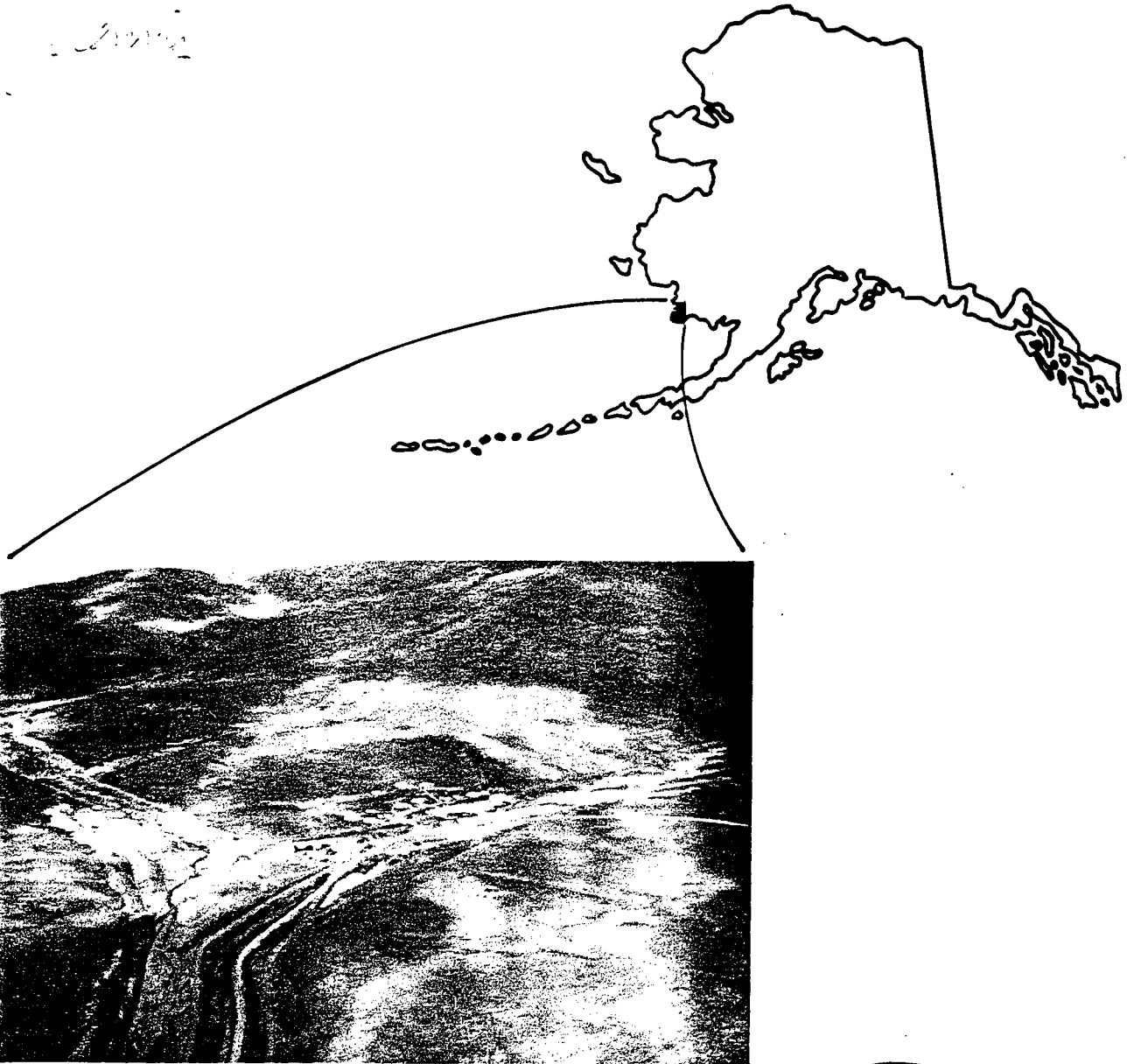


Lode Platinum-Group Metals Potential of the Goodnews Bay Ultramafic Complex, Alaska

By: D. D. Southworth and Jeffrey Y. Foley



UNITED STATES DEPARTMENT OF THE INTERIOR
Donald P. Hodel, Secretary

BUREAU OF MINES
Robert C. Horton, Director



CONTENTS

	<u>Page</u>
Abstract.....	1
Introduction.....	2
Location.....	3
Previous investigations.....	4
Prospecting and development history.....	5
Ownership.....	7
Access.....	7
Physiography.....	7
Sampling and analytical procedures.....	8
Regional geology.....	22
Local geology.....	22
Intrusive igneous rocks.....	22
Dunite.....	24
Wehrlite.....	26
Clinopyroxenite.....	27
Hornblende clinopyroxenite.....	30
Hornblendite and hornblende gabbro.....	31
Leucocratic tonalite.....	32
Chemistry and olivine mineralogy of ultramafic rock suite.....	33
Introduction.....	33
Major oxides.....	34
Olivine mineralogy.....	35
Economic minerals.....	35
Gold.....	35
Chromite.....	35

CONTENTS--Continued

	<u>Page</u>
Copper and nickel sulfide minerals.....	36
Magnetite.....	37
Platinum-group minerals.....	37
Comparison of PGM in the Goodnews Bay Complex with other mafic-ultramafic complexes in Alaska.....	41
Geophysical investigations.....	46
Introduction.....	46
Magnetometer traverses.....	48
Gravimeter traverses.....	48
Placer PGM source, lode PGM potential, and placer reserves.....	54
Summary and recommendations.....	58
References.....	60
Appendix A -- Description of rock samples collected in the vicinity of the Goodnews Bay ultramafic complex.....	64
Appendix B -- Churn drill results from Salmon River Valley.....	67

ILLUSTRATIONS

	<u>Page</u>
1. Index map of Alaska.....	3
2. Geologic map of the Goodnews Bay ultramafic complex.....	pocket
3. Bucket line dredge in Salmon River Valley.....	6
4. Reworked glacial material at northwestern end of Red Mountain.....	8
5. Pan concentrate and stream sediment sample location map....	11
6. Rock sample location map.....	14
7. Distribution of forsterite (Fo) content of olivines in the Goodnews Bay ultramafic complex.....	21
8. Geologic map of Fox Gulch.....	23
9. Chromite pods in dunite.....	25
10. Magnetite schlieren in dunite.....	25
11. Clinopyroxenite dike swarm exposed in dunite along beach on west side of Red Mountain.....	26
12. Photomicrograph of wehrlite.....	28
13. Photomicrograph of magnetite clinopyroxenite.....	29
14. Photomicrograph of magnetite-hornblende clinopyroxenite....	31
15. Photomicrograph of leucocratic tonalite.....	33
16. Alkalies-FeO-MgO diagram of rocks from the Goodnews Bay complex and comparative rock suites.....	34
17. Placer nugget from Salmon River, showing intergrowth of crystalline PGM (light gray) and chromite (black).....	38
18. Placer nugget with intergrown magnetite (Mag) and ferroplatinum alloy (Fe-Pt).....	40

ILLUSTRATIONS--Continued

	<u>Page</u>
19. Variation in composition of platinum metals in streams that drain Red Mountain ridge, adapted from Mertie.....	42
20. Location of geophysical traverses and gravity contour map of the Goodnews Bay Complex.....	47
21. Magnetometer profiles with interpreted geology.....	49
22. Sketch map of placer claims and areas of anomalous platinum concentrations in churn drill samples from Salmon River placer deposits.....	pocket

TABLES

1. Fire assay analyses of pan concentrate samples from the Goodnews Bay study area.....	11
2. Chemical analyses of stream sediment samples from the Goodnews Bay ultramafic complex.....	14
3. Chemical analyses of rock samples from the Goodnews Bay ultramafic complex.....	16
4. Whole-rock major oxide analyses of rocks from the Red Mountain ultramafic body and adjacent area.....	20
5. Forsterite (Fo) content of olivines in selected samples from the Goodnews Bay ultramafic complex.....	21
6. Concentrations, in parts per million, of platinum, palladium, rhodium, and iridium in some mafic-ultramafic complexes in Alaska.....	44
7. Distribution of platinum-, palladium-, rhodium-, and iridium-bearing samples from some mafic-ultramafic complexes in Alaska.....	45

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

F	Fahrenheit	oz	troy ounce
ft	feet	oz/ton	troy ounce per ton
g	gram	pct	percent
in	inch	ppm	parts per million
lb	pound	sp gr	specific gravity
mgal	milligal	yr	year
my	million years		



LODE PLATINUM-GROUP METALS POTENTIAL OF THE GOODNEWS BAY
ULTRAMAFIC COMPLEX, ALASKA

By D. D. Southworth¹ and Jeffrey Y. Foley²

ABSTRACT

In 1981, 1982, and 1983, the Bureau of Mines examined the potential for lode deposits of platinum-group metals (PGM) in the Goodnews Bay ultramafic complex, Alaska. The complex consists of the Red Mountain, Suzie Mountain, and Smalls River ultramafic bodies and displays concentric zoning of rock types similar to complexes in southeast Alaska, British Columbia, and the Ural Mountains in the U.S.S.R. Results of the study indicate that platinum is preferentially associated with chromite and magnetite in the dunite core of the complex, and palladium is preferentially associated with sulfide minerals in the outer clinopyroxene-rich zones.

The most promising targets for PGM lode deposits are the chromite-rich dunite at the heads of Fox Gulch and Squirrel Creek and iron-nickel and iron-copper sulfide-bearing magnetite clinopyroxenite and hornblende-rich rocks outward of the dunite core, also in the Fox Gulch-Squirrel Creek area. Significant placer reserves are present in the unmined, deeply buried placer ground in the lower Salmon River Valley, and also in tailings from previous dredging.

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INTRODUCTION

The platinum-group metals (PGM) platinum, palladium, iridium, osmium, rhodium, and ruthenium function as catalysts in the automotive, chemical, and petroleum-refining industries. Other U.S. industries rely on the chemical inertness and refractory properties of PGM. The metals are considered critical and strategic commodities and are necessary to the nation's military and economic well-being.

Because the only PGM produced domestically are recovered as trace by-products and by recycling, in 1983, the United States relied on foreign imports for about 84 pct of its PGM supplies. About 16 pct of PGM consumption was recovered from domestic scrap (25)³. Most imports

³Underlined numbers in parentheses refer to items in the list of references preceding the appendixes.

were from the Republic of South Africa (56 pct of total imports), the U.S.S.R. (16 pct of total imports), and Canada (11 pct of total imports). The United Kingdom is an important processor of PGM concentrates produced in the Republic of South Africa.

Domestic U.S. PGM production is less than one pct of U.S. consumption and has mostly been as a byproduct of the refining of copper ores; minor production has also come from domestic placer mining operations and other sources. The Goodnews Bay Mining Company, in southwestern Alaska, is the only domestic mine that has produced PGM as its principal commodity. About 650,000 oz of PGM were produced from the Goodnews Bay placers during the period 1928 through 1975 (1). Since 1976 the Goodnews Bay Mining Company has operated only sporadically, mostly reworking tailings from earlier mining.

As part of its current Alaska-wide assessment of critical and strategic minerals, the Bureau of Mines investigated the potential for PGM lode deposits in the Goodnews Bay area from 1981 through 1983 using a combination of geologic mapping, geochemical sampling, and geophysical surveys to delineate the extent of the ultramafic complex and to better define the distribution of PGM within the complex.

LOCATION

The Goodnews Bay complex is located approximately 10 miles south of the entrance to Goodnews Bay, along Kuskokwim Bay, on the southwest coast of Alaska (fig. 1). The 42-square-mile study area (fig. 2) extends from approximately $161^{\circ} 36'W$ and $59^{\circ} 00'N$ to $161^{\circ} 47'W$ and $58^{\circ} 52'N$.

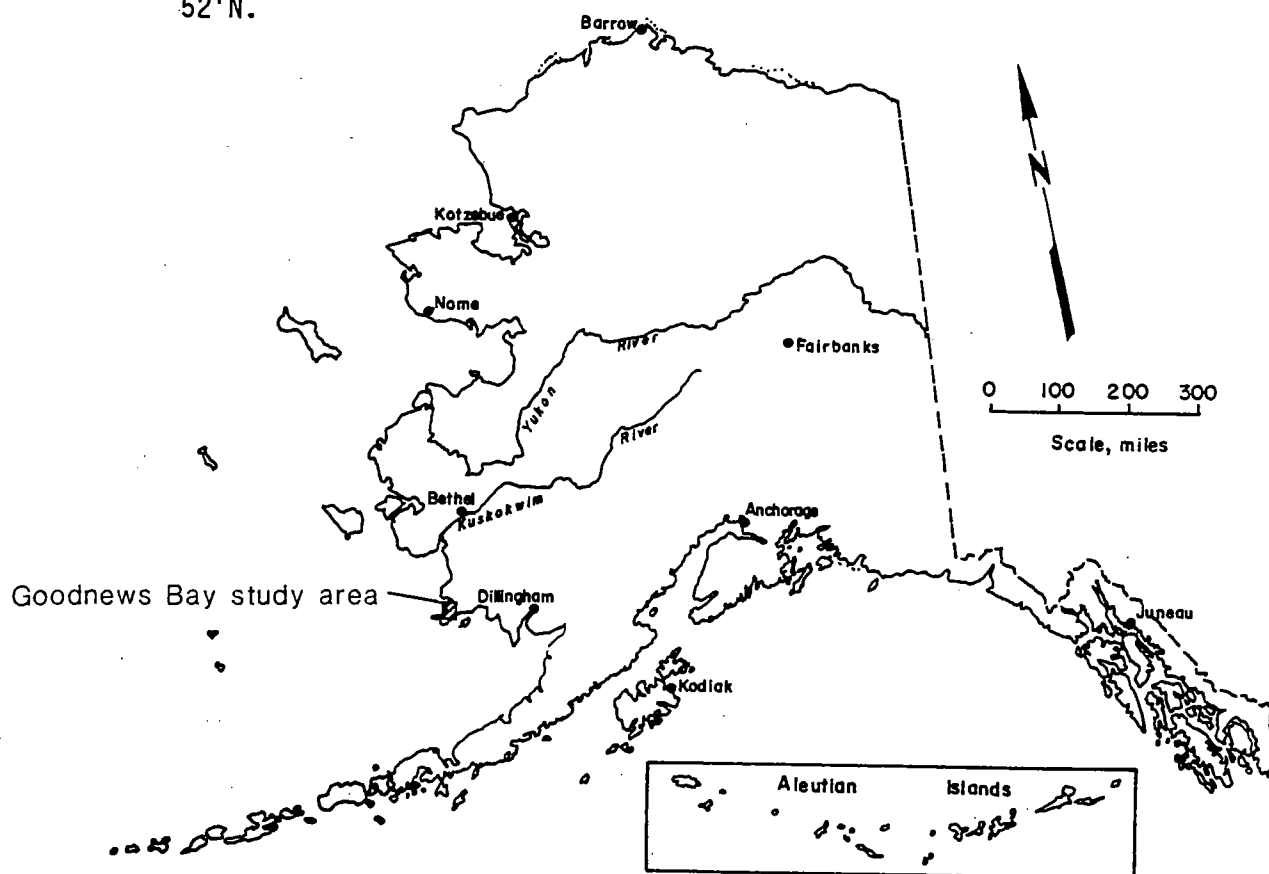


FIGURE 1. - Index map of Alaska.

PREVIOUS INVESTIGATIONS

Geologic data on the Goodnews Bay area are contained in numerous reports. Harrington (16), in 1919, described and mapped the topography and geology of the area immediately around Goodnews Bay at a scale of 1:250,000. A 1933 report by Reed (32), of the Alaska Territorial Department of Mines, detailed the early placer mining efforts in the Goodnews Bay mining district, and described the ultramafic rocks at Red Mountain. During 1937, Mertie (26) prepared geologic maps of the Goodnews Bay area at 1:62,500 scale. In 1940, Mertie (27) described the general geology of the area and reported in detail on the composition of the platinum-group minerals in the placer deposits. The Goodnews Bay placer deposits were summarized by Mertie in 1969 (28) and again in 1976 (29). The latter report contains the most detailed description available of the mineralogy and distribution of PGM in the Goodnews Bay placers. Bird and Clark (4) reported results of electron-microprobe analyses of olivine chromitites from Red Mountain and suggested a similarity of Red Mountain to the Alaska-type zoned complexes. Porter (30) described the glaciation of the area from Goodnews Bay to Chagvan Bay. His findings explain in part the distribution of the placer paystreaks in the Salmon River. Griscom's (15) interpretations of aeromagnetic data from the region help to define the extent of the ultramafic complex. Potassium-argon age determinations of rocks from many of the plutons of southwestern Alaska, including two from Red Mountain (176.4 ± 5.3 my, 186.9 ± 5.6 my) were reported by Wilson (40-41).

The potential for placer platinum and gold deposits in beach sands near Red Mountain has also been the subject of several studies. The

earliest of these was by Berryhill (3), who, in 1963, investigated the placer potential of beach sands along much of the Bristol Bay coastline. Although Berryhill collected twenty-one samples along the beach adjacent to Red Mountain, he detected greater than trace amounts of PGM or gold in only four samples. The highest values Berryhill obtained were 0.0573 oz/ton Pt and 0.0736 oz/ton Au from "thin sand veneer" collected with a shovel. Reports on the sedimentological processes active in the Goodnews and Chagvan Bay areas include several graduate studies (5, 35, 37-39). Bond (5), reported specifically on the distribution of platinum in the beach sands adjacent to Red Mountain. Potential beach placer accumulations and the recovery of PGM are also the subject of current Bureau of Mines investigations.

PROSPECTING AND DEVELOPMENT HISTORY

Reed (31) reports that PGM were first discovered in pan samples from Fox Gulch in 1926. Small-scale mining plants were operated intermittently from 1927 to 1934 on Platinum, Squirrel, and Clara Creeks, and on Fox and Dry Gulches. As the shallower paystreaks were mined out and it was discovered that large-scale, more expensive methods would be necessary to reach the deeper placer concentrations, many of the smaller claim groups were consolidated. Eventually two concerns, the Goodnews Bay and the Clara Creek mining companies, controlled most of the placer claims of the area. The Goodnews Bay Mining Co., the larger of the two, began operating with a dragline excavator in 1934 (27, 32), and the Clara Creek Mining Co. began dragline excavator operations in 1936. By 1941, however, the Clara Creek Mining Co. had ceased operations. The Goodnews Bay Mining Co. eventually acquired title to, or leased, virtually all of the mining

claims along the Salmon River and its tributaries (27). In 1937, the Goodnews Bay Mining Company began mining in the Salmon River Valley with a newly installed, 8-cubic-foot bucket-line dredge (fig. 3) (33) that has continued, with several brief hiatuses, to operate up to the present. Mertie (29) described the mining activities in the district through 1976.

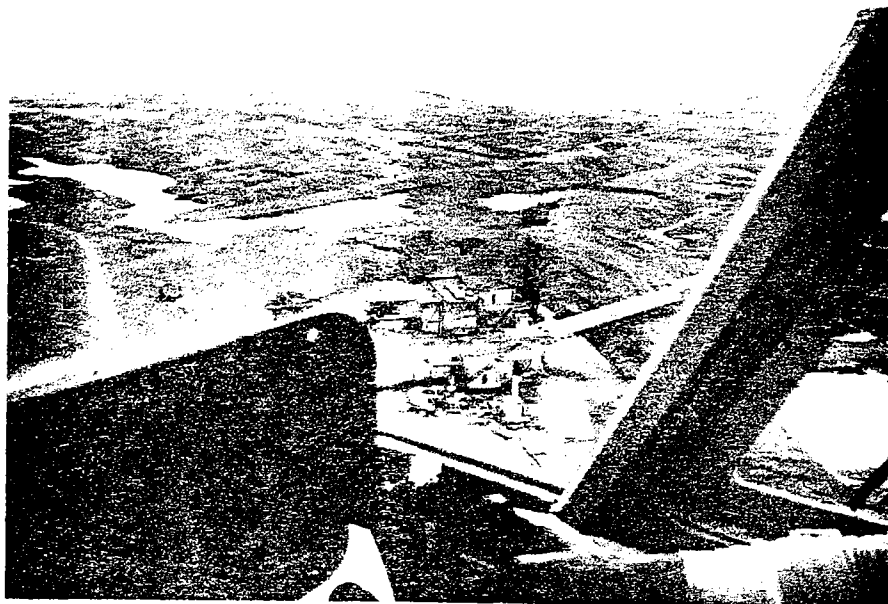


FIGURE 3. - Bucket-line dredge in Salmon River Valley.

Hanson Properties of Spokane, WA, acquired the Salmon River holdings in 1980 and is the present mine operator. The company is currently reworking tailings from previous mining, and is exploring virgin ground for both placer and lode PGM. The company holds lode claims on the east side of Red Mountain, but no hardrock mining has been done. Despite investigations by the mineral industry and government geologists, no economic lode platinum deposits have been discovered in the area.

OWNERSHIP

Virtually all of the placer mining claims in the Salmon River Valley and adjoining tributaries are currently (1985) held or controlled by the Goodnews Platinum Co., a subsidiary of Hanson Properties, of Spokane, WA. A map showing the placer claims in the area is published in the 1976 report by Mertie (29).

ACCESS

Regularly scheduled air service is available from Bethel to the village of Platinum, on Goodnews Bay. A gravel road spans the 10 miles between Platinum and the mine camp at the southeastern end of Red Mountain. The mine also has a gravel airstrip which can accommodate aircraft the size of a De Haviland "Twin Otter". There is no commercial lodging available.

PHYSIOGRAPHY

The report area lies in a region of subdued relief. Elevations range from sea-level to 1,887 ft at the summit of Red Mountain. Thorsen Mountain and Red Mountain together separate the Salmon River Valley from Kuskokwim Bay.

The area around Red Mountain has been extensively glaciated, with evidence of at least four glacial advances ranging in age from $8,910 \pm 110$ yr to greater than 45,000 yr (30). The main portion of the Salmon River Valley apparently escaped significant glaciation, however, several small cirques are preserved along the western (seaward) side of the Red Mountain ridgecrest. Mertie (27) reported finding large glacial erratics at elevations as high as 800 ft on the north end of Red Mountain. Extensive deposits of reworked glacial material (fig. 4) are found at the northwestern margin of Red Mountain and in the Salmon River Valley as far south as Dowry and Clara Creeks.



FIGURE 4. - Reworked glacial till at northwestern end of Red Mountain.

The climate in this part of Alaska is usually wet and foggy from April through September. The mean annual temperature is 33° F, although summer temperatures can range from 40° F to 75° F. The mean annual precipitation is 45 in, with the heaviest rainfall occurring in late summer. The effective working season for the dredge is usually limited by freezing temperatures to the period from late April to mid-December.

Vegetation consists principally of a thick tundra mat, except near the mouth of the Salmon River where there are a few alder and willow thickets.

SAMPLING AND ANALYTICAL PROCEDURES

Pan samples were collected to enhance recognition of PGM and gold in alluvium and regolith. In general, pan samples were collected from

the silty, poorly sorted material in active stream channels. Several samples of residual soil from the crest of Red Mountain were collected and treated similarly to those from the streams. Each stream sample represents three 16-in pans of material screened to minus 1/4-mesh from an original volume of 6 to 9 pansful. The residual soil samples each represent two pansful of material (no screening was necessary). Each sample was panned in the field and reduced to approximately 40 to 50 g of concentrate, then carefully washed into a plastic bag. Pan concentrate samples were further reduced in the laboratory either by panning to a constant volume (equivalent to a weight of about 30 g) or by concentrating them on a riffle table. Fire assay preconcentration of the samples was done by either the Bureau's laboratory in Juneau or by Bondar-Clegg Laboratories, Inc., of Lakewood, CO. This was followed by either: (1) inductively coupled argon plasma analysis (ICAP), at the Bureau's Reno, NV Research laboratory, or by Neutron Activation Services of Hamilton, Ontario, Canada, or (2) emission spectrographic analysis for Pd, Rh, Ru, Ir, and Os, at the Bureau's Reno laboratory. Because the emission spectrograph procedure utilized a platinum internal standard, no platinum analyses were possible by that technique. Results of analyses of pan concentrate samples are listed in table 1. Pan concentrate sample locations are shown on figure 5.

Stream sediment samples were collected in conjunction with pan concentrate samples from some of the unmined tributaries of the Smalls and Salmon Rivers. The samples were collected from the finer sandy portion of the active channel or deepest part of a dry but recently active stream bed. Samples were air dried before screening at minus

TABLE 1. - Fire assay analyses¹ of pan concentrate samples from the Goodnews Bay study area.

Sample	Au, oz/ton	Ir, oz/ton	Os, oz/ton	Pd, oz/ton	Pt, oz/ton	Rh, oz/ton	Ru, oz/ton
1P...	--	--	--	<0.002	<0.002	--	--
3P...	--	--	--	<.002	.006	--	--
5P...	--	--	--	<.002	.021	--	--
7P...	--	--	--	<.002	.010	--	--
10P...	--	--	--	<.002	<.002	--	--
12P...	--	--	--	<.002	<.002	--	--
14P...	--	--	--	<.002	<.002	--	--
17P...	--	--	--	<.002	<.002	--	--
19P...	--	--	--	<.002	<.002	--	--
21P...	--	--	--	<.002	.008	--	--
22P...	0.0028	0.0052	ND	--	.002	ND	ND
23P...	--	--	--	<.002	<.002	--	--
24P...	--	.12	>0.020	--	.028	0.110	0.0040
25P...	ND	.046	ND	ND	.092	.0040	ND
26P...	--	--	--	<.002	.004	--	--
27P...	--	--	--	<.002	.004	--	--
28P...	--	--	--	.011	1.530	--	--
29P...	--	--	--	.009	1.880	--	--
30P...	--	--	--	.002	.681	--	--
31P...	--	--	--	<.002	.039	--	--
33P...	--	>.56	.36	--	--	.056	.042
34P...	.016	--	--	<.007	.058	--	--
35P...	.018	--	--	.009	2.385	--	--
36P...	--	.032	ND	--	.031	.0016	ND
37P...	--	--	--	--	.0374	--	--
38P...	--	--	--	.004	.750	--	--
39P...	ND	.24	.032	ND	.140	.019	.0066
40P...	--	.28	.070	--	--	.011	.010
41P...	.005	--	--	<.003	.020	--	--
42P...	--	--	--	--	.003	--	--
43P...	.002	--	--	<.002	.010	--	--
44P...	.02	.040	ND	.001	.500	.0036	ND
45P...	--	ND	ND	--	.0426	ND	ND
46P...	ND	>.56	.08	.110	19.690	.056	.018
47P...	--	--	--	--	.0084	--	--
48P...	--	--	--	<.001	.0138	--	--
49P...	.003	--	--	<.002	.035	--	--
50P...	--	--	--	.034	--	--	--
51P...	<.002	.18	ND	<.002	.0096	.0020	ND

ND Not detected, no detection limit specified.

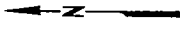
¹See text for description of analytical procedures.

NOTE: -- indicates sample was not analyzed for this element.



LEGEND

• 51 Sample site



Base adapted from U.S.G.S. Topographic Map 10-25-D-01, 63,460 scale quadrangle.

FIGURE 5. -- Pan concentrate and stream sediment sample location map

80-mesh and undergoing standard atomic absorption analyses for Co, Cu, Ni, and Pb. Results of these analyses are shown in table 2 and sample locations appear on figure 5.

Rock samples were usually collected as random chip samples across an outcrop, suspected mineralized area, or an altered zone. An effort was made while in the field to remove any weathering rind, so that only relatively fresh material was sampled. Rock sample locations are shown on figure 6.

Each rock sample was analyzed by atomic absorption methods for silver, gold, cobalt, chromium, copper, and nickel. Gold, platinum, palladium, osmium, iridium, rhodium, and ruthenium, were analyzed in a manner similar to that described above for the pan concentrate samples. Results of the analyses are listed in table 3; rock sample descriptions are listed in appendix A. Whole-rock oxide analyses were performed by Bondar-Clegg, Inc. of Lakewood, CO, using standard atomic absorption techniques. Results are listed in table 4. A computer program written at the University of Washington was used to calculate CIPW normative mineral abundances and AFM ($A = K_2O + Na_2O$, $F = FeO$, $M = MgO$) oxide ratios.

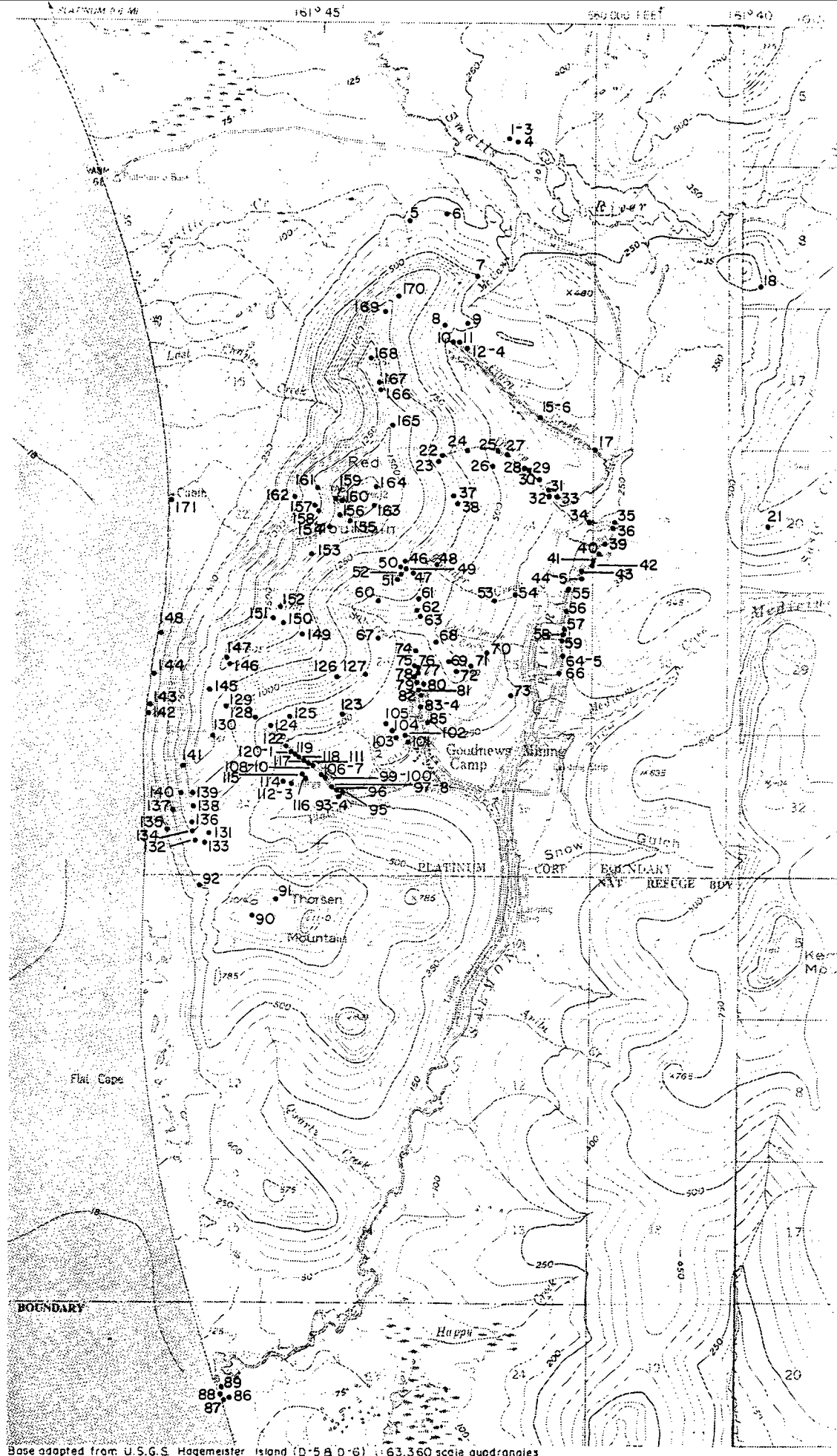
Splits of 28 rock sample pulps were used in the X-ray diffraction studies of forsterite (Fo) content described later in this report. Three separate scans were made of each sample and the results were averaged. The averages are listed in table 5 and the distribution of Fo content across the Goodnews Bay complex is shown on figure 7.

A number of samples were also collected for petrographic study and visual estimates were made of mineral abundances.

TABLE 2. - Chemical analyses¹ of stream sediment samples from the Goodnews Bay ultramafic complex.

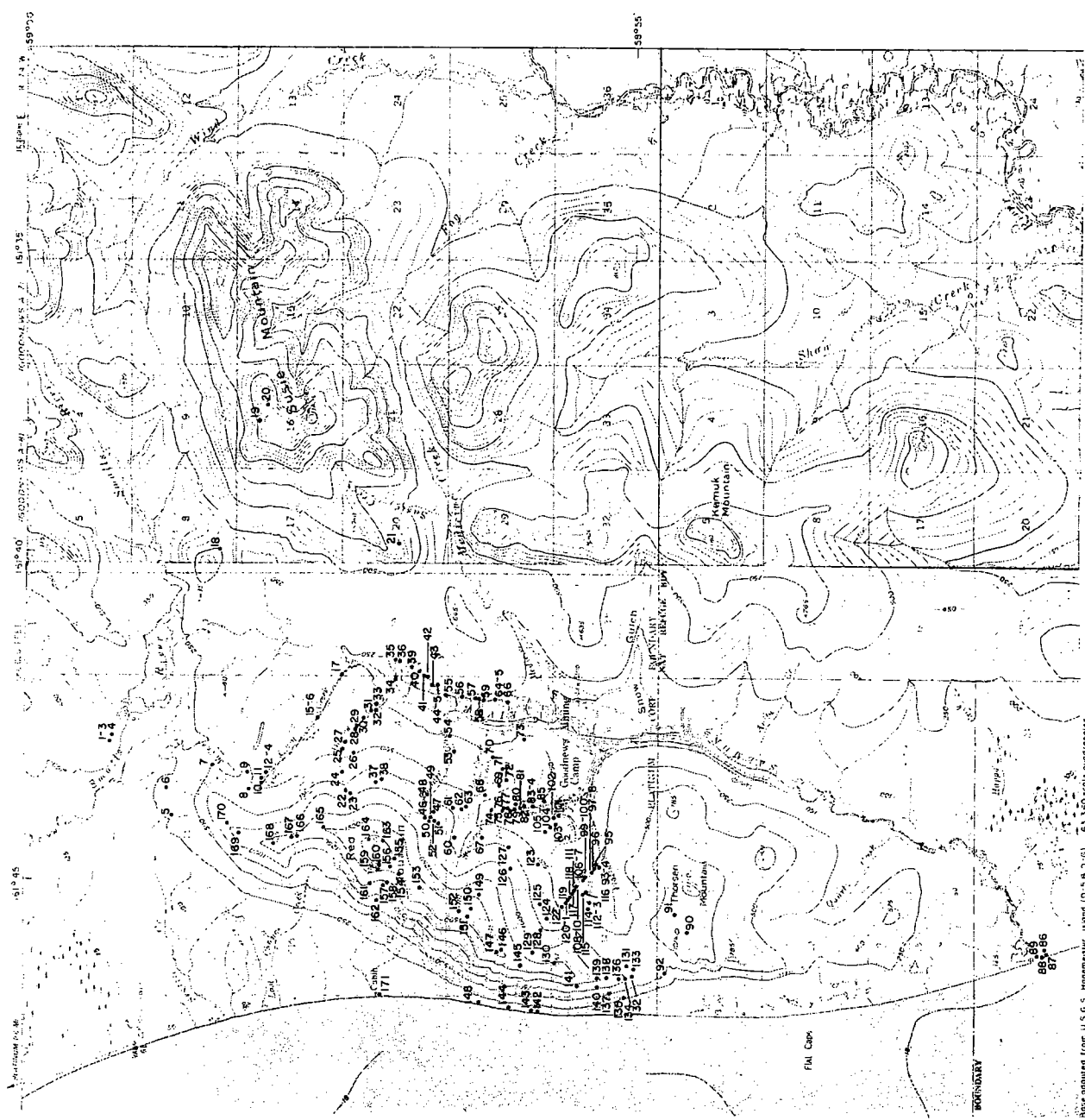
Sample	Co ppm	Cu ppm	Ni ppm	Pb ppm
2.....	35	46	80	<30
4.....	28	24	74	<30
6.....	21	7.8	38	<30
8.....	63	24	270	<30
9.....	40	58	160	<30
11.....	11	41	17	<30
13.....	20	25	30	<30
15.....	15	29	34	<30
16.....	25	64	51	<30
18.....	14	14	26	<30
20.....	61	43	320	<30
32.....	96	60	550	<30

¹See text for description of analytical procedure.



Base adapted from U.S.G.S. Hagemeister Island (D-5 B D-6) 63,360 scale quadrangles

FIGURE 6. -- Rock sample location map



LEGEND
 • 121 Sample site

0 1 2
 Scale, miles
 Contour interval 50 feet

Base acquired from U.S.G.S. Geometric Hand (D-9-B-C-61) 25,000 scale quadrangles

FIGURE 6. -- Rock sample location map

TABLE 3. - Chemical analyses of rock samples from the Goodnews Bay ultramafic complex

Sam- ple	Ag, ¹ ppm	Au, ¹ ppm	Co, ¹ ppm	Cr, ¹ ppm	Cu, ¹ ppm	Ni, ¹ ppm	Au, ² oz/ton	Ir, ² oz/ton	Pd, ² oz/ton	Pt, ² oz/ton	Os, ² oz/ton	Rh, ² oz/ton	Ru, ² oz/ton
1..	<0.1	<0.03	22	1,700	7	93	<0.007	ND	<0.0003	<0.0003	ND	ND	ND
2..	<.1	<.03	51	1,800	7	260	<.007	ND	<.0003	<.0003	ND	ND	ND
5..	--	--	--	<200	253	96	<.0002	--	<.0003	<.0003	--	--	--
7..	--	--	--	--	--	--	<.0002	--	<.0003	<.0003	--	--	--
9..	--	--	--	3,600	18	2,680	<.0002	--	<.0003	<.0003	--	--	--
10..	--	--	--	<200	54	22	<.0002	--	<.0003	<.0003	--	--	--
11..	--	--	--	400	20	24	<.0002	--	<.0003	<.0003	--	--	--
12..	--	--	125	--	--	1,700	.001	--	<.001	<.001	--	--	--
14..	--	--	35	79	--	57	--	--	--	--	--	--	--
17..	--	--	--	--	--	--	<.01	--	.00032	<.070	--	--	--
19..	--	--	--	2,700	--	--	<.0002	--	<.001	<.001	--	--	--
20..	--	--	--	1,600	--	--	<.007	--	<.030	<.030	--	--	--
23..	--	--	120	3,900	4	610	.0004	ND	<.0003	<.0003	ND	ND	ND
24..	--	--	153	1,400	4	700	.001	ND	<.0003	<.0003	ND	ND	ND
29..	--	--	--	<200	95	28	.001	--	<.0003	<.0003	--	--	--
31..	--	--	125	675	--	--	<.0002	--	<.001	<.001	--	--	--
34..	.7	<.03	62	2,300	26	205	<.01	ND	.00048	.006	ND	ND	ND
35..	--	--	--	--	--	--	<.0002	--	<.001	<.001	--	--	--
36..	.25	<.02	20	240	89	38	<.007	--	<.0003	<.0003	--	--	--
37..	--	--	136	2,100	4	840	.001	--	<.0003	<.0003	--	--	--
38..	--	--	106	3,300	6	900	<.0002	--	<.0003	<.0003	--	--	--
39..	.1	--	64	155	--	150	--	ND	ND	ND	ND	0.0014	ND
40..	<.1	--	230	--	14	2,900	<.0002	--	<.001	<.001	--	--	--
41..	--	--	--	2,100	8	1,050	<.0002	--	<.0003	<.0003	--	--	--
42..	<.1	<.03	22	1,400	15	78	--	ND	.00062	<.0003	ND	ND	ND
43..	.1	--	57	--	175	72	--	--	--	--	--	--	--
44..	<.1	<.03	97	2,050	8	795	--	ND	<.0003	<.0003	ND	ND	ND
45..	<.1	<.03	87	1,500	14	750	.0005	ND	<.0003	.001	ND	ND	ND
46..	--	<.03	115	2,700	4	900	<.0002	ND	<.0003	.013	ND	ND	ND
47..	<.1	<.03	88	2,800	5	740	<.0002	--	<.0003	<.0003	--	--	--
48..	--	--	115	250	4	740	.001	ND	<.0003	<.0003	ND	ND	ND
50..	.15	<.03	87	760	6	630	<.007	ND	<.0003	<.0003	ND	ND	ND

See explanatory notes at end of table.

Table 3. - Chemical analyses of rock samples from the Goodnews Bay Ultramafic Complex--Continued

Sam- ple	Ag, ¹ ppm	Au, ¹ ppm	Co, ¹ ppm	Cr, ¹ ppm	Cu, ¹ ppm	Ni, ¹ ppm	Au, ² oz/ton	Ir, ² oz/ton	Pd, ² oz/ton	Pt, ² oz/ton	Os, ² oz/ton	Rh, ² oz/ton	Ru, oz/ton
51..	<0.1	<0.03	69	2,900	21	980	<0.007	--	<0.0003	<0.0003	--	--	--
52..	<.1	<.03	79	1,550	9	710	<.007	--	<.0003	<.0003	--	--	--
53..	--	--	--	<200	140	59	<.0002	--	<.0003	<.0003	--	--	--
55..	<.1	--	81	--	33	81	--	--	--	--	--	--	--
56..	<.1	<.03	26	130	285	24	<.007	ND	<.0003	<.0003	ND	ND	ND
57..	<.1	<.03	15	525	7	46	<.007	ND	<.0003	<.0003	ND	ND	ND
58..	.2	<.03	20	73	305	21	--	ND	.0010	<.0003	ND	ND	ND
60..	.1	.05	81	3,050	5	735	.048	--	.040	<.0003	--	--	--
62..	<.1	<.03	83	2,900	4	660	--	ND	<.0003	<.0003	ND	ND	ND
63..	.2	<.03	84	2,150	7	760	--	--	<.0003	<.0003	--	--	--
64..	.1	<.03	13	115	44	20	--	ND	<.0003	<.0003	--	--	--
65..	<.1	<.03	18	64	61	21	--	ND	<.0003	<.0003	ND	ND	ND
66..	.3	<.03	19	28	355	33	--	ND	<.0003	<.0003	ND	ND	ND
67..	.1	<.03	77	3,250	6	785	--	ND	.00088	<.0003	ND	ND	ND
69..	--	--	28	--	105	49	<.007	0.0038	.00030	<.030	ND	ND	ND
72..	--	--	41	--	79	225	<.00015	--	<.0003	<.0003	--	--	--
73..	<.1	<.03	15	63	44	13	<.007	ND	<.0003	<.0003	--	--	--
74..	--	--	126	--	2	655	<.0002	--	<.030	<.030	ND	ND	ND
75..	--	--	--	--	--	--	<.0002	--	.004	.002	--	--	--
76..	--	--	24	62	89	14	<.0002	ND	--	--	ND	ND	ND
77..	--	<.03	41	180	20	82	<.0002	ND	.015	<.0003	ND	ND	ND
78..	--	--	15	--	140	11	.001	--	.008	<.0003	ND	ND	ND
79..	--	.10	16	77	77	13	<.0002	--	<.001	<.001	--	--	--
80..	.2	<.03	14	130	160	24	<.0007	ND	<.0003	<.0003	ND	ND	ND
81..	--	--	27	27	130	--	<.002	--	.002	<.0003	--	--	--
82..	--	--	22	22	430	--	<.002	--	<.001	<.001	--	--	--
83..	--	--	--	--	--	--	<.007	--	<.030	<.030	--	--	--
84..	--	--	--	--	--	--	<.0002	--	<.001	.049	--	--	--
85..	--	--	8	--	--	--	<.0002	--	<.001	<.001	--	--	--
86..	--	--	--	--	--	--	<.0002	--	<.001	<.001	--	--	--
87..	--	--	--	--	--	--	.001	--	.003	.009	--	--	--
88..	--	--	--	--	--	--	.026	--	ND	.114	--	--	--
89..	--	--	--	--	--	--	<.001	--	.0002	.001	--	--	--
89..	--	--	--	--	--	--	.0001	--	<.0001	.001	--	--	--

See explanatory notes at end of table.

