atmospheric O_2 during Earth's middle age

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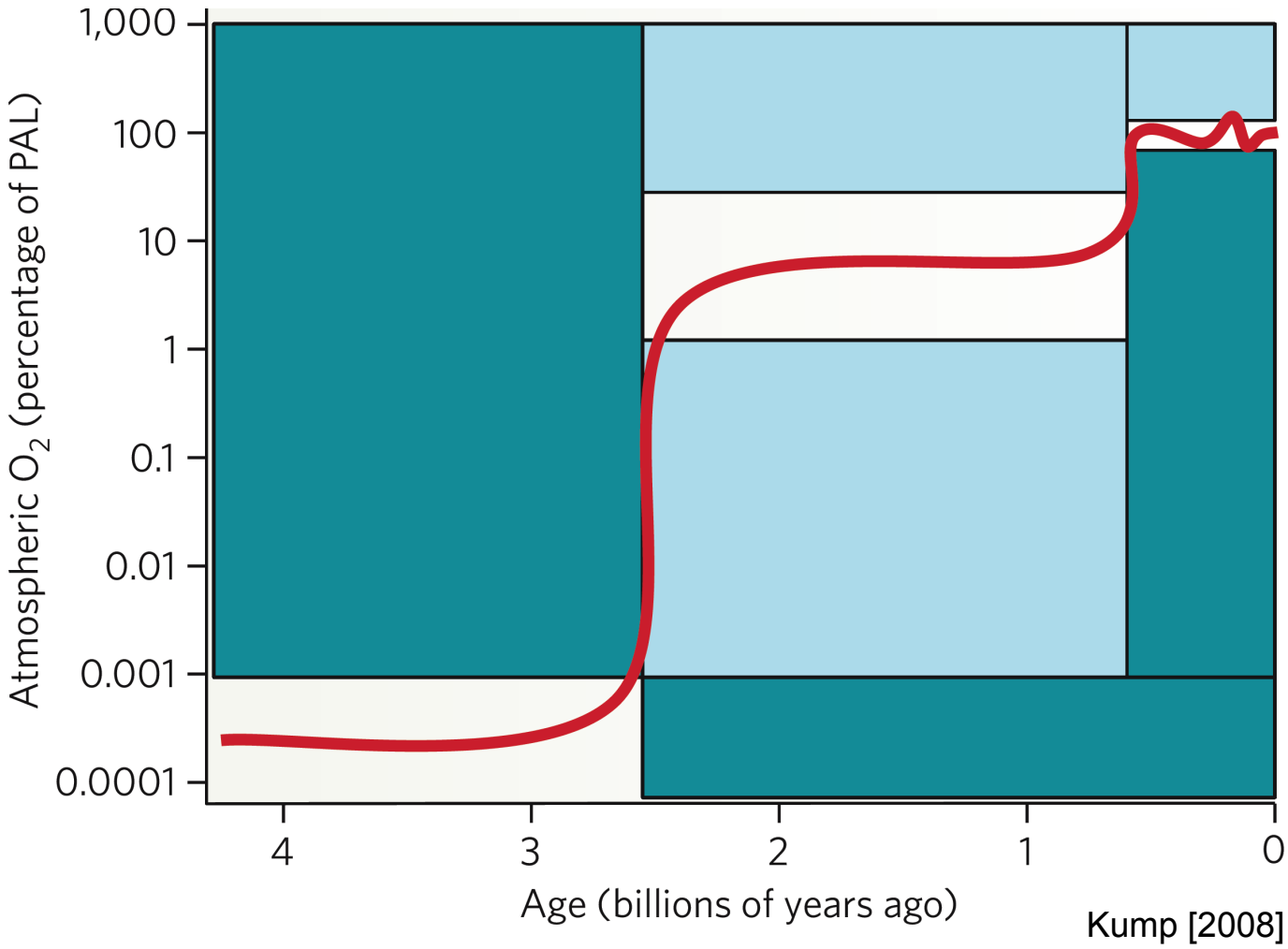
oxygen in Earth's atmosphere through time



* *PAL = **P**resent **A**tmospheric **L**evel*

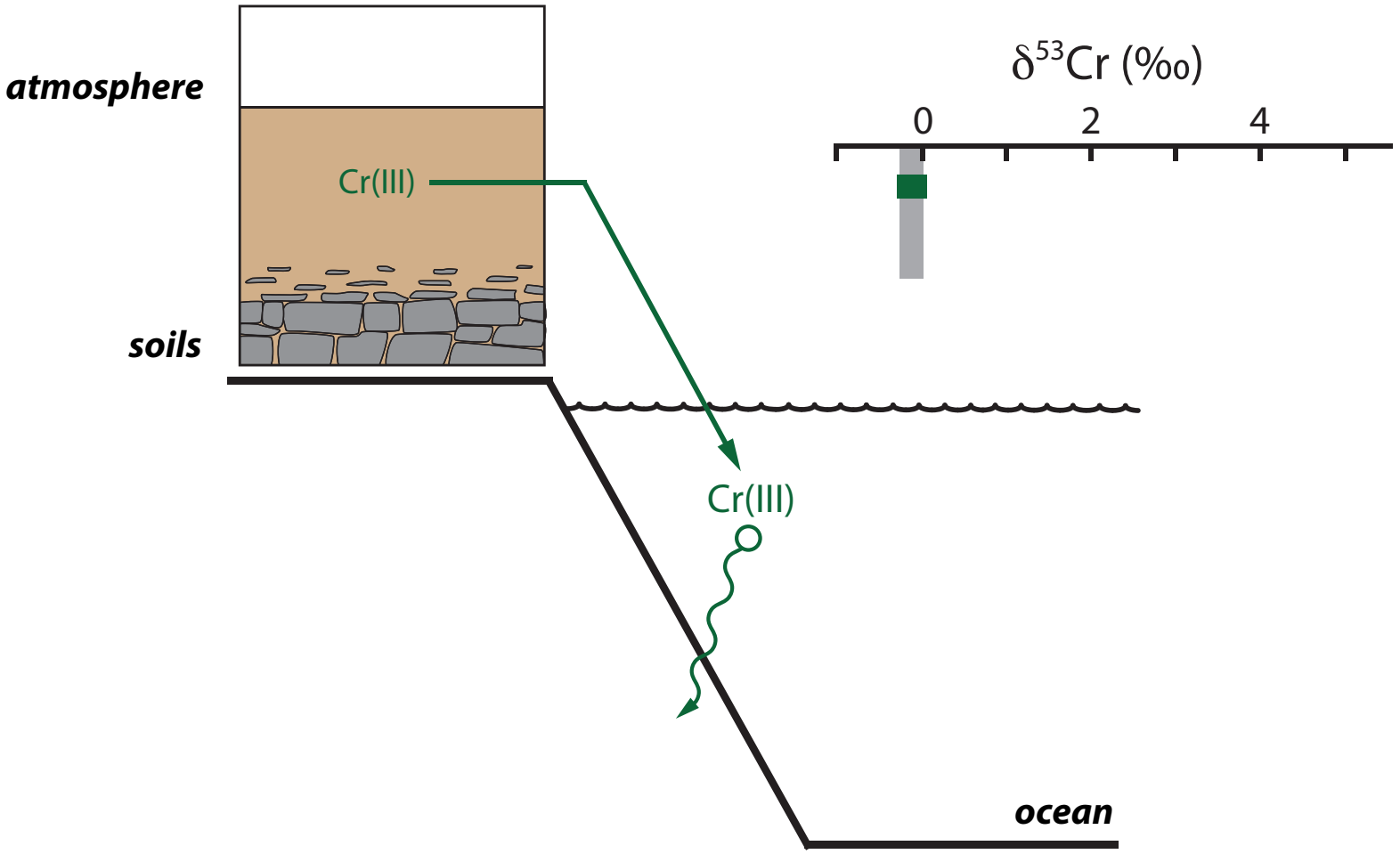
oxygen in Earth's atmosphere through time

- geochemical evidence for pervasive anoxia in the ocean interior during the mid-Proterozoic
  - [Shen et al., 2003; Scott et al., 2008; Planavsky et al., 2011; Poulton et al., 2011; Reinhard et al., 2013]

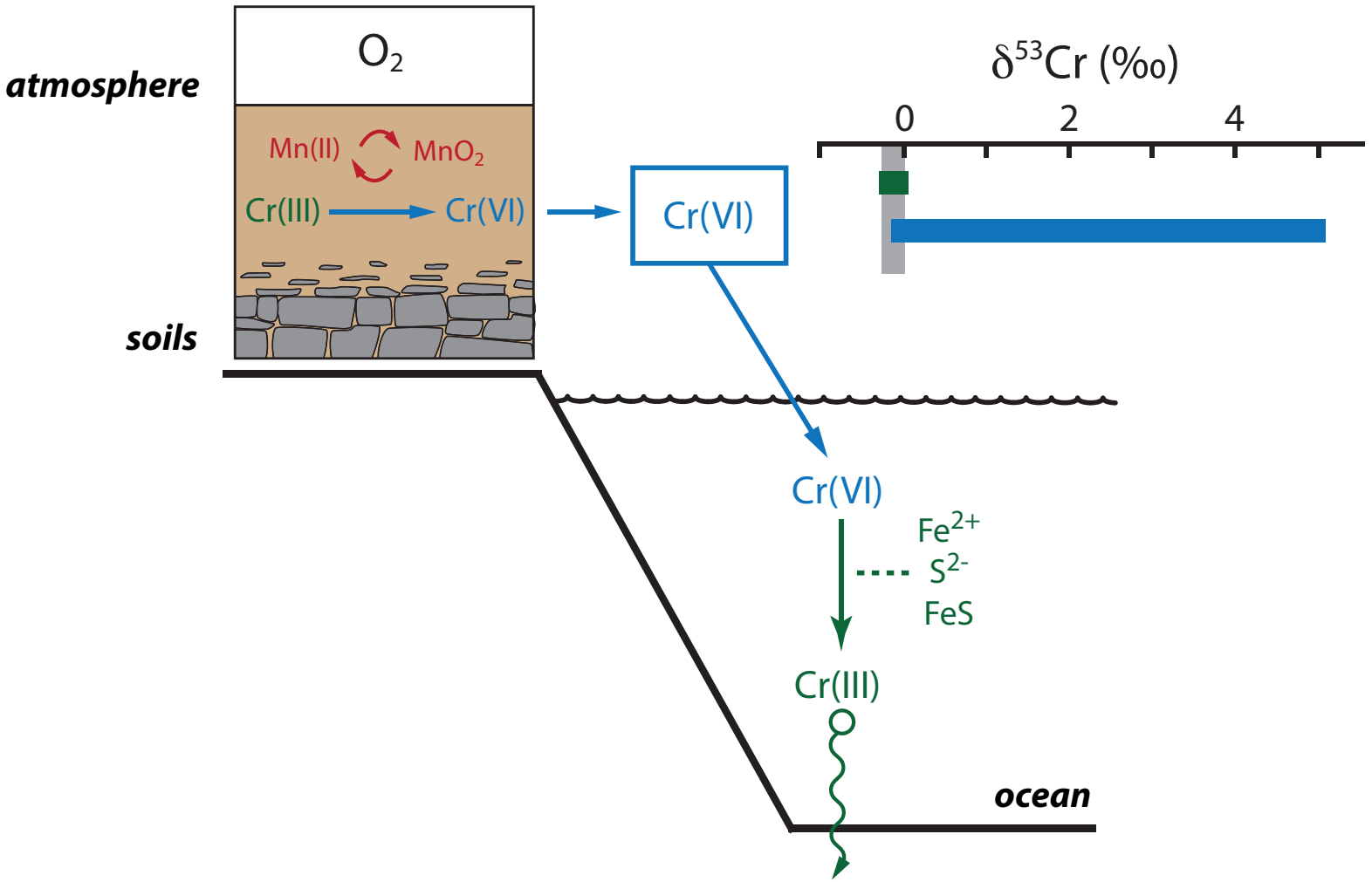
- ***BUT***, biogeochemical models predict that Earth's ocean is poised near widespread anoxia, even today
  - [e.g., Canfield, 1998; Ozaki et al., 2013; Meyer et al., 2016]

quantifying O_2 in the atmosphere?

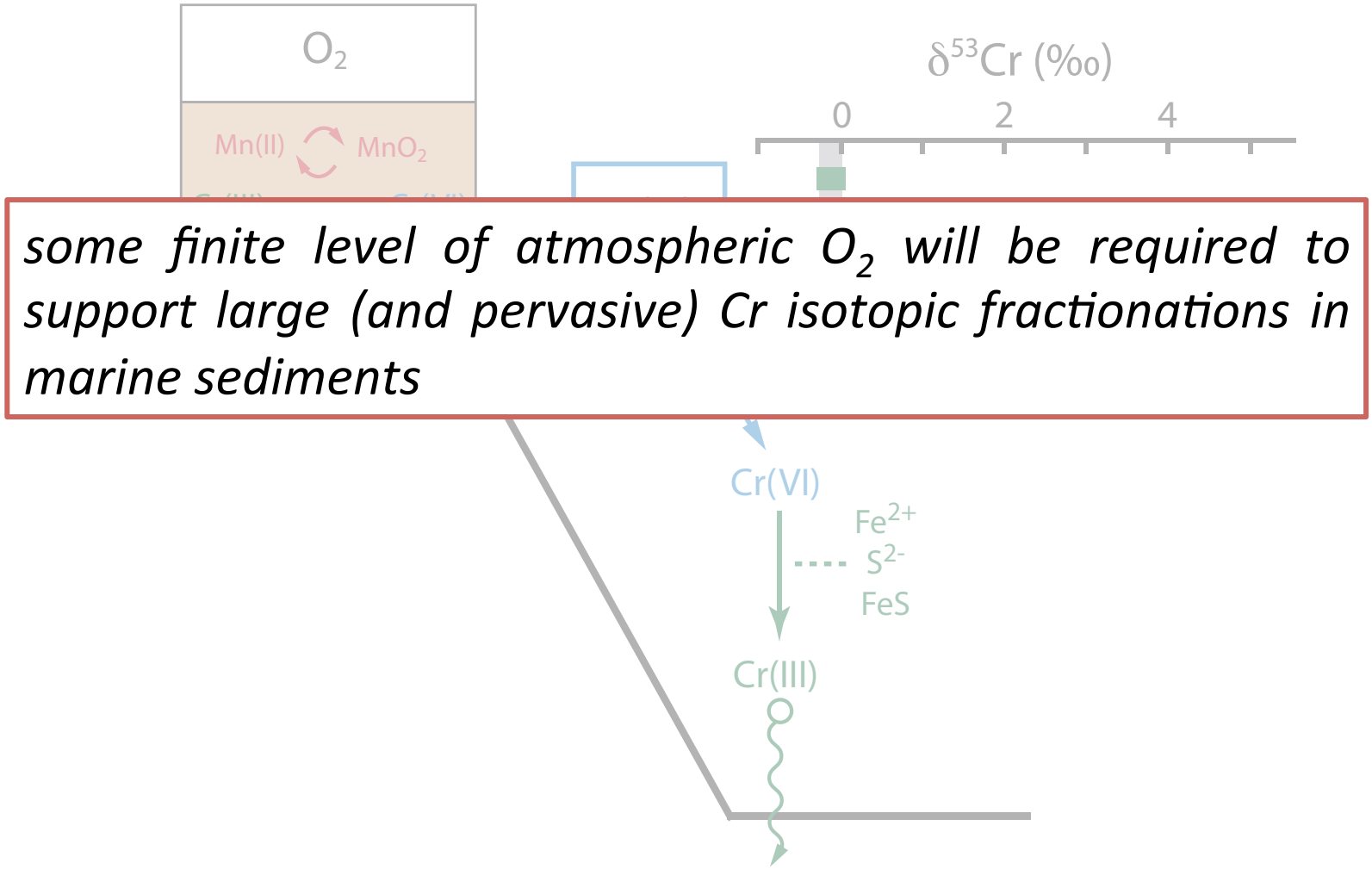
quantifying atmospheric O_2: chromium isotopes



quantifying atmospheric O_2: chromium isotopes



quantifying atmospheric O_2: chromium isotopes



some finite level of atmospheric O_2 will be required to support large (and pervasive) Cr isotopic fractionations in marine sediments

quantifying atmospheric O_2: chromium isotopes

- field calibration in modern environments, recent sedimentary rocks, and high-T settings

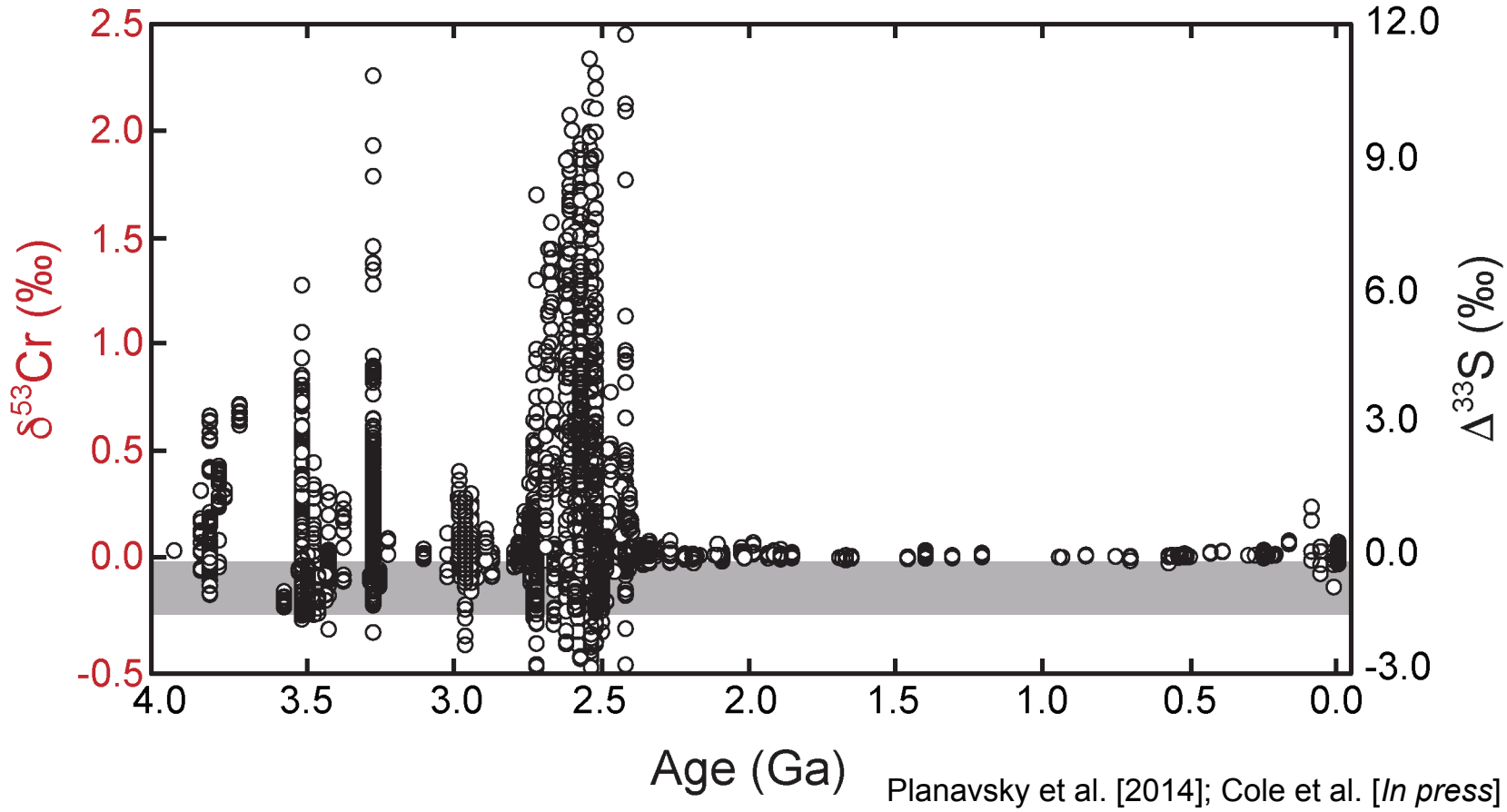
- experimental calibration of fractionation processes, the role of microbial metabolism, and potential 'false positives'

- refined quantitative modeling if O_2 levels required for significant Cr mobility and isotope fractionation

- rigorous evaluation of sedimentary archives in a petrographic context

- ***generation of large, temporally continuous datasets***

quantifying atmospheric O_2: chromium isotopes



Planavsky et al. [2014]; Cole et al. [*In press*]

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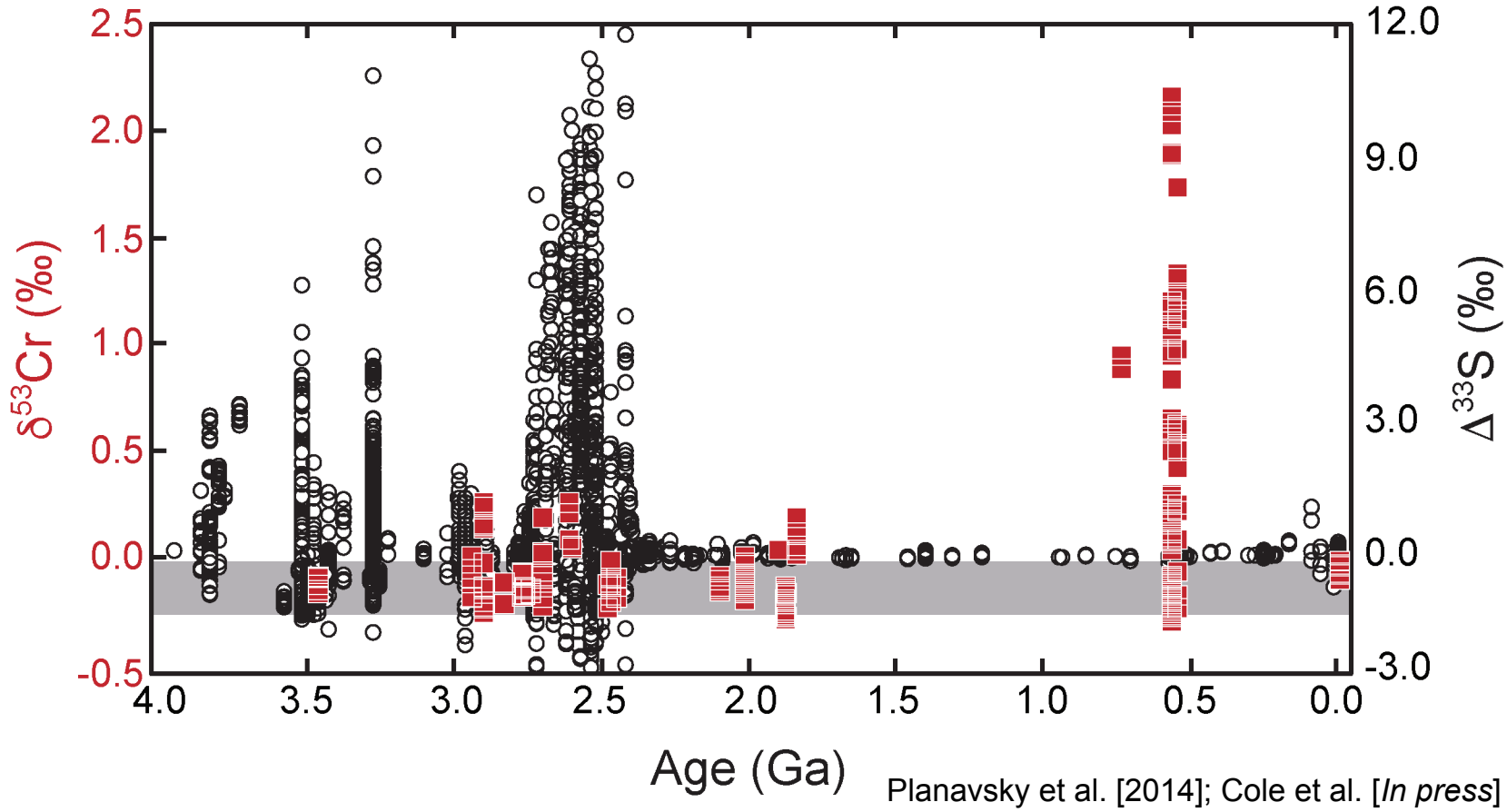
quantifying atmospheric O_2: chromium isotopes



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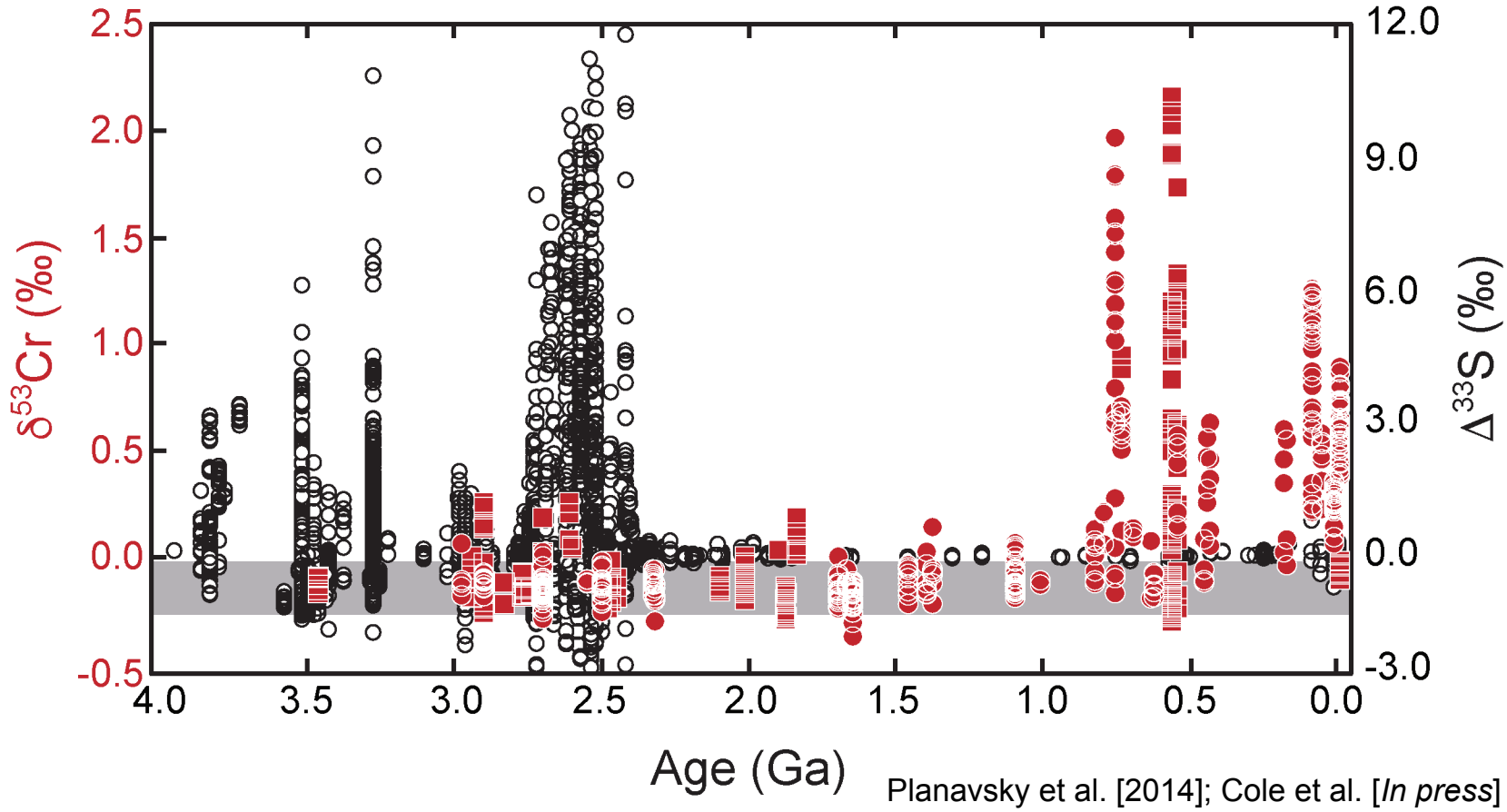

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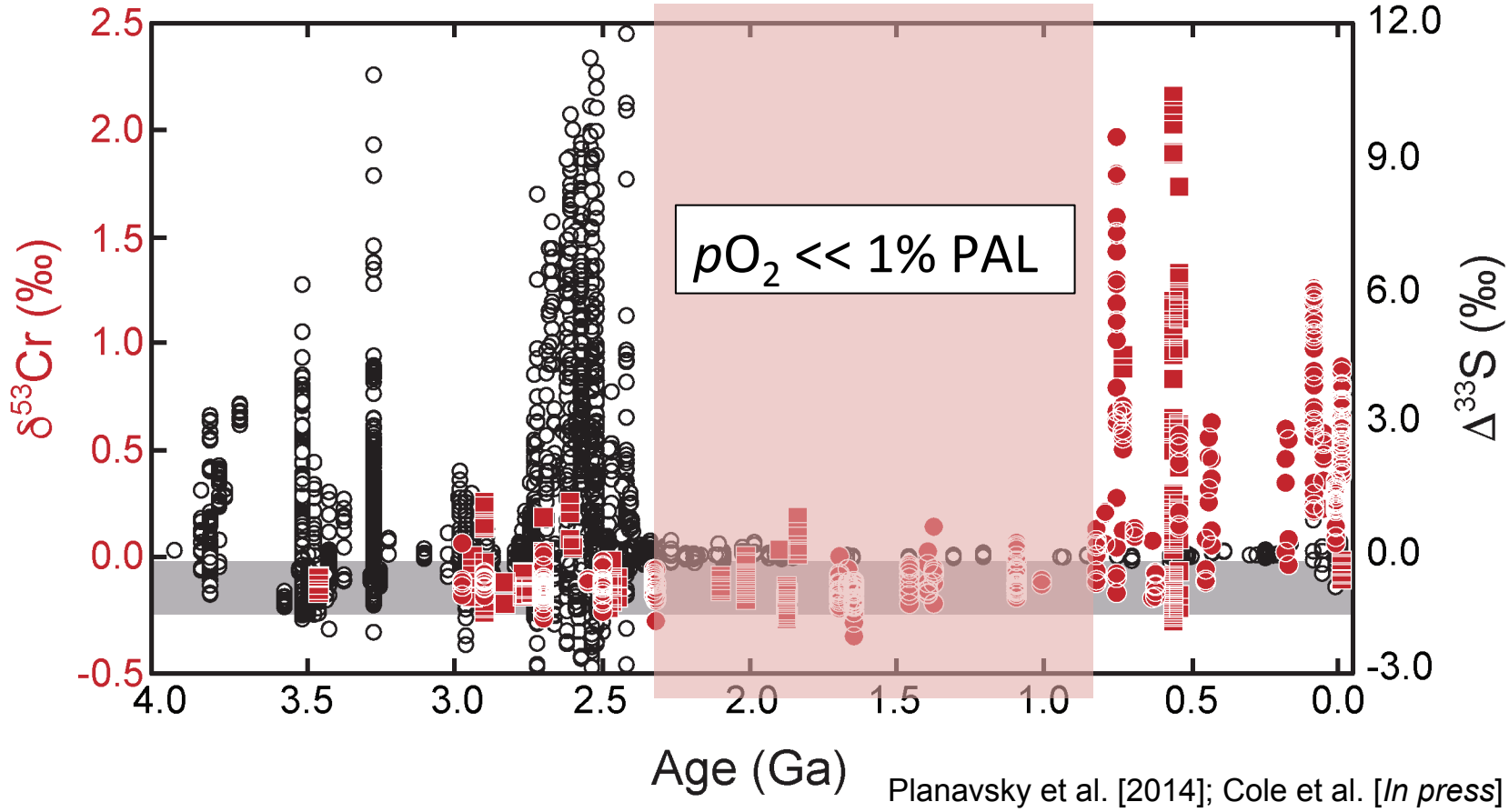

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a low-O_2 atmosphere during the mid-Proterozoic

- ramifications for all major biogenic gases in Earth's atmosphere
  - oxygen (O_2)
  - ozone (O_3)
  - methane (CH_4)
  - nitrous oxide (N_2O)

- ***detectability of the mid-Proterozoic biosphere?***