Mineralogy of the candidate Mars 2020 Landing Sites using Tetracorder

Prepared for the 4th Mars 2020 Landing Site Workshop

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Outline

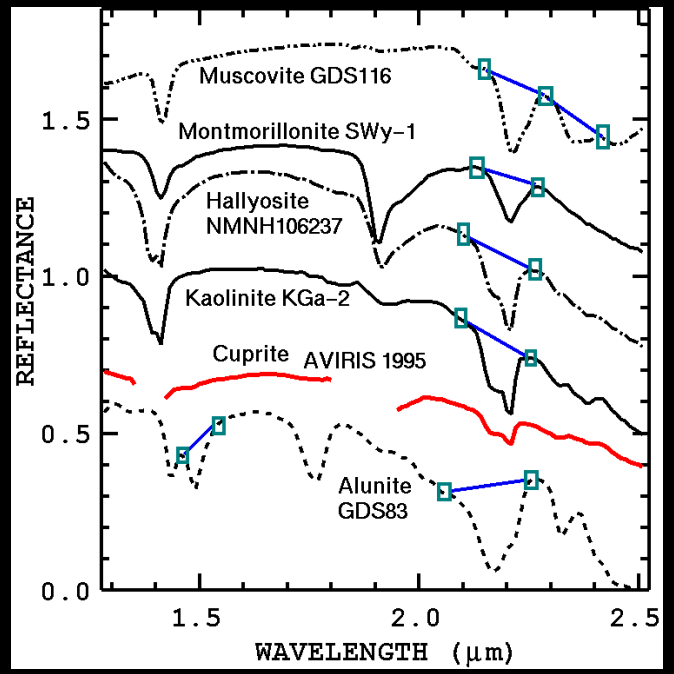
- What is Tetracorder
- Process
- Spectral matching
- Maps

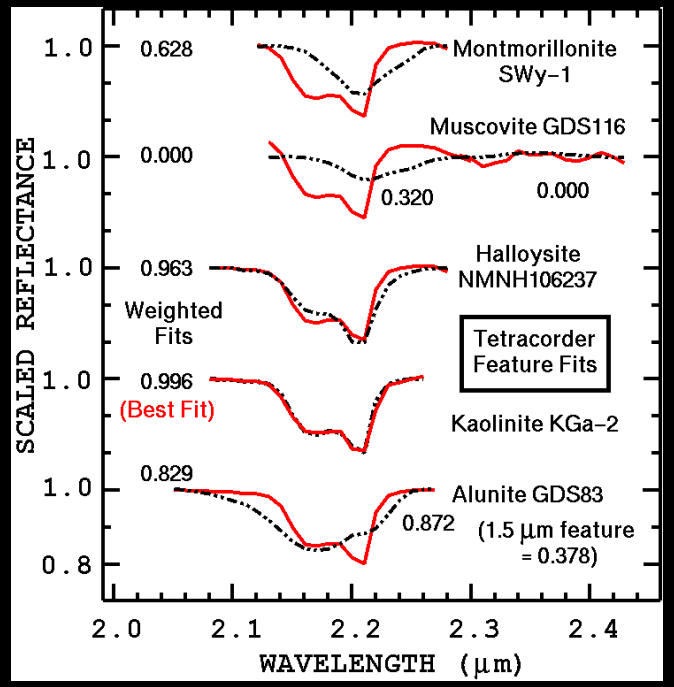
Tetracorder

- Expert system capable of identifying mineralogical composition from spectral signatures.
- Developed by a team at the U.S. Geological Survey over the past 30 years.
- The expert system can apply different algorithms, make identifications and decisions and based on those results, apply new algorithms making additional identifications and decisions.
- The most recent version (5.x) of Tetracorder (Clark et al., 2015, 2016) employs inputs from other analyses, e.g. temperature and pressure, to further constrain identifications and adapts to the available data, including spectral range and resolution.
- Tetracorder has been central to dozens of studies including mineralogical, environmental, and ecosystem mapping:
  - Earth (Livo et al., 2007; Swayze et al., 2000, 2016 and references therein),
  - Moon (Pieters et al., 2009; Kramer et al., 2010; Clark et al., 2009),
  - Mars (Ehlmann et al., 2016),
  - Icy satellites in the Jupiter (Carlson et al., 1996, Clark et al, 2003) and Saturn systems (Clark et al., 2012).
  - World Trade Center disaster where asbestiform minerals were mapped (Clark et al., 2001, 2006)
  - 2010 Deepwater Horizon oil spill where quantitative maps of the amount of oil on the ocean's surface were produced (Clark et al., 2010)]
  - mapping vegetation species, bacteria and grizzly bear habitat in Yellowstone (Kokaly et al., 2003, 2007)

- Performs continuum correction of abs bands
- Matches for fit/depth of diagnostic bands
- Library contains endmembers, mixtures, multiple particle sizes
- Investigates different portions of the spectrum separately

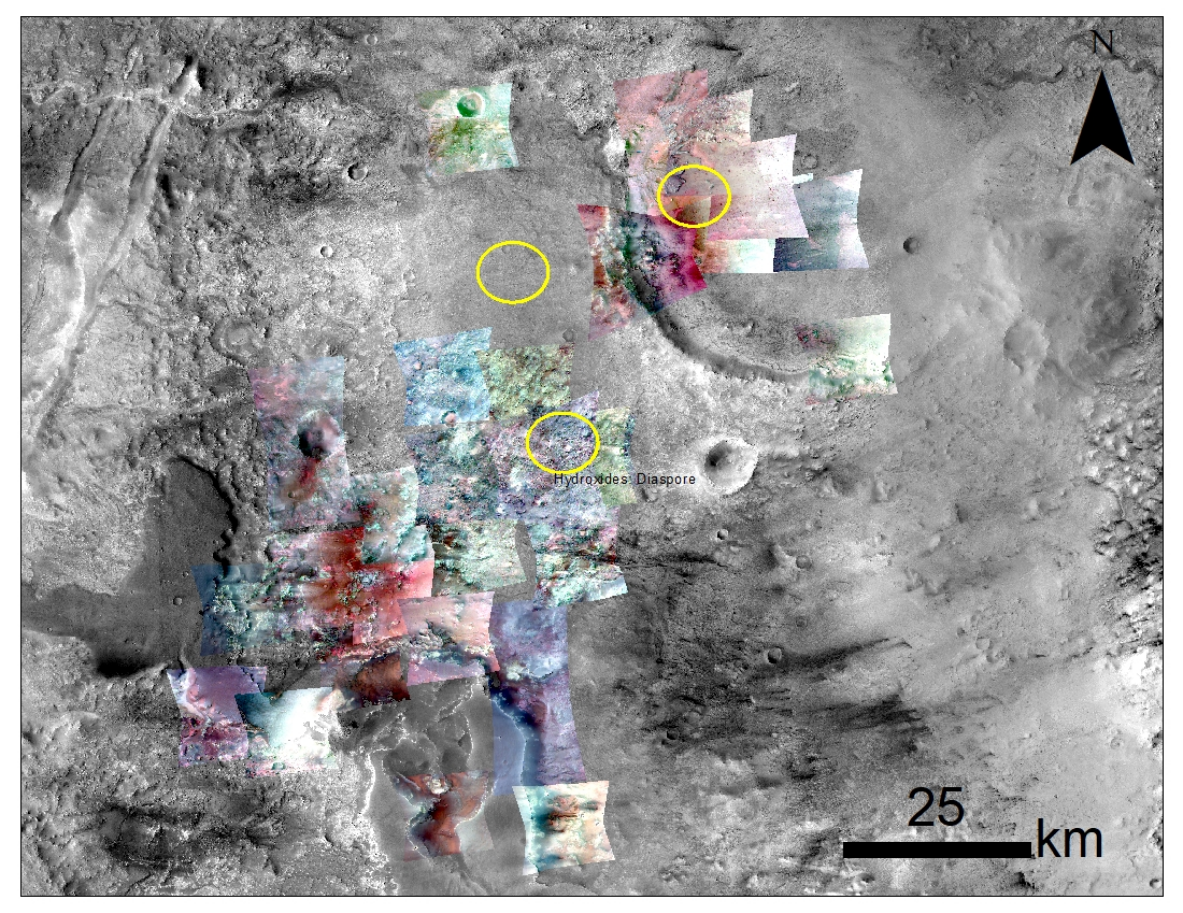
Spectral Region	Process
UV to ~ 2 microns	Electronic Absorptions
UV to ~1 micron	Fe^{3+}
~1-2 microns	Fe^{2+}
~1 to 4 microns	Vibrational Absorptions
~1.3 to 1.6 microns	OH overtones
~1.7 microns	CH overtones
~1.9-2.1 microns	OH + H2O combinations
~2 to 2.5 microns	m-OH, CO and CH combinations
~2.7 to 3.1 microns	OH and NH fundamentals
~3 to 3.5 microns	CH fundamentals

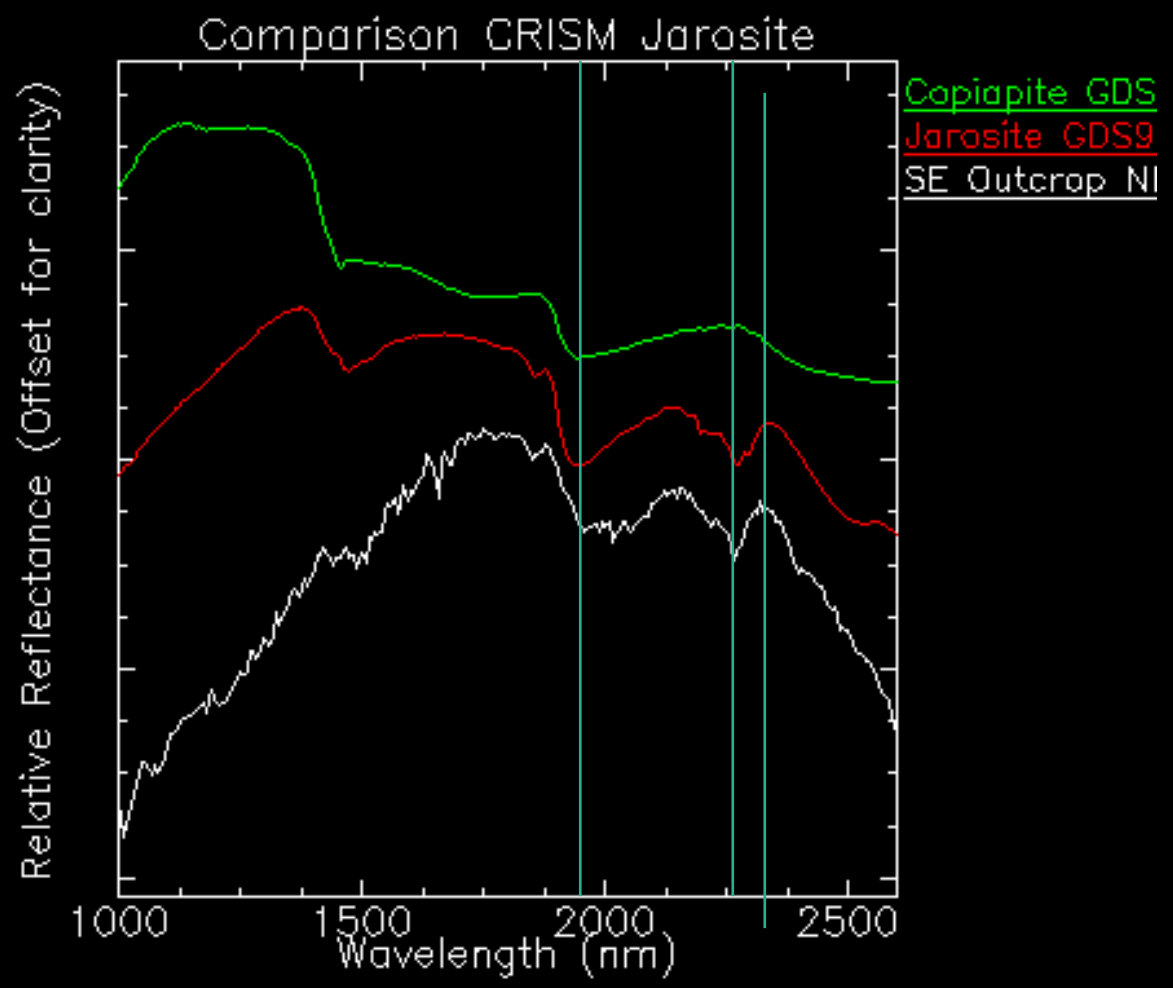


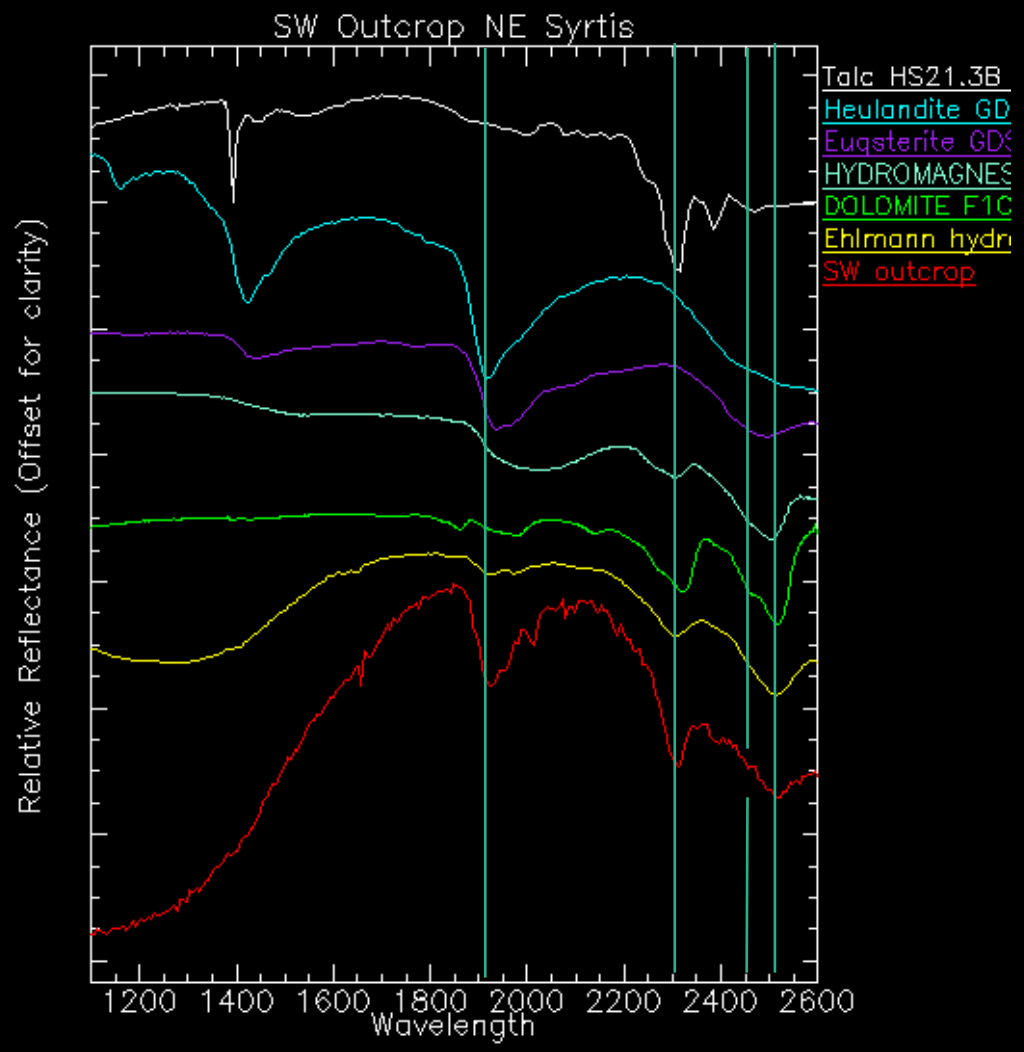


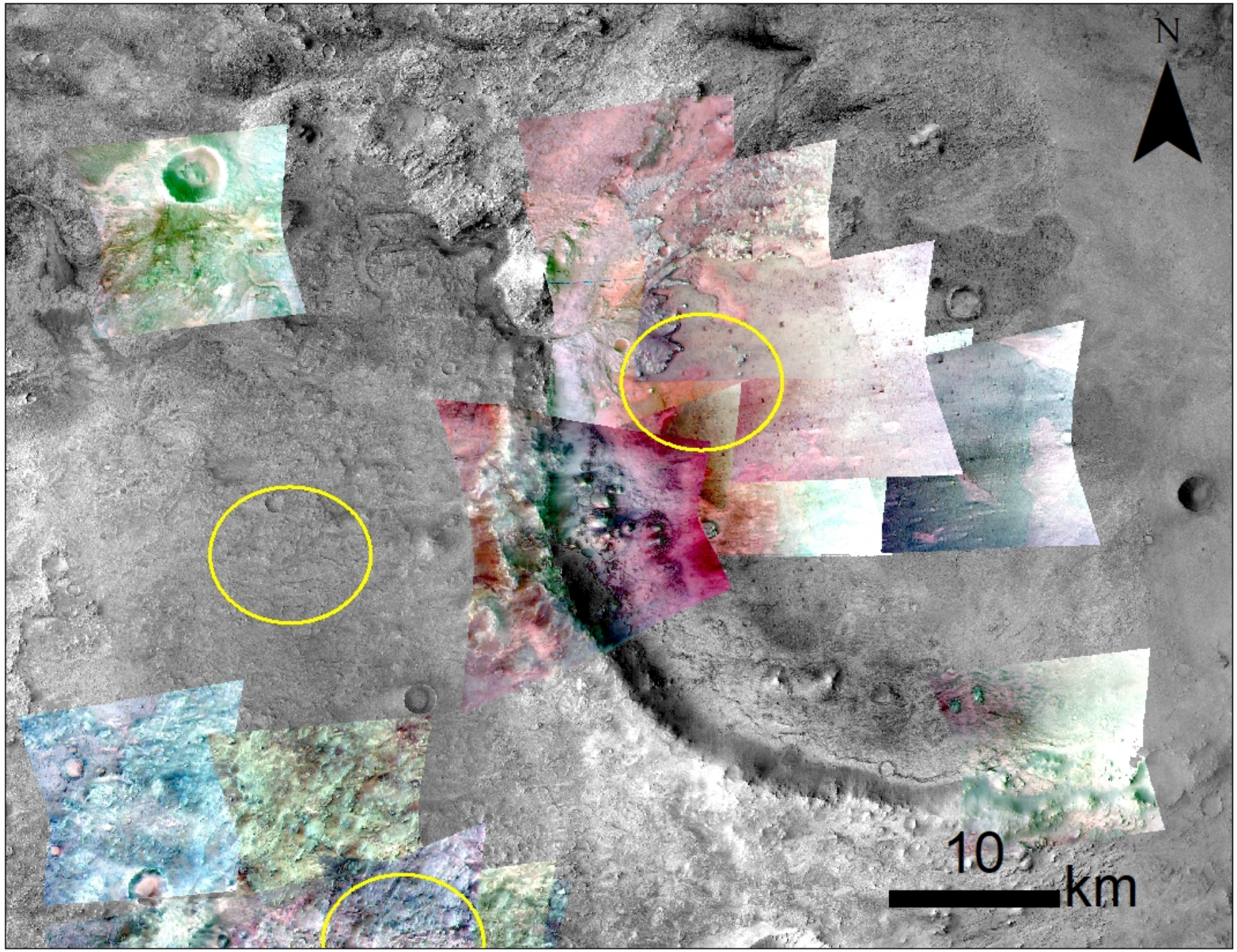
Process

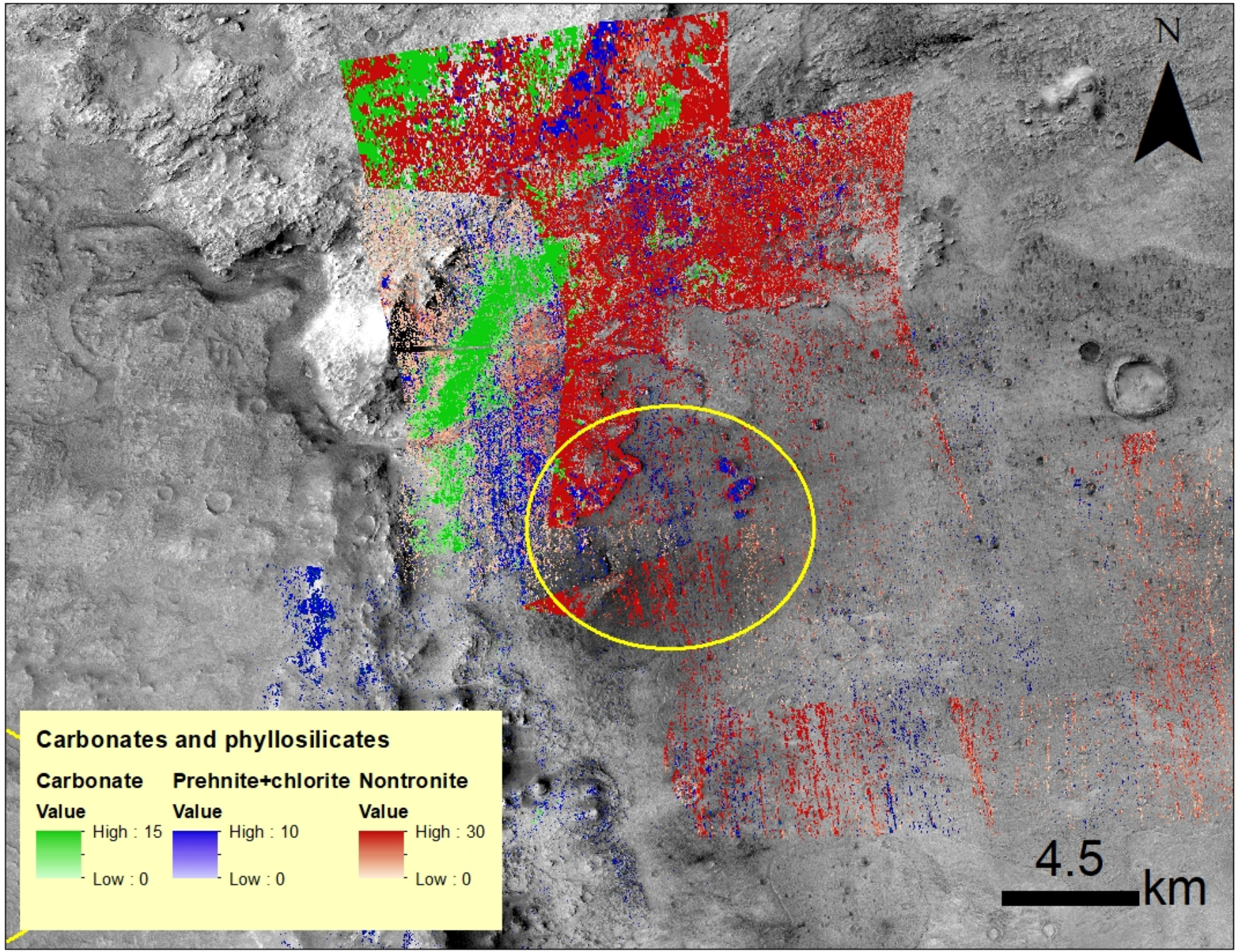
- About 30 Map Projected Targeted Reduced Data Records (MTRDR files) used.
  - Photometric / atmospheric opacity correction
  - Empirical smile correction
  - Geometric reconciliation
- Analyzed Gusev, NE Syrtis, Jezero

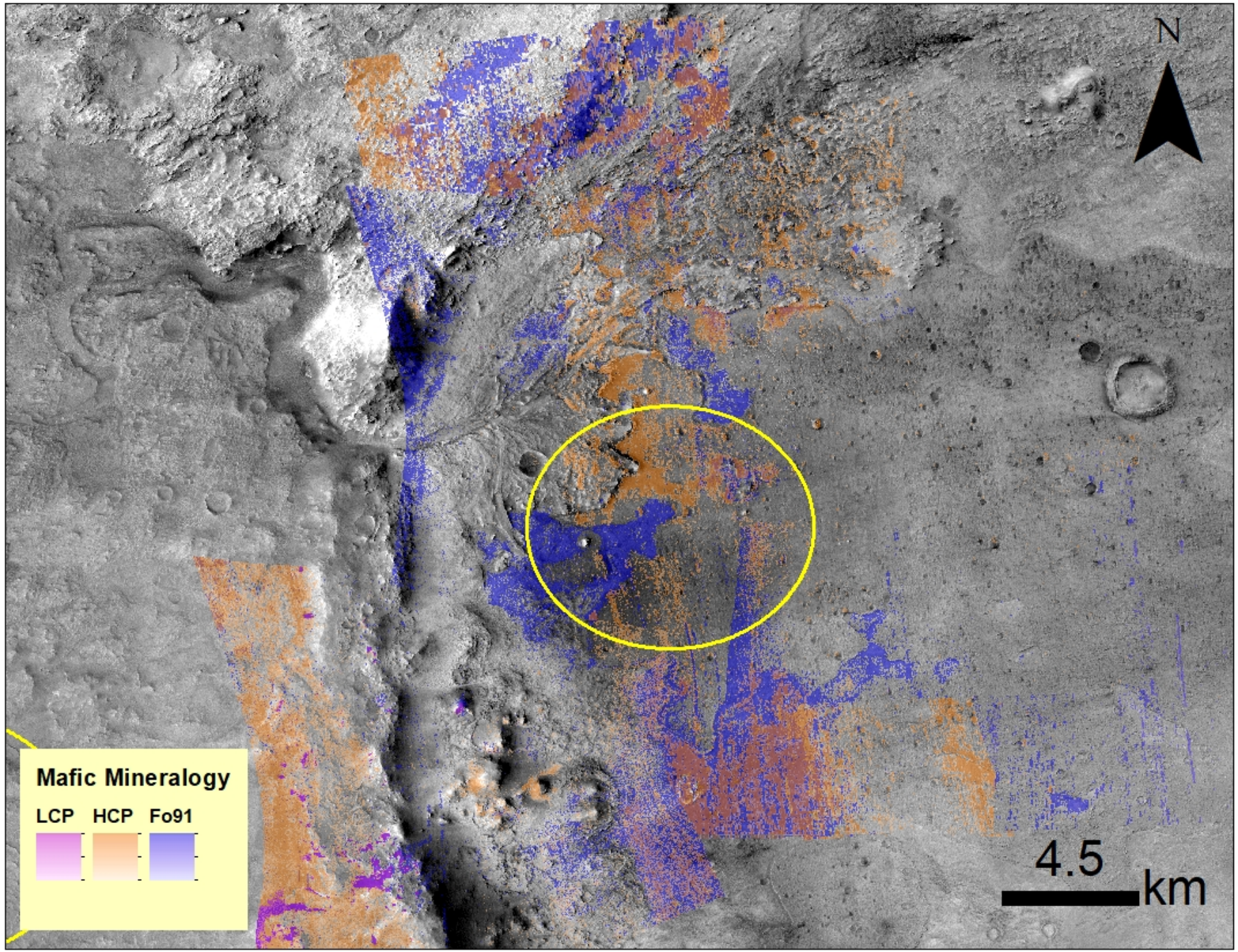



Comparison CRISM Jarosite
Copiapite GDS
Jarosite GDS9
SE Outcrop NI
Relative Reflectance (Offset for clarity)
1000
1500
2000
2500
Wavelength (nm)


SW Outcrop NE Syrtis
Talc HS21.3B
Heulandite GD
Eugsterite GD
HYDROMAGNES
DOLOMITE F1C
Ehlmann hydr
SW outcrop
Relative Reflectance (Offset for clarity)
1200
1400
1600
1800
2000
2200
2400
2600
Wavelength


N
10
km


N
Carbonates and phyllosilicates
Carbonate
Value
High : 15
Low : 0
Prehnite+chlorite
Value
High : 10
Low : 0
Nontronite
Value
High : 30
Low : 0
4.5
km


N
Mafic Mineralogy
LCP
HCP
Fo91
4.5
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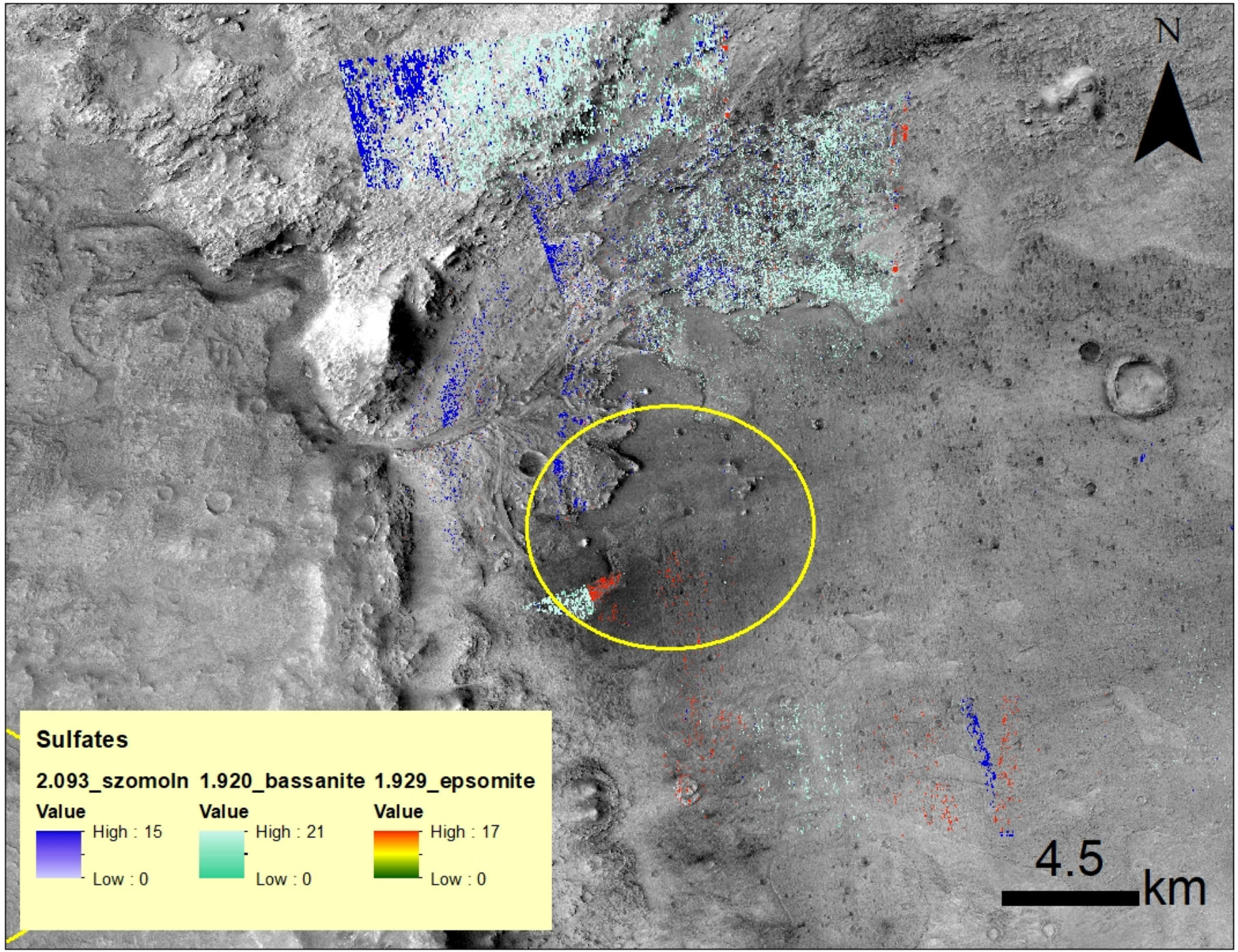
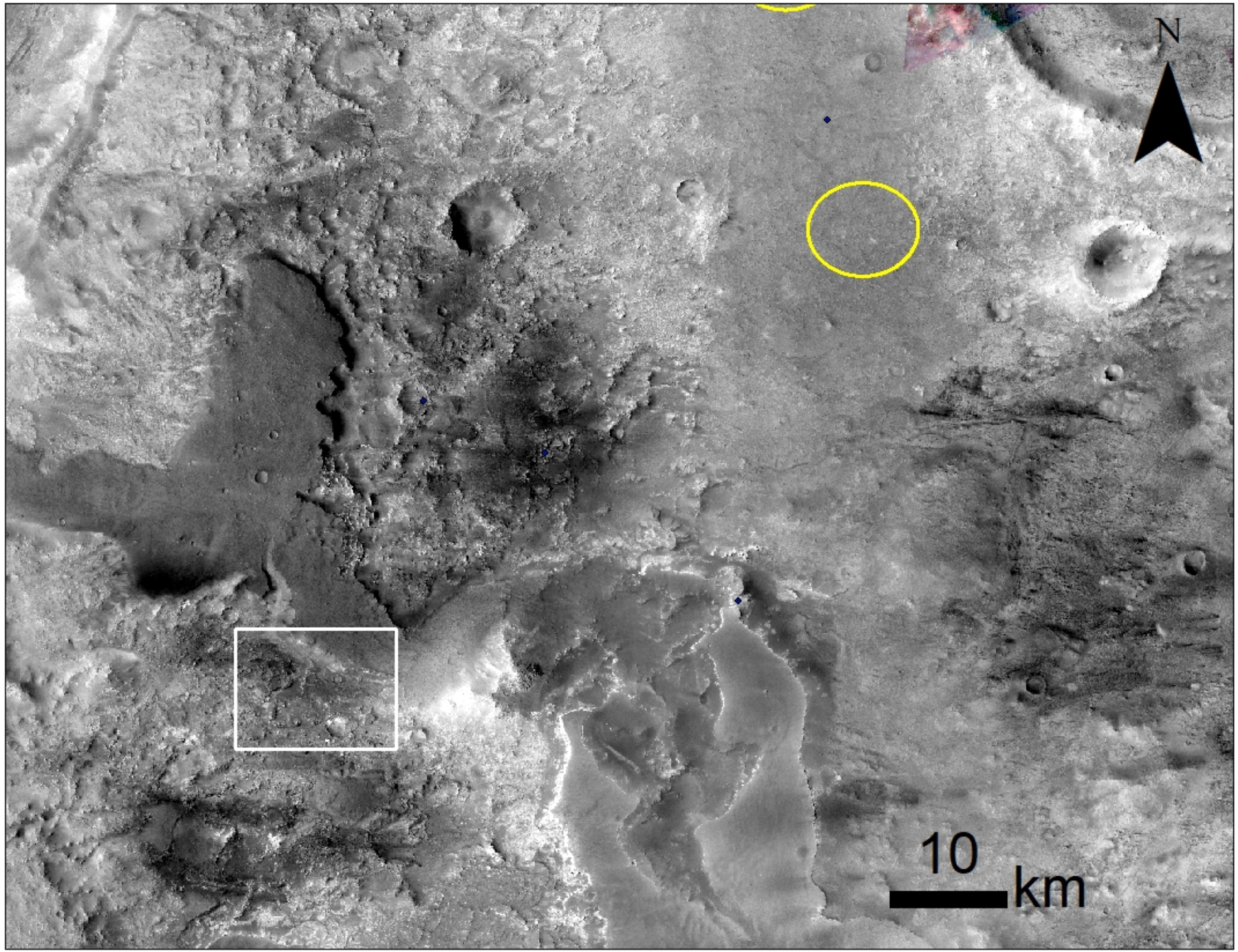
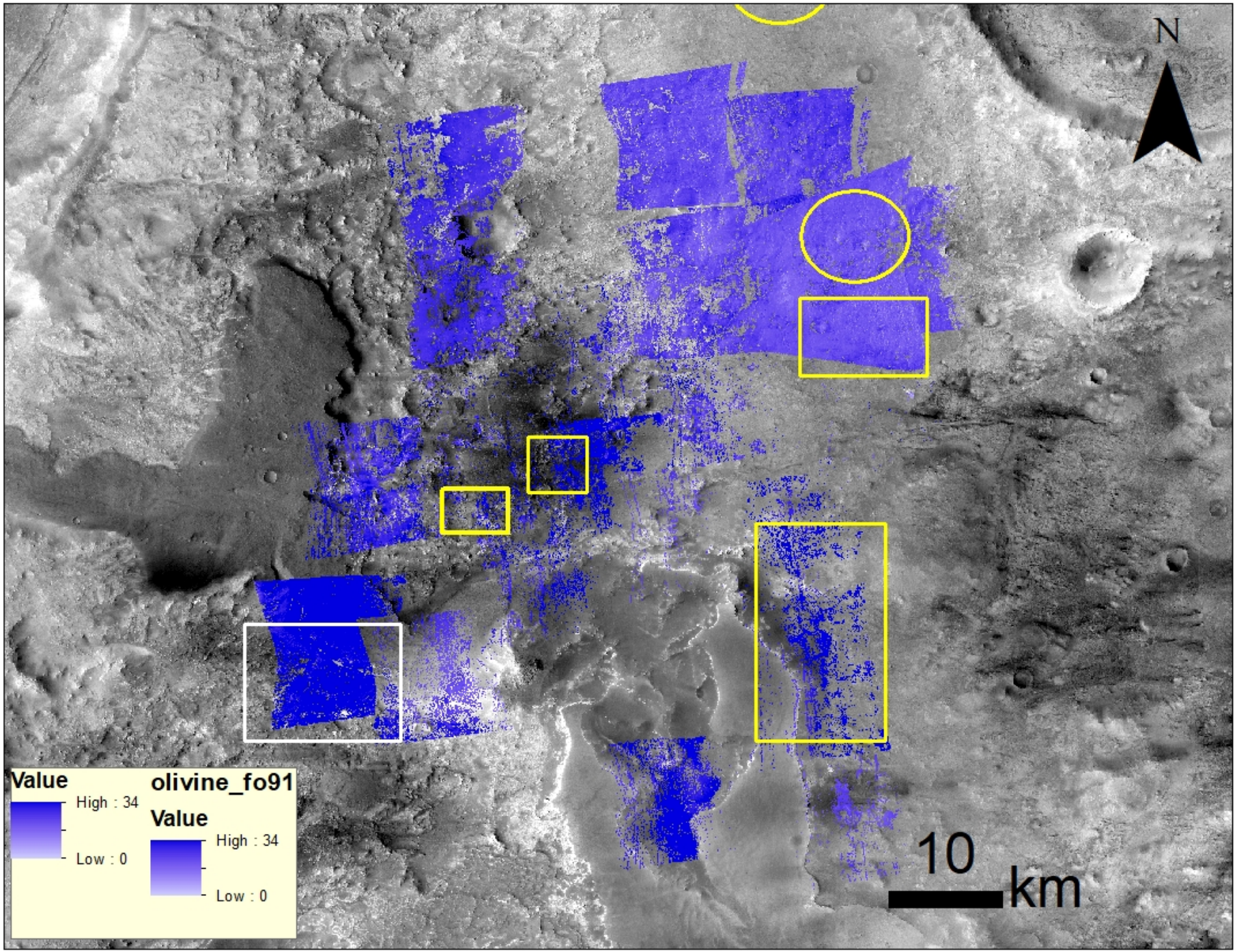
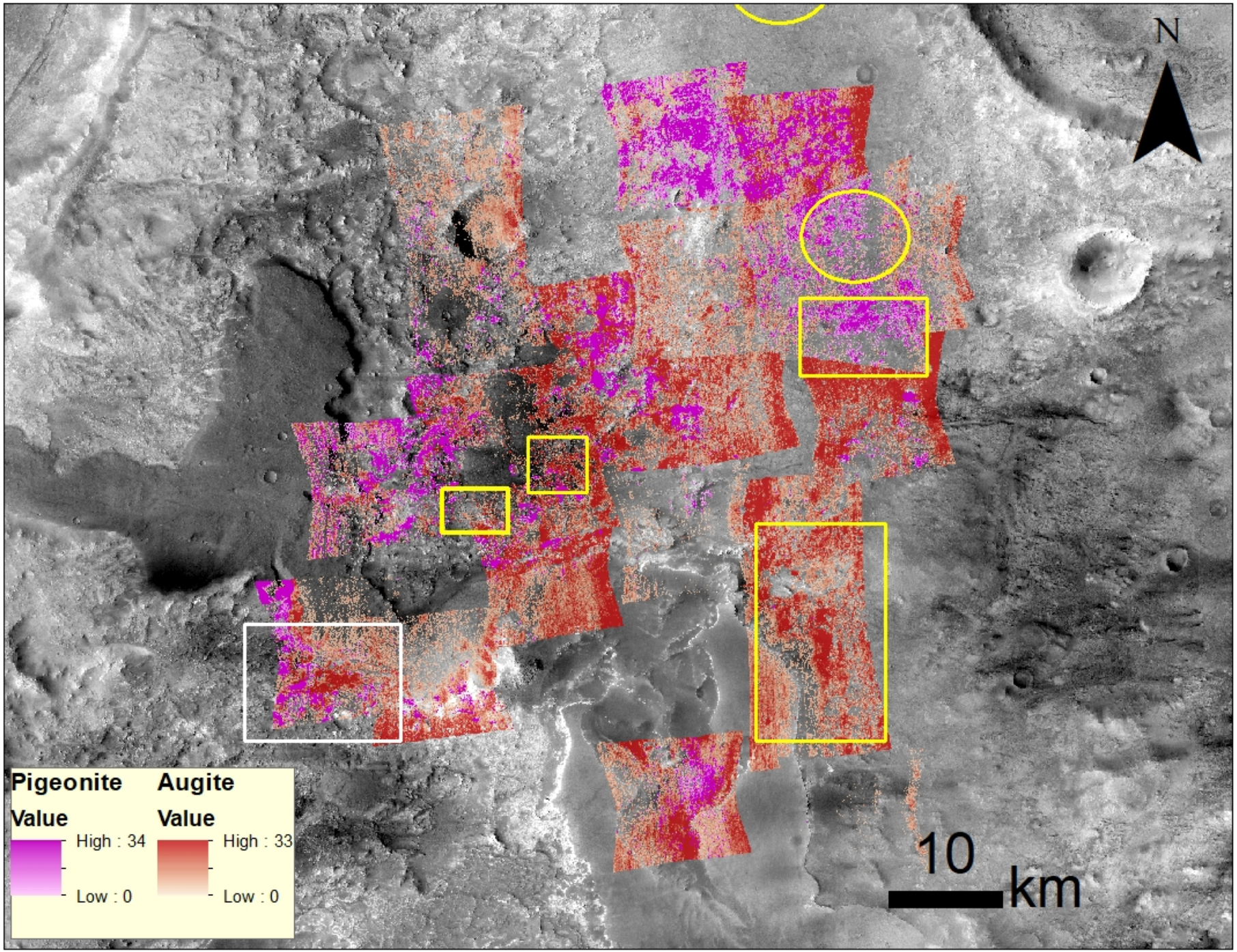
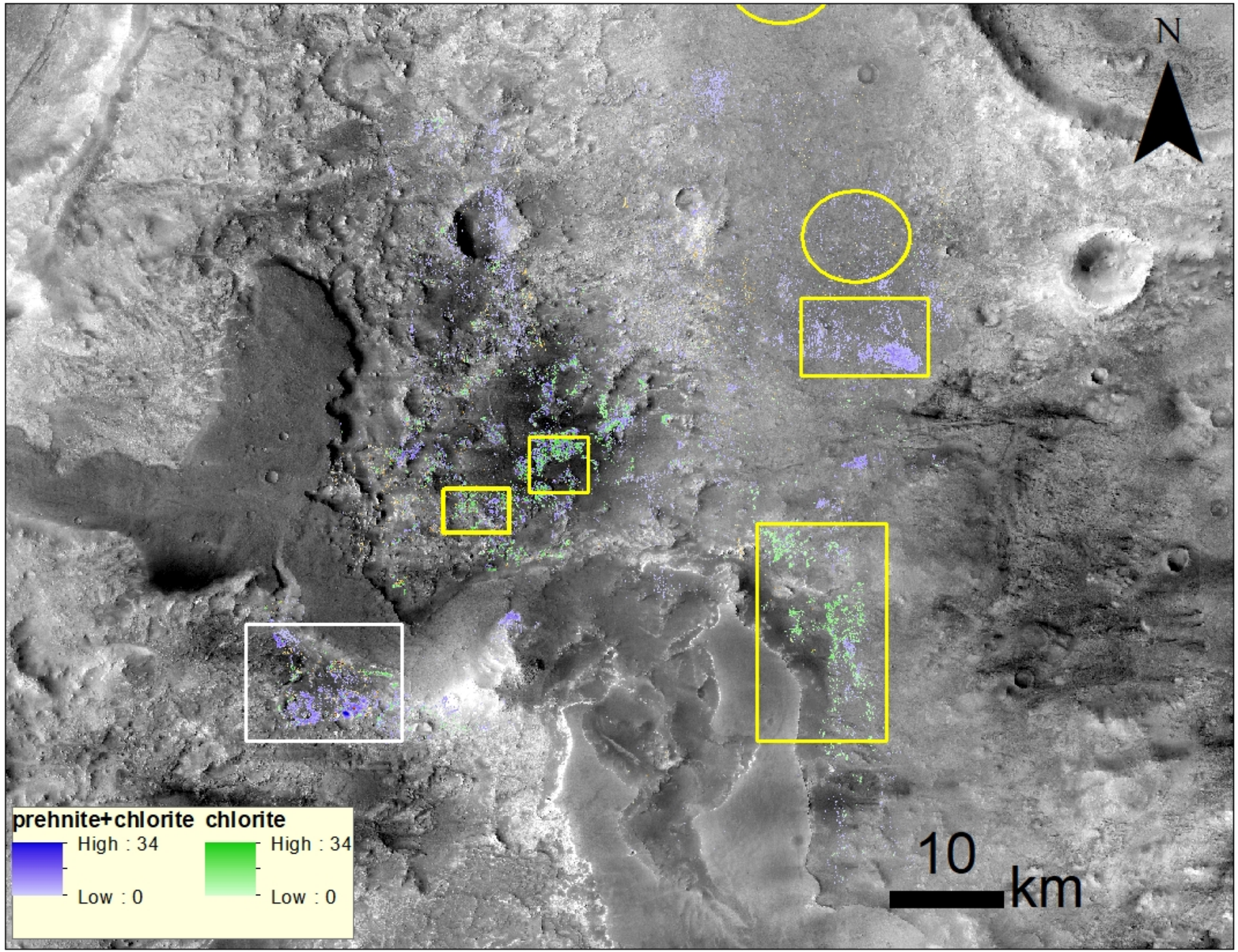
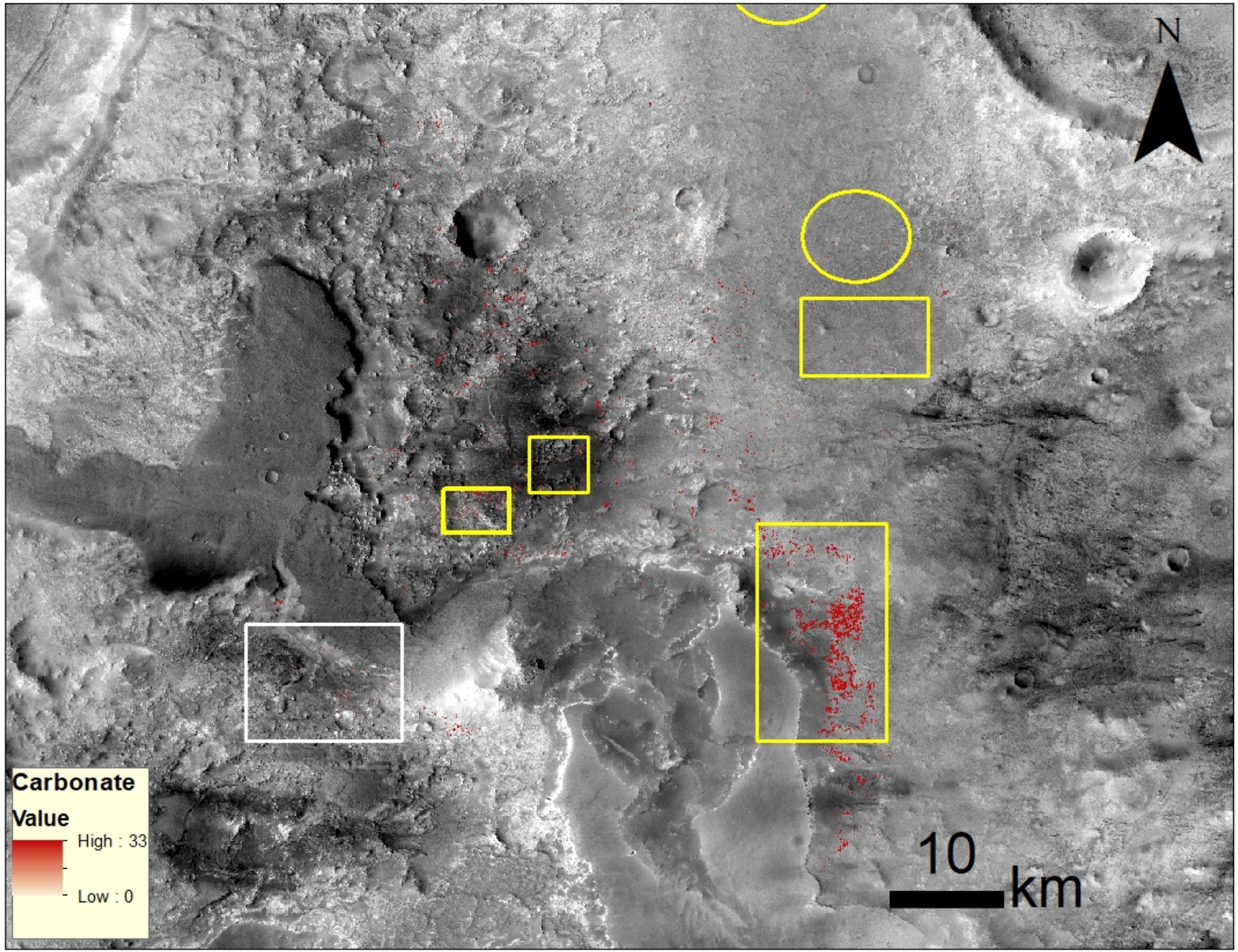

N
Sulfates
2.093_szomoln
Value
High : 15
Low : 0
1.920_bassanite
Value
High : 21
Low : 0
1.929_epsomite
Value
High : 17
Low : 0
4.5
km

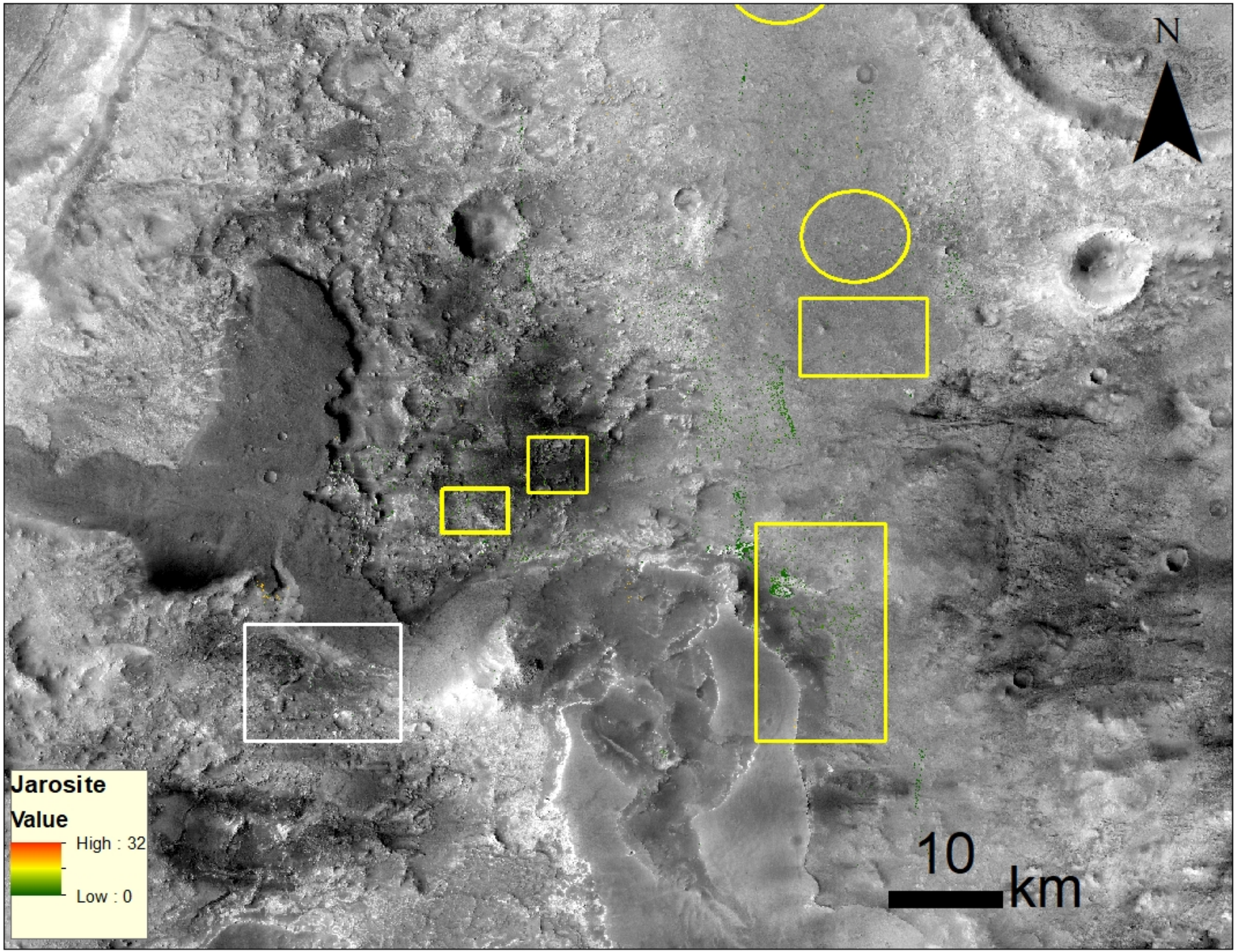

N
10
km

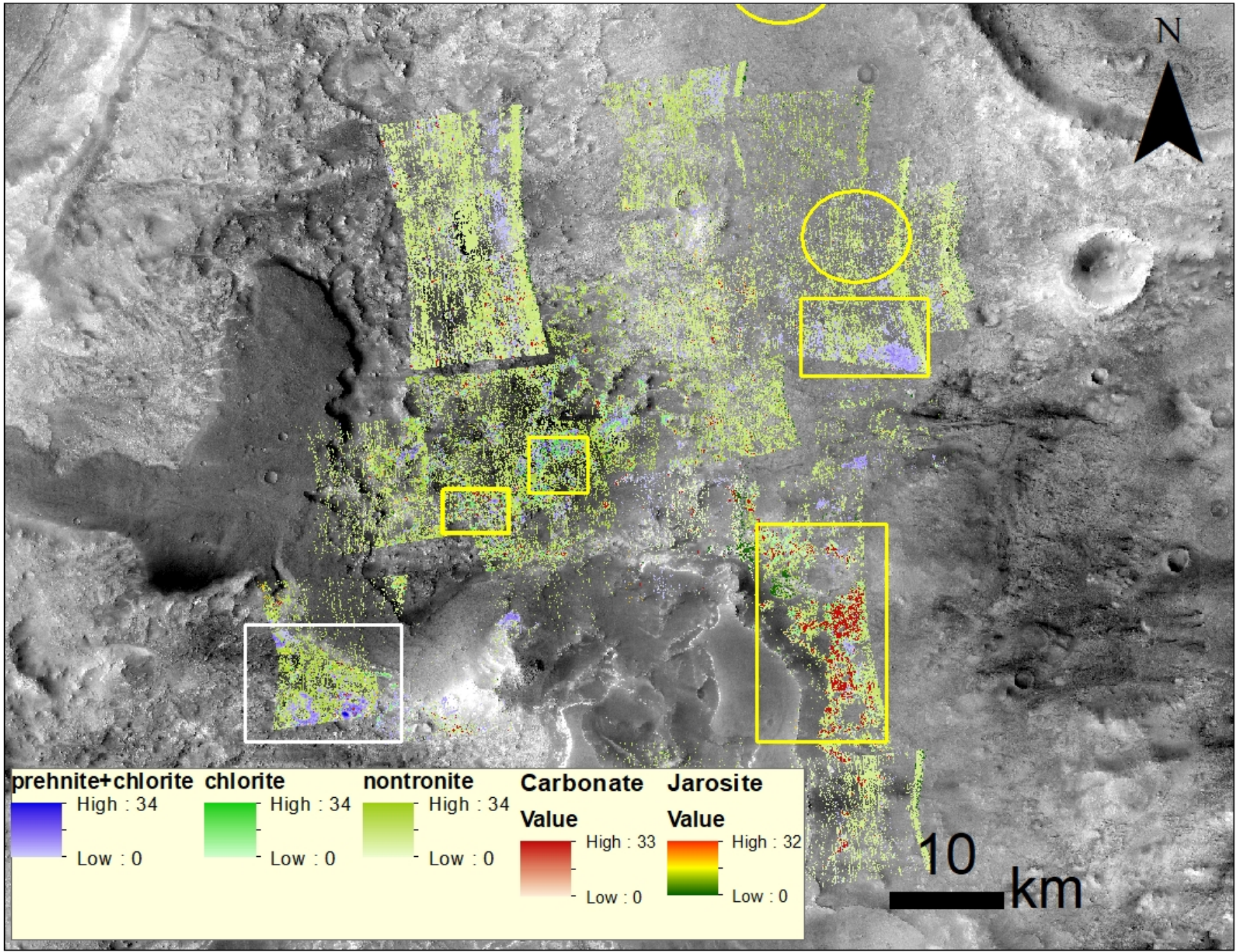

N
Value
High : 34
Low : 0
olivine_fo91
Value
High : 34
Low : 0
10
km

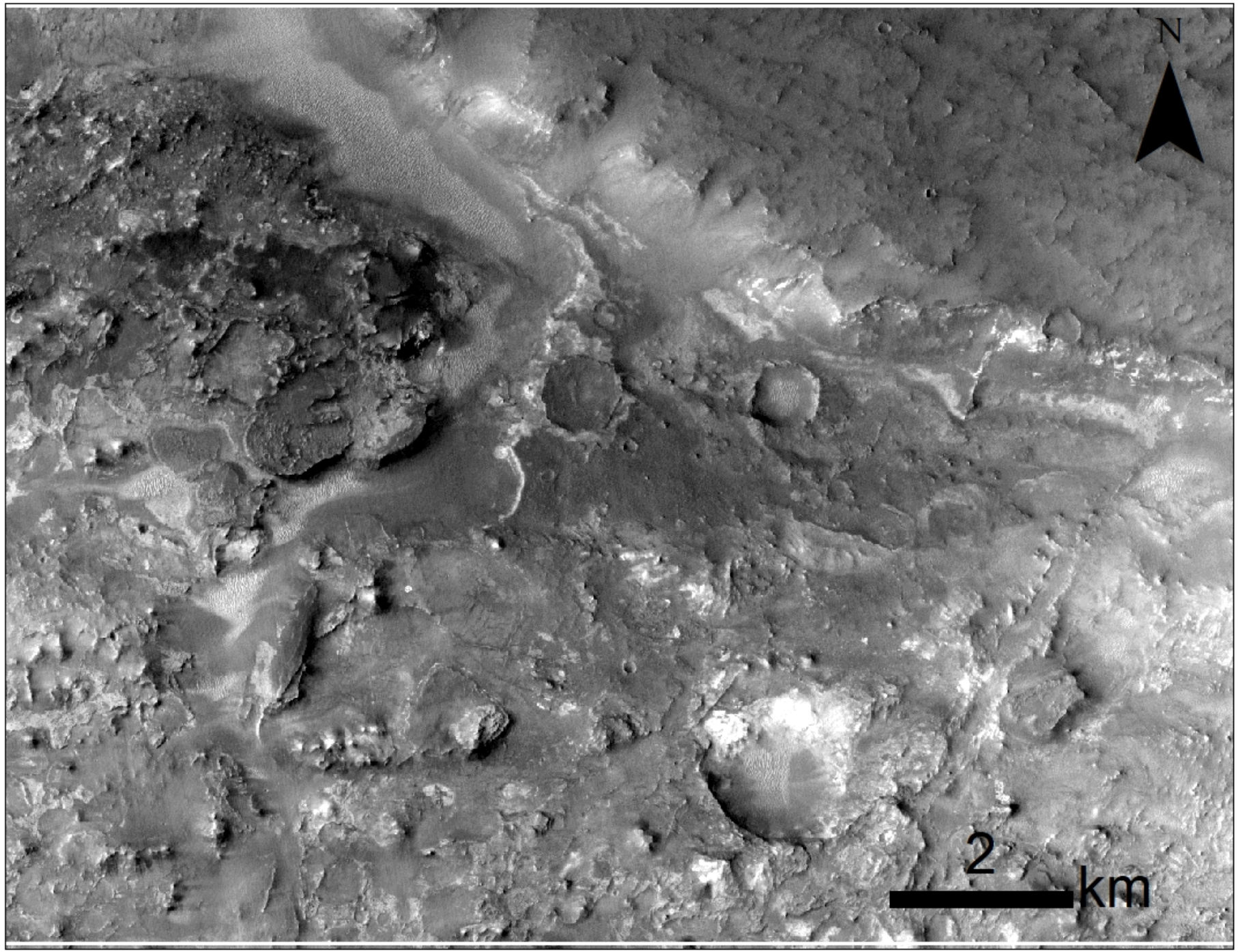

N
Pigeonite
Value
High : 34
Low : 0
Augite
Value
High : 33
Low : 0
10
km

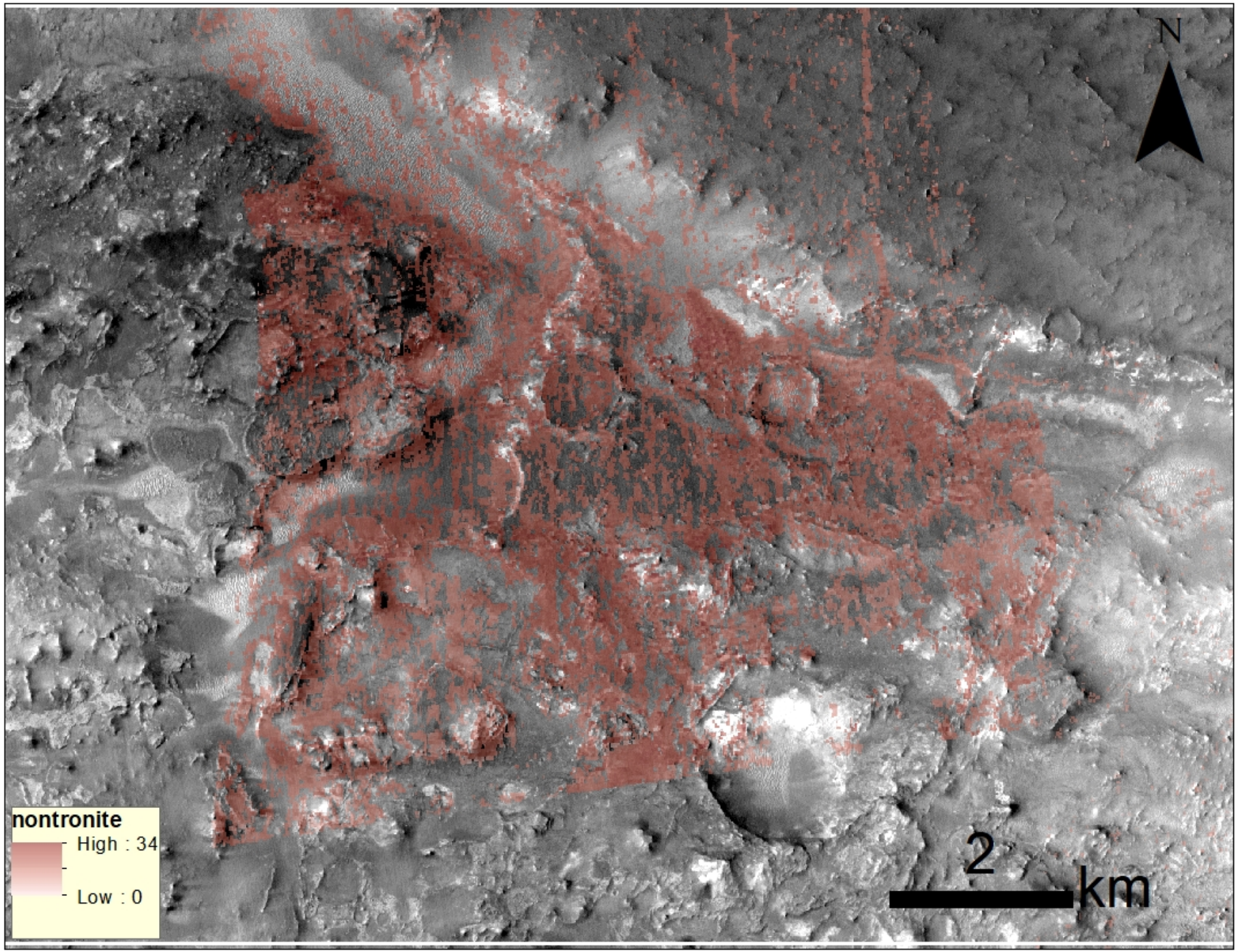

N
prehnite+chlorite
High : 34
Low : 0
chlorite
High : 34
Low : 0
10
km

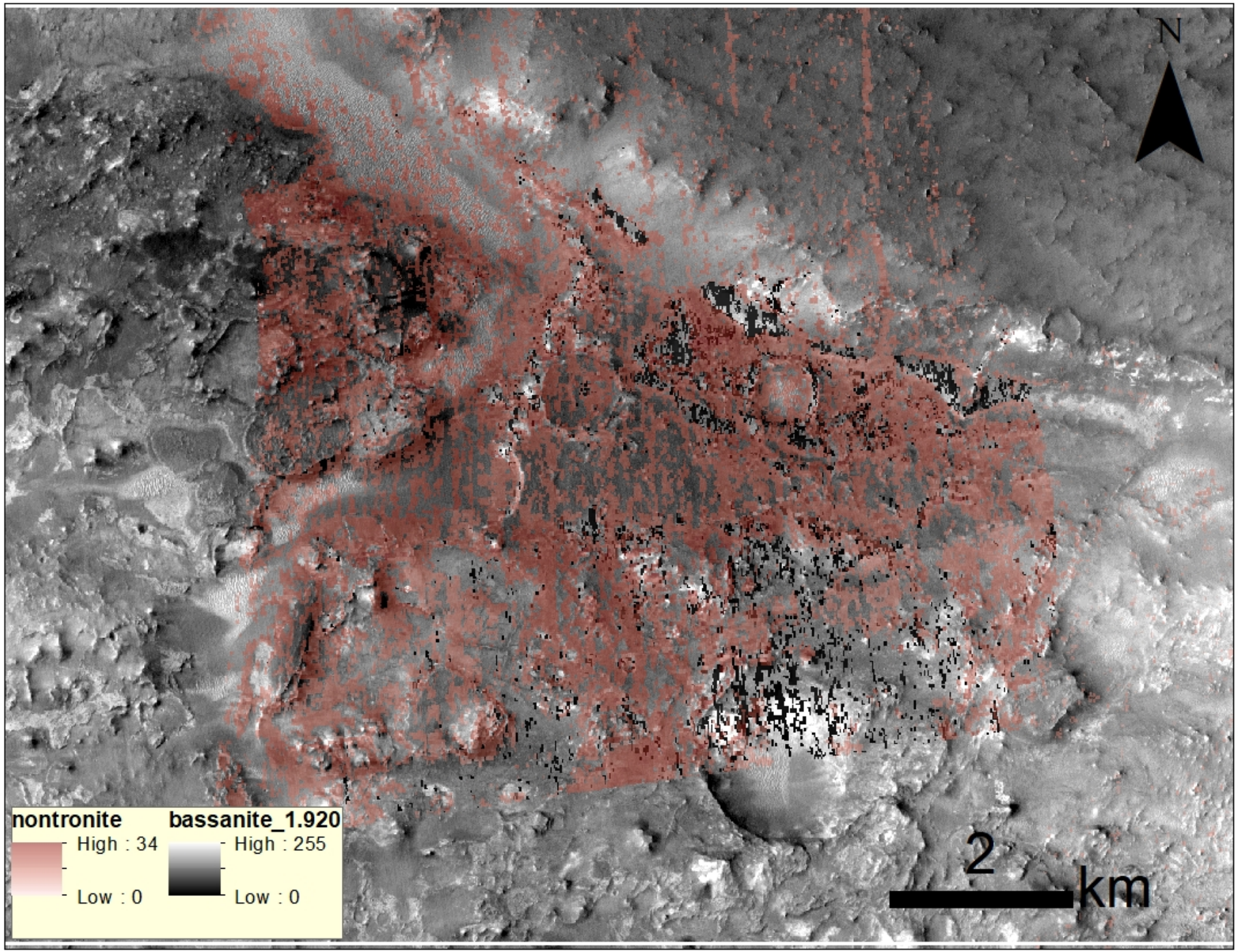

N
Carbonate
Value
High : 33
Low : 0
10
km

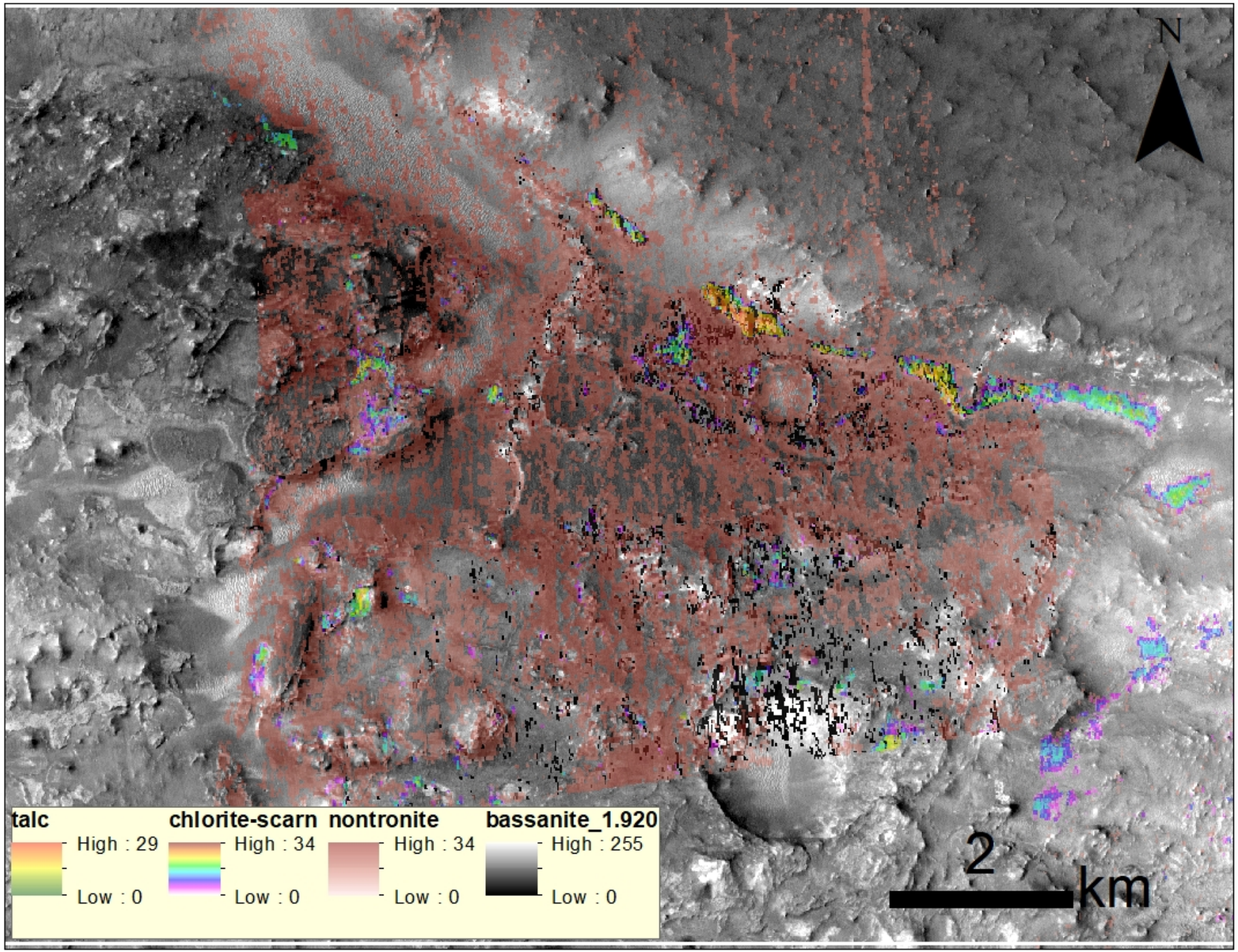

N
Jarosite
Value
High : 32
Low : 0
10
km

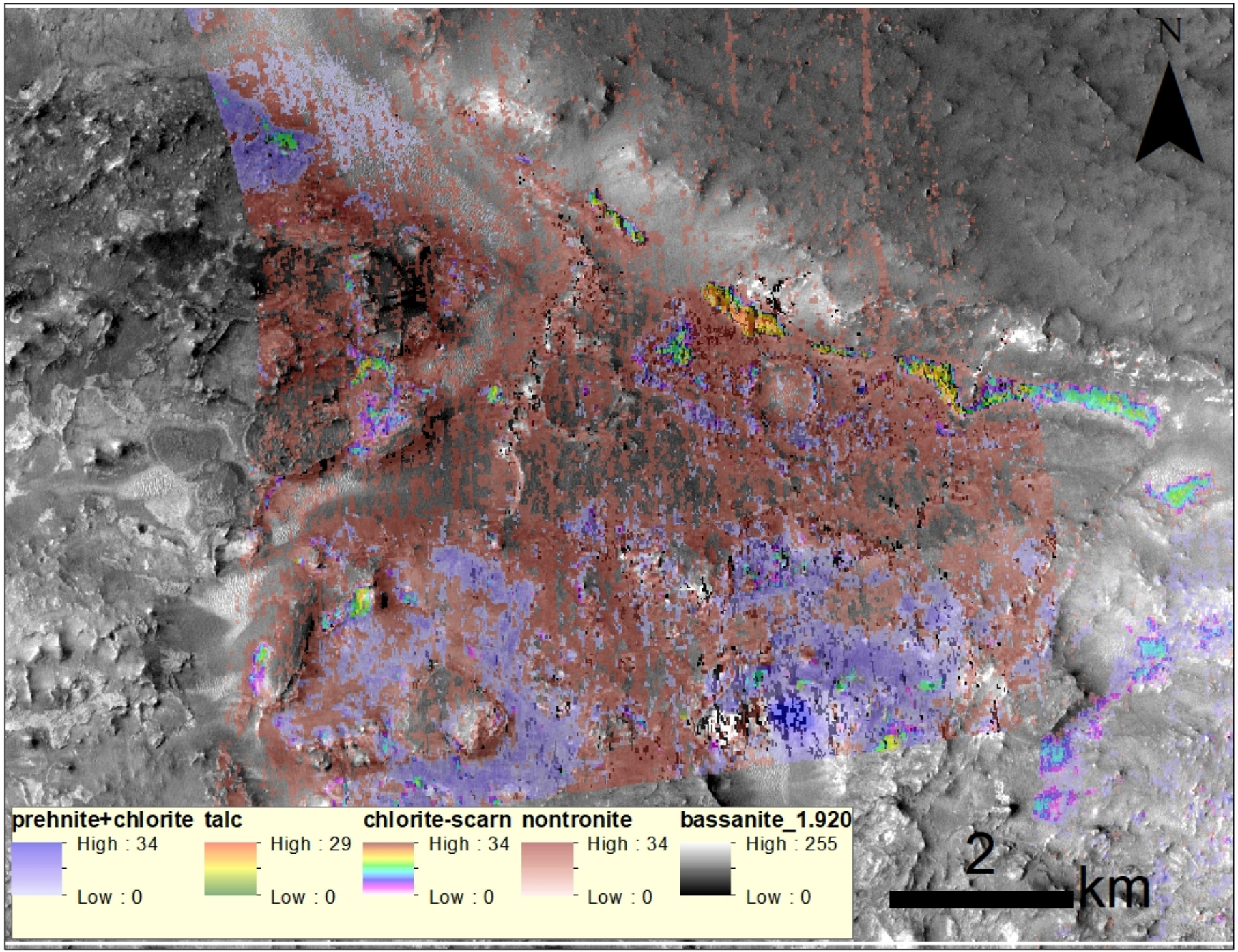

N
prehnite+chlorite
High : 34
Low : 0
chlorite
High : 34
Low : 0
nontronite
High : 34
Low : 0
Carbonate
Value
High : 33
Low : 0
Jarosite
Value
High : 32
Low : 0
10
km


N
2
km


N
nontronite
High : 34
Low : 0
2
km


N
nontronite
High : 34
Low : 0
bassanite_1.920
High : 255
Low : 0
2
km


N
talc
High : 29
Low : 0
chlorite-scarn
High : 34
Low : 0
nontronite
High : 34
Low : 0
bassanite_1.920
High : 255
Low : 0
2
km


N
prehnite+chlorite
High : 34
Low : 0
talc
High : 29
Low : 0
chlorite-scarn
High : 34
Low : 0
nontronite
High : 34
Low : 0
bassanite_1.920
High : 255
Low : 0
2
km