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Mercury surface composition: how the new insights from MESSENGER can drive the future exploration

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The surface composition of Mercury, as well as the relationship between morphological expressions and lithologies, is one of the most interesting goal to be still explored. After Mariner10, despite relevant differences observed in geophysical characteristics, Mercury surface composition was compared to the Moon (Murray et al, 1974, Science), and, subsequently, lunar surface was considered as analogue (e.g., Blewett et al., 2002, Meteor.Planet.Sci.). After MESSENGER, Mercury surface appeared mainly volcanic in origin. Plains (intercrater and smooth) seem to have a primary flood effusive origin, and even cratered terrains could have the same origin with a higher crater concentration. These volcanic units range from high reflectance red plains to low reflectance blue plains (Denevi et al., 2009, Science). No absorption is present in the visible and near-infrared spectra, indicating very low abundance of transitional elements in silicates (i.e. very low iron and titanium, e.g. FeO < 1%, Klima et al., 2014, Whispers).

XRS and GRS, onboard MESSENGER, confirmed a very low Fe/Si ratio in the surface material (Weider et al., 2014, Icarus), not only in silicates, differently from the volcanic compositions present in all the other planetary surfaces. K, Th, U GRS-based are consistent with chondritic source but with greater volatile abundances (Peplowski et al., 2011, Science; 2012, JGR). Moreover, XRS measured high volatile abundances (i.e. S, Na, K) (Evans et al., 2012, JGR; Weider et al., 2012, JGR), with a variable distribution on the surface. The presence of high level of volatiles is in agreement with the evidence of pyroclastic materials (Kerber et al., 2009, EPSL). Mg/Si shows relative high values, with a high variability on the surface. Higher values of Mg/Si are detected in some terrains related to high concentration of Ca/Si, and low Al/Si, indicating ultramafic composition, a relative high degree of partial melting and high temperature, in particular in older plains. In some regions they are also associated to high S/Si. The presence of these elements in such concentrations indicates a probably highly reduced parent material. S content may reflect a possible variability in the redox environment (Weider et al., 2012, JGR). Differently, the northern young plains characterized by flood volcanism, showing thermal erosion (Head et al., 2011, Science) and associated to komatitic-like magmatism, have higher Al/Si, Na, K, and relative lower Mg/Si, Ca/Si, with respect to older plains. All of these indications evidence different geochemical units (Weider et al., 2015, EPSL).

MESSENGER has introduced new evidences about morphology and composition of Hermean surface. The understanding of this information should drive the future investigation about Mercury surface analogues. Understanding which volcanic material and in which environment could be formed is an important goal to indicate the possible analogues appropriate for Mercury crust. This step will be important to hypothesize the spectral characteristics we could expect studying the Mercury surface with instrument onboard future BepiColombo mission.