

A THEMIS Spectral Index for the Detection of Phyllosilicates on Mars

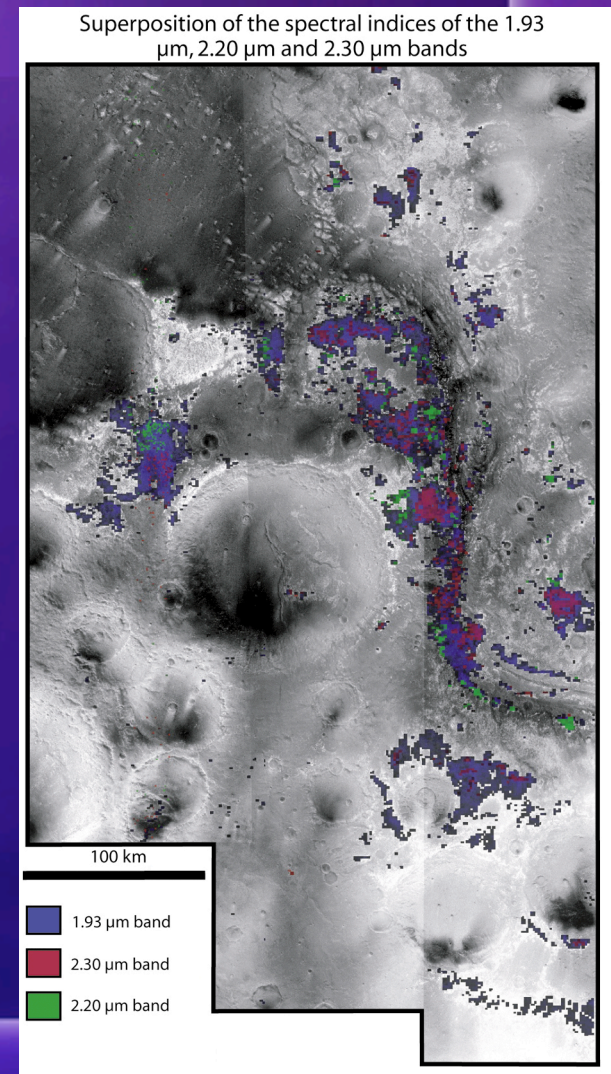
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Background: Detection of phyllosilicates on Mars

- *OMEGA and CRISM discovered and mapped mineralogically diverse, localized phyllosilicate deposits in the near-infrared (e.g. Poulet et al. 2005, Bibring et al. 2005, Mustard et al. 2008, Loizeau et al. 2007, Bishop 2008)*
- *Areas such as Mawrth Vallis, Nili Fossae, Syrtis Major, etc.*



Loizeau et al. 2007

Previous work in the thermal infrared

- *Linear deconvolution of TES spectrum*
(e.g. Banfield 2004, Wyatt and McSween 2002)
- *Michalski et al. (2006) found a spectral uniqueness for THEMIS phyllosilicates (Syrtis)*

Goals for this study

- *Utilize spectral uniqueness in the TIR to develop a phyllosilicate spectral index for THEMIS daytime IR images*
- *Eventually use this index to globally map phyllosilicates and extend current mapping regions*

Why do this?

- *THEMIS IR data provides the highest resolution global image coverage of Mars*
- *Mapping new regions*
- *Further constrain*
 - *the age of clay-rich deposits on Mars*
 - *environments of clay formation*
- *Potential for using linear spectral unmixing for quantitative clay abundance*

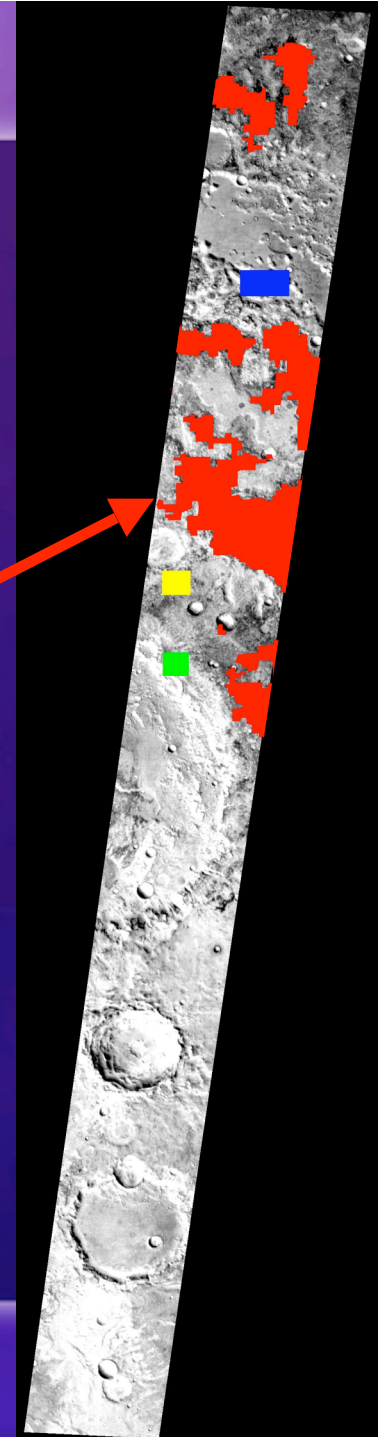
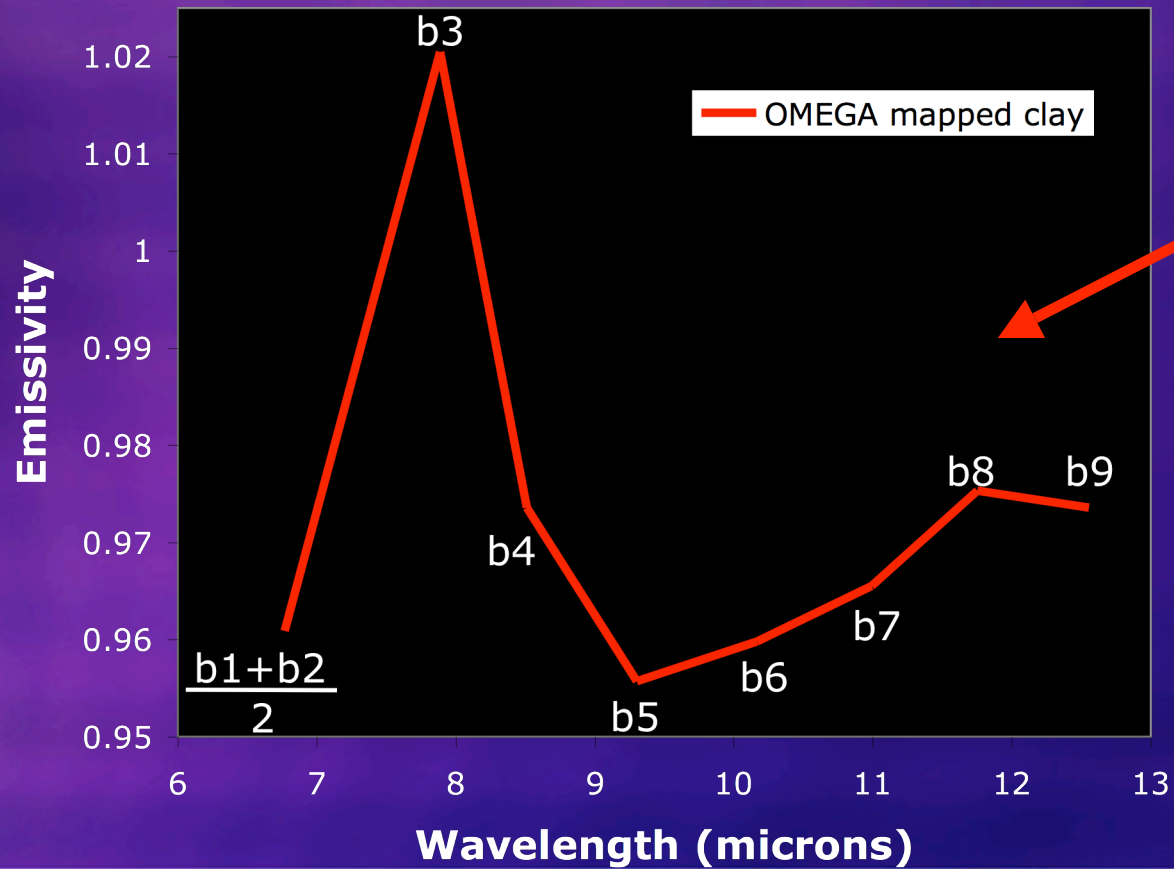
Approach

- *Compare THEMIS spectra on and off clay-rich regions (identified by OMEGA or CRISM)*
- *Develop THEMIS band ratios emphasizing spectral uniqueness*
- *Purely empirical based on spectral shapes in THEMIS data*

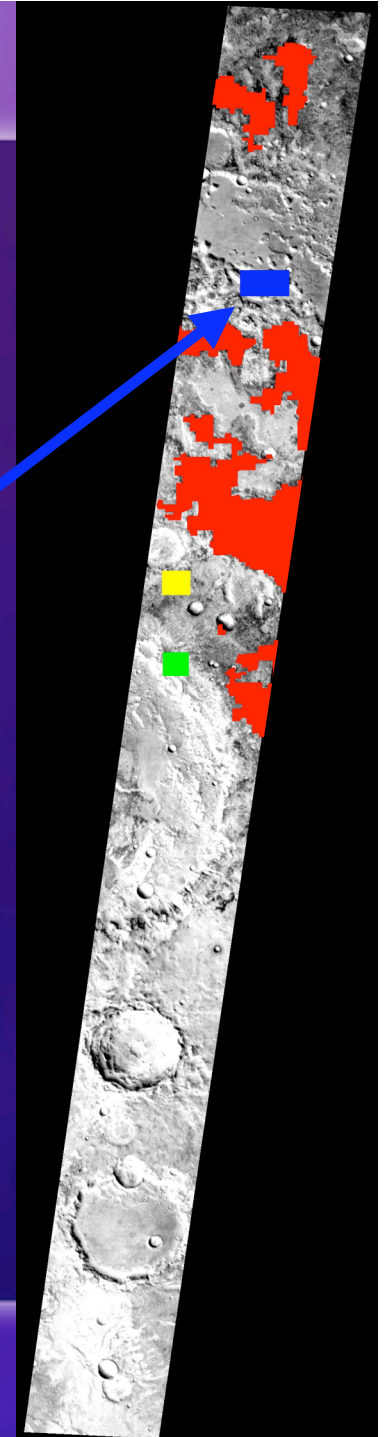
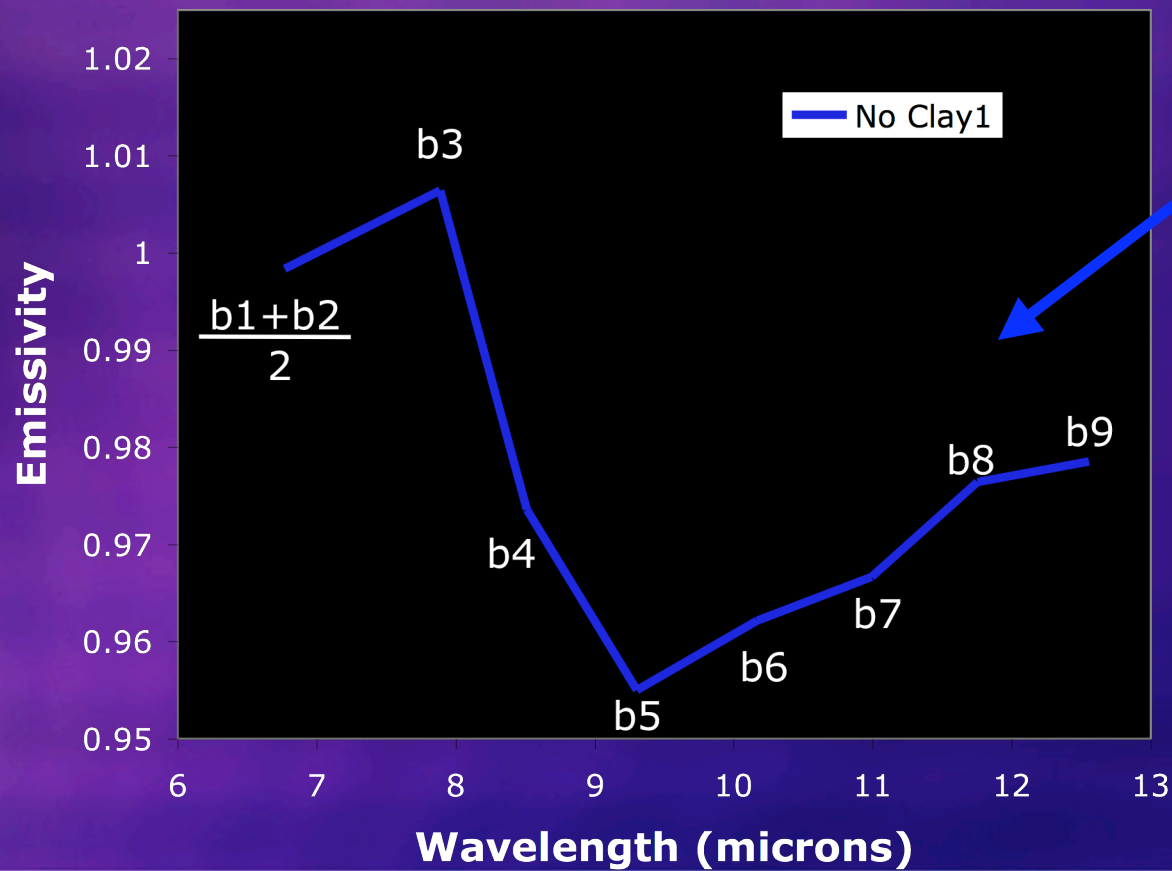
Method: Training Regions

- *THEMIS* daytime infrared images of *OMEGA*-identified clay-rich regions
 - *Mawrth Vallis*
 - *Nili Fossae*
 - *Syrtis Major*
 - *Ismenius Lacus*

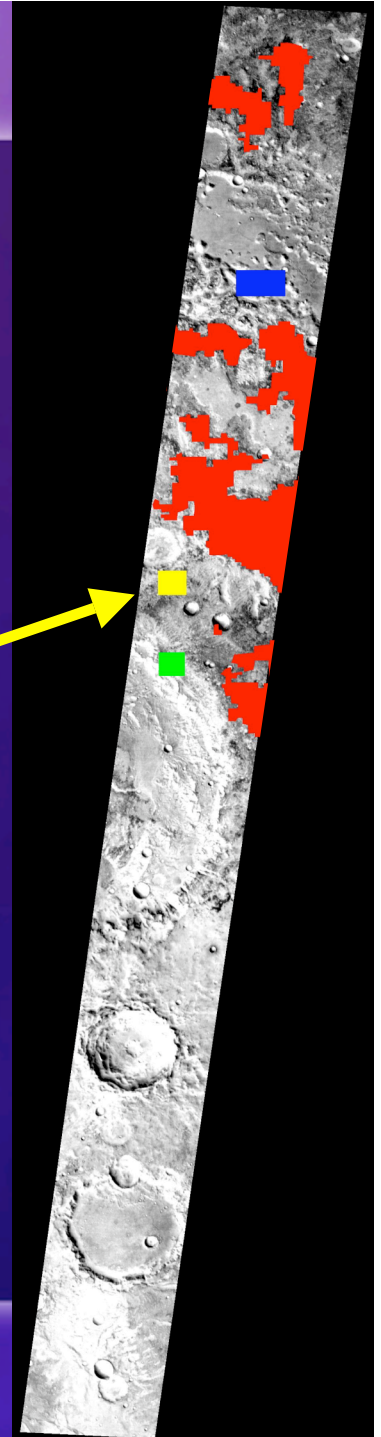
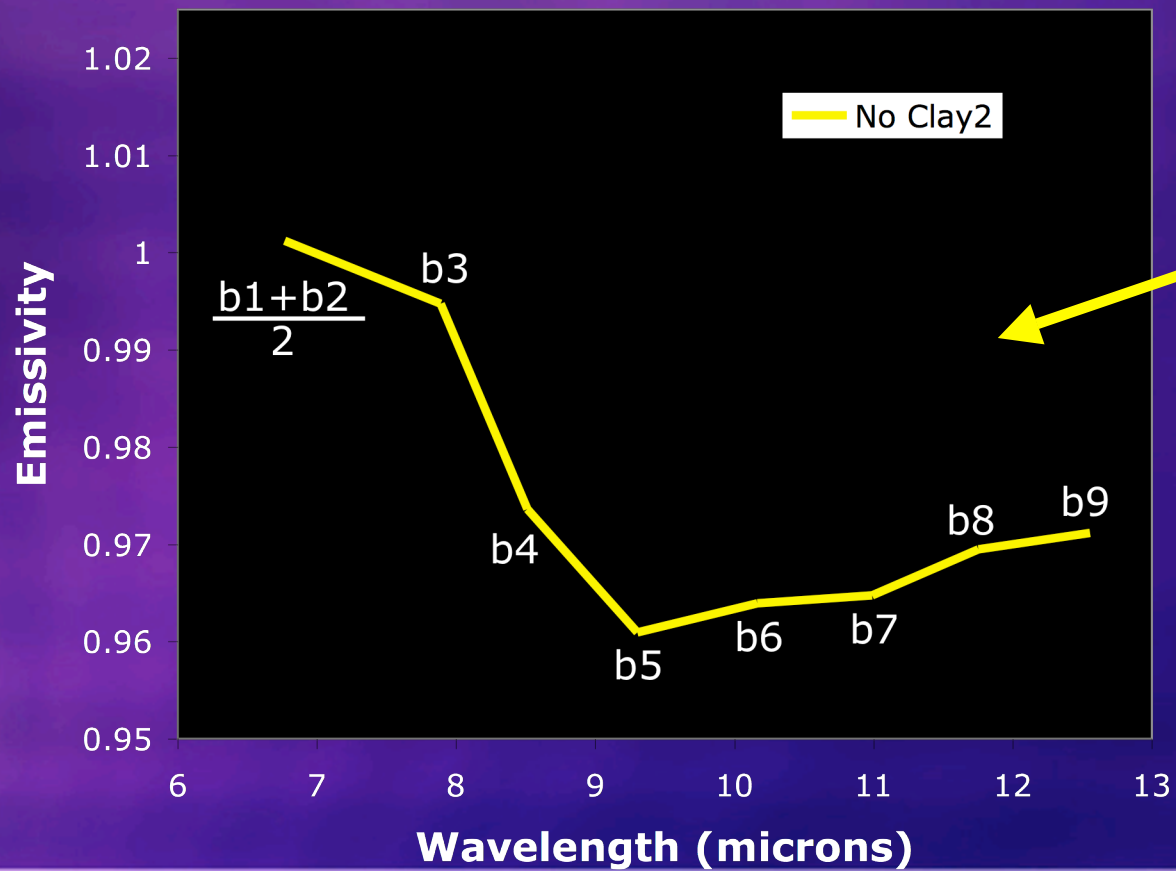
Developing the index



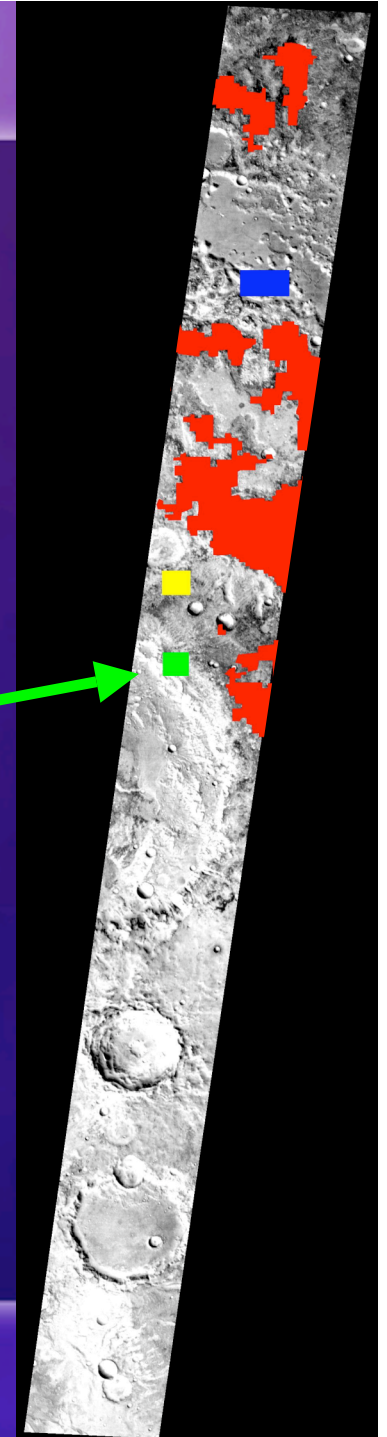
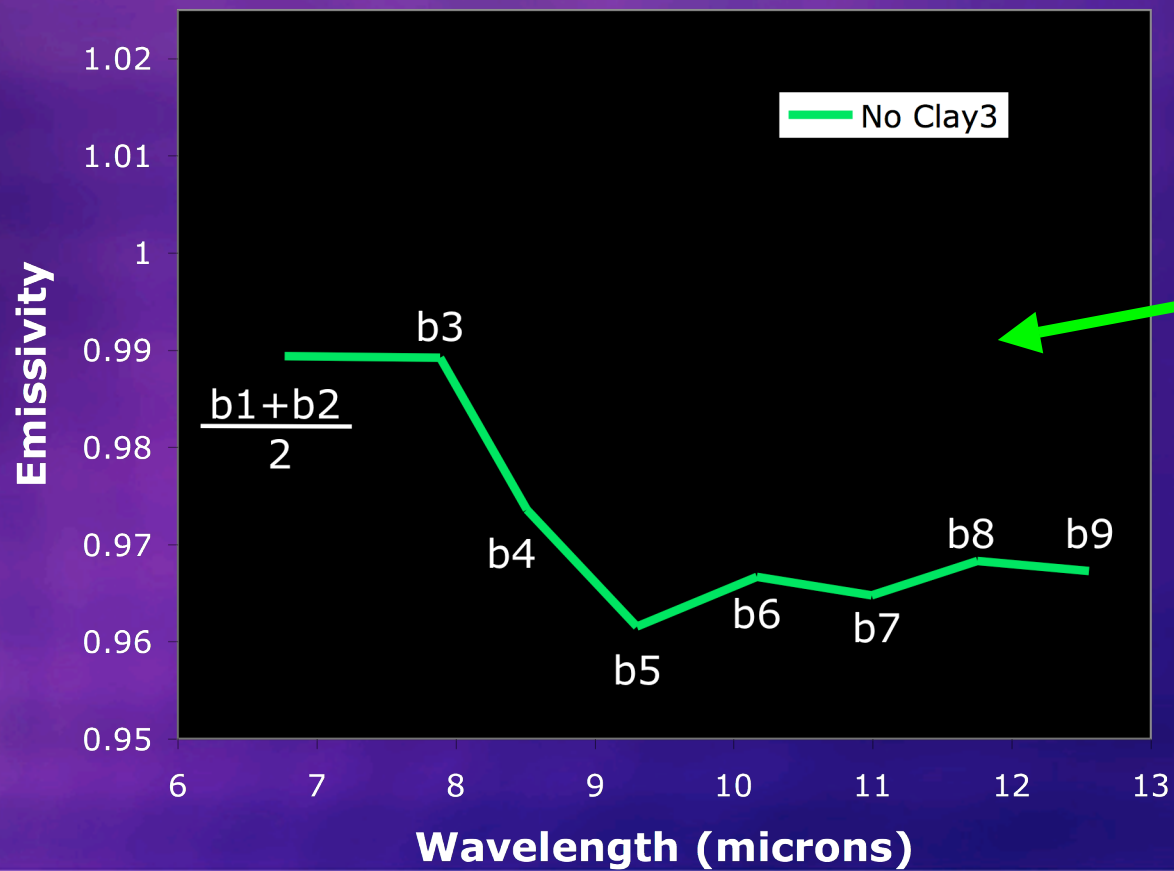
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Developing the index

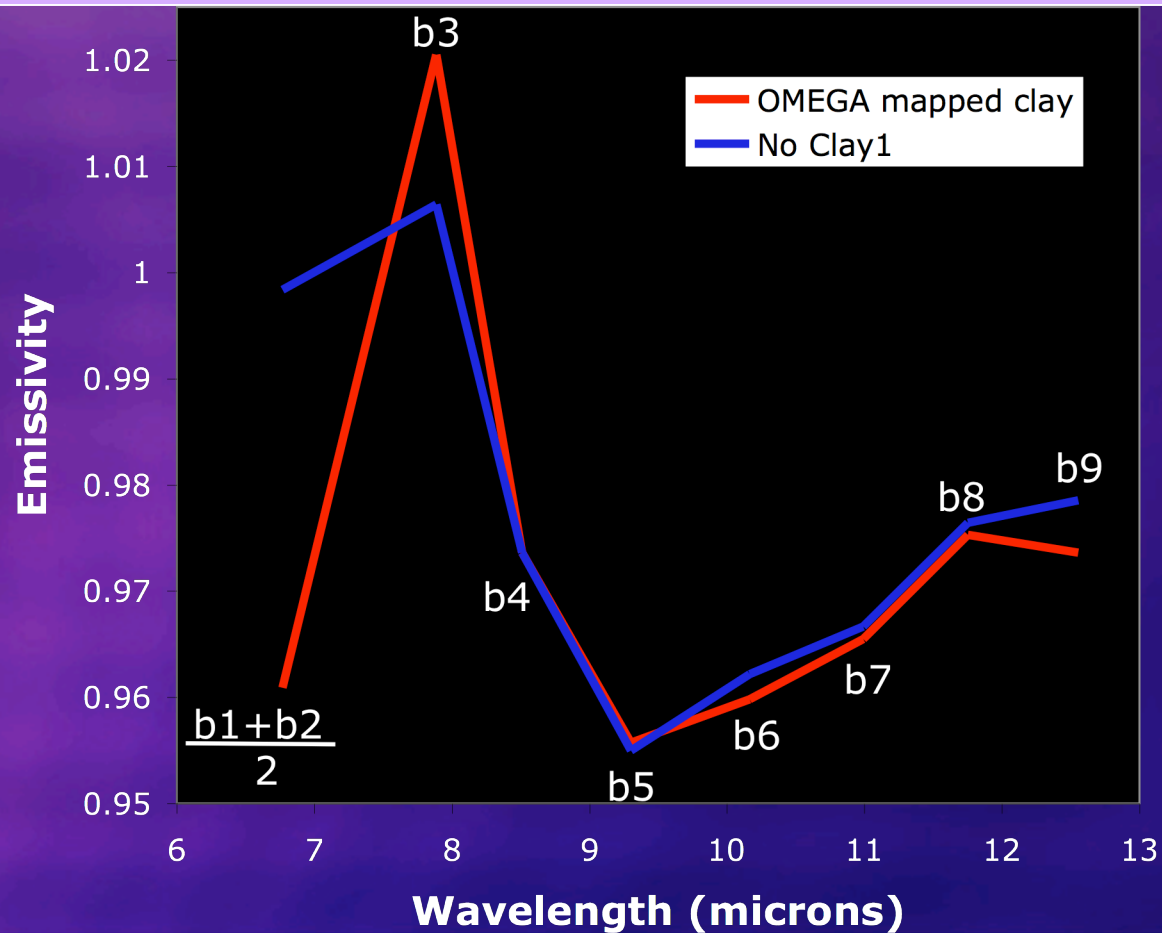


Developing the index



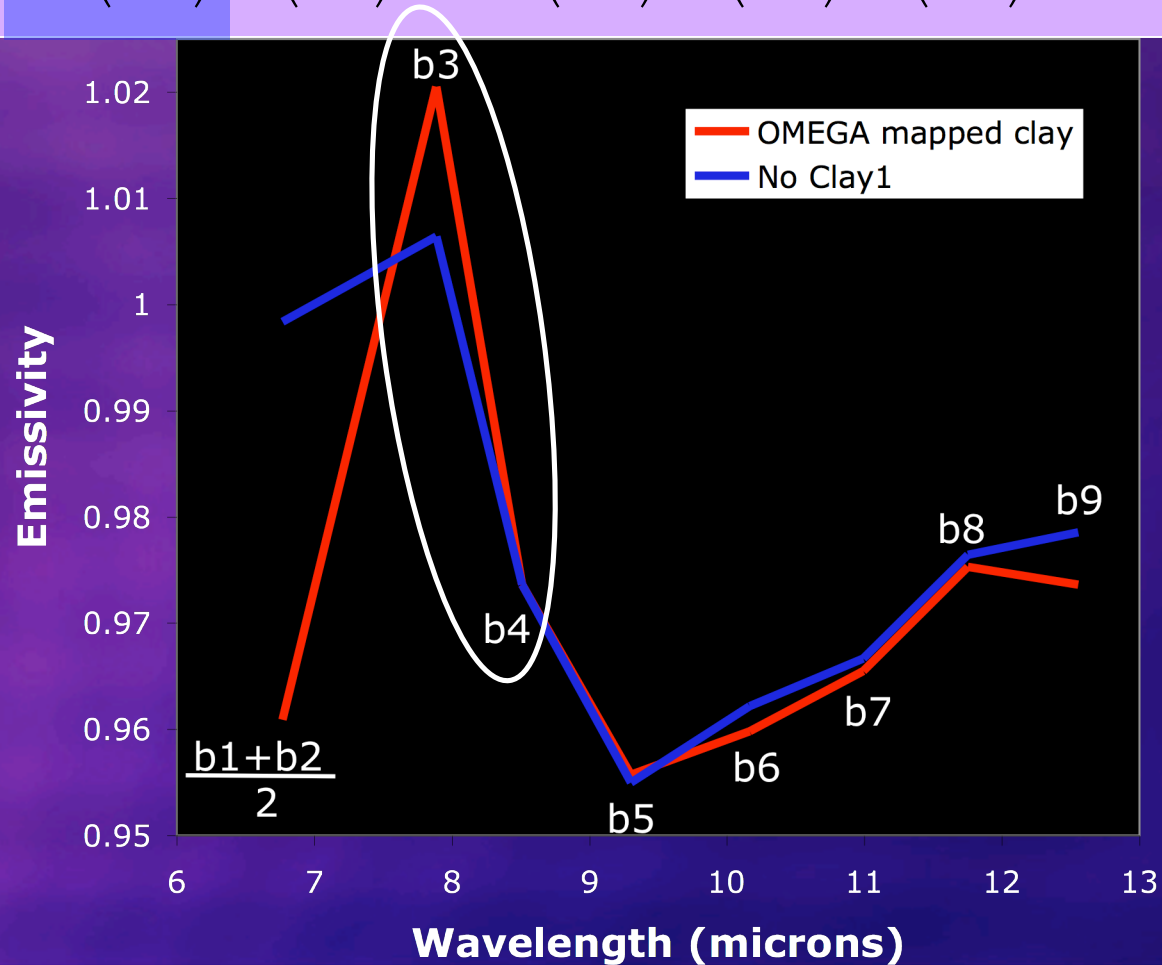
Deriving the index...

$$TPI = 2 * \left(\frac{b3}{b4} \right) + \left(\frac{b6}{b5} \right) + 3 * \left(\frac{b7}{b6} \right) + \left(\frac{b7}{b5} \right) + \left(\frac{b8}{b7} \right) + 2 * \left(\frac{b8}{b5} \right) + \left(\frac{b8}{b9} \right)$$



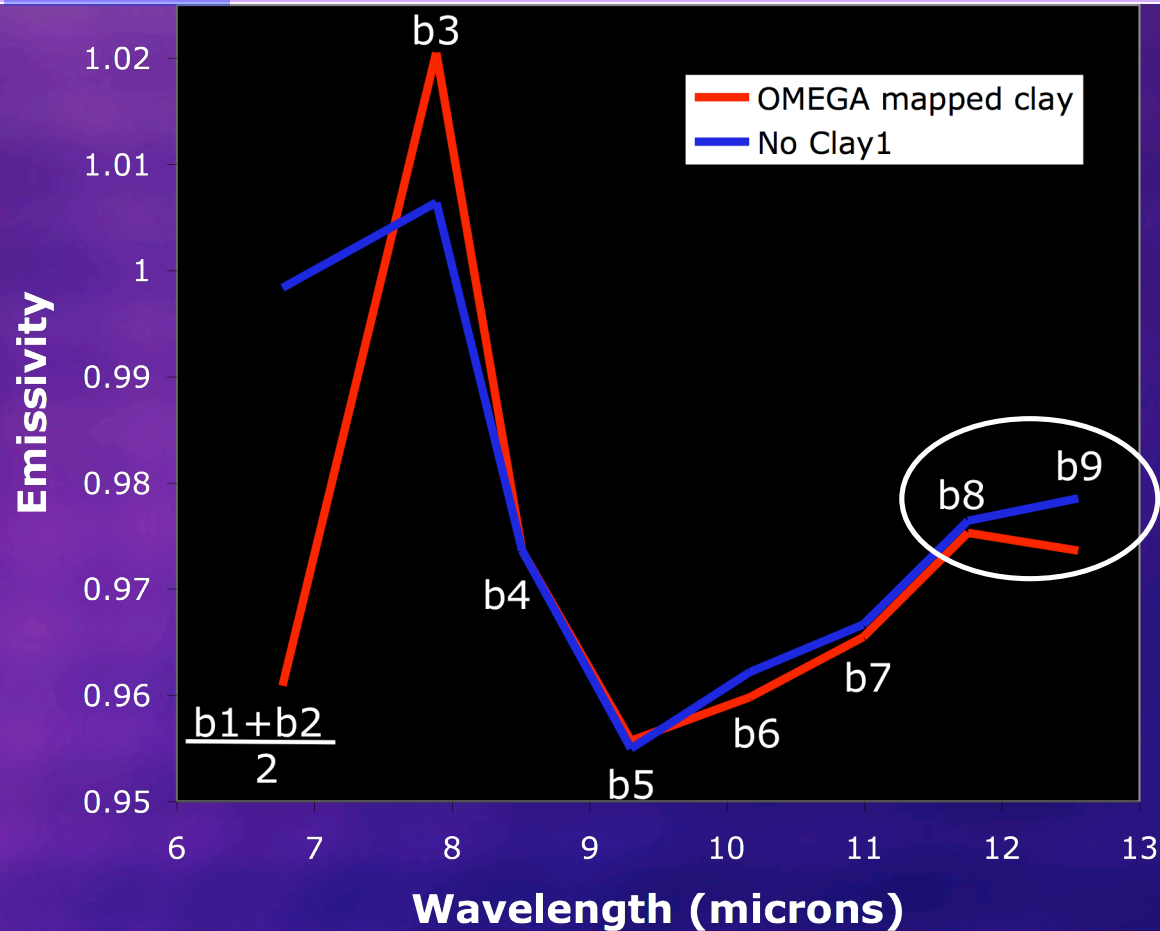
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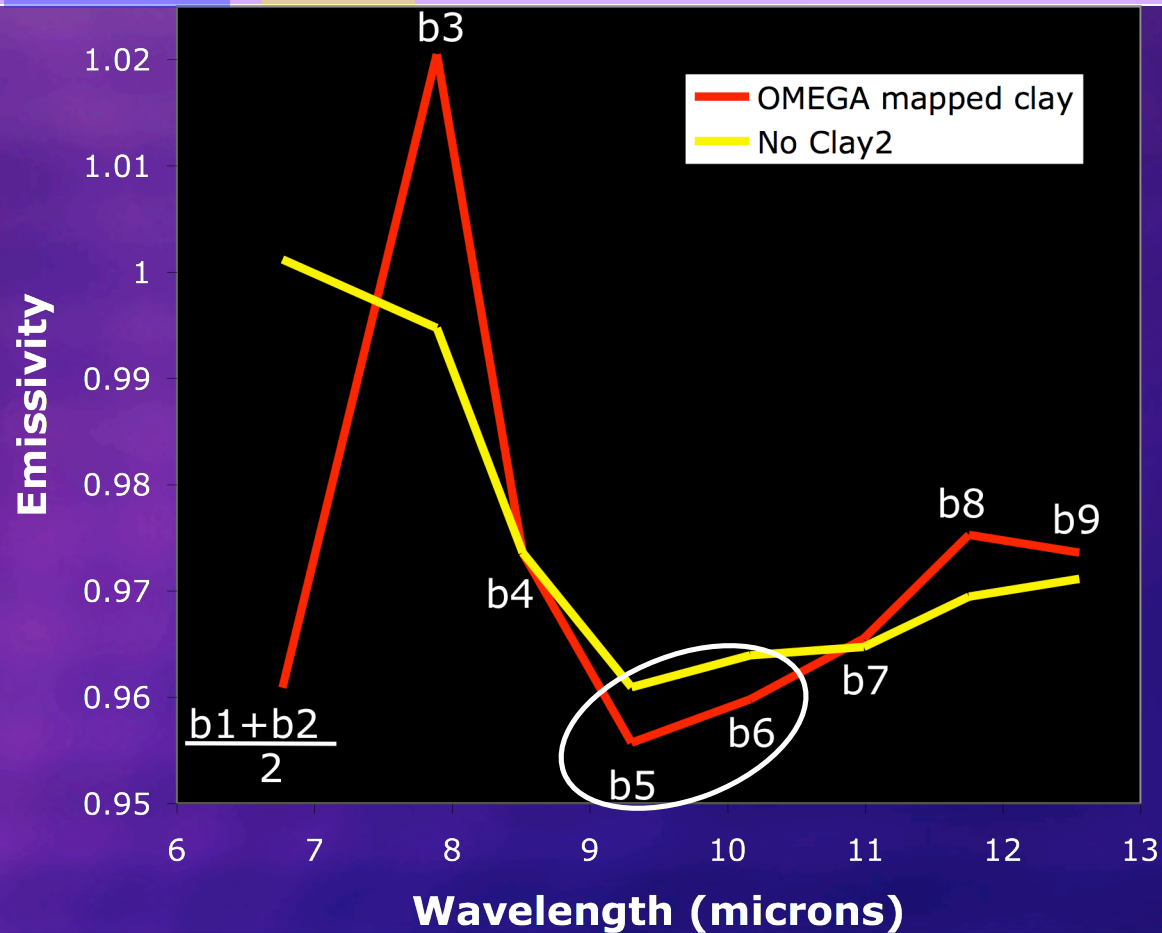
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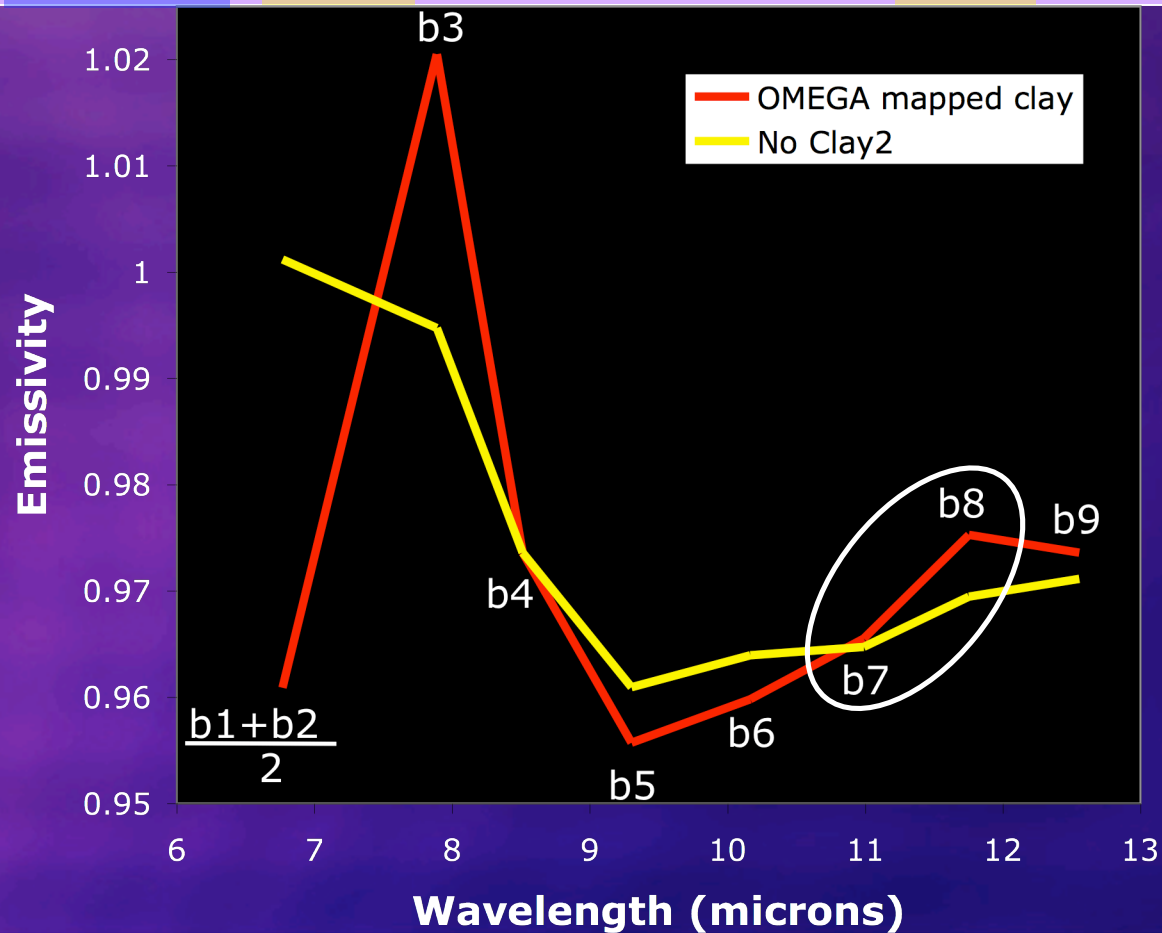
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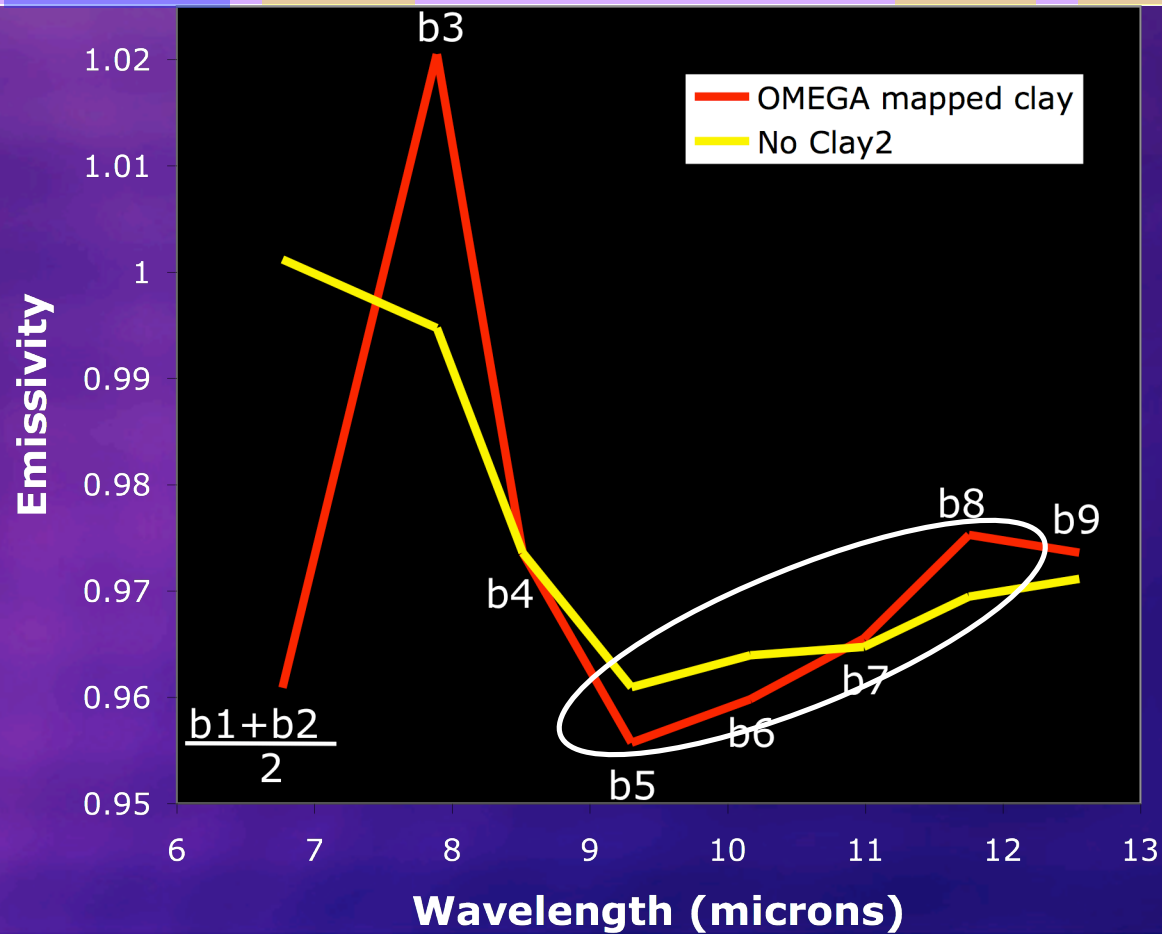
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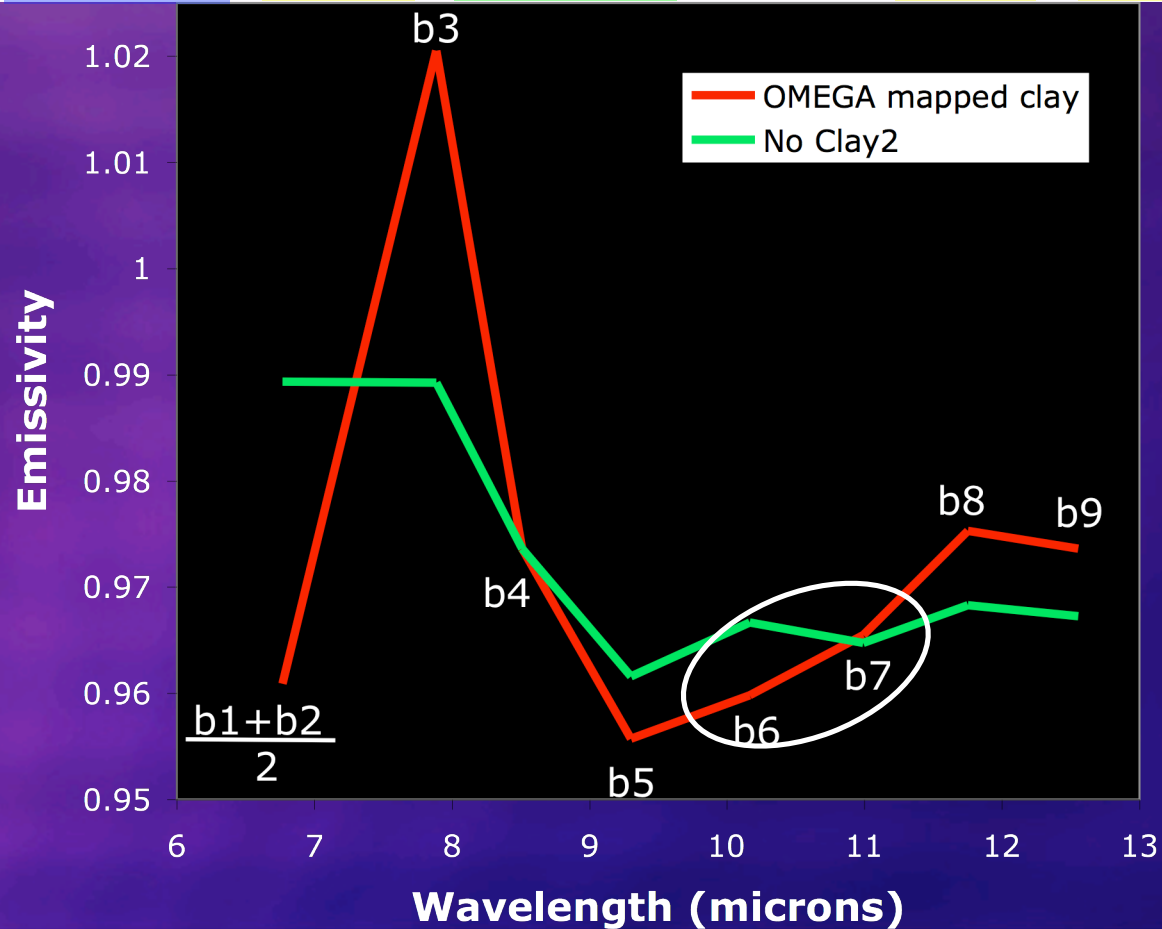
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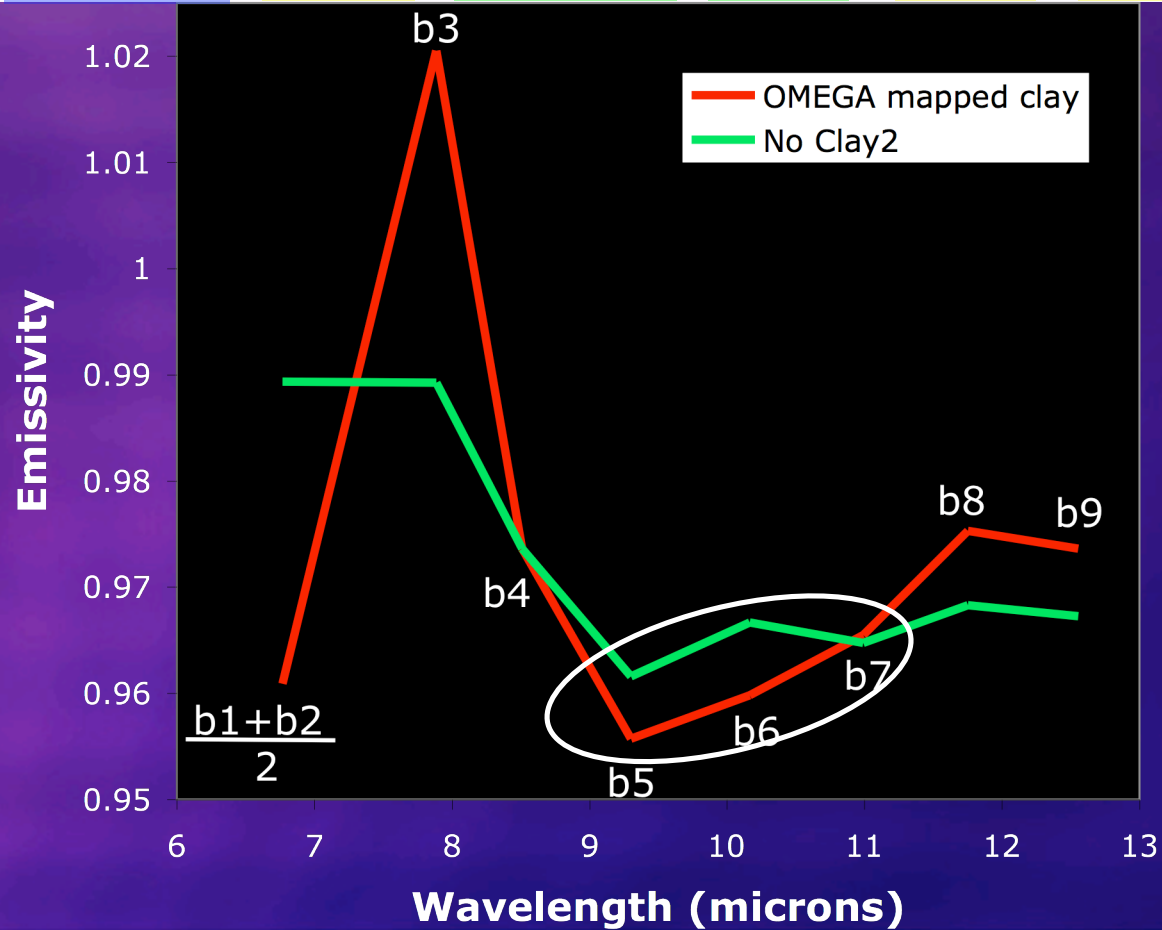
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Critical Values

- *TPI critical threshold >11.2*
- *Filtered out pixels < 240 K*
 - *Noise in shadowed regions*

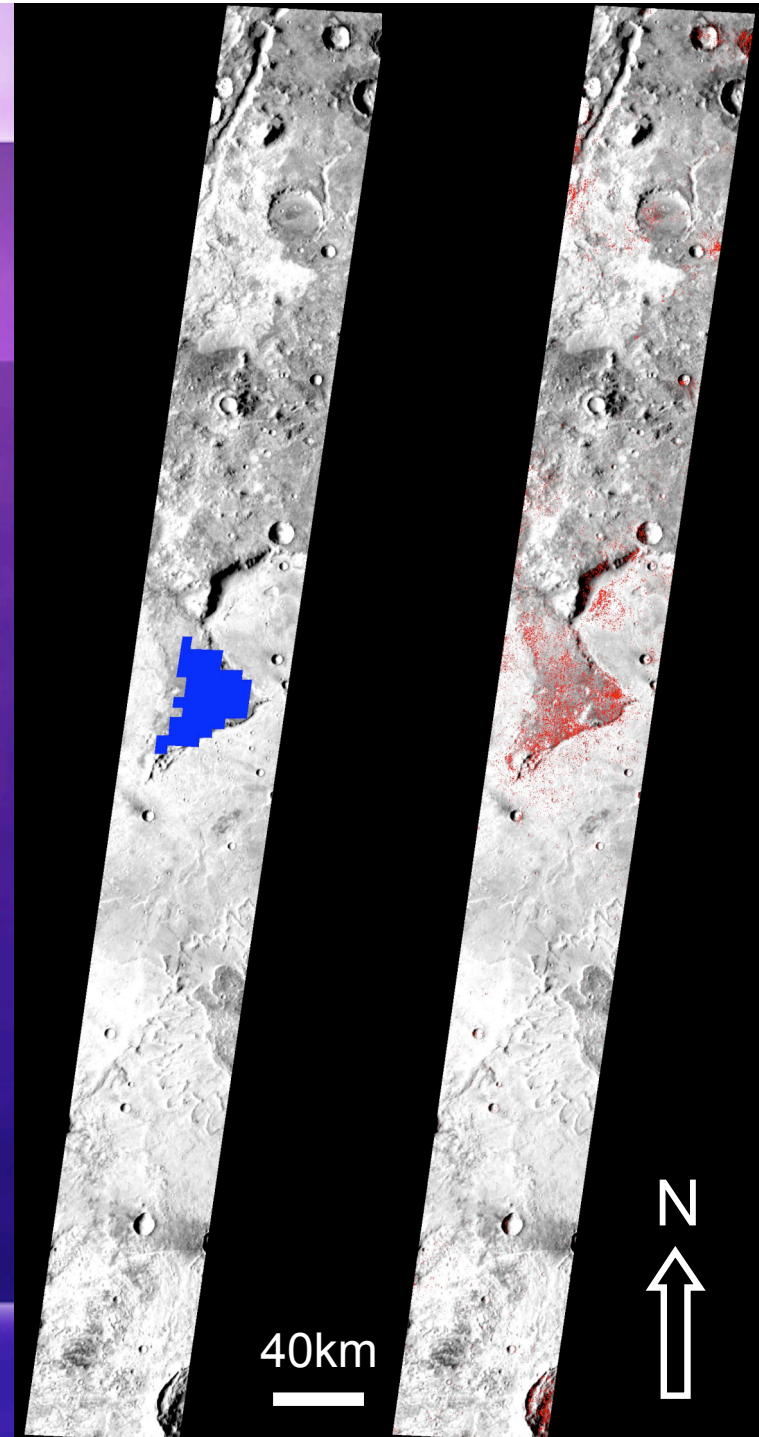
Results of the index...

Syrtis Major

- *Centered at*
 - $\sim 19^{\circ}45' N, 73^{\circ}1' E$

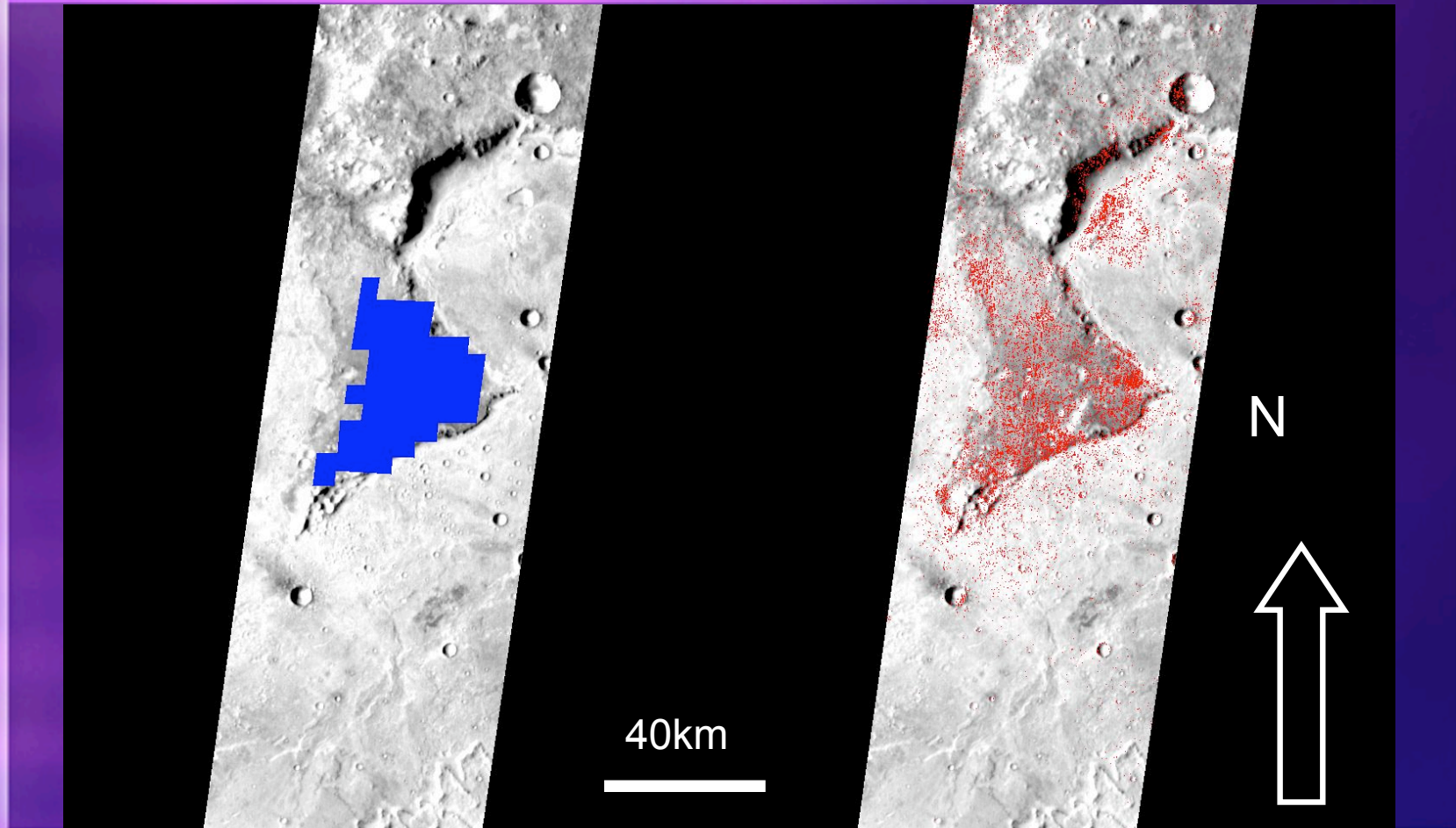
 *Poulet et al. 2005*

 *This study (TPI)*



Results of the index...

Syrtis Major



Poulet et al. 2005



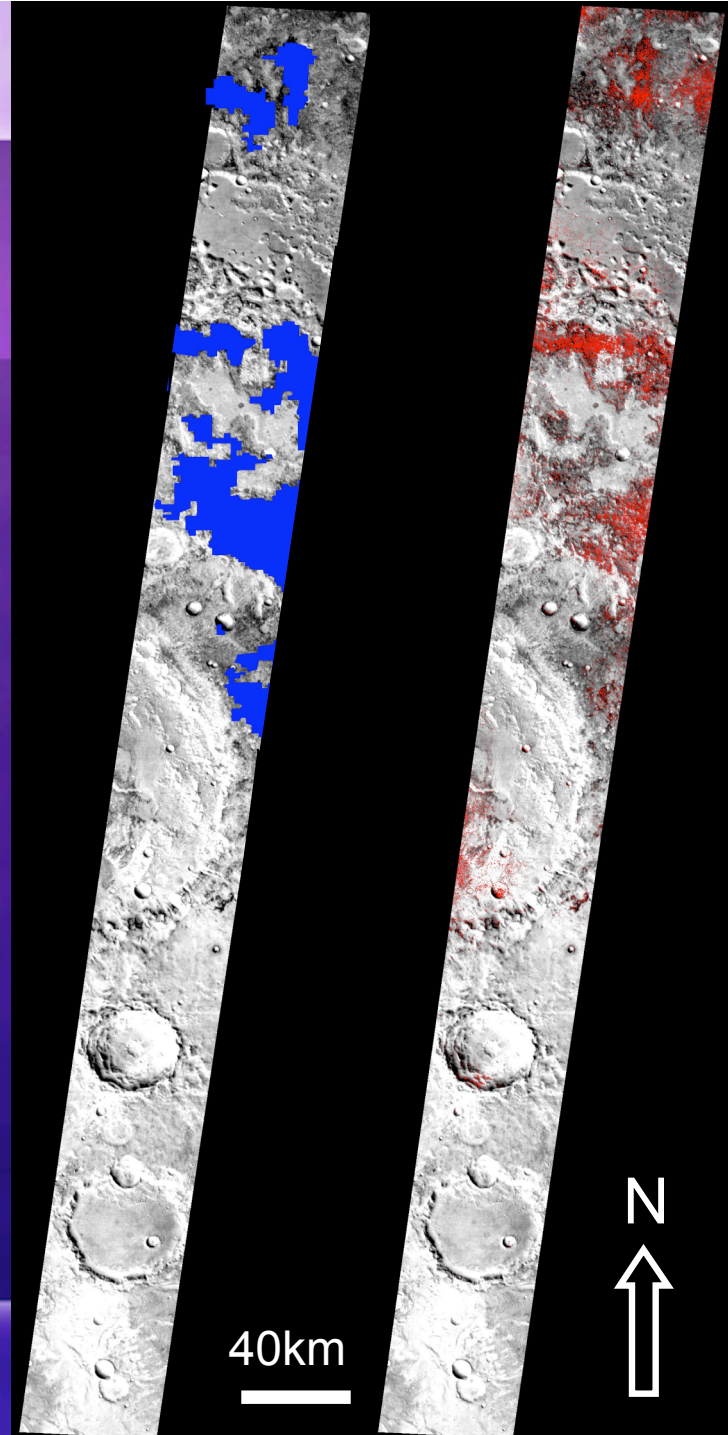
This study (TPI)

Mawrth Vallis

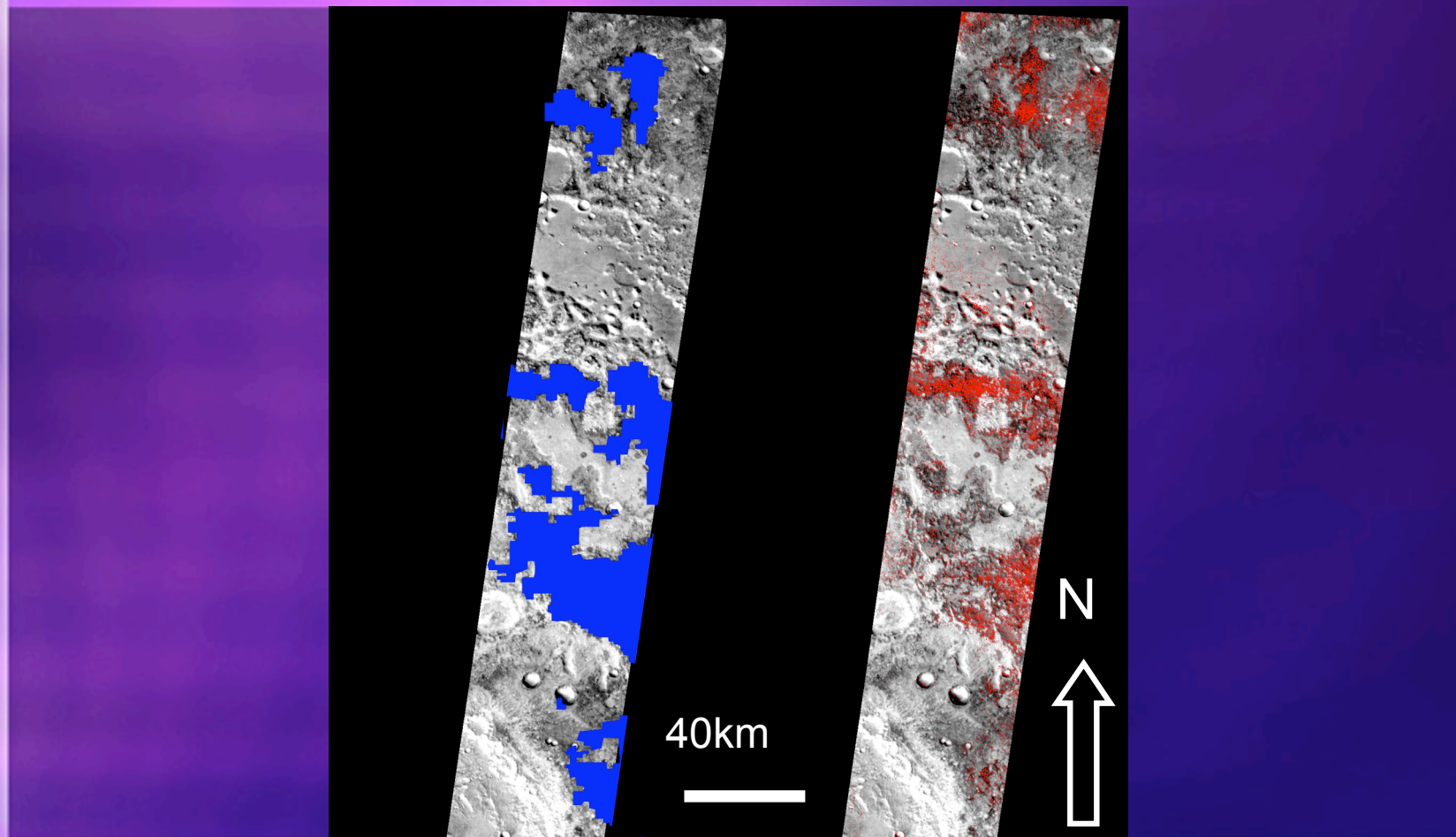
- *Centered at*
 - $\sim 24^{\circ}41' N, 340^{\circ}48' E$

 *Loizeau et al. 2007*

 *This study (TPI)*



Mawrth Vallis



 *Loizeau et al. 2007*

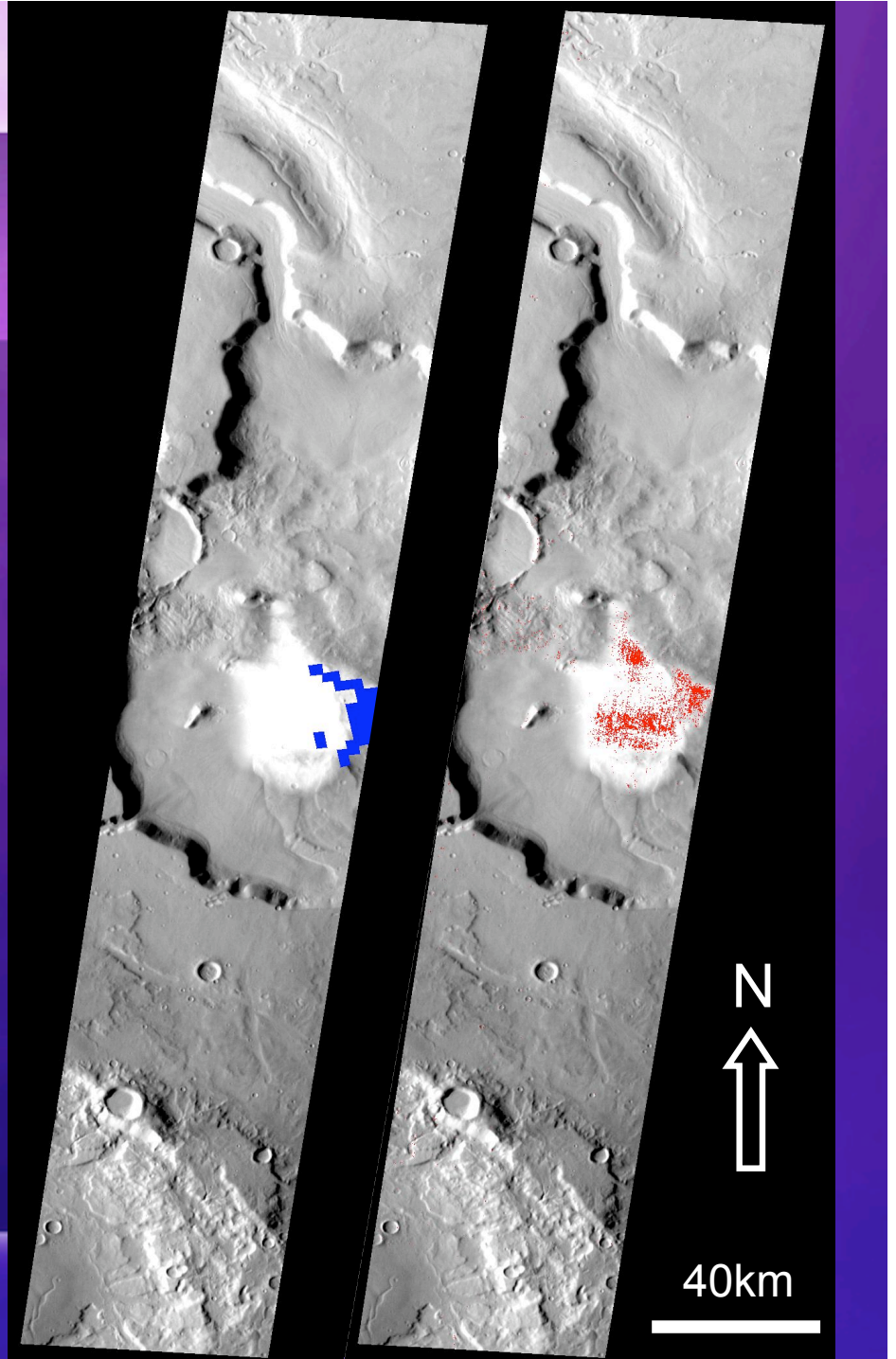
 *This study (TPI)*

Ismenius Lacus

- *Centered at*
 - $\sim 34^{\circ}10' N, 16^{\circ}57' E$

 *Poulet et al. 2005*

 *This study (TPI)*

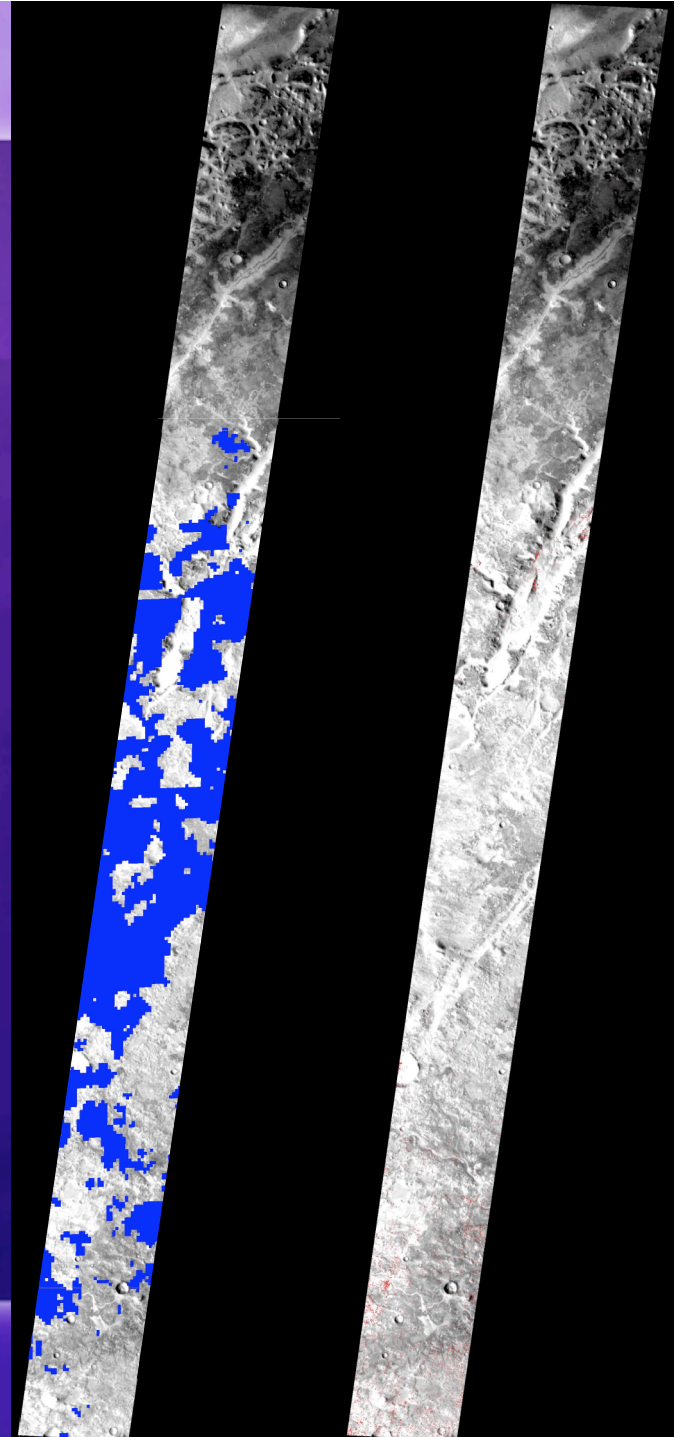


Nili Fossae

- *Centered at*
 - $\sim 21^{\circ}40' N, 77^{\circ}20' E$

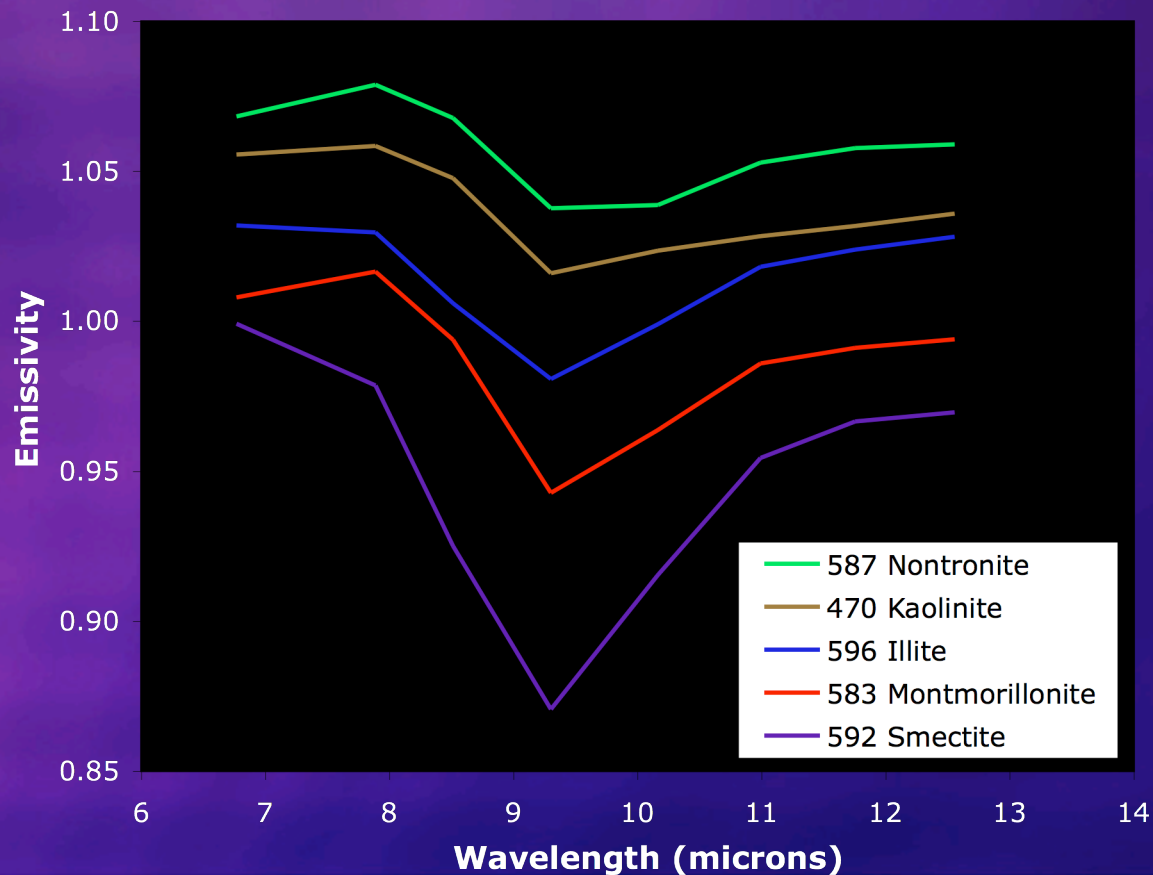
 *Mustard et al. 2008*

 *This study (TPI)*



Phyllosilicate index of lab clays

Laboratory Spectra (ASU Library)



Detectability vs. Temperature/LST

- *THEMIS is currently moving into an earlier orbit*

Location	ID	Local Solar Time	Detection
Mawrth Vallis	I01199005	15.262	y
Mawrth Vallis	I01561006	15.442	n
Syrtis Major	I02469002	15.970	y
Mawrth Vallis	I17799021	16.273	y
Ismenius Lacus	I03220002	16.446	y
S. highlands	I08174001	16.482	n
Mawrth Vallis	I18423010	16.490	n
S. highlands	I15325001	17.495	n

Results

- *We have developed a THEMIS spectral index sensitive to most phyllosilicates mapped by OMEGA*
 - *Nontronite is the one exception so far*
 - *TPI works best when:*
 - *Temp > 240 K*
 - *Dust opacity is low*
- But: Expect higher temperatures as Odyssey orbit changes*

Future Applications

- *Developing a nontronite THEMIS index*
- *Unmixing THEMIS spectra to determine phyllosilicate abundances*
- *Mapping global distribution of phyllosilicates on Mars*
- *Targeting specific area of interest*
- *Suggest targeting for future OMEGA and CRISM observation for confirmation*