

# Red Relief Image Map New Visualization Method



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# Introduction

Why is new visualization method for DEM need?

- Fine resolution LiDAR DEM become available.
- Representation of DEM affects interpretation of terrain.
- Existing visualization methods have limitations.
- Needs for more comprehensible visualization method.



- **Red Relief Image Map** (abbr. **RRIM**) is originally intended to use in geomorphological interpretation by LiDAR DEM.
- In this presentation, I will show RRIM's principal, advantage, and application.



# History of development

Mt. Fuji, the birthplace of RRIM

# Mt. Fuji

- A symbol of Japan - historically active volcano



# Aokigahara “Ocean of trees”

Piedmont of Mt. Fuji is covered with thick forest.





# Labyrinthian terrain

Complicated patterns formed by lava flow ... get lost easily



# Airborne LiDAR Project

GPS

GPS Satellites

IMU

$\phi$

$\omega$

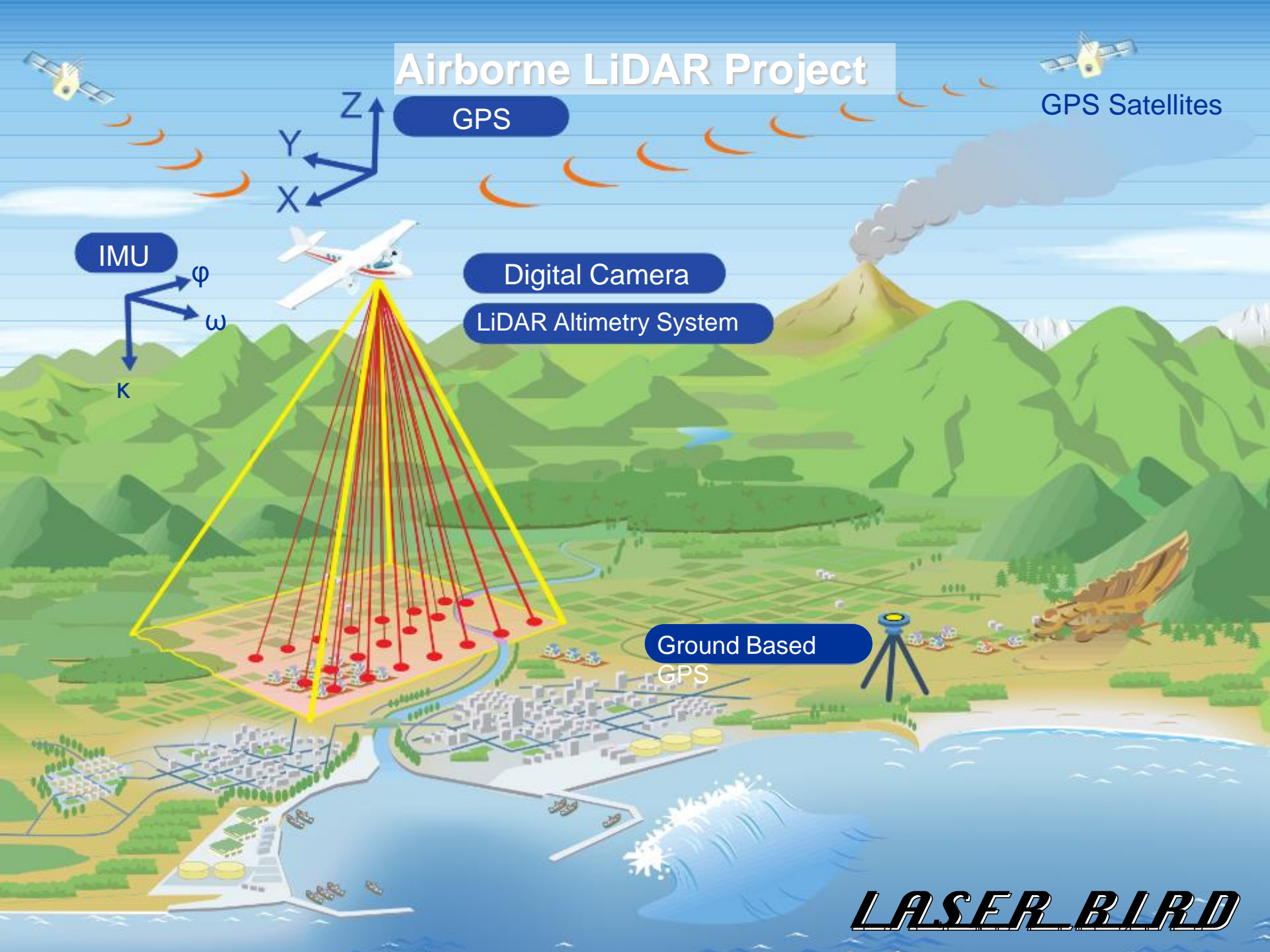
K

Digital Camera

LiDAR Altimetry System

Ground Based  
GPS

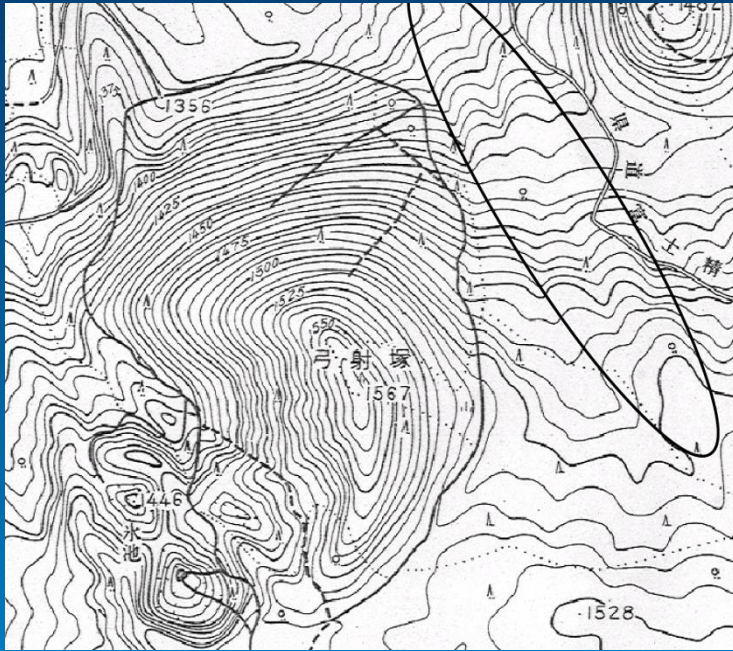
***LASER BIRD***



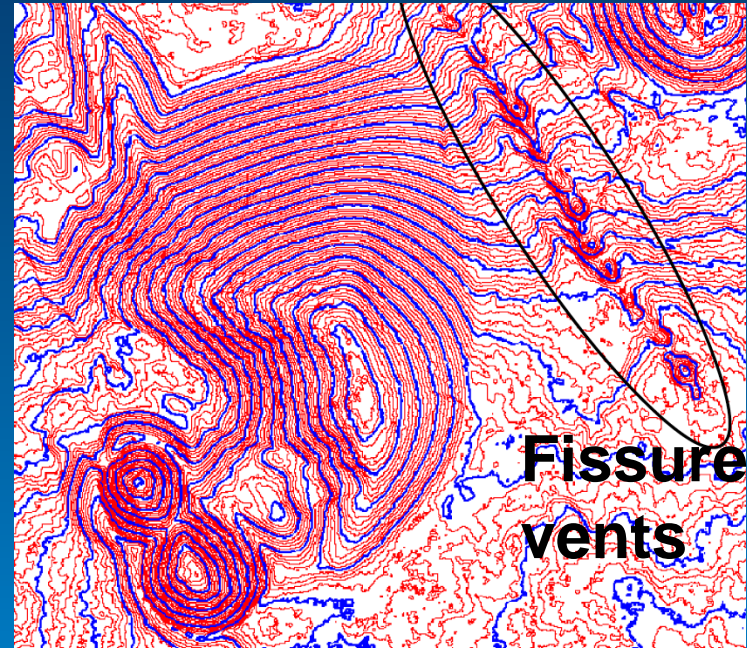


# Micro-landform mapping

Fine airborne LiDAR DEM discovered under the forest



- Unseen surface of ground had been estimated photogrammetrically.



- LiDAR revealed bare earth directory, turned out differences from old maps.

- LiDAR data get enormous information of ground, but contour map is not able to express in detail, especially in flat plain and steep slope.

# **Problem of Existing Visualization Methods**

Comparison of traditional methods

# Visualization affects perception and interpretation

Importance of coloring, shading and scaling

- **Traditional way of DEM visualizing technique**

1. **Contour**

- ✓ Poor expression for flat or steep

2. **Hill-shading**

- ✓ Problem of dependency on light source

3. **Colored relief**

- ✓ Color number limitation, shade's problem

4. **Slope gradient**

- ✓ Can not distinguish convex and concave

5. **Stereoscopic approach**

- ✓ Need specific devices  
( ex. 3D monitor, blue and red colored glasses)



# Countour

150

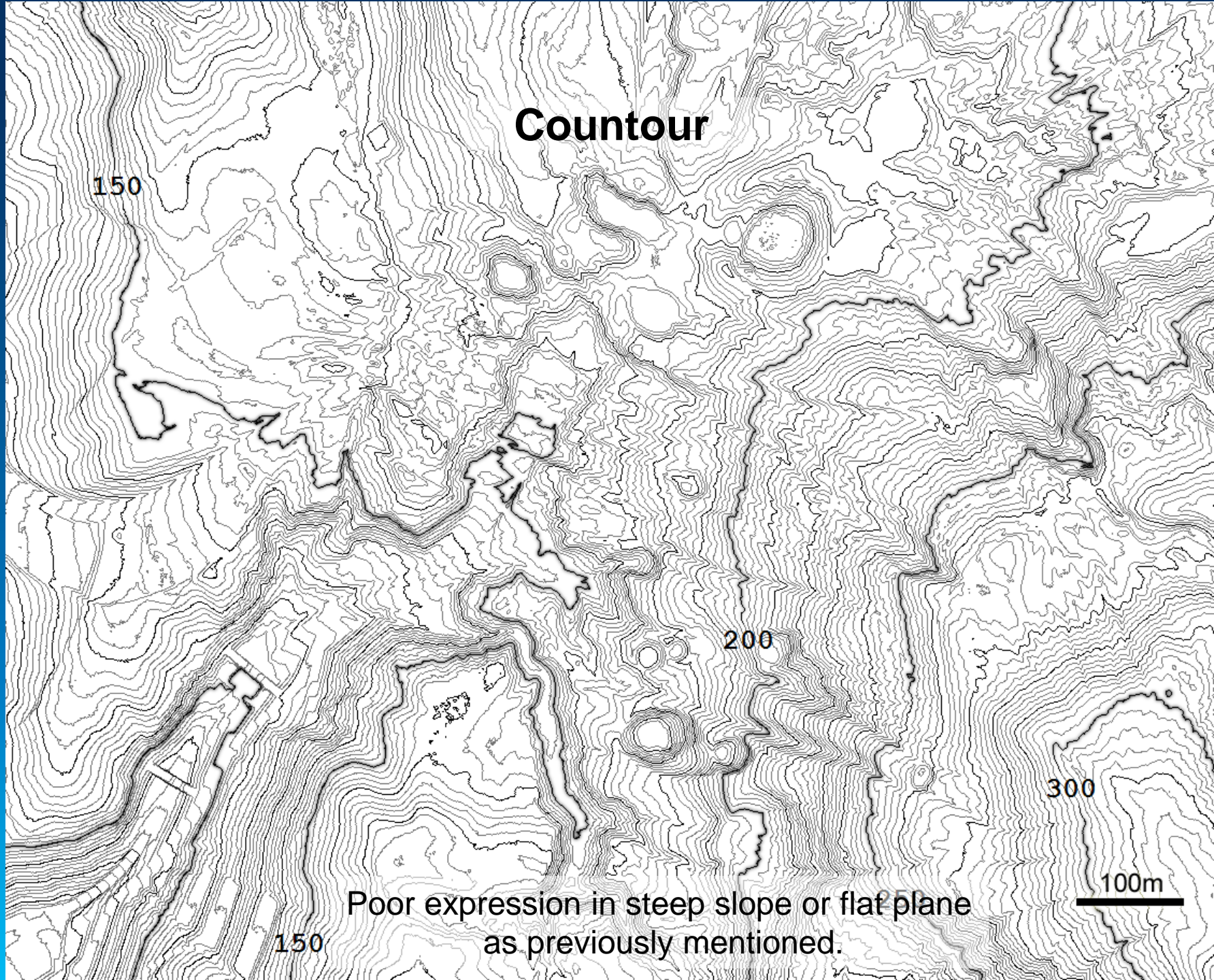
200

300

100m

150

Poor expression in steep slope or flat plane  
as previously mentioned.







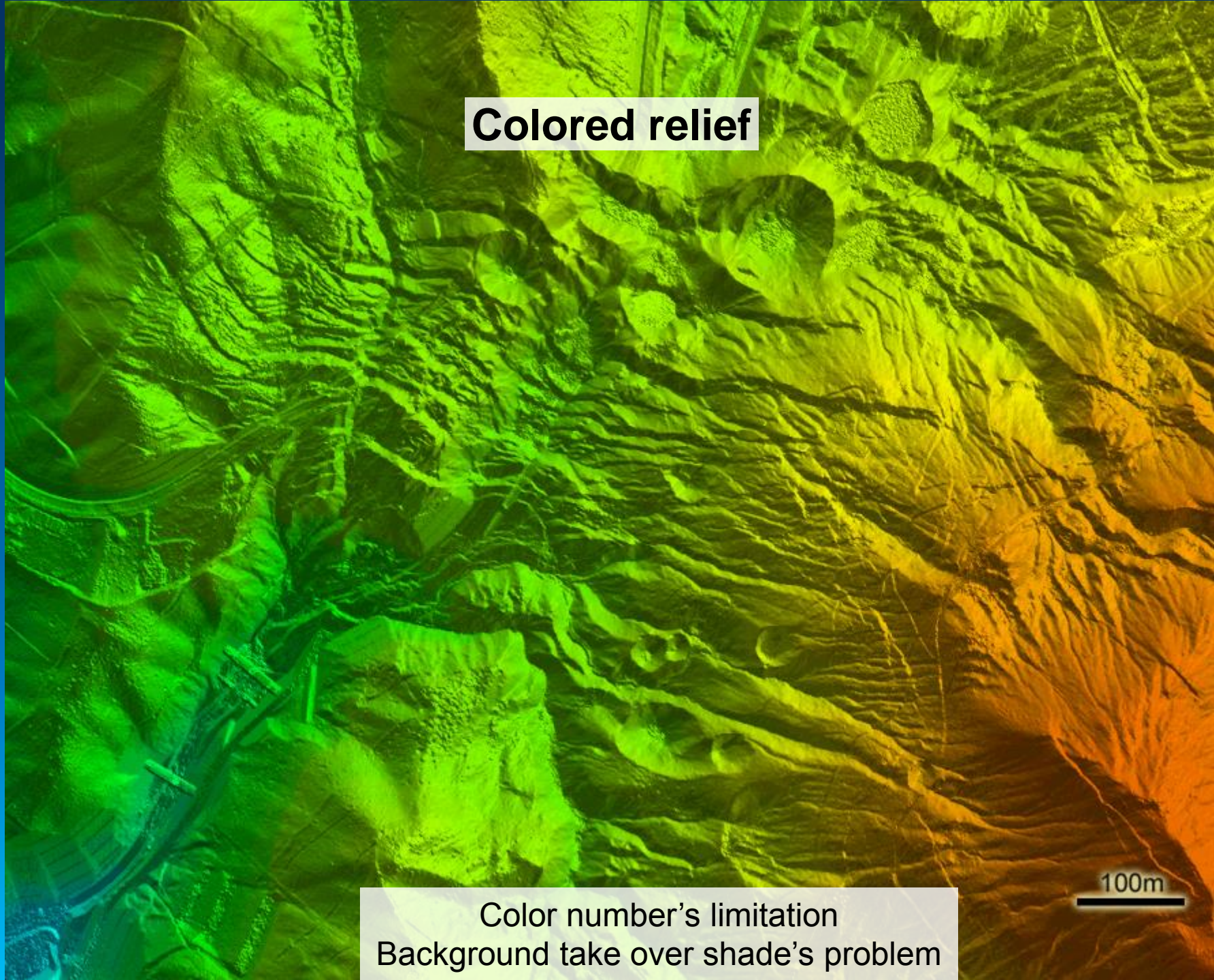
## Hill shading

Highlighted feature (ridge and valley)  
depends on the direction of light source.

100m



## Colored relief



Color number's limitation  
Background take over shade's problem

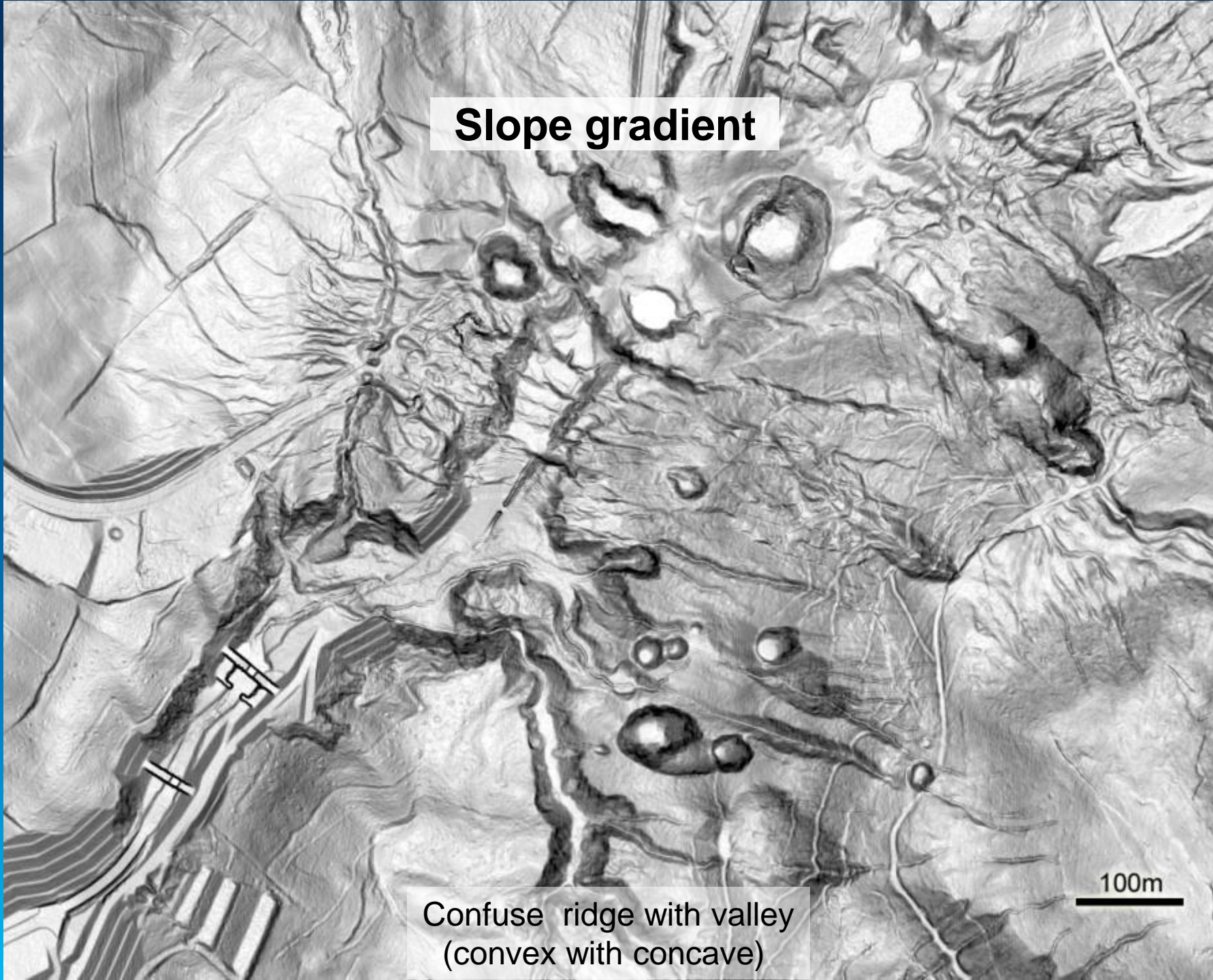
100m



# Slope gradient

Confuse ridge with valley  
(convex with concave)

100m



# **Principle of Red Relief Image Map**

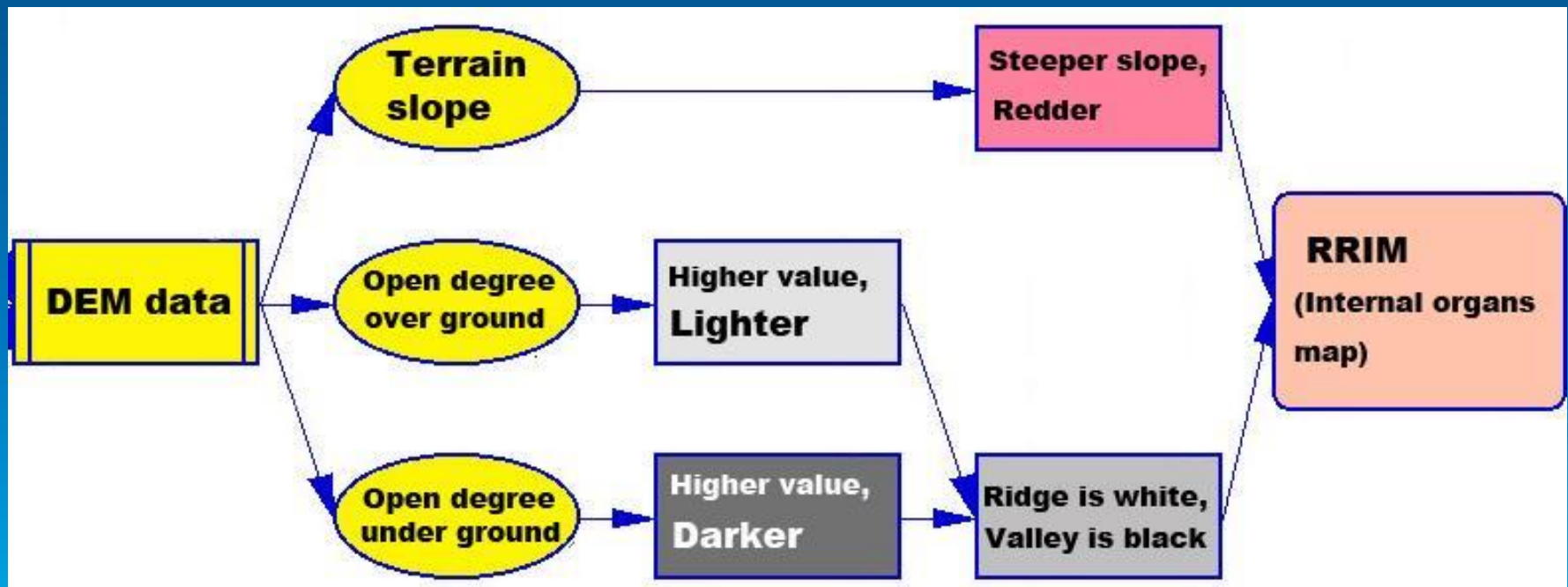
Distinctive invention on color mixing



# Procedure for making RRIM

Color imposing with DEM-derived parameters

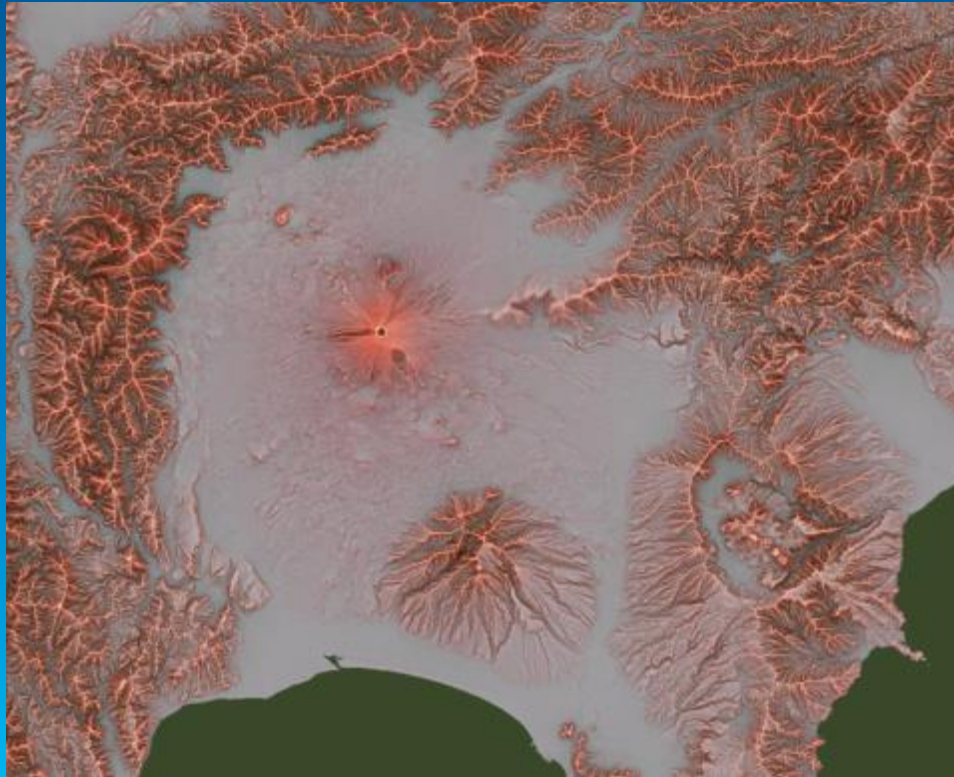
- Elements of RRIM
  - Slope, Positive openness, Negative openness



# Look and feel

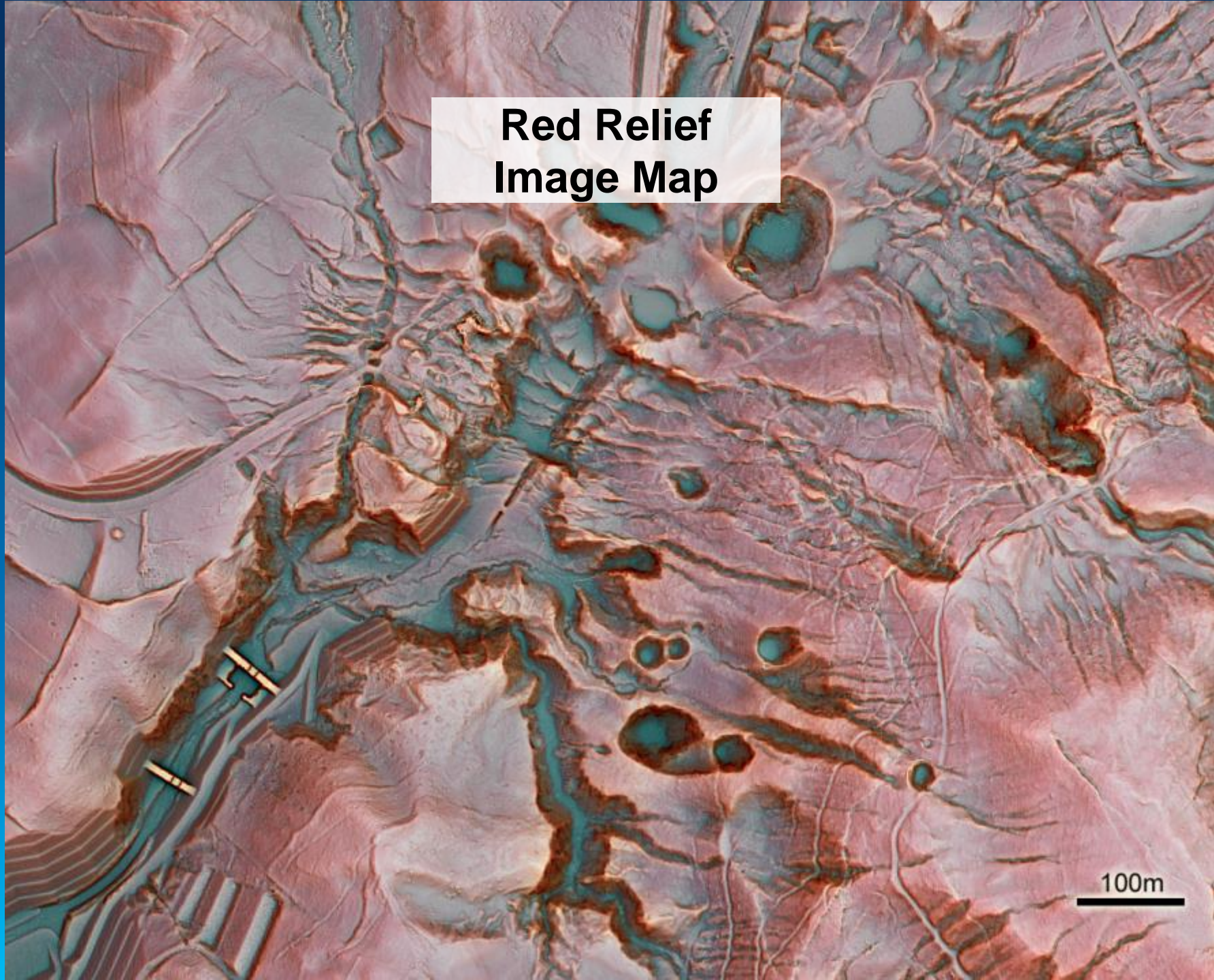
Impressive and attractive appearance

- The stepper, the redder.
- The more upward than surround, the brighter.
- The more downward than surround, the darker.



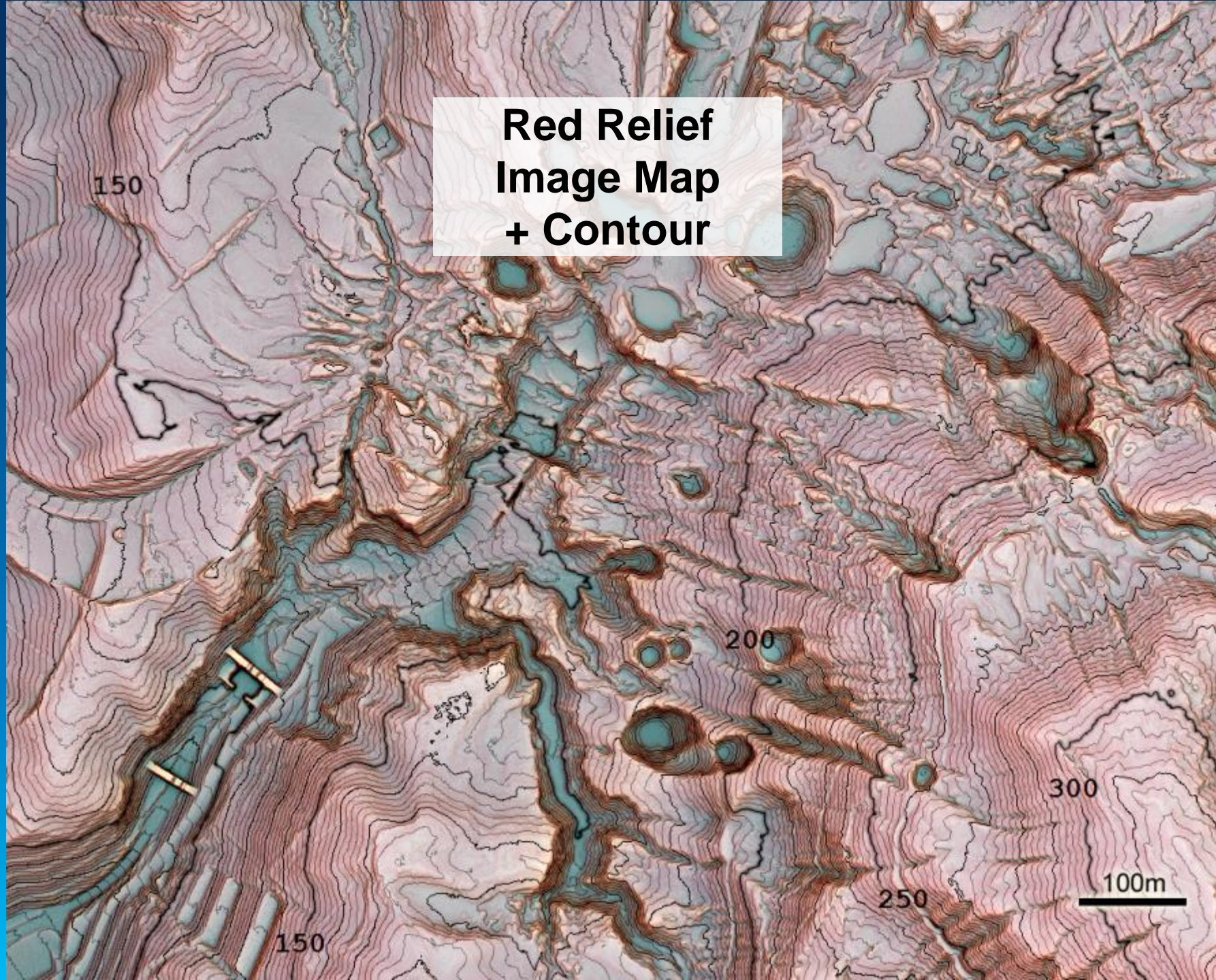


# Red Relief Image Map





# Red Relief Image Map + Contour



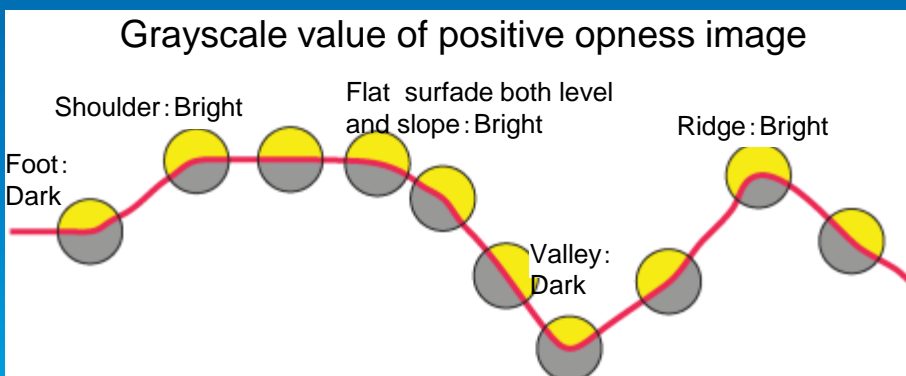
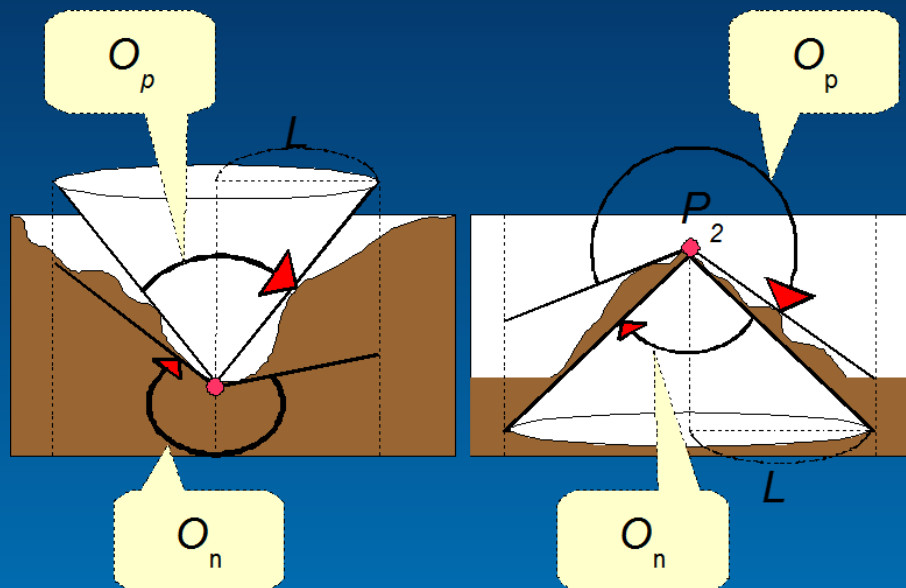


# Key features of RRIM

- Slope gradient value assign **red** color.
- **Openness** exaggerate relative relief, gives 3D appearance.
- **Combination** of slope, positive and negative openness enhance 3D effect.

# What is Openess?

- Similar to skyview factor (volume of the visible sky)
- Calculated by simple algorithm (8 directional relative elevation in arbitrary extent range).
- Two openesses, positive( $O_p$ ) and negative( $O_n$ ), represent opposite side of terrain surface.
  - Yokoyama, T. et. Al (1999) Representation of topographical features by openesses ,photogrametry and remotesensing,38,4,26-34

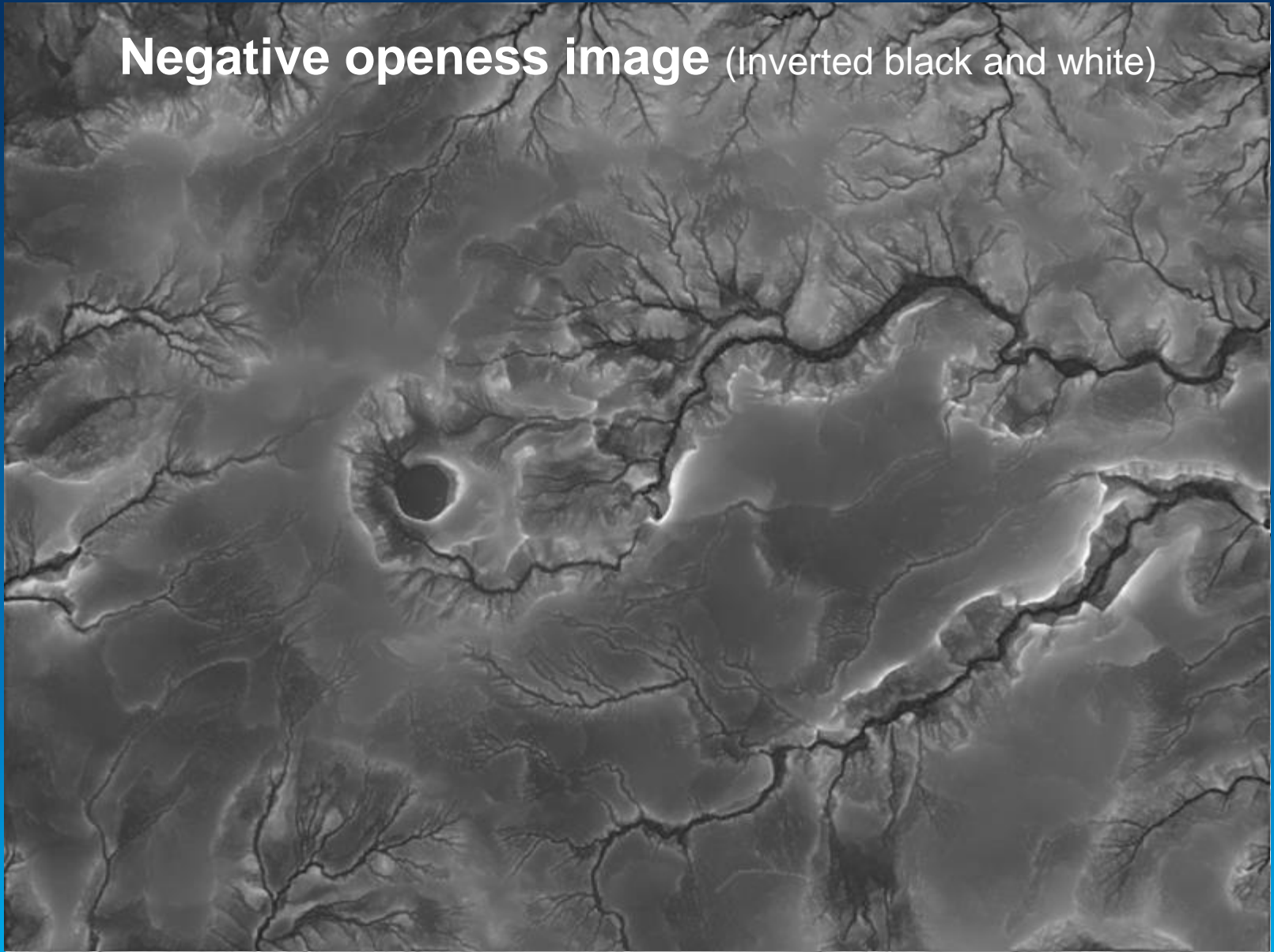


- *Positive* openness takes high value at convex point.
- *Negative* openness takes high value at concave point.

Positive Openess image



**Negative openness image** (Inverted black and white)





# Ridge and valley index

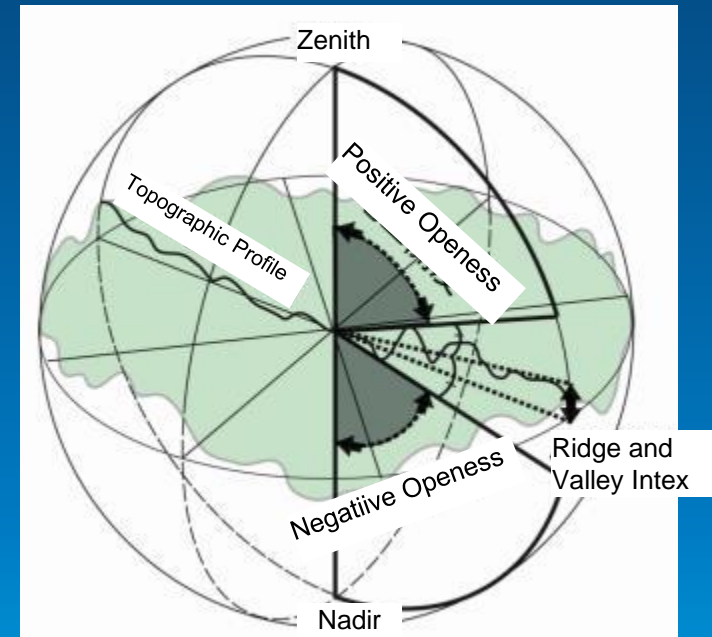
## Combined negative and positive openness

- Positive openness clear at ridge and peak (obscure at valley and pit)
- Negative openness clear at valley and pit (obscure at ridge and peak)
- Positive and Negative opennesses are not totally opposite, have asymmetric diversity

### *Ridge and Valley Index : I*

$$I = ( O_{positive} - O_{negative} ) / 2$$

- $I = (O_o - O_u) / 2$  takes high at convex point and low at concave point.

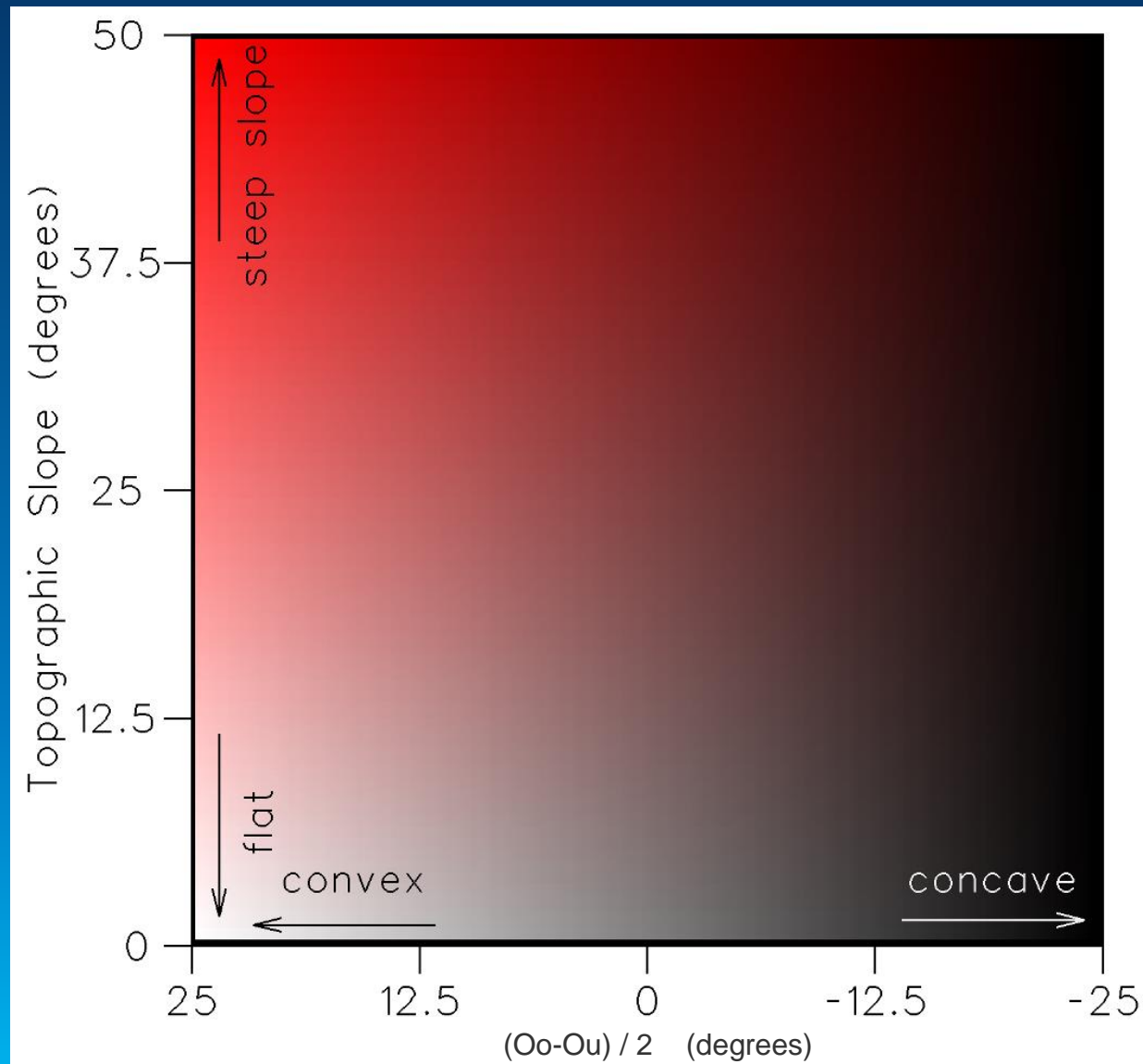


## Ridge and valley index image



# Color diagram

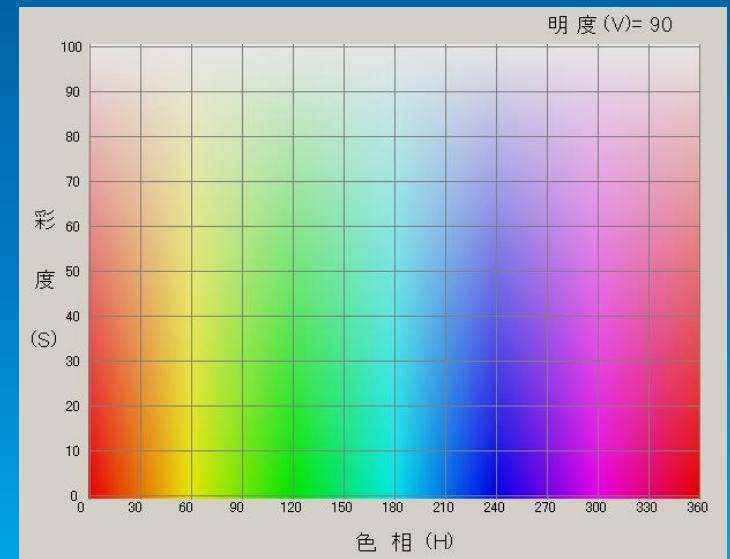
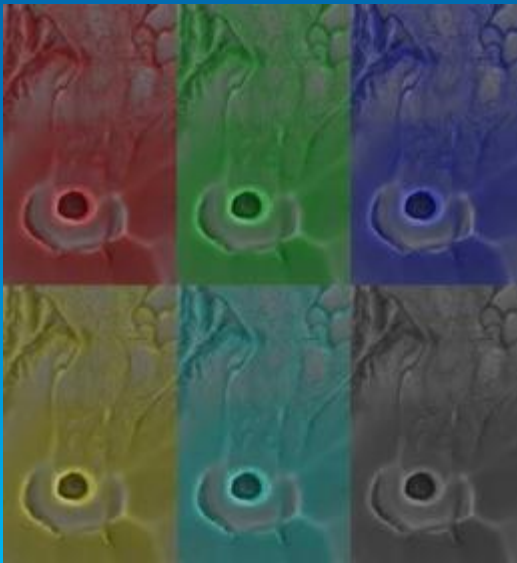
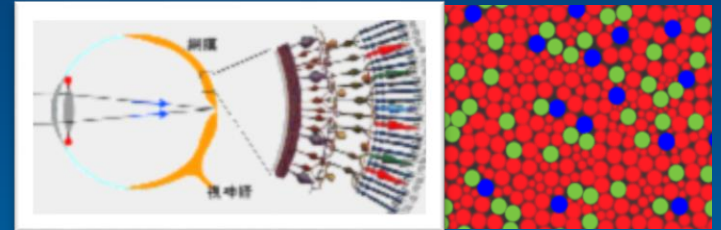
- Slope angle showed as chroma values of red.

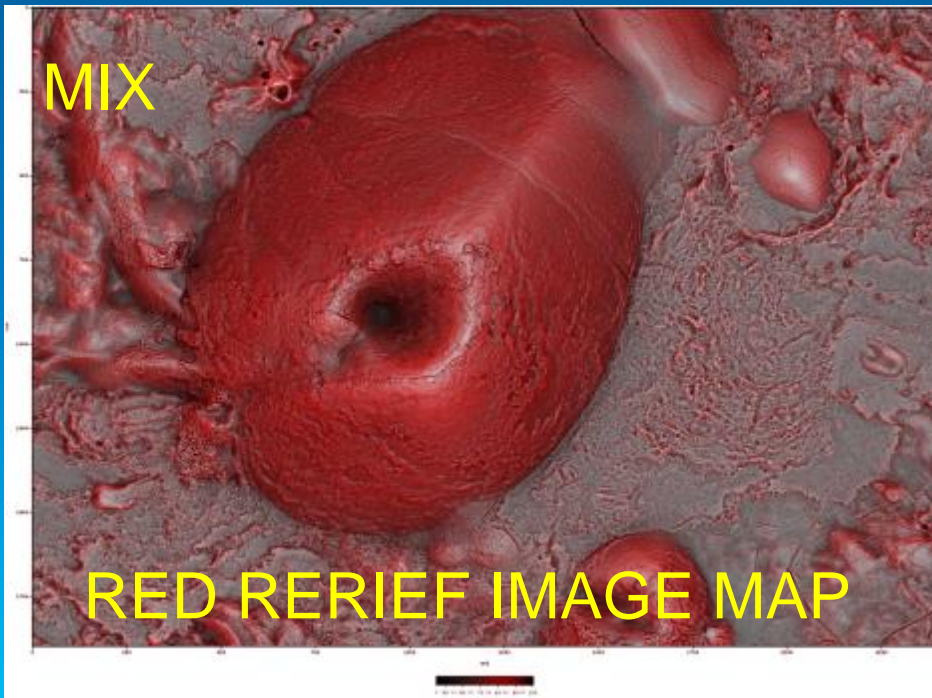
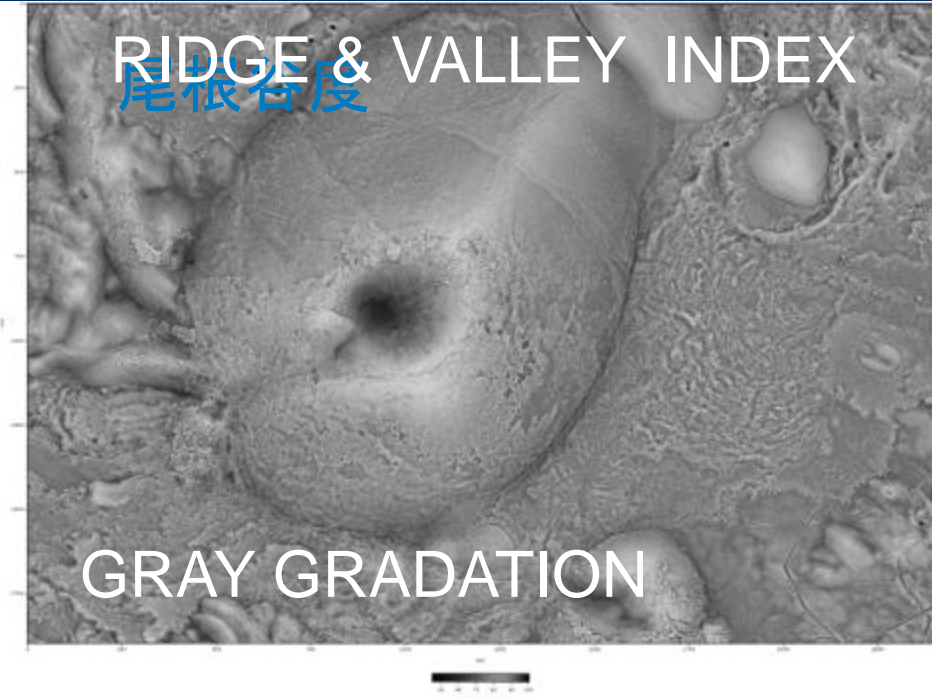
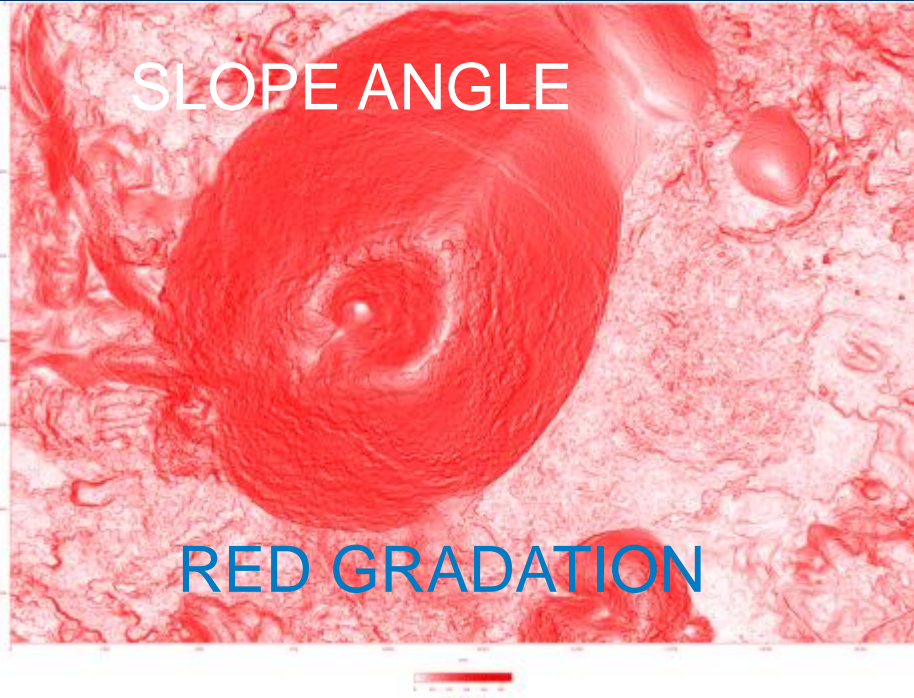




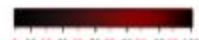
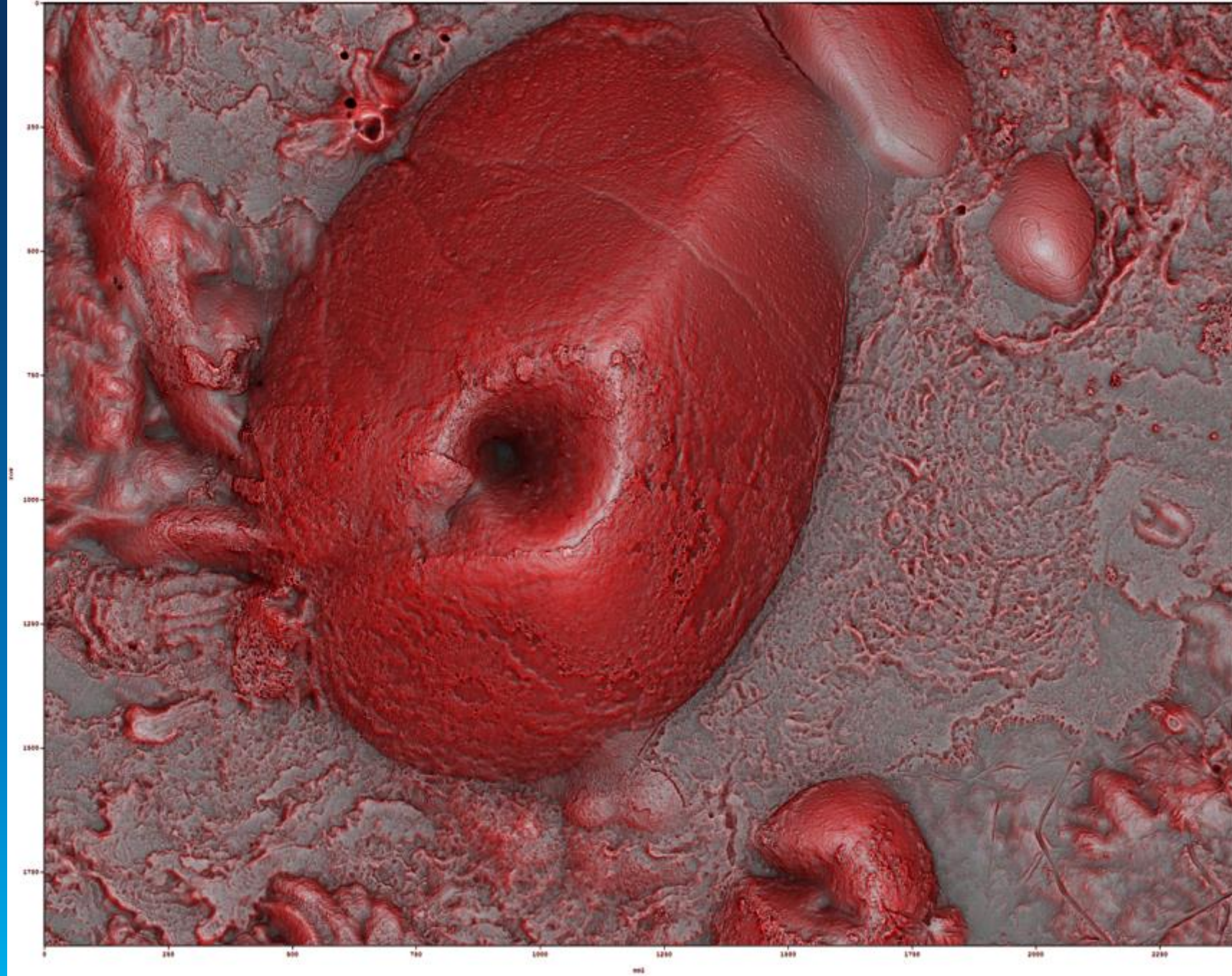
# Why Red ?

- Human being's cognitive ability
  - Both feeling and neuro-opthalmologically
- Chromatic resolving power
  - RGB monitor and CMYK printer handle red color sensitively







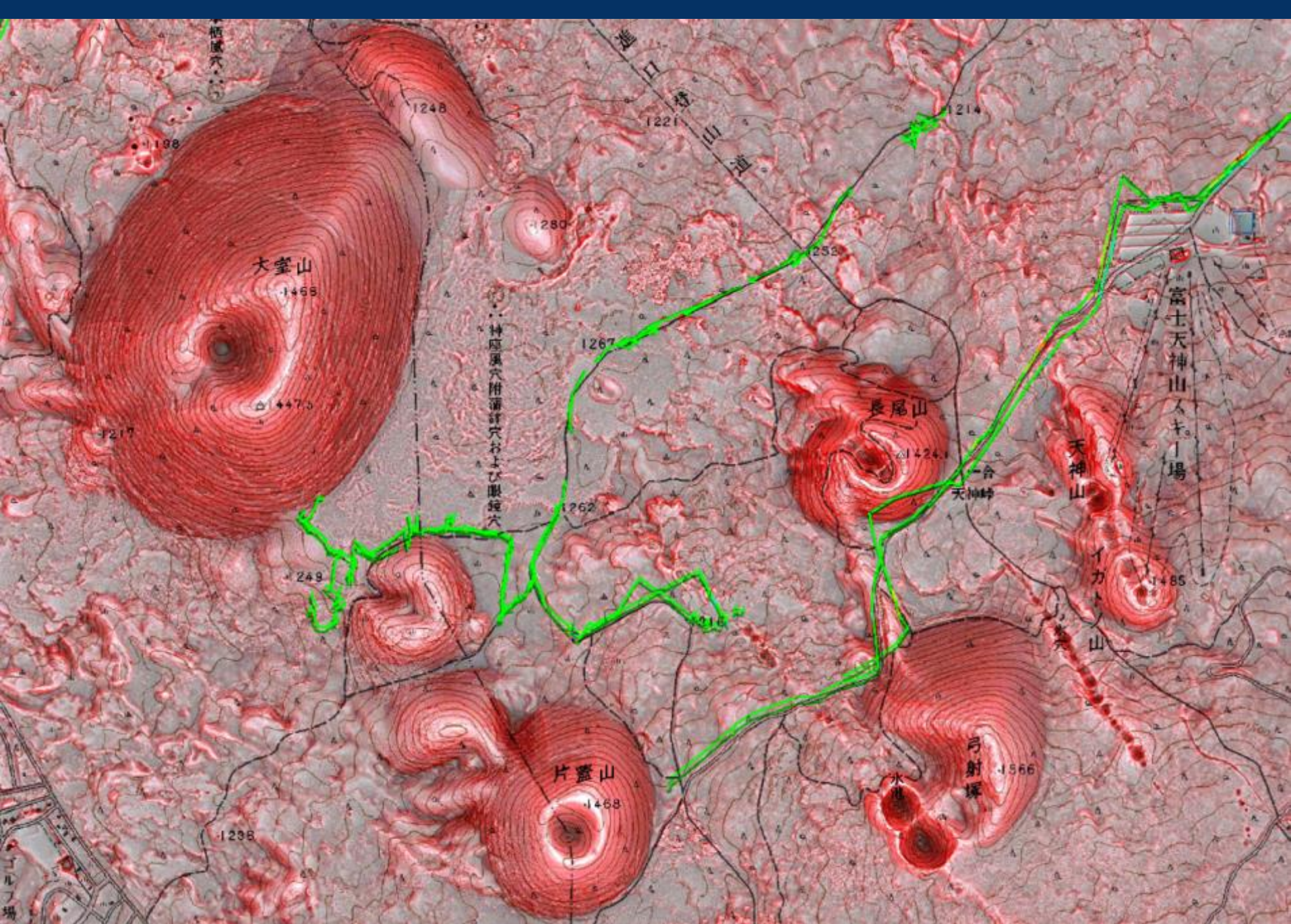


vortic\_speed\_mms

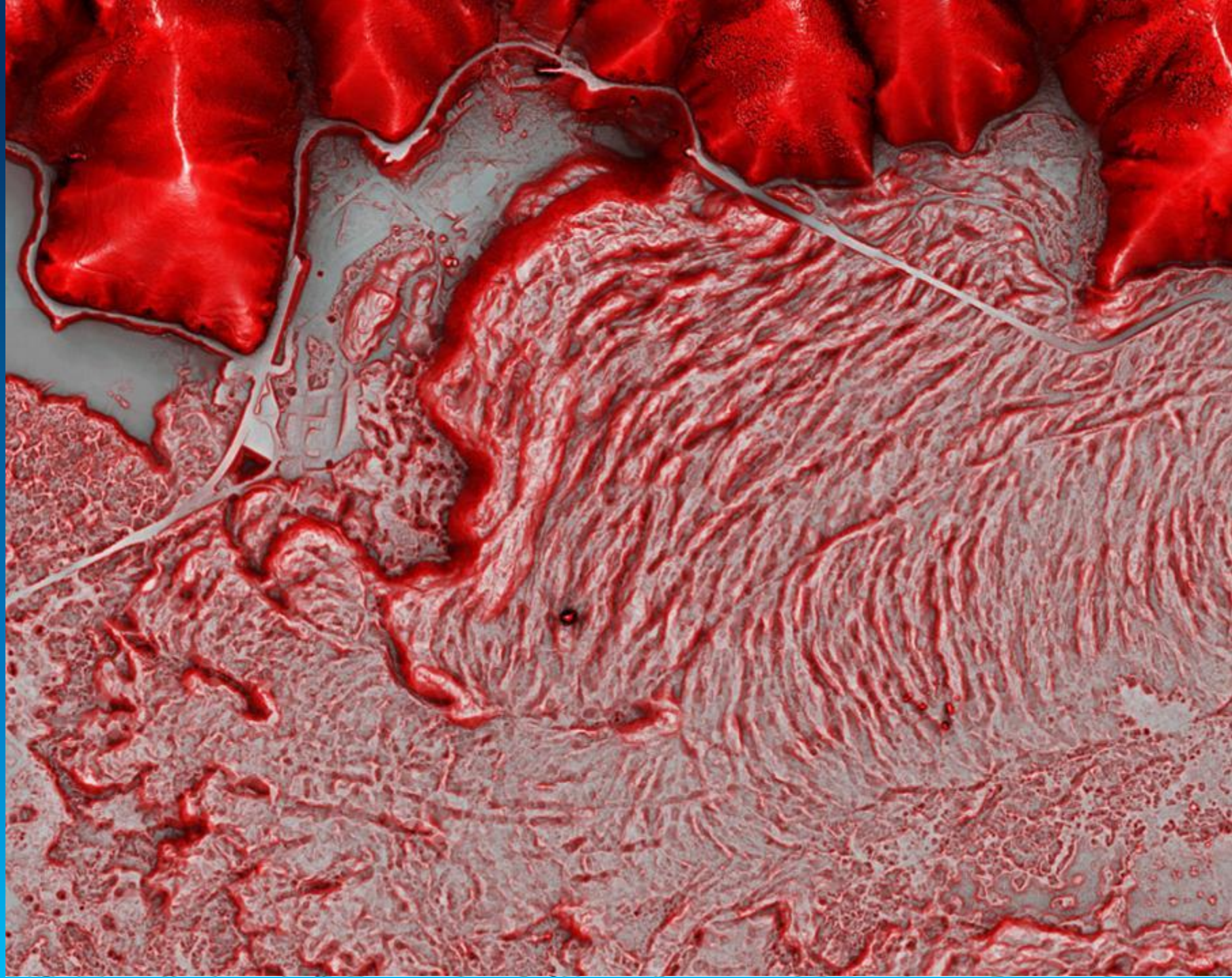




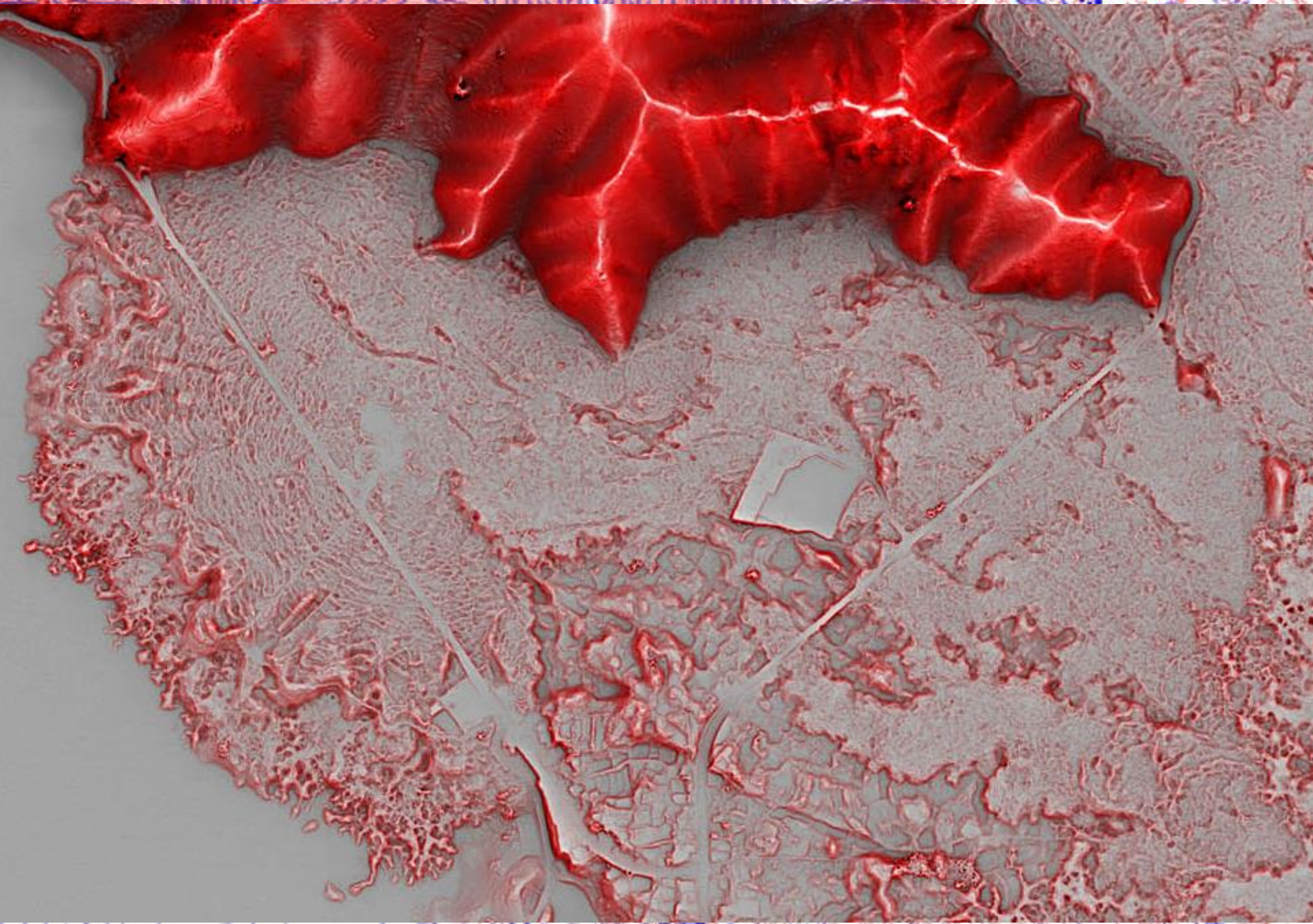












# Examples

San Andreas Fault, California  
Oso Landslide, Washington  
Mt. St. Helens, Washington  
Kilauea Creater, Hawaii

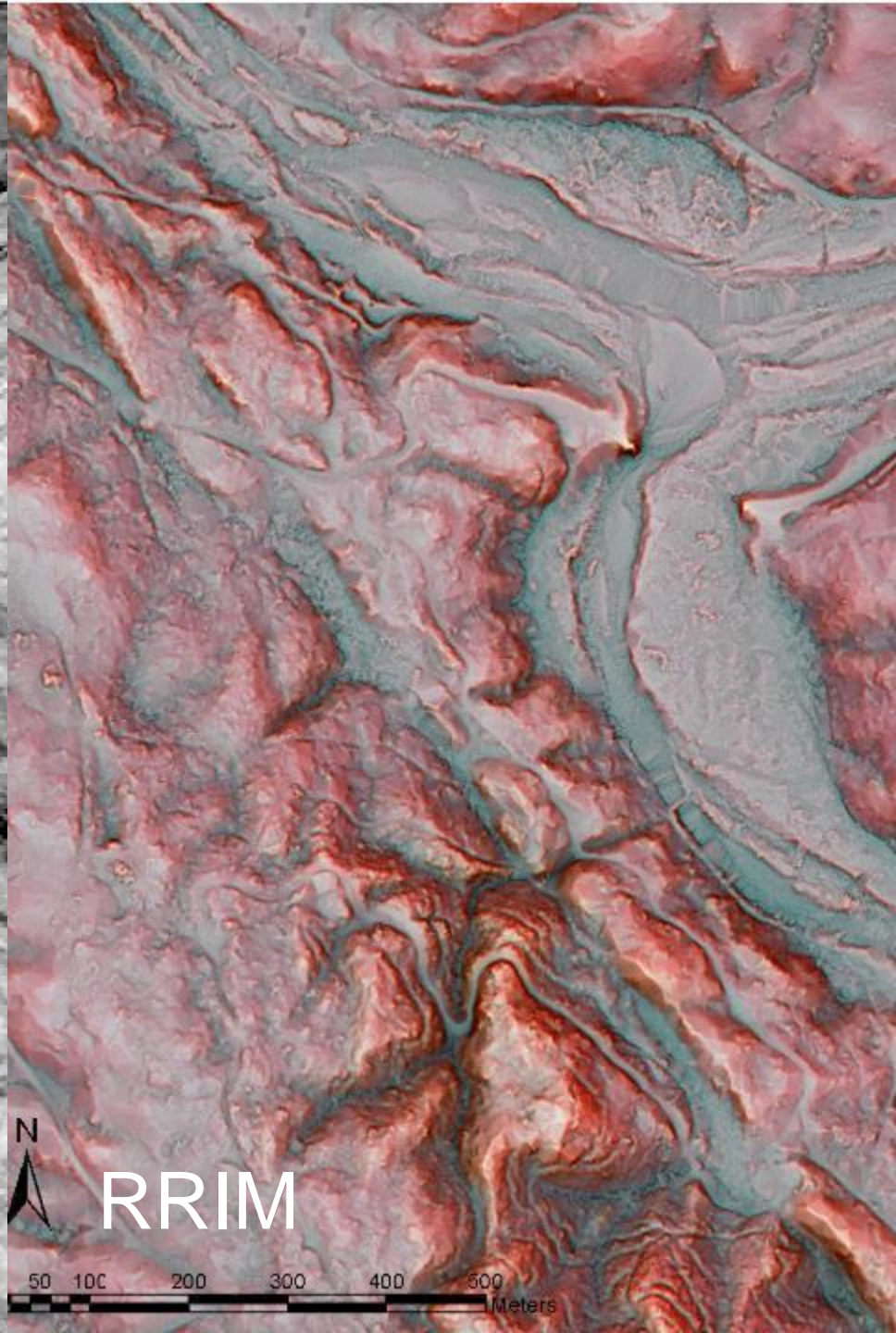
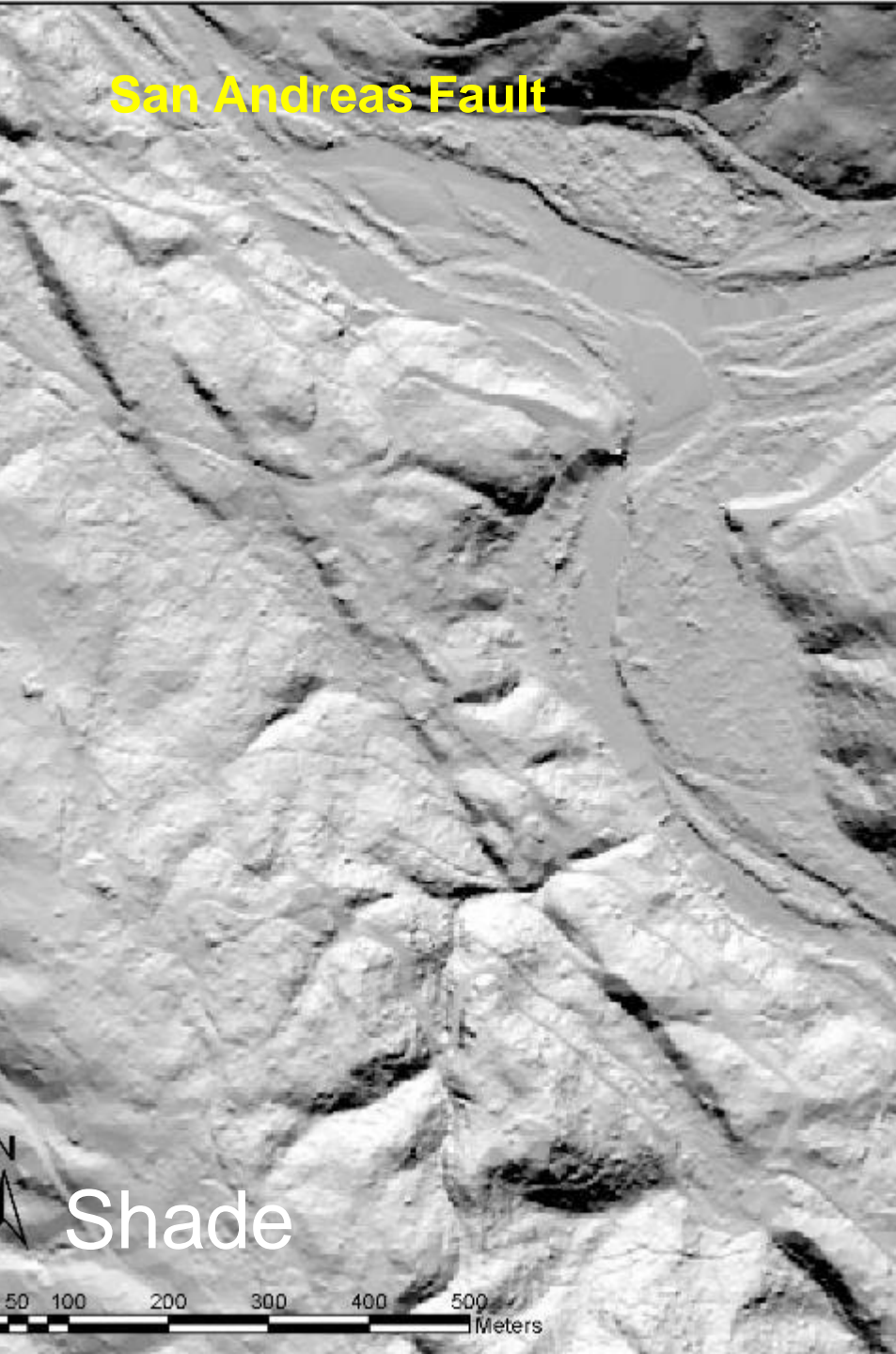
Any scale

Moon , plate textonics , SRTM1





# San Andreas Fault

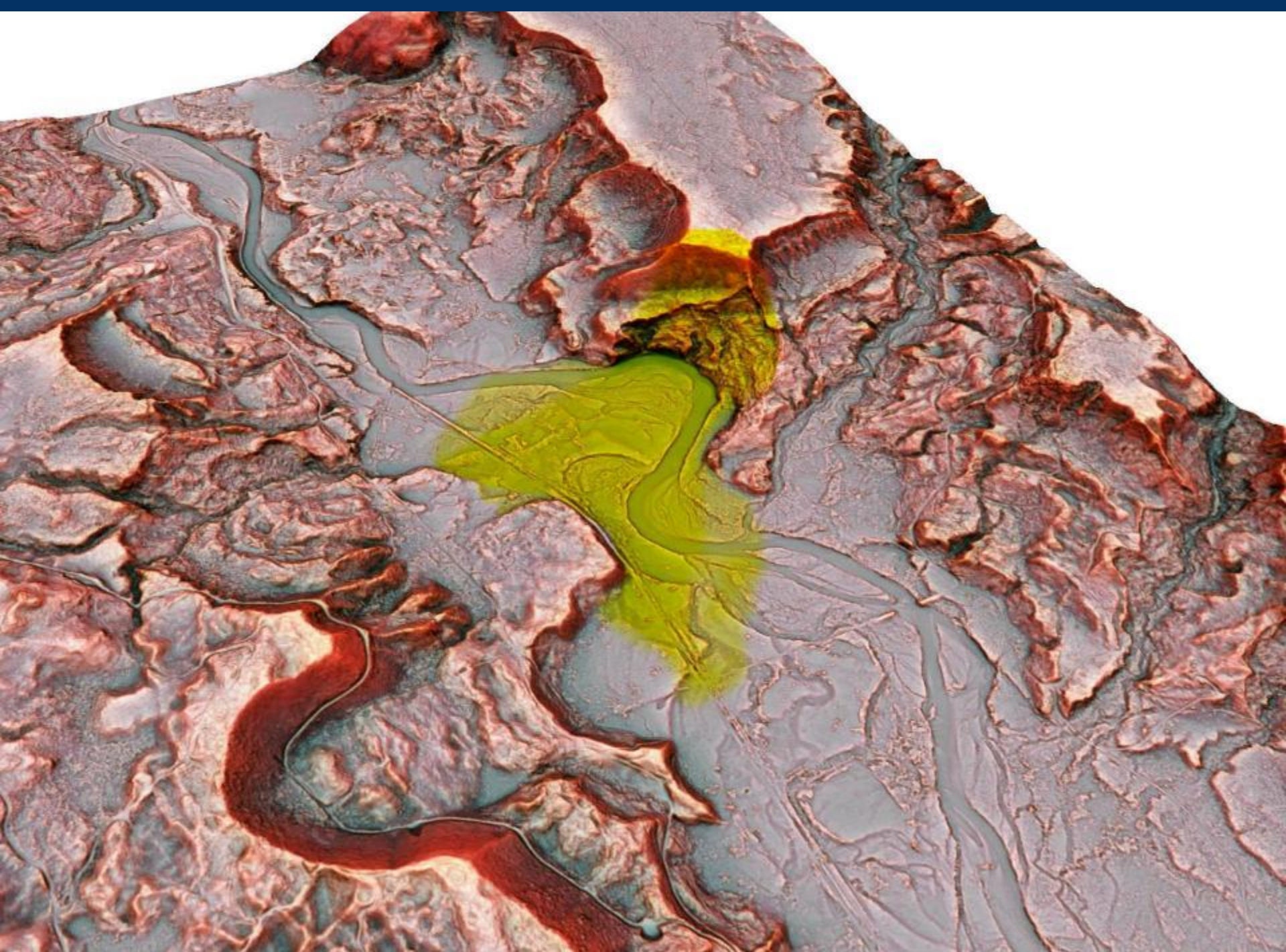




## Oso Landslide, Washington State

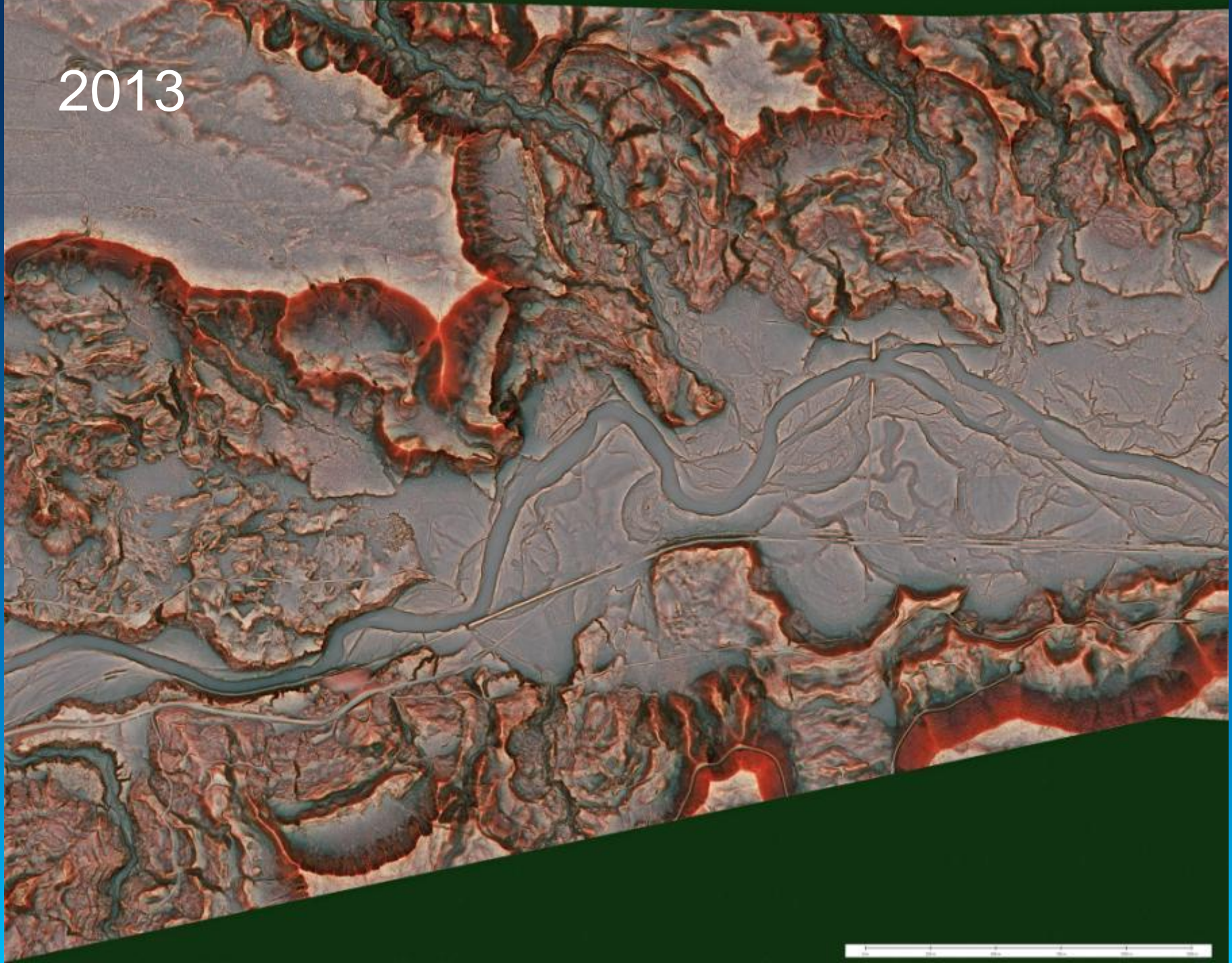






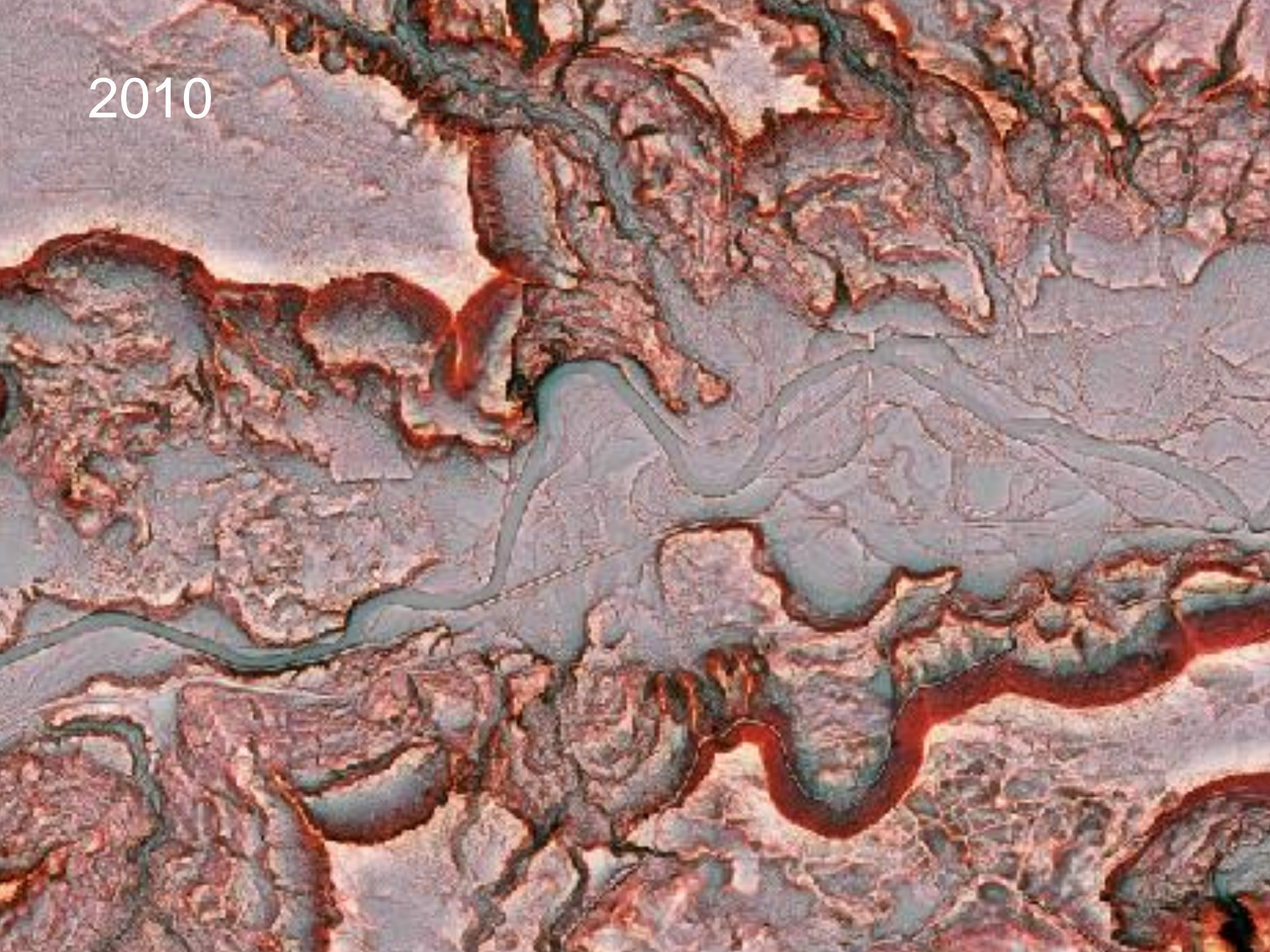


2013



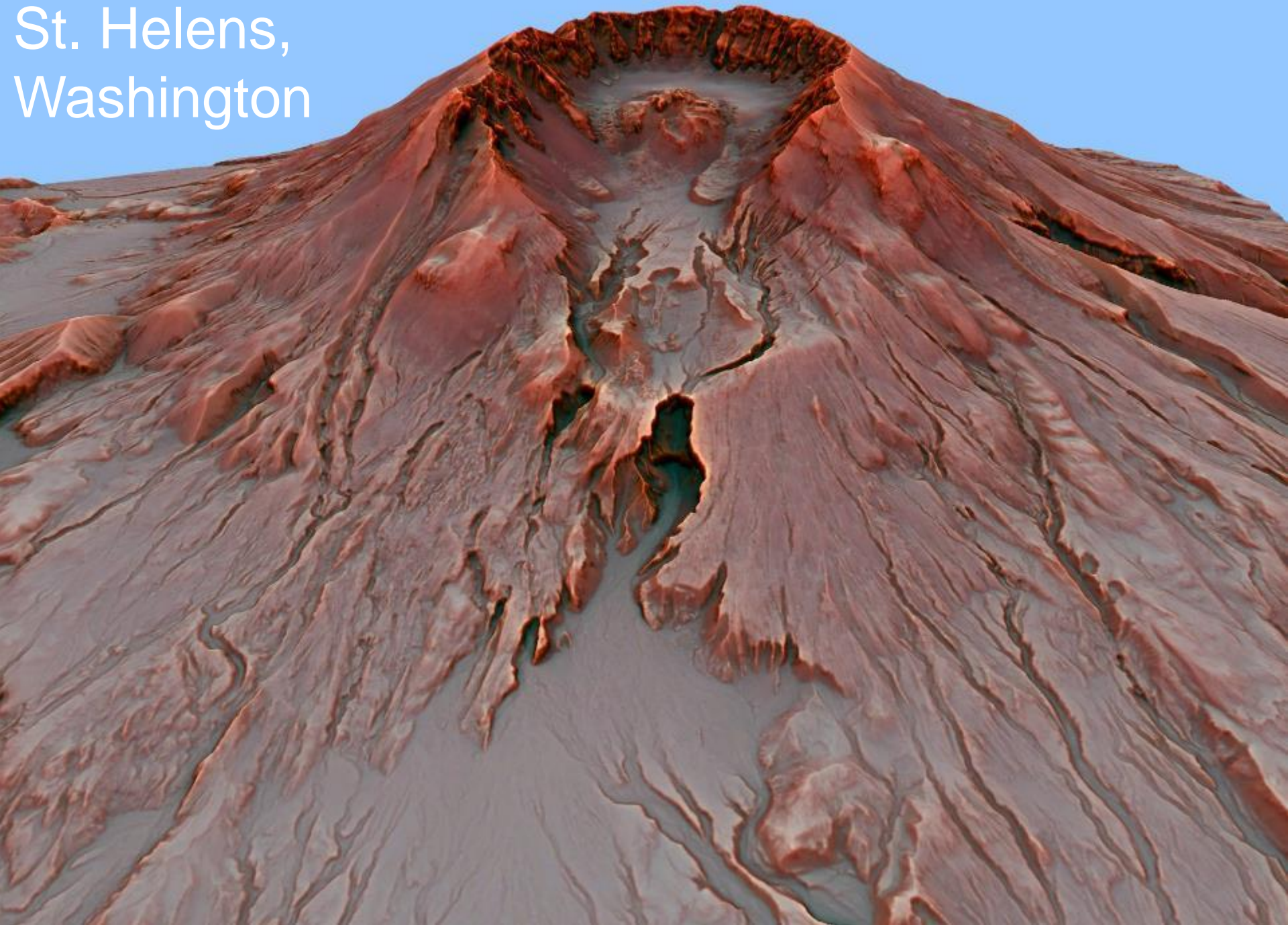


2010



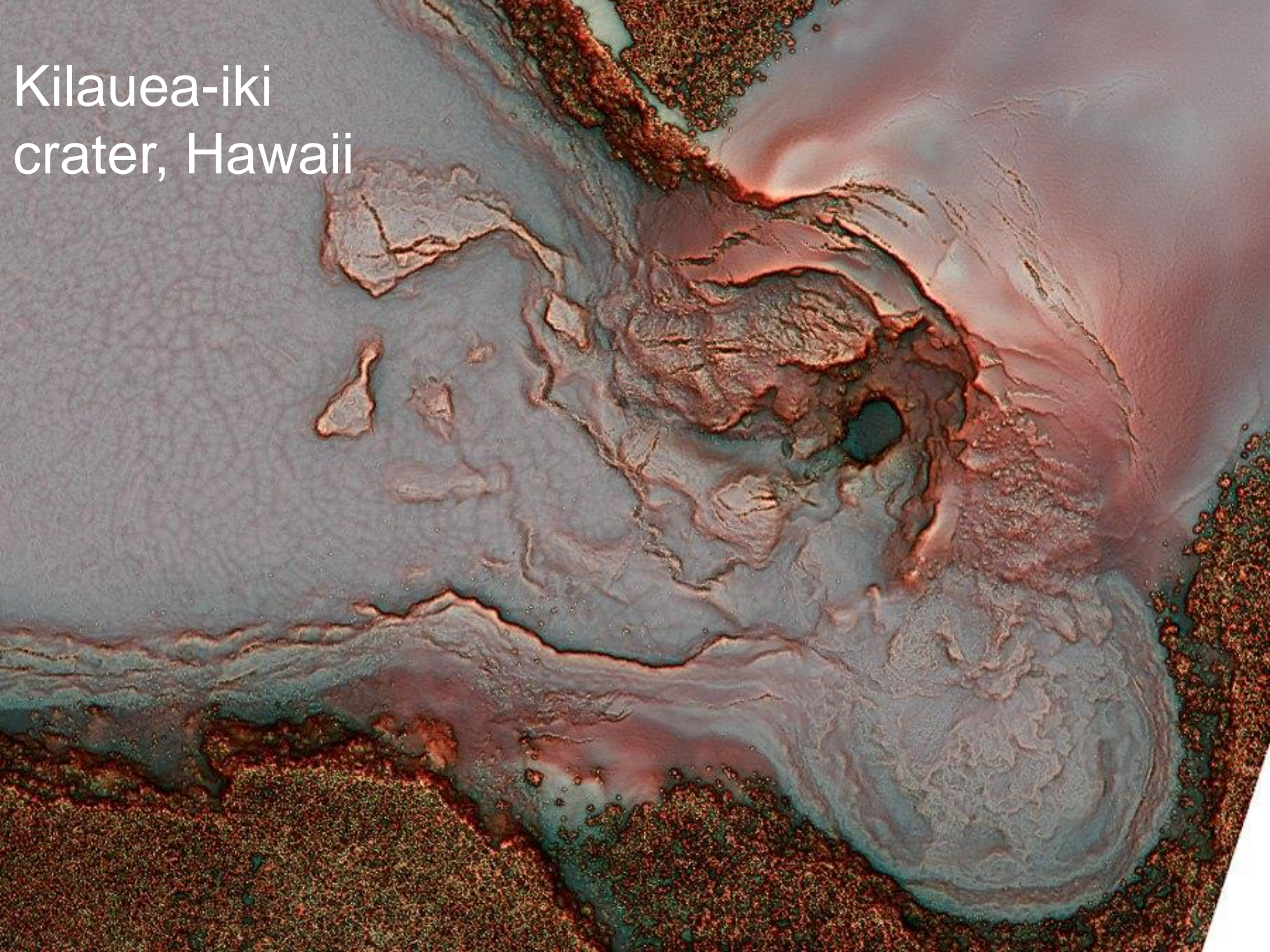


# St. Helens, Washington





# Kilauea-iki crater, Hawaii





# RRIM of moon selected by CNN web site

EDITION: INTERNATIONAL | U.S. | MÉXICO | ARABIC | **CNN** | Log in | Sign up | Log in

TV: CNN | CNN en Español | not all on preferences | SEARCH | powered by Google

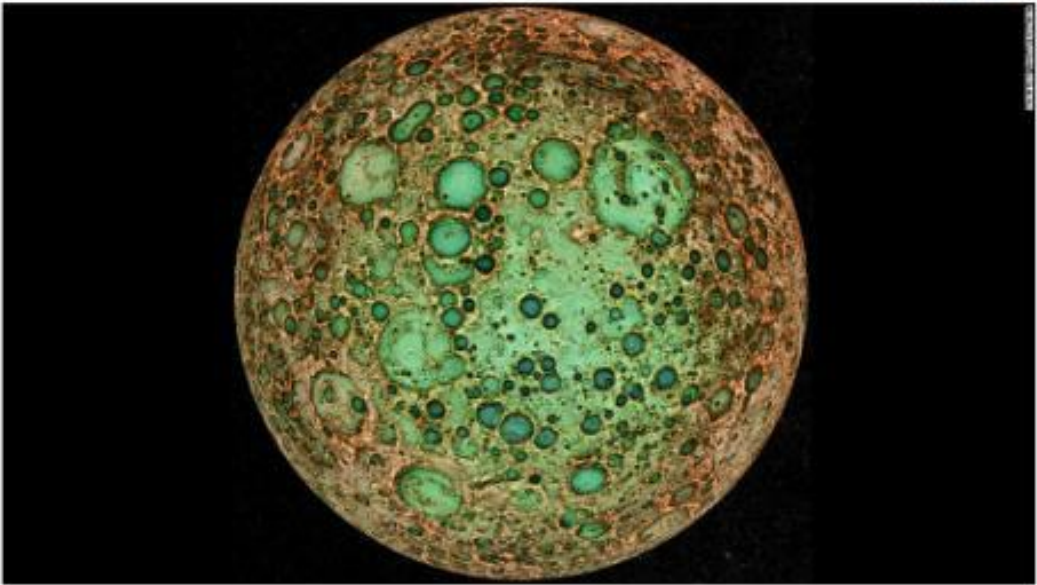
Home | Video | **World** | U.S. | Africa | Asia | Europe | Latin America | Middle East | Business | World Sport | Entertainment | Tech | Travel | iReport

part of complete coverage on **Art of Movement** | THE ART OF **Movement** | sponsored by **OMEGA**

## 10 beautiful moon maps through the ages


SHARE THIS: f t+ in | Facebook | Twitter | Google+ | LinkedIn | Recommended 2.4k | Print | Email | More sharing

Previous Next



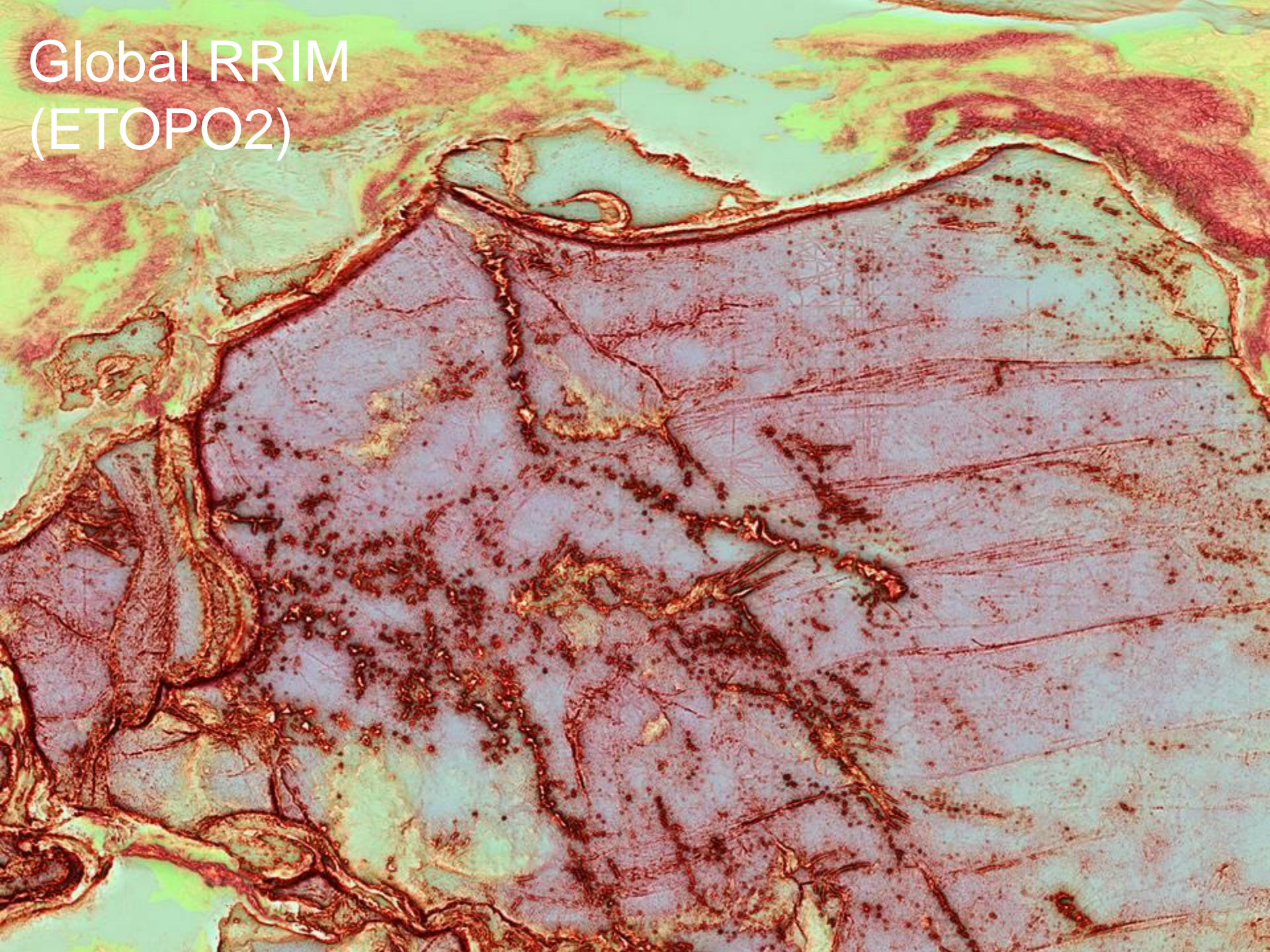
NAOJ, GSI and JAXA, 2013

The result of a collaboration between the National Astronomical Observatory of Japan, the Geospatial Information Authority of Japan, and the Japan Aerospace Exploration Agency, this slightly ominous map gives us a better idea of exactly how deep the moon's largest impact crater really is (the redder the area, the higher the elevation.) For another interesting perspective, check out their late-eye-view rendering of the same area.





# Global RRIM (ETOPO2)





# Summary

## Advantage of Red Relief Image Map

- Overcome weakness in existing visualizing methods.
- Enhance cognitive function
  - anyone interpret topography intuitive
- Usability on GIS
  - RRIM is georeferenced raster imagery
- Self-contained
  - no stereo pair, no need specific devices
- Scale free ( from micro- to macro-scale)
- Easy to compute (not time-consuming)
- Also useful as a means of ground filtering process of LiDAR data





Thank you for your attention

TATSURO CHIBA

