The role of South Pole-Aitken Basin in understanding impact history and the origin of the lunar crust

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The South Pole-Aitken (SPA) Basin plays a central role in understanding the impact history of the Moon and of the inner Solar System because it predates all other clearly recognized impact basins on the Moon. Determining the absolute age of SPA and the ages of other basins that formed within it will therefore constrain the timing of the heavy bombardment that affected the inner Solar System. The SPA Basin also plays a key role in understanding the makeup of the lunar crust because the formation of the Basin dug deep into the lower crust, and materials within the SPA Basin retain a lower crustal signature in geochemistry and in mineralogy and lithology. Examination of samples from the SPA Basin will allow us to determine the lithologic makeup of the lower crust in this part of the Moon and to test for mantle components that might also have been excavated and mixed into the SPA deposits. These are goals of the New Frontiers MoonRise mission to return samples from the SPA Basin, now in Phase A.

The distinctive geochemical signature of the SPA Basin interior was first demonstrated by results of the 1994 Clementine mission and again by the results of the 1998 Lunar Prospector mission. The Fe-rich interior is consistent with expectations of a lower crust that is more mafic (less anorthositic) than the highly feldspathic upper crust, exposed broadly in the lunar highlands. Modest elevation of thorium, however, indicates that this lower crust differs significantly from the crustal section exposed in the Th-rich Procellarum KREEP Terrane [1]. Without samples, the possibility of mantle components contributing to the geochemical signature [2] is unclear, although the predominance of norite (i.e. orthopyroxene-dominated mineralogy) in remotely sensed data [e.g. 3] favors lower crust. From the makeup of mafic rocks of the lower crust, we can better understand magma-ocean processes and post-magma-ocean modifications. MoonRise will provide direct samples of the SPA substrate through impact-melt-derived crystalline rocks and impact-melt breccias, allowing for identification of crust and mantle components. Samples will also include basalt and volcanic glass as direct samples of the far-side mantle beneath the SPA Basin.

[1] Jolliff *et al.* (2000) *J. Geophys. Res.* **105**, 4197–4216.
[2] Lucey *et al.* (1998) *J. Geophys. Res.* **103**, 3701–3708.
[3] Pieters *et al.* (2001) *J. Geophys. Res.* **106**, **28**, 001-28, 022.

The geochemical characteristics of early Cretaceous volcanic rocks from Songliao basin, Northeast China, and its tectonic implications

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Early Cretaceous volcanic rocks from Songliao basin, northeast China, are characterized with basic rocks (BRS) which include dorgalite and basalt, intermediate rocks (IRS) which include basaltic andesite, andesite and trachyandesite, and acid rocks (ARS) include trachyte, trachydacite, dacite and rhyolite. The major element, trace element and isotopic data of the early Cretaceous volcanic rocks are reported in this paper. All samples have distinct characteristics with enriched large ion lithophile elements (LILE) relative to high field strength elements (HFSE), enriched light rare earth element (LREE) relative to heavy rare earth element (HREE), relatively low in $(^{87}Sr/^{86}Sr)_i$ and high in ε_{Nd} (t). Additionally, BRS have Ce/Nb=1.92~8.31, Th/Nb=0.08~0.44, $(^{87}Sr/^{86}Sr)_i$=0.7031~0.7047, ε_{Nd} (t)=+1.7~+5.2. IRS have Ce/Nb=3.70~15.80, Th/Nb=0.34~2.58, $(^{87}Sr/^{86}Sr)_i$=0.7040~0.7054, ε_{Nd} (t)= 0~+3.0 and ARS have Ce/Nb=4.29~15.80, Th/Nb=0.11~1.02, $(^{87}Sr/^{86}Sr)_i$=0.7038~0.7066, ε_{Nd} (t)= +1.0~+3.3, respectively. According to their geochemical characteristics, the magmas of BRS were generated partial melting of the depleted mantle which have been enriched, with little contaminated by crust. The generation of IRS magmas origined from melting of juvenile crust components underplated by upwelling of depleted mantle and the magmas of ARS derived from partial melting of juvenile crust components which origined from depleted mantle with contaminated by supracrust. Conclusionally, the dynamic model of stretch and extension in late Jurassic-early Cretaceous in Songliao basin was a result, from partial melting depleted mantle induced by delamination of thickened subcontinental mantle root induced by orogenesis with Okhotsk- Mongolia ocean closure. The rift-extensional tectonic setting of Songliao basin showed active rift characteristics.