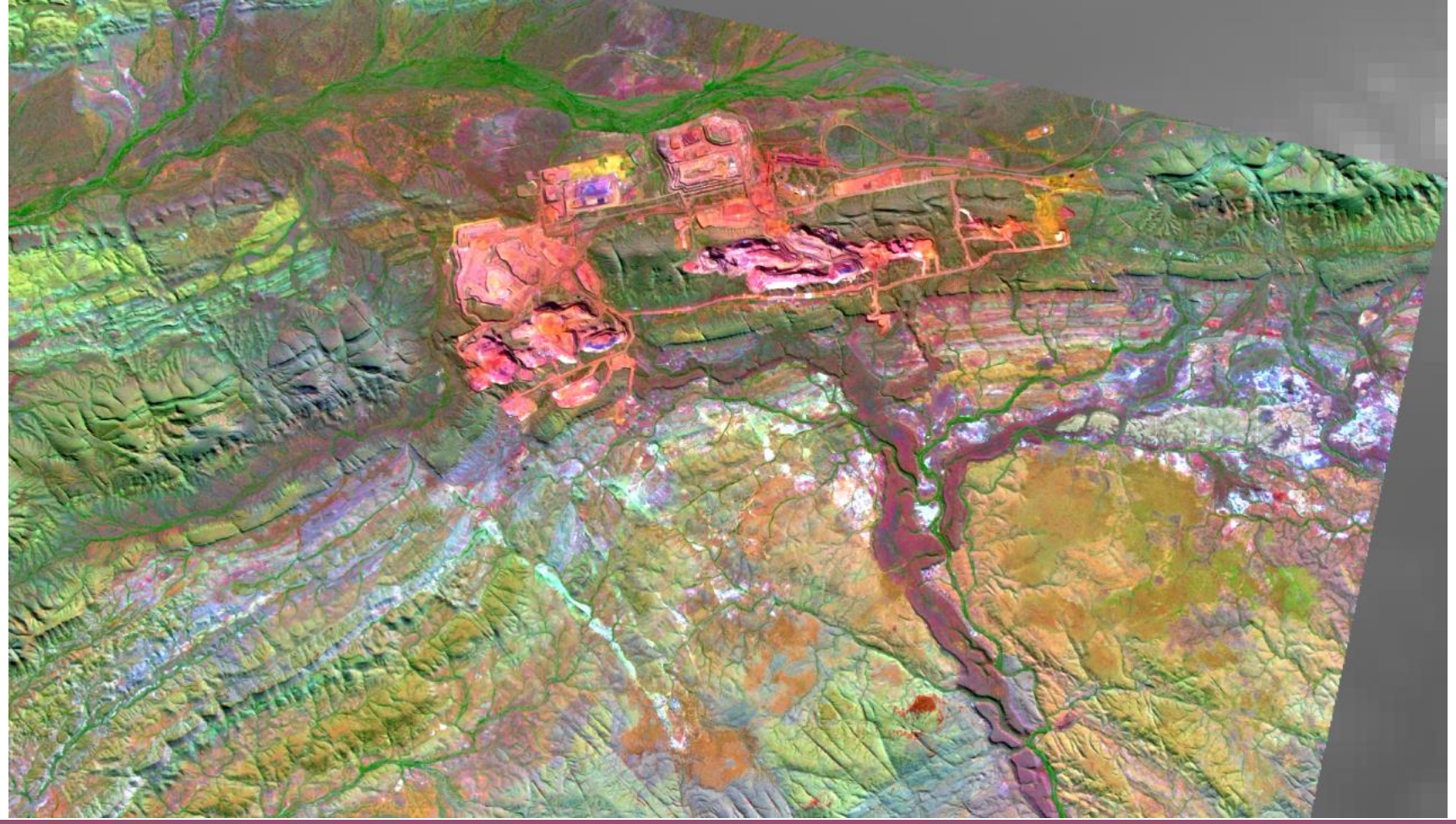
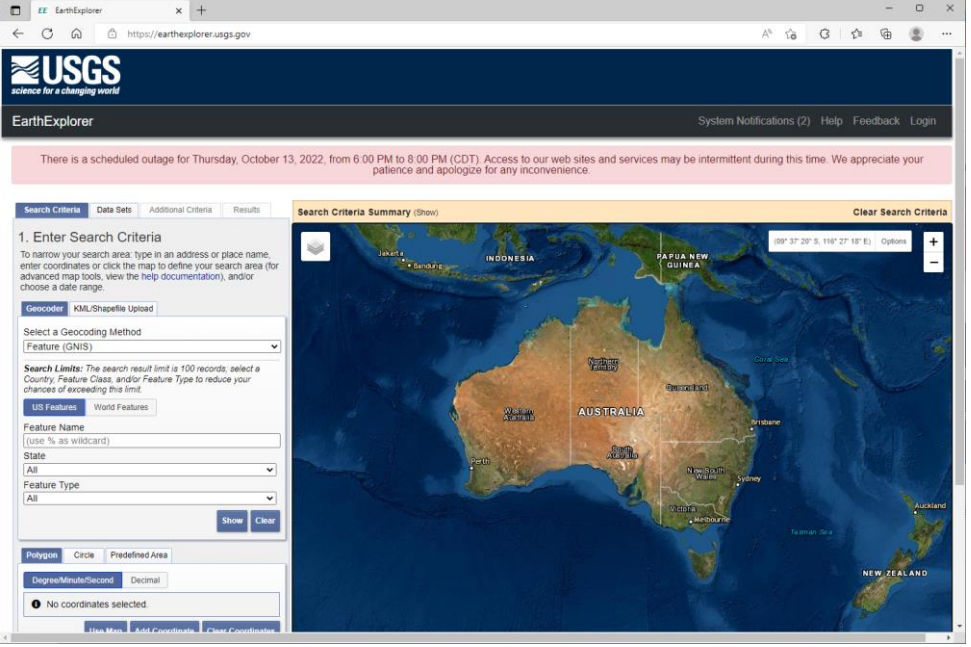


Hyperspectral Satellite Data for QGIS

Grant Boxer – Consultant Geologist – email: boxerg@iinet.net.au



Sources of Satellite Data

NASA

European Space Agency (ESA)

Italian Space Agency

German Space Agency

QGIS Plug-ins

- QuickMapServices
- Google Earth Engine
- JAXA Earth API Plugin
- Semi-Automatic Classification Plug-in
- STAC API Browser

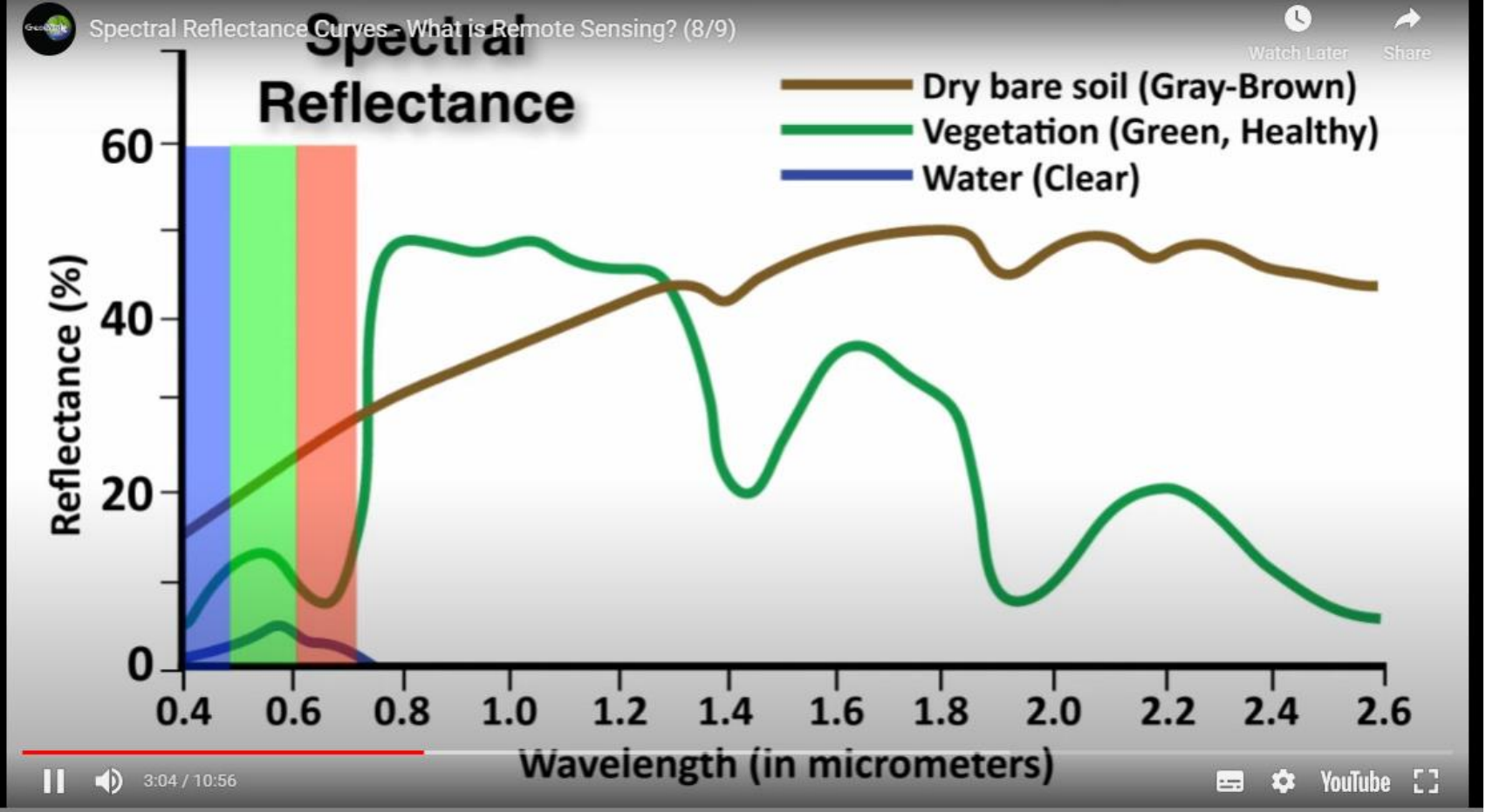
What our eyes can and can't see

remote sensing spetral an...

What Is Remote Sensing | Remote Sensing Spectral | Reflectance | Spectral Analysis of Signals | FFT Analysis in MATLAB | Spectrum Analyzer | Spectral Netflix | Phenix of Vibra

Spectral Reflectance Curves - What is Remote Sensing? (8/9)

Watch Later Share

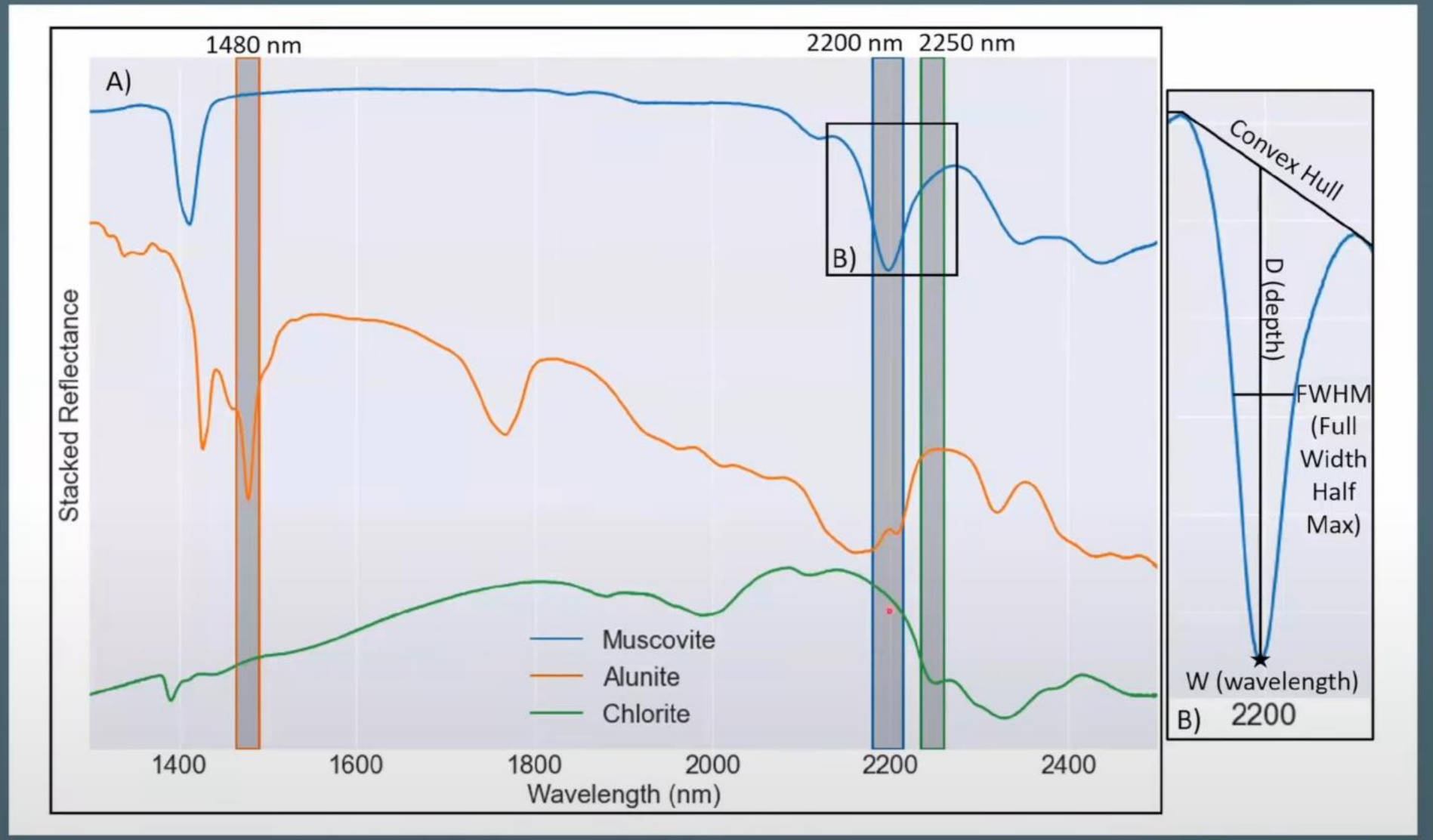


3:04 / 10:56 YouTube

pectral Reflectance Curves - What is Remote Sensing? (8/9)

YouTube · 24,000+ views · 12/2/2018 · by GeoMindz.com

Spectral Data and Methodology



Trott et. al 2022 (EXPLORE Newsletter)

ASTER

Advanced Spaceborne Thermal Emission and Reflection Radiometer

ASTER Data is free available world-wide

Essentially 30 m pixel size for the SWIR bands that enable limited mineral mapping

DEM data also available, 30 m pixels, 1 degree tiles

Launched 1999, still in service

Repeat imaging time – 16 days

VNIR – 15 m

SWIR – 30 m

TIR – 90 m

SWIR sensor failed May 2008

ASTER Users Handbook

Subsystem	Band No.	Spectral Range (μm)	Spatial Resolution, m	Quantization Levels
VNIR	1	0.52-0.60	15	8 bits
	2	0.63-0.69		
	3N	0.78-0.86		
	3B	0.78-0.86		
SWIR	4	1.60-1.70	30	8 bits
	5	2.145-2.185		
	6	2.185-2.225		
	7	2.235-2.285		
	8	2.295-2.365		
	9	2.360-2.430		
TIR	10	8.125-8.475	90	12 bits
	11	8.475-8.825		
	12	8.925-9.275		
	13	10.25-10.95		
	14	10.95-11.65		

Table 1: Characteristics of the 3 ASTER Sensor Systems.

Landsat
Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Landsat Data is free available world-wide

The Landsat program started in 1972 and we are now up to Landsat 9. Essentially 30 m pixel size for the SWIR bands that enable limited mineral mapping

Landsat 8 and 9 collects 11 bands from visible and near infrared, through SWIR to two thermal bands. Band 8 is a 15 m panchromatic band that can be used to "pansharpen" to 30 m pixel data.

	Bands	Wavelength (micrometers)	Resolution (meters)
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) **Launched February 11, 2013**	Band 1 - Coastal aerosol	0.43 - 0.45	30
	Band 2 - Blue	0.45 - 0.51	30
	Band 3 - Green	0.53 - 0.59	30
	Band 4 - Red	0.64 - 0.67	30
	Band 5 - Near Infrared (NIR)	0.85 - 0.88	30
	Band 6 - SWIR 1	1.57 - 1.65	30
	Band 7 - SWIR 2	2.11 - 2.29	30
	Band 8 - Panchromatic	0.50 - 0.68	15
	Band 9 - Cirrus	1.36 - 1.38	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100

ESA
Sentinel Constellation

Sentinel Data is free available world-wide

Essentially 30 m pixel size for the SWIR bands that enable limited mineral mapping

DEM data also available, 30 m pixels, 1 degree tiles

Sentinel 1 – C –band synthetic aperture radar

Sentinel 2 – Multi-spectral scanner

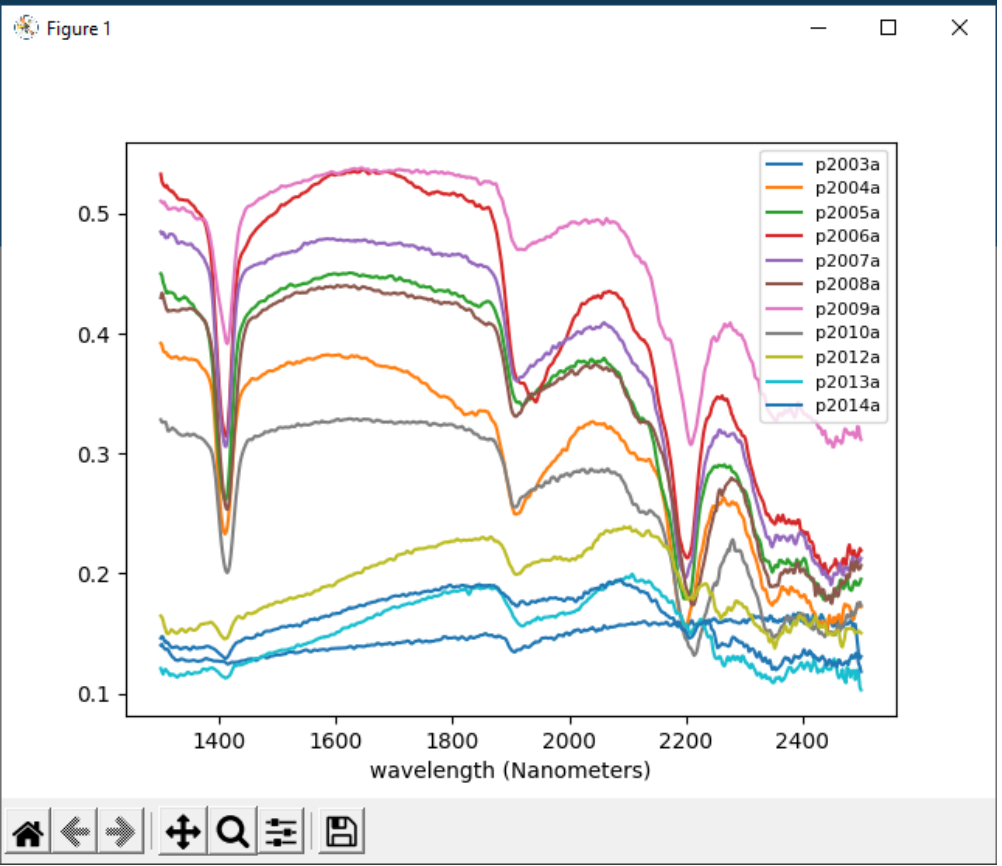
Sentinel 3 – various instruments to measure land and sea conditions

Sentinel 4 & 5 – monitors air quality and gases

Sentinel 6 – sea-surface heights

	Waveband	Central λ (nm)	Bandwidth (nm)	Spatial resolution (m)
1	Coastal aerosol	442.7	21	60
2	Blue	492.4	66	10
3	Green	559.8	36	10
4	Red	664.6	31	10
5	Vegetation red edge	704.1	15	20
6	Vegetation red edge	740.5	15	20
7	Vegetation red edge	782.8	20	20
8	Near infrared	832.8	106	10
8A	Narrow near infrared	864.7	21	20
9	Water vapour	945.1	20	60
10	Shortwave infrared – Cirrus	1373.5	31	60
11	Shortwave infrared	1613.7	91	20
12	Shortwave infrared	2202.4	175	20

Hyperspectral Imagery



Hyperspectral imagery has > 200 spectral bands

Numerous narrow (6 – 20 nm) width spectral windows to allow detailed analysis of crops and for mineral mapping.

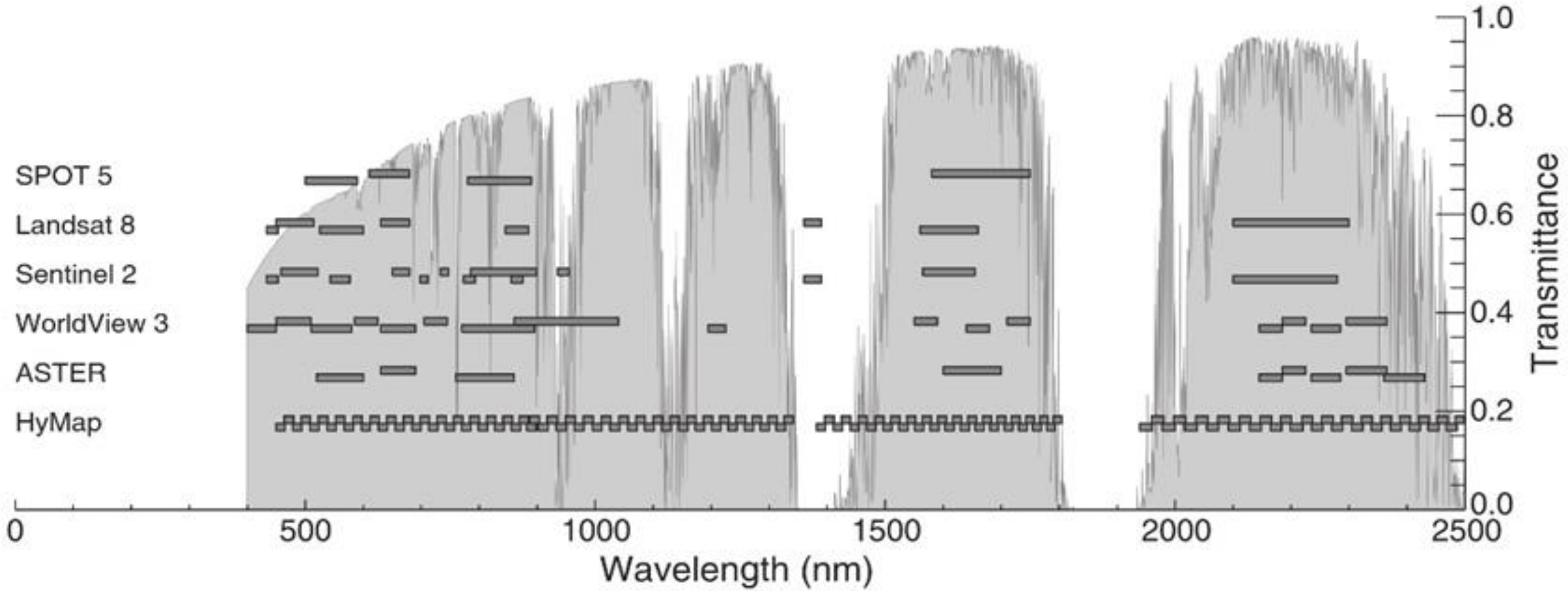
HyMap – airborne sensor – pixel size variable (depending on altitude), 10 – 20 nm band width. Campaign based, company data, local surveys.

PRISMA – Italian space agency (30 m), 12 nm band width, **pan band 5 m spatial**, world-wide.

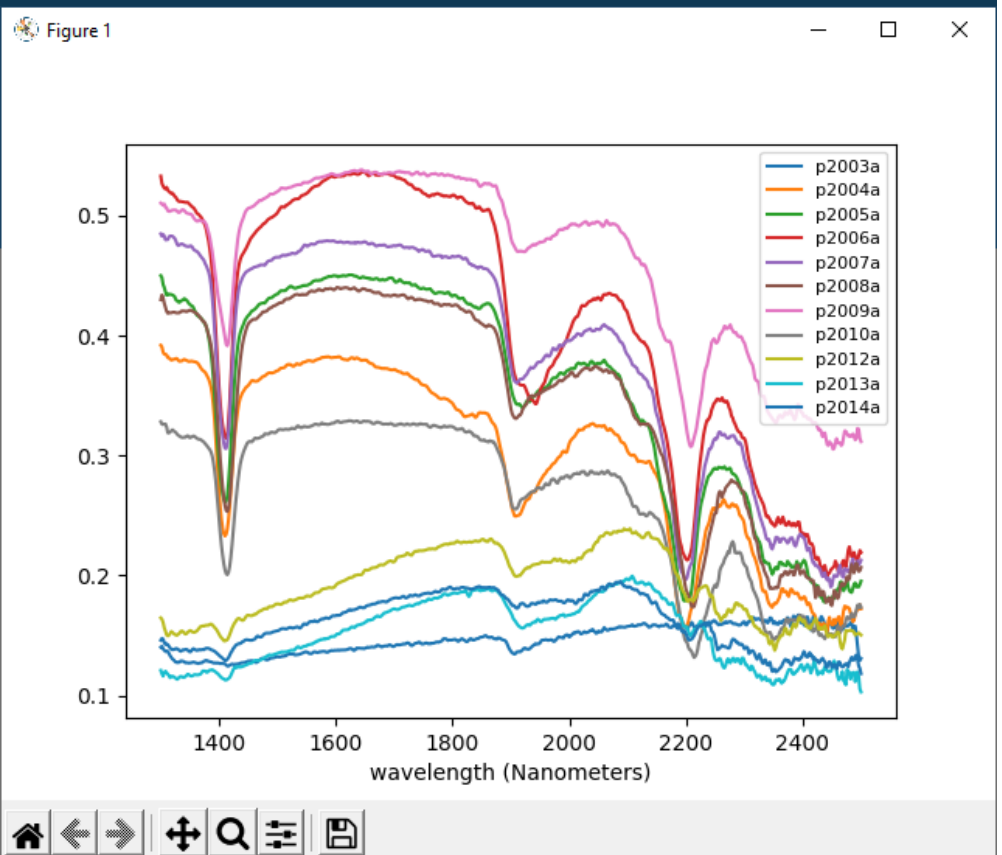
EnMAP – German space agency (30 m), 6 - 14 nm band width, world-wide

Other commercial satellite companies are launching hyperspectral satellites

Spectral bands for sensors



Multispectral and Hyperspectral Satellite data in QGIS



Multispectral Satellite data comes in a variety of formats

- ASTER - hdf
- Landsat –tar archive
- Sentinel 2 – jp2

Most multispectral satellite data requires some amount of correction for atmospheric effects.

The Semi-Automatic Classification plugin (SCP) can do atmospheric corrections for ASTER and approximate corrections for Sentinel 2 data.

ESA's SNAP software has options for accurate atmospheric corrections via their sen2cor plugin.

Hyperspectral data also comes as a variety of formats, e.g.

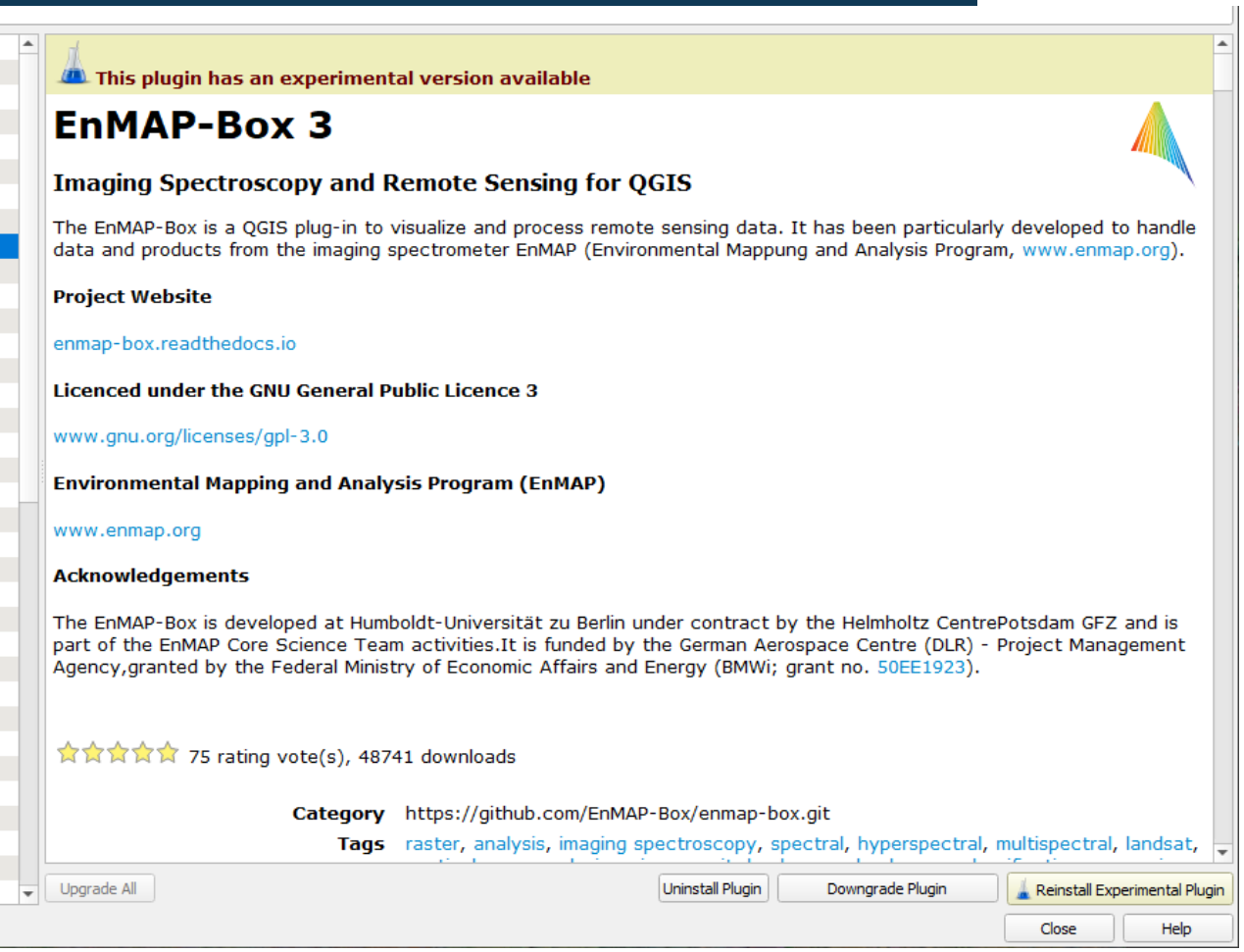
- EnMAP – tif files, opened via an xml file
- PRISMA – he5

And typically requires specialist software like ENVI (expensive! $20-30k) SCP cannot open this data - yet.

Both EnMAP and PRISMA have a 30 m pixel size.

Enter EnMAP-Box!

ESA EnMAP-Box



EnMAP-Box

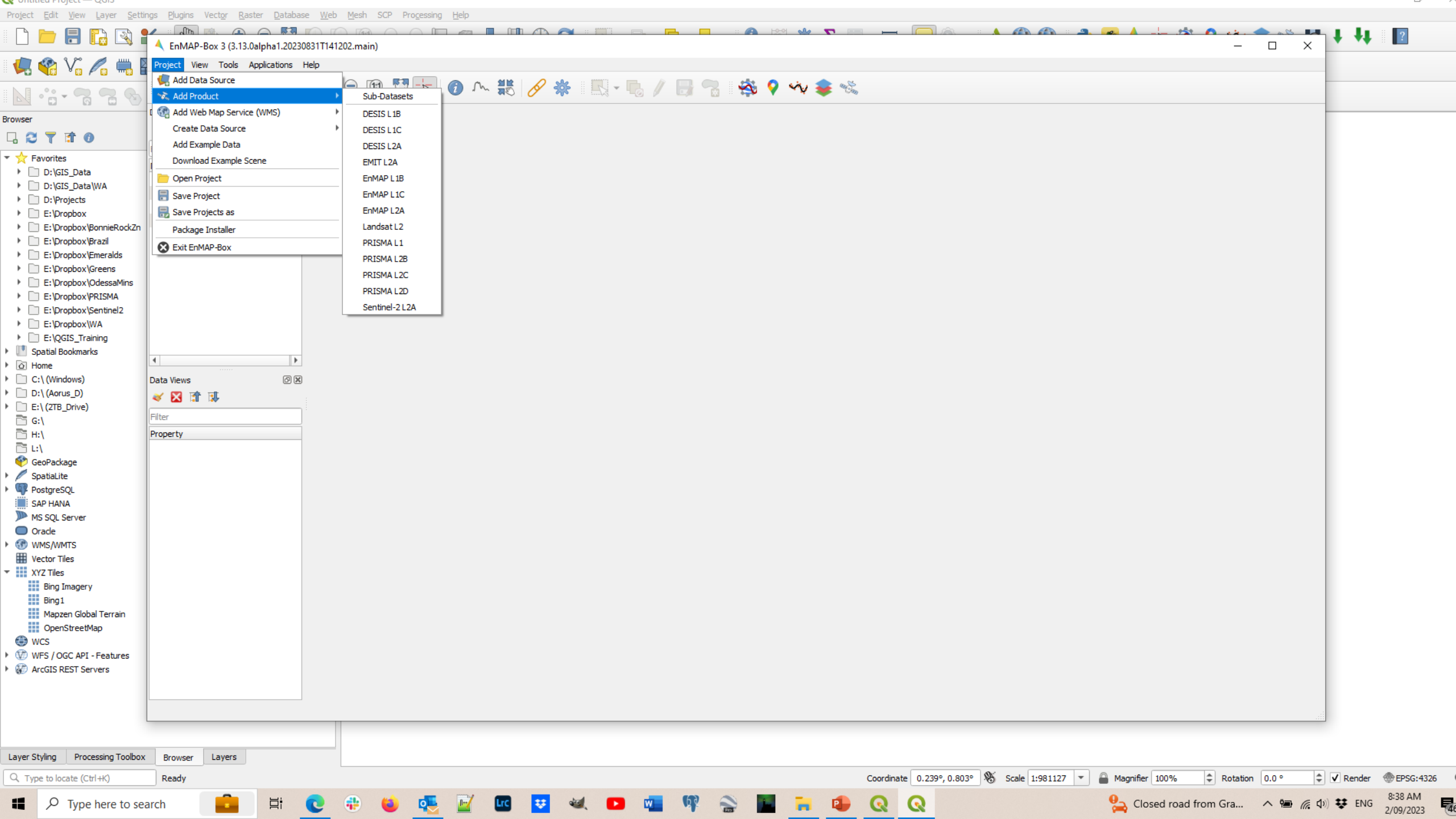
QGIS Plug-in written by and for the German space agency's EnMAP hyperspectral satellite launched a couple of years ago.

Can also be used with the Italian space agency's PRISMA hyperspectral satellite data.

Import, display and process hyperspectral satellite data

When installing, it is important to "read-the-docs" as it requires a number of python dependencies.

Access to data requires registration – currently mainly for "research"


EnMAP-Box 3 (3.13.0alpha1.20230831T141202.main)
Project
View
Tools
Applications
Help
Add Data Source
Add Product
Add Web Map Service (WMS)
Create Data Source
Add Example Data
Download Example Scene
Open Project
Save Project
Save Projects as
Package Installer
Exit EnMAP-Box
Sub-Datasets
DESIS L1B
DESIS L1C
DESIS L2A
EMIT L2A
EnMAP L1B
EnMAP L1C
EnMAP L2A
Landsat L2
PRISMA L1
PRISMA L2B
PRISMA L2C
PRISMA L2D
Sentinel-2 L2A
Data Views
Filter
Property
Browser
Favorites
D:\GIS_Data
D:\GIS_Data\WA
D:\Projects
E:\Dropbox
E:\Dropbox\BonnieRockZn
E:\Dropbox\Brazil
E:\Dropbox\Emeralds
E:\Dropbox\Greens
E:\Dropbox\OdessaMins
E:\Dropbox\PRISMA
E:\Dropbox\Sentinel2
E:\Dropbox\WA
E:\QGIS_Training
Spatial Bookmarks
Home
C:\ (Windows)
D:\ (Aorus_D)
E:\ (2TB_Drive)
G:\
H:\
L:\
GeoPackage
SpatiaLite
PostgreSQL
SAP HANA
MS SQL Server
Oracle
WMS/WMTS
Vector Tiles
XYZ Tiles
Bing Imagery
Bing1
Mapzen Global Terrain
OpenStreetMap
WCS
WFS / OGC API - Features
ArcGIS REST Servers
Layer Styling
Processing Toolbox
Browser
Layers
Type to locate (Ctrl+K)
Ready
Coordinate 0.239°, 0.803°
Scale 1:981127
Magnifier 100%
Rotation 0.0 °
Render
EPSG:4326
Type here to search
Closed road from Gra...
ENG
8:38 AM
2/09/2023

EnMAP-Box 3 (3.13.0alpha1.20230831141202.main)

Project View Tools Applications Help

Data Sources

Filter

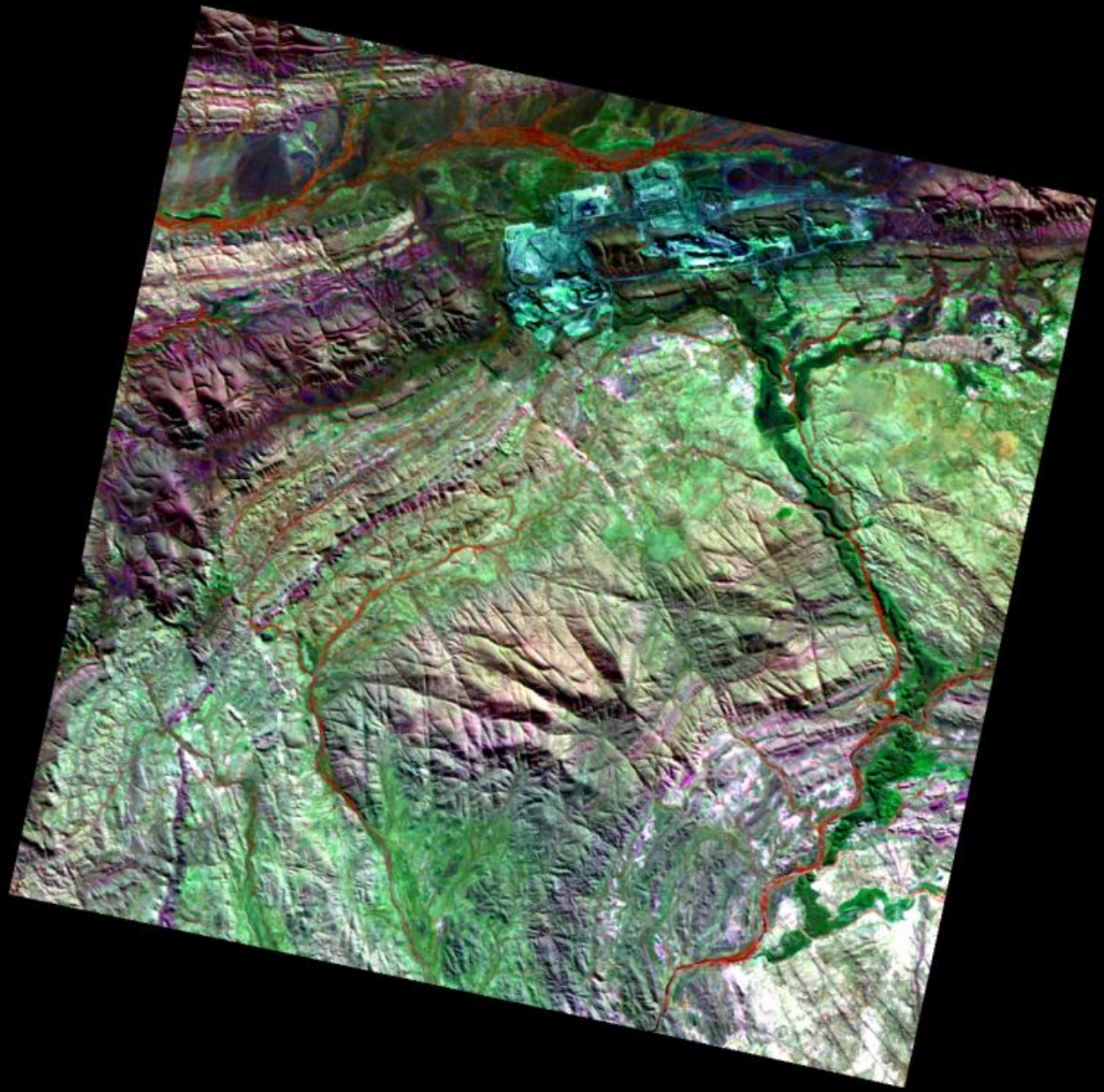
Name	Value
Rasters (2)	
outputPrismaL2D_spectralCu...	
outputPrismaL2D_spectralCu...	
Vectors (0)	
Models (0)	
Other Files (0)	

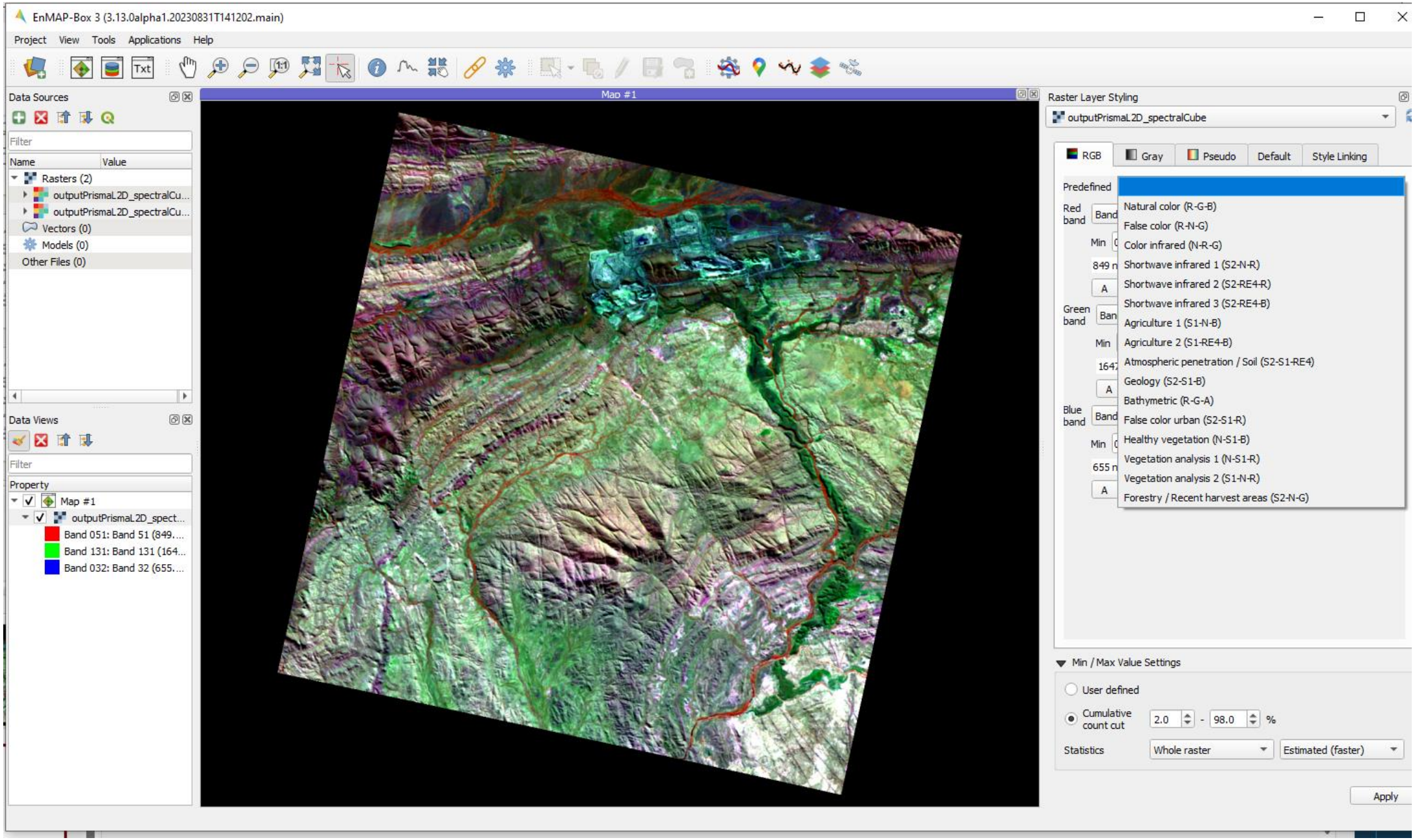
Data Views

Filter

Property
Map #1
outputPrismaL2D_spect...
Band 051: Band 51 (849....
Band 131: Band 131 (164...
Band 032: Band 32 (655....

Map #1




EnMAP-Box 3 (3.13.0alpha1.20230831T141202.main)
Project View Tools Applications Help
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outputPrismaL2D_spectralCu...
Vectors (0)
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Other Files (0)
Data Views
Filter
Property
Map #1
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Band 051: Band 51 (849....
Band 131: Band 131 (164...
Band 032: Band 32 (655....
Map #1
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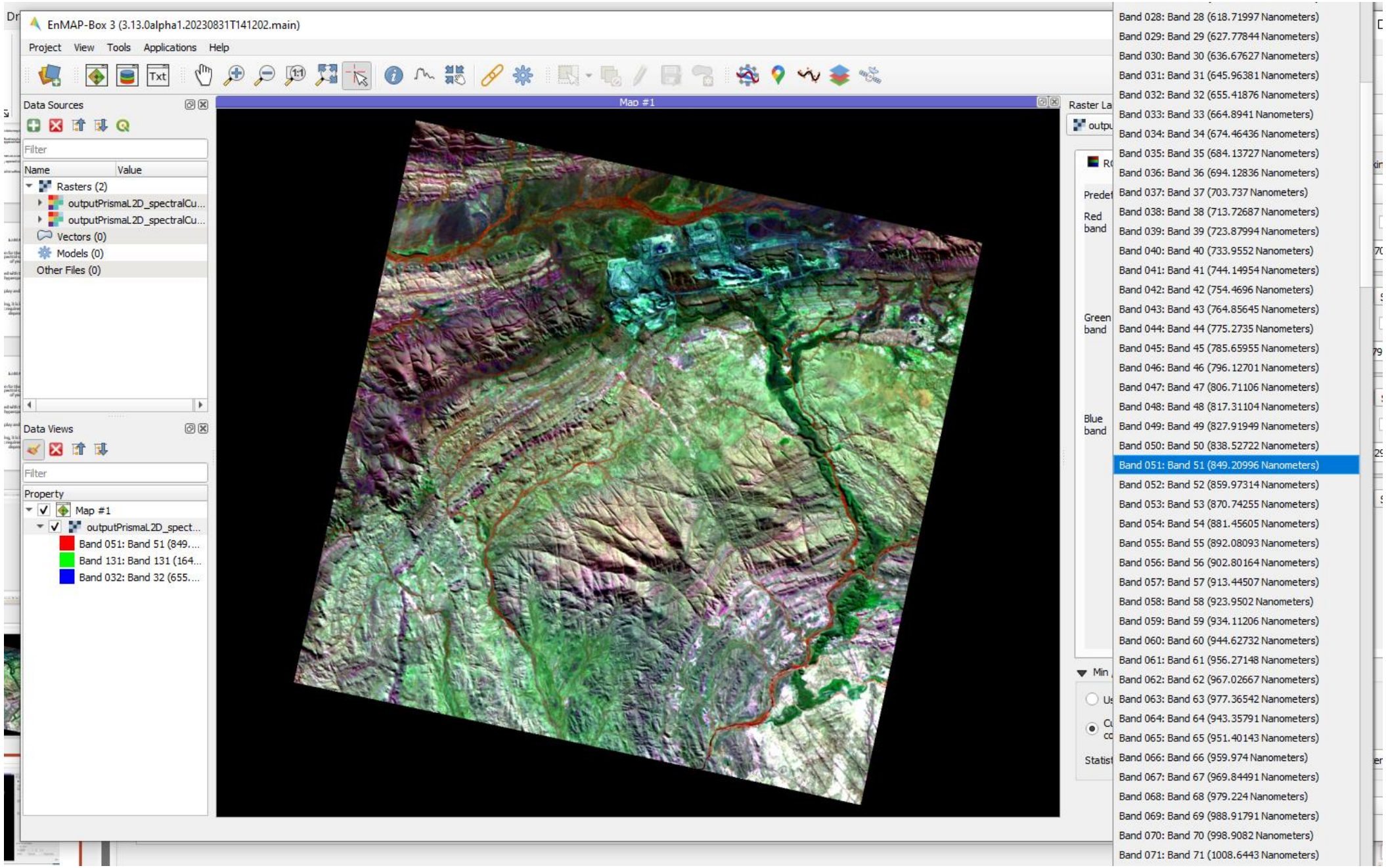
Predefined
Natural color (R-G-B)
False color (R-N-G)
Color infrared (N-R-G)
Shortwave infrared 1 (S2-N-R)
Shortwave infrared 2 (S2-RE4-R)
Shortwave infrared 3 (S2-RE4-B)
Agriculture 1 (S1-N-B)
Agriculture 2 (S1-RE4-B)
Atmospheric penetration / Soil (S2-S1-RE4)
Geology (S2-S1-B)
Bathymetric (R-G-A)
False color urban (S2-S1-R)
Healthy vegetation (N-S1-B)
Vegetation analysis 1 (N-S1-R)
Vegetation analysis 2 (S1-N-R)
Forestry / Recent harvest areas (S2-N-G)
Red band
Green band
Blue band
Min
Min / Max Value Settings
User defined
Cumulative count cut
2.0
98.0
%
Statistics
Whole raster
Estimated (faster)
Apply


EnMAP-Box 3 (3.13.0alpha1.20230831T141202.main)
Project View Tools Applications Help
Data Sources
Filter
Name Value
Rasters (2)
outputPrismaL2D_spectralCu...
outputPrismaL2D_spectralCu...
Vectors (0)
Models (0)
Other Files (0)
Data Views
Filter
Property
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Band 131: Band 131 (164...
Band 032: Band 32 (655....
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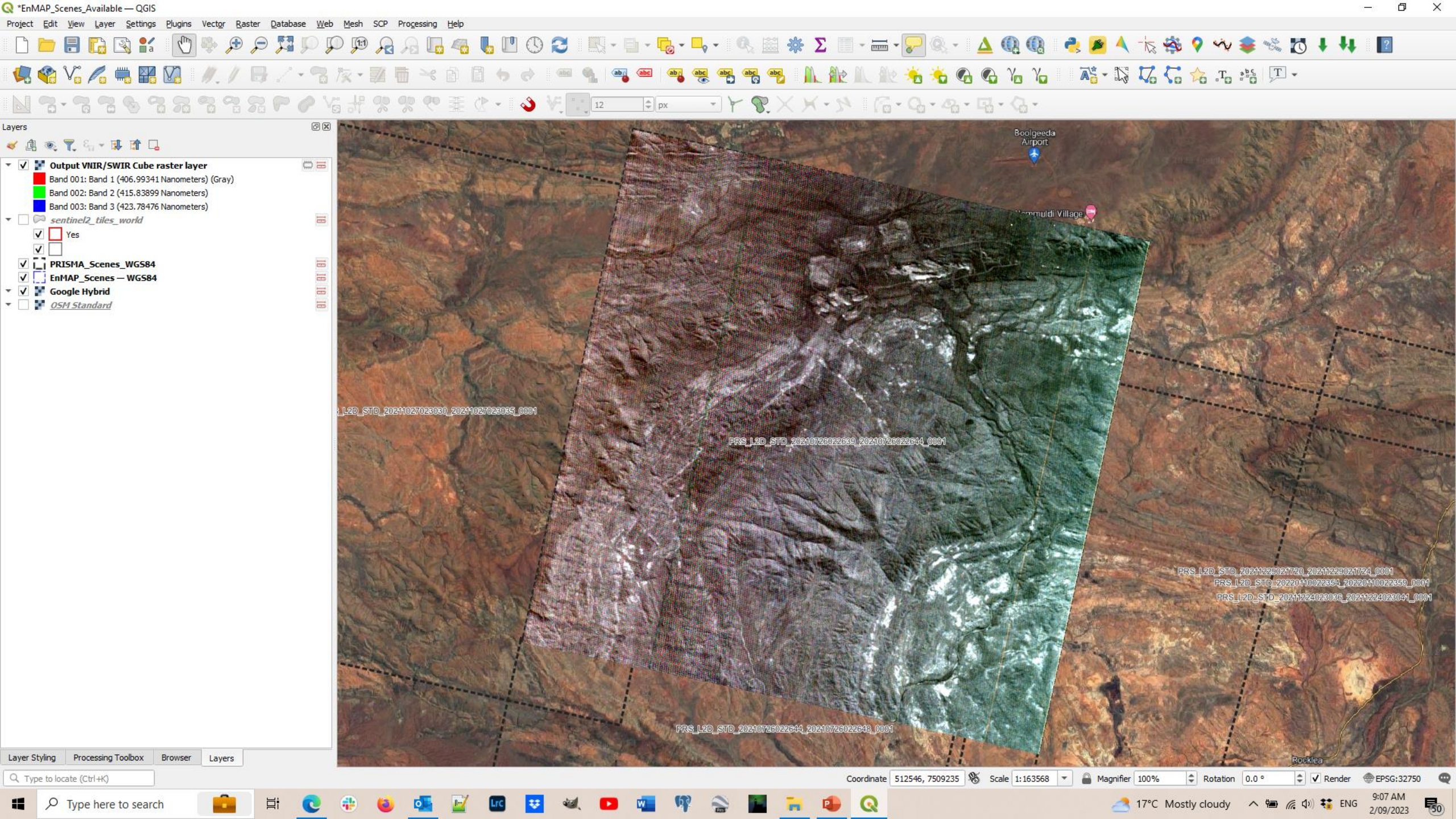
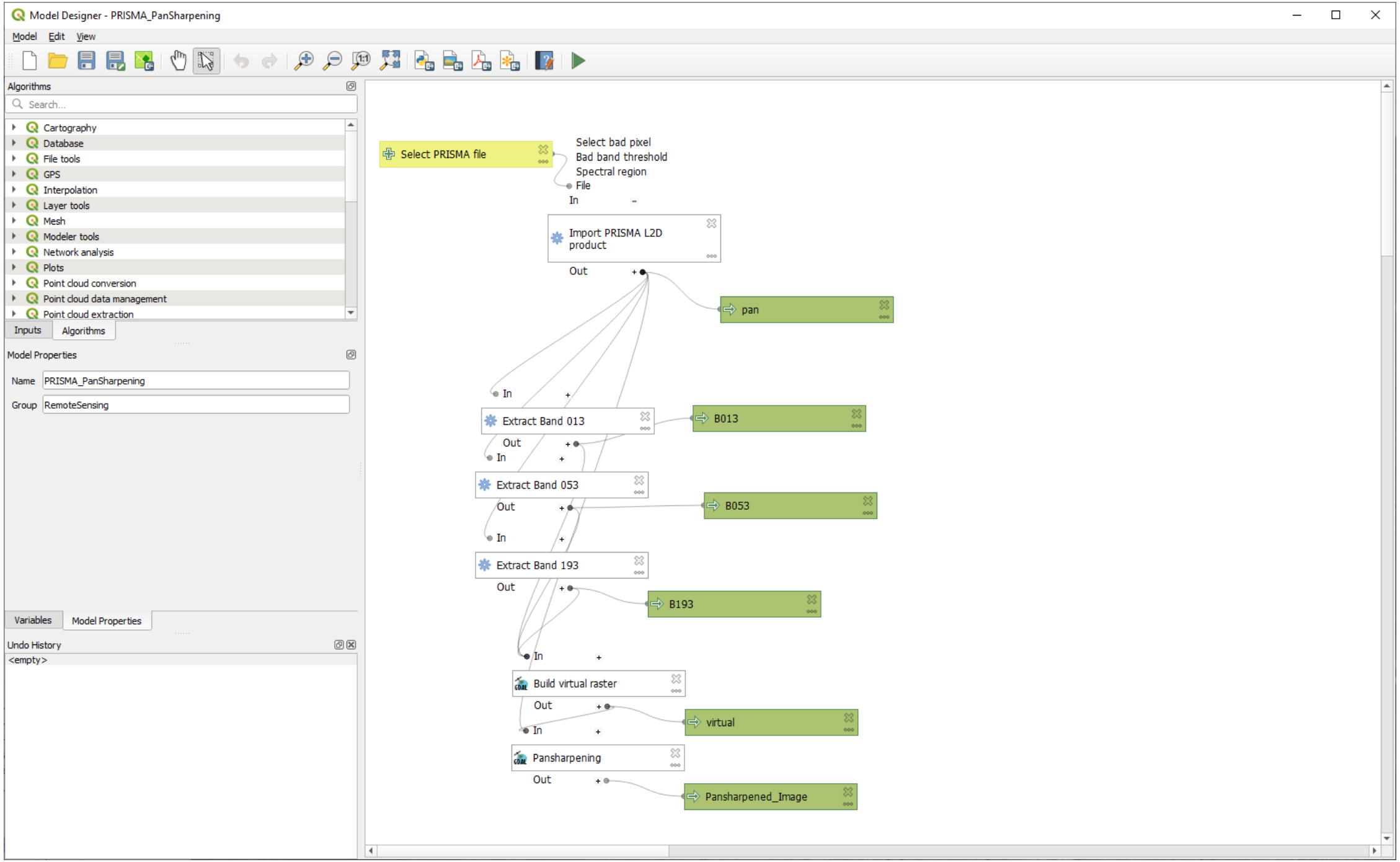
Band 029: Band 29 (627.77844 Nanometers)
Band 030: Band 30 (636.67627 Nanometers)
Band 031: Band 31 (645.96381 Nanometers)
Band 032: Band 32 (655.41876 Nanometers)
Band 033: Band 33 (664.8941 Nanometers)
Band 034: Band 34 (674.46436 Nanometers)
Band 035: Band 35 (684.13727 Nanometers)
Band 036: Band 36 (694.12836 Nanometers)
Band 037: Band 37 (703.737 Nanometers)
Band 038: Band 38 (713.72687 Nanometers)
Band 039: Band 39 (723.87994 Nanometers)
Band 040: Band 40 (733.9552 Nanometers)
Band 041: Band 41 (744.14954 Nanometers)
Band 042: Band 42 (754.4696 Nanometers)
Band 043: Band 43 (764.85645 Nanometers)
Band 044: Band 44 (775.2735 Nanometers)
Band 045: Band 45 (785.65955 Nanometers)
Band 046: Band 46 (796.12701 Nanometers)
Band 047: Band 47 (806.71106 Nanometers)
Band 048: Band 48 (817.31104 Nanometers)
Band 049: Band 49 (827.91949 Nanometers)
Band 050: Band 50 (838.52722 Nanometers)
Band 051: Band 51 (849.20996 Nanometers)
Band 052: Band 52 (859.97314 Nanometers)
Band 053: Band 53 (870.74255 Nanometers)
Band 054: Band 54 (881.45605 Nanometers)
Band 055: Band 55 (892.08093 Nanometers)
Band 056: Band 56 (902.80164 Nanometers)
Band 057: Band 57 (913.44507 Nanometers)
Band 058: Band 58 (923.9502 Nanometers)
Band 059: Band 59 (934.11206 Nanometers)
Band 060: Band 60 (944.62732 Nanometers)
Band 061: Band 61 (956.27148 Nanometers)
Band 062: Band 62 (967.02667 Nanometers)
Band 063: Band 63 (977.36542 Nanometers)
Band 064: Band 64 (943.35791 Nanometers)
Band 065: Band 65 (951.40143 Nanometers)
Band 066: Band 66 (959.974 Nanometers)
Band 067: Band 67 (969.84491 Nanometers)
Band 068: Band 68 (979.224 Nanometers)
Band 069: Band 69 (988.91791 Nanometers)
Band 070: Band 70 (998.9082 Nanometers)
Band 071: Band 71 (1008.6443 Nanometers)


*EnMAP_Scenes_Available — QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help
Layers
Output VNIR/SWIR Cube raster layer
Band 001: Band 1 (406.99341 Nanometers) (Gray)
Band 002: Band 2 (415.83899 Nanometers)
Band 003: Band 3 (423.78476 Nanometers)
sentinel2_tiles_world
Yes
PRISMA_Scenes_WGS84
EnMAP_Scenes — WGS84
Google Hybrid
OSM Standard
Boolgeeda Airport
PRS_L2D_STD_20210726022639_20210726022644_0001
PRS_L2D_STD_20210726022644_20210726022648_0001
PRS_L2D_STD_20211229021720_20211229021724_0001
PRS_L2D_STD_20220110022354_20220110022359_0001
PRS_L2D_STD_20211224023036_20211224023041_0001
Rocklea
Layer Styling
Processing Toolbox
Browser
Layers
Type to locate (Ctrl+K)
Coordinate 512546, 7509235
Scale 1:163568
Magnifier 100%
Rotation 0.0 °
Render
EPSG:32750
Type here to search
17°C Mostly cloudy
ENG
9:07 AM
2/09/2023


Model Designer - PRISMA_PanSharpening
Model
Edit
View
Algorithms
Search...
Cartography
Database
File tools
GPS
Interpolation
Layer tools
Mesh
Modeler tools
Network analysis
Plots
Point cloud conversion
Point cloud data management
Point cloud extraction
Inputs
Algorithms
Model Properties
Name
PRISMA_PanSharpening
Group
RemoteSensing
Variables
Model Properties
Undo History
<empty>
Select PRISMA file
Select bad pixel
Bad band threshold
Spectral region
File
In
Import PRISMA L2D product
Out
pan
In
Extract Band 013
B013
Out
In
Extract Band 053
Out
B053
In
Extract Band 193
Out
B193
In
Build virtual raster
Out
virtual
In
Pansharpening
Out
Pansharpened_Image

*EnMAP_Scenes_Available — QGIS

Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help

Processing Toolbox

Search...

- Mesh
- Network analysis
- Plots
- Point cloud conversion
- Point cloud data management
- Point cloud extraction
- Raster analysis
- Raster creation
- Raster terrain analysis
- Raster tools
- Vector analysis
- Vector creation
- Vector general
- Vector geometry
- Vector overlay
- Vector selection
- Vector table
- Vector tiles
- EnMAP-Box
- GDAL
- GRASS
- Models
  - ColouriseGeologyLayer
  - General_createRGB_image
  - PRISMA_Calculate_P_layers
  - PRISMA_open_file
  - Sentinel2_test
- Geology
- Remote Sensing
- RemoteSensing
  - PRISMA_calc_p_layers
  - PRISMA_ENVI_Indices
  - PRISMA_PanSharpening
  - PRISMA_PanSharpening_133-196-211
  - PRISMA_PanSharpening_193-170-050
  - PRISMA_PanSharpening_193-530-013
  - PRISMA_PanSharpening_ExtractBands
  - PRISMA_PanSharpening_False_Col
  - PRISMA_PanSharpening_Nat_Col
  - PRISMA_Processing
- SLYR (community edition)

You can add more algorithms to the toolbox, enable additional providers. [close]

Layer Styling | Processing Toolbox | Browser | Layers

Boolgeeda Airport

PRS_L2D_STD_20211027023030_20211027023035_0001

PRS_L2D_STD_20210726022639_20210726022644_0001

PRS_L2D_STD_20210726022644_20210726022648_0001

PRS_L2D_STD_20211229021720_20211229021724_0001

PRS_L2D_STD_20220110022354_20220110022359_0001

PRS_L2D_STD_20211224023036_20211224023041_0001

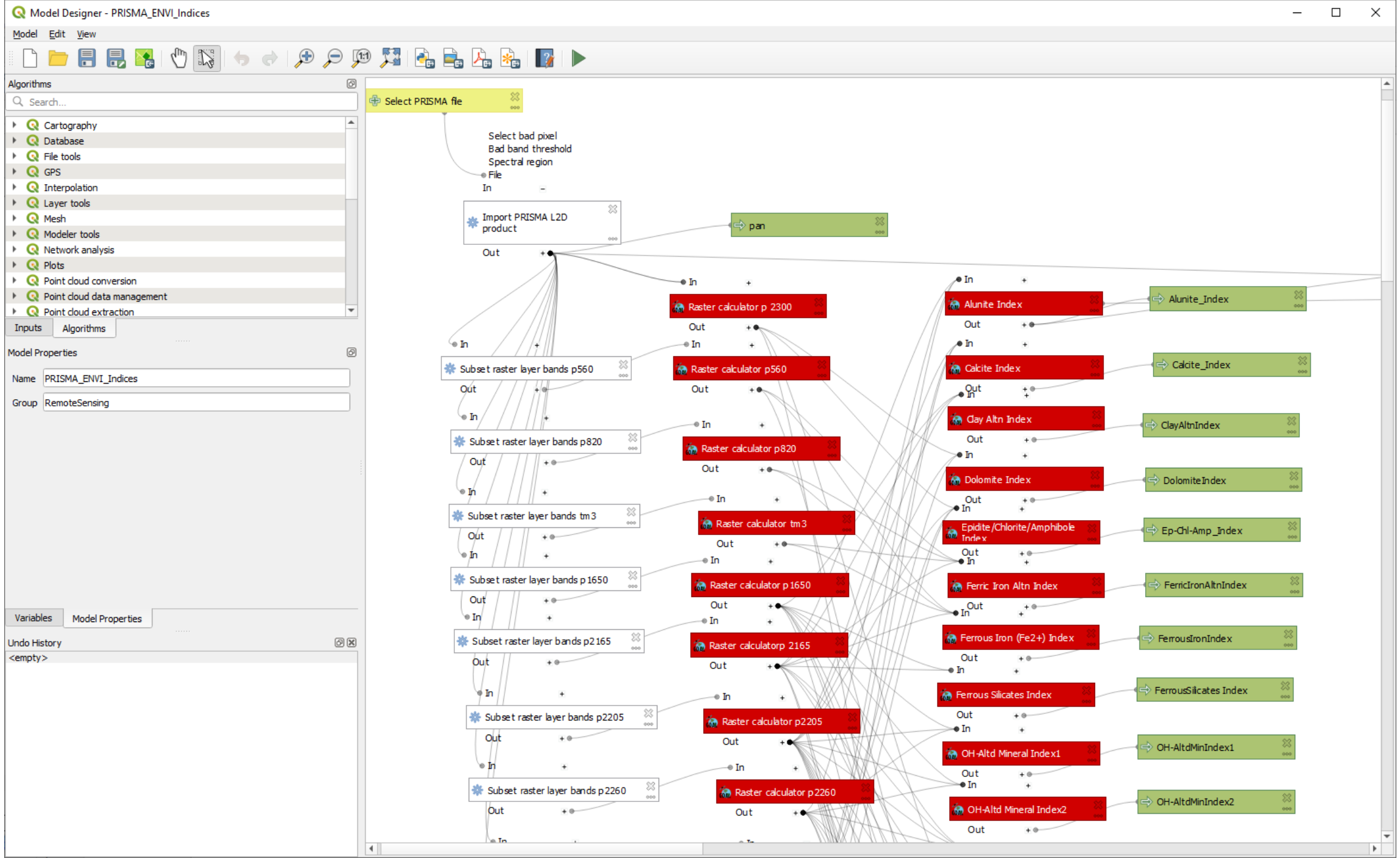
Rocklea

Type to locate (Ctrl+K)

Coordinate 496014, 7509495 Scale 1:163568 Magnifier 100% Rotation 0.0 ° Render EPSG:32750

Type here to search

18°C Mostly cloudy ENG 9:17 AM 2/09/2023

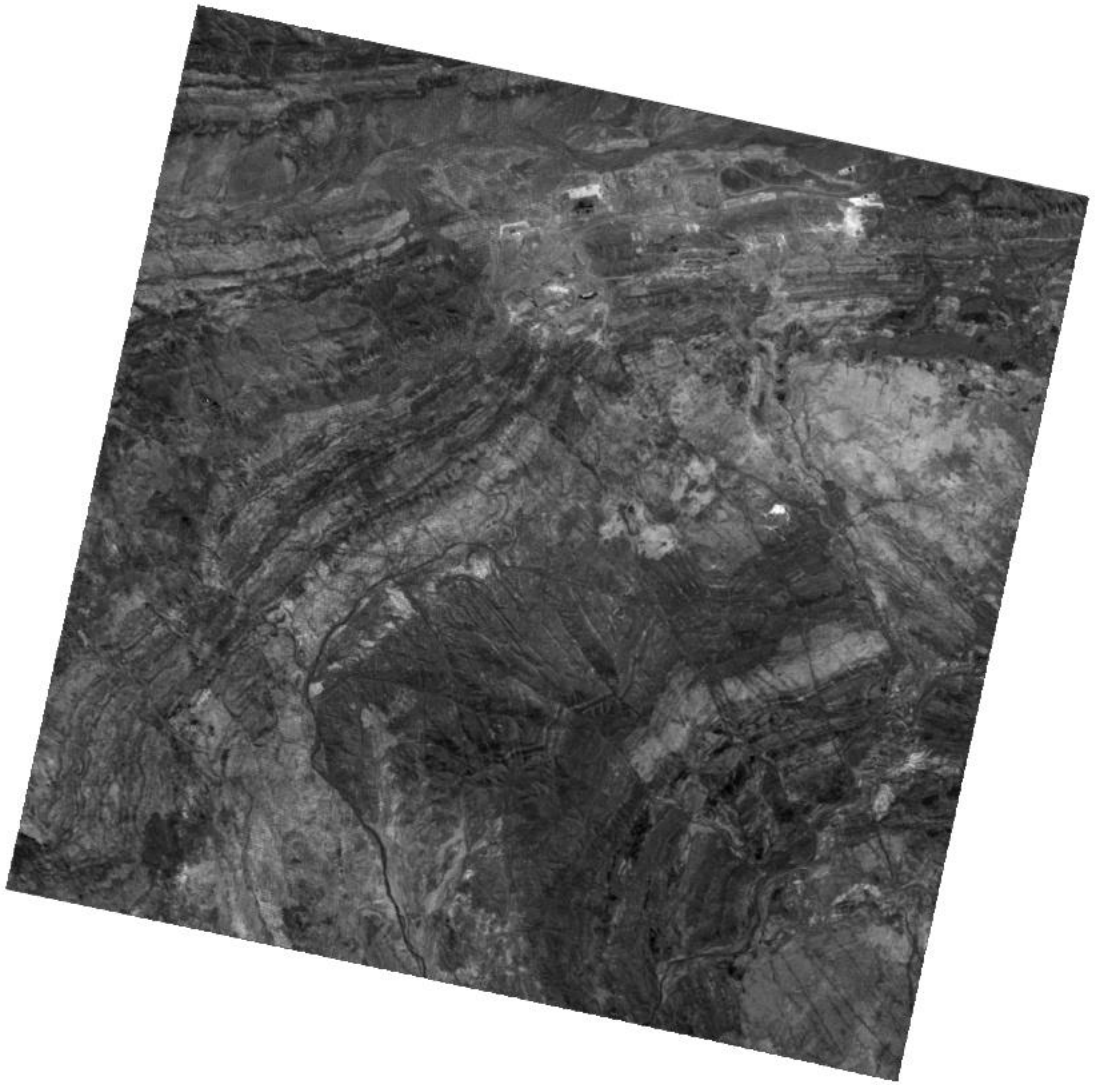

Model Designer - PRISMA_ENVI_Indices
Model
Edit
View
Algorithms
Search...
Cartography
Database
File tools
GPS
Interpolation
Layer tools
Mesh
Modeler tools
Network analysis
Plots
Point cloud conversion
Point cloud data management
Point cloud extraction
Inputs
Algorithms
Model Properties
Name
PRISMA_ENVI_Indices
Group
RemoteSensing
Variables
Model Properties
Undo History
<empty>
Select PRISMA file
Select bad pixel
Bad band threshold
Spectral region
File
In
Import PRISMA L2D product
Out
pan
Raster calculator p 2300
Subset raster layer bands p560
Raster calculator p560
Subset raster layer bands p820
Raster calculator p820
Subset raster layer bands tm3
Raster calculator tm3
Subset raster layer bands p 1650
Raster calculator p 1650
Subset raster layer bands p2165
Raster calculatorp 2165
Subset raster layer bands p2205
Raster calculator p2205
Subset raster layer bands p2260
Raster calculator p2260
Alunite Index
Calcite Index
Clay Altn Index
Dolomite Index
Epidite/Chlorite/Amphibole Index
Ferric Iron Altn Index
Ferrous Iron (Fe2+) Index
Ferrous Silicates Index
OH-Altd Mineral Index1
OH-Altd Mineral Index2
Alunite_Index
Calcite_Index
ClayAltnIndex
DolomiteIndex
Ep-Chl-Amp_Index
FerricIronAltnIndex
FerrousIronIndex
FerrousSilicates Index
OH-AltdMinIndex1
OH-AltdMinIndex2

*Untitled Project — QGIS

Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help

Layers

- LateriteIndex
- Ep-Chl-Amp_Index
- KaoliniteIndex1
- OH-AltdMinIndex1
- PhyllicAltnIndex
- DolomiteIndex
- FerrousSilicates Index
- OH-AltdMinIndex2
- pan
- OH-AltdMinIndex3
- KaoliniteIndex2
- ClayAltnIndex
- MuscoviteIndex
- PropyliticAltnIndex
- PhengiticIndex
- MontmorIndex
- KaoliniteIndex3
- Alunite_Index
- MgOHCarbAbunIndex
- FerricIronAltnIndex
- Alunite_Pan
- Calcite_Index
- FerrousIronIndex
- MagnesiteIndex



Layer Styling | Processing Toolbox | Browser | Layers

Type to locate (Ctrl+K)

Coordinate 485443, 7472559 Scale 1:166868 Magnifier 100% Rotation 0.0 ° Render EPSG:32750

Type here to search

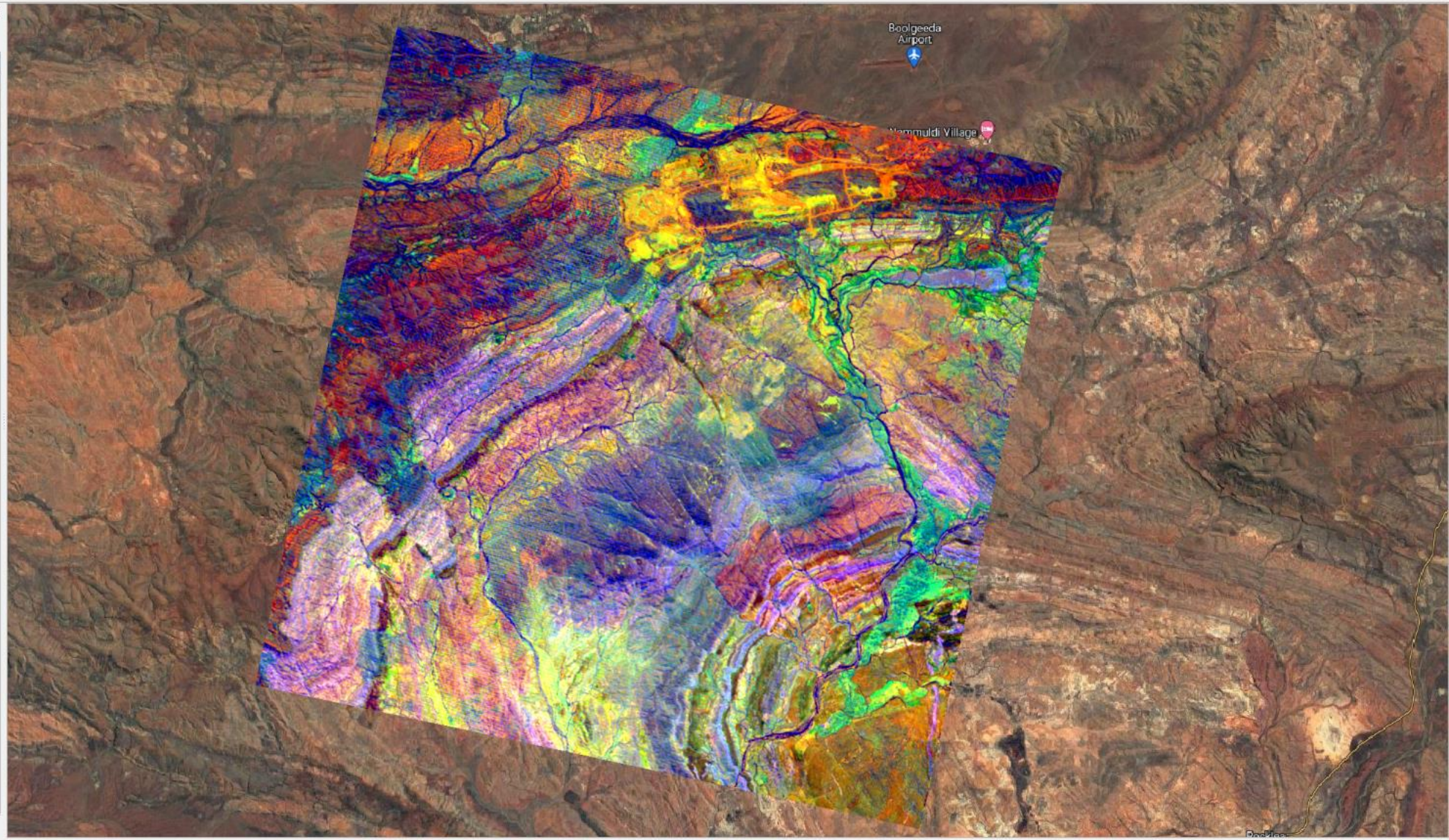
18°C Mostly sunny ENG 3:22 PM 2/09/2023

*EnMAP_Scenes_Available — QGIS

Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh SCP Processing Help

Layers

- sentinel2_tiles_world
- PRISMA_Scenes_WGS84
- EnMAP_Scenes — WGS84
- PRS_Beasley1_FerSil-FerIrAlt-MgOHAbun
- PRS_Beasley1_193-053-013_RGB_pansharp
- Google Hybrid
- OSM Standard



Layer Styling | Processing Toolbox | Browser | Layers

Type to locate (Ctrl+K)

Coordinate 516149, 7488370 Scale 1:163568 Magnifier 100% Rotation 0.0 ° Render EPSG:32750

Type here to search

18°C Mostly cloudy ENG 9:30 AM 2/09/2023

PRISMA
vs
HYMAP

Comparison of HyMap Indices and PRISMA Bands

Index	HyMAP Bands	Wavelengths	PRISMA Equivalent Bands
Alteration	B81/B109	1652.6/2207.4	B131/B194
Alunite/Kaolinite/Pyrophyllite	(B081+B109)/B107	(1652.6+2207.4)/2173	(B131+B194)/B190
Amphibole	B109/B116	2207/2326.3	B194/B210
Amphibole/MgOH	B109/B120	2207/2391.4	B194/B219
Carbonate/Chlorite/Epidote	(B114+B120)/B116	(2293.4+2391.4)/2326.3	B205+B120)/B210
Clay	(B107 to B114)/(B109*B109)	(2173 to 2293)/(2207 * 2207)	(190 to B205)/(B194*B194)
Dolomite	(B109+B116)/B114	(2207+2326)/2293	(B194+B210)/B205
Epidote/Chlorite/Amphibole	(B109+B120)/(B114+B116)	(2207+2391)/(2293+2326)	(B194+B210)/(B205+B210)
Ferris Iron 2+	((B107/B26)+(B009/B16)	(2173+816)+(557/664)	(B190/B48)+(B22/B33)
Ferrous Iron F3+	B16/B9	664/557	B31/B21
Ferric Oxides	B81/B26	1653/816	B132/B48
Ferrous Silicates	B107/B81	2173/1653	B190/B132
Gossan	B81/B16	1653/664	B132/B48
Host Rock	B107/B109	2173/2207	B190/B194
Kaolinite	B114/B107	2293/2173	B205/B190
Laterite	B81/B107	1653/2173	B132/B31
Muscovite	B114/B109	2293/2207	B205/B194
Phengitic	B107/B109	2173/2207	B190/B194
Sericite/Muscovite/illite/Smectitie	(B107+B114)/B109	(2173+2293)/2207	(B190+B205)/B194