

Supplemental material describing sample collection, sample preparation, and analysis used in the acquisition of mineralogical and geochemical data for the heavy-mineral concentrate fraction of samples collected in the Taylor Mountains quadrangle, Alaska.

Sample Collection:

A total of 819 pan concentrated stream-sediment samples were collected during a geological survey of the Taylor Mountains quadrangle, Alaska. About 10 percent of the samples are site duplicates collected for quality control.

Samples are composites of active alluvium collected primarily from first- or second-order streams as shown on USGS 1:63,360-scale maps. Each composite sample was created by collecting sediment from several places at the sample site, generally along a 30-ft. stretch of the channel and combining the increments to form a single sample for the site. When possible, moderately coarse gravel material was selected from areas where heavy minerals tend to drop out of the actively flowing stream water, such as at point bars or inside curves in the stream course. Sediment was wet-sieved through a 10-mesh (2 mm) screen until a 14-inch stainless steel or plastic pan was full. The material was then carefully panned until about 100 grams of the heaviest material was left in the pan. The panned material was swirled in the pan until a heavy mineral trail developed. This trail was examined with a 10X hand-lens for minerals of interest, such as gold or cinnabar. The panned material was saved in 4-mil plastic zip-loc bags for processing at the USGS laboratory in Denver, Co.

Laboratory preparation of the heavy mineral concentrate sample

In the laboratory, the panned samples were air dried and then sieved through a 30-mesh (0.60 mm) sieve. The minus-30 mesh fraction was further separated using a heavy liquid, bromoform, to remove the remaining lighter minerals having a specific gravity of 2.85 or less. A Frantz Isodynamic Separator was used to split the concentrate samples into two mineral phases: a relatively magnetic phase containing

magnetite, ilmenite, garnet, amphibole, pyroxene, epidote, and other iron-rich silicates, and, a relatively nonmagnetic phase containing most ore-related and low-iron oxide and silicate minerals.

Mineralogical Analysis of the non-magnetic fraction of the heavy mineral concentrate sample

The non-magnetic fractions of the heavy mineral concentrate samples were scanned visually under a ring-light illuminated binocular microscope using as much as 56X magnification. Shortwave ultraviolet illumination was also used to identify scheelite and powellite. In most cases, the mineral grains could be identified from their physical properties, but occasionally X-ray diffraction or chemical analysis was used to confirm some mineral identifications. Minerals of primary interest include gold, cinnabar, monazite, barite, cassiterite, scheelite, and iron sulfides such as pyrite, arsenopyrite, and chalcopyrite.

Geochemical Analysis of the non-magnetic fraction of the heavy mineral concentrate sample

A subset of 93 of the nonmagnetic heavy mineral concentrate samples were analyzed for 55 major, rare-earth, and trace elements by inductively coupled plasma-atomic emission spectrometry-mass spectrometry (ICP-AES-MS) using a modification of Meier and Slowik (2002) (<https://www.usgs.gov/media/files/60-elements-icp-oes-ms-na2o-fusion-method>; U.S. Geological Survey, 2010). A 0.10 g aliquot of the non-magnetic fraction of heavy mineral concentrate sample was decomposed using a sodium peroxide sinter heated to 450°C. The resultant cake was leached with water and acidified with nitric acid. After an addition of tartaric acid, aliquots of the digested samples were aspirated into the ICP-AES-MS. Data were considered acceptable if recovery for all 55 elements was plus or minus 15 percent at five times the lower reporting limit and the calculated relative standard deviation (RSD) of duplicate

sample analysis was no greater than 15 percent. Lower and upper reporting limits for this method and detector used are shown in the table below.

Table giving the lower and upper reporting limits and detector by element for the inductively coupled plasma-atomic emission spectrometry-mass spectrometry method used in determining the major, rare earth, and trace element concentration in the non-magnetic fraction of the heavy mineral concentrate sample. Note: % is percent, ppm is parts per million.

Element	Detector	Lower reporting limit	Upper reporting limit	Element	Detector	Lower reporting limit	Upper reporting limit
Aluminum, Al	AES	0.01%	25%	Lanthanum, La	MS	0.1 ppm	10,000 ppm
Calcium, Ca	AES	0.01%	35%	Lithium, Li	AES	10 ppm	50,000 ppm
Iron, Fe	AES	0.01%	30%	Lutetium, Lu	MS	0.05 ppm	1,000 ppm
Potassium, K	AES	0.01%	25%	Molybdenum, Mo	MS	2 ppm	10,000 ppm
Magnesium, Mg	AES	0.01%	30%	Niobium, Nb	MS	1 ppm	10,000 ppm
Manganese, Mn	AES	10 ppm	10%	Neodymium, Nd	MS	0.1 ppm	10,000 ppm
Phosphorous, P	AES	0.01%	25%	Nickel, Ni	AES	5 ppm	10,000 ppm
Titanium, Ti	AES	0.01%	25%	Lead, Pb	MS	5 ppm	10,000 ppm
Silver, Ag	MS	1 ppm	1,000 ppm	Praseodymium, Pr	MS	0.05 ppm	1,000 ppm
Arsenic, As	MS	30 ppm	10%	Rubidium, Rb	MS	0.2 ppm	10,000 ppm
Barium, Ba	AES	0.5 ppm	10,000 ppm	Antimony, Sb	MS	0.1 ppm	500 ppm
Beryllium, Be	AES	5 ppm	2,500 ppm	Scandium, Sc	AES	5 ppm	50,000 ppm
Bismuth, Bi	MS	0.1 ppm	1,000 ppm	Samarium, Sm	MS	0.1 ppm	1,000 ppm
Cadmium, Cd	MS	0.2 ppm	10,000 ppm	Tin, Sn	MS	1 ppm	10,000 ppm
Cerium, Ce	MS	0.1 ppm	10,000 ppm	Strontium, Sr	AES	0.1 ppm	1,000 ppm
Cobalt, Co	MS	0.5 ppm	10,000 ppm	Tantalum, Ta	MS	0.5 ppm	10,000 ppm
Chromium, Cr	AES	10 ppm	10%	Terbium, Tb	MS	0.05 ppm	1,000 ppm
Cesium, Cs	MS	0.1 ppm	10,000 ppm	Thorium, Th	MS	0.1 ppm	1,000 ppm
Copper, Cu	AES	5 ppm	10,000 ppm	Thallium, Tl	MS	0.5 ppm	1,000 ppm
Dysprosium, Dy	MS	0.05 ppm	1,000 ppm	Thulium, Tm	MS	0.05 ppm	1,000 ppm
Erbium, Er	MS	0.05 ppm	1,000 ppm	Uranium, U	MS	0.05 ppm	1,000 ppm
Europium, Eu	MS	0.05 ppm	1,000 ppm	Vanadium, V	AES	5 ppm	10,000 ppm
Gallium, Ga	MS	1 ppm	1,000 ppm	Tungsten, W	MS	1 ppm	10,000 ppm
Gadolinium, Gd	MS	0.05 ppm	1,000 ppm	Yttrium, Y	MS	0.5 ppm	10,000 ppm
Germanium, Ge	MS	1 ppm	1,000 ppm	Ytterbium, Yb	MS	0.1 ppm	1,000 ppm
Hafnium, Hf	MS	1 ppm	10,000 ppm	Zinc, Zn	AES	5 ppm	10,000 ppm
Holmium, Ho	MS	0.05 ppm	1,000 ppm	Zirconium, Zr	MS	0.5 ppm	10,000 ppm
Indium, In	MS	0.2 ppm	1,000 ppm				

Description of data

The data reported here include hand lens inspection of the panned concentrate samples in the field, microscopic examination of the non-magnetic fraction of the HMC samples in the lab, and chemical analyses of selected nonmagnetic HMC samples. The number of gold and cinnabar grains observed in the panned sample in the field are listed. The number of gold, cinnabar, and scheelite grains observed or estimated during microscopic examination in the non-magnetic fraction of the heavy mineral concentrate sample are also recorded. Other minerals listed individually include monazite (dark and yellow), barite, cassiterite, and scheelite. Iron sulfides such as arsenopyrite, chalcopyrite, and pyrite were identified infrequently and are grouped together as sulfides. Size, color, and morphological characteristics of gold, cinnabar, and dark monazite identified in some samples are noted. When identified, other minerals that may be of interest such as corundum, ilmenite, dravite or schorl tourmaline, topaz, rutile, sillimanite, and rare and unusual quartz crystals are noted in the observation comment field. In general, almost every nonmagnetic heavy mineral concentrate sample contained detrital amphibole and pyroxene minerals, anatase, andalusite, apatite, clinocllore, cordierite, epidote, garnet, and zircon in varying amounts. Minerals such as galena, orpiment, realgar, sphalerite, and stibnite were looked for but not identified in these samples. Concentrations of the major, rare earth, and trace element data for 93 of the heavy mineral samples are given.

Citations:

Meier, A.L. and Slowik, T., 2002, Rare earth elements by inductively coupled plasma-mass spectrometry, *in* J.E. Taggart, Jr., ed., Analytical methods for chemical analysis of geologic and other materials, U.S. Geological Survey: U.S. Geological Survey Open-File Report 2002-

223-K, version 5.0, p. K1-K8, http://pubs.usgs.gov/of/2002/ofr-02-0223/K19NewREE_M.pdf. (last accessed last accessed January 22, 2021)

U.S. Geological Survey, 2010, Method 22—55 element ICP-AES-MS sodium peroxide sinter, *in* USGS in-house methods: Central Mineral and Environmental Resources Science Center website, <https://www.usgs.gov/media/files/60-elements-icp-oes-ms-na2o-fusion-method>. (last accessed January 22, 2021)