

Prospecting for Diverse Igneous Rock Types on Mars: PIXL on “Black Beauty” NWA 7533

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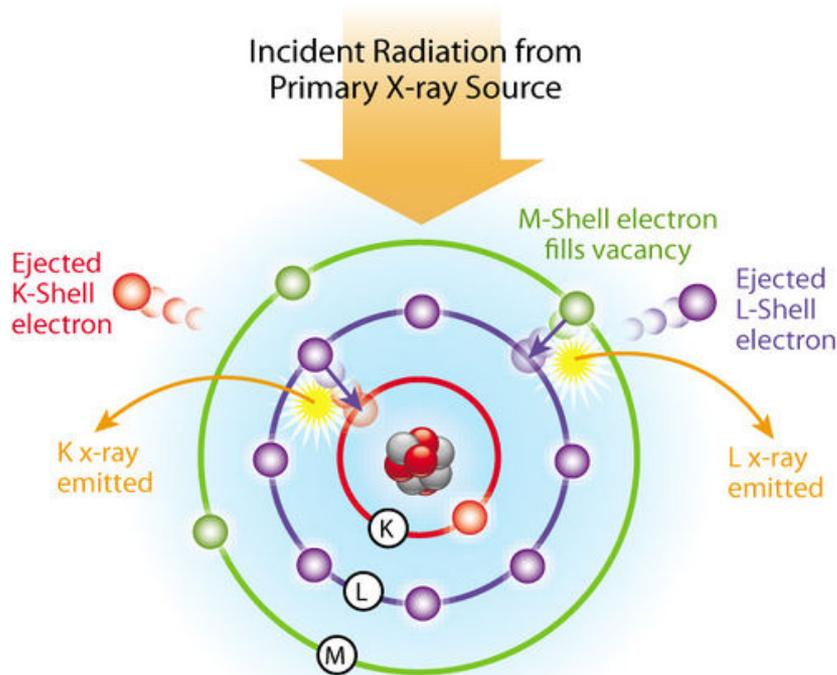
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Planetary Instrument for X-ray Lithochemistry (PIXL)

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



Uses X-ray fluorescence to measure the elemental chemistry of rocks and soils



Measurements of elemental chemistry are fundamental for exploring geology

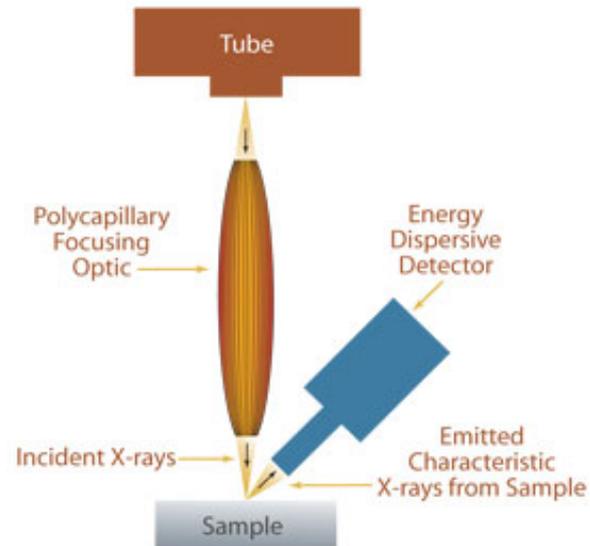
- Almost every mars surface mission has had this capability

But previous instruments have not been able to accurately **correlate chemistry with texture**

- Interpreting past environments, conditions (habitability, preservation potential)
- Seeking, characterizing ancient microbial biosignatures
- Evolutionary history of surface rocks

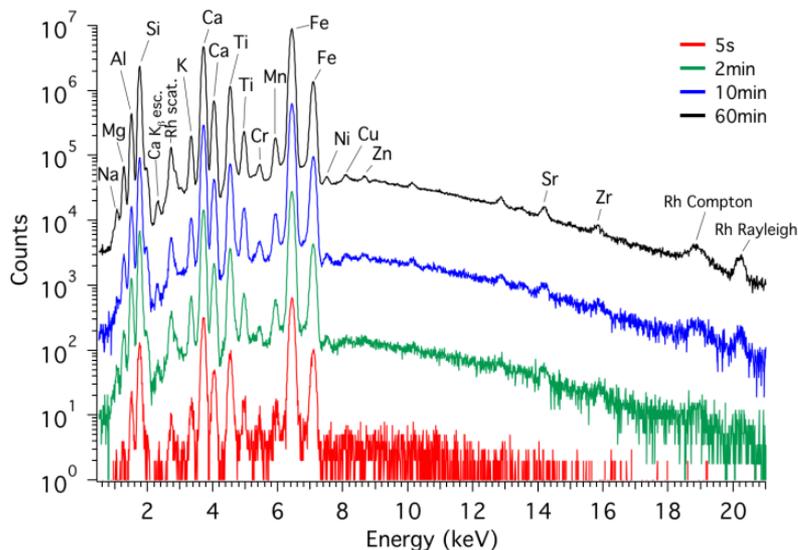
Planetary Instrument for X-ray Lithochemistry (PIXL)

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



PIXL uses micro-focus X-ray fluorescence

- X-ray tube generates x-rays
- Polycapillary optic focuses x-rays to a small spot ($\varnothing = 0.1 \text{ mm}$)
 - Very little loss of flux compared to pinhole
 - Beam is relatively collimated
- Beam is scanned to produce lines, grids, maps at a given step size
- Microcontext camera & Optical Fiducial System (OFS) for visual registration & positioning guidance
- Result: a tiny, high-flux beam on sample surface
 - fast acquisition and high spatial resolution
 - Typical spot dwell 10 s gives major and minor elements



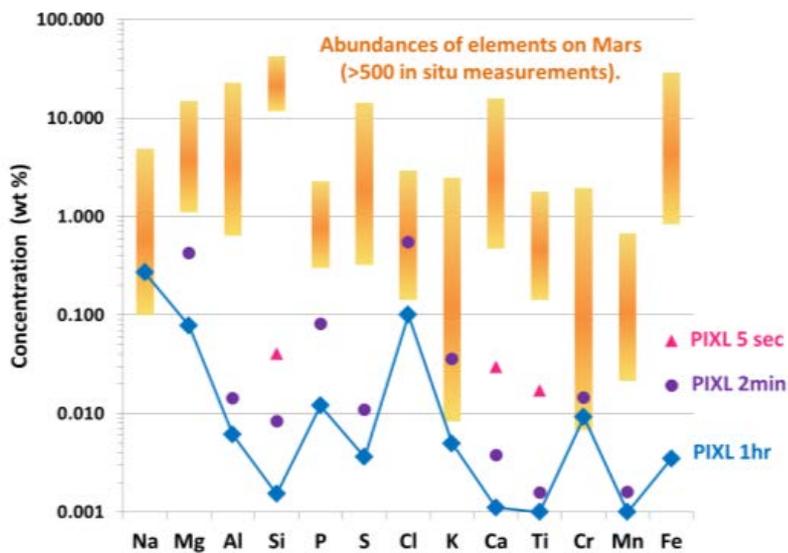
PIXL Performance

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

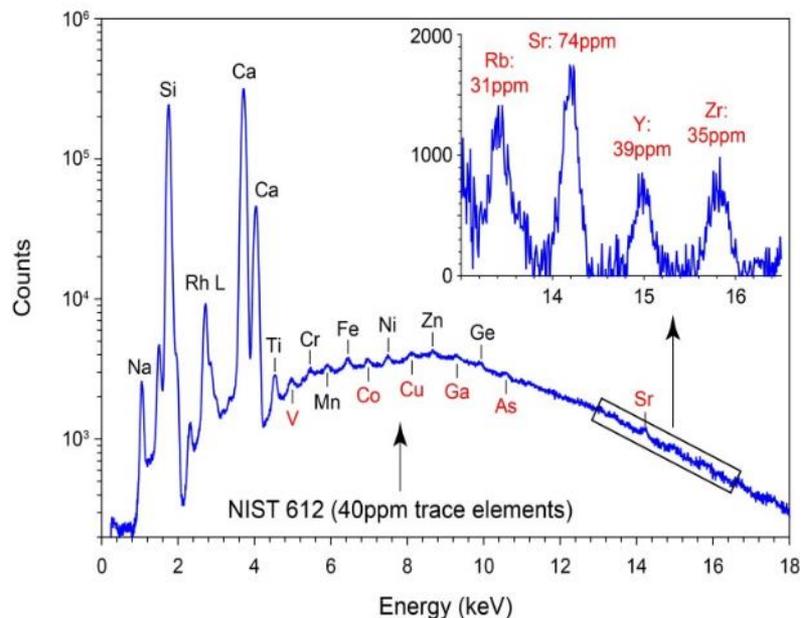


PIXL Breadboard Performance

SENSITIVITY



RANGE OF ELEMENTS (example)



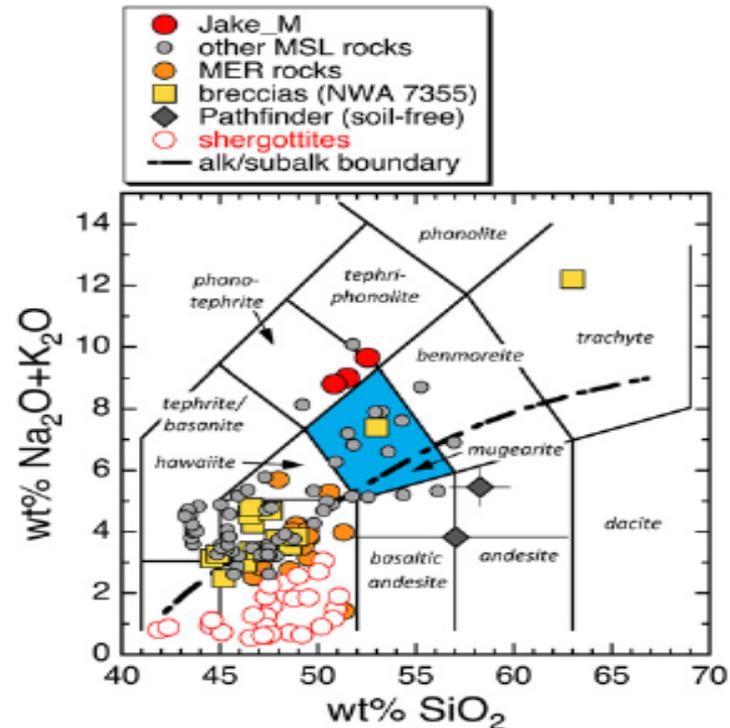
PIXL Breadboard Performance

'Black Beauty' meteorite: NWA 7034/7533/more

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

Ideal for testing PIXL's operational strategies on Mars

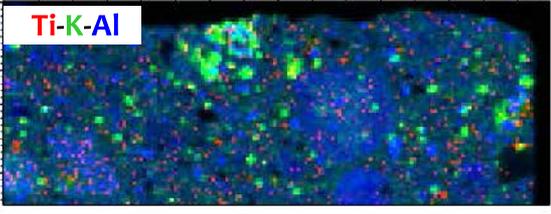
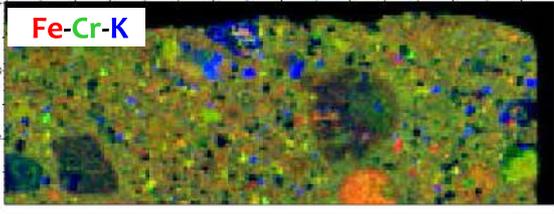
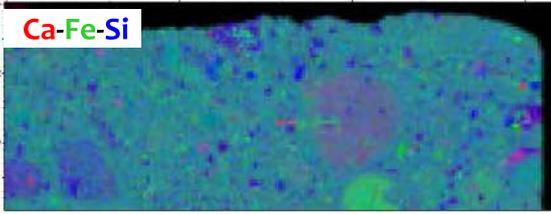
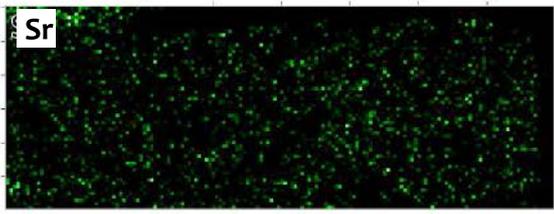
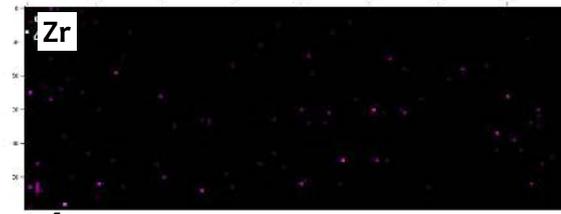
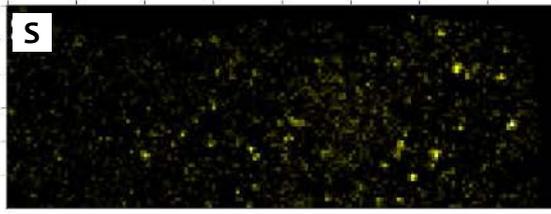
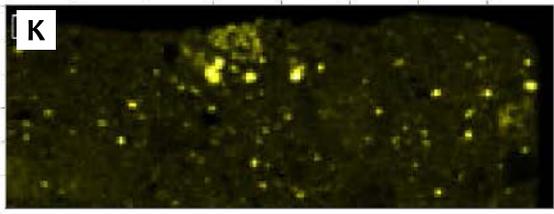
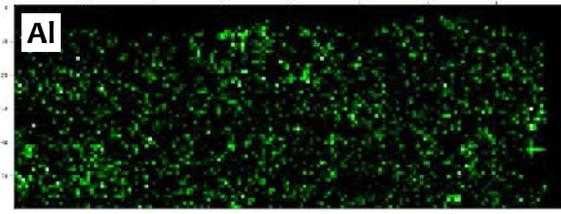
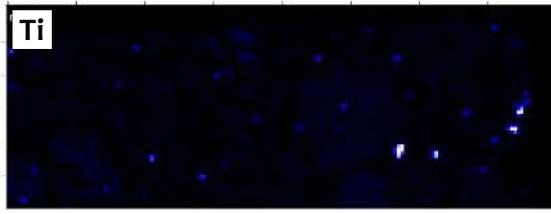
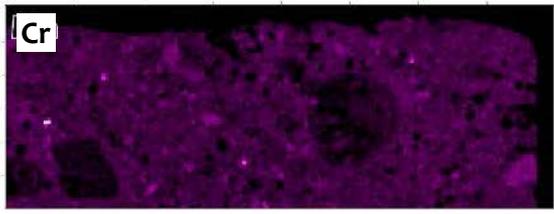
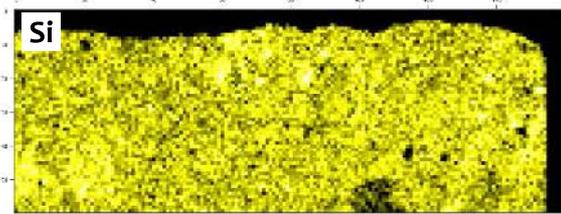
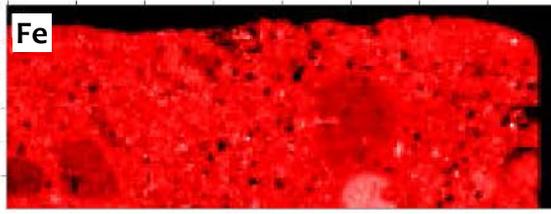
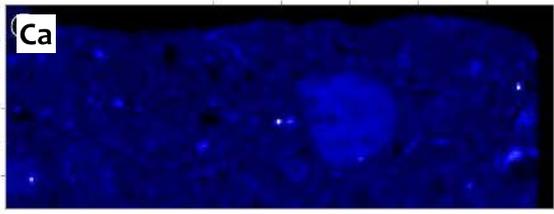
- the **first** Martian 'sedimentary' or 'regolith' meteorite
- the **first** Martian rock \approx average crust composition by GRS (Mars Odyssey)
- many components similar to surface rocks by rovers



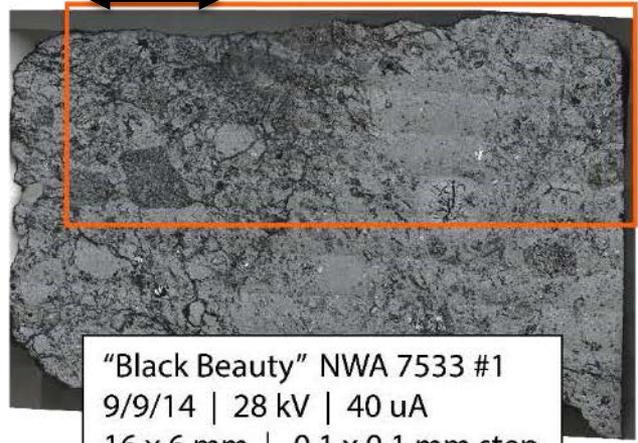
- first martian rock with zircons and rare-earth element phosphates, rare-earth-element silicates,
- abundant 'large' alkali feldspars, pyrite, magnetite, ilmenite, rutile,
- enriched in large ion lithophile elements

PIXL on NWA 7533

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



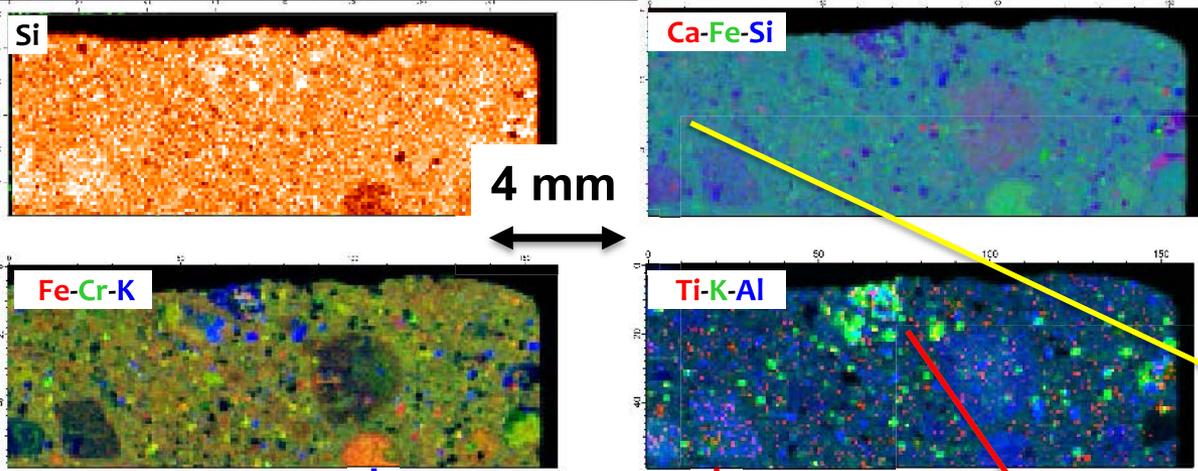
4 mm



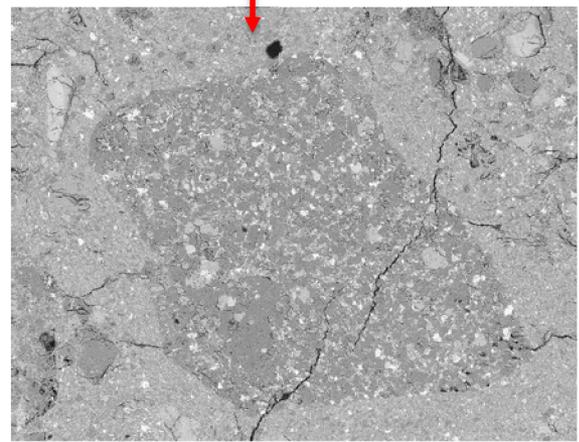
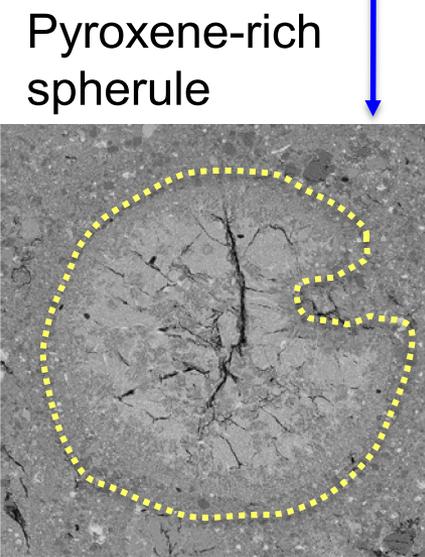
"Black Beauty" NWA 7533 #1
9/9/14 | 28 kV | 40 uA
16 x 6 mm | 0.1 x 0.1 mm step

PIXL on NWA 7533

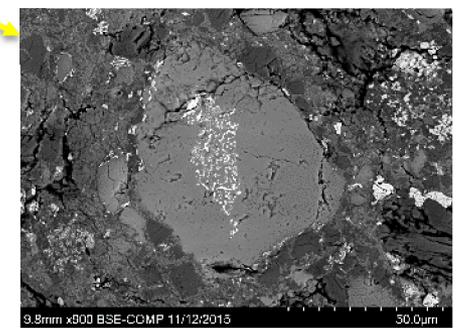
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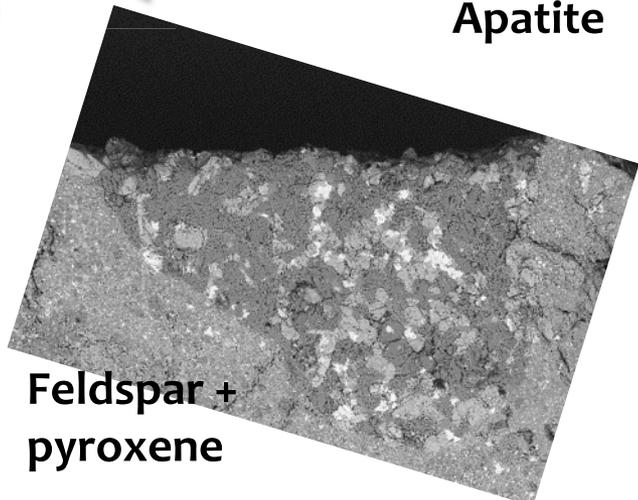
- Multiple elemental map at 0.1 mm resolution
- Chemistry + texture = petrologically significant components



Plagioclase + pyroxene + oxide



Apatite



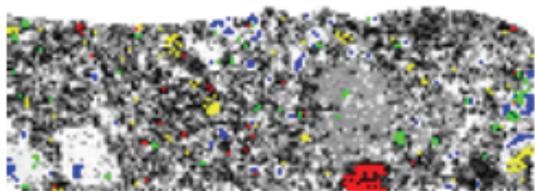
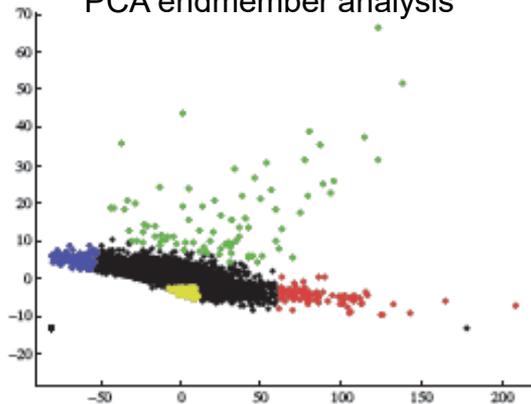
Feldspar + pyroxene

PCA analysis on NWA 7533

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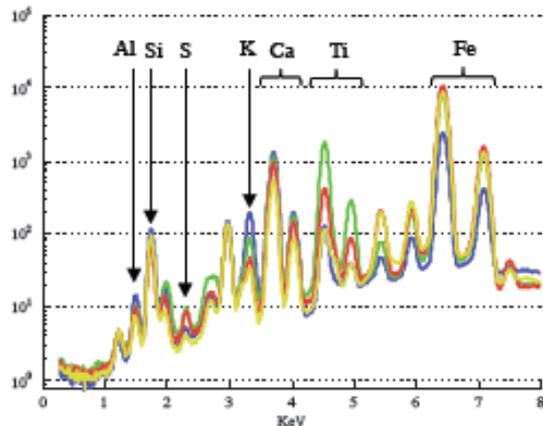


PCA endmember analysis



- Algorithm for autonomously processing of large amount of data
- PCA endmember analysis inform the operators on potentially different components
- Feed forward for adaptive sampling
- Work in progress for algorithm to identify petrologically meaningful components

Thompson et al. 2015



Summary

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



- PIXL's ability to correlate chemistry with texture,
- PIXL's ability to detect distinct petrological components
- Critical for meaningful interpretation of:
 - Interpreting past environments, conditions (habitability, preservation potential)
 - Seeking, characterizing ancient microbial biosignatures
 - Petrological history of surface rocks
- Calibration in progress