UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical results and sample locality map for stream-sediment, panned-concentrate, and rock samples collected in 1988 in and near the Ragged Top Wilderness Study Area (AZ-020-197), Pima County, Arizona

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents additional results of a geochemical survey of the Ragged Top Wilderness Study Area (AZ-020-197), Pima County, Arizona.

INTRODUCTION

In March 1987, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the Ragged Top Wilderness Study Area, Pima County, Arizona. Highly anomalous concentrations of gold, silver, lead, vanadium, and other elements in one of the samples prompted additional sampling in December 1987. Analytical results and sample localities for the samples collected in 1987 were presented by McHugh and others (1988). The significance of the geochemical anomaly was discussed by Sawyer and Nowlan (1988) and by Spencer and Sawyer (1988). Kreidler (1987) noted anomalous concentrations of gold in mineralized samples from adits adjoining the wilderness study area. In order to further delineate the geochemical anomaly and to investigate its source, additional samples were collected in April and October, 1988. This present report presents analytical results and sampling localities for the samples collected in 1988.

The Ragged Top Wilderness Study Area comprises 4,460 acres (about 7 mi^2) in the north central part of Pima County, Arizona, and lies about 35 mi northwest of Tucson, Arizona (fig. 1). Access to the study area is provided by the Silver Bell, Avra Valley, and Red Rock roads.

Topography of the study area is dominated by the rugged mass of Ragged Top Peak, elevation 3,907 ft, and a shorter subsidiary peak called Wolcott Peak which rise abruptly to a maximum of 1,700 ft above the surrounding bajada. The two peaks, which are collectively known as Ragged Top, are the northeastern peaks of the Silver Bell Mountains. Ragged Top is separated from the main mass of the Silver Bell Mountains by a mile-wide valley.

Vegetation is characteristic of the Sonoran Desert. Common species include saguaro and other cacti, paloverde, acacia, ironwood, mesquite, and creosote bush.

Kreidler (1987) conducted an investigation of mineral occurrences in the study area. Nowlan and others (1989) assessed the mineral resources and mineral-resource potential of the Ragged Top Wilderness Study Area. The southwest part of the study area lies within the Silver Bell mining district (Richard and Courtright, 1966; Graybeal, 1982). The first recorded mining activity in the district was in 1865 about 2 miles south-southwest of the wilderness study area; silver and copper were recovered from skarn ore. Exploitation of porphyry copper deposits at the El Tiro and Oxide pits began in 1954 and continued until 1985. The El Tiro pit is about 2 miles southwest of the wilderness study area and the Oxide pit is about 3 miles south. A third, presently unexploited, porphyry copper deposit, lies about 1 mile west of the southwest corner of the wilderness study area; this third deposit is the North Silver Bell deposit. Production from the El Tiro and Oxide deposits from 1954 to 1977 totaled 75,655,000 tons averaging 0.80 percent copper, 0.07 oz/ton silver, and 0.022 percent molybdenum sulfide (Graybeal, 1982). Copper

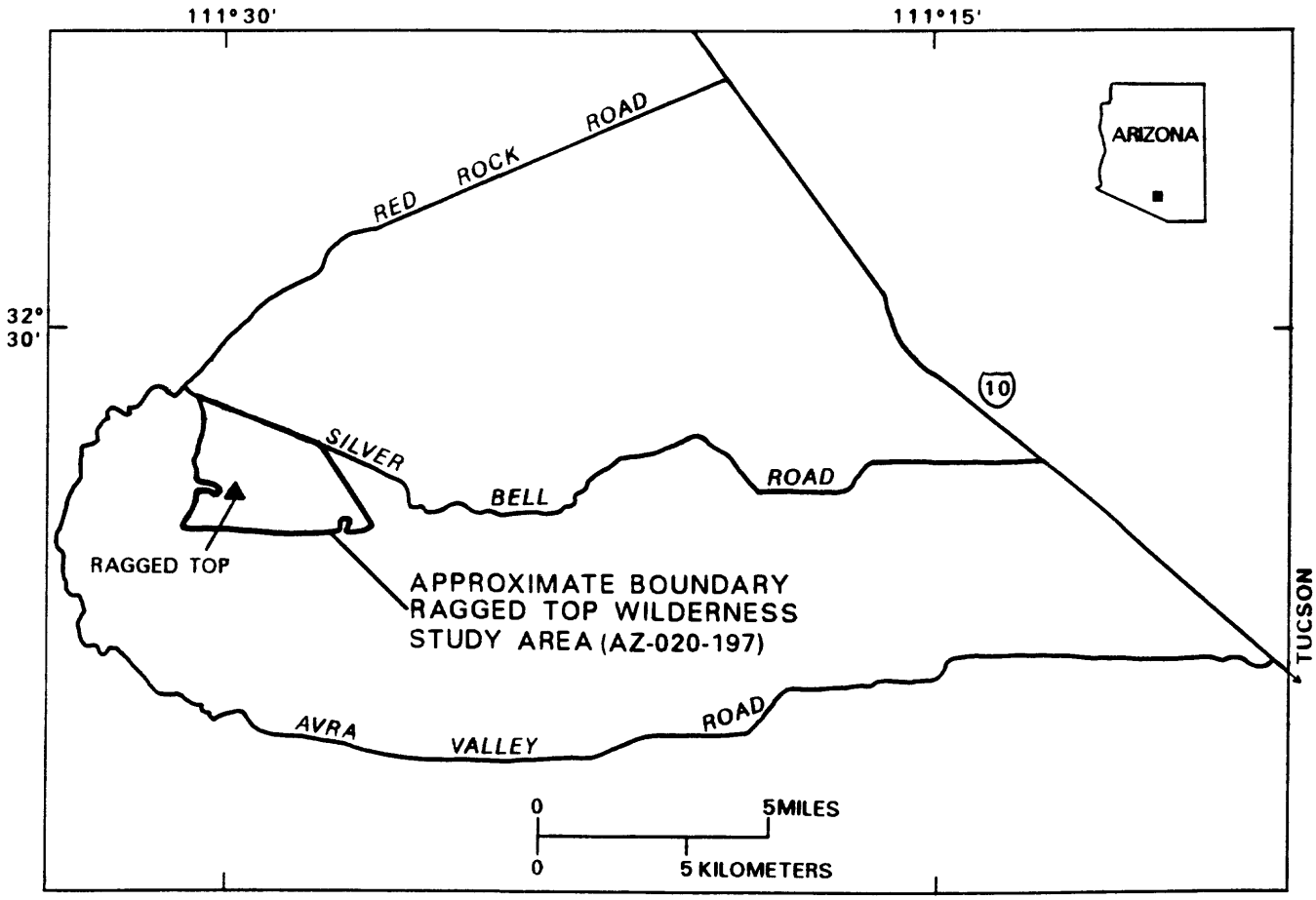

Figure 1. Index map of the location of the Ragged Top Wilderness Study Area, Pima County, Arizona.

has been the predominant commodity produced in the Silver Bell district but a mine about 2 miles southwest of the wilderness study area produced about 150,000 tons of ore averaging 16 percent zinc, 1.3 percent copper, 0.6 oz/ton silver, and minor amounts of lead and gold (Keith, 1974). Total production of base and precious metals in the Silver Bell district from 1885 to 1981 amounted to 90,351,000 tons of ore (Keith and others, 1983).

Geology of the study area is described in reports by Sawyer (1986, 1987) and Spencer and Sawyer (1988). A major structural feature in the study area is the Ragged Top fault, a probable strike-slip fault that runs from near the southeast tip of the wilderness study area west-northwest across the wilderness study area. Proterozoic Oracle-type granite predominates on the north side of the fault and Proterozoic Apache Group sedimentary rocks overlie the granite east of Ragged Top. Upper Cretaceous volcanic rocks predominate south of the Ragged Top fault. The volcanic rocks consist of andesite-to-dacite extrusive rocks and rhyolite tuffs. Upper Cretaceous sedimentary rocks southwest of Ragged Top contain clasts that include Precambrian schist, Paleozoic sedimentary rocks, probable Lower Cretaceous sandstone, Cretaceous algal limestone, and volcanic rocks. An Upper Cretaceous granodiorite porphyry laccolith underlies part of the southwestern section of the wilderness study area. Ragged Top is an Oligocene rhyolite dome that was extruded along the trace of the Ragged Top fault. Quaternary sediments that are mostly unconsolidated cover much of the low-relief sections of the study area.

Sawyer (1986, 1987) and Lipman and Sawyer (1985) present evidence to support the concept that the Upper Cretaceous sedimentary rocks, the Upper Cretaceous andesite-to-dacite extrusive rocks, and certain of the Upper Cretaceous rhyolite tuffs formed during Late Cretaceous caldera collapse. Mineralized quartz monzodiorite porphyry intrusions were emplaced along the ring-fracture zone of the caldera.

METHODS OF STUDY

Sample Media

Analyses of stream-sediment samples represent the chemistry of the rock material eroded from the drainage basin upstream from each sample site. Such information is useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits. Panned-concentrate samples derived from stream sediment provide information about the chemistry of certain minerals in rock material eroded from the drainage basin upstream from each sample site. The selective concentration of minerals in panned-concentrate samples, many of which may be ore related, permits determination of some elements that are not easily detected in stream-sediment samples. Analyses of unmineralized or unaltered rock samples provide background geochemical data for individual rock units. Analyses of mineralized or altered rocks may provide useful geochemical information about the major- and trace-element assemblages associated with a mineralizing system.

Sample Collection and Preparation

Sampling sites are represented on plate 1. During the sampling in April, 1988, a stream-sediment sample and two panned-concentrate samples derived from stream sediment were collected at each of the 16 sites (numbers 164-166, 172-176, 178-185). The two panned-concentrate samples from each site were

treated differently, as described below, and after preparation were respectively termed a "nonmagnetic heavy-mineral-concentrate sample" and a "raw panned-concentrate sample." During the sampling in October, 1988, nonmagnetic heavy-mineral-concentrate and raw panned-concentrate samples were collected at 15 sites (numbers 8200-8209, 8211-8215). Rock samples were collected at 12 sites (plate 1). Samples were collected by Gary A. Nowlan and David A. Sawyer.

Stream-sediment samples

The stream-sediment samples consisted of active alluvium collected primarily from first-order (unbranched) and second-order (below the junction of two first-order) stream as shown on U.S. Geological Survey topographic maps (scale = 1:24,000). The stream-sediment samples were dried, then sieved using 30-mesh (0.595-mm) stainless-steel sieves. The portion of the sediment passing through the sieve was pulverized to approximately minus-100 mesh (minus-0.15 mm) for analysis.

Nonmagnetic heavy-mineral-concentrate samples

At stream sites 164-185, stream sediment was screened with a 10-mesh (2.0-mm) stainless-steel screen to remove the coarse material until a heaping 16-inch pan (approximately 20 lb) of less than 10-mesh material was obtained. At stream sites 8200-8215, 10-20 lbs of unscreened stream sediment were collected at each site. The samples were panned to remove most of the quartz, feldspar, organic matter, and clay-sized material. The resulting concentrates were estimated to weigh between 1/2 and 2 oz (approximately 15-60 g).

After air drying and sieving to -35 mesh, bromoform (specific gravity 2.85) was used to remove the remaining quartz and feldspar from the heavy-mineral-concentrate samples. The resultant heavy-mineral sample was separated into three fractions using a large electromagnet (in this case a modified Frantz Isodynamic Separator) by placing the sample in contact with the face of the magnet. The most magnetic material (removed at a setting of 0.25 ampere), primarily magnetite, was not analyzed. The second fraction (removed at a setting of 1.75 ampere), largely ferromagnesian silicates and iron oxides, was saved for archival storage. The third fraction (the nonmagnetic material which may include the nonmagnetic ore minerals, zircon, sphene, etc.) was split using a Jones splitter. One split was hand ground for spectrographic analysis; the other split was saved for mineralogical analysis.

Raw panned-concentrate samples

Raw panned-concentrate samples were collected and panned in the same manner as the heavy-mineral-concentrate samples except that the samples were panned to a smaller amount, 0.03-1.oz (approximately 1-28 g). The raw panned-concentrate samples were dried and the entire amount of each sample was analyzed for gold without further preparation.

Rock samples

Nineteen rock samples were collected from outcrops, mine dumps, prospects, and as float. Descriptions of the rock samples are in table 1. Rock samples were crushed and then pulverized to approximately minus-100 mesh (minus-0.15 mm) with ceramic plates.

Sample Analysis

Spectrographic Method

The stream-sediment and rock samples were analyzed for 35 elements and the nonmagnetic heavy-mineral-concentrate samples for 37 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The elements analyzed and their lower limits of determination are listed in table 2. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (calcium, iron magnesium, sodium, phosphorus, and titanium) are given in weight percent; all others are given in parts per million (ppm). Emission spectrographic analyses were performed by John H. Bullock, Jr., Olga Ehrlich, and Peter M. Theodorakos.

Other methods

Table 3 lists other methods of analysis used on samples from the study area and lists limits of determination, precision, and references for the methods. Rock and stream-sediment samples were analyzed for gold by graphite furnace atomic absorption spectroscopy and for antimony, arsenic, bismuth, cadmium, and zinc by inductively coupled plasma emission spectrometry. Rock samples were analyzed for mercury by cold vapor atomic absorption spectroscopy, for tellurium and thallium by flame atomic absorption spectroscopy, for fluorine by ion selective electrode, and for tungsten by visible spectrophotometry. Stream-sediment samples were analyzed for thorium and uranium by delayed neutron activation analysis. Raw panned-concentrate samples were analyzed for gold by flame atomic absorption spectroscopy. Analysts were David L. Fey, Philip L. Hageman, Randall H. Hill, Mollie J. Malcolm, John B. McHugh, Theodore A. Roemer, John D. Sharkey, and Robert B. Vaughn.

DATA STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into a computer-based file called Pluto. This data base contains both descriptive geological information and analytical data. Any or all of this information may be retrieved and converted to a binary form (STATPAC) for computerized statistical analysis or publication (VanTrump and Miesch, 1977).

Analytical results for stream-sediment, nonmagnetic heavy-mineral-concentrate, raw panned-concentrate, and rock samples are listed in tables 4, 5, 6, and 7, respectively. The numeric portions of the sample identifications correspond to the numbers shown on the sample locality map (plate 1).

DESCRIPTION OF DATA TABLES

A letter "N" in the tables indicates that a given element was looked for but not detected at the lower limit of determination. If an element determined by emission spectrographic was observed but was below the lowest reporting value, a "less than" symbol (<) was entered in the tables in front of the lower limit of determination. No distinction was made between "not detected" and "less than" for samples analyzed by methods other than emission spectrography. If an element was above the highest reporting value, a "greater than" symbol (>) was entered in the table in front of the upper limit of determination. A letter "H" in the tables indicates that an element was looked for but due to elemental interferences, a value was not determined. The lower limit of determination for gold in raw panned-concentrate samples by atomic absorption spectroscopy is 0.05 ppm, based on a 10-g sample. Because the sample weight for raw panned-concentrate samples was variable, the lower limits of determination varied from 0.02 to 0.44 ppm. The weights of the raw panned-concentrate samples (table 6) are given in grams and are in the column headed by "weight."

Because of the formatting used in the computer program that produced tables 4-7, some of the elements listed in these tables (Ca, Fe, Mg, Na, P, Ti, Ag, Cd-icp, Au-aa, and Tl-aa) carry one or more nonsignificant digits to the right of the significant digits. The spectrographic determinations for P, As, Au, Bi, Cd, Ge, Nb, Sb, Sn, and Th in stream-sediment samples; for As, Ge, Sb, Sn, Pd, and Pt in nonmagnetic heavy-mineral-concentrate samples; and for P, As, Au, Nb, Sn, Th, and W in rock samples were all below the lower limits of determination shown in table 2; consequently, the columns for these elements were omitted from tables 4, 5, and 7, respectively. Results for Bi in stream-sediment samples by inductively coupled plasma spectrometry were all less than the lower limit of determination and were omitted from table 4.

Four particles of gold were removed from sample RTH181 (table 5) before analysis. Based on a concentrate sample weight of 0.634g and an estimated weight of 20 μg for each particle of gold, the recalculated concentration of gold (Au) in the sample is 130 ppm.

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TABLE 1.--Descriptions of analyzed rock samples from within and near the Ragged Top Wilderness Study Area, Pima County, Arizona

[Source codes: F, float; M, mine dump or prospect; O, outcrop]

Sample	Source	Description
RTR118AA	F	Composite of altered pebbles from stream channel.
RTR165AA	O	Diabase with calcite vein.
RTR166AA	O	Material from fault in granite; calcite (?) veins and iron oxides.
RTR166BA	O	Material from fault in granite; calcite (?) iron oxides, slickensides, brecciated.
RTR167AA	O	Volcanic conglomerate.
RTR168AA	O	Granodiorite (?) porphyry; propylitized.
RTR169AA	O	Andesite from dike (?); propylitized.
RTR170AA	O	Granodiorite porphyry; propylitized.
RTR170BA	O	Granodiorite porphyry; propylitized, iron oxides, possible slickensides.
RTR171AA	O	Andesite; propylitized.
RTR171BA	O	Granodiorite porphyry; argillically altered.
RTR172AA	O	Welded lithic tuff.
RTR177AA	M	Brecciated volcanic rocks with oxidized copper, calcite, limonite.
RTR185AA	O	Andesite (?).
RTR186AA	M	Silica-rich material.
RTR186BA	M	Barite and calcite.
RTR186CA	M	Barite and rock material.
RTR186DA	M	Barite, calcite, silica; limonitic and brecciated.
RTR186EA	M	Barite.

TABLE 2.--Limits of determination for the spectrographic analysis of rocks and stream sediments, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits listed, except as noted]

Elements	Lower determination limit	Upper determination limit
	Percent	
Calcium (Ca)	0.05	20
Iron (Fe)	.05	20
Magnesium (Mg)	.02	10
Sodium (Na)	.2	5
Phosphorus (P)	.2	10
Titanium (Ti)	.002	1
	Parts per million	
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	10	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Gallium (Ga)	5	500
Germanium (Ge)	10	100
Lanthanum (La)	50	1,000
Manganese (Mn)	10	5,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Thorium (Th)	100	2,000
Vanadium (V)	10	10,000
Tungsten (W)	20	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Palladium (Pd)*	5	1,000
Platinum (Pt)*	20	1,000

*Determined in heavy-mineral-concentrate samples only. Limits are for heavy-mineral-concentrate samples.

TABLE 3.--Analytical methods used other than emission spectrography

[AAC, cold vapor atomic absorption spectroscopy, AAF, flame atomic absorption spectroscopy; AAG, graphite furnace atomic absorption spectroscopy; ICP, inductively coupled plasma spectrometry; ISE, ion selective electrode; DNA, delayed neutron activation analysis; VIS, visible spectrophotometry; <, less than value shown]

Element determined	Sample type	Method	Lower limit of determination, ppm	Precision, percent relative standard deviation	References
Mercury (Hg)	rocks	AAC	0.02	<5	Crock and others, 1987.
Tellurium (Te)	rocks	AAF	0.1	4.5-7.3	Hubert and Chao, 1985.
Thallium (Tl)	rocks	AAF	0.05	1.6-12.5	Hubert and Chao, 1985.
Gold (Au)	raw panned concentrates	AAF	0.05[a]	9.3-42.5	Thompson and others, 1968; O'Leary and Meier, 1986.
Gold (Au)	rocks, stream sediments	AAG	0.001	3.7-21.1	Meier, 1980; O'Leary, and Meier, 1986.
Thorium (Th)	stream sediments	DNA	1[a]	1.2-74.8	Millard, 1976.
Uranium (U)	stream sediments	DNA	0.1[a]	1.0-17.7	Millard, 1976.
Antimony (Sb)	rocks, stream sediments	ICP	2	6.4-11	Crock and others, 1987.
Arsenic (As)	rocks, stream sediments	ICP	5	3.5-20	Crock and others, 1987.
Bismuth (Bi)	rocks, stream sediments	ICP	2	2.2-11.9	Crock and others, 1987.
Cadmium (Cd)	rocks, stream sediments	ICP	0.1	2.8-8.8	Crock and others, 1987.
Zinc (Zn)	rocks, stream sediments	ICP	2	1.4-11.9	Crock and others, 1987.
Fluorine (F)	rocks	ISE[b]	100 (0.01%)	0.98-5.51	Hopkins, 1977; O'Leary and Meier, 1986.
Tungsten (W)	rocks	VIS	1	2.9-6.9	Welsch, 1983; O'Leary and Meier, 1986.

[a] Based on 10-g sample
[b] Hot nitric acid digestion

TABLE 4--RESULTS OF ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.

Sample	Latitude	Longitude	Ca-pct. s	Fe-pct. s	Mg-pct. s	Na-pct. s	Ti-pct. s	Ag-ppm s	B-ppm s	Ba-ppm s
RTA164	32 27 54	111 29 42	.2	20	1.0	2.0	.50	N	<10	700
RTA165	32 27 4	111 28 44	.5	5	1.5	1.5	.50	N	15	500
RTA166	32 27 3	111 28 41	.7	10	1.5	2.0	.70	N	10	700
RTA172	32 26 0	111 30 17	.5	3	1.0	3.0	.20	N	10	1,500
RTA173	32 26 1	111 30 19	.3	3	.7	3.0	.15	N	15	1,000
RTA174	32 26 30	111 30 15	.5	3	1.0	3.0	.20	N	10	1,000
RTA175	32 26 17	111 29 50	.5	5	2.0	3.0	.30	N	N	500
RTA176	32 26 17	111 29 53	1.0	10	3.0	3.0	.50	N	<10	700
RTA178	32 26 25	111 30 48	.3	2	.7	2.0	.20	N	N	1,000
RTA179	32 26 24	111 30 55	.5	5	.5	2.0	.20	<.5	<10	>5,000
RTA180	32 26 35	111 31 23	.3	5	1.5	3.0	.30	N	10	700
RTA181	32 26 36	111 31 41	.3	3	.7	2.0	.20	N	10	1,500
RTA182	32 25 45	111 30 57	.3	2	.7	2.0	.20	N	<10	1,000
RTA183	32 25 55	111 31 10	1.0	2	.5	2.0	.15	5.0	20	5,000
RTA184	32 25 51	111 31 23	.2	3	1.0	2.0	.20	.5	N	1,000
RTA185	32 27 43	111 31 31	1.0	5	1.5	2.0	.20	N	N	700

TABLE 4--RESULTS OF ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.

Sample	Latitude	Longitude	Ca-pct.	Fe-pct.	Mg-pct.	Na-pct.	Ti-pct.	Ag-ppm	B-ppm	Ba-ppm
			s	s	s	s	s	s	s	s
RTA164	32 27 54	111 29 42	.2	20	1.0	2.0	.50	N	<10	700
RTA165	32 27 4	111 28 44	.5	5	1.5	1.5	.50	N	15	500
RTA166	32 27 3	111 28 41	.7	10	1.5	2.0	.70	N	10	700
RTA172	32 26 0	111 30 17	.5	3	1.0	3.0	.20	N	10	1,500
RTA173	32 26 1	111 30 19	.3	3	.7	3.0	.15	N	15	1,000
RTA174	32 26 30	111 30 15	.5	3	1.0	3.0	.20	N	10	1,000
RTA175	32 26 17	111 29 50	.5	5	2.0	3.0	.30	N	N	500
RTA176	32 26 17	111 29 53	1.0	10	3.0	3.0	.50	N	<10	700
RTA178	32 26 25	111 30 48	.3	2	.7	2.0	.20	N	N	1,000
RTA179	32 26 24	111 30 55	.5	5	.5	2.0	.20	<.5	<10	>5,000
RTA180	32 26 35	111 31 23	.3	5	1.5	3.0	.30	N	10	700
RTA181	32 26 36	111 31 41	.3	3	.7	2.0	.20	N	10	1,500
RTA182	32 25 45	111 30 57	.3	2	.7	2.0	.20	N	<10	1,000
RTA183	32 25 55	111 31 10	1.0	2	.5	2.0	.15	5.0	20	5,000
RTA184	32 25 51	111 31 23	.2	3	1.0	2.0	.20	.5	N	1,000
RTA185	32 27 43	111 31 31	1.0	5	1.5	2.0	.20	N	N	700

TABLE 4--RESULTS OF ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	Be-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	La-ppm s	Mn-ppm s	Mo-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s
RTA164	<1	30	200	30	100	N	500	N	30	50	15
RTA165	<1	20	70	30	70	N	700	<5	15	50	10
RTA166	1	50	70	30	150	<50	700	<5	15	50	15
RTA172	N	10	20	15	100	N	500	N	10	70	<5
RTA173	N	<10	<10	10	70	N	300	N	<5	30	N
RTA174	N	15	20	20	100	N	500	N	10	150	5
RTA175	N	20	70	30	70	N	300	N	15	30	7
RTA176	N	30	150	50	100	N	500	N	30	20	15
RTA178	N	<10	<10	20	50	N	500	N	<5	150	<5
RTA179	N	10	15	20	70	N	300	5	5	1,000	<5
RTA180	N	20	50	30	100	N	500	N	15	50	5
RTA181	N	<10	10	20	50	N	500	N	<5	70	<5
RTA182	N	<10	20	15	70	N	500	N	5	100	<5
RTA183	5	<10	<10	20	50	N	700	N	<5	2,000	<5
RTA184	N	10	<10	100	70	N	500	<5	5	200	<5
RTA185	N	15	50	30	70	N	300	N	15	70	5

TABLE 4--RESULTS OF ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	Sr-ppm S	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	As-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Au-ppm aa	Th-ppm dna	U-ppm dna
RTA164	N	200	20	<200	100	<5	2.0	<2	100	<.001	23.00	6.85
RTA165	N	150	15	<200	100	<5	1.1	8	110	<.001	16.00	4.19
RTA166	N	150	50	N	150	<5	1.3	3	110	<.001	18.00	4.69
RTA172	N	100	10	N	150	<5	.4	<2	56	.003	13.00	2.99
RTA173	N	100	<10	N	50	<5	.3	<2	40	.001	12.00	3.57
RTA174	N	100	<10	N	70	<5	.7	<2	97	<.001	9.78	2.88
RTA175	N	200	10	N	70	<5	.7	<2	63	.004	11.20	2.87
RTA176	<100	200	10	N	100	<5	.7	<2	66	<.001	9.86	2.36
RTA178	N	100	<10	N	70	<5	.8	<2	110	<.001	10.30	3.07
RTA179	N	200	<10	N	100	6	1.7	<2	210	.036	11.60	3.34
RTA180	N	200	10	N	100	7	.5	<2	70	.010	10.20	2.95
RTA181	N	150	<10	N	70	<5	.7	<2	100	.003	11.40	2.99
RTA182	N	150	10	N	100	6	.6	<2	73	.005	14.70	3.69
RTA183	N	100	<10	1,000	100	7	12.0	<2	2,000	.007	13.00	2.69
RTA184	N	100	10	<200	50	<5	2.3	<2	340	<.001	11.40	3.56
RTA185	N	200	<10	N	70	<5	.9	<2	76	.001	9.57	2.52

TABLE 5--RESULTS OF ANALYSES OF NONMAGNETIC HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.

Sample	Latitude	Longitude	Ca-pct.	Fe-pct.	Mg-pct.	Na-pct.	P-pct.	Ti-pct.	Ag-ppm	Au-ppm
			s	s	s	s	s	s	s	s
RTH164	32 27 54	111 29 42	1.50	1.5	.10	<.5	.5	2.0	N	N
RTH165	32 27 4	111 28 44	3.00	2.0	.15	N	1.0	>2.0	N	N
RTH166	32 27 3	111 28 41	5.00	2.0	.10	N	2.0	2.0	<1.0	N
RTH172	32 26 0	111 30 17	2.00	1.0	.07	N	<.5	1.0	<1.0	N
RTH173	32 26 1	111 30 19	2.00	2.0	.20	.5	1.0	1.5	N	N
RTH174	32 26 30	111 30 15	1.50	1.5	.15	<.5	.5	2.0	1.5	N
RTH175	32 26 17	111 29 50	2.00	2.0	.20	<.5	.7	>2.0	1.0	N
RTH176	32 26 17	111 29 53	3.00	2.0	.15	<.5	1.5	2.0	N	N
RTH178	32 26 25	111 30 48	1.50	1.0	.15	.5	.5	1.0	<1.0	N
RTH179	32 26 24	111 30 55	.30	.5	<.05	N	N	.2	15.0	N
RTH180	32 26 35	111 31 23	1.50	2.0	.30	.5	.5	2.0	N	N
RTH181	32 26 36	111 31 41	.50	.7	.05	N	<.5	.3	<1.0	N
RTH182	32 25 45	111 30 57	3.00	1.0	.10	N	.7	2.0	N	N
RTH183	32 25 55	111 31 10	5.00	2.0	.10	N	N	.3	20.0	N
RTH184	32 25 51	111 31 23	1.00	3.0	.15	.5	.7	2.0	<1.0	N
RTH185	32 27 43	111 31 31	2.00	1.5	.15	<.5	1.0	1.5	N	N
RTH8200A	32 25 53	111 31 54	.15	3.0	.20	.5	N	>2.0	15.0	<20
RTH8201A	32 25 56	111 32 12	.15	3.0	.10	.5	N	>2.0	N	N
RTH8202A	32 26 14	111 32 4	.10	20.0	.15	.5	N	.7	1.5	N
RTH8203A	32 26 17	111 32 3	.20	2.0	.20	.5	N	2.0	N	N
RTH8204A	32 25 39	111 31 2	.20	.5	.05	N	N	.2	20.0	N
RTH8205A	32 26 33	111 31 58	.30	2.0	.20	2.0	<.5	1.0	<1.0	N
RTH8206A	32 26 43	111 31 55	.30	1.5	.30	1.0	.7	2.0	N	N
RTH8207A	32 26 17	111 29 58	2.00	1.5	.20	<.5	.7	>2.0	N	N
RTH8208B	32 26 43	111 31 28	5.00	1.0	.15	N	2.0	2.0	300.0	>1,000
RTH8209A	32 26 46	111 31 10	.70	1.0	.05	N	<.5	.7	N	N
RTH8211A	32 26 14	111 29 35	3.00	1.0	.15	<.5	1.0	>2.0	N	N
RTH8212A	32 26 14	111 29 38	3.00	1.0	.10	N	1.5	>2.0	N	N
RTH8213A	32 27 16	111 30 48	5.00	2.0	.15	N	2.0	2.0	N	N
RTH8214A	32 27 53	111 30 13	1.00	.7	.07	N	.7	1.5	N	N
RTH8215A	32 27 37	111 30 24	5.00	1.5	.15	N	2.0	2.0	N	N

TABLE 5--RESULTS OF ANALYSES OF NONMAGNETIC HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	La-ppm s	Mn-ppm s
RTH164	20	10,000	15	100	N	N	N	N	<10	N	500
RTH165	30	10,000	7	N	N	N	N	50	<10	<100	700
RTH166	20	7,000	20	N	N	N	N	N	N	150	2,000
RTH172	N	>10,000	N	N	N	N	N	30	N	<100	100
RTH173	<20	>10,000	N	N	N	N	N	30	<10	150	500
RTH174	N	>10,000	N	N	N	N	N	50	N	<100	200
RTH175	N	10,000	3	N	N	N	N	10	<10	100	300
RTH176	N	10,000	N	N	N	N	N	50	<10	100	200
RTH178	<20	>10,000	N	N	N	N	N	10	N	<100	150
RTH179	N	>10,000	N	N	N	N	N	20	N	N	20
RTH180	<20	10,000	2	N	N	N	<20	50	<10	200	300
RTH181	N	>10,000	N	N	N	N	N	<10	N	<100	50
RTH182	20	>10,000	N	N	N	N	N	70	N	200	200
RTH183	50	>10,000	10	N	<50	N	N	20	N	100	700
RTH184	<20	10,000	N	500	N	N	N	100	<10	150	300
RTH185	<20	10,000	N	N	N	N	N	15	<10	100	200
RTH8200A	<20	1,000	N	N	N	N	N	100	<10	<100	30
RTH8201A	N	1,000	N	N	N	20	30	200	<10	<100	20
RTH8202A	<20	2,000	N	N	N	30	N	150	15	N	30
RTH8203A	<20	1,000	N	N	N	N	N	70	<10	150	30
RTH8204A	N	>10,000	N	70	N	N	N	50	N	N	50
RTH8205A	N	10,000	N	N	N	N	N	70	10	N	100
RTH8206A	N	>10,000	N	N	N	N	N	10	N	100	300
RTH8207A	N	>10,000	<2	N	N	N	N	15	N	200	500
RTH8208B	N	>10,000	N	N	N	N	N	30	N	200	300
RTH8209A	N	>10,000	N	N	N	N	N	70	N	<100	70
RTH8211A	N	7,000	<2	N	N	N	N	150	N	150	150
RTH8212A	N	10,000	2	N	N	N	N	N	N	150	200
RTH8213A	N	>10,000	N	N	N	N	N	50	N	200	300
RTH8214A	N	>10,000	10	30	N	N	N	20	N	N	300
RTH8215A	<20	>10,000	5	>2,000	N	N	N	<10	N	150	700

TABLE 5--RESULTS OF ANALYSES OF NONMAGNETIC HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s	Sr-ppm s	Th-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s
RTH164	N	N	N	30	70	N	N	50	N	1,000	N	>2,000
RTH165	N	<50	N	1,500	30	N	N	200	N	700	N	>2,000
RTH166	N	N	N	50	70	N	N	200	N	1,500	N	>2,000
RTH172	10	<50	N	1,000	N	1,500	N	30	N	50	N	2,000
RTH173	15	50	N	50	<10	300	N	50	N	200	N	>2,000
RTH174	50	<50	N	20,000	N	500	N	100	N	70	N	>2,000
RTH175	N	<50	N	2,000	30	N	<200	100	N	300	N	>2,000
RTH176	30	<50	N	200	15	N	<200	100	N	200	N	>2,000
RTH178	20	<50	N	1,000	N	700	N	50	N	50	N	>2,000
RTH179	100	N	N	50,000	N	3,000	N	20	N	<20	N	2,000
RTH180	100	<50	N	2,000	15	<200	<200	70	N	300	N	>2,000
RTH181	N	<50	N	3,000	N	3,000	N	30	N	30	N	2,000
RTH182	20	50	N	7,000	10	1,500	200	100	N	200	N	>2,000
RTH183	20	N	N	50,000	N	2,000	N	30	N	2,000	10,000	2,000
RTH184	100	50	N	3,000	<10	<200	<200	50	<50	200	N	>2,000
RTH185	N	N	N	500	<10	200	<200	70	N	150	N	>2,000
RTH8200A	50	100	N	5,000	N	N	N	100	<50	70	N	>2,000
RTH8201A	100	70	<10	300	N	N	N	150	50	100	N	>2,000
RTH8202A	N	<50	<10	30	N	N	N	50	N	30	N	>2,000
RTH8203A	N	100	N	300	N	N	N	100	N	100	N	>2,000
RTH8204A	200	N	N	>50,000	N	1,500	N	20	70	20	N	>2,000
RTH8205A	N	<50	N	1,000	N	N	N	30	N	20	N	>2,000
RTH8206A	N	70	N	70	N	200	N	70	N	150	N	>2,000
RTH8207A	N	100	N	10,000	10	300	200	150	N	200	N	>2,000
RTH8208B	N	<50	N	7,000	<10	500	N	150	N	200	N	>2,000
RTH8209A	N	N	N	200	N	1,500	<200	100	N	150	N	>2,000
RTH8211A	15	N	N	300	10	N	200	100	50	200	N	>2,000
RTH8212A	N	<50	N	200	15	N	200	100	N	300	N	>2,000
RTH8213A	70	N	N	1,500	<10	200	N	200	N	200	N	>2,000
RTH8214A	N	N	N	100	20	N	N	70	<50	1,000	N	>2,000
RTH8215A	10	N	N	500	30	N	<200	150	N	1,000	N	>2,000

TABLE 6--RESULTS OF ANALYSES OF RAW PANNED-CONCENTRATE SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.

Sample	Latitude	Longitude	Au-ppm aa	Weight gms
RTG164	32 27 54	111 29 42	1.00	10.25
RTG165	32 27 4	111 28 44	<.04	12.61
RTG166	32 27 3	111 28 41	<.05	11.99
RTG172	32 26 0	111 30 17	2.53	1.98
RTG173	32 26 1	111 30 19	<.05	11.29
RTG174	32 26 30	111 30 15	<.07	8.12
RTG175	32 26 17	111 29 50	3.22	9.31
RTG176	32 26 17	111 29 53	.93	5.71
RTG178	32 26 25	111 30 48	<.44	1.16
RTG179	32 26 24	111 30 55	5.82	3.78
RTG180	32 26 35	111 31 23	1.42	9.15
RTG181	32 26 36	111 31 41	29.00	6.61
RTG182	32 25 45	111 30 57	<.06	8.68
RTG183	32 25 55	111 31 10	<.10	5.40
RTG184	32 25 51	111 31 23	<.22	2.34
RTG185	32 27 43	111 31 31	.21	12.31
RTG8200B	32 25 53	111 31 54	<.04	12.99
RTG8201B	32 25 56	111 32 12	<.05	11.51
RTG8202B	32 26 14	111 32 4	<.05	11.22
RTG8203B	32 26 17	111 32 3	<.06	9.83
RTG8204B	32 25 39	111 31 2	1.70	20.22
RTG8205B	32 26 33	111 31 58	<.05	11.04
RTG8206B	32 26 43	111 31 55	.14	12.60
RTG8207B	32 26 17	111 29 58	.48	18.24
RTG8208B	32 26 43	111 31 28	.04	13.16
RTG8209B	32 26 46	111 31 10	.21	14.51
RTG8211B	32 26 14	111 29 35	.22	19.07
RTG8212B	32 26 14	111 29 38	<.07	8.20
RTG8213B	32 27 16	111 30 48	<.04	14.32
RTG8214B	32 27 53	111 30 13	<.02	28.87
RTG8215B	32 27 37	111 30 24	<.04	14.64

TABLE 7--RESULTS OF ANALYSES OF ROCK SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.

Sample	Latitude	Longitude	Ca-pct. s	Fe-pct. s	Mg-pct. s	Na-pct. s	Ti-pct. s	Ag-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s
RTR118AA	32 26 57	111 30 35	.15	3.00	1.00	3.0	.200	1.5	N	2,000	N	N	N
RTR165AA	32 27 4	111 28 44	5.00	15.00	1.50	.7	.200	.5	<10	100	N	N	N
RTR166AA	32 27 3	111 28 41	5.00	>20.00	1.50	1.0	.500	N	100	700	5	N	N
RTR166BA	32 27 3	111 28 41	2.00	20.00	1.00	1.0	.300	N	20	300	1	N	N
RTR167AA	32 26 45	111 29 56	.20	1.00	1.00	3.0	.070	N	N	500	N	N	N
RTR168AA	32 26 40	111 29 53	.20	2.00	1.50	3.0	.070	N	N	700	N	N	N
RTR169AA	32 26 39	111 29 52	.70	3.00	5.00	3.0	.200	1.0	N	1,500	N	N	N
RTR170AA	32 26 37	111 29 50	.50	2.00	2.00	3.0	.150	2.0	N	1,000	N	N	N
RTR170BA	32 26 37	111 29 50	.10	2.00	<.02	.5	.030	.5	N	1,000	N	<10	N
RTR171AA	32 26 49	111 29 59	1.00	3.00	3.00	3.0	.300	N	N	1,000	N	N	N
RTR171BA	32 26 49	111 29 59	.50	2.00	.30	5.0	.500	2.0	N	3,000	N	N	N
RTR172AA	32 26 0	111 30 17	.20	.70	.70	3.0	.050	N	N	700	N	N	N
RTR177AA	32 26 23	111 30 46	N	5.00	2.00	N	.070	70.0	N	2,000	1	150	100
RTR185AA	32 27 43	111 31 31	.50	2.00	2.00	5.0	.200	<.5	N	700	N	N	N
RTR186AA	32 26 54	111 30 39	20.00	.07	.03	N	N	N	50	2,000	2	N	N
RTR186BA	32 26 54	111 30 39	2.00	.07	.05	N	.020	N	N	>5,000	N	20	N
RTR186CA	32 26 54	111 30 39	.50	1.00	.50	1.5	.100	<.5	N	>5,000	N	N	N
RTR186DA	32 26 54	111 30 39	2.00	.50	.15	N	.015	N	N	>5,000	N	N	N
RTR186EA	32 26 54	111 30 39	1.50	.05	.03	N	.020	N	N	>5,000	N	N	N

TABLE 7--RESULTS OF ANALYSES OF ROCK SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	Ge-ppm s	La-ppm s	Mn-ppm s	Mo-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sr-ppm s
RTR118AA	15	20	20	70	N	N	200	5	7	200	<100	5	<100
RTR165AA	20	N	7	30	N	N	1,500	N	20	200	N	5	N
RTR166AA	50	N	70	50	N	N	2,000	15	30	150	100	20	<100
RTR166BA	30	N	20	30	N	N	1,500	7	10	500	<100	10	N
RTR167AA	<10	20	<5	50	N	N	70	N	5	10	N	N	N
RTR168AA	10	20	10	50	N	N	70	N	15	20	N	<5	<100
RTR169AA	20	70	30	70	N	N	500	N	15	15	N	10	150
RTR170AA	15	20	30	70	N	N	1,000	N	10	300	N	5	N
RTR170BA	N	N	20	20	N	N	20	30	N	300	N	N	N
RTR171AA	20	<10	15	100	N	N	300	N	<5	N	N	5	100
RTR171BA	N	<10	20	100	N	<50	50	10	N	150	N	5	150
RTR172AA	N	N	<5	70	N	N	70	N	N	30	N	N	N
RTR177AA	10	N	20,000	50	N	N	5,000	50	<5	>20,000	N	N	N
RTR185AA	20	20	50	70	N	N	100	N	10	70	N	7	N
RTR186AA	N	N	<5	N	15	N	>5,000	N	N	1,500	N	N	100
RTR186BA	N	N	7	N	N	N	200	N	<5	5,000	N	5	5,000
RTR186CA	N	10	7	50	N	50	100	N	<5	300	N	<5	100
RTR186DA	N	N	7	<5	N	N	200	N	<5	2,000	N	N	2,000
RTR186EA	N	N	<5	N	N	N	70	N	N	150	N	<5	>5,000

TABLE 7--RESULTS OF ANALYSES OF ROCK SAMPLES FROM THE RAGGED TOP WILDERNESS STUDY AREA, PIMA COUNTY, ARIZONA.--Continued

Sample	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Au-ppm aa	Hg-ppm aa	Te-ppm aa	Tl-ppm aa	W-ppm vis	F-pct. ise
RTR118AA	150	<10	N	70	13	<2	.5	<2	55	.005	.04	.65	.70	1.5	.03
RTR165AA	150	10	200	30	<5	2	1.7	<2	330	.002	.16	<.05	.15	1.0	.01
RTR166AA	200	20	300	50	33	<2	4.0	140	400	<.001	.0	<.05	.10	4.5	.02
RTR166BA	150	10	<200	10	8	<2	4.0	53	350	<.001	.20	<.05	.30	2.5	.02
RTR167AA	70	N	N	10	<5	<2	.3	<2	48	<.001	.02	<.05	.70	1.0	.02
RTR168AA	70	N	N	15	<5	<2	.3	<2	53	<.001	.02	<.05	.65	1.0	.03
RTR169AA	150	<10	N	30	<5	<2	.5	2	88	<.001	.10	<.05	1.30	1.0	.04
RTR170AA	100	<10	200	30	<5	<2	12.0	<2	410	<.001	N	<.05	1.10	3.5	.03
RTR170BA	50	N	N	N	39	<2	8.2	9	120	.014	.02	.25	2.70	4.0	.02
RTR171AA	100	<10	N	70	<5	<2	.8	<2	59	<.001	.04	<.05	.15	1.0	.03
RTR171BA	70	<10	<200	70	12	3	.9	<2	310	.046	.04	.75	.85	3.0	.03
RTR172AA	50	N	N	20	<5	<2	.1	<2	31	<.001	N	<.05	.55	1.0	.02
RTR177AA	70	<10	5,000	50	<5	300	280.0	<2	26,000	.016	.0	4.00	.40	<.5	.02
RTR185AA	100	N	N	20	<5	<2	1.0	<2	140	<.001	.06	<.05	.30	2.0	.03
RTR186AA	30	N	N	N	16	<2	35.0	<2	76	<.001	N	<.05	<.05	.5	1.96
RTR186BA	500	10	500	N	65	<2	.5	<2	460	.001	.16	<.05	<.05	.5	1.26
RTR186CA	70	N	500	30	<5	<2	1.0	<2	1,200	.004	.10	<.05	.40	4.5	.76
RTR186DA	150	10	N	N	22	<2	6.4	<2	160	.002	.08	<.05	<.05	1.0	3.38
RTR186EA	30	10	300	15	<5	<2	1.0	<2	330	<.001	.12	<.05	<.05	.5	1.10