METALLURGICAL SAMPLES FROM THE TURNER STRINGER ZONE, RED MOUNTAIN, KENAI PENINSULA

By Jeffrey Y. Foley

********** Field Report, December, 1987

UNITED STATES DEPARTMENT OF THE INTERIOR

Donald Paul Hodel, Secretary

BUREAU OF MINES

David S. Brown, Acting Director

INTRODUCTION

The Turner stringer zone, at Red Mountain on Kenai Peninsula, southern Alaska (fig. 1), is the largest known chromite deposit in the state. Published reserve estimates for the deposit are 1.25 million tons of chromic oxide (Cr_2O_3) contained in 22 million tons with an average grade of 5.6 pct Cr_2O_3 (Foley and Barker, 1985). The deposit was identified and described by Anaconda Minerals Company during their chromite investigations at Red Mountain in the early 1980's. Descriptions of chromite deposits, geology, and summaries of Anaconda's exploration activities at Red Mountain are contained in the unpublished Anaconda Company's 1981 Annual Report on the Red Mountain Project (Ellis and Scott, 1981) and Bureau of Mines Information Circular 8990 (Foley and Barker, 1985). The Bureau's Albany, Oregon Research Center (ALRC) conducted gravity beneficiation and mineralogical characterization tests on chromite samples collected by Anaconda and the Bureau's Alaska Field Operations Center (AFOC) and those results are summarized in Information Circular 8991 (Dahlin, Kirby, and Brown, 1985).

This report summarizes the Bureau's activities at Red Mountain, subsequent to completion of the above cited reports. During the present work, two metallurgical samples were collected from the Turner stringer zone for beneficiation at the Bureau's Salt Lake City Research Center (SLRC).

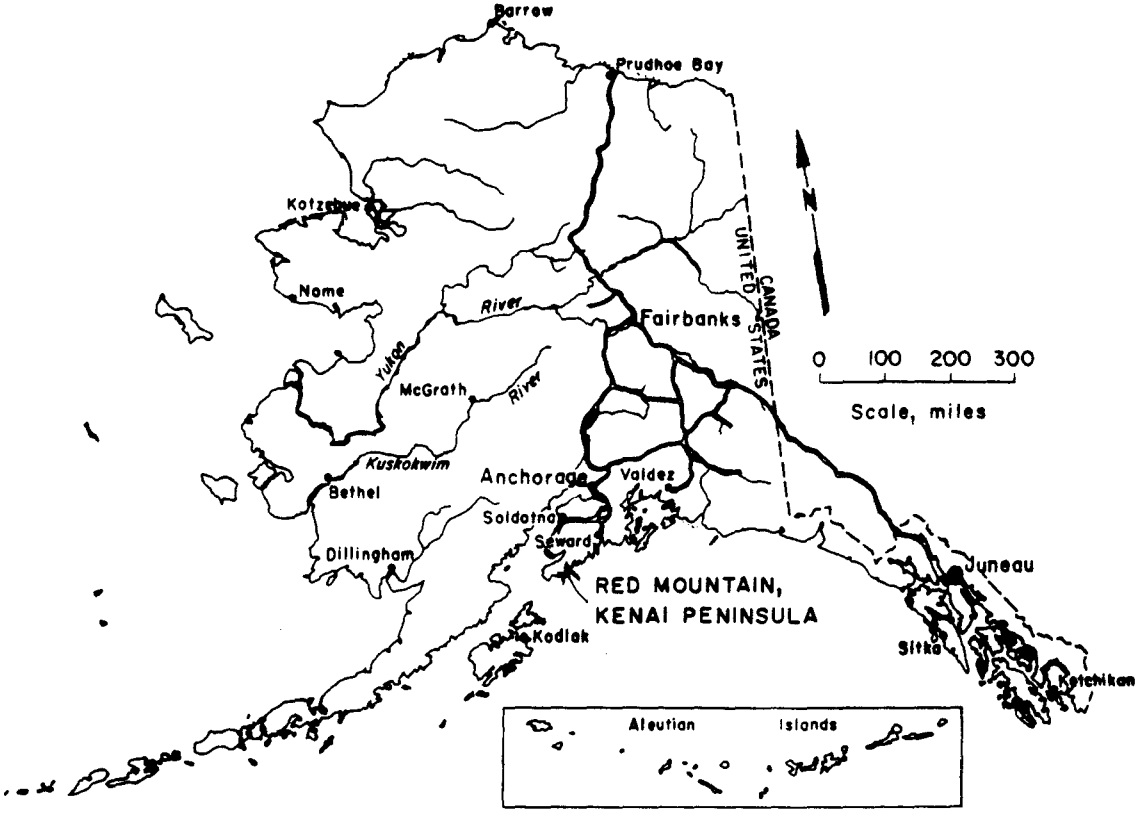

FIGURE 1.- Map of Alaska showing location of Red Mountain, Kenai Peninsula, in southern Alaska.

DEPOSIT DESCRIPTION

The Turner stringer zone (figs. 2 and 3) is a large, low-grade chromite deposit that strikes northwest and is intermittently exposed for about 2,500 ft along strike. The deposit dips to the southwest, is exposed for about 2,000 ft down a steep, west-facing dip-slope, and averages about 75 ft thick (Ellis and Scott, 1981 and Foley and Barker, 1985). The deposit comprises discontinuous chromite layers, chromite schlieren, and chromite pods, all in variably serpentinized dunite and peridotite. The chromite layers and schlieren commonly contain nodular chromite aggregates that are typical of podiform chromite deposits. The chromite nodules in the Turner stringer zone are commonly elongated and are otherwise deformed within open folds and less commonly, within tight, isoclinal folds. The Turner stringer zone appears to be, on the whole, an un-eroded eastern limb of a broad synclinal chromite deposit whose un-eroded western counterpart is the Horseshoe stringer zone, across the cirque, at the head of the Windy River Valley (fig. 2).

The Turner stringer zone was sampled by Anaconda Minerals Company in four trenches at the surface, at one in the Union Carbide Adit, and was intersected by three diamond-drill holes. Based on assays of core, channel, and trench samples, average grade for the deposit is estimated at 5.6 pct Cr_2O_3 Foley and Barker, 1985). Beneficiation tests by ALRC and previous workers indicate that high-chromium, metallurgical-quality chromite concentrates can be consistently produced from chromite-bearing material at Red Mountain (Foley and Barker, 1985 and Dahlin, Kirby, and Brown, 1985). Prior to the work described in this report, however, representative metallurgical samples had not been collected from the Turner stringer zone.

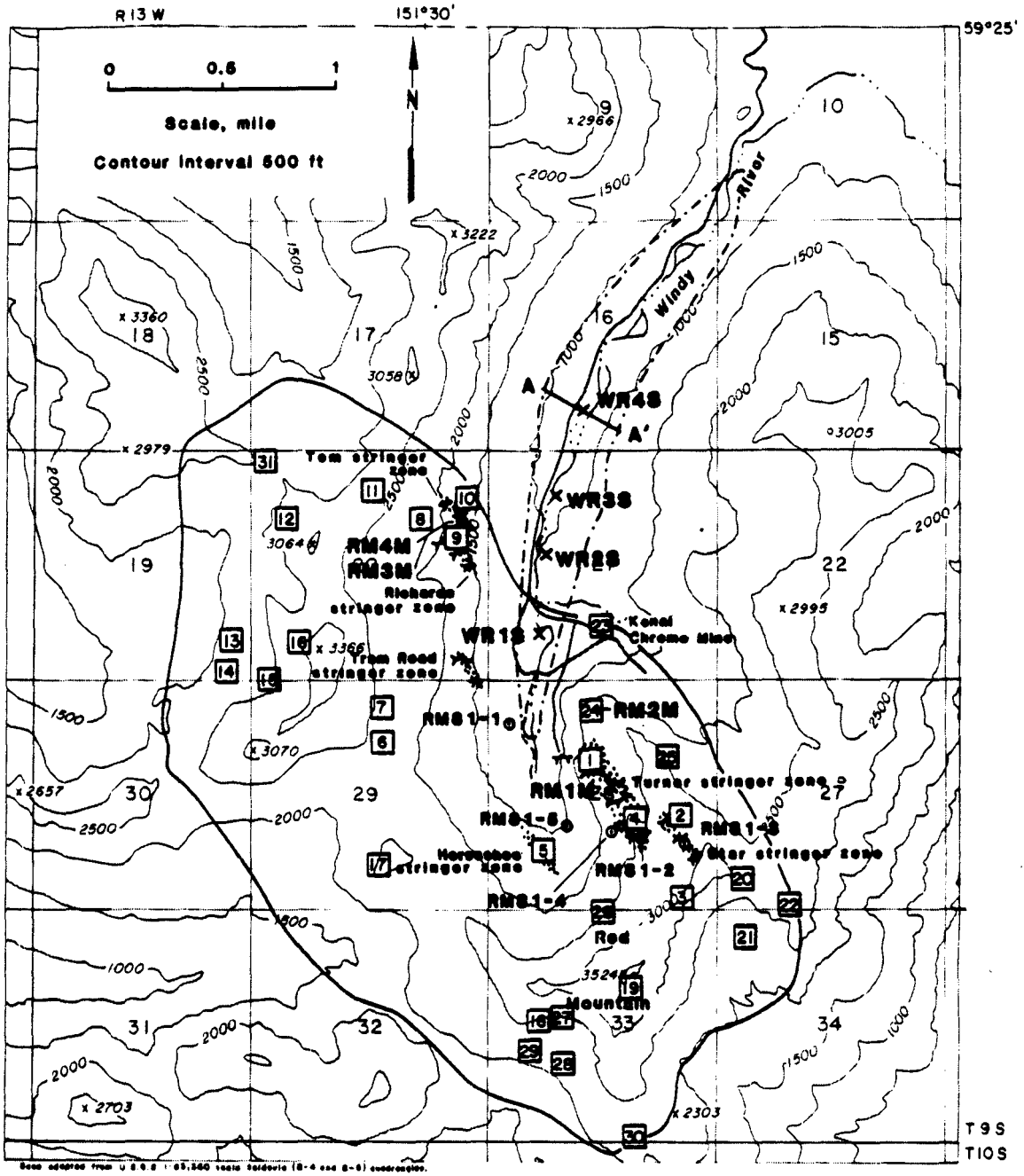

FIGURE 2.- Map of Red Mountain chromite deposits.

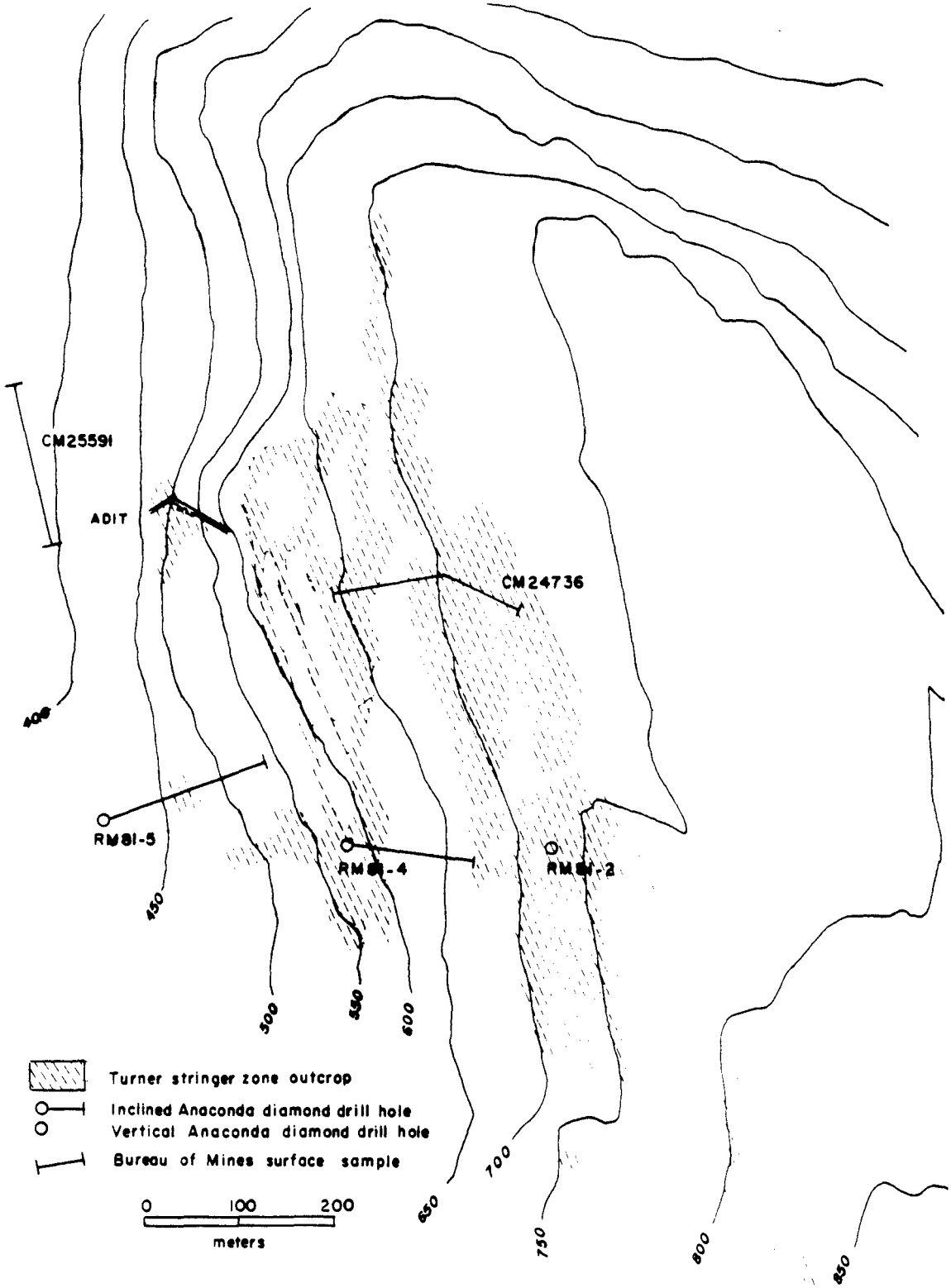

FIGURE 3.- Map of Turner stringer zone.

METALLURGICAL SAMPLES

Subsequent to completion of the AFOC and ALRC reports, the Bureau's Salt Lake City Research Center (SLRC) requested a sample from the Turner stringer zone to conduct flotation tests, which in some instances, had provided higher-quality chromite concentrates than did gravity-concentration tests like those performed at ALRC. In September, 1986, AFOC collected a 1,526-lb, continuous chip sample (CM24736) along a 700-ft interval, normal to the strike of the deposit, as shown in figure 3. This sample was collected from bedrock, along the same sample line as Anaconda's Turner North Bulk sample (Ellis and Scott, 1981). The AFOC sample was crushed to minus 1/4 inch, coned, and split. Sample heads contained from 2.5 to 4.0 pct Cr_2O_3, corresponding to chromite contents from 3.3 to 6.8 wt-pct. Several tests were run, but, the sample did not respond to flotation. After the unsuccessful flotation tests, a 400-lb split of the sample, containing 3.6 pct Cr_2O_3, was concentrated by gravity in a pilot plant as is schematically summarized in figure 4. The chromite concentrate produced during the pilot gravity test contained 52.4 pct Cr_2O_3, with 70 pct recovery and a chromium to iron (Cr:Fe) ratio of 2.2.

A second sample (CM25591), weighing 4,600 lb, was collected at SLRC's request in October, 1987. This sample was hand-sorted from colluvium and rubble, along 500 ft of deposit strike-length at the base of a steep, west-facing cliff in the Turner stringer zone (fig. 3). It is estimated that sample CM25591 contains about 15 volume pct chromite.

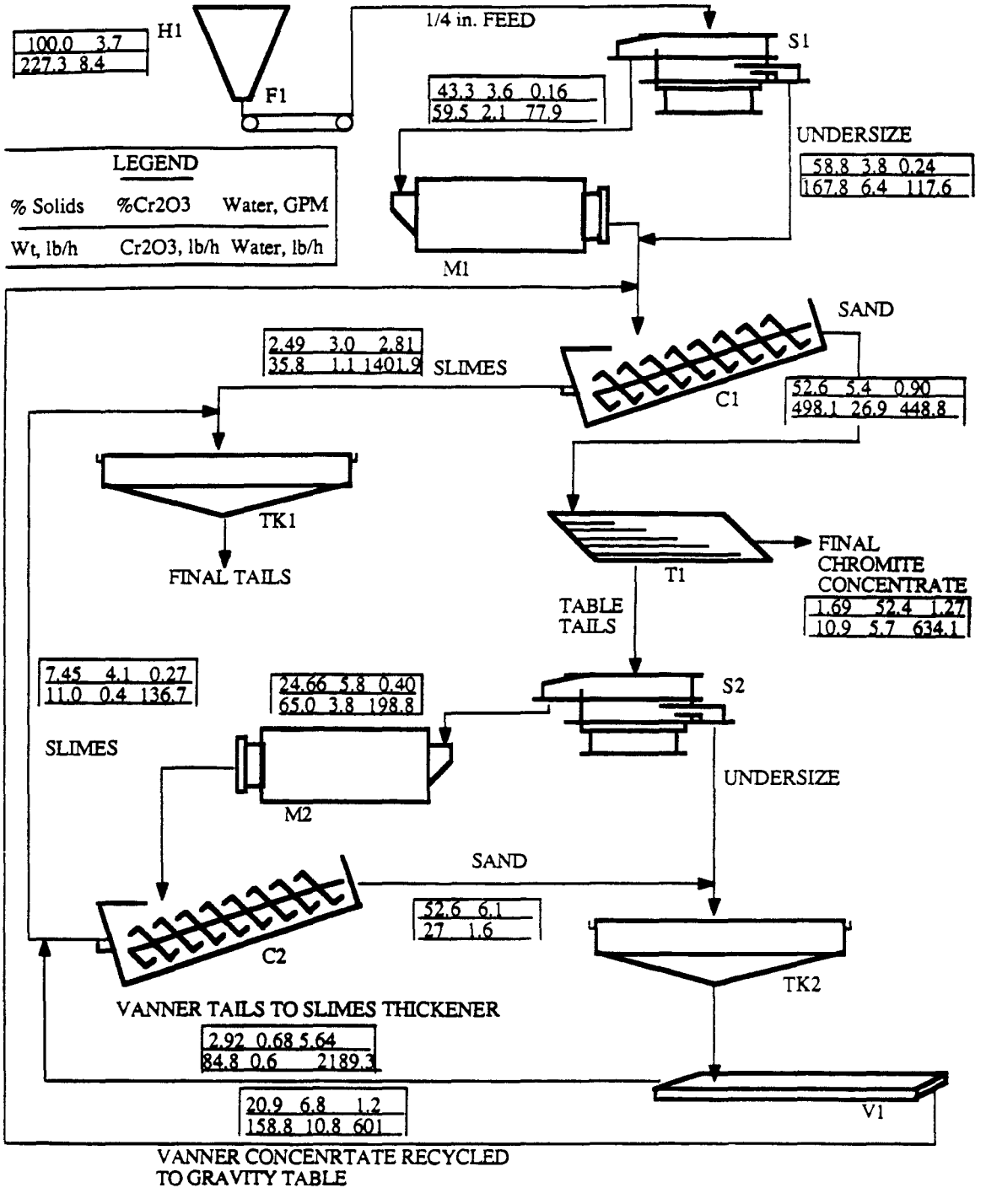

FIGURE 4.- Pilot plant results for chromite gravity circuit (sample CM24736).

United States Department of the Interior

BUREAU OF MINES

729 ARAPEEN DRIVE

SALT LAKE CITY, UTAH 84108

Salt Lake City Research Center

November 17, 1987

Memorandum

To: Jeff Foley, Physical Scientist, AFOC

RBA Through for Chief, Alaska Field Operations Center
Chief, Section for Critical Minerals, AFOC (Fairbanks)
Research Director, Salt Lake City Research Center

From: Research Supervisor, Minerals Engineering, SLRC

Subject: Red Mountain Chromite Sample (FY 87) CM24736

As requested on November 17, I have enclosed information on the Red Mountain sample collected by AFOC last fall. The research completed in FY 87 on the Red Mountain chromite sample (1526 lbs), consisted mostly of a few bench scale flotation tests and a gravity pilot plant test. The few tests completed by flotation were not very successful because of the low ore grade - about 2.5 to 4 pct Cr_2O_3. However, the pilot plant test was quite successful in producing an acceptable chromite concentrate. The enclosed material balance and flow sheet show a final concentrate of 52 pct Cr_2O_3 with about 70 pct recovery. These are only preliminary results because only 400 to 500 lbs were run through the plant, but the indications are good. Additional research needs to be conducted with a larger sample to ensure the results are as indicated. Also, research needs to be completed on the slimes using flotation to recover the 30 pct or so chromite lost to the tails. (on future samples)

We appreciate your help in obtaining the large Red Mountain sample this year. As I indicated during our phone conversation, we have not yet received the sample, but will hopefully in the near future. As we initiate research on this sample we will keep you appraised of the test results.

Richard G. Sandberg

Attachment: 1

RECEIVED — AFOC
NOV 23 1987

12/3/87 Cr: Fe for CM24736
Concentrate is 2.2

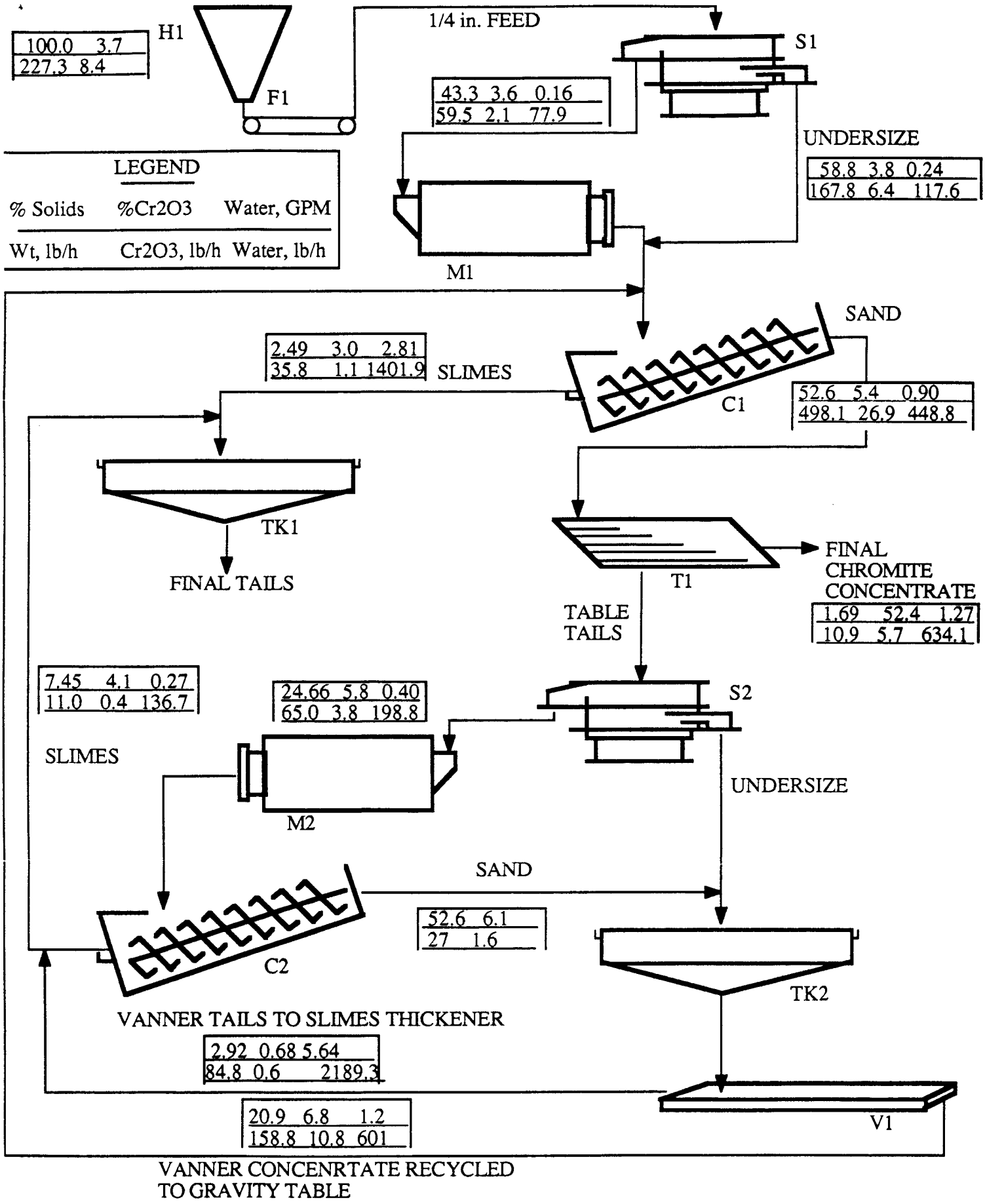

FIGURE XX. - Pilot plant results for Red Mountain chromite gravity circuit.

Sandberg 12/2/87 I called him to ask questions about CM24736 report

Sample originally requested for flotation tests.

Sample crushed to 1/4 inch

coned and quartered

heads vary from 2.5 to 4 pct Cr_2O_3

* This sample did not respond to flotation tests

other low-grade samples (eg Cal. chromites) are amenable to flotation

no future work planned for CM24736

AK 16.3

Simpson

Foley

Materials Characterization Laboratory Report

March 23, 1988

To: Dick McDonald and Wilfred Simpson

4 copies

Subject: Examination of the Red Mountain Chromite Ore

Eight screened size fractions of the Red Mountain chromite ore were submitted for mineral identification and liberation analysis.

This ore was determined to be a chromite-bearing peridotite or dunite, consisting chiefly of an olivine in the forsterite-fayalite solid solution series (Mg 40.8 pct, Si 51.6 pct, Fe 6.4 pct, Ni .7 pct, Cu .4 pct), with accessory chromite and minor amounts of pyroxene. Individual olivine grains are found to be weathered to different degrees to chlorite.

Liberation was determined by grain counting and was performed on polished sections of each size fraction. Results show that over 40 pct of the chromite grains are liberated in the 28 x 35 size fraction and that nearly all of the chromite grains are liberated in the 35 x 48 size fraction. The approximate percentage of chromite was determined for each size fraction by image analysis techniques. Analyses were performed on at least five areas (a minimum of 200 grains counted in each area) in the <48 mesh size fractions and on 10 areas in the >48 mesh size fractions because fewer grains could be examined in each area. The range of values increases in the larger size fraction indicating that the accuracy of this analysis decreases as the total number of counted grains decreases.

Mesh Size	Pct Chromite		Chromite Liberation	
	(Average)	(Range)	(Average)	(Range)
28 x 35	31	(23 to 38)	43	(22 to 86)
35 x 48	27	(22 to 33)	90	(64 to 96)
48 x 65	26	(22 to 31)	97	(96 to 97)
65 x 100	24	(22 to 26)	98	(97 to 100)
100 x 150	12	(11.4 to 12.7)	97	(95 to 100)
150 x 200	12	(10.4 to 13.1)	99	(98 to 100)

Note: Grains that were judged to be 90 pct or more liberated were considered liberated for this study.

Audie King

MEMORANDUM

To: James H. Maysilles, Group Supervisor
From: W. Richard McDonald, Metallurgist

4 copies

Subject: Monthly Report, April 1988

PROGRESS THIS M...

The research goals this month have been to: 1.) Flotation reagent screening tests for the beneficiation of chromite from the Norcross ore sample; 2.) Screen the La Primera and Red Mountain ore samples into size fractions and gravity concentrate each size fraction; 3.) Run Humphrey's spiral test on the Red Mountain ore sample; 4.) Flotation of the Denali Copper ore sample; and, 5.) Column flotation and cyanide leach of Yakataga Beach sample.

1987 Sample
CM 2559

TEST RESULTS

1. Flotation reagent screening tests for the beneficiation of chromite from the Norcross ore sample.

The test results from flotation reagent screening tests for the beneficiation of chromite from the Norcross ore sample show that Armac C and Oleic Acid & Petroflote 130 act as collectors for the concentration of chromite. Table 1. summarizes the results of these tests.

Table 1. Results of flotation reagent screening tests for the Trinidad ore sample.

	Percent Chromite				
Reagent	Concentrate		Tail		Head
	Assay	Dist.	Assay	Dist.	
Armac C pH = 2	26.2	88.2	9.1	11.8	21.4
Oleic Acid & Petroflote 130	23.7	94.1	3.8	5.9	18.1
Oleic Acid-HF	7.5	2.4	21.3	97.6	20.4
CMC - Tall Oil	18.7	35.6	24.8	64.4	22.2

2. Screen the La Primera and Red Mountain ore samples into size fractions and gravity concentrate each size fraction

The results of screen analysis and gravity concentration of a sample of the La Primera ore show that the chromite is almost evenly distributed through all size fractions; and the ore must be ground to particle sizes finer than 48 mesh to liberate the chromite from the gangue. Table 2 summarizes the test results.

Table 2. Summary of chromite and iron distribution in the size fractions of La Primera

Size Fraction, Mesh	Weight pct	Assay, pct		Distr., pct		Gravity Separation Assay, pct			
		Cr_2O_3	Fe	Cr_2O_3	Fe	Concentrate Cr_2O_3	Concentrate Fe	Tail Cr_2O_3	Tail Fe
20/35	18.0	31.3	8.6	18.4	18.0	47.5	11.0	26.4	7.8
35/48	9.0	27.9	8.2	8.2	8.6	44.0	11.2	6.4	4.1
46/65	8.4	31.3	8.5	8.6	8.3	46.1	11.0	4.0	3.8
65/100	15.0	33.5	8.7	16.4	15.1	44.6	10.5	8.2	4.7
100/150	15.6	30.2	8.5	15.4	15.4	43.3	10.6	8.0	4.9
150/200	6.8	34.0	9.3	7.5	7.3	48.4	11.8	19.4	6.7
200/325	5.2	30.9	8.9	5.2	5.4	47.5	11.7	15.0	6.3
minus325	22.0	28.5	8.6	20.4	22.0	23.0	9.8	29.4	8.4
Total	100	30.7	8.6						

The results of screen analysis and gravity concentration of a sample of the Red Mountain ore show that the chromite is depleted in the size fractions finer than 150 mesh. The depletion is not to an extent that screening will allow the finer sizes to be discarded. The ore must be ground to particle sizes finer than 65 mesh to liberate the chromite from the gangue. Table 3 summarizes the test results.

Table 3. Summary of chromite and iron distribution in the size fractions of Red Mountain.

Size Fraction, Mesh	Weight pct	Assay, pct		Distr., pct		Gravity Separation Assay, pct			
		Cr_2O_3	Fe	Cr_2O_3	Fe	Concentrate Cr_2O_3	Concentrate Fe	Tail Cr_2O_3	Tail Fe
20/35	13.7	20.4	8.2	17.6	14.8	28.5	9.5	11.8	6.9
35/48	17.2	22.6	9.7	24.4	22.0	34.5	10.3	5.7	5.9
46/65	10.5	21.4	8.5	14.1	11.8	46.2	13.1	5.8	5.7
65/100	10.5	20.3	8.3	13.4	11.5	42.4	11.9	2.8	5.4
100/150	14.4	12.8	6.8	11.6	12.9	47.6	12.7	4.2	5.4
150/200	8.1	8.8	6.0	4.5	6.4	37.7	11.2	3.4	5.0
200/325	14.0	9.4	5.9	8.3	10.9	34.4	10.4	6.1	5.3
minus325	11.6	8.4	6.2	6.1	9.5	23.2	8.8	7.9	6.1
Total	100	15.9	7.6						

3. Run Humphrey's spiral test on the Red Mountain ore sample

The test results from two Humphrey's Spiral tests to concentrate minus 28 mesh ore from the Red Mountain. The two tests were used to determine if the ore can be concentrated using a spiral and to demonstrate the use of the concentrate splitters on the spiral. The results show that neither test produced a final grade concentrate or tailing; however, better results are obtained when the concentrate splitters are used . The following tables summarize the test results.

Table 4. Summary of Humphrey's Spiral Test Results for minus 28 mesh Red Mountain ore.

Product	Weight Grams	Weight Percent	Assay Percent		Distribution Percent	
			Cr_2O_3	Fe	Cr_2O_3	Fe
Humphrey's Spiral Split Number						
1 and 2	507.4	25.6	30.5	11.4	41.3	33.6
3	224.4	11.3	20.5	8.7	12.3	11.3
4	498.9	25.2	22.1	9.3	29.4	27.0
5	429.1	21.7	9.1	6.6	10.4	16.4
6	199.2	10.1	7.3	6.2	3.9	7.2
7	120.9	6.1	8.2	6.4	2.6	4.5
Head (calculated)	1979.9	100	18.9	8.7		

Table 5. Summary of Humphrey's Spiral Test Results for minus 28 mesh Red Mountain ore. No splitters used on spiral.

Product	Weight Grams	Weight Percent	Assay Percent		Distribution Percent	
			Cr_2O_3	Fe	Cr_2O_3	Fe
Humphrey's Spiral Split Number						
2	480.4	33.8	7.8	9.6	19.7	37.6
4	457.7	32.2	24.7	9.8	60.3	36.6
5	316.8	22.3	6.4	6.6	10.8	17.4
6	105.5	7.4	10.4	6.3	5.8	5.4
7	61.3	4.3	10.4	6.8	3.4	3.4
Head (calculated)	1421.7	100	13.2	8.6		

4. Flotation of the Denali Copper ore sample

The results of a bulk sulfide flotation test show that only 64.4 pct of the copper and 56.4 pct of the gold from head analyses of 12.3 pct and 0.019 o/t, respectively, were recovered. More tests will be made to determine if recovery can be improved.

5. Column flotation and cyanide leach of Yakataga Beach sample.

Results of a bulk sulfide flotation test in the 12 foot column recovered 91.5 pct of the gold in the flotation concentrate that accounted for 6.7 pct of the weight. The flotation tail contained 8.5 pct of the gold at a grade of 0.02 o/t. The flotation concentrate was leached with cyanide to extract 99.9 pct of the contained gold. The calculated head for the test was 0.235 o/t Au. The sample is every difficult to treat because the gold is very fine. The results of a previous test resulted in a calculated head of 0.008 o/t Au.

Visitors:

Ben Pocock, President of Pocock Industrial visited to discuss high rate thickeners and their application.

Rodger Woodall, Prospector visited to discuss gold metallurgy.

Tom Henry, we crushed 500 lbs of "gold ore" to minus 6 mesh for him.

Other:

Vance Gregory of Armak shipped a sample of the flotation collector, Armac C.

The Albany Research Center Humphrey's spiral is in place and will be ready for use as soon as the sample splitter is built.

We received a Reichert HG7 spiral.