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Deep versus surficial volatile reservoirs formed by the Magma Ocean degassing - *A.E. Ringwood Science Innovation Medal Lecture*

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Nitrogen, carbon, hydrogen and sulfur are essential elements for life constituting less than ca. 1 % of terrestrial planet masses. These elements dominate planetary surfaces due to their volatile nature, but the Earth's interior constitutes major C-H-N-S reservoirs. Capturing the origin of the surficial versus deep volatile reservoirs require reconstructing 4.5 Giga-years of mantle outgassing and ingassing processes, with many unknowns. As an alternative, it is proposed here to define the primordial distribution of volatiles resulting from degassing of the Earth's magma ocean. The equilibrium partitioning of C-H-O-N-S elements between the magma ocean and its atmosphere is calculated by means of solubility laws as a function of redox conditions. Results show that the amount outgassed by the last magma ocean episode is massive though significant C-H-O-N-S concentrations can be retained in the magma. Strikingly, for some conditions, the present-day distribution of volatiles (C-H-N-S) between the depleted mantle and the Earth's surface (atmosphere+ocean+crust) is found to be very close to the primordial magma ocean - atmosphere distribution. Two scenarios must yet be distinguished: reduced vs. oxidized magma oceans. For strongly reduced cases (<IW-1), H-C-rich atmospheres can be formed whereas, under oxidizing conditions (>IW+2), the atmospheres would be dry and C-N-S-rich. Overall, the present-day surficial masses of volatiles must have mainly been defined by magma ocean degassing for carbon and nitrogen. Subsequent volcanism, plumes and crustal recycling superimpose a volatile redistribution among the different reservoirs. This volatile redistribution may, however, not have significantly modified the volatile reservoirs formed by magma ocean degassing. This model will be used to discuss the diverse magma ocean degassing path in a comparative planetary perspective, focusing on the effect of variable fO2 expected in the Mercury, Venus and Earth suite.