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Beneficiation of Potential Platinum Resources From Southeastern Alaska

By D. C. Dahlin, A. R. Rule, and L. L. Brown



UNITED STATES DEPARTMENT OF THE INTERIOR

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BENEFICIATION OF POTENTIAL PLATINUM RESOURCES FROM SOUTHEASTERN ALASKA

by

D. C. Dahlin,¹ A. R. Rule,¹ and L. L. Brown²

ABSTRACT

The Bureau of Mines conducted laboratory batch beneficiation tests on samples from four potential platinum resources in southeastern Alaska to concentrate platinum and other precious metals. This investigation was done as part of the mission of the Bureau to insure an adequate supply of minerals to meet the Nation's needs. Petrographic studies and beneficiation methods including gravity concentration, froth flotation, and magnetic separation were used to determine mineral association and to attempt to concentrate the platinum values with a primary mineral value such as chromite, copper sulfide, or magnetite. A high-graded sample from the Salt Chuck copper sulfide deposit yielded the best platinum-group metal concentrate; the maximum grade attained was 0.04 oz Pt and 1.5 oz Pd per ton of high-grade copper sulfide concentrate. The other samples yielded low-grade primary mineral concentrates with low platinum-group values, and/or the platinum-group metals did not concentrate with the primary mineral value.

INTRODUCTION

The platinum-group metals (platinum, palladium, rhodium, iridium, ruthenium, and osmium) have chemical and physical properties that are critically important in many industrial applications. The United States produces less than 1 pct of the platinum-group metals it consumes annually. Approximately 10 pct is refined from scrap and, consequently, the United States must import nearly 90 pct of its annual consumption. Nearly all of the world production comes from two countries, the Republic of South Africa and the U.S.S.R., and the dependence of the United States on foreign sources has strategic as well as economic implications. Although the United States has small reserves of platinum-group metals, its resources are large (5);³ most, however, are poorly explored or otherwise defined.

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³Underlined numbers in parentheses refer to items in the list of references at the end of this report.

The United States consumed an estimated 2.5 million troy ounces of platinum-group metals in 1979 (8). The automotive industry used the largest portion of the total, 40 pct, for catalysts in emission control devices. The electrical industry used 18 pct of the total consumption, and the chemical industry used 15 pct. Other significant users include the petroleum, dental and medical, glassware, and jewelry industries. The metals are used as chemical reaction catalysts; electrical contacts; medical and dental instruments, alloys, and drugs; laboratory and process equipment; and galvanic systems for corrosion protection. Potential use of platinum-group metals in solar power and fuel cell technologies could significantly increase domestic consumption.

U.S. production of platinum-group metals, all as a byproduct of copper mining, was estimated at 10,000 troy ounces in 1979 (8). This represents less than 0.2 pct of the estimated world production. The Republic of South Africa and the U.S.S.R. together accounted for 95 pct of world production, with Canada supplying most of the remainder. The United States imported nearly

90 pct of its annual consumption of platinum-group metals. This dependence on foreign sources creates a poor strategic position for this critical industrial metal and an adverse affect on the national balance of payments.

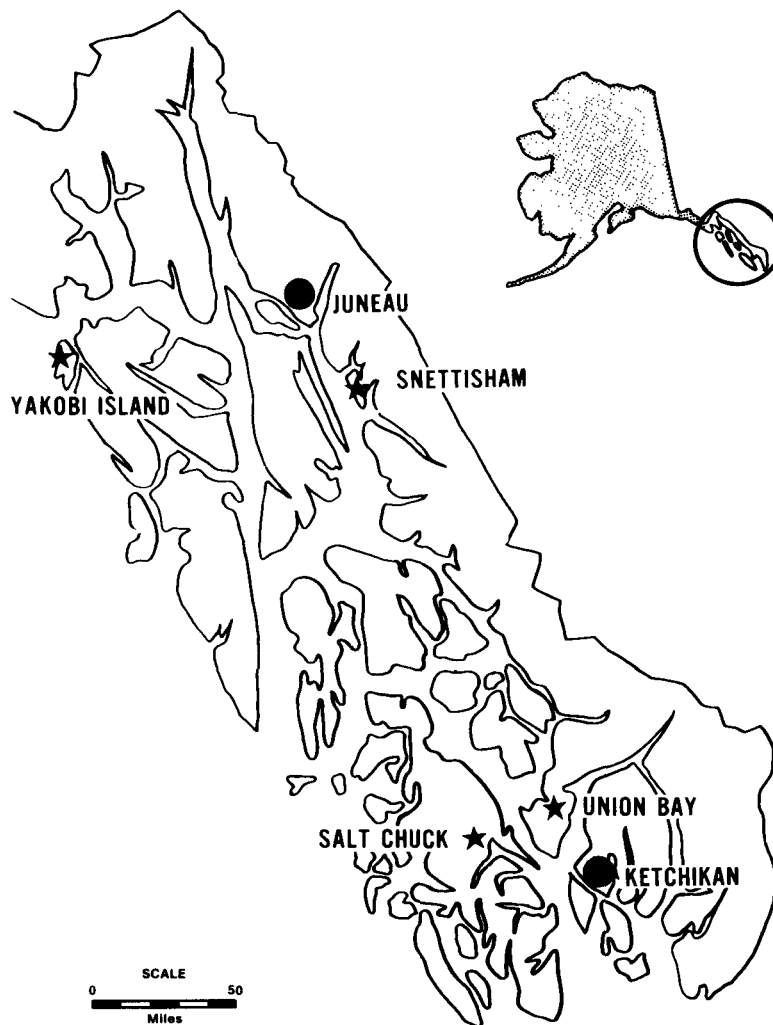


FIGURE 1. - Locations of the four sample sites in southeastern Alaska.

As part of its mission to insure an adequate supply of minerals to meet the Nation's needs, the Bureau of Mines has conducted research to identify potential platinum resources in the United States. Although U.S. production is unlikely to ever meet U.S. demand, the need and desirability of exploring for and evaluating potential platinum-group metals resources is evident. The Bureau of Mines is currently investigating platinum-group metals resources in the Stillwater Complex, Montana; the Duluth Gabbro, Minnesota; and the basic igneous rocks of the Pacific Northwest and Alaska. This report describes the potential of four sites in southeastern Alaska, shown in figure 1,

as platinum-group metals resources that may be recovered as byproducts with other valuable minerals.

Alaska has long been considered a resource for platinum-group metals (2, 6). Both placer and lode deposits have been identified. The mafic and ultramafic complexes in southern and southeastern Alaska have been studied as potential lode-type platinum deposits (1).

Samples from four mafic-ultramafic areas reported to contain platinum-group metals were obtained for petrographic and beneficiation tests. The samples were as follows:

1. Pyroxenite that contains copper sulfide from Salt Chuck.
2. Pyroxenite that contains titaniferous magnetite from Snettisham.
3. Dunite that contains chromite from Union Bay.
4. Pyroxenite that contains copper and nickel sulfides from Yakobi Island.

The Bureau of Mines has published reports of earlier work at Salt Chuck (4), Snettisham (7), and Yakobi Island (3). These reports describe comprehensive drilling and sampling programs and some beneficiation studies. Determination of platinum content and association in the materials was not considered in the reports on Snettisham and Yakobi Island, and it was not an important part of the Salt Chuck report. The present study examines the samples as potential platinum resources by determining platinum and palladium content, and by determining whether the platinum and other precious metals concentrate with the primary mineral values in the sample, such as sulfides, magnetite, or chromite. The precious metals content of the four samples in this investigation is very low, so their economic recovery would be as a byproduct of concentrating a primary mineral value. No attempts were made to recover the precious metals beyond producing the concentrates.

ACKNOWLEDGMENTS

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MATERIAL PREPARATION AND TEST PROCEDURES

The investigation was similar for each sample. Representative hand specimens were selected from as-received materials, and head samples and splits for beneficiation tests were prepared from the materials after they had been crushed to approximately minus 1/4-inch. Petrographic examination was done on hand specimens and beneficiation products to determine mineral identification and associations. Preliminary beneficiation tests were performed on 1- or 2-kg samples to develop effective procedures to concentrate the primary

mineral values, with which the platinum-group metals were associated. Large-scale batch tests using 10- or 20-kg samples were then performed to provide beneficiation products for precious metals analyses. Products were sent to the Bureau's Reno Research Center for determination of platinum, palladium, gold, and silver. Analyses were done by a fire assay-atomic absorption technique with a minimum level of detection of 0.001 oz/ton. Weight distributions of the beneficiation products and the small amounts of the precious metals present were such that very small changes in analyses caused large changes in distributions. Therefore, distribution data for the precious metals were not included in the metallurgical balances in this report.

SALT CHUCK SULFIDE

Location

Salt Chuck is a shallow, saltwater inlet located at the head of Kasaan Bay on Prince of Wales Island, about 45 miles northwest of Ketchikan. A mine and a mill operated at this location intermittently from 1905 to 1941; the mill is now in ruins.

Platinum-group metals were reported to be associated with bornite, so sampling was done by high-grading for bornite. The intent was to determine platinum occurrence, not to determine average grade of the deposit. Waste rock and blast debris were selected from the waste dumps to the north and northeast of the glory hole, from the eastern flank of the deposit and from the mill waste dump. No attempt was made to segregate the samples.

Petrography

Petrographic examination of representative hand specimens showed the samples were medium-grained, sulfide-enriched pyroxenites. The rocks consisted essentially of pyroxene with some amphibole, chlorite, and bornite; a small amount of magnetite; very small amounts of feldspar, epidote, and malachite (as copper stain); and traces of pyrite and chalcopyrite. The bornite was randomly distributed in small to relatively large masses and showed some alteration to covellite. Head analyses of the sample are shown in table 1.

Electron microprobe examination was done on polished surfaces prepared from selected high-sulfide specimens. No platinum was found, but many very small grains of a palladium-tellurium mineral containing variable amounts of mercury were observed. These grains were included in and interfaced with sulfide minerals and, to a minor extent, also in the silicate gangue minerals. Minor amounts of silver and selenium were observed in the sulfide and palladium minerals.

TABLE 1. - Head analyses of four potential platinum resources
from southeastern Alaska

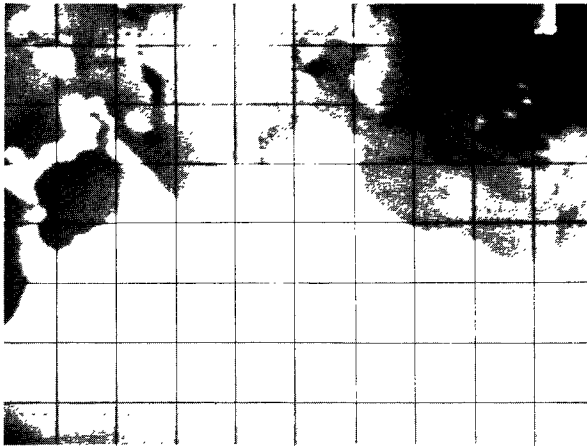
Constituent	Salt Chuck sulfide ¹	Snettisham titaniferous magnetite	Union Bay chromite	Yakobi Island sulfide
PERCENT				
Al ₂ O ₃	9.19	7.92	0.34	6.76
CaO.....	1.14	14.4	.41	8.13
Co.....	.01	.01	.01	.01
Cr ₂ O ₃10	.09	1.13	.10
Cu.....	2.36	.04	.01	.21
Fe.....	10.3	17.0	8.30	7.46
MgO.....	9.64	10.4	25.8	11.5
Ni.....	.01	.01	.14	.32
S.....	1.03	.27	.004	1.31
SiO ₂	41.5	36.5	41.1	50.0
TiO ₂	1.08	2.92	.45	.48
OUNCE PER TON				
Ag.....	0.6	0.2	² 0.011	0.1
Au.....	.2	2.006	2.003	2.003
Pd.....	.13	2.002	2.003	2.001
Pt.....	2.004	2.001	2.002	2.001

¹Sample contained 2.4 ppm Hg.

²Average calculated head analysis determined from individual tests. The element was not detected in the head sample.

Electron microprobe examination was also conducted on polished surfaces prepared from sulfide flotation concentrates. Figure 2 shows an electron backscatter image and microprobe X-ray scans for platinum, palladium, tellurium, and copper for a portion of the concentrate. Scans were also made for iron, aluminum, silicon, mercury, and sulfur but are not shown. The bright areas in each micrograph show the element concentrations. A platinum grain approximately 15 μm by 5 μm is seen at the interface between a copper sulfide and an iron-aluminum silicate. It is also associated with a palladium-tellurium grain that, in this instance, contains almost no mercury.

Electron microprobe quantitative analyses were made on a region of bornite and telluride association. The telluride contained 36.5 pct Pd, 38.7 pct Te, 22.8 pct Hg, 1.6 pct Cu, 0.2 pct Fe, and 0.1 pct S. The bornite contained 64.0 pct Cu, 11.3 pct Fe, 24.6 pct S, and less than 0.1 pct Te. Palladium and mercury were not detected in the bornite.

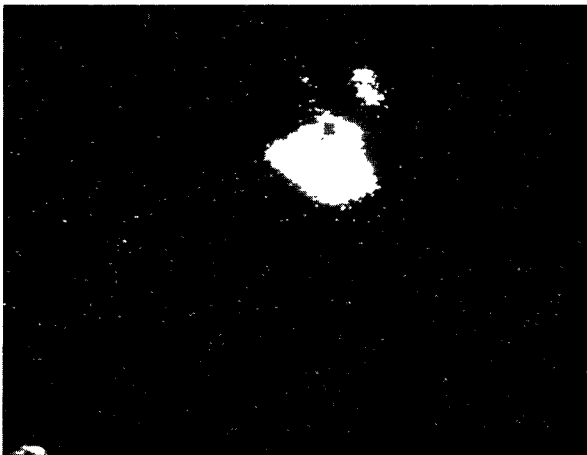


Specimen

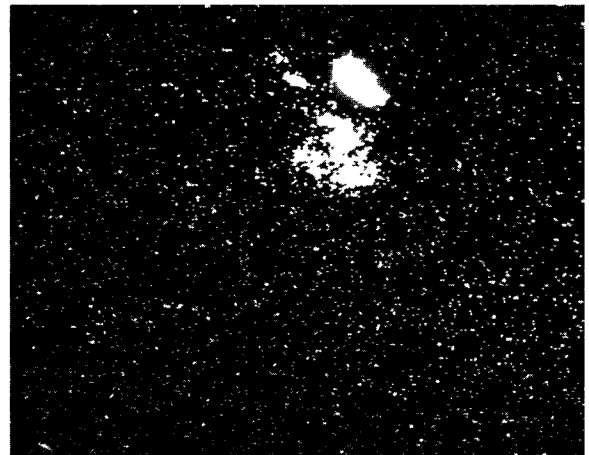
10μm



Platinum



Palladium



Tellurium



Copper

FIGURE 2. - Electron microprobe element displays of Salt Chuck sulfide concentrate. The grads are 10 micrometers square.

Beneficiation

Beneficiation tests were designed to concentrate the sulfide minerals and associated platinum-group minerals. Also, magnetic separation was investigated to determine whether platinum-group metals concentrated in the magnetic fraction.

Small-scale exploratory tests were done, and the following procedure was designed for large-scale batch tests. A 10-kg sample was ground in a rodmill for 20 minutes at 50 pct solids. Grab samples indicated that the ground material was essentially minus 65 mesh, but a complete size analysis of the grind was not done. The ground pulp was conditioned with potassium amyl xanthate and a frother for sulfide flotation. In flotation, a rougher step and one or two cleaner steps were done to produce a high-grade copper sulfide concentrate. The rougher tailings and sometimes the first cleaner tailings from flotation were treated in a concurrent wet drum magnetic separator with a field intensity of 500 to 1,100 gauss. A final magnetic concentrate was produced from a rougher and a cleaner magnetic separation step.

Results from a typical test using this procedure are shown in table 2, and table 3 shows the conditions and reagents used in the flotation step. The sulfide flotation cleaner concentrate analyzed 43.8 pct Cu with recovery of 93 pct of the copper and contained, per ton, 0.036 oz Pt, 1.5 oz Pd, 1.1 oz Au, and 6.4 oz Ag. The magnetic cleaner concentrate analyzed 61.4 pct Fe with recovery of 43 pct of the total iron and contained, per ton, 0.003 oz Pt, 0.013 oz Pd, 0.005 oz Au, and 0.035 oz Ag.

TABLE 2. - Sulfide flotation and magnetic separation of Salt Chuck sulfide

Product	Weight, pct	Analyses, pct			Analyses, oz/ton			
		Cu	Fe	S	Pt	Pd	Au	Ag
Flotation cleaner concentrate	5.6	43.8	9.5	20.0	0.036	1.5	1.1	6.4
Flotation cleaner tailings...	.3	3.37	11.4	1.30	NA	NA	NA	NA
Nonmagnetic rougher tailings.	85.6	.19	6.5	.04	.003	.032	.006	.021
Magnetic cleaner tailings....	.9	.26	7.4	.06	.003	.024	.038	.044
Magnetic cleaner concentrate.	7.6	.09	61.4	.01	.003	.013	.005	.035
Composite/totals.....	100.0	2.64	10.9	1.16	.005	.113	.067	.379
	Weight, pct	Distribution, pct						
		Cu	Fe	S				
Flotation cleaner concentrate	5.6	93.1	4.9	96.6				
Flotation cleaner tailings...	.3	.4	.3	.3				
Nonmagnetic rougher tailings.	85.6	6.2	51.2	2.9				
Magnetic cleaner tailings....	.9	.1	.6	.1				
Magnetic cleaner concentrate.	7.6	.2	43.0	.1				
Composite/totals.....	100.0	100.0	100.0	100.0				

NA Not analyzed; insufficient sample for analysis.

TABLE 3. - Conditions and reagents for Salt Chuck sulfide flotation

Operation	Conditions		Reagents, lb/ton of flotation feed
	Time, min	pH ¹	
Conditioning.....	2.5	9.6	0.1 potassium amyl xanthate, 0.05 frother.
Rougher flotation....	6	ND	None.
Cleaner flotation....	6	9.0	None.

ND Not determined.

¹Natural pH = 9.5.

The data in table 2 show the platinum and palladium to be present in the flotation concentrate in approximately a 1:40 ratio. In the flotation concentrates from other tests, the platinum to palladium ratio ranged from 1:1 to 1:80. In this series of tests, the platinum content in the sulfide flotation cleaner concentrate ranged from 0.020 to 0.051 oz/ton, and the palladium content ranged from 0.046 to 1.6 oz/ton.

SNETTISHAM TITANIFEROUS MAGNETITE

Location

The Snettisham Peninsula is located on the south side of Port Snettisham and west of Gilbert Bay, about 30 miles southeast of Juneau. A titaniferous magnetite deposit extends along the northern shoreline. The composite sample for this study was collected in the area of an old mill site on the western end of the deposit. Representative material was taken from two small pits and from outcrops along the beach between the pits.

Petrography

Hand specimens from the deposit were medium- to coarse-grained pyroxenites consisting essentially of pyroxene with some magnetite and amphibole, small amounts of ilmenite, and small veins and random concentrations of pyrite with associated chalcopyrite and pyrrhotite. Smaller amounts of chlorite, epidote, actinolite, quartz, and calcite occurred in veins and alteration halos. Random feldspar and apatite crystals also were observed. Magnetite and ilmenite grains were intergrown with the ferromagnesian silicates. Head analyses of the sample are shown in table 1.

Sulfide mineralization occurred in at least two stages. One accompanied the epidote alteration stage, and one accompanied the chlorite alteration stage. Some sulfide mineralization appeared to be random and may be primary.

A scanning electron microscope was used to examine polished surfaces prepared from magnetic and nonmagnetic sulfide concentrate products. No platinum-group metals or minerals were observed during microscopic examination.

Beneficiation

Beneficiation tests were designed for magnetic concentration of the magnetite and flotation of the sulfide minerals. Chemical analyses of beneficiation products indicated that the platinum and palladium concentrate with the sulfides.

For each large-scale batch beneficiation test a 10-kg sample was ground in a rodmill for 20 minutes at 50 pct solids. The ground pulp was treated in a concurrent wet drum magnetic separator with a field intensity of 500 to 1,100 gauss. The rougher magnetic concentrate was sized at 200 mesh, and the oversize fraction was stage-ground to about 85 pct minus 200 mesh. The rougher concentrate was then treated in two cleaner magnetic steps to produce the second cleaner magnetic concentrate. The second cleaner magnetic step was

done primarily to improve the grade of the magnetic concentrate and the second cleaner nonmagnetic tailings were considered, at the time of the tests, to be low in sulfides. Subsequent chemical analyses indicated that they, too, should have been included in the sulfide flotation feed. The rougher and first cleaner tailings from magnetic separation were conditioned with potassium amyl xanthate and a frother, and a single flotation step was done to produce a sulfide concentrate.

Results of a test using the above scheme are shown in table 4, and table 5 shows the conditions and reagents used in the sulfide flotation step. Platinum did not concentrate with the primary mineral value, magnetite, but it concentrated with the sulfide fraction. The sulfide concentrate contained 2.32 pct Cu, 31.9 pct Fe, and 33.5 pct S with recovery of 62 pct of the copper, and it contained, per ton, 0.02 oz Pt, 0.03 oz Pd, and 0.03 oz Au. The second cleaner magnetic concentrate contained 63.2 pct Fe and 3.77 pct TiO₂ with recovery of 58 pct of the total iron. Platinum and palladium were not detected in the magnetic concentrate.

TABLE 4. - Magnetic separation and sulfide flotation of Snettisham titaniferous magnetite

Product	Weight, pct	Analyses, pct				Analyses, oz/ton			
		Fe	TiO ₂	Cu	S	Pt	Pd	Au	Ag
Second cleaner magnetic concentrate.....	15.7	63.2	3.77	0.01	0.08	ND	ND	0.01	0.01
Second cleaner nonmagnetic tailings.....	.6	13.6	6.85	.04	.35	ND	ND	.01	ND
Nonmagnetic flotation products:									
Sulfide concentrate.....	.7	31.9	1.60	2.32	33.5	0.02	0.03	.03	NA
Flotation tailings.....	83.0	8.2	2.49	.01	.03	ND	ND	Trace	ND
Composite/totals.....	100.0	17.0	2.71	.03	.27	<.01	<.01	<.01	<.01
	Weight, pct	Distribution, pct							
		Fe	TiO ₂	Cu	S				
Second cleaner magnetic concentrate.....	15.7	58.2	21.8	6.1	4.8				
Second cleaner nonmagnetic tailings.....	.6	.5	1.5	.8	.7				
Nonmagnetic flotation products:									
Sulfide concentrate.....	.7	1.3	.4	61.6	85.4				
Flotation tailings.....	83.0	40.0	76.3	31.5	9.1				
Composite/totals.....	100.0	100.0	100.0	100.0	100.0				

ND Not detected.

NA Not analyzed.

TABLE 5. - Conditions and reagents for sulfide flotation of Snettisham titaniferous magnetite

Operation	Conditions		Reagents, lb/ton of flotation feed
	Time, min	pH ¹	
Conditioning.....	2	7.2	0.15 potassium amyl xanthate, 0.05 frother.
Flotation.....	2	ND	None.

ND Not determined.

¹Natural pH = 7.1.

UNION BAY CHROMITE

Location

Union Bay is located on the northwest end of Cleveland Peninsula, about 35 miles north-northwest of Ketchikan. About 5 miles east of the bay, a large dunite outcrop is exposed on a mountain at an elevation of 2,535 feet. The dunite occurs as uniform, large masses cut occasionally by thin dikes of peridotite up to about 6 inches thick. Random samples were taken from the surface over an area approximately 100 yards by 30 yards near the middle of the exposure.

Petrography

The samples were medium-grained dunite consisting essentially of olivene with a small amount of associated chromite. Some of the samples were cut by small dikes or veins of enstatite. No sulfides were observed. Chromite was randomly distributed in the dunite as small euhedral crystals and in larger masses of crystals. In some cases the chromite masses stood out in relief as the result of erosion of the surrounding highly fractured olivene. Head analyses of the sample are shown in table 1.

Some of the chromite has an atypical response to magnetic separation; it is much more magnetic than is normal for chromite. Chemical analyses showed that it contains considerable chromium, yet it can be concentrated by a hand magnet. The analyses indicated that this chromite contains an excess of iron when compared with analyses of other chromites, and some of this iron may be present as magnetite or maghemite. However, optical and microprobe examination of polished surfaces of high-grade sections of the sample showed no zoning or compositional variations to explain the anomalous magnetic susceptibility.

Beneficiation

Gravity concentration and magnetic separation techniques were applied to produce chromite concentrates. From the results of exploratory tests, the following procedure was designed for large-scale batch tests. A 10- or 20-kg sample was ground for 20 minutes in a rodmill at 50 pct solids. Grab samples indicated that the ground material was minus 100 mesh. The ground slurry was pumped to a slime deck on a shaking table. A wide cut was made on the first pass to provide good recovery. The rougher concentrate was then retabled, and a narrower cut was made to improve concentrate grade. The cleaner table concentrate was treated in a concurrent wet drum magnetic separator with a field intensity of 500 to 1,100 gauss to separate a magnetic fraction from a nonmagnetic fraction.

Results from a typical test are shown in table 6. The platinum concentrated in the magnetic fraction of the cleaner table concentrate at a grade of 0.032 oz/ton Pt. The concentrates do not meet any chromite specifications. The magnetic cleaner table concentrate analyzed 29.4 pct Cr_2O_3 and 40.1 pct Fe with recovery of 5 pct of the chromium. The nonmagnetic cleaner table concentrate analyzed 39.6 pct Cr_2O_3 and 27.0 pct Fe with recovery of 42 pct of the chromium.

TABLE 6. - Tabling and magnetic separation of Union Bay chromite

Product	Weight, pct	Analyses, pct		Analyses, oz/ton				Distribu- tion, pct		Cr/Fe ratio
		Cr ₂ O ₃	Fe	Pt	Pd	Au	Ag	Cr ₂ O ₃	Fe	
Magnetic cleaner table concentrate.....	0.2	29.4	40.1	0.032	0.001	<0.003	0.039	4.9	1.0	0.50
Nonmagnetic cleaner table concentrate....	1.3	39.6	27.0	.002	.006	<.002	.016	42.3	4.3	1.00
Cleaner table tailings	6.0	3.0	9.0	.003	.001	<.001	.011	14.8	6.7	
Rougher table tailings	92.5	.5	7.7	.003	.001	<.001	.033	38.0	88.0	
Composite/totals.	100.0	1.2	8.1	.003	.001	<.001	.031	100.0	100.0	

YAKOBI ISLAND SULFIDE

Location

Yakobi Island is located approximately 75 miles west of Juneau and 75 miles north of Sitka. The Bohemia Basin, the area from which the sample was taken, lies on the east side of the island, about midway between the north and south ends. The sample was taken from an existing adit. A layer of oxidized material was removed from the adit wall prior to sampling freshly exposed surfaces.

Petrography

The sample, as received, was already crushed to approximately minus 1/4-inch, so hand specimens were not available for rock characterization. The sample, probably a peridotite, consisted essentially of pyroxene with small amounts of pyrrhotite, pentlandite, chalcopyrite, and quartz, and traces of bornite and nickeliferous pyrite. Head analyses of the sample are shown in table 1.

Spectroscopic examination of products from magnetic separation of a sulfide flotation concentrate revealed a relatively high nickel content in the nonmagnetic fraction. Subsequent examination with a scanning electron microscope showed that the sulfide mineral is nickeliferous pyrite that contains about 17 pct Ni. Platinum group minerals were not detected in the microscopic examination.

Beneficiation

Beneficiation tests including sulfide flotation and magnetic separation were designed to concentrate the copper and nickel sulfides. A series of small batch flotation tests was done to determine conditions for good flotation. Reagent schemes in acid, alkaline, and neutral circuits were tested. The general procedure was to grind the sample to minus 100 mesh in a rodmill, condition the pulp at about 40 pct solids, and make a rougher and one or two cleaner sulfide floats.

Best results occurred when lead acetate was used as an activator in an alkaline circuit, and potassium hexyl xanthate was used as the sulfide collector. This scheme was used in large-scale batch flotation tests.

In one test, a 10-kg sample was ground in a rodmill for 30 minutes at 50 pct solids. Size analysis of a grab sample of the ground material showed it to be about 90 pct minus 200 mesh, but sizing of a representative sample was not done. Conditioning and flotation were done as described above. The flotation concentrate and

three flotation tailings fractions were treated separately in a concurrent wet drum magnetic separator with a field intensity of 500 to 1,100 gauss. The magnetic concentrates from the first and second cleaner flotation tailings and the second cleaner flotation concentrate were combined as one product (magnetic flotation products) for chemical analyses.

The results of the test described above are shown in table 7, and the conditions and reagents used in the flotation step are shown in table 8. The nonmagnetic second cleaner flotation concentrate contained, per ton, 0.005 oz Pt, 0.008 oz Pd, 0.04 oz Au, and 0.1 oz Ag, and it analyzed 3.78 pct Cu, 3.19 pct Ni, and 0.09 pct Co with recoveries of 78 pct of the copper, 52 pct of the nickel, and 28 pct of the cobalt.

TABLE 7. - Bulk flotation and magnetic separation of Yakobi Island sulfide

Product	Weight, pct	Analyses, pct				Analyses, oz/ton					
		Cu	Ni	Fe	Co	S	Pt	Pd	Au	Ag	
Nonmagnetic second cleaner flotation concentrate.....	4.6	3.78	3.19	15.9	0.09	13.3	0.005	0.008	0.04	0.1	
Nonmagnetic second cleaner flotation tailings.....	.5	.80	2.08	10.6	.06	6.2	ND	ND	.01	.1	
Nonmagnetic first cleaner flotation tailings.....	2.8	.23	.37	4.9	.02	.9	ND	ND	ND	.1	
Nonmagnetic rougher flotation tailings.....	90.5	.04	.11	2.6	.01	.1	ND	ND	ND	ND	
Magnetic flotation products ¹	.5	.58	1.95	47.4	.04	34.4	.006	ND	ND	ND	
Magnetic rougher flotation tailings.....	1.1	.06	.76	29.7	.03	17.8	ND	ND	ND	ND	
Composite/totals.....	100.0	.22	.29	3.8	.01	1.1	<.001	<.001	<.01	<.1	
	Weight, pct	Distribution, pct									
		Cu	Ni	Fe	CO	S					
Nonmagnetic second cleaner flotation concentrate.....	4.6	77.7	51.6	19.0	28.1	54.3					
Nonmagnetic second cleaner flotation tailings.....	.5	1.8	3.5	1.4	2.1	2.7					
Nonmagnetic first cleaner flotation tailings.....	2.8	2.7	3.5	3.6	4.1	2.2					
Nonmagnetic rougher flotation tailings.....	90.5	16.1	35.1	61.3	62.3	8.1					
Magnetic flotation products ¹	.5	1.3	3.5	6.2	1.3	15.3					
Magnetic rougher flotation tailings.....	1.1	.4	2.8	8.5	2.1	17.4					
Composite/totals.....	100.0	100.0	100.0	100.0	100.0	100.0					

ND Not detected.

¹The products were magnetic second cleaner flotation concentrate, 70.8 pct; magnetic second cleaner flotation tailings, 18.8 pct; and magnetic first cleaner flotation tailings, 10.4 pct.

TABLE 8. -Conditions and reagents for bulk flotation of Yakobi Island sulfide

Operation	Conditions		Reagents, lb/ton of flotation feed
	Time, min	pH ¹	
Conditioning.....	3	9.5	1.2 CaO.
Do.....	3	8.9	0.5 Pb(C ₂ H ₃ O ₂) ₂ .
Do.....	2	8.7	0.1 potassium hexyl xanthate, 0.05 frother.
Rougher flotation.....	7	ND	None.
First cleaner flotation...	10	8.2	None.
Second cleaner flotation..	8	8.0	None.

ND Not determined.

¹Natural pH = 7.1.

CONCLUSIONS

Four samples of mafic-ultramafic deposits from southeastern Alaska were examined as potential platinum resources. Beneficiation schemes including gravity concentration, magnetic separation, and froth flotation were used to concentrate platinum-group minerals with a primary mineral value.

The Salt Chuck sulfide sample yielded a high-grade copper sulfide concentrate with 0.04 oz/ton Pt and 1.5 oz/ton Pd. Gold and silver also concentrated with the sulfide.

Although the primary mineral value of the Snettisham deposit is magnetite, platinum concentrated with the small sulfide fraction. A low-grade iron-copper sulfide concentrate was produced that contained 0.02 oz/ton Pt.

Platinum concentrated with the magnetic fraction of a table concentrate from the Union Bay chromite sample. The grade was 0.03 oz/ton of concentrate. Neither the magnetic fraction nor the nonmagnetic fraction of the table concentrate met any chromite specifications.

The Yakobi Island sulfide sample was beneficiated to a low-grade copper-nickel sulfide concentrate that contained 0.005 oz/ton Pt.

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BENEFICIATION OF POTENTIAL PLATINUM RESOURCES
 FROM SOUTHEASTERN ALASKA

by

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ERRATA

Corrected table 7 below should be used instead of the one that appears on page 12.

TABLE 7. - Bulk flotation and magnetic separation of Yakobi Island sulfide

Product	Weight, pct	Analyses, pct					Analyses, oz/ton			
		Cu	Ni	Fe	Co	S	Pt	Pd	Au	Ag
Nonmagnetic second cleaner flotation concentrate.....	4.6	3.78	3.19	15.9	0.09	13.3	0.005	0.008	0.04	0.1
Nonmagnetic second cleaner flotation tailings.....	.5	.80	2.08	10.6	.06	6.2	ND	ND	.01	.1
Nonmagnetic first cleaner flotation tailings.....	2.8	.23	.37	4.9	.02	.9	ND	ND	ND	.1
Nonmagnetic rougher flotation tailings.....	90.5	.04	.11	2.6	.01	.1	ND	ND	ND	ND
Magnetic flotation products ¹	.5	.58	1.95	47.4	.04	34.4	.006	ND	ND	ND
Magnetic rougher flotation tailings.....	1.1	.06	.76	29.7	.03	17.8	ND	ND	ND	ND
Composite/totals.....	100.0	.22	.29	3.8	.01	1.1	<.001	<.001	<.01	<.1
	Weight, pct	Distribution, pct								
		Cu	Ni	Fe	Co	S				
Nonmagnetic second cleaner flotation concentrate.....	4.6	77.7	51.6	19.0	28.1	54.3				
Nonmagnetic second cleaner flotation tailings.....	.5	1.8	3.5	1.4	2.1	2.7				
Nonmagnetic first cleaner flotation tailings.....	2.8	2.7	3.5	3.6	4.1	2.2				
Nonmagnetic rougher flotation tailings.....	90.5	16.1	35.1	61.3	62.3	8.1				
Magnetic flotation products ¹	.5	1.3	3.5	6.2	1.3	15.3				
Magnetic rougher flotation tailings.....	1.1	.4	2.8	8.5	2.1	17.4				
Composite/totals.....	100.0	100.0	100.0	100.0	100.0	100.0				

ND Not detected.

¹The products were magnetic second cleaner flotation concentrate, 70.8 pct; magnetic second cleaner flotation tailings, 18.8 pct; and magnetic first cleaner flotation tailings, 10.4 pct.