DR 2024-1

DATA RELEASE FOR THE DEL NORTE NICKEL-COBALT LATERITE GEOCHEMICAL RECONNAISSANCE PROJECT, DEL NORTE COUNTY, CALIFORNIA

2024

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California
Department of Conservation
California Geological Survey

Data Release 2024-1 (GC)

Version 1.0

December 2024

California Geological Survey

California Department of Conservation

Sacramento, California

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Authorship Documentation

PUBLICATION TITLE: Data Release for the Del Norte Nickel-Cobalt Laterite Geochemical Reconnaissance Project, Del Norte County, California (DR 2024-1)

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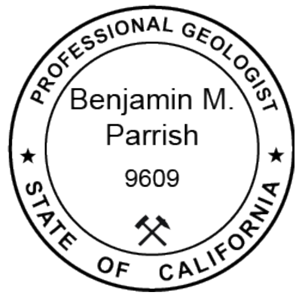

Date: December 23, 2024

Expires 7/31/2026

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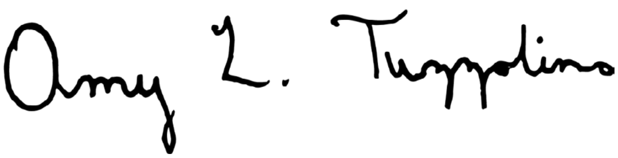

Date: December 23, 2024

Expires 10/31/2025

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Work in Responsible Charge: Data compilation, research, evaluation of sample locations, field identification of geologic units, development of sampling protocol, and map generation.

This authorship document accompanies DR 2024-1 with the following citation. When using data that accompanies this document, reference this citation.

Parrish, B.M., Tuzzolino, A.L., Wagoner, M.J. , Parol, A., 2024, Data Release for the Del Norte Nickel-Cobalt Laterite Geochemical Reconnaissance Project, Del Norte County, California, DR2024-1. California Department of Conservation, California Geological Survey, 5 pp.

DATA RELEASE FOR THE DEL NORTE NICKEL-COBALT LATERITE GEOCHEMICAL RECONNAISSANCE PROJECT, DEL NORTE COUNTY, CALIFORNIA

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INTRODUCTION

The Mineral Resources Program (MRP) at the California Geological Survey (CGS) conducted geochemical reconnaissance sampling of laterite and associated ultramafic rocks in Del Norte County, California as part of a statewide geochemical reconnaissance initiative. The goal of the initiative is to design and conduct geochemical reconnaissance projects to support current and future critical mineral, precious metal, base-metal, and industrial mineral activities within California.

Samples from laterite and ultramafic rocks of the Josephine Ophiolite in Del Norte County were collected for geochemical analyses. Samples were selected to evaluate trace element signatures and distribution in laterite deposits and compare trace element concentration in underlying ultramafic rocks. Samples were also selected to evaluate laterite enrichment processes for nickel, cobalt, and chromium in these deposits. Samples were analyzed by American Laboratory Services (ALS) in Reno, Nevada and Vancouver, British Columbia, and the results of these analyses are presented in this data release report. Pulp and reject material will be retained by the CGS for potential future analyses. Analytical data tables associated with this report are available in digital format as comma-separated value (CSV) files. All files can be downloaded from the CGS website: https://www.conservation.ca.gov/cgs

PROJECT DESCRIPTION

This project was selected to focus on nickel, cobalt, and chromium deposits and occurrences in Del Norte County to better understand mineralization characteristics and geochemical relationships between these critical minerals (Figure 1). Nickeliferous laterites are formed from intense weathering of peridotite and other ultramafic rocks; nickel, cobalt, chromium, and iron are immobile and are concentrated in the residual soils. There are three horizons in laterite soils: an upper hematite zone, a limonite zone, and a lower saprolite zone. Cobalt is often enriched near the top of laterite deposits and nickel near the base (Gray and others, 1983). In Del Norte, the upper hematitic zone is locally missing or landslides have displaced laterite deposits and caused mixing of horizons.

Critical minerals such as nickel, cobalt, and chromium are important to renewable energy production and the transition from fossil fuels. Del Norte County was selected due to historical exploration and mining activity surrounding nickel, cobalt, chromium in the area. From the 1850s to 1870, the Low Divide Mining District produced copper from several cupreous magnetite vein deposits including the Alta Mine. Copper was produced sporadically from other deposits into the early 1900s (Gray and others, 1983). Podiform chromite deposits were first mined at the Mountain View mine in the 1860s. Major exploration and mining of chromite occurred between 1918 and 1958 (Gray and others, 1983). Nickel was identified in laterite deposits in 1865, but most exploration in Del Norte County occurred after World War II during the 1950s and 1960s. Renewed exploration occurred during the 1980s (Gray and others, 1983).

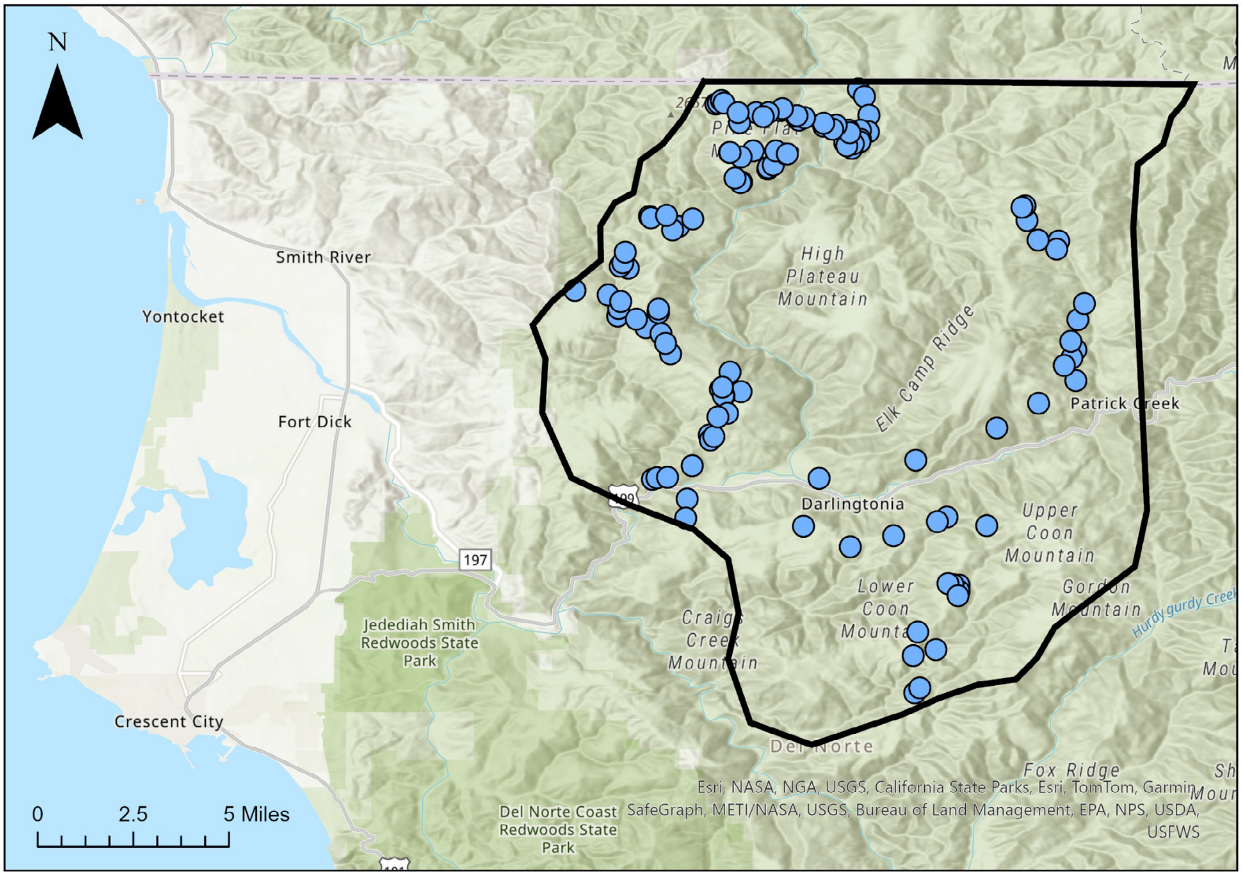

Figure 1: Map showing location and size of reconnaissance area (black outline), and distribution of sample locations (blue dots).

METHODOLOGY

Sample Collection and Location Accuracy

Sampling was conducted over the course of two weeks during the summer of 2023 by two MRP geologists, a geologic graduate student assistant for the MRP, and a geologic student assistant for the U.S. Geological Survey (USGS).

Rock and soil materials were collected as grab samples. Rock samples focused on moderately weathered to unweathered, variably serpentinized to fresh peridotite, serpentinite, gabbro, and diabase of the Josephine Ophiolite sequence.

Soil samples focused on laterite sequences derived from peridotite and other ultramafic rocks. Sampling was conducted in locations where vertical profiles of the lateritic sequence were exposed, typically in road cuts or historical exploration trenches. Vertical channel samples were collected from the exposed profiles. Samples were composited over 18 inches on average. Where no vertical profile was exposed, a small, 6 to 12 inch hole was dug to collect enough material for an appropriate geochemical sample. Care was taken to avoid organic material and weathered exposures of laterite. This included digging into vertical exposures to expose “fresh” laterite. Where all three zones of the laterite were intact and discernable, they were sampled together as a composite. Zonation was not used to focus sampling due to the absence of the upper hematitic zone in many exposures. Sampling focused on multiple sites over a wide area of laterite exposure for maximum coverage.

Field stations were labeled using the “23LAT” prefix and applied to samples from those locations; at least 2 pounds of material was collected at each location and bagged for transport to Sacramento.

Location data was collected using an Apple iPad Pro (11-inch 3rd generation) with built-in GPS and the Avenza Maps application. Average location accuracy in Avenza Maps was approximately 1 foot and the devices have a reported accuracy of 3 meters. Latitude and longitude values were collected and are reported in the WGS84 datum.

Sample Processing

Rock samples were trimmed of weathered material by the CGS staff and submitted to ALS in Reno and processed using their PREP-31Y package. The samples were crushed to greater than 70% passing 2 mm, and a 250g split was pulverized to greater than 85% passing 75 microns.

Soil samples were catalogued and submitted to ALS Reno and processed using their PREP-31Y methods. The samples were crushed to greater than 70% passing 2 mm, and a 250g split was pulverized to greater than 85% passing 75 microns.

The CGS also submitted four different standard reference materials for Quality Assurance Quality Control (QAQC).

Lab Analyses and Quality Assurance

All samples were analyzed at ALS Vancouver, British Columbia using their ME-ICP61 package; a 4-acid digestion and ICP-AES method. Analyses included in-house laboratory QAQC methodology in addition to QAQC samples submitted by the CGS. This information is available for download with formatted analytical results for this project. Only cursory analyses of standard performance have been conducted, more detailed analyses should be performed by the user.

ANALYTICAL RESULTS

Formatted data tables associated with this report are available in digital format as comma-separated value (CSV) files. Certificate of authenticity and quality control data from ALS are available in Portable Document Format (PDF) files. Certified values for certified reference materials used as standards by the CGS are available as PDF files. All files can be downloaded from the CGS website: https://www.conservation.ca.gov/cgs/

Values for aluminum, chromium, iron, magnesium, and manganese for standards CGL001 and OR182 appear to be underreported due to incomplete digestion. Values for bismuth, lanthanum, strontium, and nickel for standards OR21f and OR45f appear to be overreported due to being near detection limit and utilization of a 4-acid digestion method. The end user should conduct their own analyses of standard performance before utilizing this data.

Analytical results confirm expected enrichment of nickel, cobalt, and chromium in laterite samples. Values greater than 7,000 parts per million (ppm) nickel cluster around the Pine Flat and Lower Coon Mountain areas. Pine Flat was the center of exploration activities in the 1950s and 1960s. Elevated cobalt concentrations between 500 and 800 ppm is noted on the west side of the field area and along the Highway 199 corridor in the east. Values for cobalt ranging from 800 to 3,000 ppm occur along the west side of the field area from Gasquet Mountain to Pine Flat. Values for chromium were at or above detection limit (10,000 ppm) for most samples.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Matthew Wagoner (CGS), Stephen Harrington (CGS), and Adam Parol (USGS) for assistance in the field, sample collection, and sample preparation.

SELECTED REFERENCES

Gray, F., Page, N. J., Hamilton, M. M., Buehler, A. R., & Gabby, P. N., 1983, Mineral resource potential maps of the North Fork Smith River Roadless Areas, Del Norte County, California, Curry and Josephine counties, Oregon. United States Geological Survey, Miscellaneous Field Studies Map 1423-B. https://doi.org/10.3133/mf1423B