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Estimation of atmospheric oxygen concentrations based on paleosols: not drastic but gradual rise of oxygen

Takashi Murakami[1]; Bulusu Sreenivas[2]; Suburata Das Sharma[3]; Hirokazu Sugimori[4]

[1] Deprt. of Earth Planet. Sci.., Univ. of Tokyo; [2] National Geophys. Res. Inst.; [3] National Geophys. Res. Ins.; [4] EPS, Sci., Univ. of Tokyo

'The study of Precambrian oxygen evolution has matured into a serious science (Canfield, 2005).' The first oxygen rise occurred sometime between 2.6 and 2.0 Ga. The most popular model of this rise is characterized by a drastic increase by 3 orders of magnitude at around 2.3 Ga. This model requires the partial pressure of atmospheric carbon dioxide (PCO2) to calculate the partial pressure of atmospheric oxygen (PO2). We propose a new method that applies Fe2+ oxidation kinetics to calculate PO2, which is independent of PCO2. Fe2+ oxidation kinetics, -d[Fe2+]/dt = k[Fe2+] [OH-]2(PO2)(x), was finally transformed to f/fA = (PO2)A(x)/(PO2)(x) where f is the ratio of the concentration of Fe2+ dissolved from primary minerals to that of Fe2+ flowing out of paleosol, A the reference paleosol, and x the variable. The above equation was solved numerically assuming several constraints, for instance, more than 10(-6) atm before 2.45 Ga as revealed by S isotope study. The calculations indicated that the atmospheric oxygen increased rather gradually from about 10(-8) - 10(-6) to 10(-4) - 10(-2) atm between 2.6 and 2.0 Ga. The drastic rise by 3 orders of magnitude at around 2.3 Ga could occur only if the f value decreased very rapidly at around 2.3 Ga, which was not possible as revealed by the geochemistries of Fe and Mn in paleosols.