

Origin and Interior of Earth

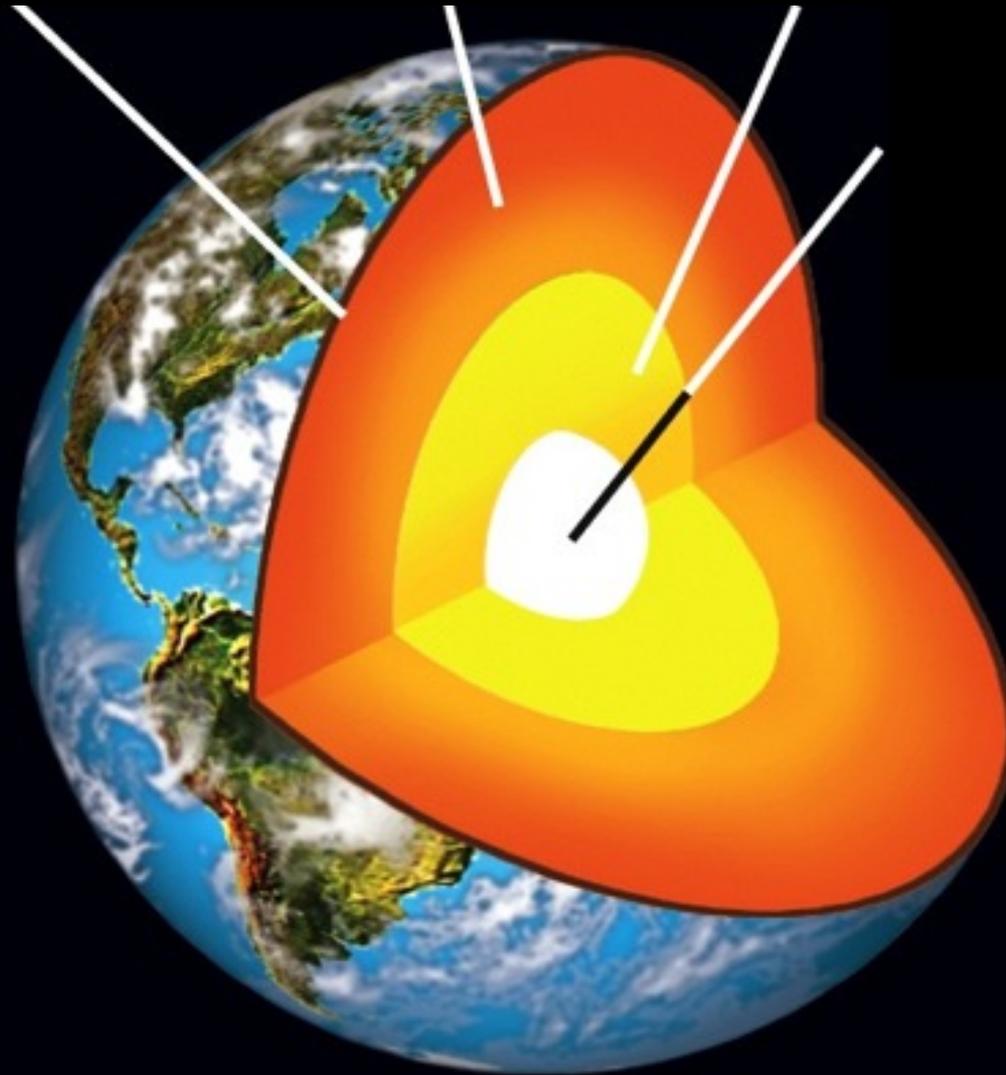
12.001 – 7 September 2012

How did the Earth form?



Courtesy of NASA. Image in the public domain.

What's on the inside, and how do we know?



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1

A diffuse, roughly spherical, slowly rotating nebula contracts under the force of gravity.

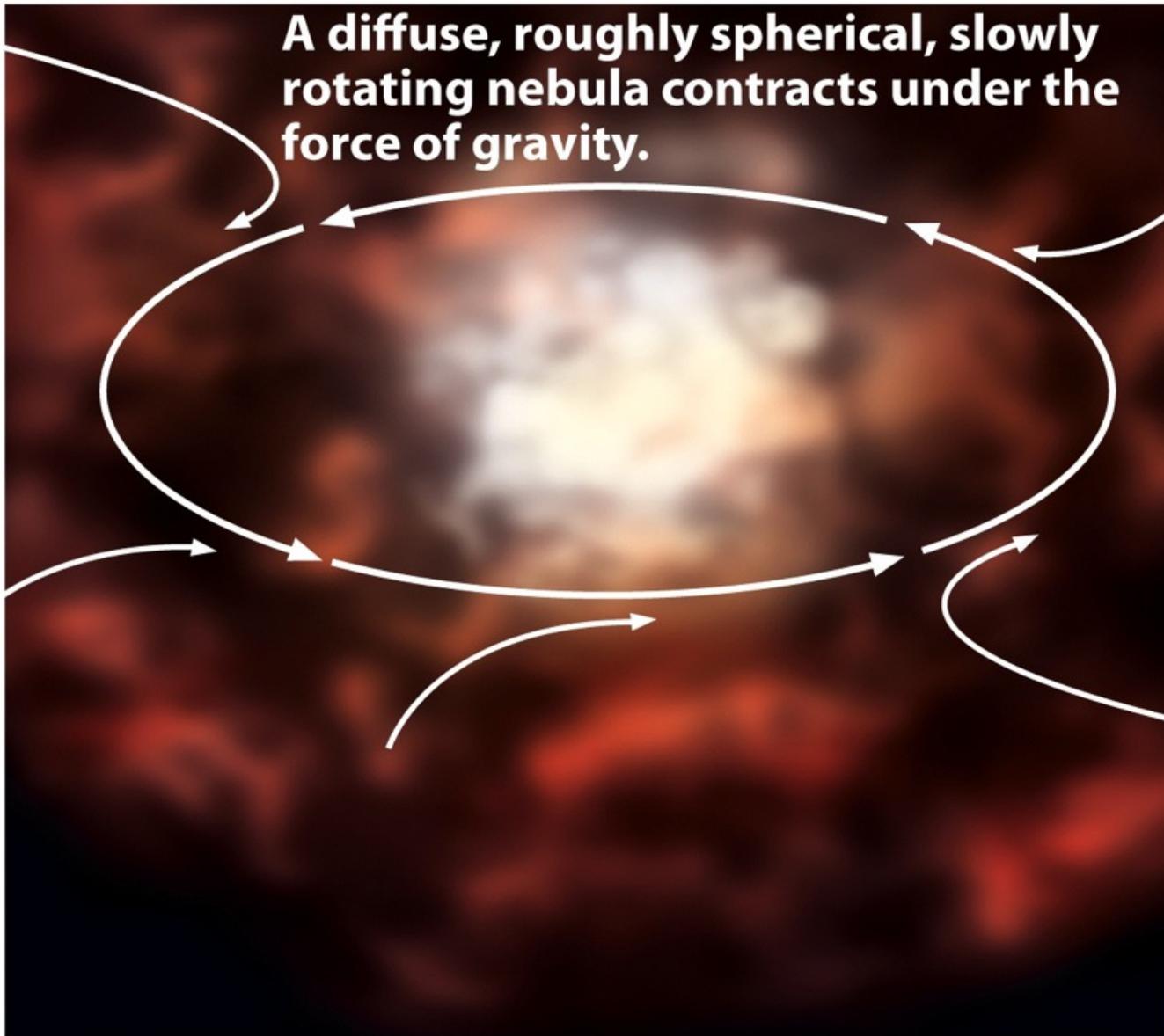


Figure 9.2 part 1
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2 A flat, rapidly rotating disk forms, with the matter that will become the proto-Sun concentrated at the center.

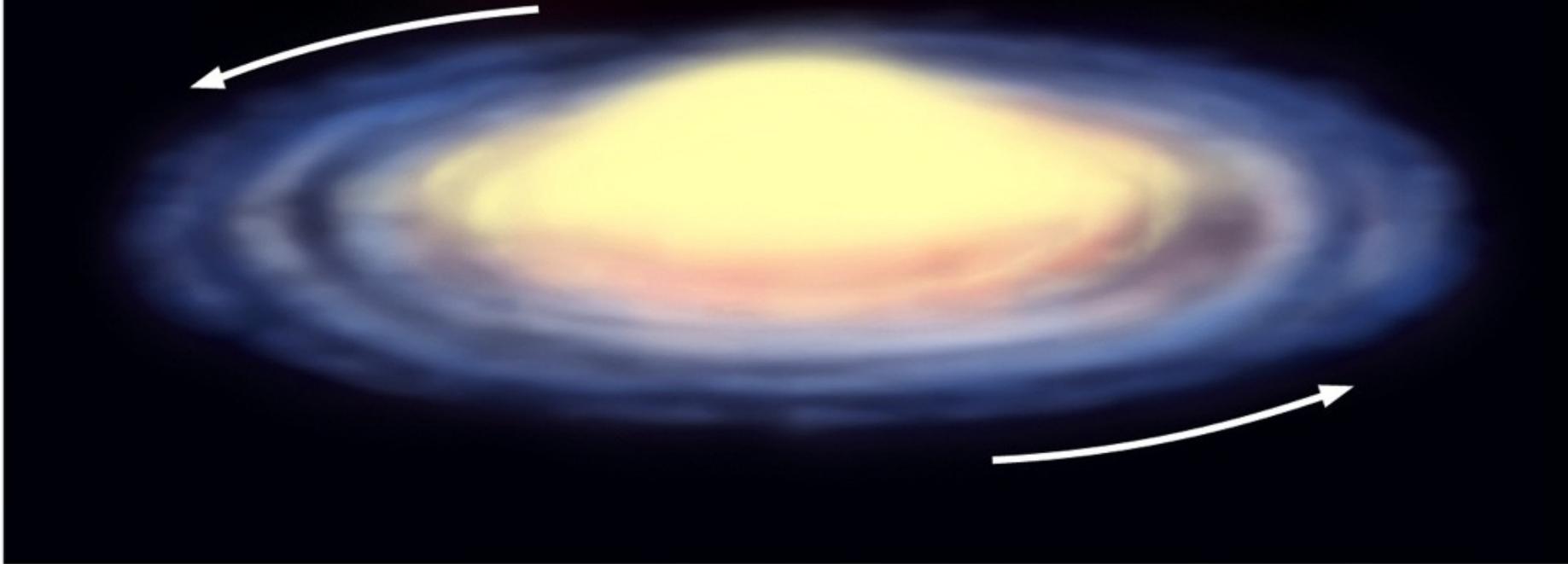


Figure 9.2 part 2
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Table 2 Cosmochemical and geochemical classification of the elements.

	<i>Elements</i>	
	<i>Lithophile (silicate)</i>	<i>Siderophile + chalcophile (sulfide + metal)</i>
Refractory	$T_c = 1,850\text{--}1,400\text{ K}$ Al, Ca, Ti, Be, Ba, Sc, V, Sr, Y, Zr, Nb, Ba, REE, Hf, Ta, Th, U, Pu	Mo, Ru, Rh, W, Re, Os, Ir, Pt
Main component	$T_c = 1,350\text{--}1,250\text{ K}$ Mg, Si, Cr, Li	Fe, Ni, Co, Pd
Moderately volatile	$T_c = 1,230\text{--}640\text{ K}$ Mn, P, Na, B, Rb, K, F, Zn	Au, As, Cu, Ag, Ga, Sb, Ge, Sn, Se, Te, S
Highly volatile	$T_c < 640\text{ K}$ Cl, Br, I, Cs, Tl, H, C, N, O, He, Ne, Ar, Kr, Xe	In, Bi, Pb, Hg

T_c , condensation temperatures at a pressure of 10^{-4} bar (Wasson, 1985; for B, Lauretta and Lodders, 1997).

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Source: Carlson, Richard W., ed. *The Mantle and Core: Treatise on Geochemistry*. Vol. 2. Elsevier, 2005.

3 The enveloping disk of gas and dust accretes into kilometer-sized chunks called planetesimals.

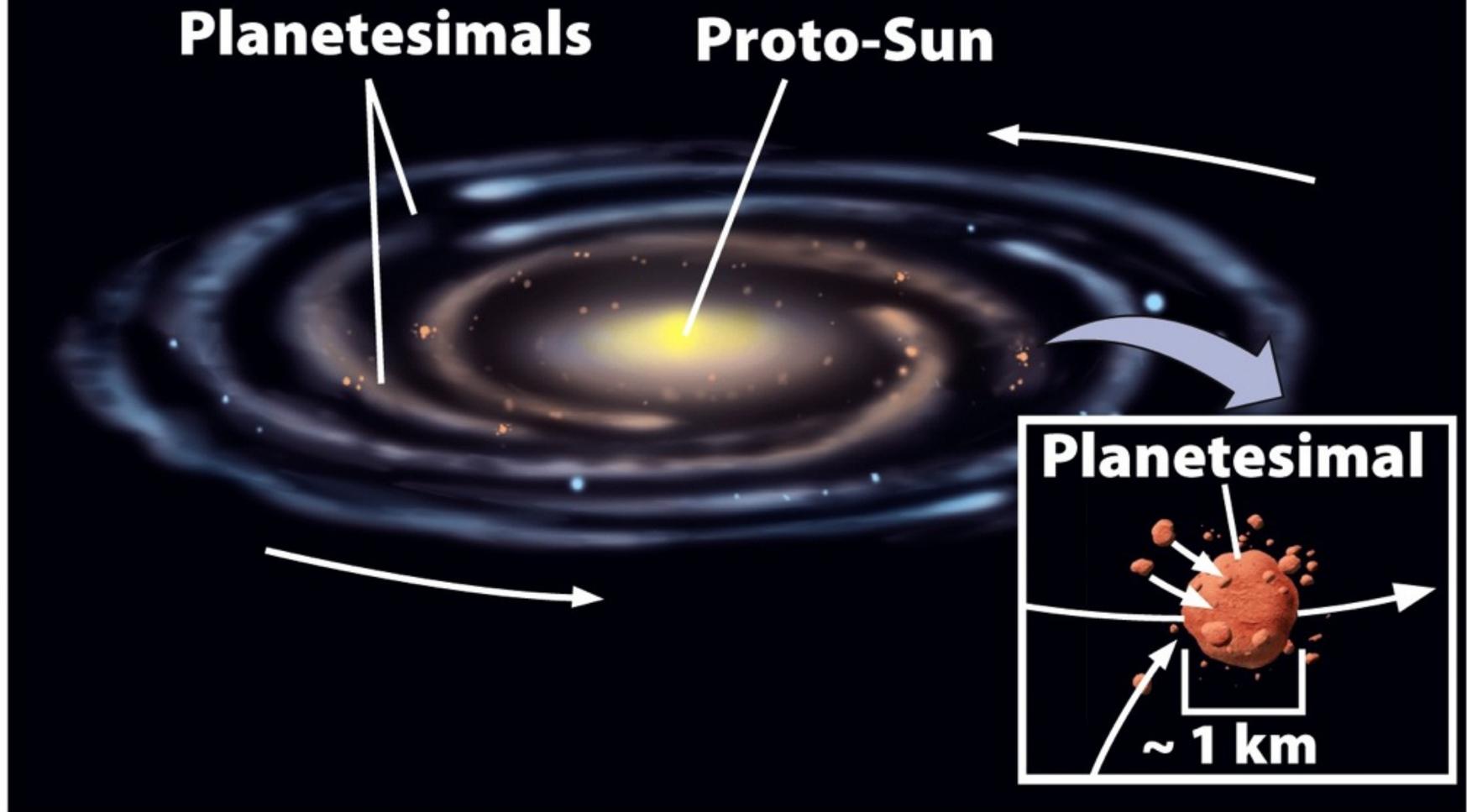


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4 The terrestrial planets build up through collisions of planetesimals. The giant outer planets form mostly from gases.

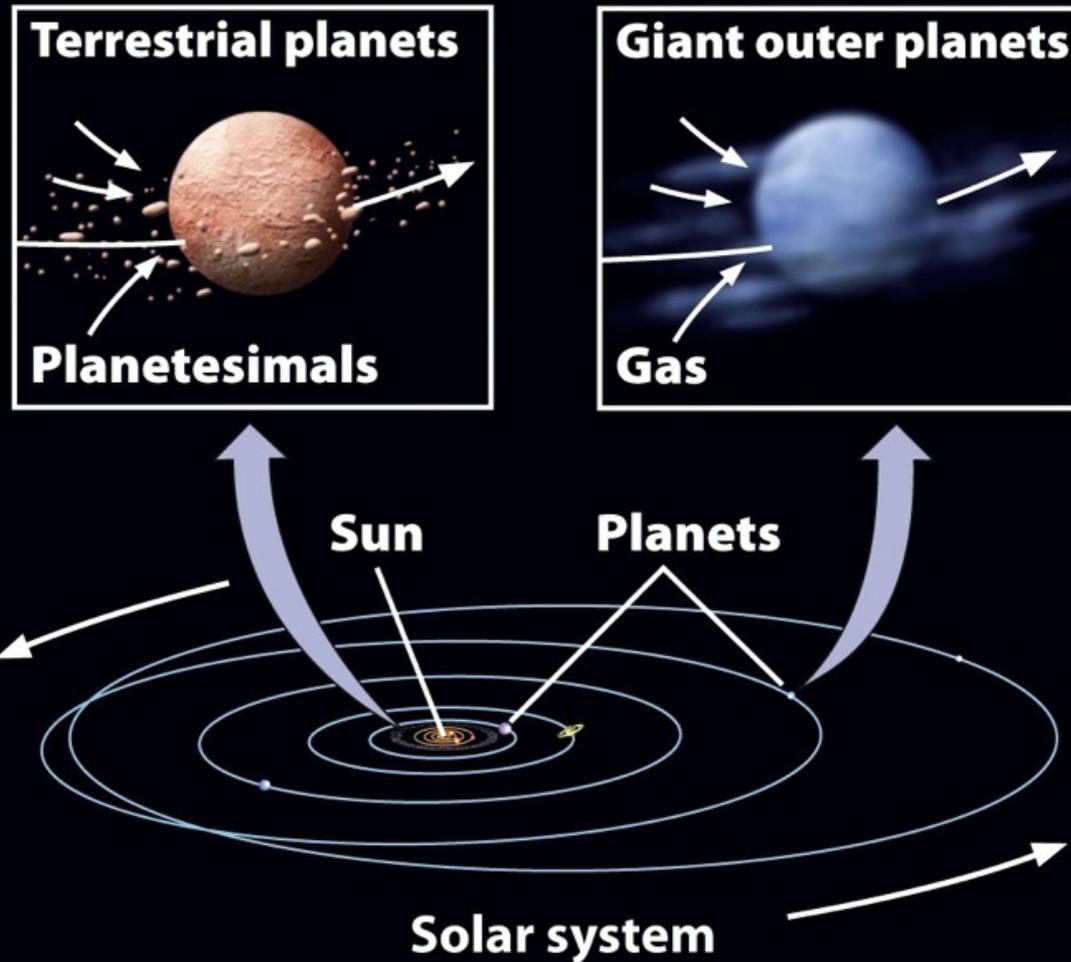


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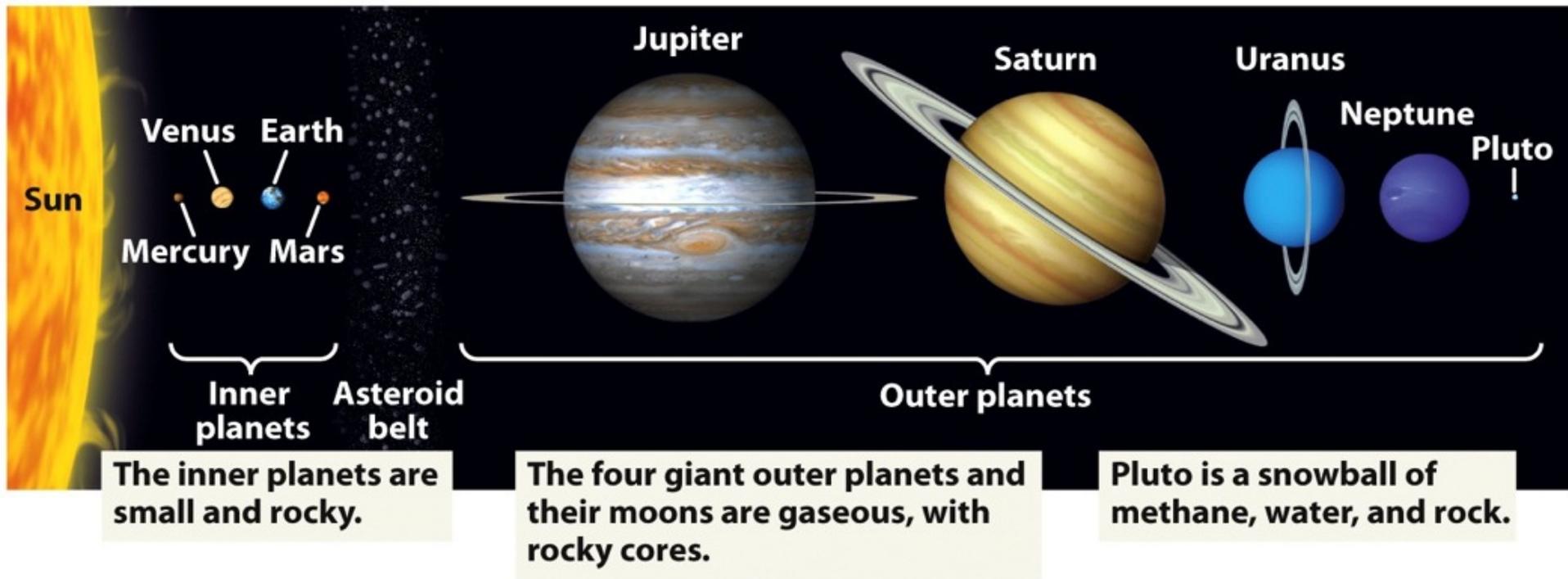


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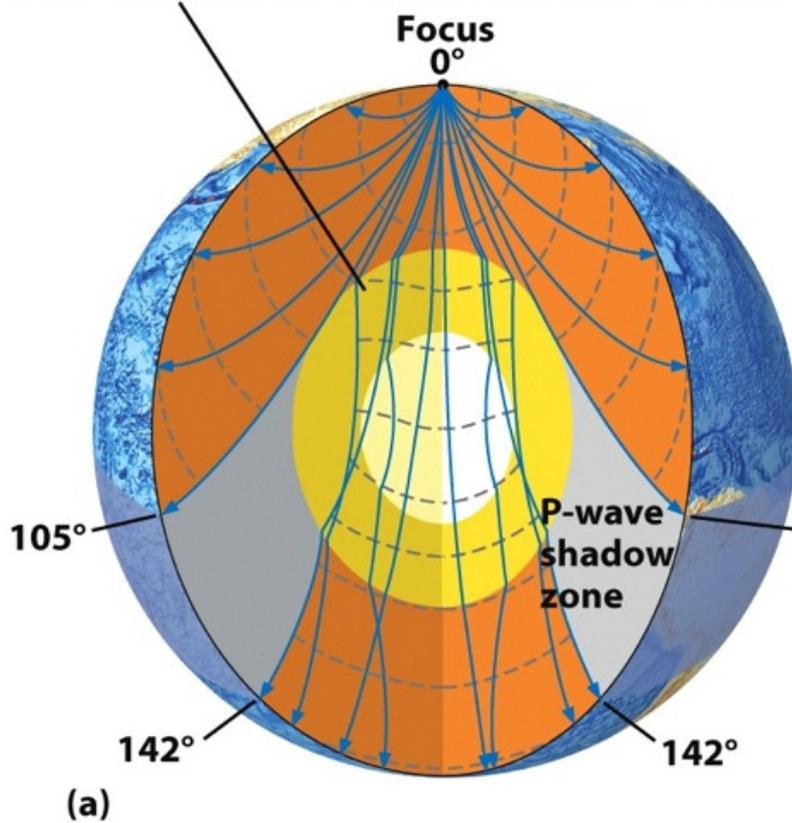
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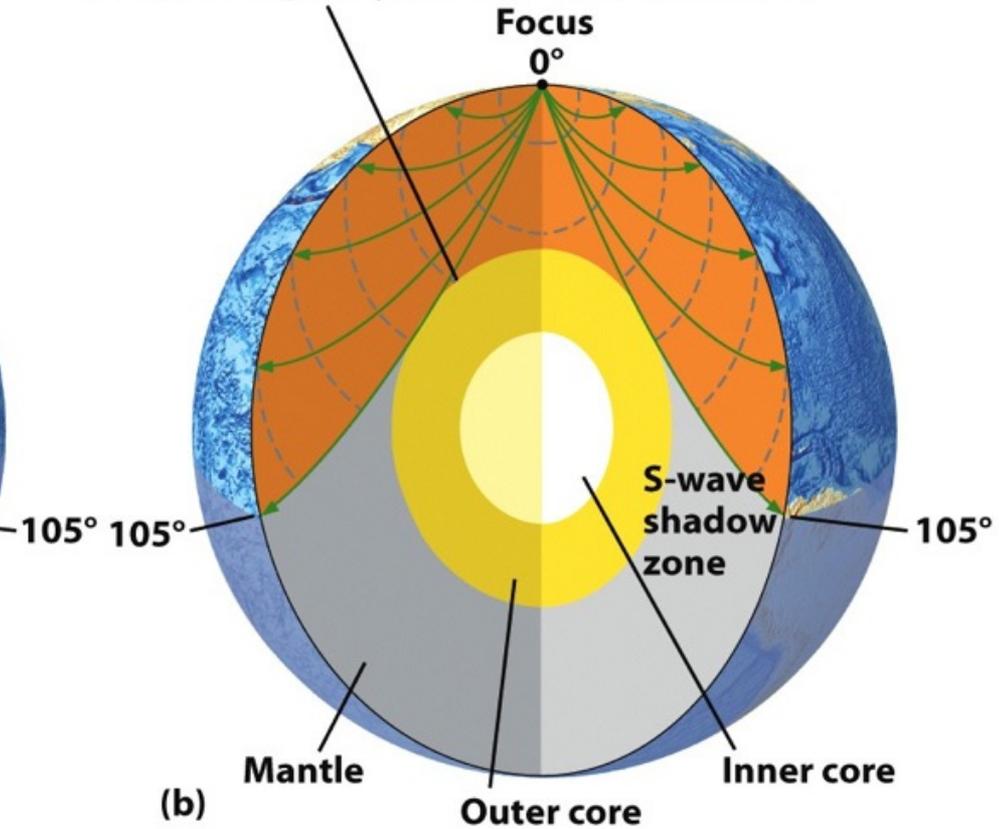
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P waves cannot reach the surface within the shadow zone because of the way they are refracted when they enter and leave the core.



Although S waves reach the core, they cannot travel through its liquid outer region, and therefore never emerge beyond 105° from the focus.



Key
blue: P waves
green: S waves

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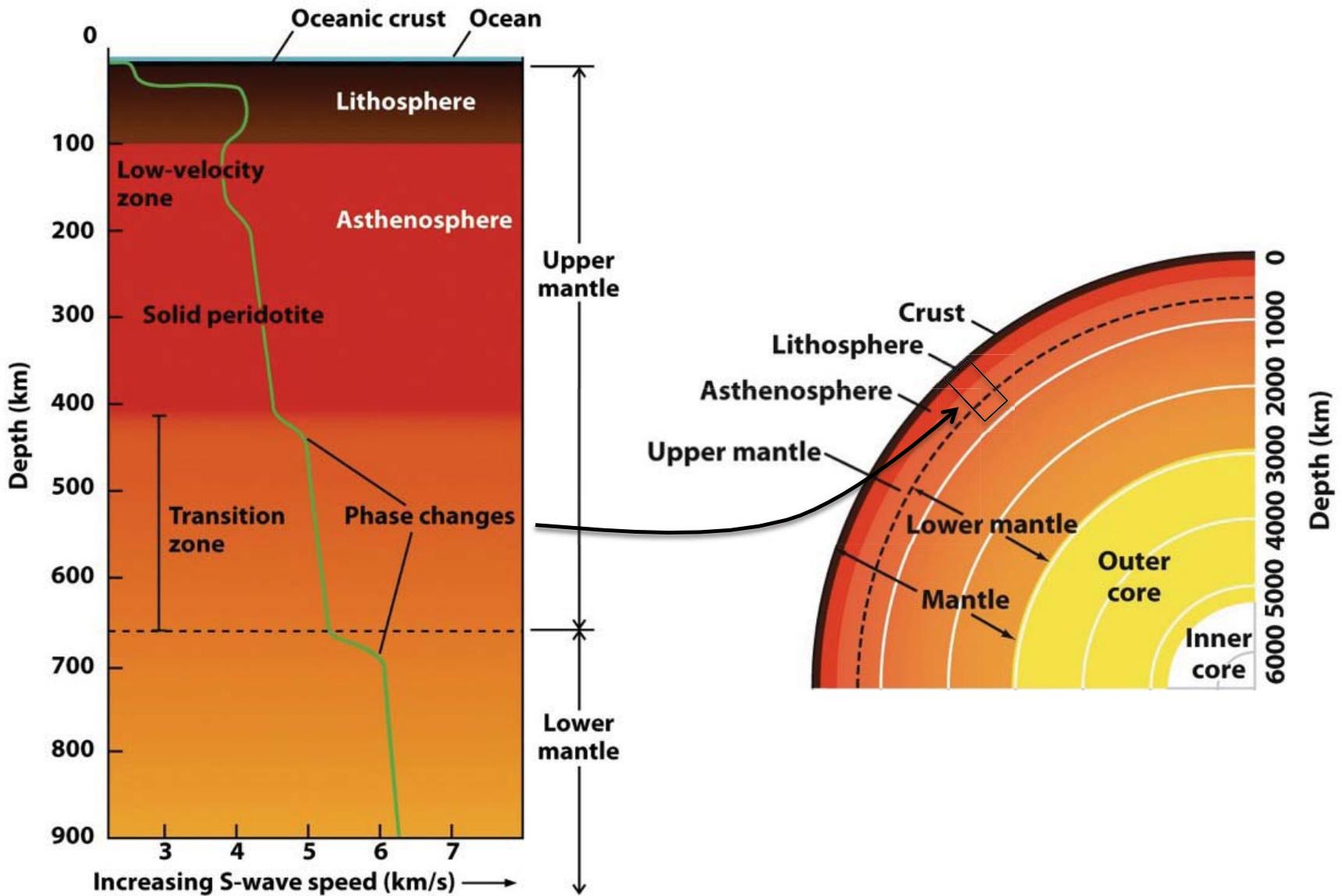
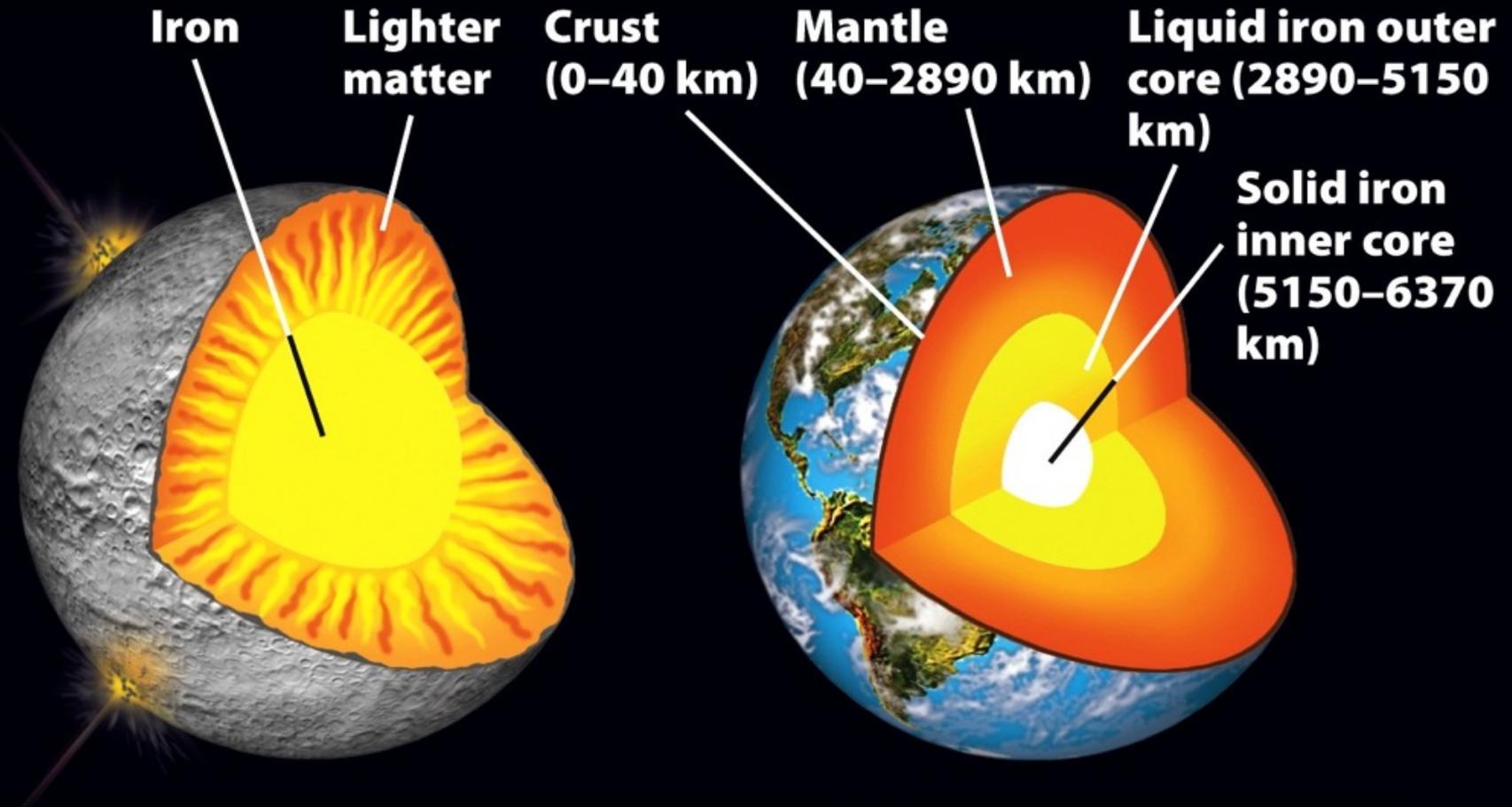


Figure 14.8
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During gravitational differentiation, iron sank to the center and lighter material floated upward...

...to give us Earth as a layered planet.

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12.001 Introduction to Geology
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