Appendix 1: Sample Description

*Porphyry*

Rock samples of porphyry deposits are all from British Columbia deposits. The porphyry deposits are divided into five subgroups: alkalic porphyry Cu-Au, porphyry Cu-Au, porphyry-related Cu-Au breccia, porphyry Cu-Mo, and porphyry Mo deposits.

The alkalic porphyry Cu-Au group consists of nine samples of weakly to strongly altered rocks from the Mount Polley, Shiko, and Dobbin deposits. Apatites from these samples are typically large (250–500 μm), euhedral, inclusion-free (clear) grains. Most grains share boundaries with, or are inclusions within, hornblende, clinopyroxene, or biotite, excluding one sample from Mount Polley where apatite is associated with altered K-feldspar and sericite (App. Table 1).

The porphyry Cu-Mo group consists of four samples from Gibraltar, Highmont, Highland Valley, and the Lornex deposits. Apatites occur in potassically and phyllically altered quartz monzonite or granodiorite porphyry in spatial association with muscovite, plagioclase, quartz, and chalcopyrite.

The porphyry Cu-Au group includes two samples from the Kemess South deposit. Apatite forms euhedral grains (180–500 μm) in zones of altered K-feldspar and/or plagioclase.

The porphyry-related Cu-Au breccia group consists of the Willa deposit located within the Omineca belt of the Quesnel terrane. Copper and Au mineralization occurs in a volcanic breccia unit interpreted to have formed at the porphyry-epithermal transition (Wong and Spence, 1995; Ash and Makepeace, 2012). The “pipe-like” orebody is therefore considered a separate group in this study. Small (100–200 μm), euhedral apatite grains are ubiquitous in the pyrite-actinolite matrix of the breccia.

The porphyry Mo group contains four samples. The Endako and Boss Mountain deposits are low-F porphyry Mo deposit types, whereas Cassiar Moly and Brenda are normal porphyry Mo deposits (e.g., Seedorff et al., 2005). Apatite occurs with quartz and altered K-feldspar, excluding the quartz monzodiorite porphyry from the Brenda deposit where apatite is spatially associated with chlorite and altered hornblende.

*Iron oxide Cu-Au and iron oxide-apatite deposits*

Eleven samples representing the iron oxide-associated deposits are from the Wernecke breccia in Yukon, the Rainy Lake pluton of the Great Bear magmatic zone in the Northwest Territory, the Aoshan mine in China, and the Cerro de Mercado (Durango) mine in Mexico. The Great Bear, Aoshan, and Cerro de Mercado deposits are of the Kiruna-type IOA deposits. Samples from Aoshan and Great Bear are pegmatitic apatite-actinolite ± magnetite rocks with pink or green apatite prisms commonly ranging from a few mm up to 5 cm in length. The Durango sample is a single transparent, yellow apatite megacrystal (>1 cm long) that was also used as a matrix-matched standard in this study.

Four samples from the Proterozoic Wernecke breccia represent an IOCG deposit. Apatite grains were separated from two breccia samples hosted in sedimentary rocks (Fairchild Group) and two breccias hosted in igneous rocks. In these latter rocks, apatite typically occurs in spatial association with quartz, excluding the potassically altered diorite breccia sample, where apatite occurs with biotite.

*Orogenic Au*

Five orogenic Au samples are from the Congress deposit and the Dentonia mine in British Columbia, the Seabee mine in Saskatchewan, and the Kirkland Lake mines in Ontario. All of these samples are igneous rocks, except for one sample from Seabee that is a metapelite layer within a volcanic rock succession. Apatite grains are commonly colorless and relatively large (up to ~500 μm), except apatite from Dentonia (up to ~120 μm).

*Skarn*

Sixty samples from 12 skarn deposits were examined in thin section. Only 7 samples, however, contained apatite grains of sufficient size for analysis. Three Au-Co skarn samples (Minyari and Racine) contain mostly subhedral to anhedral apatites (~60–250 μm). Apatite grains from two W skarn samples (Molly and O’Callaghan’s) are typically euhedral and up to 500 μm in length.

Apatites are extremely rare in samples from the other types of skarn. The Cu skarn (Little Bittle) and Pb-Zn skarn (Gold Canyon) samples each yielded a single grain for in situ microanalysis. These data are combined with the Au-Co skarn group in this study.

*Carbonatite*

We investigated 30 separated apatite samples from a total of 29 intrusive carbonatite complexes worldwide, ranging in age from the Neoarchean to the late Cretaceous. The samples are mainly from calcite carbonatites (sövites). Others are from dolomite carbonatites (beforsites), apatite-magnetite±olivine±pyroxene±phlogopite rocks (phoscorites), and silicocarbonatite. Apatite is a major constituent in these rocks, forming stubby prisms typically 250 to 750 μm in length, and more rarely >1000 μm.

*Unmineralized rocks*

The unmineralized rock samples include mid-ocean ridge basalt (MORB) and a variety of ultrabasic to intermediate-felsic intrusive rocks (e.g., ijolite, clinopyroxenite, monzonite, syenite, diorite, granodiorite, etc…). The MORB samples represent plutonic section of the oceanic crust from three localities (Mid-Atlantic Ridge, Southwest Indian Ridge, and the East Pacific Rise) and contain apatites typical of the differentiation products of tholeiitic basalts. Apatites samples from other unmineralized rocks are relatively large (~180–500 μm), euhedral to subhedral grains, which are commonly transparent and colorless to light yellow in color. The apatite-calcite-feldspar-biotite ijolite is from a carbonatite intrusive massif; data from this rock are discussed together with carbonatites.

*Others*

One diorite sample from an orogenic Ni-Cu deposit (Jason, B.C.) contains abundant apatite prisms (300–500 μm-long) as intercumulus minerals or inclusions in cumulate hornblende. For the epithermal Au-Ag deposits, only three samples (one from Cinola, B.C. and two from Cripple Creek, Colorado) contain apatites of suitable size for analysis. The apatites in altered monzodiorite samples from the Cripple Creek mine are euhedral prisms up to 400 μm in length. The restricted analytical data for apatites from epithermal deposits limits their interpretation.