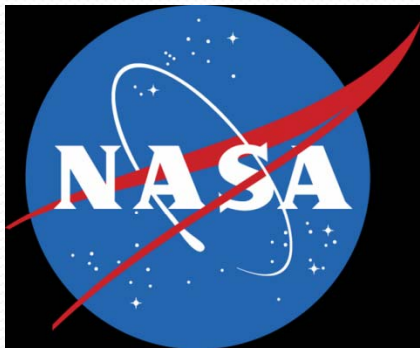


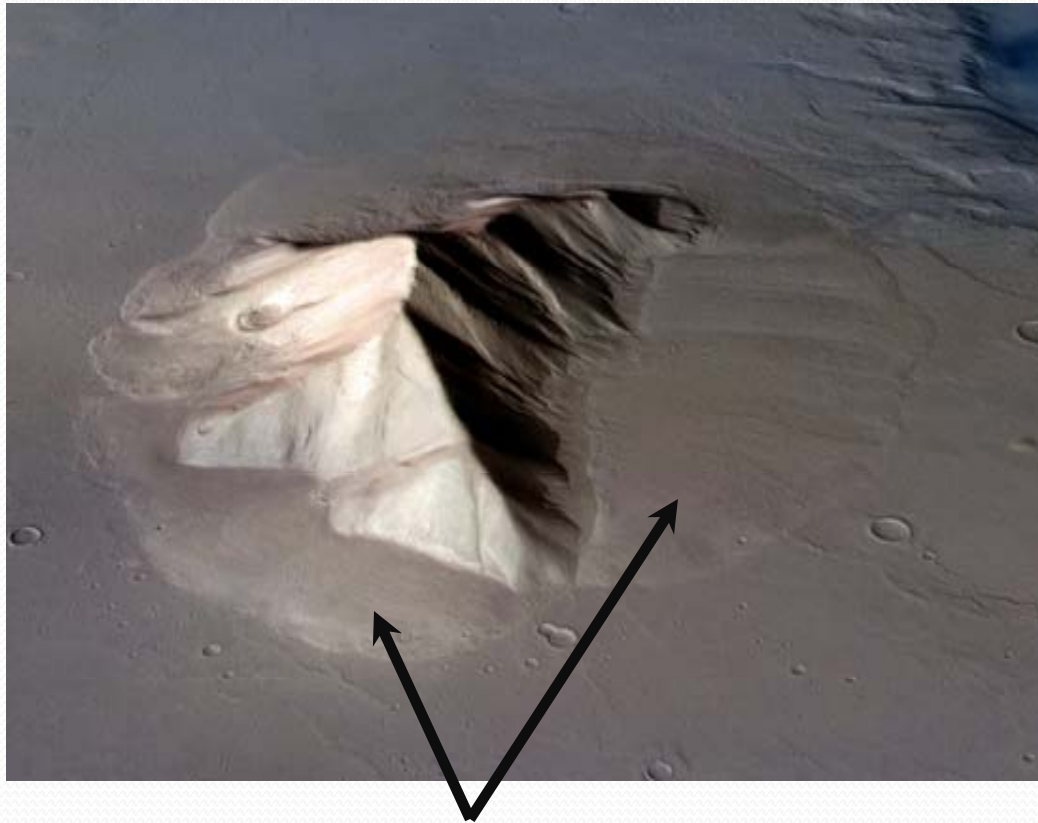
Neutron evidence of ice in Mars mid-latitude Lobate Debris Aprons (LDA)

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Goddard Space Flight Center,
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July 15th, 2009



Lobate Debris Aprons (LDA)



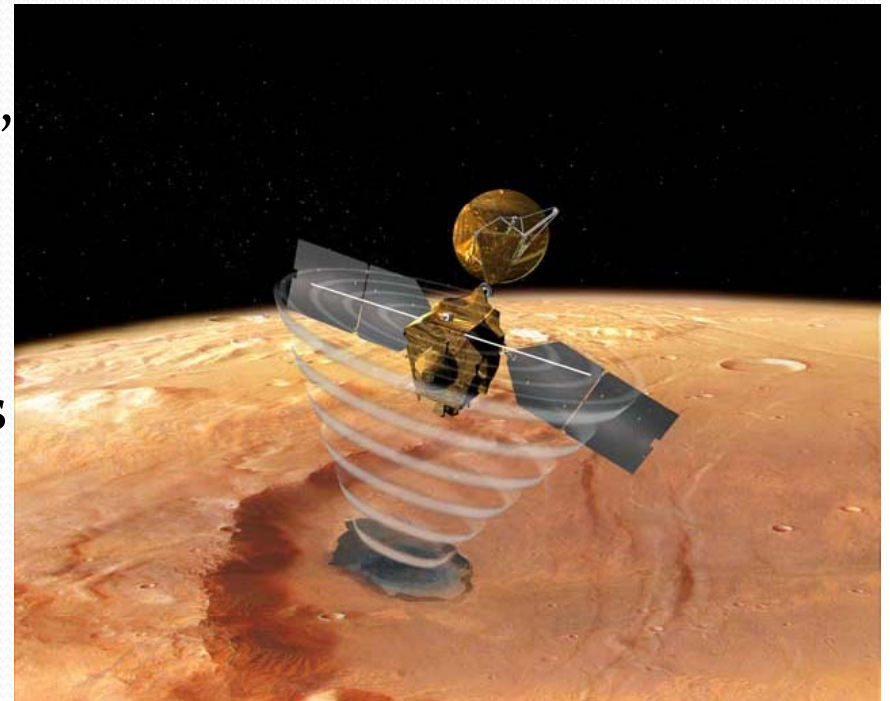
Lobate means lobe-like.

Lobate Debris Apron around mid-latitude Massif from Mars Express High Res. Stereo Camera (40.6 S, 103 E)

Mars Reconnaissance Orbiter, Shallow Subsurface Radar Detector

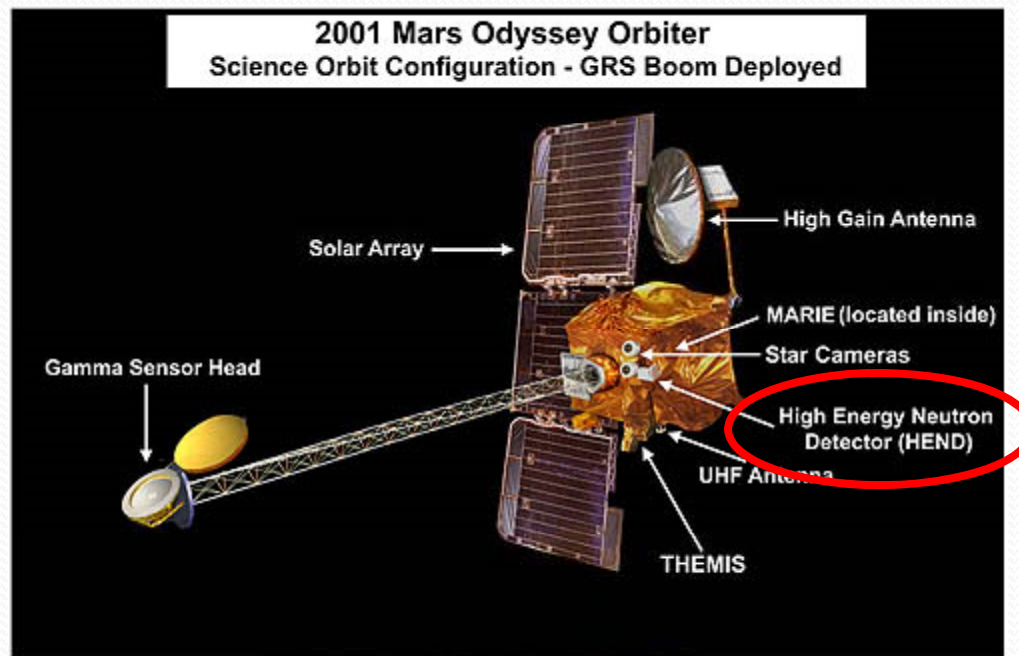
Mars Reconnaissance Orbiter (MRO),
Shallow Subsurface Radar Detector
(SHARAD) makes putative detection
of subsurface water ice in Mars
mid-latitudes ($S 42^{\circ}, 103^{\circ}$) near Helles
(Holt et al, Science December 2008)

Does NOT provide geochemical information.



Mission:

- Use neutron data from the High Energy Neutron Detector (HEND) to find geochemical evidence of subsurface water in mid-latitude LDAs.



HEND is a precursor to LEND.

The Moon, Mars and Beyond

Lunar Exploration Neutron Detector

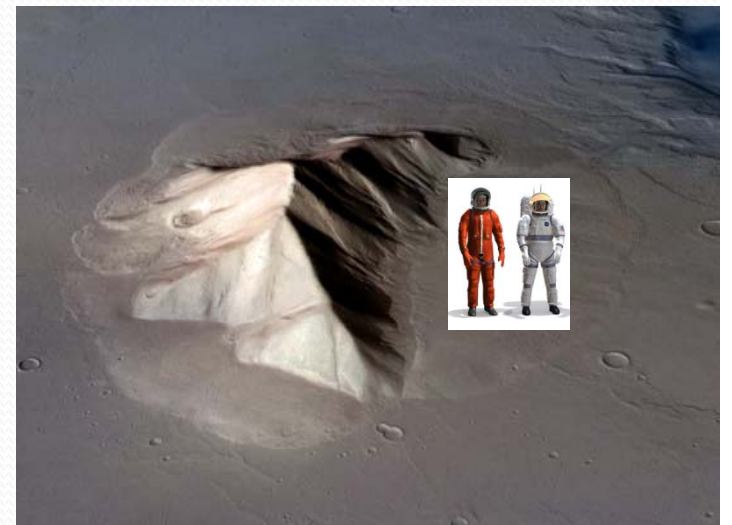
Manned mission to the Moon
by 2020.

Prepare for manned mission to Mars.



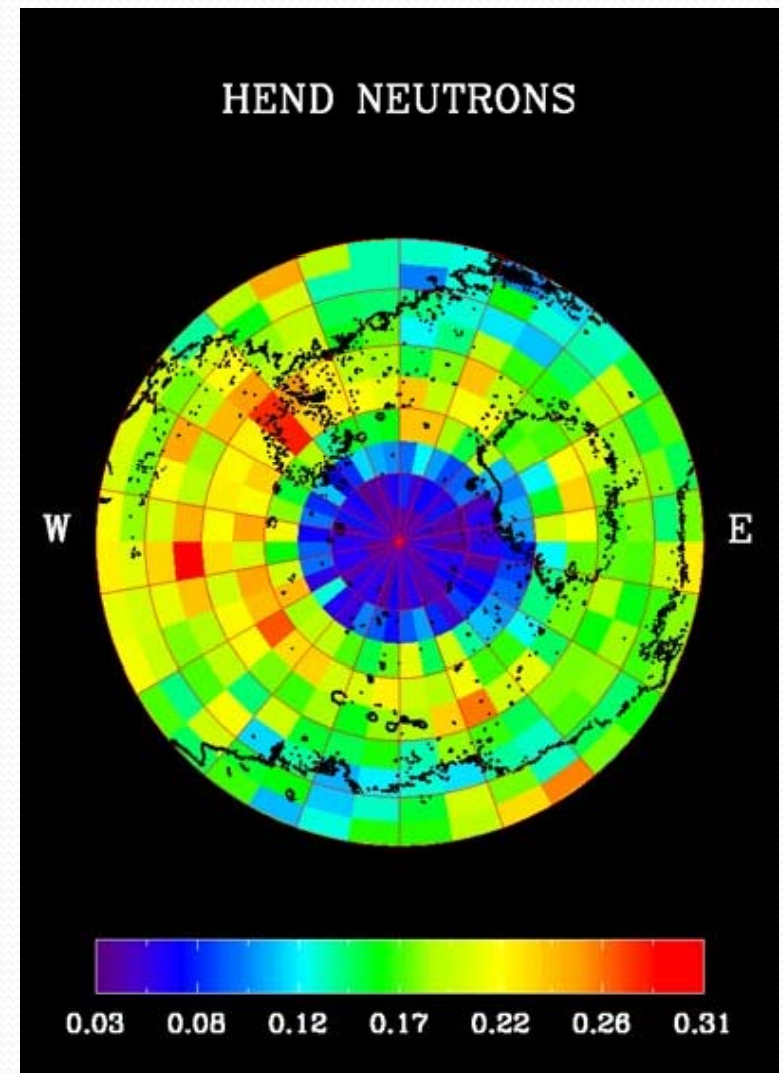
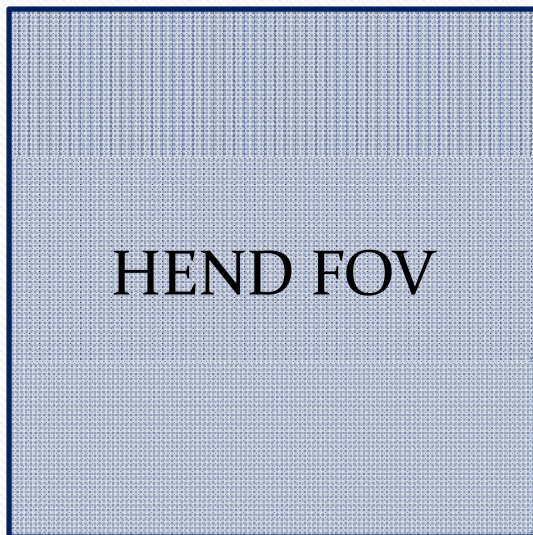
Significance

- Validate previous research.
- History of water on Mars.
- Targets for future landing missions.
- Analyze for biomarkers.
- Use as a resource.

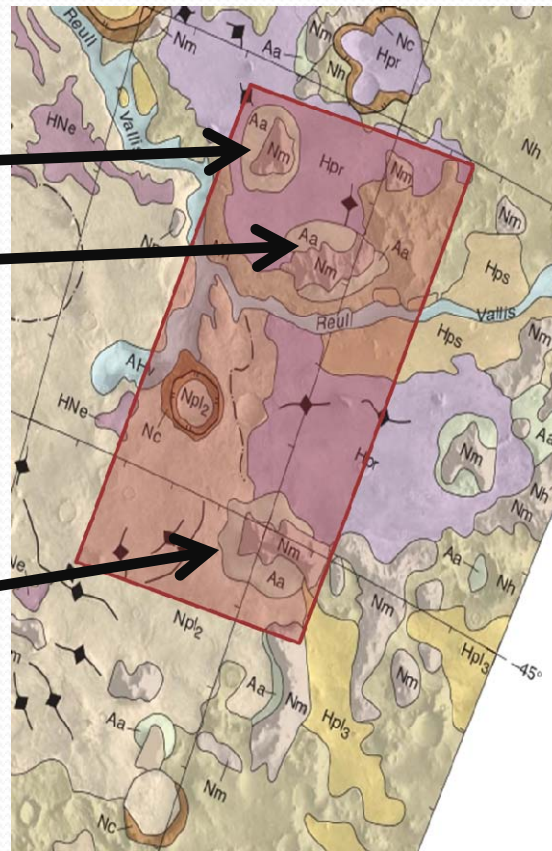
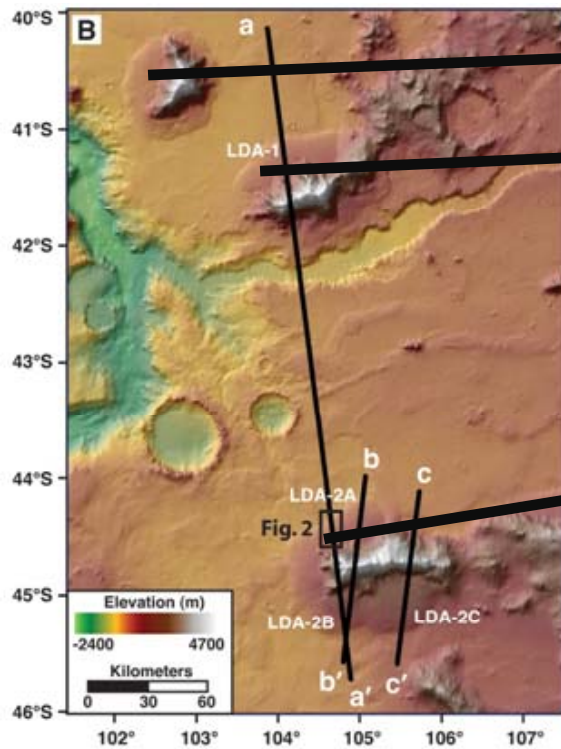
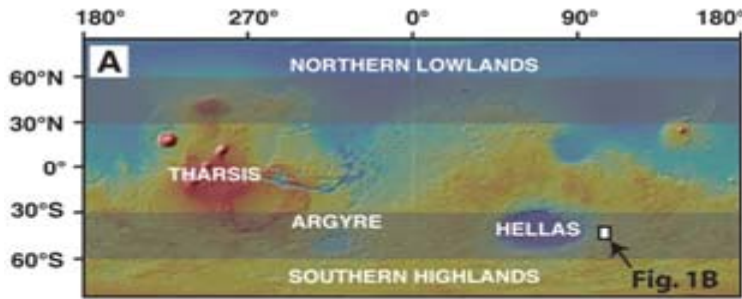


Issues:

- Water ice possibly below effective range to influence epithermal neutron emission.
- HEND field of view
FOV \gg size of single LDA



Study Region: Reull Vallis (East of Hellas)



Holt et al studied the same region using the SHARAD instrument in 2008.

Holt et al, Science 2008





USGS Astrogeology: Aa = Lobate Debris Aprons

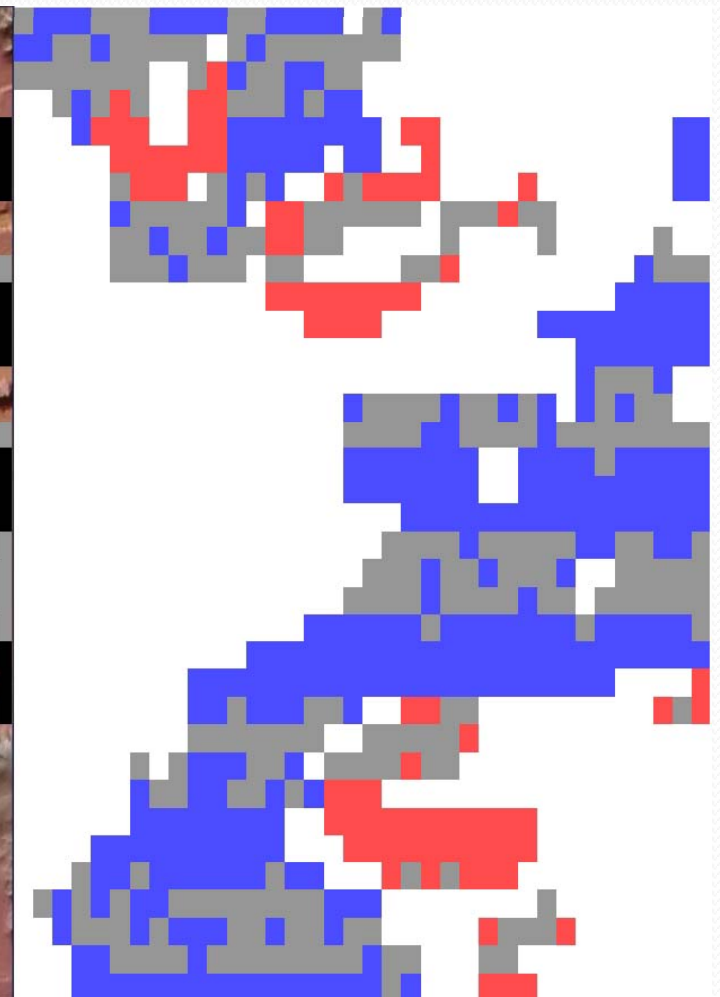
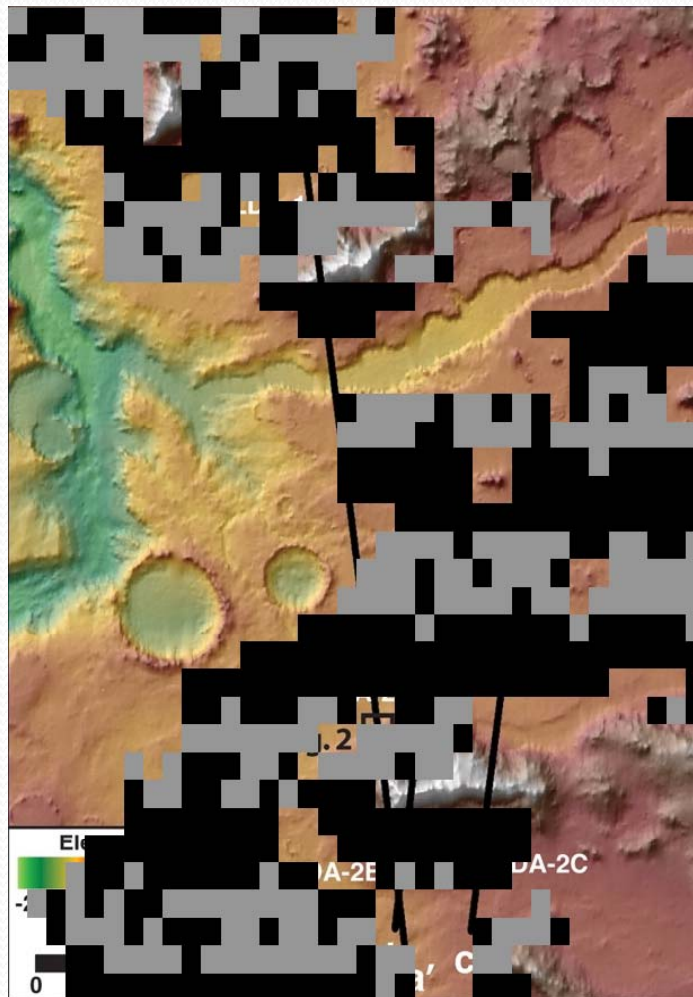


Approach:

- **Compare the neutron count from multiple LDAs to the neutron count from a dry background.**
 - Define LDA region as a set of 10 km² pixels
 - Define background as a 2nd set of pixels
 - Integrate 7+ years of HEND data
 - Perform Hypothesis testing

Manual pixel selections

-  Valid pixel
-  Invalid pixel
-  LDA
-  Background





Hypothesis Testing

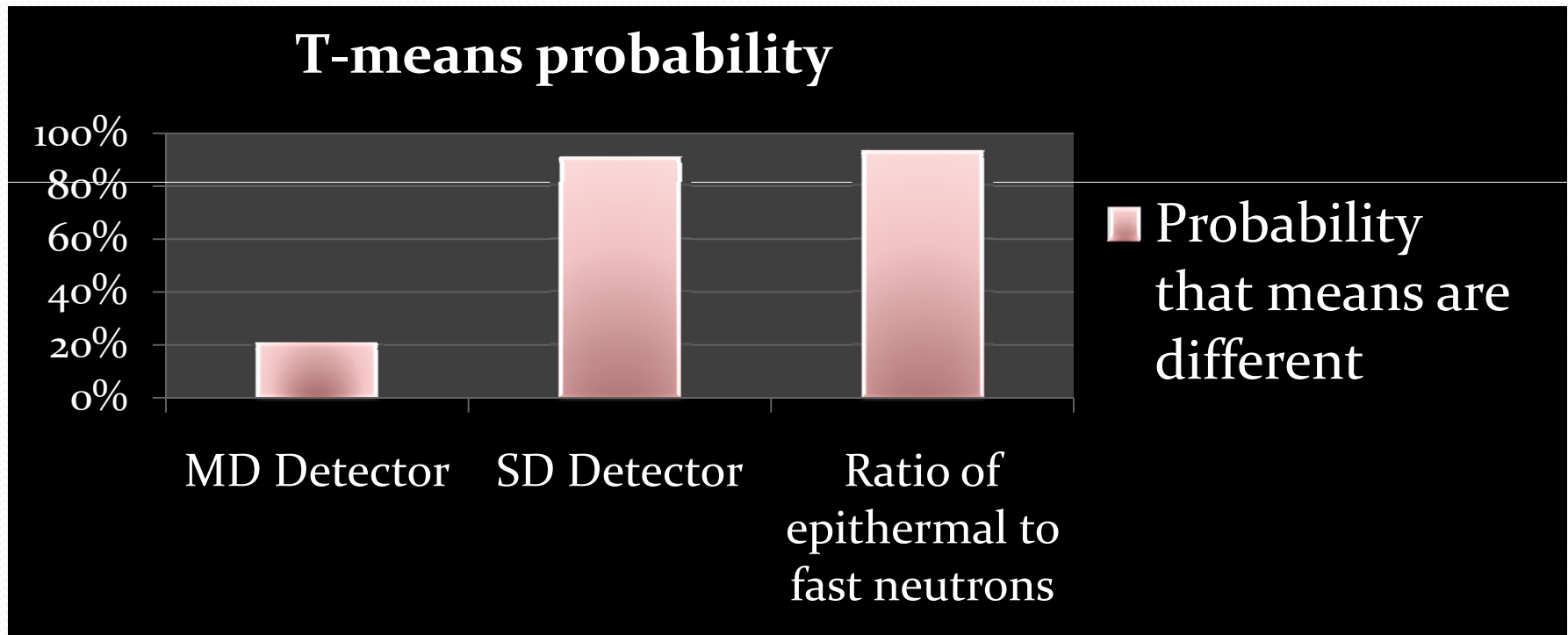
- T-means test
 - Indicates if **means** of two data sets are statistically different.
- F-variance test
 - Indicates if the **variances** of two data sets are statistically different.

High Energy Neutron Detector, HEND

- Five energy ranges:

- Small Detector (SD): 0.4 eV -- 10 eV
 - Medium Detector (MD): 0.4 eV -- 100 keV
 - Large Detector (LD): 10eV – 1 MeV
- } Epithermal Neutrons
-
- Inner Scintillator Low: 1 MeV – 2.5 MeV
 - Inner Scintillator High: 2.5 MeV – 10 MeV
- } Fast Neutrons

Results



Given sample distributions:

If you reject the Null Hypothesis:

i.e. Decide means are different - You will be correct 93% of the time.

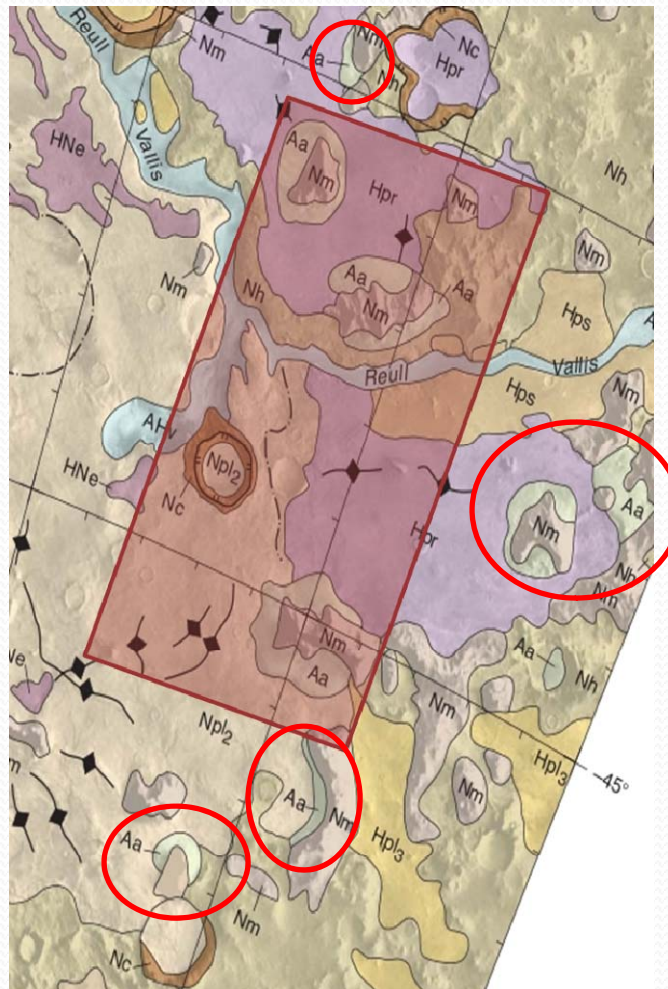


Future Work

- Study the mapping issue
- Extend the study region to include more LDA's, thereby increasing the statistical significance.

Future Study Region

Include up to
5 more LDAs



USGS Astrogeology: Aa = Lobate Debris Aprons



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