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Earl of Rosse drawing, Ireland, 1845

Galaxy

## From the Journey-work of the Stars to the Wealth of Nations

**Energy** radiates to space as a means of dissipation,  
employs star formation to force dissipation,  
achieves nucleosynthesis as a mechanism of  
dissipation,  
discharges supernovae to continue dissipation,  
devises differentiation as alternative routes to  
dissipation,  
pursues planetary aggregation as a procedure of  
dissipation,  
conceives convection as an operative of dissipation.

**Energy** invents biosynthesis as a route to dissipation,

exercises coded metabolists as processors for dissipation,

finds evolution is a search engine for dissipation,

invites competition that cells might cooperate in dissipation,

deploys an ecosystem as a path toward dissipation,

activates oxygenic photosynthesis as an instrument of dissipation,

ignites fire to further dissipation.

**Energy** develops consciousness to conduce dissipation,

discovers missiles to project dissipation

machines tools to advance dissipation,

implements agriculture to maintain dissipation,

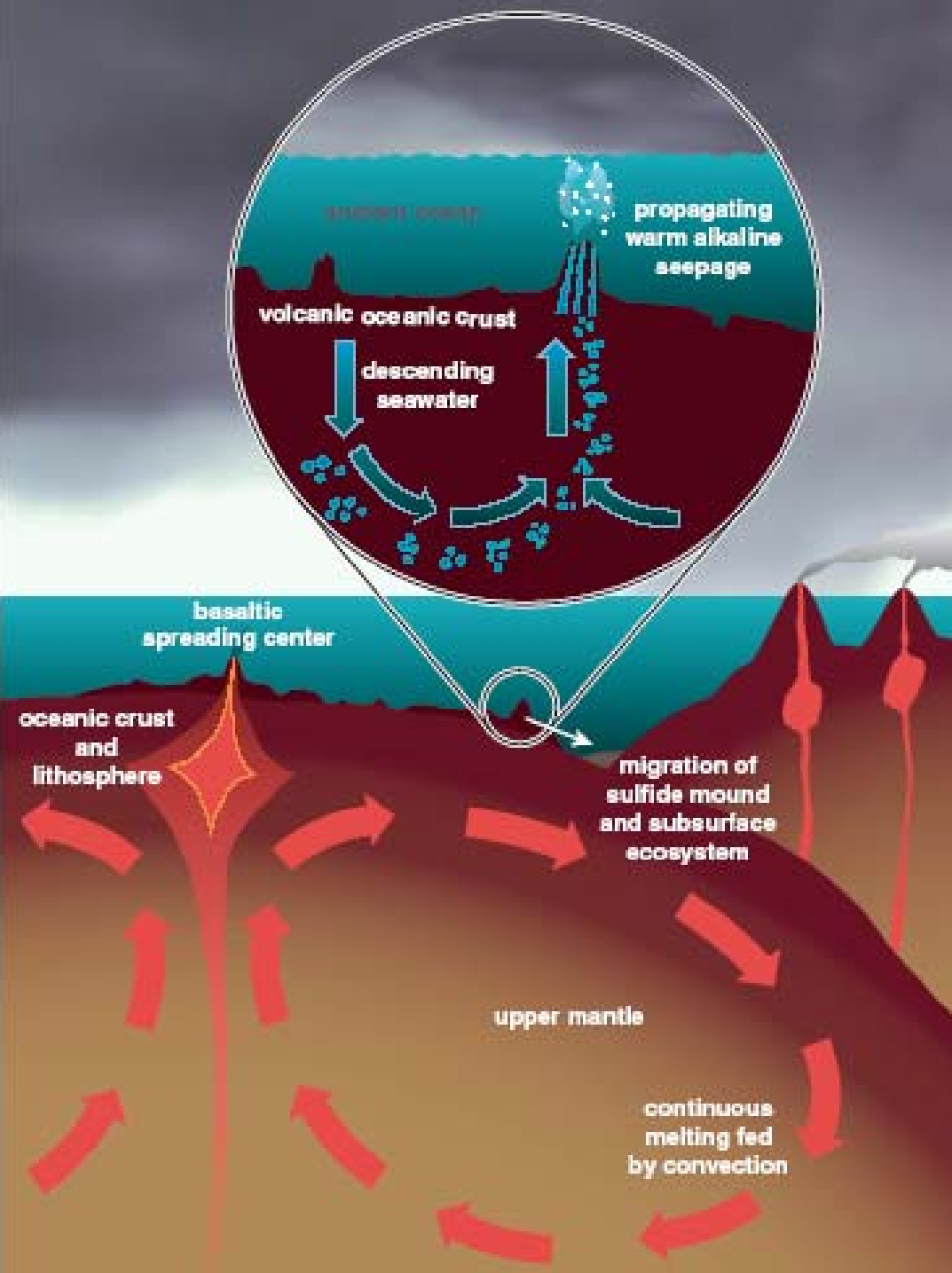
works a nation to engineer dissipation,

wages war as a weapon for dissipation,

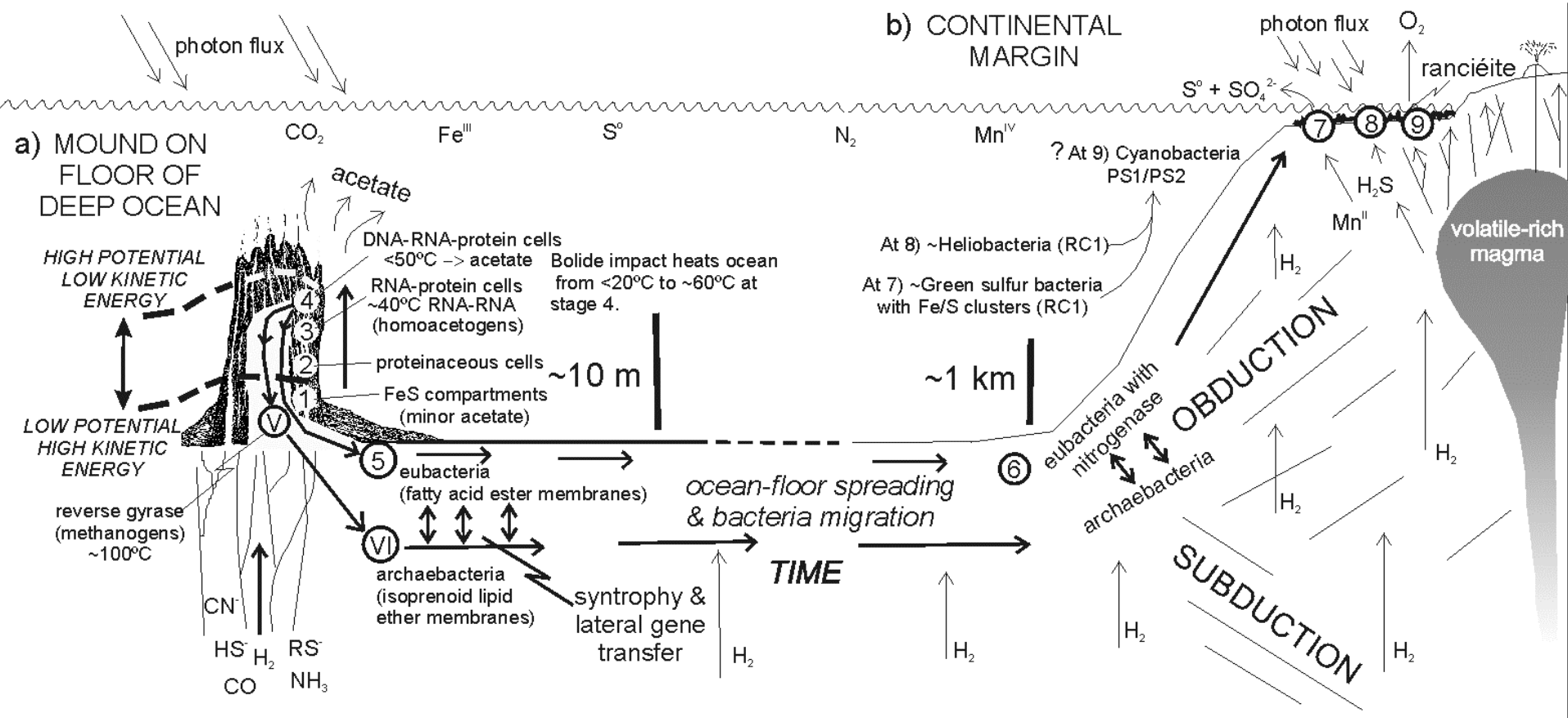
exploits capitalism as a vehicle for dissipation.



# METABOLISM is coupled to CONVECTION



# Geodynamic and metabolic cycles in the Hadean



Martin and Russell, 2003, Trans. Roy. Soc. London, 358B, 27-85 (Fig. 5)

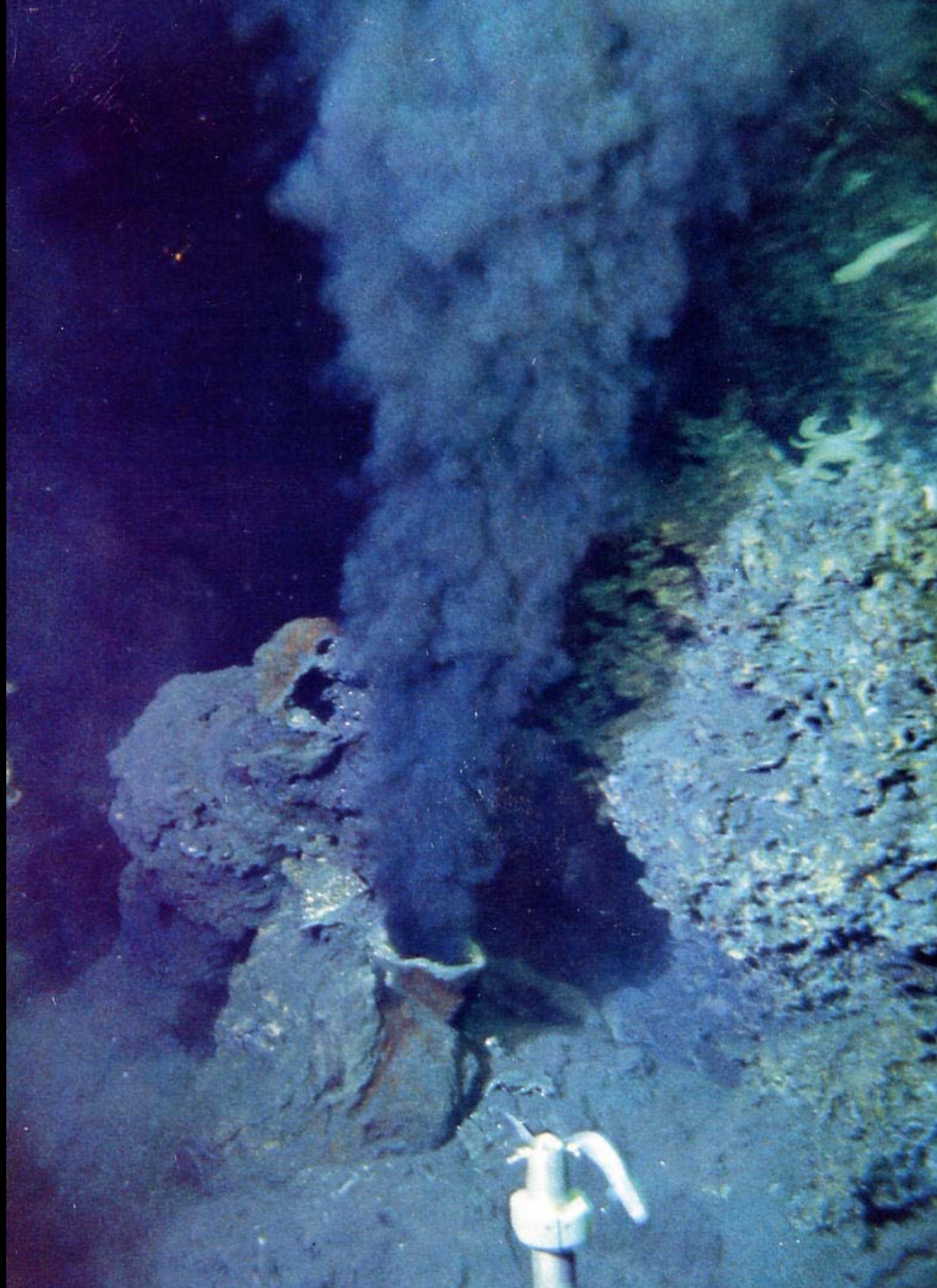
Russell & Martin 2004, TIBS 29, 358-363 (Fig. 3)

Russell and Arndt, 2005, Biogeosciences, 2, 97-111 (Fig. 2)

**Black Smoker**  
**at 360°C, pH ~3.4**  
**East Pacific Rise**

Dudley Foster (WHOI)  
National Geographic  
November 1979,

Melting point of  
lead is 327.5°C



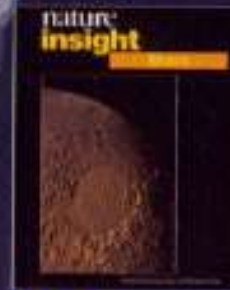
12 July 2001

International weekly journal of science

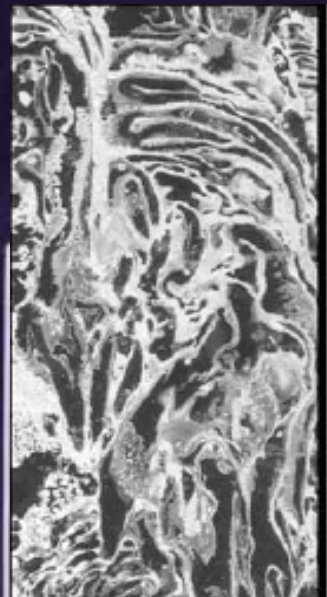
# nature

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Mars  
Nature Insight



500µm

C

## Hydrothermal vents in the 'Lost City'

## ALKALINE SUBMARINE SPRING



$$\text{pH} \leq 11$$

$$T \leq 90^\circ\text{C}$$

$$\text{H}_2 \sim 15\text{mmol}$$

>35,000 years

Kelley et al.

2001, Nature

412, 145

& Science 2005,

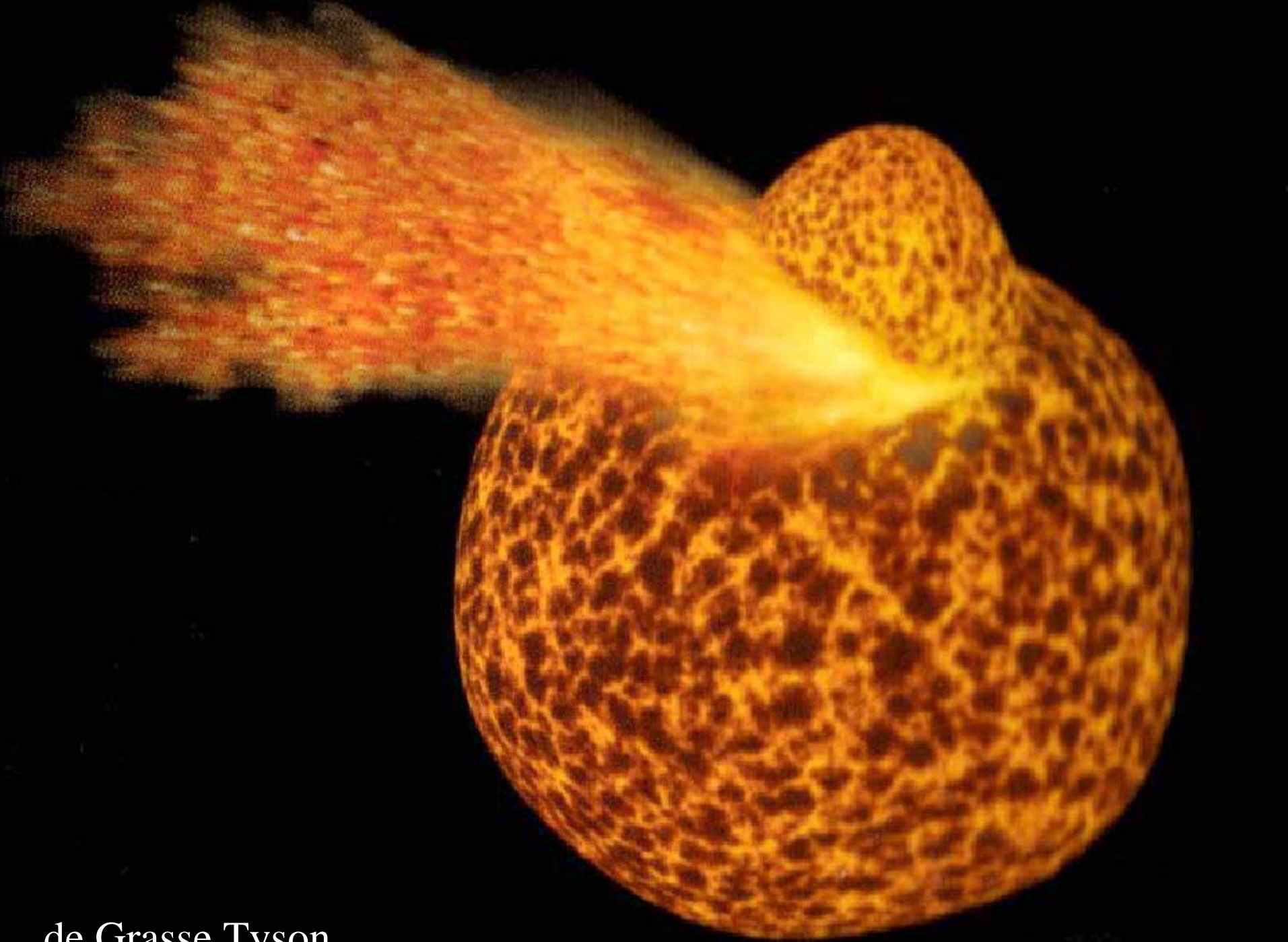
307, 1428.

Früh-Green et al.

2003, Science

301, 495

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de Grasse Tyson

# The outputs of convection were the inputs to emerging life

