EGU General Assembly 2022

UNIONE EUROPEA
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PON RICERCA E INNOVAZIONE 2014 - 2020

First Evaluation of PRISMA Scene for geological mapping: the Dallol hydrothermal area in the salt flat of Danakil Desert, NE Ethiopia

Francesca Mancini[1,2], Adriano Tullo[1,4], Pascal Allemand[3], and Gian Gabriele Ori[1,4]

[1] International Research School of Planetary Sciences, Università "G. d'Annunzio", Pescara, Italy

[2] Dipartimento di Ingegneria e Geologia, Università "G. D'Annunzio", Pescara, Italy

[3] Université Claude Bernard Lyon 1, ENS Lyon, Université Jean Monnet Saint-Étienne & CNRS, Laboratoire de Géologie de Lyon, Terre Planètes Environnement, UMR 5276, 69100 Villeurbanne, France

[4] Ibn Battuta Centre, Université Cadi Ayyad, Boulevard Abdelkrim Al Khattabi, Marrakech, Morocco

Abstract QR code

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The PRISMA mission (**Precursore IperSpettrale della Missione Applicativa**) is an initiative of the Italian Space Agency (ASI) which has been developed since 2008 and was launched in March 2019.

Table 1: Main technical characteristics of PRISMA (modified from Vangi et al., 2021)

	PAN	VNIR	SWIR
GSD	5 m	30 m	30 m
Spectral Range	400-700 nm	400-1010 nm	920-2500 nm
Bands		66	173

PRISMA logo

Spectral Profile
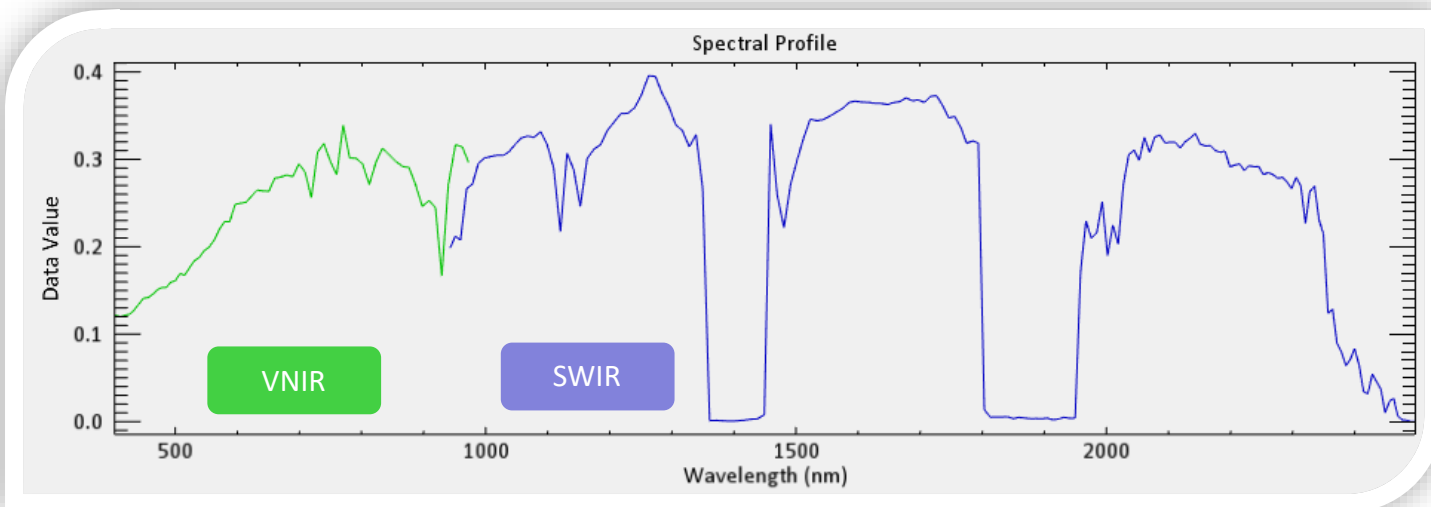
Three different levels of processing (*PRISMA User Manual*):

- **L0**: raw data in binary files including instrument and satellite ancillary data, like the cloud cover percentage;

- **L1**: top-of-atmosphere6 radiance imagery with 2 radiometrically calibrated7 and 2 coregistered hyp/pan radiance cubes;

- **L2B**: atmospheric correction + geolocation of L1 => bottom-of-atmosphere radiance;

- **L2C**: further atmospheric correction + geolocation => bottom-of-atmosphere reflectance (including optical thickness & water vapor map);

- **L2D**: geocoding of L2C (orthorectification).

Our analysis of PRISMA imagery was mainly performed on an arid environment in NE Ethiopia (**Dallol**; Long: 40.299351, Lat: 14.244367). One advantage of this area is that the nebulosity is generally low, in fact the image selected during the dry season has a cloud coverage percentage less than 1%.
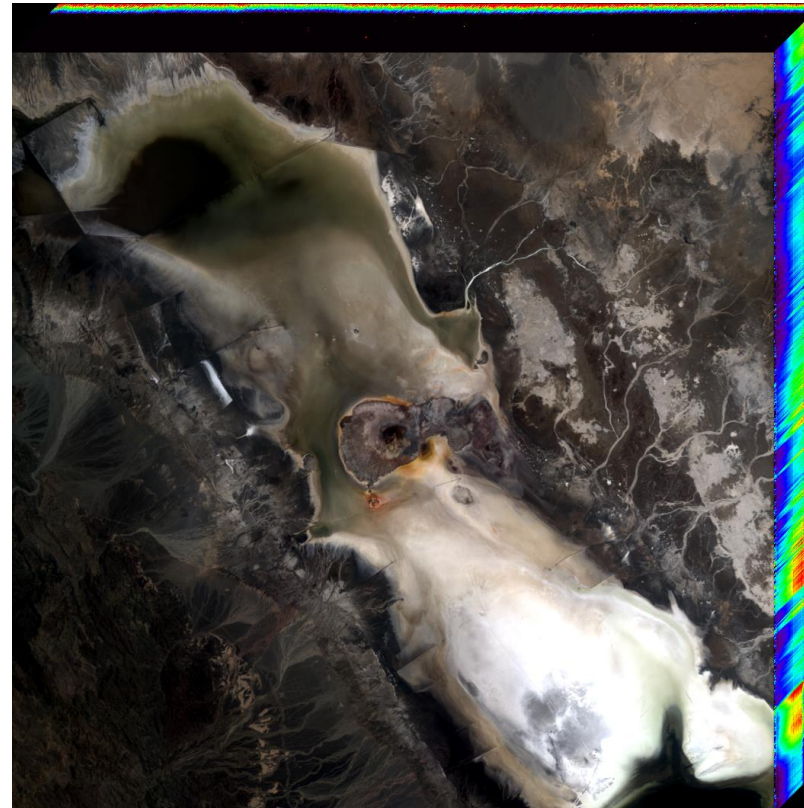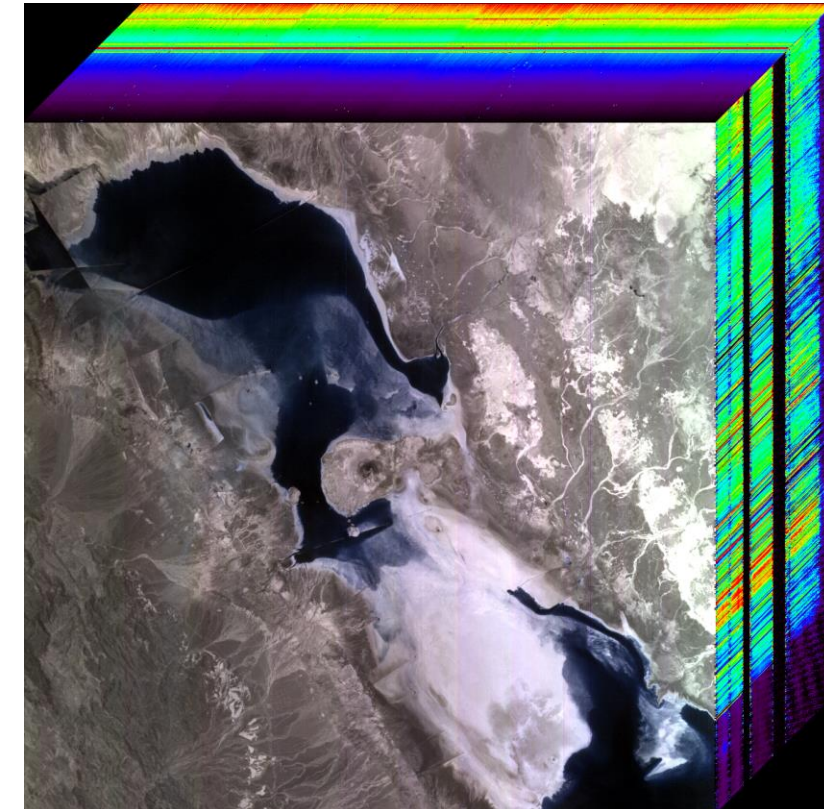
21-08-2021 PRISMA cube - Cloud coverage: 0.0026 %

PAN L2D product
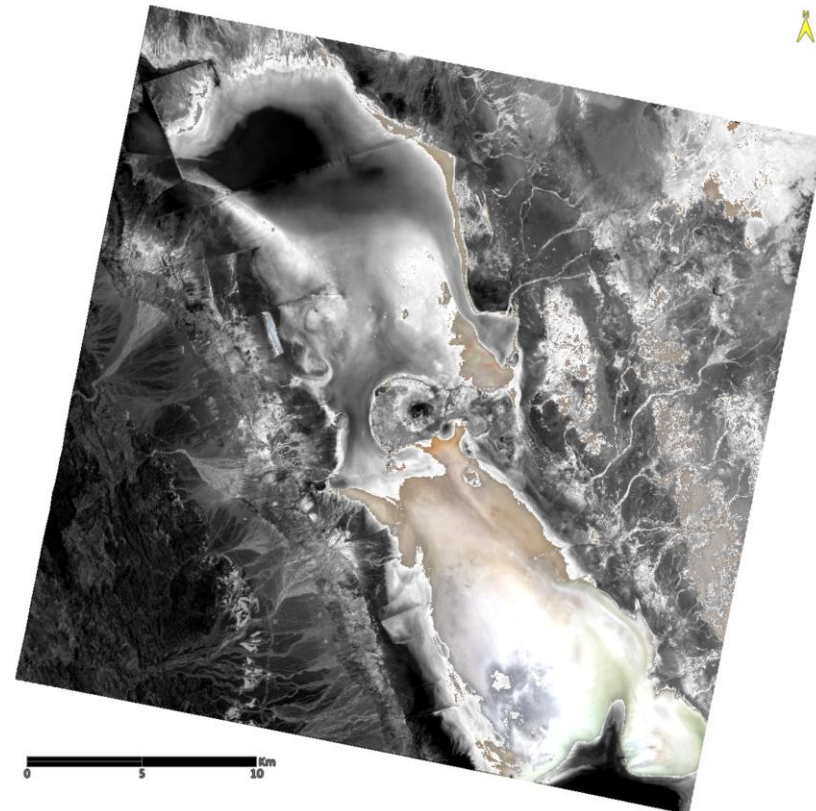
VNIR 3D build Cube

SWIR 3D build Cube

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Mount Dallol is situated in the Danakil Depression, which is part of the East African Rift System. In the selected site, a salt suite was deposited and re-worked by hydrothermalism. The characteristic minerals of the area are: carbonate, halite, carnallite, anhydrite, gypsum, native sulfur of hydrothermal origin.
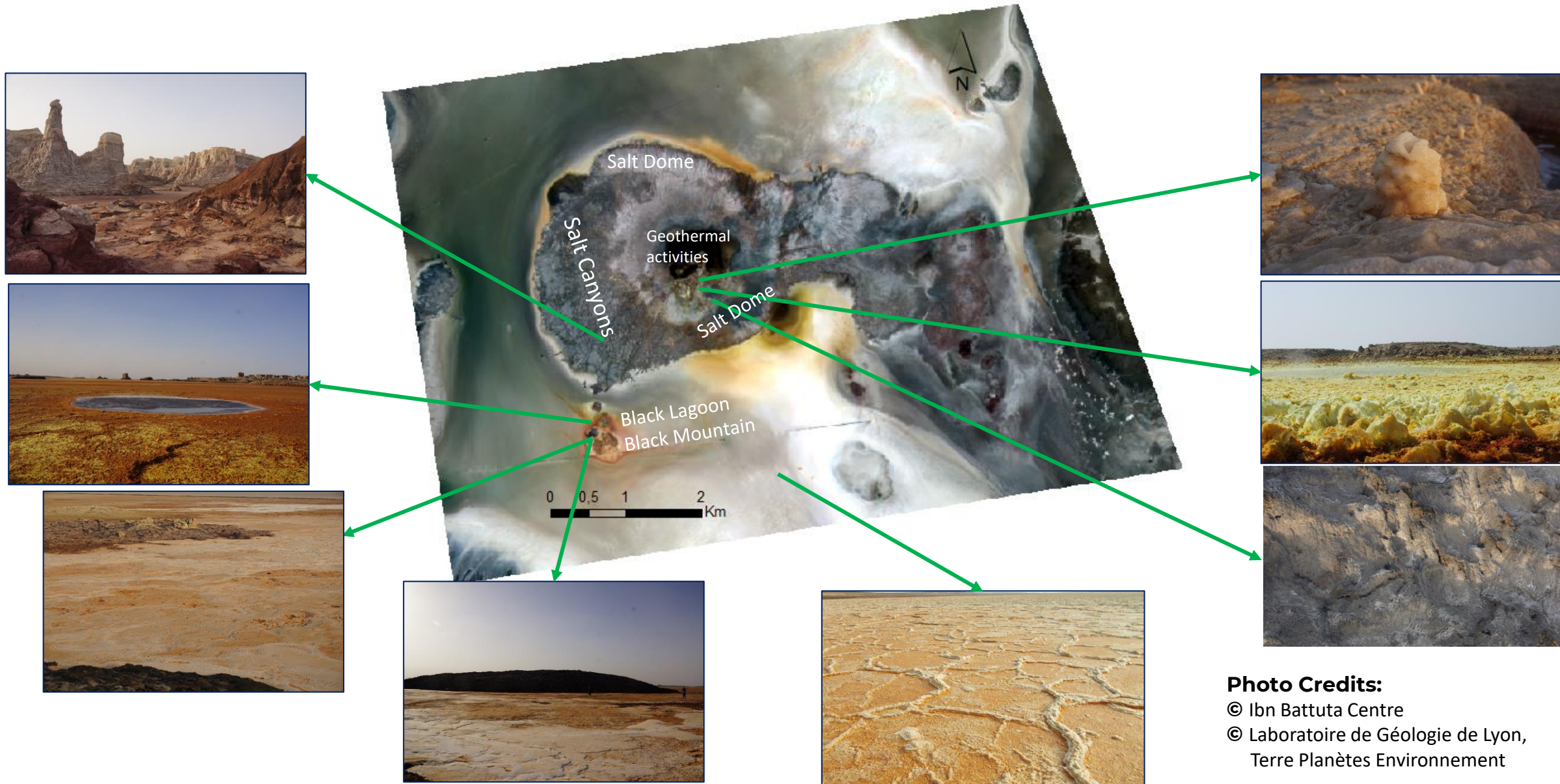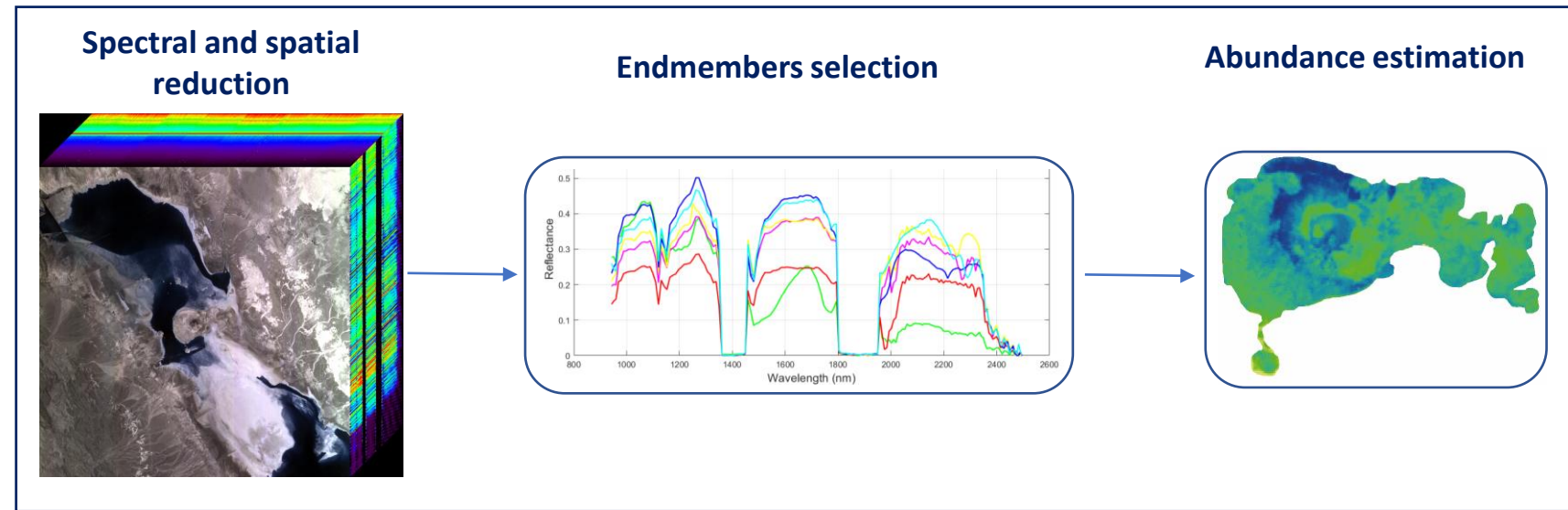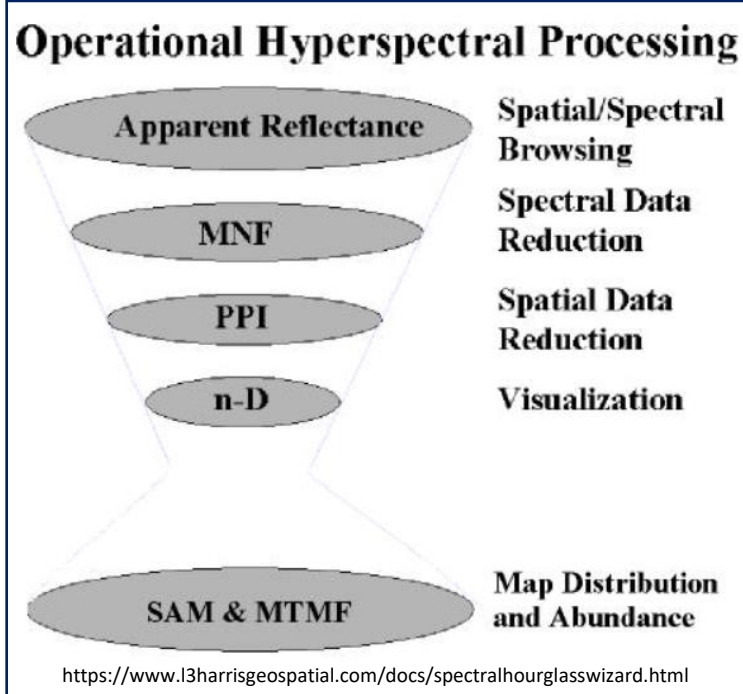

Salt Dome

Salt Canyons

Geothermal activities

Salt Dome

Black Lagoon
Black Mountain

0   0,5   1   2 Km

N

Photo Credits:
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Operational Hyperspectral Processing

Operational Hyperspectral Processing

Apparent Reflectance	Spatial/Spectral Browsing
MNF	Spectral Data Reduction
PPI	Spatial Data Reduction
n-D	Visualization
SAM & MTMF	Map Distribution and Abundance

https://www.l3harrisgeospatial.com/docs/spectralhourglasswizard.html

Spectral and spatial reduction

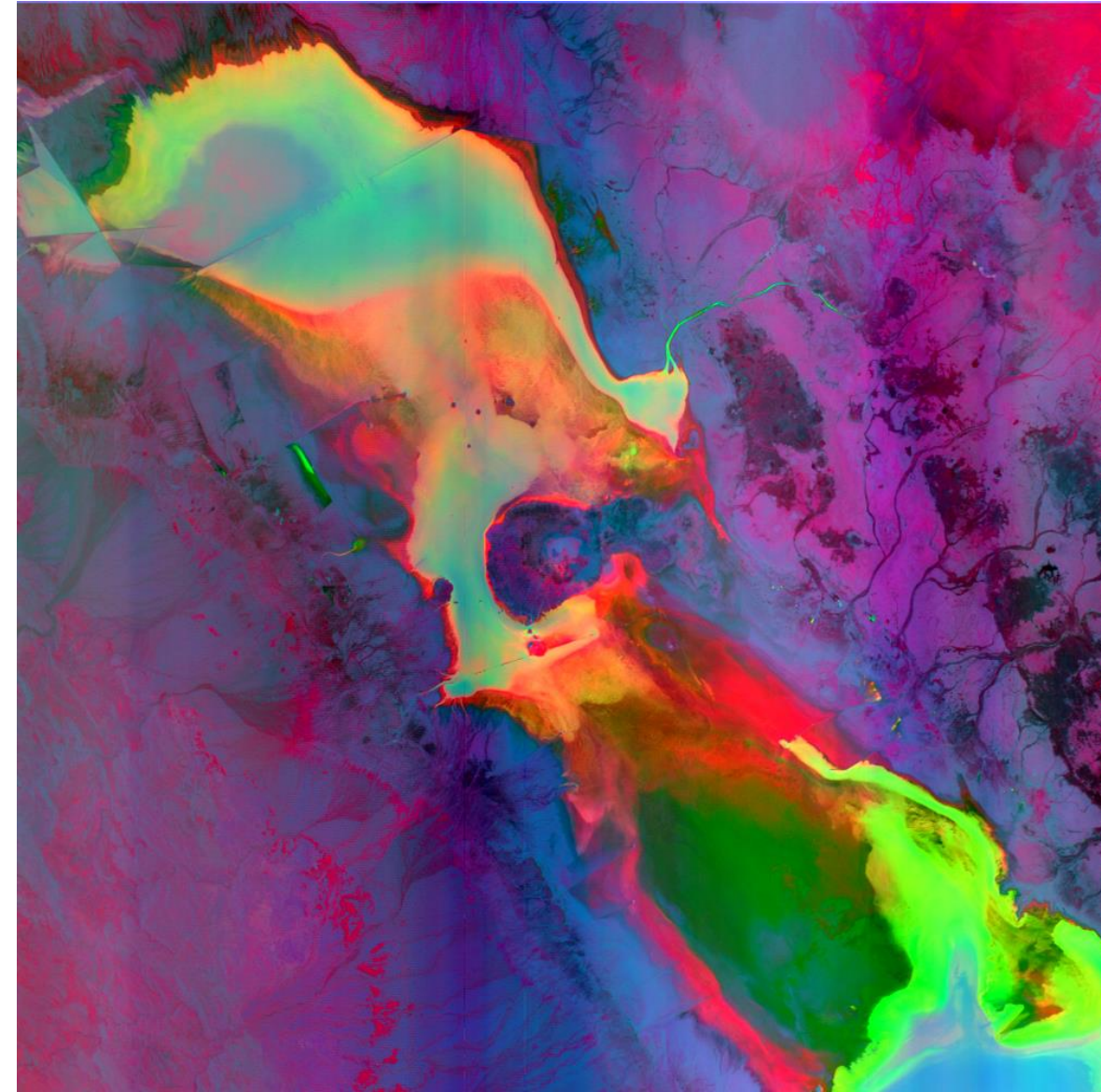**Endmembers selection**

Abundance estimation

The images acquired prior to the image selected for analysis on 21 August 2021 had several preprocessing problems, in particular for stripe removal.
By rotating the 15 May 2021 L2D image or considering the L2C image and applying **SPEAR Vertical Stripe Removal** and **Destripe Raster Data**, no good results were obtained.
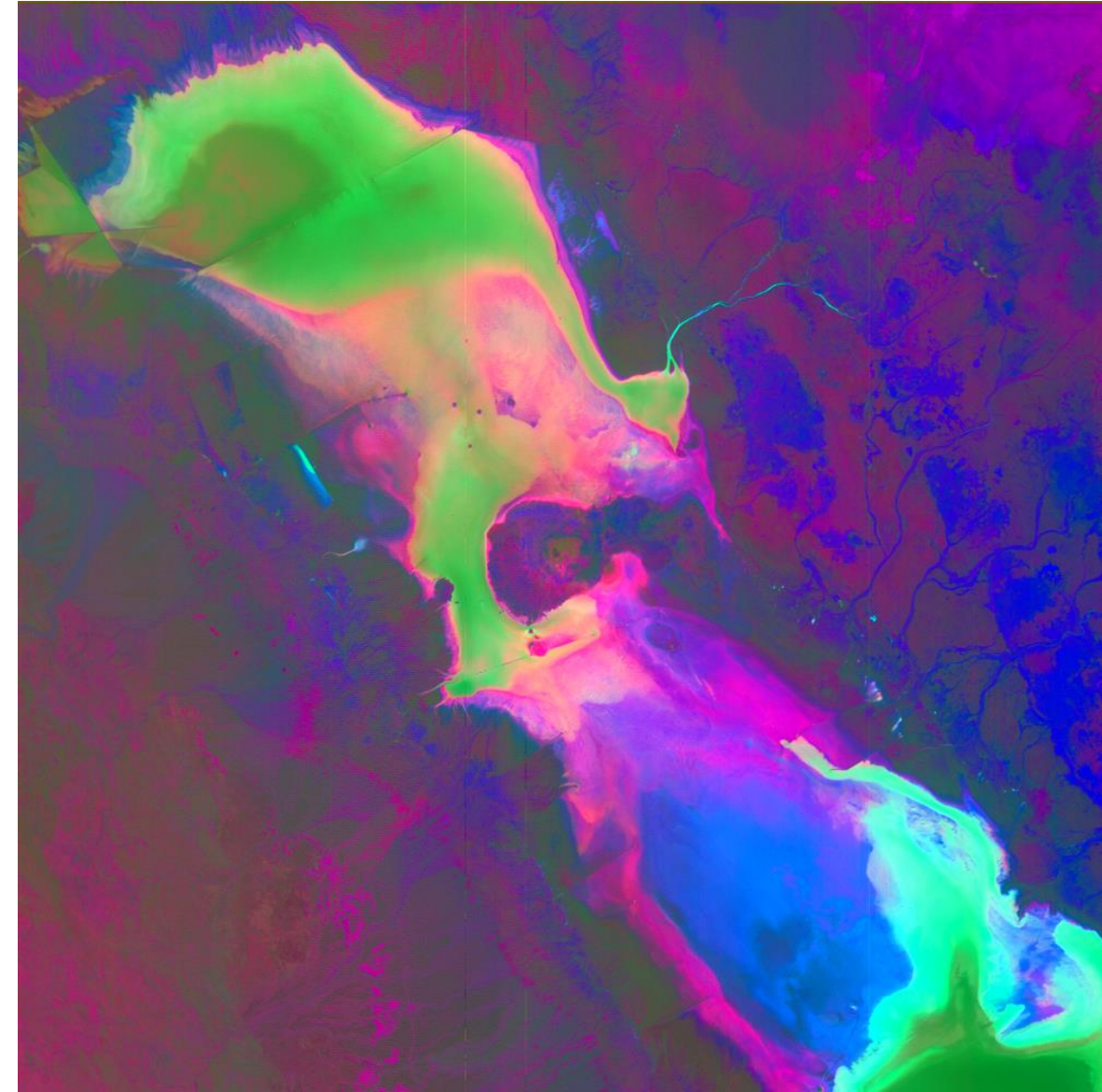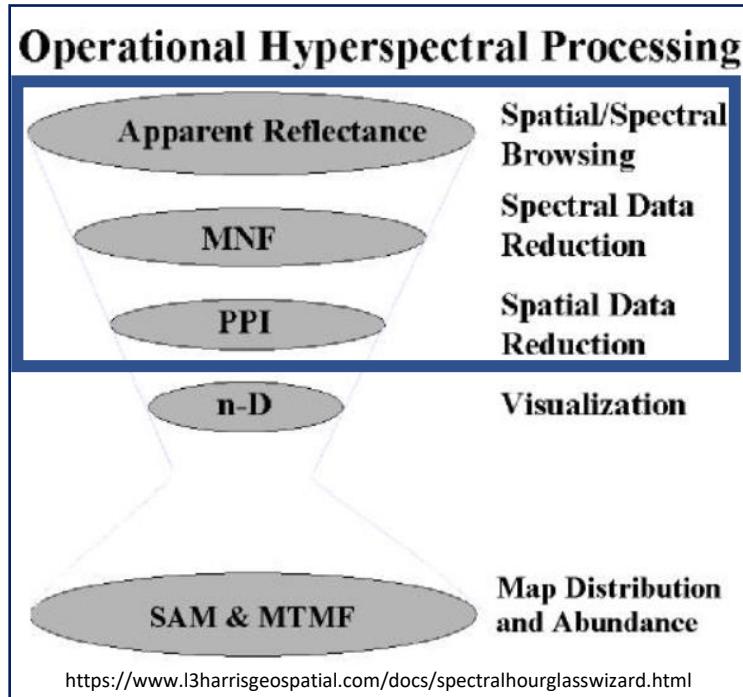
MNF

SAM
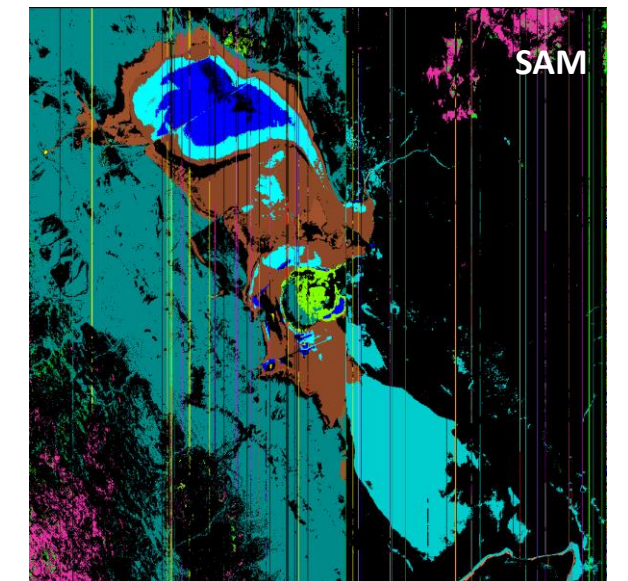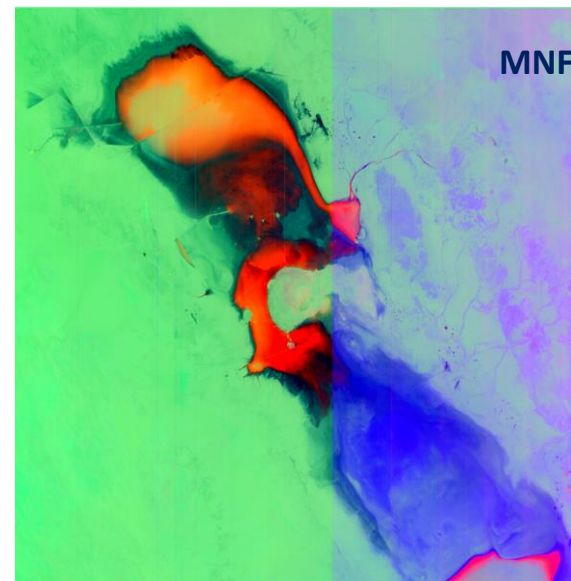
With **THOR Atm Correction:**
Internal Average Relative Reflectance with Dark Subtraction

~~Without **THOR Atm Correction:**~~
~~**Internal Average Relative Reflectance with Dark Subtraction**~~

Operational Hyperspectral Processing

Apparent Reflectance	Spatial/Spectral Browsing
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https://www.l3harrisgeospatial.com/docs/spectralhourglasswizard.html

1) Region of interest (ROI) and Bad Bands Removal

Reduction:
SWIR: 120 bands
VNIR: 62 bands

2) MNF

3) Pixel Purity Index

SAM: n-D class Endmembers Visualization
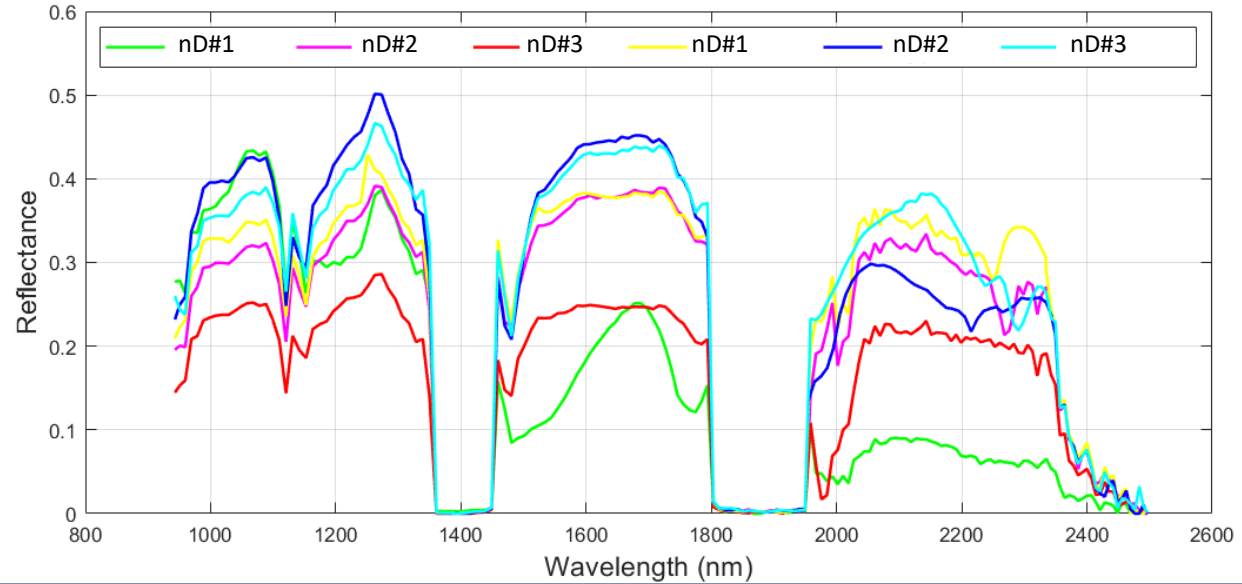

Table 2: THOR Material Hyperspectral Identification

Signature Name	ACE	Library Source
Carnallite_HS430,4B_ASDFRa	0,9003	minerals_asdfr,sli
Jarosite GDS24 Na [W1R1Bb AREF]	0,8729	minerals_beckman_3375,sli
Kainite MgSO4*KCL*3H2O [chloride-none-coarse-kainitc]	0,8548	minerals_usgs_perknic_2756.sli
Polyhalite K2Ca2Mg(SO4)4 * 2H2O [sulfate-none-coarse-polyhac]	0,7934	minerals_usgs_perknic_2756.sli
Gypsum HS333.3B (Selenite) [W1R1Ba AREF]	0,7697	minerals_beckman_3375.sli
Nontronite SWa-1.b <2um [W1R1Ba AREF]	0,7593	minerals_beckman_430.sli

Material Identification

Legend
- Carnallite
- Jarosite
- Kainite
- Polyhalite
- Gypsum
- Nontronite
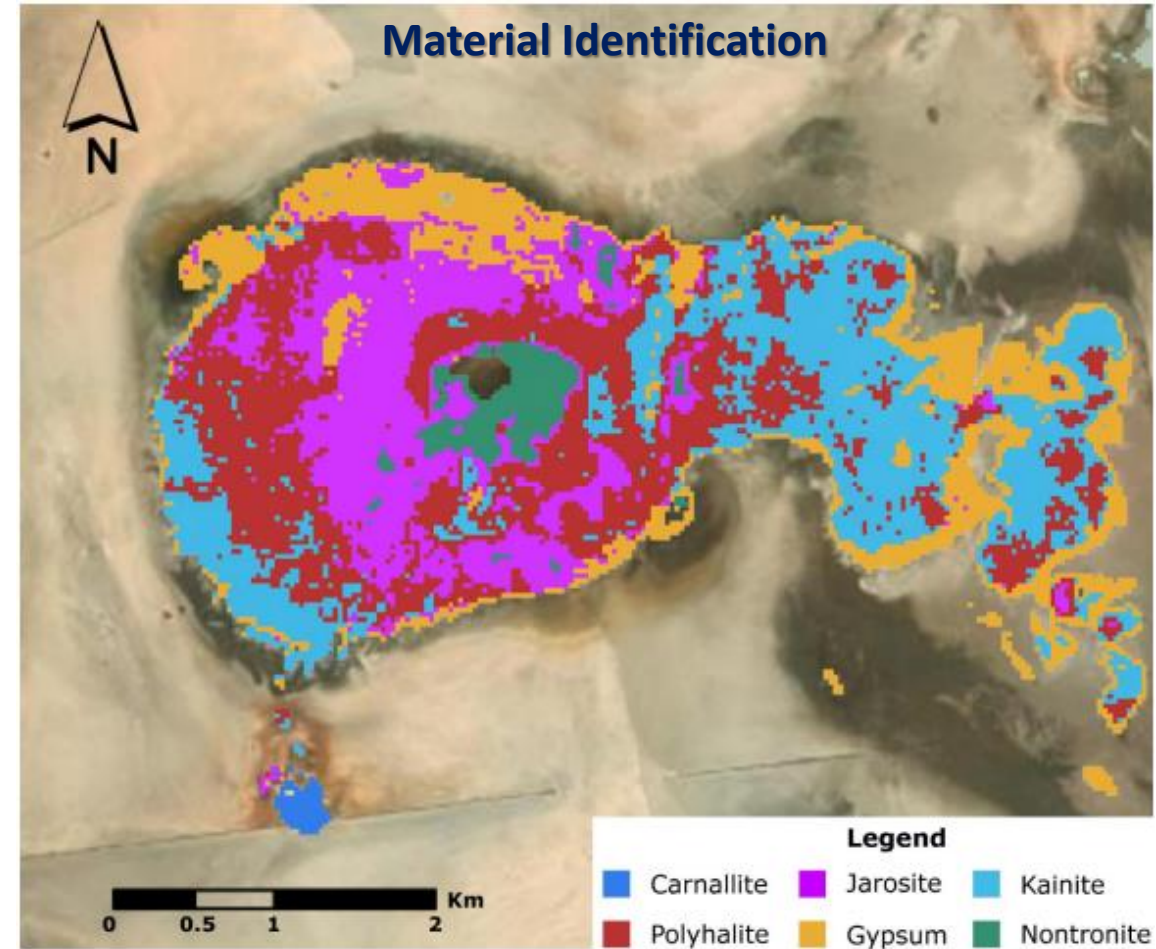
ACE measures if a spectrum is a good match for the spectrum in the selected image. Use ACE to determine candidate materials; that is, materials that may be contained in the pixel. ACE values range from -1 to 1 with scores close to 1 indicating a best match. The spectra in the table are initially sorted by ACE with the best matches listed on top.

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Linear spectral unmixing is a standard technique for spectral mixture analysis that infers a set of endmembers and fractions of these, called abundances.
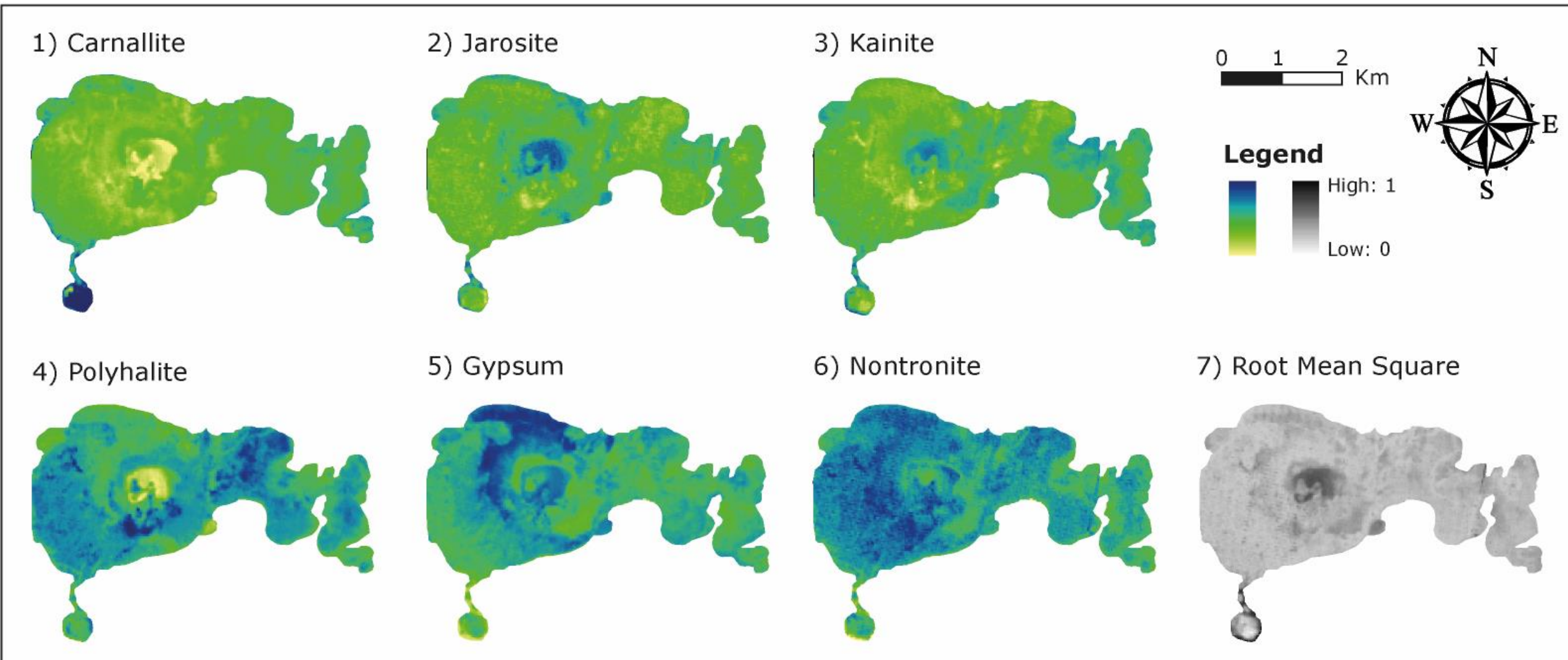
Conclusion

- Additional atmospheric correction on the PRISMA images already corrected allows better highlighting of geomorphological features;

- Endmembers identification and the correspondent minerals obtained good match for the spectrum in the selected image;

- The six recognised minerals are in excellent agreement with the previous studies;

- **PRISMA represents a valuable instrument for distinguishing not only the geometric characteristics, but also the chemical-physical composition of the Earth surface**

Thank you for listening

If you have any feedback, suggestions or questions feel free to contact me:
francesca.mancini@unich.it