The origin of boninites on Mercury

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With the X-Ray Spectrometer (XRS) and Gamma-Ray Spectrometer (GRS) onboard the MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) spacecraft, we now have our first opportunity to directly investigate the compositions of lavas from the planet Mercury and indirectly investigate the chemical make-up of Mercury's interior [1-3]. XRS and GRS measurements of Mercury's surface from MESSENGER commonly have footprints that overlap several geologic terrains, so determining an appropriate melt composition for experimental study is a complicated process; however, the northern volcanic plains (NVP) on Mercury may represent an important exception.

The NVP are smooth plains that cover more than 6–7 % of the surface area of Mercury [4]. Spanning a 4.7 x 10^6 to 10^7 km^3 region of Mercury, this unit is less cratered than its surroundings and purported to be the product of flood volcanism [4.] Although there is some evidence that suggests this unit is not completely homogeneous [2] [3], it is the largest volcanic province that has been assessed from orbit by MESSENGER. The most recent XRS and GRS footprints reported by the MESSENGER team that specifically targeted the NVP region were used to determine an average composition of the NVP lavas. The bulk composition of the northern volcanic plains is that of an alkalic boninite and represents the first evolved crustal terrain identified on an extraterrestrial planet. Phase equilibrium experiments were conducted over the pressure range of the mercurian mantle (0.5–5 GPa) at very low oxygen fugacity (ΔIW-5 to -7) using a piston-cylinder apparatus (P 0.5–1.0 GPa) and a Walker-style multi-anvil device (P $\geq$ 2.5 GPa). Our results indicate the origin of the northern volcanic plains lavas (boninites) are best explained by high degrees of partial melting of an olivine-dominant, pyroxene and plagioclase-bearing mantle source at low pressure ($\leq$1.4 GPa) and does not require plate tectonics or hydrous melting to achieve the evolved melt composition typically required for the formation of terrestrial boninites.

[1] Nittler, L.R. et al. (2011) *Science,* **333**, 1847-1850. **[2]** Weider, S.Z. et al. (2015) *EPSL,* **416**, 109-120. **[3]** Peplowski, P.N. et al. (2012) *JGR,* E00L04. **[4]** Ostrach et al. (2015) *Icarus,* **250**, 602-622.