



# Geochemical Processes Along the Glen Torridon/Greenheugh Pediment, Unconformity, Gale Crater, Mars:

## Results from the Sample Analysis at Mars Instrument

*Brad Sutter<sup>1</sup>, Amy McAdam<sup>2</sup>, Doug Archer Jr.<sup>1</sup>, Douglas Ming<sup>3</sup>, Jennifer Eigenbrode<sup>2</sup>, Elizabeth Rampe<sup>3</sup>,  
Joanna Clark<sup>1</sup>, Tanya Peretyazhko<sup>1</sup>, Daniel Glavin<sup>2</sup>, Albert Yen<sup>4</sup>, Rafael Navarro-Gonzalez<sup>5</sup>,  
Valerie Fox<sup>6</sup>, Alex Bryk<sup>7</sup>, Charles Malespin<sup>2</sup> and Paul R Mahaffy<sup>2</sup>*

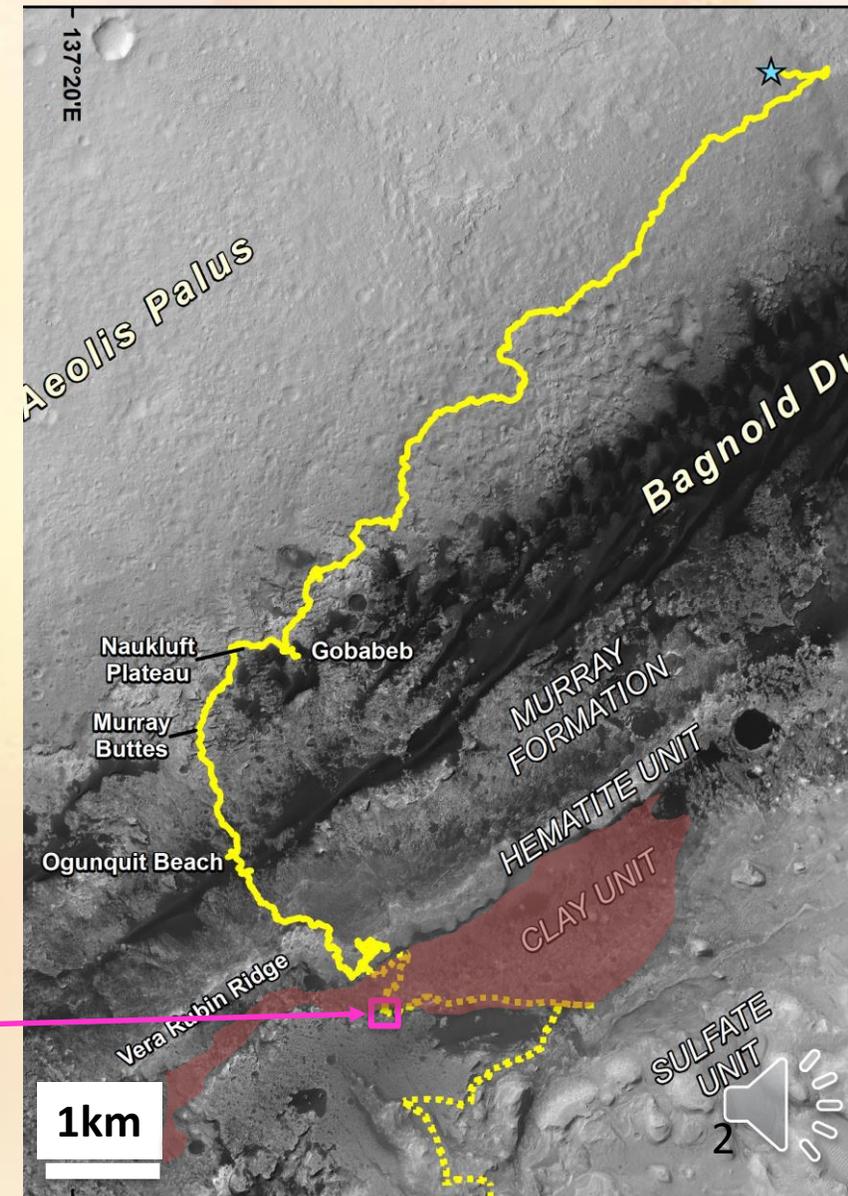
*(1) Jacobs Technology, NASA, Houston, TX (2) NASA GSFC, Greenbelt, MD, (3) NASA JSC, Houston, TX,  
(4) NASA JPL, Pasadena, CA, United States, (5) Universidad Nacional Autonoma de Mexico, Mexico City, (6) Univ.  
Minnesota, Minneapolis, MN, (7) Univ. California, Berkley, CA*

# Introduction

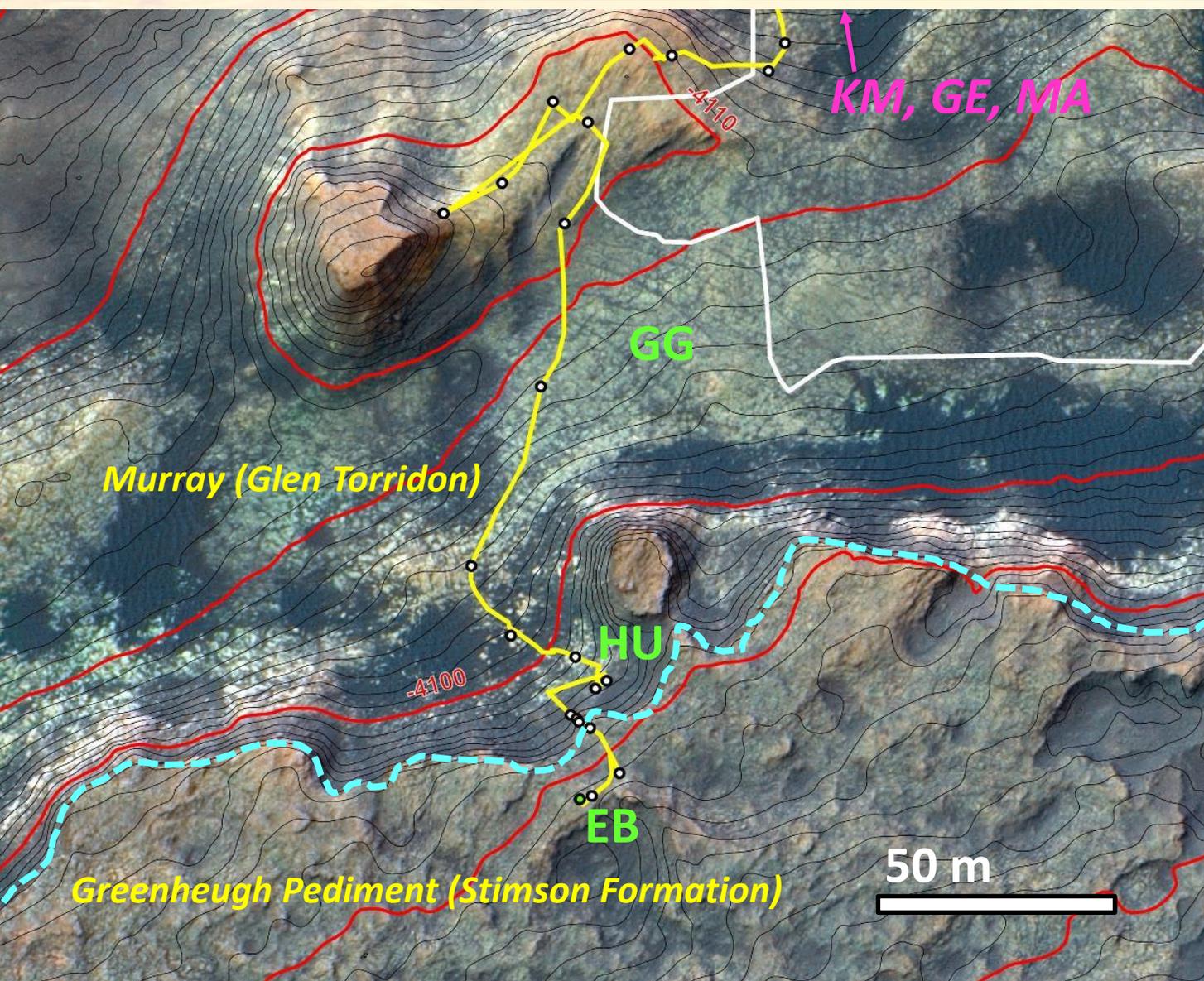


- A driving factor for sending the Curiosity Rover to Gale Crater was the orbital detection of clay minerals in the Murray sediments of the Glen Torridon (GT) region
- The presence of clay minerals suggests an ancient aqueous environment (>3.1Ga) that may have been habitable for microbiology.

Study Area



# Study Area (Orbital View)



Lower Murray (Glen Torridon)  
*Kilmarie (KM), Glen Etive (GE),  
Mary Anning (MA)*

**Glasgow (GG)**

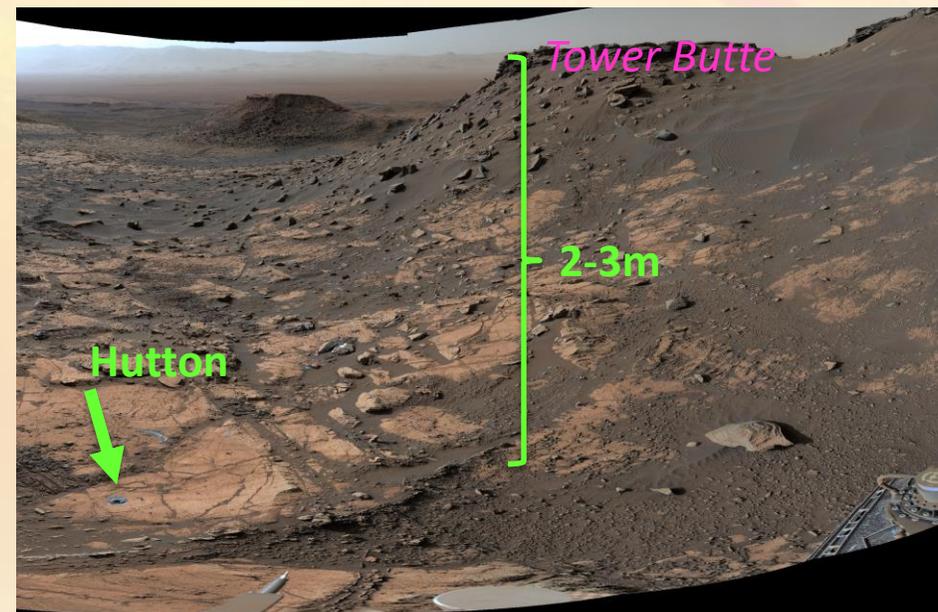
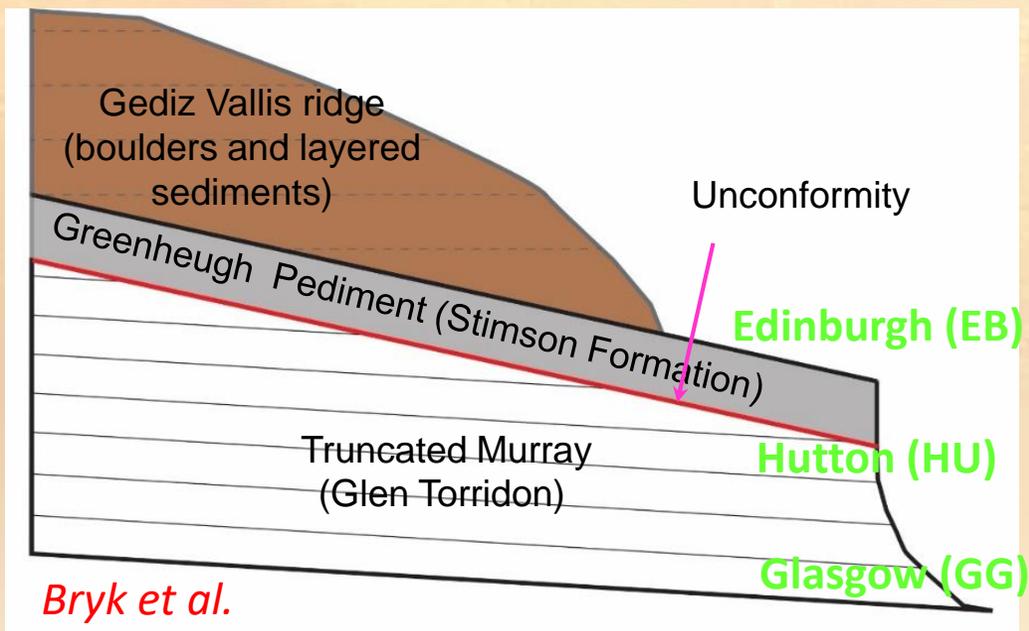
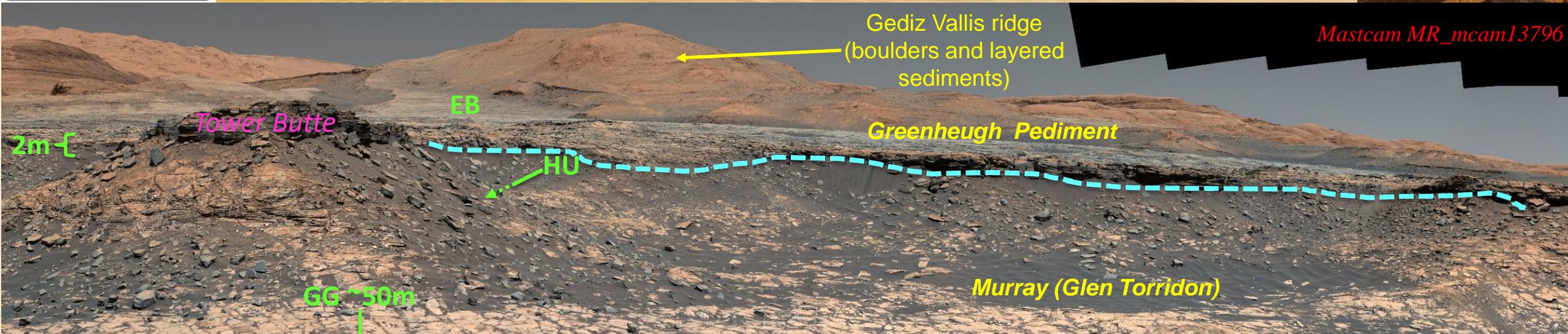
Upper Murray (Glen Torridon)  
**Hutton (HU)**

\*Brighter tone

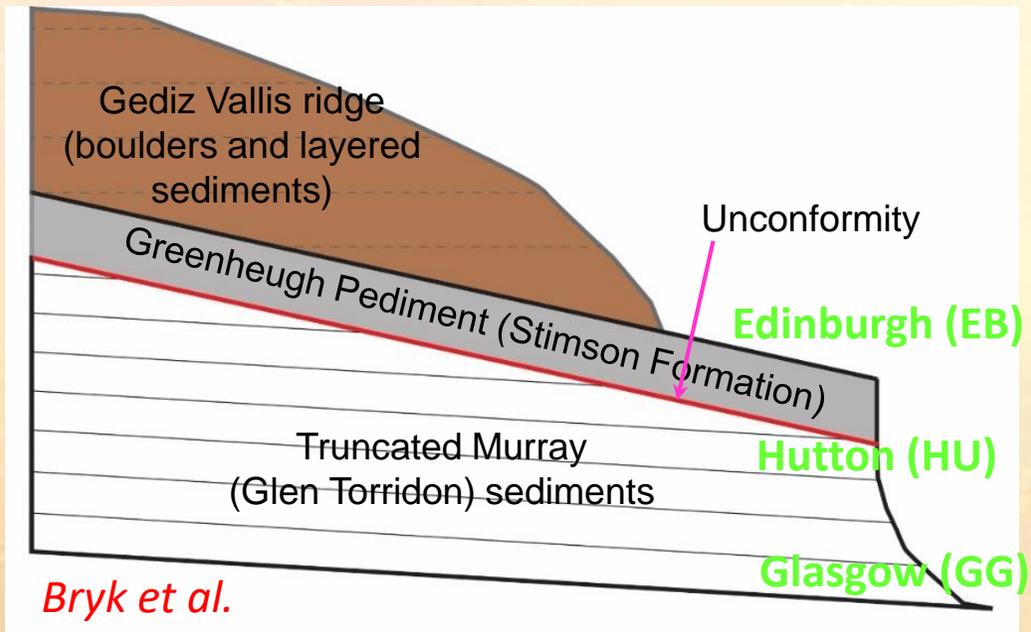
\*Geochemistry differs from  
material below Hutton

Greenheugh Pediment  
(Stimson Formation)  
**Edinburgh (EB)**

# Study Area (Rover View)



# Objectives



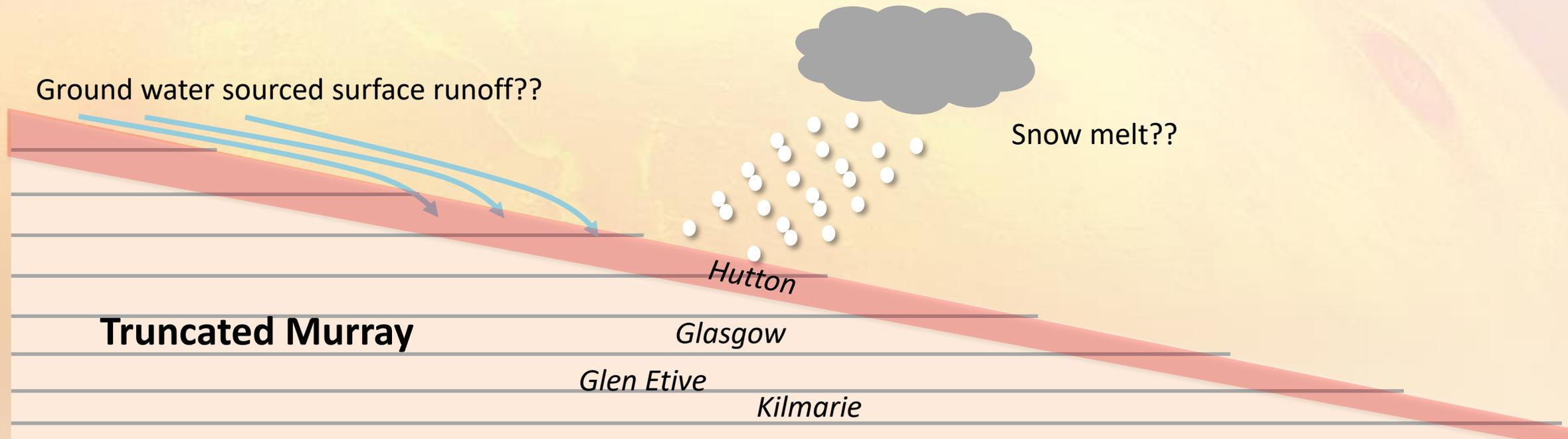
- Utilize the SAM-Evolved Gas Analyzer (SAM-EGA) capability to understand the origin of geochemical differences just below contact between the Greenheugh Pediment and the Murray sediments.
- The key to this will be to compare SAM-EGA results of Hutton relative to samples below and above Hutton
- Results will be used to test 3 MSL Team hypotheses to assess the origin of these geochemical differences.



# Hypothesis #1



- Sub-aerial weathering alteration occurred after the truncation of the Murray unit or just after pedimentation began.



# Hypothesis #2



- The contact between Greenheugh pediment and Murray sediments was a conduit for diagenetic fluids that altered Murray sediments near the contact.



# Hypothesis #3

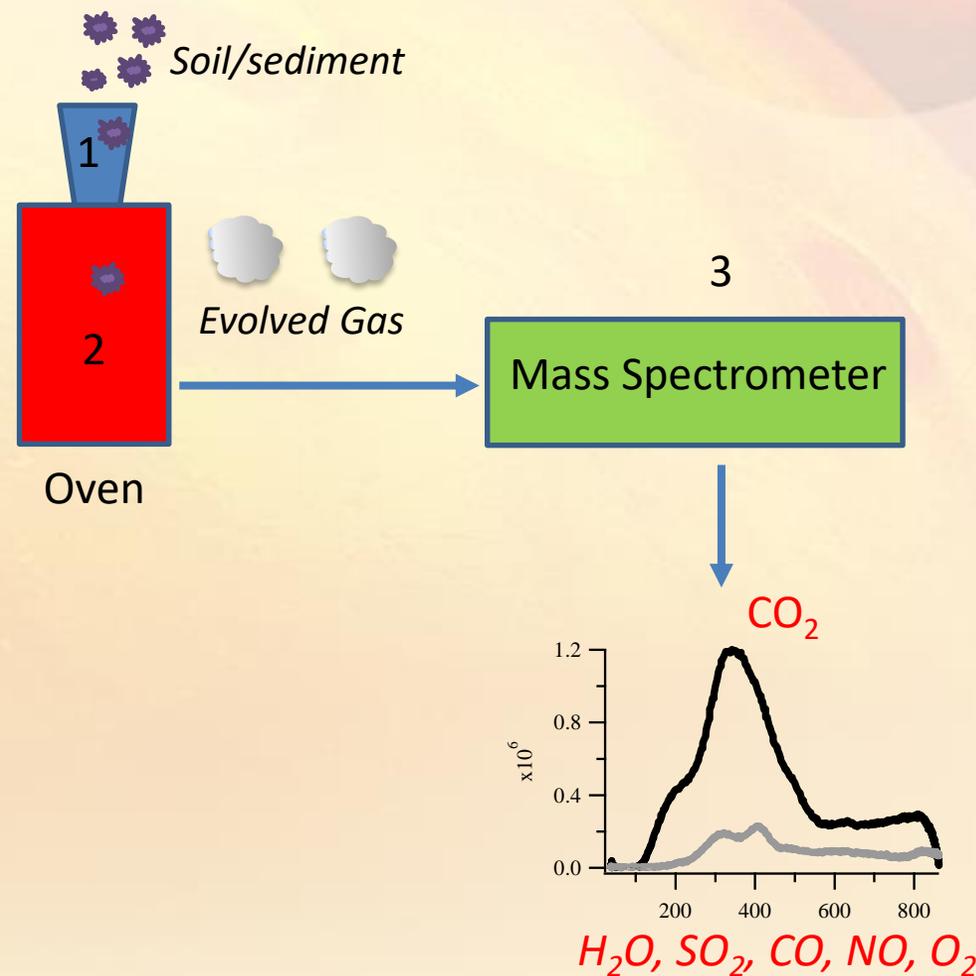


- Groundwater flowing through the Greenheugh material could have resulted in preferential precipitation/leaching of material near the contact.





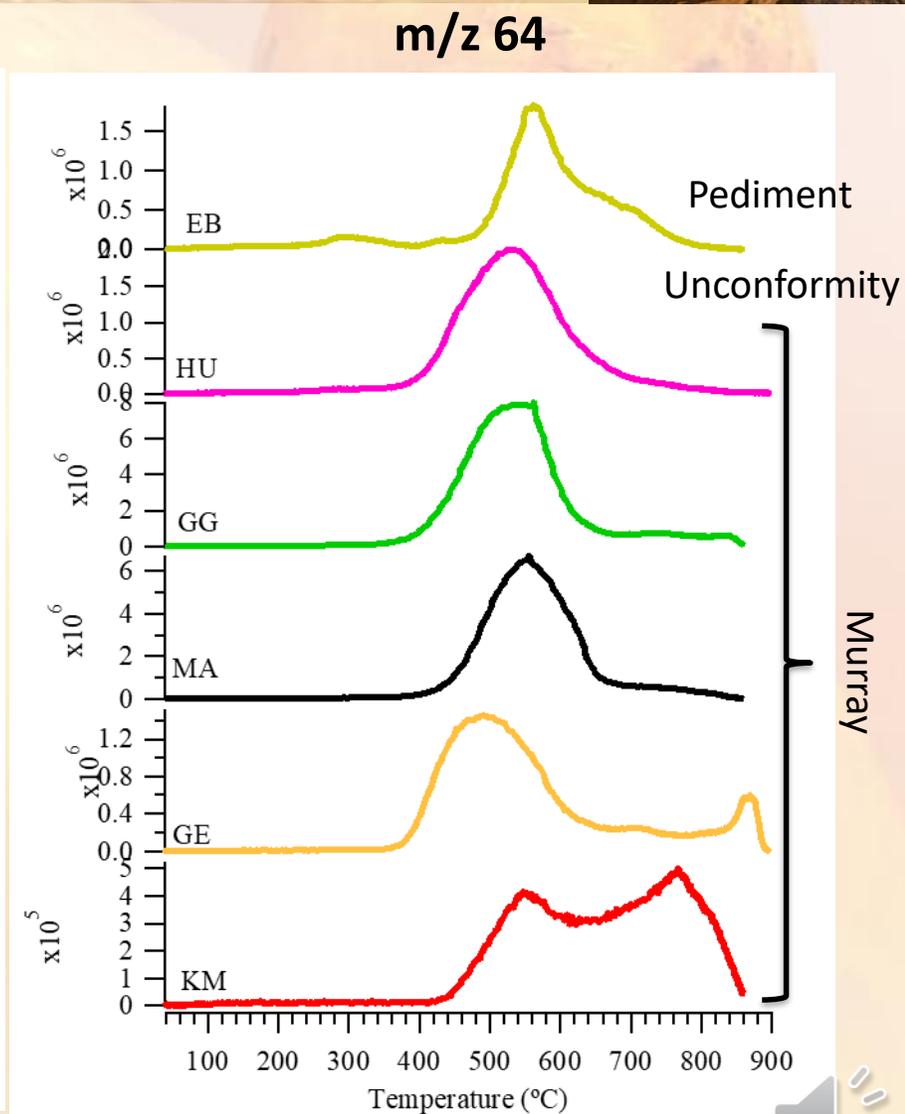
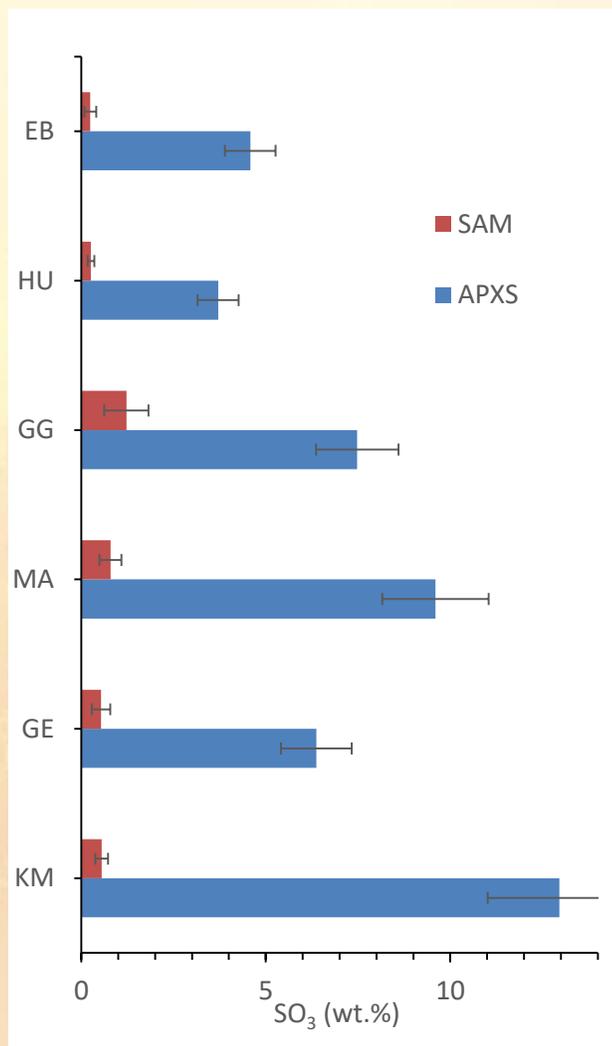
- CheMin provided bulk mineralogy and SAM extends that mineralogical assessment
  - Detects phases below CheMin detection limits
    - CheMin (1 wt.%)
    - SAM-EGA (0.01 wt.%)
  - Provide insight into the nature of the amorphous phase
- SAM Operation
  - Drilled/scooped sample delivered to oven (1)
  - Sample heated (2) (870°C)
  - Evolved gas measured (3)
  - *Gas species and evolved gas temperature(s) identifies the volatile bearing phase*



# Edinburgh S differed from Hutton



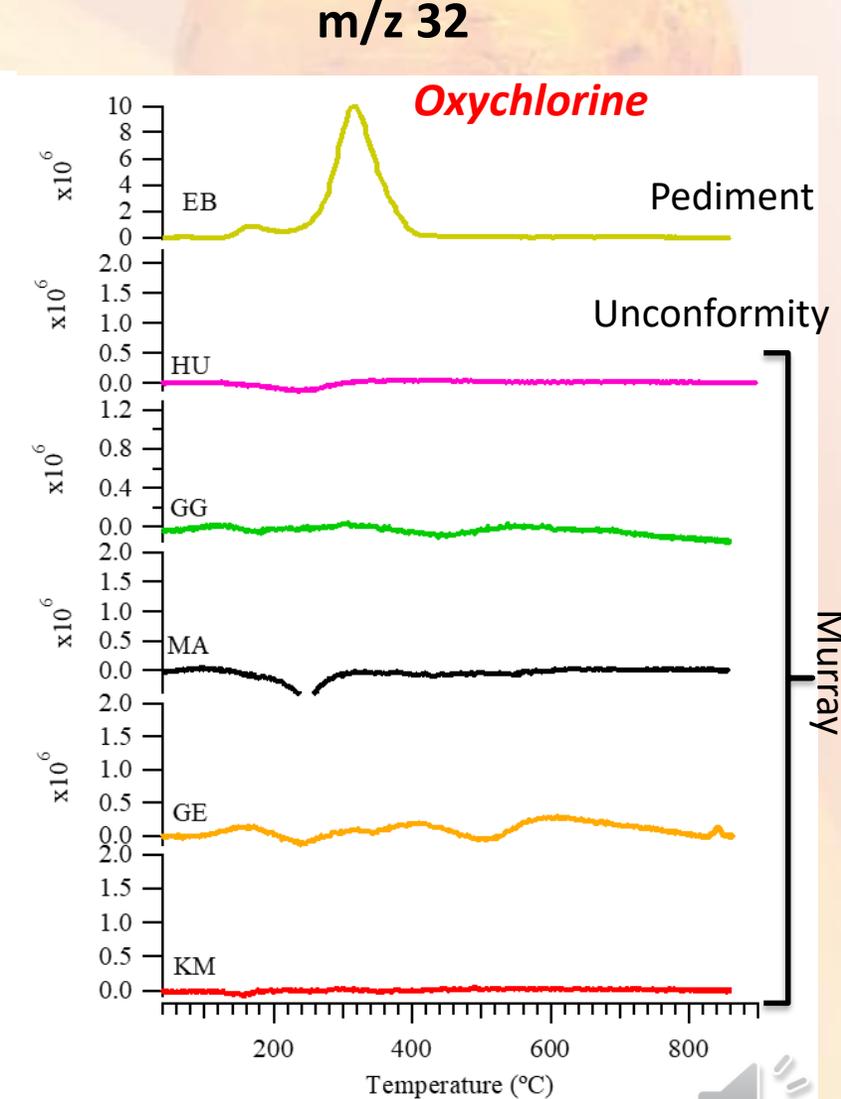
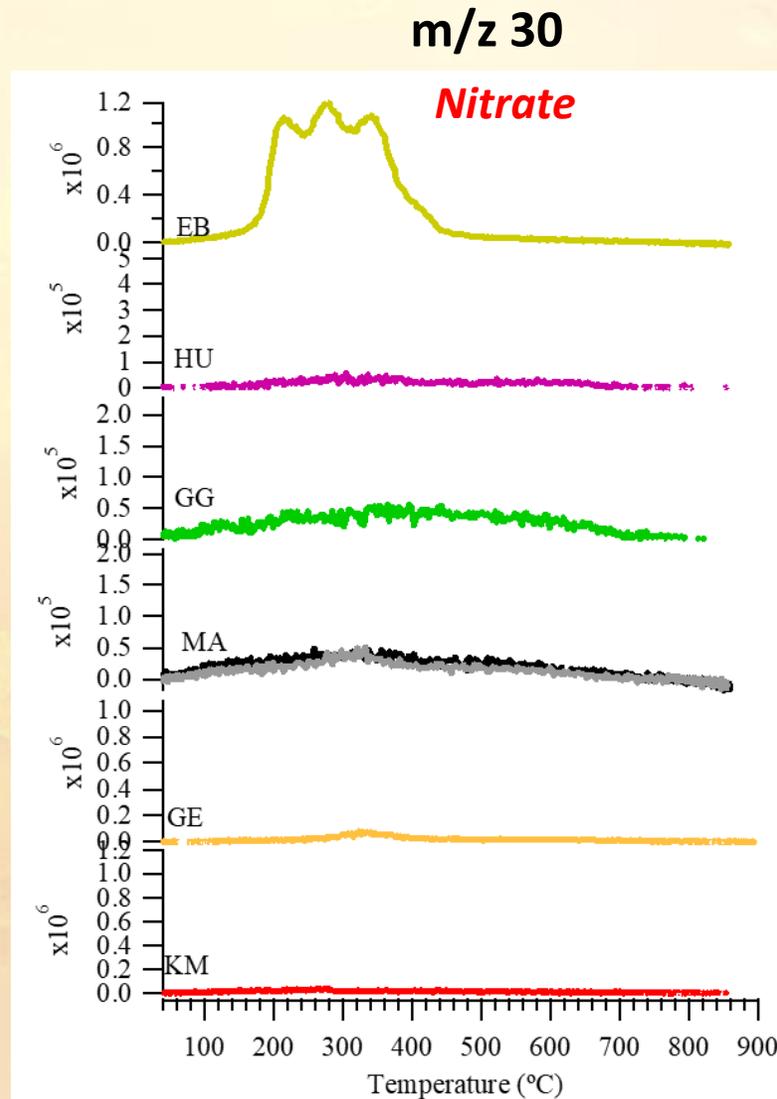
- EB evolved SO<sub>2</sub> profile differed from HU and other Murray materials
  - Differing distribution of Fe and Mg S phases than HU.
- Evolved SO<sub>2</sub> similar in HU and lower GG and MA samples
  - Fe sulfate indicated in HU, GG, and MA
  - Total APXS-S >> SAM-S/SAM
    - CaSO<sub>4</sub> >> FeSO<sub>4</sub>
- But!!! HU S abundances are lower than GG and MA



# Nitrate/Oxychlorine Detected in EB but not HU and other Murray



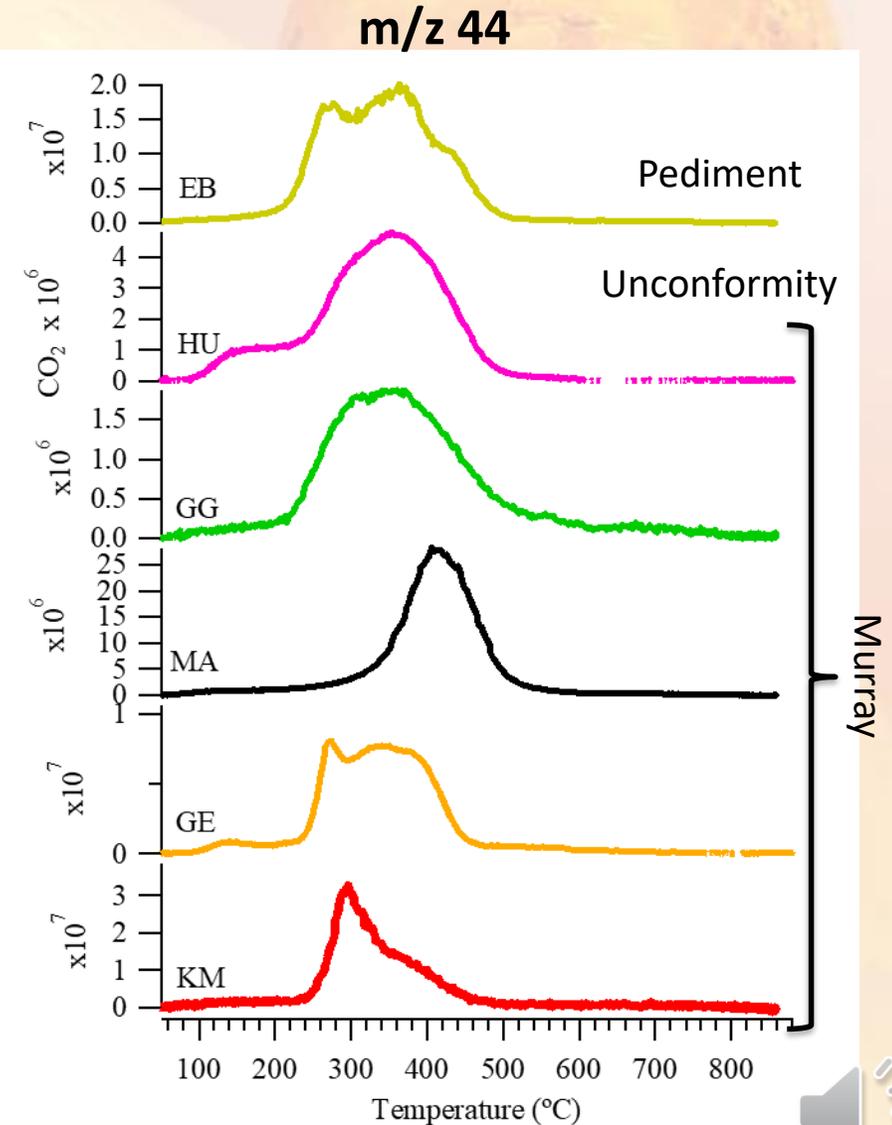
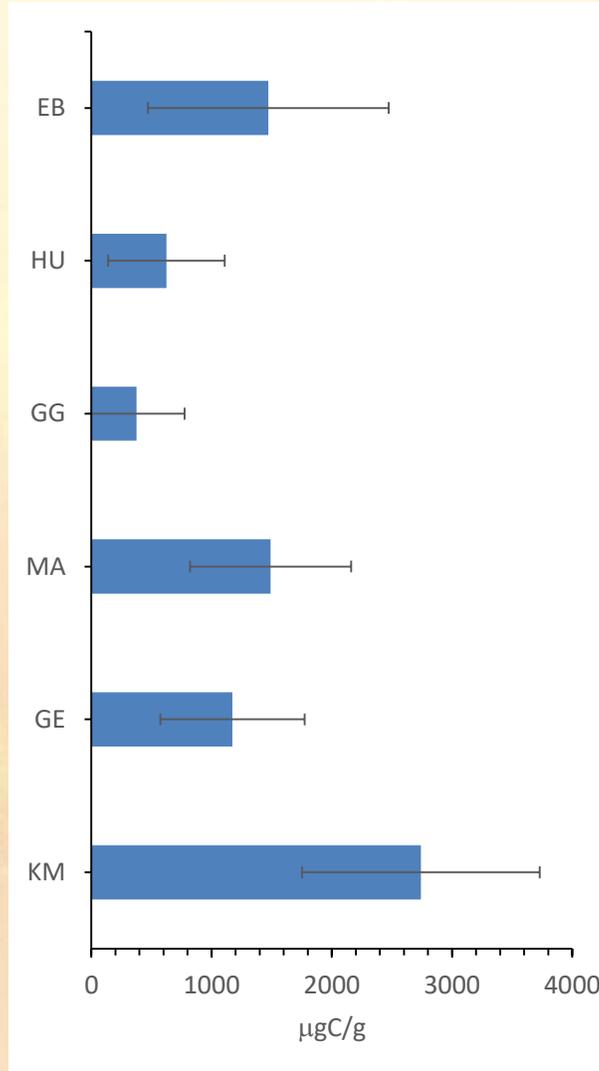
- Nitrate and Oxychlorine detected in EB
- No nitrate and oxychlorine were detected in HU or other Murray
  - Never deposited?
  - Deposited but leached out later?
- Consistent with no contributions of nitrate/oxychlorine from overlying pediment into the Murray.



# Evolved Edinburgh CO<sub>2</sub> Differed from HU



- Evolved CO<sub>2</sub> profile from EB differed from HU
  - Differing C phases.
- HU evolved CO<sub>2</sub> profile similar to GG
  - Similar C phases as GG
- HU and GG C abundance were less than other Murray materials and EB.

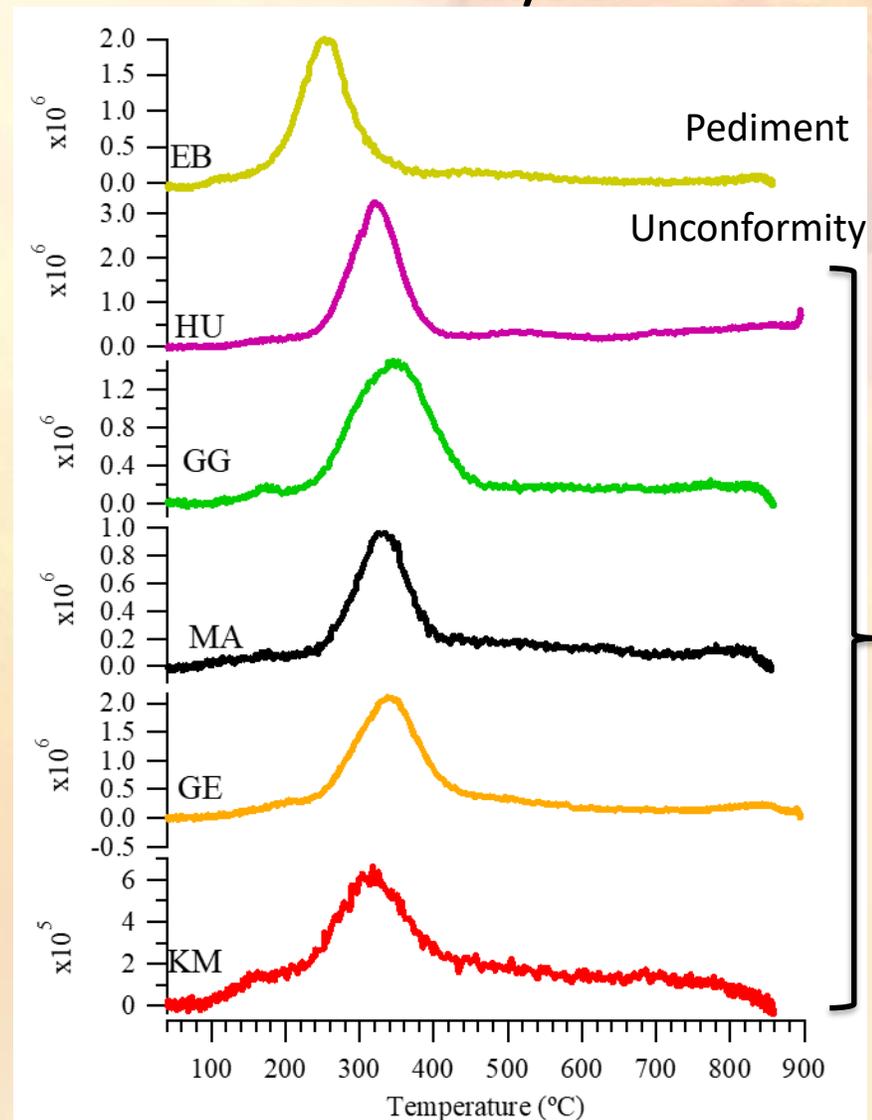


# Evolved Edinburgh CO differed from HU



- EB evolved CO profile differs from HU and other Murray materials.
  - Differing C bearing phases
- Evolved CO profile similar in HU and other Murray
  - Similar C bearing phases

m/z 28

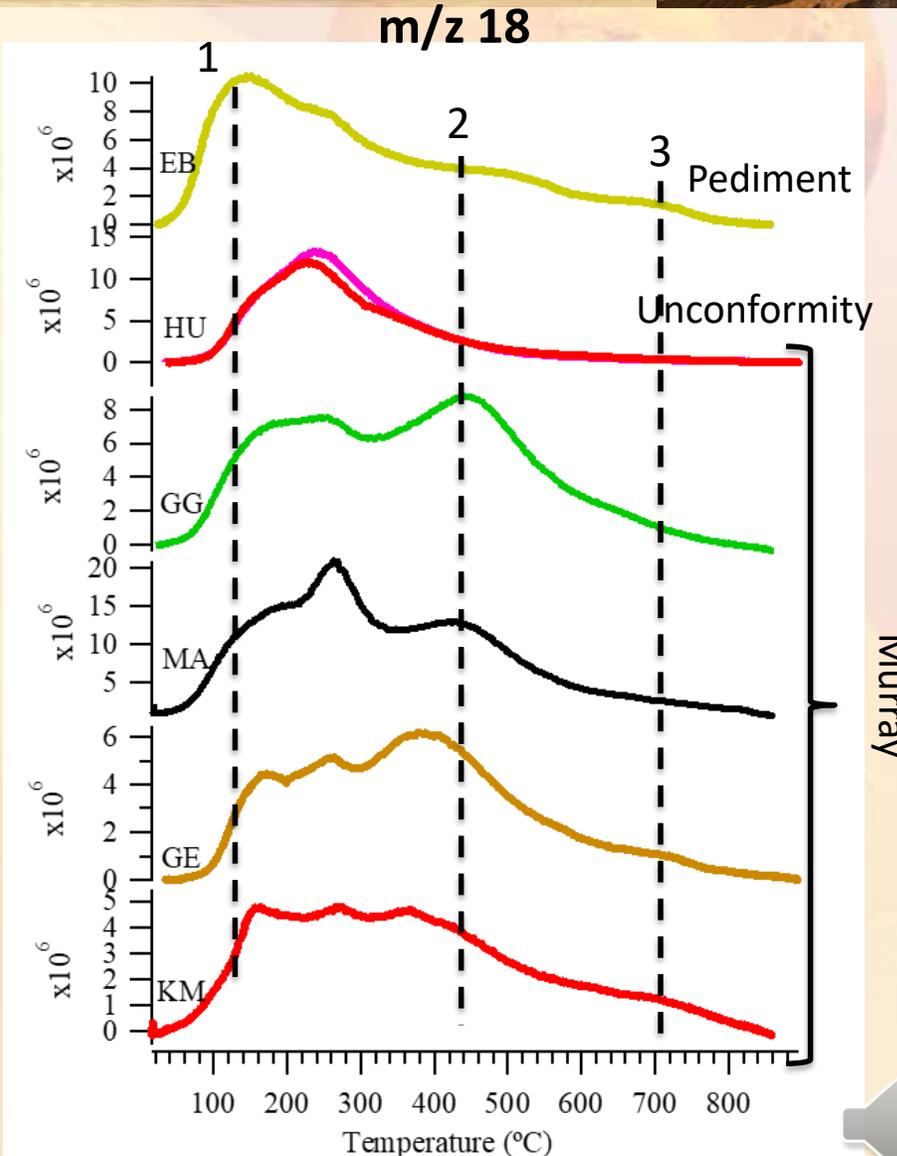
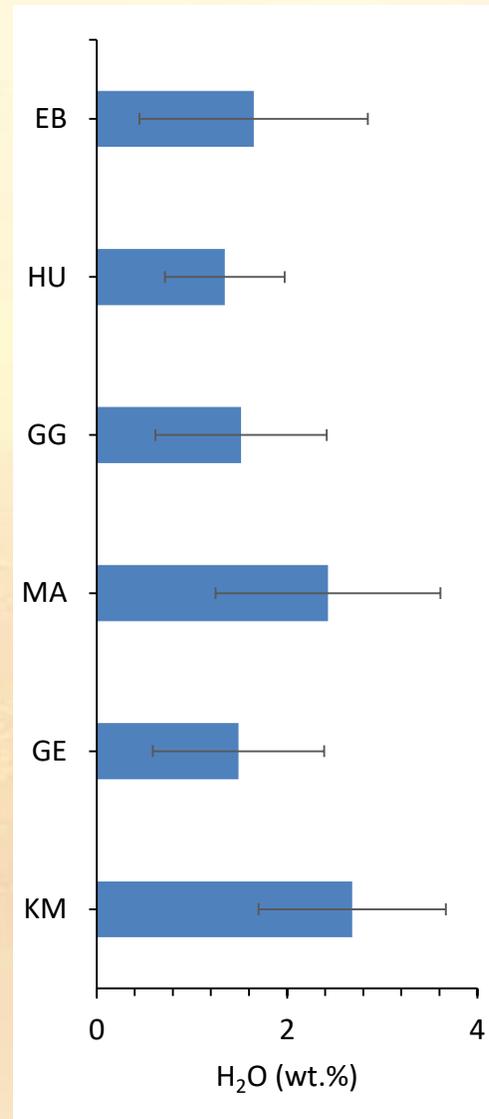


Murray

# Hutton had less high temperature water than other Murray materials.



- HU has very low peak 2 intensity
  - Corresponds with HU having less di-octahedral smectite than other Murray samples
- EB peak 1,2,3 intensity >> HU peak 1,2,3
  - EB water bearing phases not present in same distribution as HU



# Conclusions



- Minimal groundwater infiltration from the pediment into the Murray sediments immediately below contact.
  - Soluble nitrate, oxychlorine,  $\text{MgSO}_4$ , and along with differing carbon and more diverse water bearing phases detected in Edinburgh were not detected in the Murray materials just below contact.
- SAM-EGA results consistent with past diagenetic conduit alteration or subaerial alteration processes.
  - Diagenetic or sub aerial open-system alteration occurred near the unconformity that lowered sulfur, carbon, and smectite concentrations in Hutton relative stratigraphically lower Murray materials.

# Questions??



*Send questions to [brad.sutter-2@nasa.gov](mailto:brad.sutter-2@nasa.gov)*

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