EARTH'S ACCRETION RATE. C. Hatton, De Beers GeoScience Centre, P.O. Box 82232, Southdale 2135, South Africa. (chatton@debeers.co.za)

The earth grew, and continues to grow, by accretion of progressively smaller bodies. Bodies accreting today have compositions similar to CM meteorites [1]. From the observation that 15 to 50 tonnes are added each year [1], the current accretion rate, τ in the equation $\ln(M_u/M_p) = \exp(-t/\tau)$, is at least 208 to 220 million years; M_p is the present mass of the earth; M_u is the mass still to be accreted at time t, and t is the time since accretion began.

The late veneer, which supplied the mantle with noble metals, also has CM meteorite proportions of noble metals, S-Se-Te and C-H-N [2]. Using a CM meteorite composition, 0.397±0.029%M_p is all that is required to supply the mantle budget of noble metals. Prior to addition of the late veneer, accreting bodies must have lost all their noble metals to the core. The phenomenon which allows the present day mantle to retain its noble metals is the steep thermal gradient across the core-mantle boundary. Calculations show that impact of a body 0.25%M_p could heat the base of the mantle to the point that this steep thermal gradient would be eliminated. Assuming a naturally logarithmic distribution of accreting bodies, a body 0.248%M_p is added at the beginning of the 6th accretionary cycle. The cumulative mass of bodies added during the remainder of the 6th accretionary cycle and during the 7th and 8th accretionary cycles is 0.392%M_p. Because the noble metals are homogeneously distributed in the mantle, mantle heterogeneities could only develop after the 8th accretionary cycle, when M_u is 0.0335%M_p. The earliest unequivocal evidence of mantle heterogeneities is the development, at about 3.53 Ga, of high Rb/Sr in the protolith to inclusions trapped in diamonds from the Finsch and Kimberley kimberlites [3]. Diamondiferous eclogites from the Newlands kimberlites have Os isotope ratios which show their protolith separated from the mantle at 3.56±0.6 Ga [4]. Life might originate, but could not persist, above a mantle subject to vigorous stirring during homogenisation. The earliest evidence of life is about 3.68 Ga[5] and by 3.56 Ga life could persist on stable terranes such as the Pilbara. Mantle heterogeneities are thus assumed to persist from between 3.5 and 3.6 Ga, when earth's accretion rate would be between 120 and 130 million years.

Accreting bodies have left clear marks on the moon, and crater density, relative to a datum at 3.25-3.65 Ga, is well documented [6]. Taking the datum as 3.55 Ga and earth's accretion rate at that time as 125 million years, the change in earth's accretion rate can be determined by fitting a second order polynomial to the crater density profile (Fig. 1). Assuming that earth's accretion rate cannot decrease with time, extrapolation yields a present day accretion rate of 280±10 million years, in concord with the minima established from currently observable accretion. For the changing accretion rates determined here, the core would form about 16 million years after initial accretion, but core-mantle equilibration would only cease at 4.22 Ga, 336 million years after initial accretion at 4.56 Ga. The moon could have formed at 4.54 Ga, when a body $M_p/(2e)$ collided with the proto-earth of mass M_p/e; e is the natural number. If impact of a Mars sized body is sufficient to form the moon, then the moon could have formed at 4.53 Ga, when a body M_p/e^2 collided with proto-earth.

References: [1] Kurat, G. et al. (1994) *GCA 58,* 3879-3904. [2] Hatton, C. (1997) *S. A. J. Geol. 100,* 301-310. [3] Richardson S.H. et al. (1984) *Nature 310,* 198-202. [4] Menzies A.H. et al. (1998) *Abstracts 7IKC,* 579-581. [5] Moorbath S., Kamber B.S. and Whitehouse M.J. (1998). *Min. Mag. 62A,* 1019-1020. [6] Basaltic Volcanism Study Project (1981)