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12.001 Introduction to Geology  
Spring 2008

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# 12.001 in 30 minutes

Minerals

Rocks

Dating: Radiodecay and paleontology

Rock deformation: Folds, faults, brittle vs. ductile

Field techniques

Planetary formation

Plate tectonics

Earthquakes

Volcanoes

Formation of continents

Rivers

Deserts

Glaciers

Coastlines

Climate and weather

# 5. The atomic structure of minerals












<b>CATIONS</b>	Silicon (Si <sup>4+</sup> )	Aluminum (Al <sup>3+</sup> )	Iron (Fe <sup>3+</sup> )	Magnesium (Mg <sup>2+</sup> )	Iron (Fe <sup>2+</sup> )	Sodium (Na <sup>+</sup> )	Calcium (Ca <sup>2+</sup> )	Potassium (K <sup>+</sup> )
								
	0.27	0.53	0.65	0.72	0.73	0.99	1.00	1.38
	Oxygen (O <sup>2-</sup> )	Chloride (Cl <sup>-</sup> )	Sulfide (S <sup>2-</sup> )					
								
	1.40	1.81	1.84					

Figure by MIT OpenCourseWare.

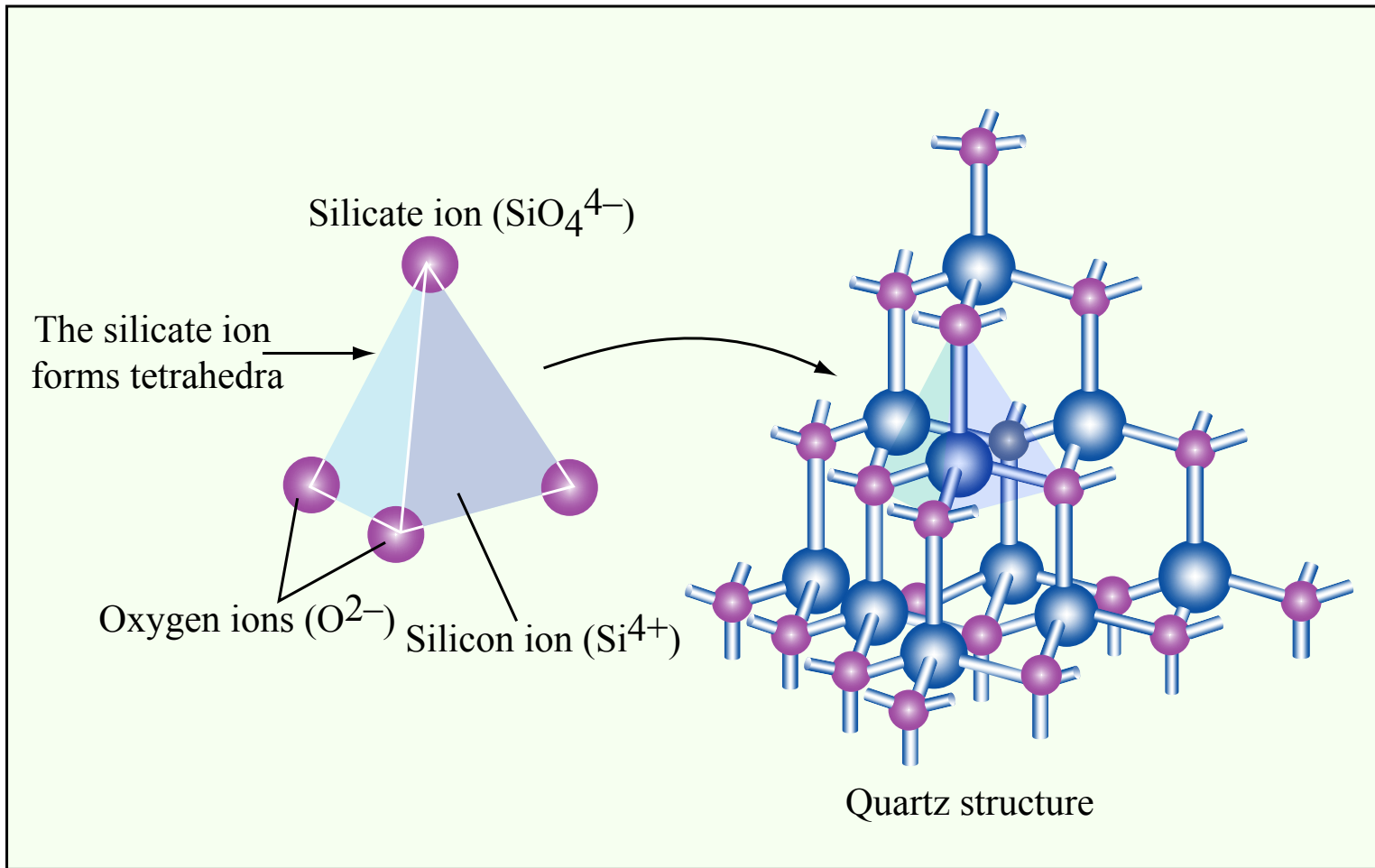


Figure by MIT OpenCourseWare.

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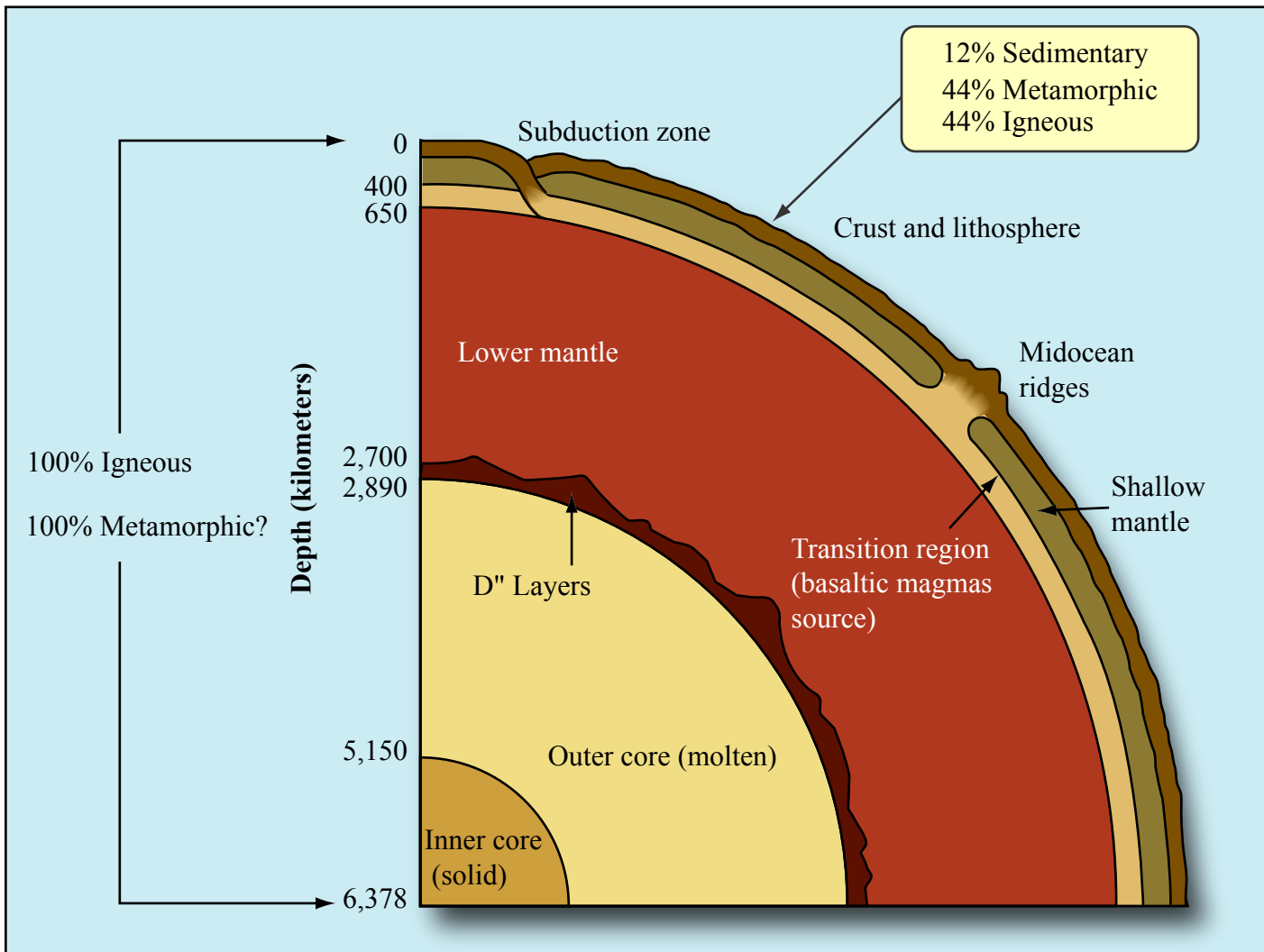


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Image removed due to copyright restrictions.

Is this the world's oldest known fossil?

Is it an ancient cyanobacteria, or a partially-resorbed inorganic mineral grain?

It was found in the 3.465 Ga Apex chert in western Australia.

Schopf (1992, 1993)



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Normal faults in volcanic ashes and paleo-soils, El Salvador, photo by Chuck DeMets. U. Wisc.

Courtesy of Dennis Charles Demets. Used with permission.

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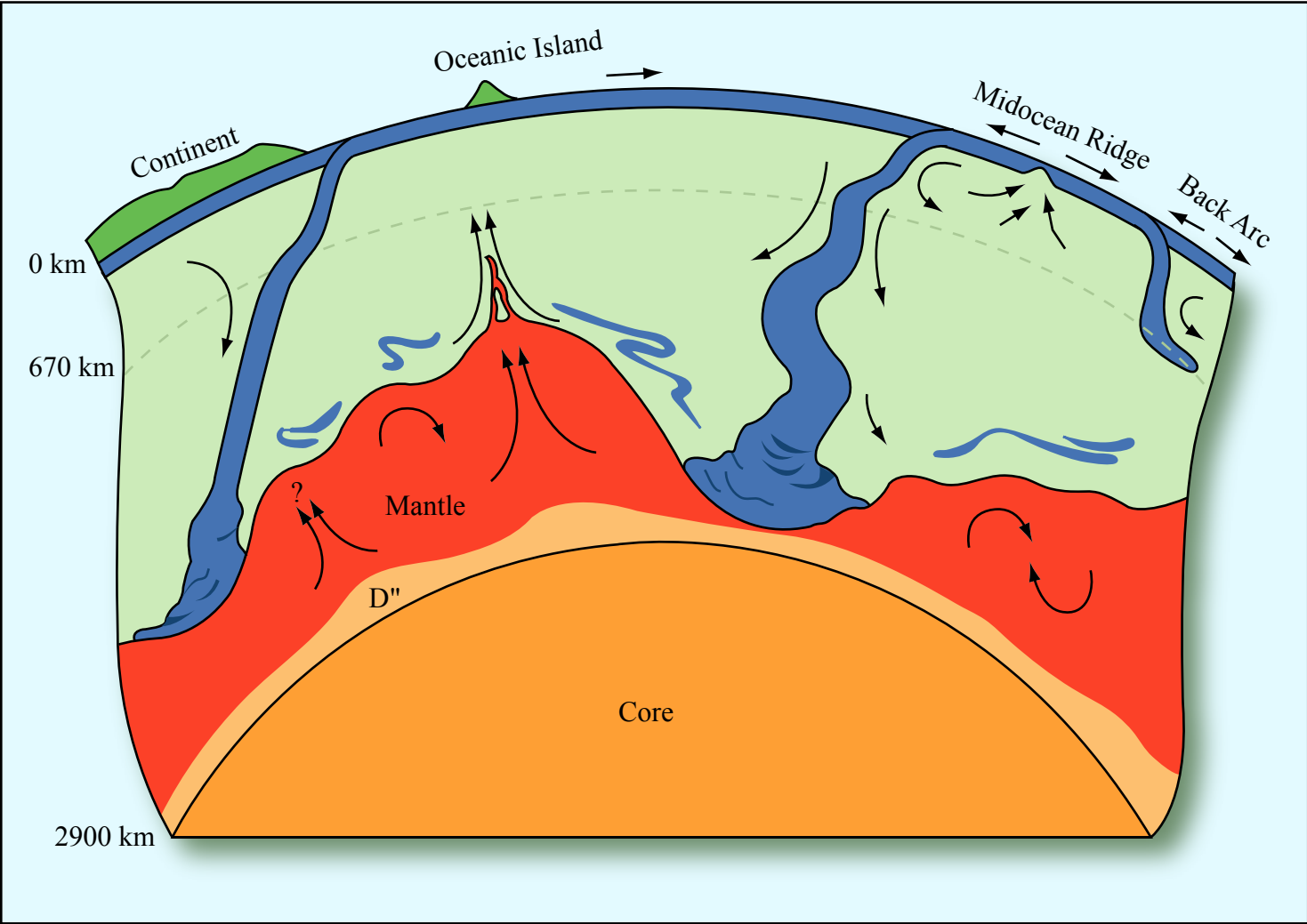
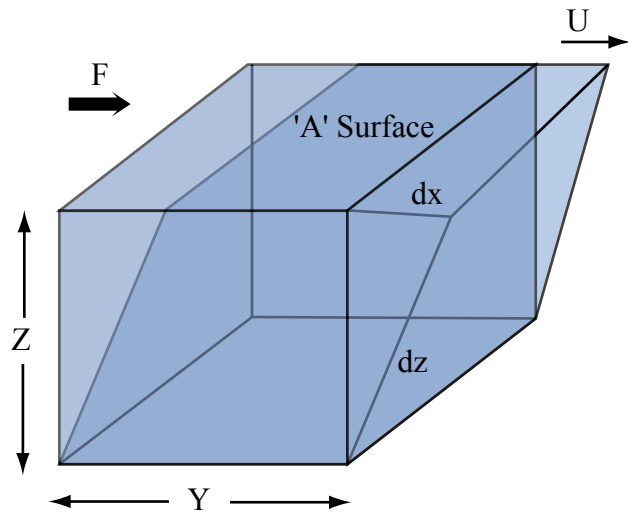
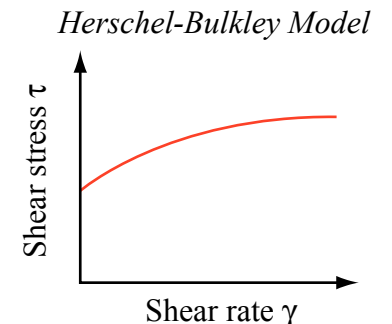
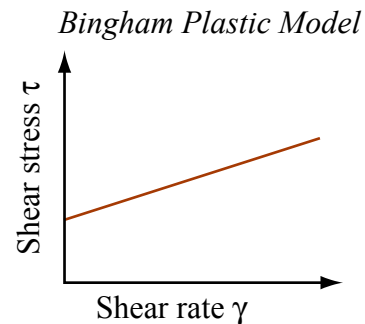
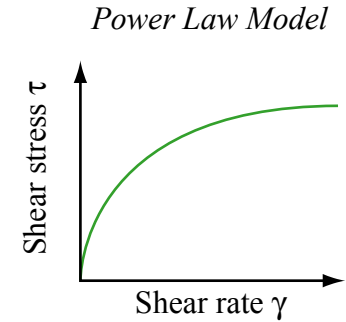
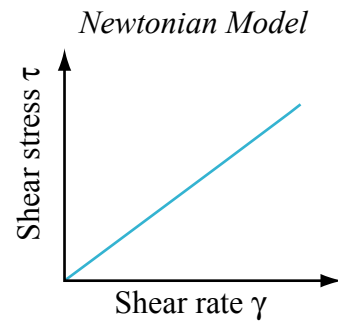


Figure by MIT OpenCourseWare.



### Rheological Models



#### Key Numbers or Calculations

- 'A' Top layer surface
- 'F' Constant force
- ' $\gamma$ ' Shear strain  $\rightarrow \gamma = \frac{dx}{dz}$
- ' $\tau$ ' Shear stress  $\rightarrow \tau = \lim_{A \rightarrow 0} \frac{F}{A}$
- ' $\eta$ ' Viscosity (constant)  $\rightarrow \eta = \frac{\tau}{\dot{\gamma}}$
- 'u' Velocity
- ' $\dot{\gamma}$ ' Shear rate

Figure by MIT OpenCourseWare.

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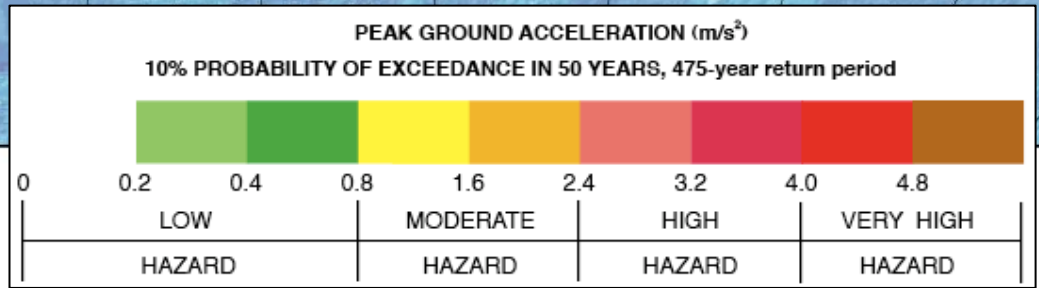
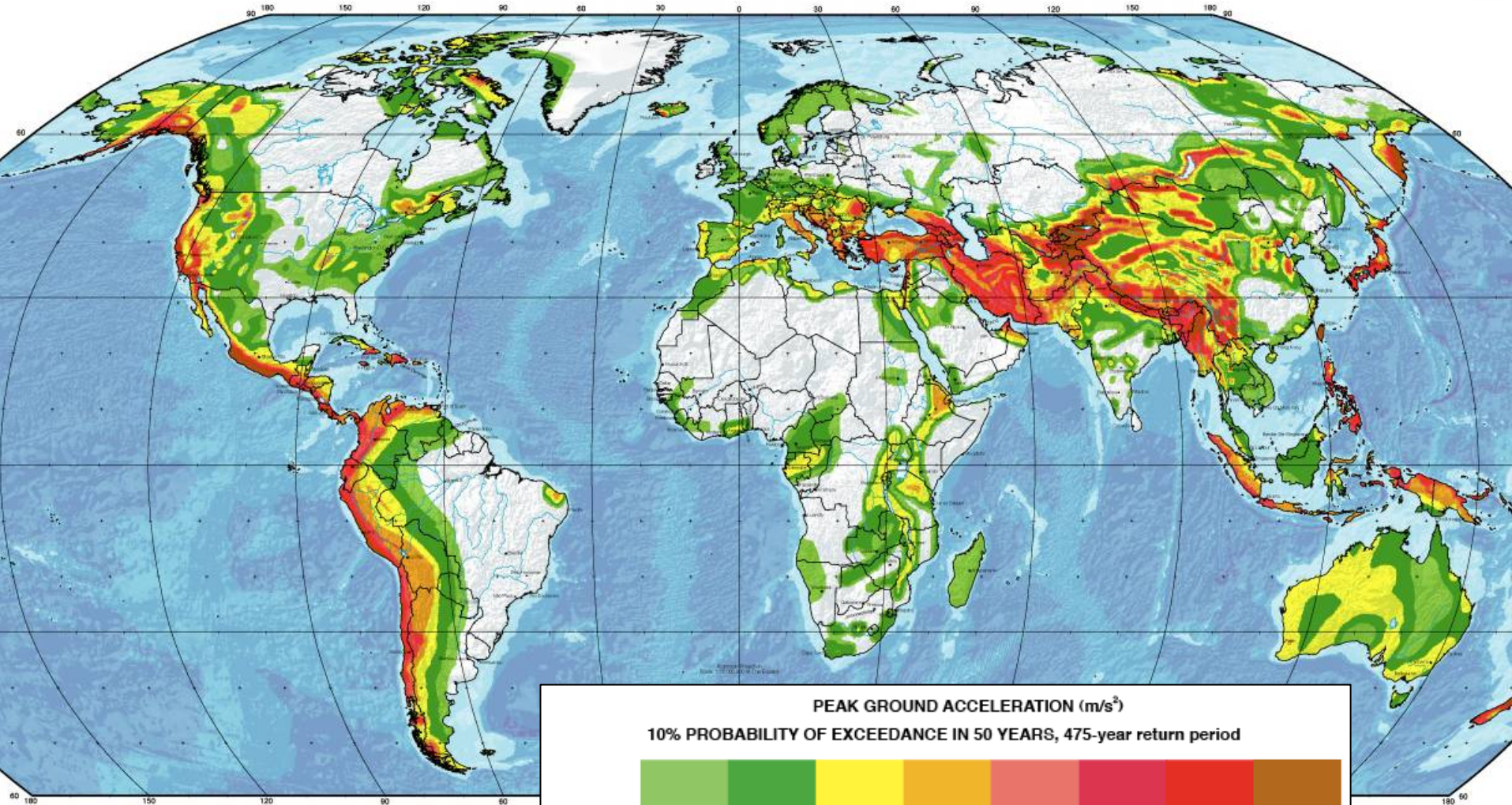


# GLOBAL SEISMIC HAZARD MAP



Produced by the Global Seismic Hazard Assessment Program (GSHAP),  
a demonstration project of the UN/International Decade of Natural Disaster Reduction, conducted by the International Lithosphere Program.

Global map assembled by D. Giardini, G. Grünthal, K. Shedlock, and P. Zhang  
1999



Courtesy of The Global Seismic Hazard Assessment Program. Used with permission.

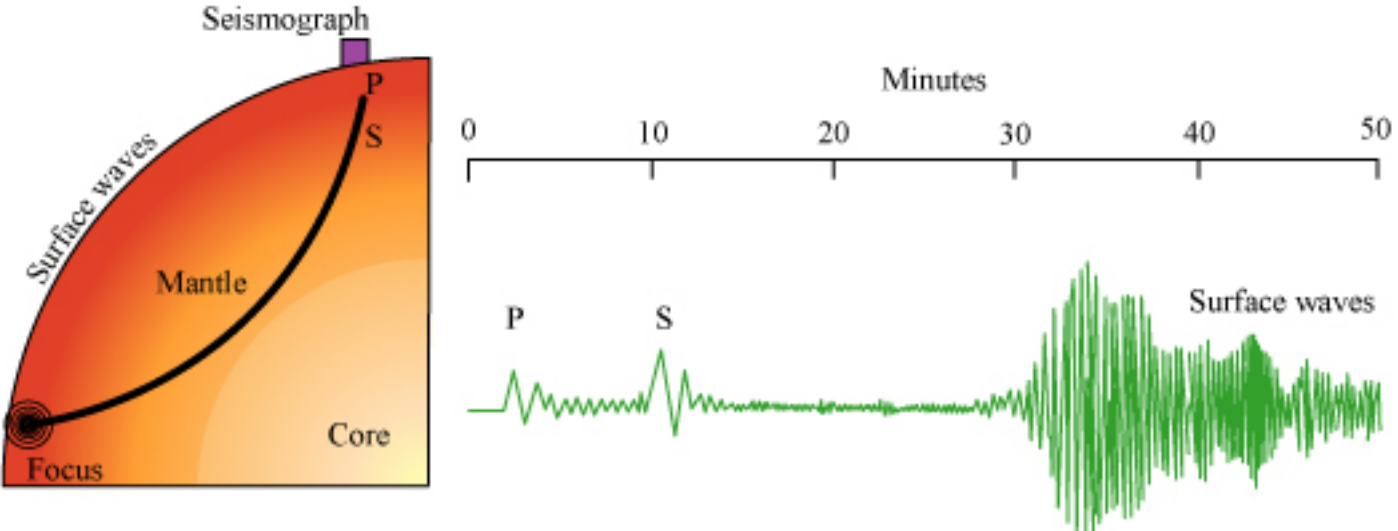
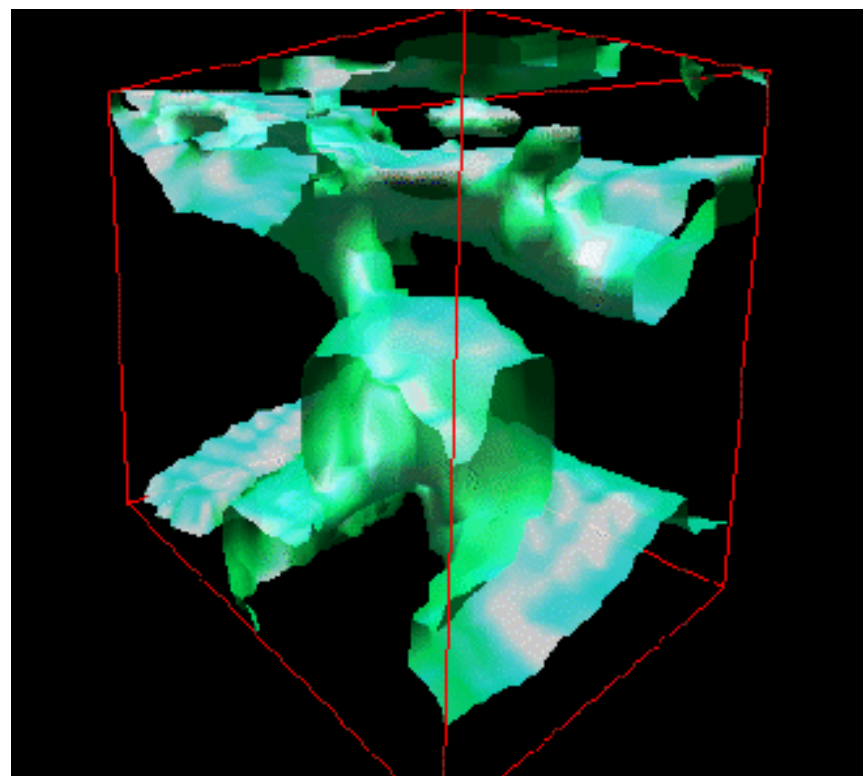


Figure by MIT OpenCourseWare.



Harmen Bijwaard, Utrecht  
 Courtesy of Harmen Bijwaard. Used with permission.



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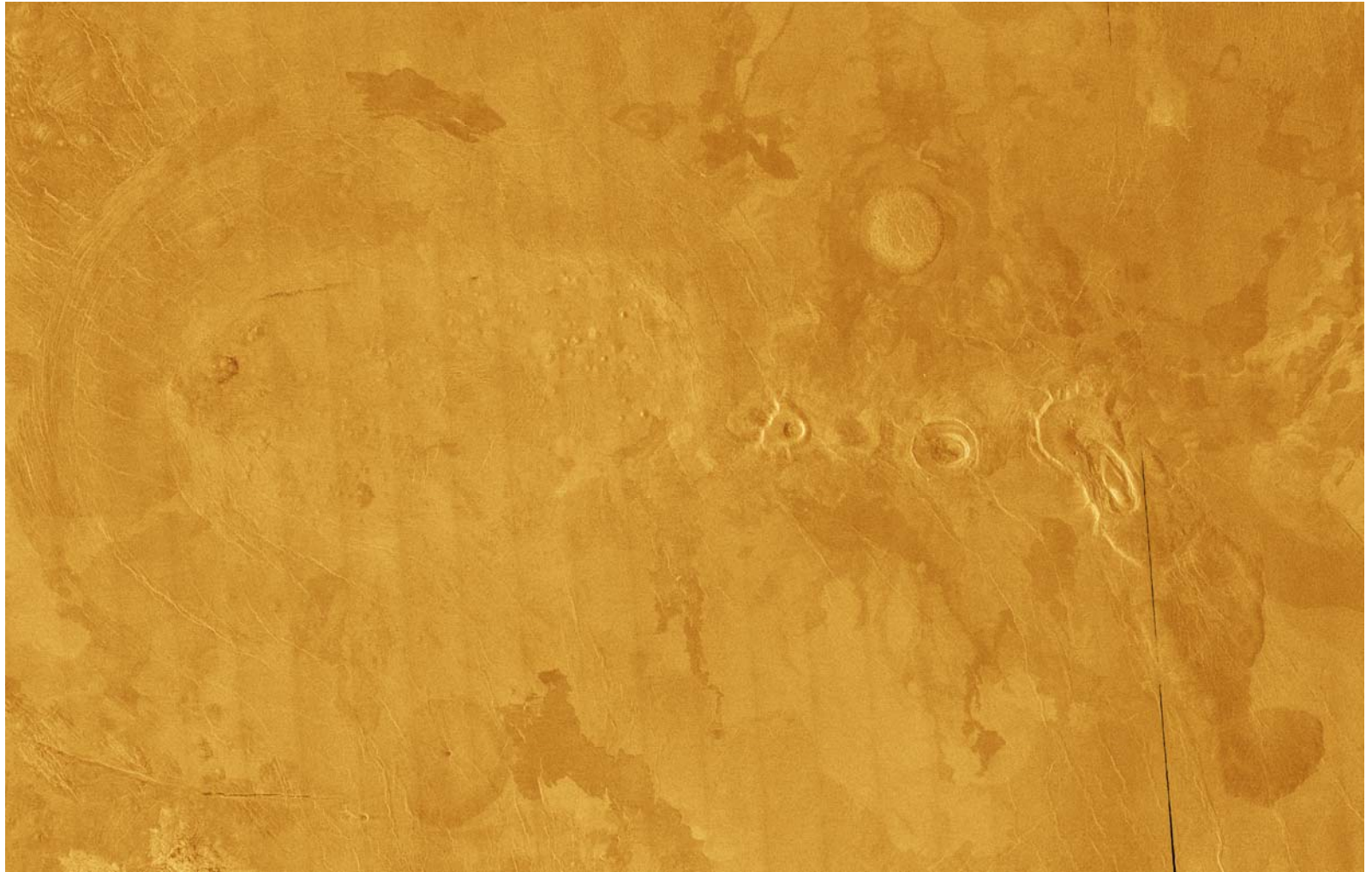
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Courtesy of NASA/Magellan.





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