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The Ore Bin

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NICKEL-BEARING STREAM SEDIMENTS FROM SOUTHWESTERN OREGON

Introduction

An anomalously high nickel content has recently been found in some of the stream-sediment samples collected by the Department in southwestern Oregon. The samples are from streams draining areas of known ultramafic rocks, the largest of which is the Josephine ultramafic sheet (figure 1), in south-east Curry and southwest Josephine Counties. Since only a few of the many samples collected from streams draining the ultramafic rocks were high in nickel, it was reasoned that the anomalous samples were derived from areas of relatively high nickel content within the ultramafic mass. It was felt that if concentratable nickel-bearing minerals could be found in the samples, the area might warrant exploration for possible economic deposits.

Geology of the Josephine Ultramafic Sheet

The Josephine ultramafic sheet is composed chiefly of an olivine-rich harzburgite with lesser amounts of pyroxenite and dunite. Large areas of this ultramafic mass have been serpentinized to varying degrees. Serpentinite is concentrated along the margins of the body in fault zones and around later intrusives, which include gabbro and diorite stocks and diabasic and dacitic dikes. The thickness of the ultramafic sheet is not known; Wells and others (1949, p. 10) state that it probably does not exceed 15,000 feet.

Preliminary Sampling and Testing

The Department conducted a stream-sediment sampling program from 1963 to 1967, sampling more than 3,000 sites in southwestern Oregon. The sediments collected were initially analyzed for copper, zinc, molybdenum, and mercury. Splits of all these samples were run by semiquantitative spectrographic analysis for 30 elements by the U.S. Geological Survey's Denver laboratory. The results were released as an open-file report with maps in 1969 (Bowen, 1969). The high nickel values were recognized as a result of the spectrographic analyses. Samples considered anomalous are those with 3,000 or more parts per million nickel (see Table 1).

Because of its high nickel content and accessibility, locality No. 28

FIGURE 1

Generalized Outline of Josephine Ultramafic Sheet Showing Locations of Anomalous Nickel Samples

x Sample sites.

960 Sample sites with 3,000 or more p.p.m. Ni.

Peridotite and Serpentinite.

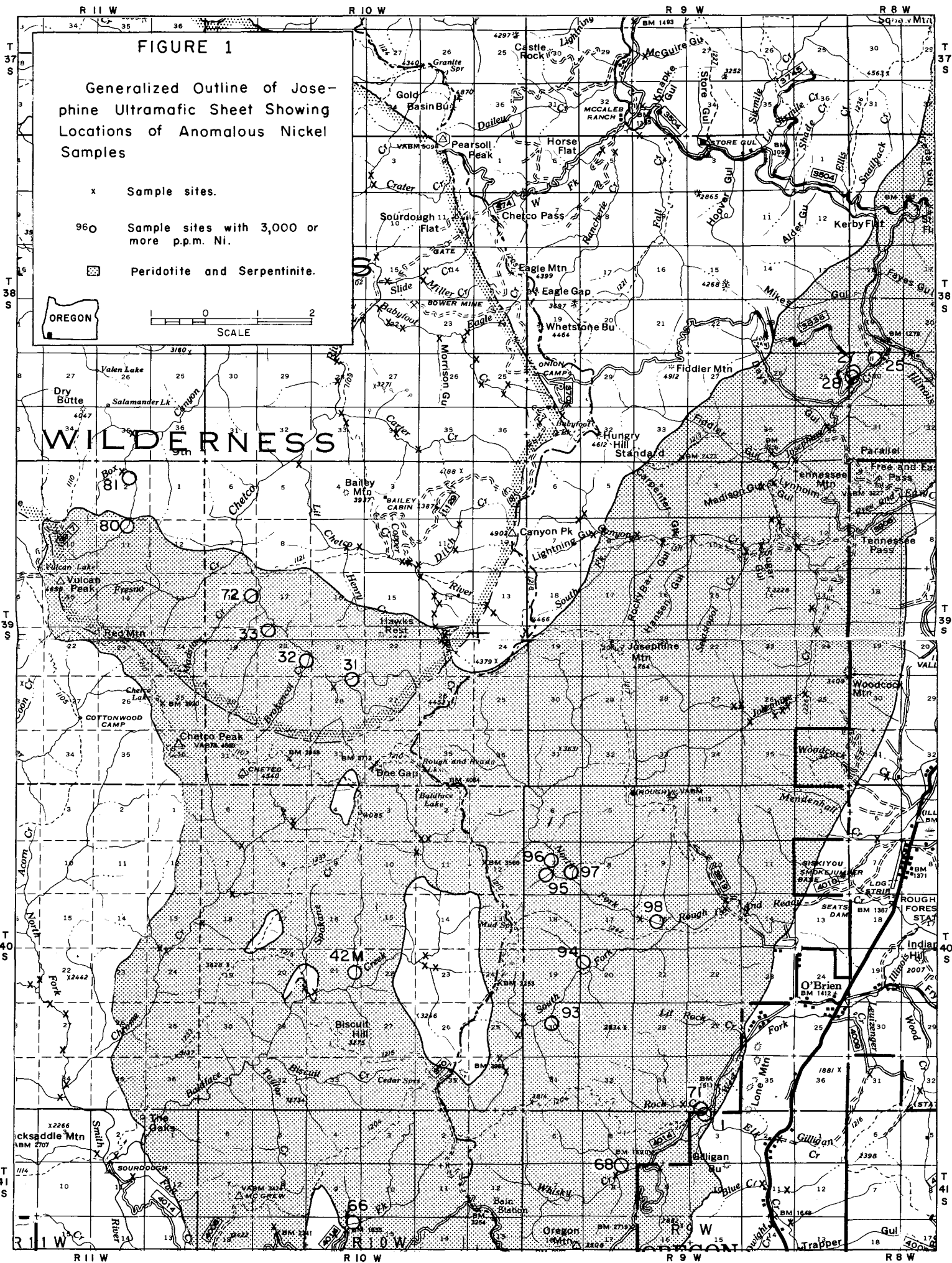
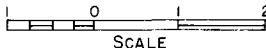


Table 1. Anomalous nickel samples.

	Sample No.	Name of Creek		Location			Ni (ppm)	
				Sec.	T.S.	R.W.		
224	Gold Beach	24*	S. Trib. Hunter Creek	NW	18	37	13	5,000
	Chetco Peak	93	S. Trib. S. fk. Rough & Ready	N $\frac{1}{2}$	30	40	9	5,000
	Chetco Peak	94	N. Trib. S. fk. Rough & Ready	NW	20	40	9	5,000
	Chetco Peak	95	S. Trib. N. fk. Rough & Ready	SW	7	40	9	5,000
	Chetco Peak	96	N. fk. Rough & Ready	C	7	40	9	3,000
	Chetco Peak	97	N. Trib. N. fk. Rough & Ready	SE	7	40	9	5,000 +
	Chetco Peak	98	N. fk. Rough & Ready	NW	16	40	9	3,000
	Chetco Peak	66	Diamond Creek	NE	16	41	10	3,000
	Chetco Peak	68	Trib. Whiskey Creek	NE	8	41	9	3,000
	Chetco Peak	71	Rock Creek	SW	34	40	9	5,000
	Chetco Peak	72	Madstone Creek	E $\frac{1}{2}$	18	39	10	3,000
	Chetco Peak	80	Box Canyon Creek	N $\frac{1}{2}$	11	39	11	5,000
	Chetco Peak	81	Trib. Box Canyon Cr.	NE	2	39	11	3,000
	Chetco Peak	31	Chetco River (head)	N $\frac{1}{2}$	28	39	10	3,000
	Chetco Peak	32	Broken Cot Creek	SE	20	39	10	3,000
	Chetco Peak	33	Un-named trib. Chetco River	NW	20	39	10	3,000
	Chetco Peak	1	Rock Creek	NW	3	41	9	3,000
	Chetco Peak	42M	Un-named trib. to Baldface Creek	SE	21	40	10	3,000
	Cave Junction	25	Un-named trib. Josephine Creek	N $\frac{1}{2}$	30	38	8	3,000
	Cave Junction	27	Un-named trib. Josephine Creek	W $\frac{1}{2}$	30	38	8	3,000
Cave Junction	28	Un-named trib. Josephine Creek	W $\frac{1}{2}$	30	38	8	5,000	

* Not on the map.

Table 2. Nickel analyses of reference group stream sediments,
Cave Junction quadrangle.

Sample No.	Name of Creek	Location				Nickel analyses (wet chemical)	Spectro- graphic (ppm)
		Sec.	TS.	RW.	percent (USBM)	(USGS)	
17	E. Fk. Chapman Cr.	SE	24	39	8	0.025	500
28	Trib. Josephine Cr.	W $\frac{1}{2}$	30	38	8	0.41	5,000
44	Little Elder Cr.		43	40	8	0.066	700
67	Trib. Josephine Cr.	NW	24	39	9	0.12	1,500
87	N.Trib. Josephine Cr.	W	26	39	9	0.18	2,000
97a	Trib. Althouse Cr.	SE	3	41	7	0.10	1,000
98a	Johnson Gulch	NE	10	41	7	0.11	1,000

was resampled, and nearly all of the subsequent work was done on bulk samples from that locality. Preliminary testing by the Department, which included screening, gravity concentration, and magnetic separation, failed to show significant variations in nickel values.

The Department then requested Jack C. White of the U.S. Bureau of Mines in Albany, Oregon to perform characterization and mineral dressing tests on the sediments from locality No. 28. The first step was to compare the high nickel sample with standard samples. Sediments low in nickel from nearby streams, some of which drained ultramafic areas, were analyzed by wet-chemical methods at the Bureau of Mines to establish reference samples with which to compare the high nickel material. Table 2 shows that sample No. 28 contained more than twice as much nickel as any other sample in the reference group.

Analytical Tests by U.S. Bureau of Mines

Petrographic examination of screen sized fractions shows that all fractions, including the minus 200 mesh material, consist predominantly of fine-grained rock fragments. Only a small percentage of discrete mineral particles was present in any size fraction, indicating that little or no concentration of a single mineral can be expected by size classification. Nickel percentages and distribution are shown in Table 3. Nickel was not significantly concentrated in any size fraction.

A polished briquette of the 10/20 mesh size fraction was examined petrographically and was analyzed by electron microprobe to identify nickel minerals and to indicate the possibility of physically beneficiating the material. Although serpentine rock fragments were the most abundant constituent in this size fraction, nickel was identified in at least three phases

Table 3. Nickel distribution in screen sized products.

Size, Tyler mesh	Weight, percent	Nickel analysis, Nickel distribution, percent			
10/20	44.68		0.41		44.69
20/35	27.14		0.41		27.15
35/65	15.49		0.39		14.74
65/150	7.05		0.41		7.05
150/200	1.79		0.47		2.05
Minus 200	<u>3.85</u>		<u>0.46</u>		<u>4.32</u>
Total	100.00	Calculated head	0.41	Total	100.00

by electron microprobe analysis.

Serpentine grains contain approximately 0.2 percent nickel in isomorphous substitution and a few scattered minute high-nickel inclusions. Probably more than half the nickel in this sample occurs in the silicate crystal lattice and, therefore, cannot be concentrated by physical beneficiation.

A small percentage of manganese oxide - iron oxide grains containing higher percentages of nickel and some cobalt were present. Such oxides are precipitated during weathering and leaching (laterization) of nickel-bearing ferromagnesian rocks (Rankama and Sahama, 1950, p. 684). Concentration of similar manganese oxide minerals by attrition scrubbing and sizing of Philippine laterite is described in Bureau of Mines Report of Investigations 6063 (Banning and others, 1962). The published data indicate that manganese oxides occur as small segregations within weathered nickel-bearing rocks rather than as massive deposits. The oxide grains should, therefore, be considered as small, high-grade segregations from a low-grade deposit rather than as small pieces of a larger high-grade deposit.

Electron microprobe analyses from high-nickel and low-nickel areas are given in Table 4.

A back-scattered electron photograph and X-ray scans of an oxide grain are shown in Figure 2. The back-scattered electron photograph seems to show relict structure of a mineral that has been replaced. Coincidence of manganese and nickel indicates codeposition of these two metal oxides. Iron occurs as a thin surface coating and in low Mn-Ni areas within the grain.

An additional nickel-bearing phase is nickel-iron sulfide which occurs as a few scattered inclusions within serpentine grains.

Possibilities of physically beneficiating this material appeared to be remote; however, concentrations of nickel and cobalt in oxide particles and the presence of nickel-iron sulfides indicated that preliminary laboratory

Table 4. Electron microprobe analyses of two areas in an oxide grain.

Element	Percent	
	High nickel area	Low nickel area
Manganese	25	12
Iron	10	28
Nickel	12	3.5
Cobalt	2	1.5
Aluminum	5	5
Silicon	2	8
Magnesium	<1	<1

mineral dressing tests were justified.

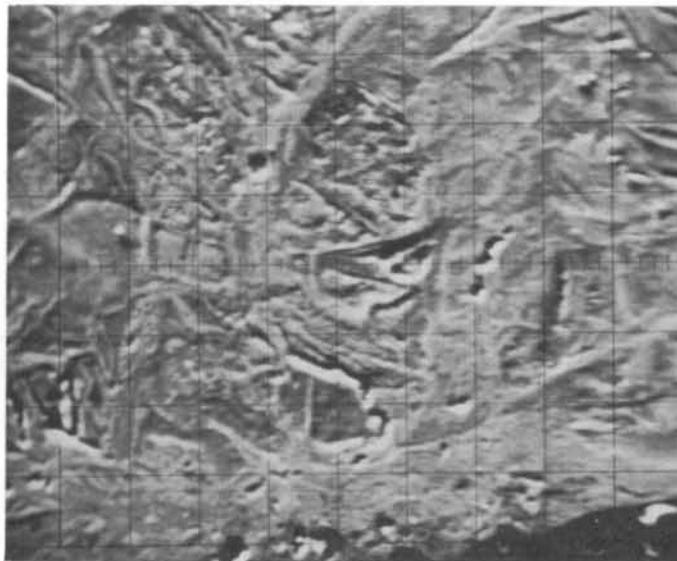
A 500-gram sample was stage ground through 325 mesh to liberate nickel sulfide minerals and a froth flotation test was made on the ground material in an attempt to concentrate the sulfide minerals. Potassium amyl xanthate was used as collector (Table 5).

Nickel was not concentrated by froth flotation indicating that very little nickel is present in the form of sulfide minerals, a conclusion which is in agreement with the microprobe data.

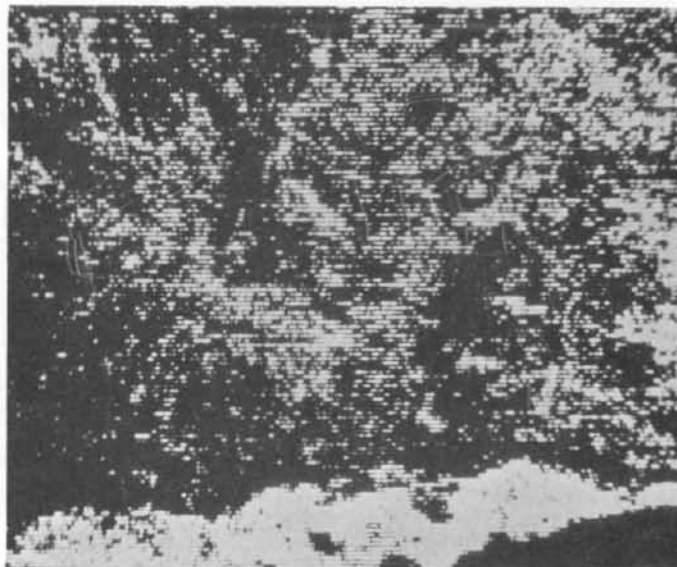
The discrete manganese oxide - iron oxide grains offered the possibility of magnetic concentration. A series of magnetic products was made with a hand magnet and the Frantz electromagnetic separator. The products are listed in Table 6 in decreasing order of magnetic susceptibility. The 0.2 amp product contains 33 percent of the sample weight and 48 percent of the nickel in the sample. This slight concentration of nickel would not be of commercial interest at the present time.

Table 5. Flotation products from the ground stream sediment sample.

Product	Weight, percent	Nickel analysis, percent		Nickel distribution, percent	
Concentrate A	1.40		0.43		1.43
Concentrate B	1.54		0.45		1.64
Concentrate C	2.44		0.45		2.61
Tailing	94.62		0.42		94.32
		Calculated			
Total	100.00	head	0.42	Total	100.00

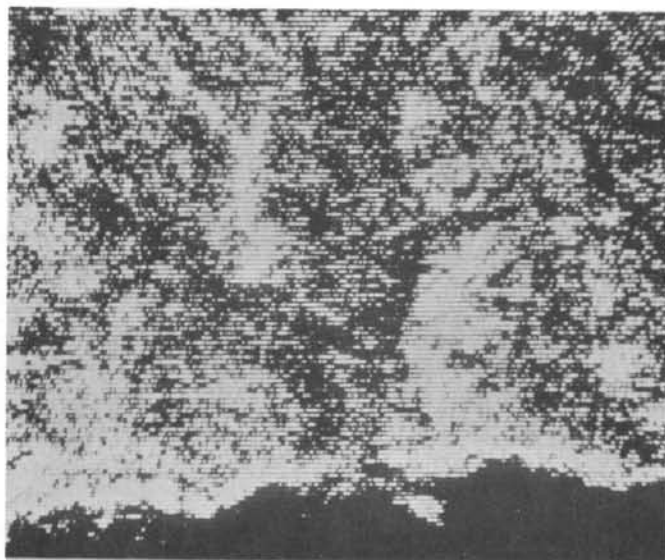


Backscattered electrons

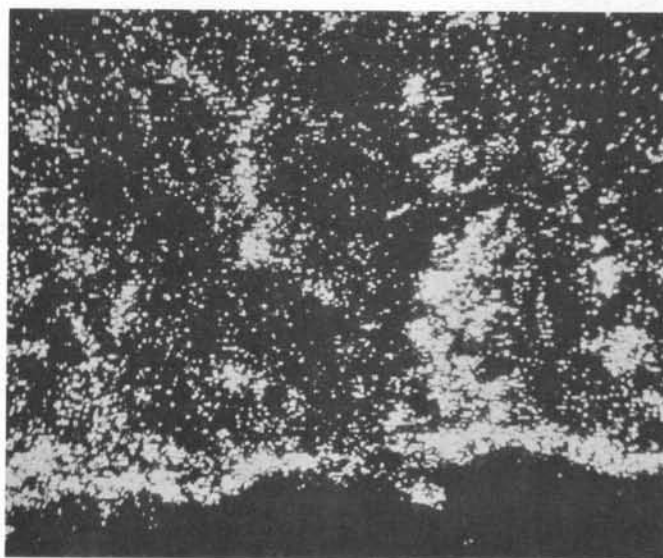


Iron

Figure 2. Electron microprobe scans of a manganese oxide - nickel oxide grain. Pictures are 275μ wide (original magnification before reduction for printing was 350 x). (Above and opposite)



Manganese



Nickel

Table 6. Magnetic products from stream-sediment sample No. 28.

Product	Weight, percent	Nickel analysis, percent	Nickel distribution, percent
Hand magnet	20.46	0.32	19.53
0.2 amp	33.00	0.49	48.24
0.3 amp	8.89	0.35	9.28
0.5 amp	15.74	0.28	13.15
Non-magnetic	<u>21.91</u>	<u>0.15</u>	<u>9.80</u>
		Calculated	
Total	100.00	head 0.335	Total 100.00

Conclusions

Although the data developed here suggest that beneficiation of the material is impractical or impossible, it should be pointed out that these tests were run on only one of the several anomalous nickel sample localities. The Department believes that further investigation of other high-nickel sample areas may be justified.

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- Bowen, R. G., 1969, Geochemical stream-sediment sampling in southwestern Oregon: Oregon Dept. Geology and Mineral Industries open-file rept.
- Rankama, Kalervo, and Sahama, Th. G., 1950, Geochemistry: Univ. of Chicago Press.
- Wells, F. G., Hotz, P. E., and Cater, F. W., Jr., 1949, Preliminary description of the geology of the Kerby quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 40.

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PLIOCENE MAMMAL STUDY PUBLISHED

"Pliocene Mammals of Southeast Oregon and Adjacent Idaho," by J. Arnold Shotwell, has been published as Bulletin 17 by the Museum of Natural History, University of Oregon. The bulletin can be ordered from the Museum. The price is \$2.00.

* * * * *

"SPATTER CONE PITS"
SAND MOUNTAIN LAVA FIELD, OREGON CASCADES

By Jim Nieland*

Three "spatter cone pits" in the Cascade Range of Oregon were explored in 1970 by the Oregon Grotto of the National Speleological Society. The pits are situated in the Sand Mountain Lava Field, an area of recent volcanism between Santiam Junction and Belknap Crater (figure 1).

The Oregon Grotto group was prompted to explore the area by an article in the July 1965 ORE BIN, "Recent volcanism between Three Fingered Jack and North Sister, Oregon Cascade Range," by Edward M. Taylor. Taylor describes three areas of the Sand Mountain alignment that contain vertical conduits ("spatter cone pits"). Two areas are located at the foot of Nash Crater -- one on the south side and one on the northwest side. The third area is associated with a vent half a mile southwest of the Sand Mountain Cones.

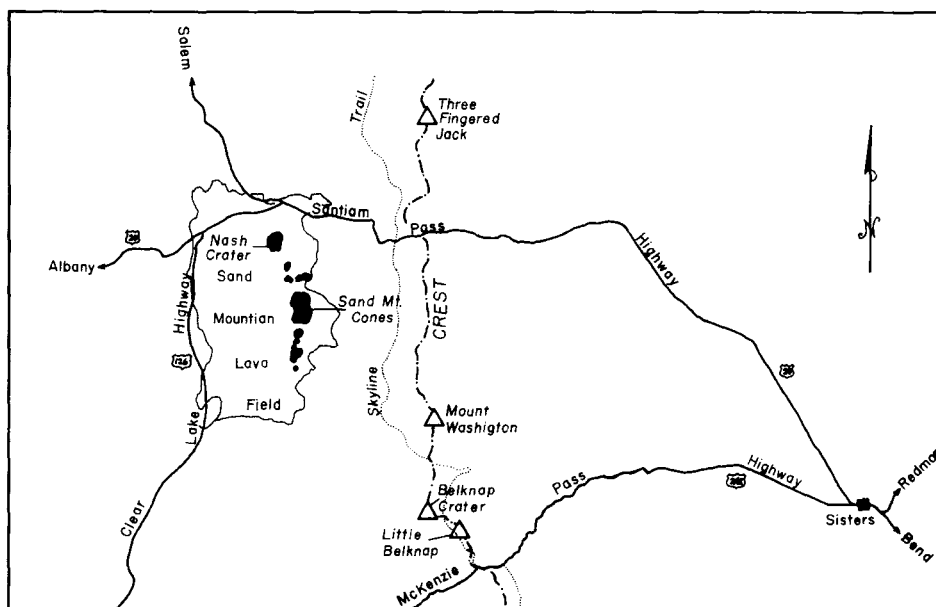
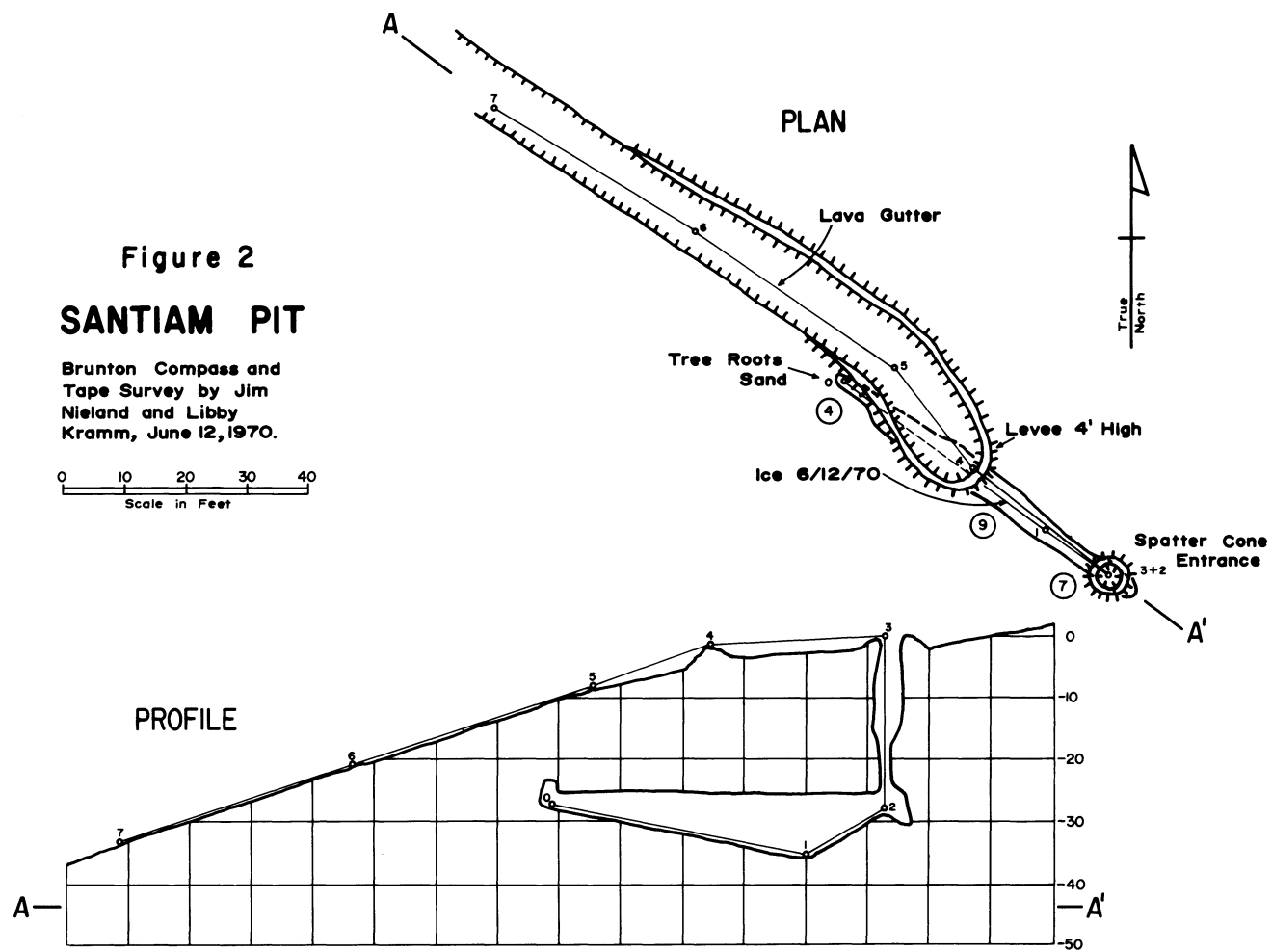
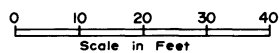


Figure 1. Index map showing location of the Sand Mountain Lava Field (adapted from Taylor, 1965).

* Geology student, Portland State Univ., and member the Oregon Grotto.

Figure 2
SANTIAM PIT

Brunton Compass and
Tape Survey by Jim
Nieland and Libby
Kramm, June 12, 1970.



"Spatter cone pits" (a term adopted for these features by the writer) are formed by the accumulation of lava spatter around a vertical conduit or vent. Originally all spatter cones probably had an open vent, but the majority of the vents have been plugged by later lava or filled by debris from weathering of the conduit walls.

Because of their depth, some of the pits are potentially very dangerous to enter. It is suggested that future investigators take extreme caution in exploring them. None of the pits can be entered safely without full vertical gear.

Nash Crater Area

Santiam Pit

Only one of the Nash Crater conduits has been investigated. It is located approximately 200 feet northwest of a broad depression rimmed with spatter at the northwest base of Nash Crater. A 5-foot spatter cone surrounds a 30-foot-deep pit (Santiam Pit) which connects with a 50-foot lava-tube segment (see figure 2). At the time of the investigation, the lava tube was blocked at its western end by sand fill and at its eastern end by debris which had fallen in through the entrance pit. Ice was found at the lowest point in the tube and a cone of snow remained at the foot of the pit when visited on June 12. At the surface, immediately down slope from the spatter-cone entrance, a lava gutter is oriented over the trend of the underlying lava tube.

Sand Mountain Area

The Sand Mountain pits (Century and Moss Pits) are located in the vent area of the Clear Lake Lava Flow, half a mile southwest of Sand Mountain Cones. The vent area consists of an east-west-oriented ridge about 1,000 feet long (figure 3). At its western end is a circular pit about 50 feet in diameter, which displays several flow units and probably represents a collapse depression over a lava source. A smaller pit 200 feet to the east separates the collapse depression from a spatter ridge 600 feet long. The west end of this ridge contains a shallow crater 30 feet in diameter (Taylor, 1965). Along the crest of the spatter ridge there are two "spatter cone pits," 4 and 8 feet in diameter and as much as 94 feet deep.

Moss Pit

The westernmost pit (Moss Pit) is about 8 feet in diameter at the surface and 63 feet in depth (figure 4). The floor at the eastern base of the pit slopes steeply downward another 10 feet, giving the pit a total depth of 73 feet.

Figure 3
CENTURY AND MOSS PITS

BRUNTON COMPASS AND TAPE
SURVEY BY JIM NIELAND, LIBBY
KRAMM AND STEVE KNUTSON.
SEP 23, 1970.

0 10 20 40 60 80 100 200 FEET

54" DISTANCE BELOW SURFACE

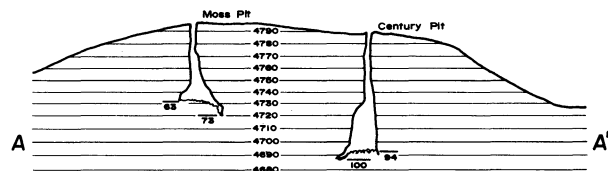
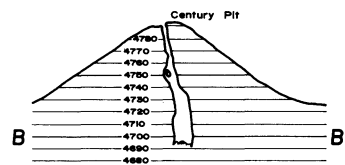
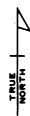




Figure 4. James H. Wolff beginning descent into Moss Pit, one of several "spatter cone pits" investigated in an area of recent volcanism between Santiam Junction and Belknap Crater.

Century Pit

The entrance of Century Pit, located 145 feet to the east of Moss Pit, is surrounded by a 2-foot-high wall of spatter. The pit is vertical to almost vertical over its entire 94-foot depth. The pit narrows somewhat at a point 25 feet below the surface, but bells out at greater depth to form a room 10 feet wide and 25 feet long at the bottom. At the western end of this room, a small opening leads downward an additional 6 feet, where it is blocked by breakdown. A strong current of air issued from the breakdown of this opening, when visited on September 23. The total depth of the pit, including the small hole at the bottom, is 100 feet, making it the deepest pit presently known in Oregon.

Age of the Pits

The approximate time when these "spatter cone pits" formed can be determined from the age of the lava flows with which they are associated.

The Clear Lake Lava Flow, which issued from the vent area near Sand Mountain, is approximately 2,950 years old B.P., as determined by radiocarbon dating of wood submerged in Clear Lake at the foot of the flow (Benson, 1965). This establishes a similar age for the Sand Mountain pits (Century and Moss Pits). The Lava Lake Flow, part of which issued from the vent at Santiam Pit, is estimated by Taylor (1965) to have occurred approximately 3,470 years ago B.P. This indicates that the Santiam Pit is about 500 years older than the Century and Moss Pits.

References

- Benson, G. T., 1965, Age of Clear Lake, Oregon: The ORE BIN, v. 27, No. 2, p. 37-40.
- Taylor, E. M., 1965, Recent volcanism between Three Fingered Jack and North Sister, Oregon Cascade Range: The ORE BIN, v. 27, No. 7, p. 121-147.

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EARTHQUAKE LEAFLETS AVAILABLE FROM USGS

Four pamphlets on earthquakes, written in a nontechnical style, are available free upon request from the U.S. Geological Survey, Department of the Interior, Washington D.C., 20242. The pamphlets are titled: "Safety and survival in an earthquake," "Earthquakes," "The San Andreas Fault," and "Active faults of California." The pamphlets contain information about the origin and nature of earthquakes and describe procedures that might be taken before, during, and after an earthquake.

* * * * *

ENGINEERING GEOLOGISTS HOLD CONFERENCE

Herbert G. Schlicker, Department engineering geologist, attended the annual meeting of the Association of Engineering Geologists in Washington, D. C., October 20-24, 1970. The conference, the 13th for the organization, had as its theme "Engineering Geology and Man's Environment." Included were two days of field trips, a day of technical sessions, and a day devoted to a symposium entitled "Geological and Geographical Problems of Areas of High Population Density," with participants from universities and consulting firms in France, England, The Netherlands, Sweden, Wales, and Japan.

* * * * *

LAND AS A BASE*

By Ralph S. Mason**

For the purpose of our discussion today geology may be defined as the "Study of the earth, the natural forces at work on it, its composition, structure, and mineral wealth." In a similar manner, land-use planning may also be defined as the "Study of the earth, its capabilities and limitations with respect to the needs of man and the environment."

Geology involves the study of the distribution and thickness of surface and subsurface rock types and structures; the engineering characteristics of soil and rock; the porosity, permeability, depth to water table and the factors influencing the water table; the prevalence or absence of geologic hazards such as landslides and faults; the potential for consecutive conservation (including determination of mineral resources and secondary and tertiary uses for mined lands); the relative sensitivity of the land to attack by man (this includes nearly everything that man does); and the best means of minimizing such damage.

Land-use planning is being, and always will be, stretched by three main forces - economics, politics, and environment. We must conduct our day-by-day activities at a profitable level. We must live, work, and plan together under guidelines established at the political level. Lastly, we must see that neither of these forces overrides the need for preservation of the environment. Of the three, the last is by far the most important despite our almost complete attention for the past 7000 years to the first two only.

Clearly, we must reorient our priorities. We have been taking the easy way out, at the expense of the environment, for far too long. Man's future activities will have to be completely planned on a full cycle basis. Such planning will sooner or later include every facet of our existence, including but certainly not limited to such diverse items as: strict maximum population controls; complete reuse of all waste products; stabilization of air, water, and vegetative resources; complete, or very nearly complete, recycling of most mineral products; restriction of all power generation to sources using solar, geothermal, or, in a few cases, hydro energy; and a complete appraisal of the total capabilities and liabilities of all land and water areas followed by mandatory "best use" of these areas.

Fortunately for man, certain segments of our environment have the

* Presented at "Land Investment for a Future Environment," Marion Motor Hotel, Salem, Oregon, October 16, 1970; third in a series of conferences.

** Mining Engineer, Oregon Department of Geology & Mineral Industries.

ability to recover from the assaults made upon them. Our air, water, and vegetative resources exist today largely because they can "fight back," but even with this recuperative ability they are severely damaged. Large areas of our land surface have suffered irreversible harm, due in part to denudation of the vegetative cover and in many cases to total disregard of basic geologic principles. Our reserves of ground water have been depleted in many areas and threatened with contamination in others, and again ignorance of geologic conditions is often to blame.

It is difficult to equate the organic with the inorganic, the animate with the inanimate, and the renewable with the nonrenewable. But it is just this difficulty that is leading us into yet one more environmental blind alley. Our mineral resources are mostly inorganic, totally lifeless, and certainly not reproducible. Furthermore, they rarely have the charismatic potential that wildlife, trees, and running water so spontaneously generate.

Friends of mining and the mineral industry are few, but the consumers of their products include every living man, woman, and child on the face of the earth during their entire lifetimes. With little public interest and even less support and understanding, it is no wonder that we have plundered our mineral resources, taking only the very richest of the ores, fabricating them into myriads of forms, using them once and then discarding them. Our environment is suffering at all levels from the lack of public concern that has been applied to the production of our mineral resources, their processing into usable materials, and their eventual disposal in the most convenient manner.

A clearer understanding by the public and particularly by bodies of government of the over-all economics of our mineral resources is necessary before any effective steps can be taken to solve this rapidly magnifying problem. We are exhausting known mineral reserves at an ever-increasing rate, and yet the latest figures available show that we are graduating less than 150 mining engineering students a year in this country - and half of them are from foreign countries. Basic geological mapping, the necessary predecessor to the discovery of large, low-grade mineral deposits and to all land-use planning by state and federal agencies, is falling far behind and little hope of any change is apparent. Importing foreign ores is becoming increasingly common, but the adverse effects on our balance of payments and dependence on distant and perhaps not friendly suppliers at some future time pose serious question marks.

The beneficiation, smelting, refining, and fabricating of raw mineral ores leave much to be desired, although the industry has made great strides in recent years. Controls by pollution-abatement agencies have been enforced at the back door of the plant, rather than at the front. A totally new approach to the problem of gaseous, liquid, and solid wastes produced by these plants must be made in cooperation with industry, local, state and federal governments, and the public. The presence of industry is vital to any community and the current attitude so often expressed by many people

of "You can't do it here - go somewhere else" is patently fallacious, irresponsible, and ethically wrong. We cannot expect someone else to do our dirty work for us. Solutions are possible but public hysteria and ignorance by governing bodies have no part in this critical decision-making process.

Our handling of waste metals and minerals also requires a comprehensive understanding of basic geologic concepts. It makes little economic or environmental sense to mine minerals, refine and fabricate them, use the end products once, and then pitch them out. We are running out of raw material on the one hand and polluting the countryside on the other. Just possibly we might be able to survive the effects of continued dumping, but parts of the mineral pipeline are going to run dry before long, unless we start reusing our waste materials. Substitutes are available - at a price. The economic geologist is constantly looking for new minerals to fill old needs, but substitutes often impose compromises. The mining engineer is faced with the problem of extracting ore of lower and lower grade in steadily increasing quantities. Modern copper mines are digging ore containing as little as 12 pounds of copper per ton - and moving more than 300,000 tons of ore and waste per day. What will we do when we are forced to mine ore containing only 6 pounds of copper?

Although our ultimate goal, as a hopefully viable society in the years to come, should be the total reuse of all our waste, this is not likely to be achieved - at least not immediately. Some mineral, chemical, and nuclear wastes will have to be stored until they can be reclaimed. The storage period might conceivably extend over many months or years. The storage of these materials will in most cases be in a totally geological environment - a hole in the ground. Just where these holes are to be located is already claiming the attention of our geologists. This is no simple task. There is no lack of suitable places for burying all kinds of wastes - if the geologic factors were the only consideration. Objections have already been raised, however, by residents of various communities which have been "offered" a waste-disposal facility. The alarm is not based on scientific principles nearly as much as on purely sociologic ones - Community "A" does not want to become the dumping ground for Community "B."

Solutions to all of these problems are possible with the expertise available. The cost will be staggering. Regardless of the expense, we must make a concerted start now. Regardless of our feelings, we must base our decisions on facts and these will have to come from the earth itself, the workshop of the geologist.

* * * * *

Engineering geologists estimate that permafrost -- permanently frozen ground -- underlies about 20 percent of the entire land surface of the world.

THERMAL SPRING AND WELL MAP PUBLISHED

A map of the State of Oregon showing the location of thermal springs and wells has been published as Miscellaneous Paper 14 and is now available from the Department offices in Portland, Baker, and Grants Pass. The price is \$1.00.

The information for the map (scale 1" = 16 mi) was compiled by R.G. Bowen and N.V. Peterson, Department geologists. In addition to showing the location of all known thermal springs and wells, the map gives pertinent data about each locality, such as maximum temperature, rate of flow, utilization, and references to literature. In general, the definition of "thermal" waters used by other authors is followed -- that is, 15° above the mean annual temperature.

A large part of the compilation came from U.S. Geological Survey Professional Paper 492, by G. A. Waring and others, "Thermal Springs of the United States and Other Countries of the World." Additional sources of information were the various Survey Water-Supply Papers, water well records from the Survey's Ground Water branch office in Portland, and water well records from the State Engineer's office in Salem. Field work consisted mainly of measuring temperatures with a maximum reading thermometer where the temperatures were unknown or believed unreliable.

The map (Misc. Paper 14) is of a preliminary nature, and the Department hopes its publication, in addition to providing basic information, will encourage persons with knowledge of other thermal springs in the state to report the locations, so that more complete data can be issued later.

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DR. OSBORN APPOINTED BUREAU OF MINES DIRECTOR

On October 7, 1970 President Nixon announced his intention to nominate Elburt Franklin Osborn to be Director of the U.S. Bureau of Mines. The appointment has since been confirmed. Dr. Osborn has been vice president for research of the Pennsylvania State University since 1959. Prior to this he served as associate dean and dean, College of Mineral Industries at the University. He is a former director of the American Geological Institute (1956 - 1959), president of the Geochemical Society (1967 - 1968), and president of the Mineralogical Society of America (1960 - 1961). Dr. Osborn holds memberships in 17 professional societies.

Dr. Osborn, 59, received his B.A. at DePauw University in 1932, his master's degree at Northwestern in 1934, and his Ph. D. from California Institute of Technology in 1937. He is a member and past president of both Phi Beta Kappa, Penn State Chapter, and Sigma Xi, Penn State Chapter. He is the author of over 90 published articles.

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PORTLAND TO HOST NORTHWEST MINERALS CONFERENCE

The Pacific Northwest Metals and Minerals Conference will be held in Portland April 5, 6, and 7, 1971. The conference is jointly sponsored by the local sections of AIME, AWS, and ASM.

The conference will include technical sessions covering mining and exploration, nuclear and aerospace metals, industrial minerals, steelmaking, welding, heat treating, and gold and money. Special topics covered in the sessions will include geothermal power, undersea mining, and deep-ocean drilling.

There will be two field trips to the reactive and exotic metals complex in the Albany area and the huge new mine-mouth, coal-fired steam generation power plant near Centralia, Washington.

A full slate of social activities for the delegates and a special series of events for the ladies round out the conference.

Featured speaker will be Hollis M. Dole, Assistant Secretary of the Interior, who will address the delegates at the banquet. Also participating will be a panel of experts on gold who will be coming from as far away as South Africa.

Additional information may be obtained from Ralph S. Mason, 1069 State Office Building, Portland, Oregon 97201.

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LEWIS NAMED USBM LIASON FOR OREGON

Walter E. Lewis has been named U.S. Bureau of Mines liaison officer for Oregon. He has been research director of the Bureau's Twin Cities Mining Research Center, Minneapolis-St. Paul, Minnesota since 1964. He is a graduate mining engineer from Washington State University, and also holds master's and engineer of mines degrees from the University of Missouri, Rolla.

Mr. Lewis started with the Bureau in Minneapolis in 1949 as supervisory mine examination and exploration engineer and transferred to Washington, D.C. in 1955. In Washington his range of duties included Commodity Specialist for Iron, Assistant to the Chief Mining Engineer, Assistant Chief of the Rare and Precious Metals Branch, and Assistant Chief of the Branch of Mining Research. Prior to his employment with the Bureau of Mines, he worked for the U.S. Bureau of Reclamation on the Central Valley Project and in various capacities in the mining industry in Idaho, Montana, Utah, and California.

Mr. Lewis' office is in Suite 7, Standard Insurance Building, 475 Cottage Street N.E., Salem, Oregon; telephone number: 585-1793 (Ext.245).

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UNITED STATES GOVERNMENT MAKES LAST SILVER SALE

The U.S. Treasury Department on November 10, 1970 brought to a close the sale of surplus silver offered through the General Services Administration. Awards of 1,567,899 ounces of silver resulted from the November 10 bid opening. A balance of approximately 23 million ounces remains in the Treasury, of which about 15 million ounces is in bars containing gold and must be refined. The remaining eight million ounces is in various forms and finenesses, most of which would require refining and processing to be of significant commercial values. Since the GSA weekly sales program began on August 4, 1967, the government has sold, through competitive bids, 305 million ounces of surplus silver. Of this total, the Treasury supplied 212 million fine ounces obtained from the melting of silver dimes and quarters. The estimated profit to the government from the sale of silver under this program will be approximately \$147 million.

* * * * *

AGREEMENT REACHED ON EISENHOWER SILVER DOLLAR

Senate and House conferees have reached agreement on the minting of 150 million 40 percent silver Eisenhower dollars. The legislation was attached as an amendment to a bill that would bring one-bank holding companies under federal regulation. Also authorized was production of cupro-nickel dollar and half-dollar coins for general circulation and the sale by GSA of 2.9 million rare silver dollars which have been held in the Treasury for many years.

* * * * *

EDWIN T. HODGE

Dr. Edwin T. Hodge, noted Oregon geologist, died at his home in Portland on November 7, 1970 at the age of 81 years. Dr. Hodge was professor of geology at the University of Oregon and at Oregon State College. He served as consulting geologist for federal, state, and municipal agencies in Oregon and performed geologic investigations throughout the United States and in many foreign countries. As consultant to the U.S. Army Corps of Engineers he located the site for the Bonneville Dam and supervised its foundation work. He is particularly well known for his comprehensive mineral-resource surveys and for his geologic studies of the lower Columbia River and of north-central Oregon. He was a member of many professional organizations and held numerous honorary positions. Dr. Hodge was the founder of the Geological Society of the Oregon Country, which is now in its 36th year.

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INDEX TO THE ORE BIN

Volume 32, 1970

- Ash-flow tuffs, Cenozoic, by G. W. Walker (32:6:97-115)
- Bauxite program, Reynolds to begin (32:7:140)
- Beaulieu, John (Dept. hires stratigrapher) (32:9:181)
- California Div. Mines, Bruer named chief (32:2:36)
- Copper deposits (Homestead area) by T.L. Vallier and H.C. Brooks (32:3:37-57)
- Cove Palisades State Park, Geologic tour of, by N.V. Peterson and E. A. Groh (32:8:141-168)
- Department bulletins, Now or never for some (32:5:96)
- Department programs (32:1:15-20)
- Engineering geologists hold conference (32:12:236)
- Environment, Course in scheduled (32:3:59)
- Field work in Oregon (32:1:9-13)
- Fossils - Ancient Acacia wood, by Irene Gregory (32:11:205-210)
 - Fruits and seeds from Clarno Mammal quarry, by T.M. McKee (32:7:117-132)
 - Microfossils, electron microscope photographs (32:11:216-217)
 - Silicoflagellates, Bandon, by Orr and Weinstein (32:7:133-139)
- Geochemical analyses available on stream sediments, southwestern Oregon (32:6:115)
- Geothermal energy, Bills (How long? How long?) by R. G. Bowen (32:10:202-204)
 - Department geologist attends conference (32:10:204)
 - Greenhouse heating, Lakeview, by Jon Head (32:9:182-183)
 - Steam found in New Mexico (32:11:210)
 - Spring and well map for Oregon published (32:12:240)
- Gold and silver - precious metals predictions (32:9:180-181)
 - Content in water, plants, and animals (32:6:115)
 - Placer gold in Sixes River evaluated (32:9:181)
- Ground-water resource estimated for Oregon (32:4:72)
- Hines, Pierre, An appreciation, by F. W. Libbey (32:2:30-31)
- Hodge, Edwin T. dies (32:12:242)
- "Hole in ground," What to do with (32:4:79)
- Homestead area, Geology and copper deposits, by T. L. Vallier and H. C. Brooks (32:3:37-57)
- Klamath Falls iron meteorite, by E. F. Lange (32:2:21-24)
- K-Ar ages of Laurel Hill pluton, by M. Bikerman (32:11:211-215)
- Land as a base, by R. S. Mason (32:12:237-239)
- Mercury recovery process developed (32:9:179)
- Meteorite, Klamath Falls iron, by E. F. Lange (32:2:21-24)
- Mine where the minerals are (32:4:79-80)
- Mineral industry in Oregon, 1969, by R. S. Mason (32:1:1-5)
- Mineral resource industry - a national dilemma, by R. E. Corcoran (32:9:169)
 - Food for thought in land law report, by S. S. Johnson (32:9:176-178)
 - Mineral resource development, by H. M. Dole (32:9:170-173)
 - Prospects and challenges, by Geo. Mowbray (32:9:173-176)
- Minerals, Naming of, by L. W. Staples (32:4:73-78)
- Nickel-bearing stream sediments of southwestern Oregon (32:12:221-230)
- Oil and gas - Drilling records get computer numbers (32:3:57)
 - Exploration in Oregon in 1969, by V. C. Newton (32:1:6-8)
 - How to join the club (Wildcat wells) (32:11:220)
 - Microscope helps find (32:11:216-217)
 - Test cores near Lakeview age dated (32:9:184)

Oregon Academy of Science in Eugene (32:1:184)
 Pacific Northwest Metals and Minerals Conference, Portland to host (32:12:241)
 Percentage depletion rates revised (tables) (32:2:32-33)
 Priceite in Curry County by C. Hoffman (32:2:34-35)
 Publications announced (Department):
 Bibliography of Oregon geology, Supplement (Bull. 67) (32:9:179)
 Geochemical analyses, southwest Oregon, on open file (32:6:115)
 Geologic time chart revised (32:5:94)
 Index to ORE BIN (20-year) (Misc. Paper 13) (32:11:210)
 John Day Uplift, map on open file (32:7:140)
 Klamath and Lake Counties, Geology and mineral resources (Bull. 66) (32:4:72)
 Mining law summary (32:4:78)
 Thermal springs and wells map (Misc. P. 14) (32:12:240)
 Publications announced (U.S. Geological Survey):
 Bend quadrangle, East half (Map I-568) (32:5:95)
 Earthquake leaflets (32:12:236)
 Federal lands map (32:9:178)
 Mount Rainier story (32:2:35)
 Placer gold in Sixes River (Bull. 1312-I) (32:9:181)
 Quadrangle maps without contours (32:5:95)
 Subsea mineral resources of world (Map I-632) (32:3:57)
 Publications announced (other):
 Archaeology bibliography (Museum Natural History) (32:5:95)
 Pliocene mammal study (Museum Natural History) (32:12:230)
 Condon Lectures (32:9:184)
 One third of land (public land) (32:7:140)
 Rockhound map (32:2:31)
 Public land law - Aspinall outlines action on recommendations (32:11:218-219)
 Silver, Government makes last sale (32:12:242)
 Eisenhower dollar to be minted (32:12:242)
 Slump structure in Cretaceous sandstone, Medford area, by S. Boggs and F. G. Swanson (32:2:25-29)
 Spatter cone pits, Sand Mountain, lava field, by Jim Nieland (32:12:231-236)
 Southern Oregon coast geology, by R. E. Hunter, E. H. Clifton, and R. L. Phillips (32:10:185-201)
 South Umpqua Falls region geology, by M. A. Kays (32:5:81-94)
 Stacks and reefs off southern Oregon Coast, by R. E. Hunter, E. H. Clifton, and R. L. Phillips (32:10:185-201)
 State Geologic Map project (32:1:14-15)
 Tertiary phytoplankton, Bandon, Oregon area, by W. N. Orr and B. B. Weinstein (32:7:133-139)
 Theses on Oregon geology received in 1968-1969 (32:3:60)
 Urban planning needs earth scientists' skills (32:2:36)
 U.S. Bureau of Mines - reorganized (32:6:116)
 Osborn appointed Director (32:12:240)
 Lewis named liaison officer for Oregon (32:12:241)
 Volcanic eruptions: Pioneers' attitude on Pacific Coast, by M. M. Folson (32:4:61-71)
 We must consume; we must conserve, by R. S. Mason (32:3:58-59)
 Western Cascades volcanic series, S. Umpqua Falls, by M. A. Kays (32:5:81-94)
 Wilderness Act gets lively discussion (32:2:29)

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

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
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
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
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
66.	Reconnaissance geology and mineral resources, eastern Klamath County & western Lake County, Oregon, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th supplement) geology & mineral industries, 1970: Roberts	2.00

GEOLOGIC MAPS

Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Preliminary geologic map of Sumpter quadrangle, 1941: Pardee and others	0.40
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)	2.00
folded in envelope, \$2.15; rolled in map tube, \$2.50	
Gravity maps of Oregon, onshore and offshore, 1967: [Sold only in set]: flat	2.00
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[Continued on back cover]

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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

1. Description of some Oregon rocks and minerals, 1950: Dole 0.40
2. Key to Oregon mineral deposits map, 1951: Mason 0.15
Oregon mineral deposits map (22" x 34"), rev. 1958 (see M.P.2 for key) 0.30
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
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
13. Index to The ORE BIN, 1950-1969, 1970: M. Lewis 0.30
14. Thermal springs and wells, 1970: R.G. Bowen and N.V. Peterson 1.00

MISCELLANEOUS PUBLICATIONS

- Oregon quicksilver localities map (22" x 34"), 1946 0.30
- Landforms of Oregon: a physiographic sketch (17" x 22"), 1941 0.25
- Index to topographic mapping in Oregon, 1968 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
2. Subsurface geology of the lower Columbia and Willamette basins, Oregon,
1969: Newton 2.50