The Science of Exoplanets and Their Systems

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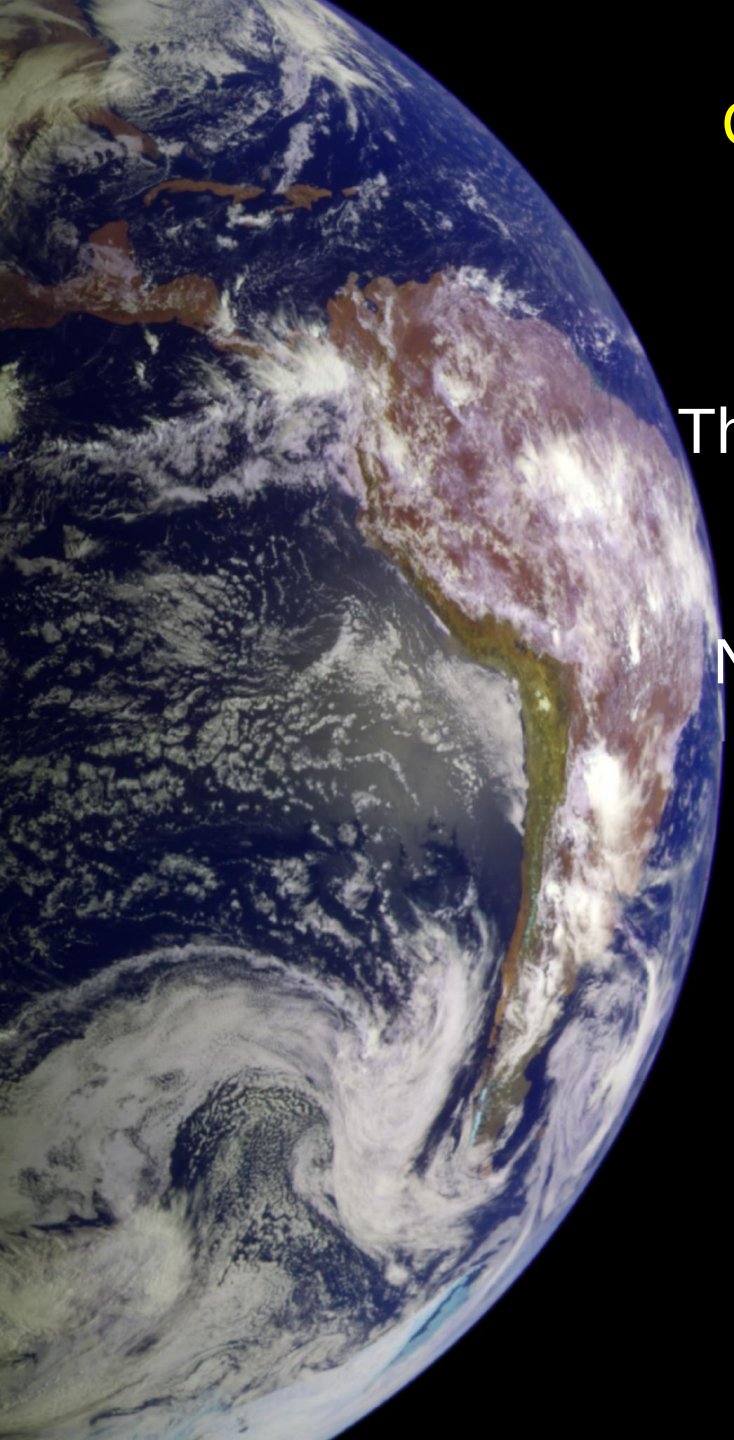

Critical need for coordination between astronomy, planetary science, and astrobiology

Theorists must aim for hypothesis testing with observations

Need to train scientists about our solar system; composition is a dominant parameter

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The “metallicity” of the star is difficult to extrapolate to planets (but we have to try)

TABLE 5

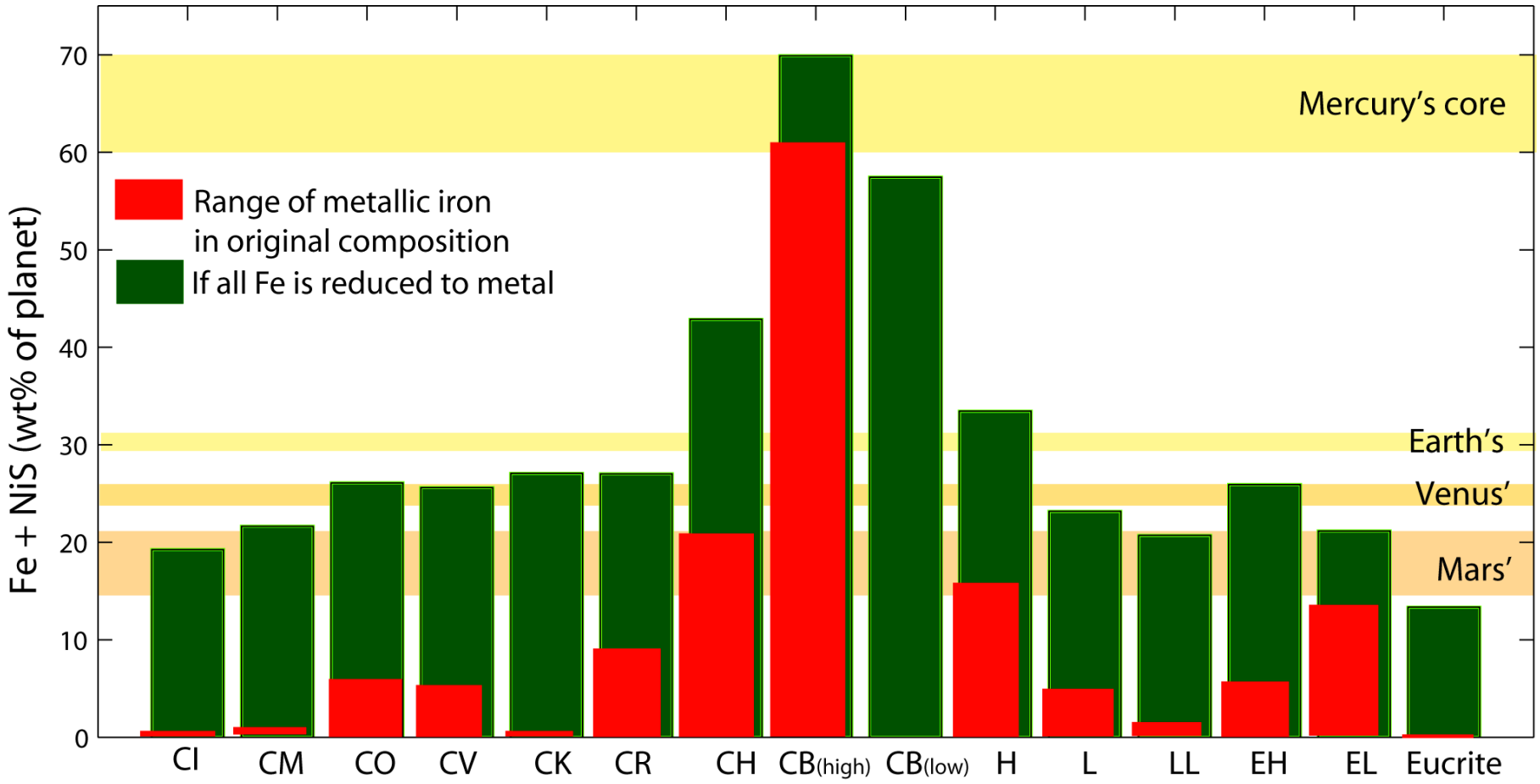
PHOTOSPHERIC Z/X IN ELEMENTAL ABUNDANCE COMPILATIONS

Z/X	Year	Reference
0.0270	1984	1
0.0267	1989	2
0.0245	1993	3
0.0244	1996	4
0.0229	1998	5
0.0208	2002	6
0.0177	2003	7

REFERENCES—(1) Grevesse 1984; (2) Anders & Grevesse 1989; (3) Grevesse & Noels 1993; (4) Grevesse et al. 1996; (5) Grevesse & Sauval 1998; (6) Grevesse & Sauval 2002; (7) this work.

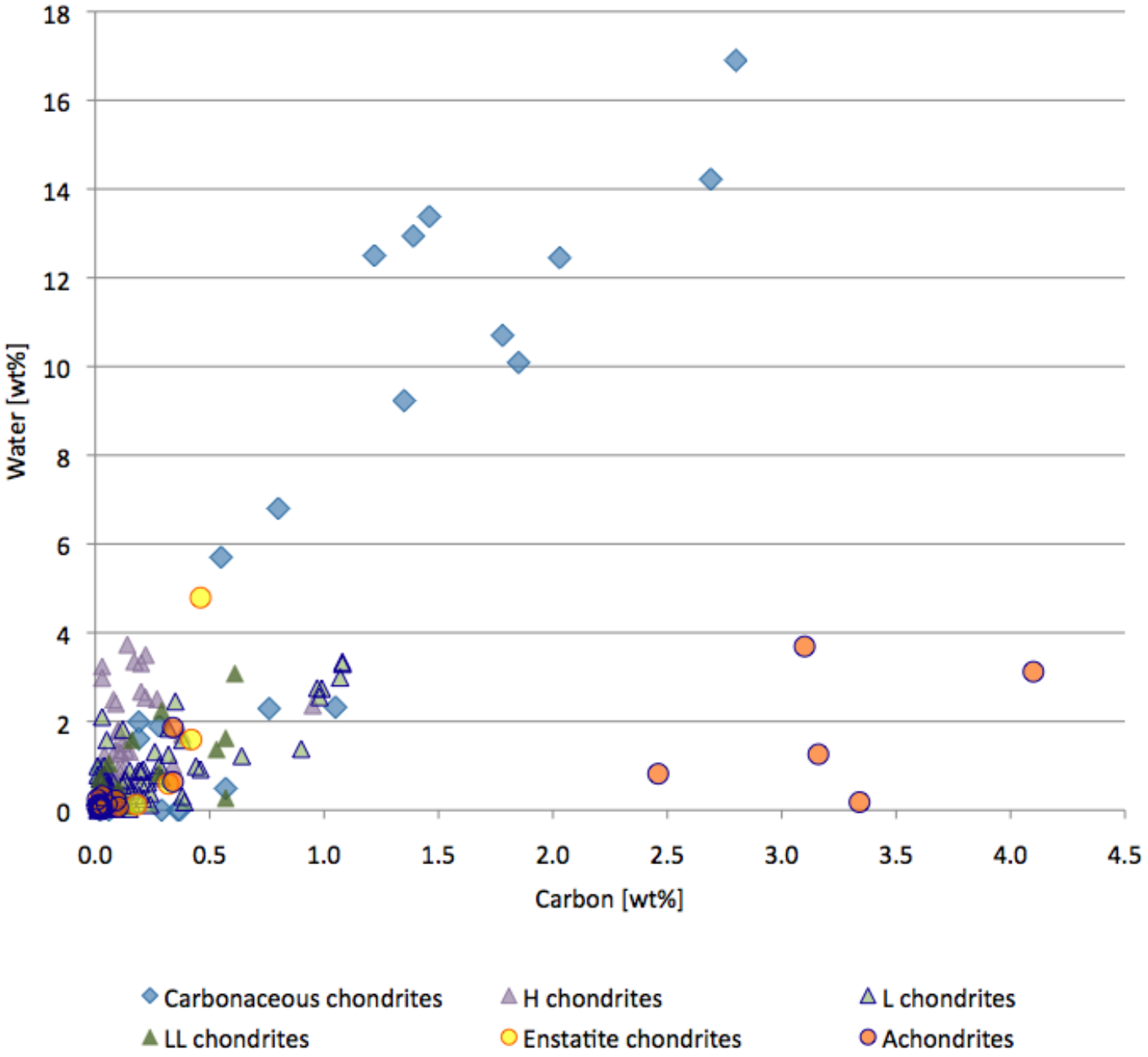
Lodders (2003)

Planets within a single system (ours) may have been built from material with a wide range of compositions

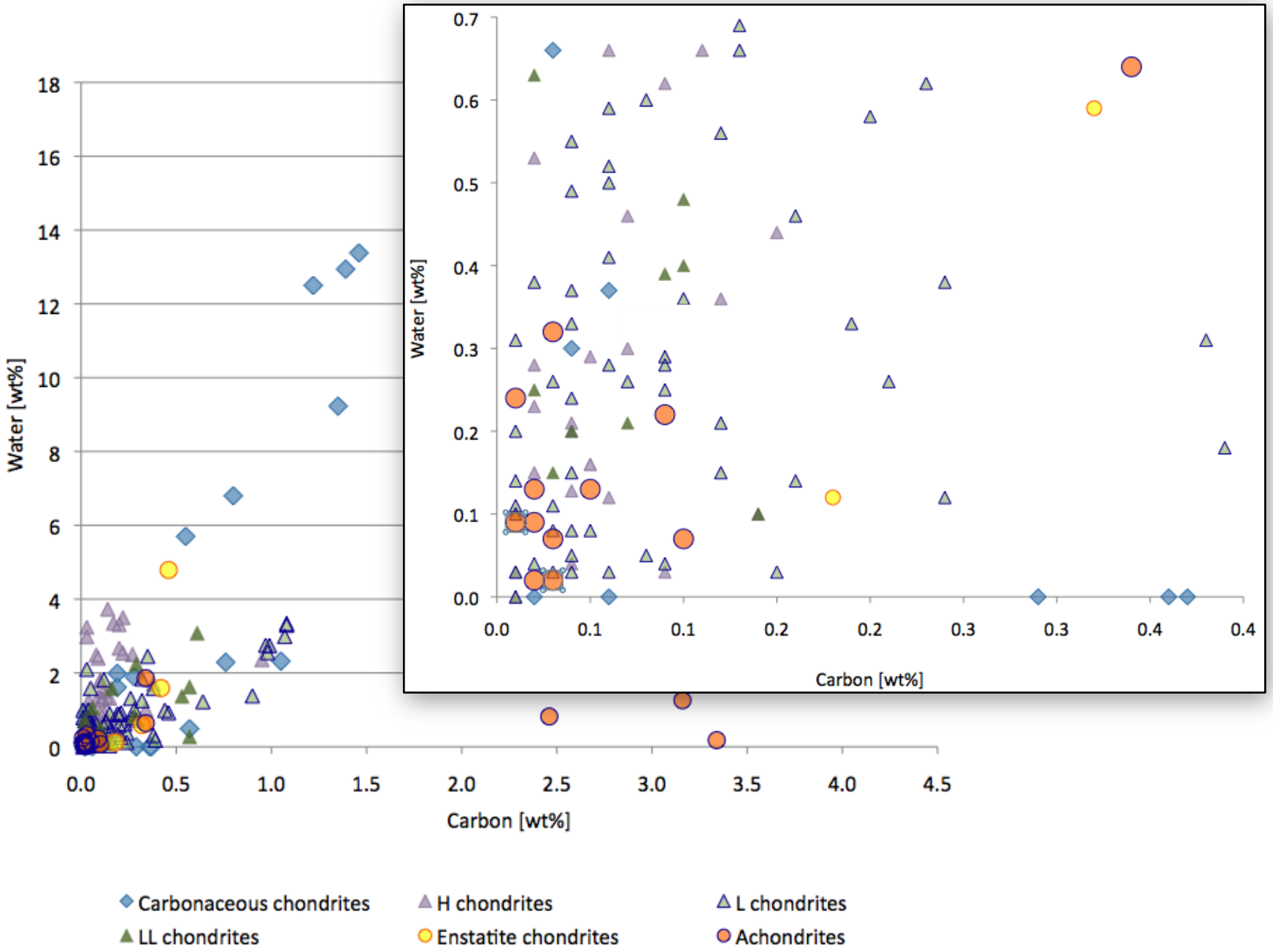


Jarosowich 1990; Lauretta 2007; Lauretta et al 2007; Weisberg et al 2001; Lodders and Fegley 1998; Kenkyujo et al 1995

Brown and Elkins-Tanton (2009)

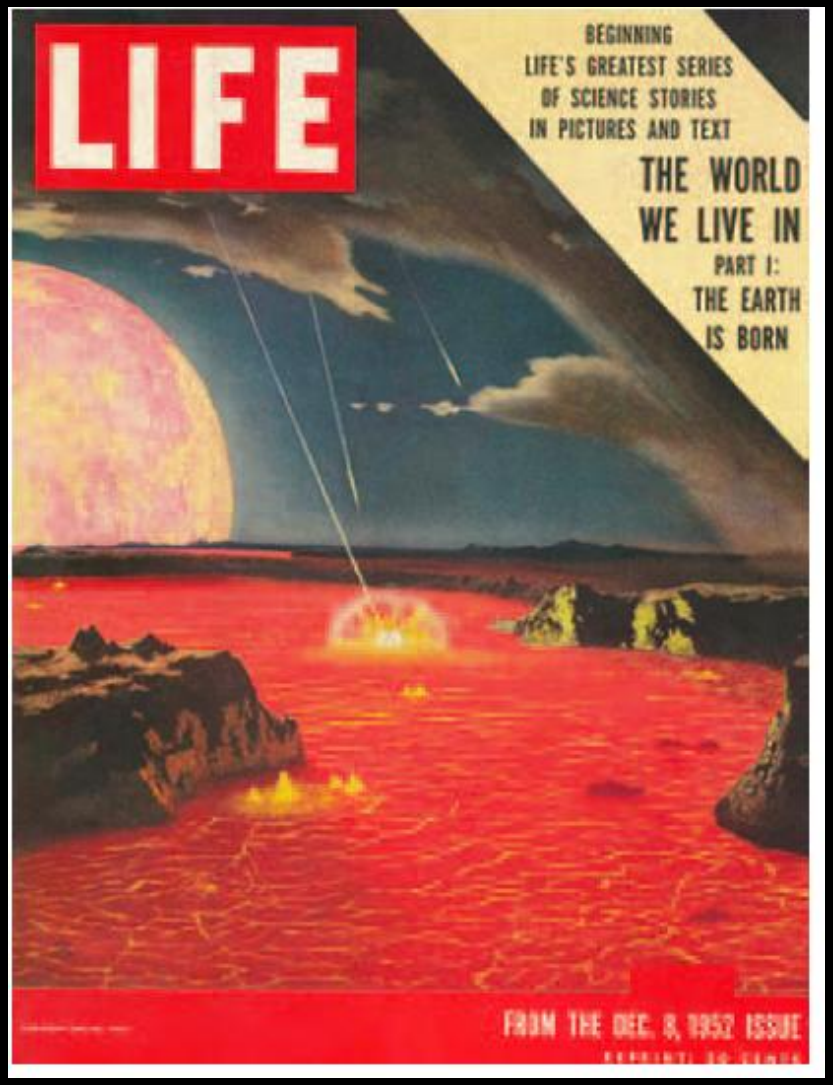


Data from Jarosewich (1990)



Data from Jarosewich (1990)

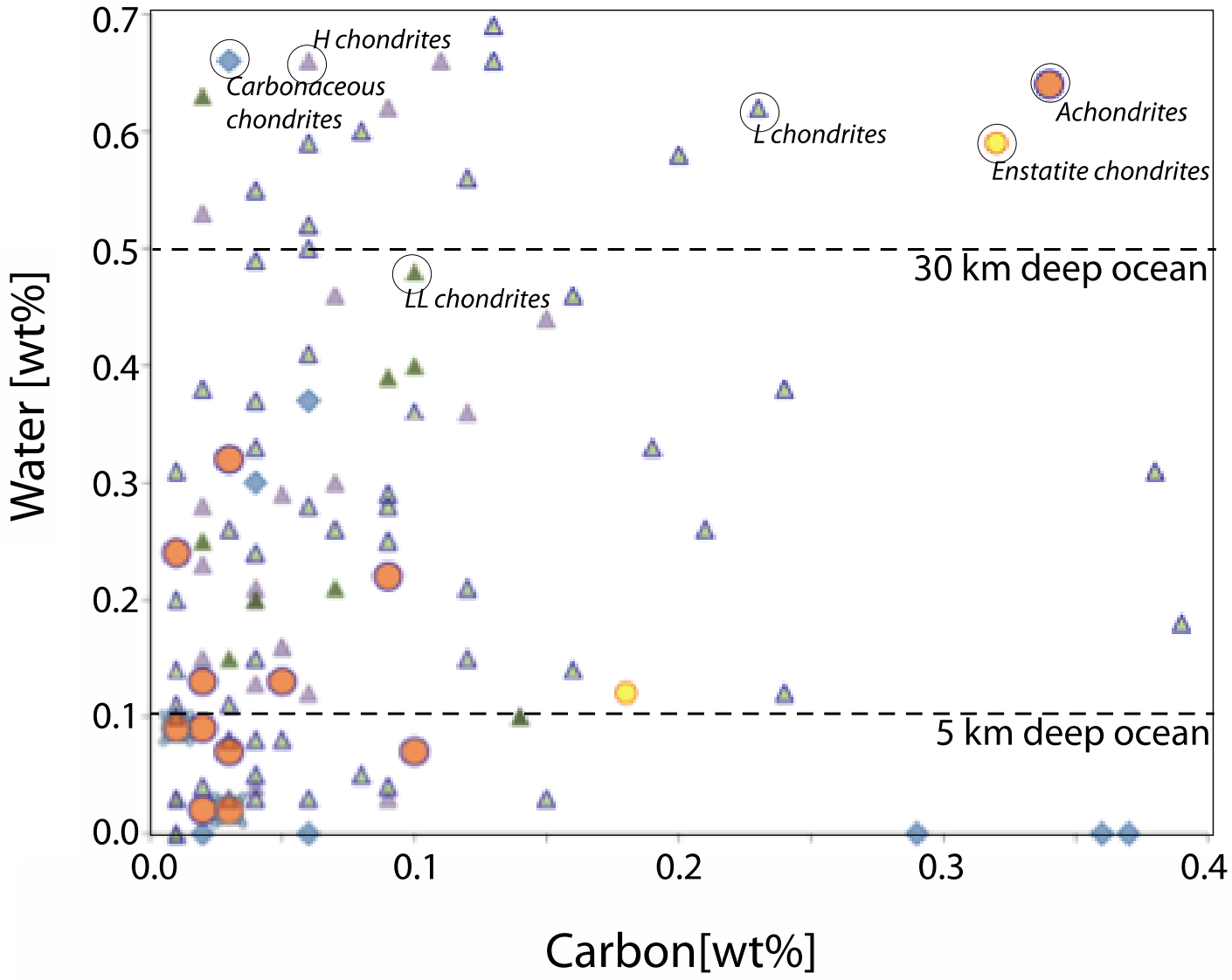
Planets form and cool to clement conditions very rapidly



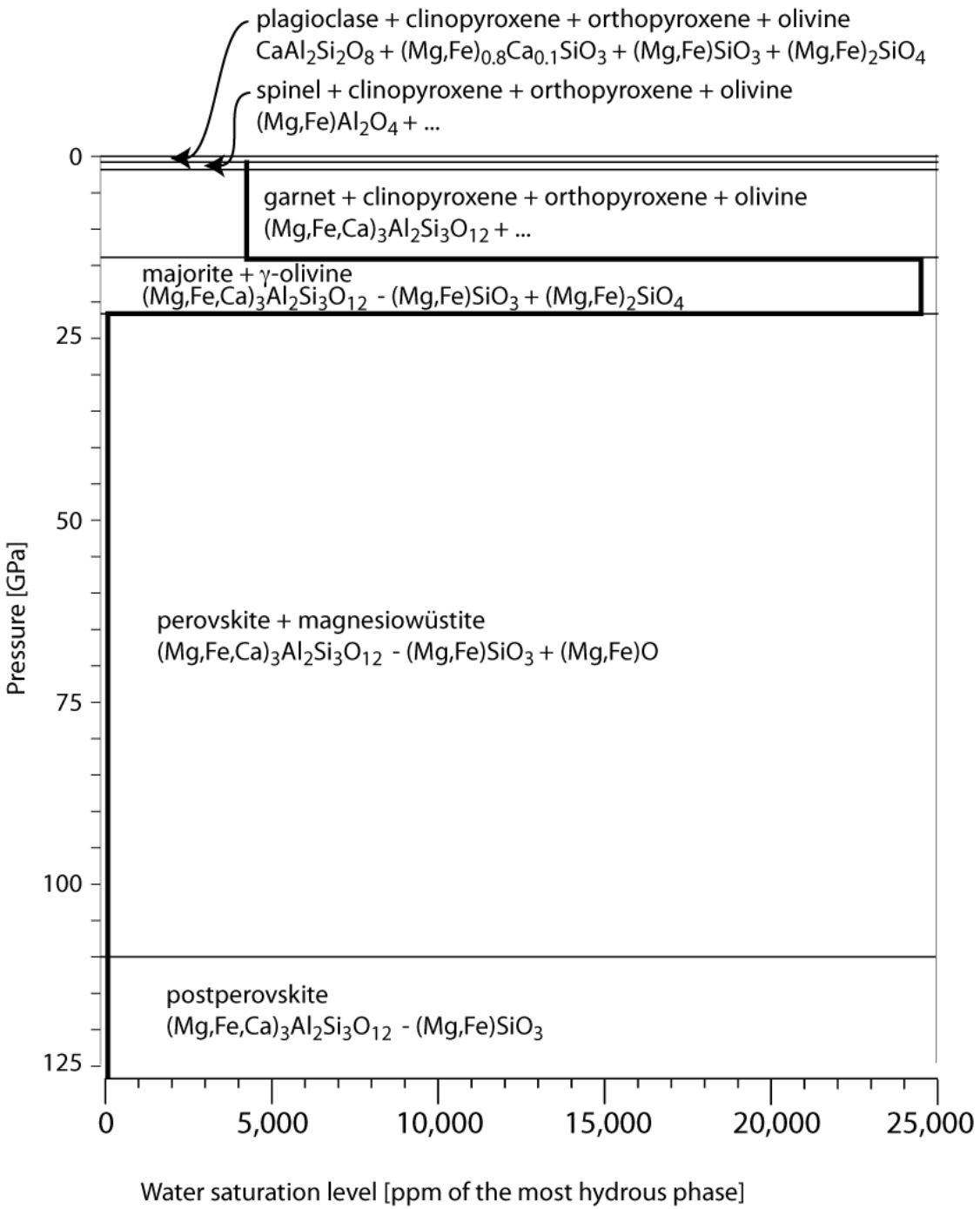
Life (1952)

New York Times (2008)

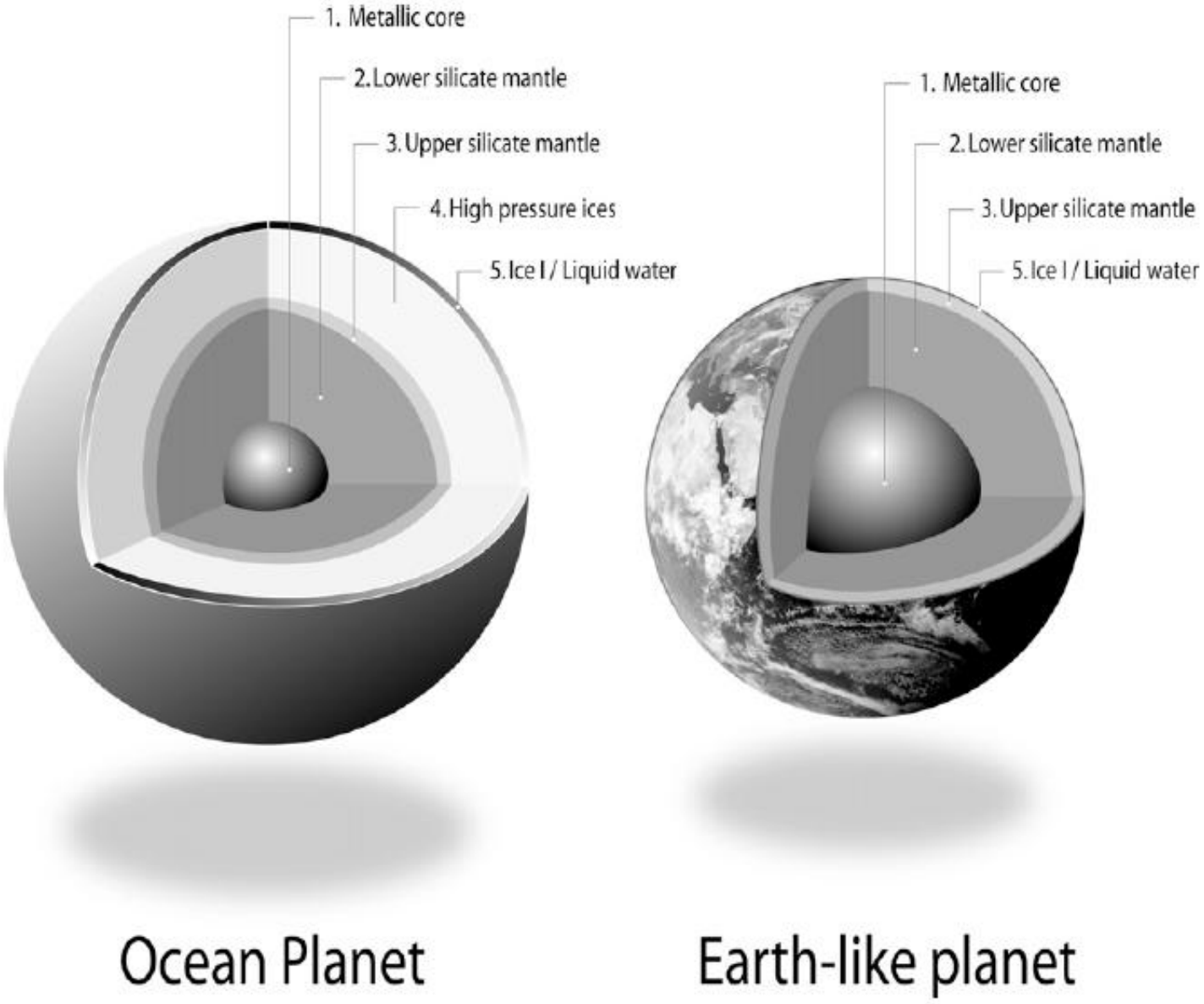
Earth starting with 100 ppm bulk water produces dense atm that collapses upon cooling into global ocean 100s m deep



Elkins-Tanton ; Data from Jarosewich (1990)



Elkins-Tanton



Sotin et al. (2007)

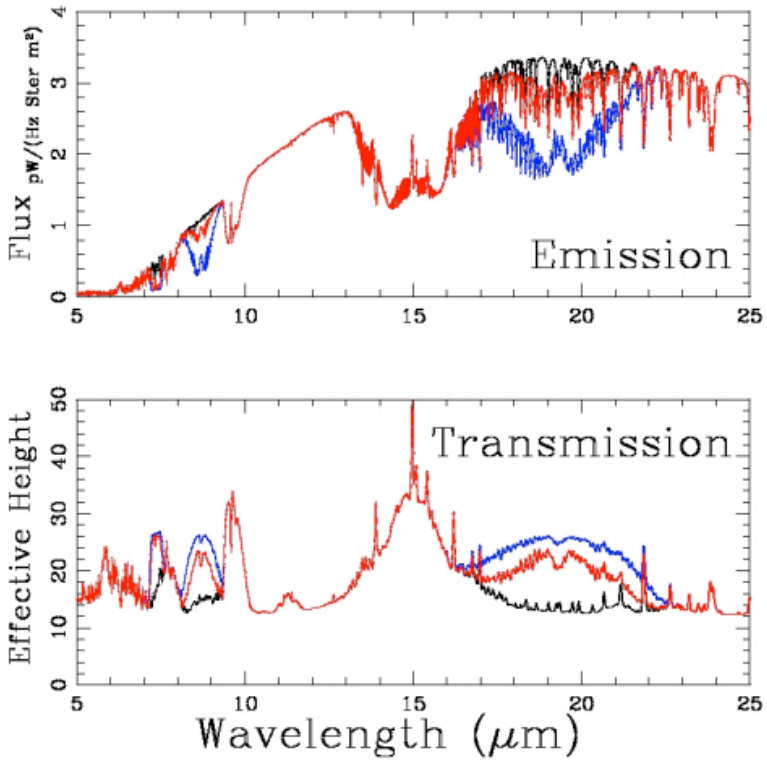


Figure 2: Case 1, thin layer (top). Case 2, thick layer (bottom). No clouds. Relative flux. Model emergent spectra 0.4 μm – 40 μm of a cloud-free atmosphere for three volcanic SO_2 concentrations (Black: No eruption. Red: 10x Pinatubo eruption (baseline). Blue: 100x baseline). The calculations are performed at very high resolution (0.1 wavenumbers) and subsequently smoothed for display (R = 150). Three sulfur dioxide features become detectable in the 10x and 100x cases.

Kaltenegger, Henning, and Sasselov (2010)

Compositions – silicate/metal, volatiles, oxidation

- Control oceans, atmospheres, and internal structure
- In turn influence surface temperature and magnetic field
- And control habitability

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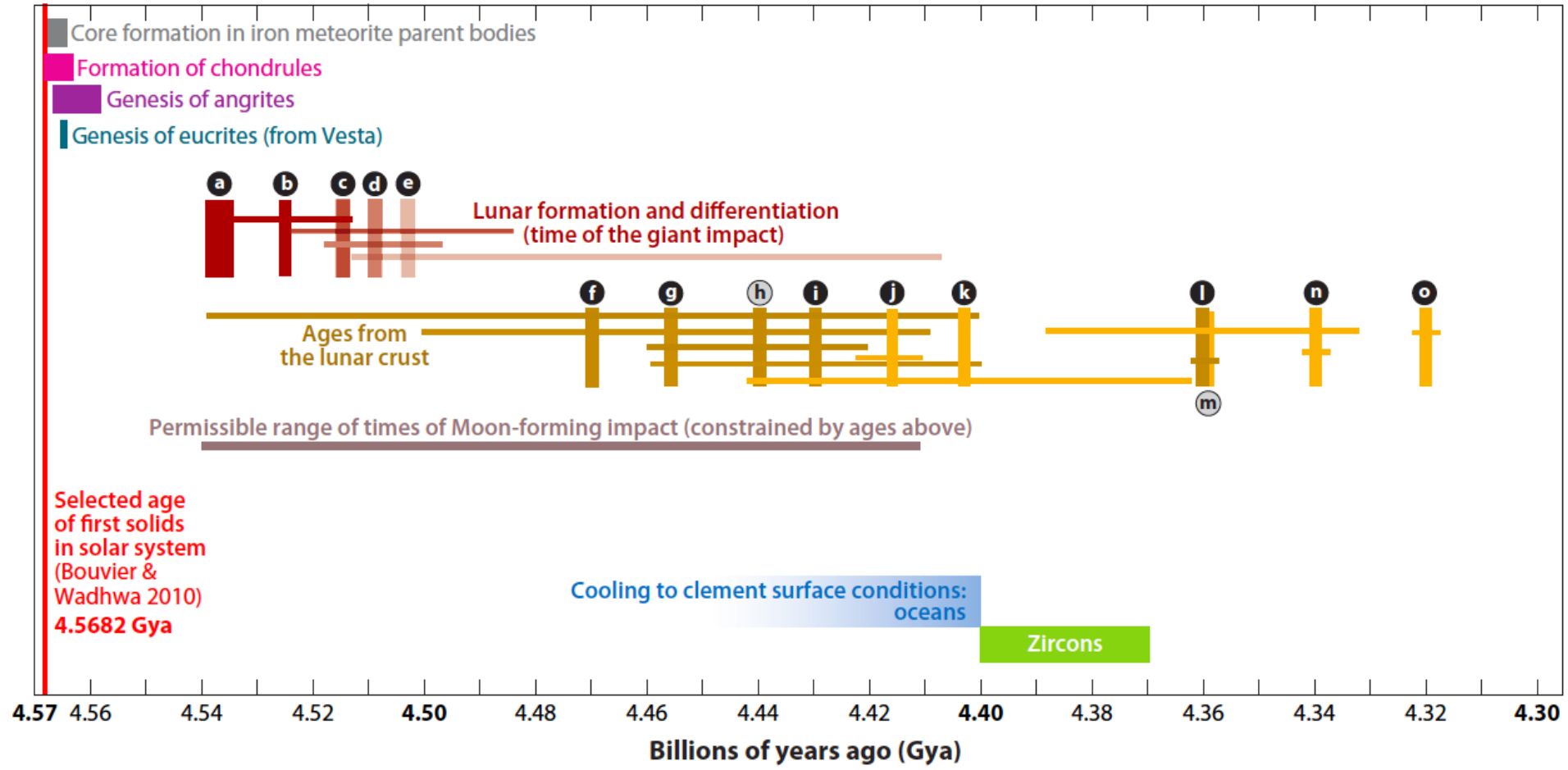
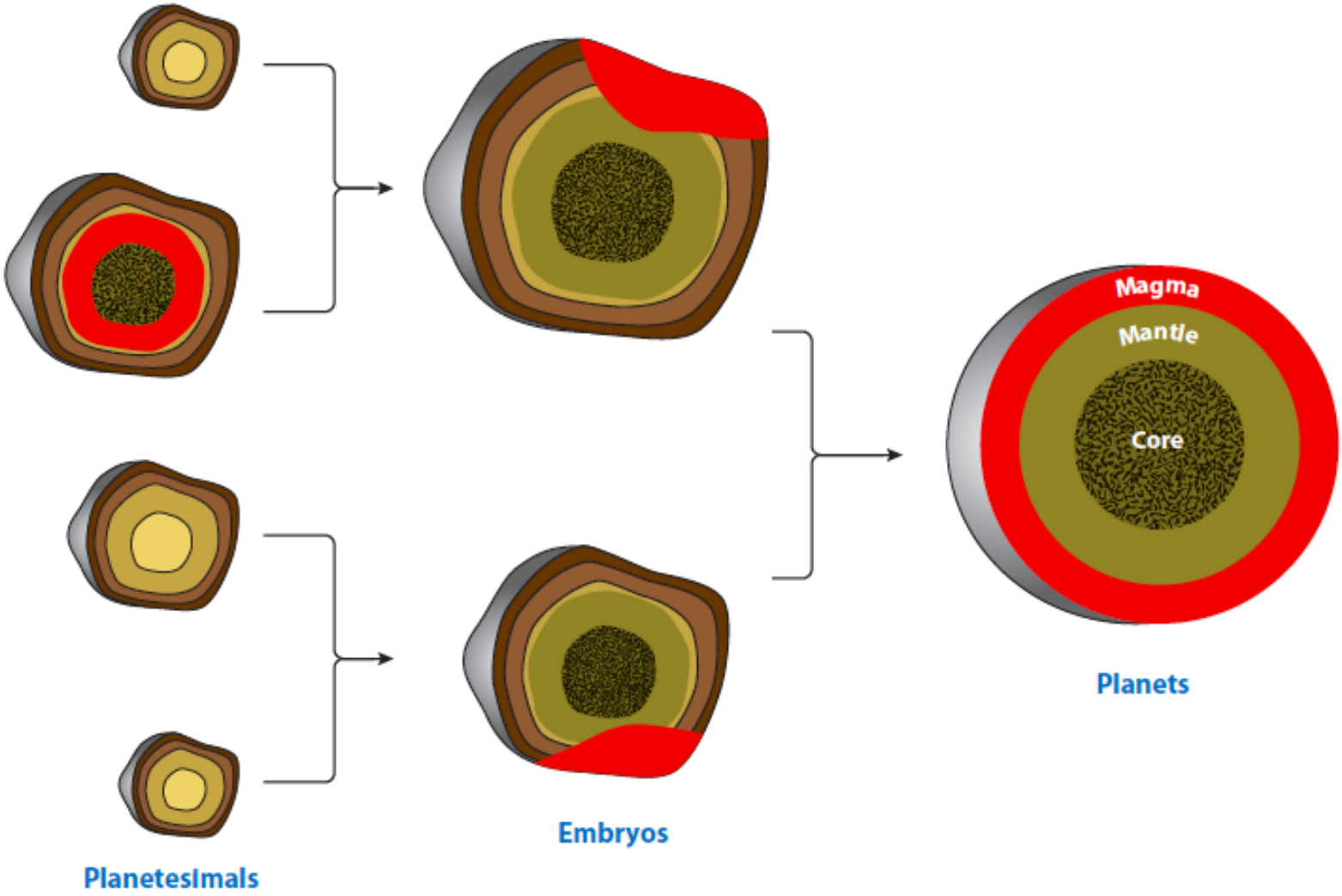


Elkins-Tanton (2012) Ann.Rev.

Planets are built by giant impacts among differentiated bodies



Elkins-Tanton (2012) Ann.Rev.