3. GEOLOGY

3.1 Introduction

This chapter discusses the baseline study of the geology and mineralization characteristics of the mine study area. The study consolidates existing geological data and exploration data collected through 2008. The mine study area is illustrated in Figure 1-4 in Chapter 1. The baseline geology study had an emphasis on the mine study area and included a review of information from exploration drilling programs, geophysics, geotechnical site investigation programs (which included drilling and test-pitting), and aerial-photograph interpretation. Geologic information for surrounding areas was obtained from desktop studies and reviews of existing published information.

3.2 Results and Discussion

3.2.1 Regional Geology

The mine study area lies within the northern circum-Pacific orogenic belt with a complex structural setting created by an active continental margin. The structure of the mine study area is broadly defined by northeast-trending faults related to translational motion along the Lake Clark Fault. The Lake Clark Fault lies on a lithotectonic boundary between the Peninsular Terrane to the east and the Kahiltna Terrane to the west. The mine study area lies within the Kahiltna Terrane, just northwest of the contact with the Peninsular Terrane.

3.2.2 Surficial Geology—Mine Study Area

Four different episodes of glaciation have been recognized in the mine study area and have produced unconsolidated surficial deposits a few to several tens of meters thick that cover most of the lower elevations (Detterman and Reed, 1973). Bow-shaped glacial drift ridges, meltwater deposits with abundant kettle depressions, broad glaciofluvial deposits, elongate valley deposits, and meltwater channels dominate the surficial geology.

Rubble formed by frost action covers many of the gently rounded hilltops and upland surfaces in the study area. Lobes of thin, water-logged sediments slide over less permeable materials on the upper part of hills. These lobes pile up on the mid-slopes of valleys. Glacial drift deposits, which were deposited by ice that moved in a south to southwesterly direction, are found at lower elevations.

3.2.3 Bedrock Geology—Mine Study Area

Bedrock types in the mine study area include a bedded sequence of Jurassic to Cretaceous, mainly andesitic, sedimentary rocks; contemporary mafic extrusive and subvolcanic rocks;

Cretaceous intrusive rocks of diverse composition; and stratified Tertiary volcanics, sedimentary rocks, and subvolcanic dykes.

A key feature of the area is a north-northeast-trending belt of stocks, sills, and dykes of diverse composition that include pyroxenite, gabbro, diorite, monzodiorite, monzonite, syenomonzonite, and granodiorite, as well as bodies of felsic to intermediate intrusion breccia. This belt has been traced for 22 kilometers in the study area. It cuts the andesitic sedimentary rocks on the eastern and southern margins of the Kaskanak Batholith and is localized along a potentially major northeast-trending structure of crustal scale that extends beyond the Pebble Deposit. Magmatic hydrothermal activity in this belt has produced many gold, copper-gold, and copper-gold-molybdenum mineral occurrences that have a close spatial and temporal relationship to more felsic intrusive phases.

3.2.4 Structural Geology—Mine Study Area

The general deposit location is divided into three main zones: the Pebble West Zone, the Central Zone, and the Pebble East Zone. These zones manifest distinct combinations of geological and hydrothermal characteristics. The primary structural feature of the Pebble West and Central zones is a broad, M-shaped convex upward fold. This fold is defined by the distribution of diorite and granodiorite sills in the gently to moderately dipping sedimentary rocks in the Central Zone. Fold axes plunge gently to the southeast. Folding has not yet been recognized in the Pebble East Zone.

Tertiary faults and shear zones are evident in drill core and from surface mapping. The general deposit location is cut by numerous brittle faults. Seven major fault zones (ZA to ZG) have been identified in the area of the general deposit location from drill-core data. A narrow, steeply sided, depressed segment of crust, bounded by faults, trending northeast subparallel to the regional Lake Clark structural zone extends along the valley northwest of Koktuli Mountain.

3.2.5 Deposit Geology

Based on the available data, the deposit is a copper-gold-molybdenum, calc-alkalic porphyry system and covers an area of approximately16 square kilometers. Each of the three main zones has distinct geological and hydrothermal characteristics.

The Pebble West Zone is dominated by a multiphase, intrusive complex that contains abundant intrusion breccias. These rocks were intruded into gently deformed andesitic sedimentary rocks and were subsequently intruded by granodiorite stocks and sills whose later-stage fluids produced potassium-silicate alteration and high-grade copper-gold-molybdenum mineralization.

The Central Zone and the Pebble East Zone are dominated by hornfelsed volcanosedimentary strata that were intruded by two main diorite sills. The Central Zone contains mineralization of moderate grade. The Pebble East Zone contains intense potassium-silicate alteration and high-grade copper-gold-molybdenum mineralization.

3.2.6 Surficial Geology—Transportation-corridor Study Area

A brief inspection of aerial photographs of the transportation-corridor study area was conducted. The Quaternary surficial deposits in the study area largely consist of glacial drift and glaciofluvial deposits, with fluvial deposits present near stream channels and a few localized swamp deposits. There are also areas of loose accumulations of rock and soil debris deposits, and scattered bedrock outcrops are common.

3.3 References

Detterman, R.L., and B.L. Reed. 1973. Surficial Geology of the Iliamna Quadrangle, Alaska. U.S. Department of the Interior, Geological Survey Bulletin # 1368-A.

Boulders and rubble caused by frost action, mine study area.

Bedrock outcrop in mine study area, looking northwest to Cone Mountain.

Typical bedrock cores from exploration/geotechnical drilling.