UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département des sciences de la Terre

Seminar of the Department of Earth Sciences, UNIGE
March 13, 11h15 in Room 001
Rue des Maraîchers 13, CH-1205 Genève or via Zoom

Oxidation state of the Earth's mantle through time and its bearing on the atmosphere

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The Earth's present-day N_2-O_2 atmosphere is the result of time-integrated processes, testament to a distnct evolutionary history to its planetary neighbours. Despite this distinction, the causes leading to oxygenation of the Earth's crust and atmosphere remain elusive. Here, we determine dependence of the Fe^{3+}/Fe^{2+} ratio on the oxygen fugacity (fO_2) of peridotitic and basaltic liquids, relevant for the Earth's mantle and partial melting products, respectively. We show that the Earth's magma ocean, prior to crystallisation, would have given rise to a CO_2-N_2 atmosphere following cooling. Furthermore, because the Fe^{3+}/Fe^{2+} ratio of basaltic liquids is inversely proportional to temperature at constant fO_2, secular cooling of the Earth would have lead to increasingly ferric iron-rich melting products. New geological evidence from the zircon record points to an upper mantle that reached its present-day fO_2 by 4.4 Ga, leading to H_2O- and CO_2-rich volcanism akin to that on the contemporary Earth. Prebiotic chemical reactions therefore likely exploited local redox gradients rather than requiring reducing, CH_4-NH_3-rich atmospheres.