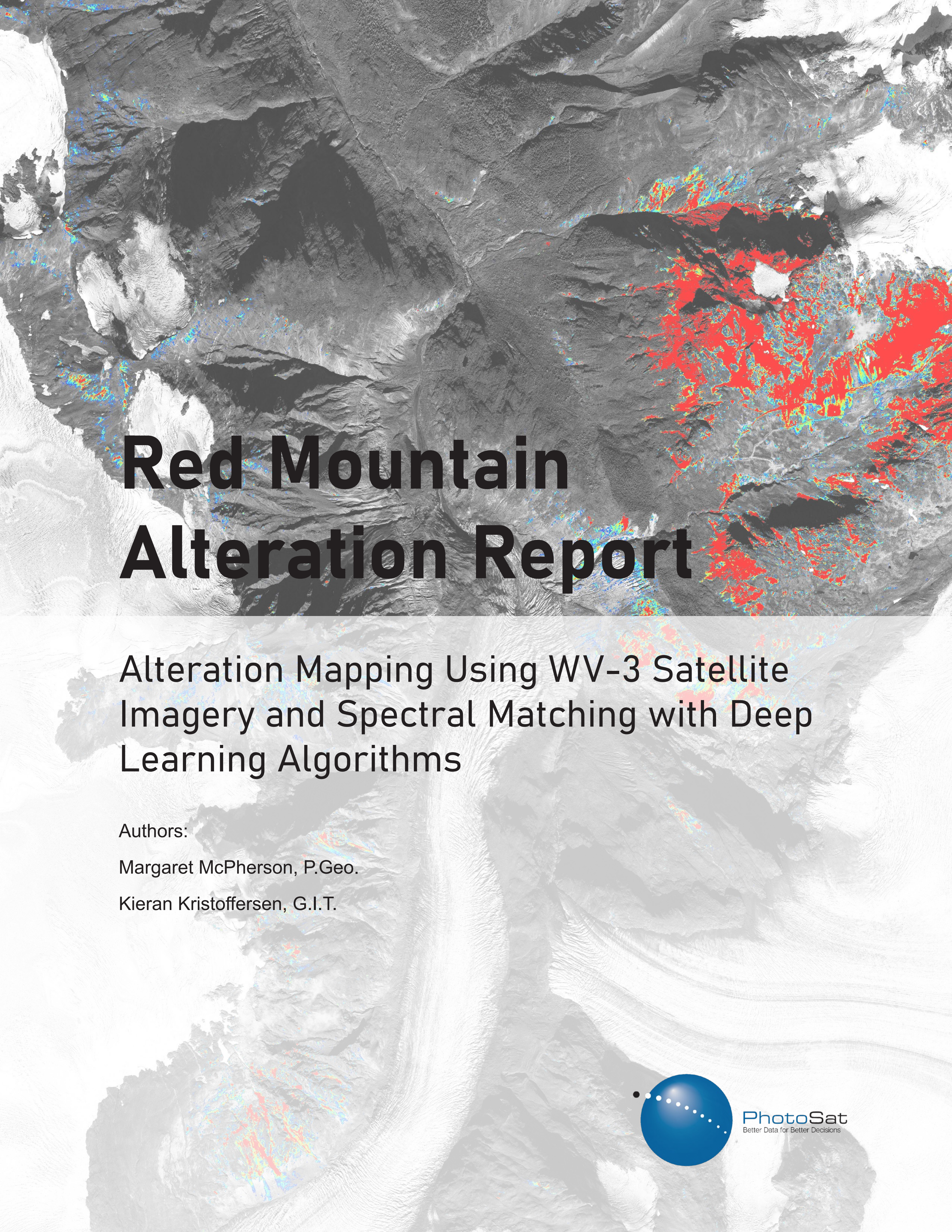

Red Mountain Alteration Report

Alteration Mapping Using WV-3 Satellite Imagery and Spectral Matching with Deep Learning Algorithms

Authors:

Margaret McPherson, P.Geo.

Kieran Kristoffersen, G.I.T.

PhotoSat

Better Data for Better Decisions

Contact Information

Head Office

PhotoSat Information Ltd.
#580-1188 West Georgia Street
Vancouver BC V6A4E2
1-604-681-9770 | info@photosat.ca

Authors

Margaret McPherson, P. Geo.
Senior Alteration Analyst
margaret.mcpherson@photosat.ca

Kieran Kristoffersen, G.I.T.
Geology Analyst
kieran.kristoffersen@photosat.ca

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Abstract

The Red Mountain deposit (Fig. 1) is located in BC's Golden Triangle, 15 km northeast of the town of Stewart.

Discovered in 1989, the deposit has been explored extensively by LAC Minerals, Barrick Gold, Royal Oak Mines, North American Metals, Seabridge Gold, Banks Island Gold and IDM Mining. In March 2019, Ascot Resources acquired IDM Mining and rights to the deposit.

Several models have been presented for the formation of the Red Mountain gold deposits, and recent interpretation is that the gold mineralization is consistent with an intrusion-related system, rather than a porphyry-gold deposit.

In this alteration report, PhotoSat produces a series of alteration mineral maps from WorldView-3 (WV-3) satellite imagery for the area around the Red Mountain deposit.

For results, read the full alteration report.

Figure 1: Location of the Red Mountain deposit in Canada

Introduction

This report details the alteration mineral mapping results for the Red Mountain deposit (Fig. 2).

Red Mountain Deposit

The geology of the Red Mountain area is characterized by upper Triassic to lower Jurassic meta-sedimentary and tuffaceous units that have been intruded by a multi-phase intermediate intrusive complex.

Gold mineralization is hosted in a series of pyrite-rich, hydrothermal breccia bodies and stockwork zones associated with the brecciated contact zone at the edge of the intrusive body. The hydrothermal breccias are accompanied by widespread potassium feldspar, silicification, sericite, calcite and iron carbonate alteration and disseminated and stockwork to massive pyrite mineralization, with lesser pyrrhotite mineralization.

Several models have been presented for the formation of the Red Mountain gold deposits, and recent interpretation is that the gold mineralization is consistent with an intrusion-related system, rather than a porphyry-gold deposit.

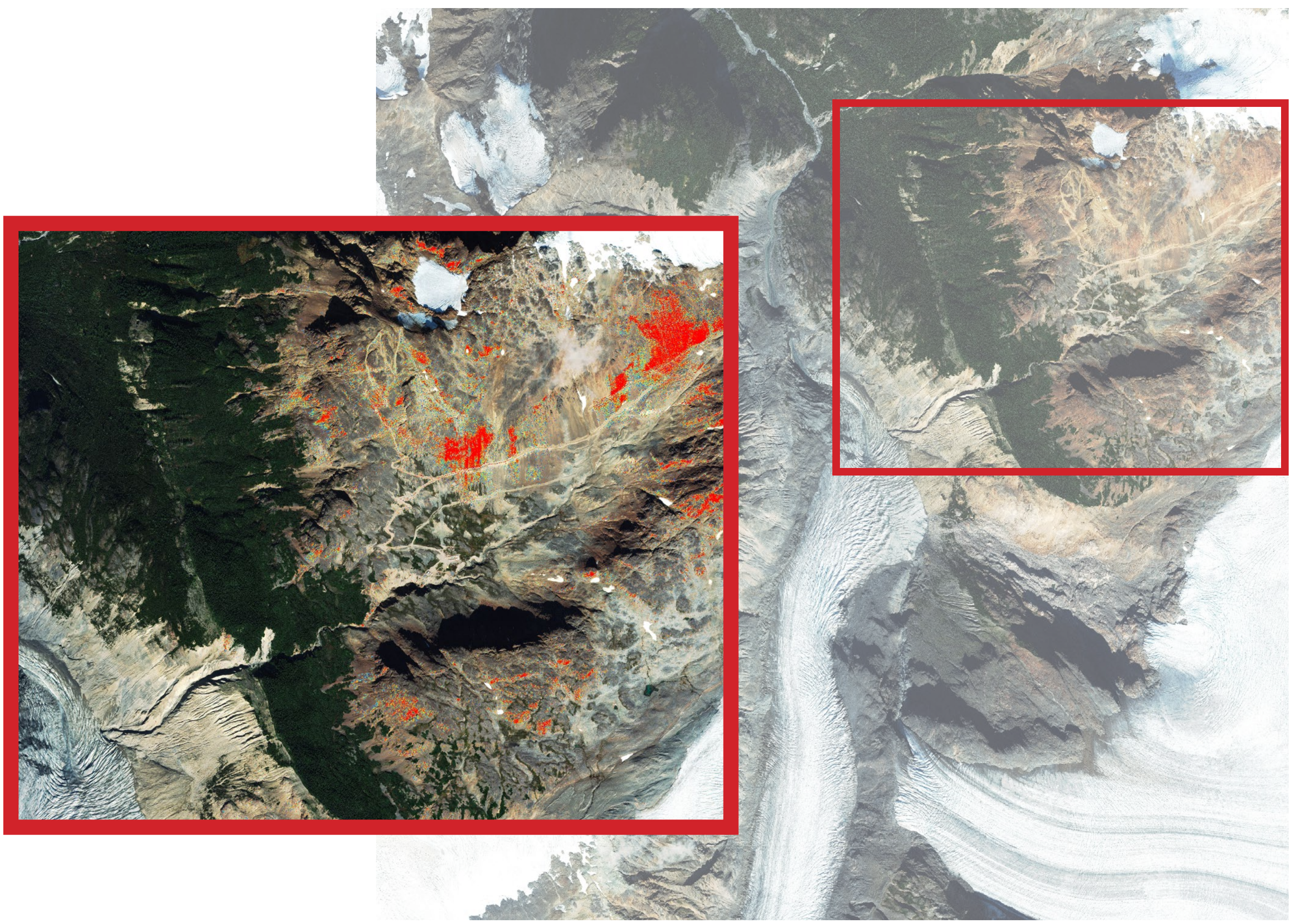


Figure 2: Close-up of jarosite at the Red Mountain deposit

Methods

Launched in 2019, our current alteration mineral mapping process is an application of spectral analysis to satellite imagery, using proprietary data processing with deep learning technology.

PhotoSat works with either ASTER or WorldView-3 (WV-3) satellite imagery. Since WV-3 has been operational since 2014, archive imagery is available, and it is also possible to task the satellite for new satellite imagery.

Spectral Resolution

WV-3 is equipped with multispectral imaging instruments capable of collecting information from 16 sensor bands.

With WV-3, these bands cover specific wavelengths of the visible and near-infrared (VNIR) and SWIR parts of the electromagnetic (EM) spectrum (Fig. 3).

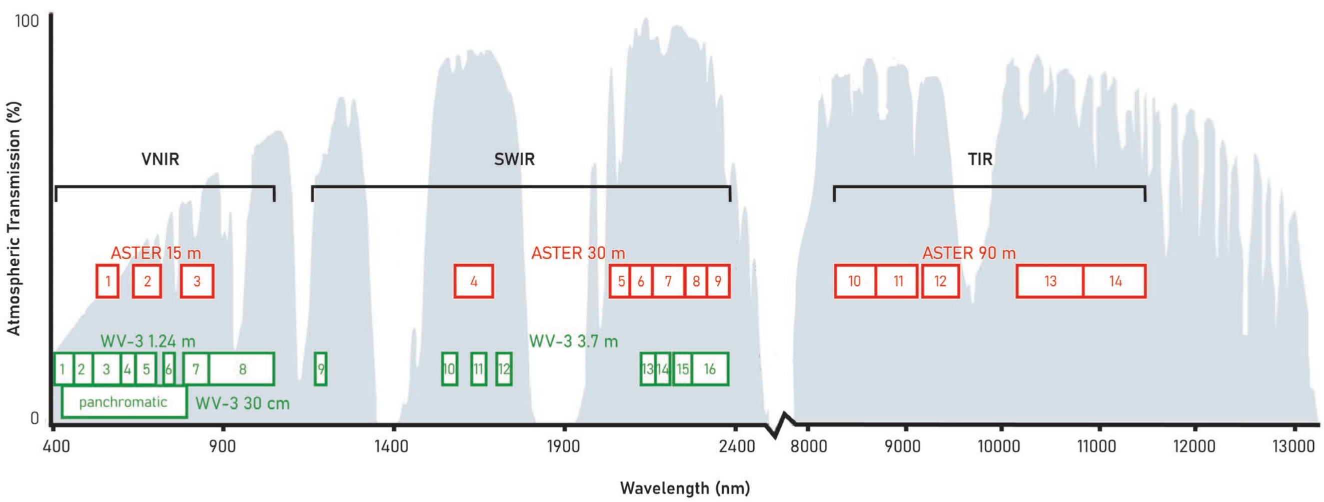


Figure 3: Bands detected by WV-3 and ASTER

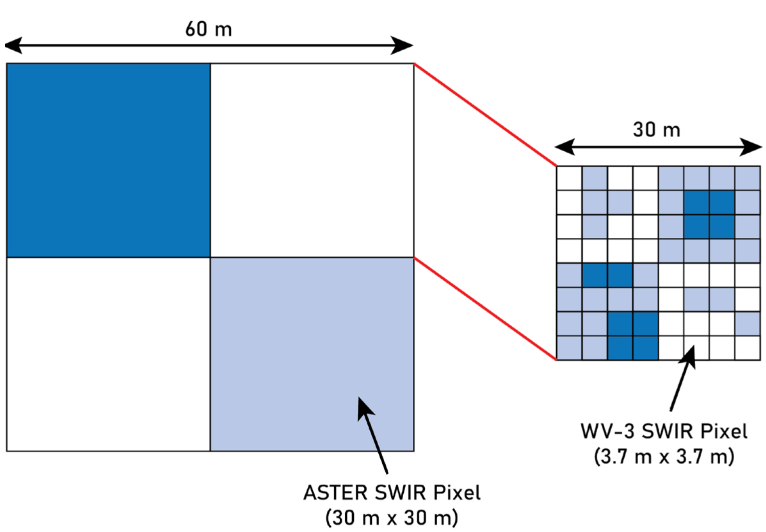


Figure 4: SWIR pixel size of WV-3 and ASTER

Spatial Resolution

WV-3 satellite imagery is high-resolution with a VNIR pixel size of 1.2 m and a SWIR pixel size of 3.7 m (Fig. 4).

Because of its small pixel sizes, WV-3 imagery provides a high level of detail. It is suitable for alteration mapping at both regional and property scale.

Spectral Matching

Minerals have unique spectral characteristics that can be used to identify them. To positively identify a mineral, we look for and examine diagnostic features in the spectral profile or "signature".

Slope

Changes in slope between spectral bands can be used to identify some minerals. Not all slopes are distinct from each other, so the slope alone may be insufficient as a means of identification.

Absorption features

Minerals have unique absorption features in their spectral signature, which appear as dips in the profile.

The spectral profile of each pixel in a satellite image can be matched or compared to reference spectral profiles of known minerals and other surface materials using resources such as the USGS Spectral Library (Fig. 5).

PhotoSat maintains an internal library of reference spectral profiles for this purpose, collected from a variety of sources.

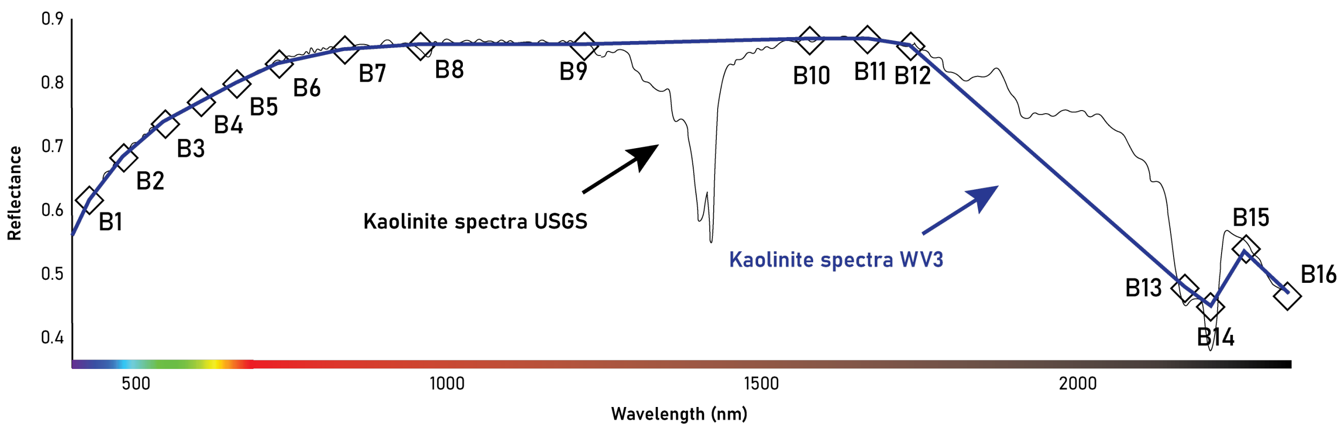


Figure 5a: Spectral profile of Kaolinite from the USGS Spectral Library

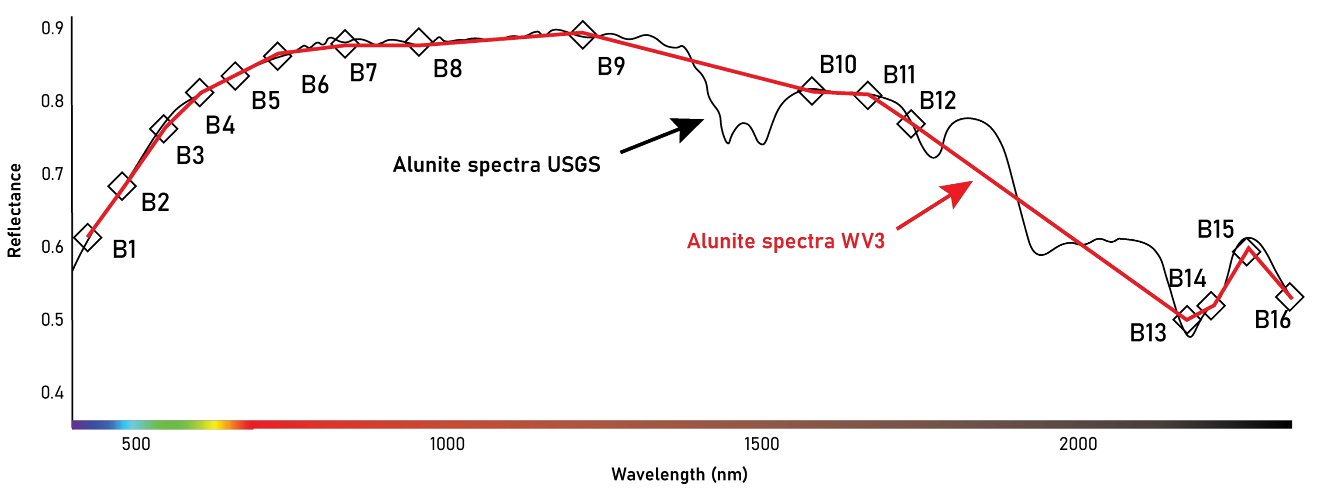


Figure 5b: Spectral profile of Alunite from the USGS Spectral Library

Deep Learning

PhotoSat uses deep learning technology in its data processing.

CNN Training

In alteration mapping, the use of convolutional neural networks (CNN) allows for continual improvement of the process. By conducting alteration mapping tests in areas rich in surficial data, we can train the CNN, therefore improving future performance and assessing the reliability of our current alteration mapping processes.

Reliability and Repeatability

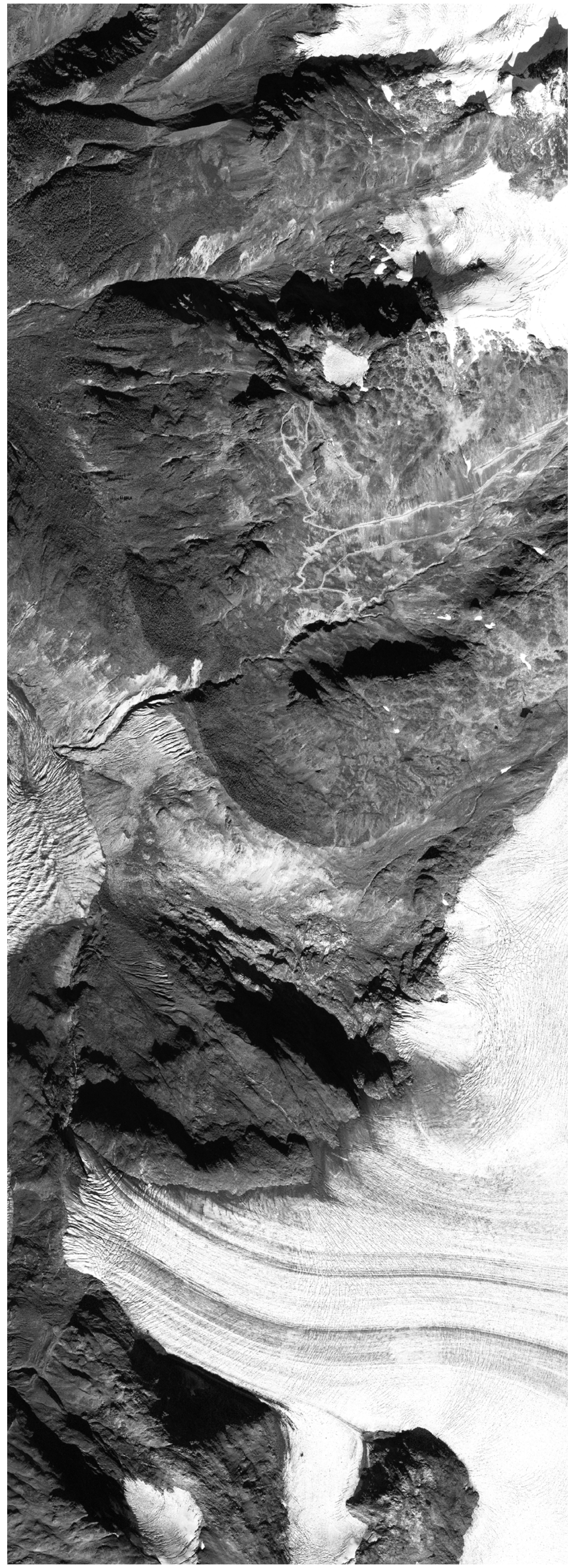
PhotoSat's data processing is governed by proprietary algorithms which create repeatable results. This consistency applies to alteration mapping at property scale, and also between alteration projects that are located in different regions.

Results

In this project area, eight key alteration minerals were detected, including sericite, calcite, chlorite/epidote, montmorillonite, jarosite, goethite, hematite and iron oxide gossans.

Figures 6 to Figure 14 show the distribution and intensity of each of these minerals on a scale from possible (blue) to probable (red).

Additional images, including compilation maps, are shown in Figure 15 to Figure 19.



Natural Colour Orthophoto

The area around the Red Mountain deposit (Fig. 6) is shown below.

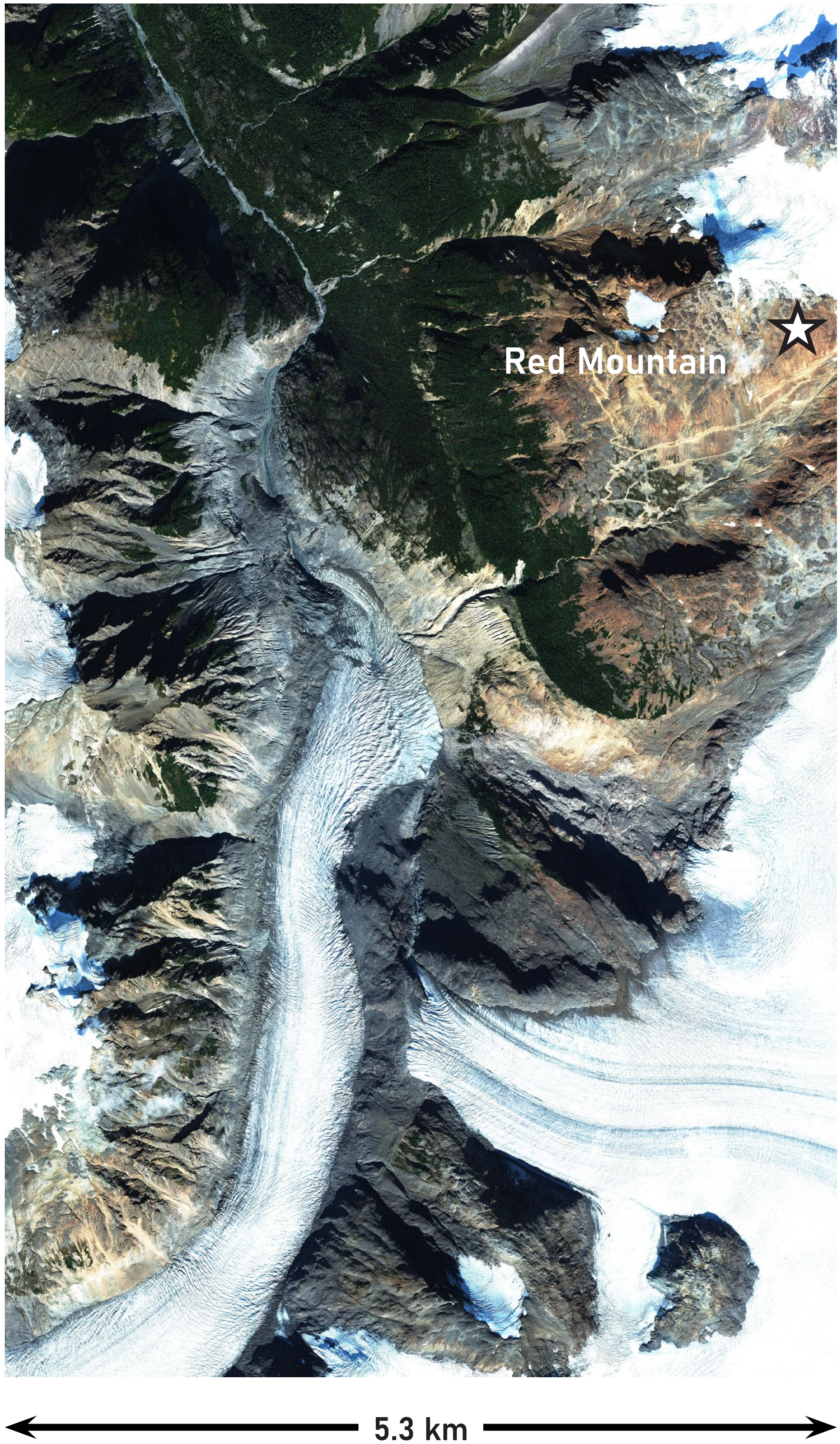
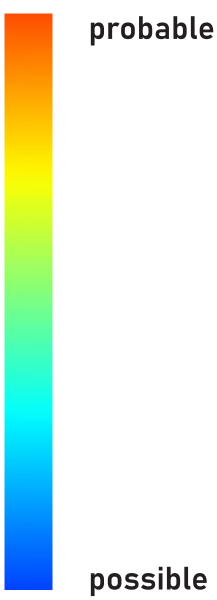


Figure 6: Natural colour orthophoto from WV-3 satellite imagery

Sericite

This alteration mineral map (Fig. 7) for sericite was produced from 16-band WV-3 satellite imagery.



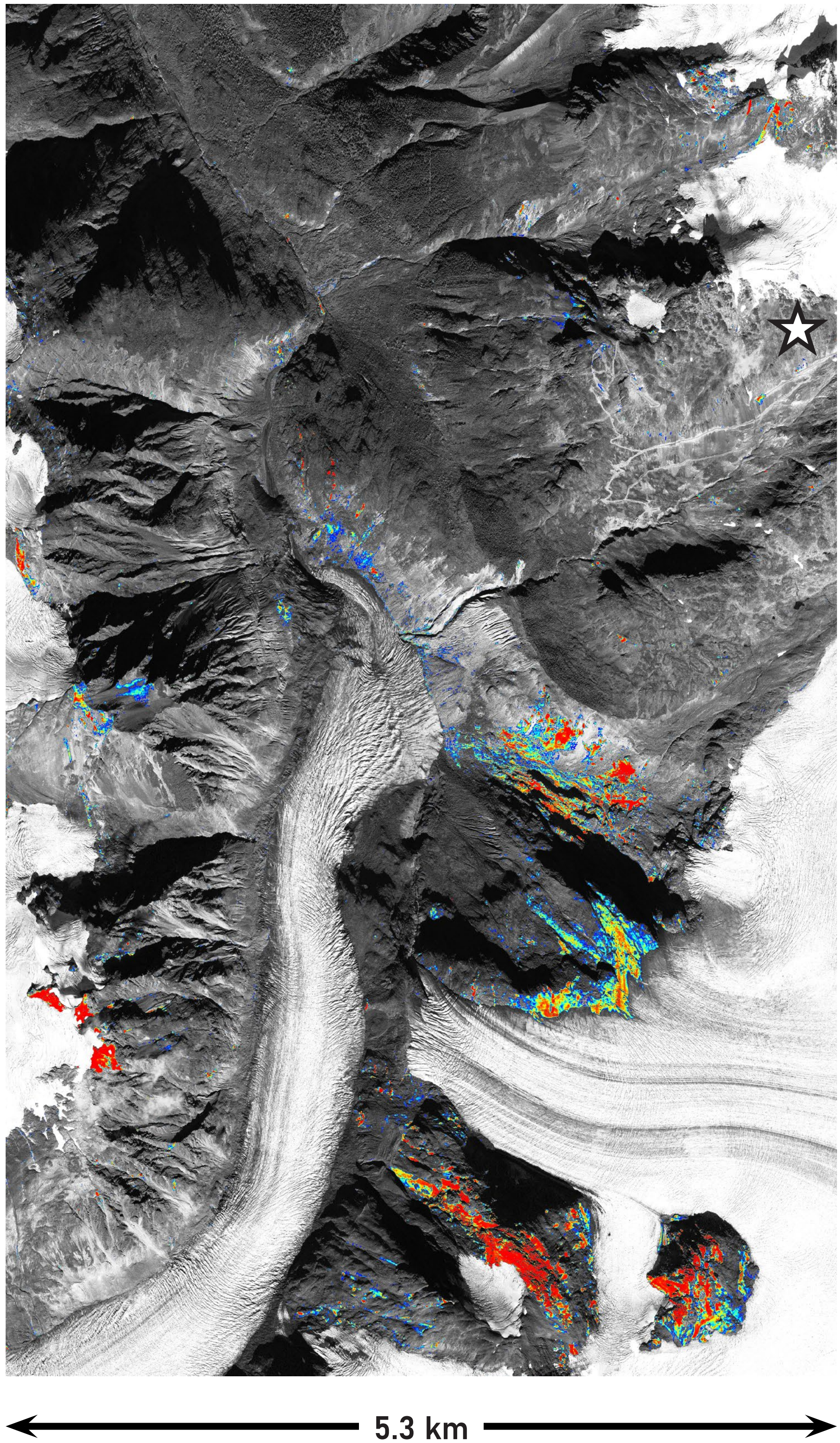
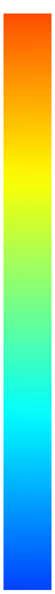


Figure 7: Sericite from WV-3 satellite imagery

Calcite

This alteration mineral map (Fig. 8) for calcite was produced from 16-band WV-3 satellite imagery.



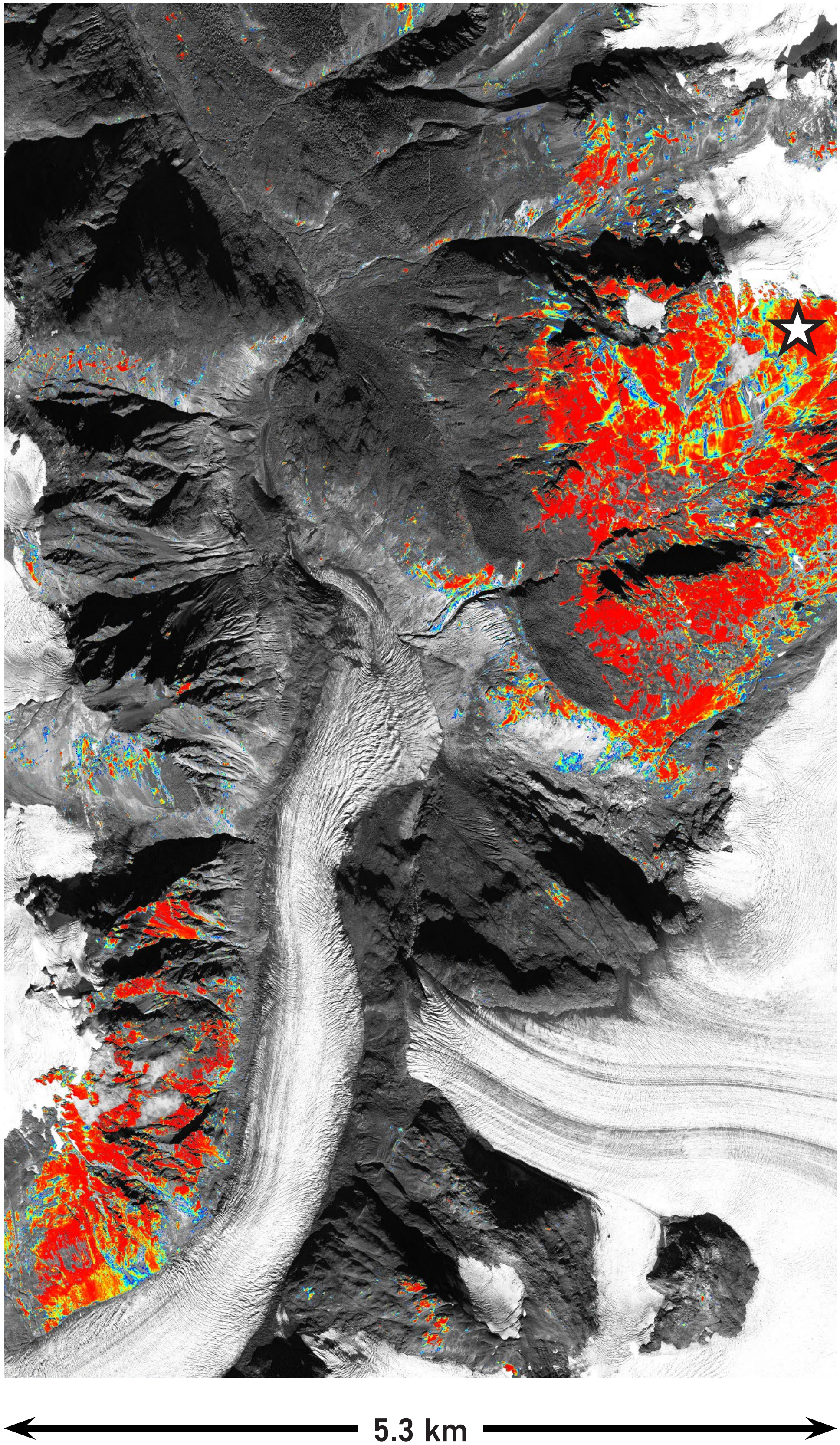
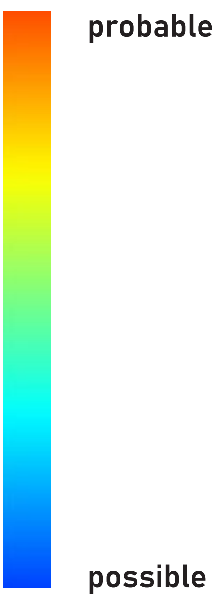


Figure 8: Calcite from WV-3 satellite imagery

Chlorite

This alteration mineral map (Fig. 9) for chlorite/ epidote was produced from 16-band WV-3 satellite imagery.



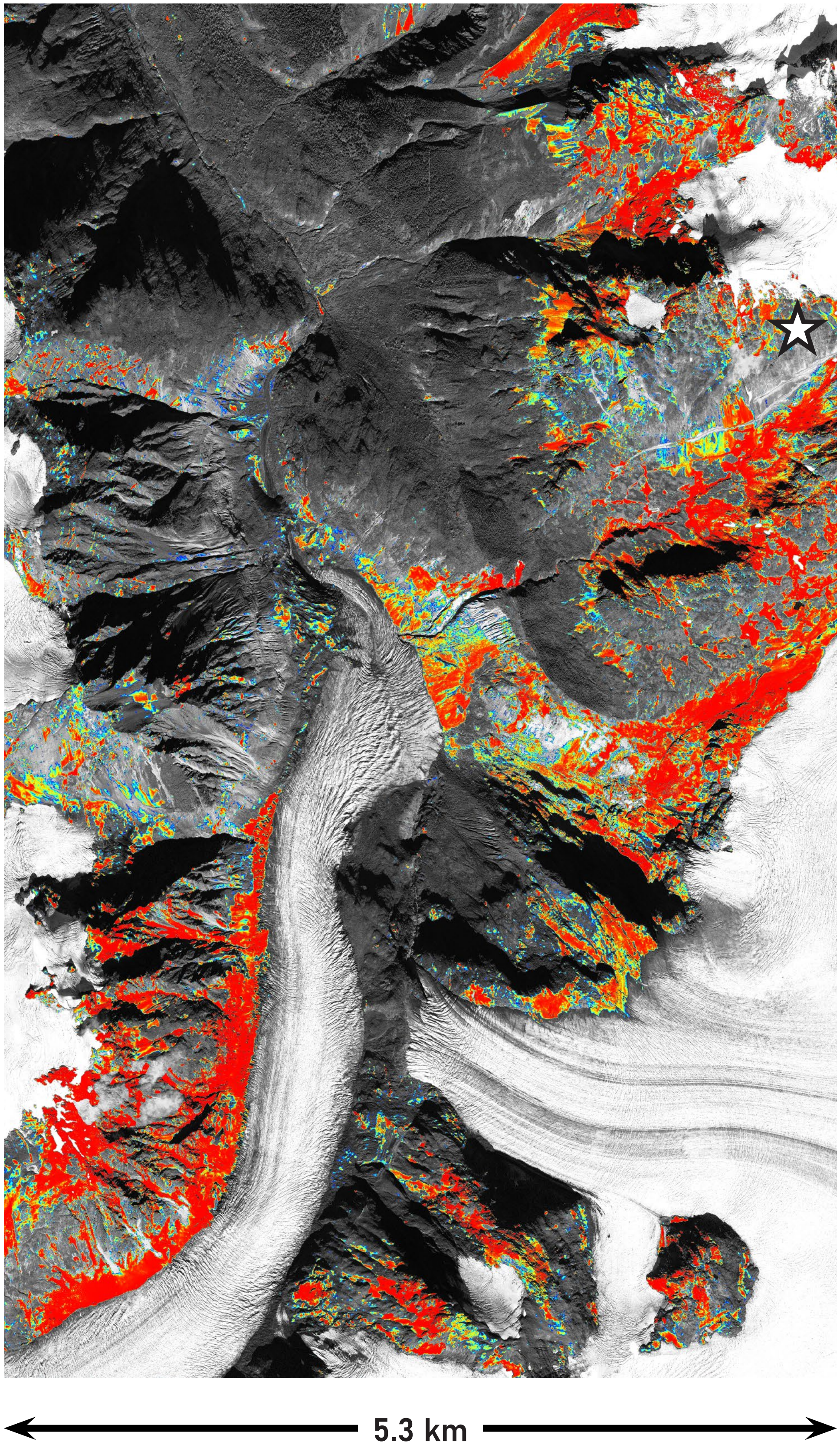
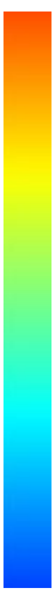


Figure 9: Chlorite/epidote from WV-3 satellite imagery

Montmorillonite

This alteration mineral map (Fig. 10) for montmorillonite was produced from 16-band WV-3 satellite imagery.



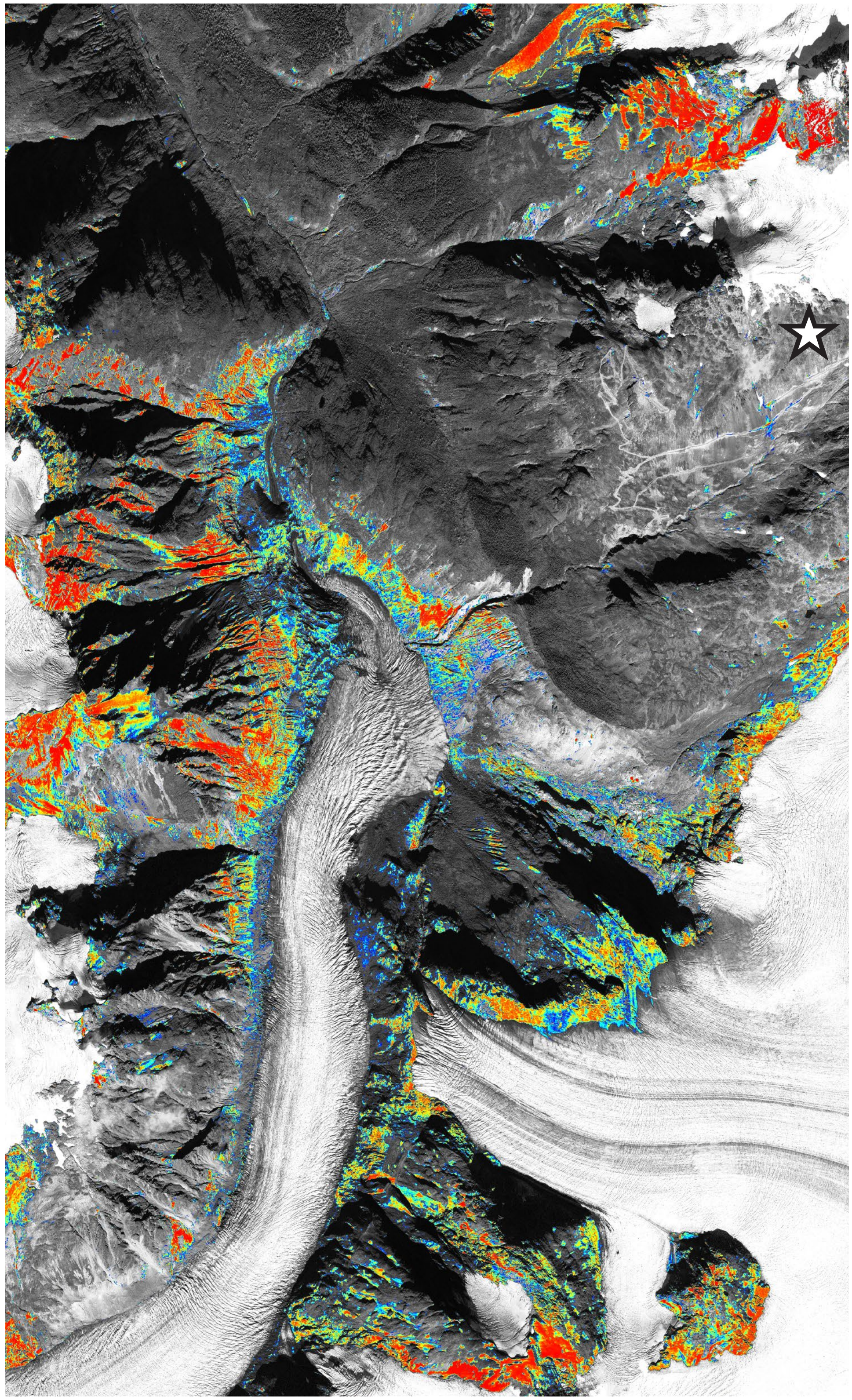
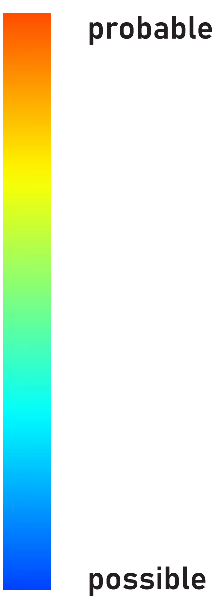


Figure 10: Montmorillonite from WV-3 satellite imagery

Jarosite

This alteration mineral map (Fig. 11) for jarosite was produced from 16-band WV-3 satellite imagery.



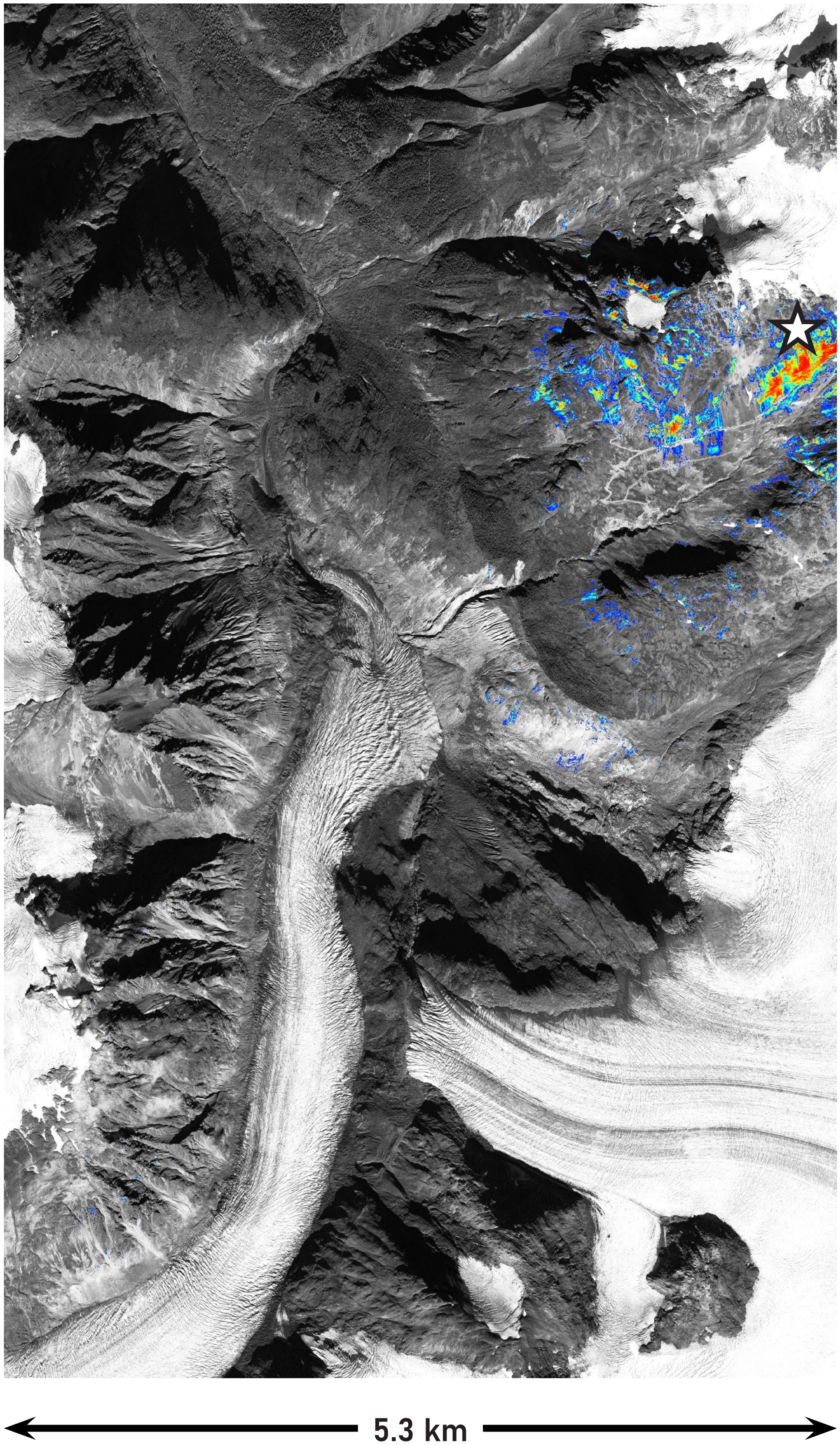
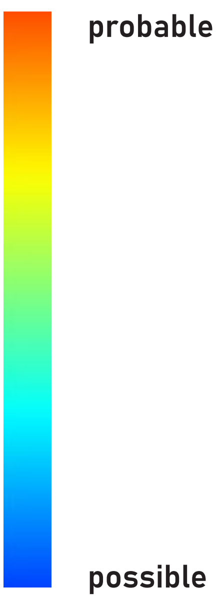


Figure 11: Jarosite from WV-3 satellite imagery

Goethite

This alteration mineral map (Fig. 12) for goethite was produced from 16-band WV-3 satellite imagery.



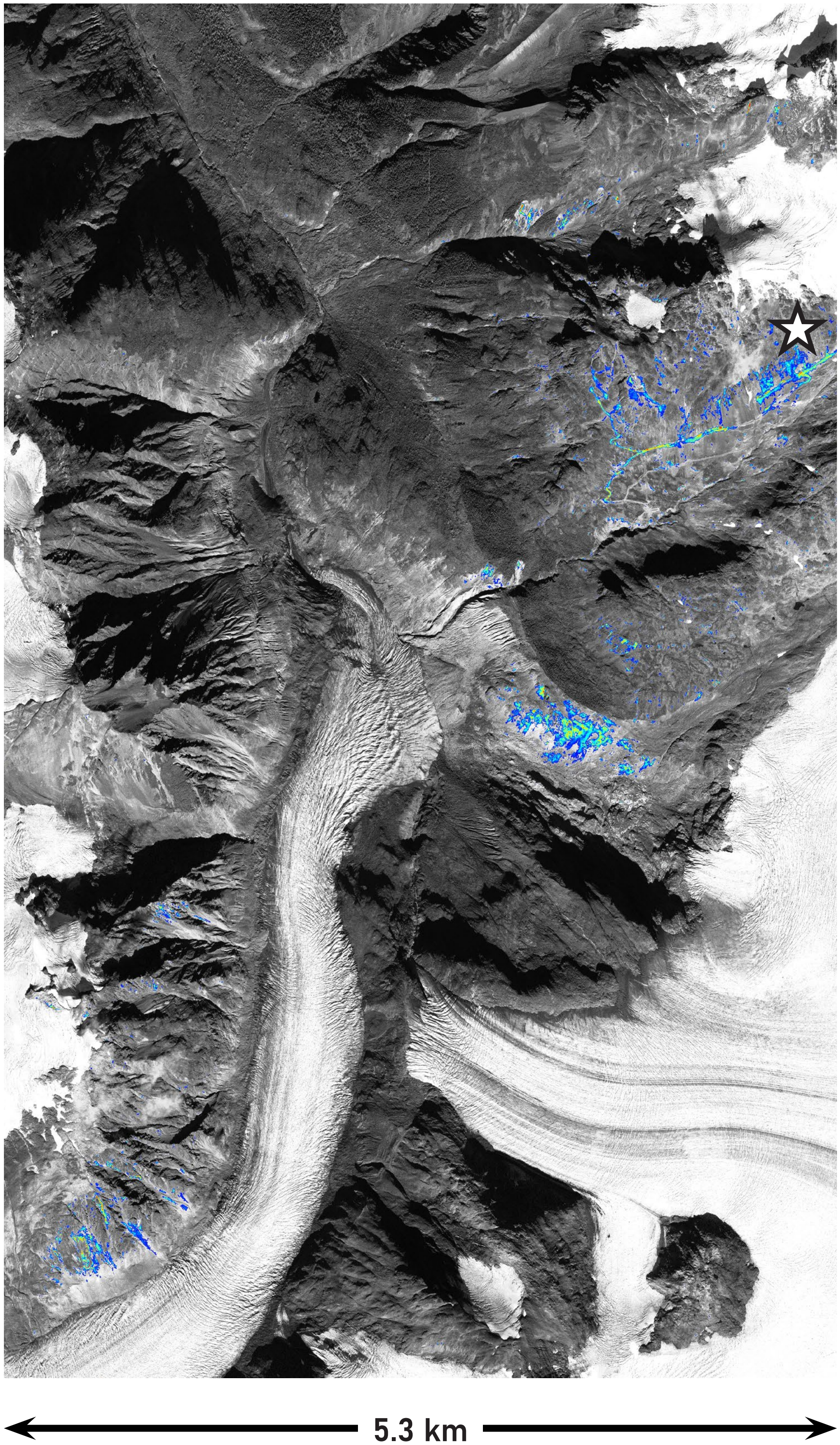
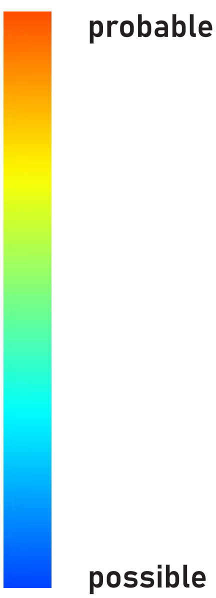


Figure 12: Goethite from WV-3 satellite imagery

Hematite

This alteration mineral map (Fig. 13) for hematite was produced from 16-band WV-3 satellite imagery.



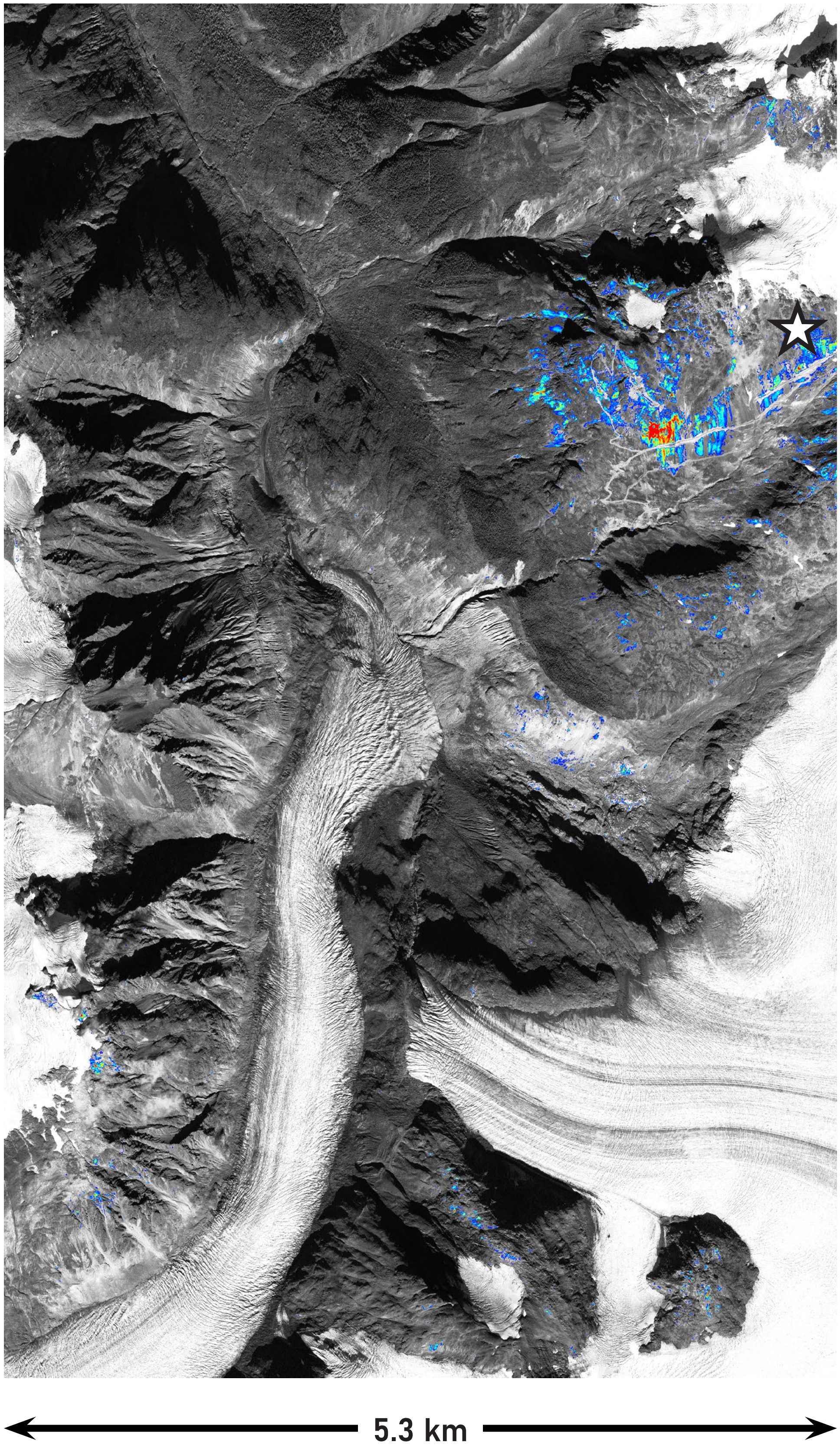
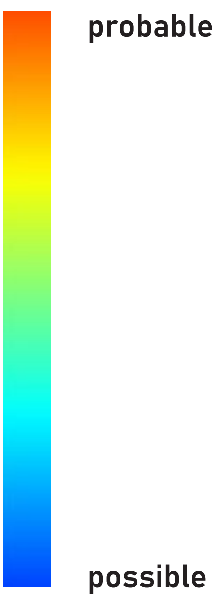


Figure 13: Hematite from WV-3 satellite imagery

Iron Oxide Gossans

This alteration mineral map (Fig. 14) for iron oxide gossans was produced from 16-band WV-3 satellite imagery.



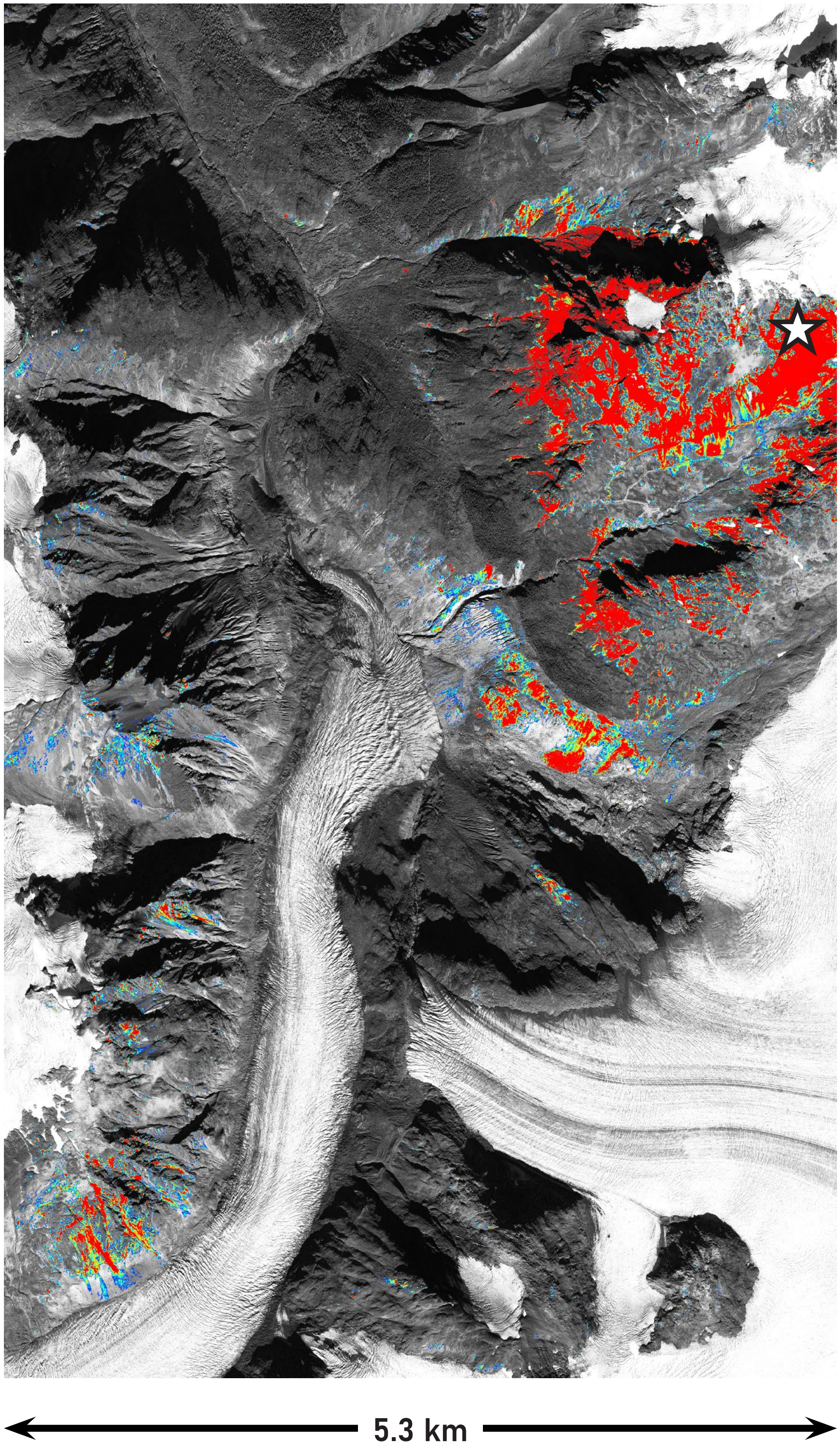
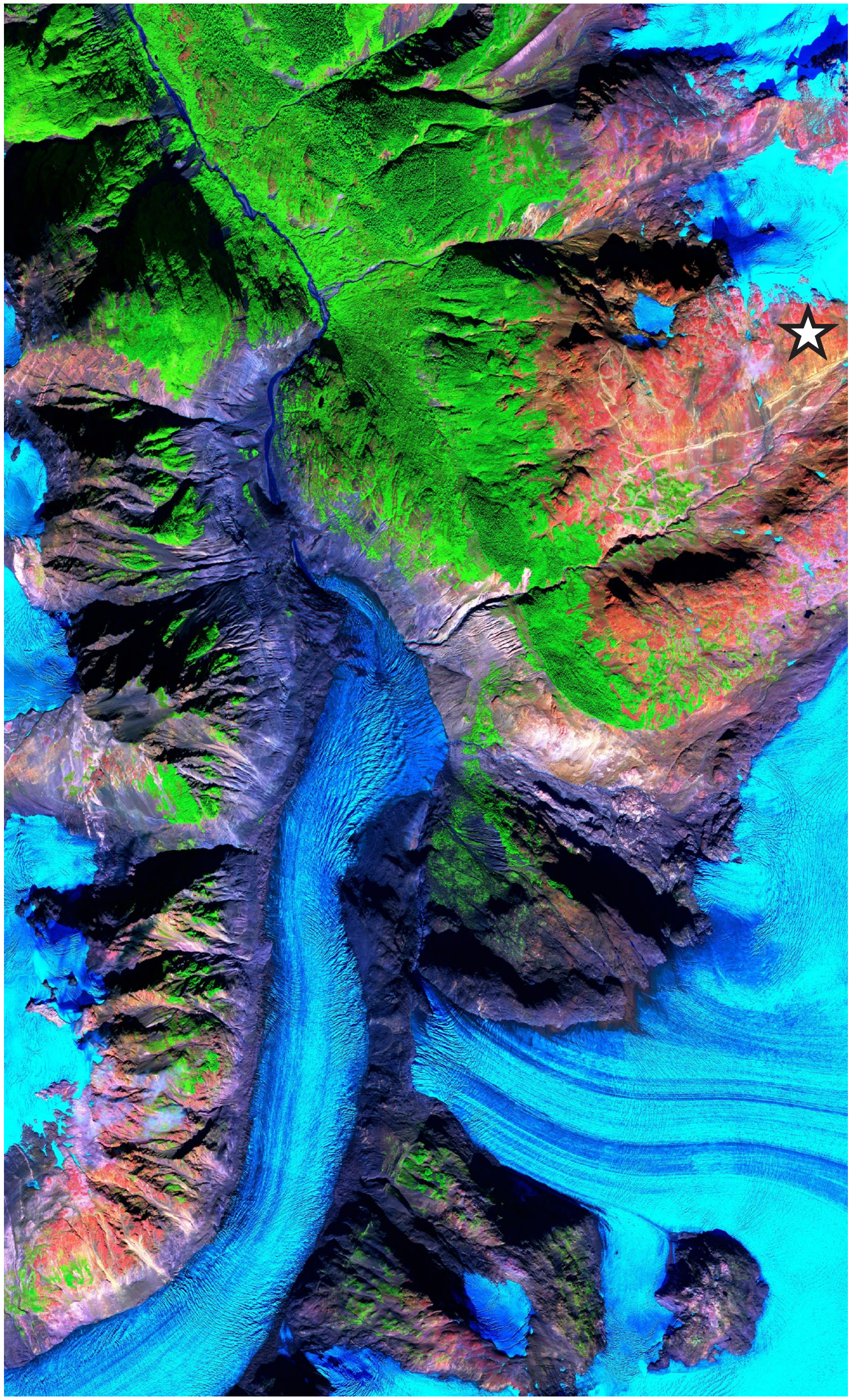


Figure 14: Iron oxide gossans from WV-3 satellite imagery

Geology Enhanced Image

This geology enhanced image (Fig. 15) shows the area around the Red Mountain deposit.

Geology enhanced images are produced by combining two VNIR bands and one SWIR band. They accentuate additional surface details that are not visible in a regular orthophoto.



5.3 km

Figure 15: Geology enhanced image from WV-3 satellite imagery

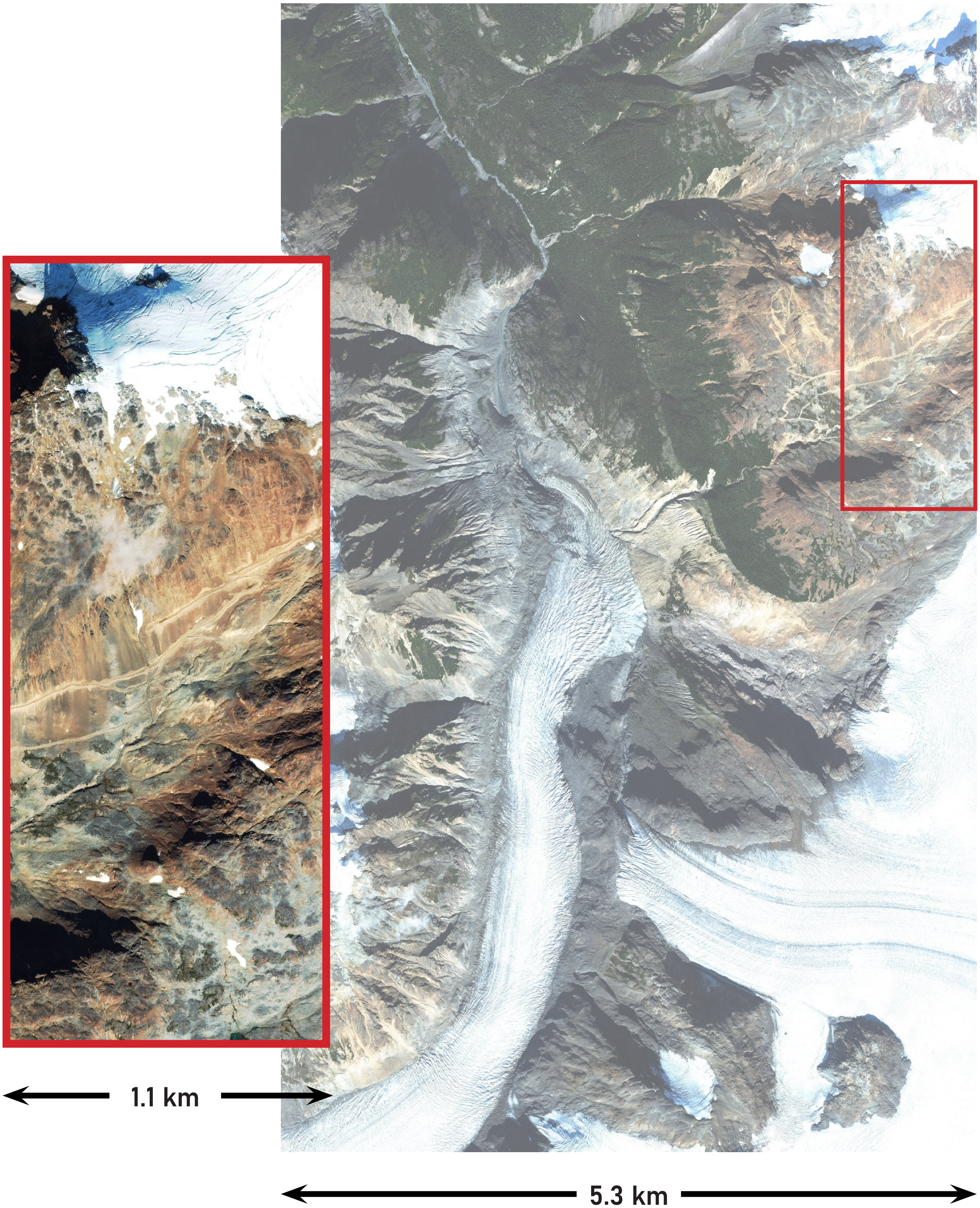


Figure 16: Close-up colour orthophoto of Red Mountain

Compilations

The distribution and intensity of the individual WorldView-3 alteration minerals can be easily combined with other datasets, such as geology, geophysics or geochemistry, to enhance the interpretation of the deposit. The distribution of multiple WorldView-3 alteration minerals can also be compiled in vector format to more readily show the relationship between different minerals (Fig. 17).

Compilation maps for Red Mountain are shown on page 22 and page 23.

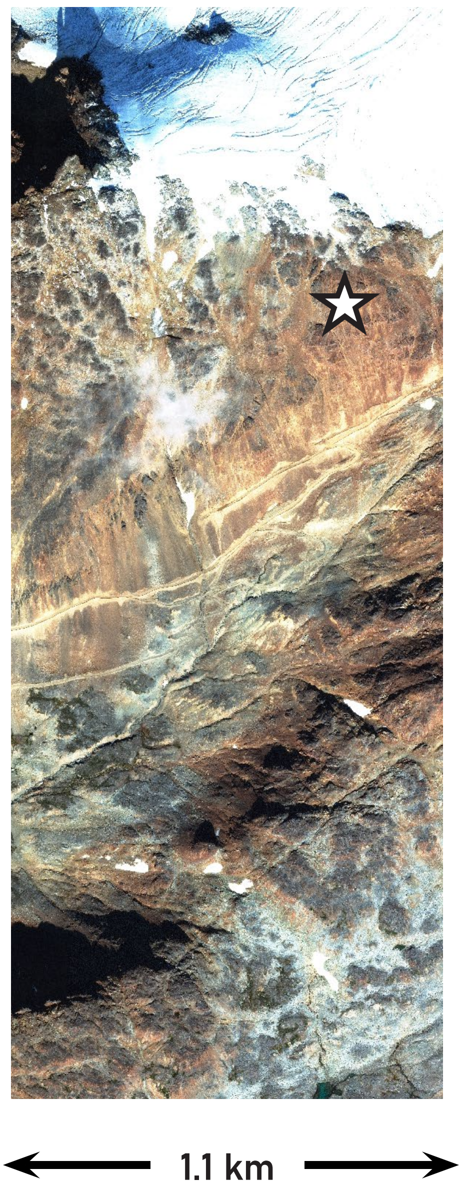


Figure 17: Close-up colour orthophoto (left), jarosite (center) and iron mineral compilation map (right)

Mineral Compilation

This compilation map (Fig. 18) shows several alteration minerals around the Red Mountain deposit.

Calcite

Chlorite

Sericite

Montmorillonite

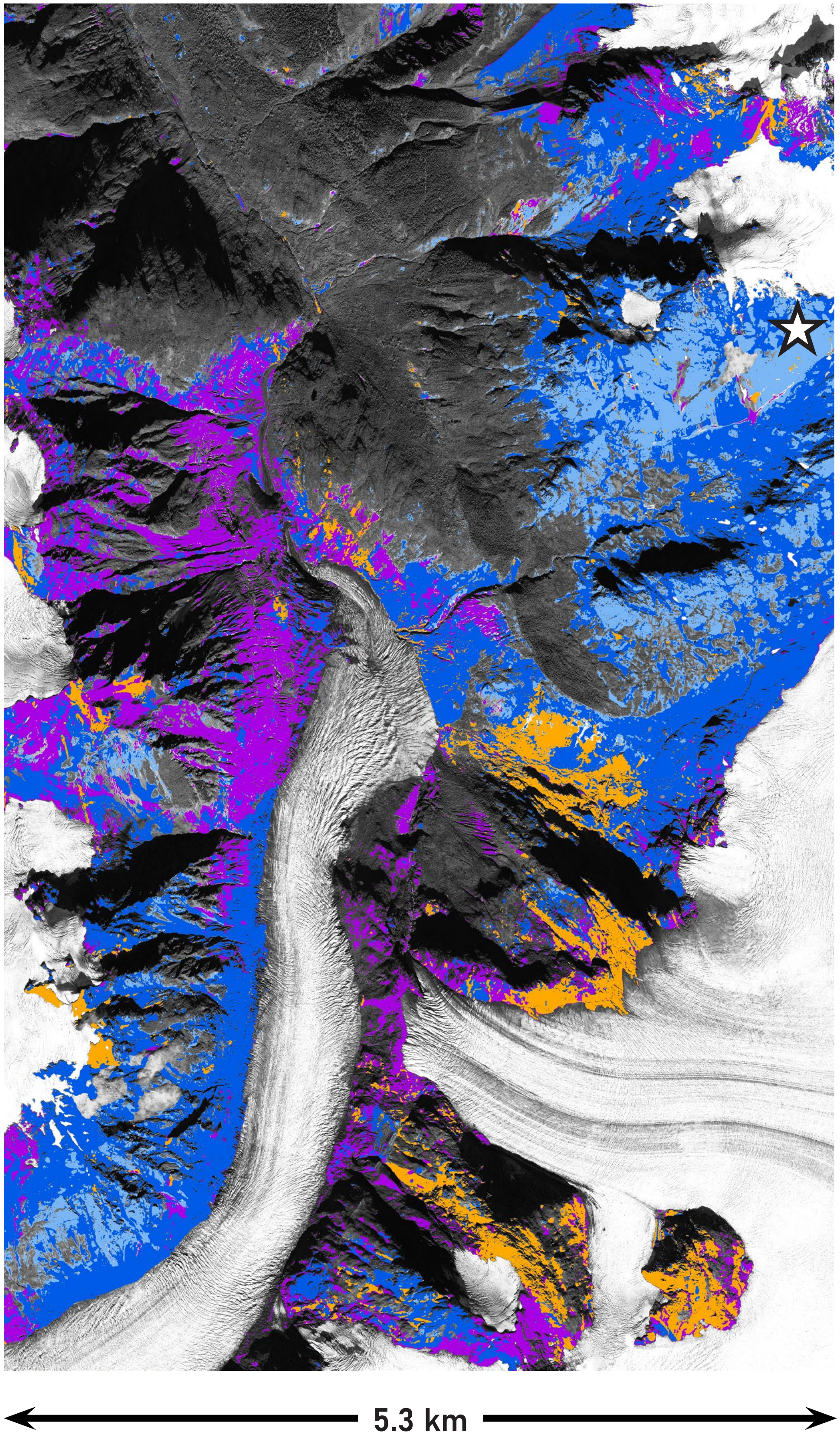


Figure 18: Mineral compilation map for Red Mountain

Iron Mineral Compilation

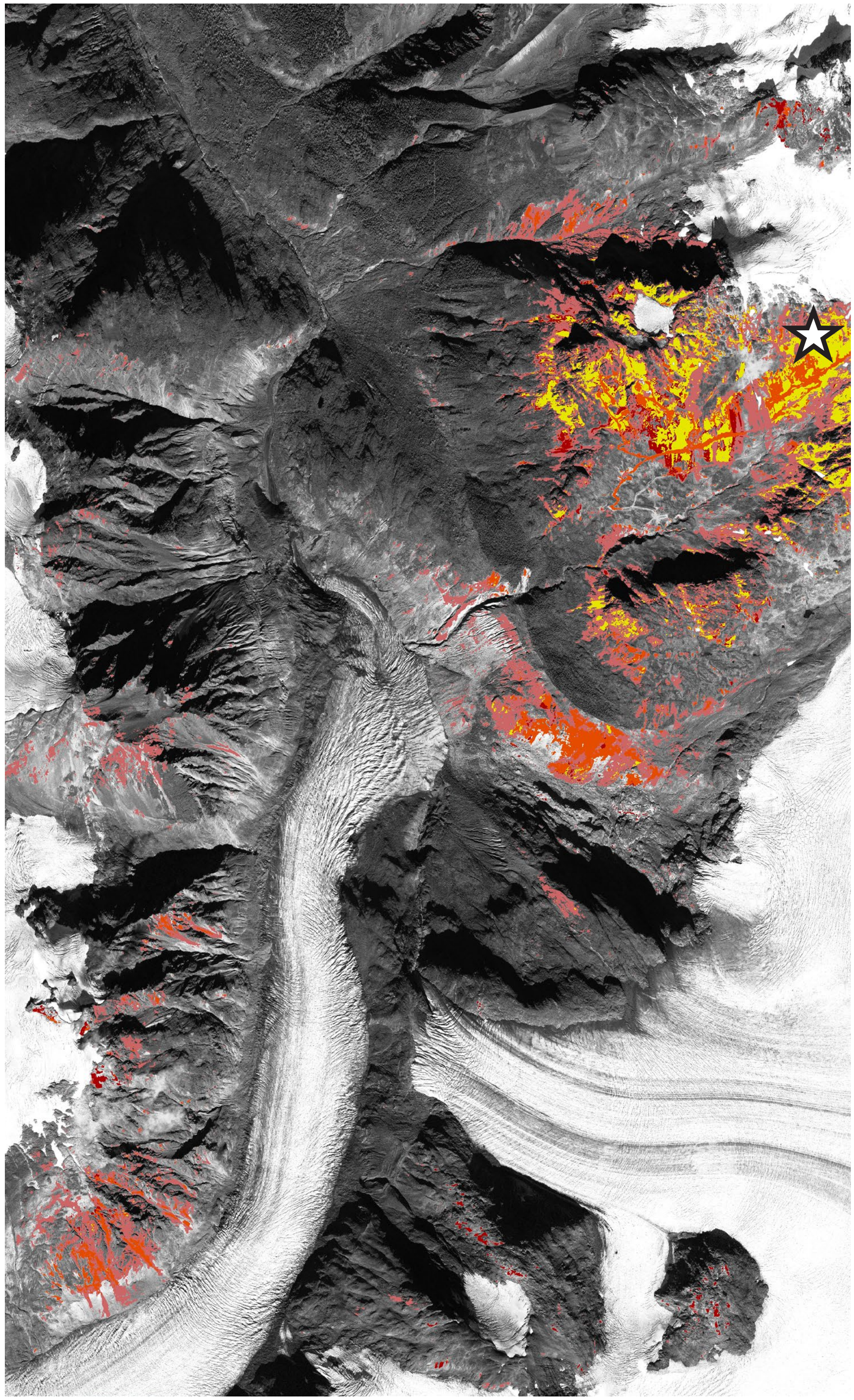
This compilation map (Fig. 19) shows iron-containing alteration minerals around the Red Mountain deposit.

Goethite

Hematite

Jarosite

Iron oxide



5.3 km

Figure 19: Iron mineral compilation map for Red Mountain

Discussion

From testing, we know that certain alteration minerals can be reliably mapped through PhotoSat's data processing with deep learning technology.

If alteration is present at surface and visible in satellite photos, PhotoSat's alteration mineral mapping produced from WorldView-3 (WV-3) satellite imagery can detect the following minerals:

Micas

The result for sericite, or white mica, may consist of one or some combination of:

- **Muscovite:** $KAl_2(Si_3Al)O_{10}(OH,F)_2$
- **Paragonite:** $NaAl_2[(OH)_2AlSi_3O_{10}]$
- **Illite:** $(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,H_2O]$

Iron Minerals

PhotoSat can identify:

- **Iron Oxide Gossans:** many different red, orange, and brown iron oxide minerals.
- **Hematite:** $Fe^{3+}{}_2O_3$
- **Goethite:** $Fe^{3+}O(OH)$
- **Jarosite:** $KFe^{3+}{}_3(SO_4)_2(OH)_6$

Clay Minerals

PhotoSat can identify:

- **Alunite:** $(Na,K)Al_3(SO_4)_2(OH)_6$
- **Kaolinite:** $Al_2Si_2O_5(OH)_4$
- **Montmorillonite:** $Na,Ca)_{0,3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot n(H_2O)$

Other Minerals

PhotoSat can identify:

- **Opal/Chalcedony*:** $SiO_2 \cdot nH_2O$
- **Buddingtonite:** $NH_4AlSi_3O_8$
- **Calcite:** $CaCO_3$
- **Chlorite/Epidote**** $(Mg,Fe,Li)_6AlSi_3O_{10}(OH)_8$ / $Ca_2(Al,Fe)_2(SiO_4)(OH)_2$

Context Images

PhotoSat also includes the following images with its WV-3 alteration mapping package:

- 2 m Geology enhanced colour image
- 2 m Vegetation intensity
- 50 cm Colour orthophoto
- 50 cm Greyscale orthophoto

*PhotoSat cannot differentiate between opal and chalcedony with 16-band WorldView-3.

**PhotoSat cannot differentiate between chlorite and epidote with 16-band WorldView-3.