Computation of Thermal Inertia

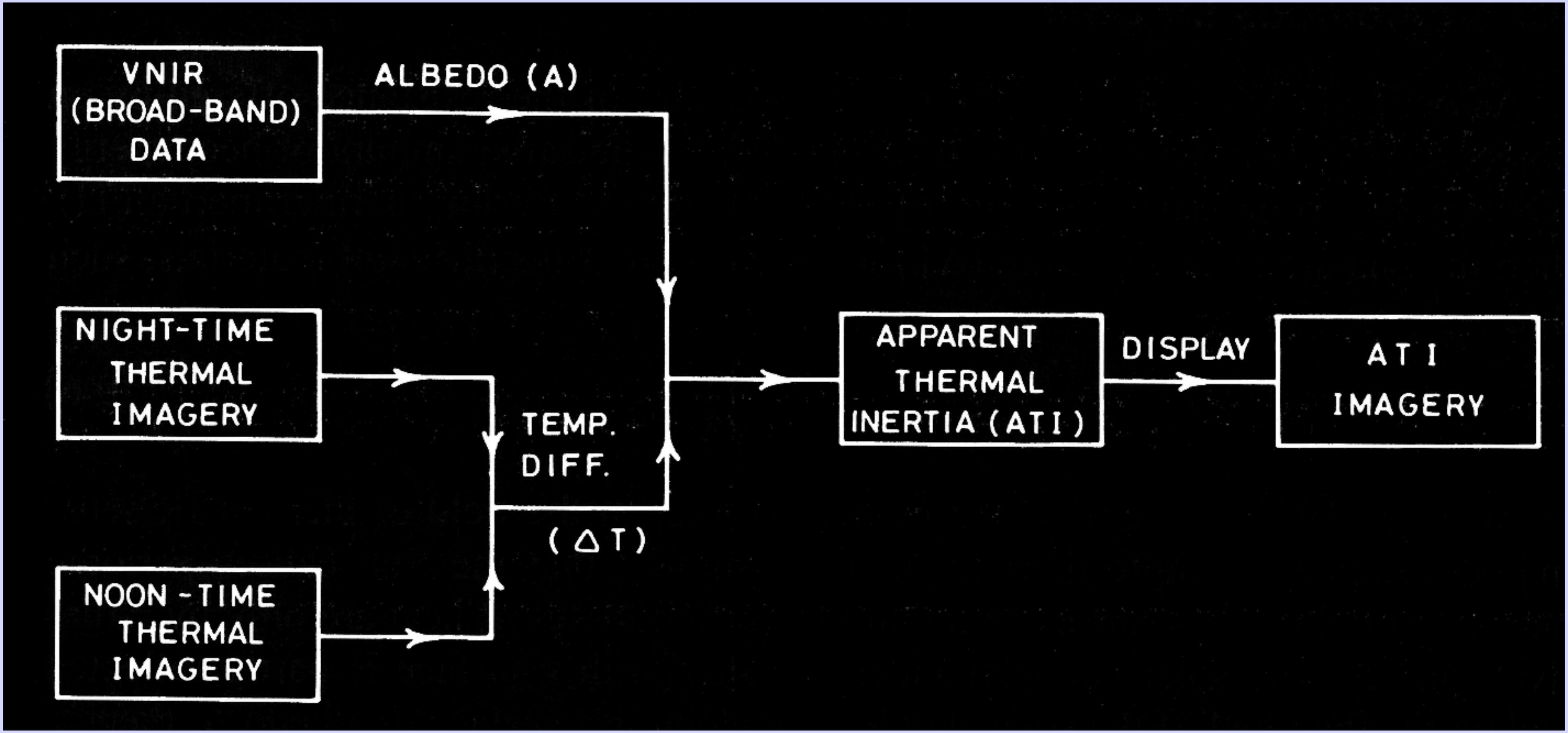
For terrestrial applications, commonly use "Apparent Thermal Inertia" (ATI).

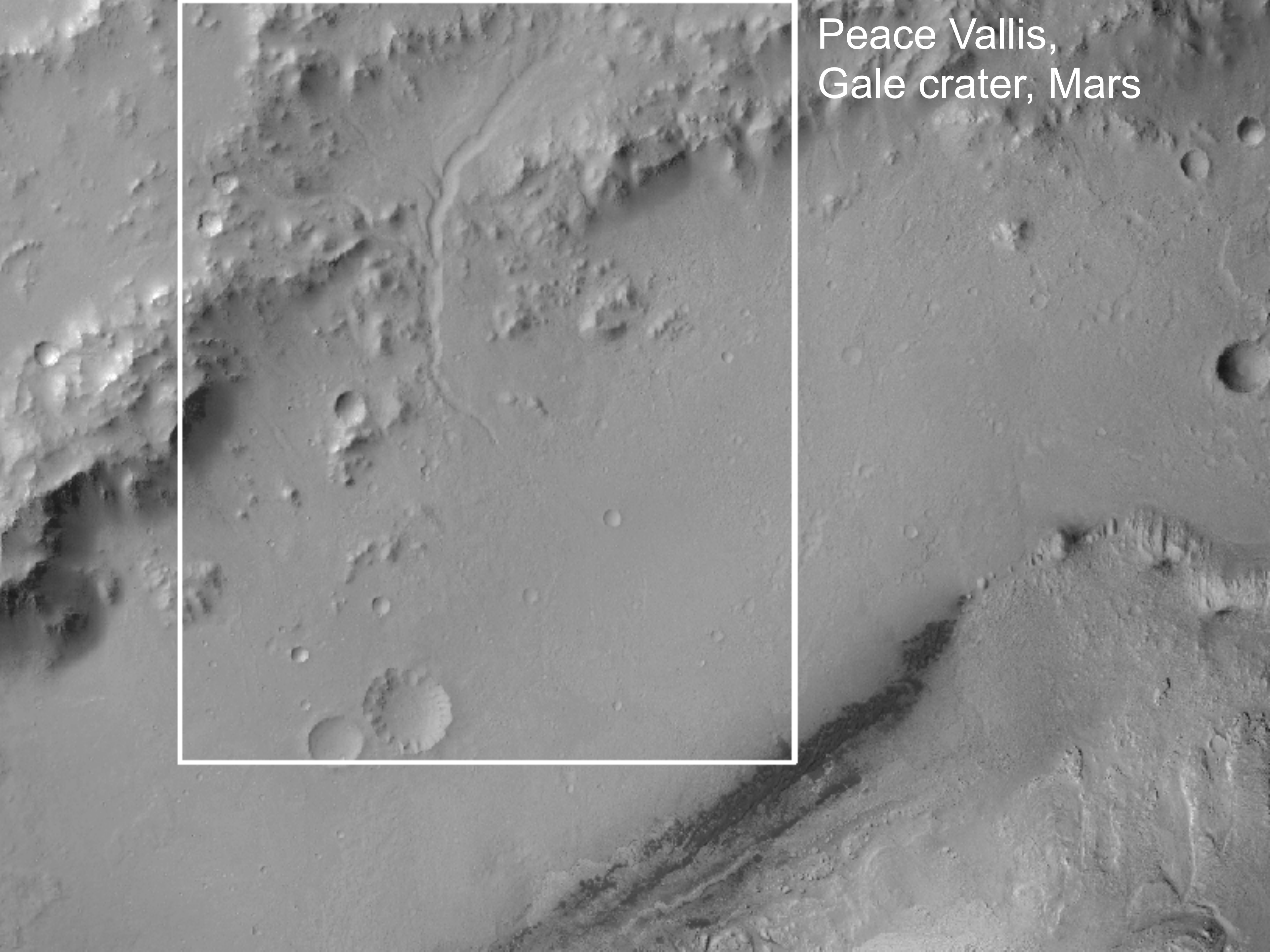
$$ATI = N * (1-A)/\Delta T$$

The denominator just indicates that thermal inertia is inversely proportional to the diurnal temperature range. The numerator normalizes for amount of insolation absorbed by the surface.

Terrestrial work mostly uses Apparent Thermal Inertia (ATI)

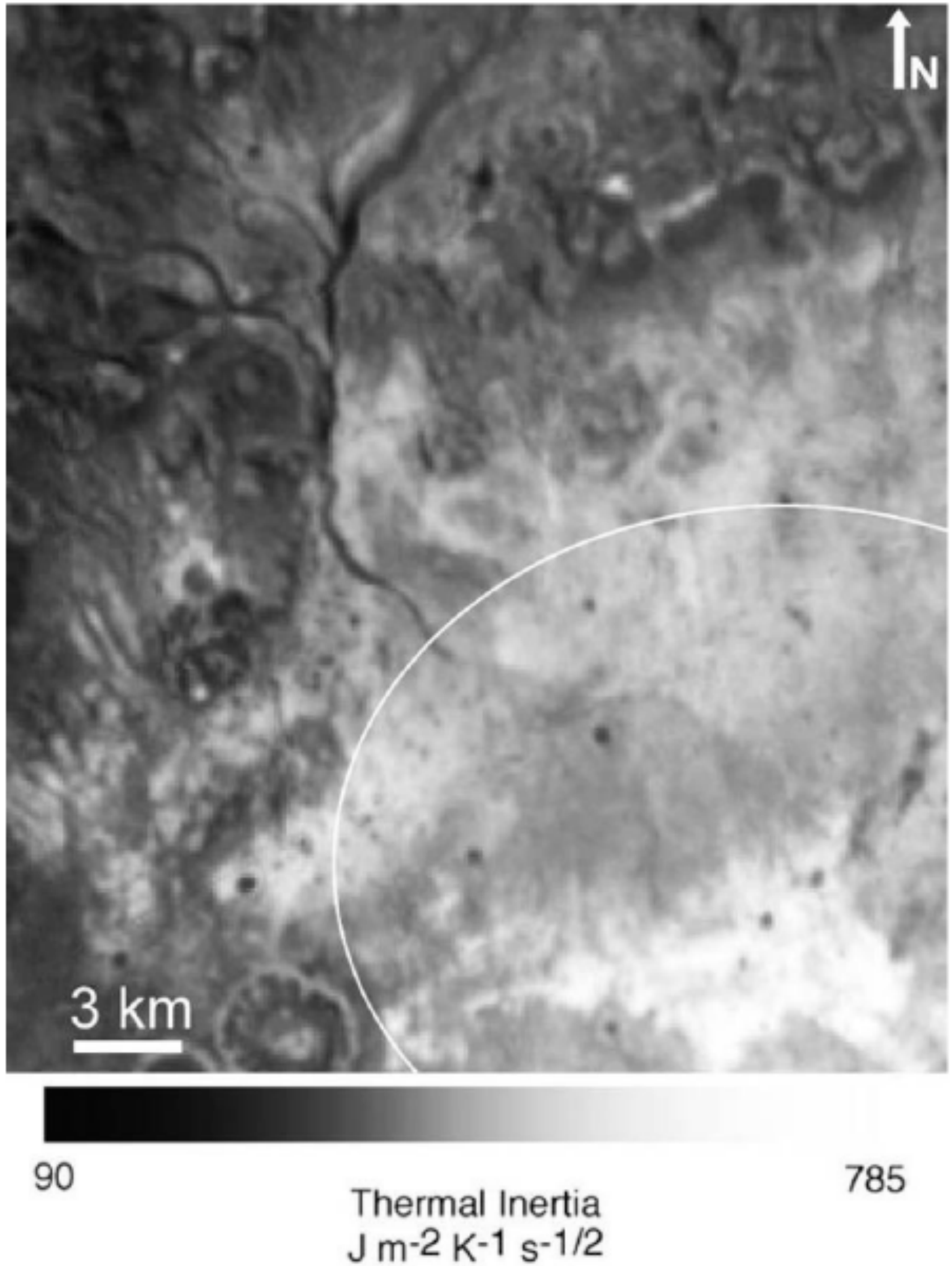
$$ATI = N * (1 - A) \,/\, \Delta T$$

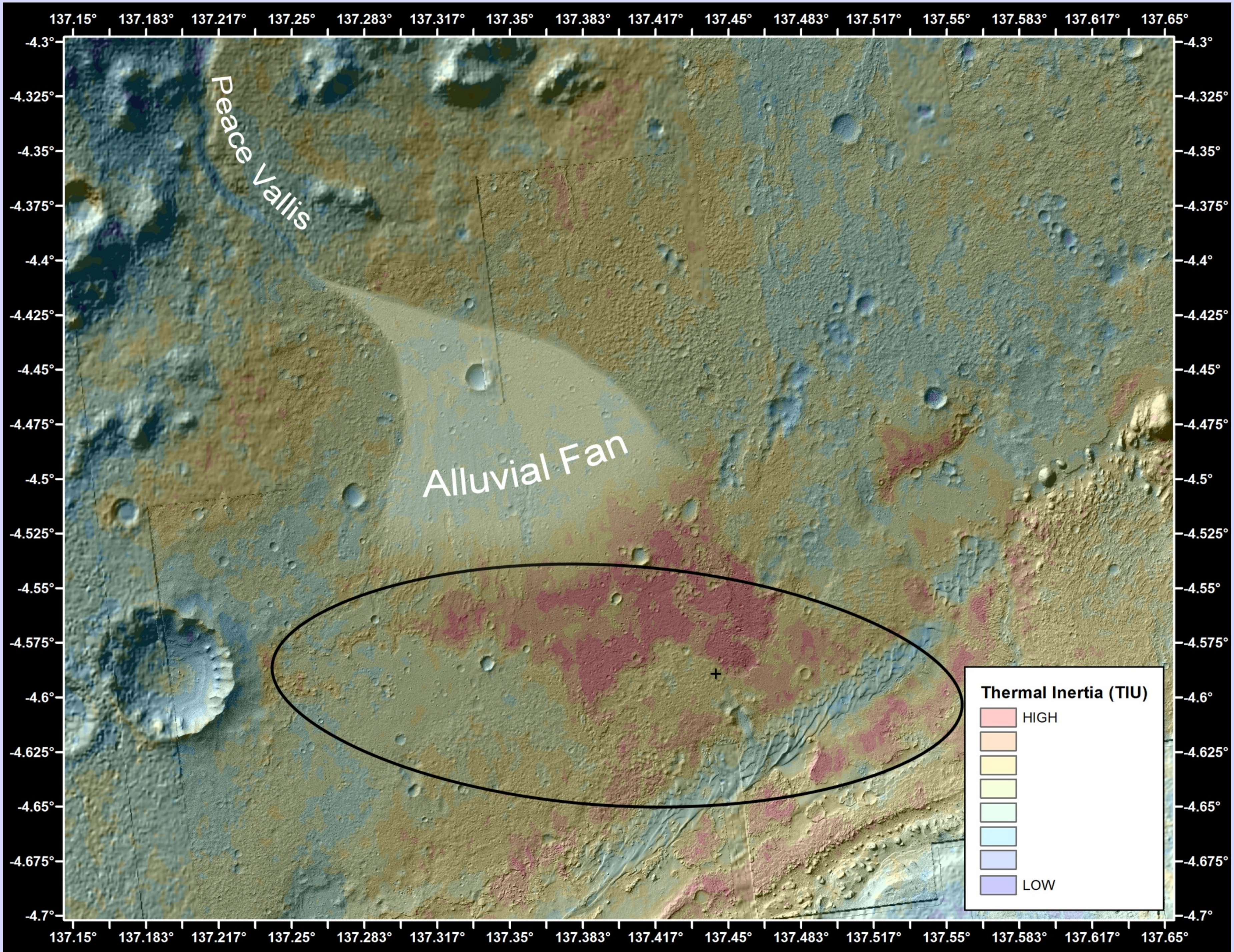



Peace Vallis,
Gale crater, Mars

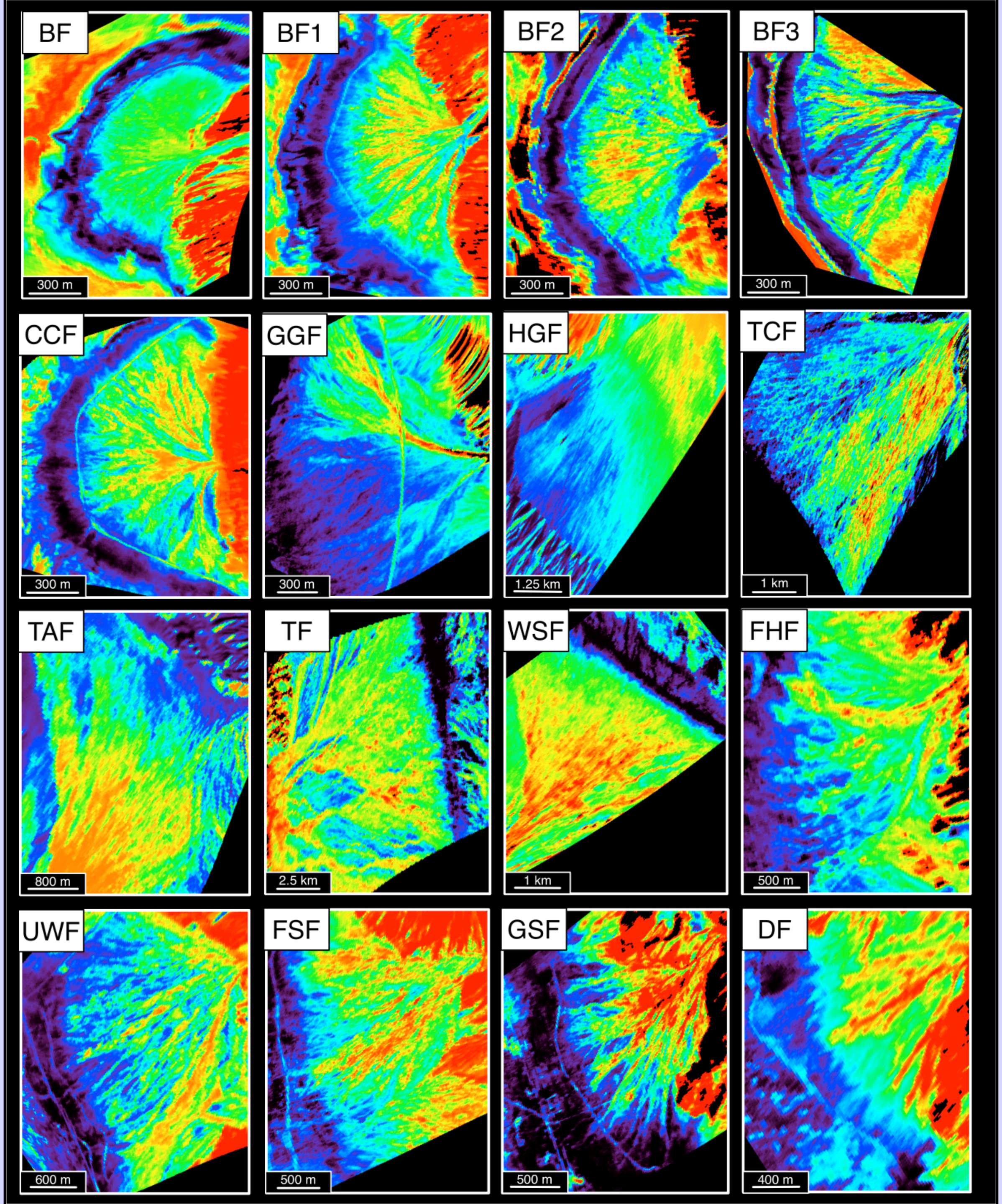
Calculated from day-night image pairs from the THEMIS instrument around Mars

Fergason et al., 2006; Anderson & Bell, 2010




137.15°
137.183°
137.217°
137.25°
137.283°
137.317°
137.35°
137.383°
137.417°
137.45°
137.483°
137.517°
137.55°
137.583°
137.617°
137.65°
-4.3°
-4.325°
-4.35°
-4.375°
-4.4°
-4.425°
-4.45°
-4.475°
-4.5°
-4.525°
-4.55°
-4.575°
-4.6°
-4.625°
-4.65°
-4.675°
-4.7°
Peace Vallis
Alluvial Fan
Thermal Inertia (TIU)
HIGH
LOW

ΔT images of alluvial fans, Death Valley & Owens Valley, CA



Hardgrove et al. (2010)

Temperature and Land Cover

Remote Sensing of Atlanta, Georgia in Thermal Infrared

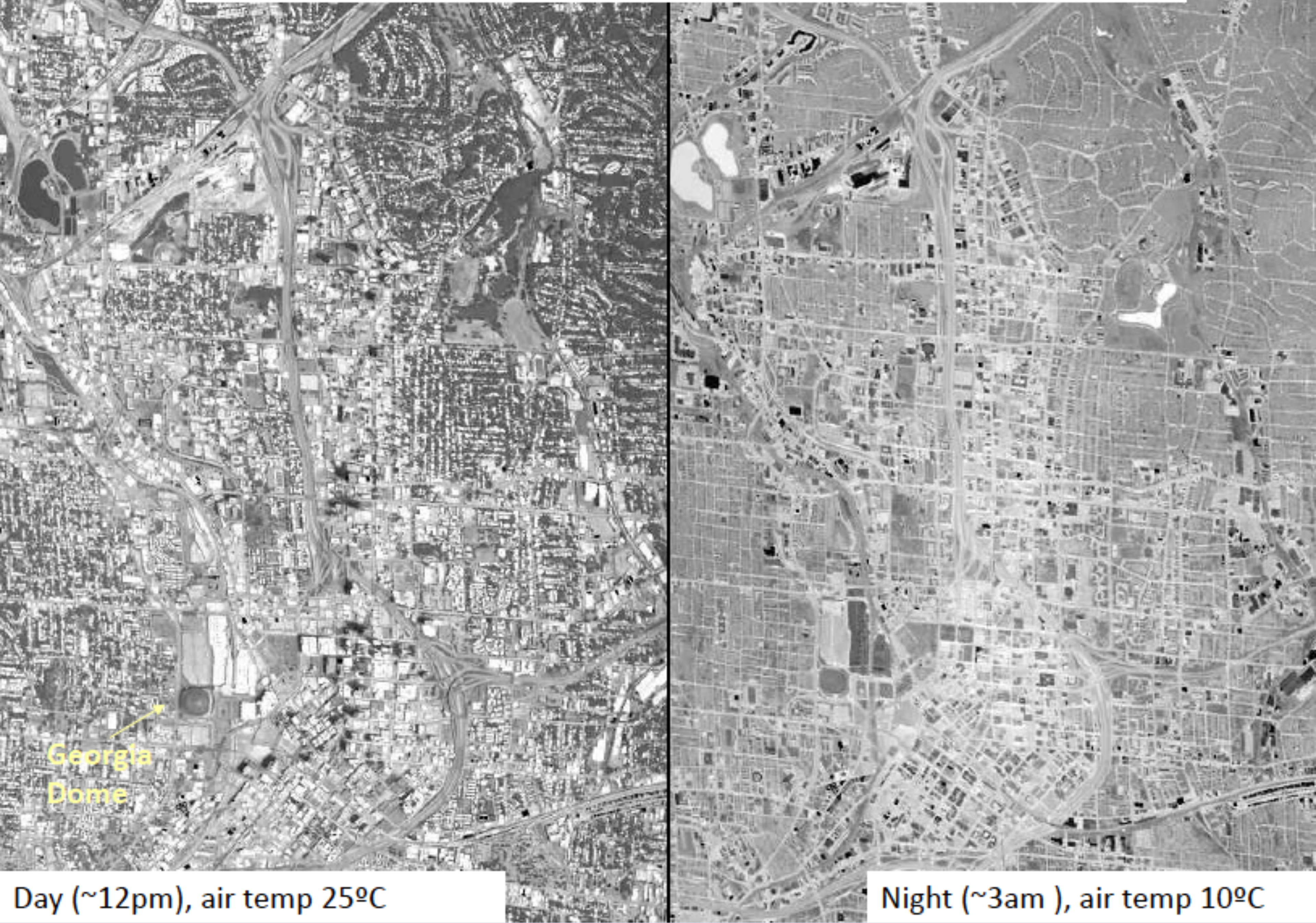
Project ATLANTA, Marshall Space Flight Center, Huntsville, Alabama. Accessed 2 Feb 2005.
http://www.ghcc.msfc.nasa.gov/atlanta/

Question

Below are daytime and nighttime thermal infrared images (9.60-10.2μm) of Atlanta at 10m/pixel resolution. Describe the changes in appearance of roads, buildings, forest, and water over the course of the day.

In light of this information, what should urban planners do to minimize the "urban heat island" effect?

ATLAS-TIR, 10m resolution, Band 13 (9.60-10.2µm)



Columbus crater *(Night IR over Day IR)*

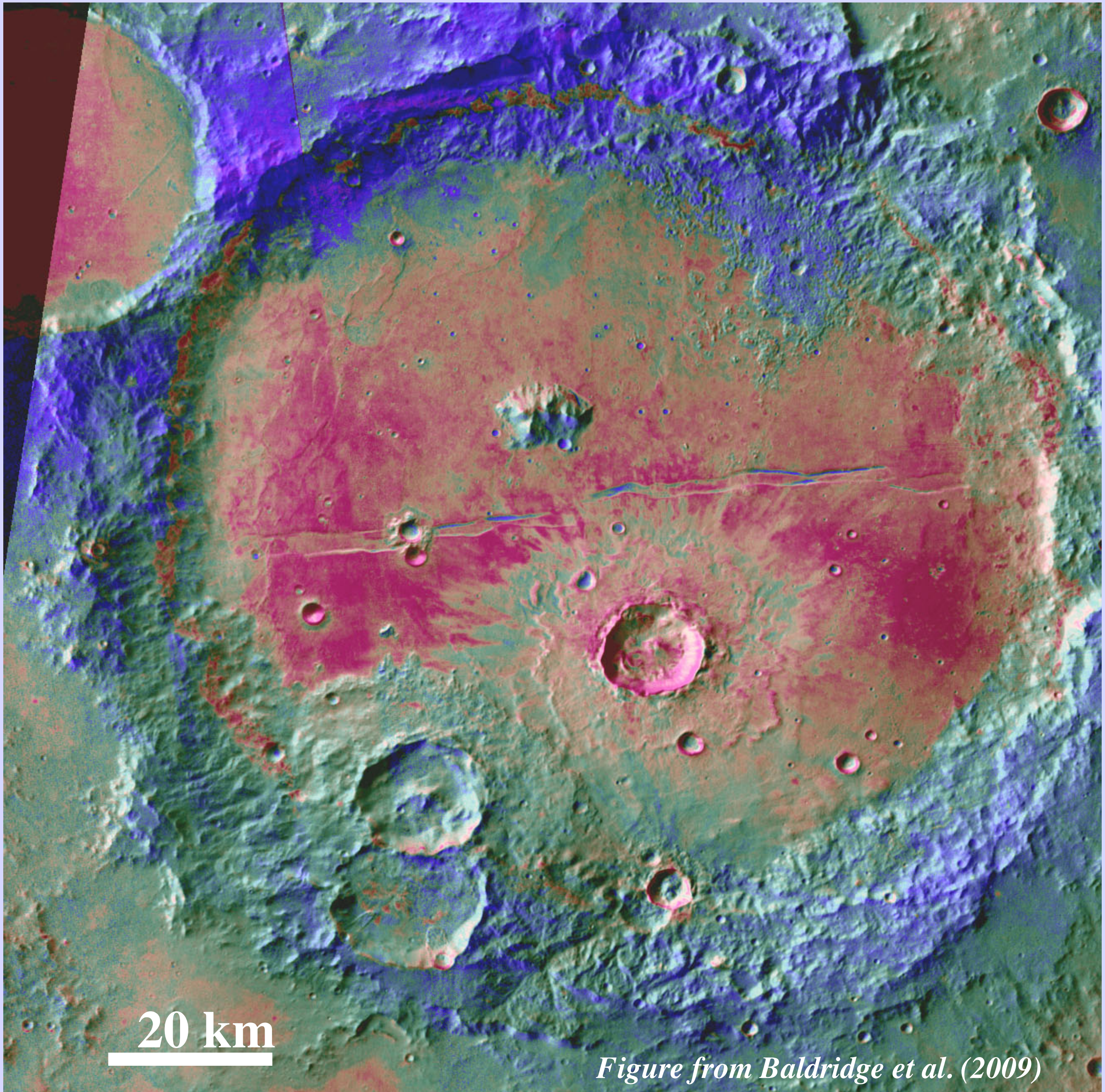
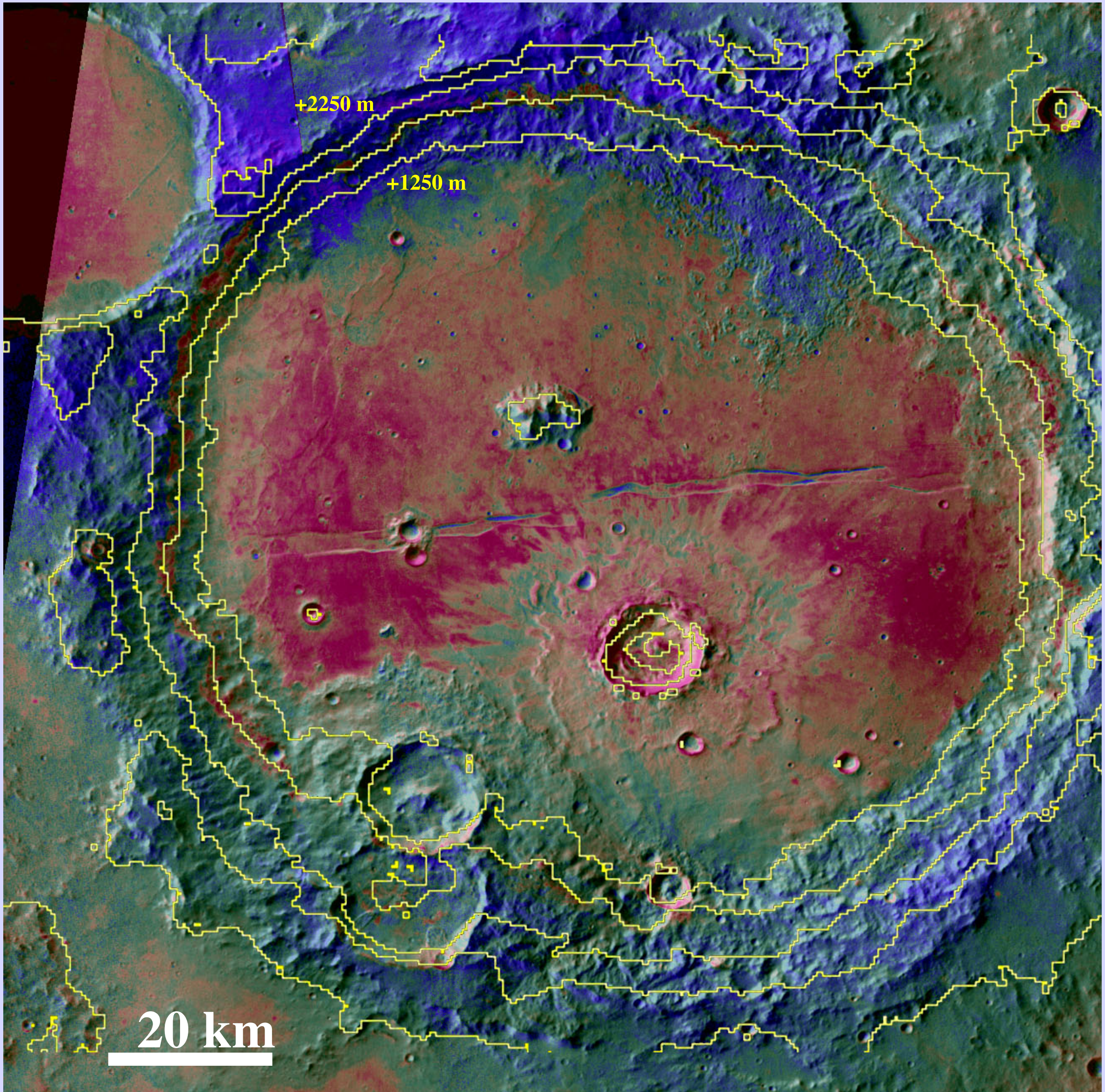
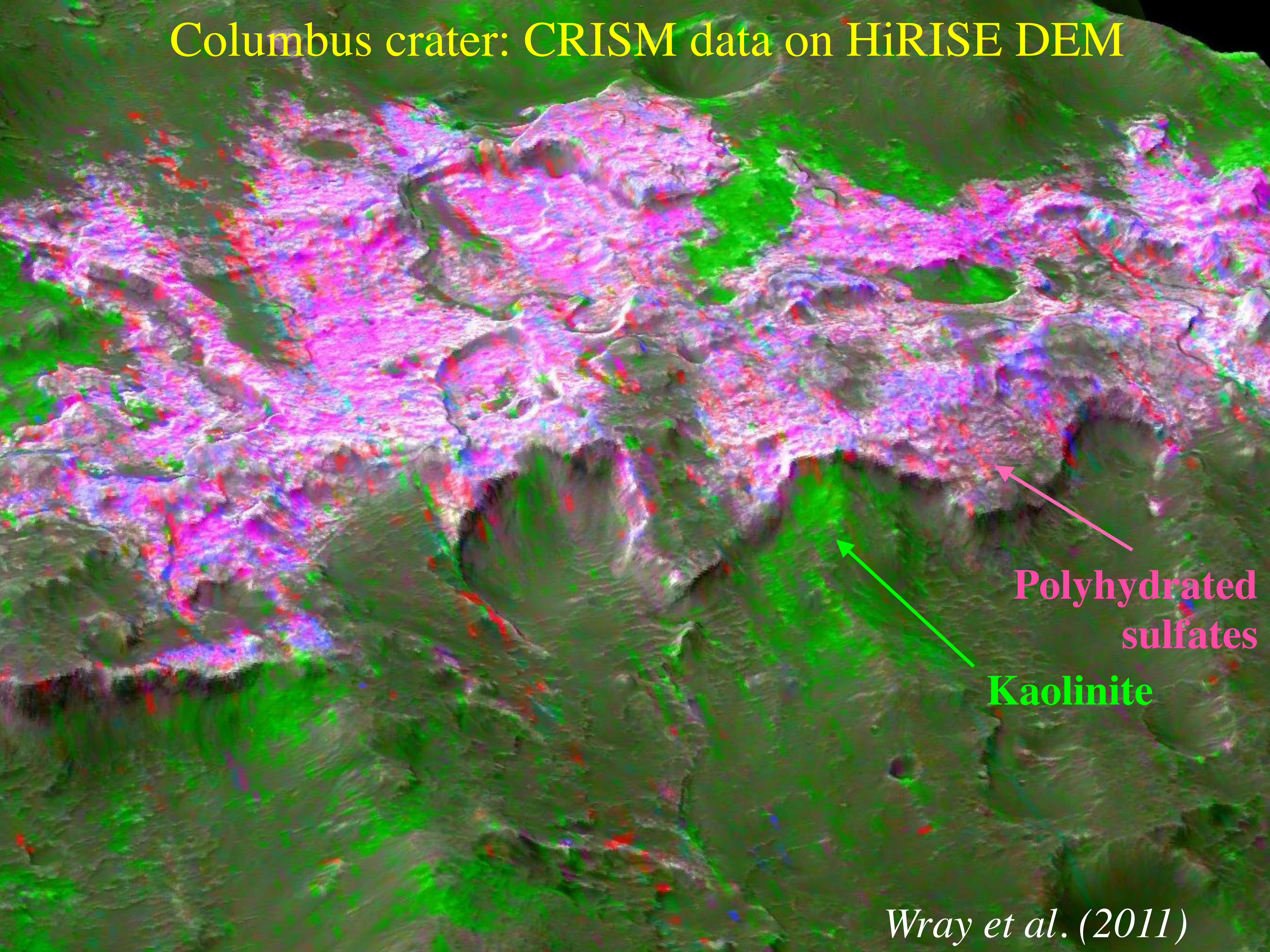


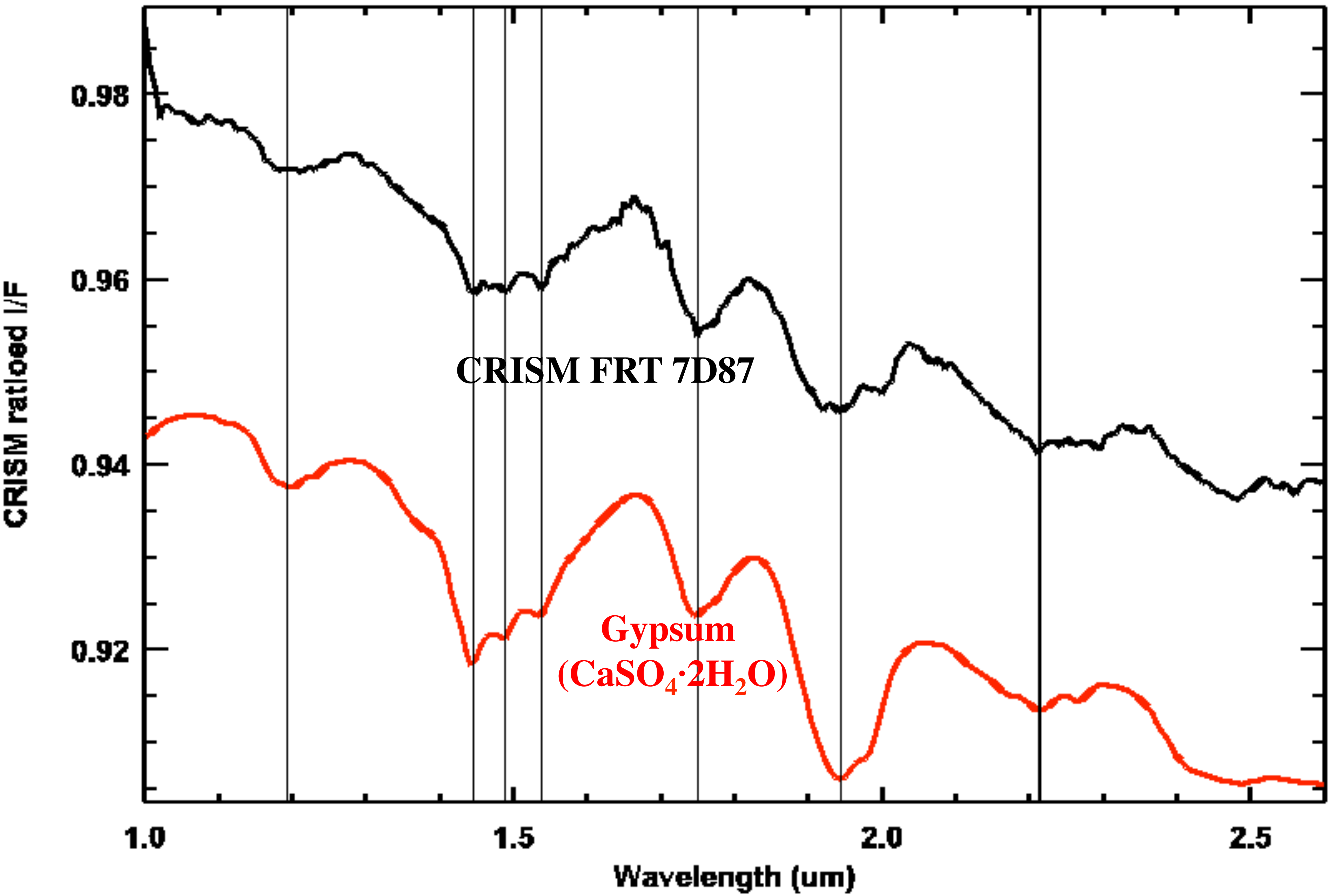
Figure from Baldridge et al. (2009)

Columbus crater *(Night IR over Day IR)*

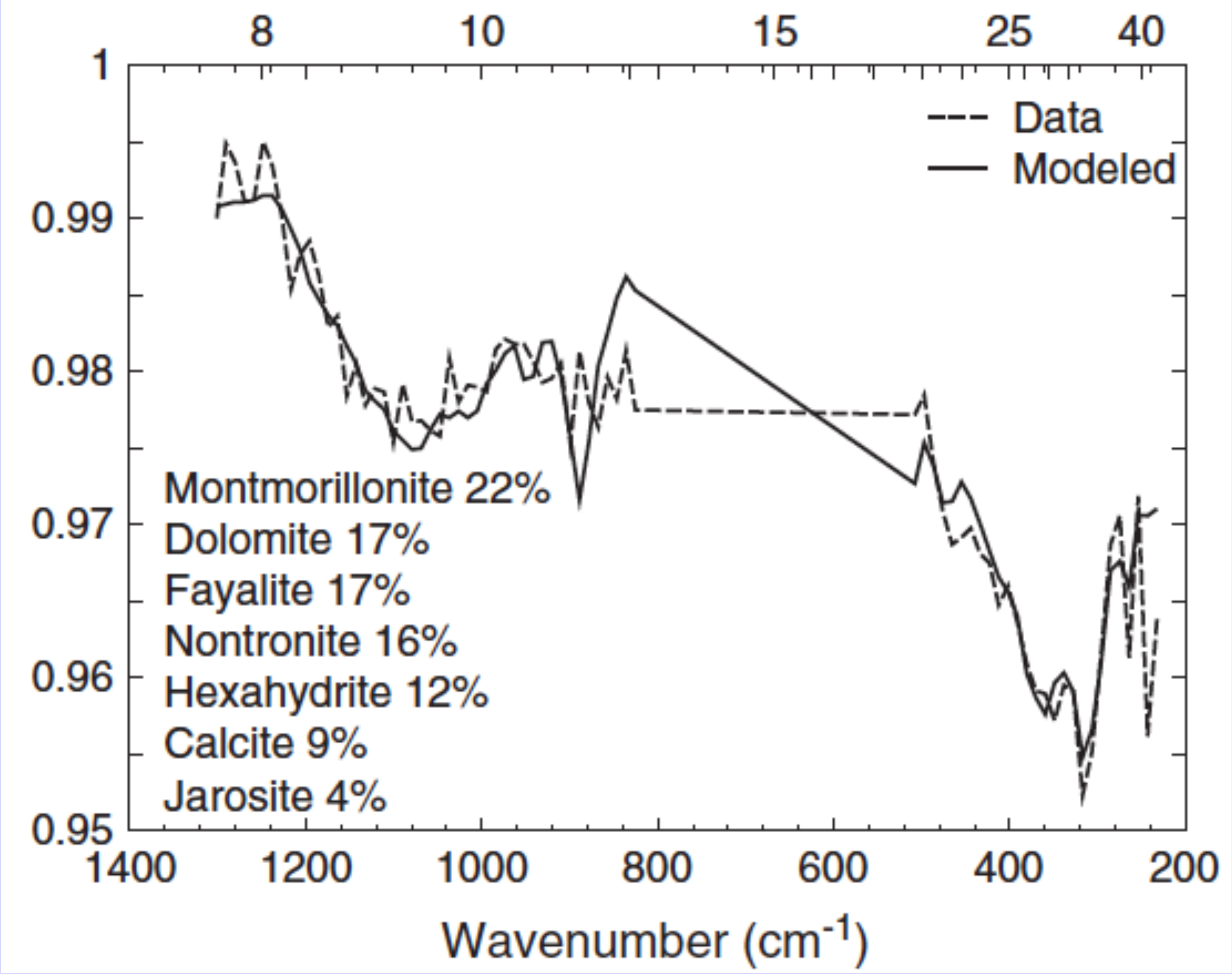



Columbus crater: CRISM data on HiRISE DEM
Polyhydrated sulfates
Kaolinite
Wray et al. (2011)

Near-IR spectra allowed precise mineral identification



Thermal IR spectral data allowed estimating ***abundances***



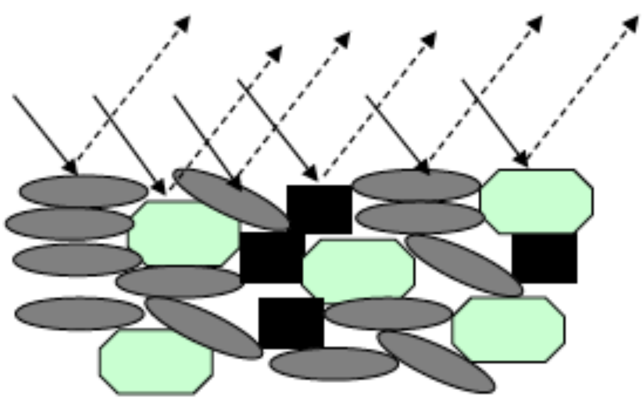
Baldridge et al. (2013)

Why is "How Much?" a difficult question?

Thermal Infrared

Dominated by single-scattering for coarse granules or rocks

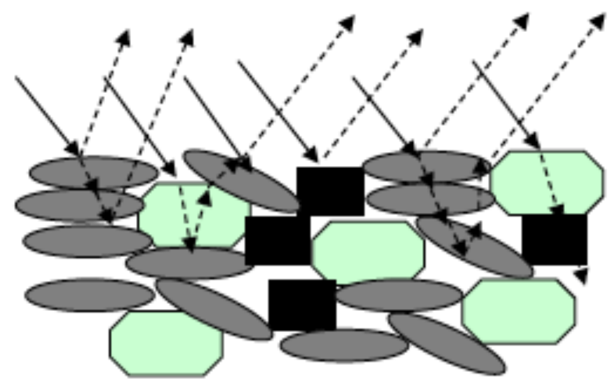
~ Linear



Visible/Near-Infrared

Dominated by multiple-scattering, grain size and composition effect scattering

~ Non-linear



But rough surfaces can complicate thermal IR unmixing…
(because single scattering no longer dominates)

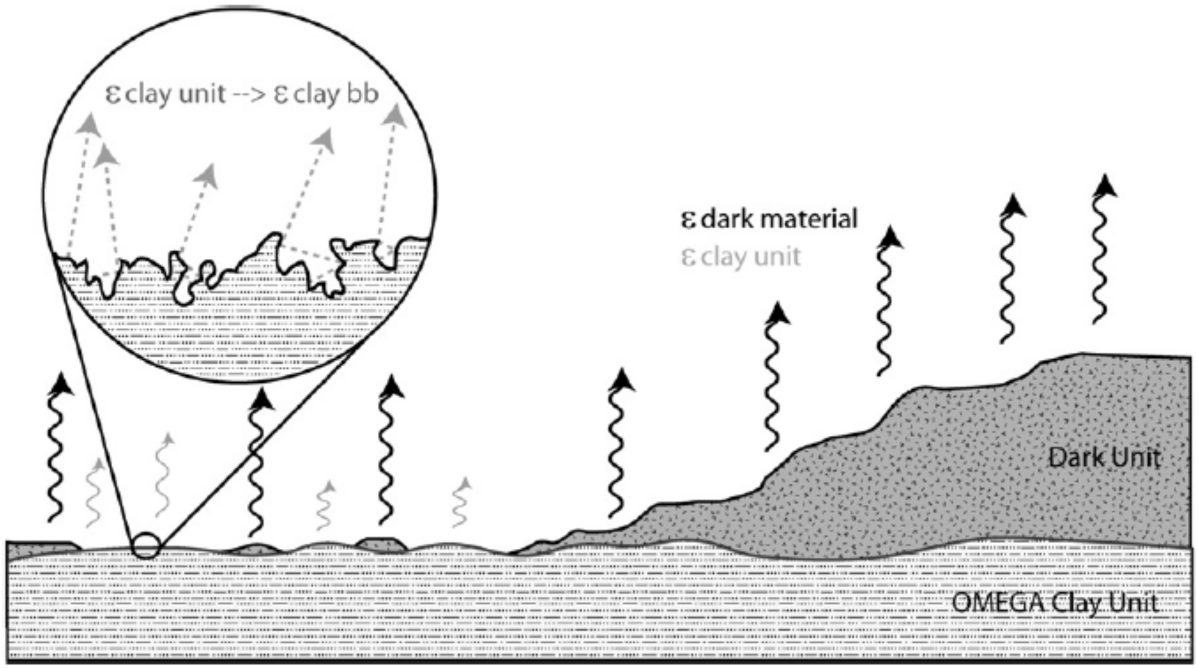
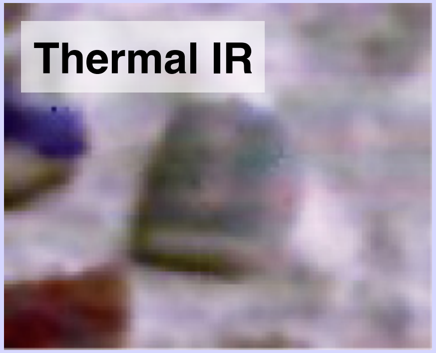


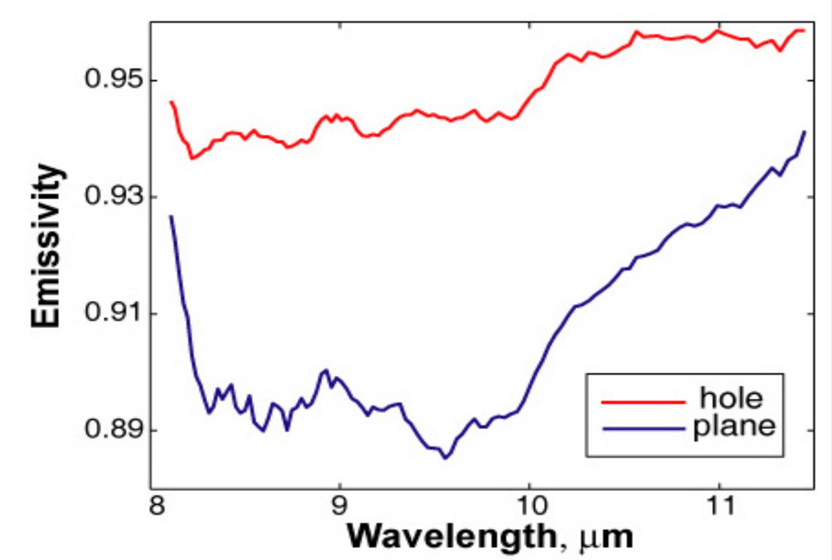
Fig. 19. A schematic diagram illustrating how the light-toned rock could have a rough surface texture that promotes multiple scattering. While this property is advantageous to near-infrared spectral detection, it is disadvantageous in the thermal infrared because as the porosity increases the emission of the surface approaches that of a blackbody.

Cavity Effect

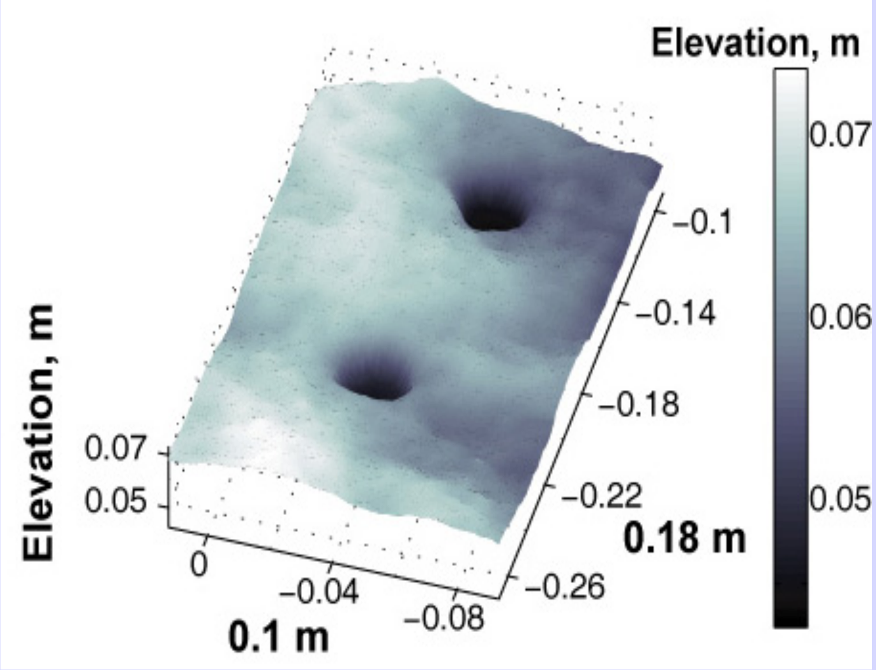
Norite rock with two drilled holes:



Thermal IR spectra:



3D view (DTM resolution 0.002 m):



Modeled apparent emissivity: