The Lunar Poles:

The Beginnings of a Revolution

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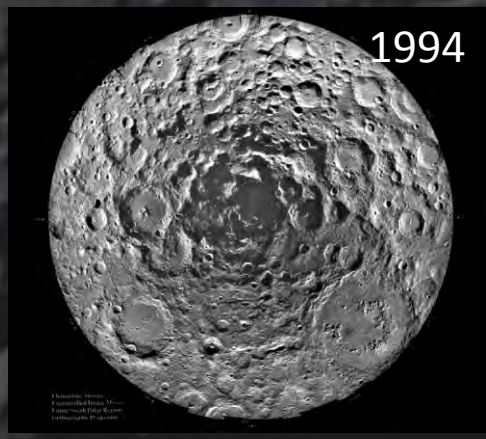
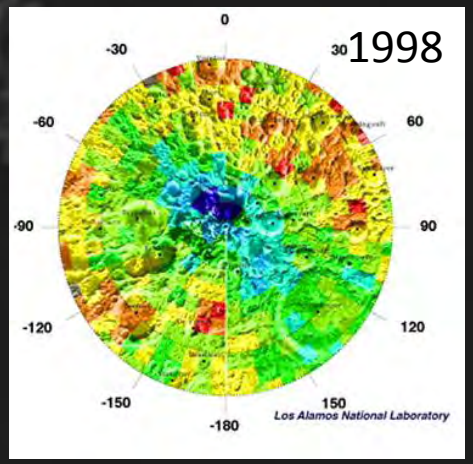
The Lunar Poles

- Until recently the lunar poles were unexplored
- Not until Clementine did we have our first good view
  - Suggested regions of eternal light and water ice
- Clementine and Lunar Prospector solidified our interest and conceptual support for lunar polar water
- Past three years have dramatically increased our appreciation for the complexity and diversity of the lunar poles

These new data have potential to revolutionize our thinking about the moons poles

Clementine





Feldman et al, 1998

The Lunar Poles

What the lunar poles have to offer:

Resources

- Water and other compounds (H_2, CH_4, NH_3)
- Near constant illumination

Environment

- More stable thermal regime
- Relatively constant and extreme thermal gradients across relatively small distances

Knowledge

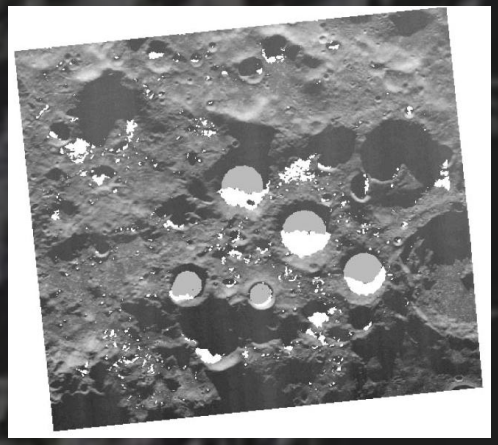
- Window into the past ~Billion years of the inner Solar System
  - Volatiles could hold clues to solar System history and evolution

Kaguya / JAXA

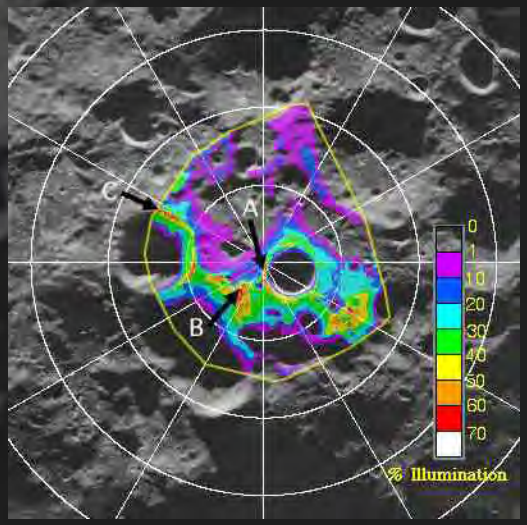
What we knew (or thought we knew)

- Extreme topography – But unmeasured!
- Results in large permanently shadowed regions (PSR) in south
- PSR temperatures as cold as 50-70 K
  - more often modeled at 70-100 K
- Several areas of near-permanent illumination

We really didn't know what "extreme" was



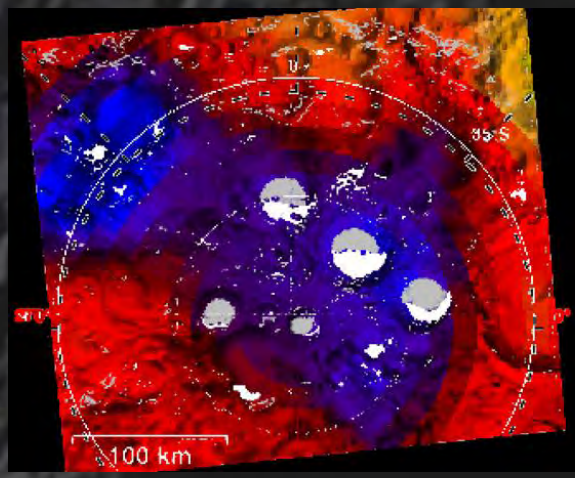
Margot et al., 1999

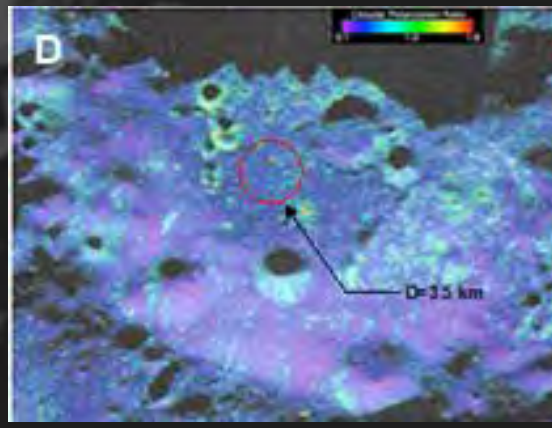


Bussey et al., 1999

What we knew (or thought we knew)

- Neutron suppressed areas
- Presumed to be associated with PSRs
- If water, concentrations ~1-2% (Feldmann)
  - But really depends on assumed distribution within LP footprint
- Possibly higher concentrations in Shackleton (Clementine bi-static radar)
  - Other Earth-based radar observations inconclusive



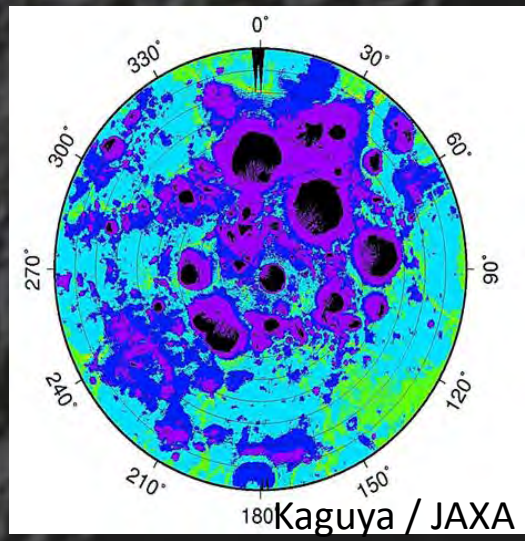


Lots of speculation about what, where and how much

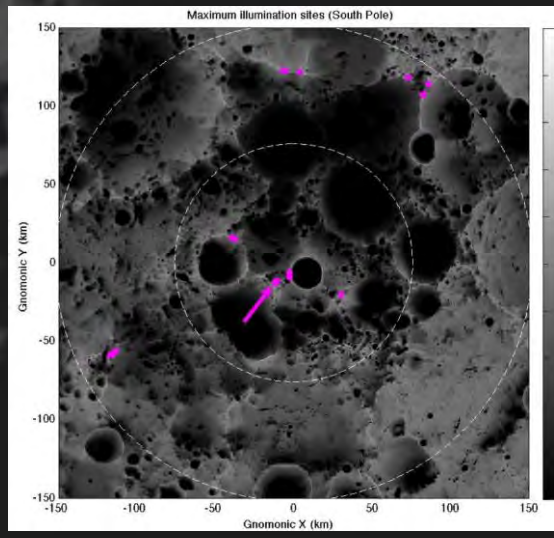
Campbell , 2006

And then something happened… New data!

- Extreme topography measured
- Could accurately define PSR boundaries
- Allows for accurate calculation of illumination (both current or for any orbital configuration one chooses)
  - Confirms this potentially valuable environment
- Allowed for proper maps
  - Can now target (or land) to < 100 m



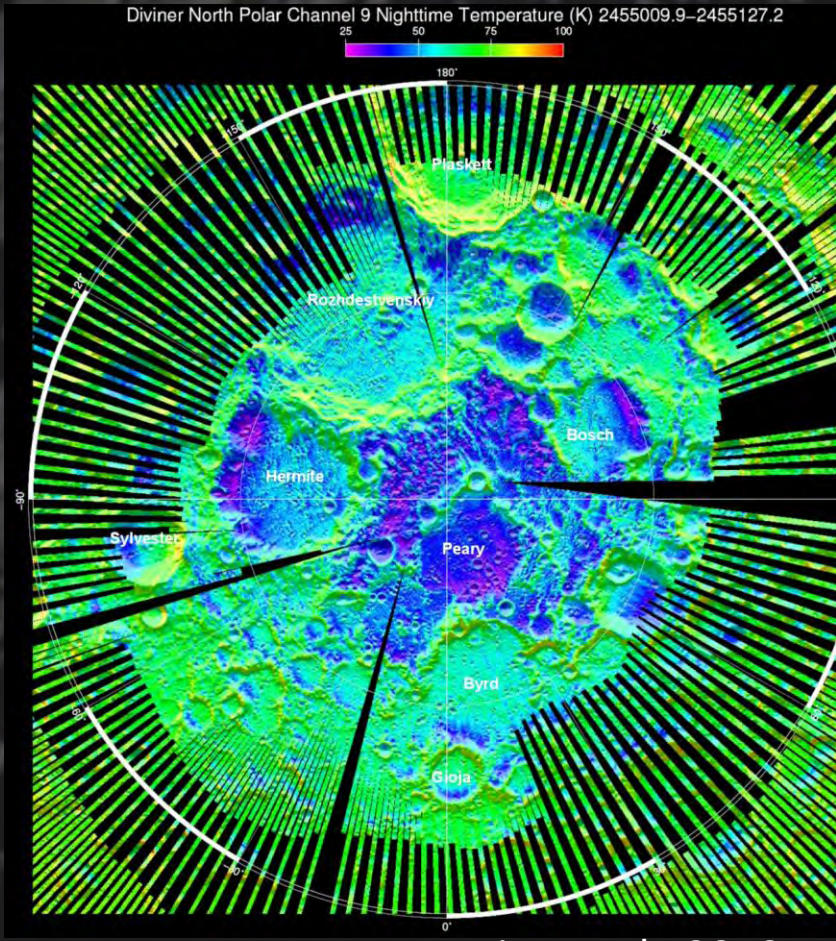
Kaguya / JAXA



Smith et al., 201

And then something happened… New data!

- Temperatures where measured
- Colder than generally anticipated…much colder!
  - Coldest temperatures <30 K
  - Many PSRs < 60 K
- Cold traps for much more than water

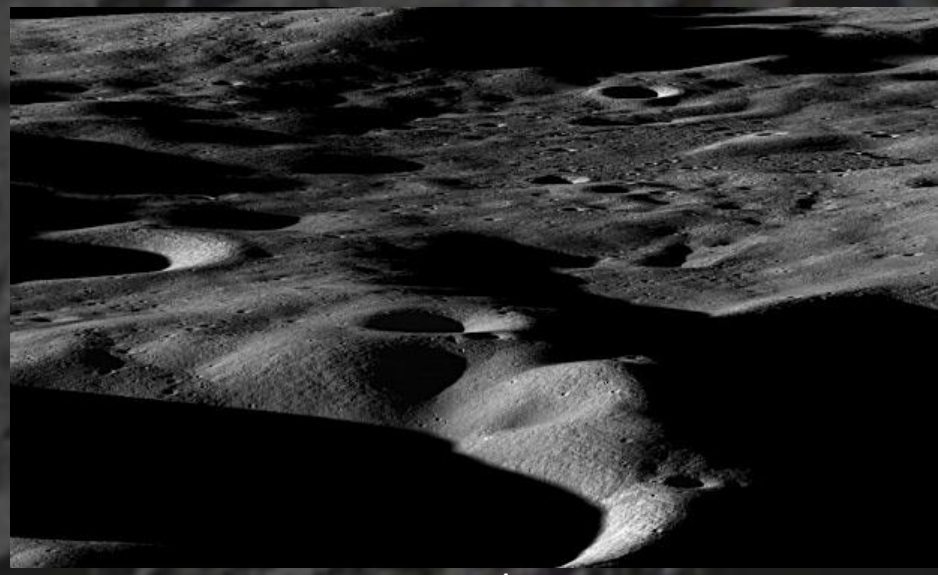


Paige et al., 2010

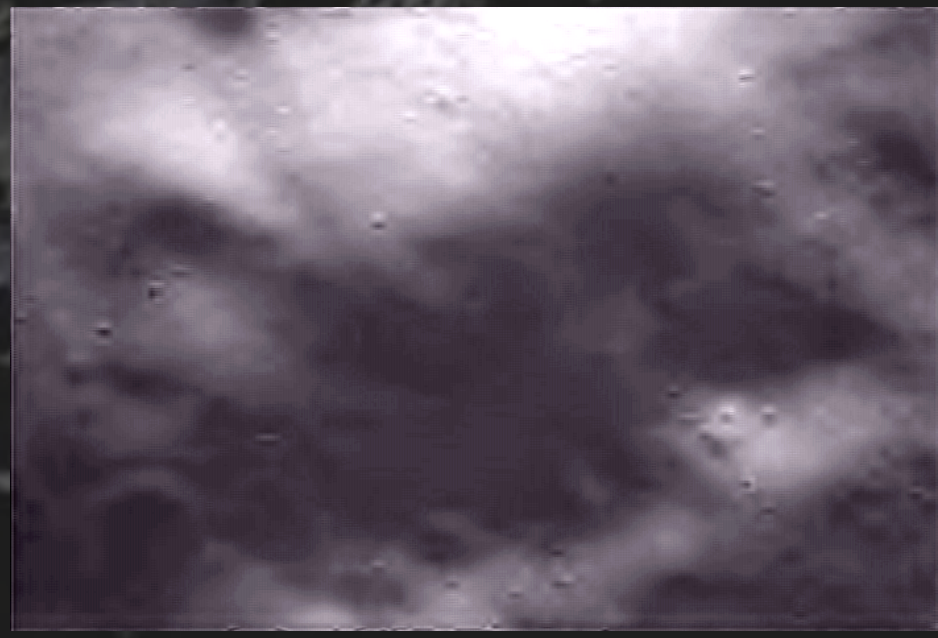
New Views

- Our first looks into PSRs
- Surface properties that may be significantly different from lit areas
  - Low porosity, fairy castle-like?
  - Localized Exospheres?
  - Unique chemistry ?

Cabeus Northern Rim



LROC / Robinson et al., 2010

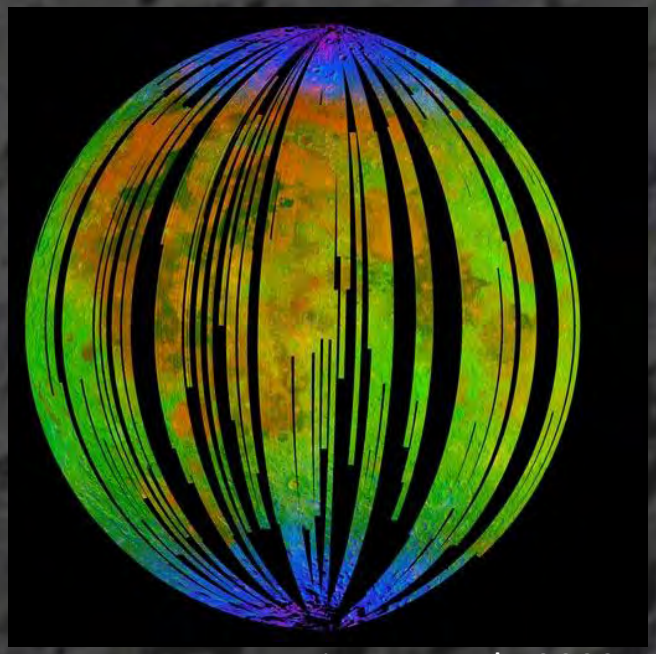


LCROSS NR

And then there's the water…

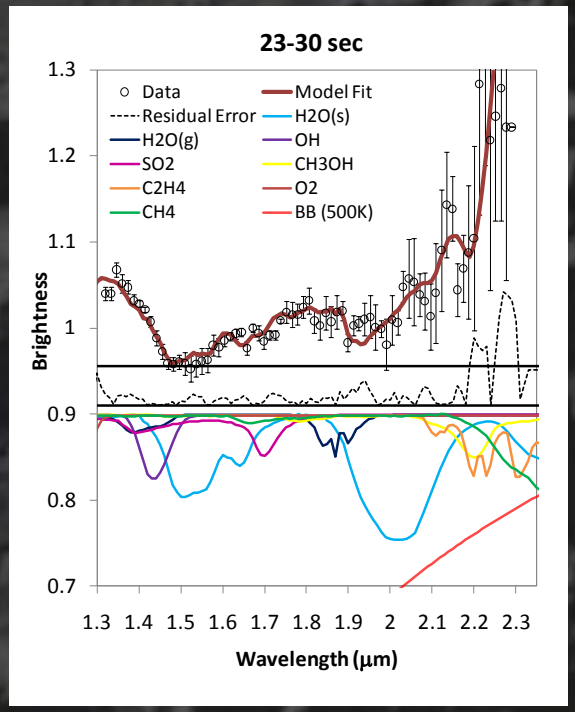
A range of forms, distributions and concentrations

~0.1-1%



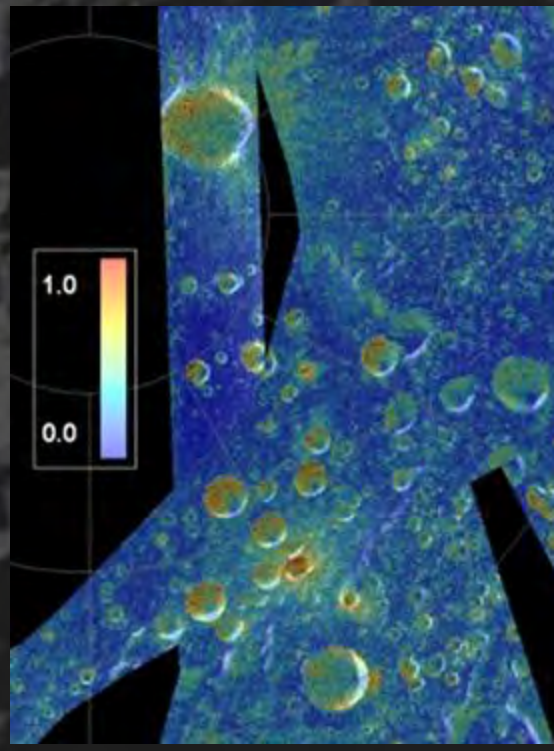
Pieters et al., 2003

~1-10%



Colaprete et al., 2010

~10-100%



Spudis et al., 2010

How are they related? How are the poles communicating with the rest of the Moon?

The Beginnings of a new Understanding

- The moons poles are more extreme than imagined
- New topographic data sets reveal craters who's rim-to-floor extent could swallow the tallest terrestrial mountains
  - Provide a new framework and context for geophysical and climate studies
- PSR temperatures cold enough to freeze out many types of volatiles
  - Suggest extended regions of water stability below the near surface
- Water forms, distribution and concentration as variable as anything else on the moon

The Beginnings of Exploration

The moons poles have all the necessary resources and environments for sustained exploration:

- Oasies of volatiles?
  - Potentially access to volatiles without going into permanent shadow?
- Regions of near constant sunshine
  - Power and thermal stability
- All this within ~50 km of each other
- Representative of other airless bodies?
  - The revolution spreads!