THERMOPHYSICAL PROPERTIES OF SELECTED LUNAR STUDY REGIONS DETERMINED FROM LROC AND DIVINER DATA.

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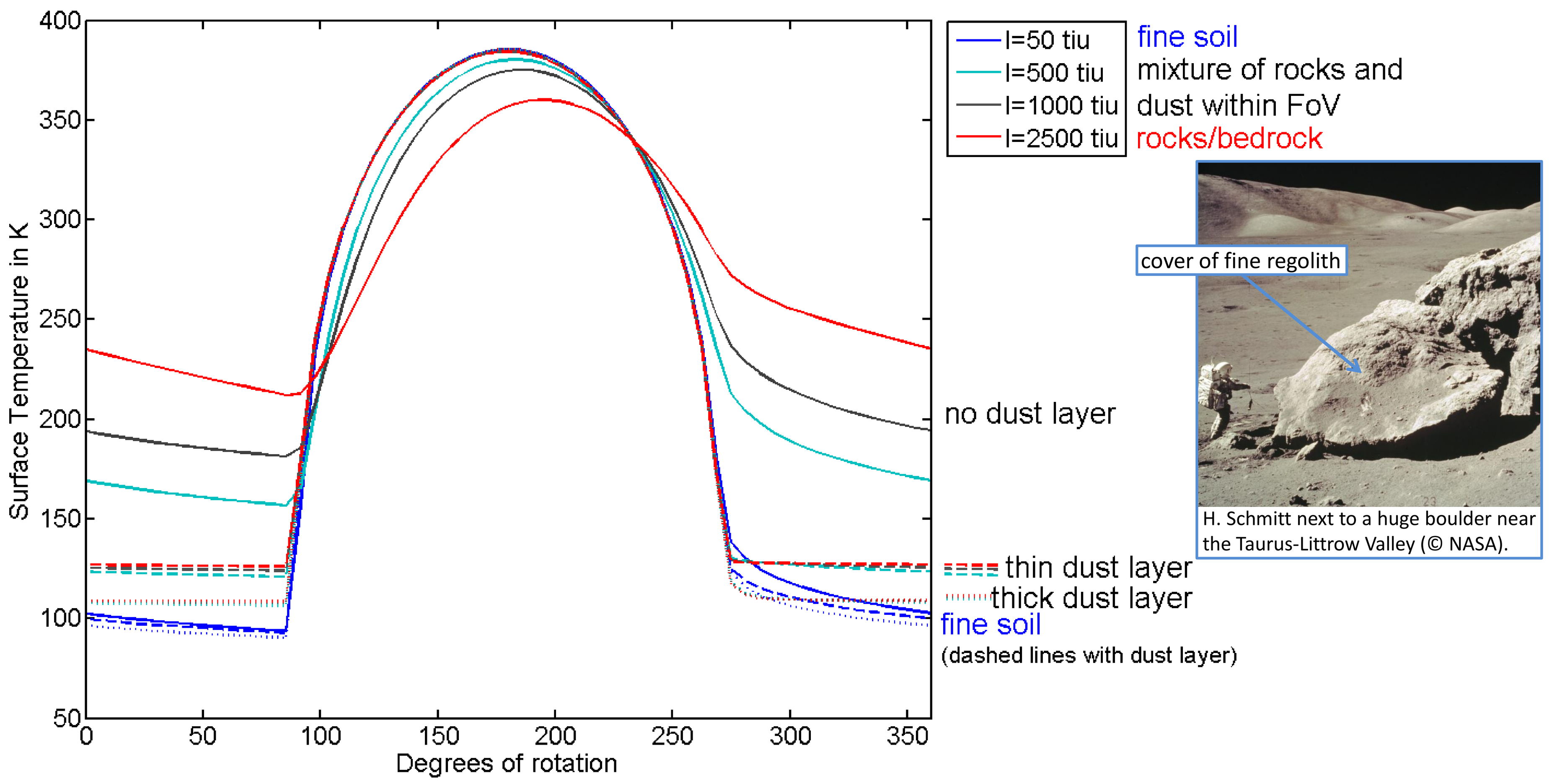
"Thermal Inertia" – Indicator of Thermophysical Properties

Using Diviner temperature data combined with subsets of the 100m grid LROC WAC DTM (GLD100, [1]), we derived maps of thermal inertia for different study regions. We use an expanded version of the thermal model presented by [2] to generate temperature-to-inertia look-up curves for different times of the lunar day. For each surface facet, we compare measured and modeled temperature data in order to find the best fitting thermal inertia value. This approach is similar to Martian thermal inertia derivations described by [e.g. 3, 4].

The thermal inertia of a surface is an important property for determining temperature variations of planetary surfaces [e.g. 3-5]. It represents the ability of a subsurface to retain heat and is defined as a combination of thermal conductivity k, density ρ and heat capacity C as $I \equiv (k\rho C)^{1/2}$.

Temperature-to-Inertia Curves



H. Schmitt next to a huge boulder near the Taurus-Littrow Valley (© NASA).

Low thermal inertia (dust):
- Subsurface quickly looses heat during the night
- ➢ Cold nighttime temperatures
- During the day the soil quickly heats up
- ➢ Relatively warm daytime temperatures
- ➢ **Large temperature amplitude!**

High thermal inertia (rocks, bedrock):
- Subsurface stores more heat during the night
- ➢ Relatively warm nighttime temperatures
- During the day the soil slowly heats up
- ➢ Relatively cold daytime temperatures
- ➢ **Smaller temperature amplitude than dust!**

Subsurface Soil Model (2 Layers)

Our subsurface soil model assumes a layer of fine regolith ("dust") on top of a more dense and conductive bottom layer. This model is similar to previous models and consistent with lunar measurements [7, 8]. The change of thermophysical parameters close to the surface can be explained by micrometeorite bombardment that pulverizes the upper layer and compacts the second layer.

As we assume a dust cover on all kind of surface units, we vary the thermophysical parameters only within the bottom layer. Besides depth these parameters are also dependent on the temperature of the soil and have the following general characteristics:

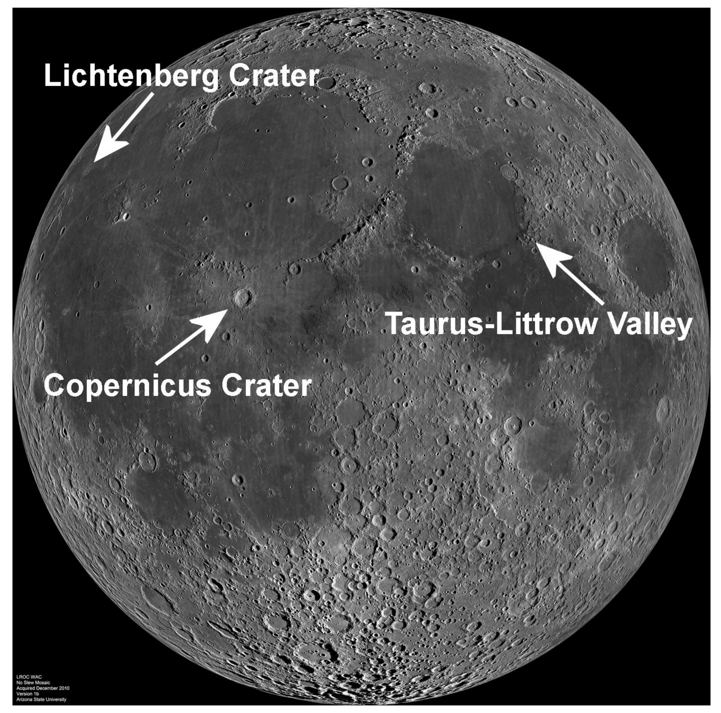
Top layer (z<2cm):
- Low thermal inertia during the night: I_{fine}<50Jm^{-2}K^{-1}s$^{-1/2}$
- Highly insulating, thermal radiation dominates solid conduction at high temperatures

Bottom layer (z>2cm):
- Denser and more conductive than top layer, solid conduction is more dominant in this layer
- Thermal inertia varies within this layer between fine soil and bedrock ($I_{bedrock}$~2500Jm^{-2}K^{-1}s$^{-1/2}$)

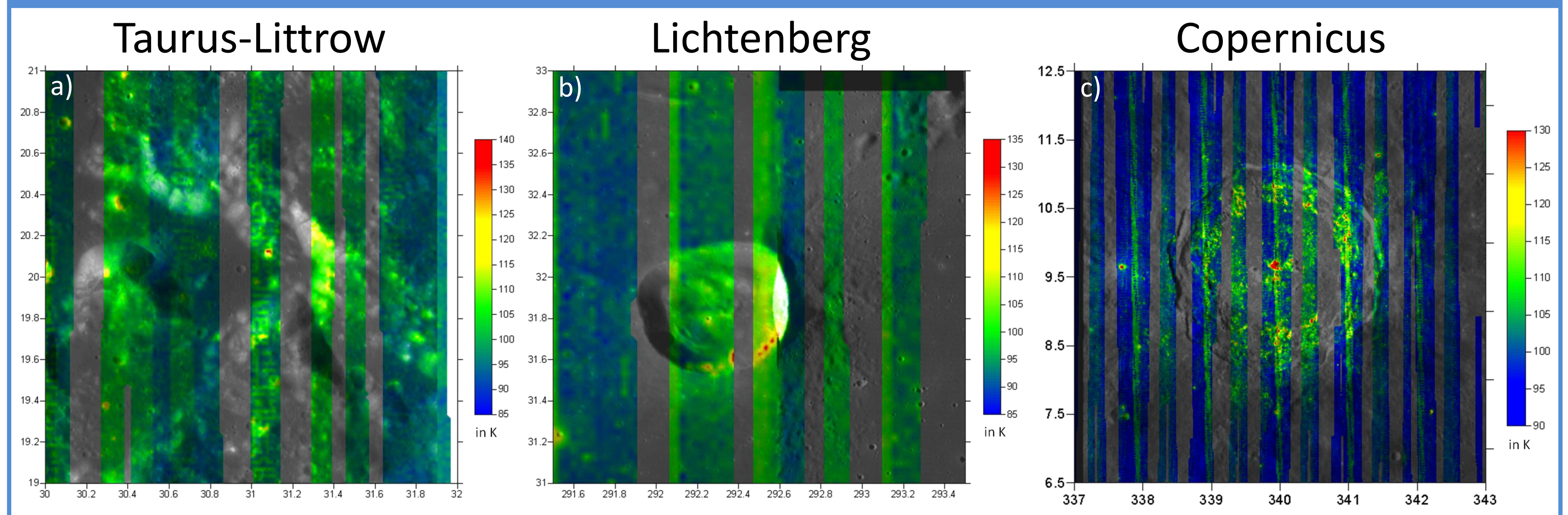
Study Regions – Taurus-Littrow, Lichtenberg and Copernicus Crater

Taurus-Littrow Valley (20°N, 31°E) is located on the southeastern edge of Mare Serenitatis. The Apollo 17 landing site is of special interest for thermal studies, because heat flow experiments have been performed during the mission and temperature data over the whole lunar cycle are available [6]. These data sets allow the derivation of a detailed model of the surface and subsurface thermophysical properties [e.g. 2, 5].

Lichtenberg Crater (~20km in diameter, 31.8°N, 292.3°E) and **Copernicus Crater** (~93km in diameter, 9.7°N, 339.9°E) are located in the western and eastern part of Oceanus Procellarum, respectively. Both craters exhibit prominent ray systems extending more than 100km (Lichtenberg) and 800km (Copernicus) from the crater rim. Lichtenberg presents a diverse geologic setting, with young basalts to the east, and older basalts with different composition in the north and west. Copernicus shows blocky central peaks and terraced crater walls, which are observable in LROC images.

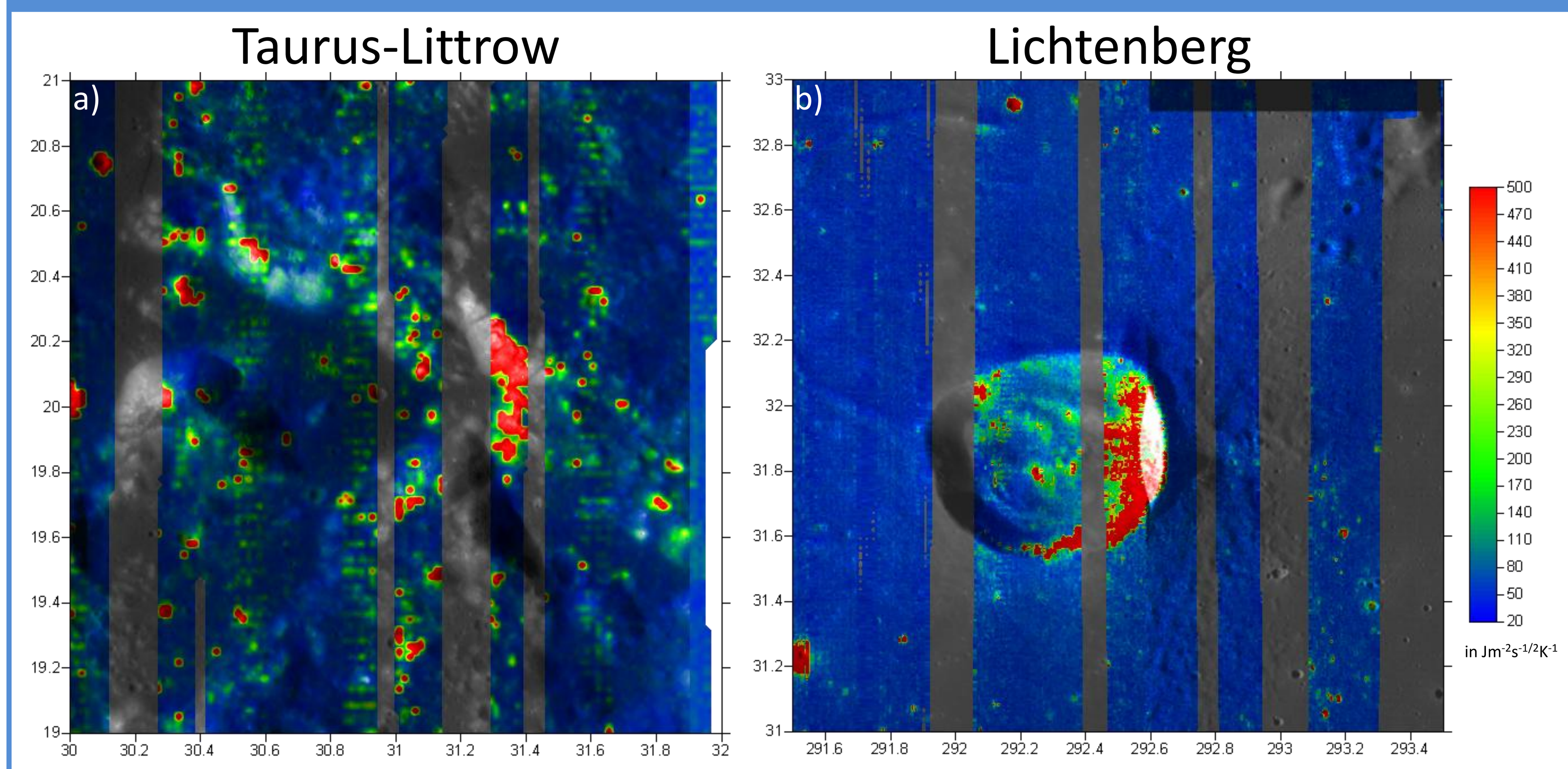


Diviner Nighttime Temperature Maps



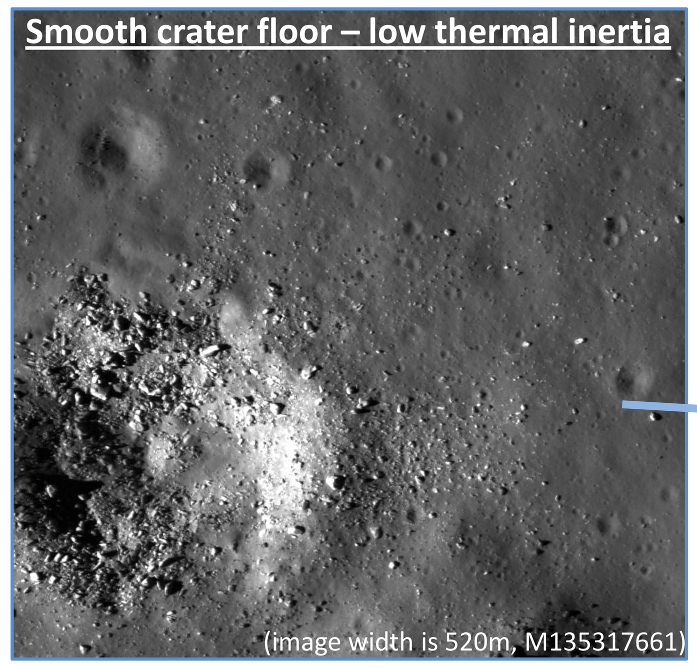
Diviner Channel 8 nighttime temperatures of the study regions Taurus-Littrow Valley (a), Lichtenberg (b) and Copernicus Crater (c), superposed on WAC-mosaics. Highest temperatures occur at the central peak of Copernicus Crater, but also at the crater walls of Lichtenberg and Copernicus Crater; lower temperatures occur at the valley floor and the ejecta blankets.

Derived Thermal Inertia Maps and Comparison to LROC Data

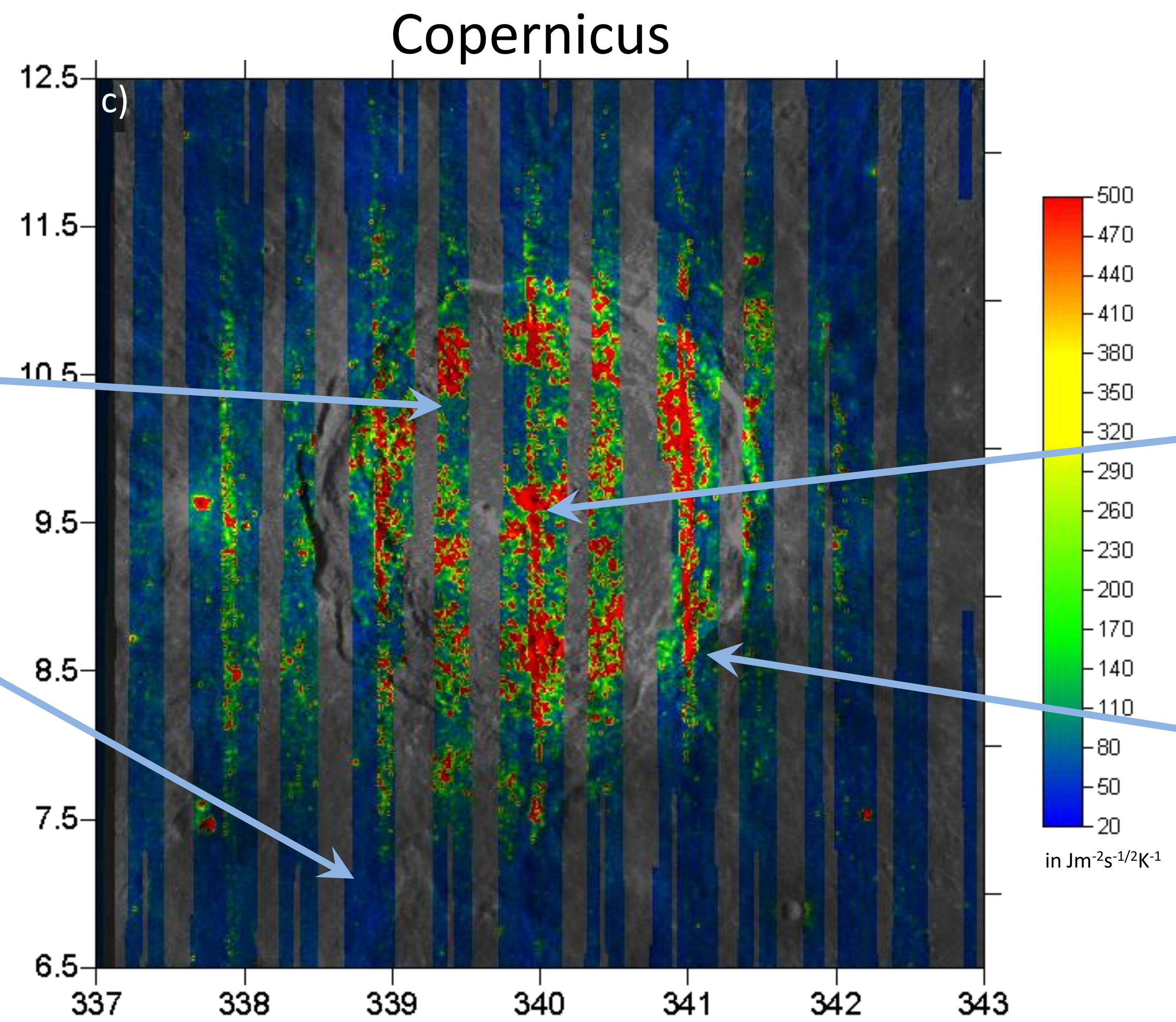


Thermal inertia superposed on WAC-mosaics of Taurus-Littrow Valley (a), Lichtenberg (b) and Copernicus Crater (c). Blue colors correspond to fine regolith (e.g. valley floor and ejecta blankets), red indicates bedrock or a high degree of rock abundance (e.g. Sculptured Hills, crater walls, central peak). LROC-NAC images highlight the different types of surfaces at Copernicus Crater.

Smooth crater floor – low thermal inertia

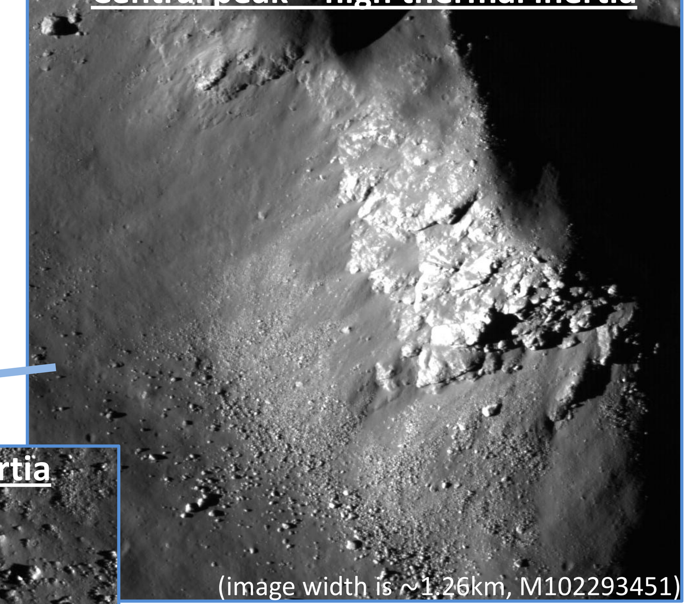


Smooth floor (north-west) and ejecta blanket show no evidence for large boulders except for recent impact craters
- ➢ Low thermal inertia, only few spots with higher thermal inertia or mixtures of rocks and fine material due to recent impact craters

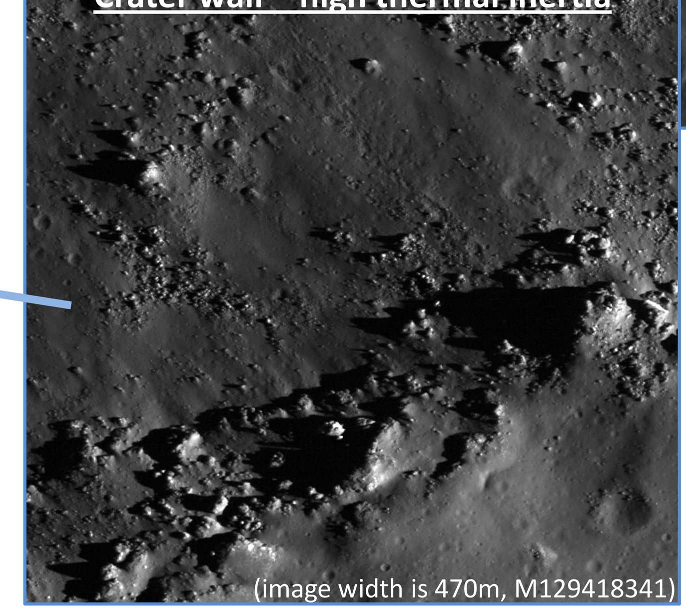


Part of the central peak (right) and south-eastern crater wall (bottom), indicating bedrock and a higher degree of rock abundance covered by a dust layer
- ➢ High thermal inertia

Central peak – high thermal inertia



Crater wall – high thermal inertia



References:
[1] Scholten, F. et al. (2011), LPSC XLII, Abstract #2046. [2] Bauch, K.E. et al. (2009), LPSC XL, Abstract #1789. [3] Mellon, M.T. et al. (2000), Icarus 148, 437-455. [4] Putzig, N.E. et al. (2005), Icarus 173, 325-341. [5] Urquhart, M.L. and Jakosky, B.M. (1997), JGR 102, 10,959-10,969. [6] Keihm, S.J. and Langseth, M.G. (1973), Proc. Lunar Sci. Conf. 4, 2503-2513. [7] Mitchell, D.J. and de Pater, I. (1994), Icarus 110, 2–32. [8] Vasavada, A. et al. (1999), Icarus 141, 2, 179-193.