Thermal (Long-wave) InfraRed Remote Sensing for Porphyry Exploration at the Oreo Mountain Cu-Mo-Ag-Au Prospect, East-Central Alaska

David Hedderly-Smith, Ph.D., PG, QP – D.A. Hedderly-Smith & Associates

The Oreo Mountain prospect is a Cu-Mo-Ag-Au porphyry system located in east-central Alaska, approximately 40 miles east of Tok, Alaska, and 15 miles north of the Alaska Highway (Figure 1). Work to date has identified a large (5-mile by 2-mile), strong copper, molybdenum, lead and silver soil anomaly corresponding to an aeromagnetic high surrounding a sharp aeromagnetic low associated with resistivity lows. Six short drill holes in 2019 identified porphyry-type mineralization and alteration in calc-alkaline intrusive rocks, but nothing that would denote a discovery. Since that work the Alaska Division of Geological and Geophysical Surveys has published a 1:100,00-scale reconnaissance geologic map of the area, greatly enhancing the area's geologic understanding.

The traditional role of satellite remote sensing in mineral exploration has been to map regional geological structures through the synoptic view provided by the satellite. Initially this work focused on identification of linears and structures. The arrival of multispectral imagery and the spectral unmixing interpretation paradigm has allowed quantitative estimates to be made of the various minerals in the scene. Early satellite imagery (*c.f.,* NASA's Landsat 1 [1972]) sampled the visible and near infrared spectrum; Landsat 4 (1982) through Landsat 7 (1999) added two short-wave infrared and a single, lower-resolution, thermal (long-wave) infrared band. In more recent decades a proliferation of remote sensing satellites from numerous countries and agencies have filled the sky. Many of these have capabilities well beyond those of the early Landsat and other pioneer efforts.

In 2024 a remote sensing study of much of the eastern two-thirds of the Tanacross 1:250,000-scale Quadrangle, including the Oreo Mountain area, was commissioned utilizing visible/near infrared (VNIR), short-wave infrared (SWIR), long-wave or thermal infrared (LWIR or TIR) and synthetic aperture radar (SAR) data collected by three satellite systems: Sentinel-2, ASTER and ALOS-1. The study focused for the most part on the remote sensing systems with penetrative ability, the ASTER TIR bands.

The ASTER thermal (TIR) or long-wave (LWIR) infrared survey and interpretation of high-resolution hyperspectral satellite imagery over the Oreo Mountain property and surrounding area returned some very interesting results. ASTER is a cooperative effort between the Japanese Ministry of Economic Trade and Industry (METI) and the U.S. National Aeronautics and Space Administration (NASA) and was launched in 1999. It consists of three separate instrument subsystems, which provide observation in three different spectral parts of the electromagnetic spectrum, including three bands of VNIR (15-meter resolution), 6 bands of SWIR (30-meter), and 5 bands of TIR (90-meter resolution). ASTER data is available in the public domain (*i.e.*, it's free!).

Data from the five ASTER bands in the thermal (TIR) or long-wave (LWIR) infrared region were accessed and processed to generate several georeferenced images. The algorithm that developed one of the images – named TargetC – was designed to target pixels in the ASTER scene with spectral signatures in the five TIR bands that corresponded to the signatures of the pixels over high-copper soil sample locations on a 370+ sample grid of soil samples over the Oreo Mountain prospect collected by Kennecott Exploration in 2018 (Figure 2).

Not too surprisingly, the resulting image highlighted the area of copper-enriched soils at Oreo. However, it also identified adjacent areas outside of the existing soil grid and claim block as potential "areas of interest" at and near Oreo Mountain and highlighted (although generally not as strongly) other areas of known copper mineralization and other areas known to contain anomalous soil geochemistry in the general area. The survey identified Contango ORE's Triple Z prospect and Cities Service's historic Alcan prospect to the west of Oreo Mountain, and Doyon's Northway prospect to the south, as well as other prospects and areas of soil anomalies identified in other, earlier reconnaissance efforts. The targeting also identified other areas to the south of Oreo that would appear to warrant follow up. Notably, however, the TargetC image did not

identify several other known porphyry occurrences in the northern half of the scene, including both Taurus and Bluff, recently explored by Kenorland Minerals, Freeport-McMoRan and Antofagasta Minerals. (Figure 3).

Nonetheless, while the science behind this is not yet thoroughly understood, the apparent identification of the copper-rich portion of the Oreo Mountain prospect and other prospects in the southern half of the ASTER scene suggests good potential for utilization of thermal infrared band data in mineral exploration in Alaska and the Canadian north. This appears to be, in effect, geochemistry from space. The analysis of the TIR bands detected something likely associated with the copper mineralization at Oreo Mountain. It could be longwave infrared radiation from the copper (or associated metal) minerals themselves or derivatives of those minerals, or perhaps some alteration of the spectral signature of the local vegetation caused by metals absorbed from the soils, or something else.

From an exploration perspective, it is not 100% critical that the cause of the spectral response be known. What is important to note is that other areas with similar spectral responses can be identified and investigated with ground follow-up. From a prospect-level standpoint, the Oreo Mountain hyperspectral analysis developed complimentary data that should be valuable in the further exploration and development of the prospect and adjacent area at a relatively minimal cost.

The hyperspectral data for ASTER and several other satellite systems is available for download in the public domain, so the costs are low – essentially the consultant's fees for downloading the data, processing it and completing a report.

Figure 1. Index map showing the locations of the Oreo Mountain Prospect and select other mines and prospect in eastern Alaska and the southwestern Yukon.

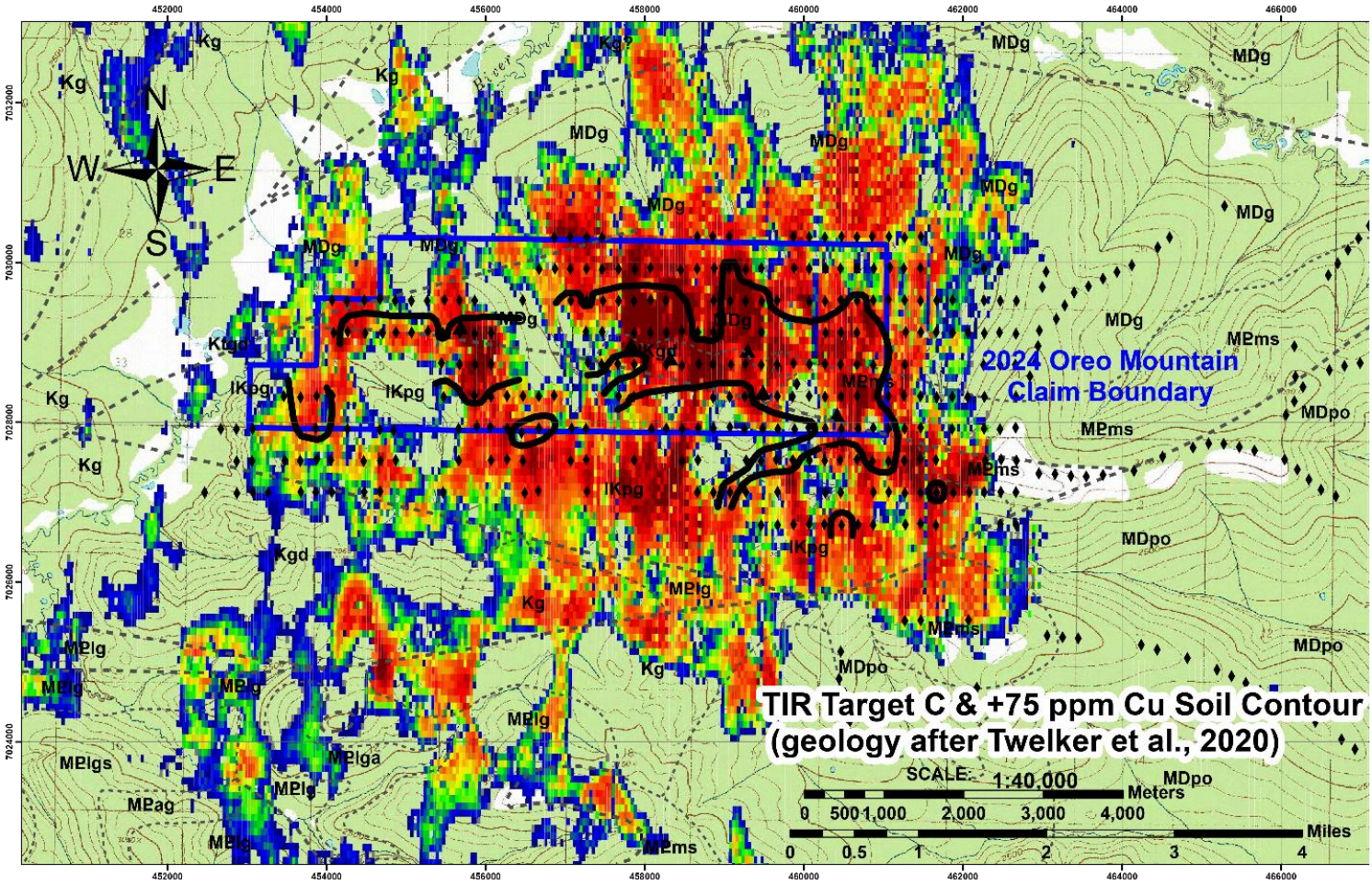

Figure 2. 2024 ASTER thermal infrared (TIR) TargetC analysis overlain on the +75 ppm Cu contour from 2018 Kennecott Exploration soil grid and geology from Alaska DGGS. Small black diamonds indicate Kennecott soil sample locations.

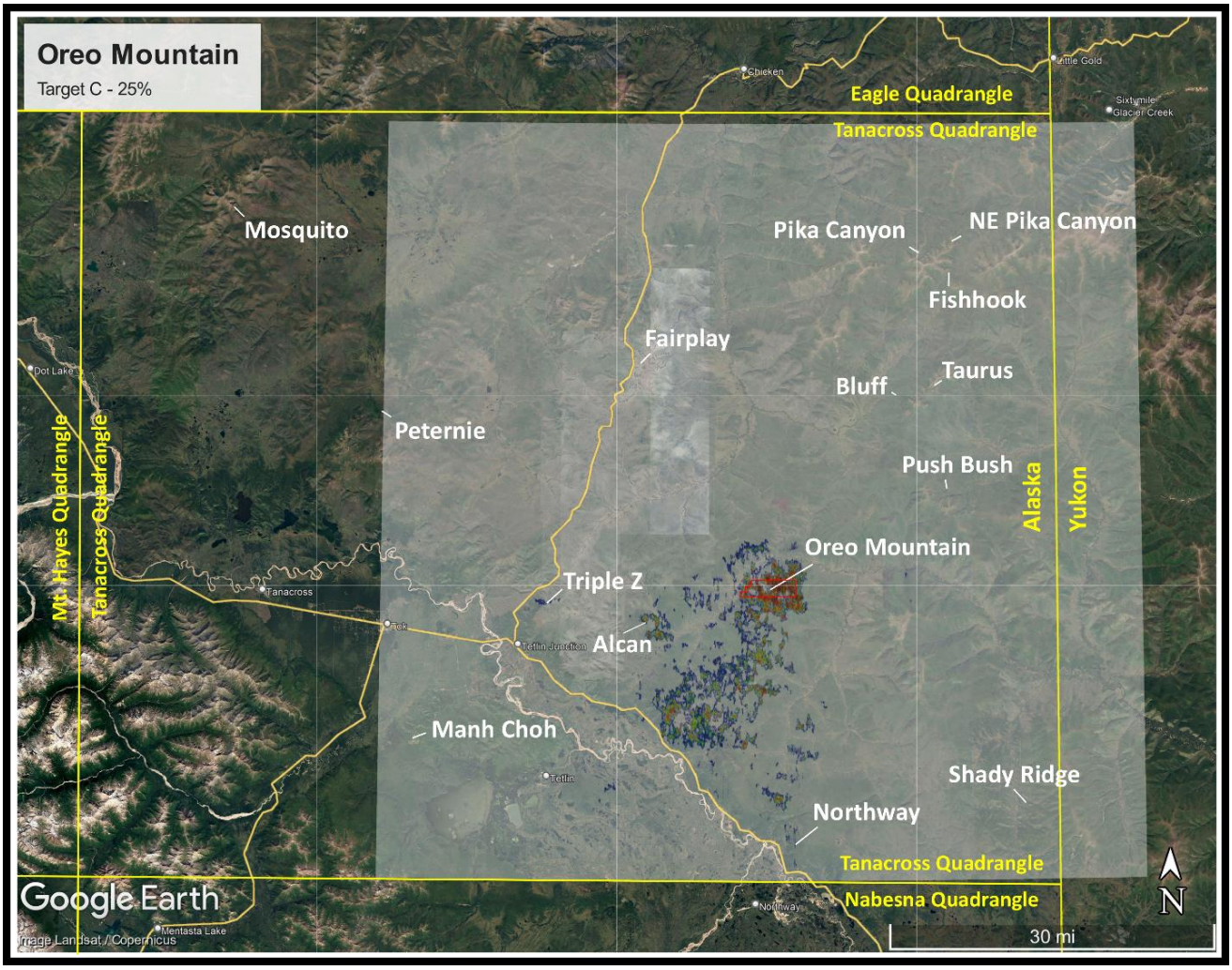

Figure 3. ASTER thermal infrared (TIR) scene with 2024 TargetC image projected onto Google Earth image, showing location of Oreo Mountain claim block and select other ±72 ma porphyry and porphyry-related prospects and deposits in the Tanacross (1:250,000 scale) Quadrangle.