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MINERALOGICAL INVESTIGATION OF A PLACER SAND SAMPLE FROM THE TULAMEEN RIVER AREA, BRITISH COLUMBIA

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Mineral Sciences Division

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Mines Branch Investigation Report IR 73-29

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SUMMARY

The minerals of economic interest are iron-bearing platinum, tulameenite, platiniridium, and gold, all of which occur as liberated grains with respect to the silicate and oxide gangue. These can all be concentrated by gravity methods using heavy liquids, and one, tulameenite, can be further separated by means of a hand magnet. The platinum-group minerals contain some or several other metals such as Ir, Fe, Os, Ru, Cu, Ni and Sb in solid solution.

The assays for Au, Pt, and Ir on half of the sample are consistent with the mineralogy as determined on the other half.

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INTRODUCTION

The Mines Branch was approached by Dr. B.H. Levelton of B.H. Levelton and Associates, 1755 West 4th Avenue, Vancouver 9, British Columbia, to assay three suites of solutions and three ore samples for platinum, gold, and iridium and to undertake a mineralogical investigation of the ore samples that would come from three areas: Tulameen River (Peterson Hill), B.C., Similkameen River, B.C., and Alaska. The reason for these studies was twofold: firstly to determine the quantities of platinum, iridium, and gold in the samples as an independent impartial check by a method different from that used by B.H. Levelton and Associates Limited and, secondly, to obtain more mineralogical information on placer precious-metal concentrates as a guide to the working of certain placer deposits.

The study of the Similkameen and Alaska samples had been completed (Cabri and Moloughney, 1973) prior to receiving the Tulameen sample which was received on March 12, 1973.

DESCRIPTION OF THE SAMPLES AS RECEIVED

Dr. B.H. Levelton provided the following information in his letter, dated March 7, 1973.

1. Sand Sample 2785

   a) From classifier tests on screened Peterson Hill material. No concentration. The classifier sands represent 30.8% of the bank-run material and are minus 10 mesh, less slimes. The sample has been subjected to "light pulverizing".

   b) Assay results (on 5 assay tons) Au - 0.052 oz. per ton
      Pt - 0.013 oz. per ton
      Ir - trace

   c) The sand sample weighed 1,681 grams on receipt.

2. Liquid sample 2785

a) Total assay solution from 5 assay tons was 10 ml of which 5 ml had been used. Matrix is 0.5% NaCl, 2% $CuSO_4 . 5H_2O$, 500 ppm Fe.

b) Solution assay results Au - 26 ppm
Pt - 6.7 ppm
Ir - trace

METHODS OF INVESTIGATION AND MINERAL SEPARATIONS

1. Sand sample 2785

This sample was cut into two fractions marked 2785 A (850 g) and 2785 B (831 g).

a) 2785A 850 g.

This sample was separated into two fractions by a heavy liquid (sp gr 2.96) -- 743.1 g of float (silicate fraction) and 103.7 g of sink (heavy fraction). Each fraction was crushed in a mortar by hand to approximately minus 200 mesh and submitted for assay. The weights after crushing were: 679.1 g of silicate fraction and 98.5 g of heavy fraction. The small loss being due to air loss of fine dust.

The assay methods were the same as reported by Cabri and Moloughney (1973).

b) 2785B 831 g.

The sample was first separated into two fractions by heavy liquid (sp gr 2.96) -- 718.7 g of float and 103.8 g of sink. The sink fraction was then divided into non-magnetic and magnetic fractions by hand magnet. Each of these fractions were screened as shown in Table 1.

TABLE 1

Screen Analysis of Sink Fraction, 2785 B, in Grams

	-28+35	-35+48	-48+65	-65+100	-100+45	-150+200	-200	Totals
Magnetic	2.49	4.05	6.88	14.63	7.09	1.20	0.61	36.95
Non-magnetic	11.65	14.92	14.31	16.10	6.88	1.37	0.99	66.22
								103.17

Some of the above fractions were combined and then separated by heavy liquid (sp gr 3.33); see Table 2.

TABLE 2

Gravity Separation with 3.33 Liquid of Screened Sink Fraction, 2785 B, in Grams

		Original wt	Sink	Float	Total
Non-magnetic	-28+65	40.88	12.77	28.02	40.79
	-65+200	24.35	12.71	11.46	24.17
Magnetic	-28+65	13.42	10.01	3.39	13.40
	-65+200	22.94	21.91	0.94	22.85

The four sink fractions shown in Table 2 were elutriated in heavy liquid (sp gr 3.33), and the separation results are tabulated in Table 3.

TABLE 3

Elutriation with 3.33 Liquid of Sink Fractions, 2785 B, in Grams

		Original Weight	1st Sink	2nd Sink	3rd Sink	Float	Overflow	Totals
Non-magnetic	-28+65	12.77	0.46	0.59	0.52	5.27	5.93	12.77
	-65+200	12.71	0.37	0.49	0.61	4.03	7.20	12.70
Magnetic	-28+65	10.01	0.52	0.80	0.93	5.71	2.04	10.00
	-65+200	21.91	0.45	0.64	0.95	18.46	1.36	21.86

Polished sections were prepared of the 1st, 2nd, and 3rd sink fractions shown in Table 3 as well as the two minus 200-mesh fractions shown in Table 1. The sections were examined with the ore microscope and mineral identifications were confirmed quantitatively and qualitatively by electron probe and X-ray diffraction. The binocular microscope was used to study the distribution of minerals in different fractions.

RESULTS

1. 2785A

The results of the assays were reported in Test Report AC-73-161 (Moloughney, 1973). The results for the sand fractions are tabulated in Table 4. These values are recalculated and compared with the values obtained by B.H. Levelton and Associates Limited in Table 5. The recalculated values can be considered equivalent to the head sample value prior to separation.

TABLE 4

Assay Results for Sand Fractions

Mines Branch Lab. No.	Assay results for sand fractions (oz./ton)				
		Au	Pt	Ir	Pt:Ir
0728	Original wt 98.5 g				
	Heavy fraction 32 g	.109	.096	.0012	80
	Heavy fraction 32 g	.105	.109	.0012	90
	Heavy fraction 32 g	.116	.107	.0014	76
	Average	.110	.104	.0013	80
0729	Silicate fraction				
	Original wt 679.1 g				
	3 x 2 A.T. sample wt	N.D.*	N.D.	N.D.	--

*N.D. = not detected.

TABLE 5

Recalculated Assay Results for Sample #2785 A and Solution 2785
Compared to B.H.L. and A values

Mines Branch assay results					B.H.L. and A assay results				
	Au	Pt	Ir	Pt:Ir		Au	Pt	Ir	Pt:Ir
#2785 A sand (oz./ton)	0.014	0.013	0.0016	81	#2785 sand (oz./ton) (5 assay tons)	0.052	0.013	trace	?
#2785 solution (ppm)	18.0	lost	N.D.	--	#2785 solution (ppm)	26.0	6.7	trace	?

2. <u>2785 B</u>

a) General Mineralogy

The minerals of economic interest were found in the magnetic and non-magnetic first sink fractions (Table 3). Four grains of Pt minerals and ten grains of gold were identified, the latter were found in the -28+65 and -65+200 non-magnetic fractions. The nature of the Pt minerals and their distribution are discussed in more detail below.

The heavy minerals in the magnetic concentrate are mostly magnetite and magnetite-hematite intergrowths; minor quantities of iron, magnetite spherules, and sulphides such as pyrrhotite were also identified. The non-magnetic heavy minerals are principally hematite and hematite with ilmenite intergrowths. Other heavy minerals, roughly in decreasing order of abundance are amphiboles, ilmenite, pyrite, apatite, garnet, epidote, arsenopyrite, chromite, galena, and chalcopyrite. The occasional piece of brass or wustite spherule was also observed. The pyrite is often euhedral and partly or completely altered to goethite or geothite plus lepidocrocite.

The intermediate heavy minerals(those that sink in the 2.96 liquid but float on the 3.33 liquid) in roughly decreasing order of abundance are amphiboles, pyroxenes, epidote, chlorite, and feldspars. The light minerals, which comprise roughly 85% of the total sample consist approximately of 60% quartz and 30% feldspar, and 10% miscellaneous other minerals.

Detailed Mineralogy

(i) Gold

Four particles of gold were found in the -28+65 -mesh, non-magnetic, 1st-sink fraction (Table 3). These had the following approximate dimensions as measured on the polished surface: 30x270µ, 60x250 µ, 95x220 µ, and 270x320 µ. Six particles of gold were found in the -65+200-mesh, non-magnetic, 1st-sink fraction (Table 3) 2 particles measured 30x150 µ, three 85x320 µ, and one 120x170 µ.

(ii) Pt minerals

Four grains of Pt-minerals were found; one in the -65+200 mesh, magnetic, 1st-sink fraction, (Table 3), one in the -28+65 mesh, non-magnetic, 1st-sink fraction (Table 3), and two in the -65+200 mesh, non-magnetic, 1st-sink fraction (Table 3). These grains, respectively, measured on the polished surface: 90x110 μ, 165x412 μ, 110x190 μ, and 54x170 μ. The latter two grains were mono mineralic iron-bearing platinum, and the former two were complex composite grains. The composite grain in the magnetic fraction was intergrown tulameenite and iron-bearing platinum (Figure 1), whereas the other composite grain was iron-bearing platinum with numerous inclusions of platiniridium (Figure 2). The electron probe analyses of these grains are given in Table 6, each grain being identified by its dimensions measured on the polished surface.

DISCUSSION

The mineralogical investigation has revealed the complexity of the Pt-bearing minerals in this placer sand sample. They occur as either discrete grains or complex intergrowths with each other and some are ferromagnetic. In the small sample examined, the most common of these minerals is iron-bearing platinum, which is non-magnetic to the hand magnet, but can be separated by high-intensity magnetic separator. This would depend on the amount of iron in solid solution in the platinum.

The minerals, besides iron also contain variable amounts of other elements Ir, Cu, and Ni and sometimes Sb, Os, and Ru in solid solution. The latter two were found in only the platiniridium, which itself occurred as inclusions in iron-bearing platinum. The Pt:Ir ratios differed considerably over the grains analysed; this ratio could be misleading if only a few grains are analysed.

Minerals such as the highly ferromagnetic PtFe alloy (found in the Similkameen sample, see Cabri and Moloughney, 1973) and the non-magnetic minerals irarsite (IrAsS), iridosmine (Os,Ir), laurite (RuS_2) and cooperite (PtS_2), all found in other Tulameen area samples, were not encountered in this investigation. It is considered, therefore, that the separation procedure employed concentrated all the Pt minerals that were in this sample.

The assay results for Au, Pt, and Ir are in good agreement with the mineralogical findings. The Pt:Ir ratio of about 80:1 can be explained as resulting from some grains having a ratio of about 10:1 and others about 180:1. There is very good agreement between the three analyses on the heavy fraction. This agreement may be fortuitous because it may be due to the just one grain of a Pt-mineral in each 32-g cut. The average values for Pt and Ir assays agree very well with those of B.H. Levelton and Associates but the Au assays do not agree.

CONCLUSIONS

1. Two different platinum minerals and one iridium mineral were found in the sample for a total of four grains of platinum-group minerals. The most common of these minerals is iron-bearing platinum.
2. One of the four platinum-group minerals, tulameenite, can be attracted with a hand magnet.
3. All the platinum-group minerals are complex solid solutions of some of several metals such as Fe, Ir, Ru, Os, Cu, Ni, and Sb. These minerals occur either as discrete grains or as composite intergrowths with each other but are free of silicates and oxides.
4. Though Ir occurs in varying amounts in all the Pt-group minerals found, Os and Ru were found only as solid solutions in platiniridium.
5. Though the minerals identified are considered representative of this sample, a considerably larger number of samples would have to be examined in order to determine the most common and the complete range of the Pt-group minerals likely to be encountered in these sands.

6. The assay values for Au, Pt, and Ir are consistent with the mineralogy of the sample. Pre-concentration of the assay sample by removal of minerals lighter than 2.96 should be done on such samples.

ACKNOWLEDGEMENTS

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REFERENCES

1. L. J. Cabri and P. E. Moloughney, "Mineralogical and chemical investigations on precious metal samples submitted by B. H. Levelton and Associates Limited", Mines Branch Investigation Report IR 73-20, Industrial Confidential, Feb. 23, 1973.

2. P. E. Moloughney, Mineral Sciences Division, Test Report AC 73-161, Analytical Chemistry Subdivision, April 4, 1973.

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TABLE 6

Electron probe Microanalyses of Pt-Minerals (wt %)

Name and Dimensions	Pt	Ir	Os	Ru	Fe	Cu	Ni	Sb	Total	Pt:Ir	Formula
Iron-bearing platinum 110x190 μ	88.15	0.45	--	--	7.66	1.73	0.14	0.86	99.01	196	$Pt_{2.16}Fe_{0.66}Cu_{0.13}Sb_{0.03}Ni_{0.01}Ir_{0.01}$
Iron-bearing platinum 55x170 μ	90.69	0.64	--	--	5.28	0.66	0.11	--	97.39	142	$Pt_{2.43}Fe_{0.49}Cu_{0.05}Ir_{0.02}Ni_{0.01}$
Composite grain, 165x412 μ											
i) Matrix of iron-bearing platinum	78.25	8.02	--	--	12.56	0.66	0.23	--	99.73	10	$Pt_{2.53}Fe_{1.32}Ir_{0.25}Cu_{0.06}Ni_{0.02}$
ii) Inclusion of platiniridium 20x20 μ	14.69	72.32	5.29	4.48	1.91	0.33	0.14	--	99.15	0.2	$Ir_{2.68}Pt_{0.52}Ru_{0.32}Fe_{0.24}Os_{0.20}Cu_{0.04}Ni_{0.01}$
Composite grain, 90x110 μ											
i) Tulameenite	70.47	6.28	--	--	12.47	10.01	0.31	--	99.54	11	$(Pt_{1.85}Ir_{0.17})_{\Sigma=2.02}(Fe_{1.14}Cu_{0.81}Ni_{0.03})_{\Sigma=1.98}$
ii) Iron-bearing platinum	76.74	8.99	--	--	12.62	0.43	0.19	--	98.97	8.5	$Pt_{2.32}Fe_{1.34}Ir_{0.28}Cu_{0.04}Ni_{0.02}$

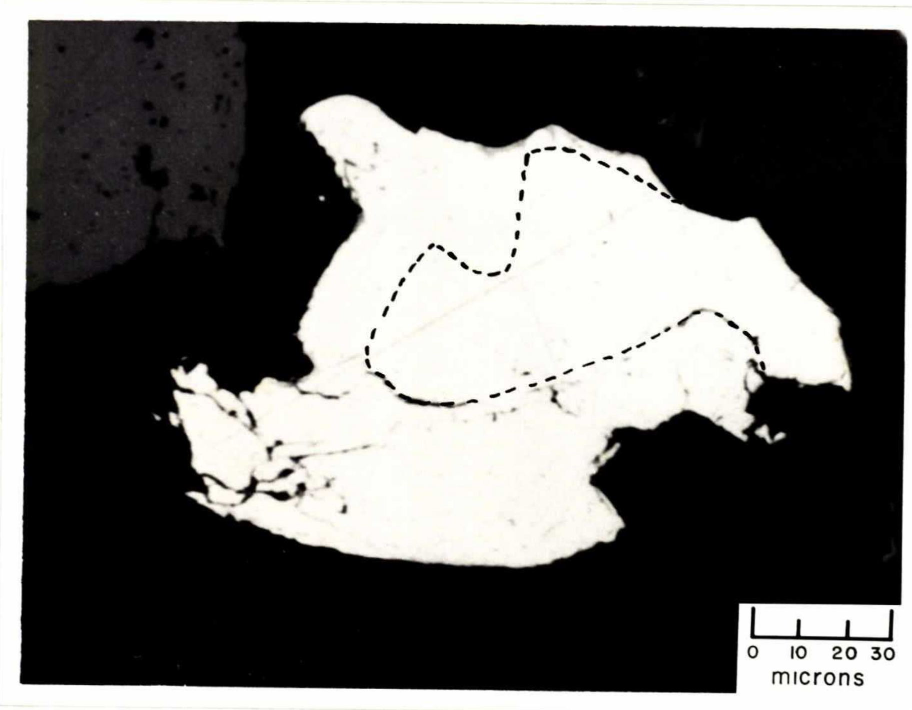

Figure 1. - Photomicrograph of an intergrown grain of tulameenite (upper) and iron-bearing platinum (lower).

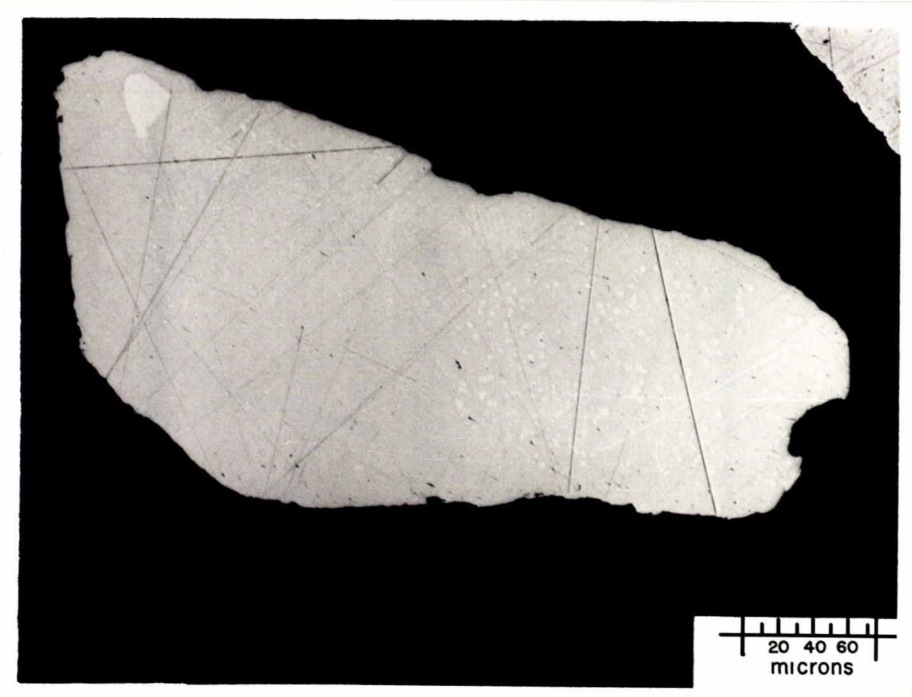

Figure 2. - Photomicrograph of a grain of iron-bearing platinum containing numerous inclusions of platiniridium.