RA No. 74

RECLASSIFICATION AUTHORIZATION

In accordance with the authority delegated to me by memorandum from the General Manager, dated December 6, 1948, subject, "Security Procedures and Policies relating to the Domestic Raw Materials Program," and based on criteria for determining classification, as outlined in Appendix A attached thereto, the documents listed below are reclassified as indicated.

Document Title and Description	Present Classification	Revised Classification
1. USGS -- TEI-25 "Preliminary Report on Trace Elements Investigations in the Sweepstakes Creek Area, Koyuk District, Seward Peninsula, Alaska," May 1946, H.R.Gault, R. F. Black, J.B.Lyon,	OFFICIAL USE ONLY	UNCLASSIFIED
2. USGS -- TEI-26 "Trace Elements Investigations in the Cache Creek - Upper Peters Creek Area, Yentna District, Alaska," March 1946, G.D.Robinson, W. Wedow, Jr., J.B.Lyons.	OFFICIAL USE ONLY	UNCLASSIFIED
3. USGS -- TEI-27 "Trace Elements Investigation at Ear Mountain, Seward Peninsula, Alaska," May 1946, P.L.Killeen and R.J.Ordway	OFFICIAL USE ONLY	UNCLASSIFIED

March 20, 1952   RK   R L Faulkner

Date

R. L. Faulkner, Acting Director
Division of Raw Materials

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RA. NO. 25

RECLASSIFICATION AUTHORIZATION

In accordance with the authority delegated to me by memorandum from the General Manager, dated December 6, 1948, subject, "Security Procedure and Policies relating to the Domestic Raw Materials Program" and Appendix A attached thereto, the document(s) listed below are reclassified as indicated.

	Document Title and Description	Present Classification	Revised Classification
1.	No. 25 "Preliminary Report on Trace Elements Investigations in the Sweepstakes Creek Area, Koyuk District, Seward Peninsula, Alaska, May 1946, H.R.Gault, R. F. Black, J.B. Lyon	UNCLASSIFIED	OFFICIAL USE ONLY
2.	No. 26 "Trace Elements Investigations in the Cache Creek - Upper Peters Creek Area, Yentna District, Alaska, March 1946, G.D. Robinson, W. Wedow, Jr., J.B.Lyons.	UNCLASSIFIED	OFFICIAL USE ONLY
3.	No. 27 "Trace Elements Investigation at Ear Mountain, Seward Peninsula, Alaska" May 1946, P.L.Killeen and R.J.Ordway	UNCLASSIFIED	OFFICIAL USE ONLY

Date

Manager
Raw Materials Operations

Copy No.________of Report listed as Item_______above has been reclassified as recommended above.

Date

Signature

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AUG 1983

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TRACE ELEMENTS INVESTIGATIONS IN THE CACHE CREEK - UPPER PETERS CREEK AREA, YENTNA DISTRICT, ALASKA

by

G. D. Robinson, Helmuth Wedow, Jr., and J. B. Lyons

March 1946

Trace Elements Investigations - Report No. 26

RP100-189

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ILLUSTRATIONS

Illustrations at back of report

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TRACE ELEMENTS INVESTIGATIONS

IN THE

CACHE CREEK-UPPER PETERS CREEK AREA,

YENTNA DISTRICT, ALASKA

by

G. D. Robinson, Helmuth Wedow, Jr., and J. B. Lyons

ABSTRACT

Preliminary scanning of the Geological Survey's collection of Alaskan placer concentrates led to an investigation for possible placer deposits of radioactive minerals on Cache and upper Peters Creeks in the Yentna District, Alaska, in the summer of 1945. Five gravel types of different age or origin - Eocene, Late Tertiary, Quaternary glacio-fluvial, Quaternary bench, and the present floodplain deposits (including tailings from placer mining) - were investigated for their content of radioactive minerals. Radioactivity was measured by gamma count, as detected by a portable Geiger-Mueller counter, at 455 field stations, and in 526 rough-screened samples and 348 field-laboratory samples. The field-station counts ranged from 8 to 20 per minute; the rough-screened sample counts from 8 to 21 per minute. Calculations from counts of carefully screened samples and gravity concentrates tested in the field laboratory show a maximum of 0.009 percent of equivalent uranium even where concentration ratios are 500:1 or greater. Sluice-box concentrates with an undetermined but extremely high concentration ratio have a maximum of 0.064 percent of equivalent uranium. The measured radioactivity of the samples may be due either to particles of radioactive minerals in the mineral aggregate of pebbles or other rock fragments, or

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to individual mineral grains. Present interest is focussed on mineral grains, the only material recoverable by normal placer-mining methods. Studies of the individual grains indicate the presence of thorium-bearing monazite and uraninite (?), both of which are radioactive. The monazite is much more abundant than the uraninite(?). Zircon, an abundant mineral, may possibly be slightly radioactive. Generalized estimates indicate reserves of tens of millions of cubic yards of gravels that might yield 6 pounds of concentrate per cubic yard which would contain 0.002 to 0.004 percent of equivalent uranium.

INTRODUCTION

Study by Harder and Reed 1/ of placer concentrates from the Yentna district, Alaska (see fig. 1), for the most part collected by J. B. Mertie, Jr., in 1917 and now on file with the Geological Survey, indicated that several valleys in the district might contain promising placer deposits of radioactive minerals. The radioactivity of the concentrates, according to Harder and Reed 2/ appears to be due to the thorium-bearing mineral monazite and a uranium-bearing mineral, possibly uraninite. In the summer of 1945 a field party was organized to search for concentrations of the radioactive material in the placer deposits of the Yentna district. The party, consisting of G. D. Robinson and Helmuth Wedow, Jr., geologists, and Fred Freitag and S. H. Dane, camphands, spent the period June 21 to September 20 in the area. After the transfer of Robinson to another project shortly after the close of the field season, the preparation of the report was carried on by Wedow. J. B. Lyons assisted by making the alpha-ray and mineralogical

1/ Harder, J. O., and Reed, J. C., Radioactivity of some Alaskan placer samples, U. S. Geological Survey, Trace Elements Investigations, Rept. No. 6, February, 1945, unpublished, pp. 15-17.
2/ Harder, J. O., and Reed, J. C., op. cit., appendix 1.

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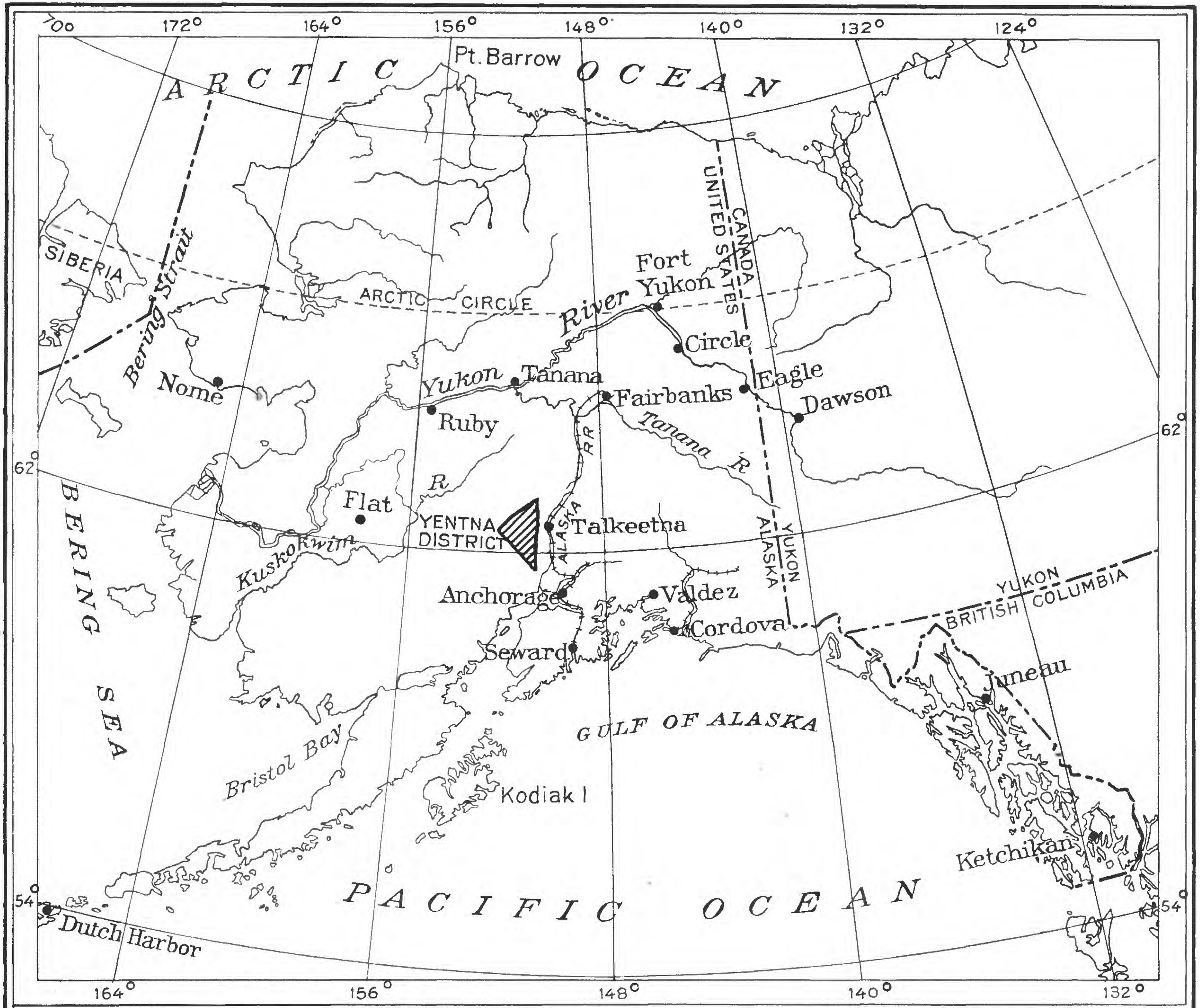

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studies described. The investigations were part of the Trace Elements program of the Geological Survey.

The aid and cooperative spirit of the mine operators in the area - C. W. Bradley, Martin Carlson, Hans Erickson, F. D. Haughan, Joseph Krummenacher, C. P. Morgan, W. C. Stoll, A. J. Zaraski, Ed. Wagner and G. H. Weatherell - are gratefully acknowledged.

Placer gold has been mined in the Yentna district since 1905; until 1916 all mining was by hydraulic methods. From 1916 to 1926 a dredge operated on Cache Creek starting just above Windy Creek and stopping just below Nugget Creek. Since 1926 all mining in the Cache Creek watershed has been by hydraulic methods. About 1936 a dragline was installed in the "bowl" at the mouth of the Peters Creek canyon in the Peters Hills and was in operation until 1941. About 10 hydraulic plants were active in the area in the summer of 1945.

Location and geography

The Cache Creek-upper Peters Creek area in the Yentna District is about 30 miles in an air line west northwest of Talkeetna, a station on the Alaska Railroad. Cache and Peters Creeks are southerly flowing tributaries of the Kahiltna River, which in turn is a tributary of the Yentna River. Cache Creek and upper Peters Creek have cut their valleys in the gently undulating surface of a trough-like basin that trends northeast and separates the Dutch Hills on the northwest from the Peters Hills on the southeast. In the areas mapped in 1945 (see index map, figure 7), the basin surface slopes gently from an average altitude of about 2,400 feet at the northeast end to an average altitude of about 2,000 feet at the southwest end. The main streams are incised as much as 400 feet below the basin surface. The Dutch Hills rise abruptly about 1,800

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to 2,500 feet above it. The principal tributaries of Cache Creek are the southward-flowing Dollar, Falls, Thunder, Rambler, Nugget and Gold Creeks (named from west to east), and the westward-flowing Spruce, Windy and Long Creeks. The main tributaries of upper Peters Creek are southeastward-flowing Bird Creek and southwestward-flowing Cottonwood Creek.

The usual route into the area during the mining season is from Talkeetna, where the Susitana River is crossed by boat. A truck road, maintained by the Alaska Road Commission, extends from the west bank of the Susitna River past Petersville, a small mining camp at the mouth of Peters Creek canyon, to the mouth of Long Creek. Tractor trails branch from the road to the various mining operations. Ferry service across the Susitna River, and truck and tractor service into the Cache Creek area are operated by George H. Weatherell of Talkeetna. Landing strips near the mouth of Bird Creek and at Petersville make it possible to enter the area by small plane.

Bedrocks and gravel deposits are well exposed in the canyon walls and cut banks of the two major streams and their larger tributaries. The broad upland areas separating the narrow stream valleys are largely "niggerhead" flats interrupted by swampy "muskegs."

The geography and climate of the area have been described by Capps 3/ and Mertie 4/.

3/ Capps, S. R., The Yentna district, Alaska: U. S. Geol. Survey, Bull. 534, 1913.
4/ Mertie, J. B., Jr., Platinum-bearing gold placers of the Kahiltna Valley, U. S. Geol. Survey, Bull. 692, pp. 233-264, 1919.

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Geology

The general geology of the Cache Creek and upper Peteres Creek area has been described in considerable detail by Capps 5/ and Mertie 6/.

The bedrocks of the area consist of two major units. The older is a sequence of slate and graywacke, with minor amounts of quartzite and conglomerate, in which the rocks are much fractured and in most places tightly folded. Quartz veins and light-colored dikes of various kinds cut the rocks of this sequence. Fossils found by Mertie 7/ indicate that these beds are of Mesozoic age and probably are, at least in part, Cretaceous. These deformed but only mildly metamorphosed sediments, called "hard bedrock" by the miners in the area, are the predominant country rocks of the Dutch and Peters Hills, and are generally well exposed in the upper or canyon portions of the major streams and their larger tributaries.

The younger of the two major bedrock units is a sequence of pebble gravels, arkosic sands, organic clays, and lignite, wholly or in part of Eocene (Kenai) age. 8/ These beds are only slightly deformed, and dip gently to the southeast with only local reversals of dip to the northwest. In the area mapped in 1945, it is estimated that a thickness of more than 300 feet of these sediments are exposed along the valley of Cache Creek and in the lower reaches of its tributaries. These slightly consolidated rocks are known locally as "soft bedrock," but the sequence includes a well-cemented gravel bed, several tens of feet thick, which crops out on Cache Creek near the mouth of Gold Creek. Similar cemented gravel crops out along lower Nugget Creek and at several places on

5/ Capps, S. R., op. cit., pp. 22-47.
6/ Mertie, J. B., Jr., op. cit., pp. 236-240.
7/ Mertie, J. B., Jr., op. cit., p. 237
8/ Capps, S. R., op. cit., pp. 28-33.

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Cache Creek between Nugget and Windy Creeks.

Overlying the bedrock units are numerous gravel deposits of diverse origin and age. The oldest of these is a sequence of clay-matrix gravels and boulder-studded clays that is younger than the Eocene rocks but older than the Quaternary glaciation. This sequence is called Late Tertiary in this report. Ancient stream channels filled with these clay-matrix gravels are exposed by post-glacial stream erosion. The deposits are in places more than 300 thick; they are commonly only a few tens or hundreds of feet wide. Away from the channels the gravel deposits are much thinner but underlie large areas to thicknesses of a few feet or tens of feet. The gravels are of the type deposited by streams in areas undergoing vellgy glaciation, and the clays seem to be glacial outwash. The Late Tertiary gravels and clays are commonly, but not invariably, conformable with the Eocene rocks.

The uppermost surface of the basin between the Dutch and Peters Hills is thinly covered by till and poorly sorted gravel, apparently deposited during the retreat of a great glacier which occupied the basin during part of the Quaternary period. Gravels of this group are herein designated Quaternary glacio-fluvial gravels.

The streams of the area, in reaching their present courses, cut and built a series of terraces or benches below the more or less even surface left by the retreating Quaternary glacier. As many as seven different bench levels are preserved in a vertical interval of as much as 300 feet below the post-glacial surface. The benches below the post-glacial surface and above the present stream courses are commonly capped with a few feet of stream-laid deposits herein designated Quaternary bench gravels. These gravels are locally several tens of feet thick.

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The youngest gravel deposits are those of the present floodplains. Much of the gravel at stream level has been mined, and large volumes of rock have been contributed to the streams by the mining of higher benches. As a result, the floodplain gravels are now for the most part slightly sorted and redistributed tailings.

FIELD METHODS

The sampling problem

To test the gravels throughout the area with any hope of getting representative results would be a project requiring many seasons. On the other hand, to confine work merely to localities actively being mined or to sands and gravels of the present floodplains might fail to give a true evaluation of the distribution of the heavy minerals in the gravels of the area.

At least a little gold has been produced from gravels of every age and origin in the district. No gravel has yielded spectacular amounts, and although the district has been intensively prospected and mined, the bulk of the production has been from Quaternary benches; the least production has come from Eocene beds. Well-defined paystreaks in any of the gravels are reportedly rare, although gold values are consistently highest near bedrock. Large yardages of low-grade gravels have made moderately profitable hydraulic and dredge operations possible. Only about 10 claims were being mined in 1945. Most of the operators are sluicing Quaternary bench gravel, but some work is being done on glacio-fluvial deposits and in high Late Tertiary gravel channels.

Because most of the gold is coarse and the grade of the gravels low, the miners commonly push as much rock through the boxes as possible, using all the head available. By doing so they tend to blast everything out of the riffles

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except gold and lead shot, and much if not most of the other heavy minerals, if present at all, are scattered in the tailings. In the past, few operators saved the heavy minerals that remained in the riffles at the cleanup, so that there is little concentrate available for testing.

For preliminary reconnaissance purposes, the low-level Quaternary bench gravels are believed to offer the most promise as sources of preliminary information on the radioactive mineral resources. Whatever heavy minerals the older gravels contain should be further concentrated in the younger beds largely derived from them; this has evidently been the case with the gold. The low-level benches have also the obvious practical advantage of being relatively near stream level making it possible to work rapidly the considerable volumes of gravel needed for the sampling procedure. In reaching this conclusion much preliminary testing was done on higher-level and older gravels.

Although occasional check traverses were made on present floodplain deposits and tailings, and on older gravels, systematic testing was mainly restricted to (1) sizable areas of Quaternary gravels, whether or not currently being mined, and (2) the vicinity of present workings, regardless of the age or origin of the gravels being worked.

The instrument

The radioactivity of the gravels and the placer samples was measured by a Geiger-Mueller counter. The general theory, procedure, and accuracy of results of this type of counter have been discussed elsewhere.9/ Because of much

9/ Stead, F. W., Preliminary report on field measurement of radioactivity, U. S. Geol. Survey, Trace Elements Investigations, Rept. No. 13, May 1945, unpublished.

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inclement weather and hard usage, it was necessary to protect the instrument in the field by a paraffin-sealed wooden carrying case, designed to permit easy operation and removal of the instrument. A small canvas sling held the counter tube against the side of the wooden box which was then covered with a paraffined canvas skirt. Even with these precautions moisture occasionally would get inside the instrument and short some of the batteries.

Sampling procedure

The general plan of sampling was to test selected areas of exposed gravels at regular intervals. Samples from areas of relatively high count in the field were then tested in a local field laboratory for semi-quantitative determination of the equivalent uranium content.

Field-station method: During the first weeks of the season the gravels were tested by taking the instrument to the traverse station. In each area to be tested a traverse was laid out, and at regularly spaced stations on the traverse gamma counts over a five minute period, or rarely a ten minute period, were taken with the counter tube laid against the gravel or the underlying bedrock. Air background readings with the instrument held from one to four feet above the ground surface were occasionally interspersed with the regular station readings. Samples for testing in the field laboratory were taken at stations giving relatively high counts, and occasionally, as a check, at stations giving indifferent counts. This method of determining the gamma count of the natural gravel or bedrock was abandoned when it was decided, after comparison of a considerable number of field and field-laboratory data, that the count was being influenced by pebble effect (see p. 21) and perhaps by mass effect of the surrounding rocks. Essentially, it appeared that the effects on the counter

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of any small but possibly significant amounts of heavy radioactive minerals in a form recoverable by hydraulic methods were being masked by the effects of volumetrically overwhelming proportions of pebbles.

Rough-screened sample method: To eliminate part of the pebble effect it was decided to test a screened fraction of the gravel from each traverse station. For this purpose the rough-screened sample or "can sample" method was devised.

When a gravel bench, exposed for 1,000 feet on both sides of a stream valley was to be tested, an instrument station was set up on the valley bottom midway along the exposure. Sampling locations were surveyed by tape-compass methods at approximately 100-foot intervals along both banks, and the section at each location was measured and described. As each location was made, a sample was taken at the base or lowest part exposed and at 5-foot vertical intervals if the section was thick enough. A sample was made by passing 1/2 cubic feet of gravel through a 4-mesh screen and collecting a one-quart, 14-ounce can full of the screenings. Eight empty cans were carried in a 5-gallon gasoline can attached to a packboard. When all eight cans were filled and taken to the instrument station, they were at once tested while another group was being collected. The sample was poured into a slightly larger can in which the Geiger-Mueller counter tube, protected by a waterproofed canvas pouch, had been placed. Five-minute readings were taken, interspersed with background readings taken with the tube in the empty can. The "can samples" were discarded after testing.

In addition to eliminating some of the pebble effect and any possible mass effect, it was found that adoption of the rough-screened sample method greatly increased the average number of traverse stations which could be tested in a day and greatly decreased the danger to the instrument. Removing and handling gravel in the rough-screened sample method introduces volume increases which

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tend to reduce the gamma count per unit volume of gravel; this reduction, however, does not affect in any significant degree the relative concentrations of radioactive material among the various sample localities.

Field-laboratory sample method: The method of sampling for tests in the field laboratory varied to some extent during the season, but became standardized about the same time that the rough-screened sample method was adopted. Early in the season gravel samples 1/2 cubic feet in volume were taken at field stations which had gamma counts of three to four or more above the air background. As a check against the reliability of field-station tests, similar samples were taken from some field stations regardless of the gamma count at the station. The sample was washed through a 4-mesh screen, the coarser material weighed and discarded, and the screenings dried. The minus-4-mesh material was next screened through 7-mesh, and the resultant fractions tested with the counter. The minus-7-mesh material was further screened through 12-mesh and again the resultant fractions tested. The test were over five-minute intervals and were in the following sequence: background; plus-7-mesh fraction; minus-7-mesh fraction; field standard; plus-12-mesh fraction; minus-12-mesh fraction; background. Any fraction in this sequence which ran more than three counts per minute above background was rerun with background and field standard in the following sequence: background; fraction; field standard; fraction; background. If the gamma count of any fraction of a sample appeared significant, a concentrate of the heavy minerals, approximately 175:1 by volume, was made at the location by running 3 cubic feet of gravel through a rocker and panning the cleanup down to 30 cubic inches.

Later the screenings through 4-mesh were reduced to a volume of about 90 cubic inches by splitting . This split sample was then dried and screened

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through 7-mesh, but not through 12-mesh as was earlier practice. If the material at the field station was sand or clay, rather than gravel, and the gamma count was relatively high, a sample of about 90 cubic inches was taken directly and dried, and then tested in the field laboratory in the usual sequence.

Still later, the method of taking the field-laboratory samples for gravel was finally standardized as follows: A 1/2 cubic foot sample was taken at each locality which gave a rough-screened sample reading 4 or more counts above air background. If no rough-screened sample tested 4 or more counts above air background in any traverse as much as 1,000 feet long, at least one representative field-laboratory sample was taken in the traverse as a check against the rough-screened sample data. The sample was washed through a 4-mesh screen. The plus 4-mesh material was weighed and discarded; pebble counts were made on some. The minus 4-mesh material was weighed and split to 90 cubic inches. A cubic foot of gravel was put through a rocker at each locality and the concentrate was panned down to 30 cubic inches; then a 9 cubic foot sample was similarly concentrated; occasionally a cubic yard of gravel was so treated.

The split from the 1/2 cubic foot sample was dried and separated into two fractions with a 7-mesh sieve. Parts of the fractioned split and of the rocker concentrates sufficient for quantitative comparison with the standard container were taken. Five-minute readings on these parts were run in the following sequence: Background; plus 7-mesh fraction; minus 7-mesh fraction; standard; 1 cubic foot rocker sample; 9 cubic foot rocker sample; background. Any fraction or concentrate 3 or more counts above background was rerun in the sequence: background; fraction; standard; fraction; background.

A traverse involving the collection of 25 to 35 rough-screened samples and two or three complete laboratory-sample and rocker-sample sets, was

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ordinarily completed in one day, [redacted]

Late in the season it was decided that enough data had been collected on the weights of the various size fractions of the 1/2 cubic foot samples, and these samples were omitted thereafter.

DISCUSSION OF SAMPLING DATA

The sampling data have been plotted on a series of maps (figures 2-7). The grade of the various samples, as determined from field-laboratory data, has been plotted in percent of equivalent uranium. The field data have been plotted as total gamma counts per minute. For each traverse the stated air background was determined by averaging all background readings taken in the traverse area.

The sample data are recorded in tabular form in tables 1-5.

Size fractions of the gravel types

The proportions of the different size fractions in many of the field laboratory samples was determined as a byproduct of the effort to discover whether the radioactivity of the samples was due to grains of radioactive minerals or to radioactive minerals in pebbles. The average percent of the arbitrary size fractions in the different gravel types is as follows:

Type of gravel	Number of samples	(In percent by weight) Plus 4-mesh	Minus 4-, plus 7-mesh	Minus 7-mesh
Eocene	9	71	8	21
Late Tertiary	28	67	13	20
Quaternary glacio-fluvial	10	72	12	16
Quaternary bench	13	65	13	22
All samples (weighed)	60	68	12	20

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Because rock fragments of maximum dimension greater than 5 inches were avoided in collecting the samples, the Quaternary beach gravels and the Late Tertiary gravels on the average, actually contain slightly more minus 4-mesh material than is indicated above. Large cobbles and boulders are not common in Quaternary glacio-fluvial gravels, and rare in Eocene gravels, and therefore the size distribution given approaches the true proportions.

It is clear from the data presented that the gravel types are not readily distinguishable on the basis of size distribution.

Pebble composition of the gravels

The pebble compositions of the various types of gravel were determined by counts of 100 pebbles selected at random from the coarse fraction (plus 4-mesh) of each of a number of the 1/2 cubic foot field laboratory samples.

The various types of pebbles recognized were:

Slate and graywacke
Schistose rock
Chert and quartzite
Cemented conglomerate
Igneous rock, fresh
Igneous rock, weathered
Vein quartz
Clay and lignite

The pebbles of slate and graywacke, characteristically subangular, are apparently derived from the Mesozoic bedrock exposed in the Dutch and Peters Hills. The schistose pebbles are chloritic and probably are metamorphosed graywacke.

The chert pebbles are usually well-rounded and are commonly light-gray to black. The quartzite pebbles are also well-rounded and are generally made up of well-cemented fine sand grains; fresh fracture surfaces are light-gray

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or yellowish-white. The cemented conglomerate forms distinctive pebbles consisting of small, well-rounded fragments of chert, quartzite and vein quartz well-cemented in a matrix of argillite or graywacke. The chert, quartzite and cemented conglomerate may be derived from Paleozoic sediments exposed in the Alaska Range.

Igneous pebbles are mainly coarse-grained granitic and dioritic rocks, but include aphanitic, fine-grained porphyritic and aplitic rocks. The pebbles grouped as weathered igneous rocks are well-rounded masses of limonitic material and quartz grains, apparently representing fragments of coarse-grained granitic rocks that were subjected to extreme weathering after fluvial transportation and deposition.

The vein quartz pebbles are usually white, and range from well-rounded fragments apparently derived from reworked older gravels to subangular fragments from the recent erosion of veins in the Mesozoic bedrock.

The clay and lignite fragments are derived from the Eocene bedrock. The clay in in blue-gray to gray balls, and the lignite in brown to black fragments, commonly splinter-shaped.

The average pebble compositions of four of the gravel groups are as follows:

(in percent)

	Eocene	Late Tertiary	Quaternary glacio-fluvial	Quaternary bench
Slate and graywacke	29	87	86	62
Schistose rock	2	4	4	4
Chert and quartzite	14	—	½	5
Cemented conglomerate	10	—	½	5
Igneous rock, fresh	35	3½	2½	13
Igneous rock, weathered	—	2½	1	—
Vein quartz	9	2½	2½	7
Clay and lignite	1	½	3	4

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readily distinguishable from the Late Tertiary and the Quaternary glacio-fluvial gravels as well as from one another on the basis of pebble composition. There is essentially no difference in pebble composition between the Late Tertiary and the Quaternary glacio-fluvial gravels, thus suggesting a similar origin for them.

The gravels also show differences in other sedimentary characteristics. The pebbles of Eocene gravels are well-sorted and usually well-rounded. Many pebbles are polished and many others superficially stained bright yellow-brown.

The pebbles of the Late Tertiary gravels are not as well-sorted as those of the Eocene gravels and are usually only subrounded. Boulders as much as 2 feet long are present locally, although most of the rock fragments are less than 6 inches long. Portions of the Late Tertiary gravels have been deeply weathered as shown by their yellowish color and the relative abundance of soft friable pebbles.

The pebbles in the Quaternary glacio-fluvial gravels are subrounded; some are striated. They are poorly sorted and in many places contain boulders as much as 1 foot or rarely several feet in length. The larger boulders are almost invariably granitic or dioritic.

The Quaternary bench gravels and the gravels of the present floodplains are poorly sorted. Some of the pebbles and cobbles are well-rounded, but most are subrounded to subangular.

The large amount of igneous rock material in the Eocene gravels indicates that the gravels were largely derived from the core of the main Alaska Range. During Late Tertiary time the source of the thick gravel deposits was closer to the basin of deposition and presumably was the Dutch and Peters Hills where large areas of Mesozoic slate and graywacke were exposed. The pebble composition of the glacio-fluvial gravels points to a local origin for these deposits which

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of the glacio-fluvial gravels points to a local origin for these deposits which apparently were laid down during Quaternary glaciation when local ice masses in the Dutch and Peters Hills were eroding the exposed Mesozoic bedrock. The Quaternary bench gravels and the floodplain gravels have clearly been derived from the erosion of all the older bedrocks and gravels.

Radioactivity

Field tests: A total of 981 field tests were made in which the counter was taken to the traverse area. Of these 455 were field-station tests and 526 were rough-screened sample tests. The distribution of these instrument readings by type of material tested is as follows:

Type of material tested	Field-station tests	Rough-screened sample tests
Mesozoic slate and graywacke	17	—
Eocene gravel and sand	47	19
Eocene clay	28	1
Late Tertiary gravel	100	72
Quaternary glacio-fluvial gravel	50	4
Quaternary bench gravel	129	213
Floodplain gravel and tailings	84	217
TOTAL	455	526

The distribution by types of material of gamma counts per minute is shown in table 2.

Mesozoic slate and graywacke: The Mesozoic slate and graywacke were tested on but one traverse (traverse 3-1. See fig. 4). The gamma counts ranged between 11 and 17 against a background of 13. About half of the readings were either 13 or 14 counts per minute.

Eocene sediments: The Eocene sediments ("soft bedrock")were tested at numerous points on Cache Creek, principally in traverses 1-1, 1-5, 1-6, 1-7 (see fig. 3), and 6-1 (see fig. 5), and also in traverses 2-2, and 2-5 (see fig. 4) on Nugget Creek. For convenience in testing, the Eocene sediments were divided into two main units: the first, gravel and sand; the second, clay and lignitic

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[redacted]

coal. The tests on gravel and sand by the field-station method showed a range of gamma counts from11 to 18 against background counts of 12 to 13 with more than 50 percent of the counts between 14 and 16. Counts on gravel and sand by the rough-screened method were from 11 to 16 with more than three quarters of the readings between 12 and 14. Field-station counts on the Eocene clay and lignitic clay ranged from 8 to 19 with about 45 percent of the readings between 14 and 15.

Late Tertiary gravels: The Late Tertiary gravels were tested by the field-station method mainly on traverses 2-3, 3-1, 4-1, 5-2 and 5-3 (see fig. 4), on Nugget Creek, and on portions of traverses 1-5 and 1-6 (see fig. 3) on Cache Creek. Rough-screened sample tests were made on them on traverses 7-1 and 7-3 (see fig. 6) on Thunder Creek, on traverse 9-1 (see fig. 6) in Cheechako Gulch, and on traverse 12-2 (see fig. 7) on Bird Creek. Gamma counts at the field stations ranged from 10 to 17 with more than 60 percent of the readings giving counts of 12 to 14, with background counts of 12 to 13, with the exception of a background count of 10 on traverses 5-2 and 5-3. Rough-screened sample counts ranged between 10 and 20 with about 40 percent 13 to 14, against background readings of 11 to 14.

Quaternary glacio-fluvial gravels: Deposits of Quaternary glacio-fluvial gravels were tested on traverses 3-1, 4-1, 5-1 and 5-3 (see fig. 3) on Nugget Creek, and traverse 13-1 (see fig. 7) on Peters Creek. The Nugget Creek traverses were by the field-station method and the gamma counts ranged from 8 to 18 with 50 percent from 12 to 14 against backgrounds of 13 counts for traverses 3-1 and 4-1, and 10 counts for traverses 5-1 and 5-3. The rough-screened samples of the Peters Creek traverse ranged from 10 to 16 with a background of 13 counts.

Quaternary bench gravels: The bench gravel deposits tested were mainly

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those exposed near the present streams, ten feet or less above the present floodplains. Tests were made along Cache Creek on traverses 1-5 and 1-6 (see fig. 3) by the field-station method; and on traverses 1-8 (see fig. 3), 6-1 to 6-7 inclusive (see fig. 5), 8-1 and 8-2 (see fig. 6) by the rough-screened sample method. A few additional tests were made by each method on several other traverses. Traverse 1-7 (see fig. 3) was tested by both methods. Field-station counts for this gravel type ranged from 10 to 20 with more than 55 percent between 14 and 16 against background counts of 12 and 13. Gamma counts on the rough-screened samples ranged between 8 and 19 with about 45 percent from 13 to 14 against background counts from 10 to 14.

Floodplain gravels and tailings: The floodplain gravels and tailings were tested on the numerous traverses along Cache Creek and its tributaries (see figs. 3-6), and along Peters Creek and its tributaries (see fig. 7). Because the floodplain gravels in most of the places tested are only slightly redistributed tailings from past mining operations, no attempt has been made to distinguish between the results except that the two are indicated separately on the illustrations. Only tailings from hydraulic operations were tested by the field-station method, whereas tailings tested by taking rough-screened samples were largely those from dredge operations along Cache Creek. The combined results of testing floodplain gravels and tailings show gamma counts of 9 to 18 against backgrounds of 11 to 13 for the field-station tests, and 8 to 21 against backgrounds of 10 to 14 for the rough-screened sample tests. About 50 percent of the field-station tests were between 13 and 15, whereas 60 percent of the readings on the rough-screened samples were between 12 and 14.

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Field-laboratory tests (equivalent uranium determinations): A total of 348 equivalent uranium determinations were made in the field laboratory. These are listed in tables 3a, 3b, 4, and 5 by gravel types. No significant variations among the different gravels are apparent. The most notable data are the variations in the equivalent uranium determinations by size fractions and gravity concentrates recorded in table 3b. More coarse fractions (minus 4, plus 7-mesh) have an equivalent uranium content above 0.003 percent than the fine fractions (minus 7-mesh). Readily seen, also, is the increase in the number of values greater than 0.003 percent when the concentration ratio exceeds 500:1. Table 4 shows the number of pounds of concentrate per cubic yard recoverable by the method used at each sample location where a gravity concentrate was obtained. The percent of equivalent uranium for each concentrate is also shown. These concentrates consist primarily of the lighter minerals and rock fragments, and include only a small percentage of heavy minerals (those with specific gravities greater than 2.8). The highest test on a concentrate shows but 0.009 percent of equivalent uranium.

Gravity concentration of moderately heavy minerals by panning and rocking is not efficient. It is probable that from 10 to 50 percent of the heavy minerals originally present are lost during concentration. Losses of this order, however, are largely inherent in any inexpensive method of working gravels, and results from sampling of this sort are thus probably fairly indicative of expectable recovery by common placer methods.

Field-laboratory tests were made on 24 sluice-box concentrates collected from various hydraulic operations in the area. Also tested were 17 panned drill cuttings from holes put down by the Alaska Exploration and Mining Company in the vicinity of the Bird Creek workings. The data on these concentrates are

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shown in table 5 and the locations of those collected in the Cache Creek watershed are plotted on figure 2. The gravel yardages in the table are only approximate having been derived from rough estimates furnished by the operators. Much of the material of mineral-grain size is lacking in the sluice-box concentrates, particularly the very fine, heavy "blowings", which probably contain a high proportion of any radioactive minerals present.

Pebble effect: The pebble effect mentioned earlier in the discussion of sampling methods is apparent in two sets of data. In a comparison of all types of gravel tested, the peak in the distribution is from one to two counts per minute less for the rough-screened sample tests than the field-station tests (see table 2). The lower counting rate of the samples is attributed to the screening out of the pebbles, although it may also be due to a lessening of the total mass which is affecting the instrument. Examination of the statistics on the equivalent uranium determinations of the field-laboratory samples (see tables 3a and 3b) also seems to disclose pebble effect. As stated earlier, more coarse size fractions (minus 4, plus 7-mesh) have an equivalent uranium content above 0.003 percent than fine fractions (minus 7-mesh); this is the reverse of the results that might be expected. Here again the general lower counting rate for the finer fractions is believed to be due to the removal of small pebbles and other coarse material. The conclusion seems to be that a closer approximation of the recoverable content of radioactive minerals in placer deposits can be reached by the use of the counter on material screened down to mineral-grain size.

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LABORATORY STUDIES

Methods

Most of the field-laboratory samples taken in the Yentna district were brought in for additional study, particularly for identification of the radioactive minerals. For this purpose several concentrates showing relatively high radioactivity were selected from each gravel type. From each of these a grain-size portion (minus 40, plus 100-mesh) was selected and five fractions prepared using heavy liquids (bromoform, specific gravity 2.8 and methylene iodide, specific gravity 3.3) and a magnetic separator:

(1) light, specific gravity 2.8
(2) specific gravity 2.8, 3.3; magnetic
(3) specific gravity 2.8, 3.3; non-magnetic
(4) specific gravity 3.3; magnetic
(5) specific gravity 3.3; non-magnetic

Portions of these five fractions of several of the samples were then mounted in bakelite on glass slides and exposed by contact to alpha-ray spectroscopic plates for periods of 4 to 14 days in order to determine specifically which grains were radioactive.

Mineralogy

The concentrates from the several gravel types studied are much the same in mineral composition. The proportions of the different minerals, however, vary to some extent, and the variation apparently is characteristic of certain of the gravel types. The following minerals are the abundant and common constituents of the concentrates: zircon, hornblende, hypersthene, augite, epidote, garnet, pyrite, ilmenite, chromite (or a chrome spinel), cassiterite, magnetite, quartz, and altered feldspar. The minor and erratic constituents are gold, tourmaline, andalusite, biotite, chlorite, iron oxides, allanite (?), arsenopyrite, copper, stibnite (?), apatite, sphene, monazite, graywacke fragments, iddingsite, prehnite,

 [redacted]

[redacted]

rutile(?), marcasite, galena, and two unidentified minerals - one of them brown and wedge-shaped; the other whitish and anhedral. Platinum has been reported by Mertie 10/ in some of the placers of the Yentna district, but was not found in the samples collected in 1945.

The columbium content of three placer concentrates collected in the Yentna district prior to 1945 has been determined.11/

The Eocene sands and gravels characteristically have heavy-mineral suites low in sulfide minerals, and lacking in tourmaline and apatite. Heavy-mineral fractions from Late Tertiary gravels are rich in pyrite, whereas Quaternary bench gravels have heavy-mineral fractions characteristically high in andalusite and cassiterite. Apatite, tourmaline, monazite, allanite(?) and iddingsite(?) are more abundant in the floodplain gravels than in the other gravel types.

Radioactive minerals: The source of radioactivity in the samples collected in 1945 is not completely clear. The only mineral which darkens an alpha-ray spectroscopic plate after two weeks exposure occurs in black, lustrous, anhedral grains tentatively identified as uraninite. Only a few grains of uraninite(?) were seen.

Monazite, in lemon-yellow, euhedral, wedge-shaped monoclinic crystals, is presumed to be radioactive because it normally contains 6 percent or more of ThO_2, and because it appears to be the only radioactive mineral sufficiently abundant to be the source of the radioactivity measured.

Zircon, which is extraordinarily abundant, may possibly be slightly radio-

10/ Mertie, J. B., Jr., op. cit.

11/ Fleischer, Michael and Harder, J. O., The occurrence of columbium and tantalum, U. S. Geological Survey, Trace Element Investigations, Rept. No. 14, unpublished, pp. 14, 20, 21.

[redacted]

[redacted]

active and responsible in part for the radioactivity measured, but direct evidence is lacking. The zircon is characteristically in euhedral tetragonal prisms and pyramids, generally colorless although some crystals are tinted purple, blue, yellow and brown.

RECOMMENDATIONS

As the examination during the summer of 1945 did not reach all the locations in the district suggested in the report by Harder and Reed 12/, it is recommended that the occurrences reported on the Kahiltna River, and on Poorman and Willow Creeks be investigated in the future. The Poorman Creek occurrence should be examined with specific regard to the relationship of the placer deposits to possible mineralized zones in the bedrock.

RESERVES

Inasmuch as the equivalent uranium content of the samples taken in 1945 was very low (0.008 percent of equivalent uranium or less, see tables 3a, 3b, and 4) no detailed estimates of reserves are presented. Although several sluice-box concentrates tested contained 0.02 to 0.06 percent of equivalent uranium (see table 5) the concentration ratios were so high that the content, as recalculated for the original gravels, is almost meaningless except as an indication of the presence of some radioactive mineral.

As a by-product of placer-gold mining these sluice-box concentrates could be saved for their content of radioactive minerals.

12/ Harder, J. O., and Reed, J. C., op. cit., pp. 15-17.

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The area includes millions of cubic yards of Quaternary bench gravels and floodplain gravels that might yield 6 pounds of concentrate per cubic yard which would contain 0.003 to 0.004 percent of equivalent uranium. The Late Tertiary and the Quaternary glacio-fluvial gravels are estimated to include tens of millions of cubic yards that might yield 6 pounds of concentrate per cubic yard which would contain 0.002 to 0.003 percent of equivalent uranium.

[redacted]

Table 1

Location and description of [redacted]

Traverse	See figure	Method of testing	Location and description
1-1	3	PS	Largely Eocene gravel in a cut bank on the right limit of Cache Creek just upstream from Nugget Creek.
1-5	3	PS	Quaternary low-bench gravel and Eocene bedrock on Cache Creek for 4,000 feet upstream from Gold Creek; some tailings also tested.
1-6	3	PS	Quaternary low-bench gravel and Eocene bedrock on Cache Creek between Gold and Long Creeks; includes H. Erickson's workings at the mouth of Gold Creek; some tailings also listed.
1-7	3	PS & C	Quaternary low-bench gravel and Eocene bedrock on Cache Creek between Long and Nugget Creeks.
1-8	3	C	Quaternary bench gravel at C. W. Bradley's workings on Cache Creek about 1.85 miles upstream from Gold Creek.
2-1	4	PS	Tailings piles and Eocene clay on Nugget Creek about 2,000 feet upstream from its mouth.
2-2	4	PS	Tailings, Quaternary bench gravel and Eocene bedrock in a low cut bank on the left limit of Nugget Creek from about 2,500 feet to about 3,500 feet upstream from its mouth.
2-3	4	PS	Quaternary low-bench gravel on top of Late Tertiary gravel in a left-limit cut bank on Nugget Creek about 4,000 feet upstream from its mouth.
2-4	4	PS	Gravel (largely reworked tailings) on small incipient floodplains in the lower part of the canyon of Nugget Creek.
2-5	4	PS	Quaternary low-bench gravel, tailings and Eocene bedrock on Nugget Creek for about 1,000 feet upstream from its mouth.
3-1	4	PS	Mesozoic slate and graywacke, Late Tertiary gravel and Quaternary glacio-fluvial gravel in C. P. Morgan's workings on the uppermost bench on the right limit of Nugget Creek just downstream from the canyon. [redacted]

Table 1 ([redacted]

Traverse	See figure	Method of testing	Location and description
4-1	4	FS	Late Tertiary gravel and Quaternary glacio-fluvial gravel in a gully on the left limit of Nugget Creek just downstream from the mouth of the canyon and opposite Morgan's workings.
5-1	4	FS	Quaternary glacio-fluvial gravel on the uppermost bench on the left limit of Nugget Creek near the mouth of the valley.
5-2	4	FS	Late Tertiary gravel about 25 feet vertically below traverse 5-1.
5-3	4	FS	Quaternary glacio-fluvial gravel and Late Tertiary gravel on the uppermost bench on the left limit of Nugget Creek about 2,500 feet upstream from the mouth of the valley.
6-1 6-2 6-3 6-4 6-5 6-6	5 5 5 5 5 5	C C Cq C C C	Traverses 6-1 through 6-6, inclusive, are continuous and are largely on Quaternary low-bench gravel on Cache Creek from Nugget Creek downstream almost to Trout Creek; some tailings were tested and a few readings were made on Eocene bedrock; traverse 6-5 includes the workings of A. J. Taraski.
6-7	5	C	Quaternary bench gravel on the left limit of Cache Creek about 1,000 feet upstream from Rambler Creek; G. H. Weatherall's workings.
7-1 7-2	6 6	C C	Floodplain gravel, Quaternary bench gravel and Late Tertiary gravel on Thunder Creek from its mouth to the mouth of the canyon.
7-3	6	C	Late Tertiary gravel in F. D. Haughan's workings on the uppermost bench on the left limit of Thunder Creek about 2,500 feet upstream from the mouth of the Thunder Creek canyon.
8-1	6	C	Quaternary bench gravel in C. P. Morgan's workings on Cache Creek at Falls Creek.
8-2	6	C	Quaternary bench gravel on the right limit of Cache Creek for about 1,500 feet upstream from Falls Creek.

[redacted]

[redacted]

Table 1 (cont.)

Traverse	See figure	Method of testing	Location and description
9-1	6	C	Late Tertiary gravel J. Krummenacher's workings in Cheechako Gulch.
10-1		C	Late Tertiary gravel in M. Carlson's workings on Falls Creek about 2½ miles upstream from its mouth.
11-1	6	C	Floodplain gravel on Cache Creek at Dollar Creek
12-1	7	C	Floodplain gravel (mostly reworked tailings) on Bird Creek for a distance of 1,200 feet upstream from its mouth.
12-2	7	C	Late Tertiary gravel in E. Wagner's workings on high bench on the right limit of Bird Creek about 2,500 feet upstream from its mouth.
13-1	7	C	Quaternary glacio-fluvial (?) gravel on the left limit of Peters Creek about 2200 feet upstream from the mouth of the canyon.
13-2	7	C	Floodplain gravel at Petersville.
14-1	7	C	Floodplain gravel on Willow Creek about 1.6 miles upstream from its mouth.

Note: FS indicates that the gravels were tested by the field-station method, and C that they were tested by the rough-screened sample method.

[redacted]

Table 2 [redacted]

Distribution of gamma counts by types of material tested
(in percent of number of tests)

Field-station tests

Counts per minute	Mesozoic bedrock	Eocene gravels and sands	Eocene clays	Late Tertiary gravels	Quaternary glacio-fluvial gravels	Quaternary bench gravels	Floodplain gravels and tailings	Weighted average - all tests
	Percent							
8	-	-	3.6	-	2.0	-	-	0.4
9	-	-	3.6	-	2.0	-	1.2	0.7
10	-	-	7.1	6.0	2.0	1.6	3.6	3.1
11	5.9	12.8	-	5.0	12.0	7.0	6.0	7.0
12	17.6	12.8	7.1	21.0	24.0	8.5	7.1	13.4
13	23.5	8.5	7.1	22.0	10.0	14.7	14.3	14.9
14	23.5	19.1	25.0	21.0	22.0	21.7	15.5	20.4
15	11.8	12.8	21.4	14.0	16.0	17.1	23.8	17.1
16	11.8	21.3	7.1	6.0	6.0	17.1	19.0	13.4
17	5.9	6.4	14.3	5.0	2.0	7.0	8.5	6.6
18	-	6.4	-	-	2.0	2.3	1.2	1.8
19	-	-	3.6	-	-	2.3	-	0.9
20	-	-	-	-	-	0.8	-	0.3
21	-	-	-	-	-	-	-	-
*	17	47	28	100	50	129	84	455

Rough-screened sample tests

Counts per minute	Mesozoic bedrock	Eocene gravels and sands	Eocene clays	Late Tertiary gravels	Quaternary glacio-fluvial gravels	Quaternary bench gravels	Floodplain gravels and tailings	Weighted average - all tests
8	no tests made	-	-	-		0.5	0.5	0.3
9		-		-		2.3	0.5	1.1
10		-		2.8	25.0	5.6	2.8	4.0
11		5.3		5.6		10.3	10.6	9.5
12		21.1	100.0	12.5	25.0	16.0	20.3	17.7
13		21.1		22.2		23.5	25.3	23.8
14		36.8		19.4	25.0	21.1	14.3	18.6
15		5.3		13.9		8.9	9.2	9.5
16		10.5		6.9	25.0	8.0	8.3	8.2
17		-		8.3		1.9	3.7	3.4
18		-		6.9		1.4	2.3	2.5
19		-		-		0.5	1.8	1.0
20		-		1.4		-	-	0.2
21		-		-		-	0.5	0.2
*		19	1	72	4	213	217	526

[redacted]

*Number of tests used in computing percentages.

Table 3a [redacted]

Percent of equivalent uranium in size fractions [redacted] gravity concentrated of samples as determined by the field-laboratory method.
(based on comparison with a standard containing .042 percent of equivalent uranium)

Material tested	Sample No.	Traverse No.	Percent of equivalent uranium: Size fractions -4,+7 mesh	Size fractions -7 mesh	Gravity concentrates 25:1 200:1	Gravity concentrates 800:1
Floodplain gravels and tailings	43	2-5	.001	.000		
	61	1-6	.000	.002		
	62	1-6	.001	.000		
	70	1-6	.001	.000		
	88	6-5	.000	.000		
	109	8-2	.000	.001	.003	.003
	112	11-1	—	.001	.003	.008
	113	11-1	.002	.000	.003	.009
	114	11-1	.000	.002	.002	.009
	115	11-1	.001	.003	.002	.004
	117	12-1	.000	.004	.004	.001
	118	12-1	.003	.001	.001	.001
	119	12-1	.000	.000	.001	.003
	123	14-1			.002	
	124	14-1			.000	
	127	13-2	.003	.000	.001	.007
	128	13-2	.002	.000	.003	.006
	129	13-2	.001	.002	.001	.006
	130	13-2	.000	.001	.001	.002
	131	13-2	.001	.001	.002	.001
	132	13-2	.000	.001	.001	.005
	510				.000	
Quaternary bench gravels	10	1-1	.003	.001	.003	
	11	1-1	.000	.002	.003	
	40	2-5	.001	.006	.001	
					.002	
	42	2-5	.000	.002		
	47	2-5	.005	.004	.003	.003
						.003
	51	1-5	.004	.001		
	52	1-5	.000	.000		
	53	1-5	.004	.000		
	54	1-5	.000	.002		
	56	1-5	.002	.001		
	59	1-5	.001	.001		
	63	1-6	.000	.000		
	65	1-6	.000	.002		
	66	1-6	.000	.000		
	67	1-6	.002	.002		
	68	1-6	.000	.001		
	69	1-6	.002	.001		

[redacted]

Table 3a - Continued [redacted]

Material tested	Sample No.	Traverse No.	Percent of equivalent uranium			
			Size fractions		Gravity concentrates	
			-4,+7 mesh	-7 mesh	25:1 200:1	500:1
	71	1-6	.000	.000		
	73	1-6	.000	.000		
	74	1-6	.001	.001		
	75	1-7	.000	.000	.001	.000
	76	1-7	.002	.001		
	81	1-7	.000	.000		
	83	1-7	.004	.002	.001	.004
					.001	.004
					.004	
	84	6-1	.001	.003	.001	.003
	85	6-2	.000	.000		
	86	6-2	.001	.003	.004	.000
	87	6-4	.000	.001		
	89	6-5	.000	.001	.000	.002
	91	1-6	.005	.001	.001	.004
	93	6-4	.006	.002	.002	.003
	94	6-5	.007	.003	.006	.003
	95	6-5	.003	.002	.004	.003
	96	6-7	.001	.003	.001	.004
	98	7-1	.003	.000	.000	.002
	101	8-1	.003	.002	.003	.005
	102	8-1	.003	.003	.004	.003
	106	8-2	.003	.002	.000	.002
	107	8-2	.000	.002	.003	.002
						.007
	108	8-2	.001	.000	.000	.002
	122	1-8	.000	.000	.003	.003
	506				.000	
	508				.001	
	511				.000	
	512				.001	
	513				.001	
Quaternary glacio-fluvial gravels	14	5-3	.000	.003		
	15	5-3	.002	.002		
	16	5-3	.003	.001		
	18	5-3	.000	.001		
	25	3-1	.001	.003	.000	
	29	3-1	.003	.001		
	30	3-1	.003	.001		
	34	4-1	.003	.004		
	36	5-1	.002	.002	.003	.004
	37	5-1	.005	.003		
	126	13-1	.001	.003	.000	.003
	501				.001	
	503				.000	

[redacted]

Table 3a - Continued [redacted]

Material tested	Sample No.	Traverse No.	Percent of equivalent uranium: Size fractions −4,+7 mesh	−7 mesh	Gravity concentrates 25:1 / 200:1	500:1
Late Tertiary gravels	17	5-3	.000	.001		
	19	3-1	.004	.002		
	20	3-1	.000	.003		
	21	3-1	.001	.001		
	22	3-1	.002	.001		
	23	3-1	.002	.002		
	24	3-1	.001	.002		
	26	3-1	.003	.002	.004	
	27	3-1	.002	.001	.000	
	28	3-1	.003	.001	.003	
					.001	
	31	2-3	.001	.001	.002	
					.004	
	32	4-1	.002	.001	.000	
					.000	
	33	4-1	.004	.002	.000	
	38	5-2	.004	.000		
	39	5-2	.003	.000		
	57	1-5	.002	.001	.001	
	60	1-6	.005	.002	.002	.003
					.002	
	97	7-1	.000	.000	.000	.001
	99	7-1	.003	.003	.005	.004
	100	7-3	.002	.000	.002	.001
	103	9-1	.004	.004	.002	.003
	104	9-1	.003	.001	.005	.004
	105	9-1	.002	.002	.001	.003
	110	10-1	.000	.001	.002	
	111	10-1	.000	.002	.001	
	120	13-2	.002	.000	.002	.002
	502				.000	
	509				.000	
Eocene gravels and sands	4	1-1	.004	.002	.003	
	5	1-1	.000	.001	.004	
	6	1-1	.001	.002	.002	
	7	1-1	.001	.001	.000	
	8	1-1	.001	.000	.001	
	9	1-1	.001	.002	.003	
	12	1-1	.001	.000	.002	
	13	1-1	.000	.001	.004	
	44	2-5	.002	.000	.000	
	58	1-5	—	.003		
	73	1-6	—	.003		
	77	1-7	—	.000		
	83	1-7	—	.001		
	504				.004	
	505				.000	
	507				.003	

[redacted]

Table 3A - Continued [redacted]

Material tested	Sample No.	Traverse No.	Percent of equivalent uranium — Size fractions: -4,+7 mesh	Size fractions: -7 mesh	Gravity concentrates: >25:1 <200:1	Gravity concentrates: >500:1
Eocene clays	41	2-6	—	.002		
	45	2-5	—	.000		
	46	2-5	—	.000		
	56	1-5	—	.001		
	64	1-6	—	.003		

Note: Samples 501-513 have been combined and concentrated by panning or rocking to 30 cubic inches as follows:

Sample	Combined samples
501	14-16, 18
502	19-24
503	25, 29, 30
504	4, 6, 7
505	8, 9
506	10, 11
507	12, 13
508	61-63, 65-71, 73, 74
509	38, 39
510	42, 43
511	51-55, 59
512	75, 76, 81
513	84-89

[redacted]

[redacted]

Table 3b

Summary of data in Table 3a

	Size fractions		Gravity concentrates	
	-4,+7 mesh	-7 mesh	>25:1 <200:1	>500:1
<u>Floodplain gravels and tailings</u>				
Number of determinations	18	19	17	14
Number of determinations .003 -.009% eq. U.	2	2	5	10
Percent of determinations .003-.009% eq. U.	11.1	10.5	29.4	71.4
<u>Quaternary bench gravels</u>				
Number of determinations	41	41	30	22
Number of determinations .003-.009% eq. U.	13	5	10	12
Percent of determinations .003-.009% eq. U.	31.7	12.2	33.3	54.5
<u>Quaternary glacio-fluvial gravels</u>				
Number of determinations	11	11	4	3
Number of determinations .003-.009% eq. U.	3	5	1	2
Percent of determinations .003-.009% eq. U.	27.3	45.5	25.0	66.7
<u>Late Tertiary gravels</u>				
Number of determinations	26	26	23	8
Number of determinations .003-.009% eq. U.	9	3	5	5
Percent of determinations .003-.009% eq. U.	34.6	11.5	21.7	62.5
<u>Eocene gravels and sands</u>				
Number of determinations	9	13	12	
Number of determinations .003-.009% eq. U.	1	2	6	
Percent of determinations .003-.009% eq. U.	11.1	15.4	50.0	
<u>Totals</u>				
Number of determinations	105	110	86	47
Number of determinations .003-.009% eq. U.	28	17	27	29
Percent of determinations .003-.009% eq. U.	26.7	15.5	31.4	61.7

[redacted]

[redacted]

Table 4

Weight of concentrate per cubic yard and percent of equivalent uranium in field-laboratory samples.

Material tested	Sample No.	Pounds of concentrate per cubic yard	Percent of equivalent uranium*
Floodplain gravels	109	5.8	.003
	112	5.8	.008
	113	7.3	.009
	114	6.0	.009
	115	6.9	.004
	117	5.4	.001
	118	6.4	.001
	119	5.3	.003
	128	5.8	.006
	129	6.0	.006
	130	5.6	.003
	131	5.6	.001
	133	5.8	.001
Tailings	127	6.2	.007
Quaternary bench gravels	10	22.0	.003
	11	20.3	.003
	40	7.5	.001
	47	6.3	.002
		2.0	.003
	75	7.5	.000
	83	5.1	.004
		2.1	.004
	84	6.6	.002
	86	6.9	.000
	89	5.6	.002
	91	7.1	.004
	93	6.4	.003
	94	6.0	.003
	95	6.2	.003
	96	6.3	.004
	98	6.6	.002
	101	5.8	.005
	103	5.6	.003
	106	5.8	.002
	107	5.6	.002
		2.0	.007
	108	5.8	.002
	132	7.1	.003
Quaternary glacio-fluvial gravels	29	20.3	.000
	35	6.0	.004
	123	5.8	.003

[redacted]

Table 4 - Continued [redacted]

Material tested	Sample No.	Pounds of concentrate per cubic yard	Percent of equivalent uranium*
Late Tertiary gravels	26	22.5	.004
	27	35.9	.000
	28	22.5	.001
	31	22.5	.004
	32	23.0	.000
	60	6.9	.003
	97	6.2	.001
	99	5.8	.004
	100	6.8	.001
	103	6.8	.003
	104	5.4	.004
	105	6.0	.002
	120	6.6	.002
Eocene gravels	4	23.0	.003
	5	18.0	.004
	6	22.5	.002
	7	20.3	.000
	8	23.0	.001
	9	23.0	.003
	12	21.4	.002
	13	19.1	.004

* Equivalent uranium value from gravity concentrate with greatest concentration ratio.

[redacted]

Table 5

(Data not readily comparable with other tables because of lack of information on concentration ratios.)

Sample No.	Cu. yds. of gravel worked	Age	Percent eq.U.	Mesh size	Nature of sample	Location
A	?	T	.000	—	Grab sample from concentrate pile	Morgan's upper-bench cut, Nugget Creek
Ba	?	T	.000	-7	"	"
c			.002	+7		
Ca	?	?	.000	-7		Mouth of Iron Creek
c			.002	+7		
Da	?	?	.000	-7		North bank of Cache Creek, 1000' upstream from Nugget
c			.000	+7		
E	-	M	.002	—	Crushed pyrite from bedrock	Morgan's upper-bench cut, Nugget Creek
Fa	20,000	Q	.023	-7	Hydraulic sluice-box concentrate, some blowings	Taraski's workings on Cache Creek, opposite Lucky Gulch
c			—	+7		
G	?	Q	.003	—	Hydraulic sluice-box concentrate	Weatherell's cut on Cache Cr opposite Rambler Creek
a			.034	fines	Blowings from concentrate	
H	2	Q	.005	—	Sluice-box concentrate	Weatherell's cut on Cache C [redacted] 1600' downstream from Taraski's workings
J1	30,000	T	.000	+4	Tailings from panning of hydraulic concentrate	
2			.000	-4		Haughen's upper-bench cut, Thunder Creek
3			.003	-4	Concentrate from panning of hydraulic concentrate	
Ka	1,000	T and Q	.006	-7	Hydraulic concentrate	Krumenacher's workings in Cheechako Gulch
c			.002	+7		
L	5	Q	.027	—	Sluice-box concentrate	Same as sample H
M	12,000	T	.03	-12	Mostly blowings from hydraulic concentrate	Haughen's workings on lower Thunder Creek
N	8,000	T	.023	-12	"	Same as sample J
O	?	Q	.011	—	Hydraulic sluice-box concentrate	Same as sample G
P	?	T?	.001	?	Hydraulic sluice-box concentrate	Upper-bench cut on south bank of Bird Creek

Table 5 - Continued

Sample No.	Cu. yds. of gravel worked	Age	Percent eq.U.	Mesh size	Nature of sample	Location
Q	?	T?	.002	?	Hydraulic sluice-box concentrate	Upper-bench cut on south bank of Bird Creek
Ra	?	T?	.001	-7	"	
S	?	T?	.000	?	"	"
T1	?	T?	.002	-7,+12	"	"
2			.003	-12		"
U1	?	T?	.001	+12		
2			.002	-12		"
V	?	T?	.000	—	Concentrate	
W						"

These samples are panned drill cuttings from holes put down by the Alaska Exploration and Mining Company; location given by hole number and line number; samples have been screened through 7-mesh.

Sample No.	Cu. yds. of gravel worked	Age	Percent eq.U.	Mesh size	Nature of sample	Location
W1			.002			H7, L15
2			.002			H8, L14
3			.001			H8, L15 38-49'
4			.000			H8, L15 65-108' (bedrock at 114')
5	—		.002			H15, L? (probably H7, L15)
6	—		.000			H5, L15 0-91'
7	—		.001			H9, L15
8	—		.000			H4, L15
9	—		.002		Amalgamation residue	H9, L15
10	—		.002			H6, L13
11			.000			H9, L13
12			.001			H5, L15 91-201' (bedrock)
13			.000			H10, L13
14			.001			H9, L14
15			.000			H6, L15
16			.001		Amalgamation residue	H6, L15
17			.003		"	H5, L15; H8, L15; H6, L13; H8, L14 samples combined to fill container
18			.001		"	H7, L14; H8, L14; H9, L14 samples combined to fill container

Table 5 - Continued

Sample No.	Cu. yds. of gravel worked	Age	Percent eq.U.	Mesh size	Nature of sample	Location
X	4,000	R	.064	—	$\frac{1}{2}$ dragline and $\frac{1}{2}$ hydraulic sluice-box concentrate	Peters Creek at Petersville; $\frac{1}{2}$ from Patricia Bowl and $\frac{1}{2}$ from Little Bowl
Y	4,000	RSQ	.032	—	Hydraulic sluice-box concentrate	Peters Creek at Petersville; 3/4 from low-bench cut west of canyon mouth and $\frac{1}{4}$ from Little Bowl
Z	10	Q?	.000	—	•	Peters Creek at Petersville; Little Bowl

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