

Interactive comment on “Development of nascent autotrophic carbon fixation systems in various redox conditions of the fluid degassing in early Earth” by Sergey A. Marakushev and Ol’ga V. Belonogova

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Dear editor!

I. Serious comments of reviewers and interesting proposal reviewer 2 forced us to reconsider the proposed MF cycle with the inclusion of CO₂ fixation stage This forced us to reconsider the thermodynamic and kinetic possibilities of the functioning of the cycle in hydrothermal conditions with a significant presence of methane. Firstly, the stoichiometry of the cycle reactions began to coincide with the assimilation of CO₂ and

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CH₄ in many cases of methanotrophic acetogenesis and, secondly, the cycle became truly autocatalytic, for example, doubling malate in a cycle using CH₄ and CO₂ as substrates: C₄H₆O₅ (malate) + 1,5CH₄+2,5CO₂ = 2C₄H₆O₅. Despite the comments of reviewer 3, the methane reaction with fumarate still satisfies the “minimal energy requirements” for autotrophic growth [Beasley, Nunny, 2012]. II. This change in the functioning of the cycle makes it necessary to change the structure of the article and the thermodynamic table of the cycle reactions, and this, taking into account the substantial comments of the reviewers (especially reviewer 3), will take some time. III. I appeal to the editors of the journal about the possibility of resubmission of the article, with replies to the reviewers comments, after a while. denial of the existence IV. A very powerful argument from reviewers is the denial of the possibility of the existence of significant methane degassing on the early Earth. However, despite a developing consensus that the Hadean mantle and surface environments were relatively oxidizing [e.g., Kasting, 2014], some geological evidence points to more reducing conditions [e.g., Yang et al., 2014]. The major species in the gas phase under oxidizing magmatic conditions will be CO₂ and SO₂, as in modern basalts. The major species in the gas phase under reducing conditions will be CO, CH₄ and H₂S [Iacono-Marziano et al., 2012; Yang et al., 2014]. There are also good reasons to believe that methane was a significant gas in the Archean and Haden atmosphere and hydrosphere [Pavlov et al., 2000; Touret, 2003; Schaefer, Fegley, 2007; Shibuya et al., 2016; Large et al., 2018], in which case it could also be the source of nascent autotrophic paleometabolism. Fluid methane degassing of the Earth (i.e., the existence of significant concentrations of methane in the Archean and Hadean lithosphere) is confirmed by the existence of hydrocarbon gas-liquid inclusions in ancient minerals [Schreiber et al., 2017]. In addition, high-temperature deep synthesis of methane, rather than low-temperature process of serpenization (about 100°C), is the main source of methane in seeps and hydrothermal vents even now [e.g., Scott et al., 2004; Huang et al., 2017; Brovarone et al; 2017; Wang et al., 2018]. This conception will also be further additionally reviewed.

With respect Sergey Marakushev

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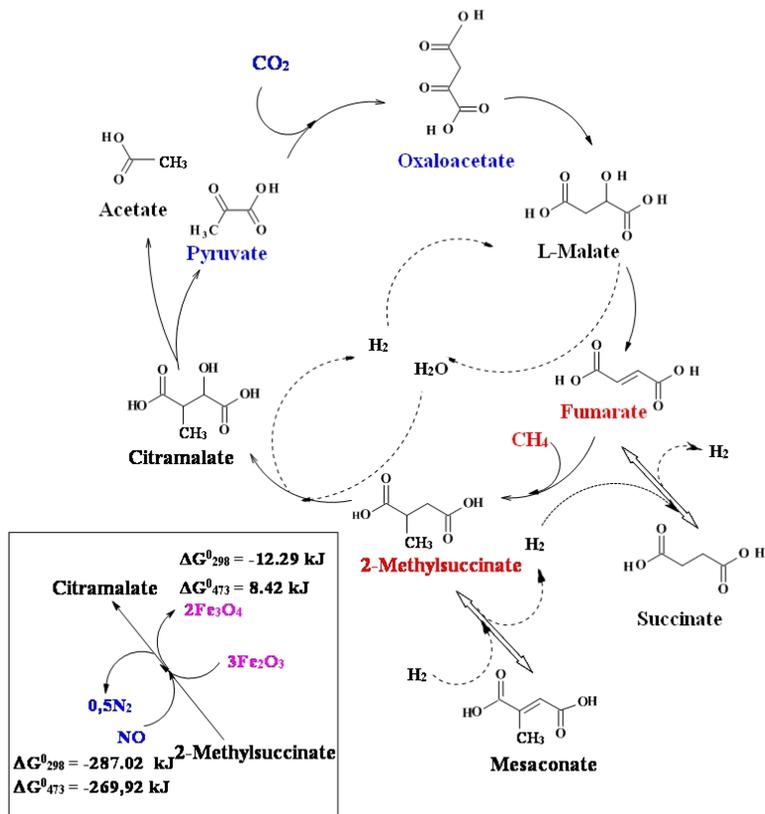
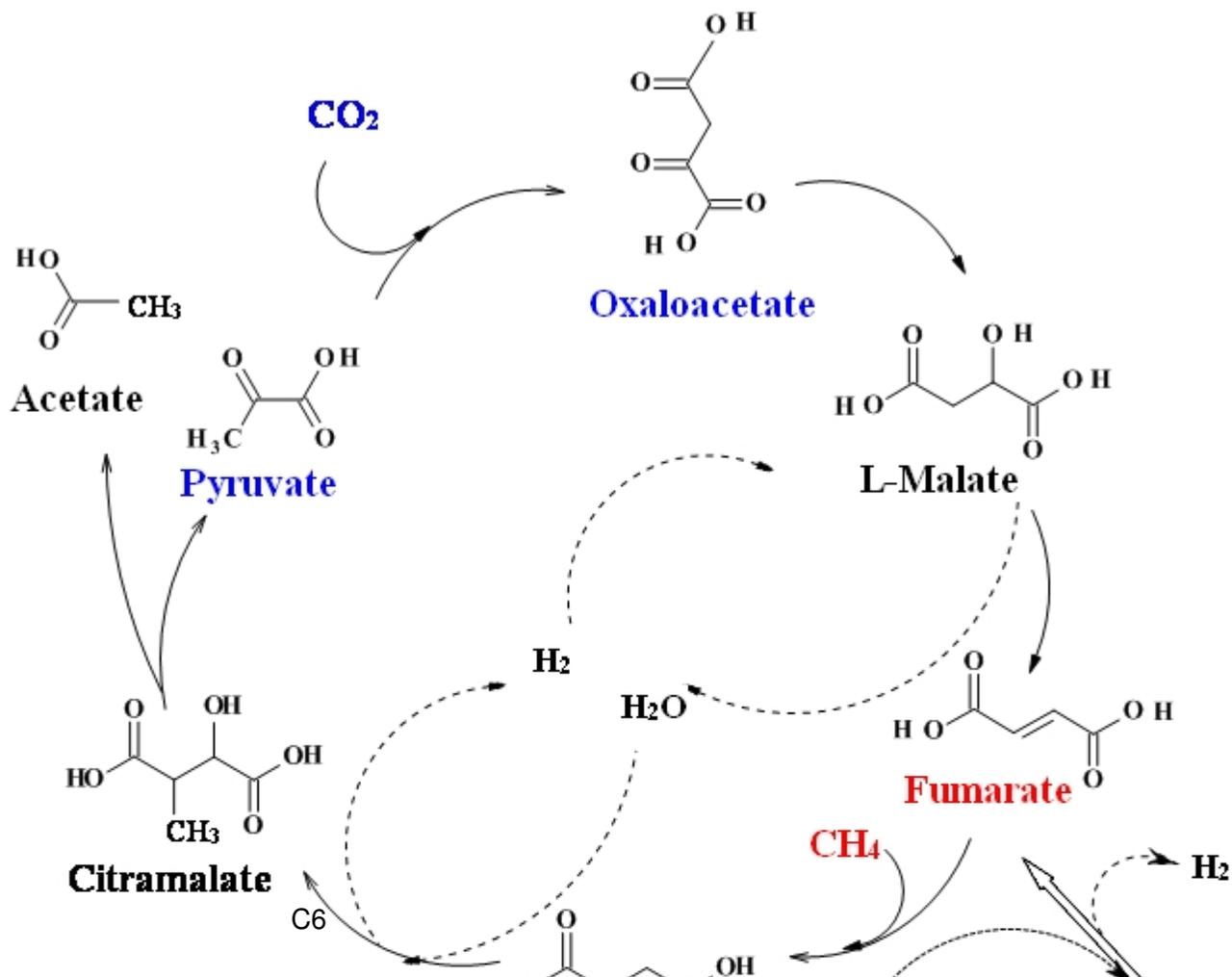


Fig. 1. The scheme of the proposed methane-fumarate (MF) cycle



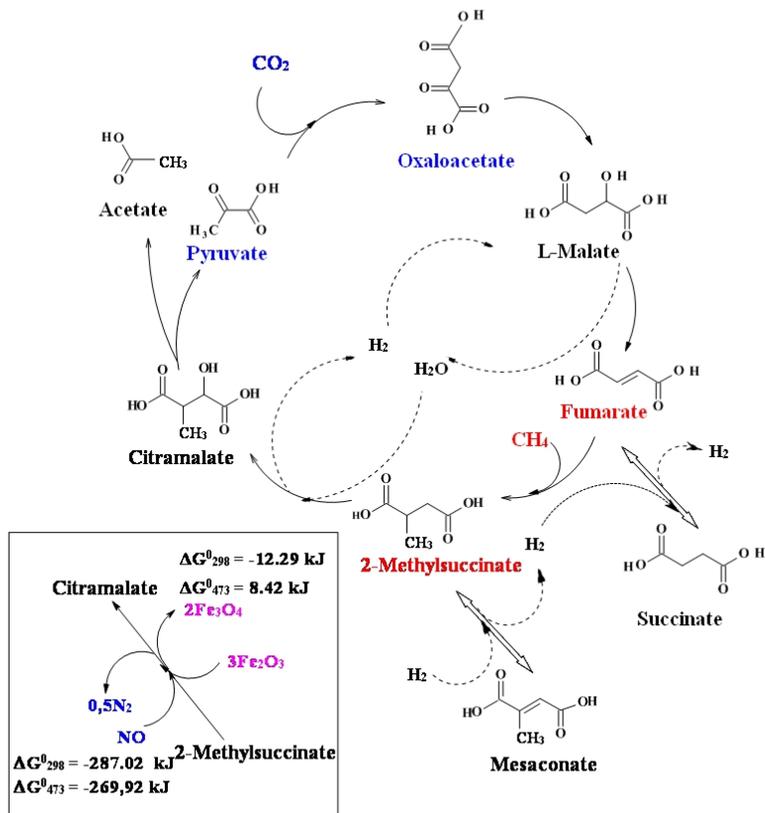


Fig. 3.