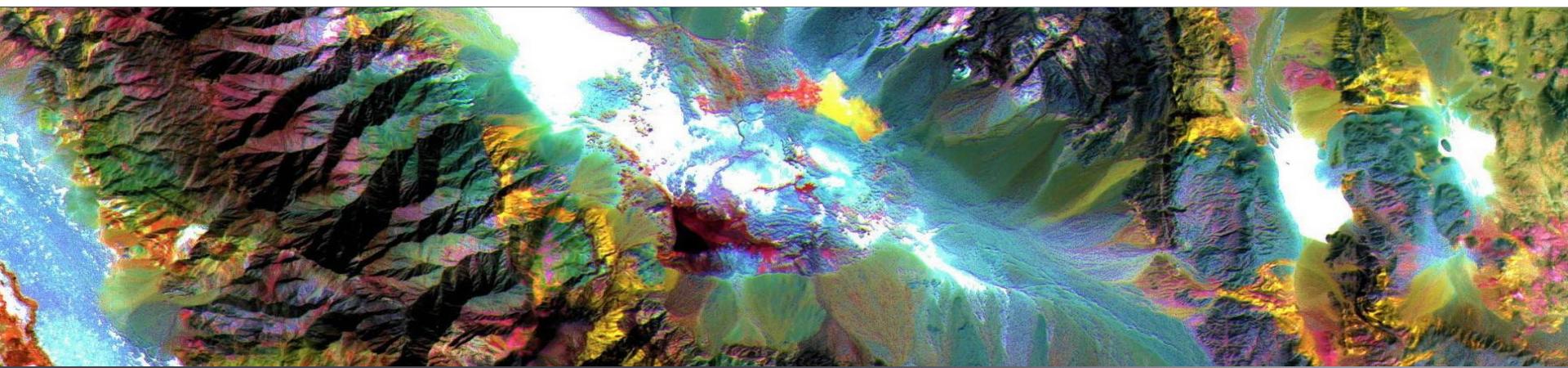


Processing and interpretation of satellite data for geological, hydrogeological and georisks applications

Czech Geological Survey

Remote sensing unit



CGS Remote sensing unit – Who we are?

- Part of the Dpt. of Regional geology of crystalline complexes
- Since 2005
- Processing of satellite and airborne data
- Geoinformation products related to geological, geomorphological and environmental applications



Veronika Kopačková M.Sc.
team coordinator
veronika.kopackova@geology.cz



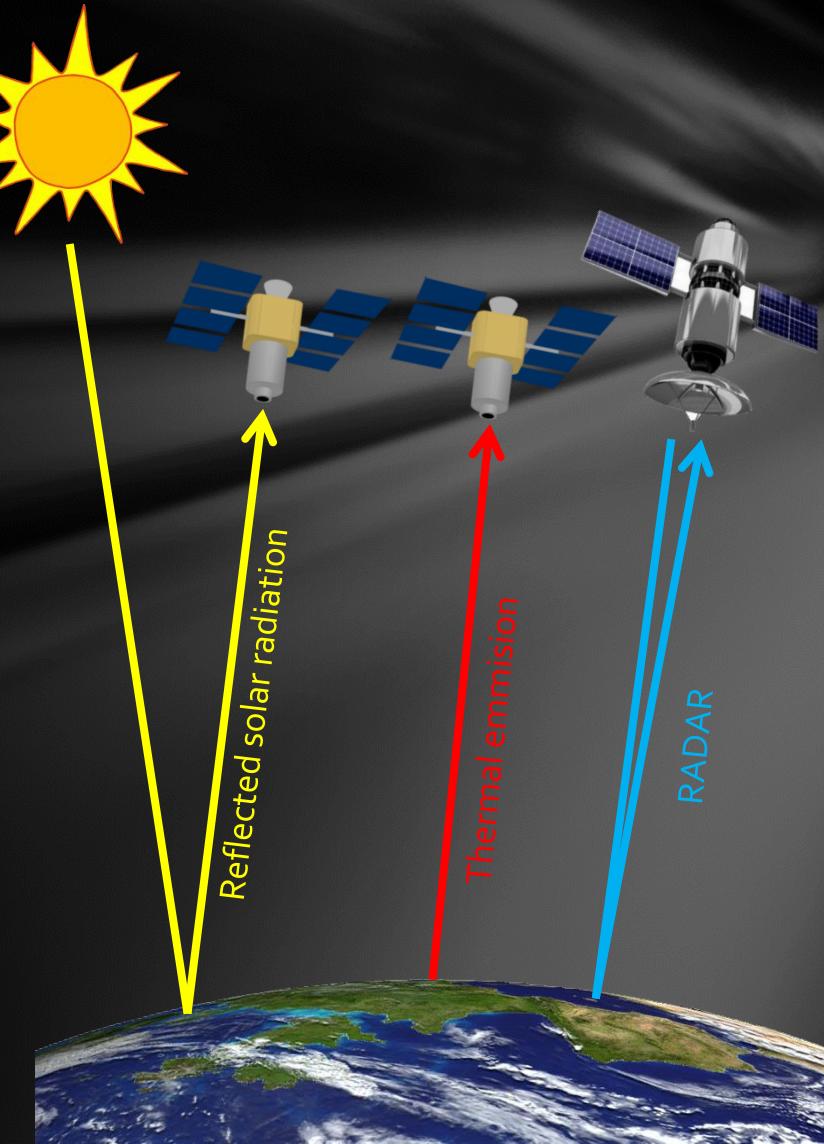
Jan Mišurec M.Sc.
jan.misurec@geology.cz



Jan Jelének B.Sc.
jan.jelenek@geology.cz

Remote sensing: basic principle

- Acquisition of information about Earth's surface without direct contact via detection of reflected or emitted electromagnetic (EM) radiation
 - a) Reflected solar radiation (0.4-2.5 μm)
 - VIS: visible - (0.4-0.7 μm)
 - NIR: near infrared (0.7-1.2 μm)
 - SWIR: short wave infrared (1.2-2.5 μm)
 - b) Emitted thermal radiation (8-15 μm)
 - c) Artificial radiation (RADAR) (0.8 mm – 1 m)
- Visualization of the measured intensities of reflected or emitted radiation → **image data**
- Data acquired in various wavelengths of EM radiation → **multispectral principle**
- Each spectral band of the image data represents different interval of EM radiation wavelengths



Remote sensing: data visualization

480 nm

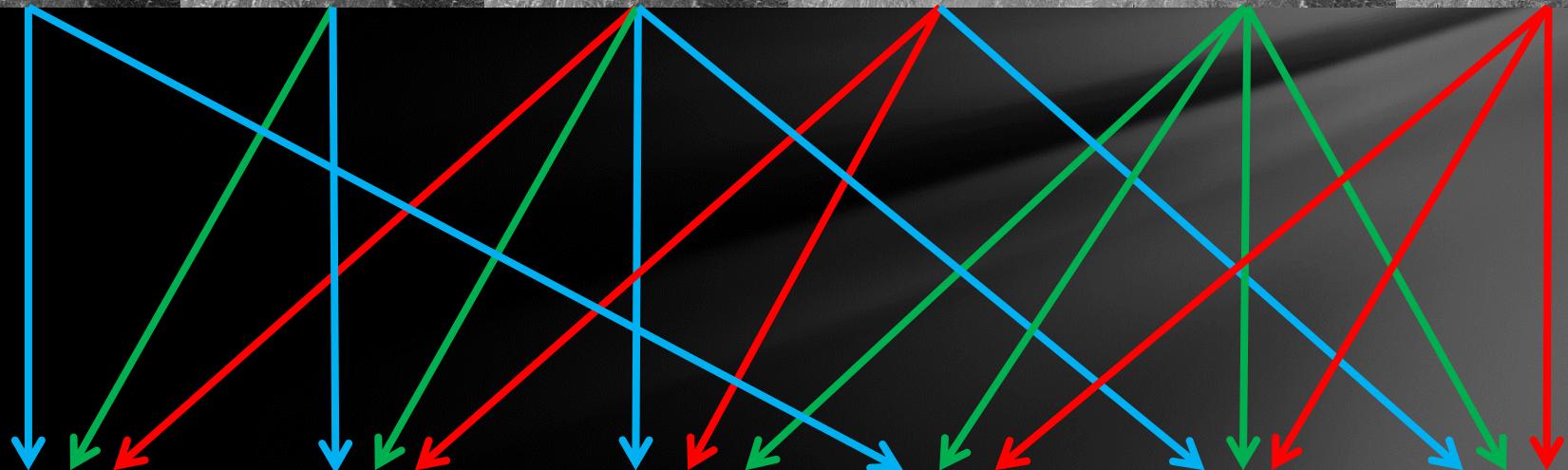
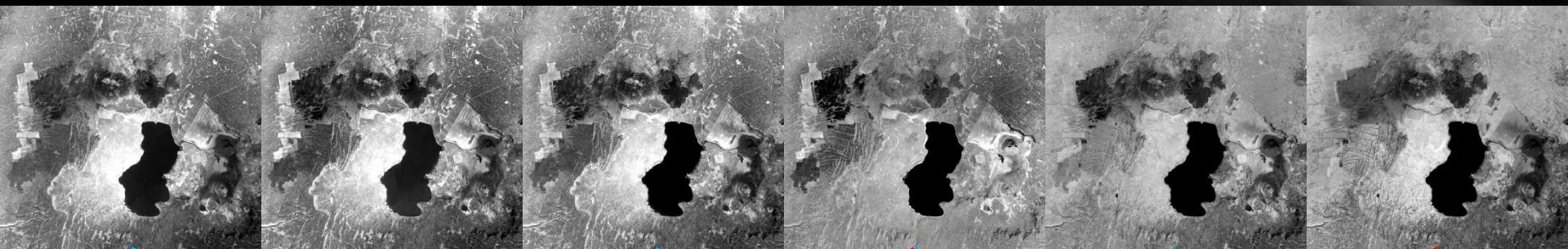
550 nm

650 nm

750 nm

1650 nm

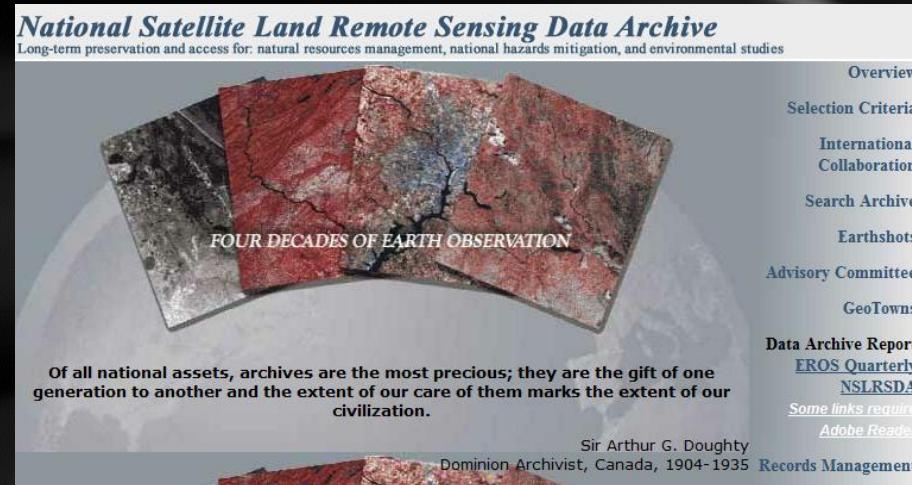
2200 nm



Sources of Remote Sensing data

U.S. Geological Survey data archive

- Available via Earth Explorer stewardship system
- <http://earthexplorer.usgs.gov>
- Required registration (free of charge)
- Wide range of RS data
 - Landsat 4, 5 and 7 (TM and ETM+)
 - EO-1 (ALI and Hyperion)
 - SRTM Digital Elevation Model
 - ASTER Digital Elevation Model



Sources of Remote Sensing data

Earth Explorer: Definition of the area of interest

- Manually, Shapefile, KML file

The screenshot shows the USGS Earth Explorer interface. On the left, there is a search criteria panel with tabs for Address/Place, Path/Row, Feature, and Circle. The Coordinates tab is selected, showing four coordinate pairs:

- Lat: 06° 00' 00" N, Lon: 039° 00' 00" E
- Lat: 06° 00' 00" N, Lon: 037° 30' 00" E
- Lat: 08° 00' 00" N, Lon: 037° 30' 00" E
- Lat: 08° 00' 00" N, Lon: 039° 00' 00" E

Below these coordinates are buttons for Use Map, Add Coordinate, and Clear Coordinates. A red box highlights this section. At the bottom of the search criteria panel are buttons for Data Sets, Additional Criteria, and Results.

The main part of the interface is a satellite map of Ethiopia. A red polygon is drawn around the center of the country, specifically over the Oromia region. Four red dots are placed along the perimeter of this polygon, labeled 1, 2, 3, and 4. The map also shows various geographical features, towns, and national parks like Abijatta-Shalla National Park and Bale Mountains National Park. The map includes a legend, a scale bar, and a north arrow. The top right corner of the map displays coordinates (08° 47' 14" N, 030° 19' 12" E), options, overlays, map, and satellite buttons.

At the very bottom of the page, a footer note reads: "The up-to-date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only."

Sources of Remote Sensing data

Earth Explorer: Selection of the dataset

USGS
science for a changing world

EarthExplorer

Home 2 New System Messages Profile Save Criteria Load Favorite Manage Criteria

Logout jmis Feedback Help

Search Criteria Data Sets Additional Criteria Results Clear Criteria

2. Select Your Data Set(s)
Check the boxes for the data set(s) you want to search. When done selecting data set(s), click the Additional Criteria or Results buttons below. Click the plus sign next to the category name to show a list of data sets.

Use Data Set Prefilter ([What's This?](#))

Data Set Search:

Aerial Photography
AVHRR
Cal/Val Reference Sites
Commercial
Declassified Data
Digital Elevation
Digital Line Graphs
Digital Maps
EO-1
Forest Carbon Sites
Global Fiducials
Global Land Survey
HCMM
JECAM Sites
Land Cover
Landsat Archive
L7 ETM+ SLC-off (2003-present)
 L7 ETM+ SLC-on (1999-2003)
 L7 ETM+ Int'l Ground Stations (Search Only)
 L4-5 TM
 L1-5 MSS
Landsat Legacy
Landsat MRLC
LIDAR

Search Criteria Summary (Show)

(11° 26' 12" N, 039° 15' 07" E) Options Overlays Mapa Satelitní



The up-to-date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only.

Clear All Selected Additional Criteria » Results »

Sources of Remote Sensing data

Earth Explorer: Additional criteria (optional)

- Scene position (row, path)
- Cloud coverage (%)
- Processing level
- Day/night data

The screenshot shows the USGS Earth Explorer search interface. At the top, there's a logo for "USGS science for a changing world" and a map thumbnail. Below the logo is the "EarthExplorer" title and a navigation bar with links: Home, 2 New System Messages, Profile, Save Criteria, Load Favorite, Manage Criteria, Search Criteria (which is selected), Data Sets, Additional Criteria (highlighted in blue), and Results.

The main content area is titled "3. Additional Criteria (Optional)". It includes dropdown menus for "Data Set" (set to "L7 ETM+ SLC-on (1999-2003)"), "Cloud Cover" (with options: All, Less than 10%, Less than 20%, Less than 30%, Less than 40%), "Station Identifier" (with options: All, EROS, Receiving station, Poker Flats, Alaska; EROS, Receiving station, Alice Springs, Australia; EROS, Receiving station, Cordoba, Argentina; EROS, Receiving station, Cuiaba, Brazil), "Data Type Level 1" (with options: All, Processing Required, ETM+ L1GT, ETM+ L1G, ETM+ L1T), "Day Night" (with options: Night, Day), and "Browse Exists" (with options: All, Yes, No). At the bottom are "Reset All Criteria" and "Results »" buttons.

A sidebar on the right shows a map with various locations labeled: Zefah Game Reserve, Shambe Nature Reserve, and Undri Town. A "Search Criteria" button is also visible in the sidebar.

Sources of Remote Sensing data

Earth Explorer: Results

- Footprint, Quicklook, Metadata

The screenshot shows the USGS Earth Explorer interface. At the top, there's a logo for USGS (science for a changing world) and a "Footprint" button. Below the header, the URL "EarthExplorer" is visible along with navigation links: Home, 2 New System Messages, Profile, Save Criteria, Load Favorite, Manage Criteria, Logout, jms, Feedback, Help, and Clear Criteria.

The main content area is titled "4. Search Results". It displays a "Search Criteria Summary" map of Ethiopia with several regions highlighted in different colors (red, green, yellow). A legend indicates the color coding for different land cover types or data sources. Below the map, a list of search results is shown:

Row	Entity ID	Acquisition Date	Path	Row
93	LT51690552011001MLK00	01-JAN-11	169	55
94	LT51680542011010MLK00	10-JAN-11	168	54
95	LT51680562011010MLK00	10-JAN-11	168	56
96	LT51680552011010MLK00	10-JAN-11	168	55
97	LT51690542011017MLK00	17-JAN-11	169	54

Each row includes a thumbnail preview, download icons, and a "Show Result Controls" dropdown. The bottom of the page features a "Submit Standing Request" button and a note: "The up-to-date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only."

Sources of Remote Sensing data

Earth Explorer: Results

- Footprint, Quicklook, Metadata

The screenshot shows the USGS Earth Explorer interface. At the top left is the USGS logo with the tagline "science for a changing world". To the right is a "Quicklook" button. Below the logo is a navigation bar with links: Home, 2 New System Messages, Profile, Save Criteria, Load Favorite, Manage Criteria, Logout, jmis, Feedback, Help, and a "Results" button.

The main area is titled "4. Search Results". It displays a list of five search results, each with a thumbnail image, entity ID, acquisition date, path, and row information, along with "Show Result Controls" buttons:

- Entity ID: LT51690552011001MLK00, Acquisition Date: 01-JAN-11, Path: 169, Row: 55
- Entity ID: LT51680542011010MLK00, Acquisition Date: 10-JAN-11, Path: 168, Row: 54
- Entity ID: LT51680562011010MLK00, Acquisition Date: 10-JAN-11, Path: 168, Row: 56
- Entity ID: LT51680552011010MLK00, Acquisition Date: 10-JAN-11, Path: 168, Row: 55
- Entity ID: LT51690542011017MLK00, Acquisition Date: 17-JAN-11, Path: 169, Row: 54

Below the search results is a "Search Criteria Summary (Show)" section containing a map of the study area. The map shows satellite imagery with various locations labeled, including Addis Ababa, Debre Zeit, Mojo, Adama, and several national parks like Omo National Park, Mago National Park, and Nechisar National Park. A specific area in the center is highlighted with a red polygon. The map includes a legend, a scale bar, and a north arrow. The bottom of the map has a note: "The up-to-date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only."

Sources of Remote Sensing data

Earth Explorer: Results

- Footprint, Quicklook, Metadata

 science for a changing world

EarthExplorer

Home 2 New System Messages Profile Save Criteria Load Favorite ▾ Manage Criteria

Search Criteria Data Sets Additional Criteria Results

4. Search Results

If you selected more than one data set to search, use the dropdown to see the search results for each specific data set.

Show Result Controls

Data Set: L4-5 TM Export Metadata

Entity ID	Acquisition Date	Path	Row
LT51690552011001MLK00	01-JAN-11	169	55
LT51680542011010MLK00	10-JAN-11	168	54
LT51680562011010MLK00	10-JAN-11	168	56
LT51680552011010MLK00	10-JAN-11	168	55
LT51690542011017MLK00	17-JAN-11	169	54

93 94 95 96 97

Entity ID: LT51690552011001MLK00
Acquisition Date: 01-JAN-11
Path: 169
Row: 55

Entity ID: LT51680542011010MLK00
Acquisition Date: 10-JAN-11
Path: 168
Row: 54

Entity ID: LT51680562011010MLK00
Acquisition Date: 10-JAN-11
Path: 168
Row: 56

Entity ID: LT51680552011010MLK00
Acquisition Date: 10-JAN-11
Path: 168
Row: 55

Entity ID: LT51690542011017MLK00
Acquisition Date: 17-JAN-11
Path: 169
Row: 54

Submit Standing Request »

The up-to-date Google map is not for purchase or for download; it is to be used as

Search Criteria Summary (Show)



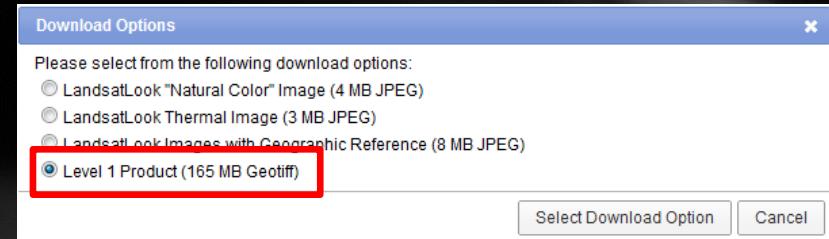
Data Set Attribute	Attribute Value
Landsat Scene Identifier	LT51680552011010MLK00
Spacecraft Identifier	LANDSAT_5
Sensor Mode	BUMPER
Station Identifier	MLK
Day/Night	DAY
WRS Path	168
WRS Row	055
WRS Type	2
Date Acquired	2011/01/10
Start Time	2011:01:10T07:30:29.98794
Stop Time	2011:01:10T07:30:56.60088
Sensor Anomalies	N
Acquisition Quality	9
Quality Band 1	9
Quality Band 2	9
Quality Band 3	9
Quality Band 4	9
Quality Band 5	9
Quality Band 6	9
Quality Band 7	9
Cloud Cover	.07
Cloud Cover Quad Upper Left	.03
Cloud Cover Quad Upper Right	.05
Cloud Cover Quad Lower Left	.02
Cloud Cover Quad Lower Right	.17
Sun Elevation	48.38421628
Sun Azimuth	135.34003319
Scene Center Latitude	7.23459 (7°14'04.52"N)
Scene Center Longitude	62.0000000000 (62°0'0"E)

Sources of Remote Sensing data

Earth Explorer: Data ordering

1. Already pre-processed data

- No shopping cart icon
- Data required by another user in the past
- Already preprocessed (Level 1G or Level 1T)
- Ready for direct download



2. Data waiting for pre-processing

- Shopping cart icon available
- Data have not been processed yet
- JPEG quicklooks available only!
- Pre-processing must be ordered (free of charge)
- Data are added into archive and prepared for download
- The user ordering the data preprocessing is informed by e-mail when the data are ready for download



Sources of Remote Sensing data

ERSDAC GDS:

- <http://gds.aster.ersdac.jspacesystems.or.jp>
- ASTER (multispectral data)
 - Level 1B
 - UTM coordinate system
- ALOS/PALSAR (radar data)

► JAPANESE

Welcome to
ASTER GDS Web Site
Earth Remote Sensing Data Analysis Center

INFORMATION

On March 30, 2012, Earth Remote Sensing Data Analysis Center (ERSDAC) merged with Institute for Unmanned Space Experiment Free Flyer (USEF) and Japan Resources Observation System and Space Utilization Organization (JAROS) to form a new organization called "Japan Space Systems". Following this, our URL address was changed to GDS.aster.ersdac.jspacesystems.or.jp/ from March 30, 2012. The activities and services presently carried out by ERSDAC including the

NEWS FLASH!

Please read the person who is using "Windows XP (SP2)".

- ASTER/PALSAR Unified Search site has been released. (2012/07/30)
 - The simultaneous retrieval of ASTER data and PALSAR data is available.
 - When placing an order, the unified search site jumps to the ordering screen of ASTER GDS and PALSAR GDS, respectively.
 - For orders of ASTER data and PALSAR data, using your user account registered at ASTER GDS site and PALSAR GDS site is required.
 - After login to the either above-mentioned user account, selecting the display of mosaic image is available for map's background.

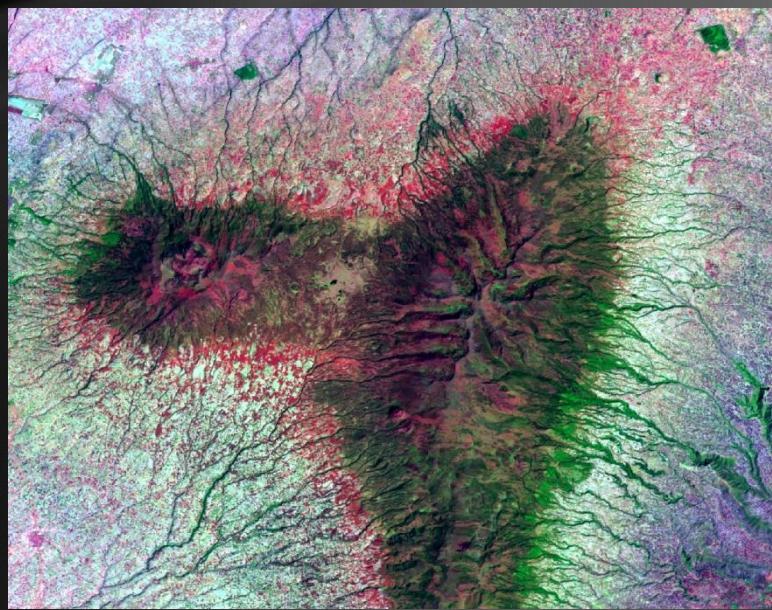
Entrance	Exhibition Room	Image Gallery	Seminar Room	Service Center
<ul style="list-style-type: none">• GDS News• ASTER GDS History• Keyword• Renewal Records	<ul style="list-style-type: none">• ASTER Project• EOS Project• TERRA• ASTER Instruments• ASTER GDS• ASTER Data Products	<ul style="list-style-type: none">• Remote Sensing• New Images• Isahaya-Bay• Toyama-Bay• Miyake Island• USU Volcano• Image Collection• Image Processing Labo	<ul style="list-style-type: none">• ASTER Products Guide• Earth Observation Satellite• Global Environmental Issues	<ul style="list-style-type: none">• Summary of Services• Procedure Flow to obtain ASTER Data Products• User Registration Service• User Modification Service
		Library Room		
		<ul style="list-style-type: none">• ASTER related documents		

Please view this page with Internet Explorer 3.0 or later or Netscape Navigator 2.0 or later, which has the frame function.

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All rights reserved

Landsat

- Long-term Earth observation mission
- Since 1972 (MSS), 1982 (TM)
- Data available via Earth Explorer
- Data cost: **free of charge**
- Scene dimensions: 180 x 180 km
- **Landsat 5** (1984-2012):
 - Thematic Mapper (TM) sensor
 - 6 spectral bands (3 VIS, 1 NIR, 2 SWIR, 1 TIR)
 - Spatial resolution: 30 m (VIS, NIR and SWIR), 120 m (TIR)
- **Landsat 7** (1999-?):
 - Enhanced Thematic Mapper + (ETM+) sensor
 - 8 spectral bands (3 VIS, 1 NIR, 2 SWIR, 1 TIR and 1 PAN)
 - Spectral resolution
 - Data acquired after May 2003 are not usable due to technical failure of the ETM+ sensor



Landsat

band	TM (Landsat 5)	ETM+ (Landsat 7)	Use
1:VIS-B (0.45-0.52 µm)	30 m	30 m	Fe ²⁺ and Fe ³⁺ absorption – low values for Fe bearing minerals (pyrite, hematite, goethite...); kaolinite – high values; absorption of vegetation pigments – low values
2:VIS-G (0.53-0,60 µm)	30 m	30 m	Fe ²⁺ reflection X Fe ³⁺ absorption - ; Fe ²⁺ higher values than Fe ³⁺ minerals; kaolinite – high values; high reflectivity of vegetation
3: VIS-R (0.63-0.69 µm)	30 m	30 m	Fe ²⁺ absorption – moderate values of Fe ²⁺ bearing minerals; absorption of chlorophyll – low values for vegetation
4: NIR (0.75-0.90 µm)	30 m	30 m	Crystal field absorption – moderate values of goethitic and hematitic iron; clays – high values; cellular structure reflection – very high values of vegetation
5: SWIR (1.55-1.75 µm)	30 m	30 m	Highest values for most rock and soil types, high values for hydrothermally altered rocks
7: SWIR (2.09-2.35 µm)	30 m	30 m	Absorption of –OH and CO ₃ bearing minerals – low values for clays, mica, carbonates and sulphates groups
6: TIR (10.4-12.5µm)	120 m	60 m	Igneous rocks, quartz and feldspars
8: PAN (0.52-0.90µm)	X	15 m	More surface details visible due to higher spatial resolution

Landsat: band combinations

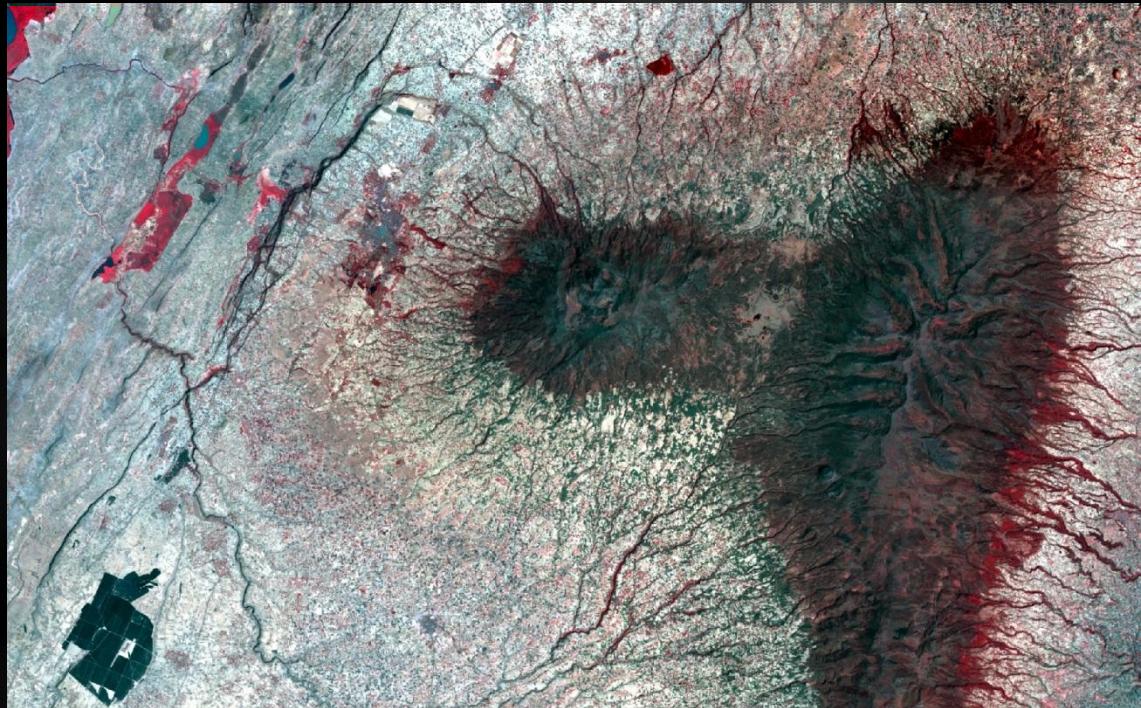
- RGB composites
- **RGB: 3-2-1 (VIS)**
 - True (natural)color
- **RGB: 4-3-2 (VNIR)**
 - Useful for vegetation studies
- **RGB: 5-4-2**
 - Mineral composition
- **RGB: 7-4-1**
 - Mineral composition
 - Hydrothermal alterations



RGB: 3-2-1 (VIS – true color)

Landsat: band combinations

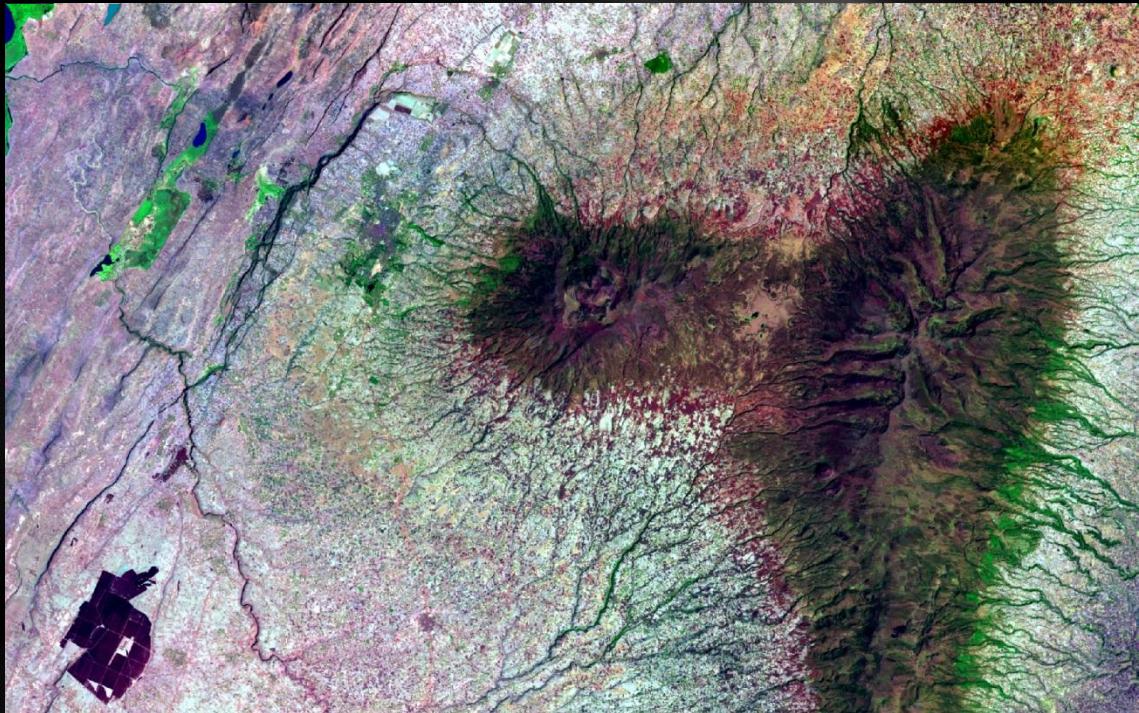
- RGB composites
- **RGB: 3-2-1 (VIS)**
 - True (natural)color
- **RGB: 4-3-2 (VNIR)**
 - Useful for vegetation studies
- **RGB: 5-4-2**
 - Mineral composition
- **RGB: 7-4-1**
 - Mineral composition
 - Hydrothermal alterations



RGB: 4-3-2 (NIR+VIS)

Landsat: band combinations

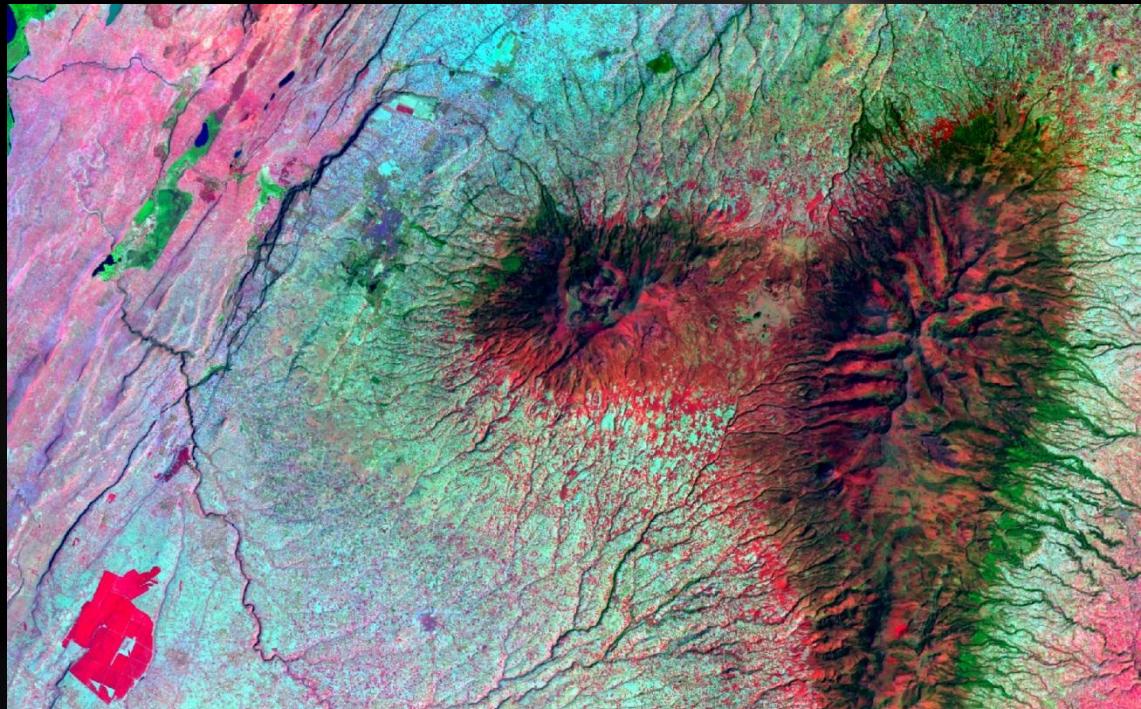
- RGB composites
- **RGB: 3-2-1 (VIS)**
 - True (natural)color
- **RGB: 4-3-2 (VNIR)**
 - Useful for vegetation studies
- **RGB: 5-4-2**
 - Mineral composition
- **RGB: 7-4-1**
 - Mineral composition
 - Hydrothermal alterations



RGB: 5-4-2 (SWIR1+NIR+VIS)

Landsat: band combinations

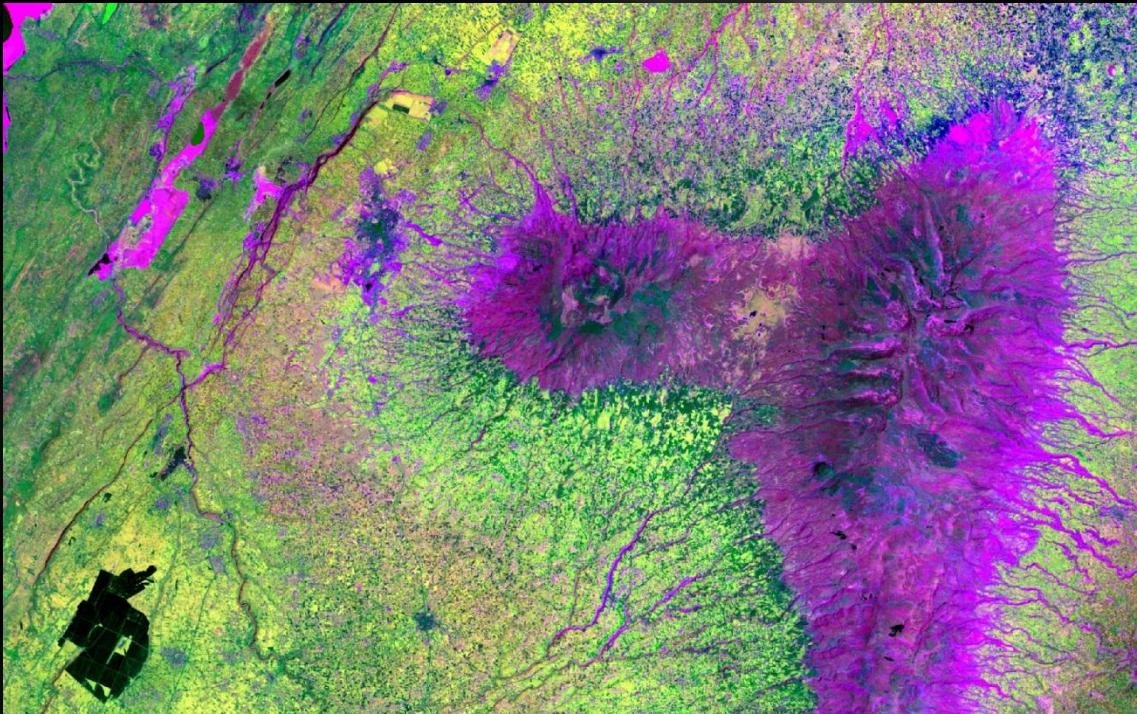
- RGB composites
- **RGB: 3-2-1 (VIS)**
 - True (natural)color
- **RGB: 4-3-2 (VNIR)**
 - Useful for vegetation studies
- **RGB: 5-4-2**
 - Mineral composition
- **RGB: 7-4-1**
 - Mineral composition
 - Hydrothermal alterations



RGB: 7-4-1 (SWIR₂-NIR-VIS)

Landsat: band ratios

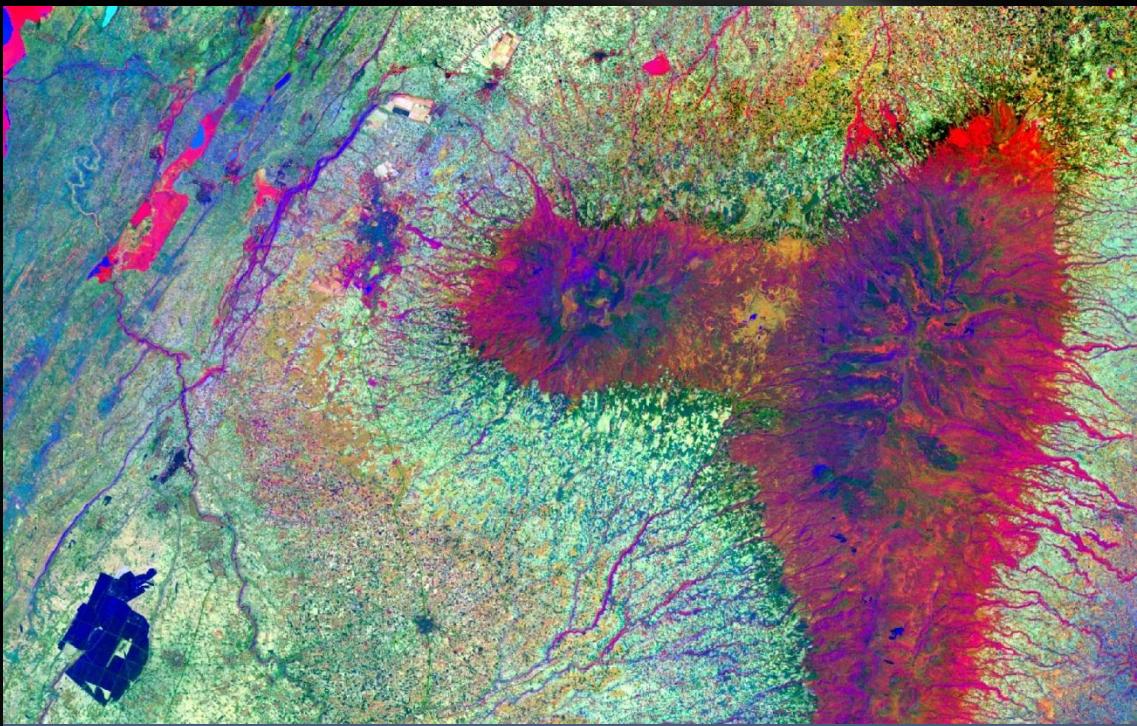
- Enhancing of the spectral contrast
- Removal of topographic effects and shadows
- 3/1: iron oxides, Fe bearing minerals (hematite, goethite, pyrite...)
- 5/7: intensity of hydroxyl absorption (clay minerals)
- 5/4: Fe^{2+} detection discrimination of gossans and iron rich zones
- RGB: 5/7-3/1-4/3 (hydrothermal alterations)
- RGB: 5/7-3/1-3/5 (hydrothermal alterations, granites, migmatites, gabbros, basalts, tuffs, trachytes)
- RGB: 5/7-4/5-3/1 (mineral composition)
- RGB: 5/7-5/4-3/1 (mineral composition)
- RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)



RGB: 5/7-3/1-4/3 (hydrothermal alterations)

Landsat: band ratios

- Enhancing of the spectral contrast
- Removal of topographic effects and shadows
- 3/1: iron oxides, Fe bearing minerals (hematite, goethite, pyrite...)
- 5/7: intensity of hydroxyl absorption (clay minerals)
- 5/4: Fe^{2+} detection discrimination of gossans and iron rich zones
- RGB: 5/7-3/1-4/3 (hydrothermal alterations)
- RGB: 5/7-3/1-3/5 (hydrothermal alterations, granites, migmatites, gabbros, basalts, tuffs, trachytes)
- RGB: 5/7-4/5-3/1 (mineral composition)
- RGB: 5/7-5/4-3/1 (mineral composition)
- RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)



Landsat: band ratios

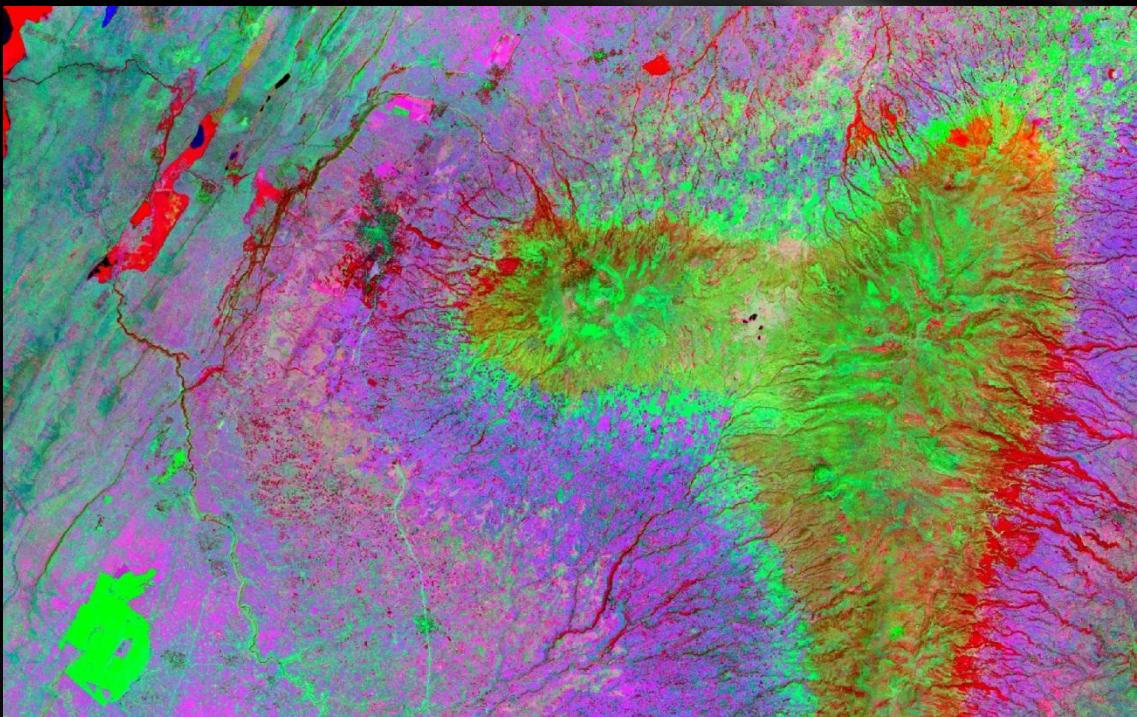
- Enhancing of the spectral contrast
- Removal of topographic effects and shadows
- 3/1: iron oxides, Fe bearing minerals (hematite, goethite, pyrite...)
- 5/7: intensity of hydroxyl absorption (clay minerals)
- 5/4: Fe^{2+} detection discrimination of gossans and iron rich zones
- RGB: 5/7-3/1-4/3 (hydrothermal alterations)
- RGB: 5/7-3/1-3/5 (hydrothermal alterations, granites, migmatites, gabbros, basalts, tuffs, trachytes)
- RGB: 5/7-4/5-3/1 (mineral composition)
- RGB: 5/7-5/4-3/1 (mineral composition)
- RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)



RGB: 5/7-4/5-3/1 (mineral composition)

Landsat: band ratios

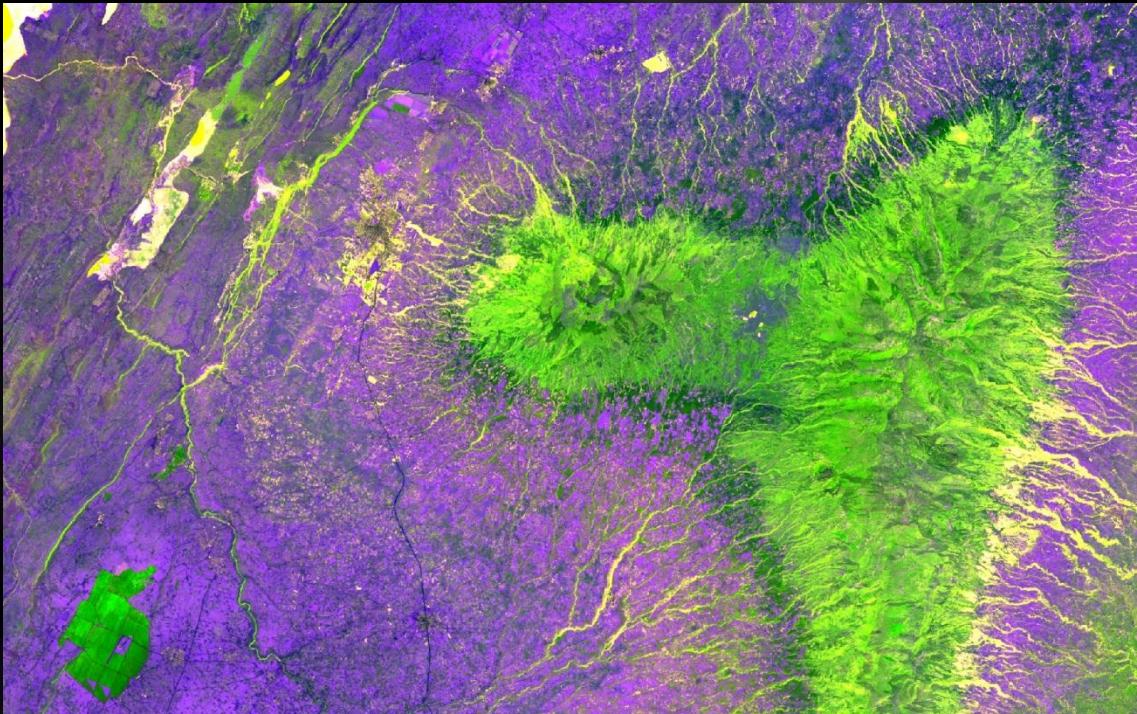
- Enhancing of the spectral contrast
- Removal of topographic effects and shadows
- 3/1: iron oxides, Fe bearing minerals (hematite, goethite, pyrite...)
- 5/7: intensity of hydroxyl absorption (clay minerals)
- 5/4: Fe^{2+} detection discrimination of gossans and iron rich zones
- RGB: 5/7-3/1-4/3 (hydrothermal alterations)
- RGB: 5/7-3/1-3/5 (hydrothermal alterations, granites, migmatites, gabbros, basalts, tuffs, trachytes)
- RGB: 5/7-4/5-3/1 (mineral composition)
- RGB: 5/7-5/4-3/1 (mineral composition)
- RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)



RGB: 5/7-5/4-3/1 (mineral composition)

Landsat: band ratios

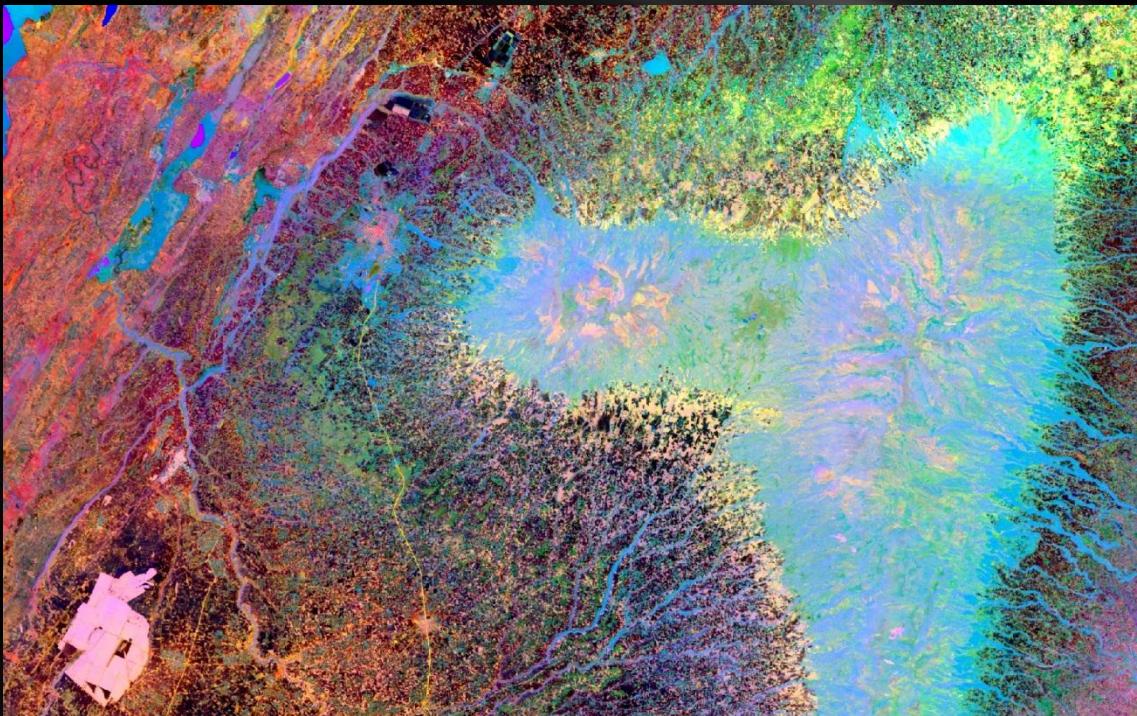
- Enhancing of the spectral contrast
- Removal of topographic effects and shadows
- 3/1: iron oxides, Fe bearing minerals (hematite, goethite, pyrite...)
- 5/7: intensity of hydroxyl absorption (clay minerals)
- 5/4: Fe^{2+} detection discrimination of gossans and iron rich zones
- RGB: 5/7-3/1-4/3 (hydrothermal alterations)
- RGB: 5/7-3/1-3/5 (hydrothermal alterations, granites, migmatites, gabbros, basalts, tuffs, trachytes)
- RGB: 5/7-4/5-3/1 (mineral composition)
- RGB: 5/7-5/4-3/1 (mineral composition)
- RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)



RGB: 4/5-6/7-4/6 (granitoids, igneous rocks)

Landsat: PCA transformation

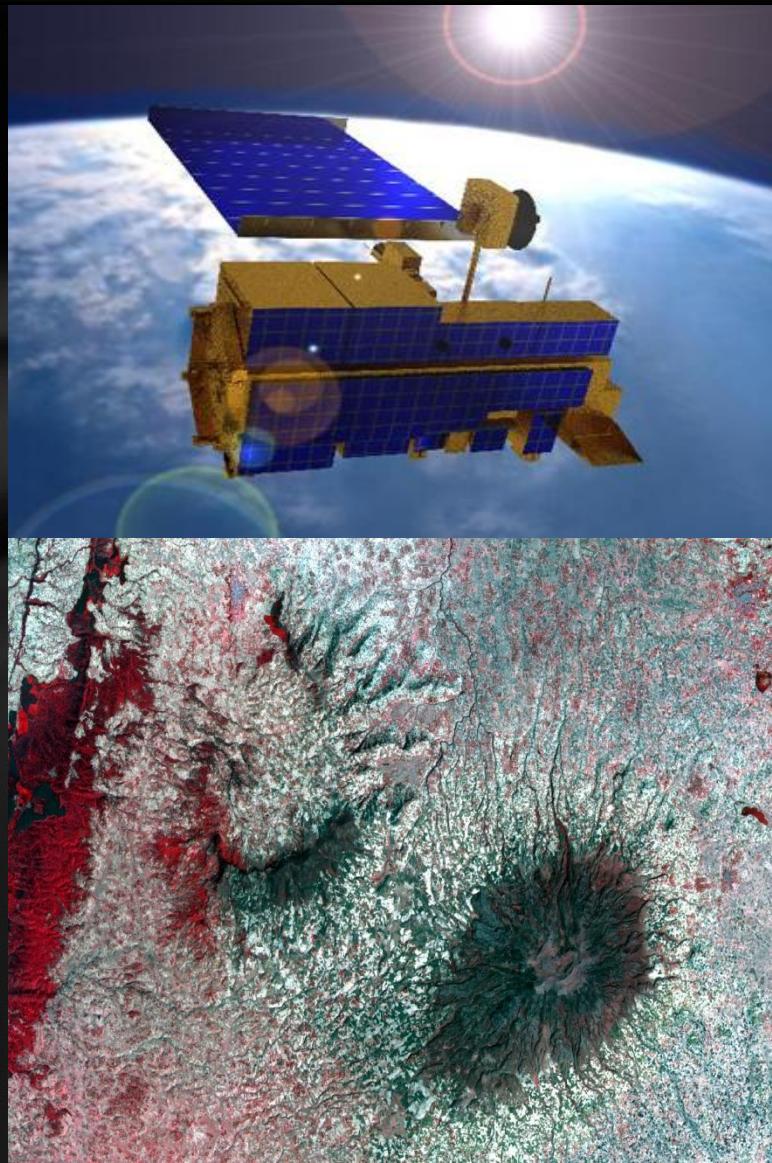
- Only 3 bands can be visualized by any RGB combination → information beard by other bands is invisible
- Spectral bands are strongly correlated
- Principle Component Analysis (PCA)
- Compression of the information from original correlated bands into few uncorrelated components
- E.g.: 95% of information from 6 original bands of TM/ETM+ could be compressed into 3 components that might be easily visualized



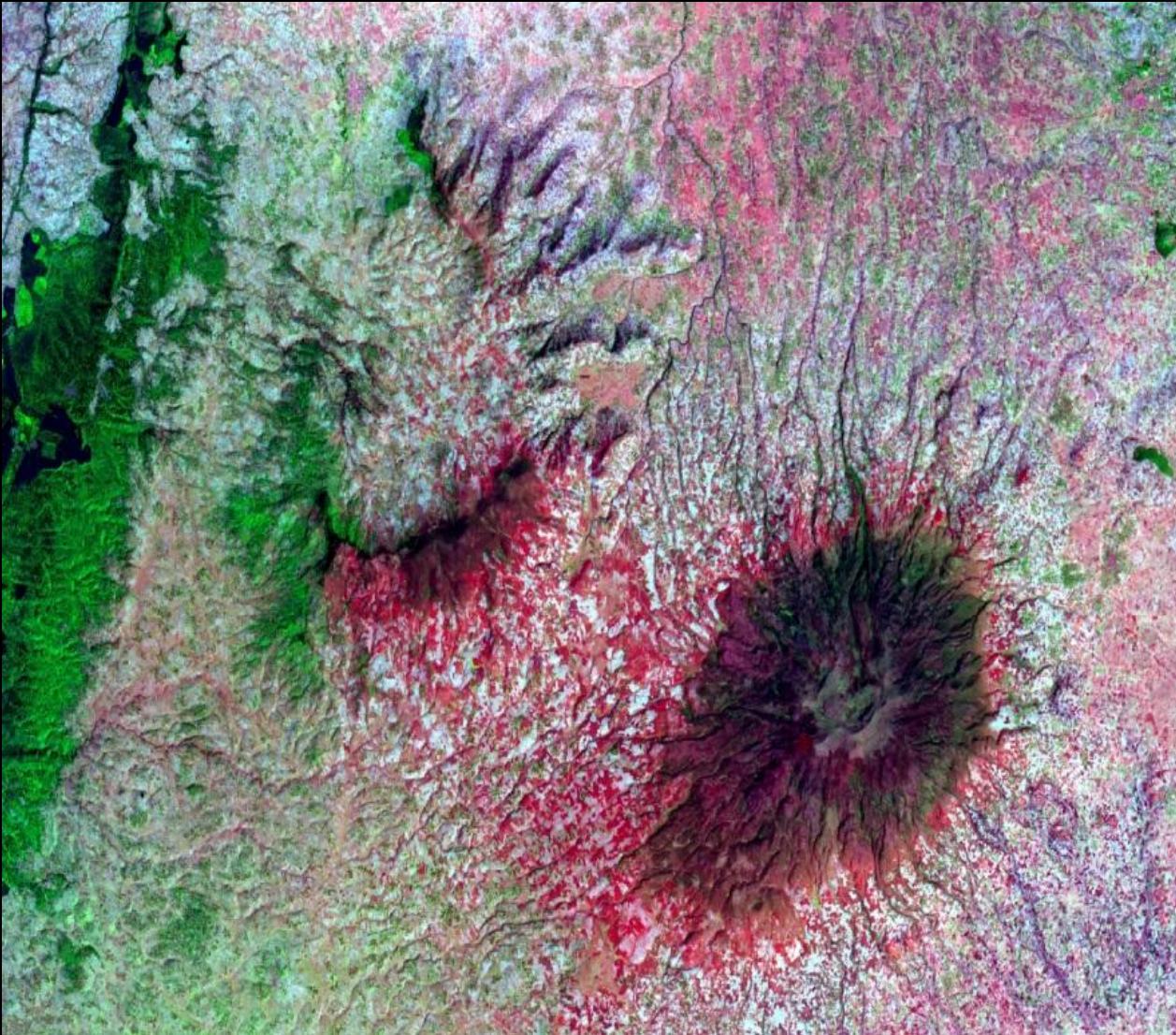
RGB: PCA₁-PCA₂-PCA₃

ASTER

- EOS – Terra satellite
- Operated since 2000
- Data ordering via ERSDAC
- Data cost: 125 USD (9800 YEN) per scene
- Scene dimensions: 62 x 62 km
- 16 spectral bands
 - 2 VIS (15 m)
 - 2 NIR (15 m, nadir and backward looking →DEM)
 - 6 SWIR (30 m)
 - 5 TIR (90 m)
- Data acquired after April 2008 are not usable due to technical failure of the sensor (in SWIR domain)



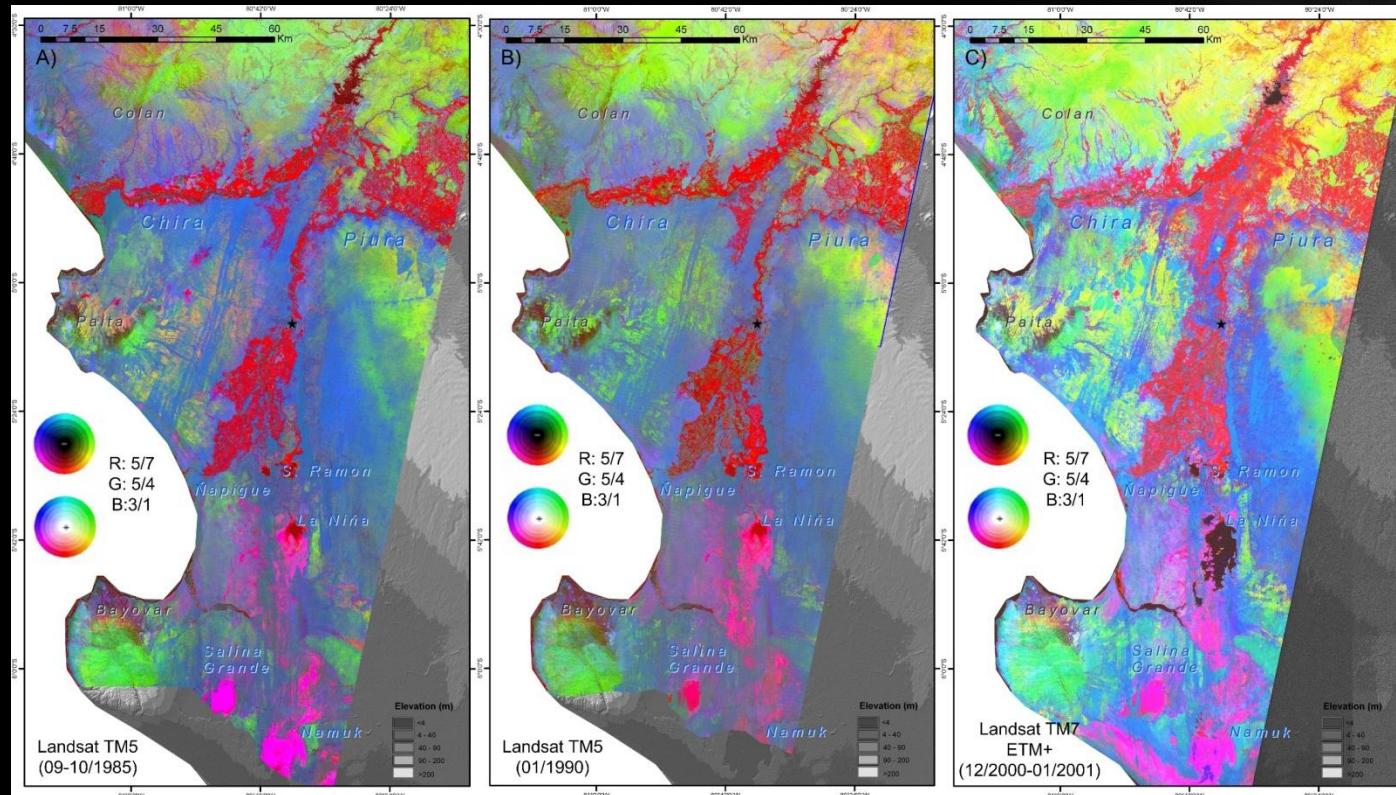
ASTER



band	range	resolution
1: VIS-G	0.52-0.60 µm	15 m
2: VIS-R	0.63-0.69 µm	15 m
3N: NIR	0.76-0.86 µm	15 m
3B: NIR	0.76-0.86 µm	15 m
5: SWIR	1.60-1.70 µm	30 m
6: SWIR	2.15-2.19 µm	30 m
7: SWIR	2.19-2.23 µm	30 m
8: SWIR	2.24-2.29 µm	30 m
9: SWIR	2.30-2.37 µm	30 m
10: SWIR	2.36-2.43 µm	30 m
11: TIR	8.13-8.48 µm	90 m
12: TIR	8.48-8.83 µm	90 m
13: TIR	8.93-9.28 µm	90 m
14: TIR	10.25-10.95 µm	90 m
15: TIR	10.95-11.65 µm	90 m

ASTER/Landsat

Detection of El-Niño induced changes based on analysis of multitemporal EO data

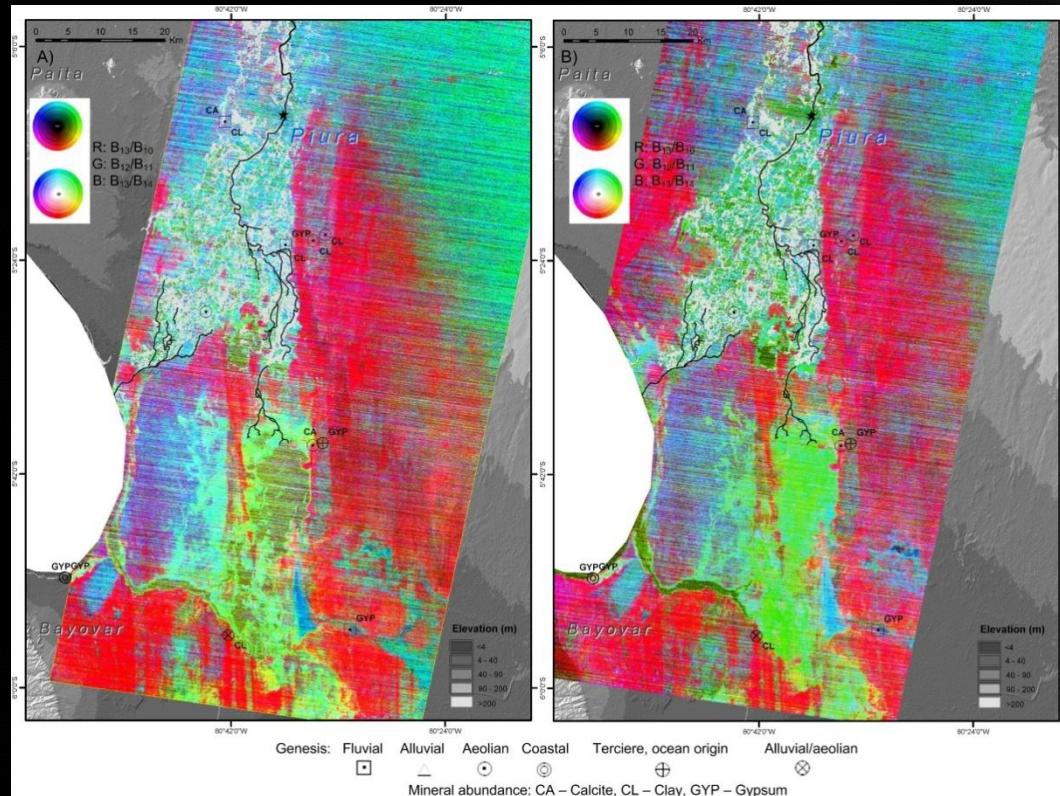


Mineral composition color scheme of Landsat TM data

A) 1985 B) 1990 C) 2000/2001

ASTER

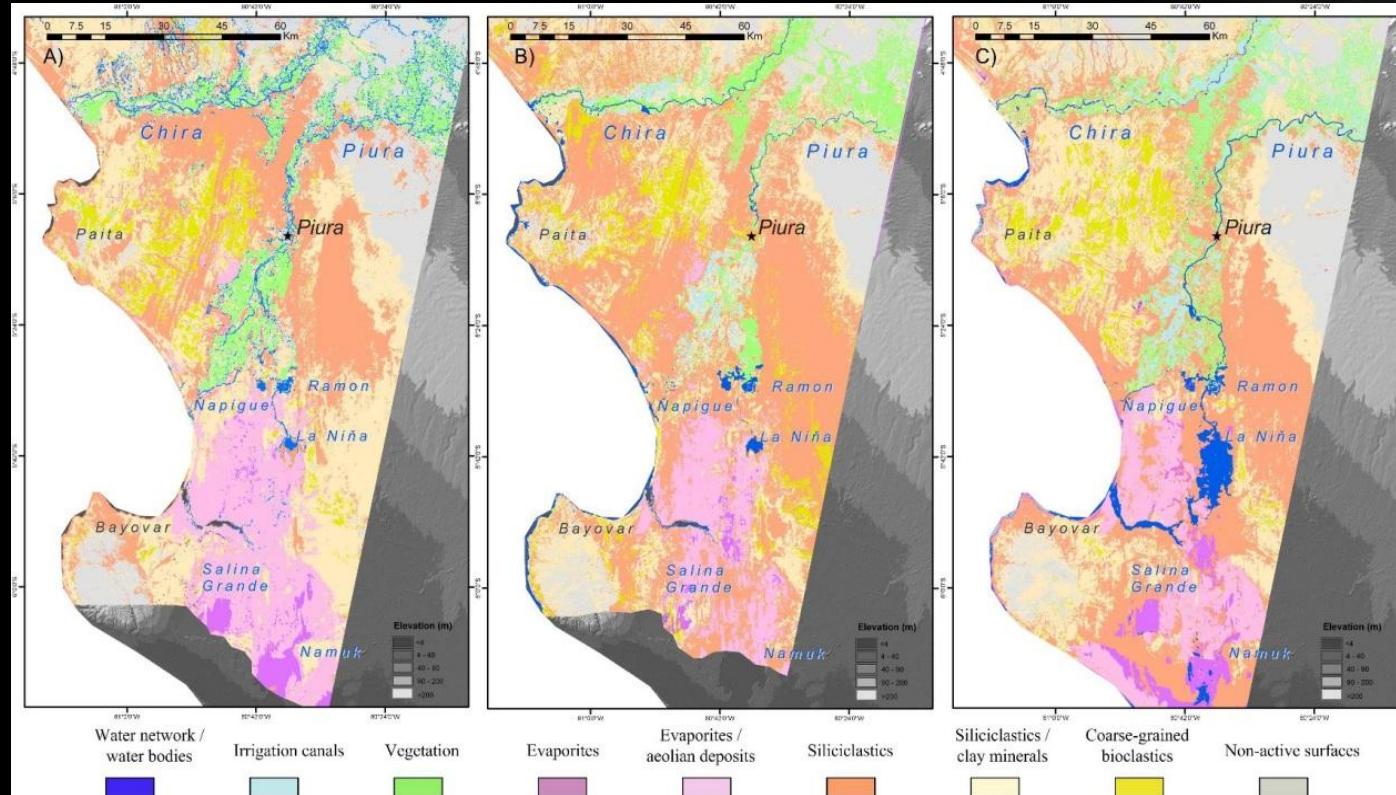
Detection of El-Niño induced changes based on analysis of multitemporal EO data



ASTER TIR analysis – mineralogical band ratios
A) wet season B) dry season

ASTER/Landsat

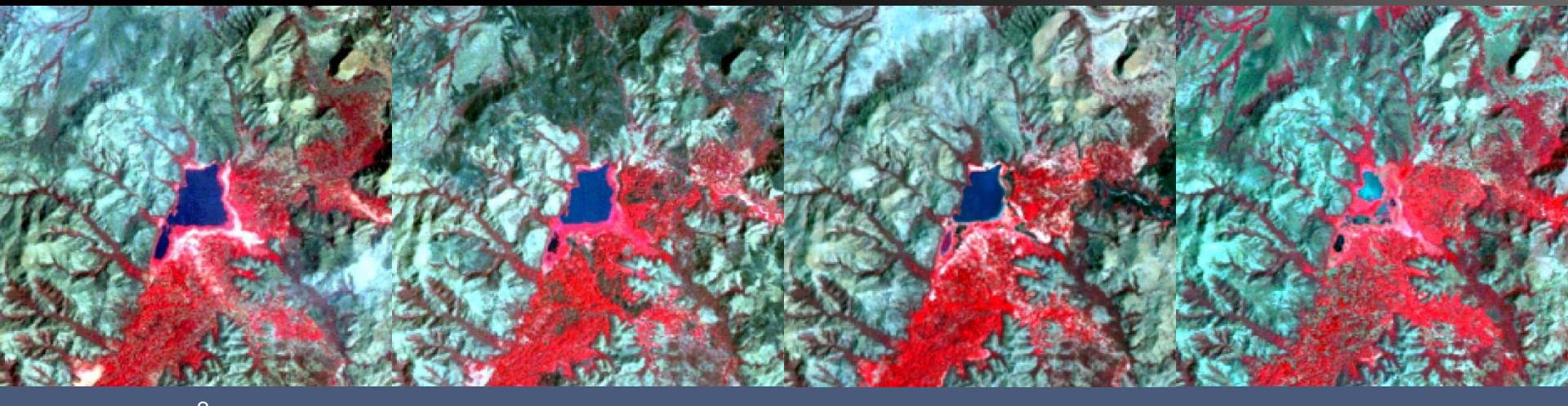
Detection of El-Niño induced changes based on analysis of multitemporal EO data



Land cover classification of Landsat TM data
A) 1985 B) 1990 C) 2000/2001

Temporal changes: coastal lines

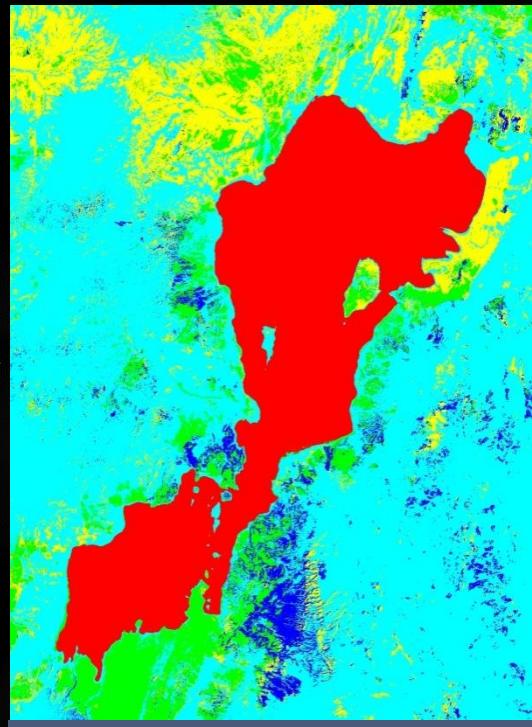
- Landsat TM/ETM+ data available since 1982
- 30 years long time series
- Detection of the changes of lake coastal lines
- Data from the same part of the year (month) → comparable conditions → periodical changes of the water level (dry/wet periods)
- 4 time horizons:
 1. 1987 (Landsat 5 TM)
 2. 1995 (Landsat 5 TM)
 3. 2000 (Landsat 7 ETM+)
 4. 2010/2011 (Landsat 5 TM)



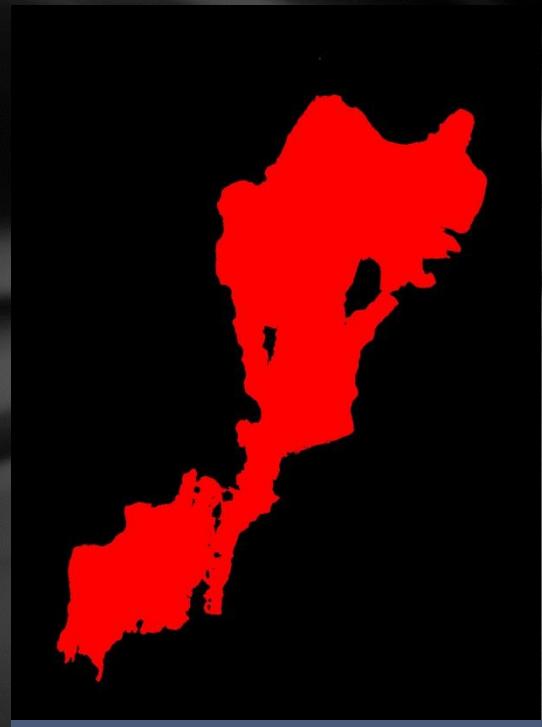
Temporal changes: coastal lines



Landsat data



Classification:
Water and other surfaces
ENVI, ERDAS Imagine...



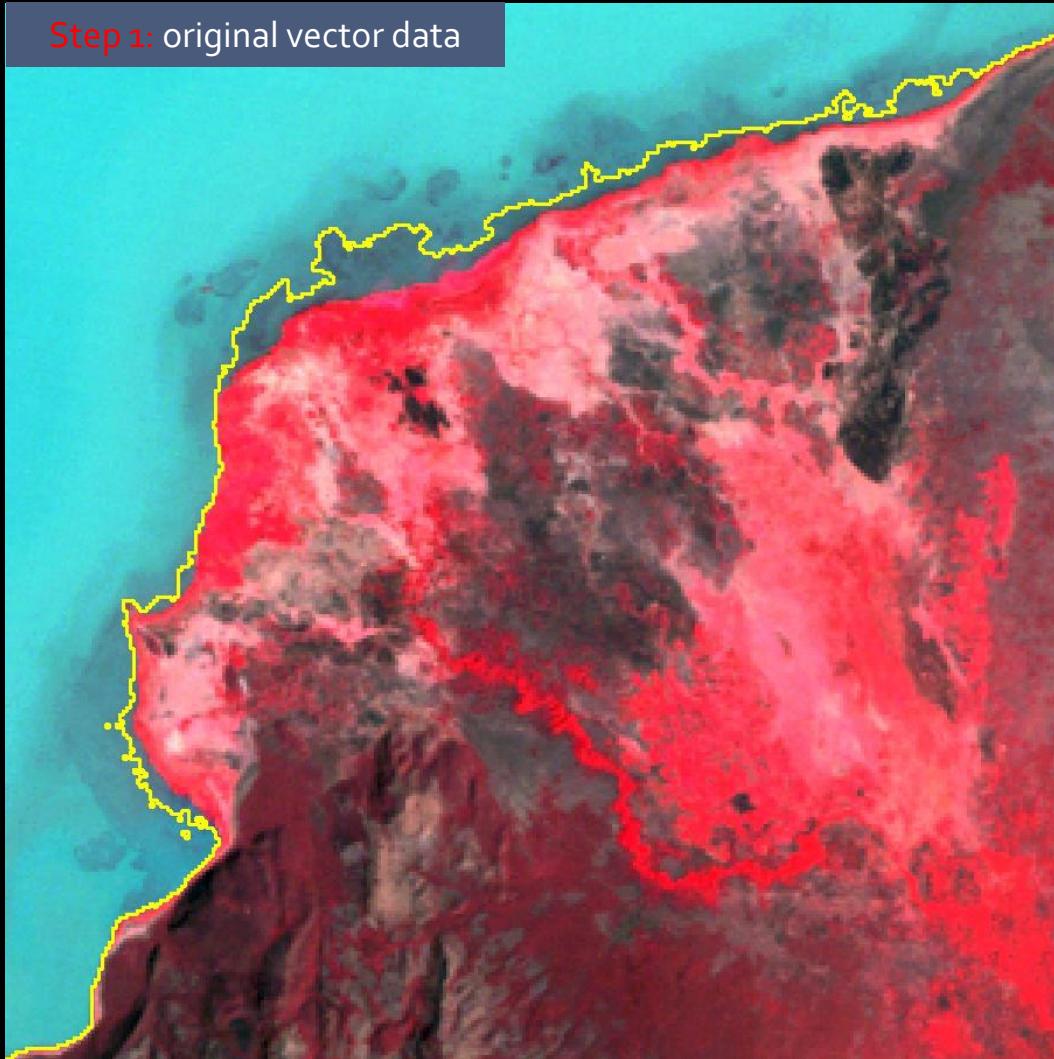
Water mask extraction:
ENVI, ERDAS Imagine, ArcGIS...



Conversion of raster water mask to
vector data
ArcGIS: Raster to Polygon
No polygon simplification!!!

Temporal changes: coastal lines

Step 1: original vector data



Step 1: Original vector data

- Original data are ragged → lines follow pixels of the original raster data

Step 2: Polygon simplification

- ArcGIS: Simplify polygon
- Bend simplification
- Simplification tolerance 90 m

Step 3: Polygon smoothing

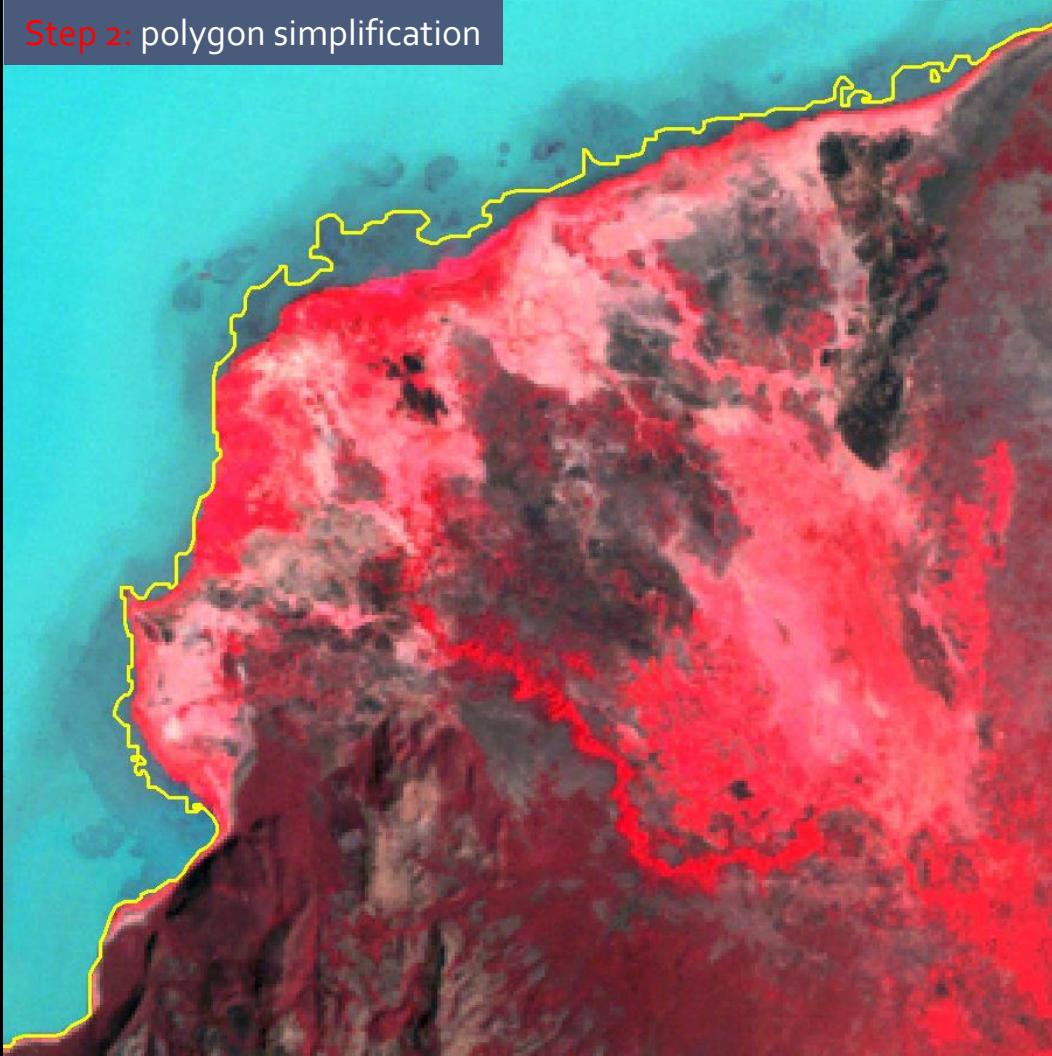
- Simplified polygons → sharp edges
- ArcGIS: Smooth polygon
- PAEK smoothing

Step 4: Final editing

- Final editing of incorrectly classified areas
- ArcGIS: Editor/Reshape feature

Temporal changes: coastal lines

Step 2: polygon simplification



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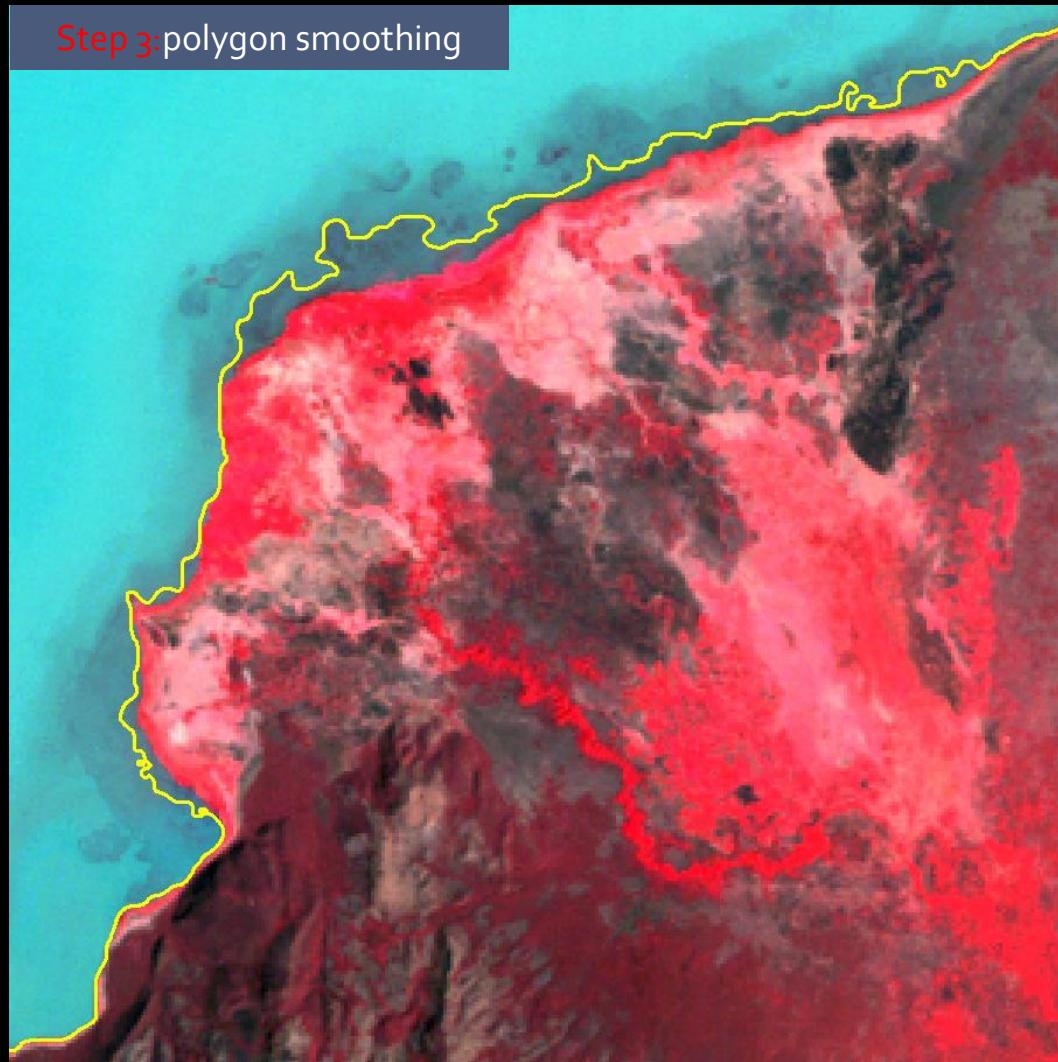
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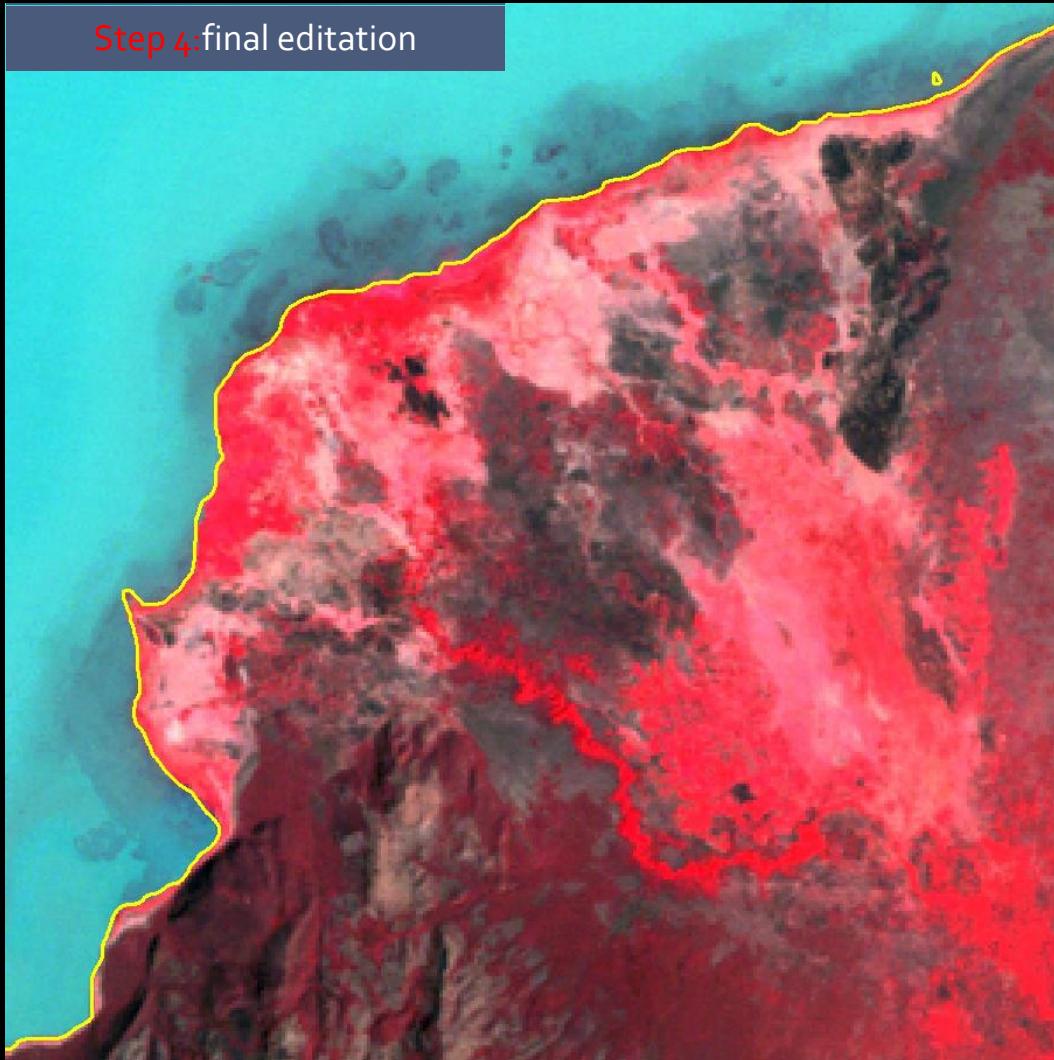
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Step 4: Final editing

- Final editing of incorrectly classified areas
- ArcGIS: Editor/Reshape feature

Temporal changes: coastal lines

Step 4: final editation



Step 1: Original vector data

- Original data are ragged → lines follow pixels of the original raster data

Step 2: Polygon simplification

- ArcGIS: Simplify polygon
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- Simplification tolerance 90 m

Step 3: Polygon smoothing

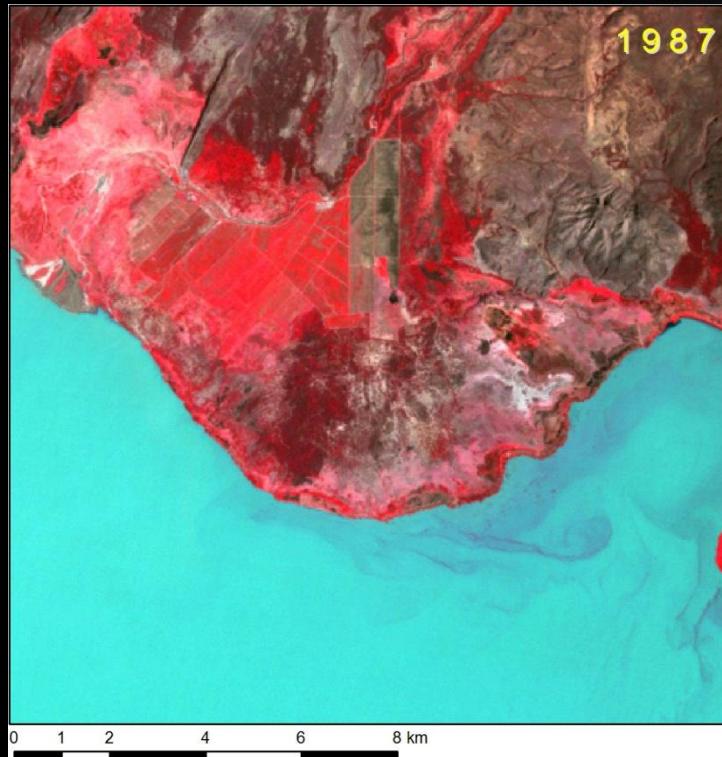
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Step 4: Final editing

- Final editing of incorrectly classified areas
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Temporal changes: coastal lines

Lake Abaya (Bilate river delta)

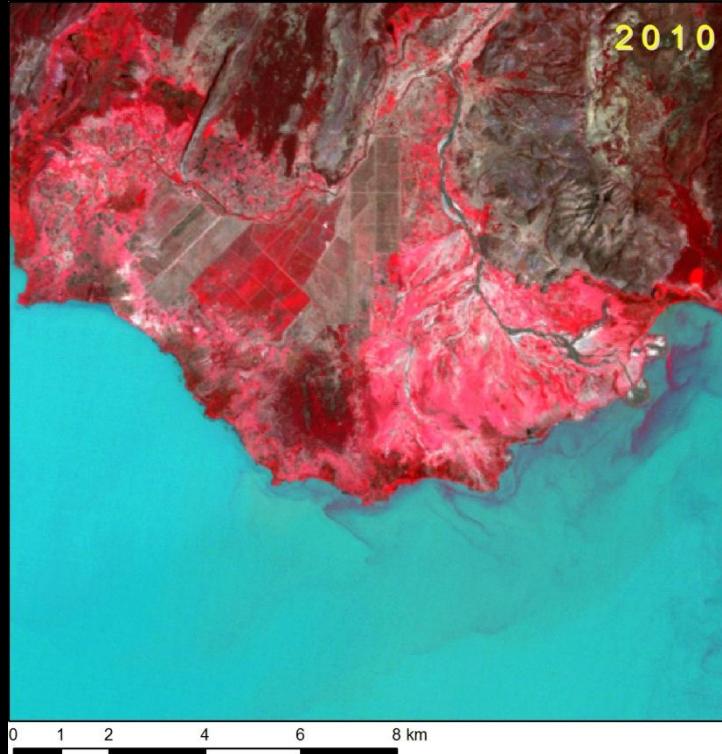


Lake Abijata



Temporal changes: coastal lines

Lake Abaya (Bilate river delta)

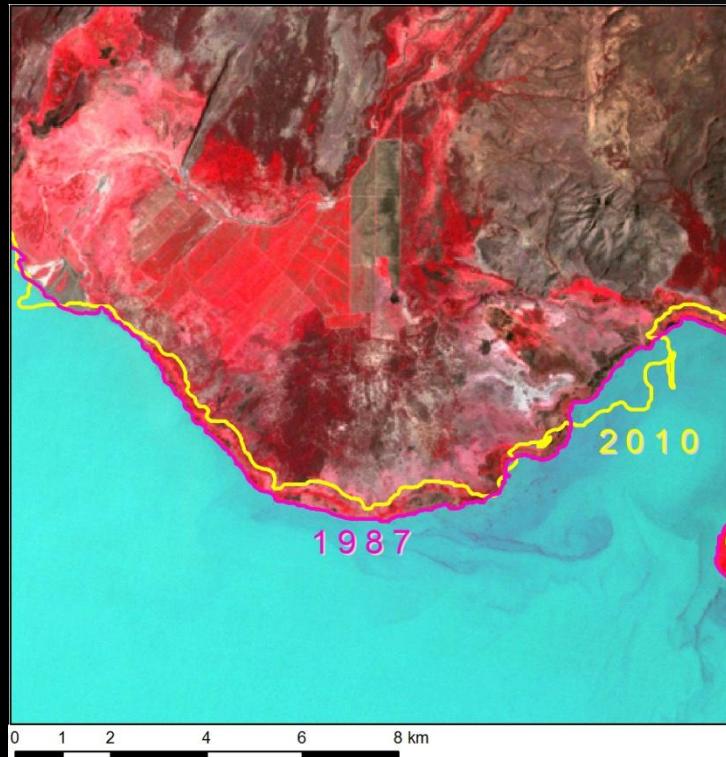


Lake Abijata

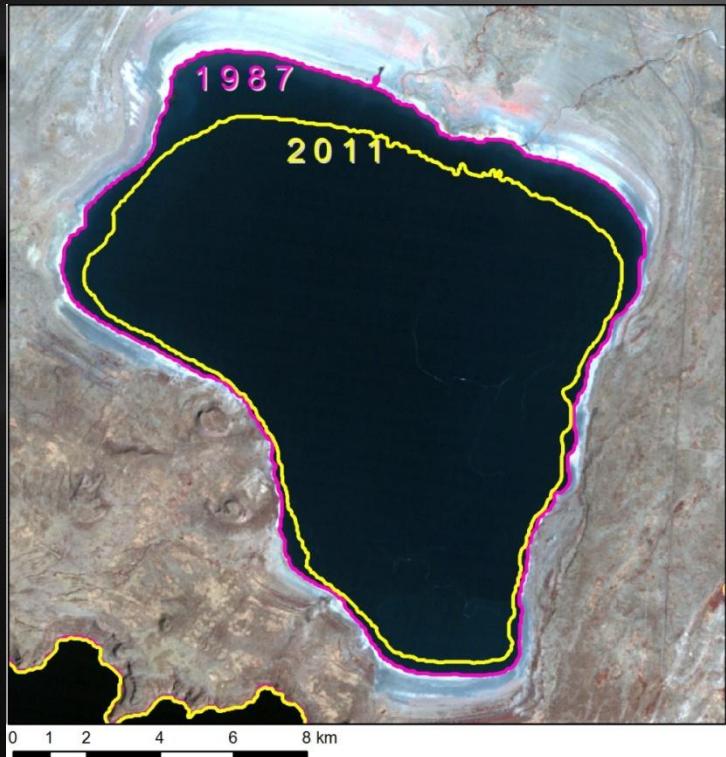


Temporal changes: coastal lines

Lake Abaya (Bilate river delta)



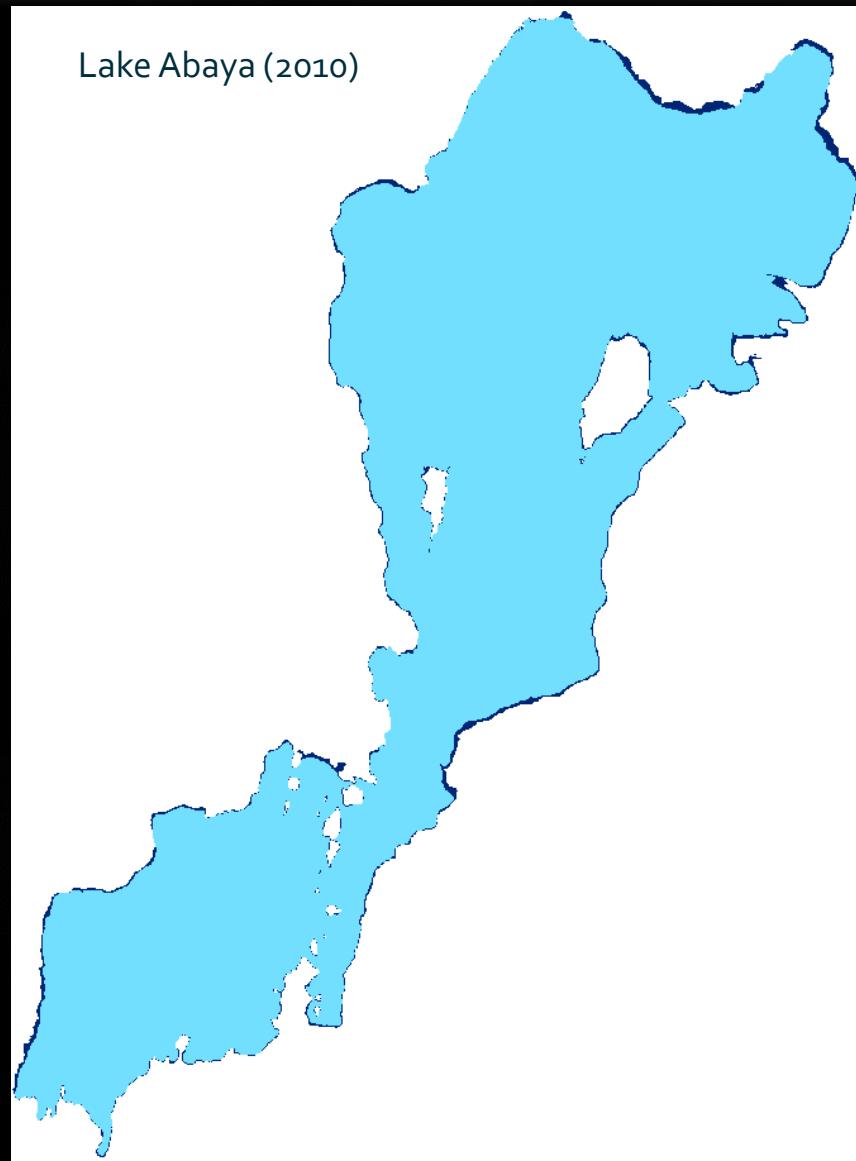
Lake Abijata



Temporal changes: coastal lines



Temporal changes: coastal lines



Temporal changes: coastal lines



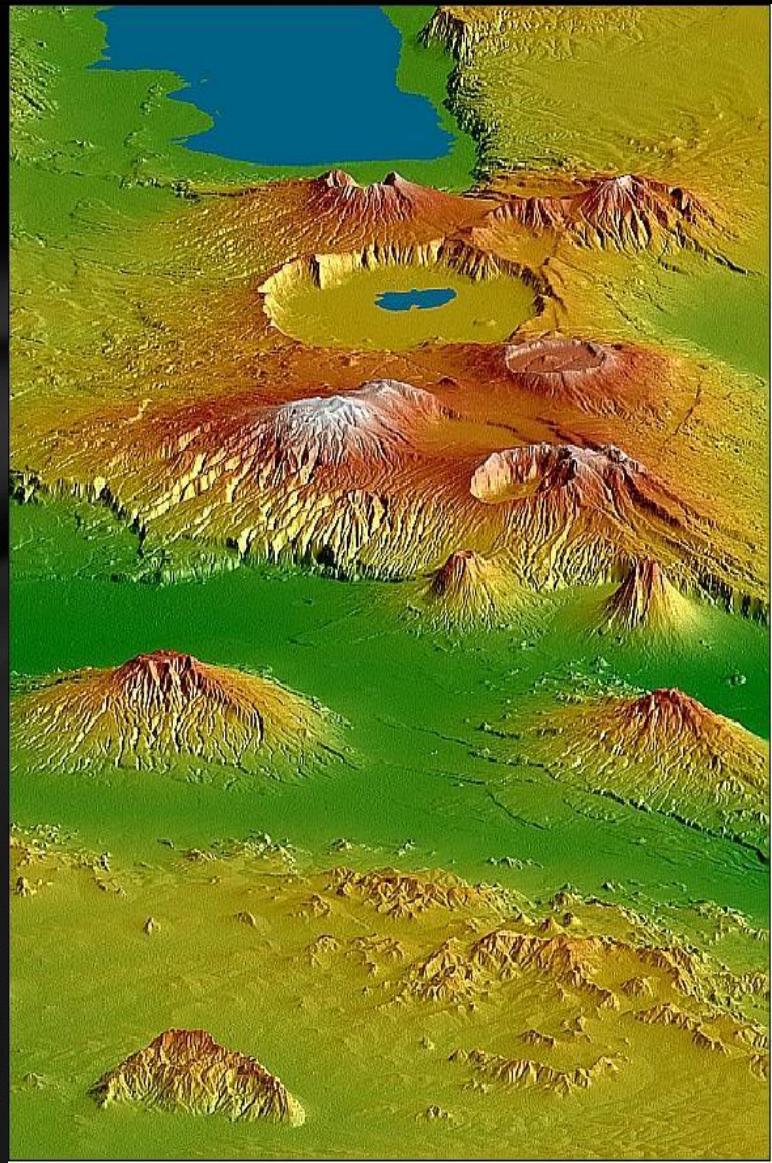
Digital Elevation Models: ASTER vs. SRTM

ASTER DEM

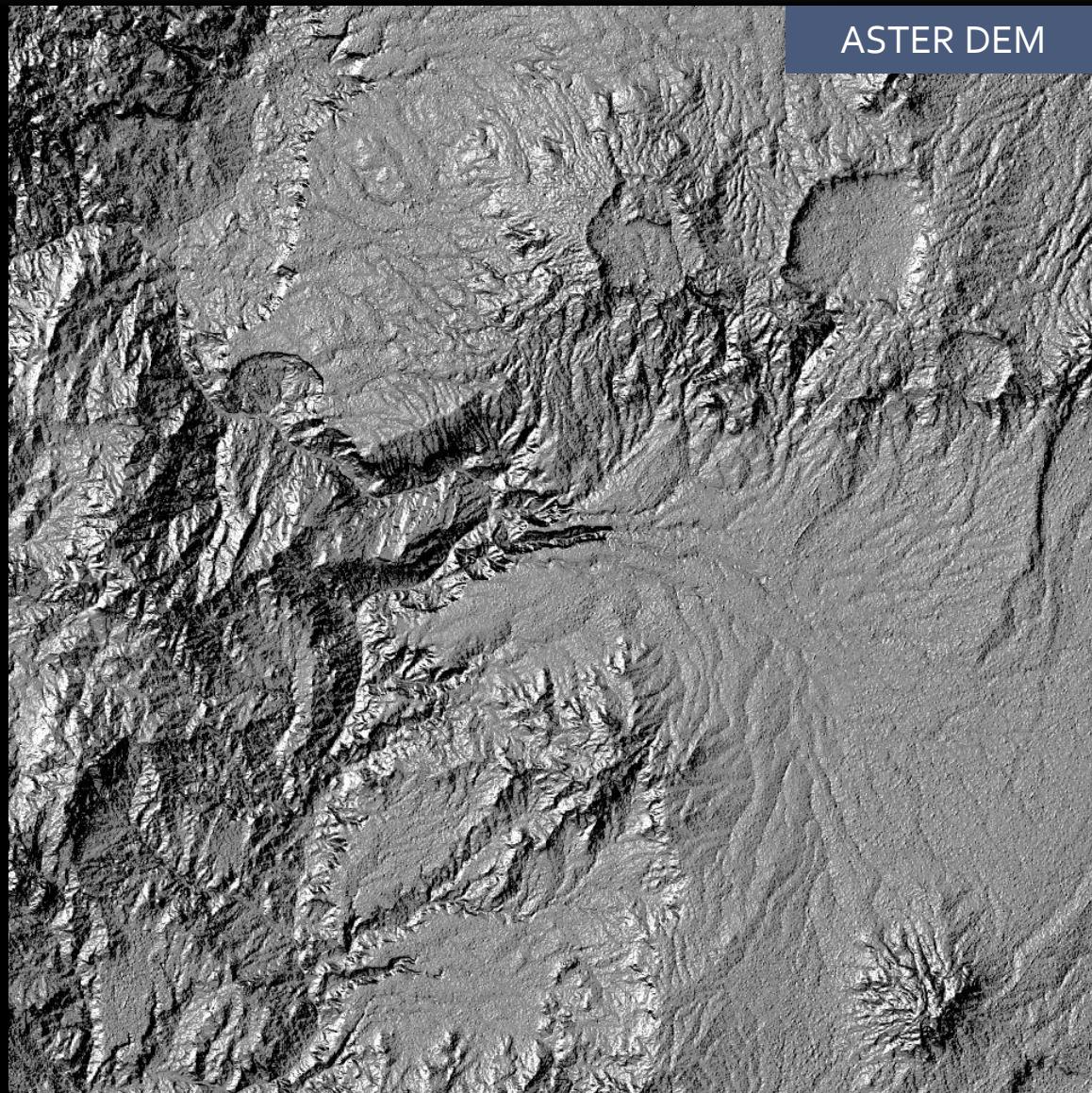
- ASTER nadir and backward looking sensors (NIR)
- Stereo pair image combination
- Spatial resolution: 30 m
- Complete coverage between 83°N and 83°S
- Many significant artifacts

SRTM DEM

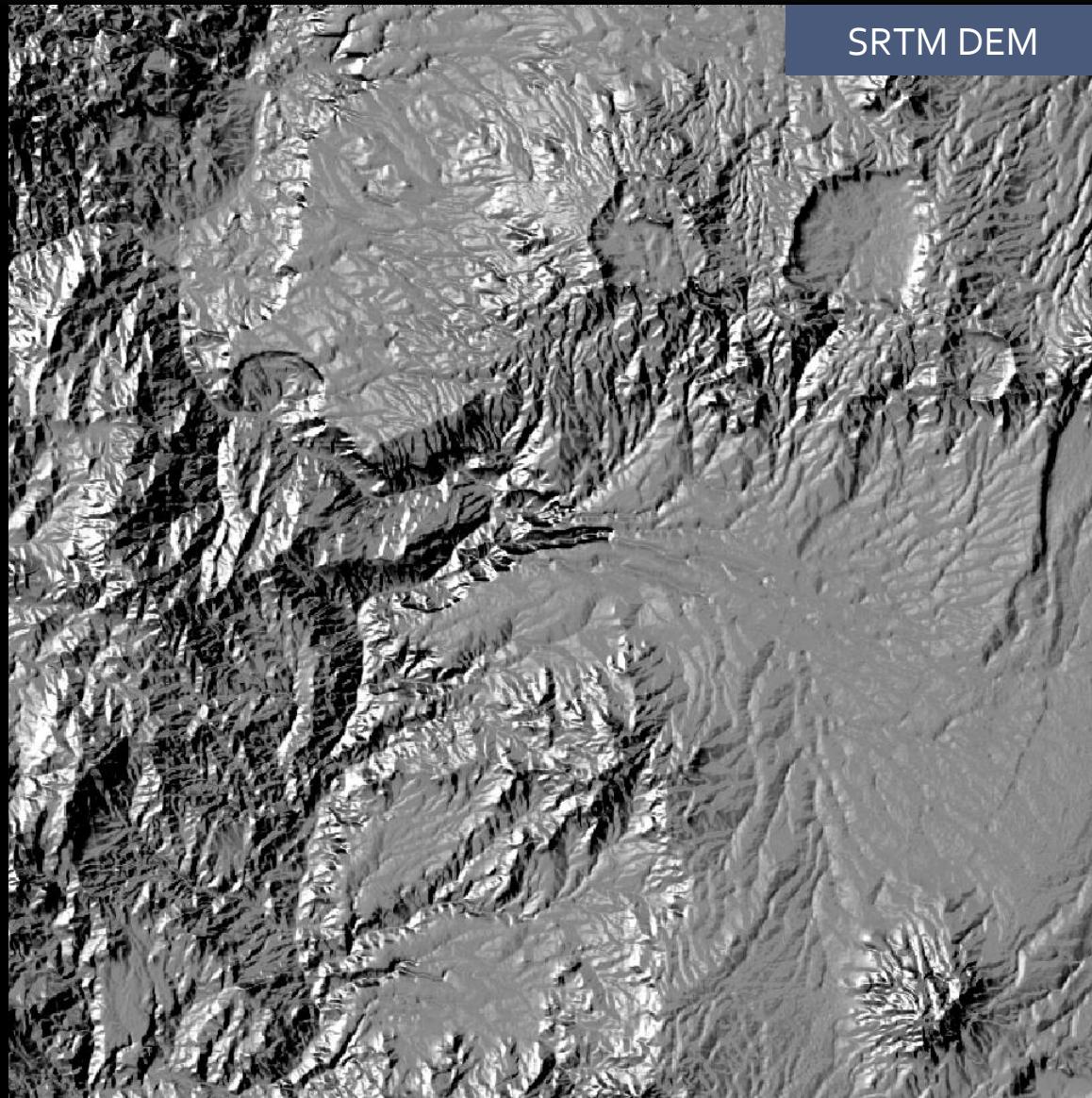
- Shuttle Radar Topographic Mission (STS-99, 2000)
- Radar Interferometry
- Spatial resolution: 30 m (US only), 90 m (other areas)
- Complete coverage between 60°N and 56 °S
- Voids - corrected data available via Earth Explorer
- No significant artefacts



Digital Elevation Models: ASTER vs. SRTM



Digital Elevation Models: ASTER vs. SRTM



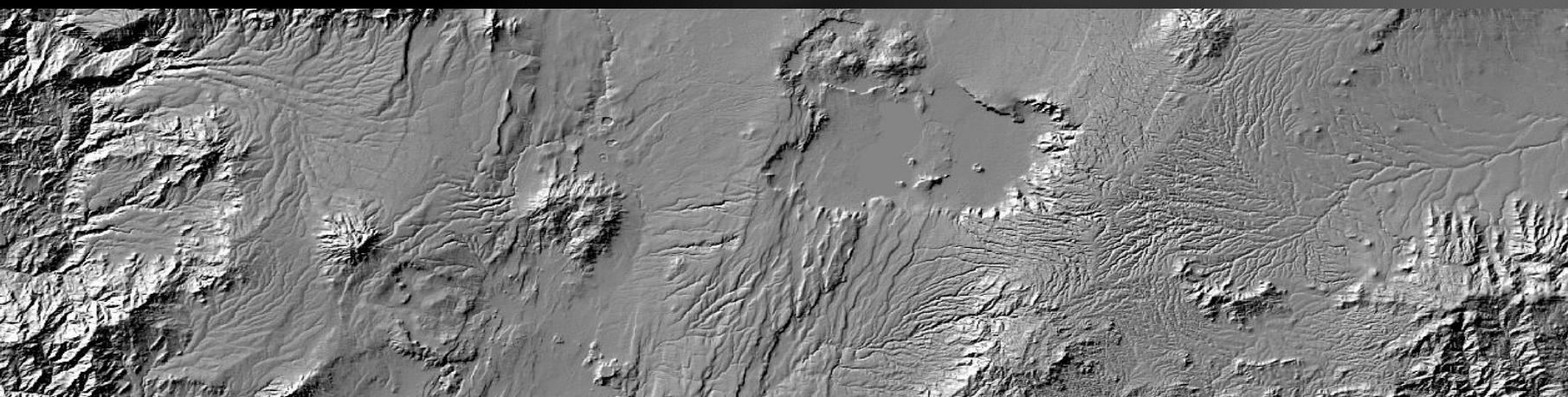
Digital Elevation Models: Shaded relief

Classical shading

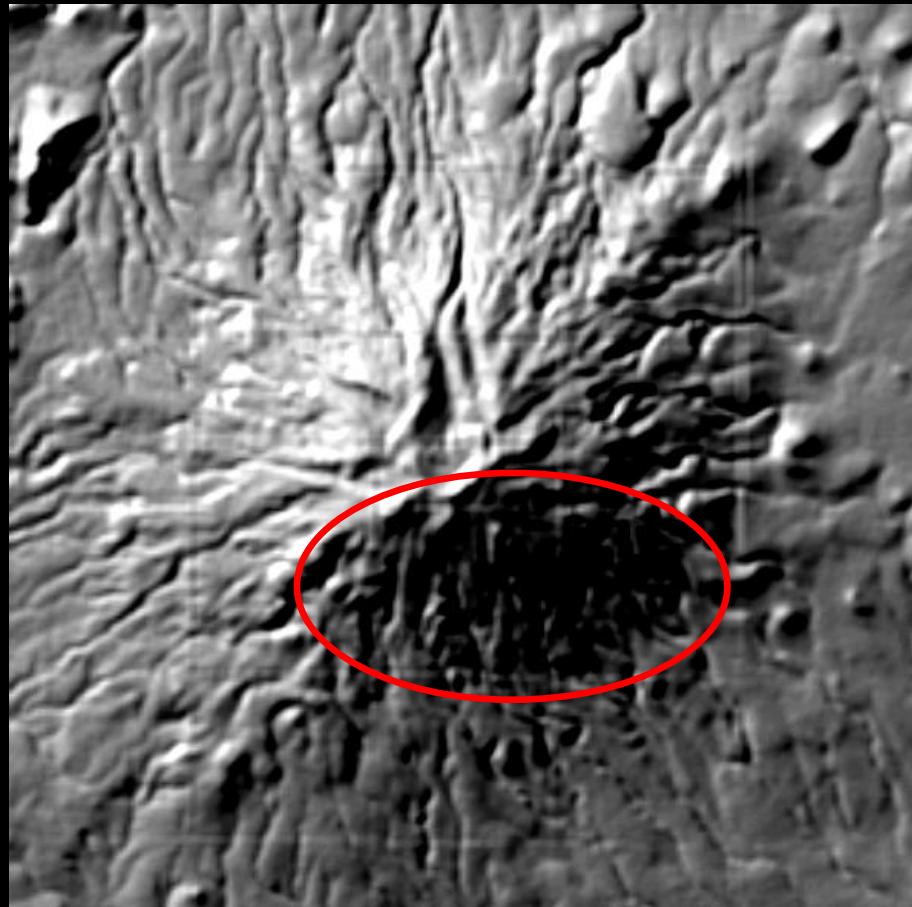
- Light incoming from one direction
- Standard: $A = 315^\circ$ (NW), $h = 45^\circ$
- Enhancing topographical features perpendicular to the incoming radiation (in SW-NE direction) X suppressing topographical features parallelly oriented with the incoming light (in NW-SE direction)
- Too many shadows (some topographical features are hidden)

Multidirectional weighted shading

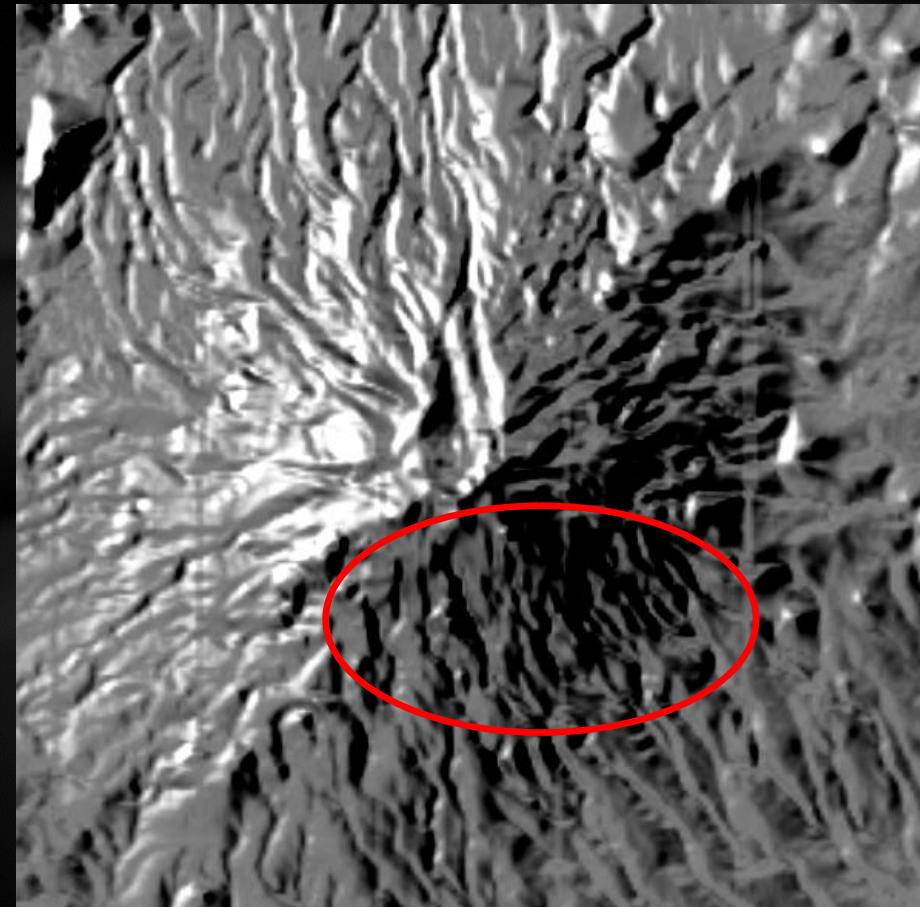
- 4 different directions of incoming light
- $A_1=225^\circ, A_2=270^\circ, A_3=315^\circ, A_4=360^\circ, h=30^\circ$
- Weighted average of the single shadings
- Enhancing either sunlit and shadowed topographical features
- None of feature is hidden in shadow



Digital Elevation Models: Shaded relief

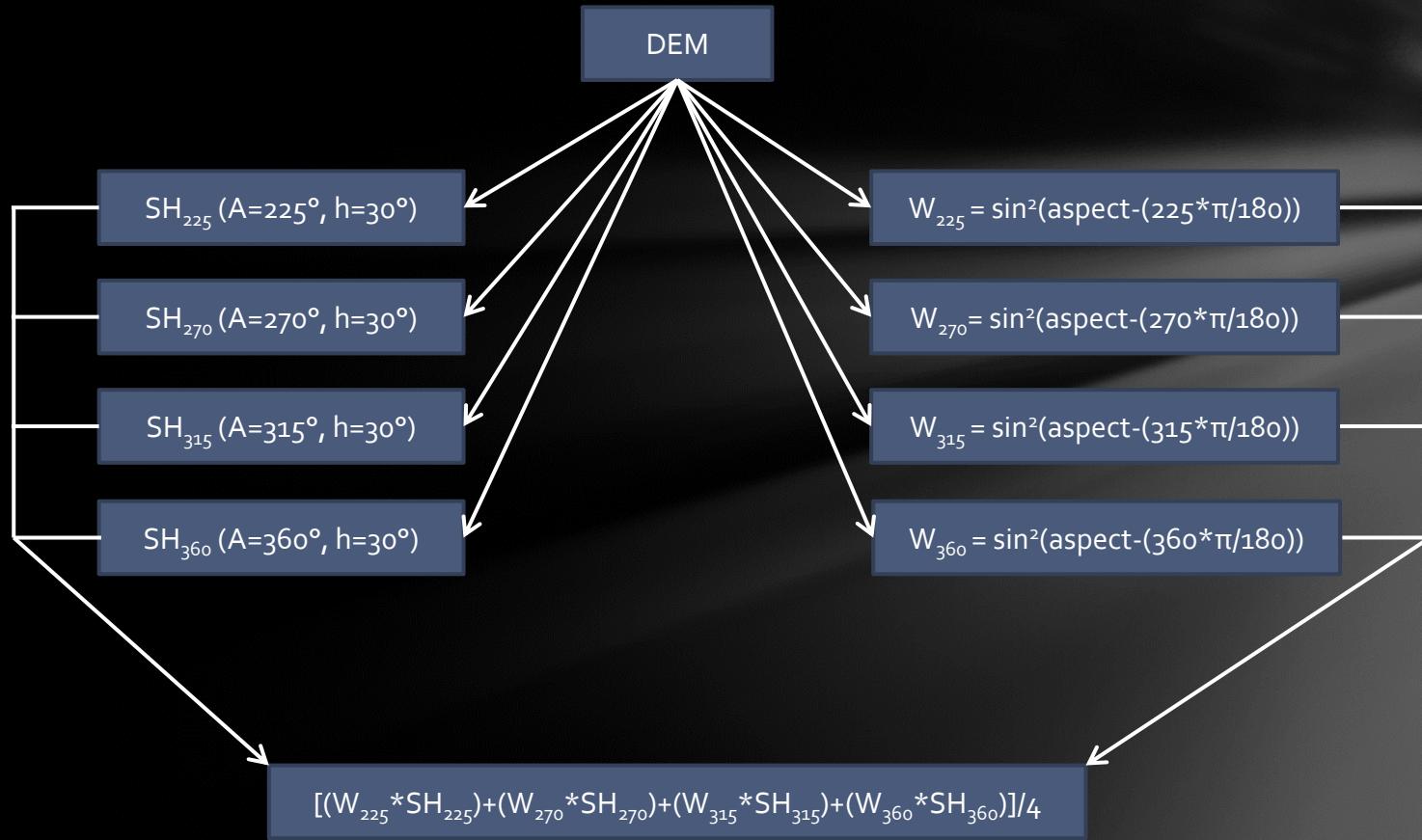


Classical shading

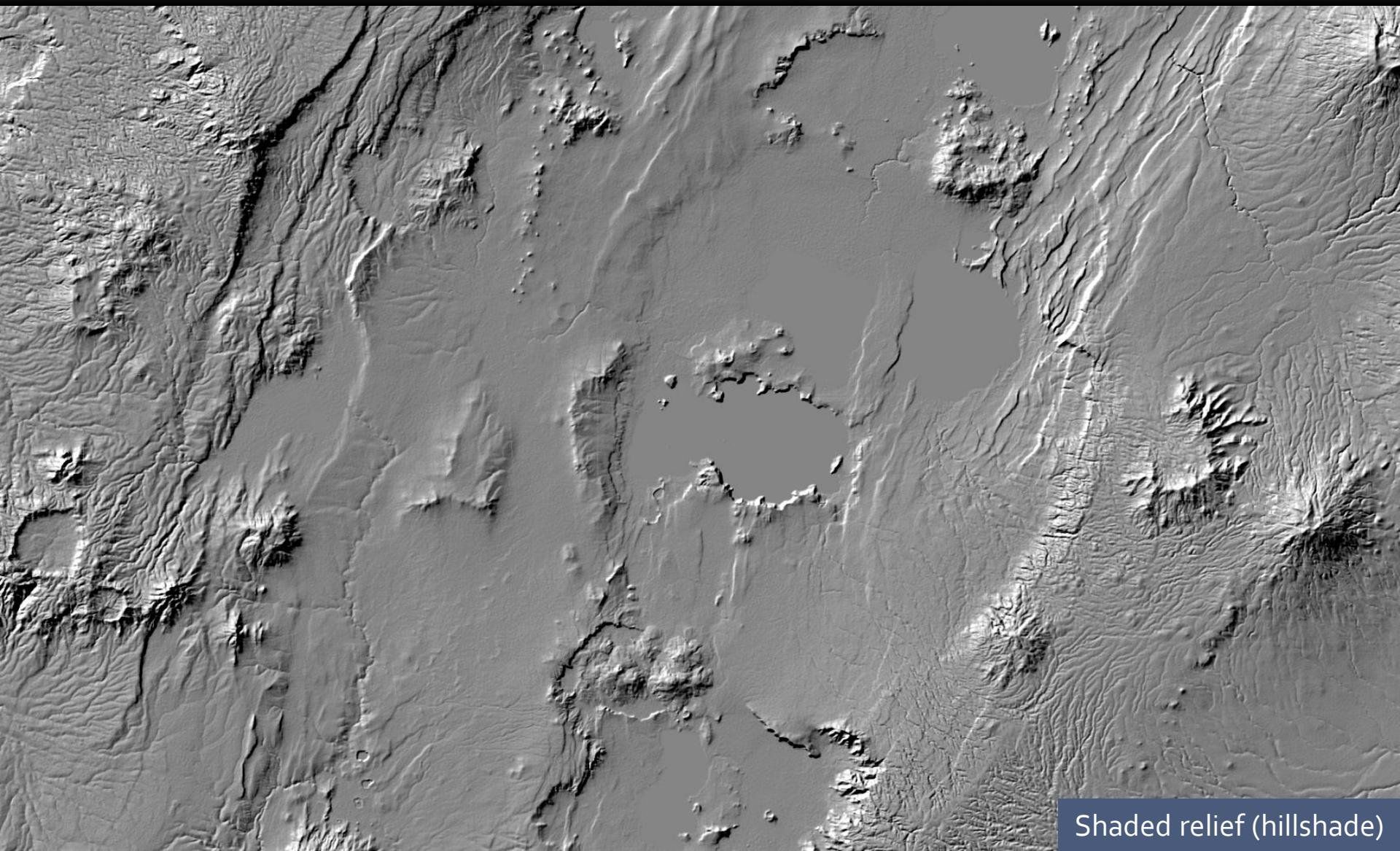


Multidirectional weighted shading

Digital Elevation Models: Multidirectional shading

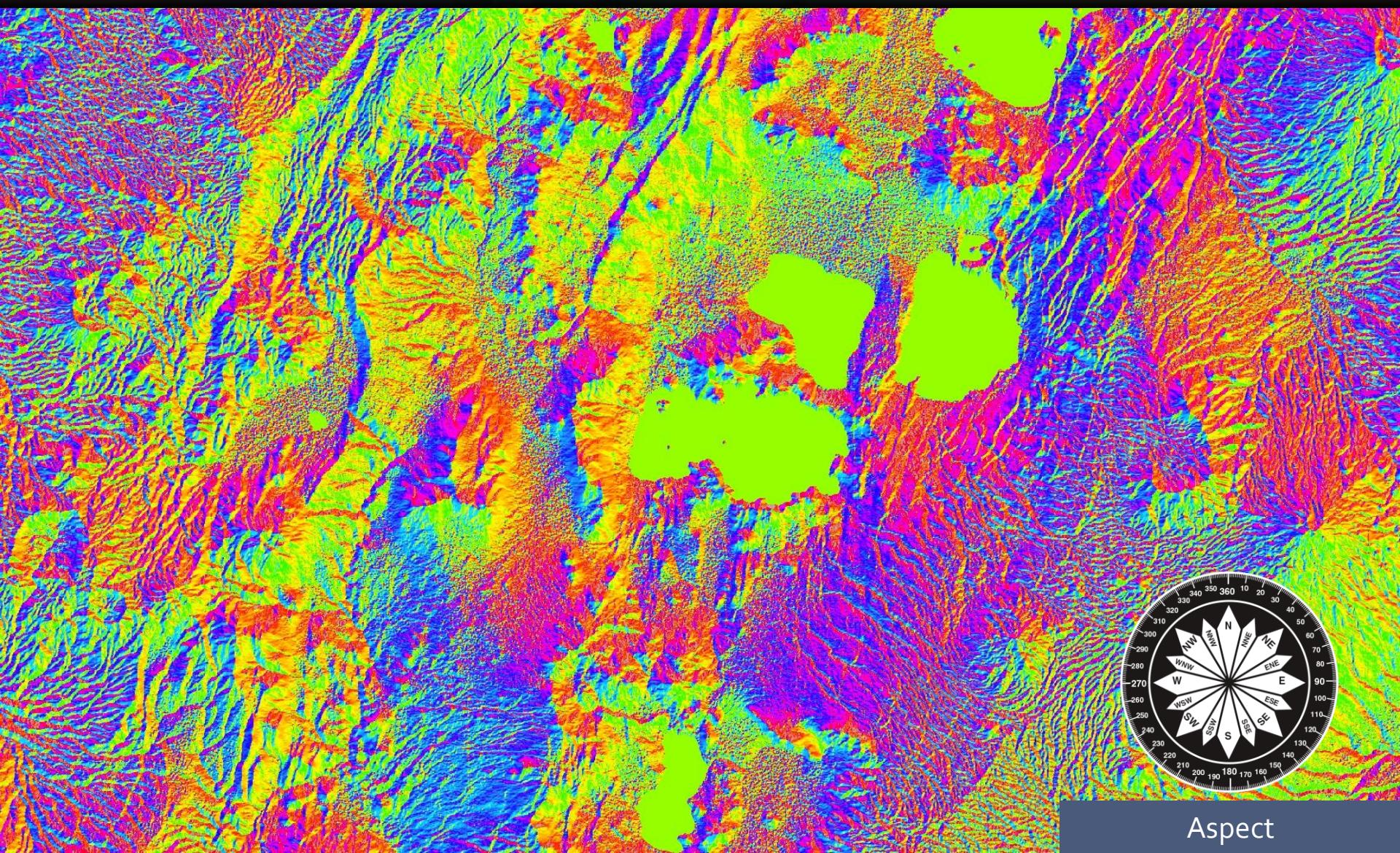


Digital Elevation Models: DEM products



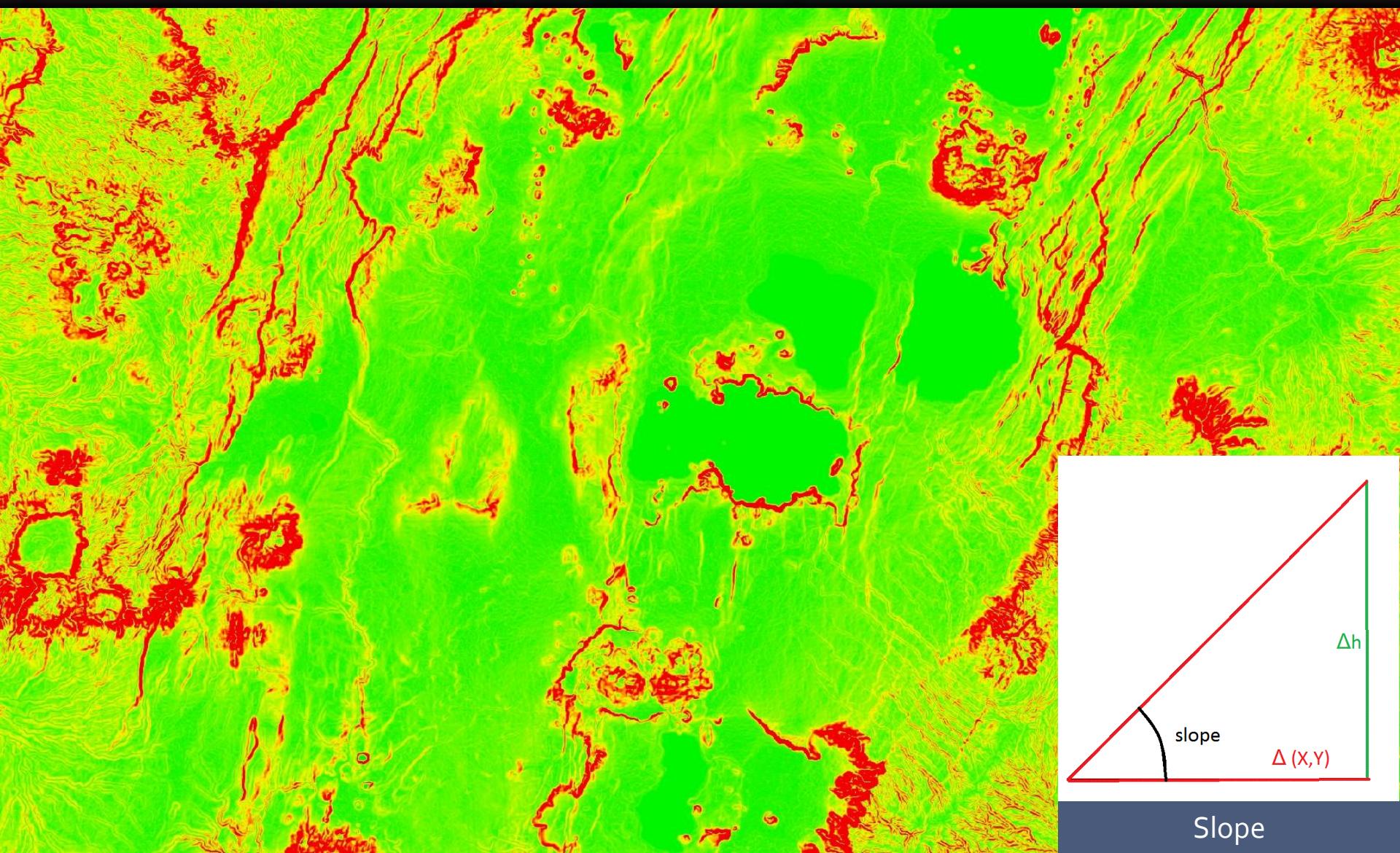
Shaded relief (hillshade)

Digital Elevation Models: DEM products



Aspect

Digital Elevation Models: DEM products



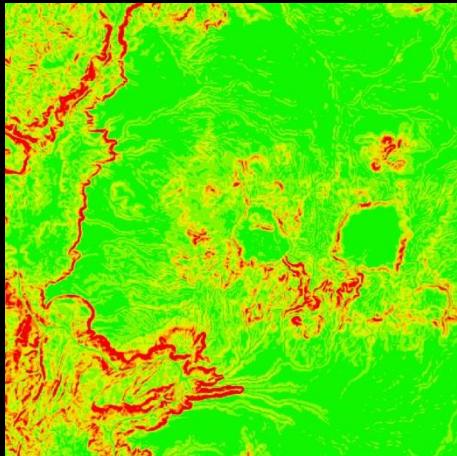
Slope

Digital Elevation Models: Morphometric analysis

Slope dependant morphometric analysis

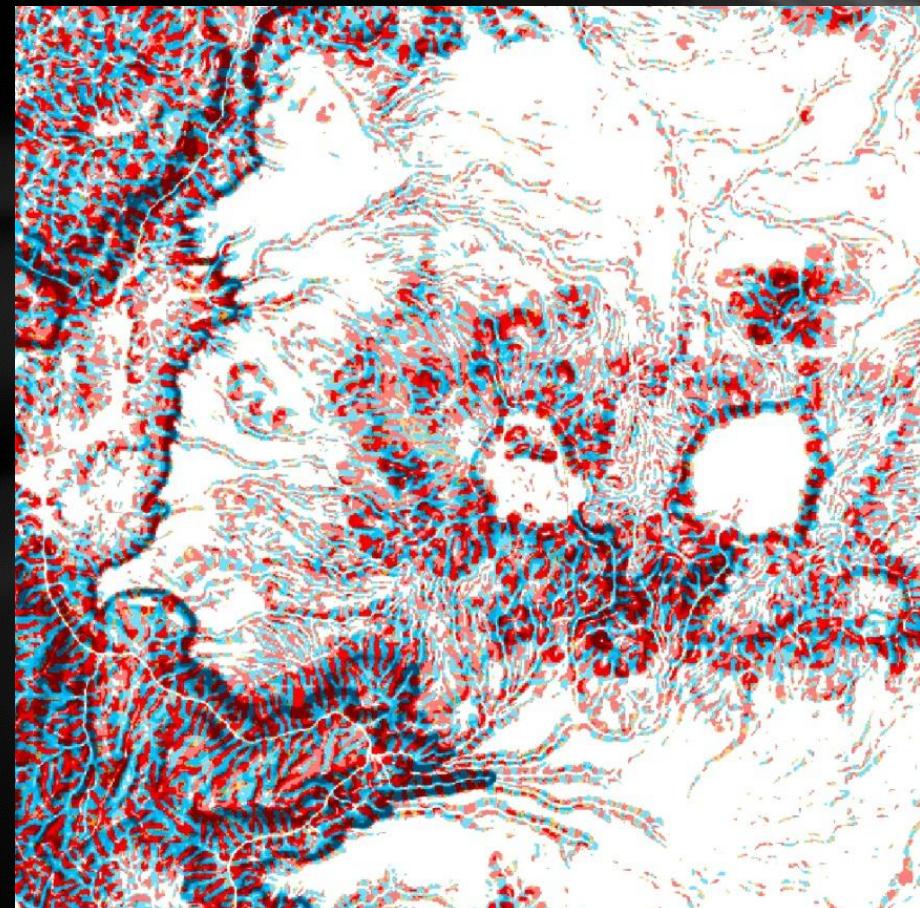
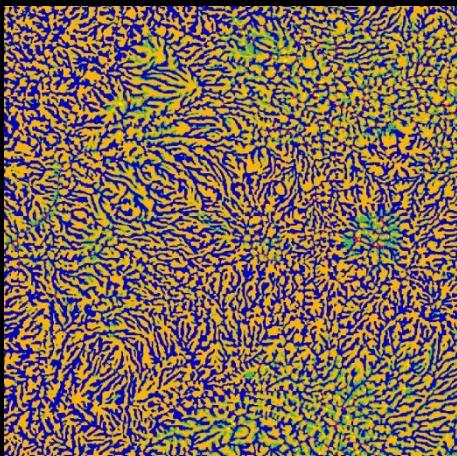
Slope classification

- 0-5°
- 5-10°
- 10-15°
- 15-20°
- 20-25°
- more than 25°



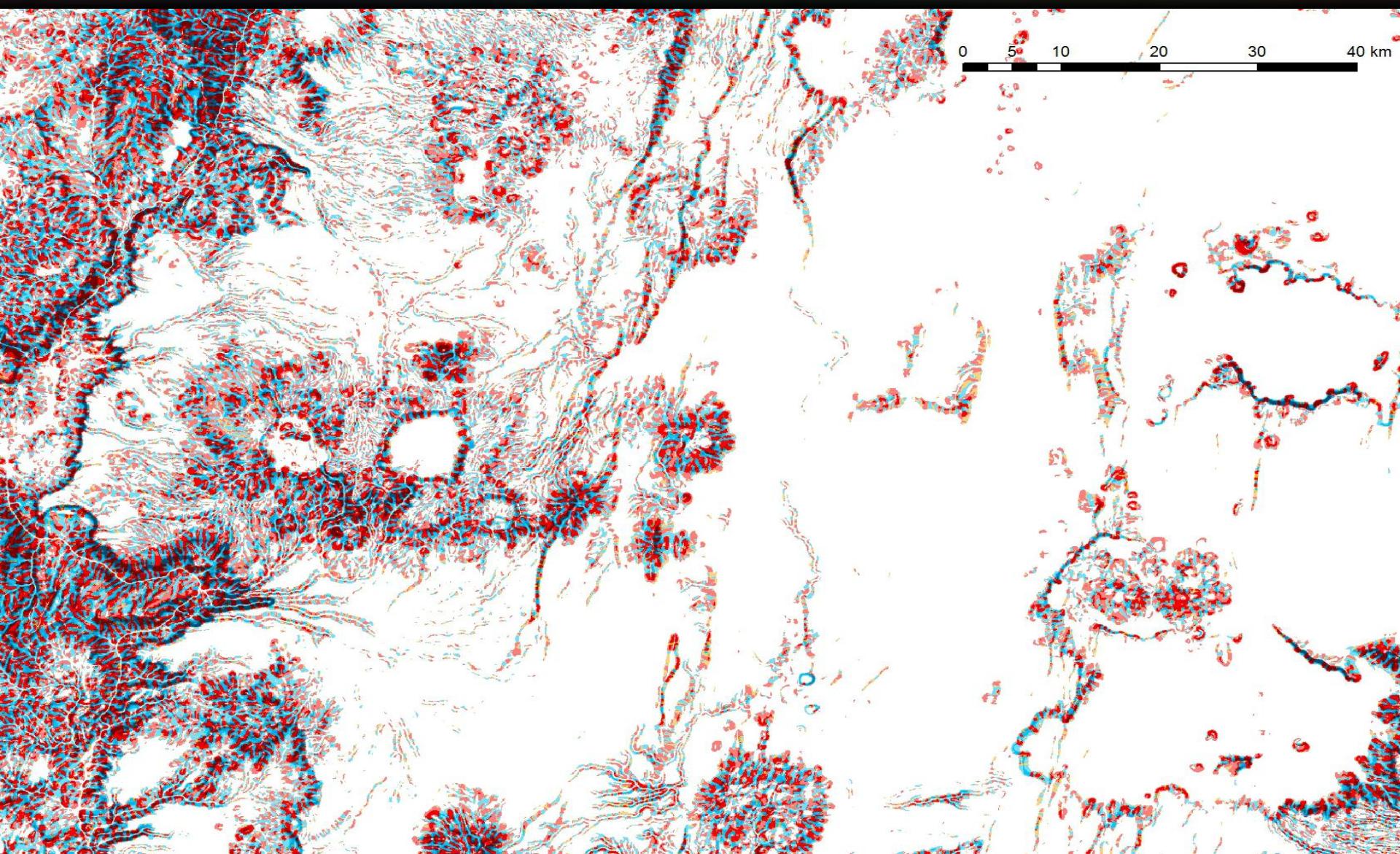
Topographic features

- Peak
- Ridge
- Pass
- Plane
- Channel
- Pit



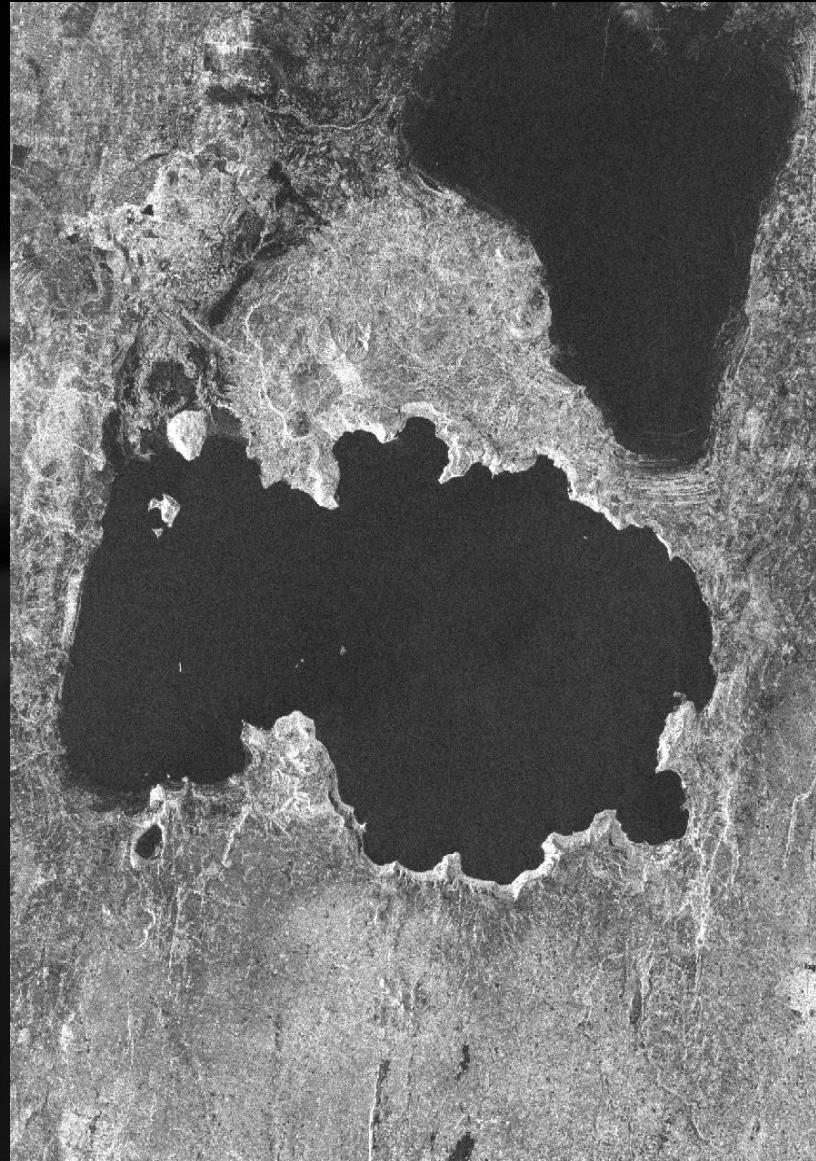
Morphometric map: hue = topographic feature, lightness: slope

Digital Elevation Models: Morphometric analysis



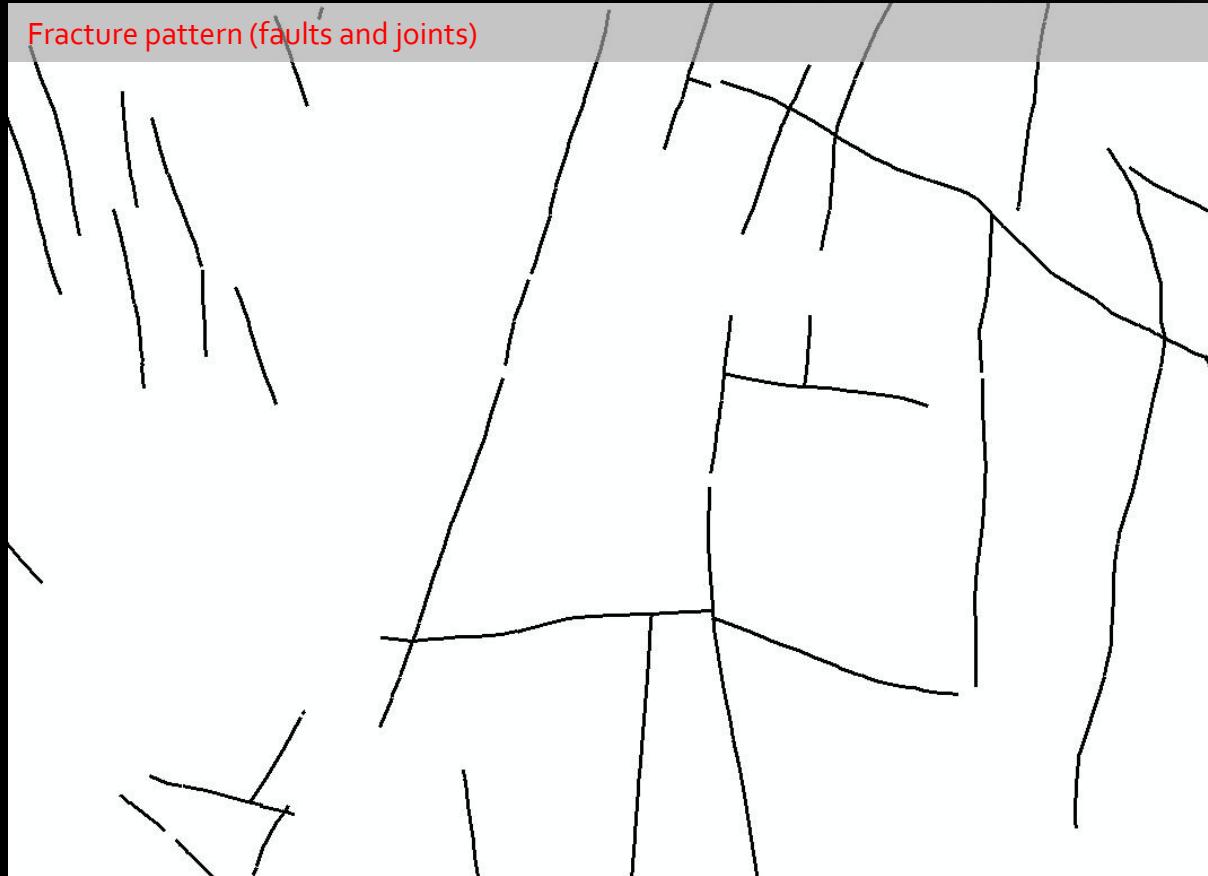
ALOS/PALSAR

- ALOS (Daichi) satellite
- Operated since 2006 by JAXA
- Data ordering via ERSDAC
- Data cost: 252 USD (20 000 YEN) per scene
- Scene dimensions: 70 x 70 km
- Dual polarization (HH + HV)
- L-band ($\lambda = 23$ cm)
- 12.5 m spatial resolution
- Extraction and interpretation of the linear structures connected with brittle tectonics and terrain morphology
- Gradients of surface dielectric properties



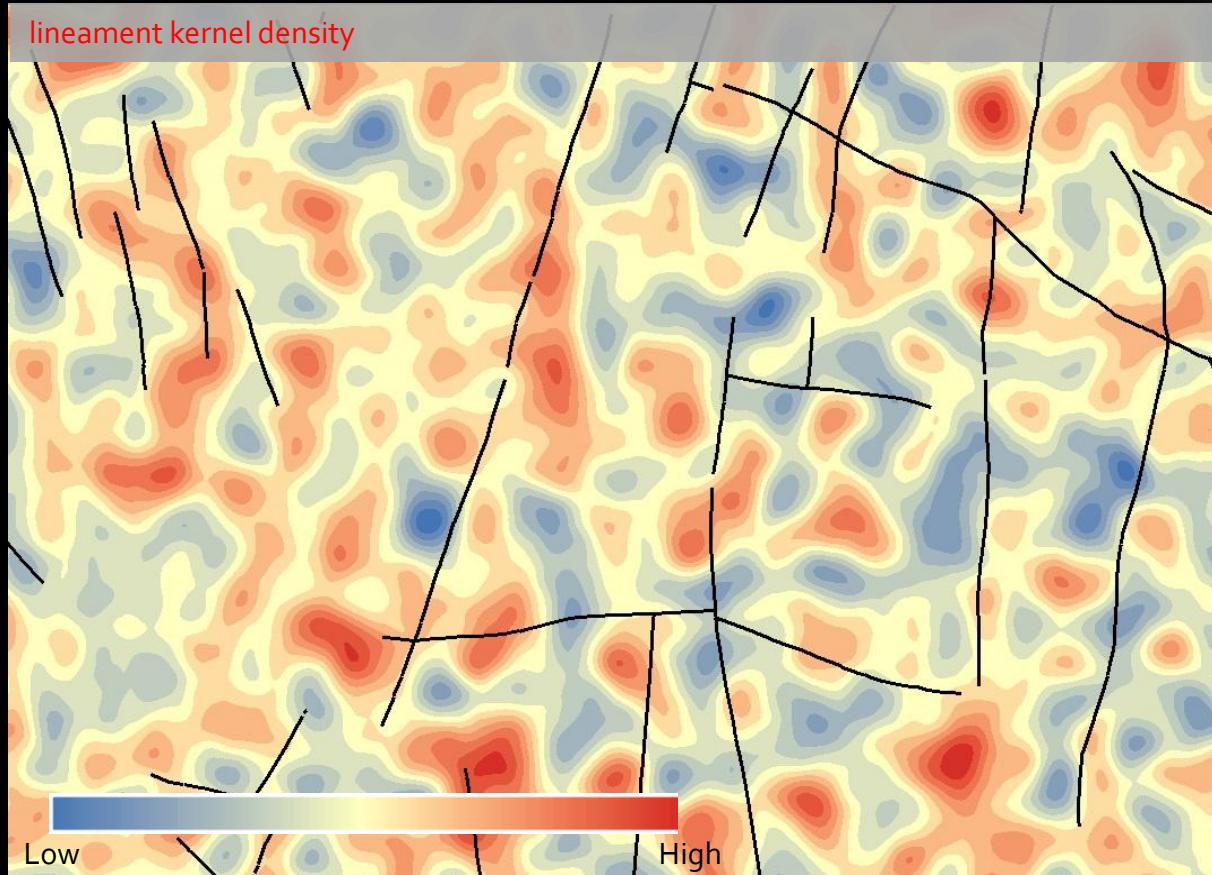
ALOS/PALSAR

Tectonic interpretation using ALOS/PALSAR derivatives



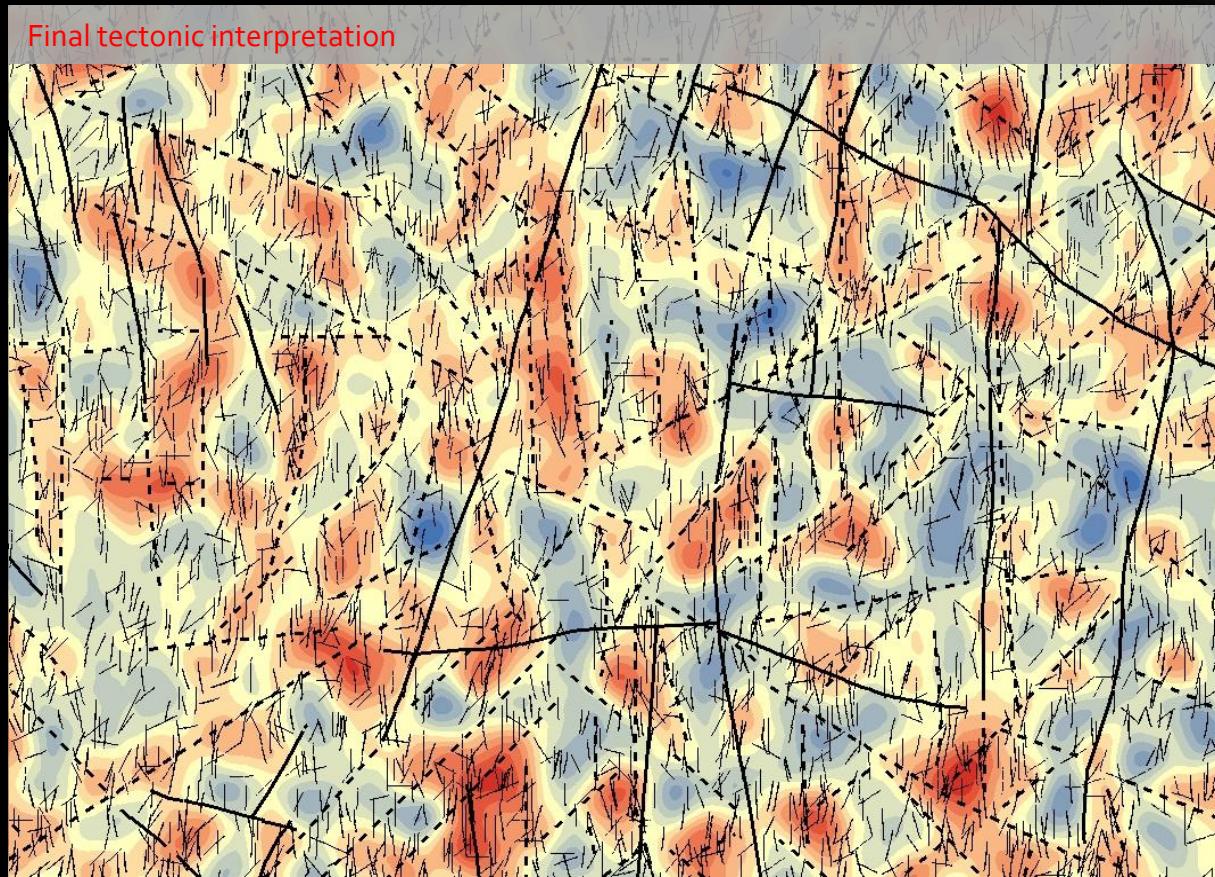
ALOS/PALSAR

Tectonic interpretation using ALOS/PALSAR derivatives



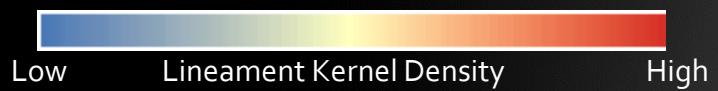
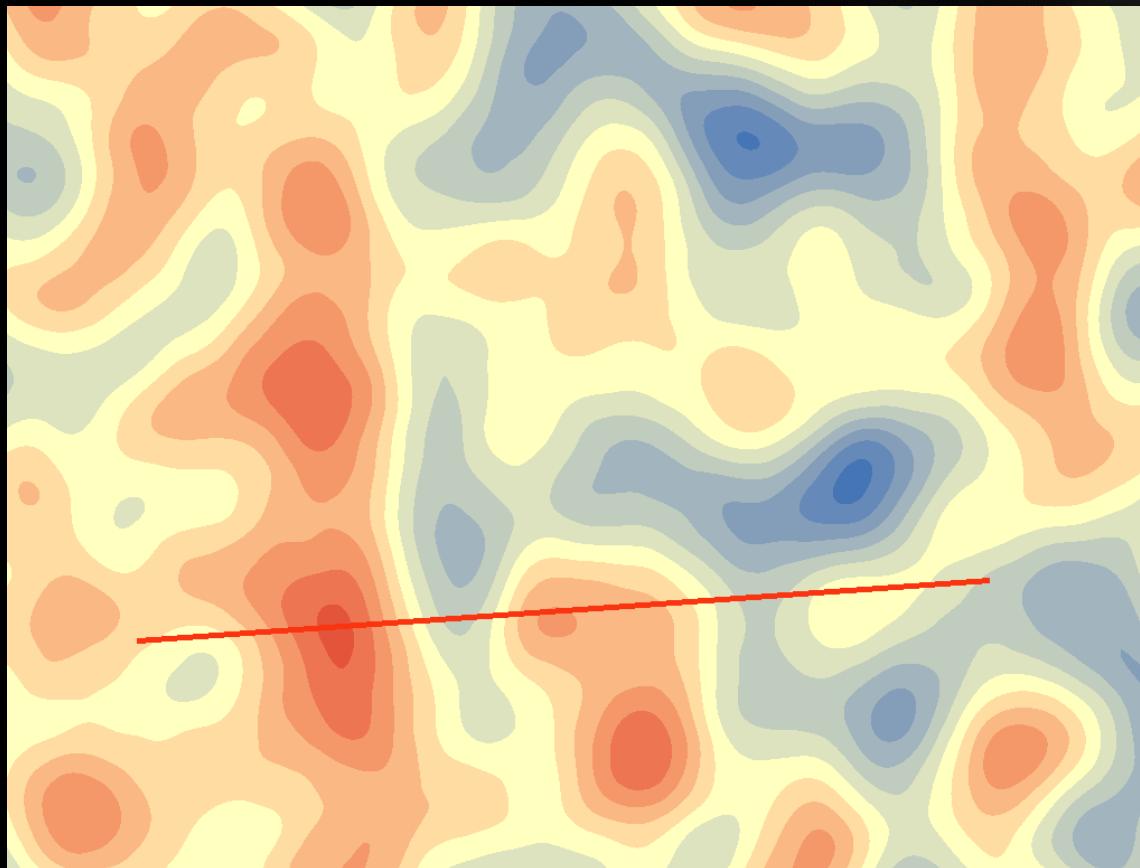
ALOS/PALSAR

Tectonic interpretation using ALOS/PALSAR derivatives

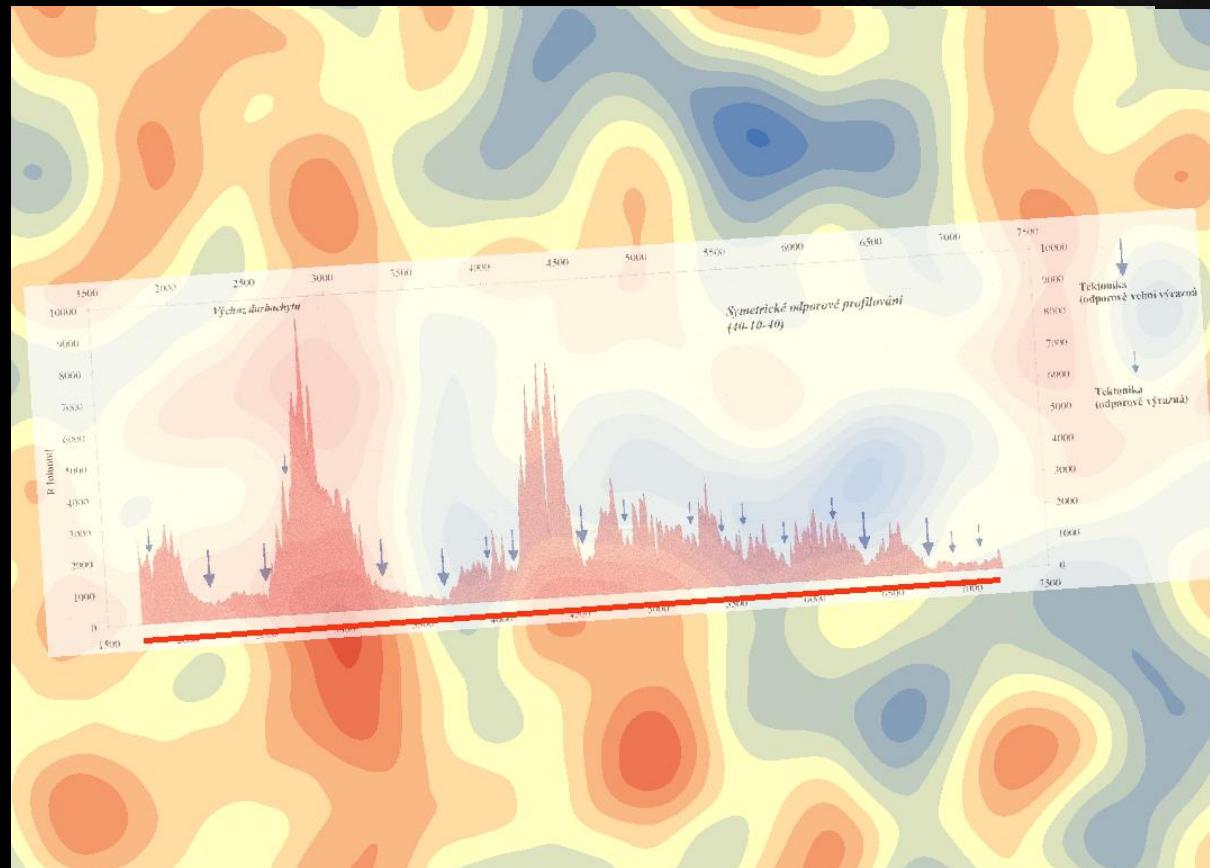


ALOS/PALSAR

Validation: Lineament density and Symmetric Resistivity Profiling



ALOS/PALSAR



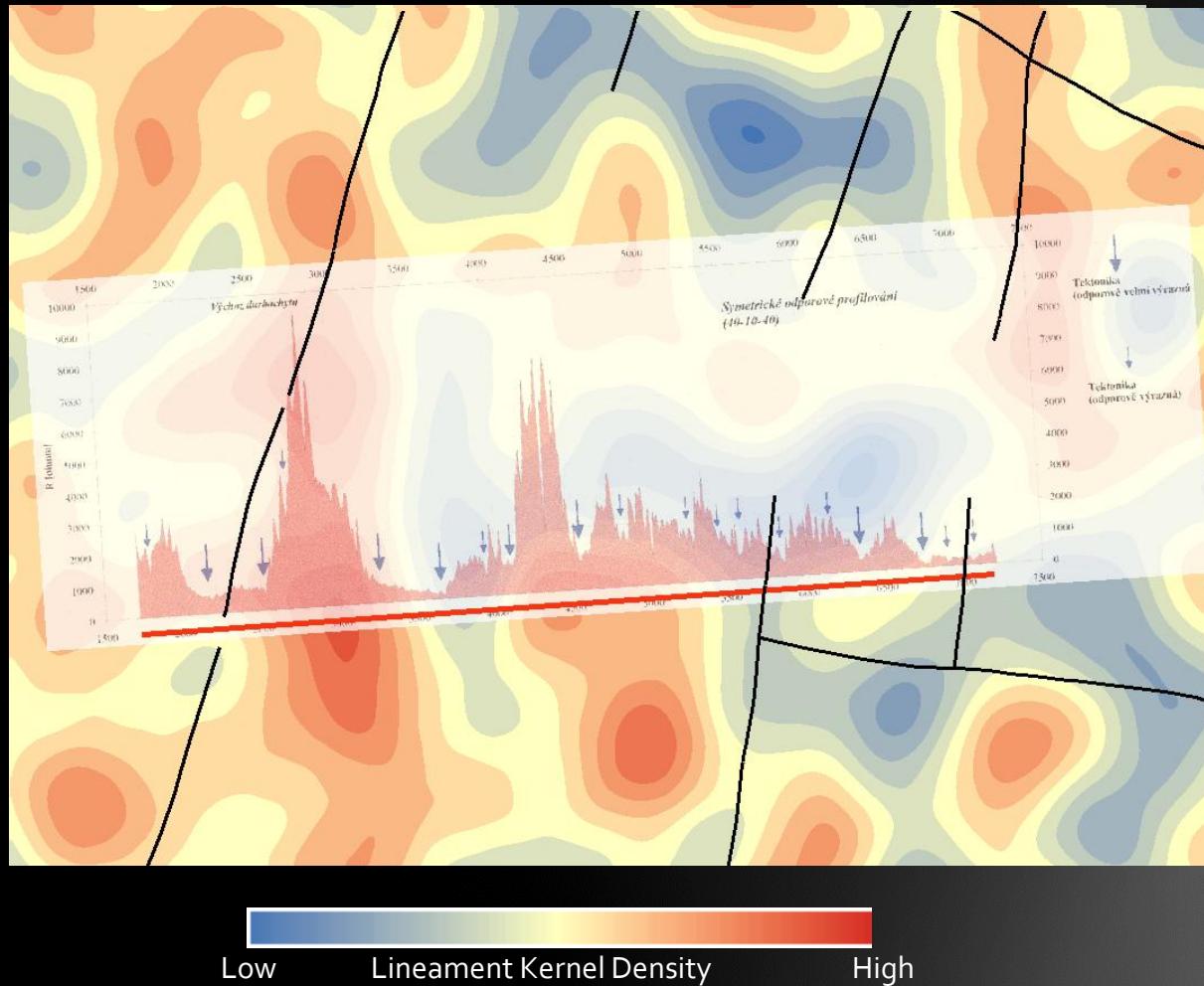
Low

Lineament Kernel Density

High

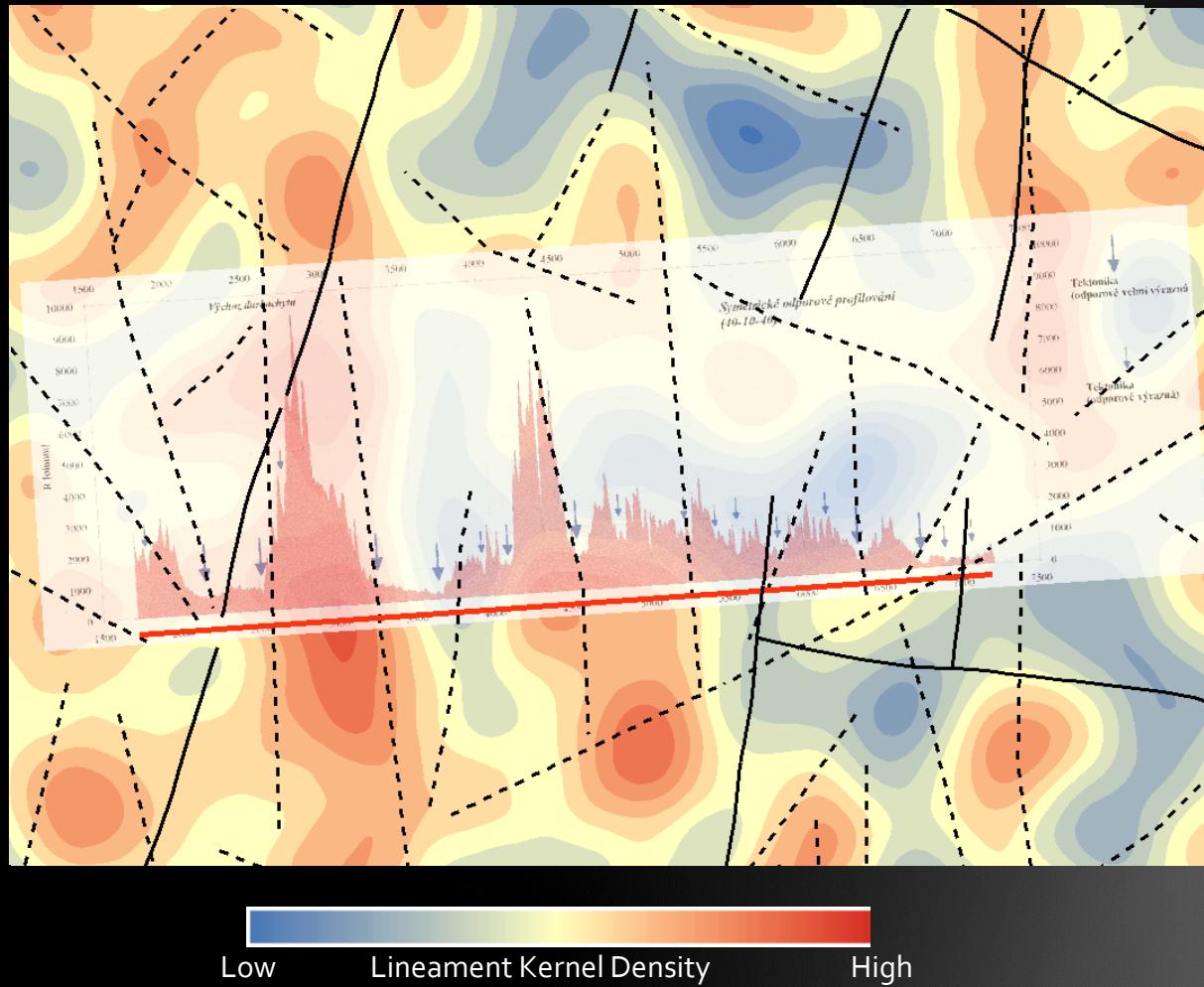
ALOS/PALSAR

Validation: Lineament density and Symmetric Resistivity Profiling



ALOS/PALSAR

Validation: Lineament density and Symmetric Resistivity Profiling



Thank you for your attention



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