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UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

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Thomas B. Nolan, *Director*

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The Gold Pan as a Quantitative Geologic Tool

By PAUL K. THEOBALD, Jr.

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THE GOLD PAN AS A QUANTITATIVE GEOLOGIC 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 beds 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 containing 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 handtool 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 miner's 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 analysed 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.

ACKNOWLEDGMENTS

This study was made by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. The writer is indebted to the men who panned the samples for the work in the field and to the personnel of the laboratories of the U. S. Geological Survey for mineral identifications and grain counts.

PREVIOUS WORK

In 300 B. C., Theophrastus (Hill, 1746) wrote of a vessel like a gold pan used to concentrate heavy minerals from sand and commented 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) made 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, as follows:

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 pan 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 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.

In the analysis on which this report is based, a single screen or pair of nesting screens was used to remove gravel from the 26 samples, and clay and silt were removed in suspension by kneading the samples in quiet or gently flowing water. The remaining sand, which ranged in size from ⅛ 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).

In the analysis for this report, two systems were used to check the proportion of the heavy minerals recovered. The simpler method was to place the sample in a pan and place another pan in the stream under 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 repanned. This process was repeated twice. The defects of this 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 to remedy the second required a revision of the method. An improved method consists of panning in a large washtub 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 repanned 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.

The samples were collected from two principal sources: riffles in streams and banks of streams. 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 them 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. The samples were classified in the field as sand or gravel on the basis of the quantity of material in the original volume (0.34 cubic foot) that would pass a punch plate with ⅛-inch openings. If this quantity was half of the original volume or less, the material was classified as gravel; if the quantity was greater than half of the original volume, it was classified as sand. The volumes of material that passed through the ⅛-inch openings are shown as the volume panned in table 1.

Bank samples are mixtures of gravel, sand, silt, and clay. All bank samples 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 with the volume of material

TABLE 1.—*Location and characteristics of multiple panned samples*

Sample	Field and laboratory nos.	Panner	Location	Volume panned (cubic feet)	Stages of panning
Riffle gravel					
A	52-CS-415 (109875-109884)	R. R. Thompson	Big Buck Creek, Spartanburg Co., S. C.	0.09	[1] 7
B	52-CS-416 (109885-109890)	J. B. Pollard, Jr.	do	.09	6
C	52-CS-656 (110127-110135)	do	South Durbin Creek, Laurens Co., S. C.	.11	9
D	52-DC-42 (82903-82906)	P. K. Theobald, Jr.	Devils Fork Creek, Anderson Co., S. C.	.14	4
E	52-DC-834 (110984-110988)	D. W. Caldwell	Howards Creek, Lincoln Co., N. C.	.09	5
F	52-OT-42 (82583-82589)	B. R. Long	Pickens Creek, Anderson Co., S. C.	.08	7
G	52-OT-43 (82590-82602)	W. C. Overstreet	do	.12	[1] 7
H	52-OT-64 (82603-82613)	B. F. Spradlin	Floyds Creek, Rutherford Co., N. C.	.15	[1] 6
I	52-PK-1 (81176-81182)	P. K. Theobald, Jr.	Brushy Creek, Cleveland Co., N. C.	.18	7
J	52-PK-20 (90564-90573)	do	Unnamed creek near Suck Creek, Rutherford Co., N. C.	.08	[1] 4
K	52-PK-126 (98834-98846)	do	Tributary to Thicketty Creek, Cherokee Co., S. C.	.09	[1] 5
L	52-WE-160 (88405-88411)	A. M. White	Floyds Creek, Rutherford Co., N. C.	.10	7
M	52-WE-184 (90657-90664)	J. W. Wissert, Jr.	do	.06	8
N	52-WE-275 (90711-90717)	W. C. Overstreet	Silver Creek, Burke Co., N. C.	.10	7
Riffle sand					
O	52-CS-282 (90410-90417)	R. R. Thompson	Lawson Fork Creek, Spartanburg Co., S. C.	.25	[1] 5
P	52-CS-601 (110064-110068)	J. B. Pollard, Jr.	Rocky Creek, Greenville Co., S. C.	.29	[1] 5
Q	52-CS-602 (110069-110073)	N. P. Cuppels	do	.29	5
R	52-DC-413 (99158-99163)	B. R. Long	Hurricane Creek, Anderson Co., S. C.	.25	6
S	52-DC-562 (109718-109723)	do	Reedy River, Greenville Co., S. C.	.19	6
T	52-OT-65 (82614-82620)	W. C. Overstreet	Floyds Creek, Rutherford Co., N. C.	.27	7
Bank gravel					
U	52-PK-127 (98847-98851)	P. K. Theobald, Jr.	Tributary to Thicketty Creek, Cherokee Co., S. C.	.10	5
V	52-WE-274 (90705-90710)	J. W. Wissert, Jr.	Silver Creek, Burke Co., N. C.	.08	6
Bank silt					
W	52-DC-563 (109724-109728)	B. R. Long	Reedy River, Greenville Co., S. C.	.09	5
X	52-WE-359 (90799-90805)	A. M. White	Hoyle Creek, Burke Co., N. C.	.11	7
Y	52-OT-36 (81129-81137)	W. C. Overstreet	Brushy Creek, Cleveland Co., N. C.	.01	
Bank clay					
Z	52-WE-1 (81207-81210)	A. M. White	do	.02	4

[1] 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.

larger than ⅛ 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 the basis of feel and coherence.

Clay and silt are washed from a sample before panning is begun, and a cloud of suspended material 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 repanned 5 times. Sediment in the slurry was allowed to settle for about 6 hours and the water was decanted. The settled slurry was carefully rewashed to remove most of the silt and clay. The recovered sand, equal in volume to that panned in the first operation, was panned 3 times.

LABORATORY WORK

The concentrates were analysed 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: 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 results of these analyses are given in table 8.

The grain counts were converted from frequency to weight percent with a chart based on the specific gravity of the minerals (Berman, 1953). Calculations in this paper are based on the weight percent of the mineral in the total concentrate and are recorded to 1 percent. The weight of the total concentrate is recorded to 0.1 gram.

ANALYSIS OF RECOVERY

A few grains of heavy minerals escaped 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 9 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 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, although 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. 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 along 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, although a general trend toward decreasing quantities of these minerals in successive stages is shown. 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, generally 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 minerals of low specific gravity on the log plots. The scattering of points on graphs like figure 1 discourages use of them to determine the recovery that could be obtained theoretically,

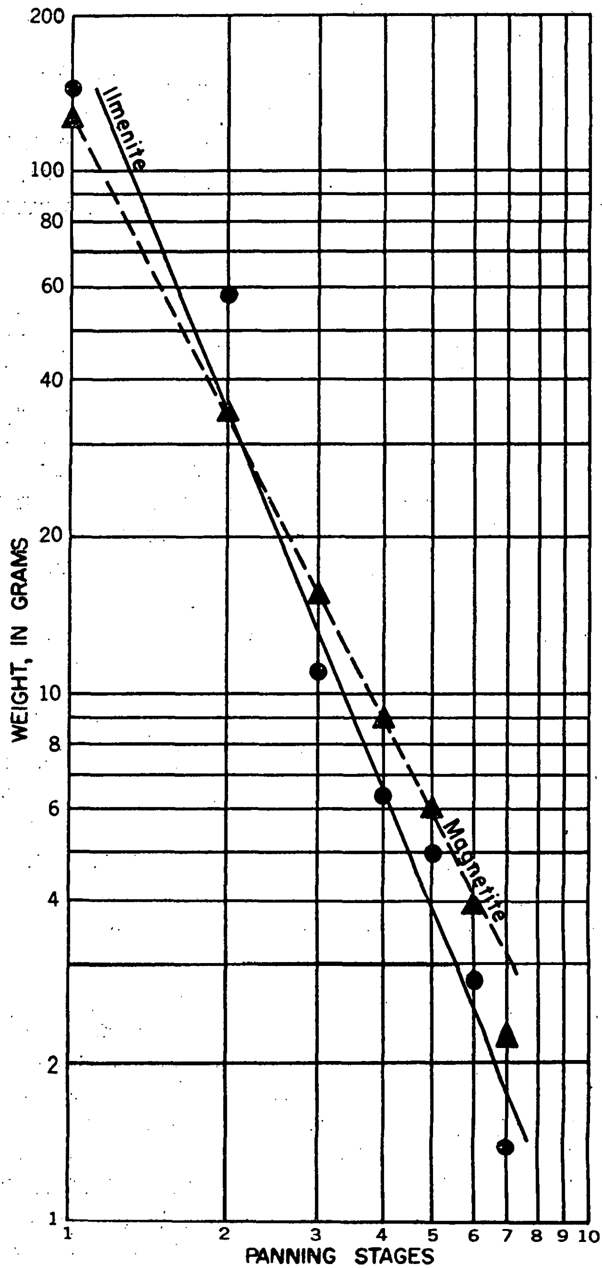

FIGURE 1.—Weights of ilmenite and magnetite recovered in stages of multiple panning.

but they 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 table 8. 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 report, 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 2 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 (table 2). This is due to 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 gravities of the minerals although factors of size and shape 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

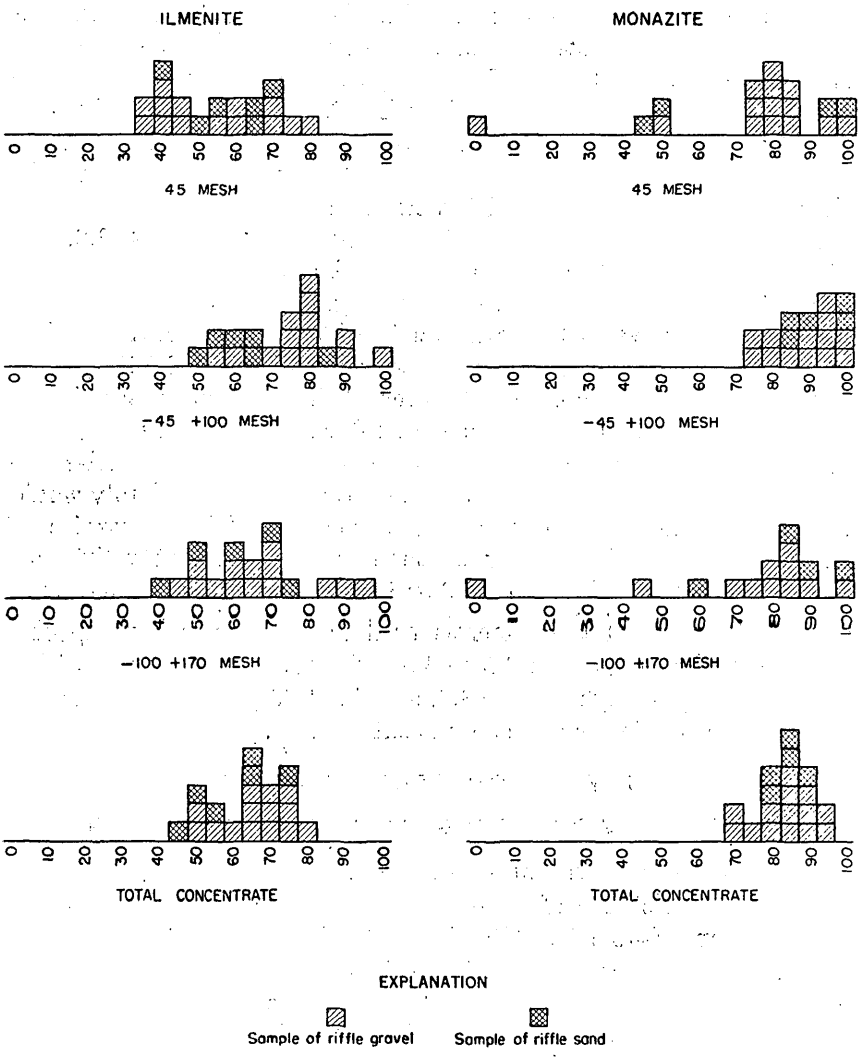

FIGURE 2.—Histograms showing recoveries of ilmenite and monazite.

on the average recovery. The trend of the recoveries among the minerals is toward increased recovery of minerals with successively higher specific gravities, as shown on figure 3.

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: those above the line, those close to the line, and those below the line. These three groups each appear to reflect the shape of the grains. The first group consists of points related to minerals with a single direction of

TABLE 2.—*Recovery (in percent) of heavy minerals in the first panning of samples from riffles and banks*

[Except where figures are given, the total quantity is less than 1 percent of the first concentrate. An asterisk (*) indicates recovery not computed.]

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
Average riffle samples	34	44	62	64	59	84	68	37	29	72
Bank gravel										
U	(*)	23	(*)	63	(*)	90	38	30	(*)	0
V	(*)	--------	(*)	56	(*)	83	100	0	(*)	76
Bank silt										
W	(*)	--------	(*)	48	(*)	90	23	20	(*)	80
X	(*)	--------	(*)	33	(*)	67	--------	30	(*)	27
Y[1]	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Bank clay										
Z	(*)	9	(*)	52	(*)	84	53	44	(*)	72
Average bank samples	(*)	16	(*)	42	(*)	83	54	25	(*)	51

[1] Handled separately; recoveries not comparable with other bank samples.

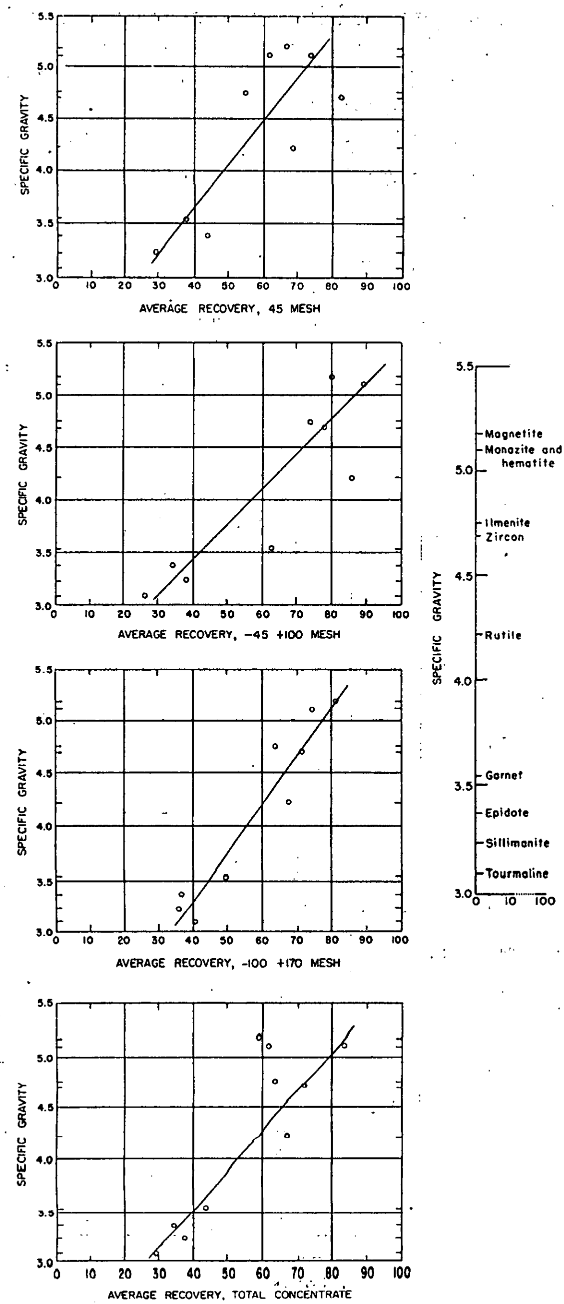

FIGURE 3.—Relation of recovery to specific gravity for riffle samples.

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 bouyant 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 high specific gravities 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 contained 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 are in 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 89 and 84 percent, respectively. The spread is greatest in the 45- and 170-mesh fractions of ilmenite where the average recoveries are 54 and 61 percent, respectively. 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 gravities with high average recoveries.

RECOVERY AND GRAIN SIZE OF THE HEAVY MINERALS

The relation of recovery to grain size may be 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; 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
Do	170	3
Magnetite	170	2
Tourmaline	170	2
Zircon	45	2

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

[Except for magnetite, where figures are not given the total quantity is less than 1 percent of the first concentrate. Magnetite is subdivided by mesh only in samples *D, F, G, I*, and *N*]

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			66
J		50		71		87				
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
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		
Average 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*

[Except for magnetite, where figures are not given the total quantity is less than 1 percent of the first concentrate. Magnetite is subdivided by mesh only in samples *D, F, G, I,* and *N*]

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
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
Average riffle samples	34	63		73	80	89	86	38	26	78

Recovery in the 170-mesh fraction is generally better than that in the 45-mesh fraction, indicating 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 the 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 (see 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 more important factor and will be discussed in detail later. Because 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

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

[Except for magnetite, where figures are not given the total quantity is less than 1 percent of the first concentrate. Magnetite is subdivided by mesh only in samples *D*, *F*, *G*, *I*, and *N*]

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
				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
Average riffle samples	37	50	--------	61	82	75	58	36	41	72

with diameters less than ⅛ 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 has 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 time to settle.

Clay and silt, generally 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. Because most of the fine-grained heavy minerals were lost when the clay and silt were removed, the decrease in recoveries between riffle samples and bank samples is not as marked on table 2 as would be expected. The results of an attempt 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.

TABLE 6.—*Recoveries of heavy minerals in sample Y*

[Where figures are not given the total quantity is less than 1 percent of the first concentrate]

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

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 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 can be related to systematic changes of recovery in these samples. In the project described in this report,

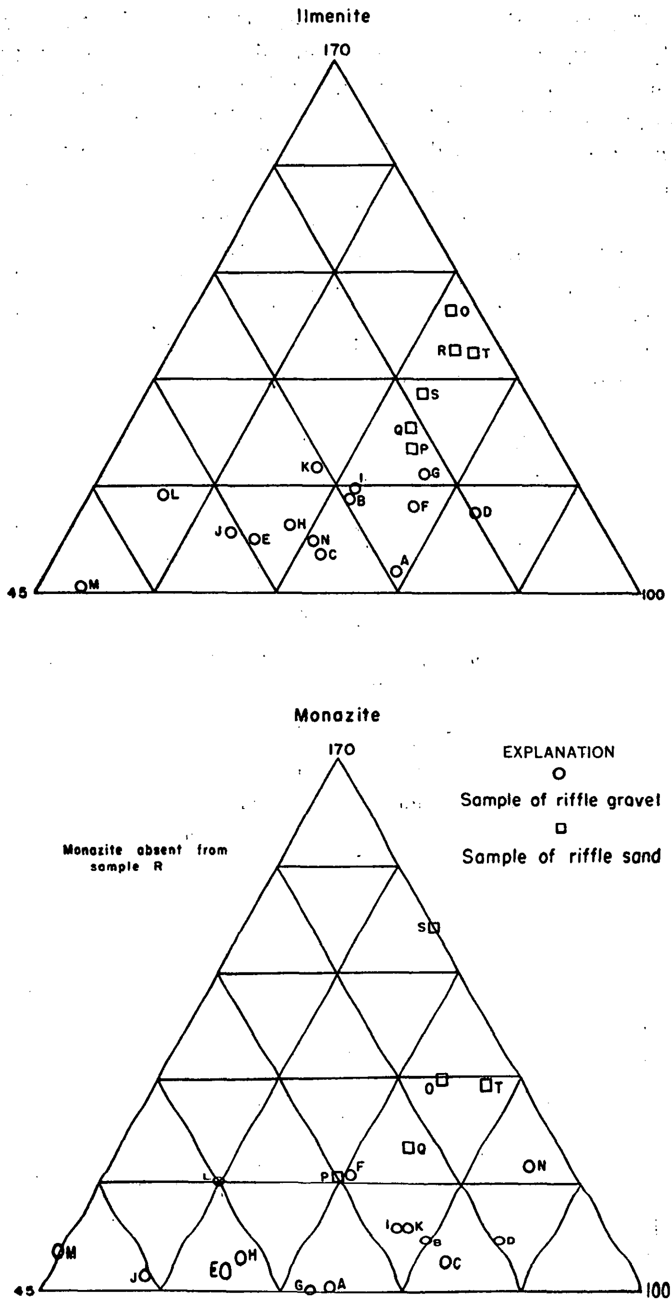

FIGURE 4.—Size distribution of ilmenite and monazite in riffle samples.

none of the panners, with the exception of two men, was experienced in the use of a gold pan, and two had no knowledge of minerals. The men were shown the panning procedure and given a few days to practice before multiple panning their first sample. The remainder of the samples were distributed through the 8-month field season. It had been anticipated that the recoveries would vary with the ability of the panner and that as he gained experience the recovery would improve. As it turned out, however, only one man had an unusually low recovery in the first attempt, and he was deliberately given no time to practice. Otherwise the samples show no systematic increase in recovery with experience, and no specific difference among the panners is evident.

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 are lost if none of the light minerals are 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, although 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 chiefly garnet and sillimanite than if they are chiefly 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 that contain large proportions of epidote also contain large proportions of magnetite, and samples that contain large proportions of sillimanite also contain 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 hence 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 (see 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.

TABLE 7.—*Distribution of the losses of garnet, ilmenite, monazite, and sillimanite during panning*

[Where figures are not given the total quantity is less than 1 percent of the first concentrate]

Sample	Split	Percent of loss by sieved fractions															
		Garnet				Ilmenite				Monazite				Sillimanite			
		45	100	170	Total	45	100	170	Total	45	100	170	Total	45	100	170	Total
A	First ¼	34	10	----	32	21	15	24	20	55	11	0	43	38	23	20	23
	Last ¾	66	90	----	68	79	85	76	80	45	89	100	57	62	77	80	77
G	First ⅔	Trace	----	----	Trace	45	53	29	46	70	----	----	70	----	----	----	----
	Last ⅓	----	----	----	----	55	47	71	54	30	----	----	30	----	----	----	----
H	First ¾	49	29	----	46	47	39	33	43	54	36	27	46	0	38	76	45
	Last ¼	51	71	----	54	53	61	67	57	46	64	73	54	100	62	24	55
J	First ⅓	19	17	----	19	22	22	12	21	51	65	100	56	----	59	45	50
	Middle ⅓	30	33	----	30	35	42	80	43	24	13	0	20	----	17	11	13
	Last ⅓	51	50	----	51	43	36	8	36	25	22	0	24	----	24	44	37
K	First ⅓	20	20	0	19	18	21	41	26	0	40	0	18	0	13	32	21
	Middle ⅓	26	38	100	31	27	32	27	29	100	60	100	82	0	23	28	23
	Last ⅓	54	42	0	50	55	47	32	45	0	0	0	0	100	64	40	56
O	First ½	14	53	100	34	16	14	9	11	100	2	0	10	----	----	----	----
	Last ½	86	47	0	66	84	86	91	89	0	98	100	90	----	----	----	----

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 sorting action of the pan may be used to best advantage to remove coarse grains that are a 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 being recognized, but during the later part of the process, when the heavy minerals could be seen, special care was taken to save coarse-grained monazite.

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 were 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. When sampling streams at a density of 1 sample per square mile, a team of 2 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, although 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. 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: the specific gravity of the minerals, the grain size of the minerals, and the proportions of the various grain sizes. The greatest loss occurs during the last part of the process, although 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.

The loss of coarse monazite in the early part of panning may be lessened if a long period of agitation is employed before any of the light minerals are washed out. By imparting a circular motion to the pan the classification activity is increased, allowing undesirable coarse particles to be removed. If horizontal shaking is employed before the circular motion, the coarse grains will separate by specific gravity, and the loss during removal of the coarse grains will be lessened.

Most of the loss of fine-grained material occurs during the last stages of cleaning the concentrate. The fine-grained quartz settles through the heavy-mineral concentrate but may be removed by lifting it into temporary suspension in the water and pouring the water from the pan before the quartz has settled. Fine-grained heavy minerals can be lifted into suspension nearly as readily as the quartz. To avoid this loss, the concentrate can be passed through a 65-mesh screen and the quartz panned from the undersize. Much of the loss owing to the interference of grains of various sizes may be overcome by separating the original sample into two fractions with a 65-mesh screen. The quartz is then panned from both.

Several stages of panning may be used if higher recovery is desired. The concentrate from each stage may be plotted on logarithmic paper, and the theoretical heavy-mineral content of the original sample may be determined by extrapolation.

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*

[The last figure of each mineral weight is carried only for purposes of calculation]

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. Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	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			.256	(*)				
		Total		2.304	9.984	0.256	5.888	5.888	1.280	
2 (109876)	3.9	45		.819	.975	(*)	.312			
		100		.117	.390	(*)	.156	.780	.078	
		170			.078	(*)	.039	.039	.039	
		Total		.936	1.443	.078	.507	.819	.117	
3 (109877)	1.0	45		.240	.150		.010			
		100		.030	.060		.020	.300	.070	0.020
		170			.040		.010	.030	.010	.010
		Total		.270	.250		.040	.330	.080	.030
4 (109878)	.7	45		.203	.084		.014			
		100		.014	.021			.140	.077	.042
		170			.042			.028	.028	.007
		Total		.217	.147		.014	.168	.105	.049
5 (109879)	.6	45		.132	.060				.006	
		100		.018	.018			.222	.030	.012
		170			.036			.048	.018	
		Total		.150	.114			.270	.054	.012
6 (109880)	.5	45		.150	.045					.005
		100		.015				.130	.035	.020
		170			.015			.040	.040	.005
		Total		.165	.060			.170	.075	.030
7 (109881)	.7	45		.035	.021			.028	.007	.007
		100		.014	.028			.413	.007	.042
		170						.077	.014	.007
		Total		.049	.049			.518	.028	.056
8 (109882)	2.2	45		.660	.286	(*)	.396	.154		
		100	0.022	.022	.044	(*)	.022	.308	.066	
		170			.066	(*)		.022	.022	
		Total	.022	.682	.396	.110	.418	.484	.088	

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
9 (109883)	.8	45			.112	.048		.008	.024	.008	
		100				.024			.456	.016	.008
		170							.080	.016	
		Total			.112	.072		.008	.560	.040	.008
10 (109884)	.7	45			.056	.028			.014		
		100				.021			.476	.007	
		170							.098		
		Total			.056	.049			.588	.007	

Sample *B* (52-CS-416 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
1 (109885)	21.1	45	0.422	1.266	(*)	2.532					
		100	.211	2.954	(*)	5.697	1.266		0.422		
		170		1.266	(*)	.844	3.165		.633	0.211	
		Total	.633	5.486	0.211	9.073	4.431		1.055	.211	
2 (109886)	3.8	45	.190	.494		.304					0.038
		100	.456	.228		.304	.342		.190	.114	
		170		.152		.114	.646		.114		
		−170		.038					.076		
		Total	.646	.912		.722	.988		.380	.114	.038
3 (109887)	2.3	45	.345	.667		.184					
		100	.115	.345			.345		.069	.023	
		170					.207				
		Total	.460	1.012		.184	.552		.069	.023	
4 (109888)	.5	45	.065	.100		.025		0.005		.005	
		100	.025	.030		.010	.090		.035	.010	
		170		.010		.010	.055		.025		
		Total	.090	.140		.045	.145	.005	.060	.015	
5 (109889)	4.5	45	.675	.540		.090					
		100	.135				2.205		.225	.135	
		170					.405		.045	.045	
		Total	.810	.540		.090	2.610		.270	.180	
6 (109890)	.5	45	.100	.100							
		100	.010	.030			.125		.025	.010	
		170					.095		.005		
		Total	.110	.130			.220		.030	.010	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *C* (52-CS-656 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Staurolite	Zircon
1 (110127)	85.1	45		2.553	4.255		20.424	(*)	2.553	2.553				
		100			.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	.560	.560		4.200	(*)		.980		0.140		0.140
		100		.140	.280	0.140	2.380	(*)	.280	.420	0.140			
		170					.280	(*)		.140				
		Total	.280	.700	.840	.140	6.860	2.940	.280	1.540	.140	.140		.140
3 (110129)	6.8	45	.340	.748	.340		.816	(*)		1.292				
		100		.204	.068		1.156	(*)		.340		.068		
		170					.272	(*)						
		Total	.340	.952	.408		2.244	1.156		1.632		.068		
4 (110130)	3.8	45	.152	.304	.152		.722	(*)		.380		.076		
		100		.152	.038		.684	(*)		.190	.038			
		170					.190	(*)	.076					.038
		Total	.152	.456	.190		1.596	.608	.076	.570	.038	.076		.038
5 (110131)	3.6	45	.072	.540		.144	.540	(*)		.792				
		100	.036	.108			.432	(*)		.216				
		170					.144	(*)	.036					.036
		Total	.108	.648		.144	1.116	.504	.036	1.008				.036
6 (110132)	2.8	45	.224	.308	.056		.252	(*)		.644		.028		
		100	.056	.168	.028		.392	(*)		.196	.028	.028		
		170					.112	(*)	.056					.028
		Total	.280	.476	.084		.756	.196	.056	.840	.028	.056		.028
7 (110133)	3.7	45	.111	.333			.851	(*)		.111		.074		
		100	.074	.111			.592	(*)		.814				
		170					.296	(*)	.074					.037
		Total	.185	.444			1.739	.222	.074	.925		.074		.037

8 (110134)	2.5	45	.075	.100	.025		.100	(*)		.200				
		100	.100	.325			.375	(*)		.500				
		170					.225	(*)	.100					.075
		Total	.175	.425	.025		.700	.300	.100	.700				.075
9 (110135)	3.4	45		.340	.102		.442	(*)		1.190		.034	.204	
		100	.068	.102			.068	(*)		.442				
		170					.102	(*)						
		Total	.068	.442	.102		.612	.306		1.632		.034	.204	

Sample *D* (52–DC–42 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.790	.790			
		100		30.020		2.370	6.320		2.370
		170		19.750		1.580	4.740	.790	1.580
		Total		57.670	.790	4.740	11.060	.790	3.950
3 (82905)	18.3	45		3.294	.183	.183			
		100		4.575	.183	.366	3.111		.366
		170		2.562		.183	2.745		.366
		−170		.183					
		Total		10.614	.366	.732	5.856		.732
4 (82906)	9.4	45	0.094	1.974	.094	.094			
		100		1.410			2.726		
		170		1.034			1.880		
		−170		.094					
		Total	.094	4.512	.094	.094	4.606		

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *E* (52-DC-834 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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	.576		.576	
		100	.576	2.016	.864	(*)	2.304	3.456		3.168	
		170		.576		(*)	.288			.288	
		Total	2.880	6.336	2.304	.576	8.640	4.032		4.032	
3 (110986)	20.1	45	2.613	2.613		(*)	.603	4.020		.804	
		100		.804		(*)		7.035			
		170		.402		(*)		.201	.201		
		Total	2.613	3.819		.804	.603	11.256	.201	.804	
4 (110987)	16.9	45	2.028	2.366	1.690	(*)	.507	2.704		1.352	
		100		.338	.676	(*)	.169	3.042		.845	
		170		.338		(*)				.169	
		Total	2.028	3.042	2.366	.676	.676	5.746		2.366	
5 (110988)	13.6	45	2.040	1.632	2.312	(*)		1.768		.816	
		100			.136	(*)		3.808			
		170		.136	.136	(*)					
		Total	2.040	1.768	2.584	.816		5.576		.816	

Sample *F* (52–OT–42 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	Total weight of concentrate (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	.340	.340	
		100				3.740	3.060		5.440	
		170				1.360	.340	.340	.680	.340
		−170				.340				
		Total				10.880	15.640	.680	6.460	.340
4 (82586)	20.3	45				3.654	7.714	.203	.203	
		100				2.030	1.421	.406	3.045	
		170				.609		.203	.812	
		Total				6.293	9.135	.812	4.060	
5 (82587)	14.1	45				2.679	5.217	.141		
		100				1.974	.846	.282	2.115	
		170				.282			.564	
		Total				4.935	6.063	.423	2.679	
6 (82588)	9.9	45				1.881	3.465	.198	.198	
		100	.099	0.198		.693	.495		2.079	
		170				.198	.099		.297	
		Total	.099	.198		2.772	4.059	.198	2.574	
7 (82589)	5.0	45				1.000	1.800	.050	.050	
		100		.100		.300	.300		1.100	
		170				.050	.100		.150	
		Total		.100		1.350	2.200	.050	1.300	

TABLE 8.—*Weights (in grams) of minerals 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 the last one-third of the tailing and stages 8 through 13 are repanning of the first two-thirds of tailing. Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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		.295			1.770	.590		.295	0.295
		−170					.295				
		Total		.590			13.275	12.095		3.245	.295
3 (82592)	5.4	45					1.134	1.242	.108	.054	
		100	0.108	.108			.810	.486		.540	
		170					.486	.108			.054
		−170					.054				.108
		Total	.108	.108			2.484	1.836	.108	.594	.162
4 (82593)	2.5	45				0.025	.625	.400	.025	.025	
		100		.050			.475	.200		.275	
		170		.025			.150	.100		.025	
		−170					.075				.025
		Total		.075		.025	1.325	.700	.025	.325	.025
5 (82594)	1.2	45		.012		.012	.252	.252		.024	
		100		.036			.168	.180		.072	
		170		.012			.084	.084		.012	
		Total		.060		.012	.504	.516		.108	
6 (82595)	1.3	45		.013		.013	.208	.182		.052	
		100		.052			.156	.182		.169	
		170		.013			.065	.091		.013	
		−170								.039	.052
		Total		.078		.013	.429	.455		.273	.052

7 (82596)	1.8	45		.018			.072	.180			
		100	.018	.108			.306	.090		.558	
		170		.036			.162	.090		.054	.018
		−170					.054				.036
		Total	.018	.162			.594	.360		.612	.054
8 (82597)	23.5	45					4.700	7.990	.235	.235	
		100					4.935	2.115		1.880	
		170					.705	.470		.235	
		Total					10.340	10.575	.235	2.350	
9 (82598)	7.4	45			.074		1.554	2.516	.074	.296	
		100	.074	.074			1.258	.370		.814	
		170					.222	.074			
		Total	.074	.074	.074		3.034	2.960	.074	1.110	
10 (82599)	2.8	45		.028	.028	.028	.588	.980		.168	
		100		.028			.252	.196		.308	
		170					.112	.084			
		Total		.056	.028	.028	.952	1.260		.476	
11 (82600)	1.6	45	.032	.016		.016	.272	.560		.112	.032
		100	.016	.032			.128	.096		.192	
		170						.096			
		Total	.048	.048		.016	.400	.752		.304	.032
12 (82601)	1.2	45		.012	.012	.012	.216	.336		.192	
		100		.024			.096	.084		.132	
		170						.084			
		Total		.036	.012	.012	.312	.504		.324	
13 (82602)	2.8	45					.476	.560		.700	
		100	.028	.028			.056	.112		.728	
		170					.084				.028
		Total	.028	.028			.616	.672		1.428	.028

TABLE 8.—*Weights (in grams) of minerals 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. Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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		.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	.773		
2 (82604)	18.9	45		.378	4.158	0.189	4.347	1.512			0.189
		100		.189	2.835		2.457	.567	.378		
		170			.756		.756				
		—170					.189				
		Total		.567	7.749	.189	7.749	2.079	.378		.189
3 (82605)	3.5	45		.070	.420	.105	.245				.035
		100			.805		.420	.525	.105		
		170			.280		.245	.035	.070		.035
		—170			.035		.070				
		Total		.070	1.540	.105	.980	.560	.175		.070
4 (82606)	2.0	45		.140	.500		.120	.320			
		100		.040	.240		.060		.180		.020
		170			.180		.200				
		Total		.180	.920		.380	.320	.180		.020
5 (82607)	4.1	45		.369	1.599	.082	.205	.164			
		100			.410		.082	.615	.205	0.082	
		170			.123		.164				
		Total		.369	2.132	.082	.451	.779	.205	.082	
6 (82608)	.8	45		.048	.104		.016	.024	.008		
		100			.048		.016	.280	.160		
		170			.040		.040		.016		
		Total		.048	.192		.072	.304	.184		
7 (82609)	15.5	45		.310	2.790		4.030	.465			
		100			1.550		1.240	3.875	.465		
		170			.310		.310		.155		
		Total		.310	4.650		5.580	4.340	.620		

8 (82610)	7.3	45		.365	1.898	.219	1.387	1.022			
		100		.073	.584	.219	.292	.949	.073		
		170			.146		.073				
		Total		.438	2.628	.438	1.752	1.971	.073		
9 (82611)	2.4	45		.144	.600		.240	.072			
		100			.408		.192	.456			
		170			.120		.072		.096		
		Total		.144	1.128		.504	.528	.096		
10 (82612)	1.0	45		.040	.220		.100	.030			.010
		100	0.020	.020	.100		.020	.320	.020		
		170			.050		.030	.010	.010		
		Total	.020	.060	.370		.150	.360	.030		.010
11 (82613)	1.3	45		.091	.403		.039	.065			
		100			.104			.416	.078		
		170			.052		.039		.013		
		Total		.091	.559		.078	.481	.091		

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample I (52-PK-1 series)

[Mineralogical analysts: M. E. Morisawa and L. A. Weiser. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.496	10.416	1.984		0.496		
		170				2.976		1.984	8.928	.496	.992		.496
		Total			3.472	11.408	1.984	18.352	10.912	.992	1.488		.992
2 (81177)	18.7	45		0.187	1.683	2.244	.374	1.122		.374			.187
		100			.561	2.244		.748	1.870		.561		
		170				.187		.374	5.610		.374		
		Total		.187	2.244	4.675	.374	2.244	7.480	.374	.935		.187
3 (81178)	6.2	45			.496	1.054	.062	.496		.124			.062
		100			.186	.434		.186	.682		.124		
		170				.062		.062	2.108		.062		
		Total			.682	1.550	.062	.744	2.790	.124	.186		.062
4 (81179)	6.7	45			.603	.603	.268	.134					
		100	0.134		.268	.469	.067	.670	.469	.067	.134		.067
		170	.067			.536	.067	.201	1.474	.134	.134		.134
		Total	.201		.871	1.608	.402	1.005	1.943	.201	.268		.201
5 (81180)	7.6	45			.988	.912	.152	.152		.228			
		100				.684	.076	.304	.912	.076	.228	0.076	
		170				.380		.152	1.596	.152	.304	.076	.076
		—170				.076							
		Total			.988	2.052	.228	.608	2.508	.456	.532	.152	.076
6 (81181)	2.3	45			.299	.184		.069		.046			
		100	.023		.069	.115	.023	.046	.322	.023	.069		
		170			.069	.184		.046	.483	.023	.207		
		Total	.023		.437	.483	.023	.161	.805	.092	.276		
7 (81182)	.7	45	.007		.084	.140	.028	.007	.007	.021			.007
		100			.021	.028			.084		.014		
		170	.007		.007	.007		.028	.168	.007	.028		
		Total	.014		.112	.175	.028	.035	.259	.028	.042		.007

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. Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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	(*)	.695	5.560	2.085		
		Total			4.865	15.985	0.695	22.935	18.070	6.255	.695	
2 (90565)	4.5	45			.450	.855		.450				
		100			.090	.315		.135	.315		.090	0.315
		170				.090			.720	.495	.090	
		−170				.045		.045				
		Total			.540	1.305		.630	1.035	.495	.180	.315
3 (90566)	3.5	45			.455	.490		.210				
		100			.070	.035			.595	.105	.105	.035
		170							1.190	.070	.105	
		−170				.035						
		Total			.525	.560		.210	1.785	.175	.210	.035
4 (90567)	2.0	45			.460	.380		.040				
		100			.060	.060		.060	.080	.060	.020	
		170							.480	.140	.040	
		−170				.040		.020		.060		
		Total			.520	.480		.120	.560	.260	.060	
5 (90568)	3.6	45	0.108	0.036	.216	.684	(*)	.540				
		100			.108	.432	(*)	.108	.108	.036	.036	
		170				.072	(*)		.756	.108	.036	
		−170				.036	(*)		.036	.036		
		Total	.108	.036	.324	1.224	.108	.648	.900	.180	.072	
6 (90569)	2.4	45		.024	.456	.552		.096				
		100							.360	.024	.048	
		170				.816				.024		
		Total		.024	.456	1.368		.096	.360	.048	.048	
7 (90570)	1.3	45			.130	.169		.026				
		100			.039	.052		.013	.039	.052	.026	
		170							.702	.052		
		Total			.169	.221		.039	.741	.104	.026	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *J* (52-PK-20 series)—Continued

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
8 (90571)	5.3	45			0.371	0.583		1.219				
		100				.159		.477	0.530	0.371	0.265	
		170				.106		.159	.477	.371	.106	
		−170						.053		.053		
		Total			.371	.848		1.908	1.007	.795	.371	
9 (90572)	1.6	45			.048	.128		.128				
		100			.064	.064		.112	.016	.032	.016	
		170				.032			.464	.320	.064	
		−170				.064				.048		
		Total			.112	.288		.240	.480	.400	.080	
10 (90573)	1.0	45			.100	.150		.050				
		100	0.010		.010	.030			.050			
		170							.460	.030	.010	
		−170				.030			.020	.040	.010	
		Total	.010		.110	.210		.050	.530	.070	.020	

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 the tailing, and stages 10 through 13 are repanning of the first one-third of the tailing. Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh)]

Stage of panning and laboratory nos.	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		.666			6.660		(*)	.666	12.654	.666	0.666		0.666
		Total		1.998	7.992	.666	30.636		1.332	5.994	14.652	1.998	.666		.666
2 (98835)	5.3	45			.530		.795								
		100		.106	.265		.742				.212		.371		
		170		.159			.371				1.431		.106		
		−170					.159								.053
		Total		.265	.795		2.067				1.643		.477		.053
3 (98836)	5.9	45			.531		.472		.118						
		100	0.177	.354	.177		.177				1.062		.236		
		170		.118			.413				1.888		.059		
		−170					.059						.059		
		Total	.177	.472	.708		1.121		.118		2.950		.354		
4 (98837)	3.1	45			.248		.341								
		100		.248	.062		.124				.651		.031		
		170	.093	.062			.062				1.085				
		−170					.093								
		Total	.093	.310	.310		.620				1.736		.031		
5 (98838)	5.7	45			.627	.114	.342	0.114	.114				.057		
		100	.399	.285	.228		.171				.912		.285	0.114	
		170	.057								1.767		.114		
		Total	.456	.285	.855	.114	.513	.114	.114		2.679		.456	.114	
6 (98839)	5.7	45			.342		.456		.057	.114					.057
		100		.057	.399		.627			.114	.114		.114		.057
		170		.171			.570			.114	2.109	.057			
		−170					.171								
		Total		.228	.741		1.824		.057	.342	2.223	.057	.114		.114
7 (98840)	3.5	45			.210		.280		.105						
		100		.070	.035		.105				.350		.035		
		170	.210	.175			.140				1.610			.070	
		−170					.070								.035
		Total	.210	.245	.245		.595		.105		1.960		.035	.070	.035

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *K* (52-PK-126 series)—Continued

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Hematite	Ilmenite	Kyanite	Magnetite	Monazite	Quartz and feldspar	Rutile	Sillimanite	Tourmaline	Zircon
8 (98841)	1.9	45			0.133		0.057	0.019				0.019			
		100	0.038	0.019	.019						0.095	.019	0.038		
		170	.076	.152	.076						.969		.057		
		−170					.076						.019		0.019
		Total	.114	.171	.228		.133	.019			1.064	.038	.114		.019
9 (98842)	3.5	45			.245		.140		0.105			.035			
		100	.245	.175	.210		.105				.490		.140		
		170	.105	.070							1.295		.140		
		Total	.350	.245	.455		.245		.105		1.785	.035	.280		
10 (98843)	2.5	45			.150		.275					.050			
		100			.075		.300			.075		.025			
		170	.025	.025			.250				.875	.025	.150		
		−170					.100				.025	.025	.025		.025
		Total	.025	.025	.225		.925			.075	.900	.125	.175		.025
11 (98844)	2.5	45			.175		.150		.100						
		100		.050	.050		.225				.125		.025		
		170		.100							1.350		.050		
		−170					.075						.025		
		Total		.150	.225		.450		.100		1.475		.100		
12 (98845)	2.6	45			.234		.182		.104						
		100	.078	.052	.156						.728		.130		
		170	.052				.858						.026		
		Total	.130	.052	.390		1.040		.104		.728		.156		
13 (98846)	1.2	45			.132		.036	.012	.096						
		100	.024	.012	.060		.012	.012			.024		.036		
		170	.012								.636				
		−170					.060				.024		.012		
		Total	.036	.012	.192		.108	.024	.096		.684		.048		

Sample *L* (52-WE-160 series)

[Mineralogical analysts: Jerome Stone, M. N. Girhard, and E. J. Young. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.330	2.310	----	1.980	2.640	0.330	0.330	----
		170	.330	3.300	----	1.980	1.980	.660	----	0.330
		Total	1.980	13.860	.990	9.900	4.620	.990	.330	.330
2 (88406)	15.5	45	1.085	3.100	1.550	.775	----	----	----	----
		100	.155	.620	----	.465	3.875	.465	----	----
		170	----	.930	----	.465	1.395	.620	----	----
		Total	1.240	4.650	1.550	1.705	5.270	1.085	----	----
3 (88407)	9.0	45	.360	1.620	.720	.450	----	----	----	----
		100	.090	.360	----	.090	1.800	.270	----	----
		170	----	.450	----	.180	1.890	.720	----	----
		Total	.450	2.430	.720	.720	3.690	.990	----	----
4 (88408)	7.3	45	.292	.949	1.022	.146	----	----	----	----
		100	----	----	----	.073	2.555	.219	----	----
		170	----	----	----	----	1.679	.365	----	----
		Total	.292	.949	1.022	.219	4.234	.584	----	----
5 (88409)	9.5	45	1.140	2.660	----	.190	----	----	----	----
		100	.095	----	----	----	2.850	.285	----	----
		170	----	----	----	----	1.995	.285	----	----
		Total	1.235	2.660	----	.190	4.845	.570	----	----
6 (88410)	4.7	45	.141	.705	.705	.047	----	----	----	----
		100	----	.047	----	----	1.175	.094	----	----
		170	----	----	----	----	1.410	.376	----	----
		Total	.141	.752	.705	.047	2.585	.470	----	----
7 (88411)	5.5	45	.495	.770	1.045	----	----	----	----	----
		100	.055	----	----	----	1.980	.110	----	----
		170	----	----	----	----	.880	.165	----	----
		Total	.550	.770	1.045	----	2.860	.275	----	----

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *M* (52-WE-184 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of planning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Magnetite	Ilmenite	Magnetite (grams)	Monazite	Quartz and feldspar	Sillimanite
1 (90657)	97.5	45			4.875	1.950	21.450	(*)	15.600	2.925	
		100					2.925	(*)		30.225	1.950
		170						(*)	.975	4.875	.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					.358			2.148	.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	.920	1.380	
		100	0.230							8.280	
		170							.230	2.530	.690
		Total	.230		2.070		4.140	2.530	1.150	12.190	.690
4 (90660)	27.0	45		0.270	.810		4.320	3.240		5.670	
		100								9.450	
		170								3.240	
		Total		.270	.810		4.320	3.240		18.360	
5 (90661)	13.5	45			.810		1.890	1.755		2.970	
		100								4.725	.135
		170								.945	.270
		Total			.810		1.890	1.755		8.640	.405
6 (90662)	18.3	45			.549		.183	1.647		13.176	
		100								2.562	.183
		Total			.549		.183	1.647		15.738	.183
7 (90663)	31.0	45			1.860			1.860		25.110	.620
		100								1.550	
		Total			1.860			1.860		26.660	.620
8 (90664)	18.0	45			.180		.180	1.260		16.020	
		100								.360	
		Total			.180		.180	1.260		16.380	

Sample *N* (52-WE-275 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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	.523	1.046	.523		9.937		
		170		.523					1.046		
		Total	14.121	5.230	6.799	4.184	3.661		18.305		
3 (90713)	15.7	45	1.884	.628	2.512	.785	.785	.314	3.297		
		100	1.099	.942	.157	.314			2.669		
		170		.157		.157					
		Total	2.983	1.727	2.669	1.256	.785	.314	5.966		
4 (90714)	17.5	45	2.450	1.400	2.275	1.050	.525		1.750	0.350	
		100	1.225	1.750					4.025		
		170	.175	.175					.175		
		−170				.175					
		Total	3.850	3.325	2.275	1.225	.525		5.950	.350	
5 (90715)	16.6	45	2.656	1.660	1.826	2.822	(*)		4.150		
		100	.830	.664			(*)		1.328		
		170		.166			(*)				
		Total	3.486	2.490	1.826	2.822	.498		5.478		
6 (90716)	7.9	45	1.817	.553	.869	.237	.079	.158	2.133		
		100	.632	.079					.790		.316
		170	.079	.079							.079
		Total	2.528	.711	.869	.237	.079	.158	2.923		.395
7 (90717)	7.7	45	.770	.231	.462	.770	.077		1.771		
		100	.308	.462	.154	.231			2.233		
		170		.077		.077			.077		
		Total	1.078	.770	.616	1.078	.077		4.081		

TABLE 8.—*Weights (in grams) 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. Mineralogical analysts: Jerome Stone, M. N. Girhard, and E. J. Young. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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			.234	.468	(*)					
		100	.702	.702		3.744	(*)	.702	4.446			.234
		170		.234		7.254	(*)		.468			.702
		−170				.468	(*)					
		Total	.702	.936	.234	11.934	3.042	.702	4.914			.936
3 (90412)	10.0	45			.200	.200	(*)					
		100	.500	.600		.700	(*)		2.300			
		170	.100	.200		2.400	(*)		1.000			.300
		−170				.300	(*)					.100
		Total	.600	.800	.200	3.600	1.100		3.300			.400
4 (90413)	5.9	45			.059	.118	(*)					
		100	.295	.295	.118	.590	(*)		1.357	.059	.059	
		170		.059		1.829	(*)		.236			.118
		−170				.295	(*)					
		Total	.295	.354	.177	2.832	.413		1.593	.059	.059	.118
5 (90414)	2.0	45					(*)					
		100		.020		.120	(*)		.060			
		170	.040	.040		1.060	(*)	.020	.220			
		−170				.280	(*)					.040
		Total	.040	.060		1.460	.100	.020	.280			.040
6 (90415)	4.9	45			.049	.098	(*)	.049				
		100		.147	.098	.686	(*)		1.372			
		170		.098	.098	.882	(*)		.294			
		−170				.147	(*)					
		Total		.245	.245	1.813	.882	.049	1.666			

Stage of panning and laboratory nos.	Total weight of concentrate (grams)	Sieved fraction	Amphibole and biotite	Epidote	Garnet	Ilmenite	Magnetite	Monazite	Quartz and feldspar	Sillimanite	Tourmaline	Zircon
7 (90416)	1.6	45			.032	.048	(*)	.016				
		100	.016	.032	.032	.080	(*)	.016	.288			
		170	.032	.016		.272	(*)		.320			
		−170				.096	(*)					
		Total	.048	.048	.064	.496	.304	.032	.608			
8 (90417)	.5	45					(*)					
		100		.015	.005	.040	(*)		.100			
		170		.015		.115	(*)		.110			
		−170					(*)					
		Total		.030	.005	.155	.100		.210			

Sample *P* (52–CS–601 series)

[Mineralogical analysts: Jerôme Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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	.474	8.532	(*)	.237	2.607	.711		
		170				4.266	(*)					
		Total		.237	1.896	16.827	0.474	.474	2.844	.948		
2 (110065)	8.9	45	0.178	.089	.890	.712	(*)		.267	.445		
		100	.178		.178	2.670	(*)		.712	.534	0.089	
		170				1.602	(*)	.089				
		Total	.356	.089	1.068	4.984	.267	.089	.979	.979	.089	
3 (110066)	6.8	45	.612		.612	.680	(*)		.816	.816	.068	
		100	.136	.068	.204	.680	(*)		.952	.476	.204	
		170				.408	(*)					
		Total	.748	.068	.816	1.768	.068		1.768	1.292	.272	
4 (110067)	2.4	45	.096		.216	.096			.072	.192	.024	
		100	.096		.048	.360			.312	.336	.048	
		170				.384		.048		.048		0.024
		Total	.192		.264	.840		.048	.384	.576	.072	.024
5 (110068)	5.4	45	.162		.216	.648	(*)		1.134	.324		
		100		.108		.756	(*)		.702	.648	.216	
		170				.378	(*)					
		Total	.162	.108	.216	1.782	.108		1.836	.972	.216	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample Q (52-CS-602 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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			.267	3.293	(*)	.356	0.267	.356		
		170				1.691	(*)	.178				
		−170				.089	(*)					
		Total			.801	6.319	0.178	.623	.267	.712		
2 (110070)	5.0	45			.450	.700	(*)	.100	.100	.150		
		100	0.100	0.100	.100	.900	(*)		.600	.600	0.100	
		170				.850	(*)					0.050
		Total	.100	.100	.550	2.450	.100	.100	.700	.750	.100	.050
3 (110071)	4.2	45	.042	.042	.294	.420	(*)		.126	.252		
		100	.210	.084	.168	.588	(*)		.882	.420	.084	
		170				.420	(*)			.084		
		Total	.252	.126	.462	1.428	.084		1.008	.756	.084	
4 (110072)	2.4	45		.024	.192	.096			.048	.216	.024	
		100		.072		.264			.792	.360		
		170				.264		.024		.024		
		Total		.096	.192	.624		.024	.840	.600	.024	
5 (110073)	1.5	45			.045	.015				.045		
		100	.120	.015	.015	.210			.360	.345	.030	
		170		.015		.180			.030	.060	.015	
		Total	.120	.030	.060	.405			.390	.450	.045	

Sample *R* (52-DC-413 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	Total weight of concentrate (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		.495			8.415	(*)				0.0495
		Total	.990	2.970			21.285	13.860	9.900			.495
2 (99159)	19.6	45				0.196	.784	1.372				
		100		.588			3.724	1.568	3.724			1.176
		170		.392	0.196		3.724	.980	.588			.392
		−170					.196					
		Total		.980	.196	.196	8.428	3.920	4.312			1.568
3 (99160)	20.3	45				.203	.609	.812	.406			
		100		1.015			5.075	1.624	8.932			
		170					1.218	.203	.203			
		Total		1.015		.203	6.902	2.639	9.541			
4 (99161)	13.6	45					.272	.544				
		100		.408			1.360	.680	3.808	0.272		
		170		.272			3.400	.408	1.224	.136		.680
		−170					.136					
		Total		.680			5.168	1.632	5.032	.408		.680
5 (99162)	13.6	45					.136	.816				
		100		.408			.816	1.360	1.632	.136		.272
		170	.408	.544			3.808	.408	1.360	.272		.680
		−170					.408					.136
		Total	.408	.952			5.168	2.584	2.992	.408		1.088
6 (99163)	5.4	45					.108	.324				
		100		.324			.432	.324	1.026		0.054	
		170		.378			1.188	.108	1.026			
		−170					1.108					
		Total		.702			1.836	.756	2.052		.054	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *S* (52-DC-562 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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	.253	
		170	.253	.253			5.819		.506	.253	1.012				
		Total	.506	.759			13.915	2.530	.759	4.048	1.518	.506	.253	.506	
2 (109719)	5.3	45					.106	(*)							
		100		.212			.689	(*)	.053	.265	.371	.159			0.053
		170		.212			1.431	(*)	.106	.371	.636	.106			.053
		Total		.424			2.226	.477	.159	.636	1.007	.265			.106
3 (109720)	6.9	45					.414	(*)							
		100	.069	.759			2.208	(*)		2.001	.138	.414			
		170					.207	(*)			.069				
		−170					.138	(*)							
		Total	.069	.759			2.967	.483		2.001	.207	.414			
4 (109721)	2.6	45			0.026		.156	(*)			.026				
		100	.104	.156	.026		.364	(*)		.780	.078	.156			.026
		170	.026	.052			.130	(*)		.130	.078	.104			
		Total	.130	.208	.052		.650	.182		.910	.182	.260			.026
5 (109722)	2.3	45	.023	.023	.023	0.023	.161	(*)		.207	.023		.023		
		100	.391	.138	.069		.092	(*)		.759		.115	.046		
		Total	.414	.161	.092	.023	.253	.184		.966	.023	.115	.069		
6 (109723)	2.6	45	.078	.078	.052		.390	(*)		.078	.052	.052	.052		
		100	.234	.130			.312	(*)		.598	.052	.208	.026		
		Total	.312	.208	.052		.702	.208		.676	.104	.260	.078		

Sample *T* (52-OT-65 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.960	.450	0.030	0.030	0.270		0.030
		170	0.030		.750	.210					
		−170				.060					.030
		Total	.030	.060	1.770	.750	.030	.030	.270		.060
2 (82615)	1.3	45		.026	.039	.013			.013		
		100	.078	.039	.286	.039	.078		.312		
		170	.026		.234	.052			.065		
		Total	.104	.065	.559	.104	.078		.390		
3 (82616)	.6	45		.024	.030	.006	.012				
		100	.018		.180		.024		.156		
		170			.114	.018			.018		
		Total	.018	.024	.324	.024	.036		.174		
4 (82617)	.4	45									
		100		.012	.084	.008	.004		.052		
		170			.168	.020	.008		.044		
		Total		.012	.252	.028	.012		.096		
5 (82618)	1.0	45			.030	.010	.040		.010		
		100			.110		.210		.410		
		170			.130	.020			.030		
		Total			.270	.030	.250		.450		
6 (82619)	.7	45									
		100		.014	.056		.105		.322		
		170		.007	.126	.028	.007		.035		
		Total		.021	.182	.028	.112		.357		
7 (82620)	.5	45									
		100	.015	.025	.070		.105		.185	0.015	
		170			.045		.005		.035		
		Total	.015	.025	.115		.110		.220	.015	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *U* (52-PK-127 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.720		4.320			2.880	.360	3.960	
		Total	.720	1.080	2.160	18.000	.360	3.960	3.600	1.440	4.680	
2 (98848)	21.2	45			1.060	2.756		.424		.636		
		100		1.060	.848	2.968			1.484		.424	0.636
		170	1.060	.212	.212	.424			2.332	.424	3.604	
		−170				.424					.212	
		Total	1.060	1.272	2.120	6.572		.424	3.816	1.060	4.240	.636
3 (98849)	14.8	45			.888	1.628	.148			.148		
		100	.888	.592	.888	.888			2.072	.592	.888	
		170	.592	.296					2.368		1.628	
		−170				.148					.148	
		Total	1.480	.888	1.776	2.664	.148		4.440	.740	2.664	
4 (98850)	13.7	45			1.507	1.096	.137			.411		
		100	.822	.274	.685	.137			2.740		.411	
		170	.822						2.603		1.781	
		−170				.137					.137	
		Total	1.644	.274	2.192	1.370	.137		5.343	.411	2.329	
5 (98851)	6.8	45	.068		.476		.068		.272	.136		
		100	.748		.340				2.176		.680	
		170	.136						.884		.680	
		−170				.068					.068	
		Total	.952		.816	.068	.068		3.332	.136	1.428	

Sample V (52-WE-274 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.888	1.776			1.184
		−170				.296	.296				.296
		Total	.296	1.776		15.392	5.328	3.552	.296		2.960
2 (90706)	7.3	45				.073					
		100	.438		0.219	3.723	1.095	.511			
		170	.073	.219	.073	.584		.146			
		−170				.073					.073
		Total	.511	.219	.292	4.453	1.095	.657			.073
3 (90707)	14.2	45	.142			.426					
		100		1.562		5.822		1.562		0.142	.710
		170	.568	.852		.426		1.846			
		−170									.142
		Total	.710	2.414		6.674		3.408		.142	.852
4 (90708)	17.5	45	.350	.350		.175		.875			
		100	1.925	2.450		.700		9.100			
		170	.525	.350		.175		.525			
		Total	2.800	3.150		1.050		10.500			
5 (90709)	17.6	45	.176	.176				.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	.488	.488				.488			
		100	3.904	1.952				12.200			
		170	.732	1.464				2.440		.244	
		Total	5.124	3.904				15.128		.244	

TABLE 8.—*Weights (in grams) of minerals in concentrates from stages of panning*—Continued

Sample *W* (52–DC–563 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate. Magnetite fractions marked by an asterisk (*) are not subdivided by mesh]

Stage of panning and laboratory nos.	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		.668	1.670
		170		.334	7.348		(*)	1.336	.334	0.668		3.006
		Total	2.338	.668	15.030		1.670	2.672	4.676	.668	1.002	4.676
2 (109725)	22.9	45			.458		(*)					
		100	.687	.916	8.015		(*)		6.412	.916	1.145	
		170		.229	2.061	0.229	(*)			.229		.229
		−170			.229		(*)					.229
		Total	.687	1.145	10.763	.229	.916		6.412	1.145	1.145	.458
3 (109726)	14.8	45	.296		.296		(*)			.148	.148	
		100	1.924	.148	1.776		(*)	.296	4.292	.444	.740	
		170	.148	.148	2.220		(*)		.148	.296	.148	.296
		−170			.148		(*)					.148
		Total	2.368	.296	4.440		.592	.296	4.440	.888	1.036	.444
4 (109727)	10.0	45	.600				(*)		.100		.100	
		100	3.900	.400			(*)		3.500		.700	
		170			.300		(*)					
		−170					(*)					.100
		Total	4.500	.400	.300		.300		3.600		.800	.100
5 (109728)	11.9	45	.595		.119		(*)		.357		.238	
		100	2.618	.119	.595		(*)		5.593		.595	
		170	.119		.238		(*)			.119	.119	.119
		−170			.119		(*)					
		Total	3.332	.119	1.071		.238		5.950	.119	.952	.119

Sample *X* (52-WE-359 series)

[Mineralogical analysts: Jerome Stone and M. N. Girhard. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.384	.576	.672		
		−170				.192	.192				0.048
		Total				2.640	.624	.720	.768		.048
2 (90800)	2.8	45									
		100			0.028	.252		.112	.028		
		170				1.652	.084	.308	.112		
		−170				.112	.084				.028
		Total			.028	2.016	.168	.420	.140		.028
3 (90801)	2.3	45									
		100				.506		.828	.230		
		170				.299		.184	.138	0.023	
		−170				.046	.023				.023
		Total				.851	.023	1.012	.368	.023	.023
4 (90802)	3.8	45						.076			
		100				.190		1.254		.114	
		170				.836		.950	.114	.038	
		−170				.152	.076				
		Total				1.178	.076	2.280	.114	.152	
5 (90803)	3.4	45			.034	.034		.034			
		100	0.068			.238		1.224	.204		
		170		0.068		.578		.510	.306		
		−170				.068					.034
		Total	.068	.068	.034	.918		1.768	.510		.034
6 (90804)	5.8	45						.174			
		100	.058					4.234			
		170						1.218			
		−170				.116					
		Total	.058			.116		5.626			
7 (90805)	4.4	45				.088		.308			
		100						2.728	.440		
		170				.176		.308	.220		
		−170				.044	.044				.044
		Total				.308	.044	3.344	.660		.044

TABLE 8.—*Weights (in grams) of minerals 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. Mineralogical analysts: M. E. Morisawa and L. A. Weiser. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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			.210	.084	.112	0.266				
		170			.154		.084	.126		0.028		0.056
		Total			.462	.168	.294	.392		.028		.056
2 (81130)	.09	45		0.0144	.0153							
		100						.0540		.0063		
		Total		.0144	.0153			.0540		.0063		
3 (81131)	.11	45		.0099	.0143			.0022		.0033		
		100						.0671		.0132		
		Total		.0099	.0143			.0693		.0165		
4 (81132)	.42	45						.3486				
		100						.0672		.0042		
		Total						.4158		.0042		
5 (81133)	.06	45										
		100			.0126		.0060	.0270	0.0012	.0114		.0018
		Total			.0126		.0060	.0270	.0012	.0114		.0018
6 (81134)	.11	45		.0220	.0198					.0077		
		100			.0055			.0484		.0066		
		Total		.0220	.0253			.0484		.0143		
7 (81135)	2.8	45										
		100			.644	.084	.280	.616				
		170			.448	.084	.252	.168	.056	.056		.112
		Total			1.092	.168	.532	.784	.056	.056		.112
8 (81136)	.12	45										
		100	0.0052		.0455		.0078	.0520	.0065	.0130		
		Total	.0052		.0455		.0078	.0520	.0065	.0130		
9 (81137)	.09	45										
		100										
		170			.0396		.0054	.0216	.0018	.0072	0.0027	.0117
		Total			.0396		.0054	.0216	.0018	.0072	.0027	.0117

Sample Z (52-WE-1 series)

[Mineralogical analysts: M. E. Morisawa and L. A. Weiser. Except where figures are given for fractions, the total quantity is less than 1 percent of concentrate]

Stage of panning and laboratory nos.	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	.160		.080	0.020				
		170			.280		.060	.780	0.060	0.200	0.020	
		−170			.080		.040	.020		.020		0.040
		Total		.040	.540	.040	.220	.820	.060	.220	.020	.040
2 (81208)	.9	45		.081	.099		.018					
		100	0.027	.045	.108			.153	.027	.045		
		170	.018		.072		.018	.108	.009	.063		.009
		Total	.045	.126	.279		.036	.261	.036	.108		.009
3 (81209)	.6	45		.138	.060							
		100	.006	.012	.018			.120		.048		
		170	.012	.006	.054		.006	.072	.006	.036		.006
		Total	.018	.156	.132		.006	.192	.006	.084		.006
4 (81210)	.55	45		.0495	.0440					.0055		
		100	.0055	.0275	.0275			.1650	.0055	.0220		
		170	.0110	.0110	.0110			.1045	.0055	.0550		
		Total	.0165	.0880	.0825			.2695	.0110	.0825		

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