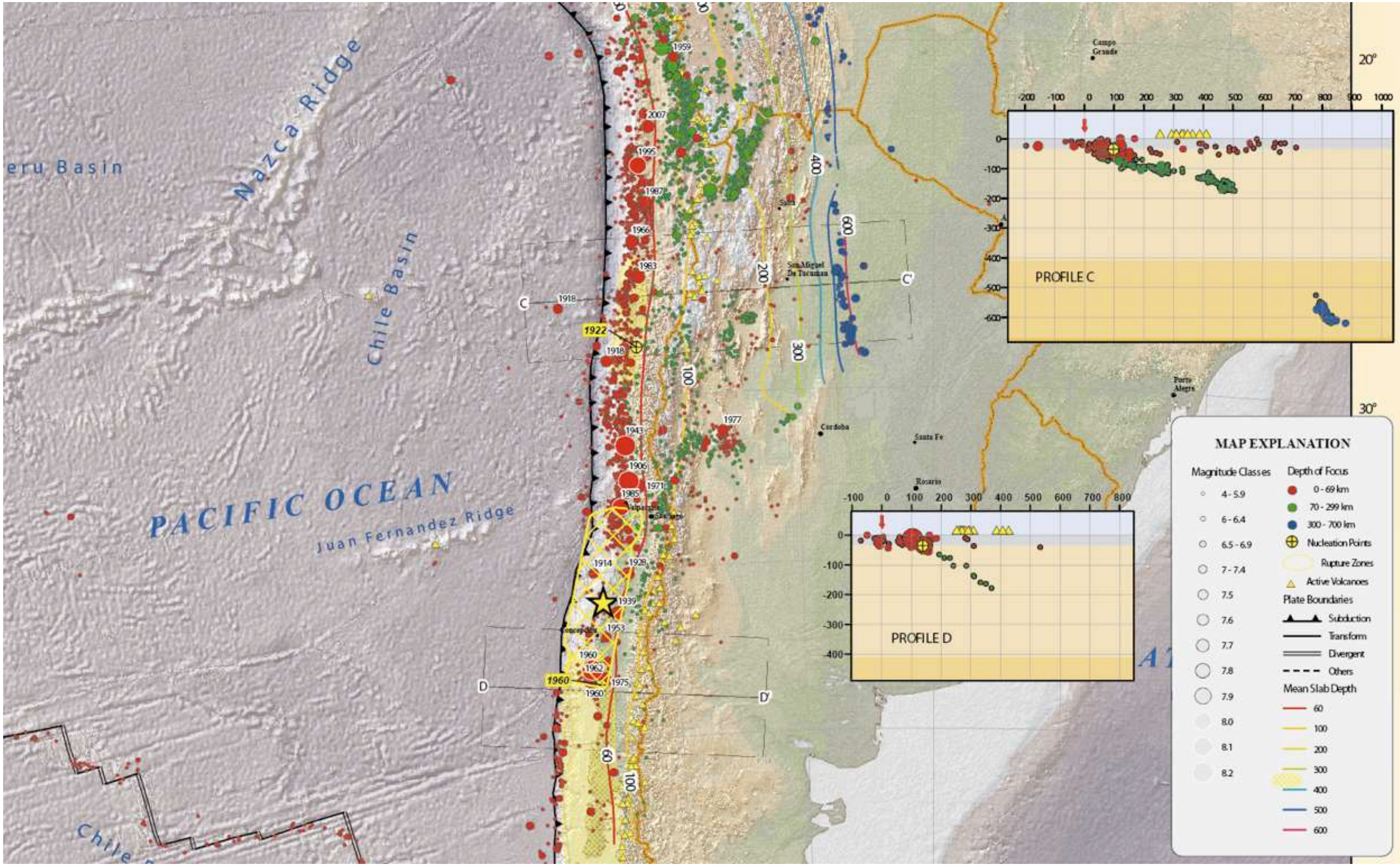
#	Event, by date	Magnitude	Notable Effects	Destruction
1	Japan March, 2011	9.0	Land dropped; tsunami wave heights up to 24 meters traveled up to 10 km inland devastating coastal communities. This was a triple disaster due to earthquake, tsunami, & radiation leaks from earthquake-damaged nuclear power plants.	>10,000 killed; 17,000 reported missing; 125,000 buildings damaged; > 500,000 homeless
2	Christchurch, New Zealand February, 2011	6.3	Extensive ground shaking by the shallow earthquake in area of high population density. Liquefacton caused upwelling of >200,000 tonnes of silt.	>180 killed; 80% of water & sewer system damaged
3	Yushu, China April, 2010	6.9	At least 11 schoools destroyed in this sparsely populated region on the Tibetan Plateau. 12th century monastery and villages were severely damaged.	2,698 killed; 12,000 injured 85% of buildings (11 schools) destroyed
4	Offshore Maule, Chile February, 2010	8.8	Shaking lasted 3 minutes and was felt in Peru, 2400 km away. Damage in Santiago. The earthquake generated a tsunami that devastated coastal communities.	521 killed 370,000 homes damaged
5	Port-au-Prince, Haiti February, 2010	7.0	The damage from the quake was more severe than for other quakes of similar magnitude due to both the shallow depth of the earthquake and the poor quality of construction. 250,000 residences and 30,000 commercial buildings destroyed.	316,000 killed (May 1011, USAID adjusted figures to 46,000–85,000 killed.) 1,000,000 homeless
6	Sumatra December, 2009	7.5	Large buildings fell in the cities near the epicenter; landslides buried villages. Note: This is not the M9.1 earthquake of 2004; see below.	1,115 killed 200,000 homes damaged
7	L'Aquila, Abruzzo, Italy April, 2009	6.3	Villages in the valleys suffered greater damage than medieval mountain hill towns. L'Aquila was built on ancient lake sediments. The earthquke of 1703 destroyed the town of L'Aquila & killed 5,000 people. Felt in Rome, 60 km away.	308 killed; 1500 injured 3,000–11,000 buildings damaged 65,000 homeless
8	Sichuan Province, China May, 2008	7.9	At least 7,000 school buildings in Sichuan Province collapsed due to shoddy construction. Earthquake occurred in a poorer region where buildings are "just built; not designed" with earthquakes in mind, though they are common.	69,000 killed; 5,000,000 homeless
9	Chincha Alta, Peru August, 2007	8.0	The city of Pisco suffered 85% of the buildings destroyed. 148 deaths occurred when the cathedral collapsed in the city's main square.	519 killed; 85% buildings destroyed in Pisco & Chincha Alta. Many homeless
10	Java, Indonesia May, 2006	6.3	The earthquake's shallow depth was a major factor, but the scale of damage was made worse by failure to meet safe building standards.	5,782 killed; 36,299 injured; 135,000 homes damaged. 1,500,000 homeless
11	Pakistan October, 2005	7.6	Landslides and rockfalls damaged several main roads cutting off access to the region for several days. Several villages destroyed.	80,000 killed 32,000 buildings collapsed
12	Sumatra December, 2004	9.1	One of the deadliest natural disasters in history due to earthquake & tsunami pair. Third largest earthquake in recorded history. Vertical displacement of ~20 m over ~500 km length of the fault caused tsunamis with heights up to 30 meters.	230,000 killed in 12 countries; 1,300,000 affected; Widespread water & food shortages
13	Southeastern Iran December, 2003	6.6	Caused by fault rupture on the Bam Fault. The effects of the earthquake were exacerbated by the use of mud brick as the standard construction medium.	26,000 killed, 30,000 injured, 85% of buildings destroyed in the Nahrin area; 100,000 homeless
14	India January, 2001	7.7	Same site as the 1819 earthquake & proportionally the same number killed despite a seismic resistant building code. Liquefaction exacerbated shaking.	20,000 killed, 167,000 injured 600,000 homeless

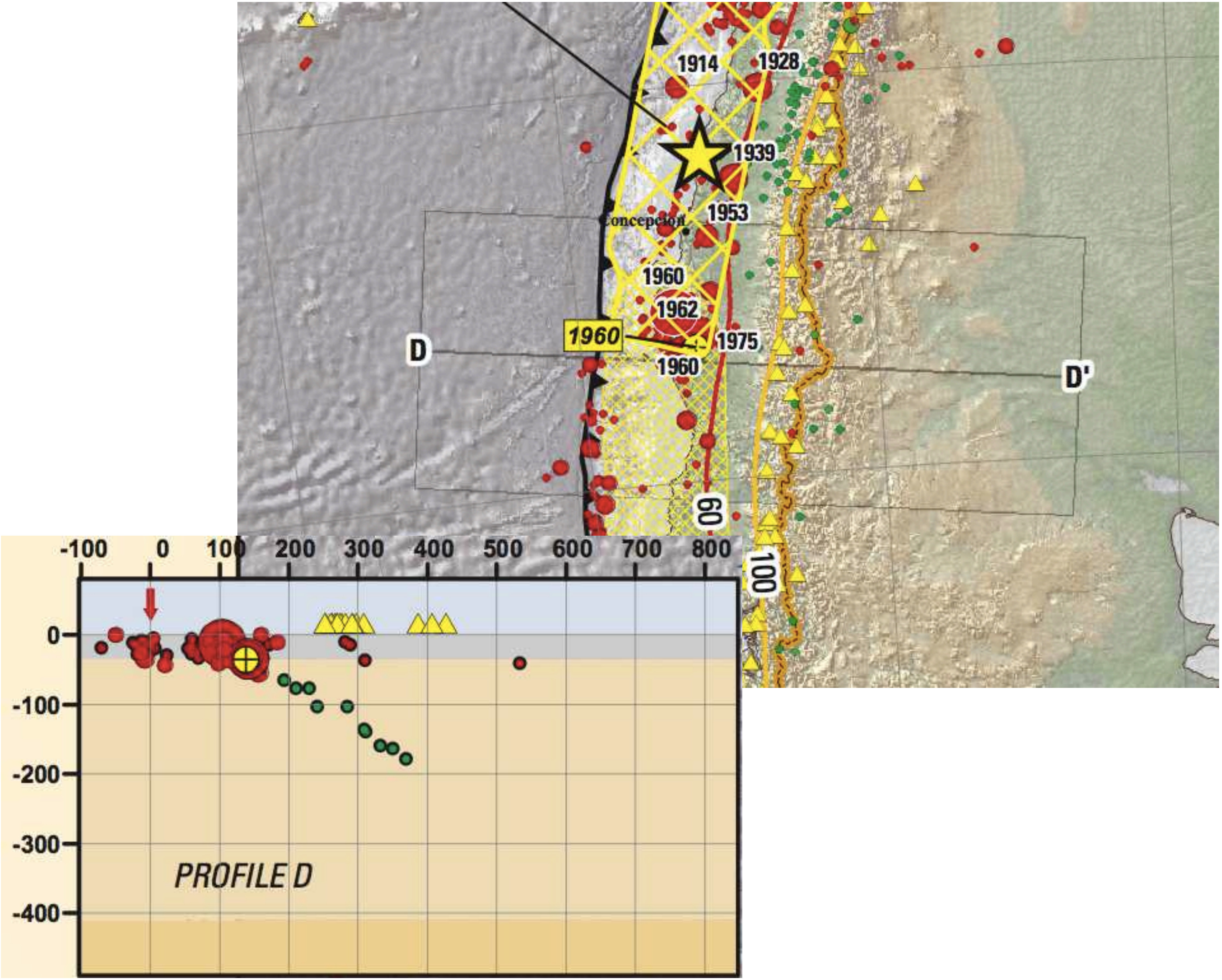
berühmte
Erdbeben
Subduktion
I

Chile 22. Mai 1960 $M_W = 9.5$



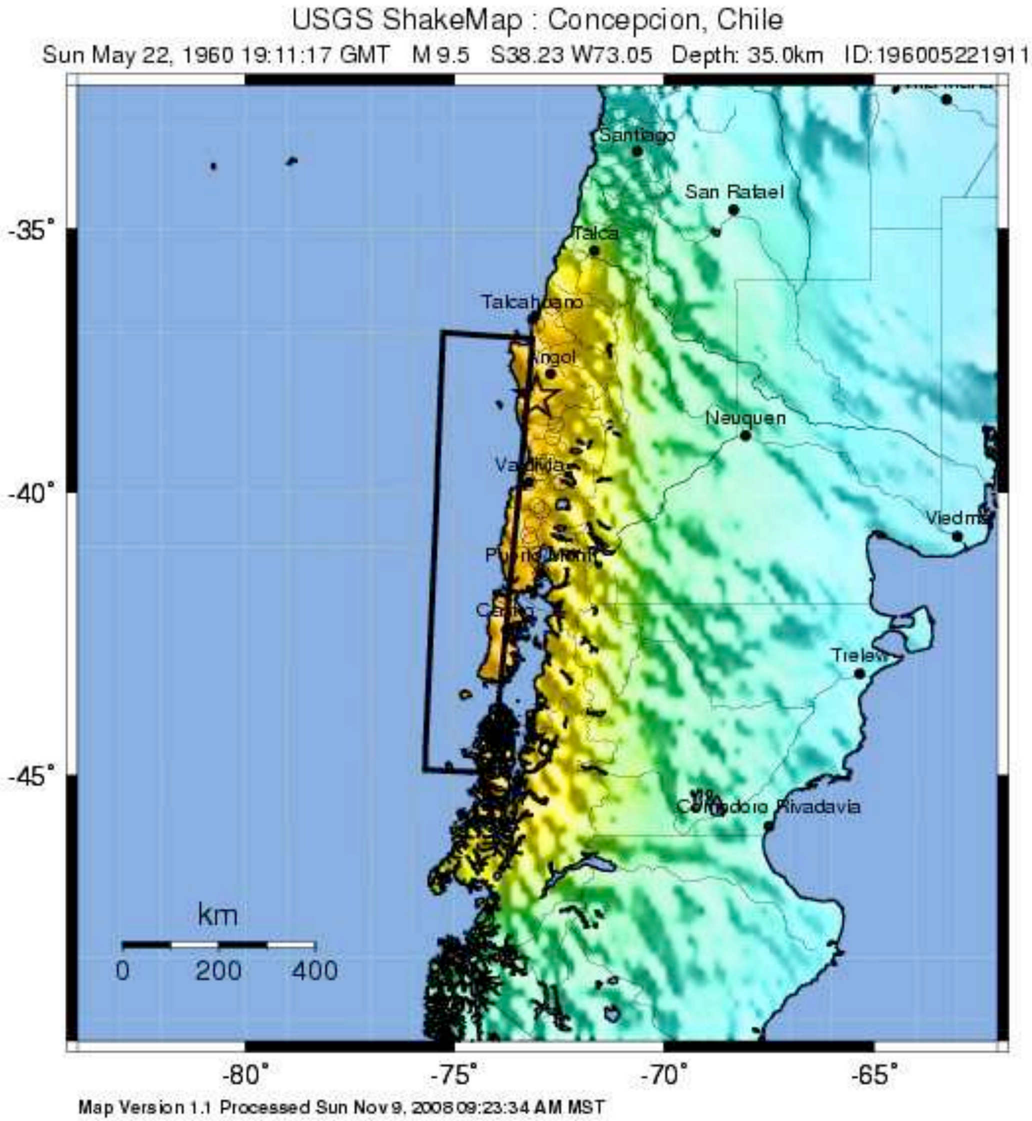
Chile 22. Mai 1960 $M_W = 9.5$





1914
1928
1939
1953
Concepcion
1960
1962
1960
1975
1960
D
D'
60
100
-100
0
100
200
300
400
500
600
700
800
0
-100
-200
-300
-400
PROFILE D

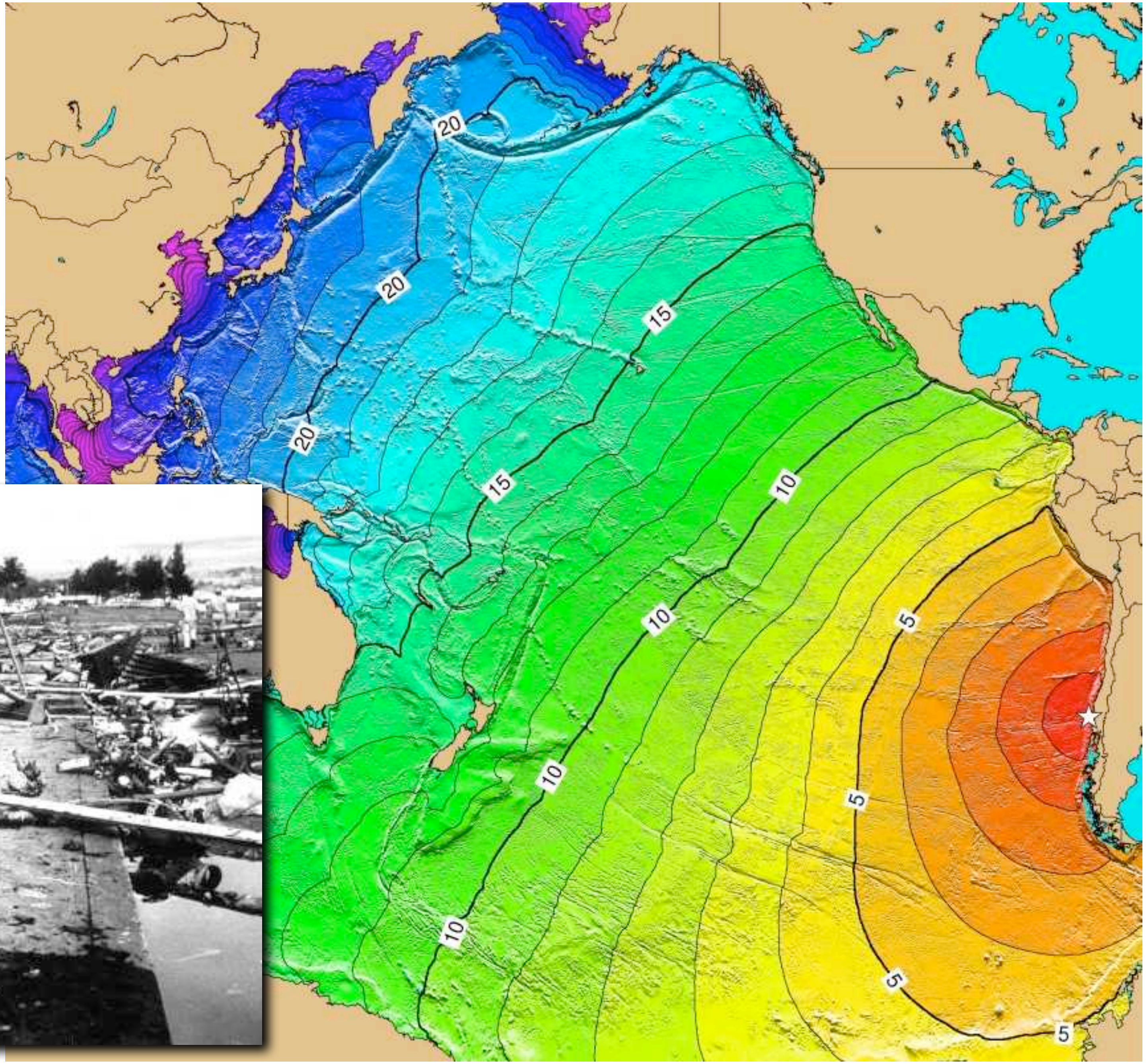
Chile 22. Mai 1960



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Chile 22. Mai 1960

Tsunami



Chile 22. Mai 1960

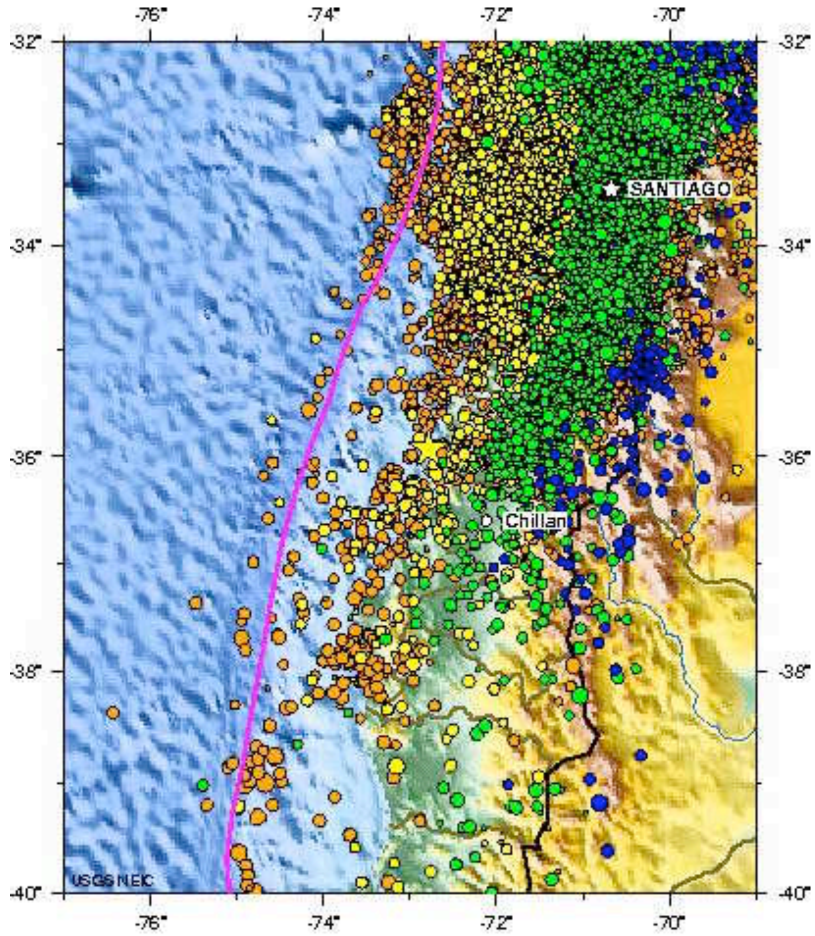
Tsunami

Puerto Montt

Chile 22. Mai 1960

berühmte Erdbeben Subduktion 2

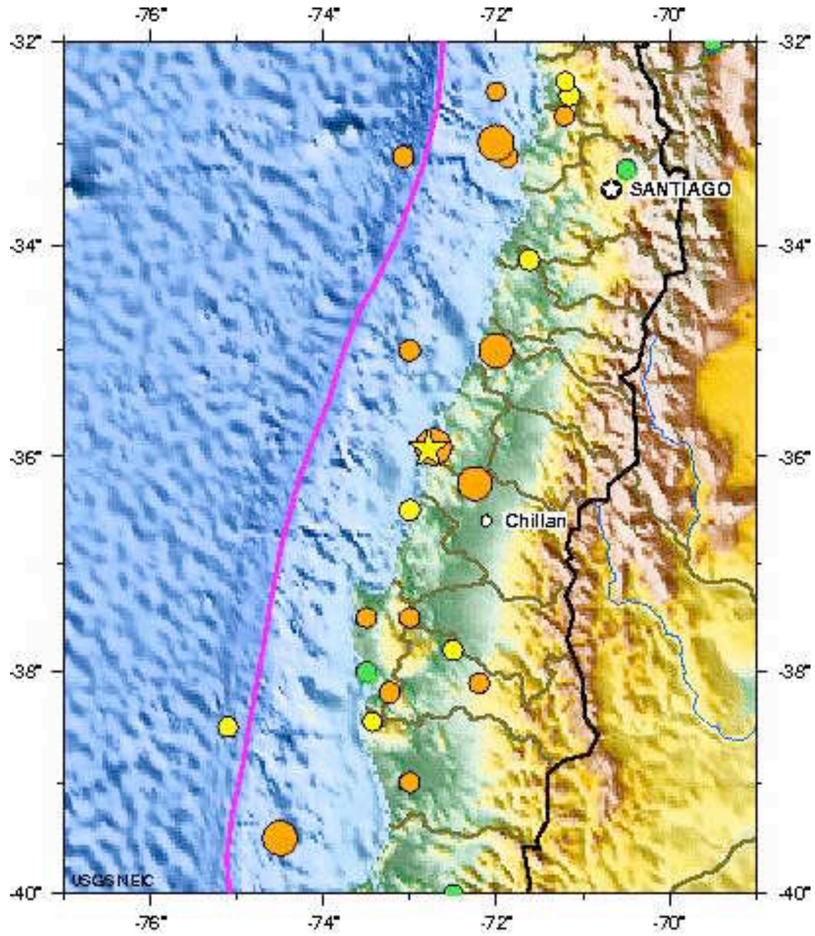
Chile 27. Februar 2010 Mw 8.8



OFFSHORE MAULE, CHILE

2010 02 27 06:34:14 UTC 35.93S 72.78W Depth: 35 km, Magnitude: 8.8

Seismicity 1990 to Present

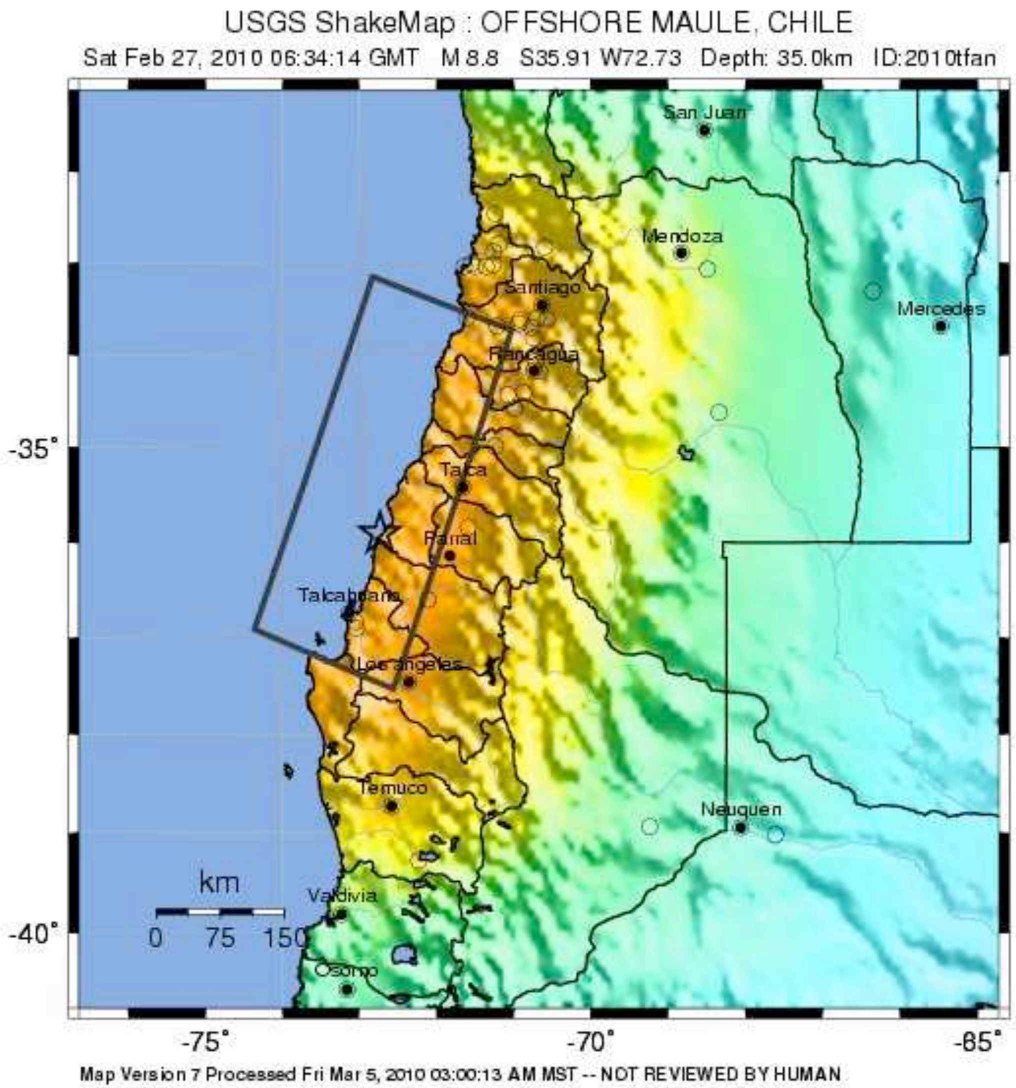


OFFSHORE MAULE, CHILE

2010 02 27 06:34:14 UTC 35.93S 72.78W Depth: 35 km, Magnitude: 8.8

Magnitude 7 and Greater Earthquakes Since 1900

Chile 27. Februar 2010 Mw 8.8



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
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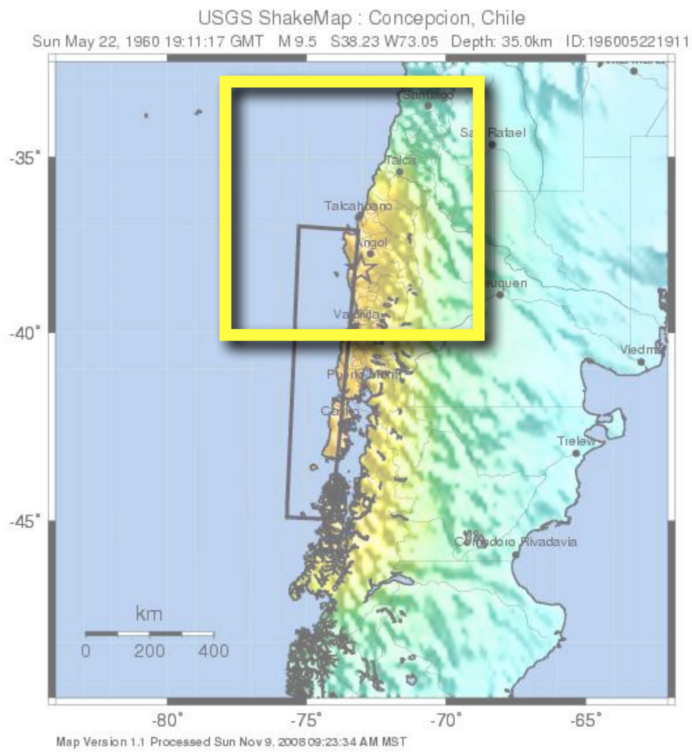
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
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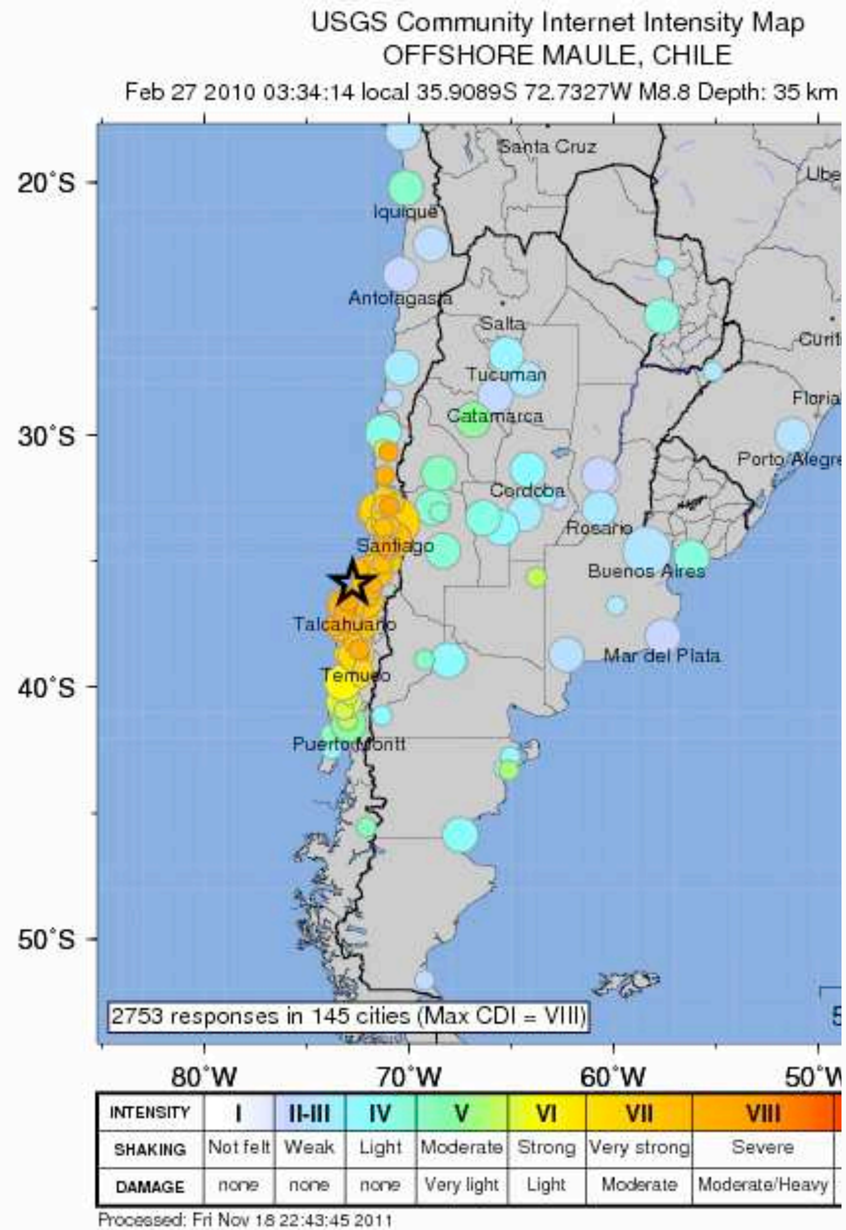
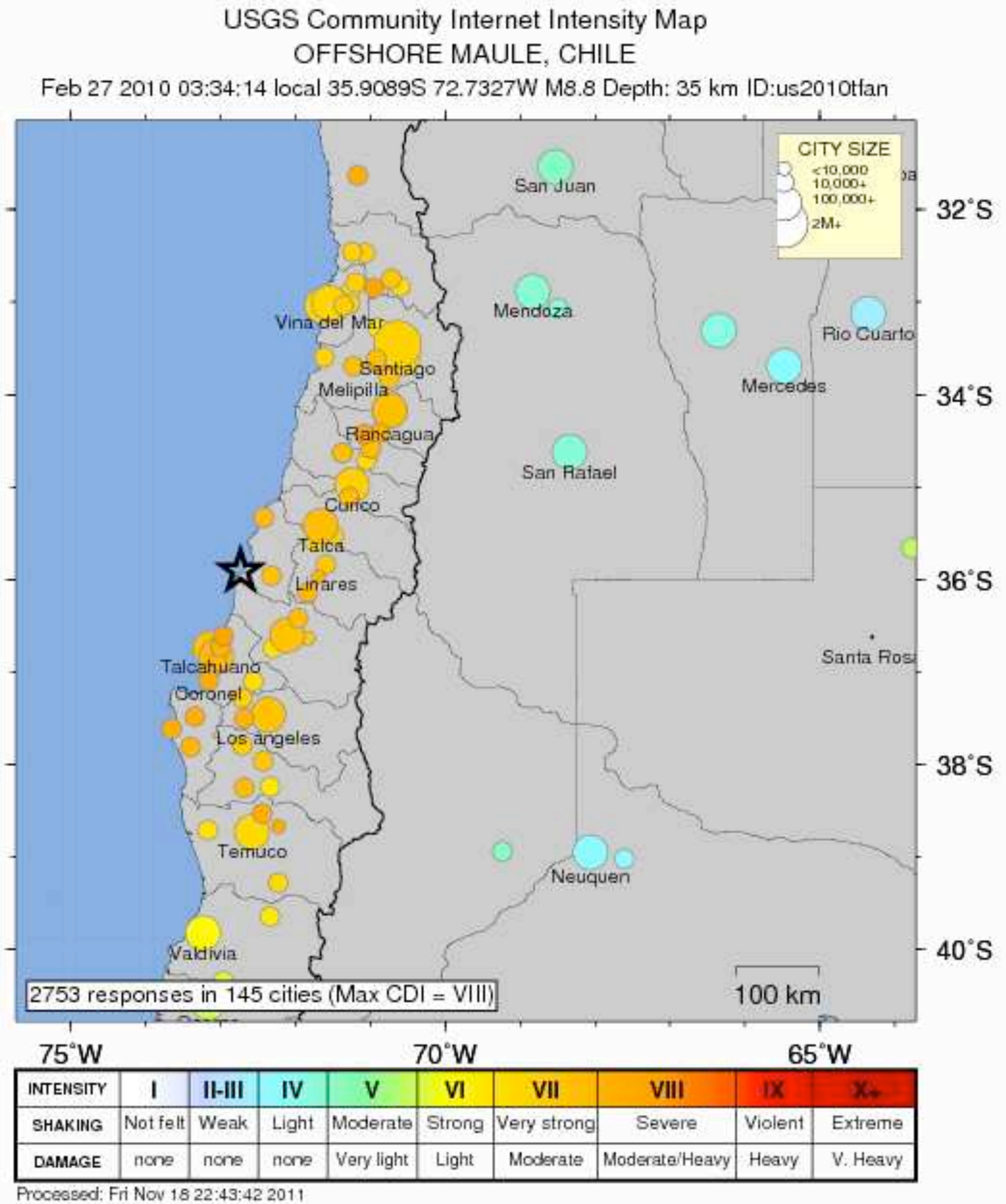
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Chile 1960

Chile 27. Februar 2010 Mw 8.8



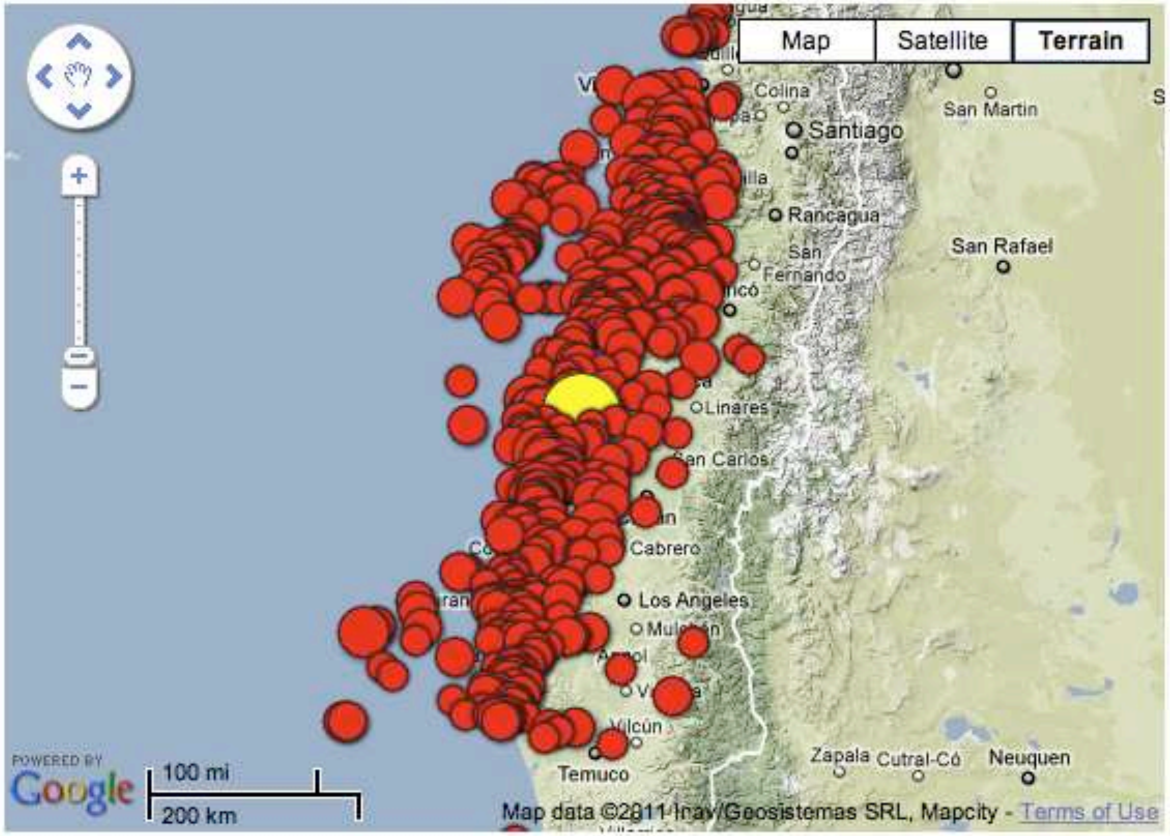


Chile 27. Februar 2010 Mw 8.8

M8.8 - Offshore Maule, Chile

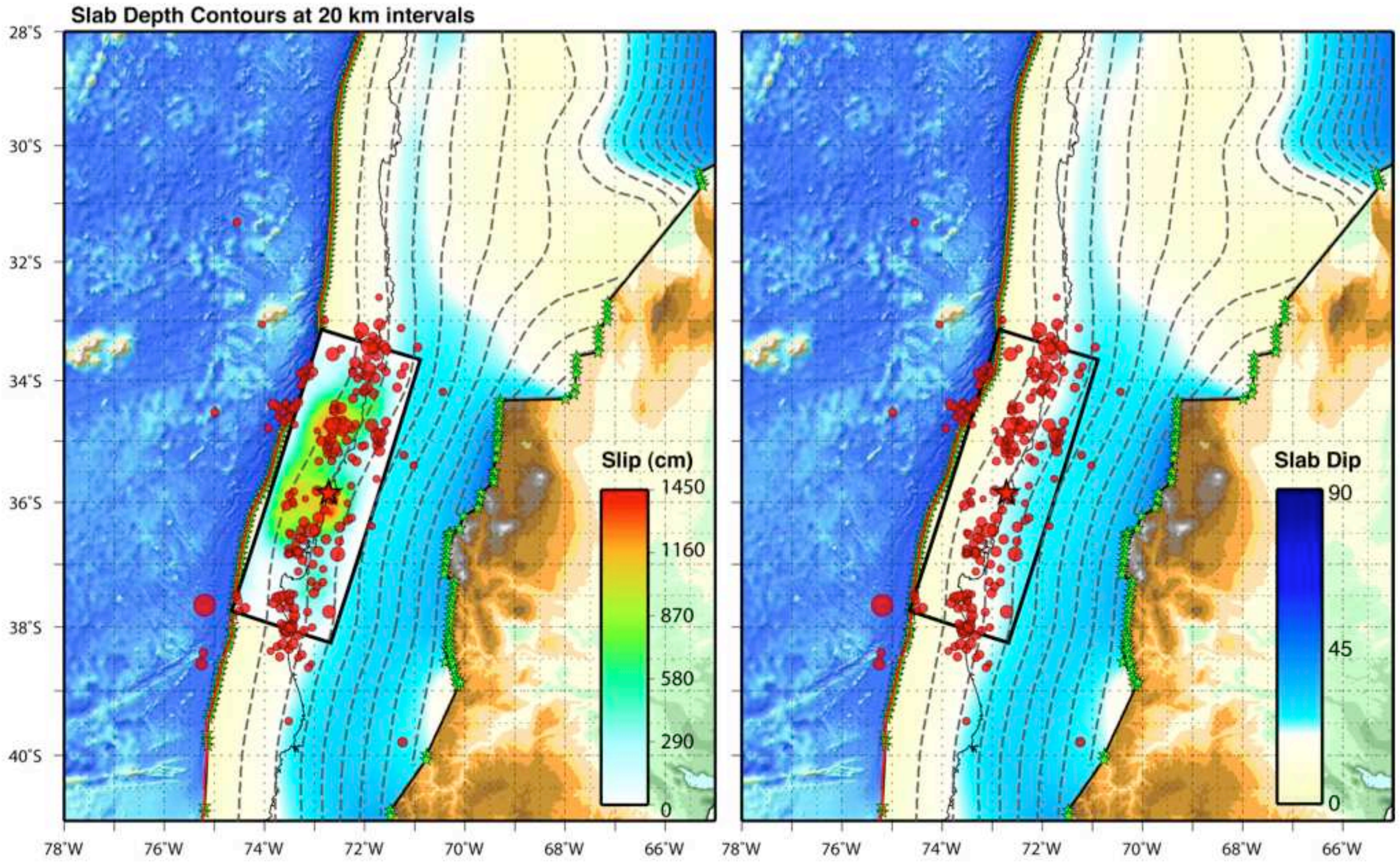
Aftershock Map - Mainshock and 458 Aftershocks

Last Updated: 29 March 2010, 18:19:54 UTC

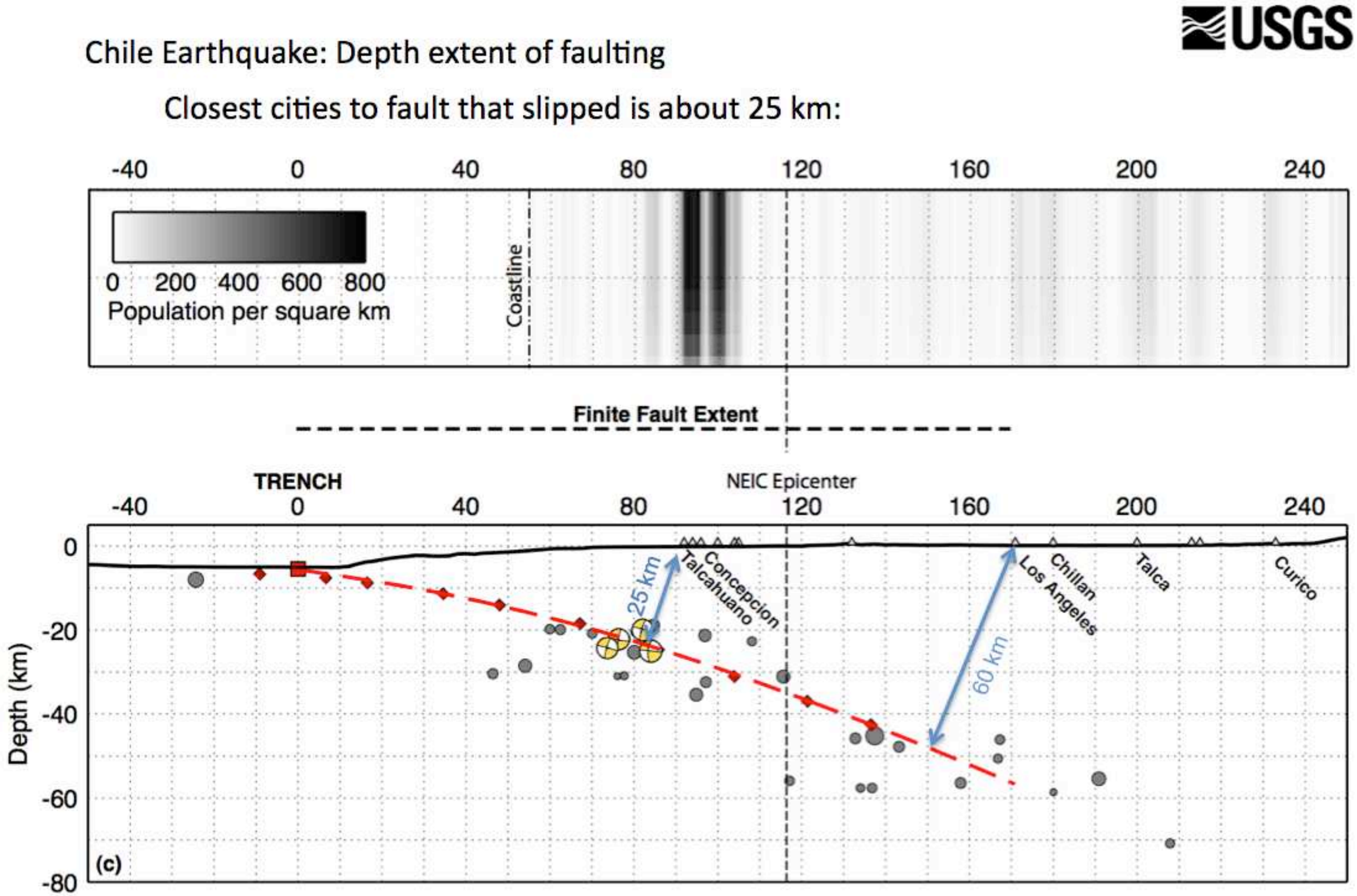


Legend

Chile 27. Februar 2010 Mw 8.8

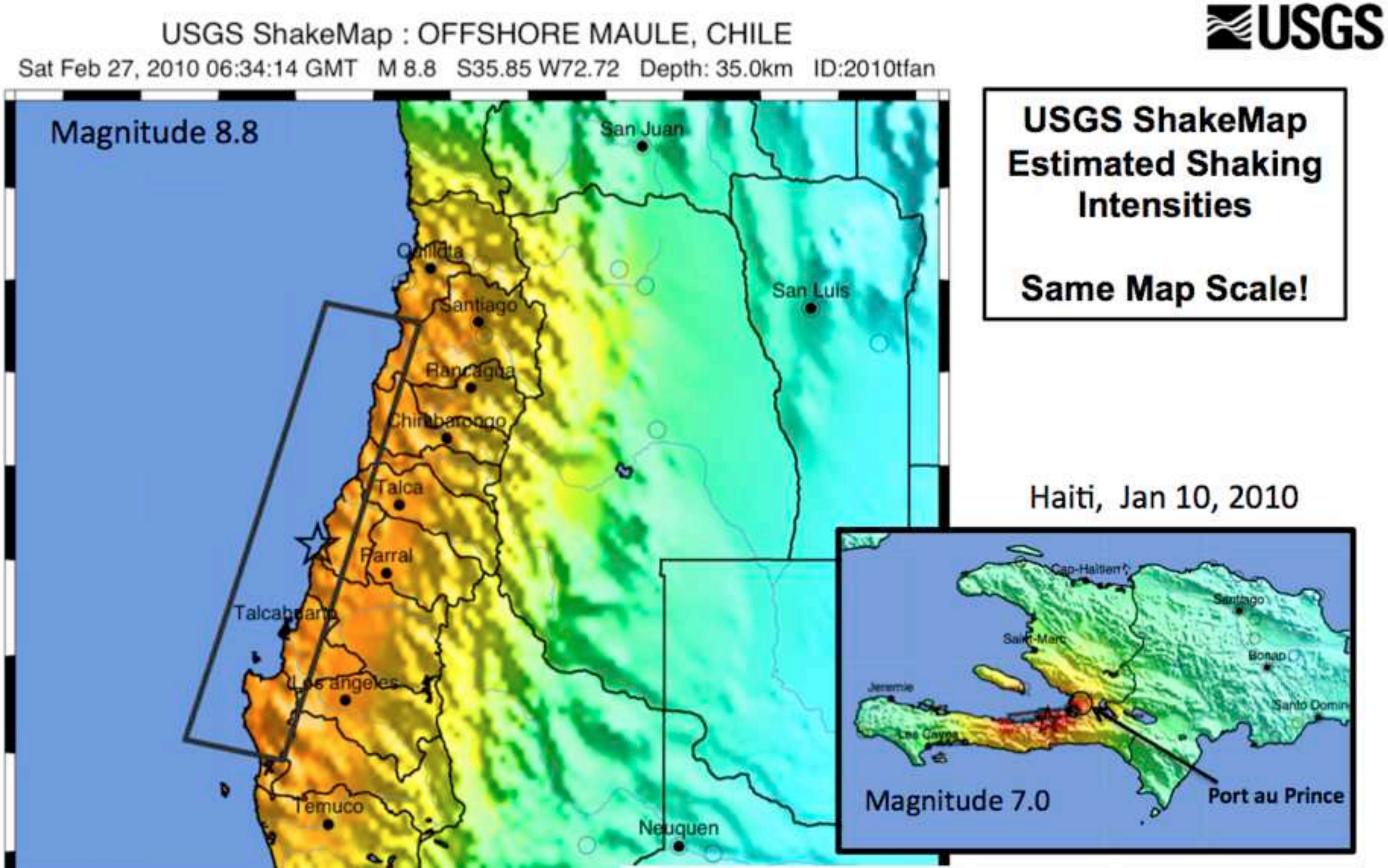


Chile 27. Februar 2010 Mw 8.8



Vergleich strikes-slip versus Subduktion

Chile 2010 - Haiti 2010 Vergleich



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
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PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

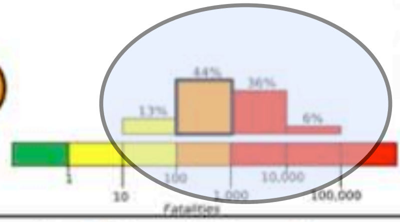
Chile 2010 - Haiti 2010 Vergleich

USGS

M 8.8, OFFSHORE MAULE, CHILE
Origin Time: Sat 2010-02-27 06:34:14 UTC (03:34:14 local)
Location: 35.85°S 72.72°W Depth: 35 km

PAGER Version 4
Created: 14 hours, 10 minutes after earthquake

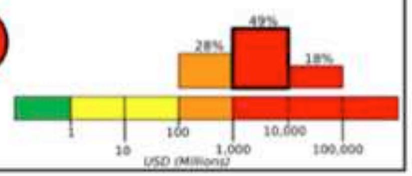
Estimated Fatalities



Red alert level for economic losses. Widespread damage is likely and the disaster is potentially widespread. Past events with this alert level have required a national or international level response.

Orange alert level for fatalities. Significant casualties are likely.

Estimated Economic Losses



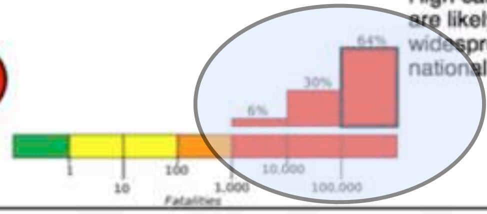
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	0*	1,223k*	2,735k*	758k*	7,361k	5,537k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

M 7.0, HAITI REGION
Origin Time: Tue 2010-01-12 21:53:10 UTC (16:53:10 local)
Location: 18.45°N 72.57°W Depth: 13 km

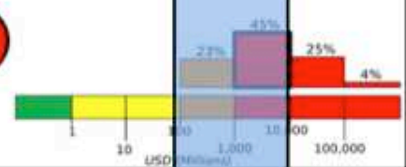
PAGER Version 1
Created: 1 month, 2 weeks after earthquake

Estimated Fatalities



Red alert for fatalities and economic losses. High casualties and widespread damage are likely and the diaster is potentially widespread. Past red alerts have required a national or international response.

Estimated Economic Losses



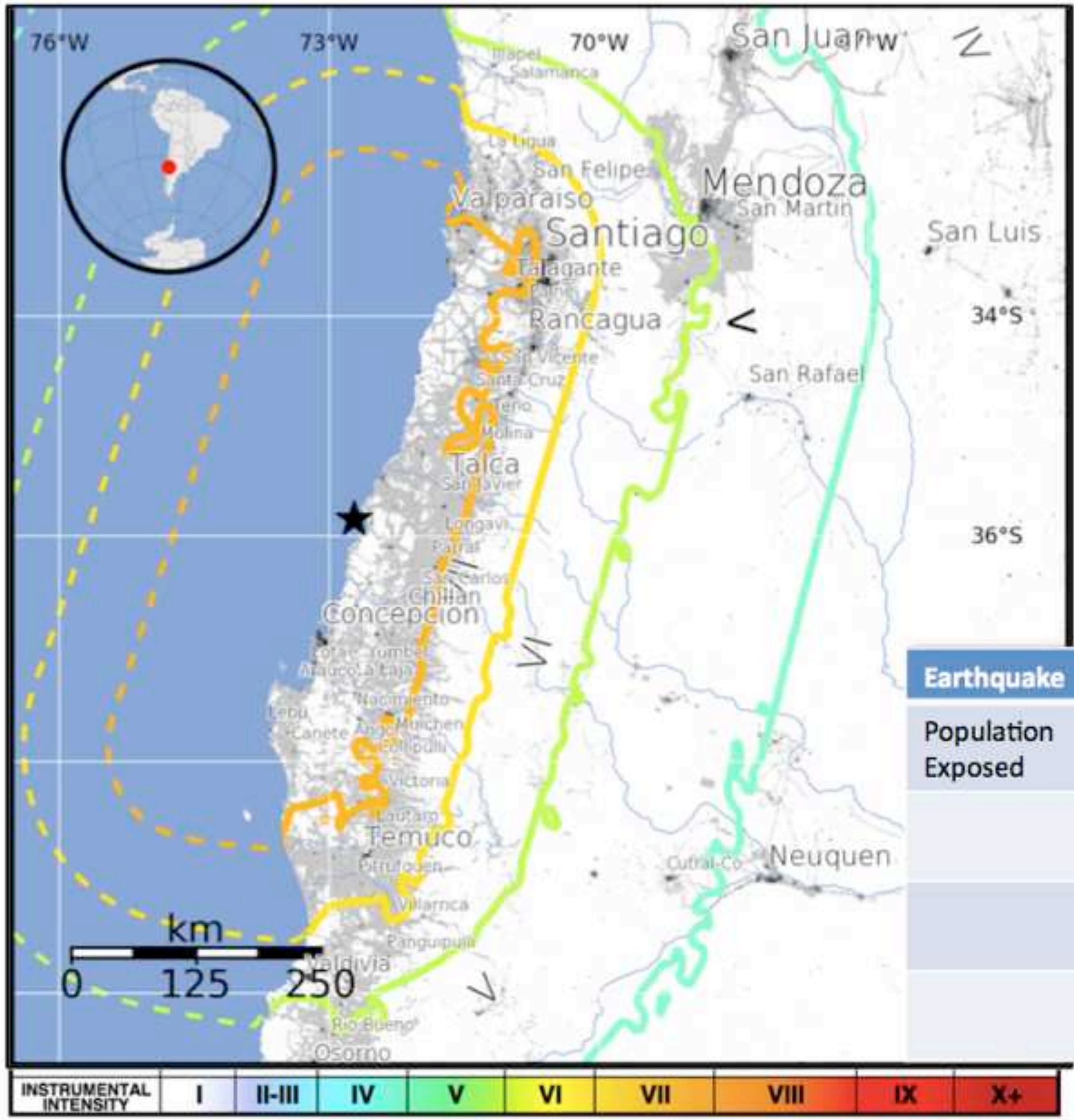
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		--*	50k*	7,272k*	6,149k	867k	513k	706k	2,370k	3k
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

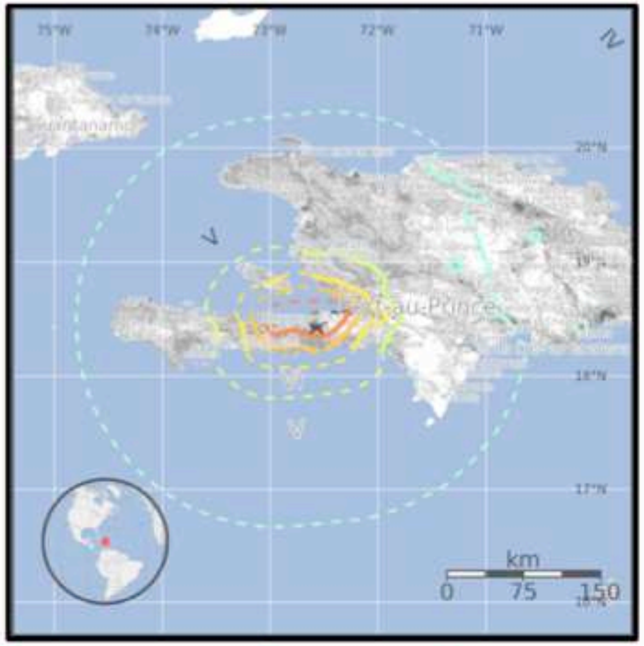
Chile 2010 - Haiti 2010 Vergleich

Population & Shaking Intensity

Chile



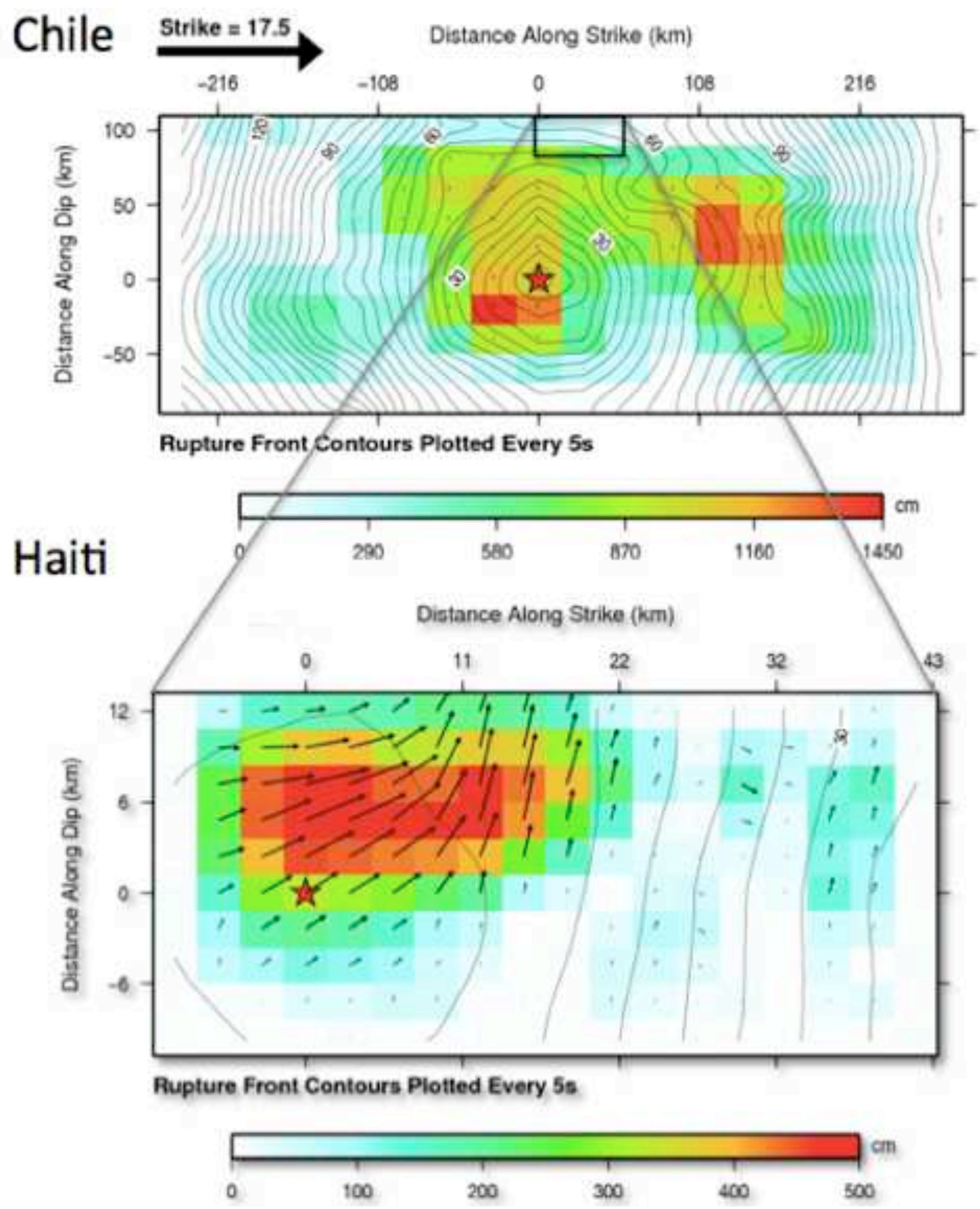
Haiti



Earthquake	Intensity	Chile	Haiti
Population Exposed	Violent Shaking (IX)	0	2,400,000
	Severe Shaking (VIII)	5,540,000	700,000
	Very Strong Shaking (VII)	7,360,000	510,000
	Strong Shaking (VI)	758,000	870,000

[Maps on approximately same scale]

Chile 2010 - Haiti 2010 Vergleich



gleicher Massstab wie Chile

Chile 2010 - Haiti 2010 Vergleich

USGS

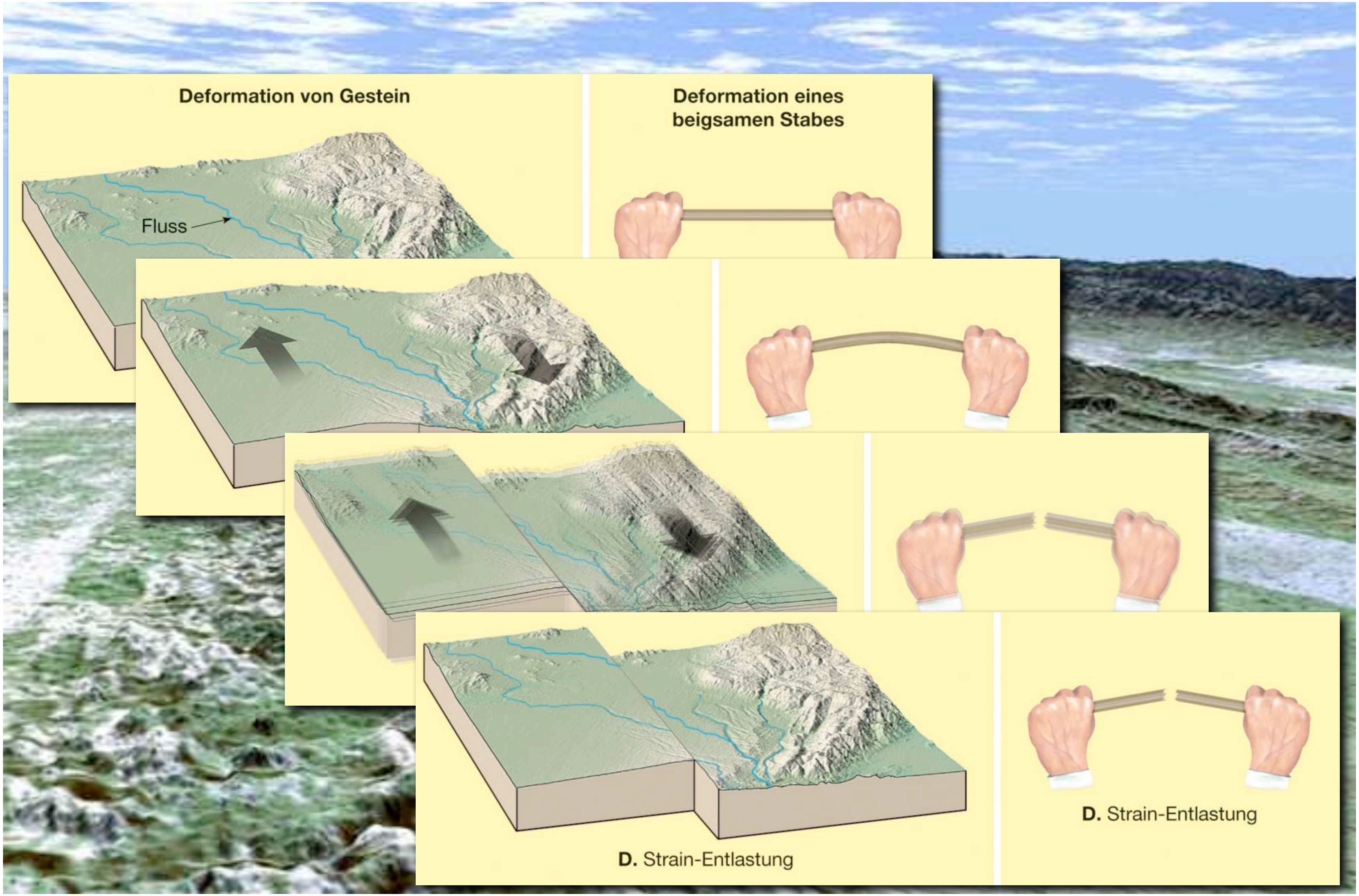
2010 Chile & Haiti Earthquake Fault Facts

The Facts	Chile	Haiti
Magnitude	**8.8**	**7.0**
Maximum Estimated Shaking Intensity	**~ VIII**	**~ IX**
Fault Size Area (km^2)	80,000 sq km	600 sq km
Maximum Slip (meters)	12	5
Average slip (meters)	7	2
ave. slip x area	560,000	1,200

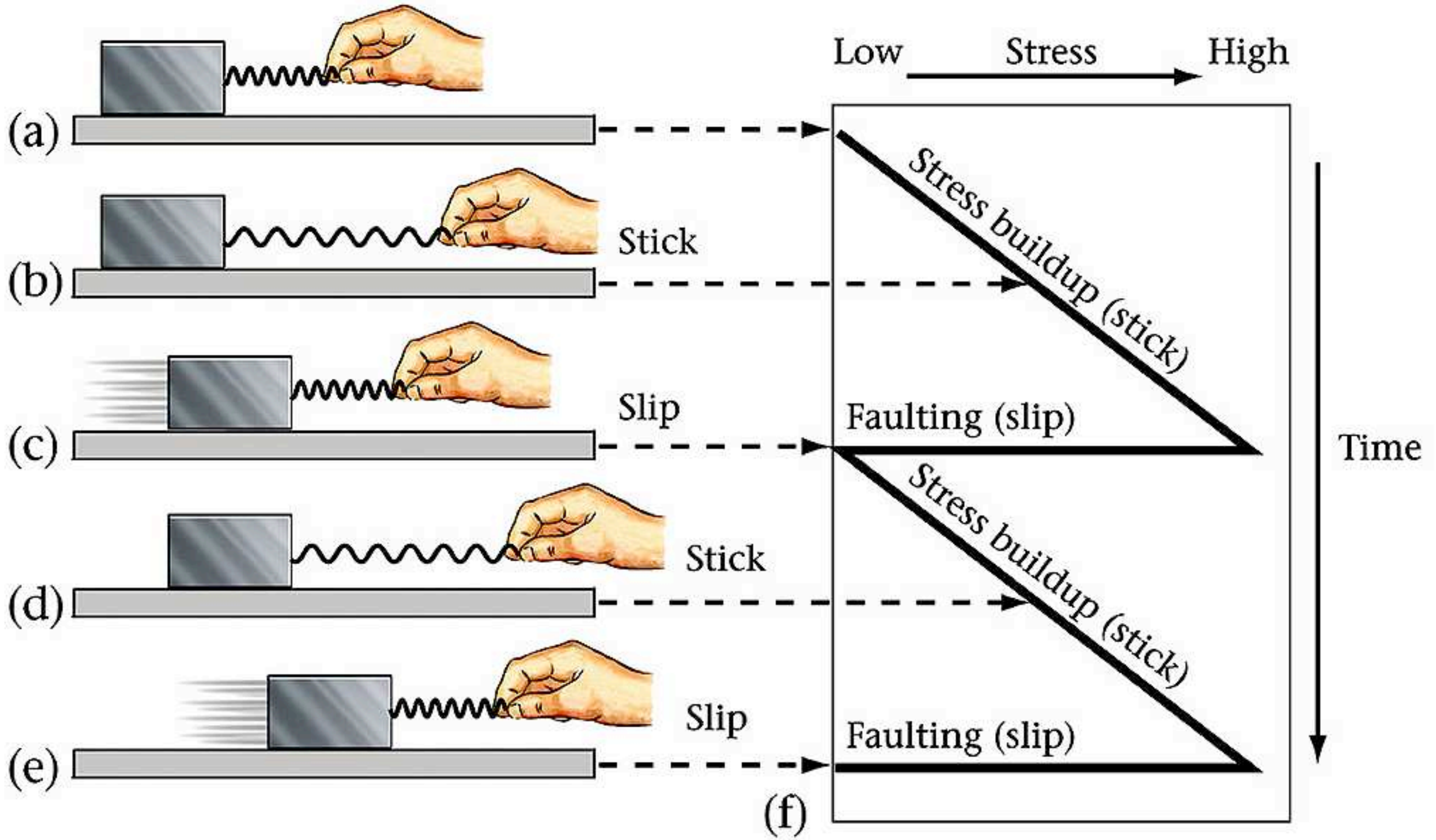
560,000/1,200 ~= 500 times energy release

Tektonische, physikalische Ursachen

Namazu, ein riesiger Wels liegt im Schlamm und Kashima, ein Gott, hält ihn mit einem Stein fest. Wenn Kashima nicht aufpasst und den Griff lockert, bewegt sich Namazu - und die Erde bebt...

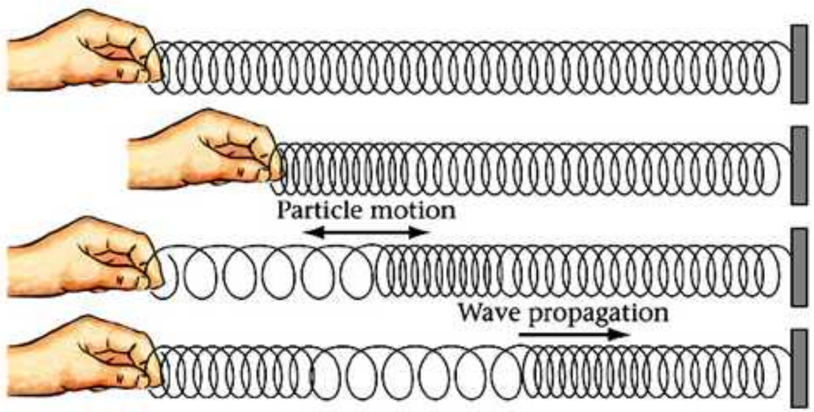

Deformation von Gestein
Deformation eines beigsamen Stabes
Fluss
D. Strain-Entlastung
D. Strain-Entlastung

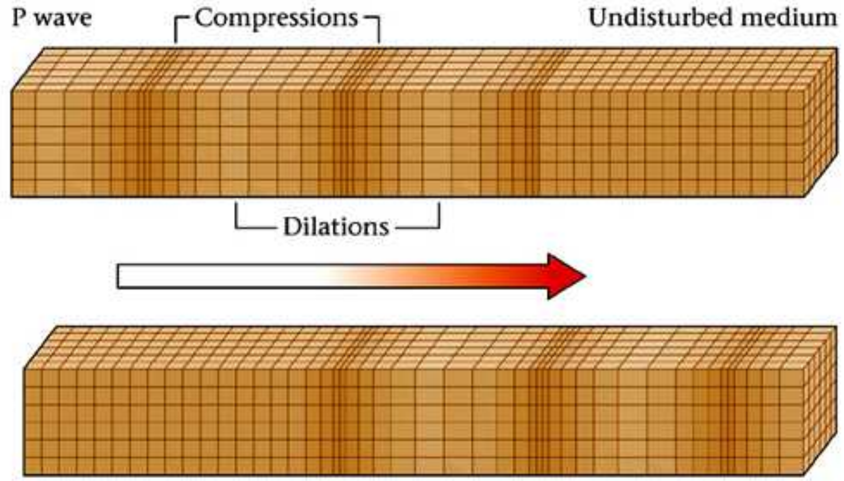
Stick - Slip - Modell



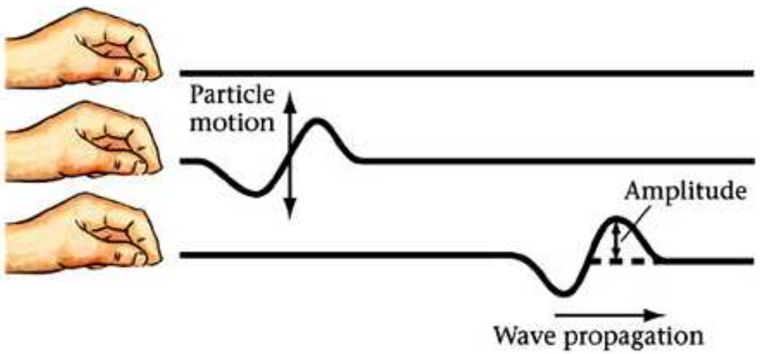
Seismik

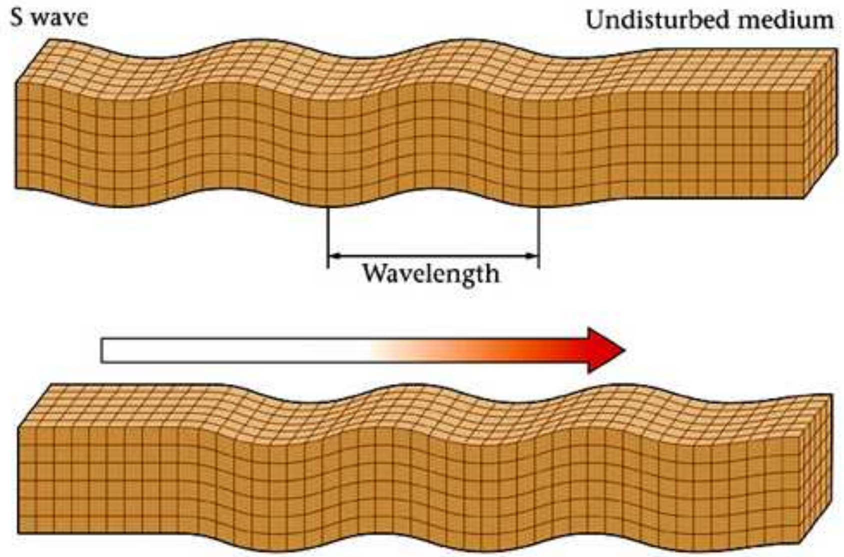
seismische Wellen





P-Wellen: Kompression





S-Wellen: Scherung

seismische Wellen

$$\text{speed} = \sqrt{\frac{\text{elastic modulus}}{\text{density}}}$$

$$v_p = \sqrt{\frac{K + \frac{4}{3}\mu}{\rho}} \qquad v_S = \sqrt{\frac{\mu}{\rho}}$$

$$v_p > v_s$$

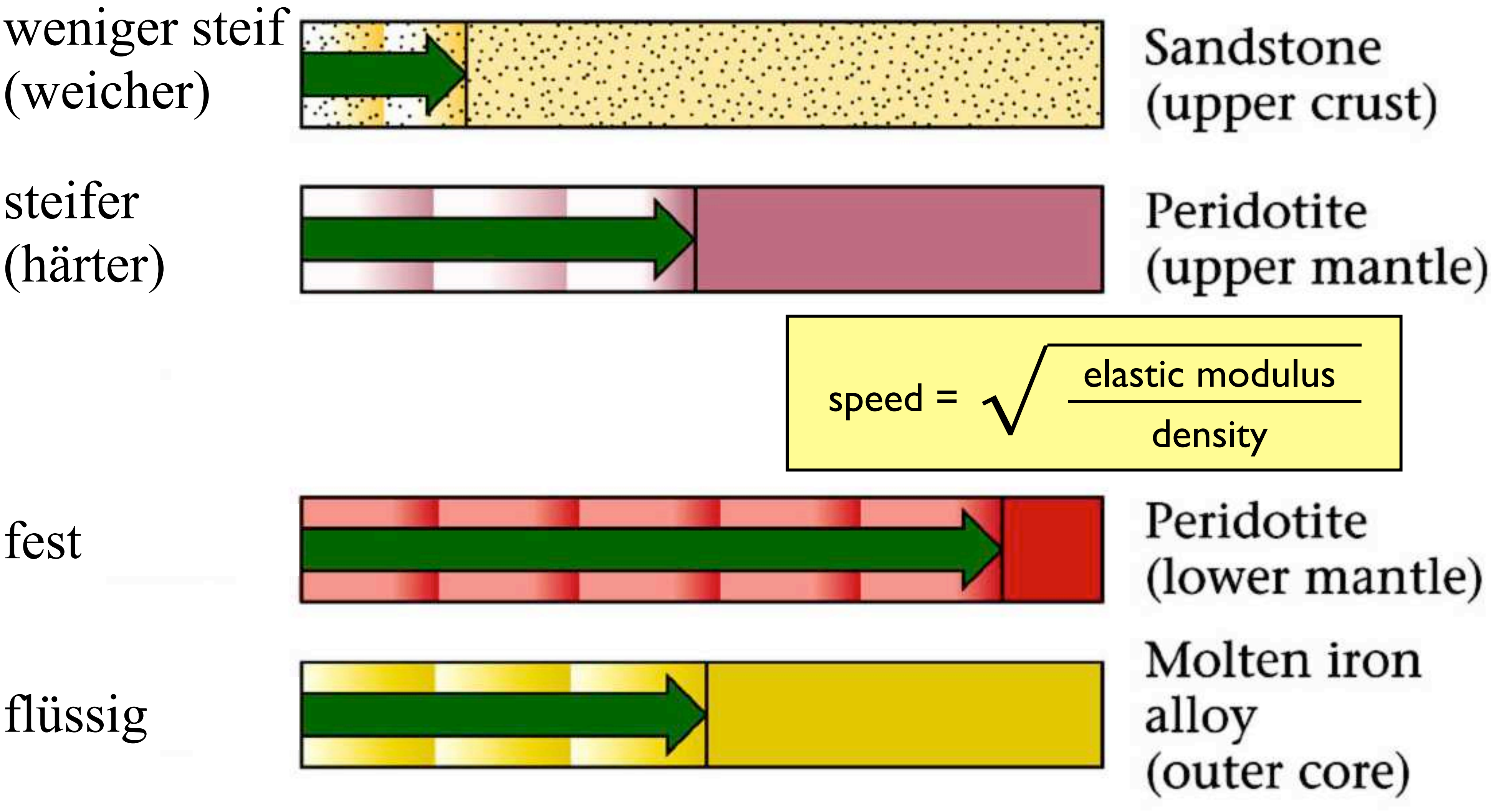
K: bulk modulus

μ: shear modulus

Geschwindigkeit seismischer Wellen

	v_P (ms^{-1})	v_s (ms^{-1})
Luft	332	
Wasser	1400-1500	
Petroleum	1300-1400	
Beton	3600	2000
Granit	5500-5900	2800-3000
Basalt	6400	3200
Sandstein	1400-4300	700-2800
Kalkstein	5900-6100	2800-3000
Sand (ungesättigt)	200-1000	80-400
Sand (gesättigt)	800-2200	320-880
Ton	1000-2500	400-1000
Tillit (gesättigt)	1500-2500	600-1000

seismische Geschwindigkeiten

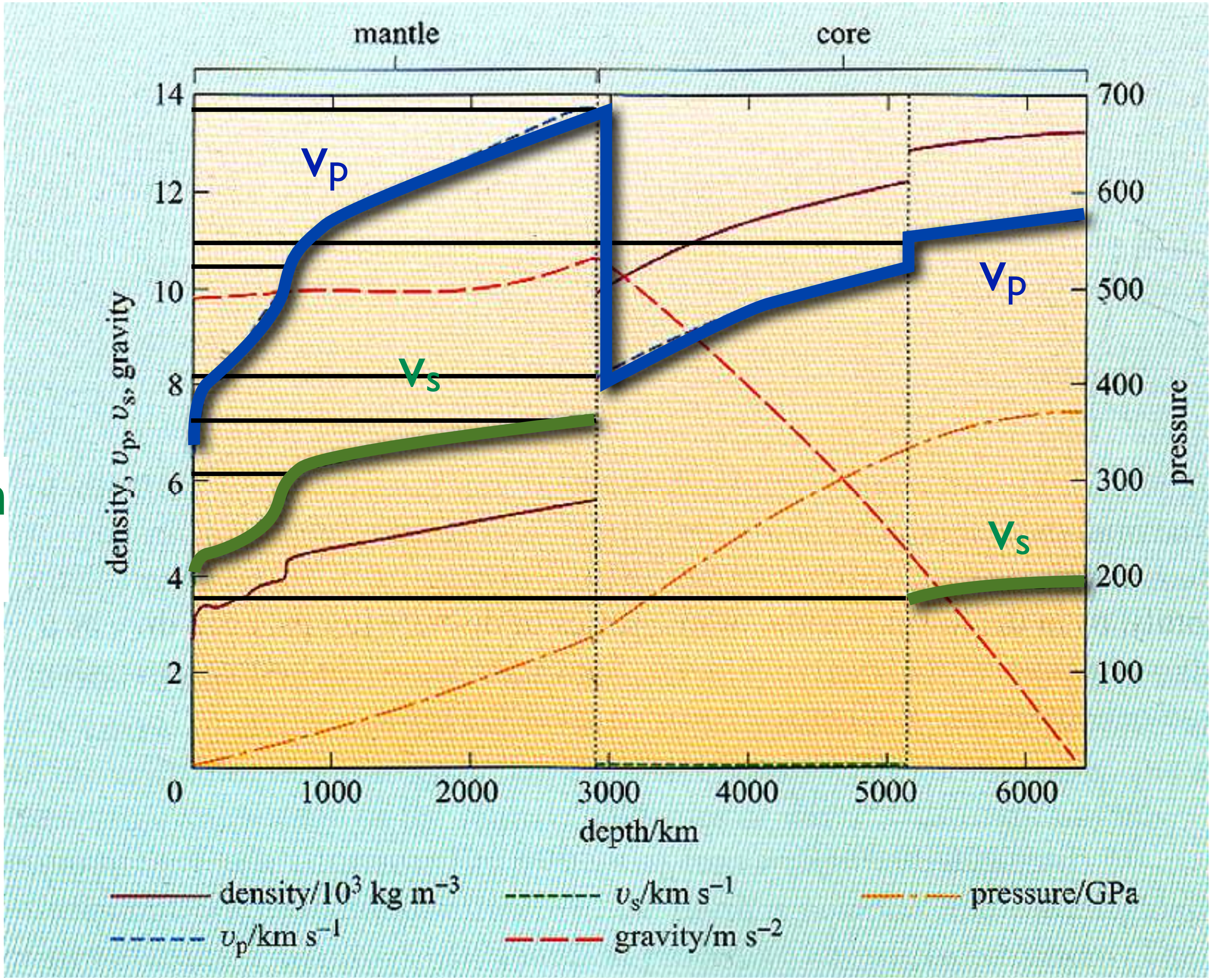


p- waves

Preliminary reference earth model

P-Wellen [kms-1]

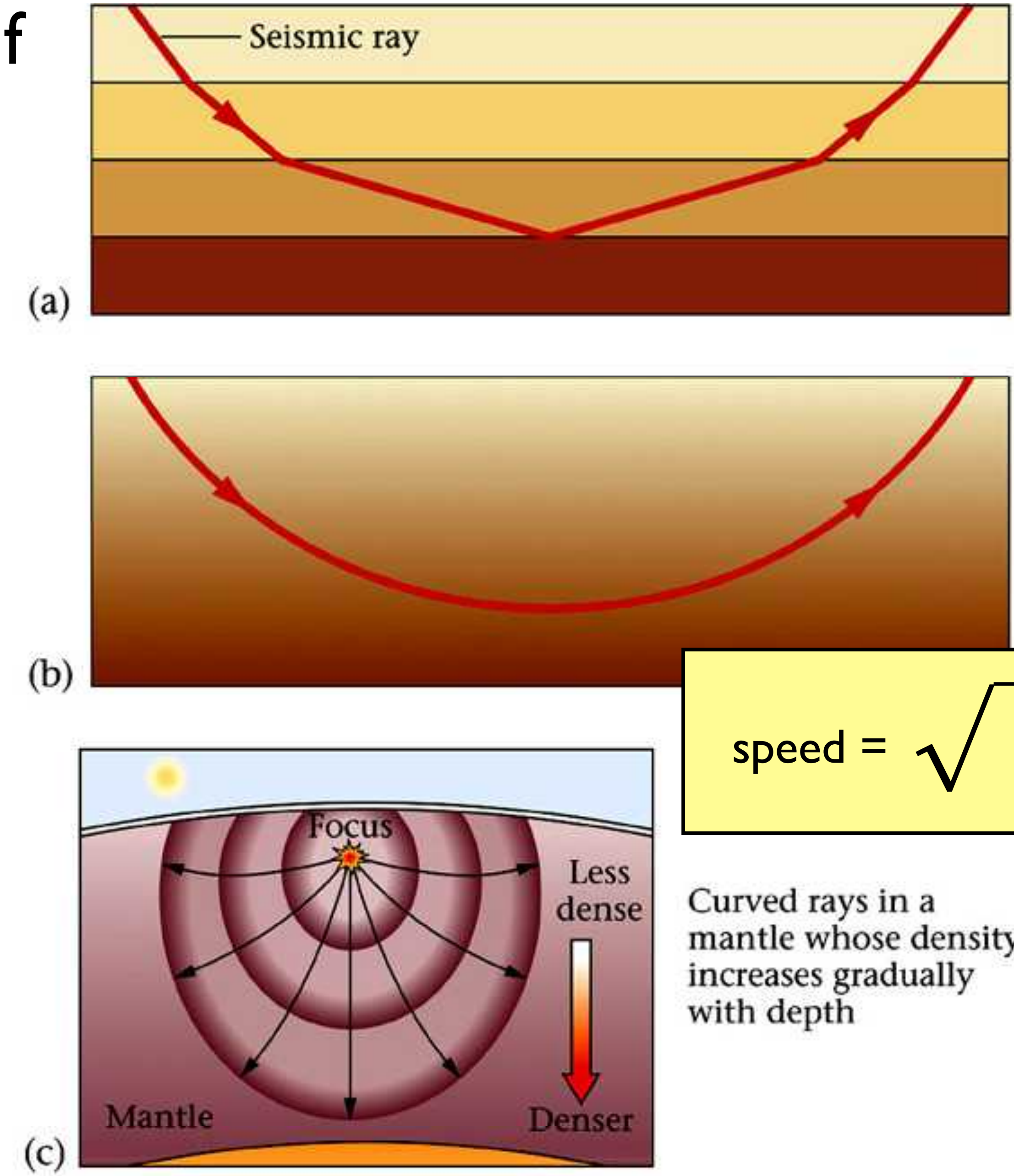
S-Wellen [kms-1]



Seismische Refraktion

weniger steif → steifer

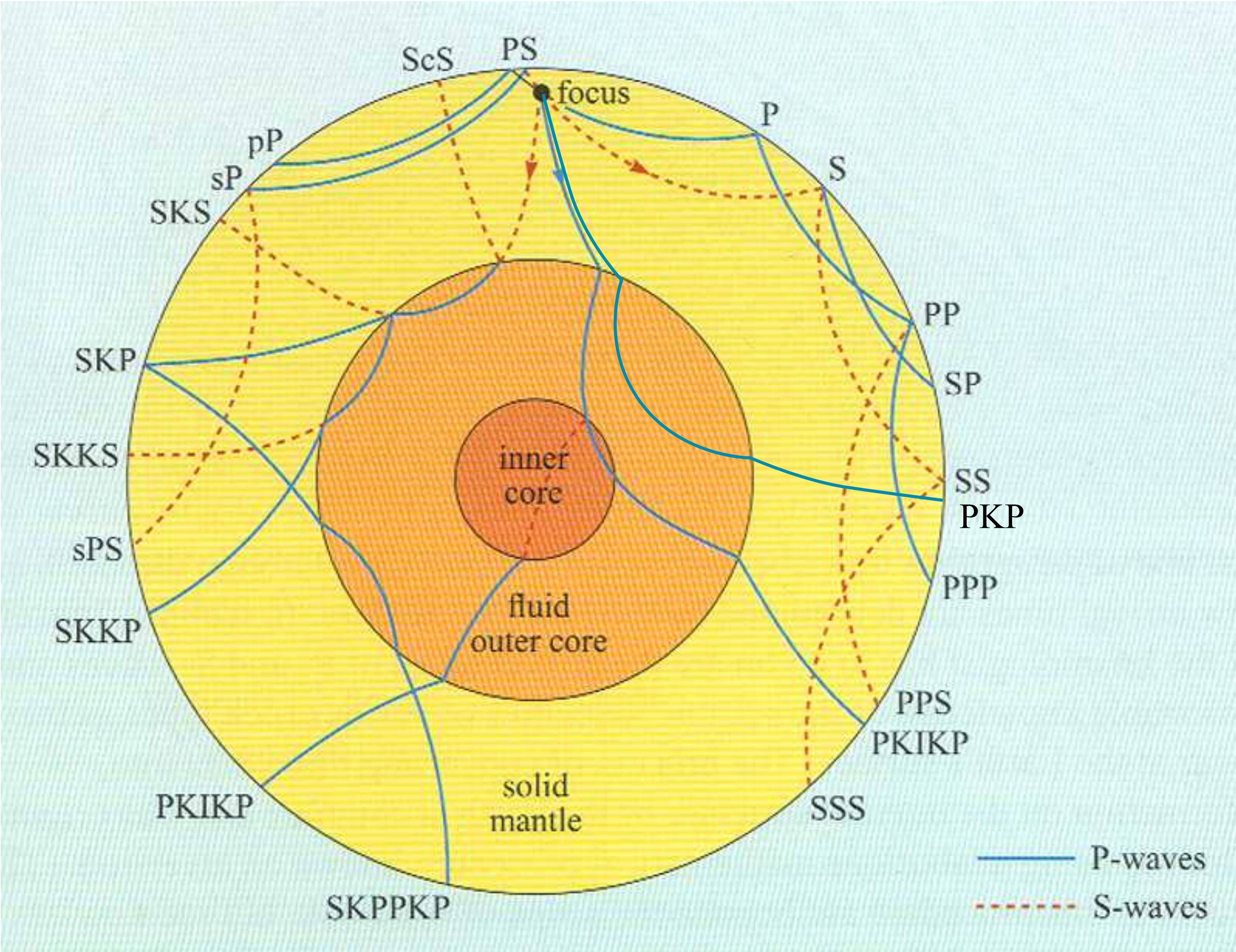
langsamer → schneller



$$\text{speed} = \sqrt{\frac{\text{elastic modulus}}{\text{density}}}$$

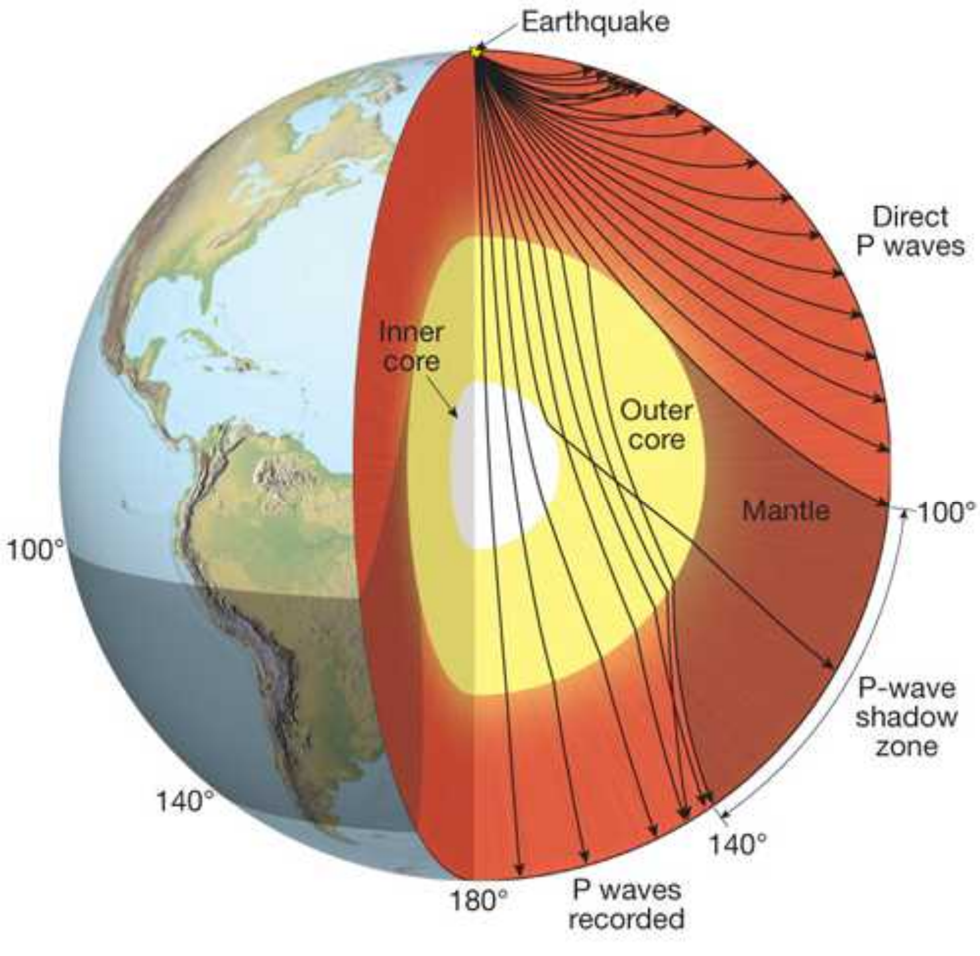
Curved rays in a mantle whose density increases gradually with depth

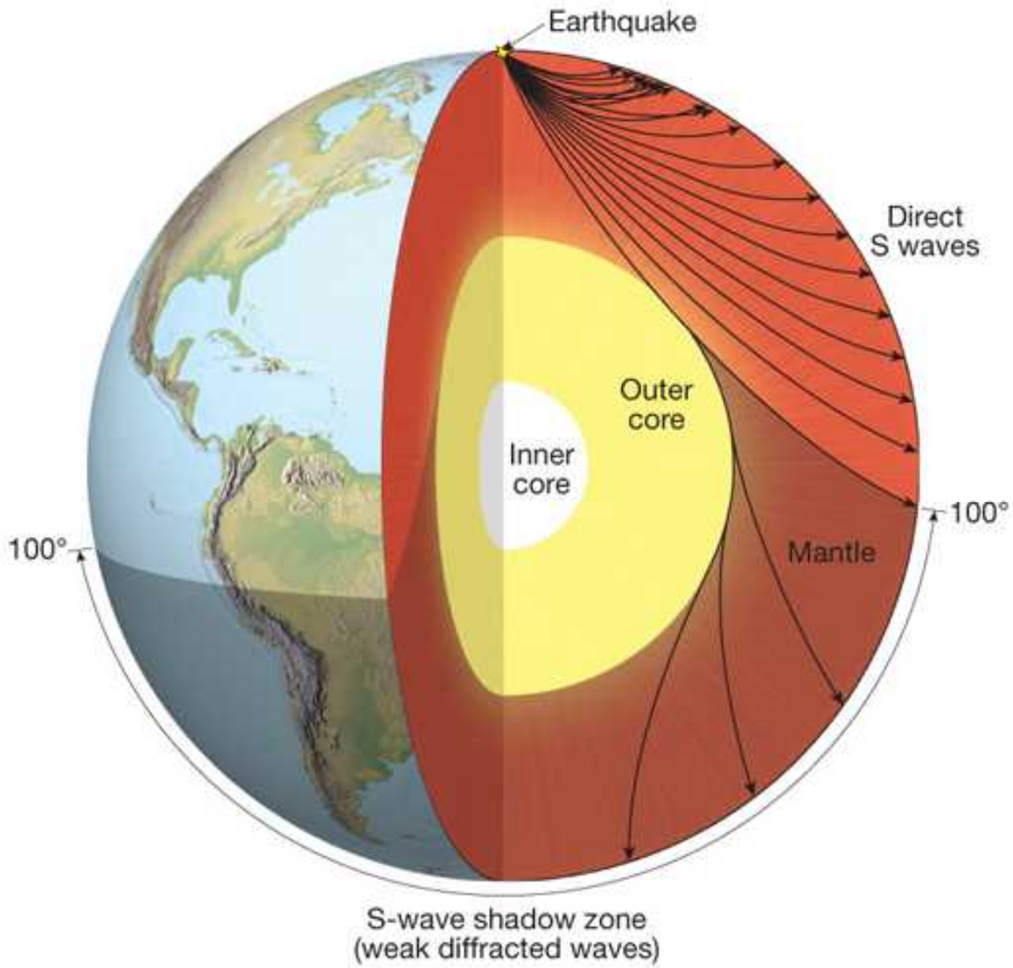
Trajektorien im Erdinnern



P - Wellen

S-Wellen

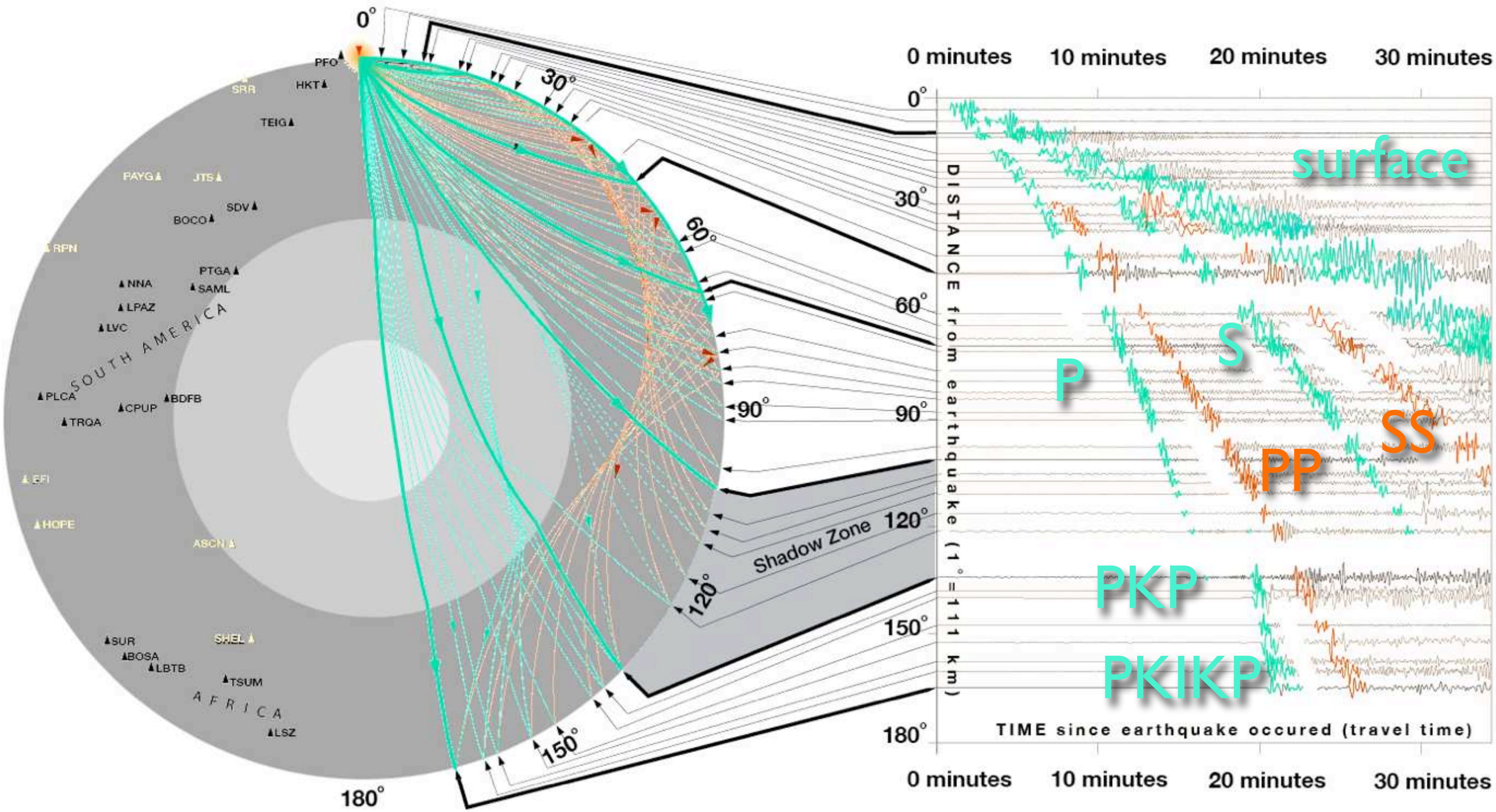




Ringförmiger Schatten

Kreisförmiger Schatten

Trajektorien von P- und S-Wellen



grün: direkt orange: reflektiert

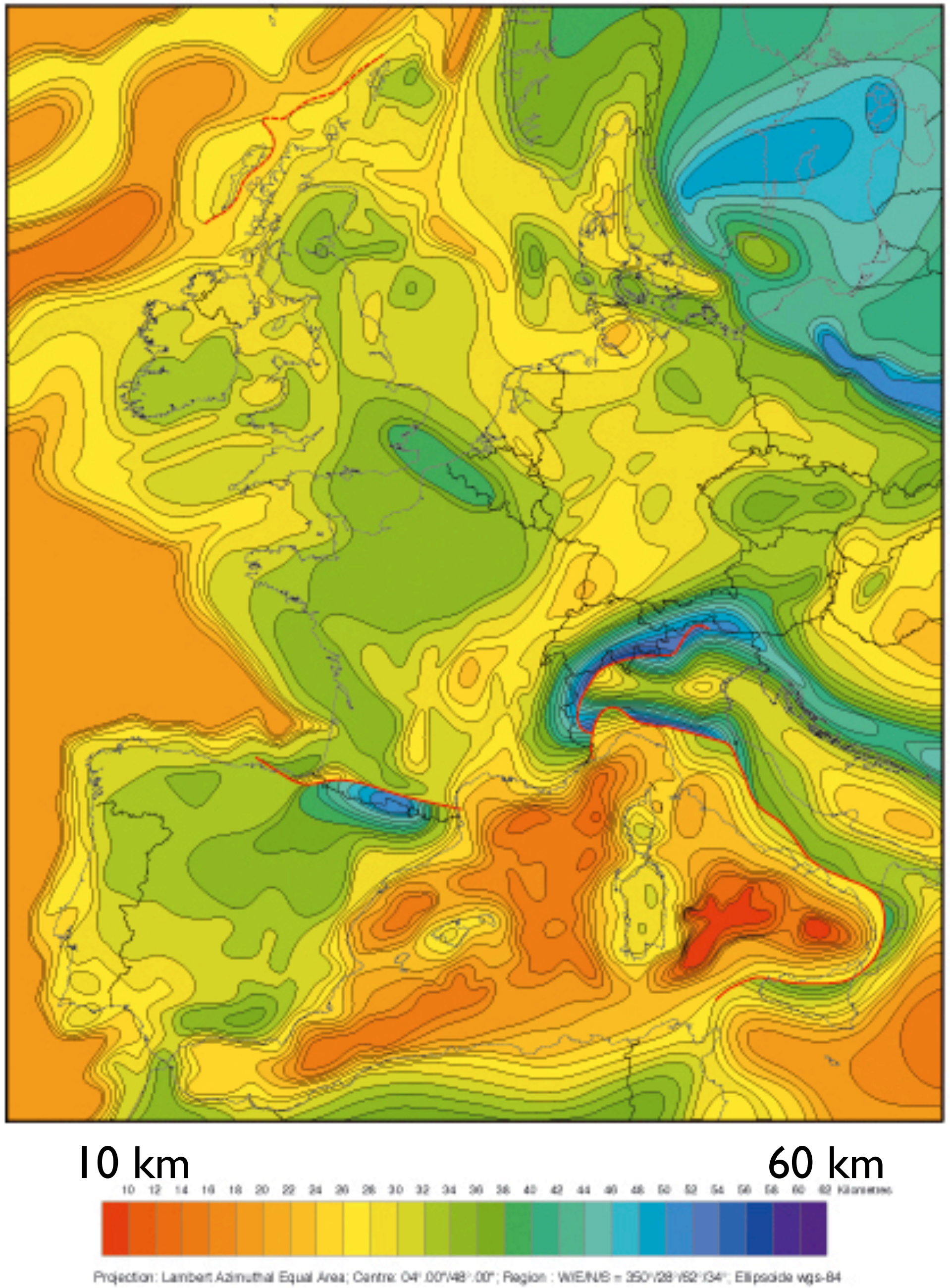
Seismische Grenzflächen

seismische Diskontinuitäten

Andrija Mohorovičić
(1857 - 1936)

1909 entdeckt Diskontinuität
von ~6 kms^{-1} auf ~8 kms^{-1}
zwischen Kruste und Mantel

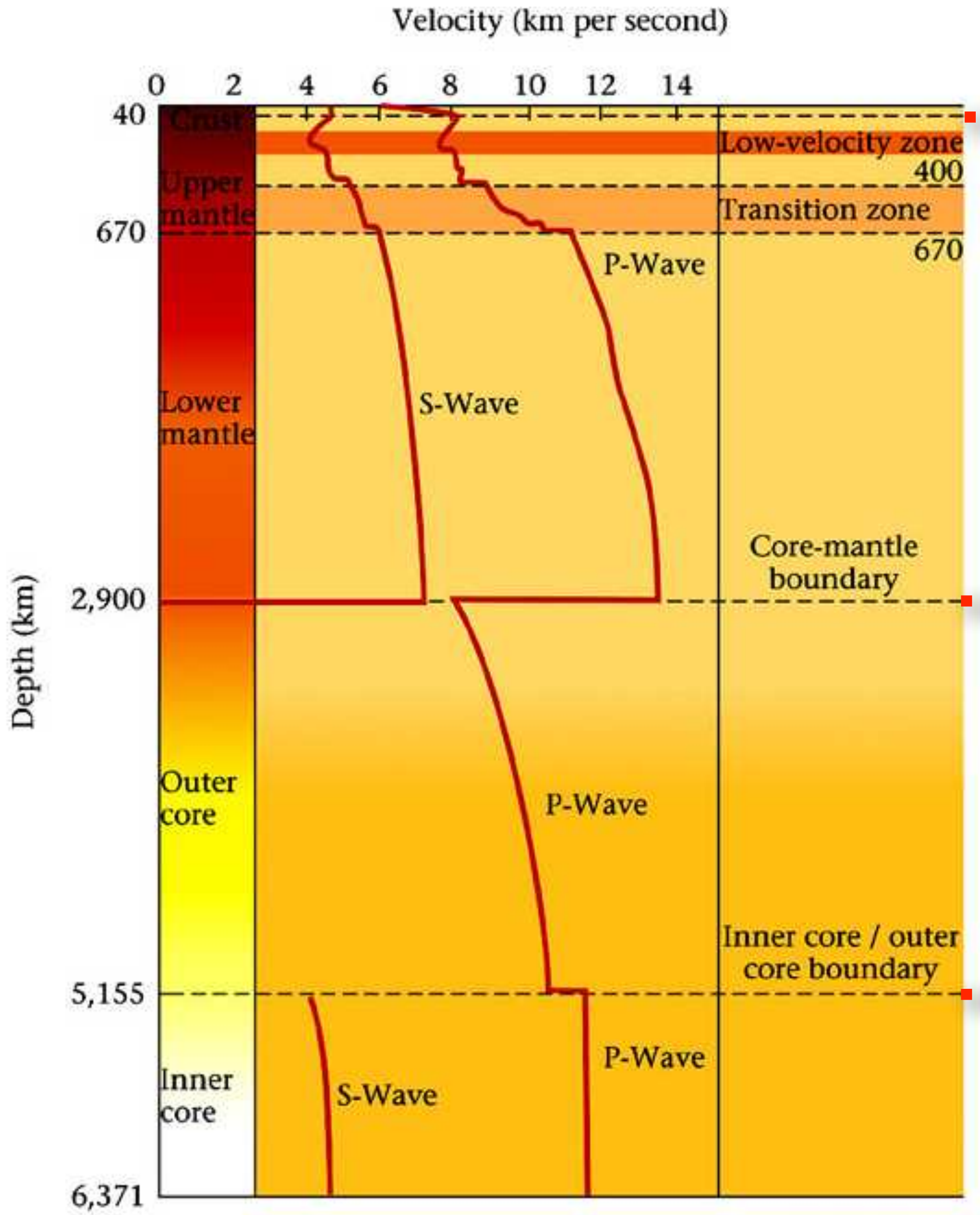
'Moho'



seismische Diskontinuitäten

Inge Lehmann
(1888 - 1993)

1936 entdeckt
Kern - Mantel-
Grenze

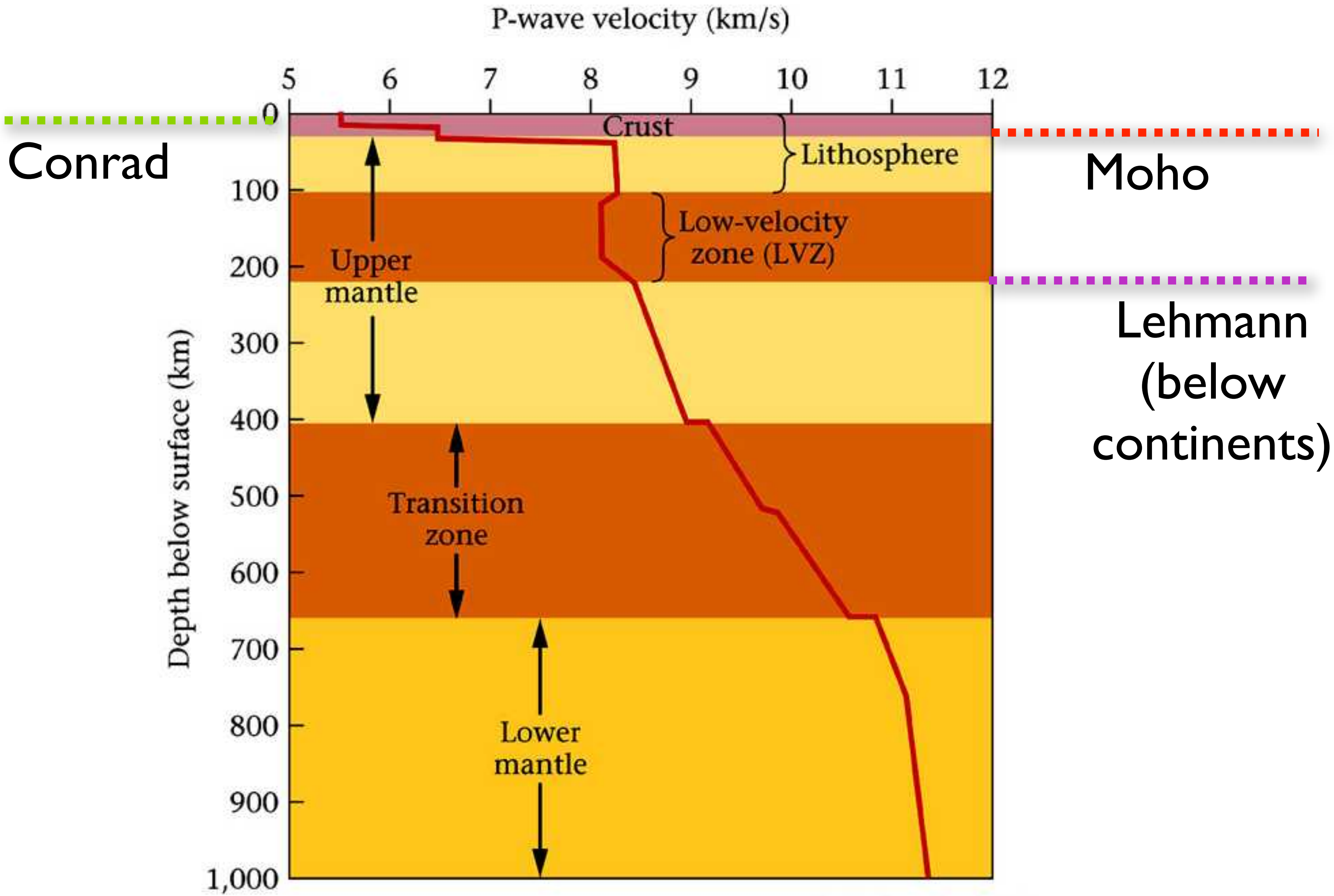


Mohorovicic

Gutenberg

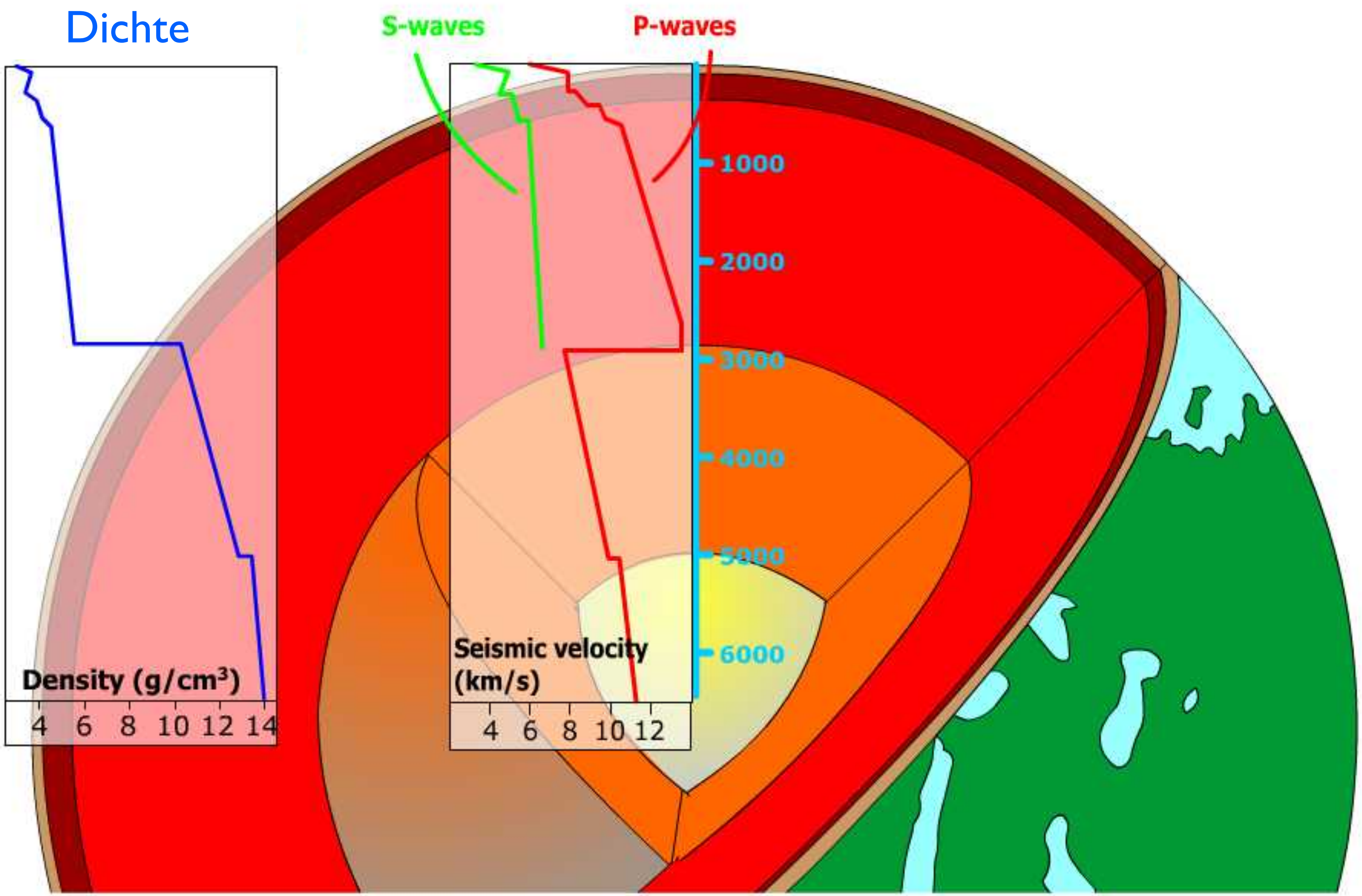
by Lehmann
(1936)

seismische Diskontinuitäten

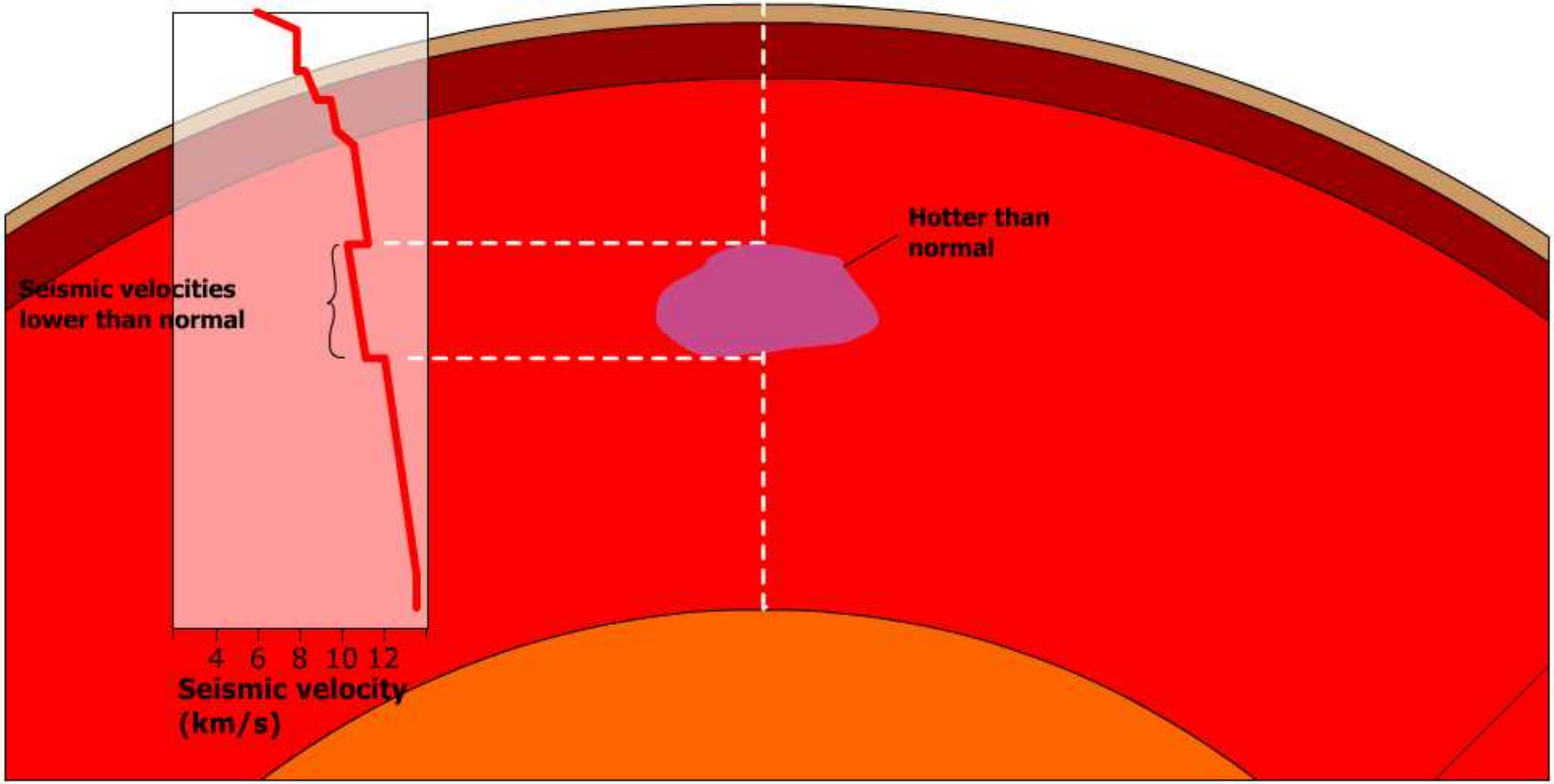


seismische Tomographie

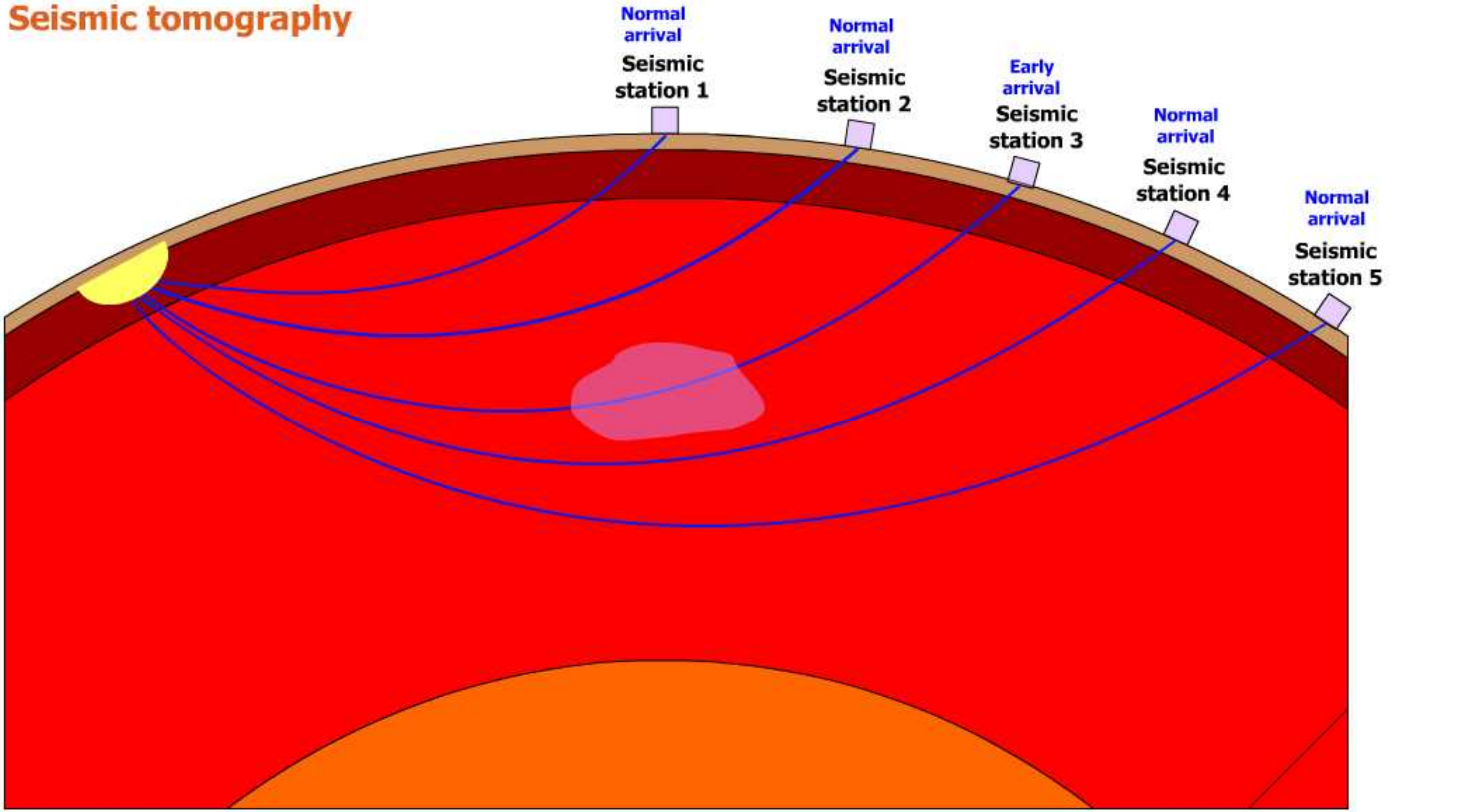
http://ansatte.uit.no/kku000/webgeology/ (Kåre Kullerud)
module: Mantle dynamics and plate tectonics



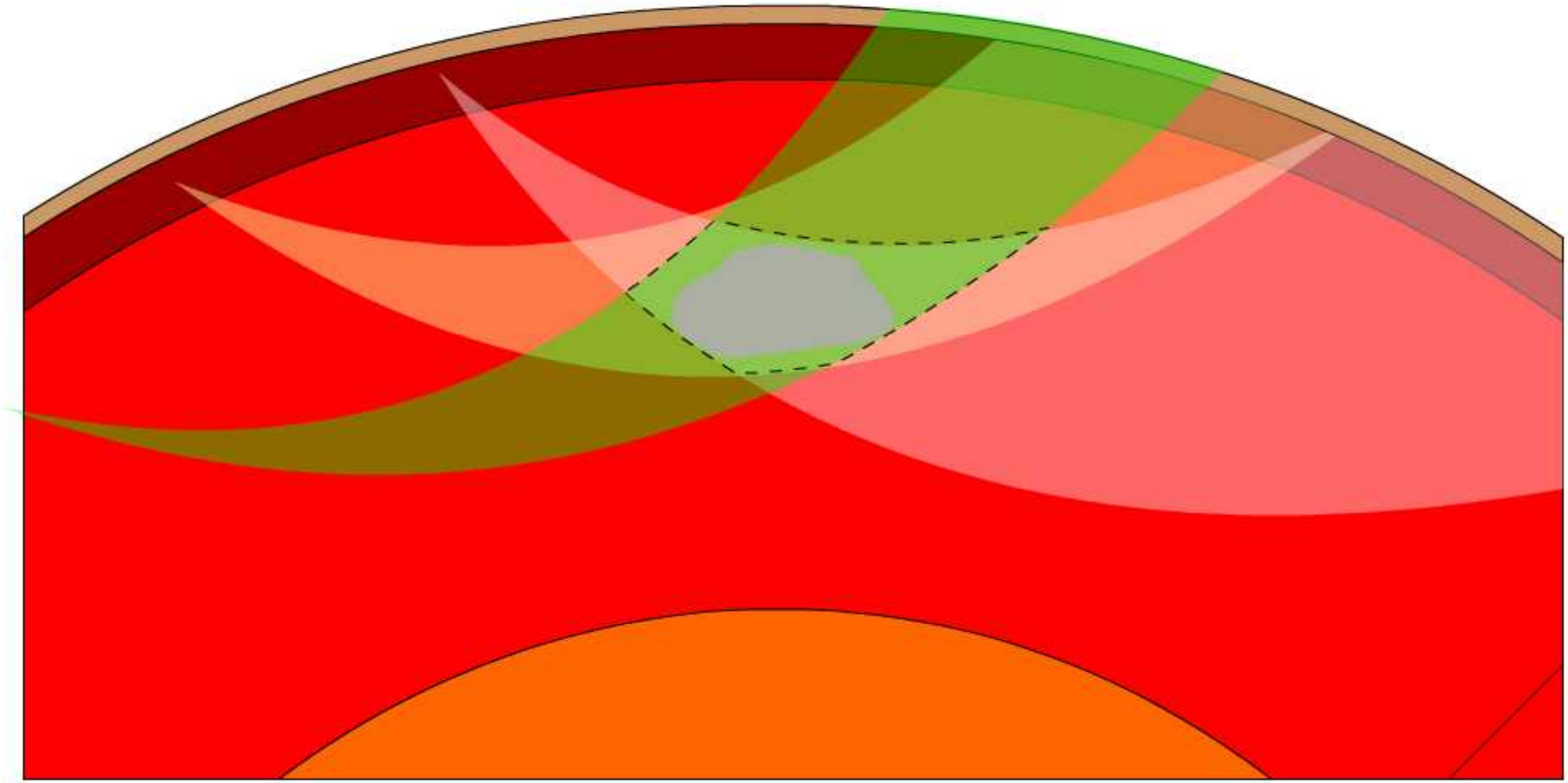
Temperature variations in the mantle

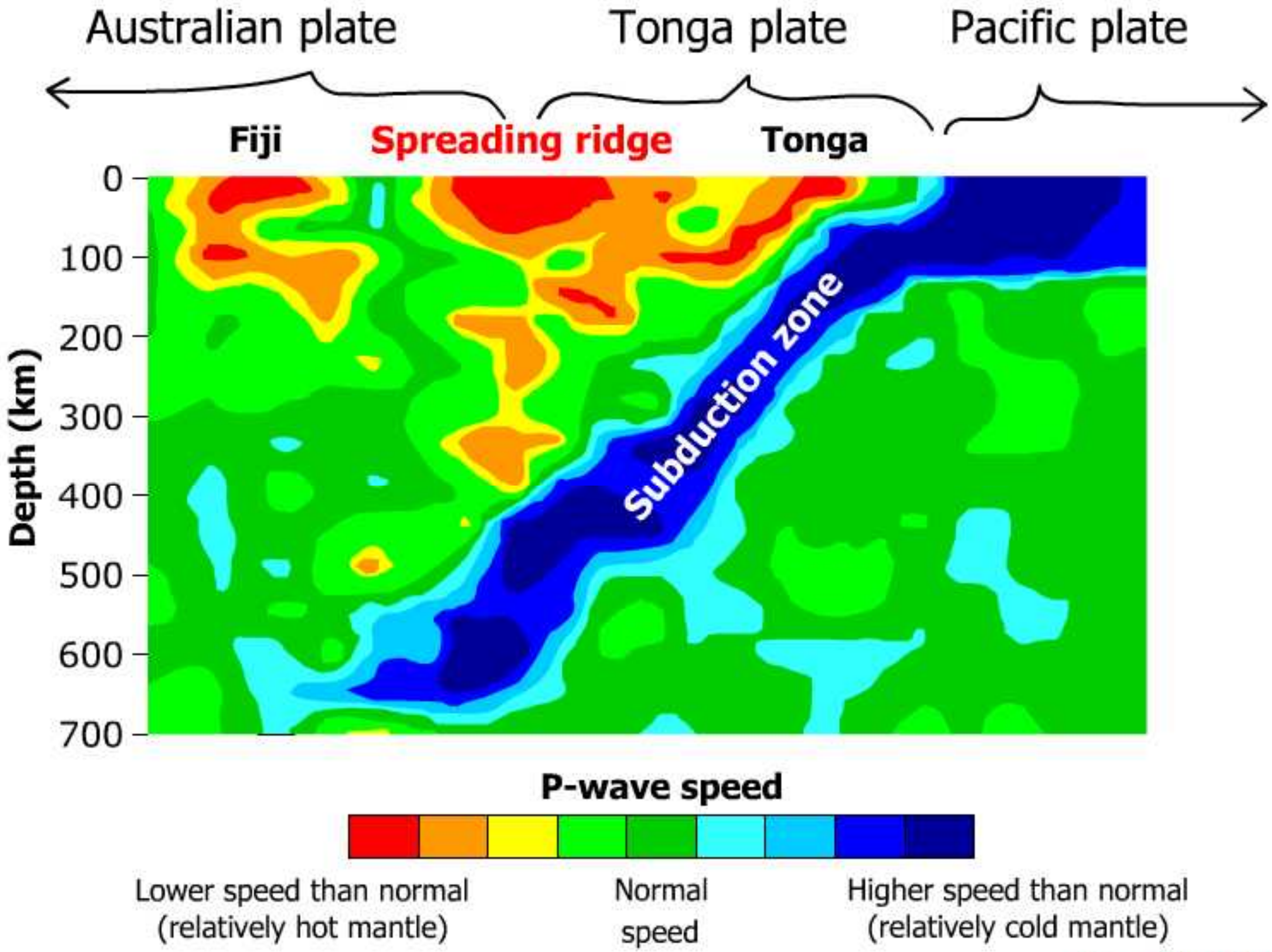


Seismic tomography



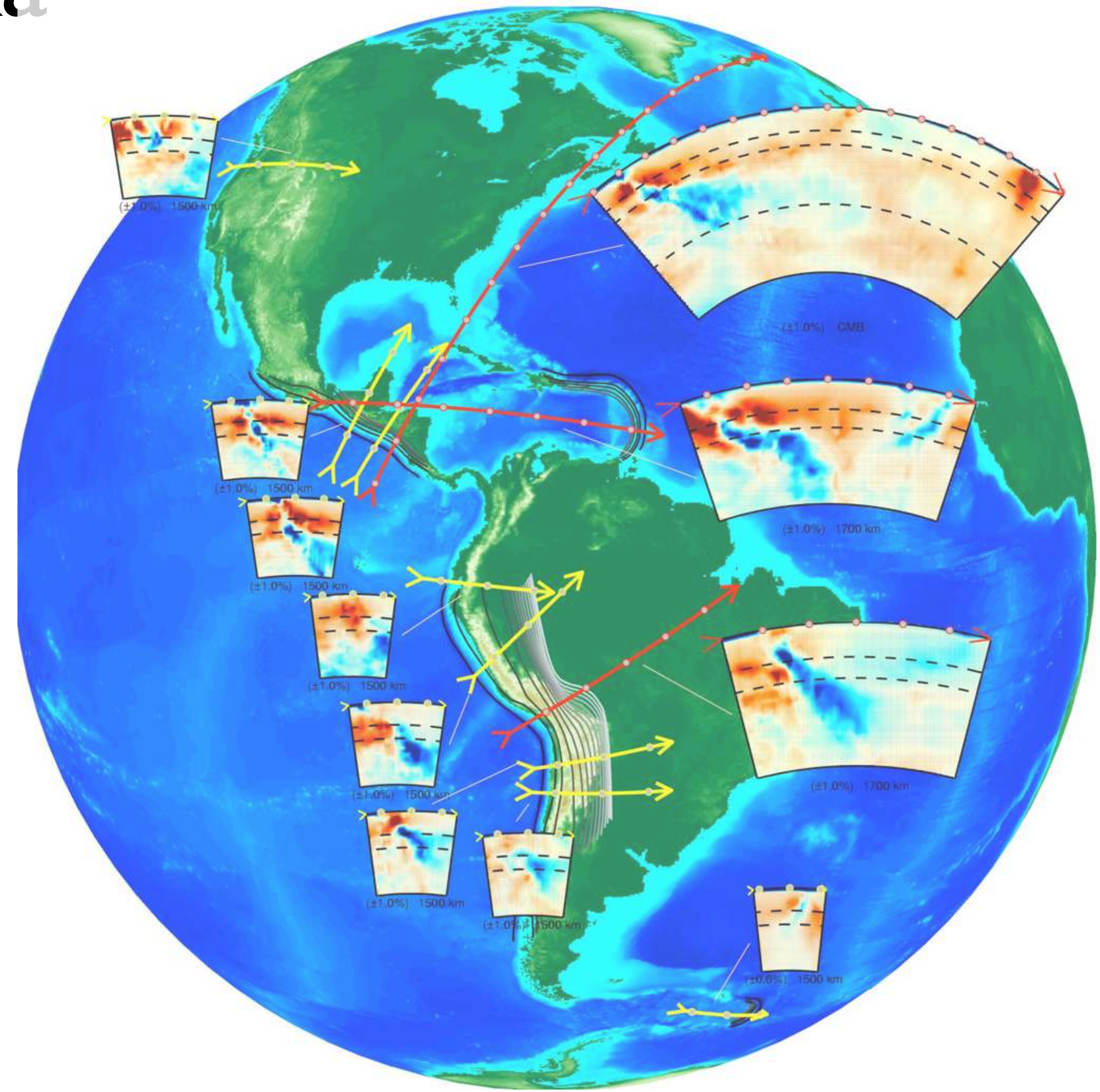
Seismic tomography





Source: Zhao & Kayal (2000)

S-Amerika



(±1.0%) 1500 km
(±1.0%) CMB
(±1.0%) 1500 km
(±1.0%) 1700 km
(±1.0%) 1500 km
(±1.0%) 1500 km
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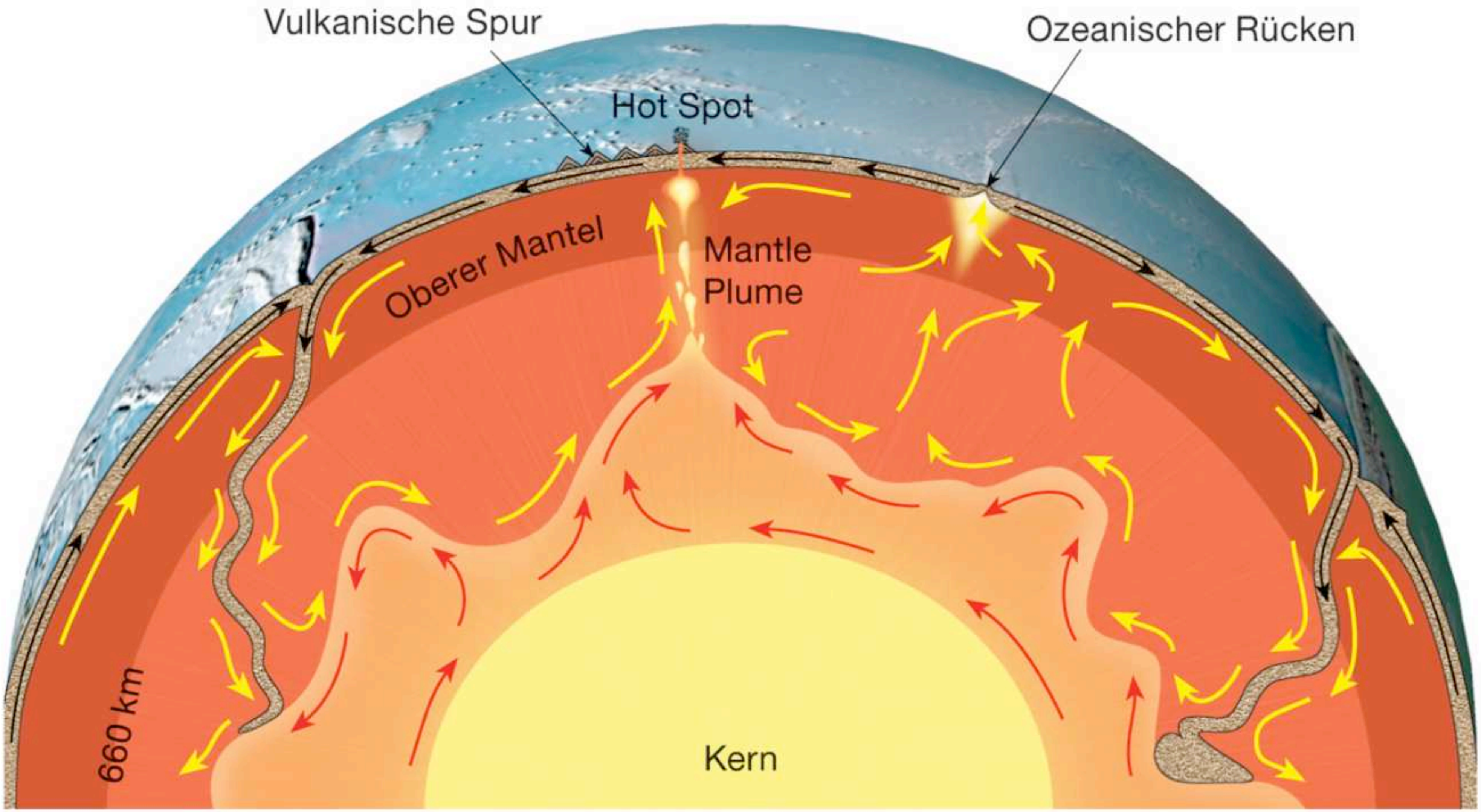
(±1.0%) 1500 km
(±1.0%) 1500 km
(±1.0%) 1500 km
1500 km

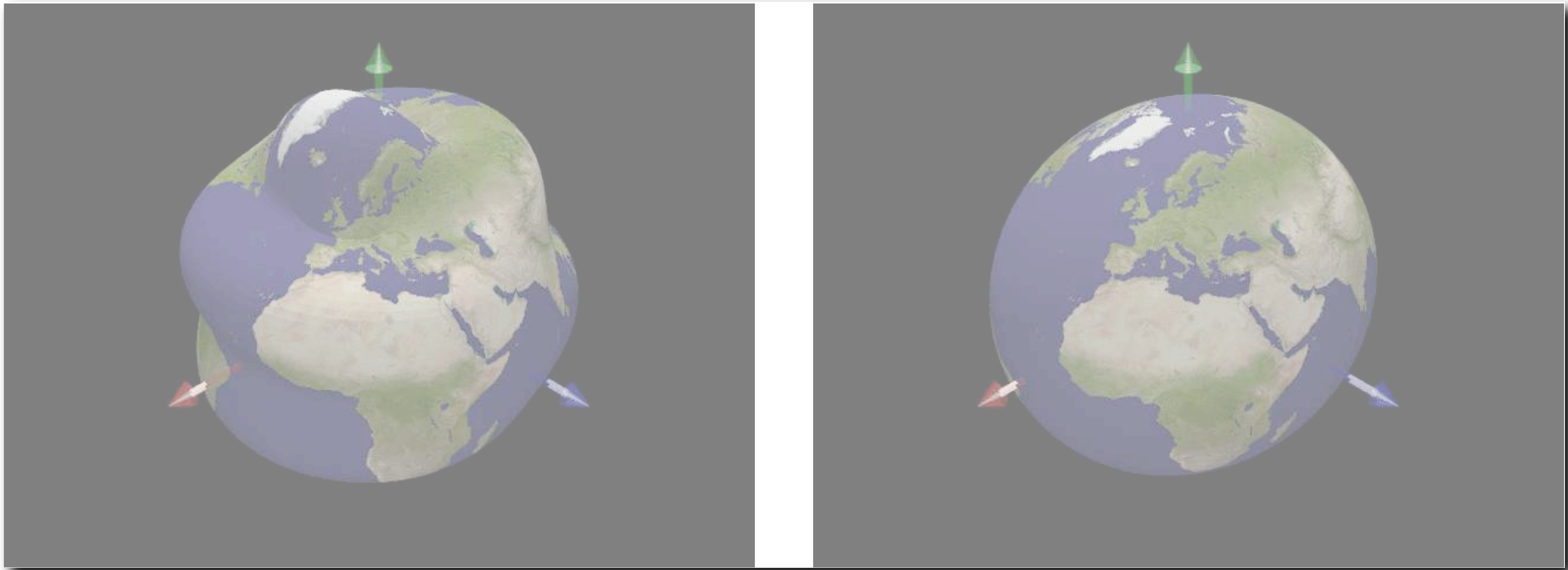
Konvektionsmodelle



C. Lagenstruktur im tiefen Mantel

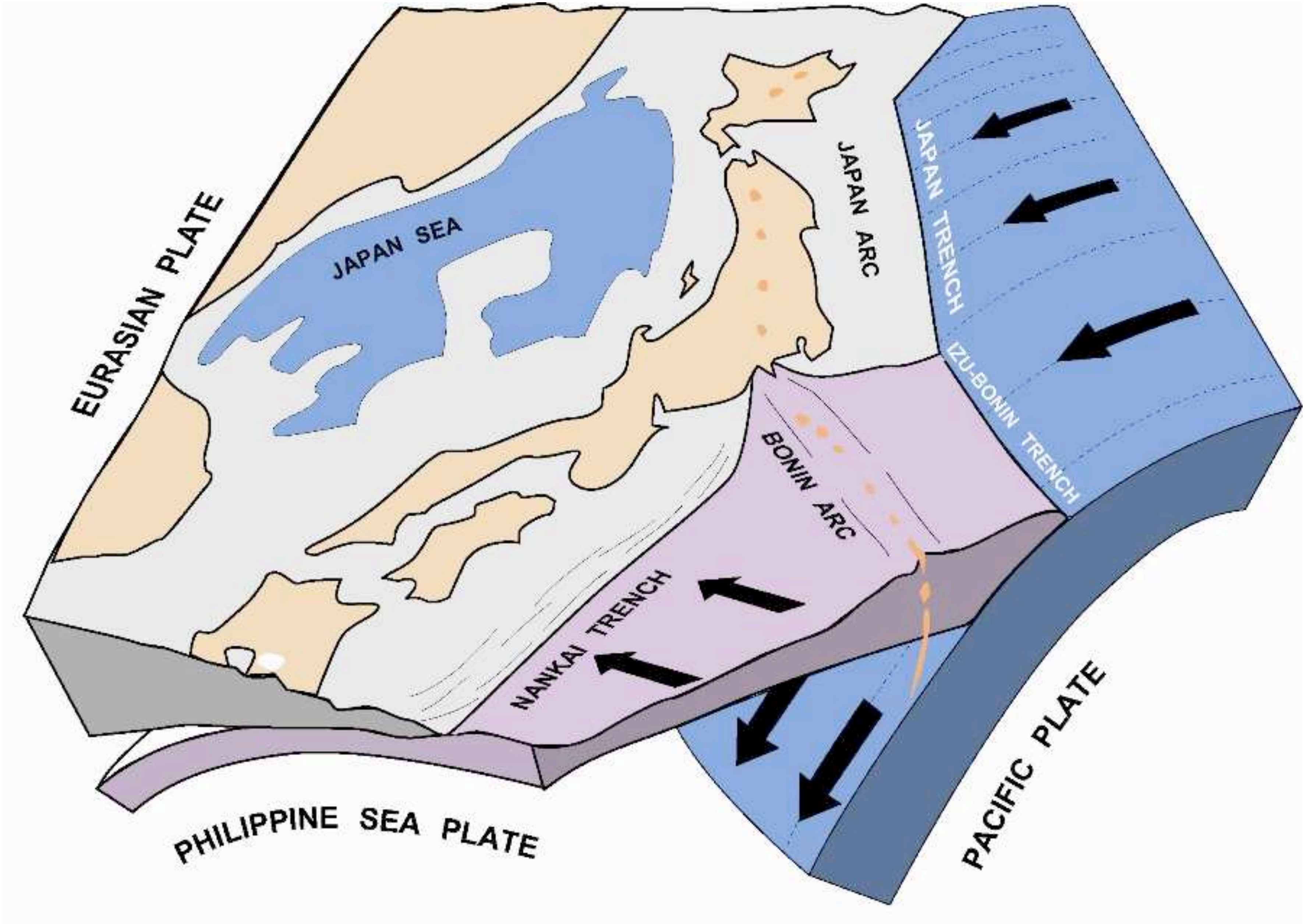
Oszillationen

Oszillationen



berühmte Erdbeben Subduktion 3

Japan, 11. 3. 2011 Mw = 9.0



Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

USGS

Japan was struck by a magnitude 9.0 earthquake off its northeastern coast Friday. This is one of the largest earthquakes that Japan has ever experienced.

In downtown Tokyo, large buildings shook violently and there is severe flooding due to a tsunami generated by the earthquake.

Part of houses swallowed by tsunami burn in Sendai, Miyagi Prefecture (state) after Japan was struck by a strong earthquake off its northeastern coast Friday, March 11, 2011.

New York Times

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Tsunami waves swept away houses and cars in northern Japan and pushed ships aground.

The tsunami waves traveled far inland, the wave of debris racing across the farmland, carrying boats and houses with it.

The tsunami, seen crashing into homes in Natori, Miyagi prefecture. *AP*

Houses were washed away by tsunami in Sendai, Miyagi Prefecture in eastern Japan, after Japan was struck by a magnitude 9.0 earthquake off the northeastern coast.

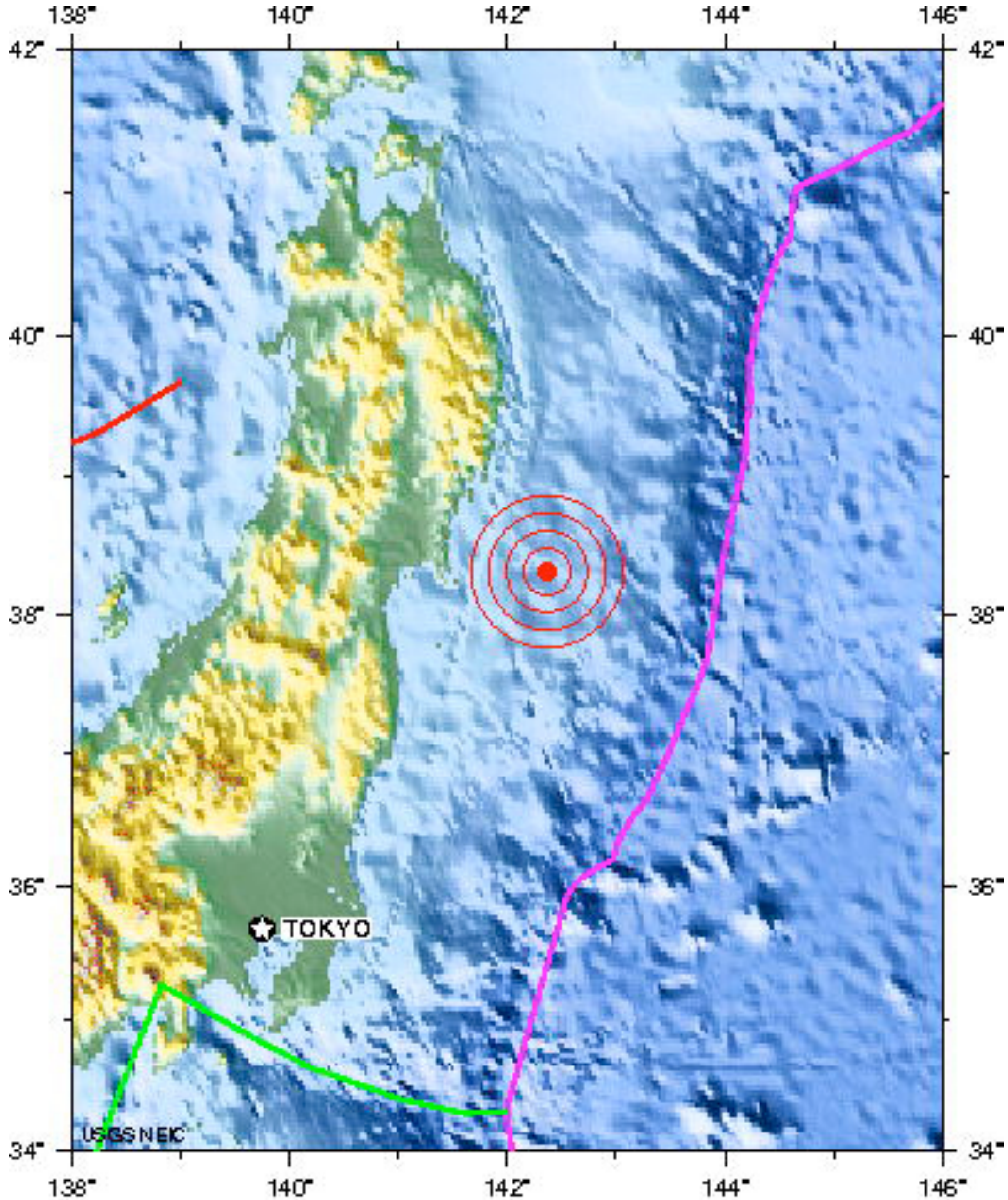
New York Times

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

Friday, March 11, 2011 at 05:46:23 UTC

This earthquake occurred 130 km (80 miles) east of Sendai, Honshu, Japan and 373 km (231 miles) northeast of Tokyo, Japan.

Images courtesy of the US Geological Survey



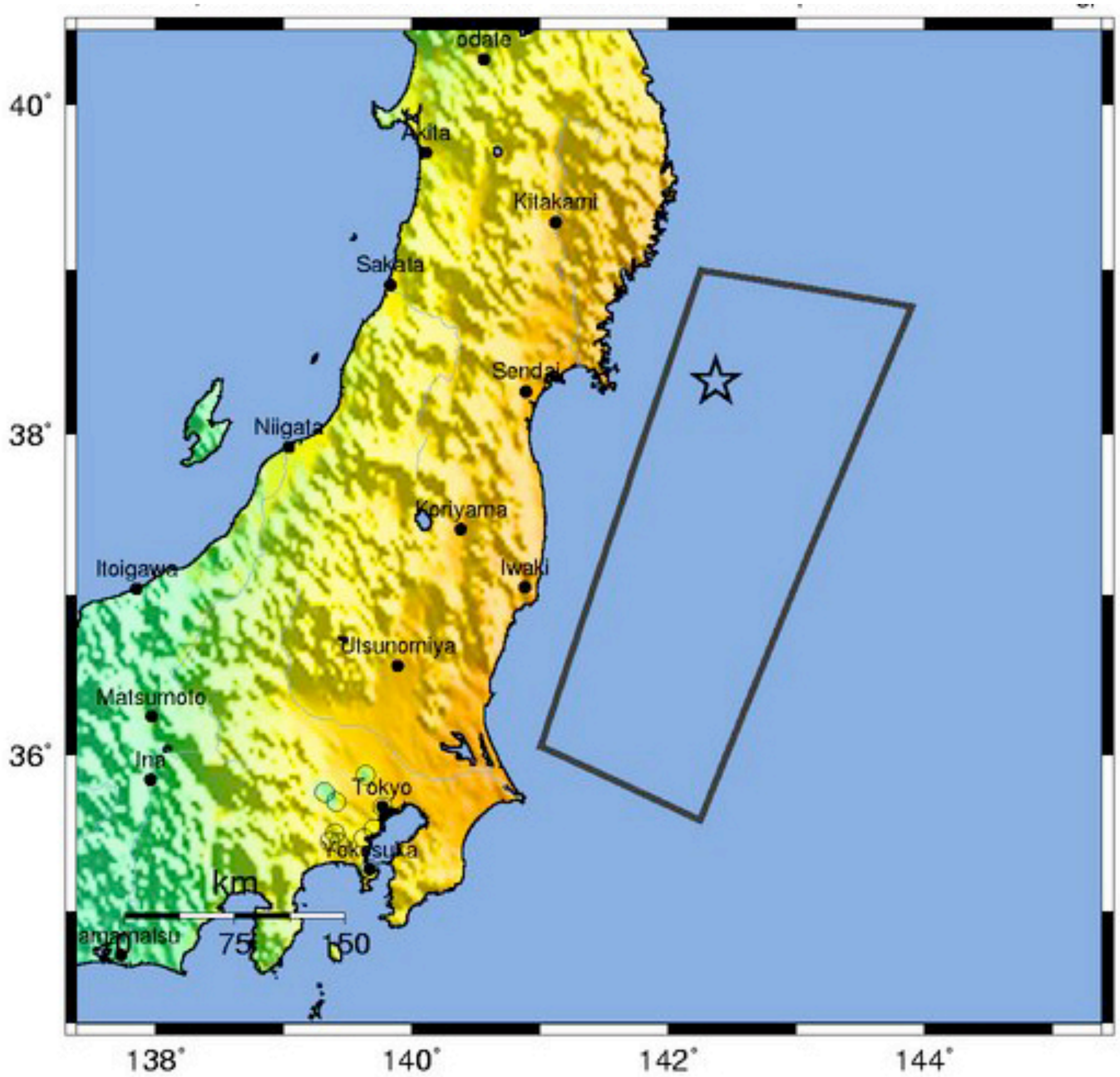
IRIS
Teachable Moments

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Shaking intensity scales were developed to standardize the measurements and ease comparison of different earthquakes. The Modified-Mercalli Intensity scale is a twelve-stage scale, numbered from I to XII. The lower numbers represent imperceptible shaking levels, XII represents total destruction. A value of IV indicates a level of shaking that is felt by most people.

Modified Mercalli Intensity	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt

Image courtesy of the US Geological Survey



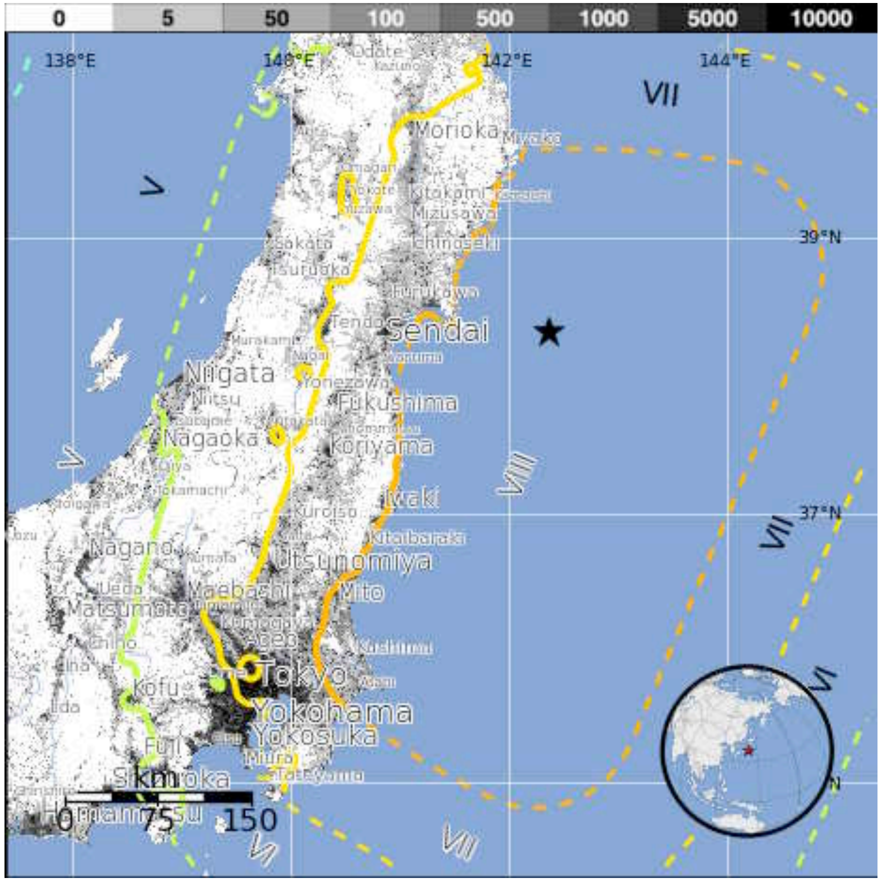
USGS Estimated shaking Intensity from M 9.0 Earthquake

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. MMI describes the severity of an earthquake in terms of its effect on humans and structures and is a rough measure of the amount of shaking at a given location.

Overall, the population in this region resides in structures that are resistant to earthquake shaking.

USGS PAGER
Population Exposed to Earthquake Shaking



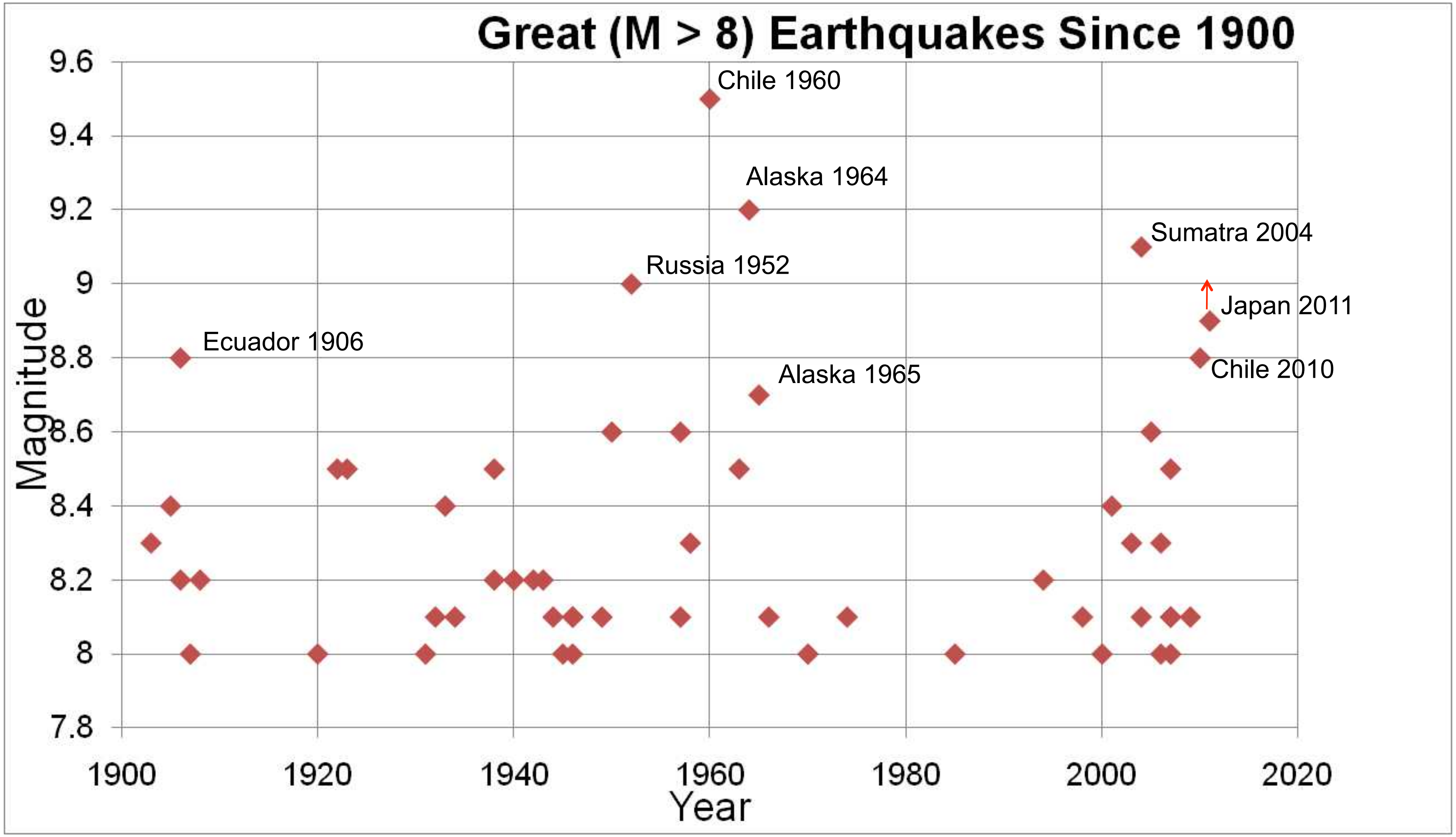
The color coded contour lines outline regions of MMI intensity. The total population exposure to a given MMI value is obtained by summing the population between the contour lines. The estimated population exposure to each MMI Intensity is shown in the table below.

Image courtesy of the US Geological Survey

Estimated Modified Mercalli Intensity	I	II-III	IV	V	VI	VII	VIII	IX	X
Est. Population Exposure	--*	--*	--*	7,071k*	19,695k*	29,969k*	2,144k	0	0
Perceived Shaking	Not Felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Globally, this is the 4th largest earthquake since 1900.



Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

Friday, March 11, 2011 at 05:46:23 UTC

Earthquake and Historical Seismicity

This earthquake (gold star), plotted with regional seismicity since 1990, occurred at approximately the same location as the March 9, 2011 M 7.2 earthquake.

In a cluster, the earthquake with the largest magnitude is called the main shock; anything before it is a foreshock and anything after it is an aftershock. A main shock will be redefined as a foreshock if a subsequent event has a larger magnitude.

This earthquake redefines the M 7.2 earthquake as a foreshock, with this event replacing it as the main shock.

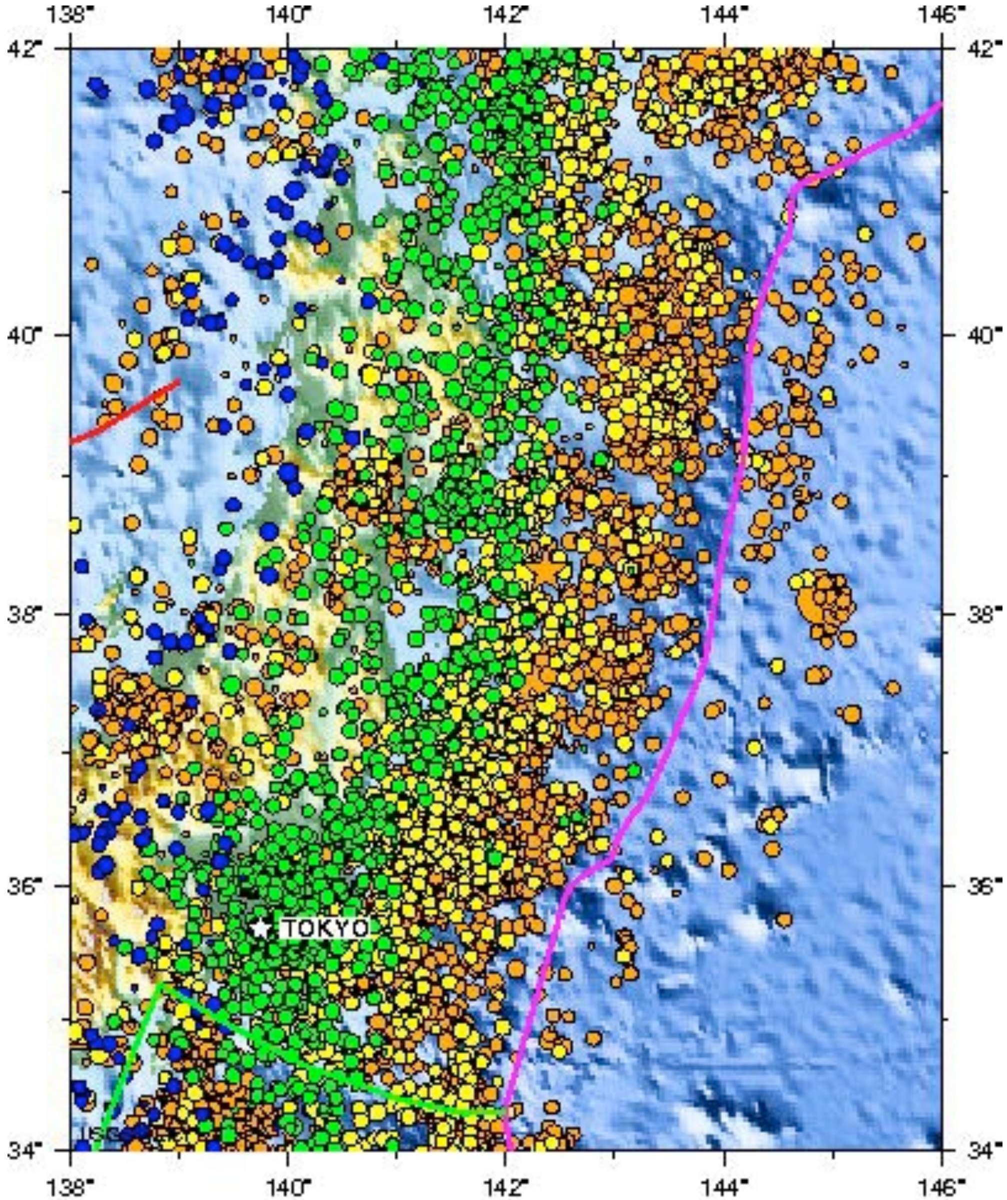
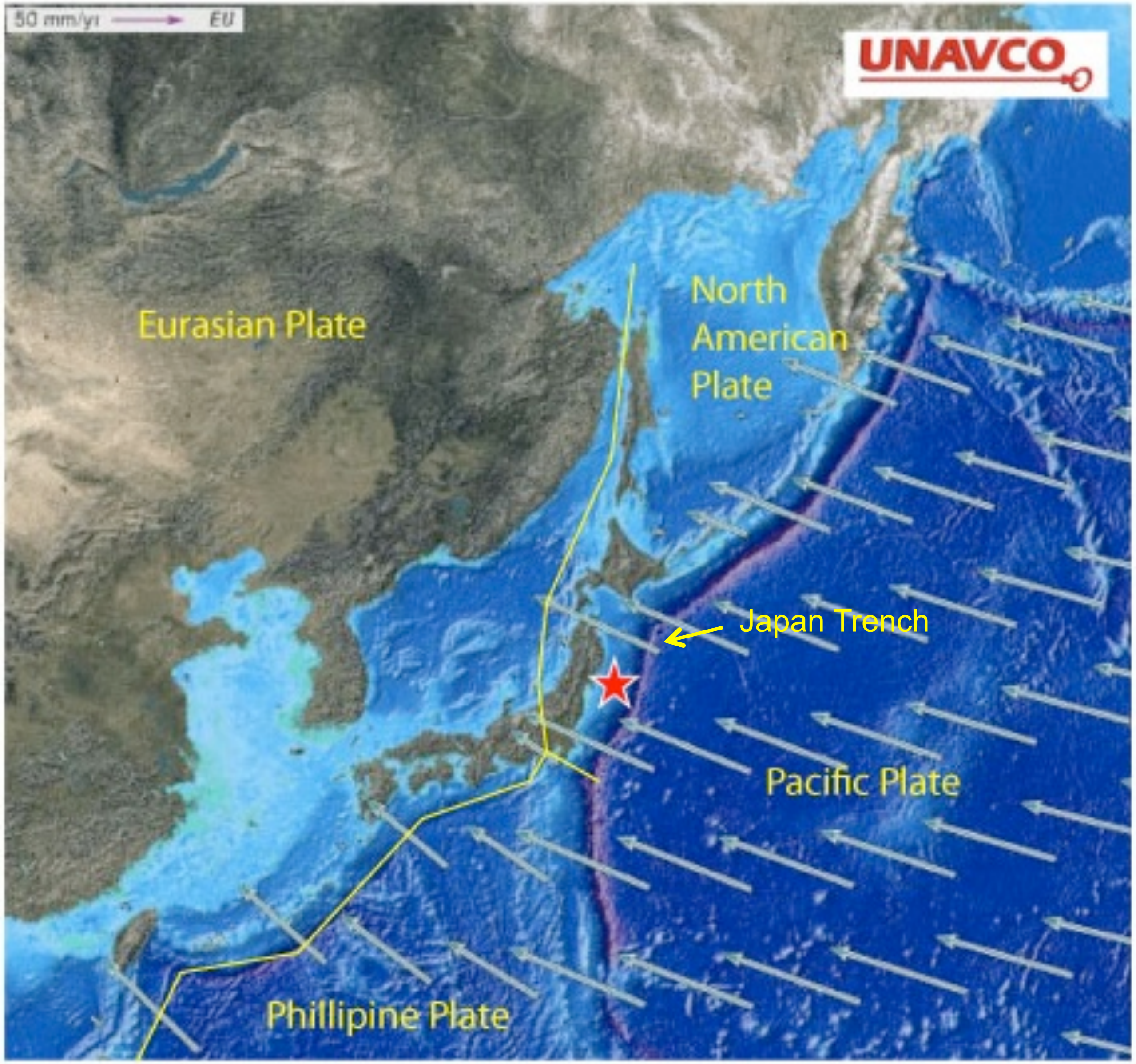


Image courtesy of the US Geological Survey

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

This earthquake was the result of thrust faulting along or near the convergent plate boundary where the Pacific Plate subducts beneath Japan.

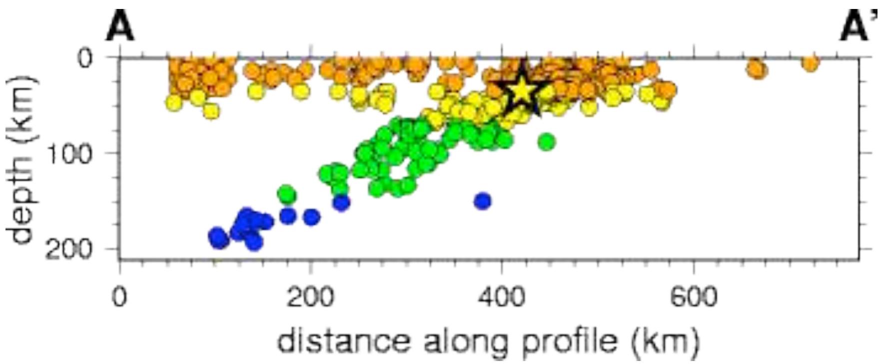
This map also shows the rate and direction of motion of the Pacific Plate with respect to the Eurasian Plate near the Japan Trench. The rate of convergence at this plate boundary is about 83 mm/yr (8 cm/year). This is a fairly high convergence rate and this subduction zone is very seismically active.



Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

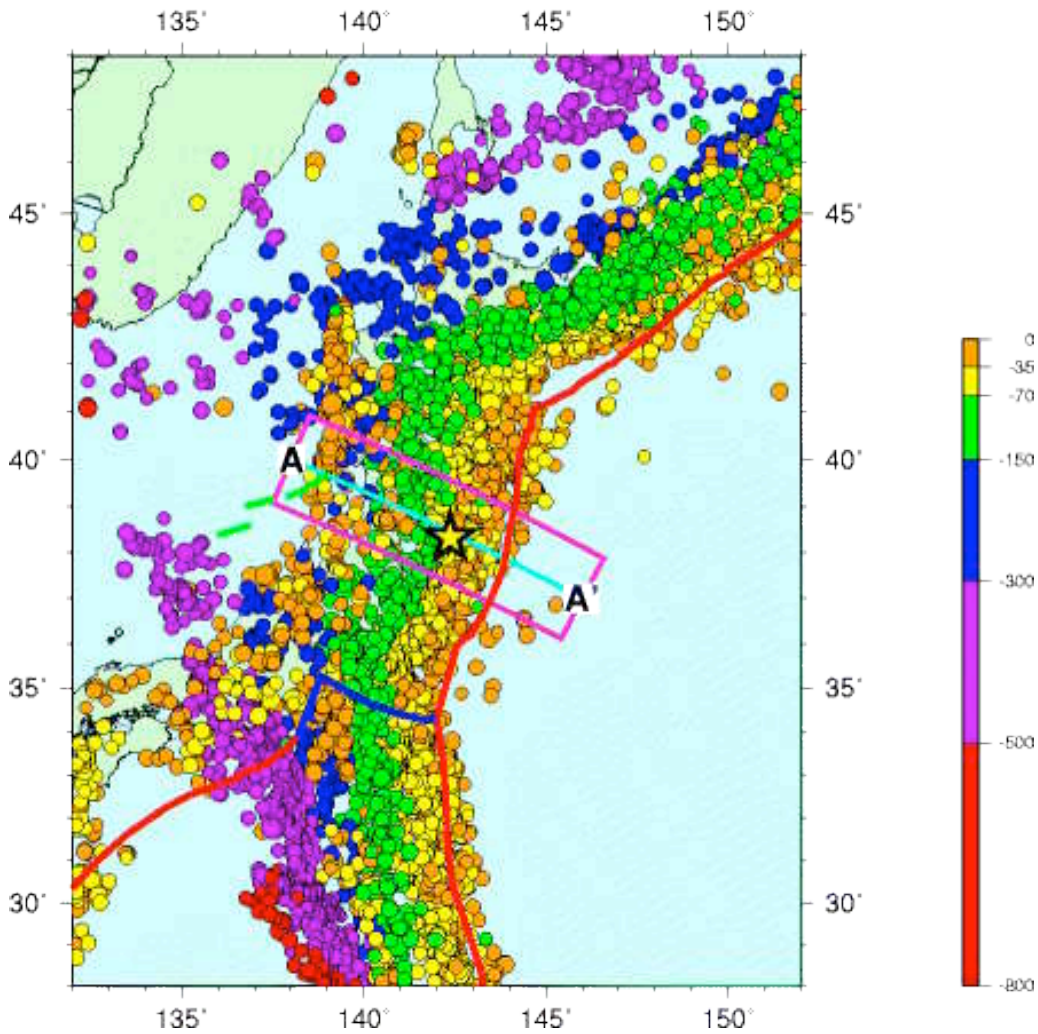
The map on the right shows historic earthquake activity near the epicenter (star) from 1990 to present.

As shown on the cross section, earthquakes are shallow (orange dots) at the Japan Trench and increase to 300 km depth (blue dots) towards the west as the Pacific Plate dives deeper beneath Japan.



Seismicity Cross Section across the subduction zone showing the relationship between color and earthquake depth.

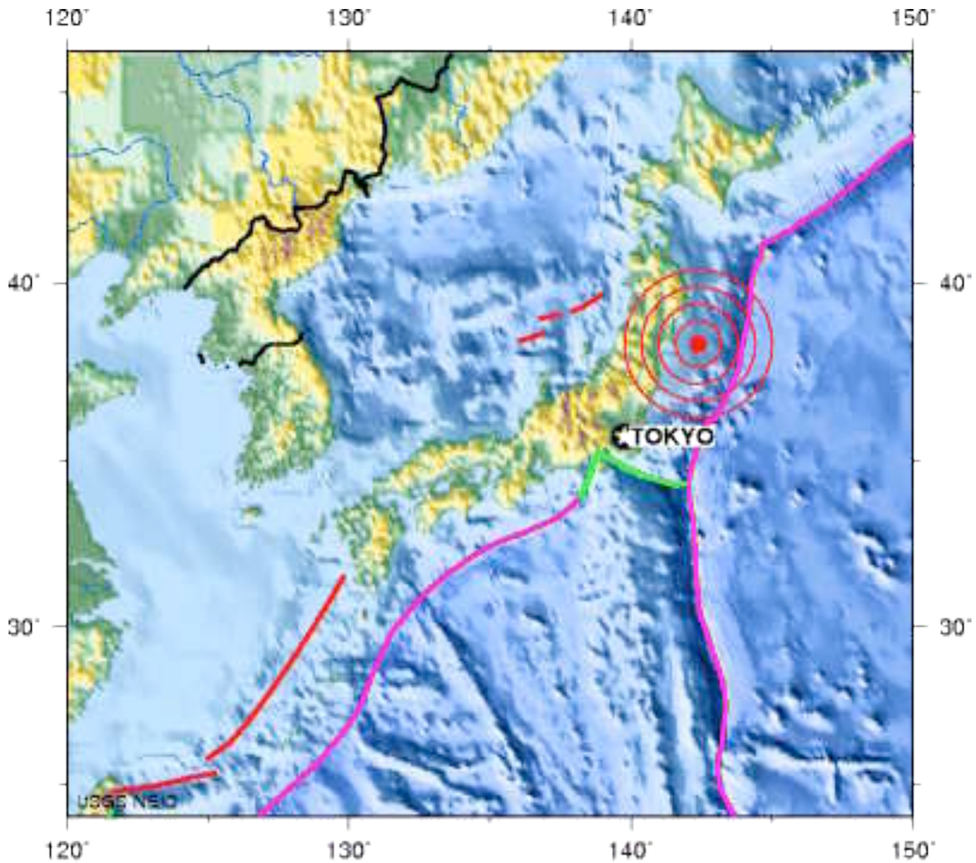
Seismicity Cross Section

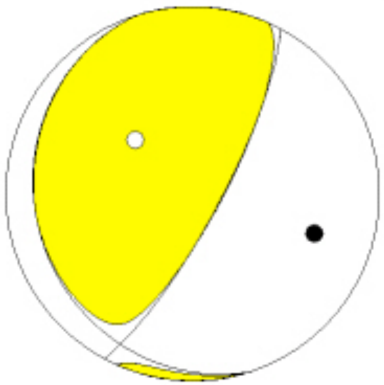


Images courtesy of the US Geological Survey

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

At the latitude of this earthquake, the Pacific plate moves approximately westwards with respect to the Eurasian plate at a velocity of 83 mm/yr. The Pacific plate thrusts underneath Japan at the Japan Trench, and dips to the west beneath Eurasia. The location, depth, and focal mechanism of the March 11 earthquake are consistent with the event having occurred as thrust faulting associated with subduction along this plate boundary.





Shaded areas show quadrants of the focal sphere in which the P-wave first-motions are away from the source, and unshaded areas show quadrants in which the P-wave first-motions are toward the source. The dots represent the axis of maximum compressional strain (in black, called the "P-axis") and the axis of maximum extensional strain (in white, called the "T-axis") resulting from the earthquake.

USGS Centroid Moment Tensor Solution

IRIS Teachable Moments

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Large earthquakes involve slip on a fault surface that is progressive in both space and time. This “map” of the slip on the fault surface of the M 9.0 Japan earthquake shows how fault displacement propagated outward from an initial point (or focus) about 24 km beneath the Earth’s surface. The rupture extended over 500 km along the length of the fault, and from the Earth’s surface to depths of over 50 km.

Image courtesy of the U.S. Geological Survey

Cross-section of slip distribution. The strike direction of the fault plane is indicated by the black arrow and the hypocenter location is denoted by the red star. The slip amplitude are showed in color and motion direction of the hanging wall relative to the footwall is indicated by black arrows. Contours show the rupture initiation time in seconds.

Teachable Moments

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Although magnitude is still an important measure of the size of an earthquake, particularly for public consumption, seismic moment is a more physically meaningful measure of earthquake size. Seismic moment is proportional to the product of the slip on the fault and the area of the fault that slips.

This graph of the moment rate function describes the rate of moment release with time after earthquake origin.

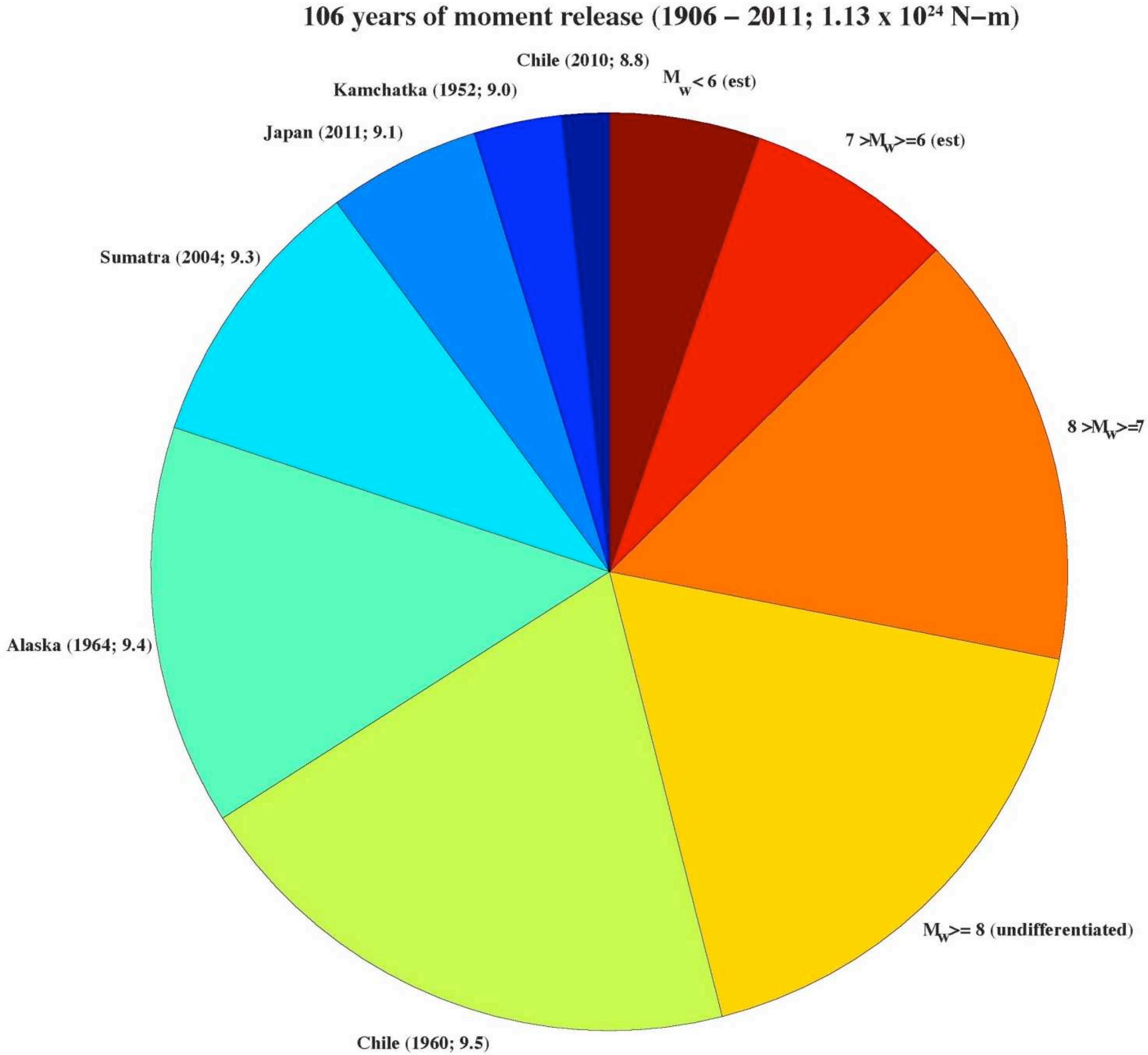
The largest amounts of rupture occurred over 100 seconds but smaller displacements continued for another 75 seconds after the start of the earthquake.

Image courtesy of the U.S. Geological Survey

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

The moment magnitude scale is designed to give an accurate characterization of the true size of an earthquake, but be tied to the original description of magnitude that was developed by Charles Richter. Moment magnitude accounts for earthquake size by looking at all the energy released.

It is striking that only 6 earthquakes over the last 106 years account for over half of the energy released during that time.

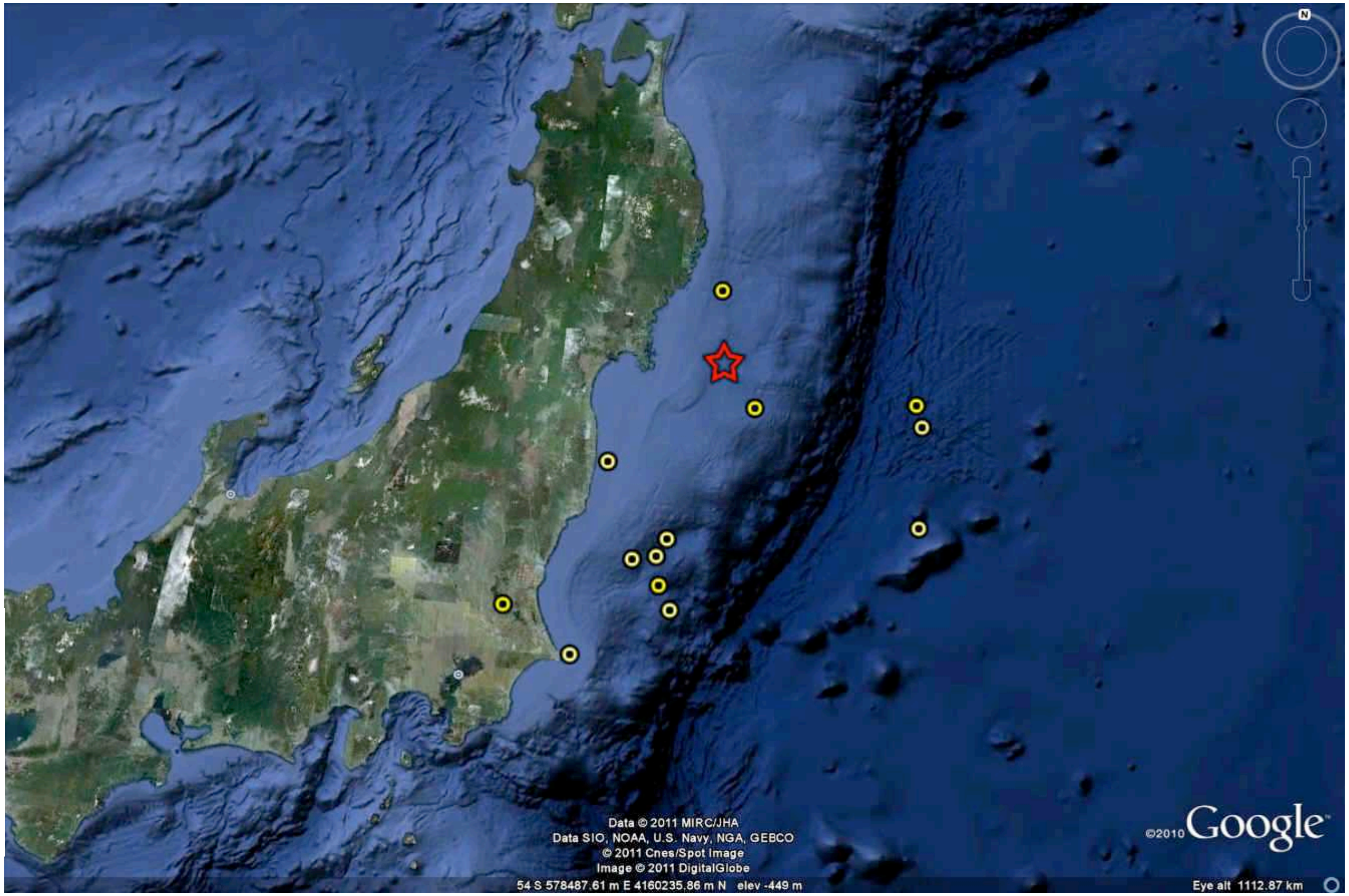


New Mexico Institute of Mining and Technology

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

This earthquake was preceded by a series of large foreshocks over the previous two days, beginning on March 9th with an M 7.2 event approximately 40 km from the March 11 earthquake, and continuing with 3 earthquakes greater than M 6 on the same day.

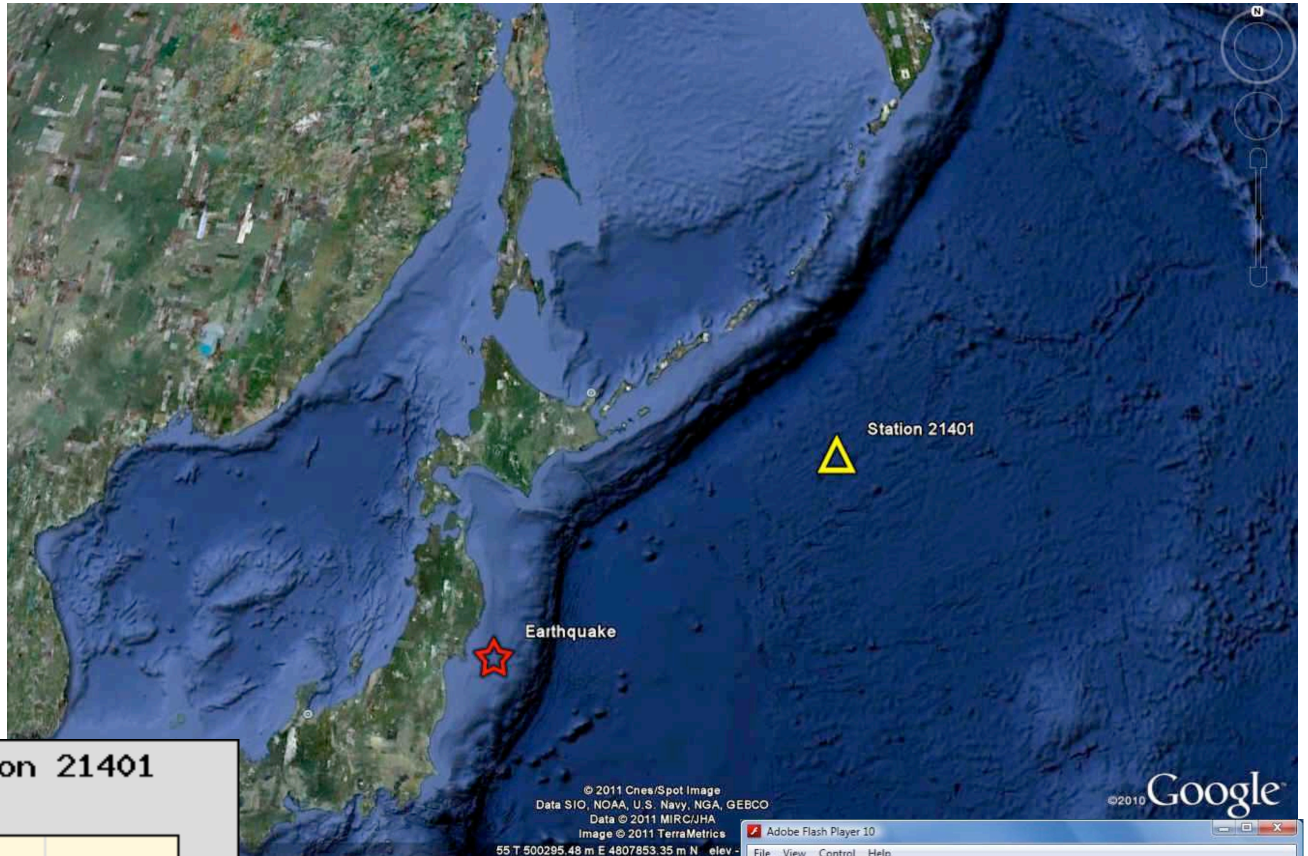
The M 9.0 earthquake has been followed by frequent large aftershocks, which can do damage on their own especially to buildings that were compromised in the main shock.

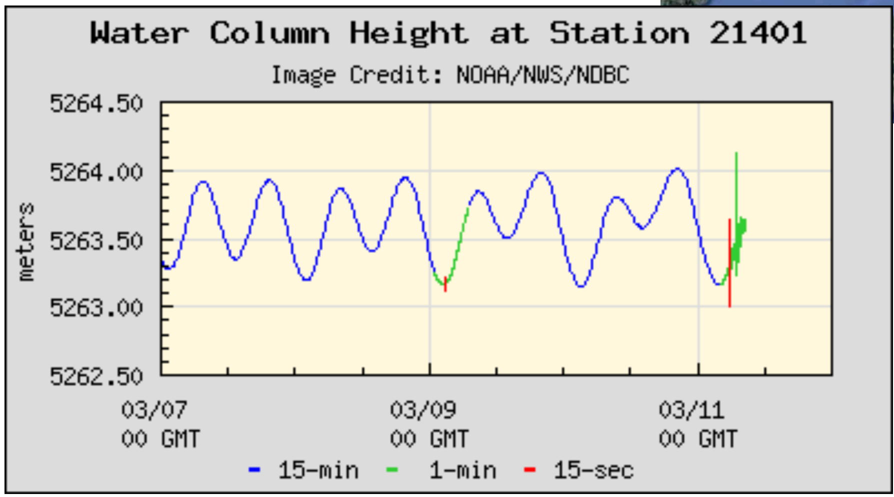


The M 9.0 main shock (red star) is plotted with 14 aftershocks larger than magnitude 6.0 that occurred in the first 6 hours after the earthquake. This includes a magnitude 7.1.

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

Shallow great earthquakes in subduction zones often cause tsunamis when they offset the ocean floor. This offset generates tsunami waves. This earthquake did produce a tsunami, which was measured on a nearby buoy and triggered the warning system.





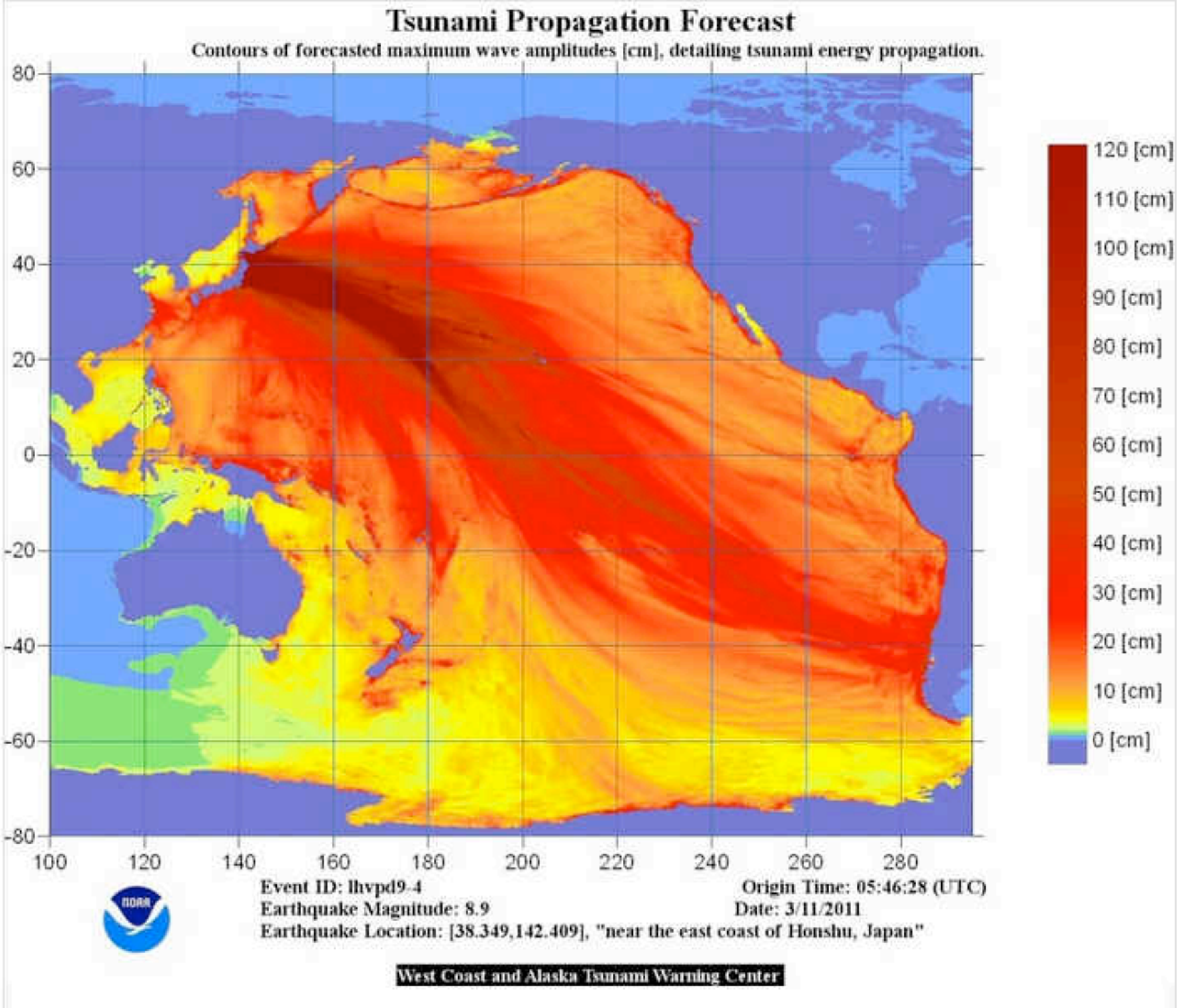
The water column height change that triggered the system.

Flash animation of how the DART system detects ocean waves

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

This tsunami propagation forecast model shows the forecast maximum tsunami wave height (in cm). Ocean floor bathymetry affects the wave height because a tsunami moves the seawater all the way to the floor of the ocean.

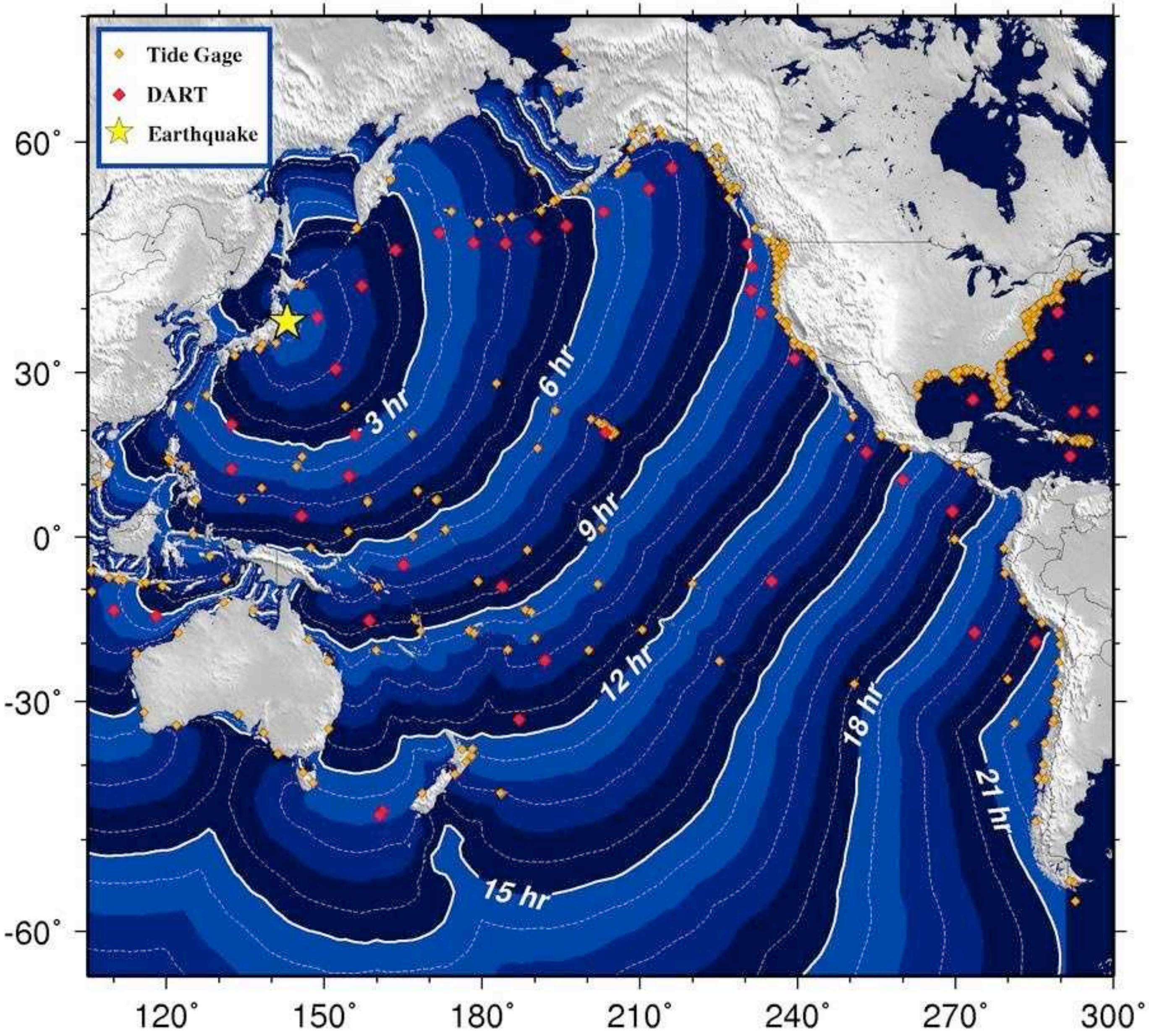
This led to a Pacific wide tsunami warning being issued.



Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN
Friday, March 11, 2011 at 05:46:23 UTC

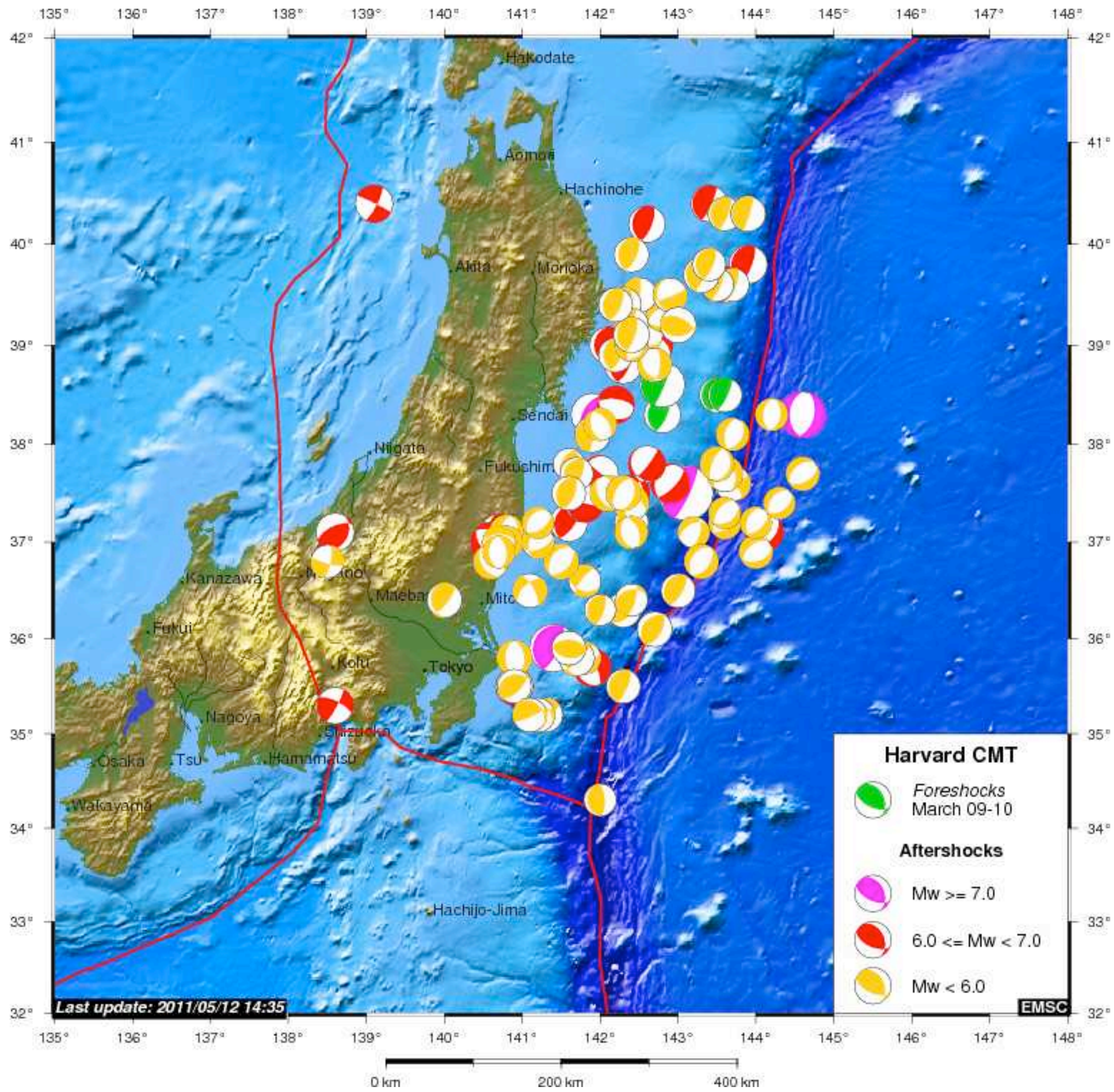
Projected travel times for the arrival of the tsunami waves across the Pacific.

Nearby the earthquake there are only minutes to evacuate. However, in many other regions there is advance warning.

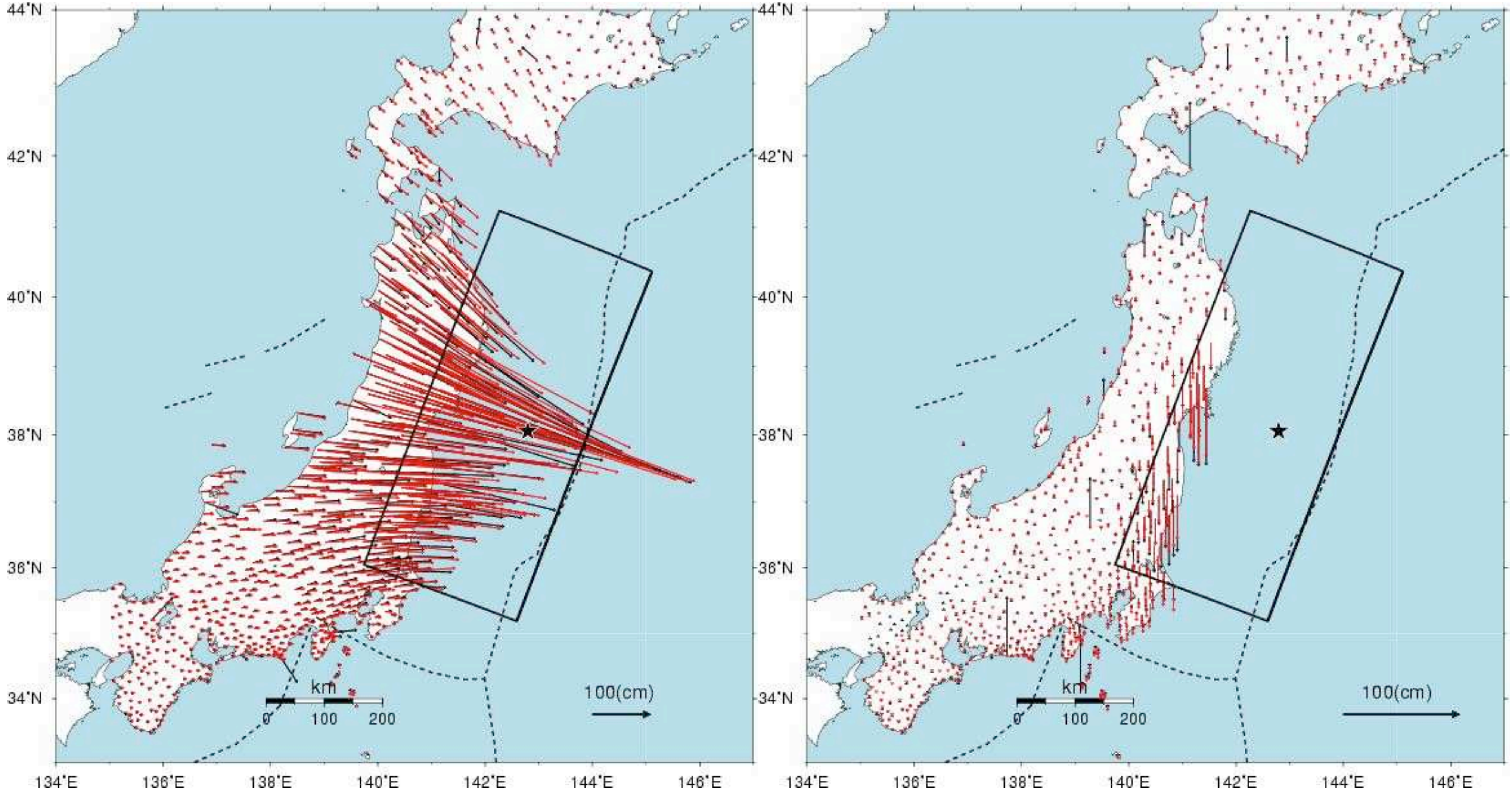


A tsunami map shows projected travel times for the Pacific Ocean. This map indicates forecasted times only, not that a wave traveling those distances has actually been observed.. NOAA

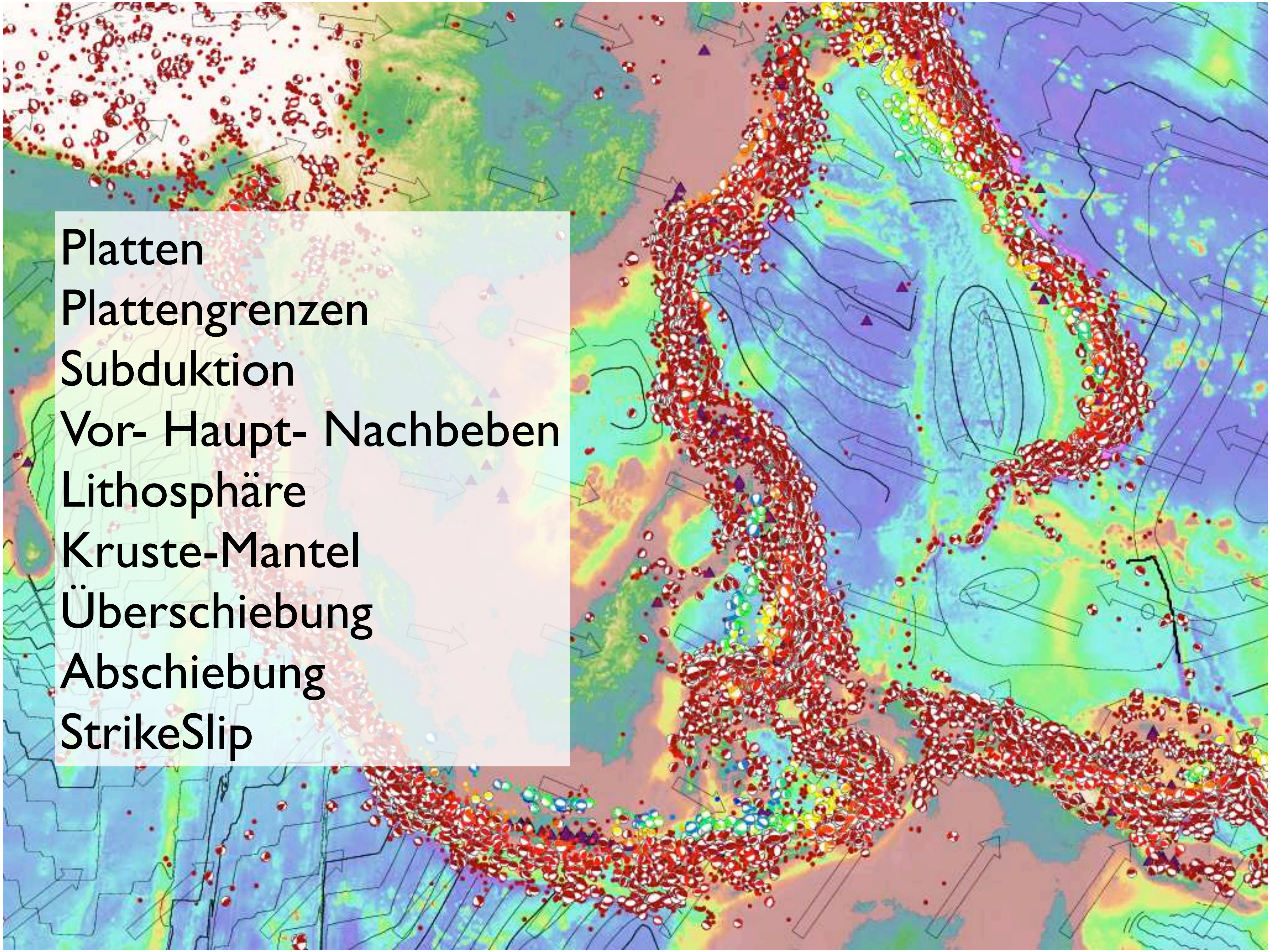
Herdflächenlösungen



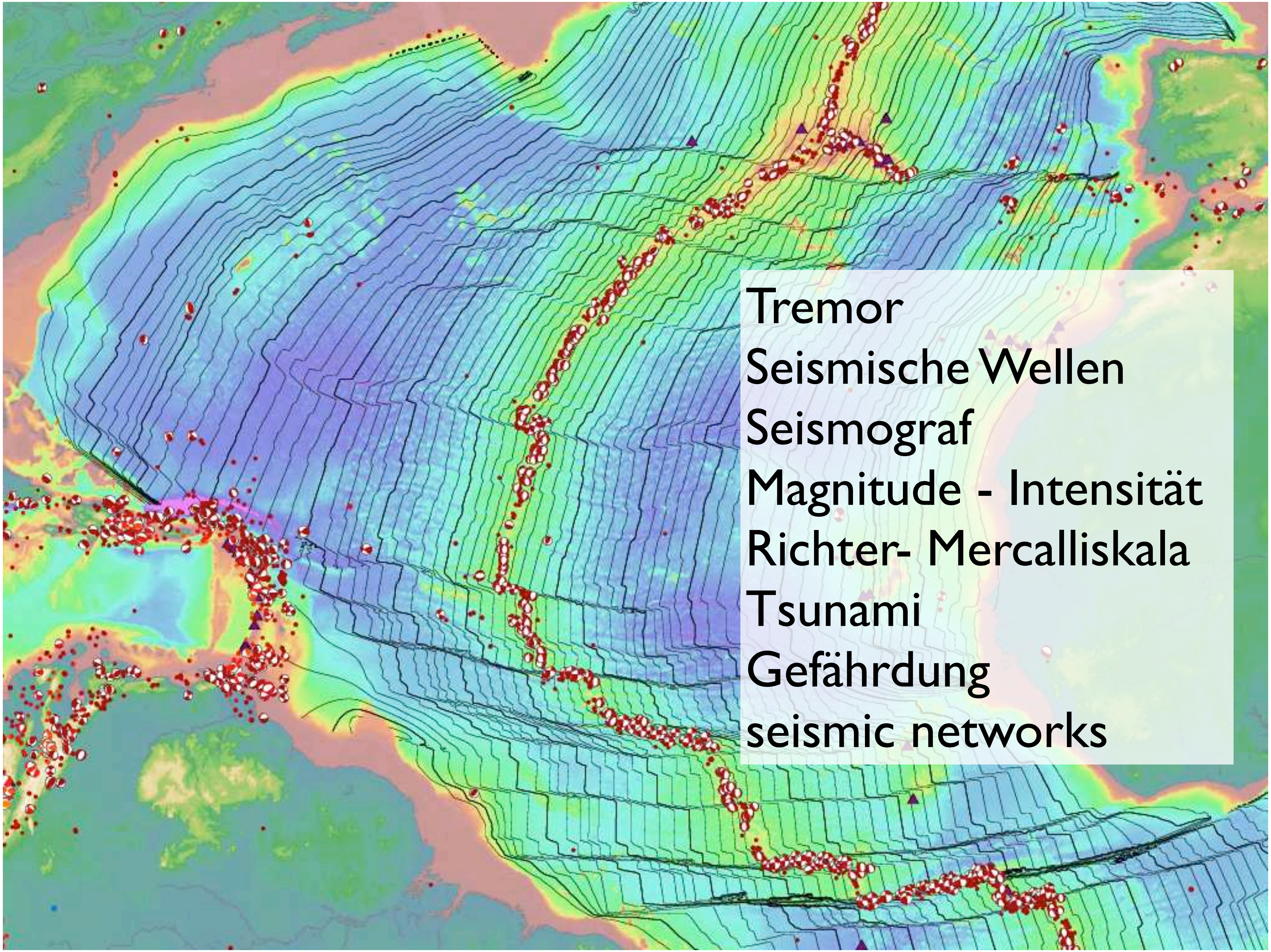
Horizontaler / vertikaler slip



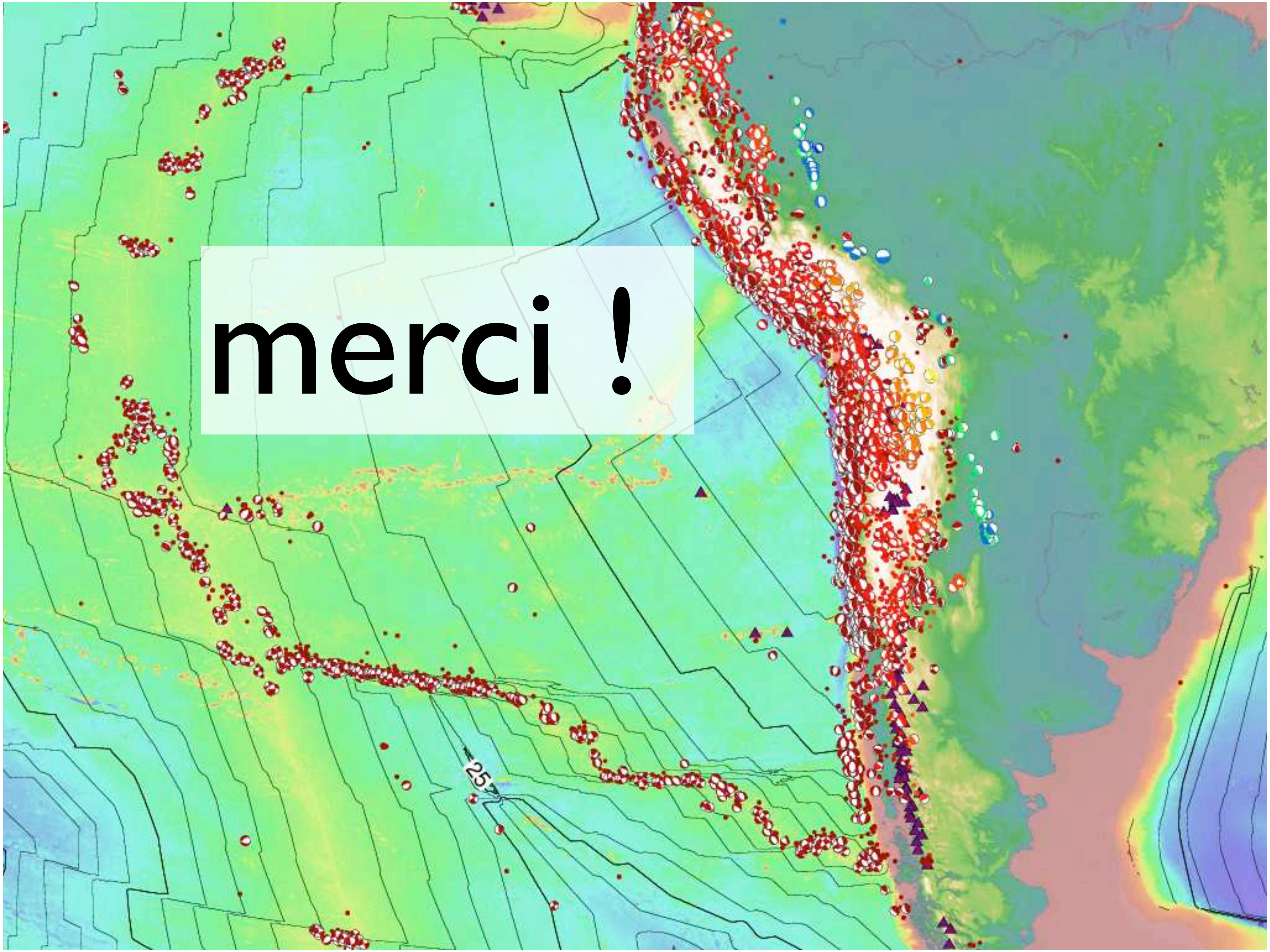
..statt einer Zusammen-fassung...



Platten
Plattengrenzen
Subduktion
Vor- Haupt- Nachbeben
Lithosphäre
Kruste-Mantel
Überschiebung
Abschiebung
StrikeSlip



Tremor
Seismische Wellen
Seismograf
Magnitude - Intensität
Richter- Mercalliskala
Tsunami
Gefährdung
seismic networks


merci !
25