New Rb-Sr constraints on the age of the Moon and the timing of volatile element depletion in the Earth

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We have reconstructed the history of volatile elements using the Rb-Sr isotope system to constrain the chronology of Rb depletion in the precursor materials of the Earth and the Moon. Our approch is to consider that the $^{87}Sr/^{86}Sr$ evolution of the early Earth can be obtained from the Sr isotope composition of the Moon at the time of Moon formation. Since all the isotope systems for refractory elements (Ti, W, Si, Cr, etc) have been shown to be identical in the Earth and the Moon, it is reasonable to assume that it is also the case for Sr isotopes. We have obtained new high precision data (1 ppm, 2 s.d.) for the Sr isotope compositions of lunar anorthosites. The decay-corrected $^{87}Sr/^{86}Sr$ value of anorthosites at the time of Moon formation is then used to determine the age of Rb depletion in Earth-forming materials, using various models for the building blocks of the Earth.

The oldest age of volatile element depletion (~1 Ma After CAI) is obtained for a model assuming that the Earth building blocks consist of CI chondrites.or Enstatite Chondrites. The youngest age (4.7 Ma) is obtained for the "OCCAM model". that showed that the isotope composition of the Earth consisted of a mixture of angrites, carbonaceous chondrites and ordinary chondrites [1]. These results show that the Earth formed from materials that lost their volatiles at a very early stage, regardless of the building blocks considered.

The new $^{87}Sr/^{86}Sr$ for anorthosites can be also used to give an upper limit for the age of the Moon of 70 Ma. If we assume that the Moon formed later than 70 Ma after CAIs, then the initial $^{87}Sr/^{86}Sr$ at the time of the formation of the solar system is below the measured value of CAI as determined by Hans et al. [2] or Nyquist et al. [3]. The Hf-W system constrains the Moon to be younger than 45 Ma (Touboul et al. [4]), while the highly siderophile element budgets combined with astrophysical constraints [5] is also consistent with our independent new inference.

[1] Fitoussi et al., (2016), *EPSL* 434, 151–160. [2] Hans et al., (2013), *EPSL* 374, 204-214. [3] Nyquist et al., (2003) *LPSC XXXIV* 1388. [4] Touboul et al., (2007), *Nature* 450, 1206-1209. [5] Jacobson et al., (2014), *Nature* 508, 84-87.