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Telephone: 226 - 2161, Ext. 488

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DISTRIBUTION OF HEAVY MINERALS IN THE SIXES RIVER, CURRY COUNTY, OREGON

Sam Boggs, Jr.*

Introduction

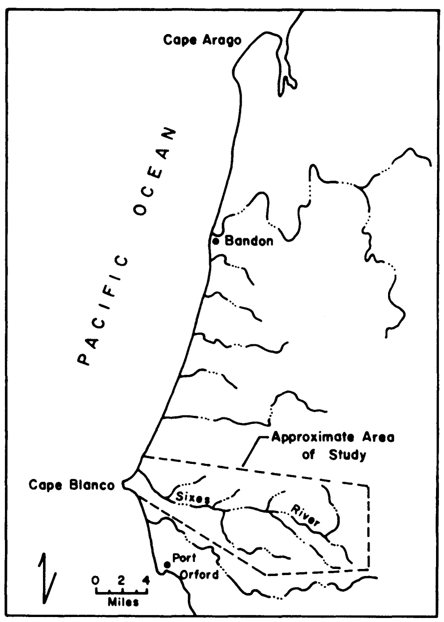

Figure 1. Index map of a portion of the southern Oregon coast showing area of study.

An investigation of heavy minerals and heavy metals in coastal streams of southwestern Oregon was begun in 1967 in conjunction with the Heavy Metals Program conducted by the U.S. Geological Survey. A part of this research involved study of the origin and distribution of heavy minerals in the drainage basin of the Sixes River, located north and east of Cape Blanco (see figure 1). The Sixes River is a short, moderately high-gradient stream that drains a diverse terrane of igneous, sedimentary, and metamorphic rocks ranging in age from Jurassic to Holocene (Wells and Peck, 1961).

The surface detritus that composes the bars and the stream bed of the river is mainly gravel with an interstitial sand content, at most localities, ranging from about 15 to 30 percent. Small "patches" of sand occupy the more protected parts of the bars and the stream bed at many places along its course, but sand-size material becomes dominant only in the extreme lowermost part of the Sixes estuary. This paper reports the results of a study of the size and composition of the sand-size heavy minerals contained interstitially in the surface gravels of the Sixes River and its tributaries.

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* Assistant Professor of Geology, University of Oregon, Eugene, Oregon.

Methods

Samples were collected at 75 localities (figure 2) situated along the river and the beach extending about 1 mile north and south of the river, and three or more samples were taken at most localities in order to evaluate local variations in heavy mineral content. Each sample, of about 2 kilograms size, was collected at a depth of 12 to 18 inches below the surface. The samples were dried and sieved through a 2.0 mm sieve to separate the sand-size material from the gravel. Approximately 100 grams of the sand-size material was split from the bulk sample with a microsplitter and separated in tetrabromoethane (sp. gvty. 2.96) into light and heavy fractions. The heavy fraction was washed in acetone, weighed, and sieved through a $\frac{1}{2}\,\Phi$ set of sieves ranging in size from $-0.5\,\Phi$ (1.41 mm) to $4.5\,\Phi$ (0.044 mm). Magnetite was removed from each $\frac{1}{2}\,\Phi$ size group of the heavy fraction and weighed. Mean size of total heavy minerals (including magnetite) and of magnetite alone was computed statistically by computer methods. About 135 samples were analyzed to determine the content and size of total heavy minerals and magnetite, and about 80 samples were analyzed petrographically.

Petrographic analysis was made of the 80 to 120 mesh (0.177 mm - 0.125 mm) size fraction of the heavy minerals from which magnetite had been removed. Preliminary examination of several size fractions showed that this size fraction offered the best compromise between minimum amount of rock fragment contaminants, a sufficiently large number of grains to make an adequate analysis, and a grain size that could be readily studied in grain mounts. Grains were cleaned in an ultrasonic tank and mounted in AROCHLOR 4465 (Monsanto Chemical Co.), which has an index of refraction of 1.660 - 1.665. The relatively high refractive index of AROCHLOR greatly facilitates identification of certain minerals such as the amphiboles. Two samples from each of 29 selected localities, and single samples from 21 other localities were examined petrographically. The point counting procedure consisted of first counting 300 grains to establish the relative percentage of rock fragments, "cloudy" grains, opaque grains, and non-opaque grains. Counting then continued, with only non-opaque grains being counted, until a total of at least 200 non-opaque grains had been identified and counted. "Cloudy" grains are those grains that are too badly altered for identification; in most cases they appear to be single grains, but some are probably rock fragments.

Distribution of Heavy Minerals

Total heavy minerals

The distribution of heavy minerals in the Sixes River and its tributaries is summarized in figure 2, which shows the average percent of total heavy minerals (including magnetite) in the sand-size fraction of the samples at each sample locality. The values shown are the averages of two to three samples in most cases; however, a few are single-sample values. Average heavy mineral content of the sand-size material ranges from about 1 percent to 6 percent; most of the samples contain 2 to 5 percent heavy minerals.

The Sixes River drains a diverse geologic terrane with a variety of igneous, sedimentary, and metamorphic rocks exposed throughout the drainage basin. This heterogeneity of source rocks and consequent mixing of heavy minerals in the various tributaries and the main stream leads to a poorly defined concentration gradient

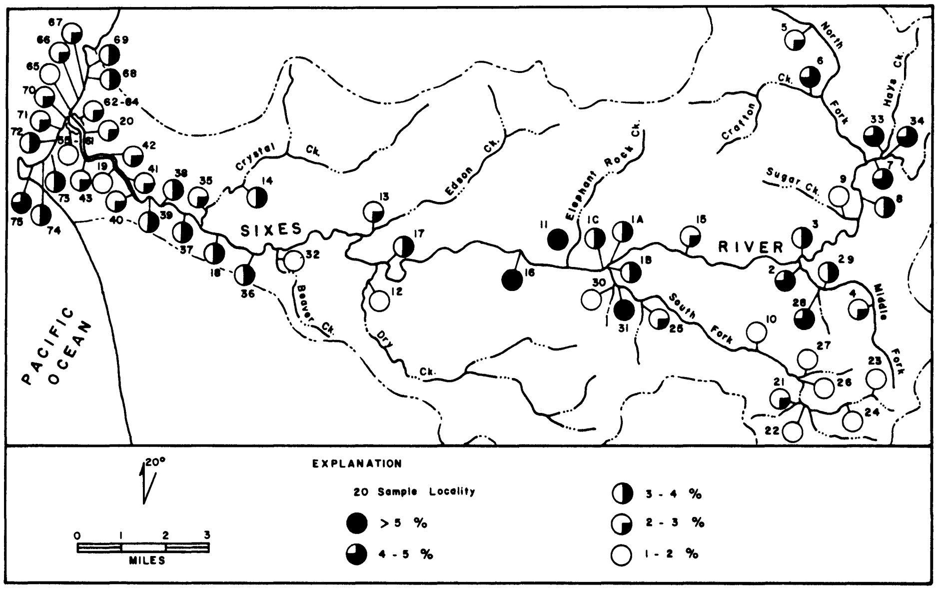


Figure 2. Concentration of total heavy minerals in the sand-size fraction of surface gravels in the Sixes River drainage basin.

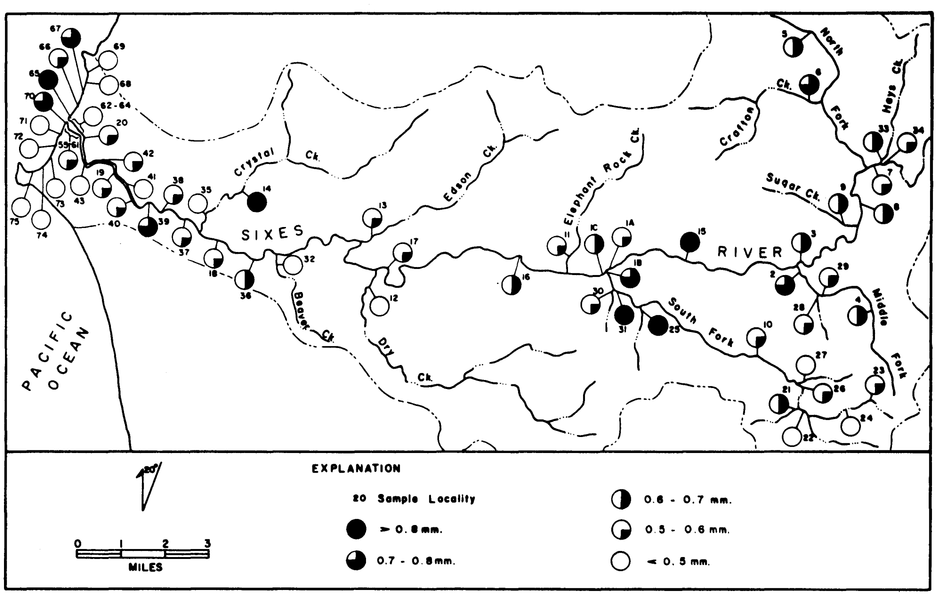


Figure 3. Average mean size of total heavy minerals in the sand-size fraction of surface gravels in the Sixes River drainage basin.

within the basin; however, highest heavy mineral concentrations are generally in the upper, or eastern, portion of the drainage system. Note that the heavy mineral content of certain tributaries, notably Dry Creek, Beaver Creek, Sugar Creek, and the extreme headwaters of South Fork, are particularly impoverished in heavy minerals. The heavy mineral content of deposits in the main Sixes channel appears to decrease gradually, but not uniformly, downstream. With the exception of the tributaries mentioned above, most samples from the upstream portion of the drainage system contain 3 to 6 percent heavy minerals in the sand-size fraction of the gravel; those in the middle reach of the Sixes contain 3 to 4 percent, and those from the lowermost 3 to 4 miles of the main channel contain 1 to 3 percent heavy minerals. With minor exception, samples from the beach also have comparatively low heavy mineral content (1 to 4 percent) relative to samples from the headwaters of the drainage basin.

Pétrographic analysis shows that a large percentage (more than 50 percent in many cases) of the heavy grains in the stream samples are rock fragments, and the percentage of rock fragments increases with increasing size of the grains. The general decrease in content of heavy grains in the main Sixes channel in the downstream direction may be due both to breakdown of some of the heavy rock fragments into constituent grains (thereby reducing the mass of the heavy grains), and to "dilution" of the heavy mineral content of lower Sixes sediments because downstream tributaries furnish less heavy minerals to the main channel than do upstream tributaries.

Figure 3 shows the average mean size of total heavy minerals in the sand-size fraction of the samples. The values are the averages of the mean sizes of two to three samples from most sample localities. Average mean size of the heavy grains ranges from less than 0.5 mm to more than 0.8 mm. The average mean size of the heavy minerals in the upper portion of the drainage system, particularly in parts of South Fork, Middle Fork, and North Fork and its tributaries, is generally larger than in the lower portion of the basin. However, average mean size of heavy minerals in samples even from the lowermost portion of the Sixes estuary is quite large, ranging up to 0.6 mm. This large mean size is mainly due to the abundance of rock fragments in the heavy fraction, as indicated above.

Magnetic heavy minerals

Magnetic grains were removed from each size fraction of the heavy minerals by passing a magnet over the grains; all grains were removed which adhered to the magnet while held a very short distance above, but not in contact with, the grains. Two to three passes were made over the grains to insure complete removal. The magnetic grains in the finer size fractions (less than about 0.125 mm) are mainly magnetite and ilmenite. In the coarser fractions, however, many of the magnetic grains are rock fragments which contain enough magnetite to cause them to be attracted to the magnet. No practical way was found to prevent inclusion of the rock fragments during the process of removing the magnetite. The data which follow with regard to concentration and size of magnetite necessarily include these magnetic rock fragments. Because the amount of rock fragments increases with increasing size of the grains, these fragments have a pronounced effect on the apparent size and concentration of magnetite, and it must be realized in studying these data that both the concentration and size of the magnetic grains, exclusive of rock fragments, are probably less than the figures shown.

Figure 4 shows the average magnetite concentration at each sample locality. Average values range from less than one-tenth percent to more than seven-tenths

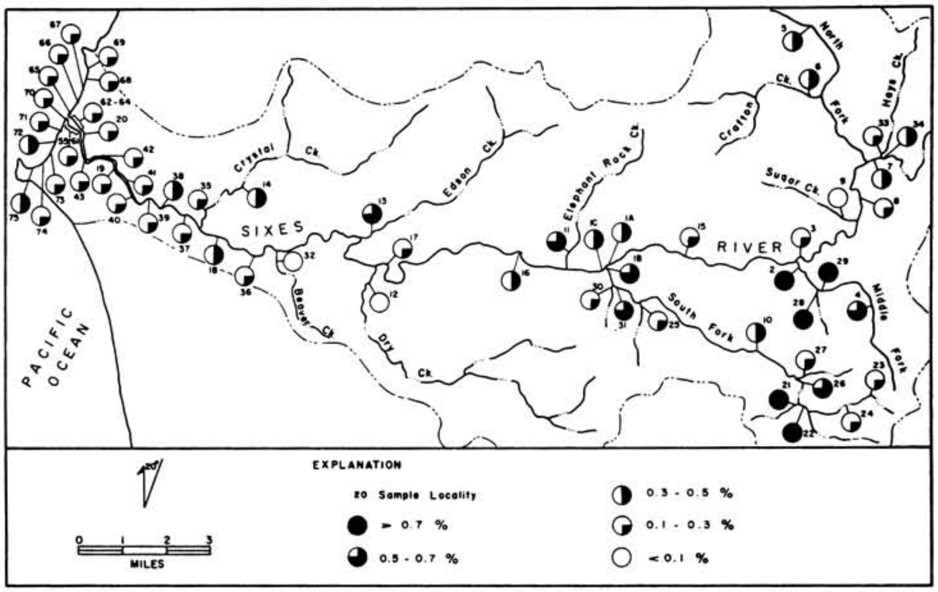


Figure 4. Concentration of magnetic heavy minerals in the sand-size fraction of surface gravels in the Sixes River drainage basin.

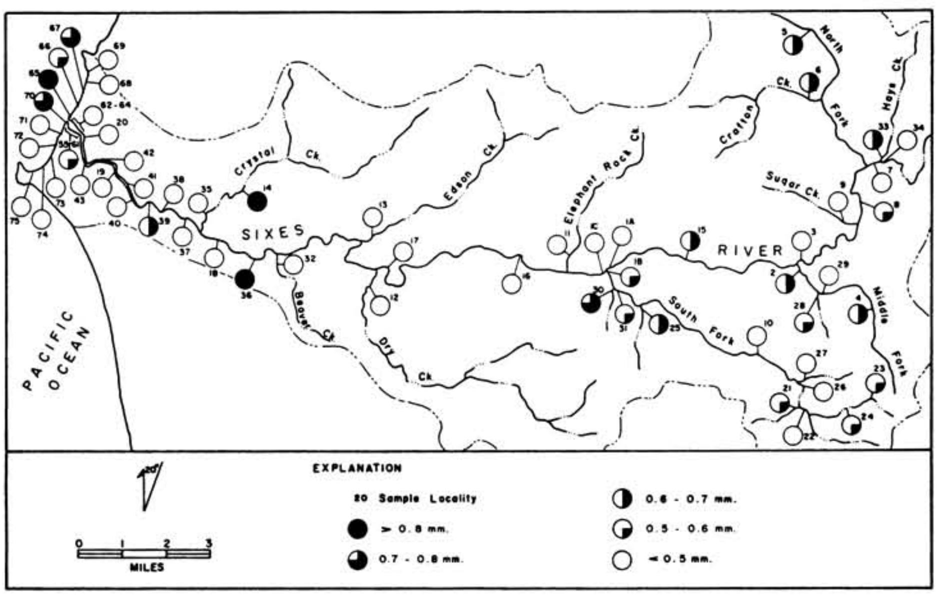


Figure 5. Average mean size of magnetic heavy minerals in the sand-size fraction of surface gravels in the Sixes River drainage basin.

TABLE 1.

Percent Composition of the 0.177–0.125 mm. heavy mineral fraction of sand-size detritus from Sixes River gravel.

Sample Number	Sample Locality	Total Sample: Rock Fragments	Total Sample: "Cloudy" Grains	Total Sample: Opaque Minerals	Total Sample: Nonopaque Minerals	Total Sample: Magnetic Minerals	Total Sample: Non-Magnetic Minerals	Nonopaque Fraction: Augite-Diopside	"Titan" Augite	Enstatite	Hypersthene	Green Hbl.	Blu-Gn Hbl. + Actinolite	Red-Bn Hbl.	Glaucophane	Epidote	Clinozoisite-Zoisite	Pink Garnet	Clear Garnet	Zircon	Barite	Staurolite	Sphene	Other
SR-10	1A	46	16	19	19	10.6	89.4	35.5	4.0	2.5	2.0	9.5	5.5	2.5	11.5	12.0	1.5	3.5	2.0	3.5	–	–	1.5	3.0
SR-14A		39	15	11	35	35.7	64.3	53.0	–	1.0	0.5	31.0	3.5	3.0	–	1.0	–	0.5	–	2.0	–	–	–	3.5
SR-11	1B	45	6	22	27	20.7	79.3	40.5	3.5	3.0	1.5	6.5	6.0	2.5	6.0	4.5	0.5	5.5	4.0	6.0	4.5	–	1.5	3.0
SR-13A		46	2	27	25	21.3	78.7	65.0	0.5	2.0	1.0	10.0	3.5	4.0	tr.	5.5	0.5	1.5	1.5	1.5	–	–	1.0	2.5
SR-28A	15	58	8	17	17	20.6	79.4	39.0	5.0	1.0	1.0	11.0	6.5	5.0	8.5	8.0	–	7.0	2.5	3.5	2.0	–	–	0.5
SR-29A		59	4	13	24	13.7	86.3	37.0	3.5	4.5	–	14.5	9.5	2.5	7.5	13.5	–	1.0	1.5	1.0	2.5	–	1.0	0.5
SR-33A	16	55	9	12	24	10.9	89.1	37.0	7.5	5.0	1.0	23.0	10.0	1.5	3.0	2.0	0.5	2.0	1.5	–	5.0	–	–	0.5
SR-35A		51	1	10	38	19.6	80.4	57.0	3.0	5.5	–	15.0	6.0	3.0	2.0	1.5	1.0	1.0	1.0	0.5	1.0	–	1.0	1.0
SR-36A	17	58	8	12	22	18.4	81.6	49.5	2.0	2.0	0.5	17.0	5.0	1.5	1.5	6.0	1.5	1.5	1.5	0.5	2.5	–	–	6.5
SR-39A		51	5	20	24	17.1	82.9	54.5	3.5	2.5	–	14.0	7.5	3.0	1.5	4.0	1.0	1.0	0.5	2.5	2.0	–	0.5	2.0
SR-42A	18	39	5	29	27	21.6	78.4	54.5	4.5	1.0	1.0	11.0	5.5	1.5	2.0	3.5	2.5	2.5	2.0	5.0	–	–	0.5	3.0
SR-46A		29	9	30	32	17.2	82.8	56.5	3.5	2.5	–	13.5	4.5	2.0	1.5	4.5	2.5	3.5	2.0	2.5	–	–	0.5	1.5
SR-47A		38	8	21	33	14.1	85.9	52.0	5.5	1.5	–	19.5	3.0	2.5	2.5	5.0	–	3.0	2.0	0.5	–	–	–	3.0
SR-49A	19	37	3	29	31	17.7	82.3	48.0	3.5	3.5	0.5	14.0	7.5	3.5	2.5	8.0	1.5	2.0	1.5	0.5	–	–	2.0	1.5
SR-51A		39	10	25	26	16.5	83.5	40.5	5.0	6.0	2.0	20.0	9.5	3.5	5.0	2.0	1.0	1.0	–	2.0	–	–	0.5	1.5
SR-53A	20	56	5	8	31	7.7	92.3	54.5	4.0	4.5	–	15.0	5.5	3.0	3.0	6.0	1.0	0.5	1.0	–	–	–	1.0	1.5
SR-56A		18	16	34	32	16.7	85.3	48.0	2.5	3.0	0.5	16.0	8.0	3.5	2.0	4.0	3.0	2.5	2.0	2.5	–	–	–	2.5
SRX-1A	14	41	12	29	18	12.6	87.4	22.5	15.5	2.0	1.0	2.5	8.5	2.5	1.5	15.5	3.0	2.5	2.5	8.0	5.0	–	3.0	4.5
SRX-4A		33	3	42	22	15.5	84.5	24.5	13.0	4.5	3.0	1.5	9.5	1.5	2.0	18.0	0.5	2.5	1.0	11.5	4.5	–	1.0	3.0
SRE-1A	13	29	14	21	36	16.2	83.8	67.0	19.0	4.5	1.0	0.5	5.5	–	0.5	0.5	–	–	–	–	–	–	–	1.5
SRE-4A		23	2	14	61	15.5	84.5	63.5	26.0	2.5	–	1.0	3.5	1.0	–	2.0	–	–	–	–	–	–	–	0.5

TABLE 1, CONTINUED

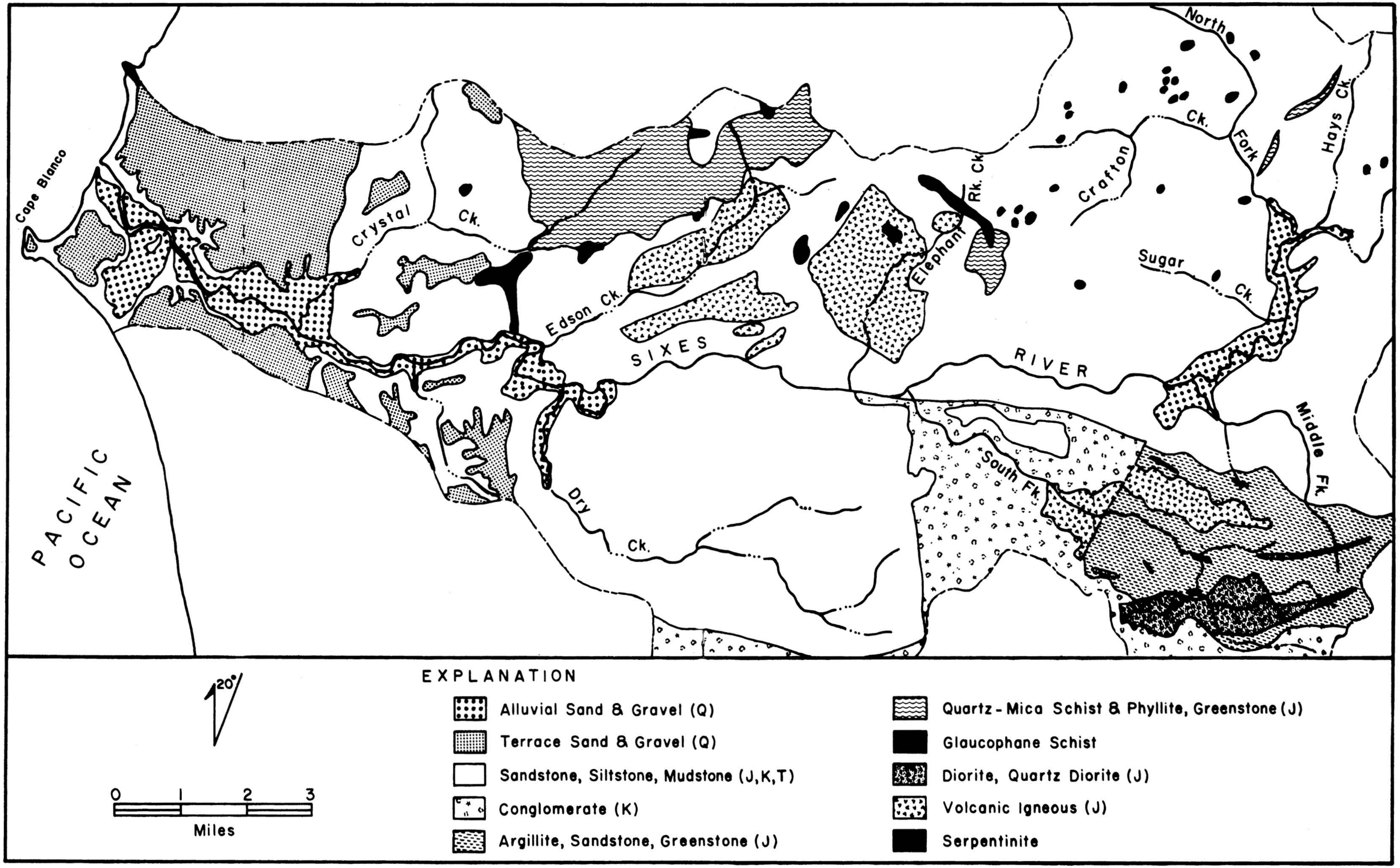
Sample Number	Sample Locality	Total Sample: Rock Fragments	Total Sample: "Cloudy" Grains	Total Sample: Opaque Minerals	Total Sample: Nonopaque Minerals	Total Sample: Magnetic Minerals	Total Sample: Non-Magnetic Minerals	Nonopaque Fraction: Augite-Diopside	"Titan" Augite	Enstatite	Hypersthene	Green Hbl.	Blu-Gn Hbl. + Actinolite	Red-Bn Hbl.	Glaucophane	Epidote	Clinozoisite-Zoisite	Pink Garnet	Clear Garnet	Zircon	Barite	Staurolite	Sphene	Other
SRD-2A	12	51	6	21	22	4.8	95.2	69.0	–	1.5	–	4.0	4.0	2.5	–	7.0	1.5	1.0	1.5	2.5	–	–	0.5	5.0
SRD-3A		62	14	9	15	1.7	98.3	71.5	–	1.0	–	7.0	3.0	2.5	–	8.0	2.0	1.5	1.5	1.5	–	–	–	0.5
SRER-3A	11	41	7	19	33	22.6	77.4	62.0	1.5	7.5	–	11.5	7.0	2.5	1.0	3.0	1.5	–	–	–	–	–	–	1.5
SRER-4A		44	18	18	20	18.7	81.3	55.0	3.0	8.0	–	13.0	19.0	2.0	–	–	–	–	–	1.0	1.0	–	–	–
SRS-2A	10	27	12	13	48	31.5	68.5	15.5	–	–	0.5	63.5	1.0	18.5	·	0.5	-	–	–	tr.	–	–	0.5	–
SRS-3A		37	2	11	50	26.4	73.6	12.5	·	1.5	–	63.5	1.5	18.0	–	1.5	0.5	–	0.5	–	-	–	–	0.5
SRM-4A	2	43	13	18	26	21.2	78.8	67.5	1.0	1.5	–	7.0	4.0	5.0	–	6.0	1.5	0.5	3.5	1.5	–	–	–	0.5
SRM-5A		32	2	30	36	18.6	81.4	58.0	1.0	1.0	0.5	17.5	2.0	5.0	·	5.0	0.5	1.5	2.0	3.0	–	-	1.5	1.5
SRM-11A	4	40	7	16	37	16.3	83.7	68.5	–	0.5	–	11.0	4.5	6.0	–	5.5	0.5	–	2.5	–	–	–	–	1.0
SRM-13A		34	17	8	41	14.2	85.8	56.0	–	–	–	25.0	3.0	11.5	–	1.0	–	–	–	0.5	–	–	–	0.5
SRN-1A	3	35	11	36	18	15.1	84.9	16.5	3.5	1.5	0.5	8.0	13.5	1.0	8.0	12.5	0.5	6.0	4.0	16.0	5.5	·	1.5	1.5
SRN-6A		42	7	25	26	14.0	86.0	16.0	3.5	1.0	–	13.0	13.5	4.0	8.5	16.5	3.0	3.5	3.0	6.5	4.0	·	1.5	2.5
SRN-8A	5	33	14	29	23	9.8	90.2	19.5	7.0	0.5	0.5	1.0	12.5	–	12.0	17.0	-	6.0	4.0	6.0	9.5	–	3.5	1.0
SRN-9A		25	4	47	23	10.2	89.8	15.5	3.5	2.5	0.5	4.0	7.5	0.5	11.5	16.5	1.0	7.0	3.5	4.0	13.0	–	6.5	3.0
SRN-12A	8	41	11	27	21	12.7	87.3	17.5	5.5	0.5	0.5	8.0	18.0	2.0	9.0	14.5	3.0	4.0	4.5	5.0	4.5	–	1.5	2.0
SRN-14A		40	9	30	21	12.6	87.4	12 5	5.0	0.5	1.5	115	8.0	0.5	7.0	15.5	2.0	8.0	7.0	10.5	7.0	–	1.0	2.5
SRSU-1A	9	51	8	26	14	5.4	94.6	14.5	3.5	1.5	3.0	2.0	13.5	–	13.5	14.5	3.5	9.0	8.0	5.0	2.0	0.5	1.5	1.5
SRSU-3A		48	21	18	13	9.4	90.6	8.0	7.0	1.0	–	3.0	14.0	0.5	7.0	18.0	2.5	10.0	11.5	9.5	0.5	–	3.0	4.5
SRH-2A	7	33	8	43	16	104	89 6	17.5	1 0	3.5	0.5	13 0	10.0	3.0	4.0	17.0	1.0	7.0	5.0	5.5	2.0	–	1.0	8.5
SRH-3A		45	28	18	9	12.8	87.2	12 5	–	2.0	1.0	14.0	20.5	4.5	8.0	14.5	3.0	6 5	3.0	4.5	2.0	–	1.0	3.0

TABLE 1, CONTINUED

Sample Number	Sample Locality	Total Sample: Rock Fragments	Total Sample: "Cloudy" Grains	Total Sample: Opaque Minerals	Total Sample: Nonopaque Minerals	Total Sample: Magnetic Minerals	Total Sample: Non-Magnetic Minerals	Nonopaque Fraction: Augite-Diopside	"Titan" Augite	Enstatite	Hypersthene	Green Hbl.	Blu-Gn Hbl. + Actinolite	Red-Bn Hbl.	Glaucophane	Epidote	Clinozoisite-Zoisite	Pink Garnet	Clear Garnet	Zircon	Barite	Staurolite	Sphene	Other
SRC-1A	6	45	17	15	23	13.4	86.6	11.0	0.5	0.5	–	26.0	21.5	1.0	12.0	8.0	1.5	6.0	0.5	4.0	3.5	--	2.5	1.5
SRC-2A		41	15	16	28	12.7	87.3	19.5	3.0	2.0	-	16.0	13.5	1.0	10.5	14.5	1.5	3.0	1.5	3.0	7.5	–	–	3.5
68-31	36	38	7	18	37	18.8	81.2	55.0	5.0	6.0	–	12.0	4.5	3.0	1.5	5.0	1.0	1.0	1.0	1.0	–	-	0.5	3.5
68-32		39	7	17	37	14.2	85.8	57.5	3.0	4.0	–	12.0	5.0	1.0	3.0	6.0	0.5	1.0	1.5	2.0	1.5	–	0.5	1.5
68-34	37	38	9	15	38	12.9	87.1	51.0	5.0	4.0	0.5	14.5	2.5	4.0	4.5	6.5	2.0	1.5	–	0.5	1.5	–	0.5	1.5
68-35		38	11	18	33	17.5	82.5	48.5	6.5	5.5	–	16.5	3.5	2.5	2.5	5.5	–	2.0	2.0	1.5	–	–	1.0	2.5
68-38	38	32	8	28	32	21.2	78.8	40.5	7.0	4.5	–	17.0	5.5	3.0	1.5	9.0	0.5	3.0	2.5	4.5	–	–	1.0	0.5
68-39		36	10	17	37	14.1	85.9	48.0	9.5	6.5	0.5	14.0	5.0	2.0	4.0	5.5	1.0	2.0	1.0	–	–	–	–	1.0
68-40	39	34	6	27	33	17.7	82.3	51.0	6.5	7.0	1.0	12.5	2.0	3.0	2.0	6.0	0.5	3.0	1.5	1.0	–	–	0.5	2.5
68-42		37	6	19	38	9.2	90.8	48.0	1.5	5.0	–	18.5	6.0	3.0	6.0	5.5	1.0	1.0	0.5	1.0	1.0	–	–	1.5
68-43	40	38	8	16	38	12.6	87.4	44.5	6.0	5.0	–	21.0	5.0	2.5	5.0	6.0	–	3.0	1.0	0.5	–	–	0.5	–
68-45		48	8	12	32	9.4	90.6	44.0	2.0	5.5	1.5	20.5	8.0	3.5	3.5	3.5	0.5	2.0	1.5	0.5	1.0	–	0.5	2.0
68-46	41	42	8	17	33	9.5	90.5	50.0	5.5	7.0	1.5	15.5	5.5	0.5	2.5	7.5	1.0	0.5	1.5	–	0.5	–	–	1.5
68-48		37	7	22	34	20.3	79.7	47.0	6.5	5.0	–	16.5	3.0	0.5	2.5	6.5	–	4.5	3.0	3.0	0.5	–	–	1.5
68-49	42	47	6	15	32	13.1	86.9	44.5	7.0	2.5	0.5	19.5	7.5	1.0	3.5	7.0	0.5	0.5	1.0	0.5	–	–	0.5	4.5
68-50		43	8	18	31	14.9	85.1	48.5	5.0	6.0	0.5	17.5	6.0	1.5	3.5	4.0	1.0	1.5	1.0	1.0	0.5	–	1.5	1.0
68-52	43	46	2	25	27	16.6	83.4	44.5	4.0	3.5	–	11.5	8.0	2.0	6.0	9.0	2.0	2.0	1.5	2.0	0.5	–	0.5	3.0
68-54		41	5	29	25	21.3	78.7	41.5	7.5	3.0	1.0	15.5	5.5	1.5	3.0	9.0	1.5	1.0	2.5	3.0	1.0	–	1.0	2.5
68-55	55	45	11	11	33	6.5	93.5	51	3.5	5.0	1.5	17.5	8.5	2.0	3.0	6.0	–	0.5	--	–	0.5	–	–	0.5
68-56	61	42	5	24	29	17.6	82.4	40.0	5.5	5.5	1.0	17.0	6.0	2.5	3.0	9.0	1.0	3.0	1.0	1.5	0.5	–	1.0	2.5

TABLE 1, CONTINUED

Sample Number	Sample Locality	Total Sample: Rock Fragments	Total Sample: "Cloudy" Grains	Total Sample: Opaque Minerals	Total Sample: Nonopaque Minerals	Total Sample: Magnetic Minerals	Total Sample: Non-Magnetic Minerals	Nonopaque Fraction: Augite-Diopside	"Titan" Augite	Enstatite	Hypersthene	Green Hbl.	Blu-Gn Hbl. + Actinolite	Red-Bn Hbl.	Glaucophane	Epidote	Clinozoisite-Zoisite	Pink Garnet	Clear Garnet	Zircon	Barite	Staurolite	Sphene	Other
68-57		32	2	35	31	21.3	78.7	47.5	4.0	6.5	1.5	8.0	5.0	2.0	2.0	9.5	1.0	2.5	2.0	4.5	0.5	–	0.5	3.0
68-58		31	2	35	32	20.8	79.2	45.0	5.0	3.0	0.5	15.0	5.0	1.0	5.0	8.0	1.5	4.5	2.0	1.0	–	–	1.0	2.5
68-59	55-61	32	3	28	37	15.6	84.4	45.5	3.0	4.0	1.5	14.5	7.0	1.0	0.5	10.0	2.5	4.0	2.5	2.0	1.0	–	1.0	–
68-60		44	4	18	34	8.9	91.1	25.5	0.5	2.0	3.5	18.0	6.0	3.0	–	16.5	5.0	5.5	8.0	3.5	–	–	1.5	2.5
68-61		53	4	9	34	4.2	95.8	32.0	2.5	2.0	2.5	22.5	13.0	2.0	1.5	11.0	2.5	2.5	3.5	–	1.0	–	0.5	1.0
68-62		41	3	22	34	8.6	91.4	27.5	1.0	2.0	4.0	18.5	8.5	2.5	2.0	12.0	2.0	8.5	7.0	2.0	–	–	1.0	1.0
68-63	62-64	38	4	25	33	14.0	86.0	45.5	4.5	2.0	1.0	10.0	6.0	2.0	4.0	11.0	1.0	3.5	2.5	1.5	3.0	–	1.0	1.5
68-64		45	3	17	35	8.9	91.1	31.5	1.5	0.5	5.0	14.5	5.0	1.5	2.5	18.0	2.5	8.0	5.0	1.5	–	–	1.5	1.5
68-65		53	1	11	35	<1.0>	99.0	29.0	2.0	3.0	6.0	24.0	7.0	4.0	1.0	10.0	2.0	1.0	5.0	–	1.0	–	2.0	3.0
68-66		53	3	13	31	5.6	94.4	28.0	2.0	0.5	5.0	25.0	4.5	1.0	1.0	17.5	0.5	5.5	5.5	–	0.5	–	2.0	1.0
68-67		50	5	11	34	8.5	91.5	22.5	1.0	1.5	5.0	22.5	6.0	1.5	1.0	20.5	1.5	5.0	6.5	1.5	–	–	1.0	3.0
68-68		53	3	7	37	4.9	95.1	23.0	1.5	1.5	3.0	24.0	7.0	2.5	1.5	16.0	3.5	6.5	3.0	–	0.5	1.0	1.0	4.5
68-69		51	4	7	38	2.7	97.3	23.0	–	1.0	4.5	28.0	8.5	5.0	1.5	17.5	–	4.0	3.0	1.0	–	0.5	–	2.0
68-70		51	3	9	37	1.1	98.9	23.5	1.5	1.0	5.5	28.5	7.0	1.5	1.0	15.5	2.0	5.0	3.0	–	–	1.5	0.5	3.0
68-71		56	3	5	36	2.3	97.7	18.5	2.0	2.0	5.0	30.0	11.5	3.5	1.0	15.5	1.0	3.5	2.0	–	1.0	–	0.5	3.0
68-72		51	4	15	30	4.9	95.1	20.0	1.5	2.0	5.0	20.0	4.0	4.5	1.0	22.0	1.5	6.5	6.0	1.0	0.5	1.5	2.0	1.0
68-73		54	4	6	36	2.4	97.6	19.5	–	2.5	5.5	24.5	9.0	3.5	1.0	14.5	1.0	3.0	8.5	0.5	0.5	1.5	1.5	2.5
68-74		58	5	6	31	3.5	96.5	23.5	0.5	1.0	6.0	24.5	6.0	3.0	1.5	17.5	1.0	9.0	3.5	1.0	0.5	–	1.0	0.5
68-75		51	4	11	34	3.8	96.2	22.5	0.5	1.0	4.5	21.0	8.0	4.0	1.5	15.5	1.0	5.5	9.0	1.5	–	2.0	1.0	1.5



Cape Blanco
PACIFIC OCEAN
Crystal Ck.
Edson Ck.
SIXES RIVER
Dry Ck.
Elephant Rk. Ck.
North Fork
Crafton Ck.
Sugar Ck.
Hays Ck.
Middle Fk.
South Fk.
20°
0 1 2 3
Miles
EXPLANATION
Alluvial Sand & Gravel (Q)
Terrace Sand & Gravel (Q)
Sandstone, Siltstone, Mudstone (J,K,T)
Conglomerate (K)
Argillite, Sandstone, Greenstone (J)
Quartz-Mica Schist & Phyllite, Greenstone (J)
Glaucophane Schist
Diorite, Quartz Diorite (J)
Volcanic Igneous (J)
Serpentinite

percent of the sand-size material. In general, there is fair correlation between magnetite content and total heavy mineral content; that is, most samples that have a high total heavy mineral content also have a high magnetite content. A close comparison of figures 2 and 4, however, reveals some discrepancies. Although the distribution of magnetite in the drainage basin does not exhibit a particularly strong trend, certain parts of South Fork, Middle Fork, Elephant Rock Creek, and Edson Creek appear to have the highest magnetite concentrations (ranging from about five-tenths percent to more than seven-tenths percent of the sand-size fraction). Magnetite content decreases slightly in the downstream direction and the content of magnetite in the sand-size fraction of most samples from the lower part of the Sixes channel, the estuary, and the beach is less than three-tenths percent.

Figure 5 shows the grain-size distribution of magnetite within the Sixes drainage basin. The average mean size of magnetite exceeds 0.8 mm at a few localities, but at most localities is less than 0.5 mm. With the exception of Crystal Creek, average mean size is somewhat larger in that part of the drainage system upstream from the junction with South Fork than in the downstream portion of the basin. Otherwise, no particular pattern of size distribution is apparent. A comparison of the average mean size of magnetite with the average mean size of total heavy minerals in individual samples shows that the mean size of magnetite is slightly smaller in most cases than the mean size of total heavy minerals. This is consistent with the principle of hydraulic equivalency by which smaller, heavier grains (in this case magnetite) would be expected to be deposited together with larger, lighter grains (nonmagnetic heavy minerals).

<u>Non-magnetic heavy minerals</u>

The data obtained by analysis of the 0.177 mm - 0.125 mm size fraction is summarized in table 1. This table shows that magnetic opaque grains (removed prior to petrographic analysis) compose about 1 percent to more than 35 percent of the total heavy minerals in this size fraction, although the majority of samples contain between 3 to 20 percent. Some samples from the extreme lower portion of the Sixes estuary, and all samples from the beach have markedly lower magnetite content than most of the other river samples. Nonmagnetic opaque minerals range in abundance from about 5 percent to 47 percent of the nonmagnetic fraction. The areal distribution of these nonmagnetic opaque grains is quite random, but like the magnetic opaque grains, the beach samples contain significantly less nonmagnetic opaque grains than do most of the river samples. No attempt has been made to identify the nonmagnetic opaque grains, but they are probably mainly ilmenite and chromite.

Table 1 shows that the percentage of rock fragments in the 0.177 mm - 0.125 mm size fraction of the heavy minerals ranges from 18 percent to 62 percent. At first it was thought that the extremely high content of rock fragments might be due to improper separations, but study of the non-opaque fraction of the heavy minerals shows that there is very little contamination with light minerals such as quartz and feldspar; therefore, the rock fragments must contain enough heavy grains to increase their specific gravity above 2.96. Although no quantitative counts were made of rock fragments in the progressively coarser size fractions, the content of rock fragments in these coarser sizes must be significantly higher than that in the 0.177 mm - 0.125 mm fraction. The extremely high rock-fragment content of the heavy mineral fraction of Sixes River samples appears to be due to the very fine grain size of many of the source rocks and to the proximity of the sample sites to the source rocks from which the grains were derived; that is, the rock fragments have not undergone adequate weathering, transportation, and reworking to cause them to break down into their constituent heavy mineral grains.

Figure 6 is a generalized rock-type map of the Sixes River drainage basin which shows the major types of source rocks in the basin. This map, compiled mainly from work by Baldwin (Baldwin and Boggs, 1969) and Lent (1969), provides a reference framework for relating the heavy minerals from given sample sites to the probable source rocks of these minerals. The major rock types include sandstone, siltstone, and mudstone of the Otter Point Formation (Jurassic), Rocky Point Formation (Cretaceous), and Umpqua Formation (Tertiary); conglomerate mainly in the Humbug Mountain Conglomerate (Cretaceous); argillite, sandstone, and greenstone in the Galice Formation (Jurassic); quartz-mica schist and phyllite, and greenstone in the Colebrooke Schist (Jurassic); glaucophane schist and serpentinite which occur in scattered "pods" that are difficult to relate to specific formations; diorite and quartz diorite (Jurassic) intruded into the Galice Formation and Humbug Mountain Conglomerate; and volcanic rock of various compositions which belongs to the Galice Formation and the Otter Point Formation. Note that the metamorphic rocks of the Colebrooke Schist and the serpentinite and glaucophane schist bodies all occur on the north side of the Sixes River, whereas intrusive igneous rocks and argillite are confined to the south side of the river mainly in the headwaters of South Fork. Other rock types are scattered throughout various parts of the basin.

The composition of the non-opaque heavy minerals is given in table 1, and the distribution of these minerals within the Sixes River basin is shown graphically in figure 7. The dominant mineral species in the basin is clinopyroxene, which predominates at almost every locality. The ratio of clinopyroxene to other heavy minerals is particularly high in such tributaries as Edson Creek, Elephant Rock Creek, Dry Creek, and Middle Fork, and clinopyroxene is clearly the dominant mineral in essentially all samples from the main Sixes channel. The clinopyroxene is mainly colorless to pale green augite and diopside, but in some tributaries, particularly Edson Creek and Crystal Creek, there is abundant moderate- to deep-brown clinopyroxene with pale, purplish-brown pleochroism. This is called "titanaugite" in table 1, although it was not positively identified optically as titanaugite. Minor amounts of "titanaugite" are found in most of the samples.

Orthopyroxene, which is not particularly common in the Sixes drainage, consists mainly of enstatite. Except in some samples from the lower part of the Sixes estuary, hypersthene rarely occurs in amounts exceeding about 2 percent, and was not found at all in many samples. Some samples from the lower part of the estuary contain 3 to 5 percent hypersthene, much of which is distinctly different from the hypersthene found in other parts of the river. Samples from the beach also contain higher hypersthene content, averaging about 5 percent; much of this also differs in appearance from the Sixes hypersthene and is probably from a different source. Hypersthene brought into the river from the beach probably accounts for the higher hypersthene content of the lower part of the estuary.

Amphibole is the second most-abundant type of heavy mineral in the Sixes drainage. Green, blue-green, and red-brown amphibole and glaucophane are all reasonably common. As shown by figure 7, green and red-brown hornblende together are generally more abundant than blue-green hornblende. However, in some tributaries such as Crafton Creek, Hays Creek, and Sugar Creek, which drain schist bodies (see figure 6) blue-green hornblende exceeds green and red-brown hornblende. Only at one locality in the headwaters of South Fork does amphibole exceed pyroxene in

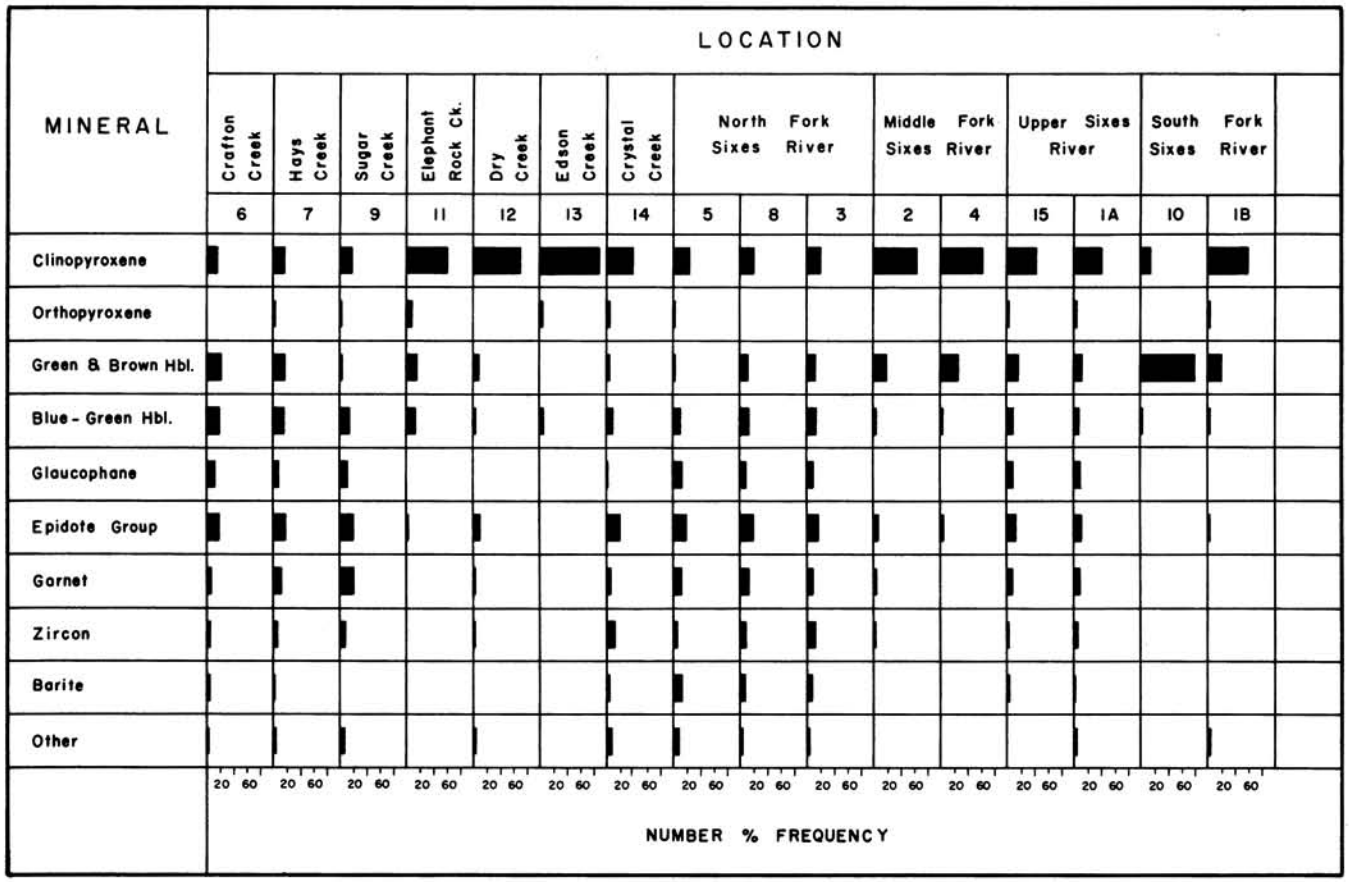


Figure 7. Composition of non-opaque heavy minerals in the 0.177 - 0.125 mm size fraction. Values less than about 3 percent are not shown.

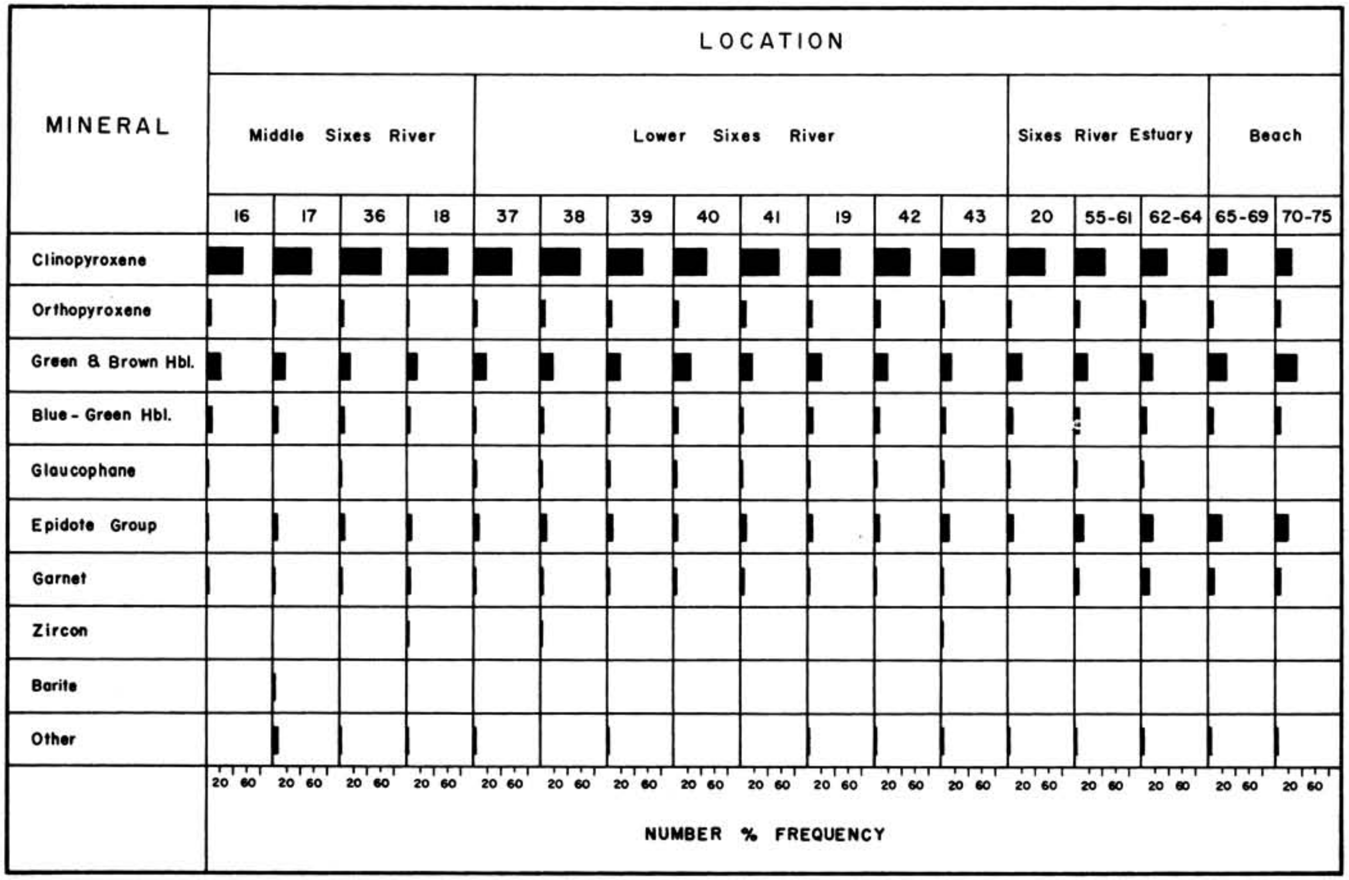


Figure 7, continued.

abundance. This locality is only a few miles downstream from a small quartz diorite stock. Analyses of samples from this intrusive by E. H. Lund (Baldwin and Boggs, 1969) show that the quartz diorite contains about 11 percent hornblende and about 2 percent accessory heavy minerals including magnetite, sphene, and apatite.

Glaucophane, together with epidote (including some clinozoisite and zoisite), garnet, and zircon are common constituents of the main Sixes channel and of most of the tributaries which drain the north slope of the Sixes basin. The rock-type map (figure 6) shows that numerous small bodies of blue schist are exposed in the middle and upper portions of the basin along the north slope. R. L. Lent (1969) analyzed a number of samples from these blue-schist bodies, and reports high percentages of glaucophane and epidote, as well as some garnet. A portion of the Colebrooke Schist thrust plate, exposed within the Sixes basin, strongly influences the heavy mineral assemblages in Edson Creek and Crystal Creek in particular. Lent reports some glaucophane in the basal part of the Colebrooke Schist, together with epidote, clinozoisite, zoisite, and other heavy minerals. The strong influence of the metamorphic bodies on the heavy mineral assemblages of the various tributaries is evident by comparing the mineral assemblages from the tributaries which drain the north slope of the basin with those which drain the south slope. Metamorphic rocks are not present in the south-slope drainage, and the southern tributaries, notably South Fork, Middle Fork, and Dry Creek all have heavy mineral assemblages which are devoid of glaucophane and impoverished in epidote, clinozoisite-zoisite, garnet, and zircon.

Samples from North Fork, in particular, and from a few other localities contain an unusual heavy mineral with abundant bubble inclusions. This mineral, which composes about 4 to 13 percent of the heavy minerals in the 0.177 - 0.125 mm size fracion in samples from North Fork, could not be positively identified in grain mounts. Dr. Adolph Pabst (University of California) kindly offered to make a single crystal x-ray analysis of the mineral. Dr. Pabst reports that the crystals are orthorhombic, biaxial positive, 2V 40° ± 10° (not measured directly), cell dimensions: a = 7.147 Å, b = 8.872 Å, c = 5.450 Å, and he identifies the mineral as barite.

Barite is not a particularly common detrital mineral, and its abundance in the stream sediments of the North Fork drainage is surprising. It is a common gangue mineral in metalliferous hydrothermal veins, and it occurs as vein or cavity fillings in various types of rocks; however, the ultimate source of barite in the North Fork drainage is not known at this time. In addition to its occurrence in North Fork, small amounts of barite were found in many samples from the main Sixes channel, but abundance decreased sharply downstream from North Fork. This is probably due mainly to "dilution" in the lower part of the stream, but decrease in abundance downstream might be the result of mechanical destruction of the relatively soft (3 -3.5 hardness) barite grains.

A few other minerals such as sphene, sillimanite, and biotite were identified in trace amounts in a number of samples, and some grains in certain samples could not be identified due to alteration of the grains or inability to measure optical properties. In figure 7 these unidentified grains and the minor heavy mineral species are all included in the "other" category.

Figure 7 shows that the non-opaque heavy mineral composition of samples from the middle and lower reaches of the main Sixes channel, excluding the estuary, is reasonably constant and reflects the mixing of heavy mineral suites from the various upstream tributaries. A distinct change in relative abundance of the various mineral species is evident, however, in samples from the extreme lower portion of the Sixes estuary, and particularly in samples collected along a stretch of the beach about 1 mile north and south of the mouth of the Sixes River. The ratio of total amphibole to total pyroxene increases slightly in the lower part of the estuary, and increases markedly on the beach to the point where amphibole equals or exceeds pyroxene. Also, the proportion of both epidote minerals and garnet increases in the lower part of the estuary and on the beach. There are also marked differences in appearance of certain heavy minerals; some of the green hornblende from the lower estuary and the beach is very highly colored and almost opaque. No such hornblende was found in any sample from the remainder of the Sixes drainage. As mentioned in a preceding section, hypersthene from the lower estuary and beach differs from that in the upper portion of the Sixes; it is generally more elongated and euhedral, and the pleochroism tends to be much stronger. A mineral tentatively identified as staurolite was found in many beach samples, but did not occur in any samples from the river.

These data indicate that the heavy mineral suite on the beach and in the lower portion of the estuary has been affected by mixing of some heavy minerals from a source other than the Sixes River. The fact that the heavy mineral assemblage of the lower portion of the estuary closely resembles that of the beach suggests that heavy minerals are being transported from the beach up the estuary a short distance and deposited along with other heavy minerals moving down the Sixes River. This is further substantiated by the fact that many heavy mineral grains from the beach and from the lower estuary are moderately well rounded. Most heavy mineral grains of this size from other samples within the Sixes basin, however, are angular to subangular; even heavy minerals from tributaries such as Dry Creek which drain only sandstone terrane (grains obviously polycyclic) are generally quite angular. In fact, the only moderately well-rounded heavy mineral grains found in any sample, exclusive of those from the lower estuary and beach, came from samples collected in Crystal Creek. The headwaters of Crystal Creek are incised into the Colebrooke Schist, and these rounded grains may be second-cycle grains derived from the Colebrooke. Small patches of marine terrace sand are also preserved within the Crystal Creek drainage, however, and these may possibly have furnished the rounded grains, many of which are zircon.

Summary

Surface detritus of the Sixes River consists mainly of gravel with an interstitial sand content of approximately 15 to 30 percent at most localities studied. The total content of heavy minerals in the sand-size fraction of the gravel ranges from about 1 percent to 6 percent, and magnetic heavy grains make up about one-tenth to seven-tenths percent of the sand-size material. Rock fragments are extremely abundant constituents of the sand-size detritus and compose more than 50 percent of many samples. The high percentage of rock fragments in both the total heavy mineral fraction and the magnetic heavy fraction results in a comparatively large mean size for these grains at most localities. The mean size of the total heavy grains and the magnetic heavy grains in the sand-size fraction of the gravel which the Sixes River furnishes to the ocean is almost one-half millimeter.

Study of the 0.177 - 0.125 mm size fraction of the non-opaque heavy minerals shows that clinopyroxene is the most abundant heavy mineral species in the Sixes River drainage basin, and is followed in abundance by monoclinic amphiboles; these include green and red-brown hornblende, blue-green hornblende, and glaucophane. Orthopyroxene (mainly enstatite), epidote, garnet, and zircon are common in many of the tributaries and in the main Sixes channel. Barite occurs in moderate abundance in some tributaries, particularly North Fork.

Hornblende increases in abundance at the expense of clinopyroxene in the lower part of the Sixes estuary, and some new types (colors) of hornblende appear. Hypersthene is uncommon throughout most of the Sixes drainage, but increases in abundance in the lower part of the estuary and on the beach. These changes in mineral composition in the lower estuary, accompanied by marked increase in roundness of heavy mineral grains, indicate that some of the heavy minerals have their source outside the Sixes River drainage basin, and were brought into the lower part of the estuary from the beach.

Source rocks which furnish heavy minerals to the Sixes River and its tributaries include sandstone, siltstone, and mudstone of the Otter Point Formation (Jurassic), Rocky Point Formation (Cretaceous), and Umpqua Formation (Tertiary); the Humbug Mountain Conglomerate (Cretaceous); argillite, sandstone, and greenstone in the Galice Formation (Jurassic); quartz-mica schist and phyllite and greenstone in the Colebrooke Schist (Jurassic); glaucophane schist and serpentinite; and volcanic igneous rock of various compositions (Jurassic).

Acknowledgments

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INTERIOR URGES NATIONAL MINERALS POLICY

Hollis M. Dole, Assistant Secretary of the Interior for Mineral Resources, spoke before the Wyoming Mining Association at its convention on June 20 and urged its support for a National Minerals Policy. The following paragraphs are quoted from his address:

On July 9 hearings will begin on S. 719, a bill to establish a National Minerals Policy. This bill, introduced by Senator Allott of Colorado and amongst others cosponsored by Senators Hansen and McGee is, in my opinion, one of the most important bills in Congress with which your Association should be interested. It is not only important to the Wyoming Mining Association and its members, it is important to all the people of Wyoming, and to all the people of the U.S.

The hearings on this bill are important because they provide a forum calling the attention of all the people of the country to the tremendous quantity of mineral raw materials that will be needed in the coming years. You know that to provide this requirement will take years of searching, billions in investment with a high risk factor, and many years of mining effort. You know this -- but unfortunately the man in the street doesn't. He buys his metal in the form of fabricated goods from the store, in accord with his requirements, never realizing that the metal he uses today may have taken many years to get to him.

All forecasts on mineral needs for the future indicate that our industry will be hard pressed to furnish the basic materials that go into the color TV's, cars, air conditioners, boats and the thousands of other items we accept as necessary today and the many new items of tomorrow that will be added to our descendants' everyday living needs. The hearings on S. 719 will be the opportunity to reveal the basic character of the mineral industry, because effort today is needed to prevent constraints on tomorrow's affluence. Unless the man in the street recognizes that his future is at stake in the minerals industry, he will continue to underestimate your requirements. The result will be ever-increasing restraints on exploration and mining, a greater dependence on overseas sources of supply with its accompanying erosion of national security and a continuing decline in the number and calibre of students studying earth sciences in our universities. Perhaps the latter is the most important problem, for it is going to take keen and imaginative minds to provide for the future. If you think getting a man on the Moon is glamorous, look at what is being currently planned or is on the drawing boards for the mineral industry; nuclear stimulation for gas, nuclear fracturing followed by leaching for copper, in situ retorting of oil shale, combustion drive for oils liquefaction and gassification of coal, offshore mining, offshore drilling in thousands of feet of water, rapid excavation underground, use of nuclear explosives to open new gas and oil fields in the West, mine mouth power generation, recovery of uranium from mine wastes, and new methods of determining open pit mine stability; and Wyoming can take pride in the fact that it is to be the site for several of these experiments.

So I urge you, join with me in giving wholehearted support and full testimony at the hearings to be held on our National Minerals Policy. If you can't attend, submit written statements, for I warn you, if due significance isn't given to the real value of our mineral industry today -- the minerals shortages could well become a social problem of the future. (American Mining Congress Memorandum, June 23, 1969.)

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ASSESSMENT WORK DEADLINE NEARS

Assessment work on claims located on the Public Domain must be completed by the end of the assessment year, which is September 1st. At least $100 worth of labor and supplies must be expended on each located claim each assessment year. The work must be of benefit to the claim. Where several claims in a group either side-line or end-line each other, all of the assessment work may be done on one claim, provided that the work is of benefit to all of the claims. Immediately upon completion of the work a Proof of Labor affidavit should be completed and filed at the County Court House for the county in which the claim is located. Mining claimants having claims located on O & C lands or power sites which are administered by the U.S. Bureau of Land Management must send a copy of the affidavit to the Bureau's Oregon State Office, P. O. Box 3965, Portland, Oregon 97208.

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MINERAL AND WATER RESOURCES OF OREGON PUBLISHED

"Mineral and Water Resources of Oregon," prepared by the U.S. Geological Survey in cooperation with the State of Oregon Department of Geology and other agencies, is expected to be available by the end of this month and will sell for $1.50. It can be obtained from the Department's offices in Portland, Baker, and Grants Pass.

The 462-page book contains two sections. Section 1, Geology and Mineral resources, describes the geology of Oregon and presents information on the known and potential mineral resources. Section 2, Water Resources and Development, deals with quantity, quality, and distribution of surface and ground water and with its utilization. The report is one of a series of state mineral and water resource summaries prepared for use of the U.S. Senate Committee on Interior and Insular Affairs, and now made available to the public. The Oregon report was commissioned by Senator Mark O. Hatfield. A. E. Weissenborn, U.S. Geological Survey, Spokane, Wash., was in charge of assembling, organizing, and editing the contents. Many authors, including geologists and engineers with the Department, contributed to the report, which is being issued as Department Bulletin 64.

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ANDESITE PROCEEDINGS PRINTED

"Proceedings of the Andesite Conference," edited by Dr. A. R. McBirney, Head of the Department of Geology at the University of Oregon, has been published by the State of Oregon Department of Geology and Mineral Industries as Bulletin 65, and will soon be available for distribution at $2.00 per copy. The 200-page bulletin contains a group of papers representative of the topics and views discussed at the Andesite Conference held July 1968 in Bend, Oregon. The bulletin can be purchased from the Department's offices in Portland, Baker, and Grants Pass. A companion volume, Bulletin 62, "Andesite Conference Guidebook," containing geologic maps and photographs, is also available and sells for $3.50.

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AVAILABLE PUBLICATIONS

(Please include remittance with order. Postage free. All sales are final and no material is returnable. Upon request, a complete list of the Department's publications, including those no longer in print, will be mailed.)

BULLETINS

2.	Progress report on Coos Bay coal field, 1938: Libbey	$ 0.15
8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
27.	Geology and coal resources of Coos Bay quad., 1944: Allen and Baldwin .	1.00
33.	Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin .	3.00
36.	Vol. 1. Five papers on western Oregon Tertiary foraminifera, 1947: Cushman, Stewart, and Stewart	1.00
	Vol. 2. Two papers on foraminifera by Cushman, Stewart, and Stewart, and one paper on mollusca and microfauna by Stewart and Stewart, 1949	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch . .	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
53.	Bibliography (3rd supplement) of the geology and mineral resources of Oregon, 1962: Steere and Owen	1.50
56.	Fourteenth biennial report of the State Geologist, 1963-64	Free
57.	Lunar Geological Field Conference guide book, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass .	5.00
60.	Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole, editor	3.50
63.	Sixteenth Biennial Report of the State Geologist, 1966-68	Free
64.	Mineral and water resources of Oregon, 1969	1.50
65.	Proceedings of the Andesite Conference, 1969: McBirney, editor . . .	2.00

GEOLOGIC MAPS

Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others . .	0.40
Geologic map of Kerby quadrangle, Oregon, 1948: Wells, Hotz, and Cater . . .	0.80
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bull. 37) .	0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker. . . .	1.00
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts . . .	0.75
Geologic map of Bend quadrangle, and reconnaissance geologic map of central portion, High Cascade Mountains, Oregon, 1957: Williams. . .	1.00
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka . .	1.50
GMS-2: Geologic map, Mitchell Butte quad., Oregon, 1962: Corcoran et al..	1.50
GMS-3: Preliminary geologic map, Durkee quad., Oregon, 1967: Prostka . .	1.50
Geologic map of Oregon west of 121st meridian: (over the counter) . . . . . folded in envelope, $2.15; rolled in map tube, $2.50	2.00
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat . folded in envelope, $2.25; rolled in map tube, $2.50	2.00

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Available Publications, Continued:

SHORT PAPERS

2.	Industrial aluminum, a brief survey, 1940: Motz	$ 0.10
18.	Radioactive minerals the prospectors should know (2nd rev.), 1955: White and Schafer	0.30
19.	Brick and tile industry in Oregon, 1949: Allen and Mason	0.20
20.	Glazes from Oregon volcanic glass, 1950: Jacobs	0.20
21.	Lightweight aggregate industry in Oregon, 1951: Mason	0.25
23.	Oregon King mine, Jefferson County, 1962: Libbey and Corcoran	1.00
24.	The Almeda mine, Josephine County, Oregon, 1967: Libbey	2.00

MISCELLANEOUS PAPERS

2.	Key to Oregon mineral deposits map, 1951: Mason	0.15
3.	Facts about fossils (reprints), 1953	0.35
4.	Rules and regulations for conservation of oil and natural gas (rev. 1962)	1.00
5.	Oregon's gold placers (reprints), 1954	0.25
6.	Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton	1.50
7.	Bibliography of theses on Oregon geology, 1959: Schlicker	0.50
7.	(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts	0.50
8.	Available well records of oil & gas exploration in Oregon, rev. '63: Newton	0.50
10.	Articles on Recent volcanism in Oregon, 1965: (reprints, The ORE BIN)	1.00
11.	A collection of articles on meteorites, 1968: (reprints, The ORE BIN)	1.00
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	Free

MISCELLANEOUS PUBLICATIONS

Oregon mineral deposits map (22 x 34 inches), rev. 1958	0.30
Oregon quicksilver localities map (22 x 34 inches), 1946	0.30
Landforms of Oregon: a physiographic sketch (17 x 22 inches), 1941	0.25
Index to topographic mapping in Oregon, 1961	Free
Geologic time chart for Oregon, 1961	Free

OIL and GAS INVESTIGATIONS SERIES

1.	Petroleum geology of the western Snake River basin, Oregon-Idaho, 1963: Newton and Corcoran	2.50