

# Using HysplRI preparatory data for rapid classification of hydrothermal alteration and lithology

Betsy Pace

# UNR project goals

- Identify new systems linked to **critical minerals**
- Identify high priority sites for **geothermal energy** development
- Assess the land surface changes associated with **large scale energy development**
- Map and monitor the impacts associated with **energy and mineral resource extraction**

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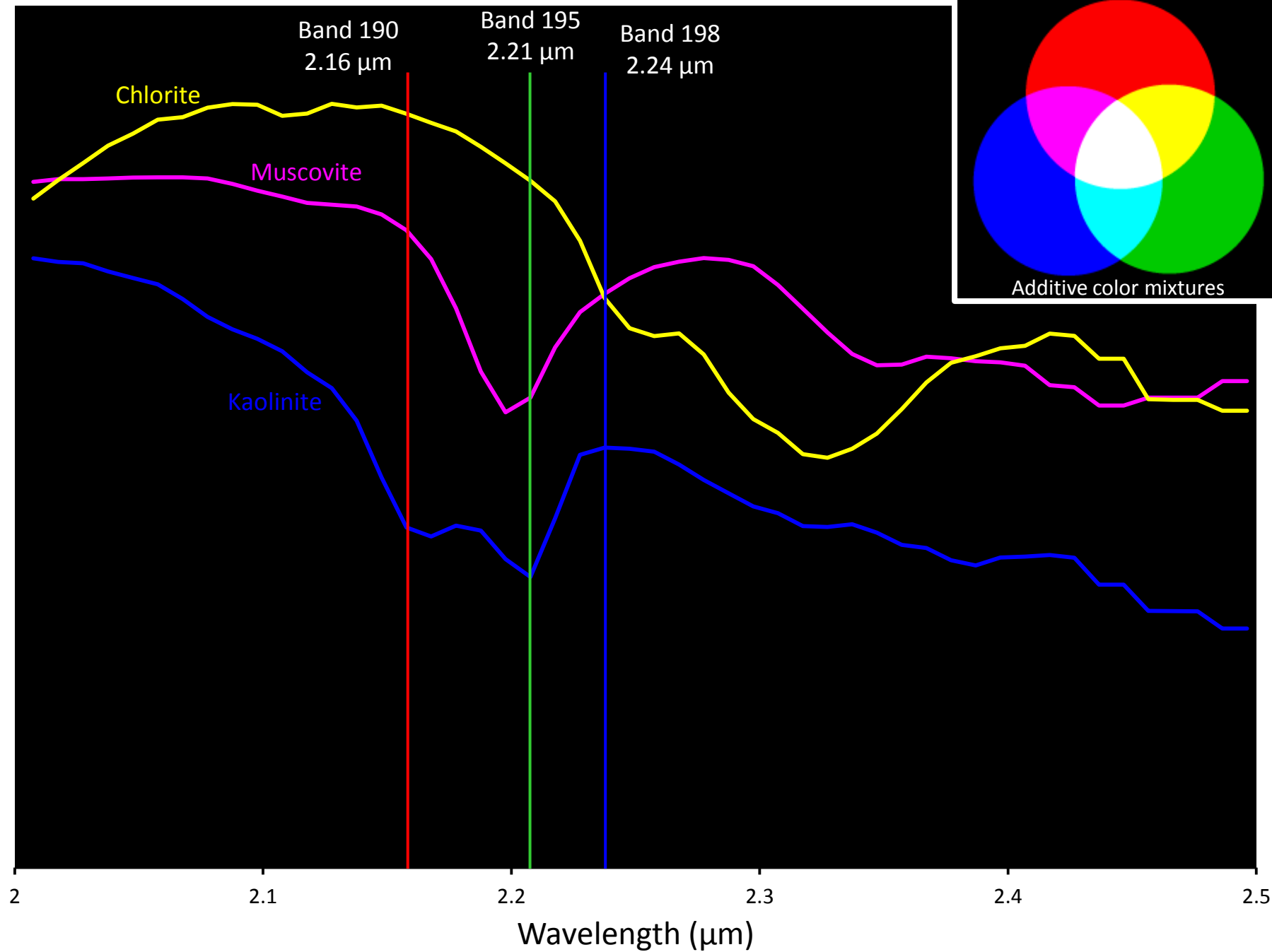
# Hydrothermal alteration

- AVIRIS data used to map hydrothermal alteration
  - Advanced argillic
  - Argillic
  - Sericitic
  - Chloritic
  - Propylitic
- May be associated with
  - Ore deposits
  - Modern geothermal systems

# Mapping hydrothermal alteration

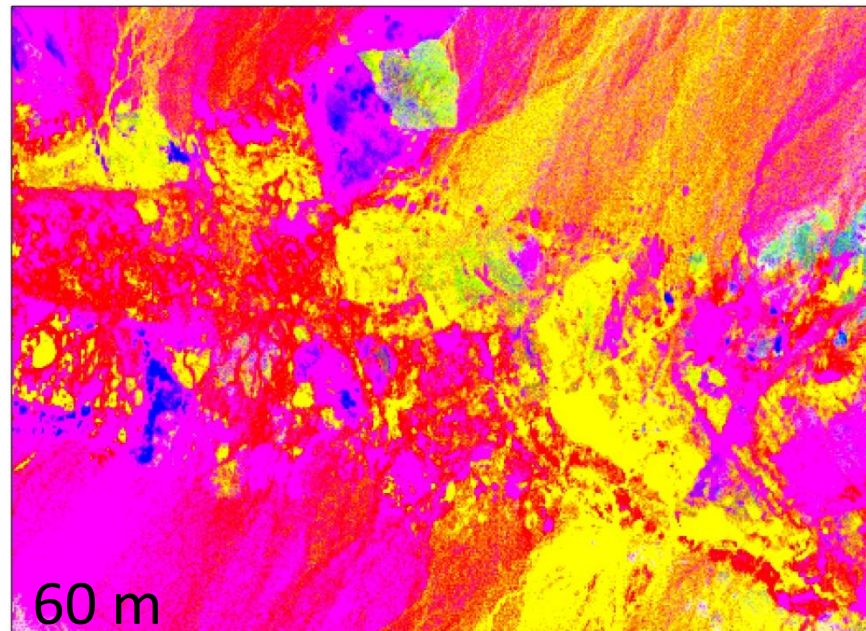
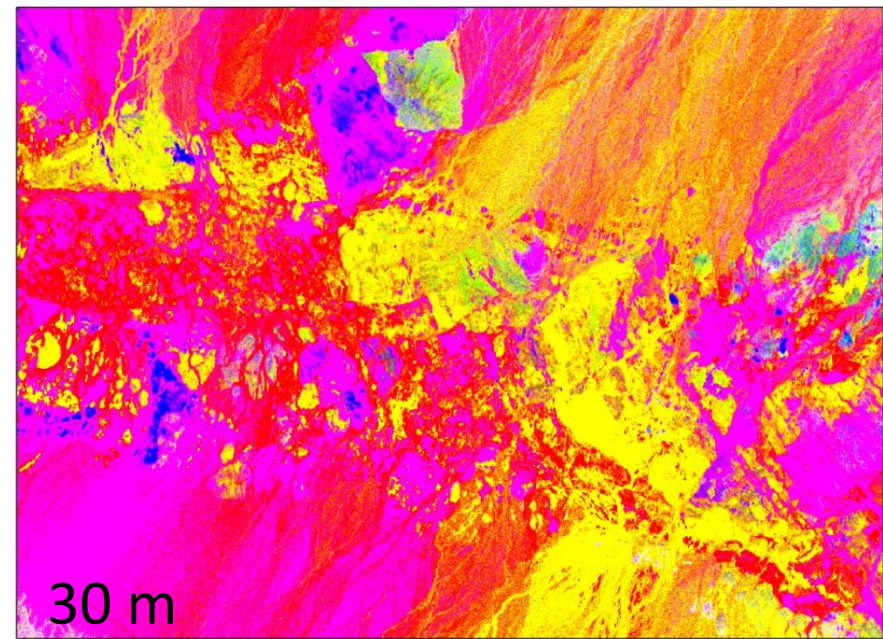
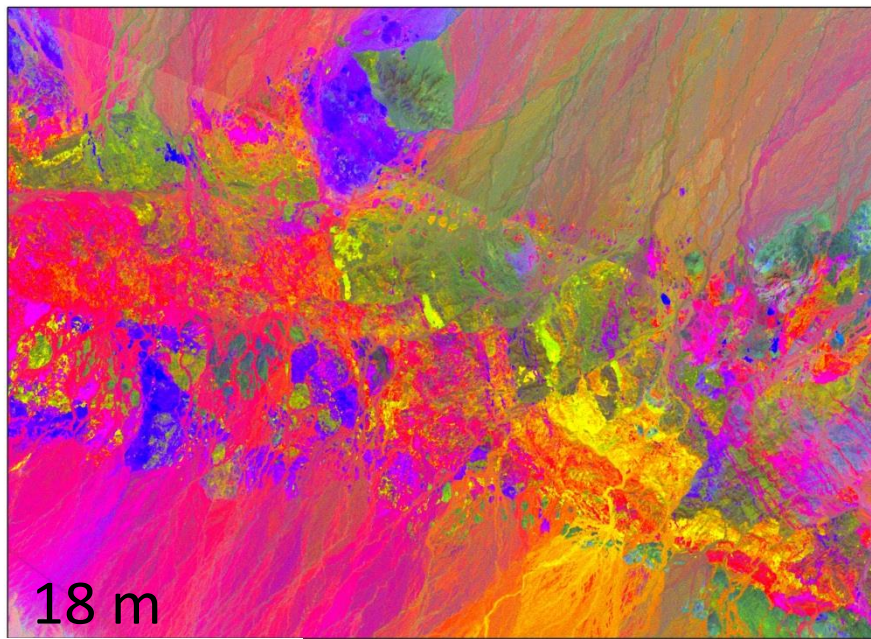
- Decorrelation stretch of AVIRIS SWIR bands
- DCS bands **190**, **195**, **198** displayed as **RGB**  
(**2.16**, **2.21**, **2.24**  $\mu\text{m}$ )
- Highlights
  - Kaolinite, alunite as **blue**
  - Muscovite, illite as **magenta**
  - Chlorite, calcite as **yellow**
  - Opal as **orange**

Reflectance



What do these DCS images look like?





- 18 m resolution is better but 60 m resolution is good
- To increase confidence, threshold DCS images or use more specific DCS combinations to highlight single minerals



# The blue areas in these images...

*Hverir fumarole field, Iceland*

## **Kaolinite**

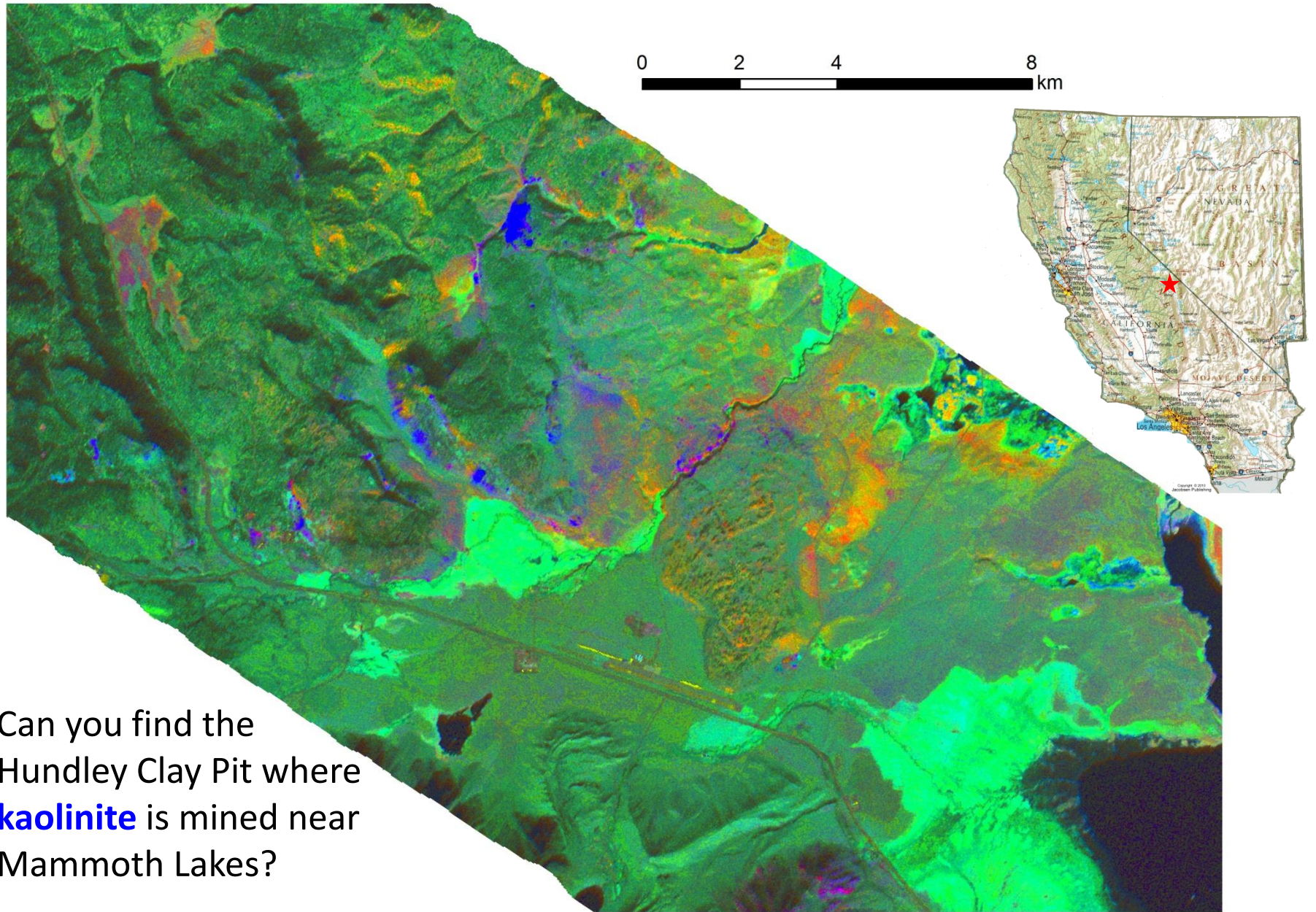
- Chemical weathering of feldspar by acidic fluids
- Argillic and advanced argillic alteration

## **Alunite**

- Sulfate, forms at acidic fumaroles
- Advanced argillic alteration

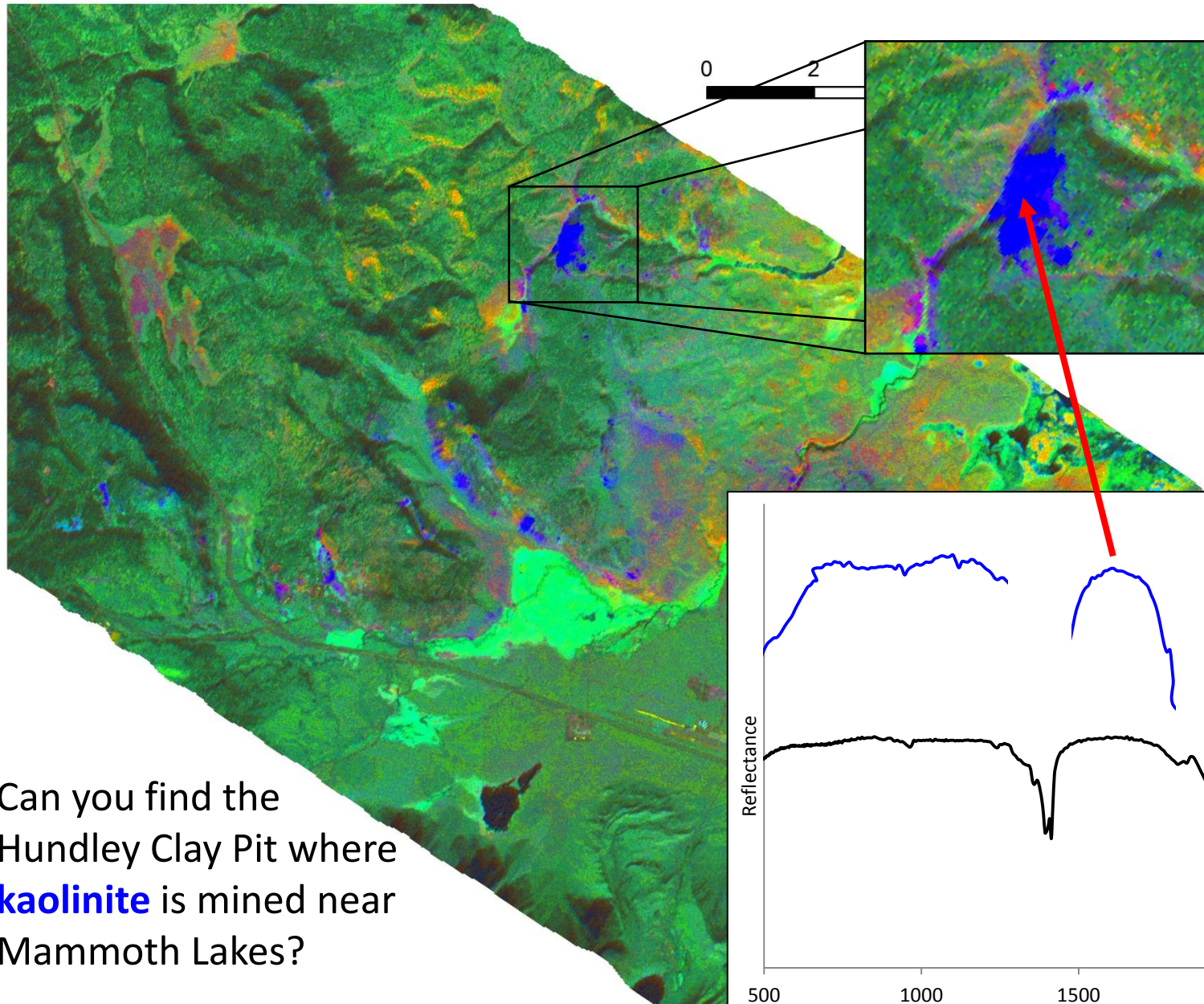
# ...indicate hot water has been present



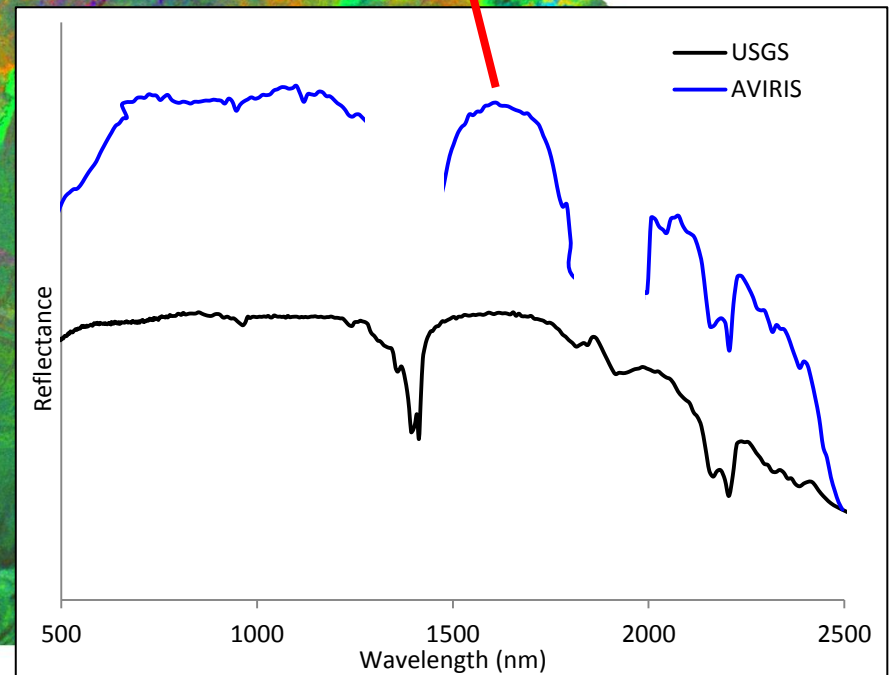


Can you find the  
Hundley Clay Pit where  
**kaolinite** is mined near  
Mammoth Lakes?





Can you find the  
Hundley Clay Pit where  
**kaolinite** is mined near  
Mammoth Lakes?







*Hundley Clay Pit*

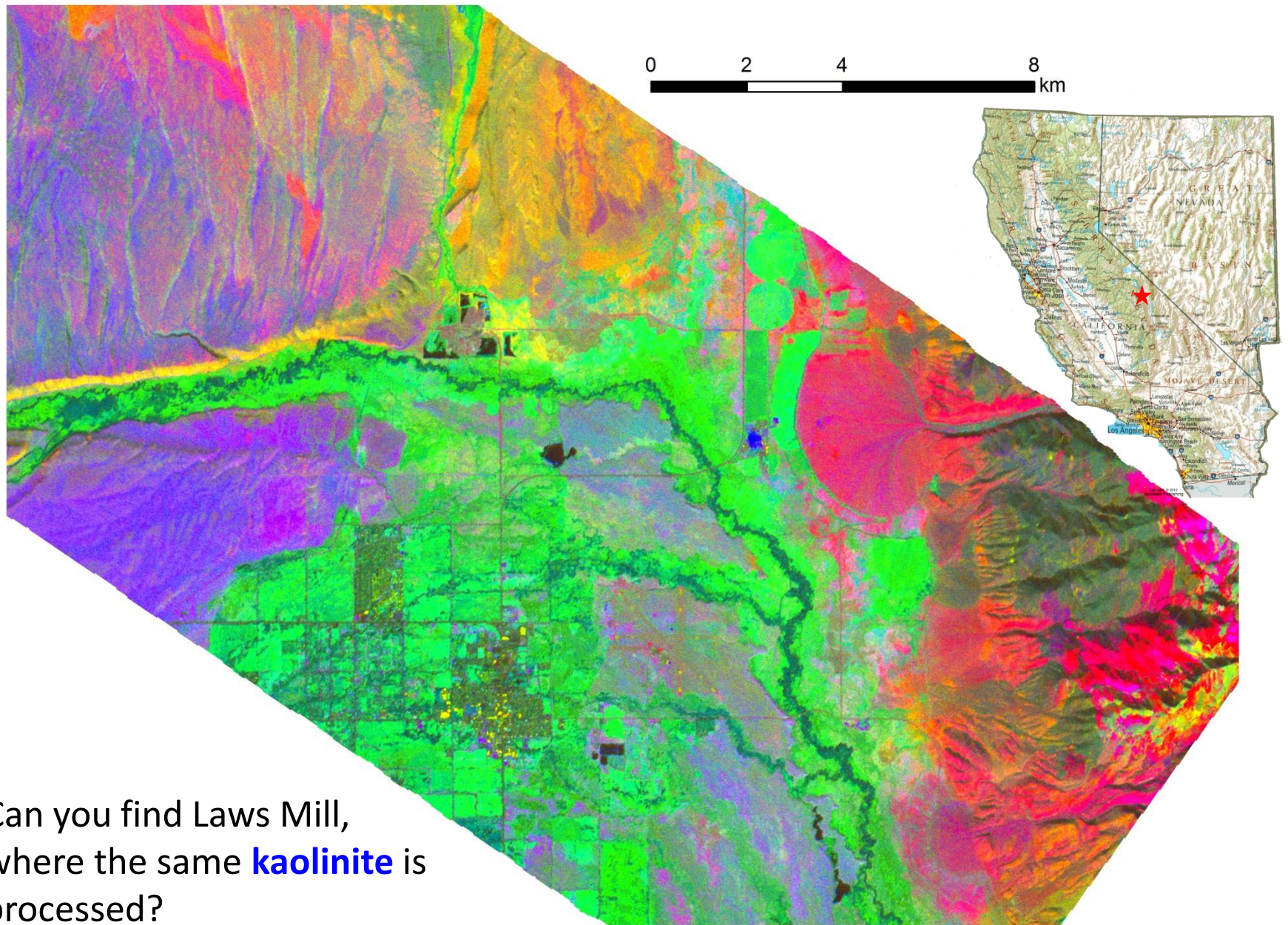


A wide-angle photograph of a large-scale industrial operation, likely a clay pit. The foreground and middle ground are dominated by vast, rolling mounds of bright white material, identified as kaolinite. The texture of the material appears fine and powdery. In the background, several large piles of the same material are visible, some with small structures or vehicles nearby. A line of evergreen trees marks the horizon under a clear, bright blue sky with a few wispy clouds on the right. The overall scene conveys a sense of massive scale and industrial activity.

Kaolinite

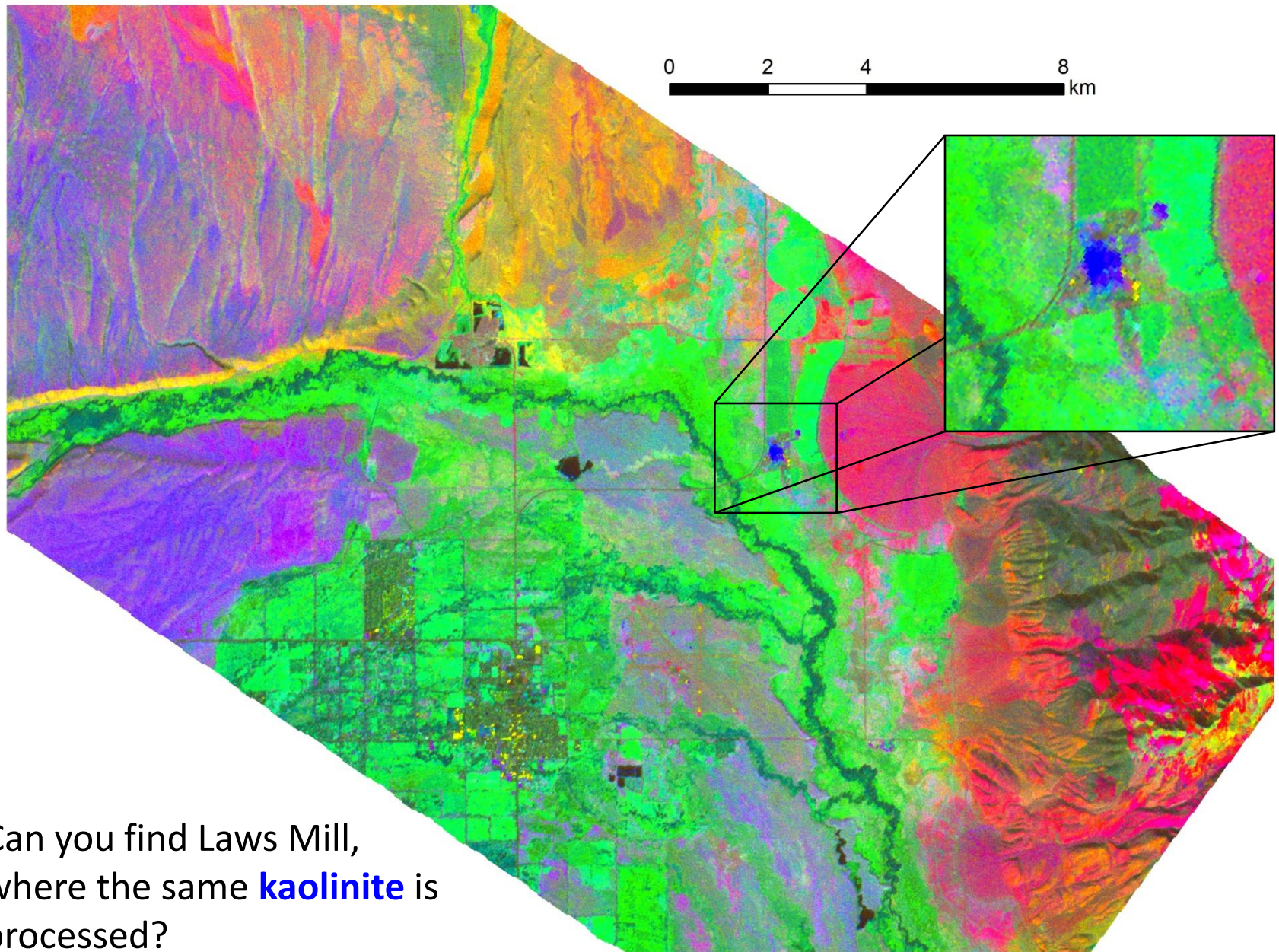
*Hundley Clay Pit*





Can you find Laws Mill,  
where the same **kaolinite** is  
processed?





Can you find Laws Mill,  
where the same **kaolinite** is  
processed?





*Laws Mill, Inyo County  
Photo by P. & G. Perazzo*





Kaolinite





# The yellow areas can indicate hot water

## Calcite

- Travertine deposited by subaerial springs
- Tufa deposited by sublacustrine springs
- Occurs in propylitic alteration

## Chlorite

- Alteration of mafic minerals
- Chloritic and propylitic alteration

# The magenta areas can indicate hot water

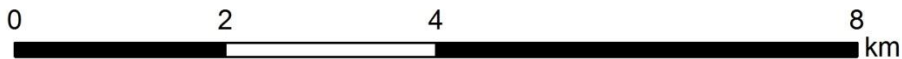
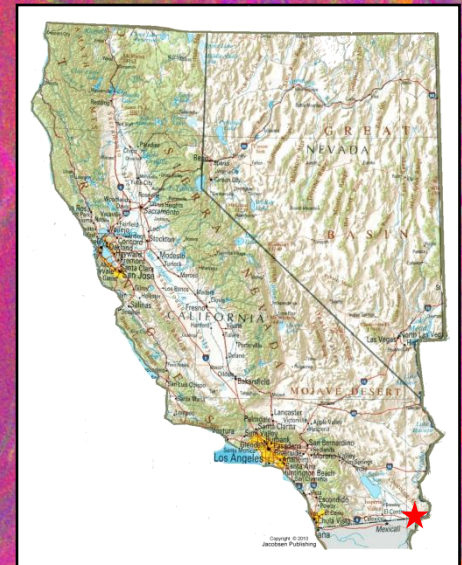


## **Muscovite & illite**

- Low temperature alteration minerals
- Argillic and sericitic alteration
- Weathering

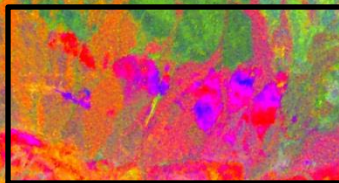


Can you find the  
**muscovite**-rich  
granite intrusion  
near the Mesquite  
gold mine?





Can you find the  
**muscovite**-rich  
granite intrusion  
near the Mesquite  
gold mine?



0 2 4 8 km



# The orange areas can indicate hot water deposits

*Waiotapu geothermal field,  
New Zealand*

6 in

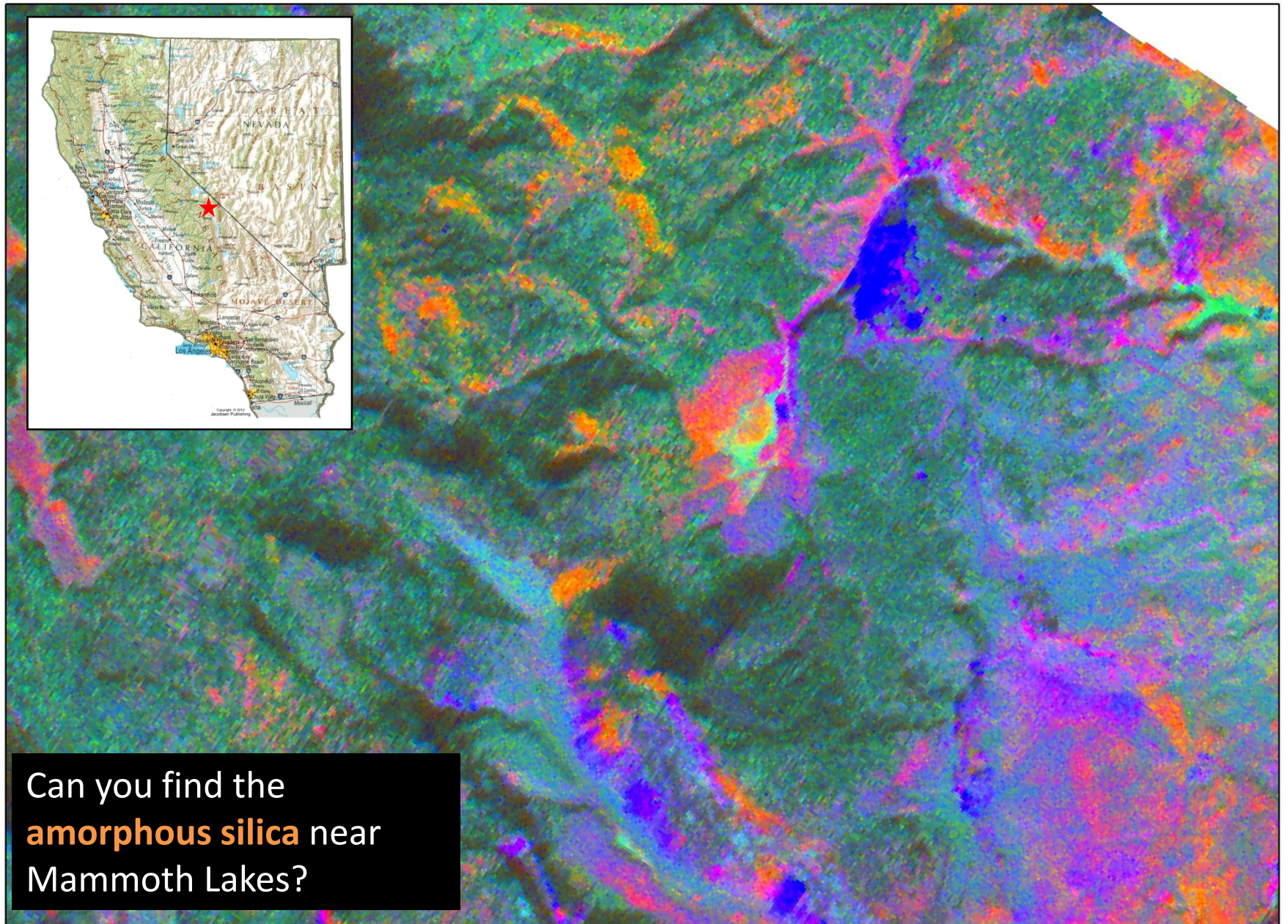
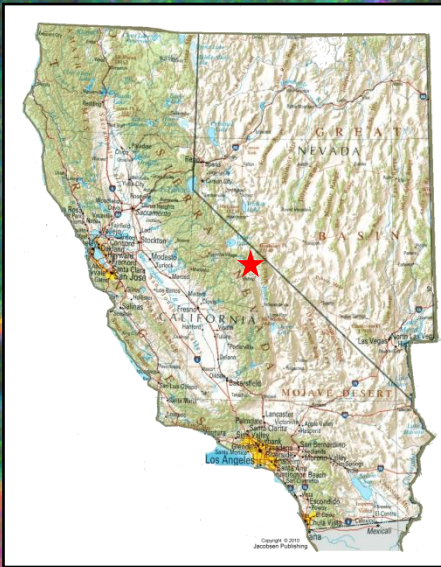
## Amorphous silica (opal)

- Deposited as hot spring sinter
- May fill fractures
- Geothermal deposit, not alteration

*Fish Lake Valley, NV*



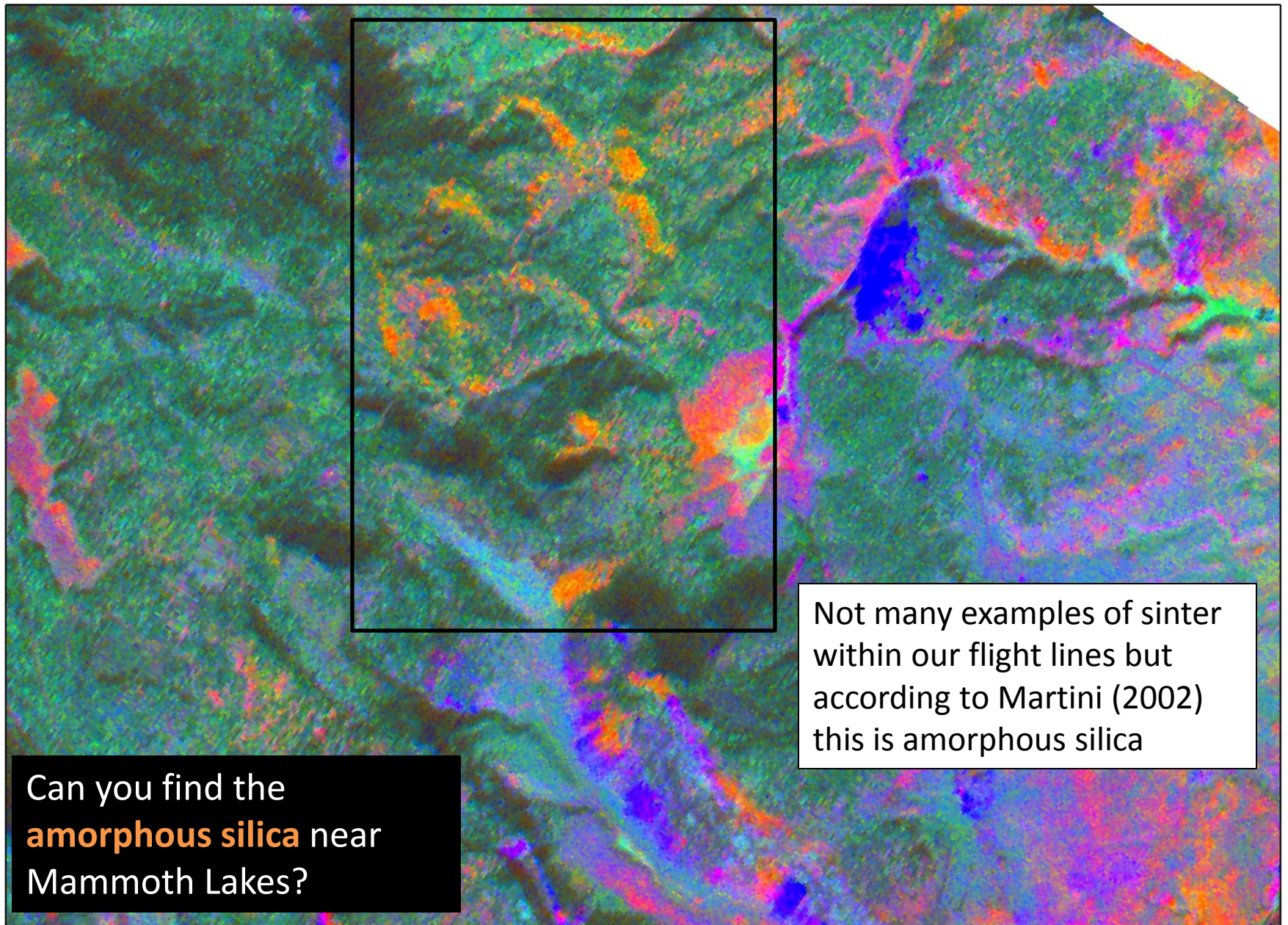




Can you find the  
**amorphous silica** near  
Mammoth Lakes?

0 1 2 4 km





Can you find the  
**amorphous silica** near  
Mammoth Lakes?

Not many examples of sinter  
within our flight lines but  
according to Martini (2002)  
this is amorphous silica

0 1 2 4 km

# Anticipated products

- Level 1
  - 1 raster image
  - DCS of AVIRIS bands 190, 195, 198
  - Highlights alteration minerals & geothermal deposits
  - HyVista is now doing this
- Level 2
  - 6 raster images
  - DCS of AVIRIS bands to carefully highlight specific minerals
    - Kaolinite
    - Alunite
    - Muscovite
    - Chlorite
    - Calcite
    - Opal

# Future work

- MASTER data
  - Emissivity data for silicate mineral mapping
  - Temperature anomaly mapping (starting with known hot spots, e.g. Salton Sea mud pots)
- Continue to monitor large scale renewable energy projects
  - Ivanpah solar farm
  - Casa Diablo, The Geysers, Imperial Valley geothermal fields
  - Altamont Pass and San Geronio wind farms



Thank you

