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Ground calorimetric studies using the REMS ground temperature sensor and the Curiosity rover

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The REMS instrument, on board the Curiosity rover, has an infrared ground temperature sensor that allows monitoring the diurnal evolution of the ground temperature every day at the different sites visited by the rover during its operation on Gale crater. The amplitude of the diurnal ground temperature oscillation depends on the local column of dust, as well as on the thermal inertia (I) of the ground.

The rover has a hot Radiosotope Thermal Generator (RTG) of which the temperature is monitored by engineering sensors. This element is an unavoidable extra source of heat that irradiates the ground where the rover stands. Whenever the rover moves and samples a new site the sensed temperature shows a significant drop that ranges between 3 and 15 K depending on the location and time of the day. This drop is the increment of temperature (ΔT) caused by the heat (q) emited by the RTG source alone, and thus the soil heat capacity (C) can be obtained by rating these magnitudes and allowing the rover to perform in
situ ground calorimetry in a simple way:

- The heat emited by the RTG can be evaluated using the Stefan Boltzman law (q=σT4)

- The soil heat capacity scales with the square of the termal inertial (C $\sim$ I2)

Orbitally determined inertias in the region of the rover [Fergason et al., 2012] range from 250 (J/m2K s1/2) to 410 (J/m2K s1/2). Thus in the area explored by the rover I may vary a factor 2, which leads to a factor 4 increment in C and thus the final ground offset induced by the RTG extra heating is expected to be significantly greater for soils of higher thermal inertia.

Once the rover stands at a fixed position the ground is heated up as the ground responses in time to the irradiated heat until a new equilibrium temperature is reached. Soils with low thermal inertia respond faster to the RTG heating source (around 40 minutes) whereas high thermal inertia soils respond more slowly (around 75 minutes). This method shall be improved for future calorimetry campaigns during the two years of nominal operation of the rover curiosity on Mars.