The Wolverine complex, a newly discovered layered ultramafic body in the western Chugach Mountains, Alaska

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INTRODUCTION

A layered ultramafic complex was discovered near the headwaters of Wolverine Creek in the summer of 1971 during the course of reconnaissance mapping of the western Chugach Mountains of southern Alaska. The complex is part of the arcuate Chugach-Kenai-Kodiak ultramafic belt (Rose, 1966) that includes ultramafic bodies on western Kodiak Island and near Seldovia, Eklutna, Tonsina, and Chitina. The discovery of the Wolverine ultramafic complex is noteworthy because of its potential economic significance and because it occurs within a large gap between known occurrences of such bodies in the ultramafic belt.

The existence of an ultramafic body in the area was suspected from reports of serpentine in the upper drainage basin of Wolverine Creek (Rose, 1966). The Wolverine ultramafic complex is similar to the chromite-bearing ultramafic body near Eklutna about 20 miles to the west-southwest (Rose, 1966; Clark and Bartsch, 1971a and b). Layered olivine chromitite was seen in one part of the Wolverine complex but in that area did not appear to be of economic grade. Most of the complex has not been examined and the economic potential is unknown. This report contains a brief description of the body, based on a limited number of observations, and provides semiquantitative spectrographic analyses for 30 elements, fire-assay spectrographic platinum-group analyses, and atomic absorption mercury analyses for samples of the ultramafic rocks.

SETTING AND AGE

The Wolverine complex is in a high, rugged, glaciated part of the western Chugach Mountains. It is accessible by helicopter from Palmer or Anchorage. The complex is above timberline and is well exposed except where covered by glaciers or surficial deposits.

The Wolverine complex is near the southeastern-most exposures of a terrane that was deformed and intruded by plutons prior to the deposition of the thick Jurassic-Cretaceous bedded sediments of the Chugach-Kenai-Kodiak Mountains (Clark, in press, b). The Knik fault (Clark, in press, b), which marks the juxtaposition of the two terranes, is south of the Wolverine complex (fig. 1). The regional geologic setting of the Wolverine complex is similar to that of other widely spaced ultramafic bodies that occur in an arcuate belt (Rose, 1966) near the west and north front of the Chugach-Kenai-Kodiak Mountains from Kodiak Island on the south to near Chitina on the east.

The Jurassic and(or) Cretaceous McHugh Complex (KJm) (Clark, in press, a), exposed south of the Knik fault, is part of the younger terrane of bedded deposits. The complex is composed of chaotically juxtaposed, weakly metamorphosed metaclastic and metavolcanic sequences. The source area for the metaclastic rocks is thought to be the older terrane northwest of the Knik fault.

The Wolverine complex is cut by albite granite plutons and dikes (M_ZTi). The plutons also cut the Jurassic and(or) Cretaceous McHugh Complex and possibly cut the fault contact between the McHugh Complex and the Jurassic(?) and Cretaceous Valdez Group (S. H. B. Clark, unpublished data). The albite granite is, therefore, no older than upper Jurassic and may be as young as Tertiary.

Hornblende-quartz diorite (Ji) of Jurassic(?) age, exposed northwest of the Wolverine ultramafic complex, is part of a larger pluton exposed along the front of the Chugach Mountains, mostly north of the Knik River. A Jurassic(?) age assignment is based on radiometric age determination of a similar plutonic rock near Eklutna (Clark and Bartsch, 1971b).

DESCRIPTION OF THE COMPLEX

The Wolverine complex is a steep-sided tabular body about 5 miles long and from 1/2 to 2 miles wide underlying an area of about 8 square miles (M_zP_zu, fig. 1). The complex trends northeast, parallel to the structural grain of the area. A unit of amphibolite facies metamorphic rocks (M_zP_zm) is in high-angle fault contact with the ultramafic body on the southeast (fig. 1). On the northwest, the body is in nearly vertical contact with a unit of greenstone (metabasalt(?) and altered diabase) and chert (M_zP_zg, fig. 1). In some places the ultramafic rocks appear to overlie the ultramafic rocks. The presence of gabbroic layers in the northwest part of the ultramafic complex and comparison with the nearby Eklutna complex (Rose, 1966; Clark and Bartsch, 1971a and b) suggest that the northwest contact is probably the upper contact and the greenstone unit stratigraphically overlies the ultramafic complex. The layering in most of the ultramafic body dips to the southeast and is probably overturned. Rose (1966) suggested that layering in the Eklutna complex might also be overturned.

The Wolverine complex is composed predominantly of layered dunite, clinopyroxenite, and peridotite. Dunite is the most abundant in areas examined. Light colored (light gray, pale green, or white), strongly altered gabbroic(?) layers are interlayered with the ultramafic layers in the northwest half of the complex (fig. 2) but have not been seen in the southeast half.

Cumulus textures are preserved in some specimens of the ultramafic rocks, and these textures are generally overprinted by deformational fabrics. Deformational fabrics in some specimens are so strong that original cumulus textures are obliterated.

Mineral grading of layers (fig. 3) in cumulus dunites and olivine chromitites is well developed at locality 544 (fig. 1). Olivine grains have polygonal outlines and equigranular mosaic textures in dunites that are not strongly deformed. In slightly deformed cumulus dunites, undulatory extinction, deformation lamellae, and cataclasis of borders of olivine grains can be seen. In more strongly deformed rocks, extinction is patchy, olivine grains are elongated and brecciated along their margins, some grains are broken and rotated to such an extent that the original crystals have lost their identity and the rock has a gneissic textures.

Clinopyroxenites are much less abundant than dunites. Clinopyroxene (diopside(?)) is the cumulus mineral; tremolite-actinolite, serpentine, and chlorite occupy intercumulus spaces replacing the original intercumulus mineral(s). Only two peridotite layers (wehrlites) were sampled (localities 1259 and 580, fig. 1). One is predominantly clinopyroxene and the other is predominantly olivine. Evidence of cataclasis seen in the pyroxene-bearing rocks is similar to those in the dunites described above. Serpentine has partly replaced the ultramafic rocks, especially the dunites. In less strongly deformed rocks, the serpentinization appears to have been controlled largely by the olivine grains. In the more strongly deformed rocks, sheared serpentinite cuts sharply across the original fabric. Tremolite-actinolite rims and partially replaces pyroxene grains and forms patches and veinlets in pyroxene-bearing ultramafic rocks.

The light-colored gabbroic(?) layers (fig. 2) include a variety of rocks with widely varying textures. Most are calc-silicate rocks that appear to be rodingite. In some, plagioclase and pyroxene are recognizable as probable original cumulus minerals although the plagioclase is now strongly altered and the pyroxene is almost completed replaced by tremolite-actinolite, which is the most common alteration product in these rocks. Some is a coarse-grained pale green amphibole that is interlayered with strongly altered plagioclase. Cores of relict pyroxene grains are uncommon in the amphibole. Tremolite-actinolite in some rocks is fine-grained, strongly schistose, and is associated only with chlorite or serpentine in tremolite actinolite schist. One sample of an altered gabbro(?) from locality 547 (fig. 1) contains about 70 percent zoisite and about 30 percent actinolite. Prehnite veinlets cut the rock. Two minerals that are usually present in rodingites, hydrogrossular and vesuvianite, have not been recognized in the altered gabbroic(?) rocks.

GEOCHEMISTRY

Opaque minerals are disseminated in most of the ultramafic rocks and in one area (locality 544, fig. 1) size-graded chromite (chrome spinel) layers in an olivine cumulate have been seen (fig. 3). At locality 544, the chromite layers are generally about 1/2 to 1 inch thick and contain an estimated 30 to 60 percent of opaque minerals. The 1/2 to 1 inch thick chromite layers occur at the base of beds about 6 to 12 inches thick and are estimated to comprise about 5 percent of the total outcrop. This concentration of chromite is not economic, but possibly economic-grade concentrations may occur elsewhere. Most of the ultramafic body has not been examined or evaluated for its economic potential.

In addition to chromite, the body should be evaluated for nickel, magnetite, platinum, and copper. Samples from several localities were analyzed by the semiquantitative spectrographic method for 30 elements (table 1). The samples were also analyzed for platinum-group metals by the spectrographic method fire-assay and for mercury and gold by atomic absorption (table 1). Gold was not detected in any of the samples.

The chromite content is more than 5,000 ppm in all but two of the samples. The nickel content is 3,000 ppm in five dunite samples. The copper content is very low in the dunite but 700 ppm of copper were reported in the clinopyroxenite sample. This is noteworthy in that native copper is present in the pyroxenites from the Eklutna ultramafic complex (Rose, 1966; A. L. Clark and S. H. B. Clark, unpublished data). Cobalt concentrations of 300 ppm were present in several samples. Platinum-group metals were detected in small quantities only.

REFERENCES CITED

Clark, S. H. B., The McHugh Complex of south-central Alaska: U.S. Geol. Bull. (in press, a)

_____Reconnaissance bedrock geology of the Chugach Mounts near Anchorage Alaska: U.S. Geol. Survey Misc. Field Studies Map, MF-350. (in press, b)

Clark, S. H. B., and Bartsch, S. R., 1971a, Reconnaissance geologic map and geochemical analyses of stream-sediment and rock samples of the Anchorage B-6 quadrangle, Alaska: U.S. Geol. Survey open-file report.

_____1971b, Reconnaissance geologic map and geochemical analyses of stream-sediment and rock samples of the Anchorage B-7 quadrangle, Alaska: U.S. Geol. Survey open-file report.

Rose, A. W., 1966, Geology of chromite-bearing ultramafic rocks near Eklutna, Anchorage quadrangle, Alaska: Alaska Div. Mines and Min., Dept. Nat. Resources Geol. Rept. no. 18, 20 p.

Figure 2.--Layering in the Wolverine ultramafic complex. View east. Light-colored layers outlined on photograph are metasomatically altered gabbroic rocks. Location of photograph shown on figure 1.

Figure 3.--Mineral-graded chromite layering in dunite from locality 544 in figure 1.


2 INCHES

Table 1.--Analyses of samples from the Wolverine ultramafic complex

[Semiquantitative spectrographic analyses by K. J. Curry; fire assay spectrographic analyses by R. R. Carlson and E. Cooley; atomic absorption analyses by R. L. Miller and D. G. Murrey. Other elements looked for but not found in semiquantitative spectrographic analyses: As, Au, Bi, Cd, La, Pb, Sb, Sn, W, Zn, Zr. Barium was found only in sample 547A but was below the limit of detection. A concentration of 10 ppm of yttrium was detected in sample 547A but yttrium was not detected in the other samples. Gold was looked for by the atomic absorption method (limit of detection = 0.02 ppm) but was not found. The terms G = greater than the value shown, L = less than the specified limit of detection, and N = not detected.]

		Semiquantitative spectrographic analysis																Fire-assay-spectrographic			Atomic absorption Hg
Field No.	Rock type	Fe	Mg	Ca	Ti	Mn	Ag	B	Co	Cr	Cu	Mo	Nb	Ni	Sc	Sr	V	Pt	Pd	Rh	
		weight %				parts per million (ppm)												(ppm)			(ppm)
71ACs1261	Dunite	15	G10	0.2	0.007	1,000	N	10	300	G5,000	50	N	L	3,000	7	N	30	0.010	0.015	N	0.5
1260	Dunite	15	G10	.3	.03	1,500	N	L	300	G5,000	150	L	N	3,000	10	N	50	N	.010	N	0.18
1259	Peridotite	20	G10	.5	.03	3,000	N	L	300	5,000	150	L	L	2,000	7	N	50	.007	.015	N	0.11
1258	Dunite	15	G10	.3	.02	1,500	N	L	300	G5,000	30	5	L	2,000	7	N	70	N	.002	N	0.14
1257	Dunite	15	G10	.15	.015	1,000	N	L	300	G5,000	20	L	L	3,000	10	N	50	N	.002	N	0.13
1256	Dunite	15	G10	.07	.007	1,500	N	L	300	G5,000	10	5	L	2,000	5	N	30	N	.002	N	0.12
571	Dunite	10	G10	.05	.007	1,500	N	L	200	G5,000	70	L	L	3,000	5	N	20	0.020	.015	N	0.06
570	Dunite(?)	15	G10	.7	.015	1,500	N	L	200	G5,000	70	L	L	1,500	15	N	70	.020	.050	N	0.12
569	Dunite	10	G10	.15	.007	1,000	N	L	150	G5,000	50	N	L	3,000	5	N	30	.050	.015	N	0.04
544D	Dunite	15	G10	L	.007	1,500	N	L	200	G5,000	7	L	N	1,500	5	N	10	.040	.040	0.010	0.06
544C	Dunite	15	G10	.5	.007	1,000	N	L	200	G5,000	30	L	N	2,000	7	N	15	.020	.010	N	0.07
544A	Dunite	15	G10	L	.03	1,500	N	L	150	G5,000	20	7	N	2,000	5	N	150	.060	.030	.010	0.05
546A	Serpentinized dunite	10	G10	.15	.007	700	N	L	150	G5,000	20	L	L	1,500	5	N	30	.010	.010	N	0.06
568	Clinopyroxenite	10	10	15	.15	1,000	N	L	70	G5,000	700	N	N	1,000	100	N	300	.005	.005	N	0.03
580	Peridotite	10	10	7	.15	1,000	N	L	100	3,000	200	L	L	1,000	70	N	200	.020	.015	N	0.14
579A	Clinopyroxenite	7	10	10	.07	1,000	L	L	70	G5,000	300	L	L	1,500	50	N	200	.030	.030	N	0.45
547A	Tremolite chlorite schist	10	7	7	.3	100	N	L	70	1,500	100	N	L	300	70	200	300	-	-	-	0.08
Limits of detection		0.05	0.02	0.05	0.002	10.0	0.5	10.0	5.0	5.0	5.0	5.0	10.0	5.0	5.0	100	10	0.005	-	0.002	0.01