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GEOLOGIC REPORT NO. 18

Geology of Chromite-Bearing Ultramafic Rocks Near Eklutna, Anchorage Quadrangle, Alaska

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GEOLOGY OF CHROMITE-BEARING ULTRAMAFIC ROCKS NEAR EKLUTNA, ANCHORAGE QUADRANGLE, ALASKA

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ABSTRACT

An ultramafic body of layered peridotite, dunite, and gabbro about ten miles long and up to two miles wide intrudes graywacke, argillite, volcanics, and other rocks along the northwest margin of the Chugach Mountains between Anchorage and Palmer. The body has a northeast elongation parallel to the regional tectonic trend. Discontinuous layering defined by compositional changes and "sedimentary" textures is well developed in many parts of the ultramafic. Several major faults cut the body but within individual fault blocks the layering is relatively consistent in attitude. Most of the dunite appears to overlie peridotite, and peridotite may overlie gabbro.

Chromite showings have been found in five areas and consist of zones up to 20 feet thick averaging 5 to 15% Cr_2O_3. Dunite is the host rock at all showings. Within the zones, chromite occurs in thin layers up to 2 inches thick separated by varying thicknesses of dunite. The known showings do not appear to be economic, because of their small tonnage and low grade, but some further prospecting is suggested.

An arcuate belt-like zone containing scattered ultramafic intrusives is present along the northwest and north margin of the Kenai-Chugach Mountains, extending on to Kodiak Island. Along the belt, ultramafic intrusives, some with associated mineral deposits, are known near Chitina, Tonsina, Eklutna, Seldovia, and western Kodiak Island. Prospecting for additional ultramafic intrusives in this belt and for associated chromite, copper-nickel sulfide, asbestos, platinum, iron, and mercury deposits is recommended. The nickel content of stream sediments and the chromium content of panned stream sediments are suggested as efficient reconnaissance guides to undiscovered ultramafic intrusives.

INTRODUCTION

About 1935, chromite was found a few miles east of the village of Eklutna, between Anchorage and Palmer (Picotte, 1942, figure 1). Chromite had been previously reported on Peters Creek a few miles south of Eklutna (Martin, 1920) but no exact location was given. The occurrences east of Eklutna were trenched by the U.S. Bureau of Mines in 1942 (Bjorklund and Wright, 1948) and examined by the Territorial Department of Mines (Joesting, 1942) and by the War Production Board

(Picotte, 1942). Some geologic mapping was done in 1942 by the U.S. Geological Survey but was never published. The best published maps of the area are regional reconnaissance maps which include the chromite-bearing ultramafic rocks with "greenstone, lava, and tuff" that forms a belt along the northeast margin of the Chugach-Kenai Mountains (Capps, 1916, 1940).

The main purposes of this study were to outline the body of ultramafic rocks, to locate and describe the chromite occurrences, and to test various methods of stream sampling to determine whether the ultramafic bodies could be detected by reconnaissance sampling. Thirteen days were spent in field work in the map area.

Up to about 1000 feet in elevation, trees and dense undergrowth combined with cover by glacial material make geologic work difficult. Above this level, travel is generally easier, but outcrops are relatively few. Along the ridges, exposures are fair to good. In the gorges of lower Eklutna River, Thunderbird Creek, and Peters Creek, exposures are excellent, but the slopes are so steep and crumbly that geologic observations are not possible in most areas. An extreme example is furnished by the Eklutna River in the central part of section 29, where it flows through a slot about 10 feet wide and many tens of feet high.

REGIONAL GEOLOGY

The map area lies on the northwest side of the arcuate Chugach-Kenai Mountains geologic province (figure 1). The geology of this province is imperfectly known, largely because of the lack of distinctive mappable units in the thick sequence of graywacke, argillite, greenstone, and volcanics, and a lack of fossils. Based on regional mapping the oldest rocks, probably of Jurassic and pre-Jurassic age, are volcanics, sediments, and intrusives exposed along the north and northwest margins of the mountains. The main body of the mountain range is composed of poorly sorted sparsely fossiliferous Cretaceous(?) graywacke and slate, plus minor greenstone. Tertiary fossils have recently been found in similar rocks in Prince William Sound on the south side of the mountains and the boundary between Cretaceous and Tertiary rocks is very uncertain. A large area of Tertiary or Quaternary tuff overlies the graywacke and slate about 10 miles southeast of the map area.

Immediately to the north and northwest of the Chugach-Kenai Mountains, relatively well-dated sediments and volcanics of Jurassic through Tertiary age are present in the Cook Inlet-Matanuska Valley province. These sediments are relatively well sorted and numerous distinctive units have been mapped. The coincidence of the change in character of Mesozoic and Tertiary sediments with the present front of the Chugach-Kenai Mountains indicates that the boundary is a fundamental tectonic feature. The locations of the ultramafic intrusives have probably been determined partly by this tectonic boundary.

ROCK TYPES

Sedimentary and volcanic rocks

The country rocks into which the ultramafic body was intruded consist largely of highly-fractured and weakly-metamorphosed sedimentary and volcanic rocks (figure 2). Nearly all the exposures mapped on the southeast side of the ultramafic body are graywacke and argillite plus minor pebble conglomerate. On the northwest side, graywacke, argillite, porphyritic andesite, andesite and dacite tuffs, phyllite, banded chert, banded argillite, minor limestone, and quartz-plagioclase-hornblende gneiss, are present. Fracture cleavage and/or foliation are apparent in some exposures close to the Knik River. Because of fracturing, shearing, veining, metamorphism, lack of bedding, and the generally fine-grained nature of the rocks, distinctions between rock types are usually difficult, but thin sections confirmed most of the field designations.

Tracing units within the country rock has not been very successful, although more detailed work might aid in determining local structure and stratigraphic relationships. The predominance of graywacke and argillite on the southeast side of the intrusive may be significant. Banded chert, banded argillite, and limestone were seen only near the northwest contact of the intrusives and probably represent a distinct stratigraphic unit. Mafic-rich gneiss and schist are exposed on Peters Creek about a half mile above the highway and were originally presumed to represent an older group of rocks. However, thin section study shows that banded argillite part way up Eklutna Mountain from the gneiss and schist exposures has been metamorphosed to a finely laminated hornblende-plagioclase assemblage, so the rocks on Peters Creek may be more metamorphosed locally than other portions of the same group of rocks. Near the tunnel connecting Eklutna Lake with the Eklutna powerhouse, Athern and Rudd (1956) distinguished east-west trending units of graywacke with argillite inclusions, argillite with some graywacke, and resistant metagraywacke, in surface mapping, but do not indicate how these units correlate with north-south striking graywacke and argillite in the tunnel. If their mapping is correct, an unconformity or major fault must be present.

The age and regional correlation of the country rock is also uncertain. In the regional summary of Capps (1940), most of the map area is shown as "basic lavas and tuffs and greenstone of pre-Cretaceous age". The southeast quarter of the map area, including the area of Eklutna Lake and the upper drainage of Peters and Thunderbird Creeks is shown by

Capps as "Undifferentiated Mesozoic rock", in part of Cretaceous age. The mapping by Athern and Rudd (1956) does not show any contact agreeing with that shown by Capps (1940), and reconnaissance observations by the writer did not pick out any obvious differences. The presence of banded chert, banded argillite, limestone, volcanics, and graywacke northwest of the ultramafic body suggests a correlation with Triassic (?) chert, limestone, tuff, slate, and graywacke described by Martin, Johnson and Grant (1915) from near Seldovia. Some volcanics in the Eklutna map area may correlate with the Jurassic Talkeetna formation (agglomerate, breccia, tuff and minor sediments) which is widely exposed in the Matanuska Valley and Talkeetna Mountains (Capps, 1927).

Diorite

Sheared, fractured, and altered diorite was mapped at several localities in section 19, 21, and 29, T15N-R1E. Two samples examined in thin section consist of 50 to 75% plagioclase (1-3 mm in diameter, An_{5-10}, probably albitized and containing some clinozoisite) with the remainder consisting of greenish-brown hornblende, tremolite-actinolite, chlorite, and accessory ilmenite partly altered to leucoxene. The tremolite-actinolite and chlorite may represent altered pyroxene. Diorite from exposures along the railroad in section 21 is distinctly foliated, and locally is much richer in mafics than that described above.

The diorite could be related to the gabbro and ultramafics described below, but in the absence of any additional information it is considered as a separate and probably older intrusive into the sedimentary and volcanic rocks.

An exposure of quartz diorite is present just north of Eklutna Village (Capps, 1916, p. 165), but was not visited in this study.

Ultramafic intrusive

As shown on figure 2, the ultramafic body extends from the Eklutna powerhouse southwestward across the Eklutna River and Thunderbird Creek, through Mt. Eklutna almost to Peters Creek. A possible extension across Peters Creek is indicated by stream sediment data (see Geochemistry). The exposed length is about ten miles, with a maximum width of about two miles. Unless it is cut off by a concealed fault, the intrusive quite likely extends a considerable distance to the northeast under the recent sediments in the Matanuska River valley. The most abundant rock type in the body is peridotite (wehrlite) composed of clinopyroxene with generally subordinate olivine. Other major rock types are dunite (composed almost entirely of olivine) and augite gabbro. In several parts of the intrusive, the different rock types occur as distinct layers or "beds", defined by compositional and textural differences. The composition of the ultramafic rocks is shown in the triangular diagram in figure 3.

The peridotite in the field is typically a medium- to coarse-grained dark green rock. In many specimens pyroxene is the only mineral that can be definitely recognized, and most of the peridotite was mapped as pyroxenite in the field. Olivine and chrome spinel are visible in some specimens. The pyroxene tends to have good cleavages (or partings) and has a grain size ranging from about 2 mm to a centimeter or more. Except in the more olivine-rich varieties, banding or layering is generally not visible.

Weathered dunite has the typical dun or orange-brown color. Beneath the weathered crust, which is usually less than a centimeter thick, the color is dark gray-green to black. Some dunite, especially that containing chromite lenses, has a light greenish tan color, in part resulting from serpentinization. Olivine grains are less than 2 mm in diameter in most specimens, although a few dunites have a grain size of 5 mm or more. Chrome spinel (chromite) is generally visible as sparse black grains in amounts of a percent or less. The layering is most commonly shown by bands of dunite from one to several inches thick that contain more abundant chromite than the surrounding rock. The best chromite "ore" consists of numerous closely-spaced layers up to 2 inches thick containing 50 to 75% chromite, separated by similar or slightly greater thicknesses of normal dunite. Layering is also expressed by "beds" of dunite from a few inches up to many tens of feet thick inter-layered with peridotite, and by thin (½ inch) layers of pyroxenite in some dunite and olivine-rich peridotite. "Graded bedding" is noticeable in some chromite layers.

The gabbro varies widely in color index, from dark gray mafic gabbro, difficult to distinguish from some altered dunite and peridotite, to light greenish-gray rock which in one exposure is banded in layers one half to several inches thick. The grain size is generally about two millimeters. Cloudy white plagioclase and pale to medium green pyroxene are the major constituents, in grains one to four millimeters in length. Layers up to several inches thick composed wholly of pyroxene are present in the layered gabbro exposures in the SW quarter, section 22, T16N-R1E. This gabbro layer is about 30 feet thick and is overlain and apparently also underlain by peridotite.

In a few localities, cross-cutting veins or dikes of peridotite and dunite a few inches to a foot wide were noted.

In thin section, the pyroxene is seen to be all clinopyroxene except in a few samples. The clinopyroxene is unusual in having lamellae (apparently of orthopyroxene) and a parting parallel to the (010) plane, which is also the optic plane, as determined by numerous universal-stage observations. Lamellae and a parting along the (100) plane are also present in many grains. Optic angles of the clinopyroxene range from 50 to 60 degrees in six specimens of peridotite and dunite studied. The orthopyroxene lamellae in one specimen have an optic angle of ~84°, indicating a composition of about En_{85}.

Olivine in the peridotite is typically in smaller grains (1-3 mm in diameter) than the clinopyroxene. In some dunites the grains are up to 5 mm in diameter. Universal stage measurements indicate a composition of Fo_{85-90} in the peridotite and Fo_{90-100} in the dunites. Strained, slightly deformed grains and partial serpentinization along fractures are common in the dunites.

Orthopyroxene as separate grains was found only in three peridotite specimens, all containing 5% or less of the mineral. The orthopyroxene is visible as small dark brown grains in hand specimen, and was detected only in the peridotite in the NW quarter of Section 26, T16N-R1E, and immediately adjacent outcrops to the northwest. A composition of En_{90} is indicated by an optic angle measurement on one sample.

Chromite or chrome spinel is present in all peridotite and dunite as euhedral to subhedral equant grains. In most specimens the mineral is opaque except on thin edges, where it is dark brown to very dark brown. In specimens of banded chromite, it is translucent medium brown in color.

Serpentine accompanied by secondary magnetite is common as an alteration product of olivine. In general, the ultramafic rocks are relatively unaltered compared to most serpentinites described in the literature. A few cross-cutting veinlets of chrysotile were observed, but they are quite sparse and all chrysotile was relatively brittle.

Traces of native copper and a silvery white or yellowish mineral were seen in many sections of the peridotite. In most cases the copper was in or adjacent to incipient fractures, associated with minor amounts of serpentinization, and is presumed to be epigenetic. Small amounts of gold were recovered from one specimen while attempting to pan chromite from a dunite (see Economic Geology), and probably are related to the copper in origin.

All thin sections of the gabbro disclosed completely saussuritized subhedral plagioclase, preventing any determinations of the plagioclase composition. The almost opaque character of the saussurite suggests that it is composed dominantly of fine-grained clinozoisite, indicating that the plagioclase was quite calcic.

Clinopyroxene in the gabbro is very similar in appearance to clinopyroxene in the peridotite, including the development of (010) lamellae. In a specimen of the thinly layered gabbro, bowlingite pseudomorphs after olivine are present. Varying amounts of actinolite are present in all the gabbro specimens, and small amounts of chlorite are present in most. Minor amounts of magnetite-ilmenite and leucoxene are typical.

The mapping was not detailed enough to trace compositional layers with any completeness. In section 26, T16N-R1E, layers 10 to 50 feet thick were followed for a few hundred feet but could not be traced across areas of poor outcrop. It is not known whether the disappearance of the layers was caused by lensing out, faulting, or some other structural complexity.

The contact of the ultramafic rock with the country rock was observed in two localities, and in both cases is a fault. A half mile southwest of the Eklutna powerhouse, a zone of highly sheared and altered ultramafic rock and graywacke-argillite several hundred feet wide separates normal ultramafic rock from relatively undisturbed graywacke-argillite. Alteration consists of serpentinization and carbonatization of the ultramafic, and orange-weathering silica-carbonate alteration of both the ultramafic and graywacke-argillite country rock. Chloritization has also been strong in some country rock. Although this contact has clearly been the site of major fault movement after emplacement of the ultramafic, the ultramafic must have been intruded earlier along the same contact to cause the alteration of the graywacke-argillite.

On the Eklutna River (section 29, T16N-R1E) the contact is a fault marked by about 20 feet of sheared and gougy altered dunite. No unusual alteration of the country rock is evident at this locality. A similar lack of contact effects exists in other country rock exposures along the northwest side of the ultramafic body.

Dacite porphyry

Dacite porphyry grading to quartz diorite porphyry is exposed in two areas on Mount Eklutna, and also in the northwest quarter of section 1, T16N-R2E. The rock is typically light gray to gray-green and contains 20 to 50% phenocrysts of plagioclase up to a few millimeters in diameter, sparse hornblende phenocrysts of similar size, and a large proportion of fine hornblende needles in an aphanitic groundmass of gray to green color. In some localities the plagioclase is altered to clay. Thin section study shows that the plagioclase is sodic oligoclase, and that quartz is present in sparse largely resorbed phenocrysts and as finer grains constituting about half the groundmass. Plagioclase is the other main constituent of the groundmass.

The dacite porphyry is less shattered and altered than the ultramafic rocks and country rocks, and is therefore considered a younger hypabyssal intrusive, probably Tertiary in age. It occurs in dikes and small plugs. Distinct flowage foliation is present in some specimens.

A dike of rhyolite porphyry containing biotite phenocrysts cuts the ultramafic intrusive in the highway chromite area and may be related to the dacite porphyry.

Glacial deposits

Glacial drift and lateral moraine mantle most of the bedrock up to about 2500 feet elevation, which was apparently the highest level reached by the Pleistocene glaciers. Several hundred feet of glacial outwash gravels fill the valley of the Eklutna River from Eklutna Lake down to the point where the ultramafic body crosses the valley. Several distinct notches in the top of the ridge between the Knik River and the Eklutna River at an elevation of about 2500 feet were apparently cut by streams along the side of the glacier when it was at this level.

STRUCTURE

The regional tectonic trend changes from N20E about 25 miles southwest of the map area to N70E about 25 miles northeast of the map area. The N50E elongation of the ultramafic body evidently conforms to the regional trend. The gross lithologic units described in the section on sedimentary and volcanic rocks also seem to have this trend, although some bedding measurements, especially in the Eklutna tunnel, depart considerably from the presumed regional structure.

As noted previously, the sheared zone along the southeast contact of the ultramafic body was apparently the original contact of the intrusive. This shear zone passes approximately through the Eklutna powerhouse. Athern and Judd (1956) describe highly fractured and sheared rocks in the north end of the tunnel and in the powerhouse area, and logged peridotite in a few drill-holes near the powerhouse, but did not recognize the direction of the shear zone or the fact that it was the contact between ultramafic rocks and the graywacke-argillite country rock. They apparently regarded the ultramafic rocks as small dikes. The shear zone is doubtless responsible for some of the difficulties encountered in driving the north end of the tunnel. No evidence of recent fault movement was noted by the writer.

The northwest contact of the ultramafic is inferred to be formed of several faults of differing trend because of the lack of metamorphism in adjacent rocks and apparent variations in trend of the contact. It may be offset by a northwest-southeast cross-fault down the Eklutna valley.

The distribution of lithologic units and the attitudes of layering in the ultramafic body indicate that it is probably made up of several fault blocks. Ultramafic rocks in T16N-R1E, sections 22, 24, 26, 27, and possibly 32, generally have moderate dips to the east and northeast and are interpreted as a single block. Within the block, the peridotite in the northwest corner of section 26 grades upward through a zone of interlayered peridotite and dunite into a thick zone composed mainly of dunite with occasional chromite layers (see cross-section, figure 2).

A second fault block in which the layers dip nearly vertically is exposed along the highway. The interlayering of dunite and peridotite, with occasional chromite-bearing zones in the dunite, indicates that layers in this block may be rotated equivalents of those in the first block.

A third fault block of gabbro and peridotite with dips opposite to the first block is present in the southwest part of section 22. The presence of gabbro suggests that this is a part of the ultramafic body not represented in the other two fault blocks.

The attitude of the rocks on Mt. Eklutna indicates that they may be a part of the first fault block. However, the large separation and the presence of gabbro make this correlation very tentative.

As seen on the cross-section (figure 2), the structure in the first block indicates that most of the dunite overlies the peridotite. Similar conclusions can be reached for the blocks along the highway and in the Mt. Eklutna area. In the latter area, peridotite appears to overlie gabbro. This sequence is the reverse of that expected from differentiation by crystal settling. Either the body was formed in the normal sequence with the mafic rocks at the base, and subsequently was overturned, possibly during cold intrusion into its present site, or it formed from a magma progressively enriched in mafic components by injections of additional mafic material from depth, as suggested for ultramafic bodies in southeastern Alaska (Ruckmick and Noble, 1959).

Many exposures near the highway are cut by a well-developed system of fractures and shears dipping shallowly to the southeast. Fracturing of this sort was not noted elsewhere in the area. The location and attitude of this shearing may indicate northwestward thrusting of the Chugach Mountains block over the Matanuska Valley-Cook Inlet block.

Athern and Judd (1956) show a group of northwest-striking faults near the Eklutna tunnel, but as the faults do not offset contacts between units, they are presumed to have had very little movement.

ECONOMIC GEOLOGY

Chromite prospects

The program of trenching and drilling carried out by the U.S. Bureau of Mines has been described by Bjorklund and Wright (1948). This work was done in two areas, the Highway area and the Pioneer Creek area (figure 2).

In the Highway area, chromite lenses are exposed in a road cut near the west boundary of section 13, T16N-R1E. The location is at mile 31.4 from the present mileposts. The Bureau of Mines excavated 10 trenches across the trend of the chromite-bearing zone, which strikes about N10E and dips vertically to 70° west. Graded bedding in the chromite lenses suggests that the layering is right side up. The chromite-bearing zone in the road cut is about 8 feet thick and averages 11.5% Cr_2O_3. One band 0.7 feet thick contains 25.8% Cr_2O_3. The remainder of the zone consists of parallel stringers or beds from 1/4 to 1 inch thick. Within the stringers and lenses, euhedral chromite grains 1-2 millimeters in diameter make up 50 to 75% of the rock, and are separated from each other by olivine and minor clinopyroxene. The trenches show that the zone of discontinuous lenses and stringers continues up the slope to about 175 feet from the road, but the zone was not found in the highest trenches 225 feet from the road. Minor faults with north-northwest strike offset the chromite layers by a foot or two. The grade of chromite in the upper trenches is lower than that in the road cut. A drillhole to test the downward extension of the zone at a depth of 170 feet below the uphill end did not encounter any chromite-rich material. The trenches are now caved and overgrown and are difficult to find.

In attempting to concentrate chromite from a sample of the road cut material, numerous grains of gold up to 20 mesh in size were found in the heavy mineral concentrate from about 2 cubic inches of banded chromite-rich rock. A new sample of about a cubic inch yielded several more grains of gold. Small nuggests of native copper were also obtained (see discussion under rock types). Resampling of this locality is desirable but has not been possible because of snow cover prior to the preparation of this report.

In the present mapping project, chromite lenses and stringers were found in dunite in the road cuts a few hundred feet east of the trench area and about 500 feet west of the trench area. The chromite-bearing rock at these localities is similar in appearance to the material at the trench area, but in neither case were the limits of the chromite-bearing rock completely exposed.

In the Pioneer Creek area, two zones of chromite-rich rock are present (Bjorklund and Wright, 1948). The lower zone, at an elevation of 900 feet, strikes about N50W and dips 37 to 78° NE. The occurrence of the chromite as discontinuous stringers and lenses of chromite grains separated by olivine is similar to the Highway area. The lower zone on Pioneer Creek was traced for about 50 feet in outcrops and trenches, but was not found by Bjorklund and Wright (1948) in several trenches 50 to 150 feet to the east. The best exposure assayed 7.5% Cr_2O_3 across 13.5 feet.

In the more southerly zone of Pioneer Creek, at an elevation of 1150, chromite bands strike about N10W and dip 35° NE. The zone was traced for about 80 feet in trenches and has a maximum width of 30 feet, but could not be found in nearby outcrops, although none are exactly on the apparent projection of the zone (Bjorklund and Wright, 1948). Some dunite in this vicinity is highly fractured, and some zones have the appearance of a breccia, suggesting that blocks of dunite and dunite talus have moved down slope. This behavior may explain the lack of persistence of the chromite-bearing zones on Pioneer Creek, and also several aberrant dips taken in this area.

During this project, chromite-rich zones similar to those trenched by the Bureau of Mines were found at three other localities, as shown in figure 2. In section 26, T16N-R1E, a zone about 10 feet thick contains numerous beds of chromite-rich dunite up to an inch thick. Chips collected across the ten-foot zone contained 7.93% Cr_2O_3. The olivine in this zone of banded chromite-rich rock weathers greenish-yellow rather than the normal orange-brown color of the dunite, and a thin section disclosed that much of the olivine has been altered to serpentine. This difference in the weathered color was noted in several other chromite-rich zones. The zone of chromite-rich rock could be traced for about 30 feet before it was covered by talus. The country rock is nearly all dunite. Several pieces of float containing about 90% chromite and up to 4 inches in diameter were found in this vicinity.

Similar zones of dunite containing chromite-rich bands were found in section 32, T16N-R1E (on the ridge between Eklutna and Thunderbird Creeks), and on the west slope of Mt. Eklutna. The exposures at these localities are not good but neither the exposures nor the float suggests that the material is any different from that described above. The chromite on Mt. Eklutna may be the source of the U.S. Geological Survey report of chromite on Peters Creek (Martin, 1920).

The layering and bedded character of the chromite-rich zones and of the enclosing dunite and peridotite suggests that the chromite has settled out of an ultramafic or very mafic magma by the classical crystal-settling process. The lack of continuity of the chromite layers may result from erratic and sporadic currents in the magma which allowed the heavy chromite grains to settle out only in certain areas, plus local scour and fill effects. Although the low grade and small size of the presently known chromite occurrences are not encouraging, there may be zones where thicker and more continuous bodies of high grade chromite have accumulated and been preserved. Some additional prospecting in the dunite areas of the intrusive seems justified, especially on the northeast slope of Mt. Eklutna, which was not mapped in this project.

Analyses of high grade samples given by Bjorklund and Wright (1956) and Picotte (1942) indicate Cr/Fe ratios between 2 and 3. Two analyses of concentrates made during this project indicate similar ratios (table 1). Ore-grade material containing chromite of this type should be readily salable. Chromite ore prices at present range from about $20/ton for ore containing 44% Cr_2O_3 to $35/ton for 50% Cr_2O_3, but have been somewhat higher in the last few years.

Table 1

Analyses of chromite concentrates

Sample	Cr	Fe	Cr/Fe
5E-173	32.67	15.58	2.1
5E-632	35.12	12.56	2.8

Sample 573 concentrated from 10 foot zone of banded chromite averaging 7.93% Cr_2O_3 in section 26, T16N-R1E. Sample 5E632 from a piece of massive chromite float in the same area.

Lead-zinc prospect, Mt. Eklutna

According to Landes (1927), lead-zinc showings have been prospected "in the face of the cliff between Peters and Eklutna Creek", in a slight draw at an elevation of 1500 feet. This is apparently near the boundary between sections 1 and 2, T15N-R2E. This area was not visited in this project. According to Landes (1927), the country rock is greenstone with a considerable amount of associated rhyolite, which could be the dacite porphyry of Eklutna Mountain described earlier. The rock in the vicinity of the mineral deposit has undergone considerable silicification. At one point the rock is reported to be impregnated with scattered crystals and small masses of arsenopyrite, pyrite, sphalerite, and galena across a width of 3 feet. At a slightly lower elevation the rock is cut by a vein less than two inches wide containing scattered bits of sphalerite, galena, and chalcopyrite in a calcite gangue. According to Landes (1927), at neither of these places are there sufficient base metal minerals exposed to encourage development work.

Cinnabar

According to Athern and Judd (1956), a very small kidney of cinnabar in a fault gouge zone was uncovered in the tunnel between Eklutna Lake and the Eklutna powerplant. According to the map of the tunnel, the cinnabar-bearing fault zone was exposed about 300 feet from the north end of the tunnel over a length of about 10 feet. Several other cinnabar occurrences have been prospected in the Eklutna River drainage, and also farther southwest near Turnagain Arm, but there is no record of the exact location or extent of any of these occurrences.

Gold

Some placer mining for gold is reported to have been done on Peters Creek, but the location of this work is not known to the writer. Capps (1916) reports several prospects on quartz veins adjacent to the Peters Creek glacier.

The presence of gold in a sample of banded chromite-bearing dunite has been mentioned in the discussion of the Highway area chromite showings.

Limestone

The thickest limestone bed in the southeast corner of section 21, T16N-R1E, was only 10 feet thick. However, it is possible that slightly thicker beds are present in this part of the section and could be of value for agricultural purposes or other small-volume uses requiring a local supply. Thin limestones have been reported from the northwest front of the Chugach-Kenai Mountains near Anchorage (Miller and Dobrovolny, 1959), and near Skilak Lake, and may be part of the same stratigraphic unit.

Jade

A local prospector reports finding jade in the Peters Creek drainage, but the exact location and geologic occurrence are not known.

GEOCHEMISTRY

Twenty-two stream sediment samples were collected in the map area, some by the writer and assistant, and some by Martin Jasper, mining engineer of the Division, on a regional sediment sampling program (Jasper, 1966). Analyses are listed in table 2. The samples were analyzed in the field for readily-extractable heavy metals by the procedure described by Hawkes (1963). Total copper, zinc, lead, molybdenum, and nickel were determined by Rocky Mountain Geochemical Laboratories of Salt Lake City, Utah, after sieving to -80 mesh.

Table 2

Analyses of stream sediments and panning concentrates

Values in parts per million except field test
and Cr contents of concentrates

Map No.	Field No.	Field test	Cu	Zn	Pb	Mo	Ni	Cr (conc.)
1	5E160							8%
2	5E201	3 ml.	50	135	10	3	600	13%
3	5F19	1 ml.	40	80	5	3	250	
4	5F44	4 ml.	45	140	15	3	40	
5	5E202	3 ml.	35	135	10	2	60	0.7
6	5F43	4 ml.	25	105	10	3	30	0.4
7	5F10	1 ml.	65	160	20	3	70	
8	5E206	2 ml.	60	170	15	1	80	
9	5E198	2 ml.	35	75	5	3	150	3
10	5F22	0 ml.	40	120	15	4	145	6
11	5F23	12 ml.	35	115	15	3	65	
12	5F24	9 ml.	20	100	15	4	80	115
13	5F25	3 ml.	30	105	10	3	60	
14	5N289	1 ml.	35	130	10		110	2
15	5E611	4 ml.	25	120	10		60	
16	5E615	4 ml	35	105	10		125	
17	5N295	1 ml.	35	110	10		160	
18	5N290	1 ml.	35	135	10		60	1.5
19	5N291	2 ml.	75	170	15		55	0.4

20	5N292	0 ml.	55	170	20		55	0.5
21	5F20	1 ml.	35	125	15	4	65	
22	5F21	1 ml.	35	85	10	3	55	

Copper, zinc, lead, molybdenum and nickel analyses by Rocky Mountain Geochemical Laboratories. Field tests by cold-extractable heavy metal procedure of Hawkes (1963). Chromium content by semi-quantitative X-ray fluorescence method.

No definite anomalies in copper, zinc, lead, and molybdenum are recognized. Samples 7, 8, 19, and 20 contain slightly higher than average copper, zinc, and lead values probably reflecting the presence of different rock types in the southeastern part of the area.

Samples 2, 3, 9, 10, 14, 16, and 17 are anomalous in nickel. Ultramafic rocks typically contain many hundred to several thousand parts per million nickel, and the high values in the stream sediments are most likely produced by the ultramafic rocks rather than nickel ores. Except for sample 16, ultramafic rock is known to be present in the drainage basin of all the nickel-rich samples. The high nickel value in sample 16 indicates that the ultramafic body probably extends onto the nose between Peters Creek and Little Peters Creek. Only two small gabbro outcrops were seen on Peters Creek, but gabbro and ultramafic rocks may be present in the intervening areas of no exposure. Nickel deposits associated with ultramafic intrusives normally contain considerable copper, and the lack of any copper anomalies makes it seem unlikely that nickel deposits are the cause of the nickel anomalies.

As nickel anomalies were found in essentially all samples from streams draining ultramafic rocks, nickel analyses of stream sediments are recommended as a means of detecting ultramafic intrusives in regions of incomplete geologic mapping of poor exposures.

An alternative reconnaissance method for detection of ultramafic intrusives is analysis of panning concentrates for chromium. Sediment from the surface layer of many of the stream beds in the area was panned in the field, and the heavy mineral concentrates were brought back to the lab and further purified using bromoform (sp. gr. 2.9). The concentrates were then analyzed for chromium using a semi-quantitative x-ray fluorescence procedure. Results are shown in table 2. All samples from drainages containing ultramafic rocks have 1.5% chromium or more. Background is 0.3 to 0.7% chromium, based on samples shown in table 2 and about 20 others from the Chugach-Kenai Mountains (Jasper, 1966). Sample 18 is an apparent exception, containing a slightly anomalous chromium content. Because most of this drainage has not been mapped, some ultramafic rock may be present in it.

Analysis of the panning concentrates for chromium appears to be a more sensitive means of detecting ultramafic intrusives than the nickel content of total stream sediment. Samples 12 and 18 are background in nickel content but weakly anomalous in chromium. The chromium anomalies in samples 9 and 10 are more distinct than the nickel anomalies. Unfortunately, the panning and heavy liquid concentration procedure are somewhat more time-consuming than the collection procedure for the total stream sediment, but the improved results may justify the additional effort.

ULTRAMAFIC ROCKS IN THE CHUGACH-KENAI MOUNTAINS

In other regions, deposits of chromite, copper-nickel sulfides, platinum, asbestos, iron, and mercury are associated with ultramafic intrusives. It is therefore of some value in exploration for these deposits to know the location and distribution of the ultramafic rocks. The accumulated evidence from various mapping projects and unpublished reports indicates that a zone or belt containing ultramafic intrusives is present along the north and northwest margin of the Chugach-Kenai Mountains and extends onto Kodiak Island in a similar tectonic environment.

At Spirit Mountain, southeast of Chitina, Kingston and Miller (1945) record the presence of "eastward-trending discontinuous peridotite and pyroxenite bodies" which are sill-like in form relative to the intruded Carboniferous metamorphic rocks. Copper-nickel sulfide deposits are present in some of the peridotite and pyroxenite bodies.

Ragan and Grybeck (1965) report two small dunite masses near Tonsina where the Richardson Highway crosses the northern margin of the Chugach Mountains. Two chromite prospects are also known in this area (Cobb, 1960).

There is no published information indicating the presence of ultramafic rocks between Tonsina and Eklutna but much of this zone is unmapped or mapped only in reconnaissance. However, residents of Palmer report serpentine in the upper drainage basin of Wolverine Creek. Also,platinum is present in placer gold concentrates from Metal Creek, which flows into the north side of the Knik River just below the terminus of the Knik Glacier (Smith, 1929). Chromite and ultramafic rocks have been found as float along the front of the Chugach Mountains near Anchorage, but these occur in the lateral moraine and have most likely been carried from the Eklutna intrusive by Pleistocene glaciers.

No indications of ultramafic rocks between Anchorage and the Seldovia area are known. In the Seldovia area, ultramafic intrusives at Red Mountain and Claim Point are well-known for their chromite deposits, which are similar to those of the Eklutna mass, but somewhat larger (Guild, 1942). Small tonnages of chromite have been mined from these bodies, but to date the mining has been profitable only during times of Government-supported prices. A nickel occurrence is also reported in this vicinity (Martin, Johnson and Grant, 1915, p. 231).

On Kodiak Island, four ultramafic intrusives have recently been discovered by G.W. Moore during a reconnaissance mapping program of the U.S. Geological Survey (Nolan, 1964 , p. A117). Small amounts of platinum are reported to be present in beach placers of western Kodiak Island in the vicinity of these ultramafic intrusives (Maddren, 1919).

SUGGESTIONS FOR PROSPECTING

Some additional prospecting for chromite deposits in the Eklutna intrusive seems justified. Prospecting should concentrate on the southwestern half of the body, as this area has received less attention both in this project and in previous work reported in the literature. Dunite is the favored host for the chromite-rich zones, and tends to occur along the southeast side of the intrusive. The known chromite -rich zones are traceable for at least short distances along strike, and this would likely be true of any additional zones.

Joesting (1942) found magnetite anomalies over chromite ore, but found larger anomalies associated with mineralogical and structural variations inthe intrusive. The magnetic method might be useful for tracing known ore bodies under cover, or for tracing the major units of dunite,peridotite, and gabbro, but an experimental survey would be needed to determine how well this would work. Gravity measurements have been used to discover chromite ore in Cuba (Davis, Jackson and Richter, 1960), but the steep topography and detailed coverage necessary would probably make this work difficult and expensive at Eklutna.

Prospecting for additional ultramafic intrusives and associated deposits of chromite, copper-nickel sulfides, asbestos, platinum, iron, and mercury is recommended along the north and northwest side of the Chugach-Kenai Mountains. The use of chromium in panned stream sediments and nickel in stream sediments appears to be a rapid and effective means of reconnaissance for the ultramafic instrusives.

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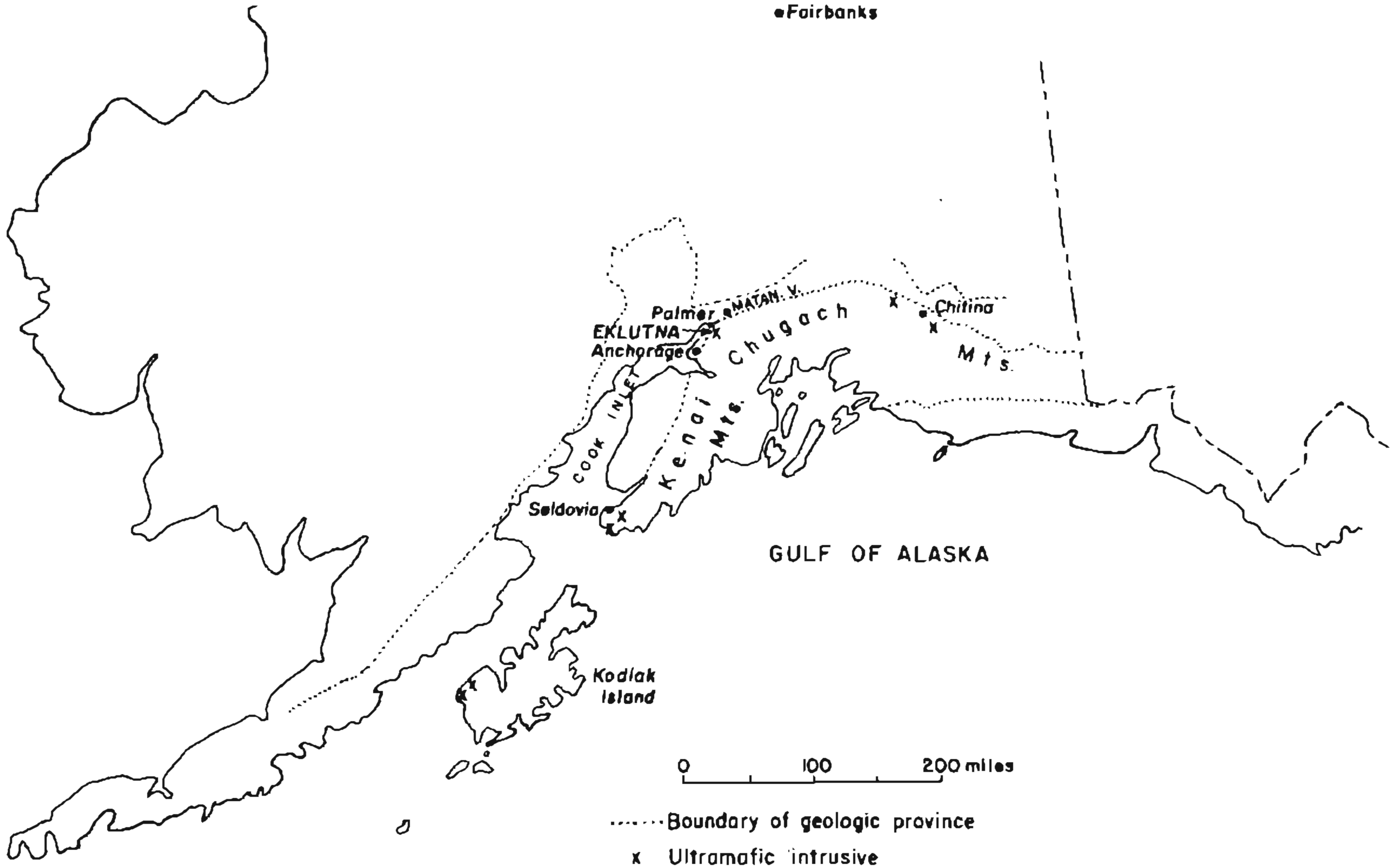

FIGURE 1. INDEX MAP

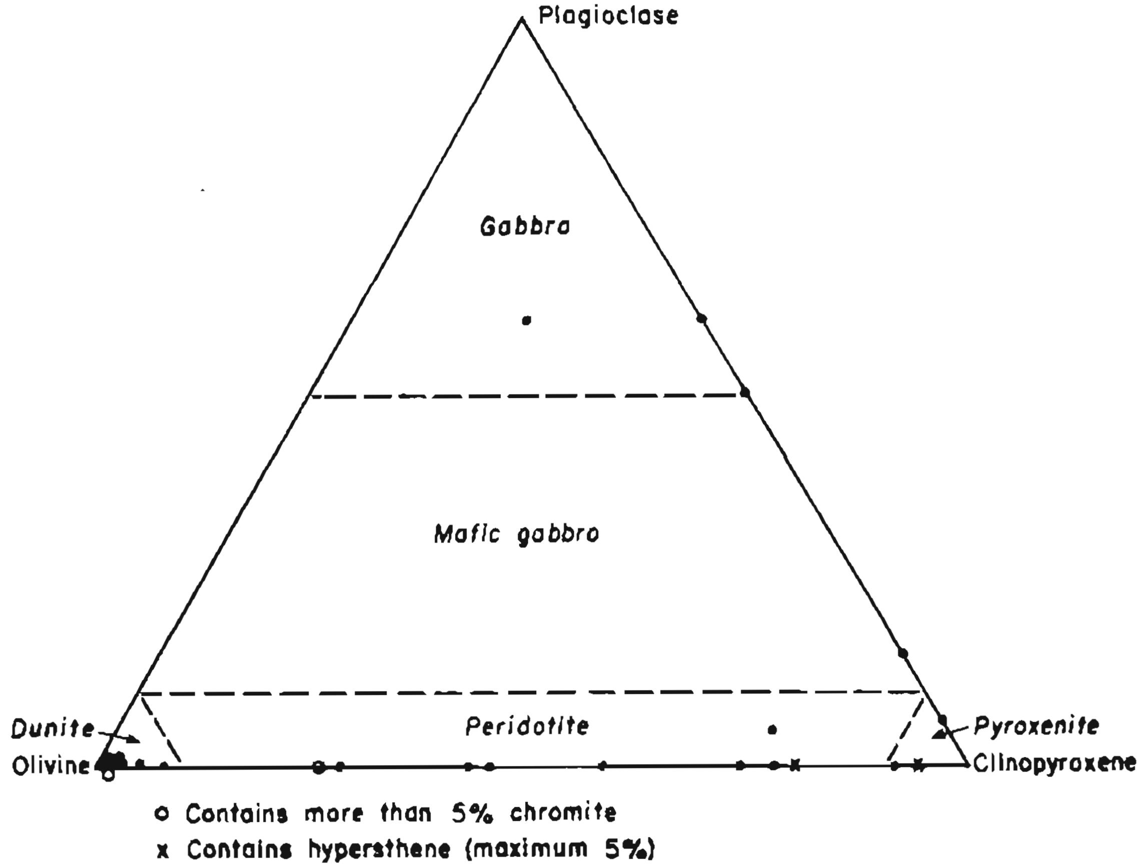

FIGURE 3. Composition of mafic and ultramafic rocks.