A new Moon

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International and commercial interest in exploring the Moon has exploded over the last 5 years. Missions from China, India, Japan, and the USA have explored and are exploring our closest celestial neighbour from lunar orbit. The Google Lunar X-Prize has stimulated commercial teams to compete in landing on the Moon, demonstrating mobility and transmitting data back to Earth. Recent and current lunar missions have revolutionized our view of the Moon through high-resolution photography [1], confirmation of polar volatile deposits [2, 3], as well as diurnal cycling of OH/H_2O [4], and identification of lithologies that are not represented in the return sample collections [5, 6]. New global datasets have been/are being collected (e.g. microwave emissions, gravity, temperature, rock abundance, etc.) that still need to be fully interpreted. Interpretation of 30+ years of laser ranging data indicates the presence of a fuid core [7]. Re-examination of the Apollo seismic data with modern computing techniques suggests that the Moon contains a solid inner and liquid outer core [8]. Continued examination of returned samples have shown that the interior of the Moon may be more volatile rich than previously thought [9-12], although interpretation of Cl isotope data [13] suggests otherwise Finally, quantitative petrography presents a promising method for distinguishing impact melts from pristine basalts [14] and crystal stratigraphy studies allow insights into basalt petrogenesis heretofore unattainable [15, 16]. These new advances demonstrate that old data are still relevant, that lunar samples are ‘the gift that keeps on giving, and that new lunar missions always yield exciting results. With lunar missions being launched by NASA in 2011 (GRAIL) and 2013 (LADEE), others being planned (US, Russia, India, Japan), and continued sample and data analysis, lunar research will inevitably produce new and exciting insights into solar system processes.

[1] Watters *et al.* (2010) *Science* **329**, 936–940. [2] Colaprete *et al.* (2010) *Science* **330**, 463–468. [3] Mitrofanov *et al.* (2010) *Science* **330**, 483–486. [4] Pieters *et al.* (2009) *Science* **326**, 568–572. [5] Ohtake *et al.* (2009) *Nature* **461**, 236–240. [6] Pieters *et al.* (2011) *LPSC* **42**, #2173.[7] Williams *et al.* (2006) *Adv. Space Res.* **37**, 67–71. [8] Weber *et al.* (2011) *Science* **331**, 309–312. [9] Saal *et al.* (2008) *Nature* **454**, 192–195. [10] McCubbin *et al.* (2010) *PNAS* **107**, 11223–11228. [11] Boyce *et al.* (2010) *Nature* **466**, 466–469. [12] Greenwood *et al.* (2011) *Nat. Geosci.* **4**, 79–82. [13] Sharp *et al.* (2010) *LPSC* **41**, #2424. [14] Neal *et al.* (2011) *LPSC* **42**, #2668. [15] Fagan & Neal (2011) *LPSC* **42**, #2137. [16] Hiu *et al.* (2011) *LPSC* **42**, #1461.

Hafnium isotope constraints on the origin of layered intrusions and the stabilisation of the Yilgarn cratonic lithosphere

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Primitive mantle-derived magmas forming the Archaean (~3 Ga) Windimurra layered mafic intrusion (LMI) in the Yilgarn Craton yield radiogenic $^{176}Hf/^{177}Hf$ considerably exceeding that of the age-corrected depleted MORB mantle source. This isotopic character is consistent with derivation from ultra-depleted mantle established as a primitive mantle reservoir in Hadaean/Early Archaean time. Ancient refractory mantle is believed to reside either in deep mantle or buoyantly underpin cratonic sub-continental lithospheric mantle (SCLM). We suggest either an ultra-depleted deep mantle reservoir was tapped by upwelling mantle or the SCLM of the Yilgarn Craton was partly re-melted; both scenarios require the involvement of a hot mantle plume. The refractory Hf isotope signal is complementary to the Hadaean zircon record from the North-Western Yilgarn, suggesting a co-genetic relationship. Unlike the ~2 Ga old Bushveld LMI that partly samples the Kaapvaal SCLM, Windimurra lacks continental isotope signatures or primary hydrous minerals. If LMI share common processes of mantle melting, we conclude: (1) LMI are sourced from deep mantle plumes; (2) the Yilgarn SCLM was not hydrated or metasomatised until ~3 Ga; (3) establishment of the Yilgarn SCLM may be related to melt events complementary to the formation of the Narryer Terrane zircon record.