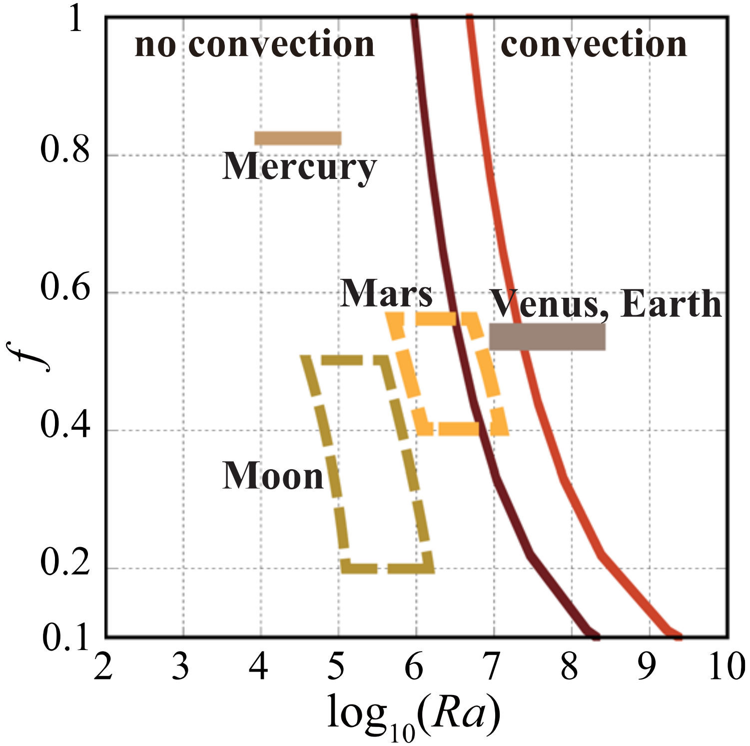
第7章　水星：異端児

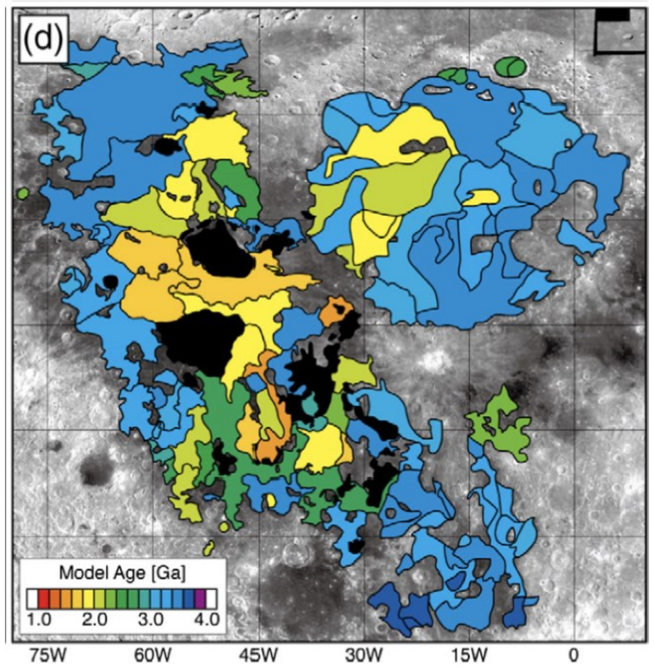
月と似たマントル・ダイナミクス？ ホットスポットなし

LIP→ MMU feedback?

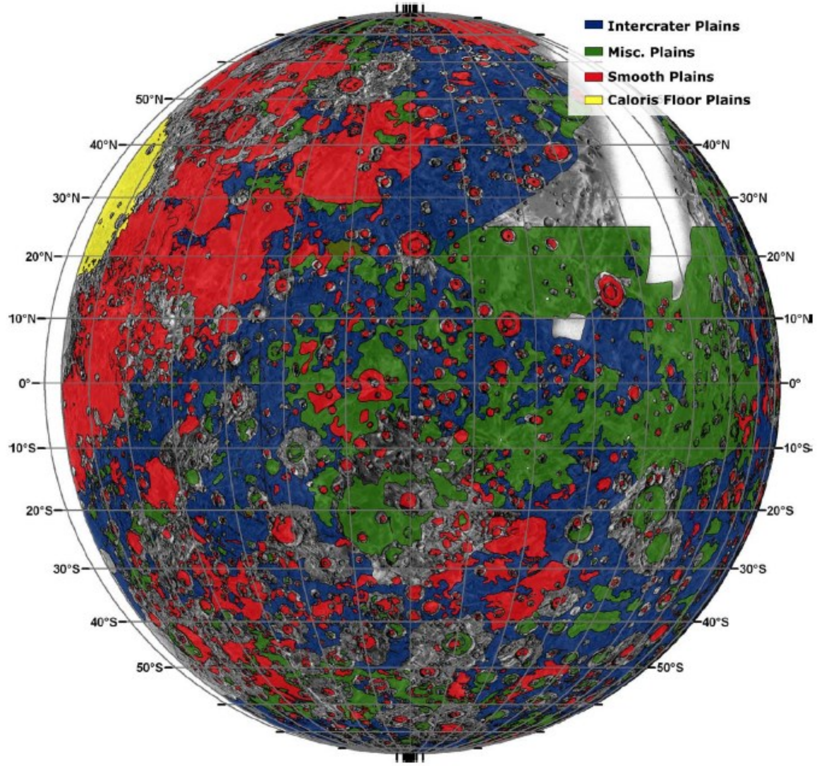


(Yanagisawa et al., 2016)

月

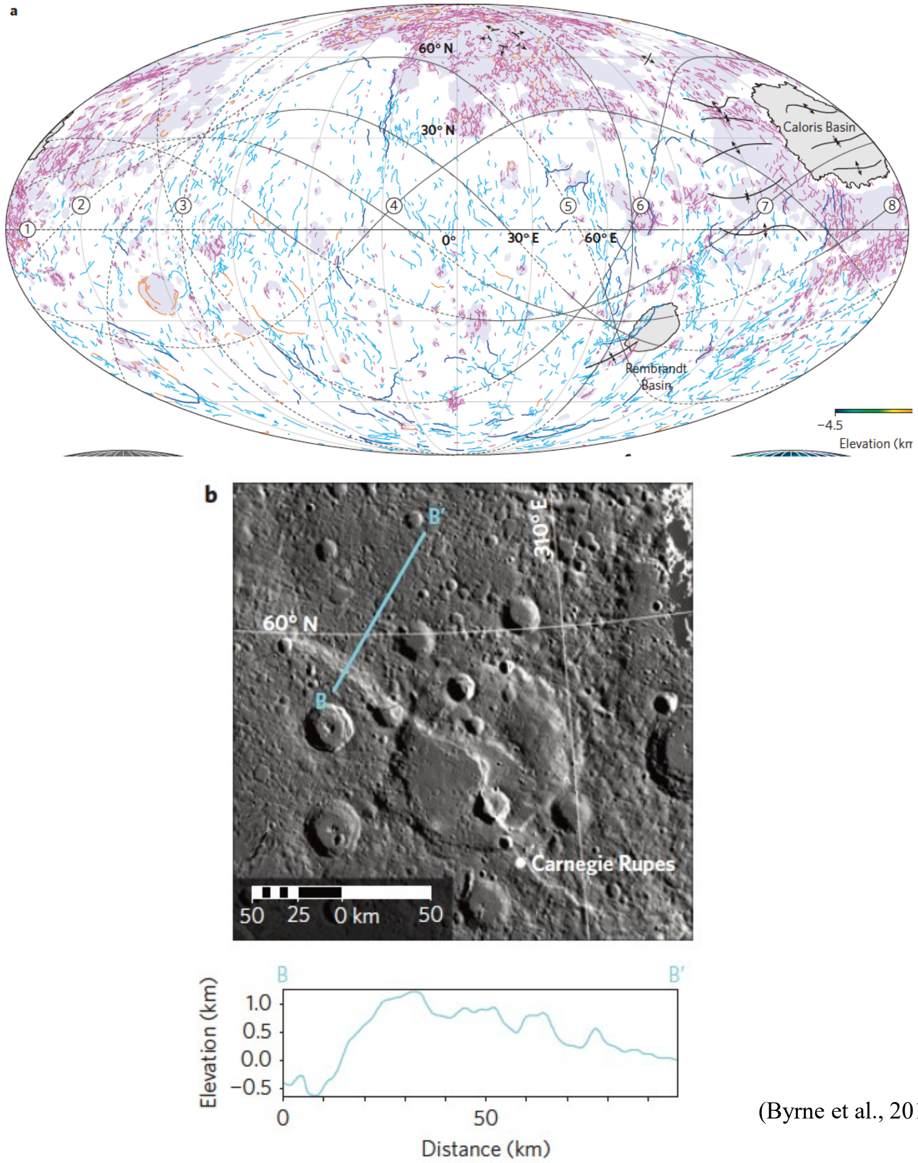


(Morota et al., 2011)



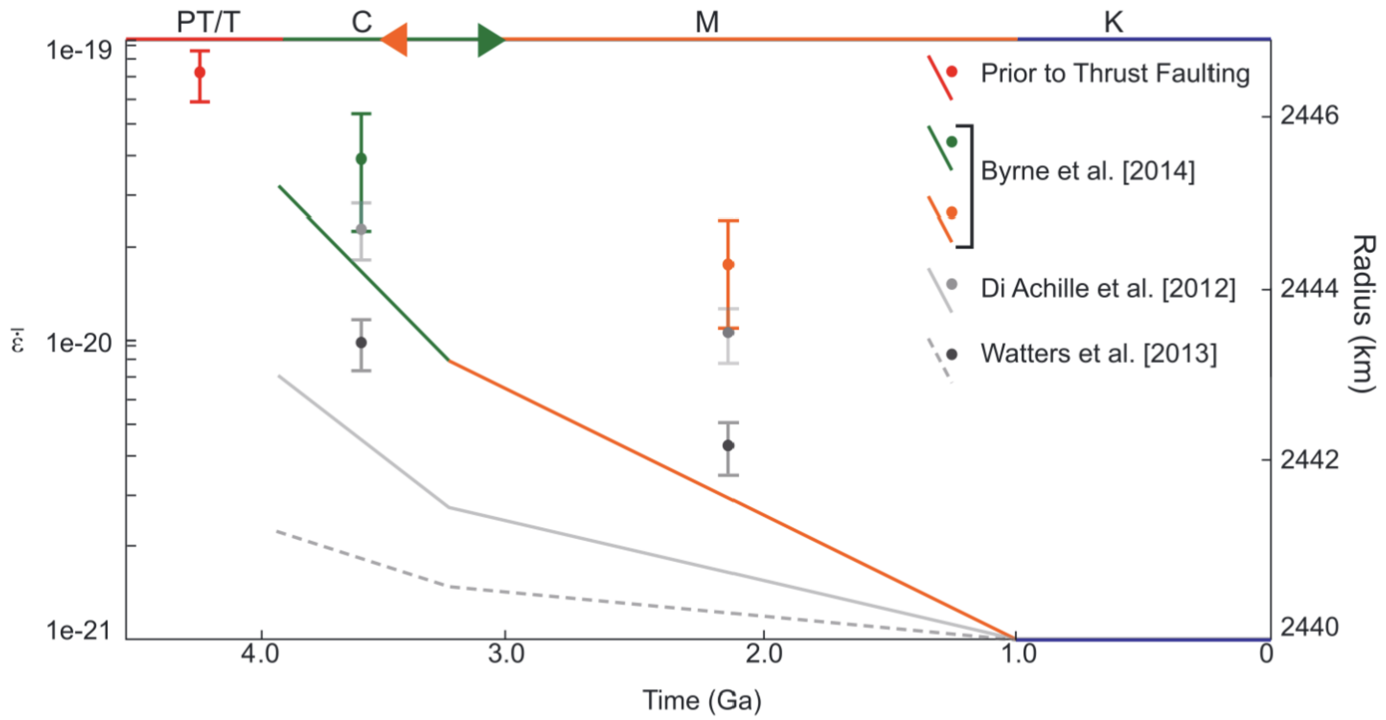
(Head et al., 2009)

7-1. 熱史と火山活動史



(Byrne et al., 2014)

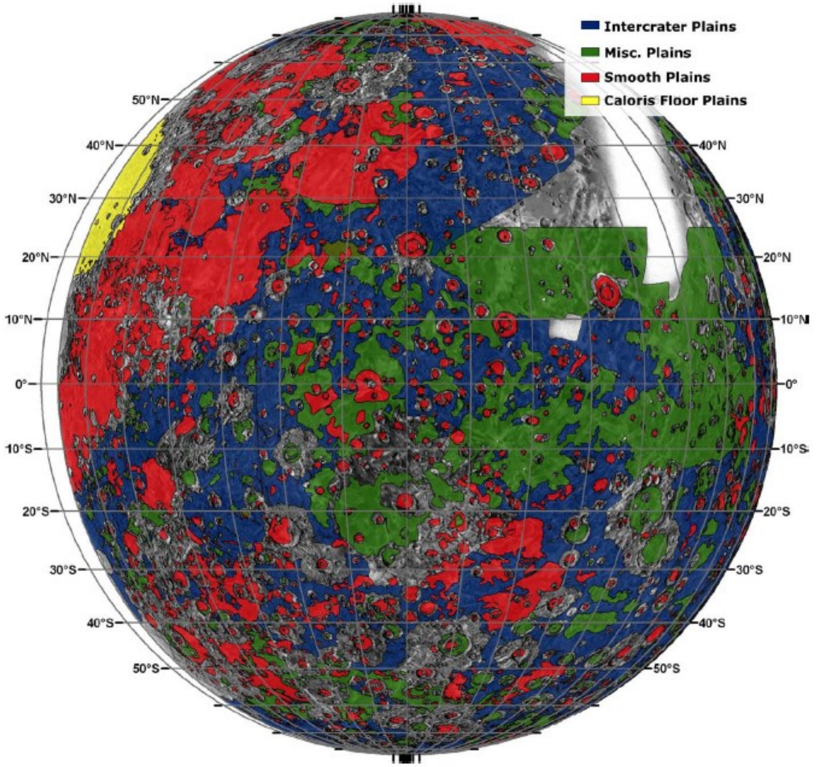
冷却による収縮：5−7 km



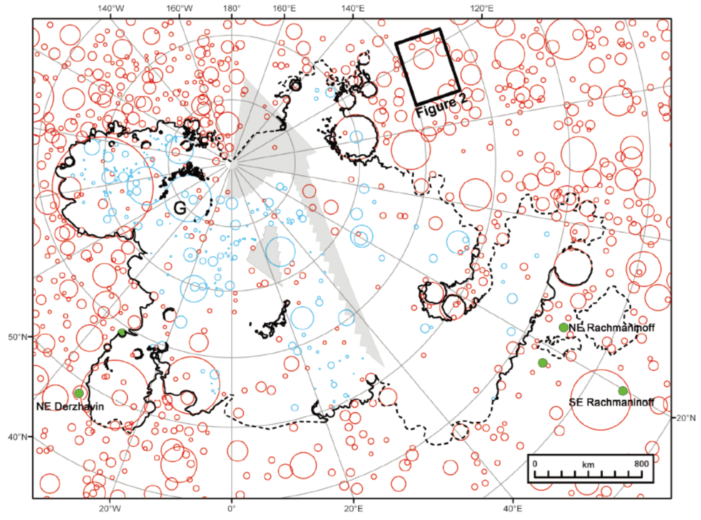
(Crane and Klimczak, 2017)

Intercrater plains 4-4.1 Ga? (Marchi et al., 2013)
smooth plain: 後期重爆撃期以降3.5 Ga まで

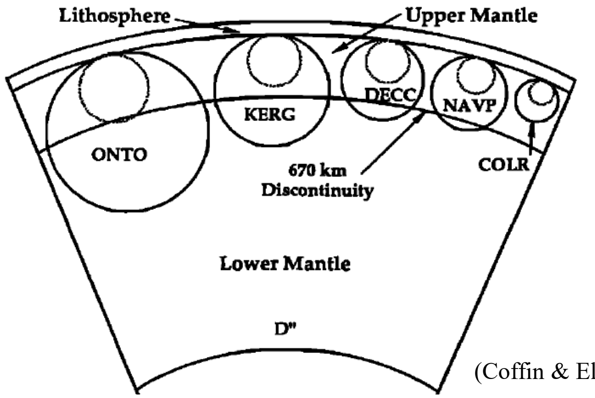
explosive volcanism: 1 Ga 頃まで



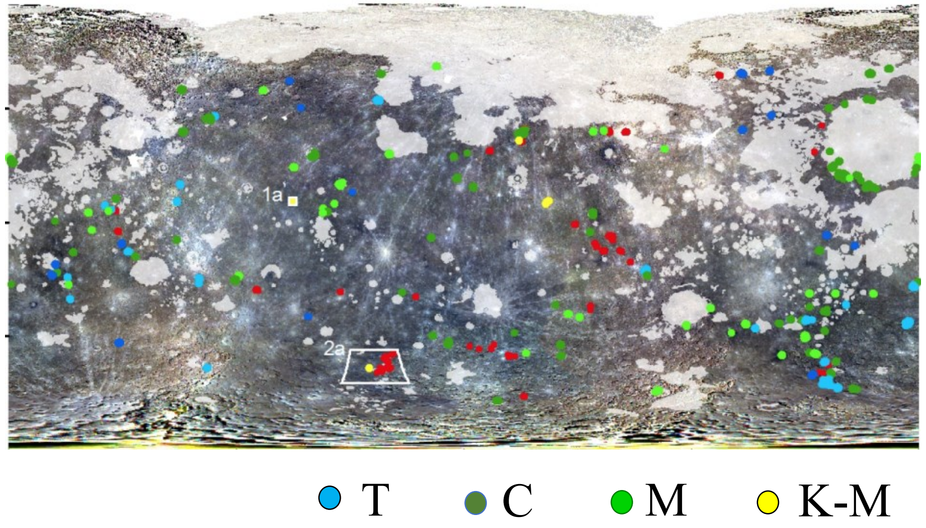
(Head et al., 2009)



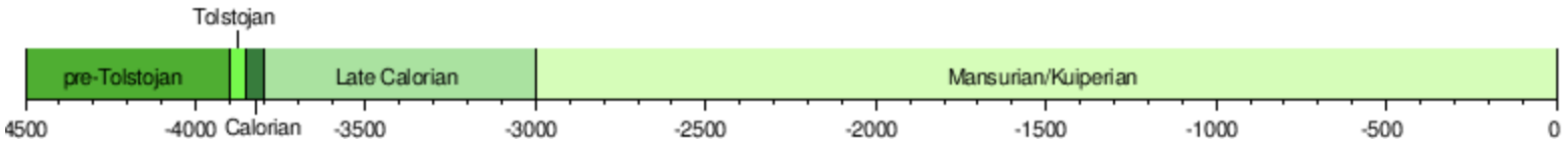
(Head et al., 2011)



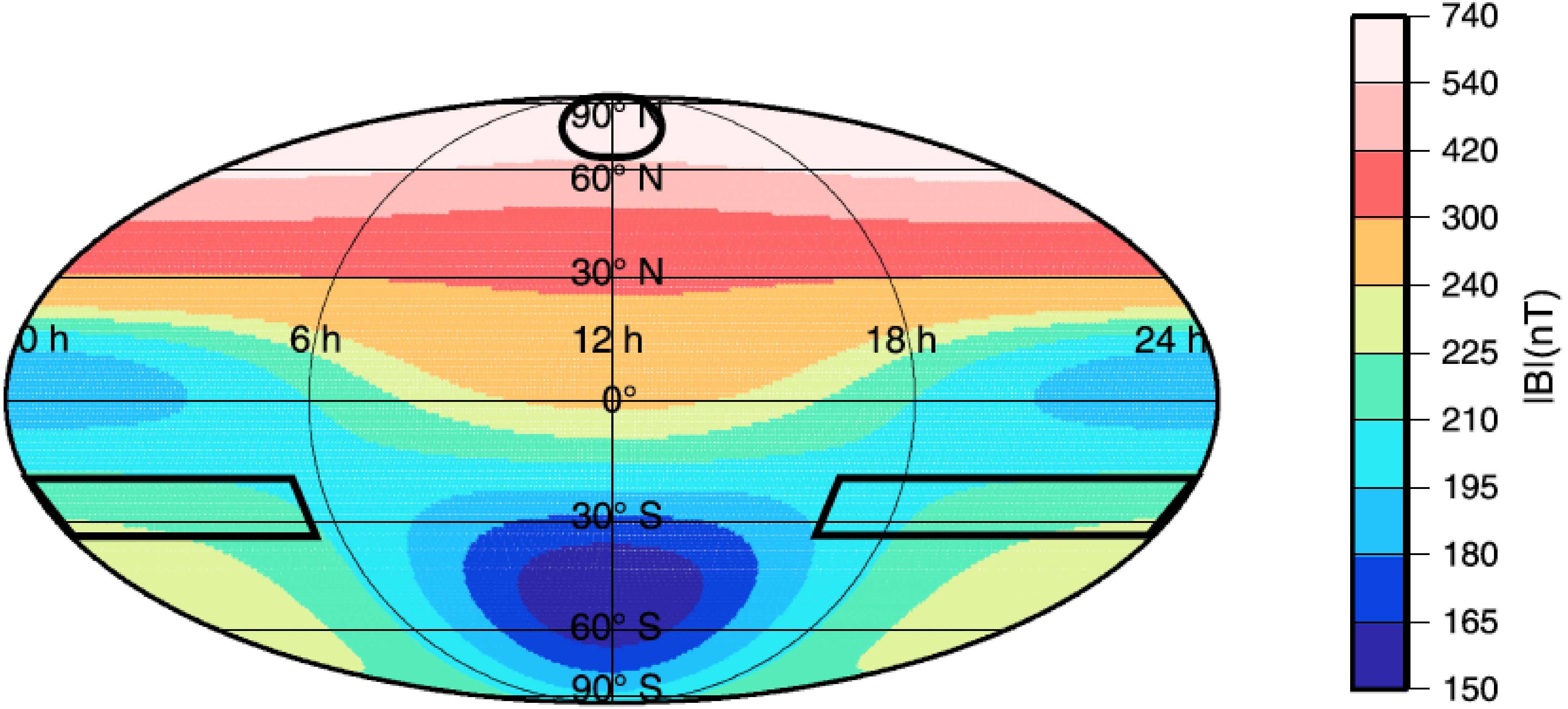
(Coffin & Eldholm, 1994)



(Thomas et al., 2014)



弱い磁場；　ダイポールの中心が北半球の30Nあたり

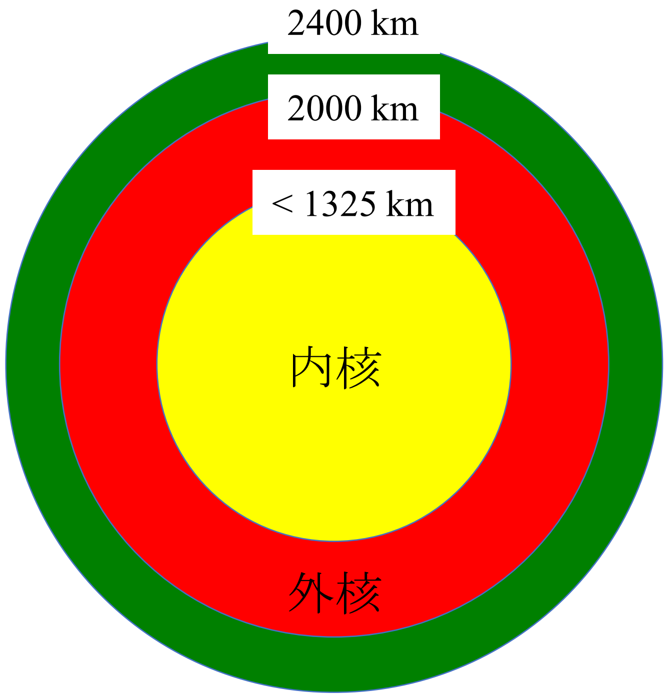


(Winslow et al., 2014)

7-2. 内部進化モデル

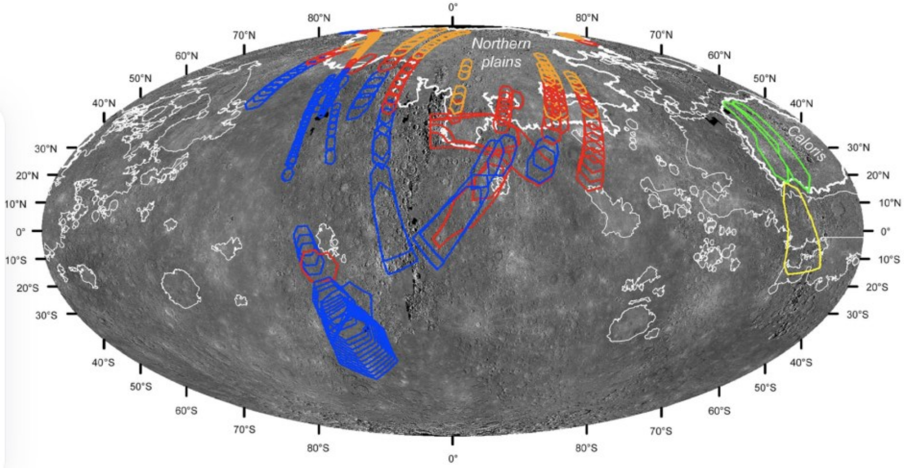
水星の特異性

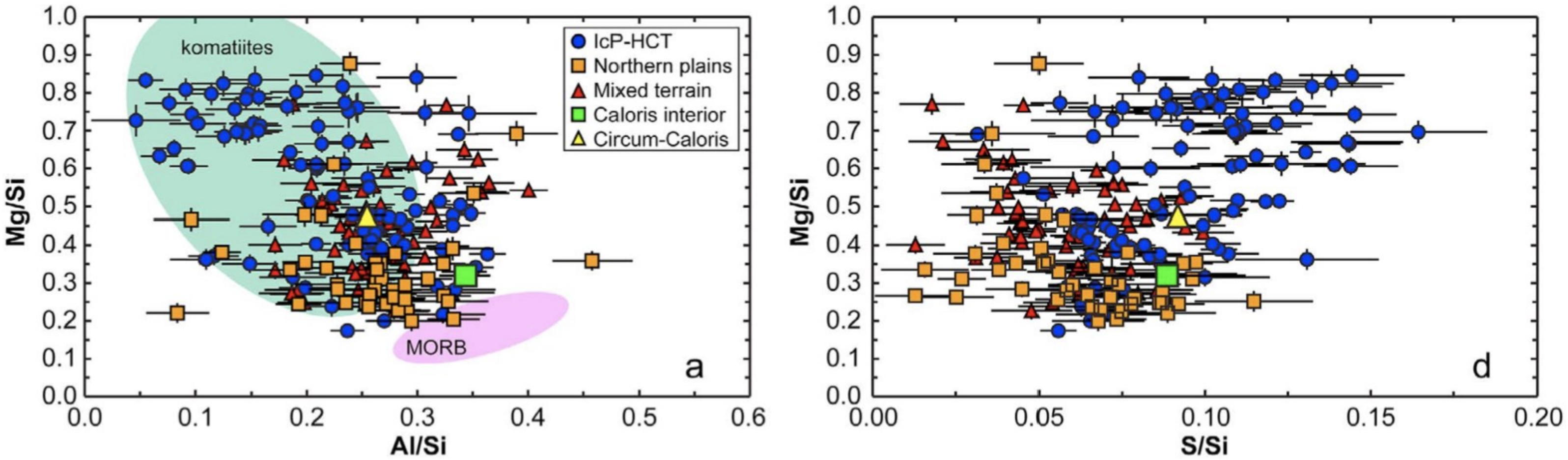
大きなコア: 熱容量＝2.5×マントル+潜熱



(Hauck et al. 2013; Dumberry & Rivoldini, 2015)

大量の硫黄





(Weider et al., 2012)

大きなコアの熱容量の効果？

LIPの存在 → MMUbフィードバックがかかるようにレイリー数を調整

地表面;温度450K

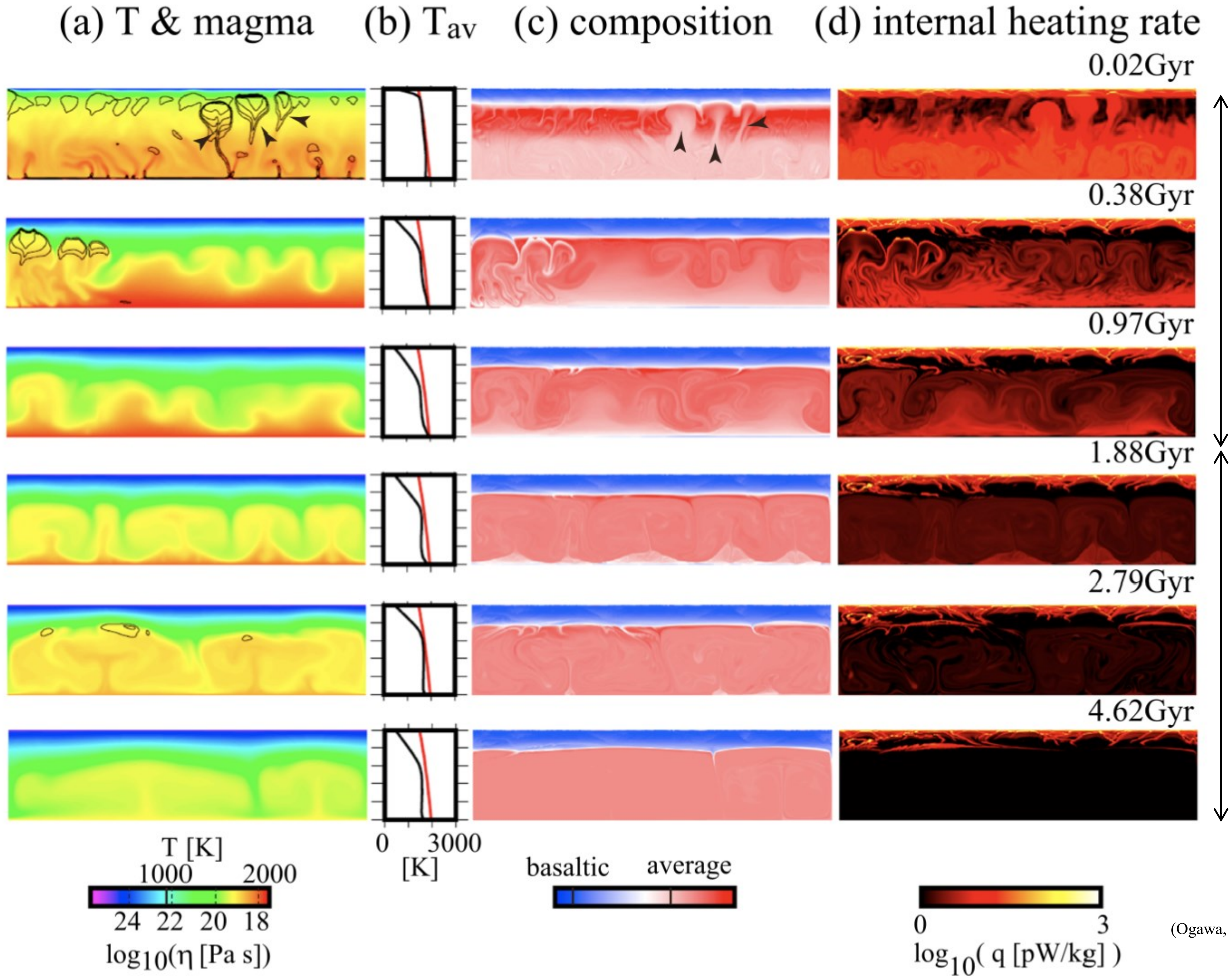
火成活動·マントル対流結合系

レイリー数1.7×10^{6}(粘性率2×10^{19}Pas)

400 km

コア＝温度一様の熱浴

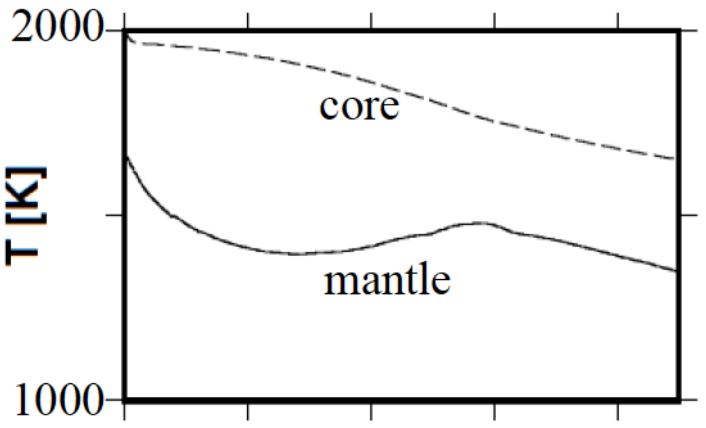
熱容量 ＝ マントルの4倍(固化の潜熱も含む)

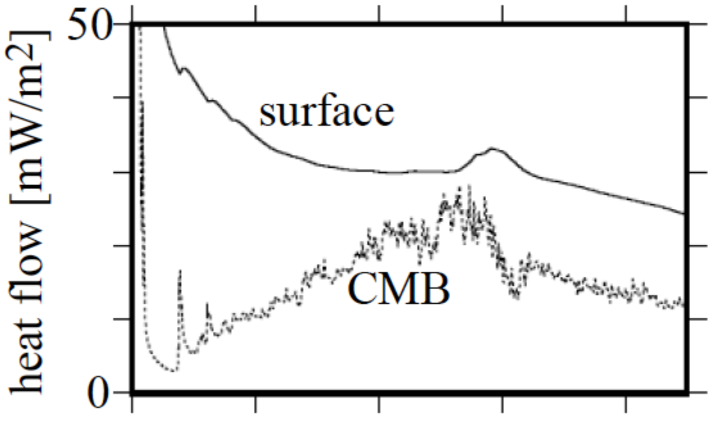


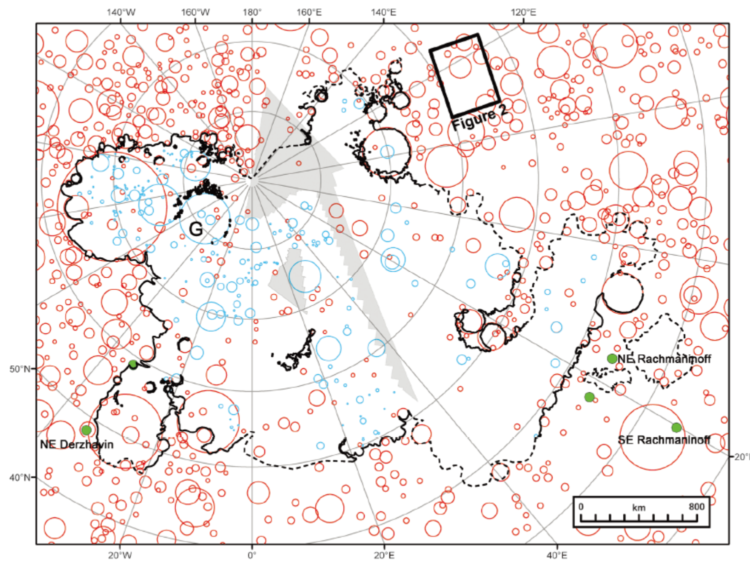
火星と同じ進化

コアからの熱
による対流撹拌
⇓
均質化
⇓
火成活動

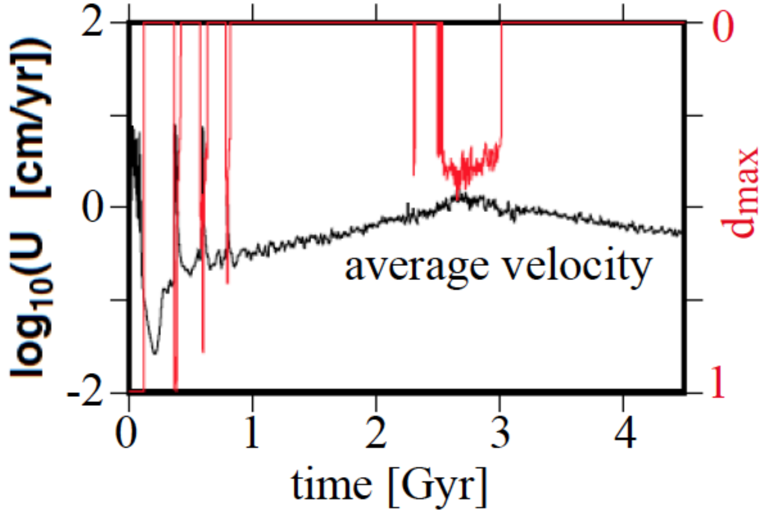
(Ogawa, 2016)

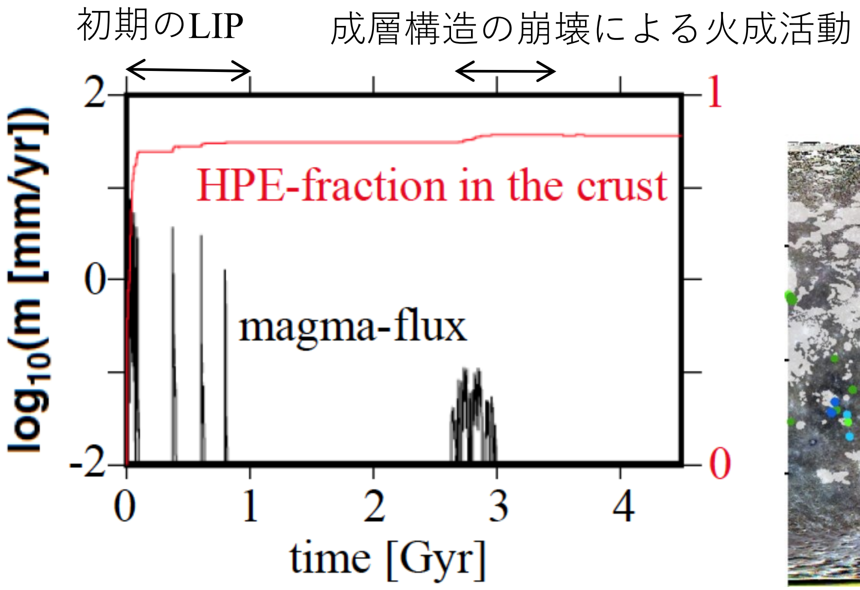


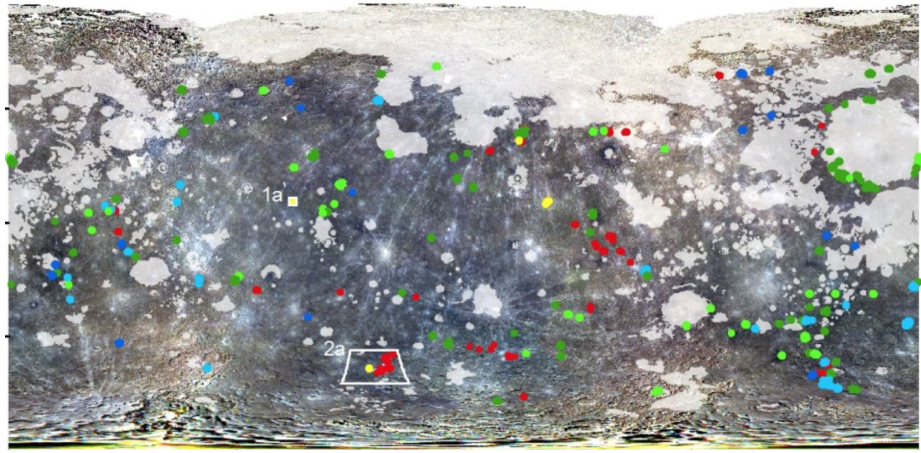




(Head et al., 2011)

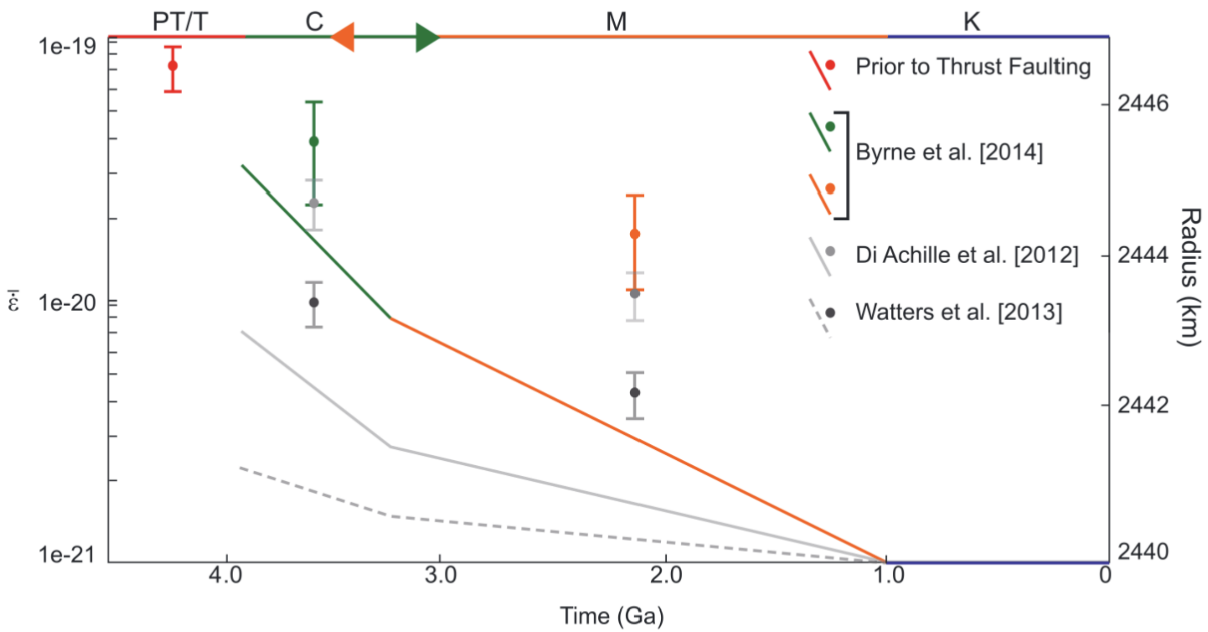




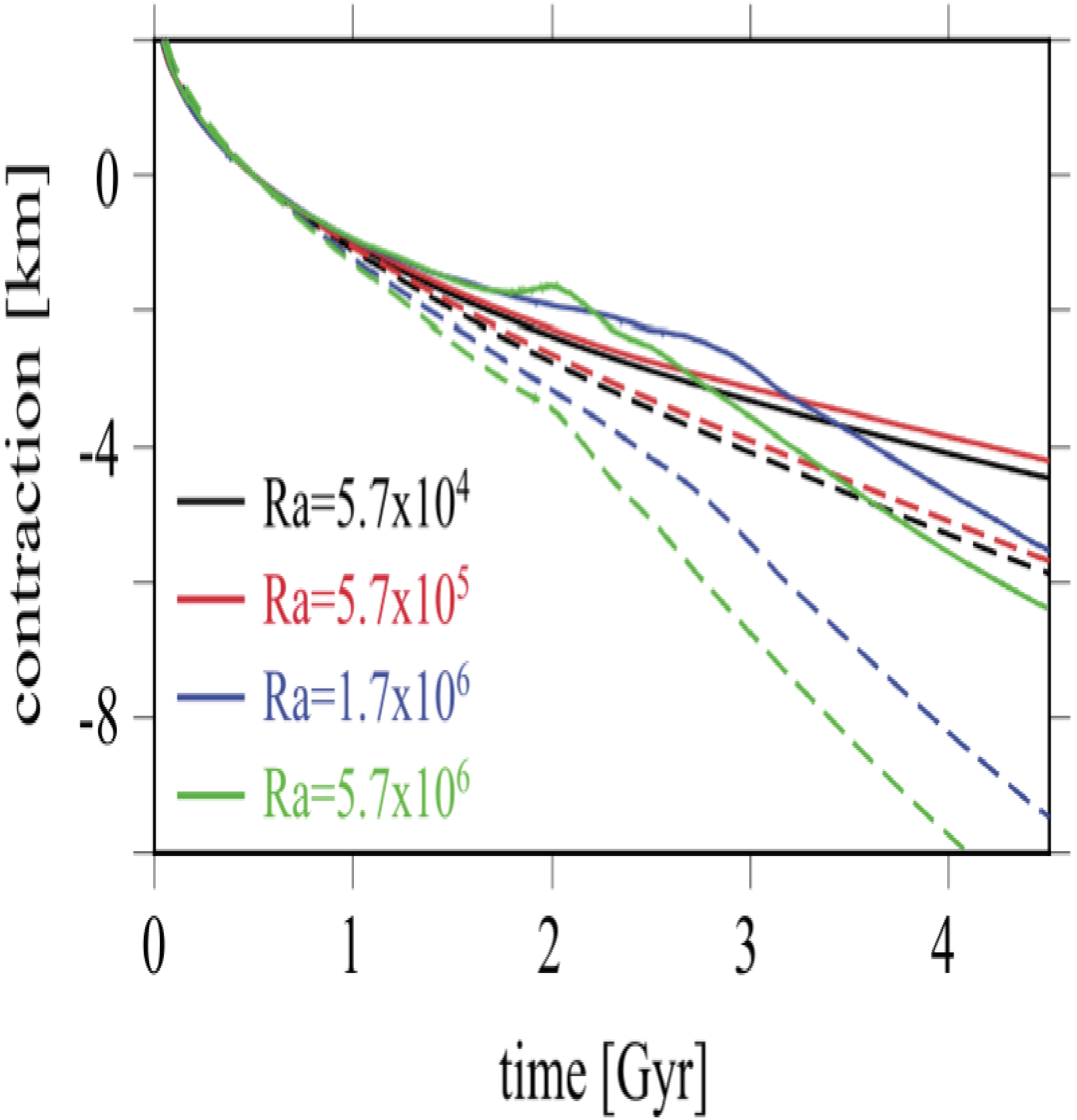


(Thomas et al., 2014)

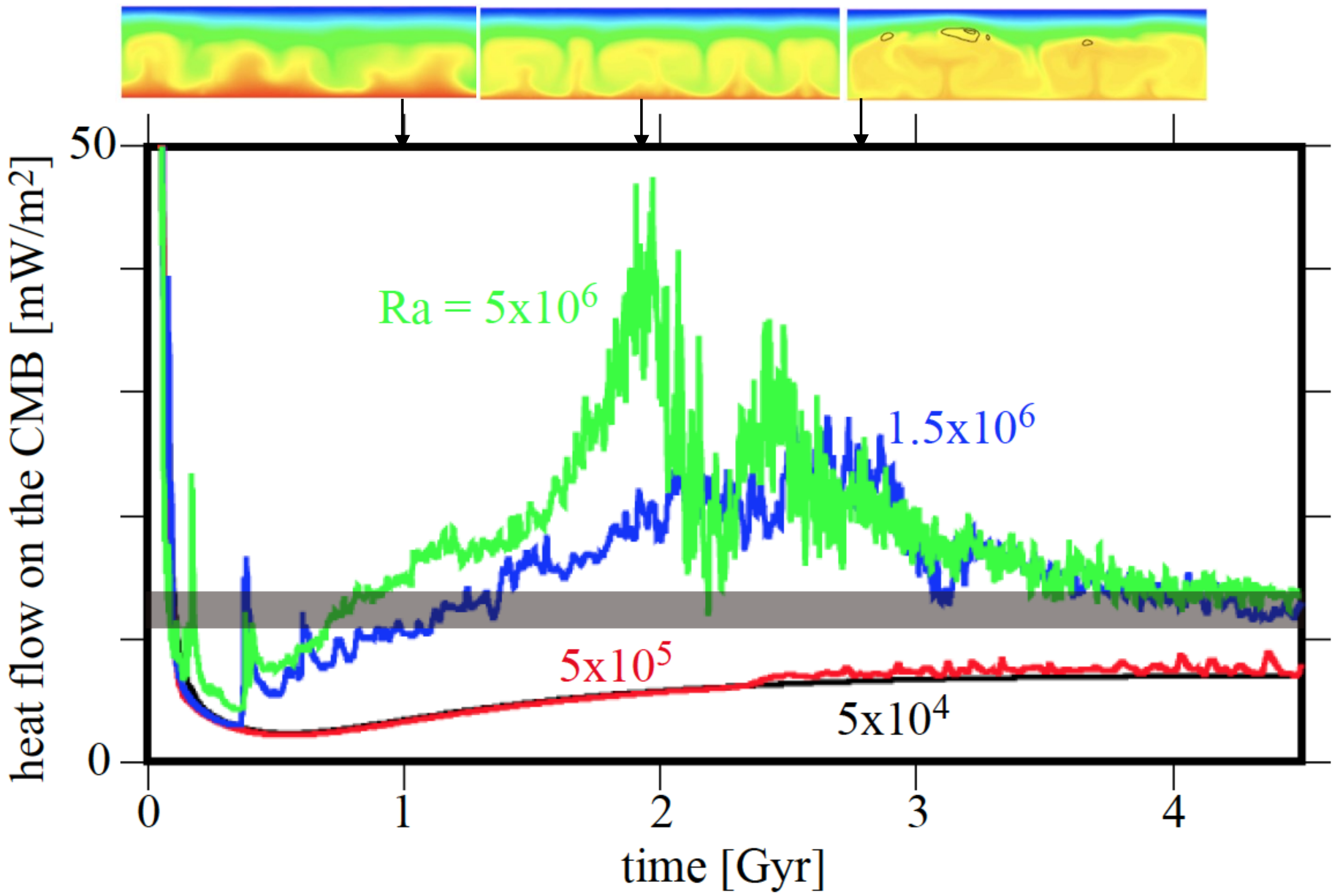
半径変化？

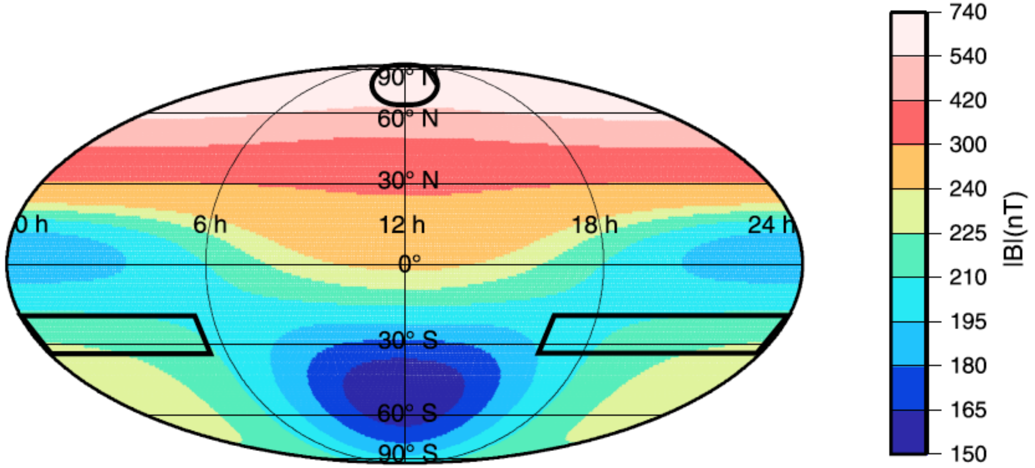


(Crane and Klimczak, 2017)



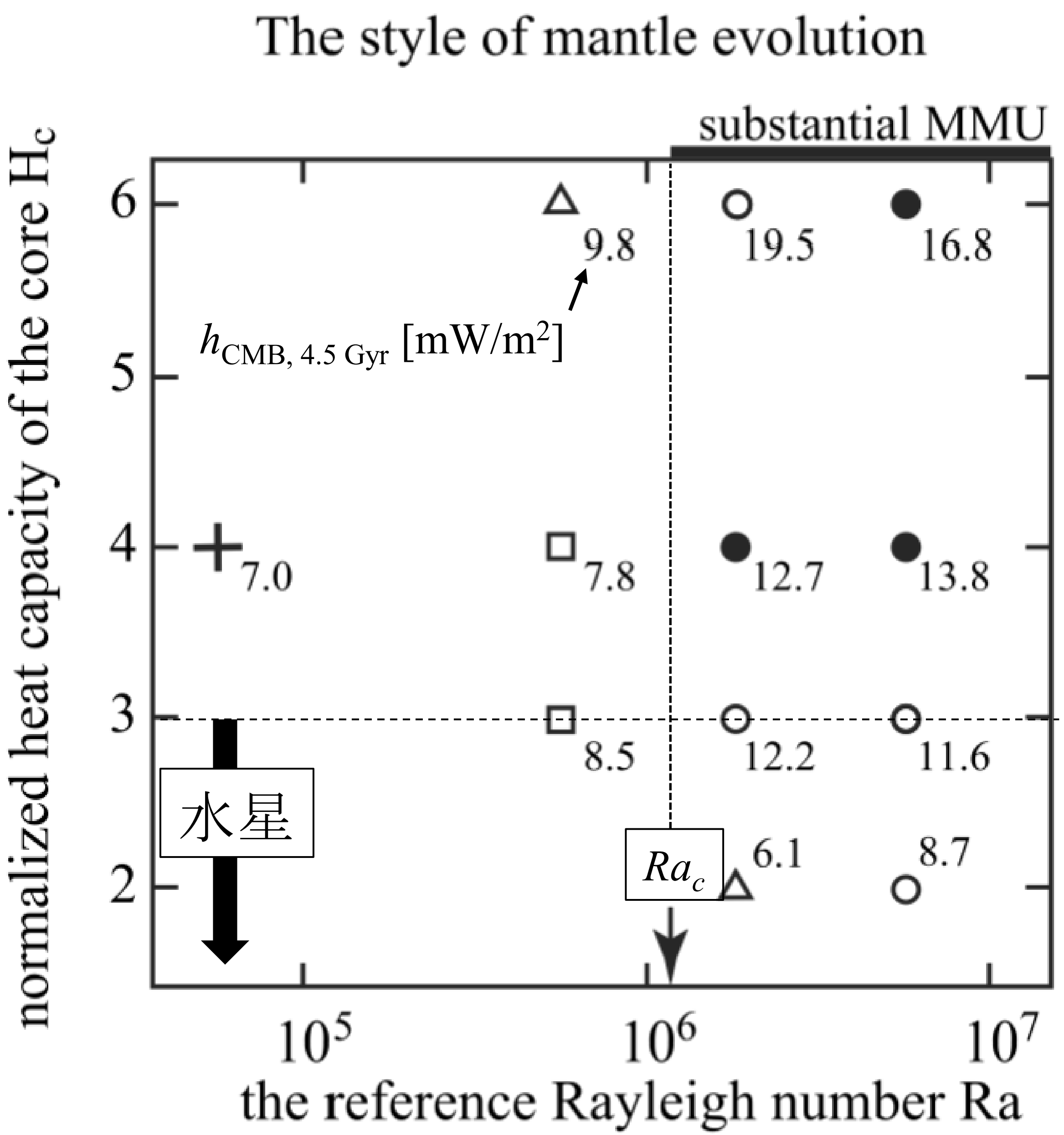
水星のダイナモ？





(Winslow et al., 2014)

マントルの均質化により火山活動が復活し、現在のh_{CMB} > 断熱流量 となる条件



$Ra > 10^6$ → mantle viscosity < 10^{19} Pa s

コアの熱容量　>4＊マントルの熱容量

⇓

水星は、大きなコアでは説明できない？

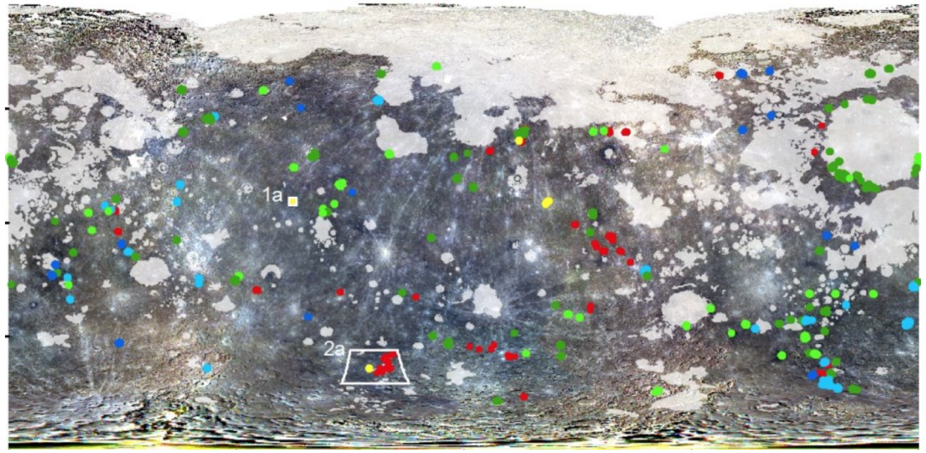
Cases where the mantle is stronly stirred
- ●; magmatism ceases but resurrects.
- ○; magmatism ceases.

Cases where the mantle remains stratified
- △; convection continues for 4.5 Gyr.
- □; convection ceases but resurrects.
- ＋; the MMU feedback does not operate.

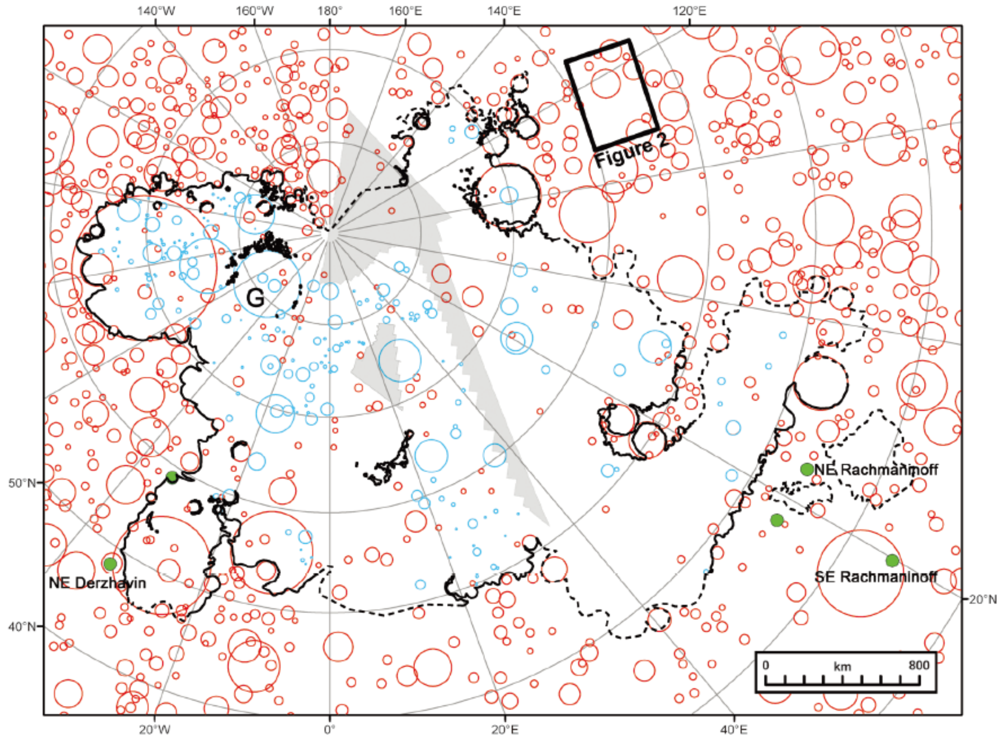
硫黄の効果？

若い爆発的火山:コアからの硫黄の継続的供給？

LIP: 硫黄によるマントルの粘性率の低下 → MMU？
cf. 水の粘性率への効果への疑問



(Thomas et al., 2014)

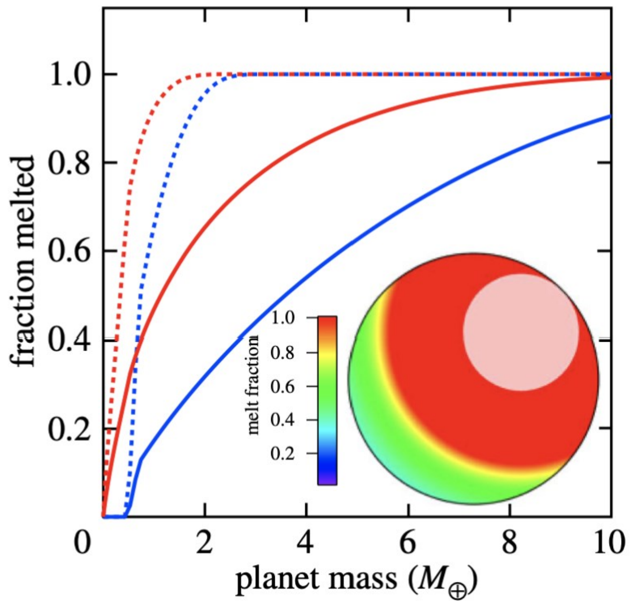


(Head et al., 2011)

第8章 スーパー地球:別世界
(1) 高いエネルギーレベル

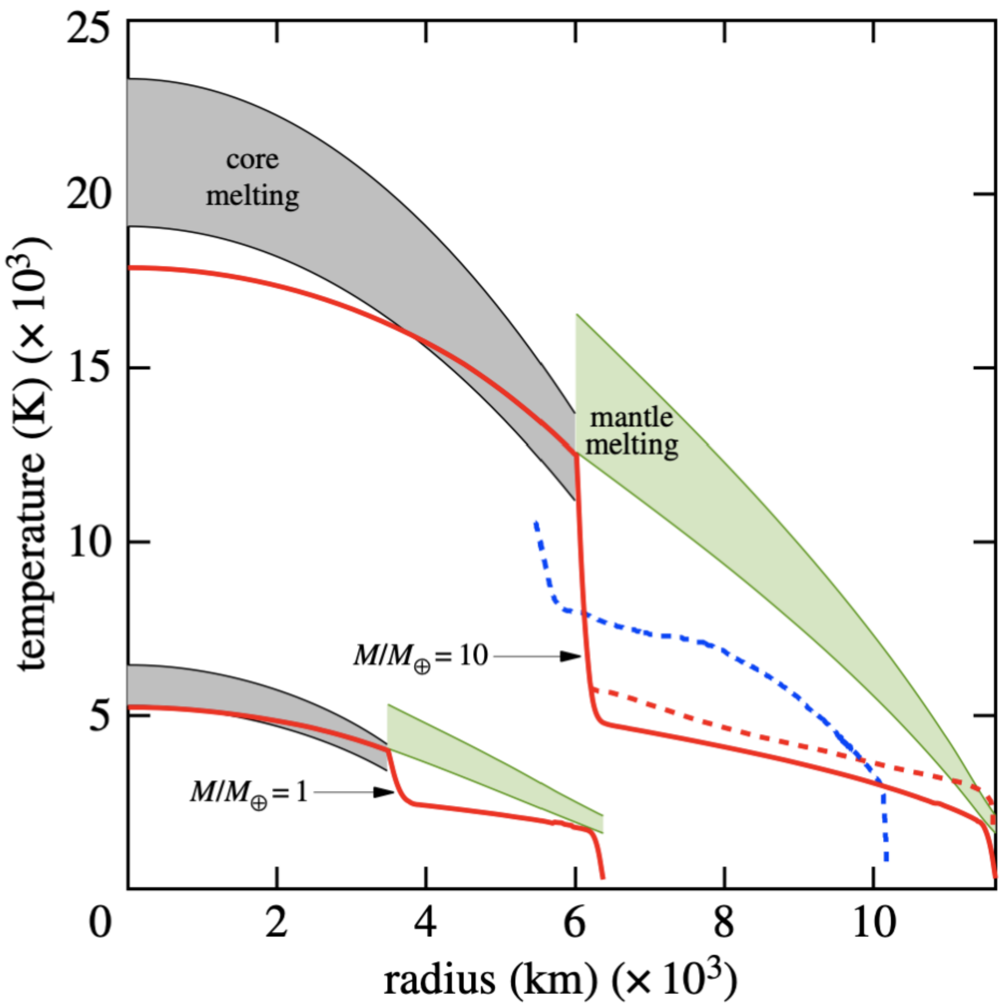
巨大衝突による温度上昇 $+10^5$ K → 高い初期温度？

内部加熱の効果（＋1000 K ）?



(Stixrude, 2014)

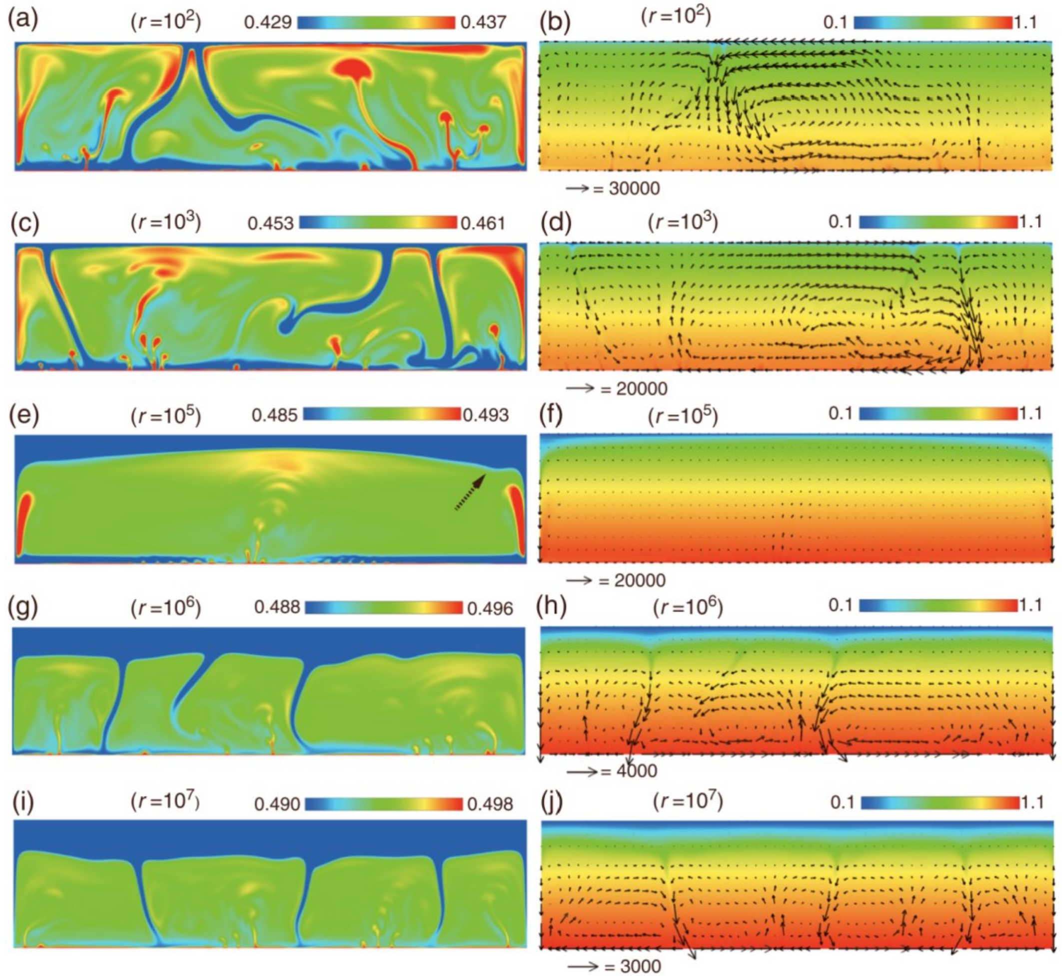
Figure 1. Fraction of planetary mass melted by impacts with $M_i/M_p = 0.1$ (solid lines) and $M_i/M_p = 0.4$ (dashed lines) and for initial temperatures $T_0 = 300$ K (blue) and $T_0 = T_{sol}$ (red) as a function of planetary mass assuming the minimal impact velocity $v_i = 11.2$ km s^{-1} $(M_p/M_\oplus)^{(1-\beta)/2}$. The inset shows the distribution of melt fraction throughout the planet for $M_p = 5M_\oplus$, $M_i/M_p = 0.1$, and $T_0 = T_{sol}$. The pink circle represents the completely molten isobaric core. (Online version in colour.)

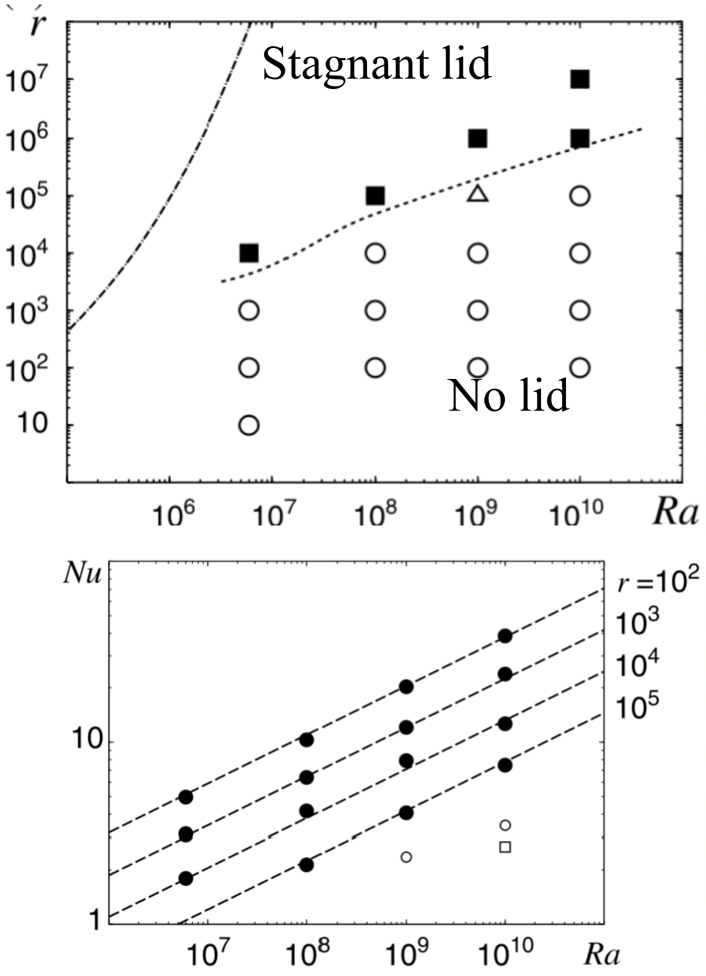


(2)断熱圧縮の対流への効果

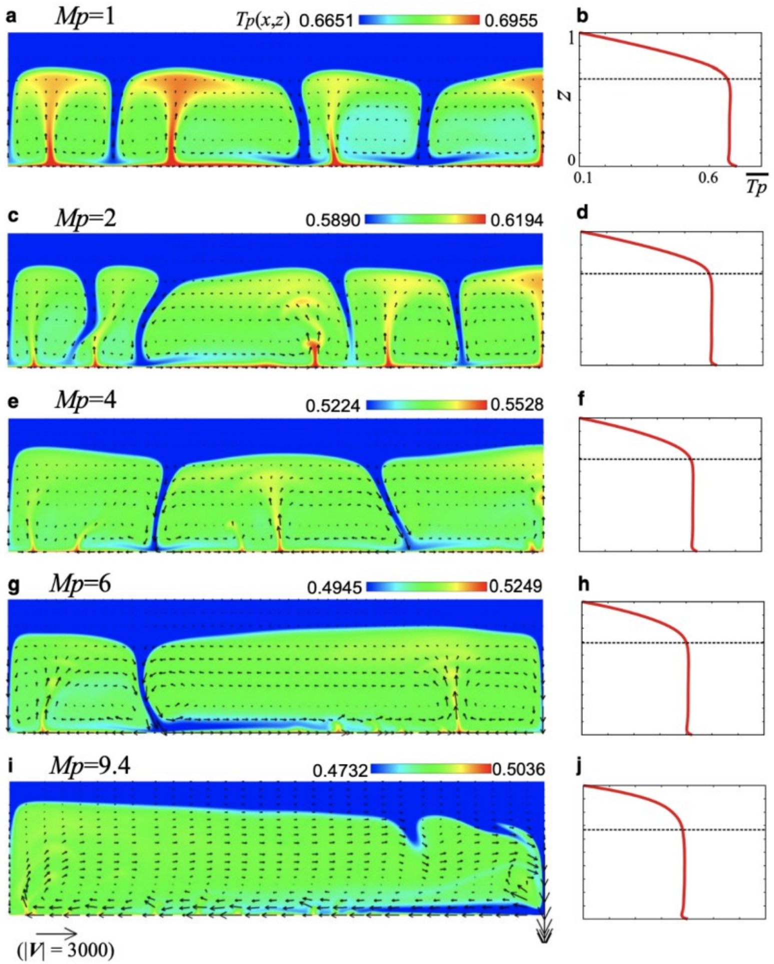
Stagnant lid regime: thick lithosphere & no significant plume activity → plate tectonics?

potential temperature　　temperature





potential temperature

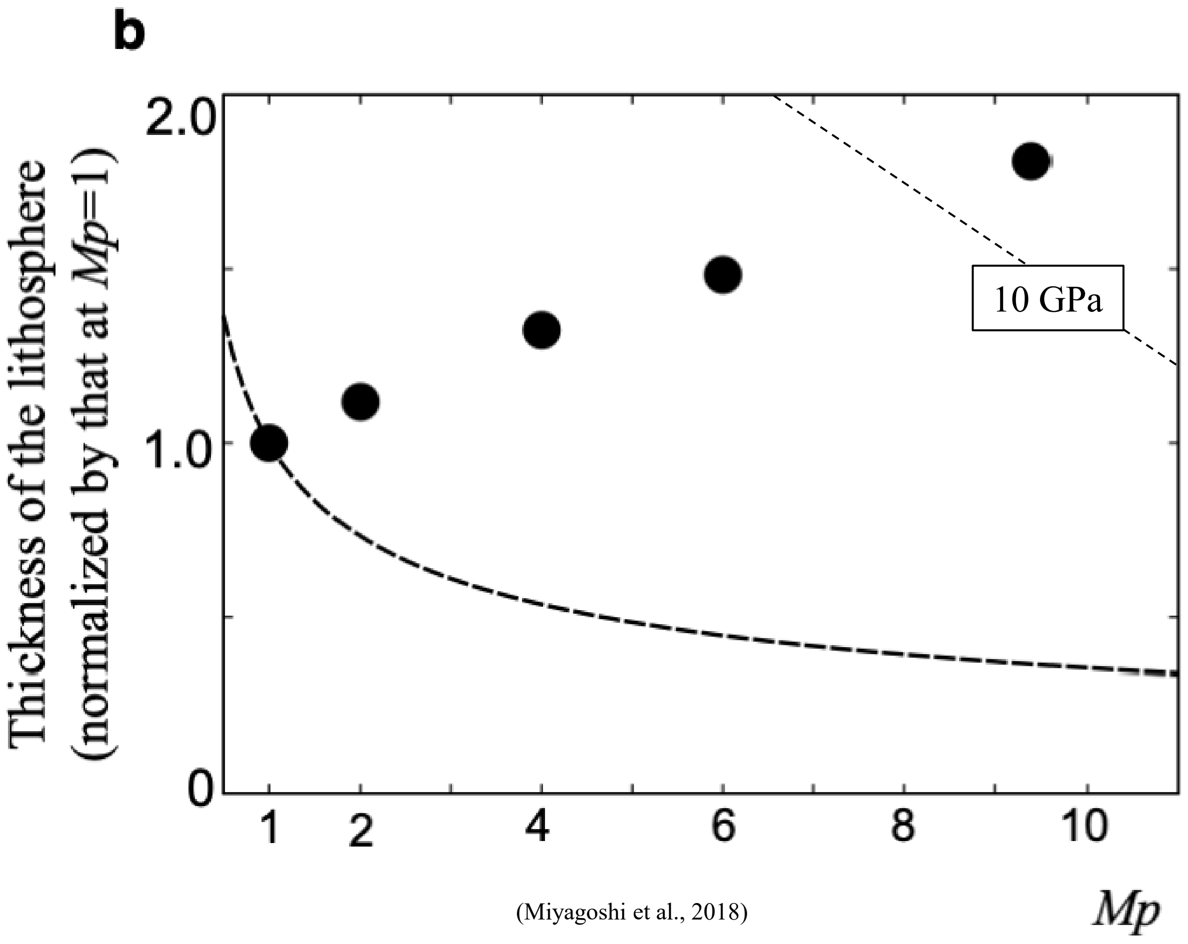


$Ra = 10^{10}, M = 10M_{earth}$

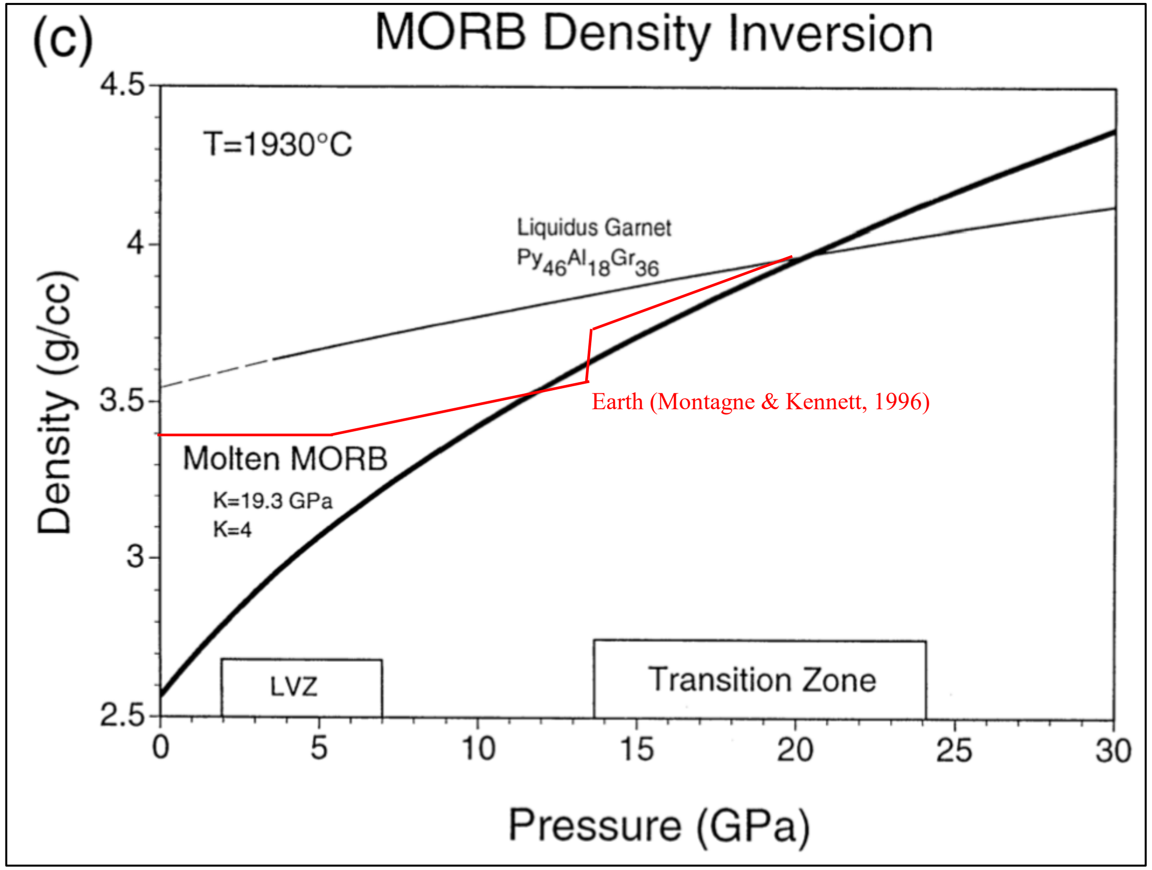
(Miyagoshi et al., 2015)

(Miyagoshi et al., 2018)

(3) MMUフィードバックは働かない？



(Miyagoshi et al., 2018)



(Agee, 1998)

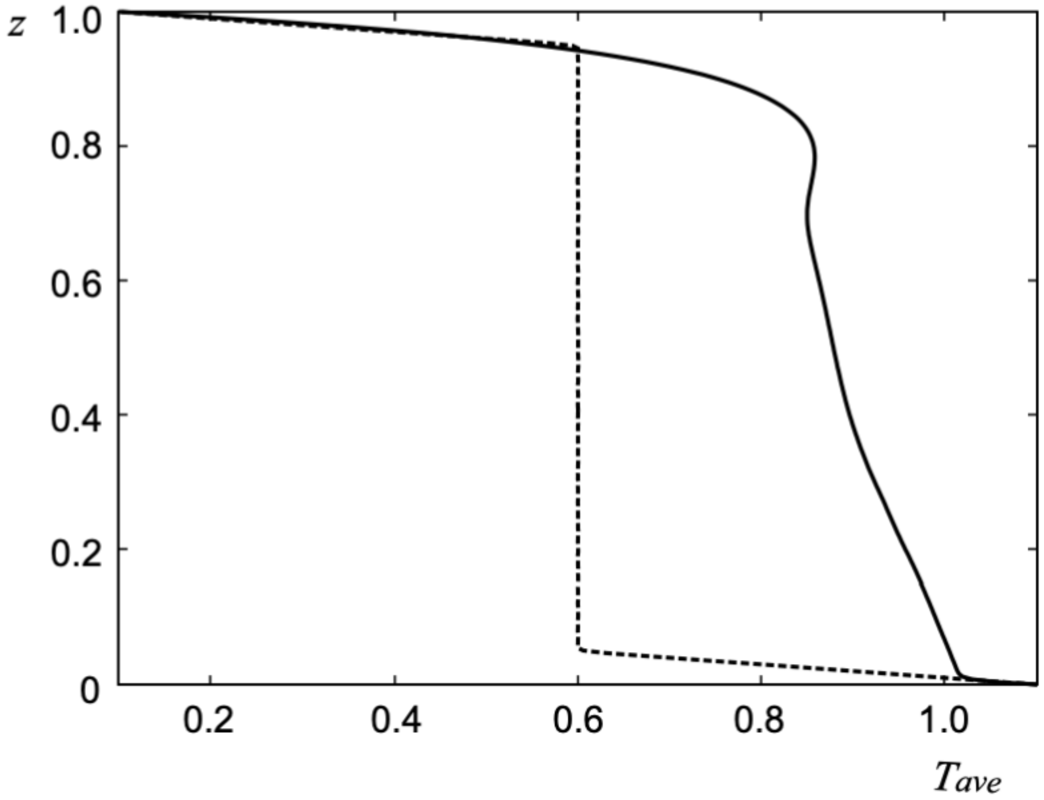
初期温度分布が支配する惑星進化

⇓

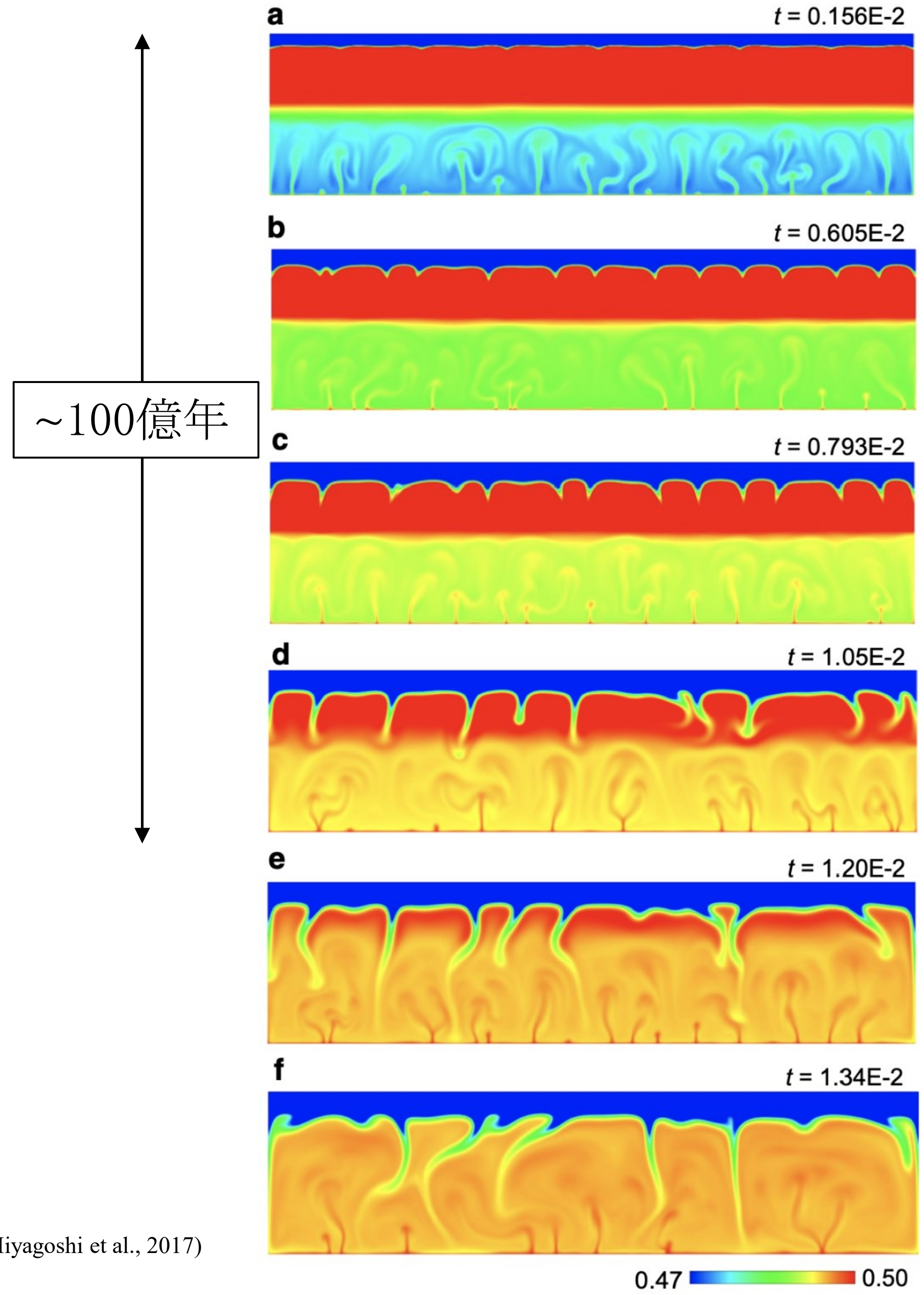
惑星形成過程と進化の密接な関連？

例：transientな二層対流

仮定した初期温度分布



ポテンシャル温度の分布図



(Miyagoshi et al., 2017)