Archaean pCO_2 reconstructed with a 3D climate-carbon model

G. LE HIR[1]*, Y. TEITLER[1], F. FLUTEAU[1], Y. DONNADIEU[2] AND P. PHILIPPOT[1]

[1]IPGP, Université Paris 7-Denis Diderot, 1 rue Cuvier, Paris, France (*correspondance : lehir@ipgp.fr)
[2]LSCE, CNRS-CEA-UVSQ, 91191 Gif-sur-Yvette, France (Yannick.Donnadieu@lsce.ipsl.fr)

During the Archaean, the Sun's luminosity was 18 to 25% lower than present-day. Climate models generally infer that high concentrations of greenhouse gases (CO_2, CH_4) are required to satisfy the Faint Young Sun Paradox (i.e an Earth temperature at least as warm as today). However, constraints on paleo-pCO_2 gained from climate modelling studies cannot be directly compared to geological data because none of them consider the carbon cycle-climate equilibrium. Here, a 3D climate model coupled to a geochemical model is used to explore the impact of Archaean conditions on long term pCO_2 and Earth's surface temperature evolution. Important variables that have been tested include (1) different scenarios of continental growth, (2) the effect of granitic vs basaltic lithologies of emerged continental surfaces and (3) different outgassing rates. Results of climate-carbon cycle simulations indicate that during the Early Archean the atmospheric pCO_2 was strongly dependant of the amount of emerged continental surfaces (ex: using a surface exposure of 80% that of present day results in a pCO_2 of 0.02bar).

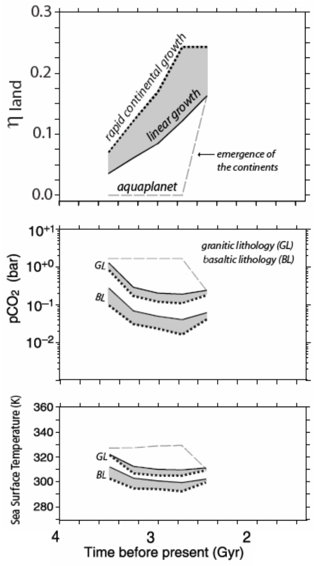

Figure a) Three different continental growth scenarios tested in this study (η_{land} represents the emerged continental surface / Earth surface).

b) pCO_2 and c) sea surface temperatures calculated for the three continental growth scenarios shown in a), two different continental mineralogies (GL, granitic lithology; BL, basaltic lithology), and an outgassing rate two times higher than the present-day flux (grey bands show uncertainties associated with continental growth scenarios).