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THE GOLD PAN AS A QUANTITATIVE TOOL*

By

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THE GOLD PAN AS A QUANTITATIVE TOOL

By Paul K. Theobald, Jr.

ABSTRACT

The gold pan or a similar device has been mentioned throughout recorded history as a valuable instrument for concentrating heavy minerals. The absence of quantitative studies of the accuracy of this tool led to the work presented here. A series of 26 samples of alluvium from the bed and banks of streams were separately panned into a tub and the tailings from each panning were repanned until the remaining concentrate was insignificant. The ratio of the weight of a mineral in the first concentrate from a sample to the total weight of the mineral in the concentrates from all the pannings of that sample, expressed as percent, is termed the recovery and is used as a measure of the accuracy of the gold pan.

The recovery of minerals is related to the type of material sampled, the grain size of the mineral, the shape of the grains, and the specific gravity of the mineral. The highest recoveries are from samples having only small amounts of silt or clay. Samples with large proportions of silt and clay must be washed to remove these constituents before panning may be started, and a part of the heavy minerals is lost in suspension with the clay and silt. Elongate grains of about 65 mesh are most easily saved and tabular or platy grains are the most difficult to save. There appears to be a direct relation between specific gravity and recovery. The greatest loss of heavy minerals is in the last part of the process of panning when the proportion of these minerals is greatest. Several suggestions are offered to reduce the effect of these factors and to improve the recovery.

The gold pan is an extremely satisfactory tool for concentrating heavy minerals, and with it much valuable information of both economic and academic importance can be obtained.

INTRODUCTION

The gold pan, which has many names and designs, is a hand tool for concentrating heavy minerals. The pan used in this country is the frustrum of a cone, in South America the whole cone is used, and in the East Indies a segment of a sphere is used. The names vary from miners pan, California pan, and riffled pan to batea, "Asiatic ladle" (Sigov, 1939, p. 3), or simply "vessels of brass" (Hill, 1746). The gold pan used in the work described in this paper has the shape of a frustrum of a cone with a diameter at the lip of 16 inches, a diameter at the base of 9.5 inches, and a depth of 2.5 inches.

This type of pan was used during a reconnaissance of monazite placer deposits in Virginia, North Carolina, South Carolina, and Georgia. Some 4,000 samples of alluvium were concentrated in a pan and analyzed mineralogically to provide the basis for evaluation of the deposits. Of this total, 26 were handled separately to provide an indication of the accuracy of the tenors derived from the panned concentrates. The results of study of these 26 samples are presented here to define the limitations of the gold pan as a quantitative tool and to suggest some improvements in the technique of sampling.

This study was made under the supervision of W. C . Overstreet who provided numerous suggestions and continuous encouragement. The work was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. I am indebted to the men who panned the samples for the work in the field and to laboratory personnel of the U. S. Geological Survey for mineral identifications and grain counts.

Previous work

Theophrastus (Hill, 1746) writes of a vessel like a gold pan used to concentrate heavy minerals from sand and comments upon the accuracy of the process: "in this work there is much art to be used; for from an equal quantity of the sand some will make a large quantity of the Powder (cinnabar), and others very little, or none at all." Consistent use of a gold pan or similar device is noted in the literature on mining from Theophrastus' time to the present, but little mention is made of the proportion of the heavy minerals saved by these tools.

Taggart (1947, section 11, p. 57) makes a comparative statement of the accuracy of the gold pan: "A pan in the hands of a skilled operator will make a lower grade of tailing on any ore amenable to gravity concentration than can be made in the most elaborate gravity mill." This statement appears to place considerable faith in a crude implement but reflects the general opinion of many who have closely observed the use of a pan.

Sigov (1939, p. 3) published the results of an experiment with the "Asiatic ladle", essentially a gold pan with a handle:

Specific gravity	Coefficient of extraction (percent)
5.2	90
4.4-5.1	83
3.9-4.2	76
3.6-3.8	60
2.8-3.3	15
2.8	1

These results are similar to those described in this paper.

METHODS

Field techniques

The gold pan is similar in theoretical operation to a jig. By agitation of a heterogeneous sample of mineral grains in water, a bedding is developed. Each bed will be comprised of grains with a characteristic size and specific gravity; the largest and lightest grains concentrate at the surface, and the smallest and heaviest grains at the base of the sample. By washing the superficial layer from the sample, the specific gravity of the remainder is raised. During successive stages of agitation and washing, the bedding is further perfected, and the average specific gravity of the sample is increased.

A wide range in size of the mineral grains hinders concentration. If fine-grained quartz is abundant in a sample that contains coarser grains of heavy minerals, quartz will accumulate in the bottom of the pen and prevent settling of the heavy minerals. Under these conditions there is danger of removing coarse-grained heavy minerals during panning.

The movement of the heavy grains to the base of the sample is not hindered if a sample of medium to coarse sand contains from 5 to 10 percent of fine sand. The fine sand filters between the coarser grains to a layer of much higher specific gravity, and the finished concentrate contains a larger proportion of quartz and feldspar than a concentrate from a sample without fine sand. To remove this fine sand the concentrate in the pan may be briskly agitated in water to lift the fine grains into suspension. The water containing the suspended fine sand is then poured from the pan.

A sized feed to the pan is desirable but impractical in rapid field work. A single screen or a pair of nesting screens were used to remove gravel from the samples, and clay and silt were removed in suspension by kneading the sample in quiet or gently flowing water. The remaining sand, which ranged in size from one-eighth inch to 200 mesh, was panned to produce a concentrate of heavy minerals. The details of the process of panning have been discussed by numerous workers, most recently by Mertie (1954, p. 639-651).

Two systems were used to check the proportion of the heavy minerals recovered by panning. The simpler method was to place the sample in a pan and place another pan in the water beneath the first pan. In theory, the tailings from the first panning were caught in the second pan. When the first concentrate had been removed, the pans were exchanged and the tailings from the first panning were re-panned. This process was repeated two times.

The defects of the first system were that panning the tailings twice did not recover enough of the heavy minerals to represent the content of heavy minerals in the sample, and that in passing from one pan to the other in the stream some of the heavy-mineral grains were lost even in a gentle current of water. The first of these defects could have been remedied by repeating the process several times, but the second required a revision of the method. An improved method consists of panning in a large wash tub in which the tailings are caught and repanned. The process may be repeated as often as necessary, and the only heavy minerals lost are those that remain in suspension in the water or those that are not recovered in subsequent panning.

The 26 samples used in this analysis were panned into a tub, and the tailings were re-panned until the volume of heavy minerals was too small to handle. The localities of these samples by stream, county, and state, the name of the panner, and the number of pannings for each sample are shown on table 1. This system offered a way to split the tailings and find where in the panning process the greatest loss occurred. To do this the original thickness of the sand in the pan was measured and panning was continued until one-quarter or one-third of the sand was removed as tailings. These tailings were removed from the tub and the next segment of the sample was panned. The losses in the separated fractions of the tailings could be estimated in this manner. The differences between panning in a tub and panning in a stream are slight, but somewhat fewer heavy minerals may be recovered in a tub because the motions of the panner are restricted.

Table 1.--Location and characteristics of multiply panned samples.

Sample	Field and laboratory numbers	Panner	Location	Volume panned (cu. ft.)	Stages of panning
Riffle gravel					
A	52-CS-415 (109875-109884)	R. Thompson	Big Buck Creek, Spartanburg County, S. C.	0.09	7*
B	52-CS-416 (109885-109890)	J. Pollard	Big Buck Creek, Spartanburg County, S. C.	.09	6
C	52-CS-656 (110127-110135)	J. Pollard	South Durbin Creek, Laurens County, S. C.	.11	9
D	52-DC-42 (82903-82906)	P. Theobald	Devils Fork Creek, Anderson County, S. C.	.14	4
E	52-DC-834 (110984-110988)	D. Caldwell	Howards Creek, Lincoln County, N. C.	.09	5
F	52-OT-42 (82583-82589)	B. Long	Pickens Creek, Anderson County, S. C.	.08	7
G	52-OT-43 (82590-82602)	W. Overstreet	Pickens Creek, Anderson County, S. C.	.12	7*
H	52-OT-64 (82603-82613)	B. Spradlin	Floyds Creek, Rutherford County, N. C.	.15	6*
I	52-PK-1 (81176-81182)	P. Theobald	Brushy Creek, Cleveland County, N. C.	.18	7
J	52-PK-20 (90564-90573)	P. Theobald	Unnamed Creek near Suck Creek, Rutherford County, N.C.	.08	4*
K	52-PK-126 (98834-98846)	P. Theobald	Tributary to Thicketty Creek Cherokee County, S. C.	.09	5*
L	52-WE-160 (88405-88411)	A. White	Floyds Creek, Rutherford County, N. C.	.10	7
M	52-WE-184 (90657-90664)	J. Wissert	Floyds Creek, Rutherford County, N. C.	.06	8
N	52-WE-275 (90711-90717)	W. Overstreet	Silver Creek, Burke County, N. C.	.10	7
Riffle sand					
O	52-CS-282 (90410-90417)	R. Thompson	Lawson Fork Creek, Spartanburg County, S. C.	.25	5*

Table 1.--Location and characteristics of multiply panned samples.--Continued

Sample	Field and laboratory numbers	Panner	Location	Volume panned (cu. ft.)	Stages of panning
Riffle sand					
P	52-CS-601 (110064-110068	J. Pollard	Rocky Creek, Greenville County, S. C.	.29	5
Q	52-CS-602 (110069-110073)	N. Cuppels	Rocky Creek, Greenville County, S. C.	.29	5
R	52-DC-413 (99158-99165)	B. Long	Hurricane Creek, Anderson County, S. C.	.25	6
S	53-DC-562 (109718-109723)	B. Long	Reedy River, Greenville County, S. C.	.19	6
T	52-OT-65 (82614-82620)	W. Overstreet	Floyds Creek, Rutherford County, N. C.	.27	7
Bank gravel					
U	52-PK-127 (98847-98851)	P. Theobald	Tributary to Thicketty Creek, Cherokee County, S. C.	.10	5
V	52-WE-274 (90705-90710)	J. Wissert	Silver Creek, Burke County, N. C.	.08	6
Bank silt					
W	52-DC-563 (109724-109728)	B. Long	Reedy River, Greenville County, S. C.	.09	5
X	52-WE-359 (90799-90805)	A. White	Hoyle Creek, Burke County, N. C.	.11	7
Y	52-OT-36 (81129-81137)	W. Overstreet	Brushy Creek, Cleveland County, N. C.	.01	--
Bank clay					
Z	52-WE-1 (81207-81210)	A. White	Brushy Creek, Cleveland County, N. C.	.02	4

*Tailings from these samples were split during the first panning, and each split was panned separately. The number shows the panning stages of each split, and is equivalent to the number of panning stages for the samples that were not split.

The samples were collected from two principal sources: riffles in the streams and banks of the streams. These will be referred to as riffle samples and bank samples respectively. Riffle samples are commonly mixtures of sand and gravel that contain only a trace of silt and clay. After screening the gravel from these samples it was not necessary to wash the samples to remove the small quantities of silt and clay, and there was no possibility of suspending fine-grained heavy minerals in a slurry of silt and clay during the process of panning. These samples were classified in the field as sand or gravel on a basis of the quantity of material in the original volume (0.34 cubic foot) that would pass a punch plate with one-eighth inch openings. If this quantity was half of the original volume or less, the material was classified as gravel, but, if the quantity was greater than half of the original volume, it was classified as sand. The volume of material that passed through the one-eighth inch openings is shown as the volume panned in table 1.

Bank samples are mixtures of gravel, sand, silt, and clay, all of which contain a sufficient quantity of silt and clay to require washing before panning. Many of the bank samples contain less than 3 percent of gravel. The amount of material remaining in the pan after screening and washing out the silt and clay is shown in table 1 as the volume panned. This volume, the volume of material larger than one-eighth inch in diameter, and the original volume of the sample were used to determine the dominant character of sand and gravel samples. Silt and clay samples are defined on a basis of feel and coherence.

Clay and silt are washed from a sample before panning is begun; these materials form a cloud of suspended material which moves away from the pan. In this investigation all but one of the bank samples in table 1 were washed in a tub and the slurry of clay and silt was poured off after the sample was washed but before it was panned. To determine the quantity of heavy minerals lost in suspension, sample Y was washed in a tub and the resulting slurry poured into another tub. The sand that was left after washing was panned once and then re-panned five times. Sediment in the slurry was allowed to settle for about 6 hours and the water was decanted. The settled slurry was carefully re-washed to remove most of the silt and clay. The recovered sand, equal in volume to that panned in the first operation, was panned three times.

Laboratory work

The concentrates were analyzed in the laboratories of the U. S. Geological Survey. The laboratory procedure was to: (1) weigh the concentrates, (2) separate and weigh the magnetite, (3) sieve the remainder of the concentrate, (4) weigh each sieved fraction, (5) split each sieved fraction to about 100 grains, and (6) count the grains to establish the frequency percentages of each mineral. U. S. Standard sieves of 45, 100, and 170 mesh were used. Only those fractions that contained 1 percent or more of the initial concentrate were counted. These were the material retained on the 45, 100, and 170 mesh sieves and rarely 1 or 2 percent of the material that passed the 170 mesh screen. These three size groups are called the 45, 100, and 170 mesh fractions.

The grain counts were converted from frequency to weight percent with a chart based on the specific gravity of the minerals (Berman, 1953, p. 120-123). Calculations in this paper are based on the weight percent of the mineral in the total concentrate and are recorded to one percent. The weight of the total concentrate is recorded to 0.1 gram.

Analysis of recovery

A few grains of heavy minerals escape the panner regardless of the number of times that the tailings were panned. The most important factor limiting the number of pannings is the minimum size of concentrate that can be cleaned to a reasonably low percentage of quartz without losing most of the heavy minerals. The maximum number of stages of panning is nine for sample C. The split samples equal or exceed this number of pannings and reach a maximum of 13 for samples G and K.

The first problem of analysis was to determine the quantity of heavy minerals that were lost during all the stages of panning. Because each panning is a complete operation, the pannings were considered as consecutive whole numbers and plotted as the abscissas in a logarithmic graph. The weight of a mineral in the concentrate at each panning was plotted as the ordinate.

Weights of ilmenite and magnetite in the concentrates of successive stages of panning sample F are plotted in figure 1. The total weights rather than the weights of sieved fractions were used in the examples, though either will produce the same type of curve. Ilmenite and magnetite were respectively 47 and 41 percent of the first concentrate, and the weights of successive stages form straight lines on the logarithmic plot.

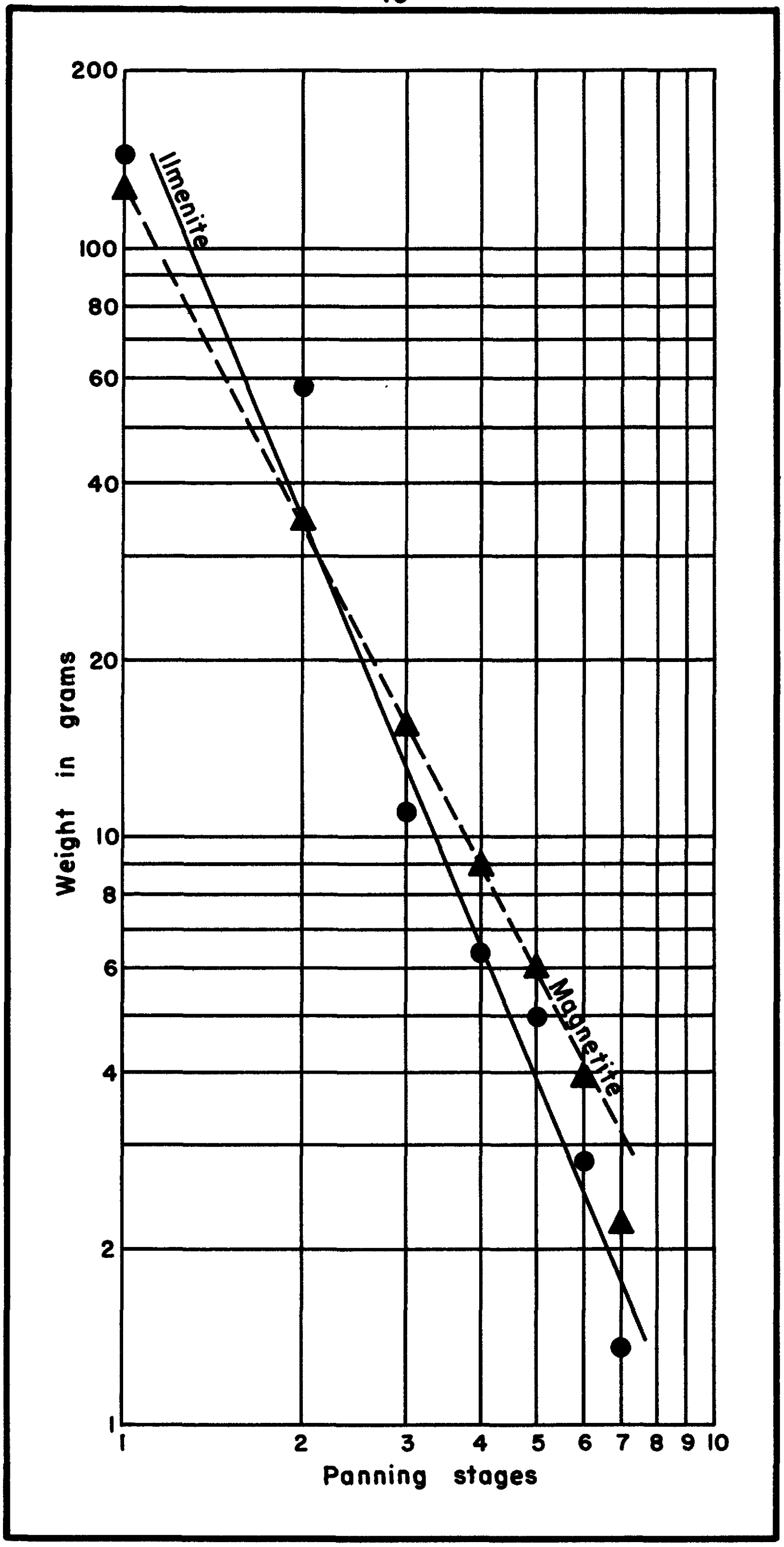

FIGURE I.-WEIGHTS OF ILMENITE AND MAGNETITE RECOVERED IN STAGES OF MULTIPLE PANNING

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The line for magnetite is particularly well defined as it is for most of the samples; but, if the proportion of magnetite in the concentrates drops to 10 percent or less, the points begin to scatter. The weights of ilmenite fall along a linear zone rather than defining a single line. This condition applies to ilmenite in the other samples and for the minerals of a specific gravity greater than 4.5 that were determined by grain counts. For these minerals the amount of scattering increases as the percent of the mineral in the concentrates decreases, and the scattering is greater for the minerals requiring more subtle methods of identification than for those whose identity is obvious. Variations in the accuracy of the grain counts and deviations from the actual weights resulting from recalculation of the grain counts to rounded percentages, particularly when the mineral is a low proportion of the concentrate, cause a greater variation in the quantity of a mineral reported from a sample than the variation inherent in panning.

Minerals with a specific gravity less than 3.5 provide points with erratic distribution on logarithmic graphs, though there is a general trend toward decreasing quantities of these minerals in successive stages. The variations in the tenors of these minerals are related to changes in the proportion of quartz left in the concentrate. Concentrates were cleaned until they contained from 2 to 40 percent of quartz, and generally had 10 to 30 percent. Small concentrates required special handling in the pan, and usually contained a larger proportion of quartz than large concentrates. Successive concentrates decreased in size and the proportion of quartz increased. This increase in quartz is erratic rather than uniform; hence the erratic distribution of the weights of the low specific gravity minerals on the log plots. The scattering of points on graphs like figure 1 discourage use of them to determine the recovery that could be obtained theoretically, but they do show that the quantity of minerals of high specific gravity recovered by panning in the several stages was generally within 5 percent of the original content of the sample.

The percentage of weight of the minerals reported from the laboratory for each concentrate was recalculated to the actual weight of the mineral in the concentrate. These weights are given by sample, stage of panning, and sieved fraction in the appendix. It is assumed that the sum of the weights of a mineral in the concentrates from successive stages is equal to the original weight of that mineral in the sample. Thus, if a sample was panned 7 times and the weight of ilmenite in each stage of panning is, respectively, 140, 57, 11, 6.3, 4.9, 2.8, and 1.4 grams, the weight of ilmenite in the original sample is assumed to be 223.4 grams. The recovery is the weight of a mineral in the first concentrate divided by the total weight of the mineral in the original sample; in the example, the recovery of ilmenite is 140/223.4 or 63 percent. Recovery, as used in this paper, has this meaning only.

All heavy minerals are not recovered during multiple panning, but for minerals with a specific gravity of 4.5 or more the difference between the measured content and the actual content probably would not change the apparent recovery 2 percent. The recoveries of minerals with a specific gravity less than 3.5 are considerably different, as the actual content is probably 2 or 3 times as great as the measured content.

Only two of the minerals used in these tests have specific gravities in the range from 3.5 to 4.5. Recoveries for garnet, with a specific gravity of slightly over 3.5, are about 50 percent in error; and recoveries for rutile are about 5 percent in error.

RECOVERY OF HEAVY MINERALS

Recovery of heavy minerals in riffle samples

The range in recoveries of each mineral is great among the samples despite the consistency of recoveries among the stages of panning of a single sample. (See table 2.) This is to be expected from the variety of samples and mineral suites. Histograms of the frequency of repetition of the recoveries in riffle samples, rounded to the nearest 5 percent, show that the distribution of the recoveries of a mineral are well defined around one or two optimum values. The histogram of the total recovery of monazite (fig. 2) rises to a single peak at 85 percent; the average monazite recovery from table 2 is 84 percent. The histogram of total recovery of ilmenite forms two less well-defined peaks; the stronger peak is between 65 and 70 percent and the weaker is at 50 percent. Average recovery of ilmenite in riffle samples is 64 percent on the left, or low-recovery side, of the stronger peak.

Relationships among these histograms are based primarily on specific gravity of the minerals although factors of size and shape must also effect changes in location and shape of the peaks. As the average recoveries for a mineral are generally indicated by the most prominent peaks on the histogram, a relation among the minerals may be based on the average recovery. The trend of the recoveries among the minerals is toward increased recovery of minerals with successively higher specific gravity, as shown on figure 3.

Table 2.--Recovery (in percent) of heavy minerals in the first panning of samples from riffles and banks.

Sample	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Rutile	Sillimanite	Tourmaline	Zircon
Riffle gravel										
A	--	46	--	80	57	86	--	68	0	--
B	--	23	--	67	--	90	--	42	38	--
C	35	75	--	73	78	92	--	--	--	--
D	--	--	--	75	69	72	78	--	--	38
E	--	35	--	63	31	88	100	66	--	100
F	--	--	--	63	63	73	--	--	--	67
G	--	--	--	70	69	90	--	--	--	85
H	--	40	--	49	--	71	--	27	--	--
I	--	39	--	52	63	79	44	40	--	65
J	--	60	--	71	86	85	--	71	39	--
K	44	59	85	76	62	94	--	22	--	74
L	--	33	--	53	16	78	--	19	--	100
M	--	36	100	61	34	85	--	46	--	--
N	45	62	--	68	87	93	--	--	--	79
Average	41	46	92	66	60	84	74	45	26	76
Riffle sand										
O	33	79	--	74	77	91	--	--	95	71
P	47	44	--	64	51	78	--	19	0	--
Q	0	38	--	56	49	83	--	21	0	--
R	40	0	0	44	54	--	--	--	--	12
S	30	--	--	67	62	83	50	27	--	--
T	--	28	--	51	--	78	--	13	--	100
Average	30	38	0	60	59	83	50	20	32	61
Avg riffle samples	34	44	62	64	59	84	68	37	29	72

Table 2.--Recovery (in percent) of heavy minerals in the first panning of samples from riffles and banks--Continued.

Bank gravel										
U	x	23	x	63	x	90	38	30	x	0
V	x	--	x	56	x	83	100	0	x	76
Bank silt										
W	x	--	x	48	x	90	23	20	x	80
X	x	--	x	33	x	67	--	30	x	27
Y*										
Bank clay										
Z	x	9	x	52	x	84	53	44	x	72
Avg bank samples	x	16	x	42	x	83	54	25	x	51

-- Total quantity is less than 1 percent of the first concentrate.

x Recovery was not computed.

* This sample was handled separately, and recoveries are not comparable with the other bank samples.

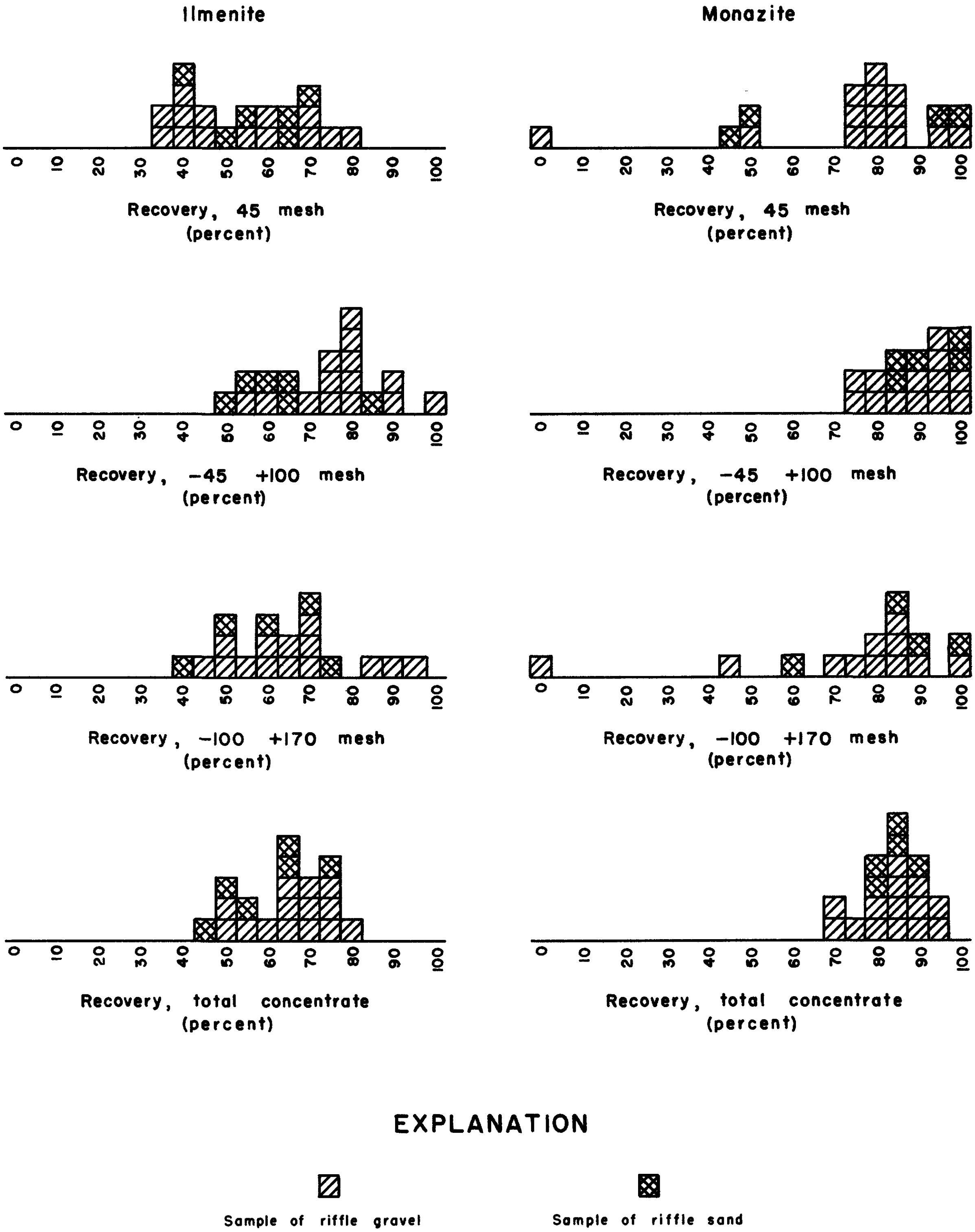

FIGURE 2.—HISTOGRAMS SHOWING RECOVERIES OF ILMENITE AND MONAZITE

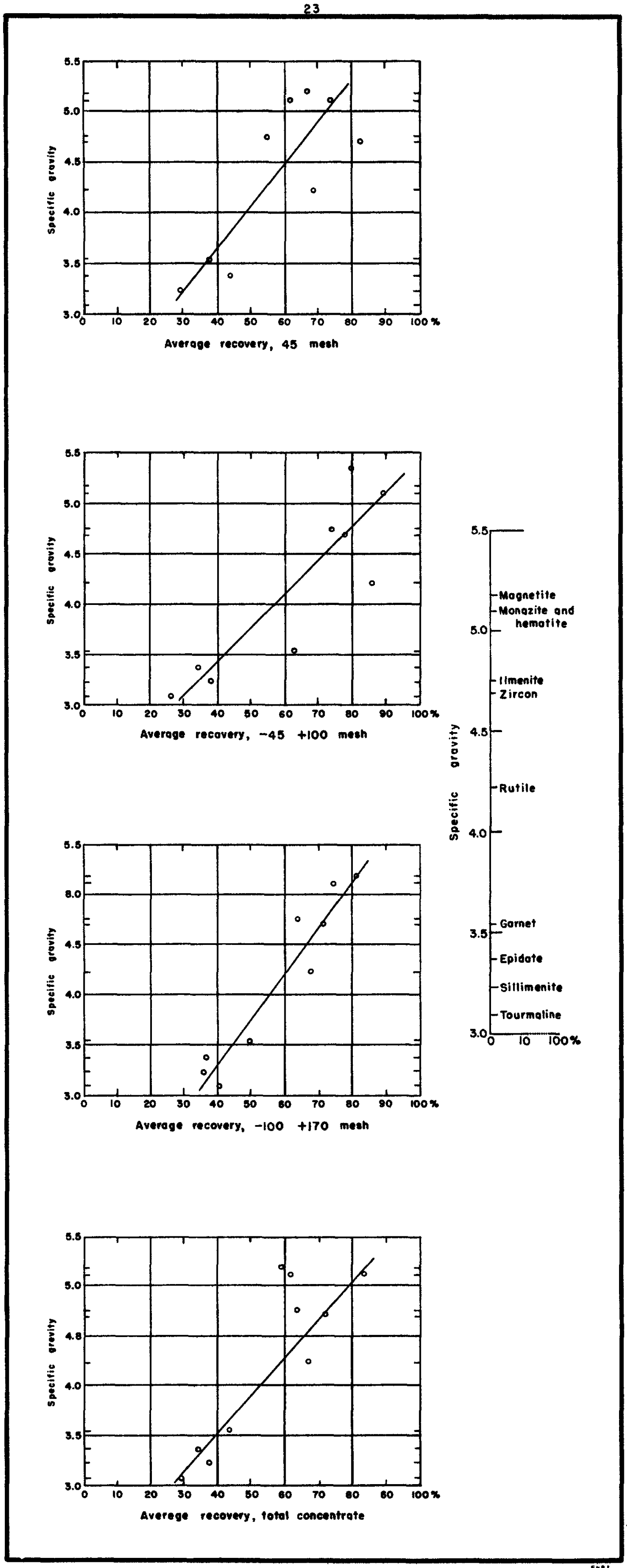

FIGURE 3.—RELATION OF RECOVERY TO SPECIFIC GRAVITY FOR RIFFLE SAMPLES.

Some of the scattering of points on figure 3 may result from variations in the average size of the mineral grains, but the effect of changes in grain size is reduced by using the sieved fractions. The scattering persists in each sieved fraction but is greatest in the 45 mesh fraction and least in the 170 mesh fraction. It is inferred that the scattering is the result of differences in shape among the minerals. The differences in shape are exaggerated in the coarser sizes, but in the finer sizes the grains approach cubic or spheroidal shapes.

The line drawn on each of the diagrams of figure 3 is a trend line that divides the plotted points into three groups: (1) those above the line, (2) those close to the line, and (3) those below the line. Each of these three groups appears to reflect the shape of the grains. The first group consists of points related to minerals with a single direction of elongation: zircon, rutile, fine-grained sillimanite, and coarse-grained epidote. Coarse-grained sillimanite is excluded from this group because, in general, it consists of rounded knots of quartz and sillimanite; and fine-grained epidote is excluded because the mineral fractures into nearly equidimensional grains. These elongate minerals resist the buoyant effects of water during panning and roll in only one direction. They are the easiest to save in the gold pan.

The second group of points is related to approximately equidimensional minerals: monazite, garnet, coarse-grained sillimanite, and fine-grained epidote. These minerals expose a smaller area for a given volume to the buoyant effects of water, but they roll in any direction. Minerals in this group have recoveries intermediate between those in the first and third groups.

The third group is defined by platy minerals, of which ilmenite is the only one represented by a point on figure 3. Only the platy minerals with a large specific gravity are recovered in the pan. Biotite and muscovite, with mean specific gravities of 3.0 and 2.8 respectively, are abundant in the stream sediments, but neither was recovered in the concentrates. Kyanite, with a mean specific gravity of 3.6, was in a few samples but was recovered in only two; in one of these it was recovered only in the later stages of panning. Hematite and magnetite fall into the third group on figure 3, but their position is deceptive because they occur as porous aggregates and pseudomorphs. The specific gravity of these grains is less than the specific gravity of solid crystals of the minerals.

The peaks of the histograms become broader and lower with decreasing specific gravity. This is not the result of change in specific gravity, but the result of change in recovery. On figure 2 the peaks broaden among the sieved fractions of both minerals as the average recovery decreases, and within a sieved fraction the peaks broaden among the minerals as the average recovery decreases. The best-defined peaks are those for monazite in the 100 mesh fraction and for the combination of the sieved fractions for monazite, where the average recoveries are respectively 89 and 84 percent. The spread is greatest in the 45 and 170 mesh fractions of ilmenite where the average recoveries are respectively 54 and 61 percent. The distribution of recoveries continues to spread in minerals of low specific gravity with average recoveries below 50 percent. For garnet and sillimanite, the most abundant of the minerals of low specific gravity, the recoveries form a low plateau rather than a peak. The spreading of the recoveries with a decrease in average recovery, or conversely the localization of the recoveries for minerals with higher average recoveries, provides additional evidence to support the conclusion from the log plots that the most accurate determinations of recovery are those for minerals of high specific gravity with a high average recovery.

Recovery and grain size of the heavy minerals

The relation of recovery to grain size is predicted from the general theory of bedding of heavy minerals during concentration, presented earlier, and it is substantiated by the recovery figures presented in tables 3, 4, and 5 and by the histograms in figure 2. The best recovery of almost all minerals is in the 100 mesh fraction and the exceptions are minerals that occur in few fractions of the samples as shown below:

Mineral	Sieve fraction (mesh)	Number of samples containing mineral
Epidote	45	1
Epidote	170	3
Magnetite	170	2
Tourmaline	170	2
Zircon	45	2

(Text is continued on page 33)

Table 3.--Recovery (in percent) of the minerals in the 45 mesh fraction of riffle samples.

Sample	Epidote	Garnet	Hematite	Ilmenite	Magnetite*	Monazite	Rutile	Sillimanite	Tourmaline	Zircon
Riffle gravel										
A	--	34	--	60	--	79	--	--	--	--
B	--	23	--	40	--	81	--	--	--	--
C	44	77	--	72	--	100	--	--	--	--
D	--	--	--	76	72	73	--	--	--	--
E	--	37	--	56	--	87	100	42	--	100
F	--	--	--	38	56	48	--	--	--	--
G	--	--	--	36	62	81	--	--	--	--
H	--	28	--	42	--	73	--	--	--	--
I	--	26	--	37	62	75	38	--	--	--
J	--	50	--	71	--	87	--	--	--	66
K	--	52	85	78	--	95	--	--	--	--
L	--	27	--	46	--	79	--	--	--	--
M	--	36	100	58	--	85	--	--	--	--
N	44	57	--	46	81	0	--	--	--	--
Average	44	41	92	52	67	74	69	42	--	83

* Magnetite is subdivided by mesh only in samples D, F, G, I, and N.

-- Total quantity is less than 1 percent of the first concentrate, except for magnetite.

Table 3.--Recovery (in percent) of the minerals in the 45 mesh fraction of riffle samples--Continued.

Riffle sand

O	--	--	--	72	--	95	--	--	--	--
P	--	42	--	65	--	100	--	11	--	--
Q	--	35	--	50	--	47	--	34	--	--
R	--	--	0	57	--	--	--	--	--	--
S	--	--	--	65	--	--	--	--	--	--
T	--	0	--	38	--	50	--	--	--	--
Average	--	26	0	58	--	73	--	22	--	--
Avg riffle samples	44	37	62	54	67	74	69	29	--	83

Table 4.--Recovery (in percent) of the minerals in the 100 mesh fraction of riffle samples.

Sample	Epidote	Garnet	Hematite	Ilmenite	Magnetite*	Monazite	Rutile	Sillimanite	Tourmaline	Zircon
Riffle gravel										
A	--	81	--	92	--	94	--	76	0	--
B	--	22	--	82	--	95	--	26	0	--
C	0	67	--	76	--	95	--	--	--	--
D	--	--	--	81	--	81	100	--	--	--
E	--	--	--	74	--	90	100	74	--	--
F	--	--	--	75	71	90	--	--	--	100
G	--	--	--	79	81	100	--	--	--	100
H	--	70	--	55	--	74	--	31	--	--
I	--	64	--	58	74	84	--	30	--	--
J	--	82	--	81	--	79	--	85	53	--
K	48	69	--	81	--	95	--	0	--	--
L	--	45	--	69	--	76	--	18	--	--
M	--	--	--	100	--	--	--	58	--	--
N	52	87	--	88	96	100	--	--	--	82
Average	33	65	--	78	80	87	100	44	18	94

* Magnetite is subdivided by mesh only in samples D, F, G. I, and N.

-- Total quantity, is less than 1 percent of the first concentrate, except for magnetite.

Table 4.--Recovery (in percent) of the minerals in the 100 mesh fraction of riffle samples--Continued.

Riffle sand										
O	40	93	--	83	--	84	--	--	95	83
P	57	52	--	66	--	100	--	26	0	--
Q	0	48	--	63	--	100	--	17	0	--
R	47	--	--	49	--	--	--	--	--	0
S	26	--	--	61	--	83	44	32	--	--
T	--	40	--	55	--	90	100	15	--	100
Average	34	58	--	63	--	91	72	22	32	61
Avg riffle samples	34	63	--	73	80	89	86	38	26	78

Table 5.--Recovery (in percent) of the minerals in the 170 mesh fraction of riffle samples.

Sample	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite*	Rutile	Sillimanite	Tourmaline	Zircon
Riffle gravel										
A	--	--	--	48	--	0	--	0	0	--
B	--	--	--	89	--	87	--	77	82	--
C	--	--	--	61	--	--	--	--	--	--
D	--	--	--	46	--	--	--	--	--	60
E	--	--	--	65	--	90	--	73	--	--
F	--	--	--	67	84	85	--	--	--	--
G	--	--	--	84	80	--	--	--	--	83
H	--	--	--	60	--	44	--	--	--	--
I	--	--	--	69	--	70	61	47	--	70
J	--	--	--	56	--	81	--	56	--	--
K	39	--	--	71	--	85	--	48	--	100
L	--	100	--	70	--	75	--	20	--	100
M	--	--	--	0	--	81	--	42	--	--
N	--	--	--	93	--	100	--	--	--	--
Average	39	100	--	63	82	68	61	45	41	83

* Magnetite is subdivided by mesh only in samples D, F, G, I. and N.

-- Total quantity is less than 1 percent of the first concentrate, except for magnetite.

Table 5.--Recovery (in percent) of the minerals in the 170 mesh fraction of riffle samples--Continued.

Riffle sand										
O	--	--	--	68	--	100	--	--	--	68
P	--	--	--	61	--	--	--	--	--	--
Q	--	--	--	50	--	88	--	0	--	--
R	23	0	--	39	--	--	--	--	--	22
S	48	--	--	77	--	83	56	--	--	--
T	--	--	--	48	--	60	--	0	--	--
Average	36	0	--	57	--	83	56	0	--	45
Avg riffle samples	37	50	--	61	82	75	58	36	41	72

Recovery in the 170 mesh fraction is generally better than that in the 45 mesh fraction, suggesting that the optimum grain size of heavy minerals for recovery in the gold pan is close to 100 mesh, or about 0.2 millimeter. Coarser material has a greater surficial area and absorbs a greater force from the water that is moving out of the pan. Many of these coarser grains are rolled out of the pan. Finer material is lifted into suspension when the pan is shaken, and it is poured from the pan before all of it has had time to settle.

Relation of recovery to type of sediment

The slight decrease in recovery in riffle sand samples compared with riffle gravel samples (table 2) results from two factors: fatigue from panning large volumes of sand and the increase in quantity of fine-grained material in sand samples. The latter is apparently the most important factor and will be discussed in more detail later. As the 16-inch gold pans will hold about 0.15 cubic foot, the samples that were classified as riffle sand (more than 0.18 cubic foot of material with diameters less than one-eighth inch) could not be panned in a single operation. The usual procedure was to fill the pan with as much sand as it would hold, pan this until the remainder would fit in the pan, pour in the remainder, and repeat the panning process. In addition to the psychological disadvantage of having to start the panning process twice, this system had the mechanical disadvantage of crowding the pan. Agitating a pan full of sand without allowing any to escape is difficult and slow, and the tendency of the panner is to begin washing off the tailings before the heavy minerals have had sufficient time to settle.

Clay and silt, which generally are absent from riffle samples, are common in all bank samples. With the increase in these fine-grained sediments there is an increase in the quantity of fine-grained heavy minerals and a consequent decrease in the average recovery. The decrease in recoveries between riffle samples and bank samples are not as marked on table 2 as would be expected because most of the fine-grained heavy minerals were lost when the clay and silt were removed. Results of an attempt made to recover heavy minerals from the material usually washed off in suspension are given in table 6 as: (1) the recovery that would have been assigned to each mineral if the sample had been handled in the same manner as the other bank samples, (2) the percentage of total weight of the mineral that was in the suspended material, and (3) the recovery of each mineral computed in the same manner as the other samples but including the concentrates obtained from the suspended material. Only one silt sample was handled in this manner, and the results from this sample may be unusual, but the quantities of the various minerals that were carried into suspension are too consistent to be overlooked. None of the 45 mesh fraction went into suspension, 0 to 100 percent of the 100 mesh fraction went into suspension, and 69 to 100 percent of the 170 mesh fraction went into suspension. If similar quantities of the heavy minerals were lost from the other bank samples, their recoveries would decrease to about one-half of that given in table 2.

Relation of recovery to sorting of the concentrate

The sorting of the bed in the concentrate that contains a mineral affects the recovery of that mineral during panning. The bed is not monomineralic nor are all the grains of the mineral in a single bed. The

Table 6.--Recoveries of heavy minerals in sample Y.

Mineral	Recovery (in percent) of heavy minerals, less those in suspension.				Percent of heavy minerals in suspended material.				Actual recovery (in percent) of heavy minerals in the first panning.			
	Sieved fractions			Total	Sieved fractions			Total	Sieved fractions			Total
	45	100	170		45	100	170		45	100	170	
Epidote	--	--	--	--	--	100	--	100	--	0	--	0
Garnet	0	--	--	0	0	--	--	0	0	--	--	0
Ilmenite	67	92	100	87	0	75	76	69	67	23	24	27
Magnetite	100	100	--	100	0	50	100	50	100	50	0	50
Monazite	100	95	100	98	0	23	75	64	100	28	25	35
Rutile	--	0	--	0	--	86	100	98	--	0	0	0
Sillimanite	0	0	100	35	0	24	69	54	0	0	31	18
Staurolite	--	--	--	--	--	--	100	100	--	--	0	0
Zircon	--	0	100	97	--	0	69	68	--	0	31	31

sorting of the bed that contains the majority of the grains of the mineral may be approximated by using the sorting of the mineral. The distribution of monazite and ilmenite among the sieved fractions for the riffle samples is given on figure 4. The lowest recoveries in a given sieved fraction for these two minerals are generally in samples that contain the least of the sieved fraction and nearly equal proportions of the other two fractions.

Other factors affecting recovery

Many psychological, climatic, and physical factors may affect the accuracy of panning, but none of these can be related to systematic changes of recovery in these samples. With the exception of two men, none of the panners had any experience with a gold pan before joining the project, and two had no knowledge of minerals. The men were shown the procedure of panning and given a few days to practice before they multiple panned their first sample. The remainder of their multiple-panned samples were distributed through the eight-month field season. It was anticipated that the recoveries would vary with the ability of the panner, and that as he gained experience the recovery would improve. Only one person had an exceptionally low recovery in the first attempt at panning, and this panner was deliberately given no time to practice. Other than this these samples show no systematic increase in recovery with experience, and no systematic difference between the panners is evident.

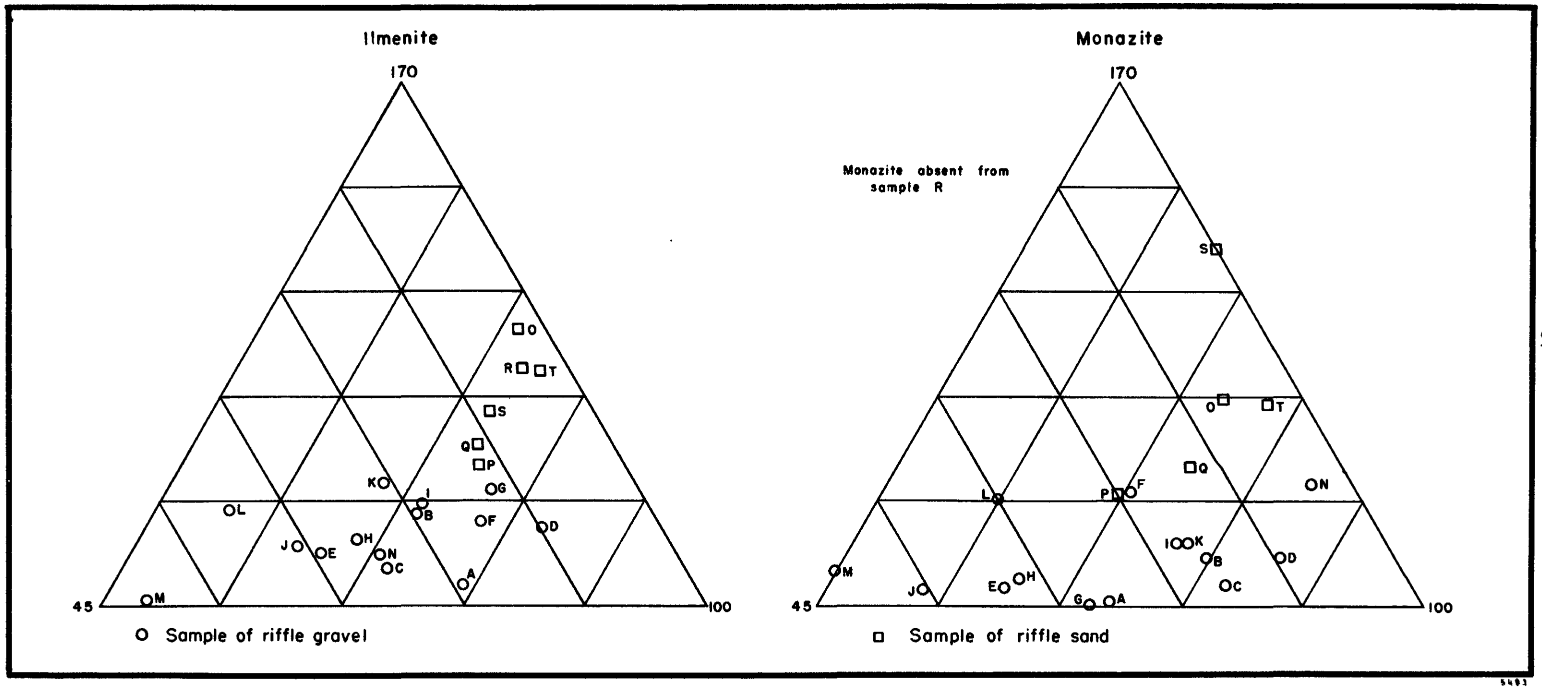

FIGURE 4.—SIZE DISTRIBUTION OF ILMENITE AND MONAZITE IN RIFFLE SAMPLES.

An increase in the recovery of heavy minerals might be expected to accompany an unusually high retention of quartz in the first concentrate because none of the heavy minerals will be lost if none of the light minerals is washed from the pan. However, no relation between percentage of quartz in the first concentrate and recovery of minerals of greater specific gravity than 3.5 could be determined, though the range in quartz content of the concentrates from riffle samples is from 2 to 40 percent. Increases in the proportion of quartz left in concentrates during successive pannings, especially where high proportions of quartz were left in small concentrates to facilitate handling, resulted in a concomitant increase in minerals whose specific gravity was less than 3.5.

More heavy minerals presumably will be lost if there is a larger percentage of heavy minerals in a sample, but this will not lower the percentage recovered. As no change in recovery could be related to change in the total weight of the concentrate, it is inferred that the weight of heavy minerals lost during panning is directly proportionate to the total weight of heavy minerals. The same relationship appears to hold as the total weight of one mineral changes from sample to sample, or as the proportion of the mineral in the concentrate changes.

Slight changes in the recovery of a mineral occur as the mineralogical suite changes. For example the recovery of rutile will be higher if the concentrates are largely garnet and sillimanite than if they are largely monazite and magnetite. The data available from these samples are insufficient to evaluate the effects of such assemblages on the recovery of a mineral, because changes in the mineralogical suites tend to cancel one another. In the area considered, samples with large proportions of epidote also have large proportions of magnetite and samples with large proportions of sillimanite also have large proportions of ilmenite. With artificially prepared samples it may be possible to relate the recovery of a mineral to the average specific gravity of the concentrate and therefore to the mineral suite.

Distribution of loss through the panning process

The losses during panning show a general increase from the first part of the process to the last stages of cleaning (table 7) because the proportion of heavy minerals in the sample increases through the process of panning; each successive washing of light minerals from the surface of the sample exposes a larger quantity of heavy minerals. In the first part of the process the heavy minerals are protected by a thick mantle of light minerals, but during the last part of the process the light minerals must be removed from the interstices among the heavy minerals.

The 45 mesh monazite, which is consistently lost in the first half of panning, is the exception. Monazite was the primary objective of the placer reconnaissance and was easily recognized in the pan, even by panners who had no training in mineralogy. During the early part of panning it is difficult to recognize any of the heavy minerals in the pan, and a larger quantity of material is removed in each cycle of shaking and washing than in the later cycles. It is also during the early part of the process that the classification action of the pan may be used to best advantage to remove coarse grains that are a particular problem in the later part of the process. It is inferred that during the early part of panning coarse grains of monazite were removed without their being recognized; but during the latter part of the process, when the heavy minerals could be seen, special care was taken to save coarse-grained monazite.

Table 7.--Distribution of the losses of garnet, ilmenite, monazite, and sillimanite during panning.

Sample	Split	Garnet 45	Garnet 100	Garnet 170	Garnet Total	Ilmenite 45	Ilmenite 100	Ilmenite 170	Ilmenite Total	Monazite 45	Monazite 100	Monazite 170	Monazite Total	Sillimanite 45	Sillimanite 100	Sillimanite 170	Sillimanite Total
		Percent of loss by sieved fractions															
A	first 1/4	34	10	--	32	21	15	24	20	55	11	0	43	38	23	20	23
	last 3/4	66	90	--	68	79	85	76	80	45	89	100	57	62	77	80	77
G	first 2/3	trace	--	--	trace	45	53	29	46	70	--	--	70	--	--	--	--
	last 1/3	--	--	--	--	55	47	71	54	30	--	--	30	--	--	--	--
H	first 3/4	49	29	--	46	47	39	33	43	54	36	27	46	0	38	76	45
	last 1/4	51	71	--	54	53	61	67	57	46	64	73	54	100	62	24	55
J	first 1/3	19	17	--	19	22	22	12	21	51	65	100	56	--	59	45	50
	middle 1/3	30	33	--	30	35	42	80	43	24	13	0	20	--	17	11	13
	last 1/3	51	50	--	51	43	36	8	36	25	22	0	24	--	24	44	37
K	first 1/3	20	20	0	19	18	21	41	26	0	40	0	18	0	13	32	21
	middle 1/3	26	38	100	31	27	32	27	29	100	60	100	82	0	23	28	23
	last 1/3	54	42	0	50	55	47	32	45	0	0	0	0	100	64	40	56
O	first 1/2	14	53	100	34	16	14	9	11	100	2	0	10	--	--	--	--
	last 1/2	86	47	0	66	84	86	91	89	0	98	100	90	--	--	--	--

Other deviations from the general distribution of the losses through the process of panning cannot be explained by the characteristics of the samples or their minerals, as the exceptions are scattered among the minerals and among the samples. Most of the garnet in the 100 mesh fraction of sample O was lost in the first half of the panning, but in the other samples and other fractions of this sample 65 to 85 percent of the garnet was lost in the last half of the panning. In the 100 mesh fraction of sample O, 86 percent of the ilmenite and 98 percent of the monazite was lost in the last half of the panning. The small quantity of minerals in the 170 mesh fractions of the concentrates may explain the deviations in this size group. If these small quantities are calculated to the nearest whole percent of the total concentrate and the percent recalculated to weight, the change in the calculated weight from the actual weight may be sufficient to reverse the distribution of the loss.

THE GOLD PAN AS A GEOLOGIC TOOL

The gold pan is a valuable tool for placer reconnaissance or geologic reconnaissance of broad areas. Sampling streams at a density of 1 sample per square mile, a team of two men can cover 10 square miles per day. Each sample weighs about 50 pounds and the recovered concentrates weigh from 10 to 1,000 grams. Such concentrates give not only the tenors of placers but also the general distribution of heavy minerals in the drainage basin of the stream. They provide means of limiting the area to be covered when prospecting for lode deposits and may be used to acquire knowledge of the broader geologic features.

Calculations should be restricted to minerals with a specific gravity greater than 4.0 when using the gold pan as a quantitative tool, though recoveries of minerals with specific gravities as low as 3.2 would probably equal the recoveries of these minerals in commercial operations using gravity separation. As determined by this investigation, the average recoveries of minerals of high specific gravity in the first panning of riffle samples are:

Mineral	Recovery (percent)
Hematite	62
Ilmenite	64
Magnetite	59
Monazite	84
Rutile	68
Zircon	72

Special care must be taken with clay and silt. Insufficient data are available to give recovery figures for these sediments, but recoveries in clay and silt samples are about half of those in riffle samples. Similarly, the recoveries given on table 2 for epidote, garnet, sillimanite, and tourmaline are probably about twice the actual recoveries of these minerals because the quantities of these minerals remaining in the tailings after the last panning may be equal to the total quantity recovered.

SUGGESTIONS FOR IMPROVED PANNING TECHNIQUE

The features of a sample that have the greatest effect on recoveries of the heavy minerals are: (1) the specific gravity of the minerals, (2) the grain size of the minerals, and (3) the proportions of the various grain sizes. The greatest loss occurs during the last part of the process, though the greatest loss of monazite in the 45 mesh sieve fraction is in the first half of the process.

The specific gravity of a mineral is constant, and it is virtually impossible to improve the recoveries of a mineral of low specific gravity and still produce a clean concentrate. To improve the recoveries of these minerals it is necessary to leave 80 percent or more of quartz in the concentrate. For quantitative study of these minerals, the gold pan may be used to remove about three-quarters of the bulk of the sample, but the remainder of the concentration should be done by laboratory methods.

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Appendix A. Weights (grams) of minerals in concentrates from stages of panning.

Sample A (52-CS-415 series). This sample was split during panning. Stages 2 through 7 are repanning of the last three-fourths of the tailing and stages 8 through 10 are repanning of the first one-fourth of the tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Garnet	Ilmenite	Magnetite	Monazite	Feldspar and quartz	Sillimanite	Tourmaline
1 (109875)	25.6	45	—	1.280	2.560	*	2.816	—	—	—
		100	—	1.024	7.168	*	3.072	5.888	1.280	—
		170	—	—	0.256	*	—	—	—	—
		Total	—	2.304	9.984	0.256	5.888	5.888	1.280	—
2 (109876)	3.9	45	—	0.819	0.975	*	0.312	—	—	—
		100	—	0.117	0.390	*	0.156	0.780	0.078	—
		170	—	—	0.078	*	0.039	0.039	0.039	—
		Total	—	0.936	1.443	0.078	0.507	0.819	0.117	—
3 (109877)	1.0	45	—	0.240	0.150	—	0.010	—	—	—
		100	—	0.030	0.060	—	0.020	0.300	0.070	0.020
		170	—	—	0.040	—	0.010	0.030	0.010	0.010
		Total	—	0.270	0.250	—	0.040	0.330	0.080	0.030
4 (109878)	0.7	45	—	0.203	0.084	—	0.014	—	—	—
		100	—	0.014	0.021	—	—	0.140	0.077	0.042
		170	—	—	0.042	—	—	0.028	0.028	0.007
		Total	—	0.217	0.147	—	0.014	0.168	0.105	0.049
5 (109879)	0.6	45	—	0.132	0.060	—	—	—	0.006	—
		100	—	0.018	0.018	—	—	0.222	0.030	0.012
		170	—	—	0.036	—	—	0.048	0.018	—
		Total	—	0.150	0.114	—	—	0.270	0.054	0.012
6 (109880)	0.5	45	—	0.150	0.045	—	—	—	—	0.005
		100	—	0.015	—	—	—	0.130	0.035	0.020
		170	—	—	0.015	—	—	0.040	0.040	0.005
		Total	—	0.165	0.060	—	—	0.170	0.075	0.030
7 (109881)	0.7	45	—	0.035	0.021	—	—	0.028	0.007	0.007
		100	—	0.014	0.028	—	—	0.413	0.007	0.042
		170	—	—	—	—	—	0.077	0.014	0.007
		Total	—	0.049	0.049	—	—	0.518	0.028	0.056
8 (109882)	2.2	45	—	0.660	0.286	*	0.396	0.154	—	—
		100	0.022	0.022	0.044	*	0.022	0.308	0.066	—
		170	—	—	0.066	*	—	0.022	0.022	—
		Total	0.022	0.682	0.396	0.110	0.418	0.484	0.088	—
9 (109883)	0.8	45	—	0.112	0.048	—	0.008	0.024	0.008	—
		100	—	—	0.024	—	—	0.456	0.016	0.008
		170	—	—	—	—	—	0.080	0.016	—
		Total	—	0.112	0.072	—	0.008	0.560	0.040	0.008
10 (109884)	0.7	45	—	0.056	0.028	—	—	0.014	—	—
		100	—	—	0.021	—	—	0.476	0.007	—
		170	—	—	—	—	—	0.098	—	—
		Total	—	0.056	0.049	—	—	0.588	0.007	—

—— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

/ (grams)
Appendix. Weights of minerals in concentrates from stages of panning—continued.

Sample B (52-CS-416 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Magnetite	Monazite	Feldspar and quartz	Rutile	Sillimanite	Tourmaline	Zircon
1 (109885)	21.1	45	0.422	1.266	*	2.532	—	—	—	—	—
		100	0.211	2.954	*	5.697	1.266	—	0.422	—	—
		170	—	1.266	*	0.844	3.165	—	0.633	0.211	—
		Total	0.633	5.486	0.211	9.073	4.431	—	1.055	0.211	—
2 (199886)	3.8	45	0.190	0.494	—	0.304	—	—	—	—	0.038
		100	0.456	0.228	—	0.304	0.342	—	0.190	0.114	—
		170	—	0.152	—	0.114	0.646	—	0.114	—	—
		-170		0.038	—			—	0.076		
		Total	0.646	0.912	—	0.722	0.988	—	0.380	0.114	0.038
3 (109887)	2.3	45	0.345	0.667	—	0.184	—	—	—	—	—
		100	0.115	0.345	—	—	0.345	—	0.069	0.023	—
		170	—	—	—	—	0.207	—	—	—	—
		Total	0.460	1.012	—	0.184	0.552	—	0.069	0.023	—
4 (109888)	0.5	45	0.065	0.100	—	0.025	—	0.005	—	0.005	—
		100	0.025	0.030	—	0.010	0.090	—	0.035	0.010	—
		170	—	0.010	—	0.010	0.055	—	0.025	—	—
		Total	0.090	0.140	—	0.045	0.145	0.005	0.060	0.015	—
5 (109889)	4.5	45	0.675	0.540	—	0.090	—	—	—	—	—
		100	0.135	—	—	—	2.205	—	0.225	0.135	—
		170	—	—	—	—	0.405	—	0.045	0.045	—
		Total	0.810	0.540	—	0.090	2.610	—	0.270	0.180	—
6 (109890)	0.5	45	0.100	0.100	—	—	—	—	—	—	—
		100	0.010	0.030	—	—	0.125	—	0.025	0.010	—
		170	—	—	—	—	0.095	—	0.005	—	—
		Total	0.110	0.130	—	—	0.220	—	0.030	0.010	—

____ Total quantity less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

/ (grams)
Appendix. Weights of minerals in concentrates from stages of panning--continued.

Sample C (52-CS-656 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Quartz and feld-spar	Rutile	Sillimanite	Staurolite	Zircon
1 (110127)	85.1	45	—	2.553	4.255	—	20.424	*	2.553	2.553	—	—	—	—
		100	—	—	0.851	—	19.573	*	5.106	1.702	—	—	—	—
		170	—	—	—	—	2.553	*	—	—	—	—	—	—
		Total	—	2.553	5.106	—	42.550	22.977	7.659	4.255	—	—	—	—
2 (110128)	14.0	45	0.280	0.560	0.560	—	4.200	*	—	0.980	—	0.140	—	0.140
		100	—	0.140	0.280	0.140	2.380	*	0.280	0.420	0.140	—	—	—
		170	—	—	—	—	0.280	*	—	0.140	—	—	—	—
		Total	0.280	0.700	0.840	0.140	6.860	2.940	0.280	1.540	0.140	0.140	—	0.140
3 (110129)	6.8	45	0.340	0.748	0.340	—	0.816	*	—	1.292	—	—	—	—
		100	—	0.204	0.068	—	1.156	*	—	0.340	—	0.068	—	—
		170	—	—	—	—	0.272	*	—	—	—	—	—	—
		Total	0.340	0.952	0.408	—	2.244	1.156	—	1.632	—	0.068	—	—
4 (110130)	3.8	45	0.152	0.304	0.152	—	0.722	*	—	0.380	—	0.076	—	—
		100	—	0.152	0.038	—	0.684	*	—	0.190	0.038	—	—	—
		170	—	—	—	—	0.190	*	0.076	—	—	—	—	0.038
		Total	0.152	0.456	0.190	—	1.596	0.608	0.076	0.570	0.038	0.076	—	0.038
5 (110131)	3.6	45	0.072	0.540	—	0.144	0.540	*	—	0.792	—	—	—	—
		100	0.036	0.108	—	—	0.432	*	—	0.216	—	—	—	—
		170	—	—	—	—	0.144	*	0.036	—	—	—	....	0.036
		Total	0.108	0.648	—	0.144	1.116	0.504	0.036	1.008	—	—	—	0.036
6 (110132)	2.8	45	0.224	0.308	0.056	—	0.252	*	—	0.644	—	0.028	—	—
		100	0.056	0.168	0.028	—	0.392	*	—	0.196	0.028	0.028	—	—
		170	—	—	—	—	0.112	*	0.056	—	—	—	—	0.028
		Total	0.280	0.476	0.084	—	0.756	0.196	0.056	0.840	0.028	0.056	—	0.028
7 (110133)	3.7	45	0.111	0.333	—	—	0.851	*	—	0.111	—	0.074	—	—
		100	0.074	0.111	—	—	0.592	*	—	0.814	—	—	—	—
		170	—	—	—	—	0.296	*	0.074	—	—	—	—	0.037
		Total	0.185	0.444	—	—	1.739	0.222	0.074	0.925	—	0.074	—	0.037
8 (110134)	2.5	45	0.075	0.100	0.025	—	0.100	*	—	0.200	—	—	—	—
		100	0.100	0.325	—	—	0.375	*	—	0.500	—	—	—	—
		170	—	—	—	—	0.225	*	0.100	—	—	—	—	0.075
		Total	0.175	0.425	0.025	—	0.700	0.300	0.100	0.700	—	—	—	0.075
9 (110135)	3.4	45	—	0.340	0.102	—	0.442	*	—	1.190	—	0.034	0.204	—
		100	0.068	0.102	—	—	0.068	*	—	0.442	—	—	—	—
		170	—	—	—	—	0.102	*	—	—	—	—	—	—
		Total	0.068	0.442	0.102	—	0.612	0.306	—	1.632	—	0.034	0.204	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample D (52-DC-42 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Zircon
1 (82903)	286.1	45	—	42.915	2.861	2.861	—	—	—
		100	—	154.494	—	11.444	40.054	2.861	—
		170	—	20.027	—	—	5.722	—	2.861
		Total	—	217.436	2.861	14.305	45.776	2.861	2.861
2 (82904)	79.0	45	—	7.900	0.790	0.790	—	—	—
		100	—	30.020	—	2.370	6.320	—	2.370
		170	—	19.750	—	1.580	4.740	0.790	1.580
		Total	—	57.670	0.790	4.740	11.060	0.790	3.950
3 (82905)	18.3	45	—	3.294	0.183	0.183	—	—	—
		100	—	4.575	0.183	0.366	3.111	—	0.366
		170	—	2.562	—	0.183	2.745	—	0.366
		-170	—	0.183	—	—	—	—	—
		Total	—	10.614	0.366	0.732	5.056	—	0.732
4 (82906)	9.4	45	0.094	1.974	0.094	0.094	—	—	—
		100	—	1.410	—	—	2.726	—	—
		170	—	1.034	—	—	1.880	—	—
		-170	—	0.094	—	—	—	—	—
		Total	0.094	4.512	0.094	0.094	4.606	—	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample E (52-DC-834 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Kyanite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Zircon
1 (110984)	131.9	45	5.276	13.190	—	*	47.484	—	2.638	2.638	1.319
		100	—	9.233	—	*	21.104	5.276	3.957	11.871	—
		170	—	2.638	—	*	2.638	—	—	1.319	—
		Total	5.276	25.061	—	1.319	71.226	5.276	6.595	15.828	1.319
2 (110985)	28.8	45	2.304	3.744	1.440	*	6.048	0.576	—	0.576	—
		100	0.576	2.016	0.864	*	2.304	3.456	—	3.168	—
		170	—	0.576	—	*	0.288	—	—	0.288	—
		Total	2.880	6.336	2.304	0.576	8.640	4.032	—	4.032	—
3 (110986)	20.1	45	2.613	2.613	—	*	0.603	4.020	—	0.804	—
		100	—	0.804	—	*	—	7.035	—	—	—
		170	—	0.402	—	*	—	0.201	0.201	—	—
		Total	2.613	3.819	—	0.804	0.603	11.256	0.201	0.804	—
4 (110987)	16.9	45	2.028	2.366	1.690	*	0.507	2.704	—	1.352	—
		100	—	0.338	0.676	*	0.169	3.042	—	0.845	—
		170	—	0.338	—	*	—	—	—	0.169	—
		Total	2.028	3.042	2.366	0.676	0.676	5.746	—	2.366	—
5 (110988)	13.6	45	2.040	1.632	2.312	*	—	1.768	—	0.816	—
		100	—	—	0.136	*	—	3.808	—	—	—
		170	—	0.136	0.136	*	—	—	—	—	—
		Total	2.040	1.768	2.584	0.816	—	5.576	—	0.816	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample F (52-OT-42 series)

Stage of panning and laboratory numbers	Total weight of concentrates (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Zircon
1 (82583)	302.2	45	—	—	—	24.176	69.506	3.022	—	—
		100	—	—	—	90.660	45.330	6.044	15.110	3.022
		170	—	—	—	24.176	9.066	3.022	6.044	—
		-170	—	—	—	3.022	—	—	—	—
		Total	—	—	—	142.034	123.902	12.088	21.154	3.022
2 (82584)	116.2	45	—	—	1.162	24.402	22.078	2.324	1.162	—
		100	1.162	—	—	22.078	11.620	—	13.944	—
		170	—	—	—	9.296	1.162	—	3.486	1.162
		-170	—	—	—	1.162	—	—	—	—
		Total	1.162	—	1.162	56.938	34.860	2.324	18.592	1.162
3 (82585)	34.0	45	—	—	—	5.440	12.240	0.340	0.340	—
		100	—	—	—	3.740	3.060	—	5.440	—
		170	—	—	—	1.360	0.340	0.340	0.680	0.340
		-170	—	—	—	0.340	—	—	—	—
		Total	—	—	—	10.880	15.640	0.680	6.460	0.340
4 (82586)	20.3	45	—	—	—	3.654	7.714	0.203	0.203	—
		100	—	—	—	2.030	1.421	0.406	3.045	—
		170	—	—	—	0.609	—	0.203	0.812	—
		Total	—	—	—	6.293	9.135	0.812	4.060	—
5 (82587)	14.1	45	—	—	—	2.679	5.217	0.141	—	—
		100	—	—	—	1.974	0.846	0.282	2.115	—
		170	—	—	—	0.282	—	—	0.564	—
		Total	—	—	—	4.935	6.063	0.423	2.679	—
6 (82588)	9.9	45	—	—	—	1.881	3.465	0.198	0.198	—
		100	0.099	0.198	—	0.693	0.495	—	2.079	—
		170	—	—	—	0.198	0.099	—	0.297	—
		Total	0.099	0.198	—	2.772	4.059	0.198	2.574	—
7 (82589)	5.0	45	—	—	—	1.000	1.800	0.050	0.050	—
		100	—	0.100	—	0.300	0.300	—	1.100	—
		170	—	—	—	0.050	0.100	—	0.150	—
		Total	—	0.100	—	1.350	2.200	0.050	1.300	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued.

Sample G (52-OT-43 series). This sample was split during panning. Stages 2 through 7 are repanning of last one-third of the tailing and stages 8 through 13 are repanning of the first two-thirds of tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Zircon
1 (82590)	189.7	45	—	—	—	—	9.485	39.837	1.897	22.764	—
		100	—	—	—	—	47.425	28.455	1.897	3.794	1.897
		170	—	—	—	—	20.867	7.588	—	—	1.897
		-170	—	—	—	—	1.897	—	—	—	—
		Total	—	—	—	—	79.674	75.880	3.794	26.558	3.794
2 (82591)	29.5	45	—	—	—	—	7.080	9.145	—	—	—
		100	—	0.295	—	—	4.130	2.360	—	2.950	—
		170	—	0.295	—	—	1.770	0.590	—	0.295	0.295
		-170	—	—	—	—	0.295	—	—	—	—
		Total	—	0.590	—	—	13.275	12.095	—	3.245	0.295
3 (82592)	5.4	45	—	—	—	—	1.134	1.242	0.108	0.054	—
		100	0.108	0.108	—	—	0.810	0.486	—	0.540	—
		170	—	—	—	—	0.486	0.108	—	—	0.054
		-170	—	—	—	—	0.054	—	—	—	0.108
		Total	0.108	0.108	—	—	2.484	1.836	0.108	0.594	0.162
4 (82593)	2.5	45	—	—	—	0.025	0.625	0.400	0.025	0.025	—
		100	—	0.050	—	—	0.475	0.200	—	0.275	—
		170	—	0.025	—	—	0.150	0.100	—	0.025	—
		-170	—	—	—	—	0.075	—	—	—	0.025
		Total	—	0.075	—	0.025	1.325	0.700	0.025	0.325	0.025
5 (82594)	1.2	45	—	0.012	—	0.012	0.252	0.252	—	0.024	—
		100	—	0.036	—	—	0.168	0.180	—	0.072	—
		170	—	0.012	—	—	0.084	0.084	—	0.012	—
		Total	—	0.060	—	0.012	0.504	0.516	—	0.108	—
6 (82595)	1.3	45	—	0.013	—	0.013	0.208	0.182	—	0.052	—
		100	—	0.052	—	—	0.156	0.182	—	0.169	—
		170	—	0.013	—	—	0.065	0.091	—	0.013	—
		-170	—	—	—	—	—	—	—	0.039	0.052
		Total	—	0.078	—	0.013	0.429	0.455	—	0.273	0.052

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

/(grams)
Appendix. Weights of minerals in concentrates from stages of panning—Continued

Sample G (52-OT-43 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Zircon
7 (82596)	1.8	45	—	0.018	—	—	0.072	0.180	—	—	—
		100	0.018	0.108	—	—	0.306	0.090	—	0.558	—
		170	—	0.036	—	—	0.162	0.090	—	0.054	0.018
		-170	—	—	—	—	0.054	—	—	—	0.036
		Total	0.018	0.162	—	—	0.594	0.360	—	0.612	0.054
8 (82597)	23.5	45	—	—	—	—	4.700	7.990	0.235	0.235	—
		100	—	—	—	—	4.935	2.115	—	1.880	—
		170	—	—	—	—	0.705	0.470	—	0.235	—
		Total	—	—	—	—	10.340	10.575	0.235	2.350	—
9 (82598)	7.4	45	—	—	0.074	—	1.554	2.516	0.074	0.296	—
		100	0.074	0.074	—	—	1.258	0.370	—	0.814	—
		170	—	—	—	—	0.222	0.074	—	—	—
		Total	0.074	0.074	0.074	—	3.034	2.960	0.074	1.110	—
10 (82599)	2.8	45	—	0.028	0.028	0.028	0.588	0.980	—	0.168	—
		100	—	0.028	—	—	0.252	0.196	—	0.308	—
		170	—	—	—	—	0.112	0.084	—	—	—
		Total	—	0.056	0.028	0.028	0.952	1.260	—	0.476	—
11 (82600)	1.6	45	0.032	0.016	—	0.016	0.272	0.560	—	0.112	0.032
		100	0.016	0.032	—	—	0.128	0.096	—	0.192	—
		170	—	—	—	—	—	0.096	—	—	—
		Total	0.048	0.048	—	0.016	0.400	0.752	—	0.304	0.032
12 (82601)	1.2	45	—	0.012	0.012	0.012	0.216	0.336	—	0.192	—
		100	—	0.024	—	—	0.096	0.084	—	0.132	—
		170	—	—	—	—	—	0.084	—	—	—
		Total	—	0.036	0.012	0.012	0.312	0.504	—	0.324	—
13 (82602)	2.8	45	—	—	—	—	0.476	0.560	—	0.700	—
		100	0.028	0.028	—	—	0.056	0.112	—	0.728	—
		170	—	—	—	—	0.084	—	—	—	0.028
		Total	0.028	0.028	—	—	0.616	0.672	—	1.428	0.028

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued.

Sample H (52-OT-64 series). This sample was split during panning. Stages 2 through 6 are repanning of the last one-fourth of the tailing and stages 7 through 11 are repanning of the first three-fourths of the tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
1 (82603)	77.3	45	—	0.773	9.276	—	28.601	1.546	—	—	—
		100	—	0.773	8.503	—	13.914	6.957	0.773	—	—
		170	—	—	3.092	—	1.546	1.546	—	—	—
		Total	—	1.546	20.871	—	44.061	10.049	0.773	—	—
2 (82604)	18.9	45	—	0.378	4.158	0.189	4.347	1.512	—	—	0.189
		100	—	0.189	2.835	—	2.457	0.567	0.378	—	—
		170	—	—	0.756	—	0.756	—	—	—	—
		-170	—	—	—	—	0.189	—	—	—	—
		Total	—	0.567	7.749	0.189	7.749	2.079	0.378	—	0.189
3 (82605)	3.5	45	—	0.070	0.420	0.105	0.245	—	—	—	0.035
		100	—	—	0.805	—	0.420	0.525	0.105	—	—
		170	—	—	0.280	—	0.245	0.035	0.070	—	0.035
		-170	—	—	0.035	—	0.070	—	—	—	—
		Total	—	0.070	1.540	0.105	0.980	0.560	0.175	—	0.070
4 (82606)	2.0	45	—	0.140	0.500	—	0.120	0.320	—	—	—
		100	—	0.040	0.240	—	0.060	—	0.180	—	0.020
		170	—	—	0.180	—	0.200	—	—	—	—
		Total	—	0.180	0.920	—	0.380	0.320	0.180	—	0.020
5 (82607)	4.1	45	—	0.369	1.599	0.082	0.205	0.164	—	—	—
		100	—	—	0.410	—	0.082	0.615	0.205	0.082	—
		170	—	—	0.123	—	0.164	—	—	—	—
		Total	—	0.369	2.132	0.082	0.451	0.779	0.205	0.082	—
6 (82608)	0.8	45	—	0.048	0.104	—	0.016	0.024	0.008	—	—
		100	—	—	0.048	—	0.016	0.280	0.160	—	—
		170	—	—	0.040	—	0.040	—	0.016	—	—
		Total	—	0.048	0.192	—	0.072	0.304	0.184	—	—
7 (82609)	15.5	45	—	0.310	2.790	—	4.030	0.465	—	—	—
		100	—	—	1.550	—	1.240	3.875	0.465	—	—
		170	—	—	0.310	—	0.310	—	0.155	—	—
		Total	—	0.310	4.650	—	5.580	4.340	0.620	—	—
8 (82610)	7.3	45	—	0.365	1.898	0.219	1.387	1.022	—	—	—
		100	—	0.073	0.584	0.219	0.292	0.949	0.073	—	—
		170	—	—	0.146	—	0.073	—	—	—	—
		Total	—	0.438	2.628	0.438	1.752	1.971	0.073	—	—
9 (82611)	2.4	45	—	0.144	0.600	—	0.240	0.072	—	—	—
		100	—	—	0.408	—	0.192	0.456	—	—	—
		170	—	—	0.120	—	0.072	—	0.096	—	—
		Total	—	0.144	1.128	—	0.504	0.528	0.096	—	—
10 (82612)	1.0	45	—	0.040	0.220	—	0.100	0.030	—	—	0.010
		100	0.020	0.020	0.100	—	0.020	0.320	0.020	—	—
		170	—	—	0.050	—	0.030	0.010	0.010	—	—
		Total	0.020	0.060	0.370	—	0.150	0.360	0.030	—	0.010
11 (82613)	1.3	45	—	0.091	0.403	—	0.039	0.065	—	—	—
		100	—	—	0.104	—	—	0.416	0.078	—	—
		170	—	—	0.052	—	0.039	—	0.013	—	—
		Total	—	0.091	0.559	—	0.078	0.481	0.091	—	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Cirhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued

Sample I (52-PK-1 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
1 (81176)	49.6	45	—	—	1.488	2.976	1.488	5.952	—	0.496	—	—	0.496
		100	—	—	1.984	5.456	0.496	10.416	1.984	—	0.496	—	—
		170	—	—	—	2.976	—	1.984	8.928	0.496	0.992	—	0.496
		Total	—	—	3.472	11.408	1.984	18.352	10.912	0.992	1.488	—	0.992
2 (81177)	18.7	45	—	0.187	1.683	2.244	0.374	1.122	—	0.374	—	—	0.187
		100	—	—	0.561	2.244	—	0.748	1.870	—	0.561	—	—
		170	—	—	—	0.187	—	0.374	5.610	—	0.374	—	—
		Total	—	0.187	2.244	4.675	0.374	2.244	7.480	0.374	0.935	—	0.187
3 (81178)	6.2	45	—	—	0.496	1.054	0.062	0.496	—	0.124	—	—	0.062
		100	—	—	0.186	0.434	—	0.186	0.682	—	0.124	—	—
		170	—	—	—	0.062	—	0.062	2.108	—	0.062	—	—
		Total	—	—	0.682	1.550	0.062	0.744	2.790	0.124	0.186	—	0.062
4 (81179)	6.7	45	—	—	0.603	0.603	0.268	0.134	—	—	—	—	—
		100	0.134	—	0.268	0.469	0.067	0.670	0.469	0.067	0.134	—	0.067
		170	0.067	—	—	0.536	0.067	0.201	1.474	0.134	0.134	—	0.134
		Total	0.201	—	0.871	1.608	0.402	1.005	1.943	0.201	0.268	—	0.201
5 (81180)	7.6	45	—	—	0.988	0.912	0.152	0.152	—	0.228	—	—	—
		100	—	—	—	0.684	0.076	0.304	0.912	0.076	0.228	0.076	—
		170	—	—	—	0.380	—	0.152	1.596	0.152	0.304	0.076	0.076
		-170	—	—	—	0.076	—	—	—	—	—	—	—
		Total	—	—	0.988	2.052	0.228	0.608	2.508	0.456	0.532	0.152	0.076
6 (81181)	2.3	45	—	—	0.299	0.184	—	0.069	—	0.046	—	—	—
		100	0.023	—	0.069	0.115	0.023	0.046	0.322	0.023	0.069	—	—
		170	—	—	0.069	0.184	—	0.046	0.483	0.023	0.207	—	—
		Total	0.023	—	0.437	0.483	0.023	0.161	0.805	0.092	0.276	—	—
7 (81182)	0.7	45	0.007	—	0.084	0.140	0.028	0.007	0.007	0.021	—	—	0.007
		100	—	—	0.021	0.028	—	—	0.084	—	0.014	—	—
		170	0.007	—	0.007	0.007	—	0.028	0.168	0.007	0.028	—	—
		Total	0.014	—	0.112	0.175	0.028	0.035	0.259	0.028	0.042	—	0.007

— Total quantity recovered is less than 1 percent of concentrate.

Mineralogical analyses by M. E. Morisawa and L. A. Weiser.

Appendix. Weights (grams) of minerals in concentrates from stages of panning.

Sample J (52-PK-20 series). This sample was split during panning. Stages 2 through 4 are repanning of the last one-third of tailing, stages 5 through 7 are repanning of the middle one-third of tailing, and stages 8 through 10 are repanning of the first one-third of tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved Fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
1 (90564)	69.5	45	—	—	2.780	9.730	*	18.765	—	—	—	—
		100	—	—	2.085	4.865	*	3.475	12.510	4.170	0.695	—
		170	—	—	—	1.390	*	0.695	5.560	2.085	—	—
		Total	—	—	4.865	15.985	0.695	22.935	18.070	6.255	0.695	—
2 (90565)	4.5	45	—	—	0.450	0.855	—	0.450	—	—	—	—
		100	—	—	0.090	0.315	—	0.135	0.315	—	0.090	0.315
		170	—	—	—	0.090	—	—	0.720	0.495	0.090	—
		-170	—	—	—	0.045	—	0.045	—	—	—	—
		Total	—	—	0.540	1.305	—	0.630	1.035	0.495	0.180	0.315
3 (90566)	3.5	45	—	—	0.455	0.490	—	0.210	—	—	—	—
		100	—	—	0.070	0.035	—	—	0.595	0.105	0.105	0.035
		170	—	—	—	—	—	—	1.190	0.070	0.105	—
		-170	—	—	—	0.035	—	—	—	—	—	—
		Total	—	—	0.525	0.560	—	0.210	1.785	0.175	0.210	0.035
4 (90567)	2.0	45	—	—	0.460	0.380	—	0.040	—	—	—	—
		100	—	—	0.060	0.060	—	0.060	0.080	0.060	0.020	—
		170	—	—	—	—	—	—	0.480	0.140	0.040	—
		-170	—	—	—	0.040	—	0.020	—	0.060	—	—
		Total	—	—	0.520	0.480	—	0.120	0.560	0.260	0.060	—
5 (90568)	3.6	45	0.108	0.036	0.216	0.684	*	0.540	—	—	—	—
		100	—	—	0.108	0.432	*	0.108	0.108	0.036	0.036	—
		170	—	—	—	0.072	*	—	0.756	0.108	0.036	—
		-170	—	—	—	0.036	*	—	0.036	0.036	—	—
		Total	0.108	0.036	0.324	1.224	0.108	0.648	0.900	0.180	0.072	—
6 (90569)	2.4	45	—	0.024	0.456	0.552	—	0.096	—	—	—	—
		100	—	—	—	—	—	—	0.360	0.024	0.048	—
		170	—	—	—	0.816	—	—	—	0.024	—	—
		Total	—	0.024	0.456	1.368	—	0.096	0.360	0.048	0.048	—
7 (90570)	1.3	45	—	—	0.130	0.169	—	0.026	—	—	—	—
		100	—	—	0.039	0.052	—	0.013	0.039	0.052	0.026	—
		170	—	—	—	—	—	—	0.702	0.052	—	—
		Total	—	—	0.169	0.221	—	0.039	0.741	0.104	0.026	—
8 (90571)	5.3	45	—	—	0.371	0.583	—	1.219	—	—	—	—
		100	—	—	—	0.159	—	0.477	0.530	0.371	0.265	—
		170	—	—	—	0.106	—	0.159	0.477	0.371	0.106	—
		-170	—	—	—	—	—	0.053	—	0.053	—	—
		Total	—	—	0.371	0.848	—	1.908	1.007	0.795	0.371	—
9 (90572)	1.6	45	—	—	0.048	0.128	—	0.128	—	—	—	—
		100	—	—	0.064	0.064	—	0.112	0.016	0.032	0.016	—
		170	—	—	—	0.032	—	—	0.464	0.320	0.064	—
		-170	—	—	—	0.064	—	—	—	0.048	—	—
		Total	—	—	0.112	0.288	—	0.240	0.480	0.400	0.080	—
10 (90573)	1.0	45	—	—	0.100	0.150	—	0.050	—	—	—	—
		100	0.010	—	0.010	0.030	—	—	0.050	—	—	—
		170	—	—	—	—	—	—	0.460	0.030	0.010	—
		-170	—	—	—	0.030	—	—	0.020	0.040	0.010	—
		Total	0.010	—	0.110	0.210	—	0.050	0.530	0.070	0.020	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals / (grams) in concentrates from stages of panning--Continued .

Sample K (52-PK-126 series). This sample was split during panning. Stages 2 through 5 are repanning of the last one-third of the tailing. Stages 6 through 9 are repanning of the middle one-third of tailing, and stages 10 through 13 are repanning of the first one-third of the tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Kyanite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
1 (98834)	66.6	45	—	—	3.996	0.666	12.654	—	*	1.998	0.666	—	—	—	—
		100	—	1.332	3.996	—	11.322	—	*	3.330	1.332	1.332	—	—	—
		170	—	0.666	—	—	6.660	—	*	0.666	12.654	0.666	0.666	—	0.666
		Total	—	1.998	7.992	0.666	30.636	—	1.332	5.994	14.652	1.998	0.666	—	0.666
2 (98835)	5.3	45	—	—	0.530	—	0.795	—	—	—	—	—	—	—	—
		100	—	0.106	0.265	—	0.742	—	—	—	0.212	—	0.371	—	—
		170	—	0.159	—	—	0.371	—	—	—	1.431	—	0.106	—	—
		-170	—	—	—	—	0.159	—	—	—	—	—	—	—	0.053
		Total	—	0.265	0.795	—	2.067	—	—	—	1.643	—	0.477	—	0.053
3 (98836)	5.9	45	—	—	0.531	—	0.472	—	0.118	—	—	—	—	—	—
		100	0.177	0.354	0.177	—	0.177	—	—	—	1.062	—	0.236	—	—
		170	—	0.118	—	—	0.413	—	—	—	1.888	—	0.059	—	—
		-170	—	—	—	—	0.059	—	—	—	—	—	0.059	—	—
		Total	0.177	0.472	0.708	—	1.121	—	0.118	—	2.950	—	0.354	—	—
4 (98837)	3.1	45	—	—	0.248	—	0.341	—	—	—	—	—	—	—	—
		100	—	0.248	0.062	—	0.124	—	—	—	0.651	—	0.031	—	—
		170	0.093	0.062	—	—	0.062	—	—	—	1.085	—	—	—	—
		-170	—	—	—	—	0.093	—	—	—	—	—	—	—	—
		Total	0.093	0.310	0.310	—	0.620	—	—	—	1.736	—	0.031	—	—
5 (98838)	5.7	45	—	—	0.627	0.114	0.342	0.114	0.114	—	—	—	0.057	—	—
		100	0.399	0.285	0.228	—	0.171	—	—	—	0.912	—	0.285	0.114	—
		170	0.057	—	—	—	—	—	—	—	1.767	—	0.114	—	—
		Total	0.456	0.285	0.855	0.114	0.513	0.114	0.114	—	2.679	—	0.456	0.114	—
6 (98839)	5.7	45	—	—	0.342	—	0.456	—	0.057	0.114	—	—	—	—	0.057
		100	—	0.057	0.399	—	0.627	—	—	0.114	0.114	—	0.114	—	0.057
		170	—	0.171	—	—	0.570	—	—	0.114	2.109	0.057	—	—	—
		-170	—	—	—	—	0.171	—	—	—	—	—	—	—	—
		Total	—	0.228	0.741	—	1.824	—	0.057	0.342	2.223	0.057	0.114	—	0.114

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued

Sample K (52-PK-126)

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Kyanite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
7 (98840)	3.5	45	—	—	0.210	—	0.280	—	0.105	—	—	—	—	—	—
		100	—	0.070	0.035	—	0.105	—	—	—	0.350	—	0.035	—	—
		170	0.210	0.175	—	—	0.140	—	—	—	1.610	—	—	0.070	—
		-170	—	—	—	—	0.070	—	—	—	—	—	—	—	0.035
		Total	0.210	0.245	0.245	—	0.595	—	0.105	—	1.960	—	0.035	0.070	0.035
8 (98841)	1.9	45	—	—	0.133	—	0.057	0.019	—	—	—	0.019	—	—	—
		100	0.038	0.019	0.019	—	—	—	—	—	0.095	0.019	0.038	—	—
		170	0.076	0.152	0.076	—	—	—	—	—	0.969	—	0.057	—	—
		-170	—	—	—	—	0.076	—	—	—	—	—	0.019	—	0.019
		Total	0.114	0.171	0.228	—	0.133	0.019	—	—	1.064	0.038	0.114	—	0.019
9 (98842)	3.5	45	—	—	0.245	—	0.140	—	0.105	—	—	0.035	—	—	—
		100	0.245	0.175	0.210	—	0.105	—	—	—	0.490	—	0.140	—	—
		170	0.105	0.070	—	—	—	—	—	—	1.295	—	0.140	—	—
		Total	0.350	0.245	0.455	—	0.245	—	0.105	—	1.785	0.035	0.280	—	—
10 (98843)	2.5	45	—	—	0.150	—	0.275	—	—	—	—	0.050	—	—	—
		100	—	—	0.075	—	0.300	—	—	0.075	—	0.025	—	—	—
		170	0.025	0.025	—	—	0.250	—	—	—	0.875	0.025	0.150	—	—
		-170	—	—	—	—	0.100	—	—	—	0.025	0.025	0.025	—	0.025
		Total	0.025	0.025	0.225	—	0.925	—	—	0.075	0.900	0.125	0.175	—	0.025
11 (98844)	2.5	45	—	—	0.175	—	0.150	—	0.100	—	—	—	—	—	—
		100	—	0.050	0.050	—	0.225	—	—	—	0.125	—	0.025	—	—
		170	—	0.100	—	—	—	—	—	—	1.350	—	0.050	—	—
		-170	—	—	—	—	0.075	—	—	—	—	—	0.025	—	—
		Total	—	0.150	0.225	—	0.450	—	0.100	—	1.475	—	0.100	—	—
12 (98845)	2.6	45	—	—	0.234	—	0.182	—	0.104	—	—	—	—	—	—
		100	0.078	0.052	0.156	—	—	—	—	—	0.728	—	0.130	—	—
		170	0.052	—	—	—	0.858	—	—	—	—	—	0.026	—	—
		Total	0.130	0.052	0.390	—	1.040	—	0.104	—	0.728	—	0.156	—	—
13 (98846)	1.2	45	—	—	0.132	—	0.036	0.012	0.096	—	—	—	—	—	—
		100	0.024	0.012	0.060	—	0.012	0.012	—	—	0.024	—	0.036	—	—
		170	0.012	—	—	—	—	—	—	—	0.636	—	—	—	—
		-170	—	—	—	—	0.060	—	—	—	0.024	—	0.012	—	—
		Total	0.036	0.012	0.192	—	0.108	0.024	0.096	—	0.684	—	0.048	—	—

Appendix. Weights of minerals in concentrates from stages of panning (grams)—continued

Sample L (52-WE-160 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Xenotime	Zircon
1 (88405)	33.0	45	1.320	8.250	0.990	5.940	—	—	—	—
		100	0.330	2.310	—	1.980	2.640	0.330	0.330	—
		170	0.330	3.390	—	1.980	1.980	0.660	—	0.330
		Total	1.980	13.860	0.990	9.900	4.620	0.990	0.330	0.330
2 (88406)	15.5	45	1.085	3.100	1.550	0.775	—	—	—	—
		100	0.155	0.620	—	0.465	3.875	0.465	—	—
		170	—	0.930	—	0.465	1.395	0.620	—	—
		Total	1.240	4.650	1.550	1.705	5.270	1.085	—	—
3 (88407)	9.0	45	0.360	1.620	0.720	0.450	—	—	—	—
		100	0.090	0.360	—	0.090	1.800	0.270	—	—
		170	—	0.450	—	0.180	1.890	0.720	—	—
		Total	0.450	2.430	0.720	0.720	3.690	0.990	—	—
4 (88408)	7.3	45	0.292	0.949	1.022	0.146	—	—	—	—
		100	—	—	—	0.073	2.555	0.219	—	—
		170	—	—	—	—	1.679	0.365	—	—
		Total	0.292	0.949	1.022	0.219	4.234	0.584	—	—
5 (88409)	9.5	45	1.140	2.660	—	0.190	—	—	—	—
		100	0.095	—	—	—	2.850	0.285	—	—
		170	—	—	—	—	1.995	0.285	—	—
		Total	1.235	2.660	—	0.190	4.845	0.570	—	—
6 (88410)	4.7	45	0.141	0.705	0.705	0.047	—	—	—	—
		100	—	0.047	—	—	1.175	0.094	—	—
		170	—	—	—	—	1.410	0.376	—	—
		Total	0.141	0.752	0.705	0.047	2.585	0.470	—	—
7 (88411)	5.5	45	0.495	0.770	1.045	—	—	—	—	—
		100	0.055	—	—	—	1.980	0.110	—	—
		170	—	—	—	—	0.880	0.165	—	—
		Total	0.550	0.770	1.045	—	2.860	0.275	—	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone, M. N. Girhard, and E. J. Young.

Appendix. Weights (grams) of minerals in concentrates from stages of panning—Continued.

Sample M (52-WE-184 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Magnetite	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite
								(grams)			
1 (90657)	97.5	45	—	—	4.875	1.950	21.450	*	15.600	2.925	—
		100	—	—	—	—	2.925	*	—	30.225	1.950
		170	—	—	—	—	—	*	0.975	4.875	0.975
		Total	—	—	4.875	1.950	24.375	8.775	16.575	38.025	2.925
2 (90658)	35.8	45	—	—	2.148	—	4.654	4.654	1.790	7.876	—
		100	—	—	—	—	—	—	—	10.740	1.074
		170	—	—	—	—	0.358	—	—	2.148	0.358
		Total	—	—	2.148	—	5.012	4.654	1.790	20.764	1.432
3 (90659)	23.0	45	—	—	2.070	—	4.140	2.530	0.920	1.380	—
		100	0.230	—	—	—	—	—	—	8.280	—
		170	—	—	—	—	—	—	0.230	2.530	0.690
		Total	0.230	—	2.070	—	4.140	2.530	1.150	12.190	0.690
4 (90660)	27.0	45	—	0.270	0.810	—	4.320	3.240	—	5.670	—
		100	—	—	—	—	—	—	—	9.450	—
		170	—	—	—	—	—	—	—	3.240	—
		Total	—	0.270	0.810	—	4.320	3.240	—	18.360	—
5 (90661)	13.5	45	—	—	0.810	—	1.890	1.755	—	2.970	—
		100	—	—	—	—	—	—	—	4.725	0.135
		170	—	—	—	—	—	—	—	0.945	0.270
		Total	—	—	0.810	—	1.890	1.755	—	8.640	0.405
6 (90662)	18.3	45	—	—	0.549	—	0.183	1.647	—	13.176	—
		100	—	—	—	—	—	—	—	2.562	0.183
		Total	—	—	0.549	—	0.183	1.647	—	15.738	0.183
7 (90663)	31.0	45	—	—	1.860	—	—	1.860	—	25.110	0.620
		100	—	—	—	—	—	—	—	1.550	—
		Total	—	—	1.860	—	—	1.860	—	26.660	0.620
8 (90664)	18.0	45	—	—	0.180	—	0.180	1.260	—	16.020	—
		100	—	—	—	—	—	—	—	0.360	—
		Total	—	—	0.180	—	0.180	1.260	—	16.380	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued.

Sample N (52-WE-275 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Zircon
1 (90711)	150.7	45	13.563	6.028	19.591	7.535	22.605	—	3.014	—	—
		100	9.042	6.028	6.028	12.056	16.577	4.521	16.577	—	—
		170	—	—	—	3.014	—	1.507	1.507	—	1.507
		Total	22.605	12.056	25.619	22.605	39.182	6.028	21.098	—	1.507
2 (90712)	52.3	45	11.506	3.138	6.276	3.138	3.138	—	7.322	—	—
		100	2.615	1.569	0.523	1.046	0.523	—	9.937	—	—
		170	—	0.523	—	—	—	—	1.046	—	—
		Total	14.121	5.230	6.799	4.184	3.661	—	18.305	—	—
3 (90713)	15.7	45	1.884	0.628	2.512	0.785	0.785	0.314	3.297	—	—
		100	1.099	0.942	0.157	0.314	—	—	2.669	—	—
		170	—	0.157	—	0.157	—	—	—	—	—
		Total	2.983	1.727	2.669	1.256	0.785	0.314	5.966	—	—
4 (90714)	17.5	45	2.450	1.400	2.275	1.050	0.525	—	1.750	0.350	—
		100	1.225	1.750	—	—	—	—	4.025	—	—
		170	0.175	0.175	—	—	—	—	0.175	—	—
		-170	—	—	—	0.175	—	—	—	—	—
		Total	3.850	3.325	2.275	1.225	0.525	—	5.950	0.350	—
5 (90715)	16.6	45	2.656	1.660	1.826	2.822	*	—	4.150	—	—
		100	0.830	0.664	—	—	*	—	1.328	—	—
		170	—	0.166	—	—	*	—	—	—	—
		Total	3.486	2.490	1.826	2.822	0.498	—	5.478	—	—
6 (90716)	7.9	45	1.817	0.553	0.869	0.237	0.079	0.158	2.133	—	—
		100	0.632	0.079	—	—	—	—	0.790	—	0.316
		170	0.079	0.079	—	—	—	—	—	—	0.079
		Total	2.528	0.711	0.869	0.237	0.079	0.158	2.923	—	0.395
7 (90717)	7.7	45	0.770	0.231	0.462	0.770	0.077	—	1.771	—	—
		100	0.308	0.462	0.154	0.231	—	—	2.233	—	—
		170	—	0.077	—	0.077	—	—	0.077	—	—
		Total	1.078	0.770	0.616	1.078	0.077	—	4.081	—	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

/ (grams)
Appendix. Weights of minerals in concentrates from stages of panning—Continued .

Sample O (52-CS-282 series). This sample was split during panning. Stages 2 through 5 are repanning of the last one-half of the tailing and stages 6 through 8 are repanning of the first one-half of the tailing.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Spinel	Tourmaline	Zircon
1 (90410)	122.5	45	——	——	——	2.450	*	1.225	——	——	——	——
		100	1.225	1.225	3.675	29.400	*	3.675	14.700	1.225	1.225	1.225
		170	——	——	——	29.400	*	3.675	3.675	——	——	2.450
		-170	——	——	——	1.225	*	——	——	——	——	——
		Total	1.225	1.225	3.675	62.475	20.825	8.575	18.375	1.225	1.225	3.675
2 (90411)	23.4	45	——	——	0.234	0.468	*	——	——	——	——	——
		100	0.702	0.702	——	3.744	*	0.702	4.446	——	——	0.234
		170	——	0.234	——	7.254	*	——	0.468	——	——	0.702
		-170	——	——	——	0.468	*	——	——	——	——	——
		Total	0.702	0.936	0.234	11.934	3.042	0.702	4.914	——	——	0.936
3 (90412)	10.0	45	——	——	0.200	0.200	*	——	——	——	——	——
		100	0.500	0.600	——	0.700	*	——	2.300	——	——	——
		170	0.100	0.200	——	2.400	*	——	1.000	——	——	0.300
		-170	——	——	——	0.300	*	——	——	——	——	0.100
		Total	0.600	0.800	0.200	3.600	1.100	——	3.300	——	——	0.400
4 (90413)	5.9	45	——	——	0.059	0.118	*	——	——	——	——	——
		100	0.295	0.275	0.118	0.590	*	——	1.357	0.059	0.059	——
		170	——	0.059	——	1.829	*	——	0.236	——	——	0.118
		-170	——	——	——	0.295	*	——	——	——	——	——
		Total	0.295	0.354	0.177	2.832	0.413	——	1.593	0.059	0.059	0.118
5 (90414)	2.0	45	——	——	——	——	*	——	——	——	——	——
		100	——	0.020	——	0.120	*	——	0.060	——	——	——
		170	0.040	0.040	——	1.060	*	0.020	0.220	——	——	——
		-170	——	——	——	0.280	*	——	——	——	——	0.040
		Total	0.040	0.060	——	1.460	0.100	0.020	0.280	——	——	0.040
6 (90415)	4.9	45	——	——	0.049	0.098	*	0.049	——	——	——	——
		100	——	0.147	0.098	0.686	*	——	1.372	——	——	——
		170	——	0.098	0.098	0.882	*	——	0.294	——	——	——
		-170	——	——	——	0.147	*	——	——	——	——	——
		Total	——	0.245	0.245	1.813	0.882	0.049	1.666	——	——	——
7 (90416)	1.6	45	——	——	0.032	0.048	*	0.016	——	——	——	——
		100	0.016	0.032	0.032	0.080	*	0.016	0.288	——	——	——
		170	0.032	0.016	——	0.272	*	——	0.320	——	——	——
		-170	——	——	——	0.096	*	——	——	——	——	——
		Total	0.048	0.048	0.064	0.496	0.304	0.032	0.608	——	——	——
8 (90417)	0.5	45	——	——	——	——	*	——	——	——	——	——
		100	——	0.015	0.005	0.040	*	——	0.100	——	——	——
		170	——	0.015	——	0.115	*	——	0.110	——	——	——
		-170	——	——	——	——	*	——	——	——	——	——
		Total	——	0.030	0.005	0.155	0.100	——	0.210	——	——	——

—— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone, M. N. Girhard and E. J. Young.

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued.

Sample P (52-CS-601 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
1 (110064)	23.7	45	—	—	1.422	4.029	*	0.237	0.237	0.237	—	—
		100	—	0.237	0.474	8.532	*	0.237	2.607	0.711	—	—
		170	—	—	—	4.266	*	—	—	—	—	—
		Total	—	0.237	1.896	16.827	0.474	0.474	2.844	0.948	—	—
2 (110065)	8.9	45	0.178	0.089	0.890	0.712	*	—	0.267	0.445	—	—
		100	0.178	—	0.178	2.670	*	—	0.712	0.534	0.089	—
		170	—	—	—	1.602	*	0.089	—	—	—	—
		Total	0.356	0.089	1.068	4.984	0.267	0.089	0.979	0.979	0.089	—
3 (110066)	6.8	45	0.612	—	0.612	0.680	*	—	0.816	0.816	0.068	—
		100	0.136	0.068	0.204	0.680	*	—	0.952	0.476	0.204	—
		170	—	—	—	0.408	*	—	—	—	—	—
		Total	0.748	0.068	0.816	1.768	0.068	—	1.768	1.292	0.272	—
4 (110067)	2.4	45	0.096	—	0.216	0.096	—	—	0.072	0.192	0.024	—
		100	0.096	—	0.048	0.360	—	—	0.312	0.336	0.048	—
		170	—	—	—	0.384	—	0.048	—	0.048	—	0.024
		Total	0.192	—	0.264	0.840	—	0.048	0.384	0.576	0.072	0.024
5 (110068)	5.4	45	0.162	—	0.216	0.648	*	—	1.134	0.324	—	—
		100	—	0.108	—	0.756	*	—	0.702	0.648	0.216	—
		170	—	—	—	0.378	*	—	—	—	—	—
		Total	0.162	0.108	0.216	1.782	0.108	—	1.836	0.972	0.216	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning—Continued.

Sample Q (52-CS-602 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
1 (110069)	8.9	45	—	—	0.534	1.246	*	0.089	—	0.356	—	—
		100	—	—	0.267	3.293	*	0.356	0.267	0.356	—	—
		170	—	—	—	1.691	*	0.178	—	—	—	—
		-170	—	—	—	0.089	*	—	—	—	—	—
		Total	—	—	0.801	6.319	0.178	0.623	0.267	0.712	—	—
2 (110070)	5.0	45	—	—	0.450	0.700	*	0.100	0.100	0.150	—	—
		100	0.100	0.100	0.100	0.900	*	—	0.600	0.600	0.100	—
		170	—	—	—	0.850	*	—	—	—	—	0.050
		Total	0.100	0.100	0.550	2.450	0.100	0.100	0.700	0.750	0.100	0.050
3 (110071)	4.2	45	0.042	0.042	0.294	0.420	*	—	0.126	0.252	—	—
		100	0.210	0.084	0.168	0.588	*	—	0.882	0.420	0.084	—
		170	—	—	—	0.420	*	—	—	0.084	—	—
		Total	0.252	0.126	0.462	1.428	0.084	—	1.008	0.756	0.084	—
4 (110072)	2.4	45	—	0.024	0.192	0.096	—	—	0.048	0.216	0.024	—
		100	—	0.072	—	0.264	—	—	0.792	0.360	—	—
		170	—	—	—	0.264	—	0.024	—	0.024	—	—
		Total	—	0.096	0.192	0.624	—	0.024	0.840	0.600	0.024	—
5 (110073)	1.5	45	—	—	0.045	0.015	—	—	—	0.045	—	—
		100	0.120	0.015	0.015	0.210	—	—	0.360	0.345	0.030	—
		170	—	0.015	—	0.180	—	—	0.030	0.060	0.015	—
		Total	0.120	0.030	0.060	0.405	—	—	0.390	0.450	0.045	—

— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals in concentrates from stages of panning—Continued.
/ (grams)

Sample R (52-DC-413 series).

Stage of panning and laboratory numbers	Total weight of concentrates (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Quartz and feldspar	Spinel	Staurolite	Zircon
1 (99158)	49.5	45	—	—	—	—	1.980	*	—	—	—	—
		100	0.990	2.475	—	—	10.890	*	9.900	—	—	—
		170	—	0.495	—	—	8.415	*	—	—	—	0.495
		Total	0.990	2.970	—	—	21.285	13.860	9.900	—	—	0.495
2 (99159)	19.6	45	—	—	—	0.196	0.784	1.372	—	—	—	—
		100	—	0.588	—	—	3.724	1.568	3.724	—	—	1.176
		170	—	0.392	0.196	—	3.724	0.980	0.588	—	—	0.392
		-170	—	—	—	—	0.196	—	—	—	—	—
		Total	—	0.980	0.196	0.196	8.428	3.920	4.312	—	—	1.568
3 (99160)	20.3	45	—	—	—	0.203	0.609	0.812	0.406	—	—	—
		100	—	1.015	—	—	5.075	1.624	8.932	—	—	—
		170	—	—	—	—	1.218	0.203	0.203	—	—	—
		Total	—	1.015	—	0.203	6.902	2.639	9.541	—	—	—
4 (99161)	13.6	45	—	—	—	—	0.272	0.544	—	—	—	—
		100	—	0.408	—	—	1.360	0.680	3.808	0.272	—	—
		170	—	0.272	—	—	3.400	0.408	1.224	0.136	—	0.680
		-170	—	—	—	—	0.136	—	—	—	—	—
		Total	—	0.680	—	—	5.168	1.632	5.032	0.408	—	0.680
5 (99162)	13.6	45	—	—	—	—	0.136	0.816	—	—	—	—
		100	—	0.408	—	—	0.816	1.360	1.632	0.136	—	0.272
		170	0.408	0.544	—	—	3.808	0.408	1.360	0.272	—	0.680
		-170	—	—	—	—	0.408	—	—	—	—	0.136
		Total	0.408	0.952	—	—	5.168	2.584	2.992	0.408	—	1.088
6 (99163)	5.4	45	—	—	—	—	0.108	0.324	—	—	—	—
		100	—	0.324	—	—	0.432	0.324	1.026	—	0.054	—
		170	—	0.378	—	—	1.188	0.108	1.026	—	—	—
		-170	—	—	—	—	1.108	—	—	—	—	—
		Total	—	0.702	—	—	1.836	0.756	2.052	—	0.054	—

—— Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

/ (grams)
Appendix. Weights of minerals in concentrates from stages of panning--Continued .

Sample 3 (52-DC-562 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Sphene	Staurolite	Zircon
1 (109718)	25.3	45	___	___	___	___	2.277	2.530	___	___	___	___	___	0.253	___
		100	0.253	0.506	___	___	5.819	___	0.253	3.795	0.506	0.506	0.253	0.253	___
		170	0.253	0.253	___	___	5.819	___	0.506	0.253	1.012	___	___	___	___
		Total	0.506	0.759	___	___	13.915	2.530	0.759	4.048	1.518	0.506	0.253	0.506	___
2 (109719)	5.3	45	___	___	___	___	0.106	*	___	___	___	___	___	___	___
		100	___	0.212	___	___	0.689	*	0.053	0.265	0.371	0.159	___	___	0.053
		170	___	0.212	___	___	1.431	*	0.106	0.371	0.636	0.106	___	___	0.053
		Total	___	0.424	___	___	2.226	0.477	0.159	0.636	1.007	0.265	___	___	0.106
3 (109720)	6.9	45	___	___	___	___	0.414	*	___	___	___	___	___	___	___
		100	0.069	0.759	___	___	2.208	*	___	2.001	0.138	0.414	___	___	___
		170	___	___	___	___	0.207	*	___	___	0.069	___	___	___	___
		-170	___	___	___	___	0.138	*	___	___	___	___	___	___	___
		Total	0.069	0.759	___	___	2.967	0.483	___	2.001	0.207	0.414	___	___	___
4 (109721)	2.6	45	___	___	0.026	___	0.156	*	___	___	0.026	___	___	___	___
		100	0.104	0.156	0.026	___	0.364	*	___	0.780	0.078	0.156	___	___	0.026
		170	0.026	0.052	___	___	0.130	*	___	0.130	0.078	0.104	___	___	___
		Total	0.130	0.208	0.052	___	0.650	0.182	___	0.910	0.182	0.260	___	___	0.026
5 (109722)	2.3	45	0.023	0.023	0.023	0.023	0.161	*	___	0.207	0.023	___	0.023	___	___
		100	0.391	0.138	0.069	___	0.092	*	___	0.759	___	0.115	0.046	___	___
		Total	0.414	0.161	0.092	0.023	0.253	0.184	___	0.966	0.023	0.115	0.069	___	___
6 (109723)	2.6	45	0.078	0.078	0.052	___	0.390	*	___	0.078	0.052	0.052	0.052	___	___
		100	0.234	0.130	___	___	0.312	*	___	0.598	0.052	0.208	0.026	___	___
		Total	0.312	0.208	0.052	___	0.702	0.208	___	0.676	0.104	0.260	0.078	___	___

___ Total quantity is less than 1 percent of concentrate.

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample T (52-OT-65 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Garnet	Ilmenite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
1 (82614)	3.0	45	—	—	0.060	0.030	—	—	—	—	—
		100	—	0.060	0.960	0.450	0.030	0.030	0.270	—	0.030
		170	0.030	—	0.750	0.210	—	—	—	—	—
		-170	—	—	—	0.060	—	—	—	—	0.030
		Total	0.030	0.060	1.770	0.750	0.030	0.030	0.270	—	0.060
2 (82615)	1.3	45	—	0.026	0.039	0.013	—	—	0.013	—	—
		100	0.078	0.039	0.286	0.039	0.078	—	0.312	—	—
		170	0.026	—	0.234	0.052	—	—	0.065	—	—
		Total	0.104	0.065	0.559	0.104	0.078	—	0.390	—	—
3 (82616)	0.6	45	—	0.024	0.030	0.006	0.012	—	—	—	—
		100	0.018	—	0.180	—	0.024	—	0.156	—	—
		170	—	—	0.114	0.018	—	—	0.018	—	—
		Total	0.018	0.024	0.324	0.024	0.036	—	0.174	—	—
4 (82617)	0.4	45	—	—	—	—	—	—	—	—	—
		100	—	0.012	0.084	0.008	0.004	—	0.052	—	—
		170	—	—	0.168	0.020	0.008	—	0.044	—	—
		Total	—	0.012	0.252	0.028	0.012	—	0.096	—	—
5 (82618)	1.0	45	—	—	0.030	0.010	0.040	—	0.010	—	—
		100	—	—	0.110	—	0.210	—	0.410	—	—
		170	—	—	0.130	0.020	—	—	0.030	—	—
		Total	—	—	0.270	0.030	0.250	—	0.450	—	—
6 (82619)	0.7	45	—	—	—	—	—	—	—	—	—
		100	—	0.014	0.056	—	0.105	—	0.322	—	—
		170	—	0.007	0.126	0.028	0.007	—	0.035	—	—
		Total	—	0.021	0.182	0.028	0.112	—	0.357	—	—
7 (82620)	0.5	45	—	—	—	—	—	—	—	—	—
		100	0.015	0.025	0.070	—	0.105	—	0.185	0.015	—
		170	—	—	0.045	—	0.005	—	0.035	—	—
		Total	0.015	0.025	0.115	—	0.110	—	0.220	0.015	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning— Continued.

Sample U (52-PK-127 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Kyanite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Zircon
1 (98847)	36.0	45	—	—	0.720	7.200	—	1.800	—	—	—	—
		100	—	0.360	1.440	6.480	0.360	2.160	0.720	1.080	0.720	—
		170	0.720	0.720	—	4.320	—	—	2.880	0.360	3.960	—
		Total	0.720	1.080	2.160	18.000	0.360	3.960	3.600	1.440	4.680	—
2 (98848)	21.2	45	—	—	1.060	2.756	—	0.424	—	0.636	—	—
		100	—	1.060	0.848	2.968	—	—	1.484	—	0.424	0.636
		170	1.060	0.212	0.212	0.424	—	—	2.332	0.424	3.604	—
		-170	—	—	—	0.424	—	—	—	—	0.212	—
		Total	1.060	1.272	2.120	6.572	—	0.424	3.816	1.060	4.240	0.636
3 (98849)	14.8	45	—	—	0.888	1.628	0.148	—	—	0.148	—	—
		100	0.888	0.592	0.888	0.888	—	—	2.072	0.592	0.888	—
		170	0.592	0.296	—	—	—	—	2.368	—	1.628	—
		-170	—	—	—	0.148	—	—	—	—	0.148	—
		Total	1.480	0.888	1.776	2.664	0.148	—	4.440	0.740	2.664	—
4 (98850)	13.7	45	—	—	1.507	1.096	0.137	—	—	0.411	—	—
		100	0.822	0.274	0.685	0.137	—	—	2.740	—	0.411	—
		170	0.822	—	—	—	—	—	2.603	—	1.781	—
		-170	—	—	—	0.137	—	—	—	—	0.137	—
		Total	1.644	0.274	2.192	1.370	0.137	—	5.343	0.411	2.329	—
5 (98851)	6.8	45	0.068	—	0.476	—	0.068	—	0.272	0.136	—	—
		100	0.748	—	0.340	—	—	—	2.176	—	0.680	—
		170	0.136	—	—	—	—	—	0.884	—	0.680	—
		-170	—	—	—	0.068	—	—	—	—	0.068	—
		Total	0.952	—	0.816	0.068	0.068	—	3.332	0.136	1.428	—

—— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued

Sample V (52-WE-274 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Zircon
1 (90705)	29.6	45	—	—	—	0.592	0.296	—	—	—	0.296
		100	0.296	—	—	4.144	3.848	1.776	0.296	—	1.184
		170	—	1.776	—	10.360	0.888	1.776	—	—	1.184
		-170	—	—	—	0.296	0.296	—	—	—	0.296
		Total	0.296	1.776	—	15.392	5.328	3.552	0.296	—	2.960
2 (90706)	7.3	45	—	—	—	0.073	—	—	—	—	—
		100	0.438	—	0.219	3.723	1.095	0.511	—	—	—
		170	0.073	0.219	0.073	0.584	—	0.146	—	—	—
		-170	—	—	—	0.073	—	—	—	—	0.073
		Total	0.511	0.219	0.292	4.453	1.095	0.657	—	—	0.073
3 (90707)	14.2	45	0.142	—	—	0.426	—	—	—	—	—
		100	—	1.562	—	5.822	—	1.562	—	0.142	0.710
		170	0.568	0.852	—	0.426	—	1.846	—	—	—
		-170	—	—	—	—	—	—	—	—	0.142
		Total	0.710	2.414	—	6.674	—	3.408	—	0.142	0.852
4 (90708)	17.5	45	0.350	0.350	—	0.175	—	0.875	—	—	—
		100	1.925	2.450	—	0.700	—	9.100	—	—	—
		170	0.525	0.350	—	0.175	—	0.525	—	—	—
		Total	2.800	3.150	—	1.050	—	10.500	—	—	—
5 (90709)	17.6	45	0.176	0.176	—	—	—	0.176	—	—	—
		100	3.168	2.640	—	—	—	7.040	—	—	—
		170	1.056	1.056	—	—	—	2.112	—	—	—
		Total	4.400	3.872	—	—	—	9.328	—	—	—
6 (90710)	24.4	45	0.488	0.488	—	—	—	0.488	—	—	—
		100	3.904	1.952	—	—	—	12.200	—	—	—
		170	0.732	1.464	—	—	—	2.440	—	0.244	—
		Total	5.124	3.904	—	—	—	15.128	—	0.244	—

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample W (52-DC-563 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Ilmenite	Kyanite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Zircon
1 (109724)	33.4	45	0.668	—	0.334	—	*	—	0.334	—	0.334	—
		100	1.670	0.334	7.348	—	*	1.336	4.008	—	0.668	1.670
		170	—	0.334	7.348	—	*	1.336	0.334	0.668	—	3.006
		Total	2.338	0.668	15.030	—	1.670	2.672	4.676	0.668	1.002	4.676
2 (109725)	22.9	45	—	—	0.458	—	*	—	—	—	—	—
		100	0.687	0.916	8.015	—	*	—	6.412	0.916	1.145	—
		170	—	0.229	2.061	0.229	*	—	—	0.229	—	0.229
		-170	—	—	0.229	—	*	—	—	—	—	0.229
		Total	0.687	1.145	10.763	0.229	0.916	—	6.412	1.145	1.145	0.458
3 (109726)	14.8	45	0.296	—	0.296	—	*	—	—	0.148	0.148	—
		100	1.924	0.148	1.776	—	*	0.296	4.292	0.444	0.740	—
		170	0.148	0.148	2.220	—	*	—	0.148	0.296	0.148	0.296
		-170	—	—	0.148	—	*	—	—	—		0.148
		Total	2.368	0.296	4.440	—	0.592	0.296	4.440	0.888	1.036	0.444
4 (109727)	10.0	45	0.600	—	—	—	*	—	0.100	—	0.100	—
		100	3.900	0.400	—	—	*	—	3.500	—	0.700	—
		170	—	—	0.300	—	*	—	—	—	—	—
		-170	—	—	—	—	*	—	—	—	—	0.100
		Total	4.500	0.400	0.300	—	0.300	—	3.600	—	0.800	0.100
5 (109728)	11.9	45	0.595	—	0.119	—	*	—	0.357	—	0.238	—
		100	2.618	0.119	0.595	—	*	—	5.593	—	0.595	—
		170	0.119	—	0.238	—	*	—	—	0.119	0.119	0.119
		-170	—	—	0.119	—	*	—	—	—	—	—
		Total	3.332	0.119	1.071	—	0.238	—	5.950	0.119	0.952	0.119

___ Total quantity is less than 1 percent of concentrate

* Magnetite not subdivided by mesh.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample X (52-WE-359 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
1 (90799)	4.8	45	—	—	—	—	—	—	—	—	—
		100	—	—	—	0.336	0.048	0.144	0.096	—	—
		170	—	—	—	2.112	0.384	0.576	0.672	—	—
		-170	—	—	—	0.192	0.192	—	—	—	0.048
		Total	—	—	—	2.640	0.624	0.720	0.768	—	0.048
2 (90800)	2.8	45	—	—	—	—	—	—	—	—	—
		100	—	—	0.028	0.252	—	0.112	0.028	—	—
		170	—	—	—	1.652	0.084	0.308	0.112	—	—
		-170	—	—	—	0.112	0.084	—	—	—	0.028
		Total	—	—	0.028	2.016	0.168	0.420	0.140	—	0.028
3 (90801)	2.3	45	—	—	—	—	—	—	—	—	—
		100	—	—	—	0.506	—	0.828	0.230	—	—
		170	—	—	—	0.299	—	0.184	0.138	0.023	—
		-170	—	—	—	0.046	0.023	—	—	—	0.023
		Total	—	—	—	0.851	0.023	1.012	0.368	0.023	0.023
4 (90802)	3.8	45	—	—	—	—	—	0.076	—	—	—
		100	—	—	—	0.190	—	1.254	—	0.114	—
		170	—	—	—	0.836	—	0.950	0.114	0.038	—
		-170	—	—	—	0.152	0.076	—	—	—	—
		Total	—	—	—	1.178	0.076	2.280	0.114	0.152	—
5 (90803)	3.4	45	—	—	0.034	0.034	—	0.034	—	—	—
		100	0.068	—	—	0.238	—	1.224	0.204	—	—
		170	—	0.068	—	0.578	—	0.510	0.306	—	—
		-170	—	—	—	0.068	—	—	—	—	0.034
		Total	0.068	0.068	0.034	0.918	—	1.768	0.510	—	0.034
6 (90804)	5.8	45	—	—	—	—	—	0.174	—	—	—
		100	0.058	—	—	—	—	4.234	—	—	—
		170	—	—	—	—	—	1.218	—	—	—
		-170	—	—	—	0.116	—	—	—	—	—
		Total	0.058	—	—	0.116	—	5.626	—	—	—
7 (90805)	4.4	45	—	—	—	0.088	—	0.308	—	—	—
		100	—	—	—	—	—	2.728	0.440	—	—
		170	—	—	—	0.176	—	0.308	0.220	—	—
		-170	—	—	—	0.044	0.044	—	—	—	0.044
		Total	—	—	—	0.308	0.044	3.344	0.660	—	0.044

— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by Jerome Stone and M. N. Girhard.

Appendix. Weights of minerals (grams) in concentrates from stages of panning--Continued.

Sample Y (52-OT-36 series). Stages 1 through 6 are from the panning of sand left after silt and clay were removed in suspension. The silt and clay were rewashed and panned as stages 7 through 9.

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Staurolite	Zircon
1 (81129)	1.4	45	—	—	0.098	0.084	0.098	—	—	—	—	—
		100	—	—	0.210	0.084	0.112	0.266	—	—	—	—
		170	—	—	0.154	—	0.084	0.126	—	0.028	—	0.056
		Total	—	—	0.462	0.168	0.294	0.392	—	0.028	—	0.056
2 (81130)	0.09	45	—	0.0144	0.0153	—	—	—	—	—	—	—
		100	—	—	—	—	—	0.0540	—	0.0063	—	—
		Total	—	0.0144	0.0153	—	—	0.0540	—	0.0063	—	—
3 (81131)	0.11	45	—	0.0099	0.0143	—	—	0.0022	—	0.0033	—	—
		100	—	—	—	—	—	0.0671	—	0.0132	—	—
		Total	—	0.0099	0.0143	—	—	0.0693	—	0.0165	—	—
4 (81132)	0.42	45	—	—	—	—	—	0.3486	—	—	—	—
		100	—	—	—	—	—	0.0672	—	0.0042	—	—
		Total	—	—	—	—	—	0.4158	—	0.0042	—	—
5 (81133)	0.06	45	—	—	—	—	—	—	—	—	—	—
		100	—	—	0.0126	—	0.0060	0.0270	0.0012	0.0114	—	0.0018
		Total	—	—	0.0126	—	0.0060	0.0270	0.0012	0.0114	—	0.0018
6 (81134)	0.11	45	—	0.0220	0.0198	—	—	—	—	0.0077	—	—
		100	—	—	0.0055	—	—	0.0484	—	0.0066	—	—
		Total	—	0.0220	0.0253	—	—	0.0484	—	0.0143	—	—
7 (81135)	2.8	45	—	—	—	—	—	—	—	—	—	—
		100	—	—	0.644	0.084	0.280	0.616	—	—	—	—
		170	—	—	0.448	0.084	0.252	0.168	0.056	0.056	—	0.112
		Total	—	—	1.092	0.168	0.532	0.784	0.056	0.056	—	0.112
8 (81136)	0.13	45	—	—	—	—	—	—	—	—	—	—
		100	0.0052	—	0.0455	—	0.0078	0.0520	0.0065	0.0130	—	—
		Total	0.0052	—	0.0455	—	0.0078	0.0520	0.0065	0.0130	—	—
9 (81137)	0.09	45	—	—	—	—	—	—	—	—	—	—
		100	—	—	—	—	—	—	—	—	—	—
		170	—	—	0.0396	—	0.0054	0.0216	0.0018	0.0072	0.0027	0.0117
		Total	—	—	0.0396	—	0.0054	0.0216	0.0018	0.0072	0.0027	0.0117

— Total quantity is less than 1 percent of first concentrate.

Mineralogical analyses by M. E. Morisawa and L. A. Weiser.

/ (grams)

Appendix. Weights of minerals in concentrates from stages of panning--Continued .

Sample 2 (52-WE-1 series).

Stage of panning and laboratory numbers	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Xenotime	Zircon
1 (81207)	2.0	45	—	—	0.020	0.040	0.040	—	—	—	—	—
		100	—	0.040	0.160	—	0.080	0.020	—	—	—	—
		170	—	—	0.280	—	0.060	0.780	0.060	0.200	0.020	—
		-170	—	—	0.080	—	0.040	0.020	—	0.020	—	0.040
		Total	—	0.040	0.540	0.040	0.220	0.820	0.060	0.220	0.020	0.040
2 (81208)	0.9	45	—	0.081	0.099	—	0.018	—	—	—	—	—
		100	0.027	0.045	0.108	—	—	0.153	0.027	0.045	—	—
		170	0.018	—	0.072	—	0.018	0.108	0.009	0.063	—	0.009
		Total	0.045	0.126	0.279	—	0.036	0.261	0.036	0.108	—	0.009
3 (81209)	0.6	45	—	0.138	0.060	—	—	—	—	—	—	—
		100	0.006	0.012	0.018	—	—	0.120	—	0.048	—	—
		170	0.012	0.006	0.054	—	0.006	0.072	0.006	0.036	—	0.006
		Total	0.018	0.156	0.132	—	0.006	0.192	0.006	0.084	—	0.006
4 (81210)	0.55	45	—	0.0495	0.0440	—	—	—	—	0.0055	—	—
		100	0.0055	0.0275	0.0275	—	—	0.1650	0.0055	0.0220	—	—
		170	0.0110	0.0110	0.0110	—	—	0.1045	0.0055	0.0550	—	—
		Total	0.0165	0.0880	0.0825	—	—	0.2695	0.0110	0.0825	—	—

—— Total quantity is less than 1 percent of concentrate.

Mineralogical analyses by M. E. Morisawa and L. A. Weiser.