The magmatic evolution of the Moon as recorded by Pb isotopes

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Studies of Pb isotopes in lunar rocks are problematic, primarily due to their characteristically low bulk Pb concentrations [1]. Now, through *in situ* Secondary Ion Mass Spectrometry (SIMS) analyses of the Pb isotopic compositions in individual minerals, we have been able to circumvent some of the problems that have previously hindered measurements of Pb isotope compositions of lunar samples. Using this method we have obtained precise crystallisation ages (2σ errors typically within ±10 Ma) for several lunar basalts. Furthermore, by assuming that the least radiogenic compositions measured in several of these samples represent initial Pb isotope compositions, we have begun to construct a multiple stage Pb isotope evolution model to describe the development of major lunar silicate reservoirs [2]. This model places important constraints on the timing of lunar formation and differentiation, indicating that the Moon formed no later than ~4495 Ma, and experienced a major magmatic event at 4376±18 Ma.

These data also provide a new way to investigate the generation of the individual suites of lunar basalts. Previous studies have attempted to investigate the mantle sources of lunar basalts, primarily using the Rb–Sr, Sm–Nd and Lu–Hf isotope systems [3]. The difficulty in obtaining accurate initial Pb compositions has made a similar approach in the Pb isotope system more challenging [4]. The results obtained so far indicate systematic differences in initial Pb compositions between the low-Ti Apollo 12 and Apollo 15 basalts, as well as the high-Ti Apollo 11 basalts.

[1] Tatsumoto (1970), *Proc. Apollo 11 Lunar Sci. Conf.* **2**, 1595-1612. [2] Snape et al. (2015), *Proc. 78th Ann. Met. Soc.* Abstract #5236. [3] Snyder et al. (1997), *GCA* **61**, 2731-2747. [4] Gaffney et al. (2007), *GCA* **71**, 3656-3671.