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CHROMITE RESOURCES OF THE PODIFORM CHROMITE DEPOSITS AND EXPLORATION FOR CONCEALED CHROMITE DEPOSITS IN THE MEDFORD-COOS BAY QUADRANGLES, SOUTHWESTERN OREGON

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Table of Contents

Illustrations

Tables

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ABSTRACT

Exploration models for podiform chromite in the Medford-Coos Bay quadrangles must consider the facts that (1) one deposit occurs for every 5 km^2 of ultramafic outcrop; similarly for a 5 km^3 volume, and (2) the average deposit has a tonnage of 206 tonnes, a volume of 8.9 m^3 and a grade between 43 and 51 percent Cr_2O_3.

INTRODUCTION

Between 1917 and 1958, 69,485 tonnes of chromite were produced from 181 deposits in 1,226.8 km^2 of ultramafic rock masses in southwestern Oregon. During periods of exploration and mining, mainly in World War I, World War II, and the Korean War, extensive prospecting of a large part of the outcrop area resulted in the discovery of 315 occurrences of podiform chromite at or near the surface. Most of the physical, chemical, and geological details of the occurrences have been described by Ramp (1961). This information and other supplementary data were compiled and put into the Computerized Resource Inventory Bank (CRIB), the mineral resources data bank of the U.S. Geological Survey (Calkins and others, 1973; Calkins and others, 1977; Keefer and Calkins, 1977). The next stage in chromite exploration would be to search for hidden ore bodies that may occur within 150 m of the surface. As a preliminary step to such exploration, the physical characteristics of the known podiform chromite deposits of the area need to be defined and evaluated based on the previously accumulated physical, chemical, and geologic details in order to postulate the characteristics of a subsurface deposit.

The purpose of this paper is to establish the characteristics of an average podiform chromite body in the Medford-Coos Bay quadrangles that would be a target for exploration. Characteristics considered in this report are (1) areal distribution, (2) vertical distribution, (3) size, (4) production tonnage, and (5) grade. The data on the 315 reported podiform chromite occurrences upon which this report is based are summarized in table 1 and are available to the public from the Director of Information Systems Programs, University of Oklahoma, 1808 Newton Drive, Room 116, Norman, Okla. 73069. Production figures in this file are based on information given by Ramp (1961) and from T. P. Thayer (written commun., 1974). Extensive use of the CRIB file and the GIPSY system (Oklahoma Univ., 1975) resulted in the maps, diagrams, and tables in the report.

Table 1.--*Summary of available data on physical characteristics of chromite deposits in southwestern Oregon*

Physical characteristic	Number of deposits
Reported podiform deposits	315
Locatable deposits	256
Outcrop elevation known	256
Total production reported	181
Cr_2O_3 grade reported	151
Length, width, or depth	110
Country rock reported	182

AREAL AND GEOLOGIC DISTRIBUTION

OF PODIFORM CHROMITE DEPOSITS

All of the chromite deposits lie in the Klamath Mountains geomorphic province in the western part of the Medford-Coos Bay quadrangles and are exclusively associated with ultramafic rocks, some masses of which have an extremely limited areal extent and cannot be shown at the scale of figure 1. Figure 1 shows the distribution of the major ultramafic masses modified from Page, Johnson, Haffty, and Ramp (1975) and the location of 256 podiform chromite occurrences. The outcrop areas of ultramafic rocks were grouped into 12 individual areas based on geologic boundaries or major differences between ultramafic masses (fig. 1). These areas occupied by ultramafic rocks were measured with a planimeter on maps (Page and others, 1975, scale 1:250,000) and converted to km^2 of map area. The numerical values for areas reported in table 2 should be considered as approximate because of the technique used, but the relative precision between areas is on the order of ±0.26 km^2. Examination of figure 1 and the number of deposits per km^2 for each area in table 2 indicates that particular areas of ultramafic rocks are enriched in chromite occurrences per km^2 ranges up to 0.71 and averages 0.2. Area G has the highest number of deposits per km^2; most of the areas have 0.15-0.33 deposits per km^2, and four areas totaling 112.4 km^2 contain only four deposits.

Table 2.--*Distribution of deposits by map area of ultramafic rock.*
[Areas measured with a planimeter on Page and others (1975)]

Area	km^2	Number of deposits	Number per km^2
A	459.1	33	0.07
B	50.0	10	.20
C	36.8	10	.27
D	20.5	2	.09
E	38.9	13	.33
F	57.3	11	.19
G	157.5	112	.71
H	178.8	26	.15
I	51.0	1	.02
J	25.6	1	.04
K	33.7	5	.15
L	117.6	29	.25
Total	1,226.8	253	.20
Placers		5	
Not in above areas		2	

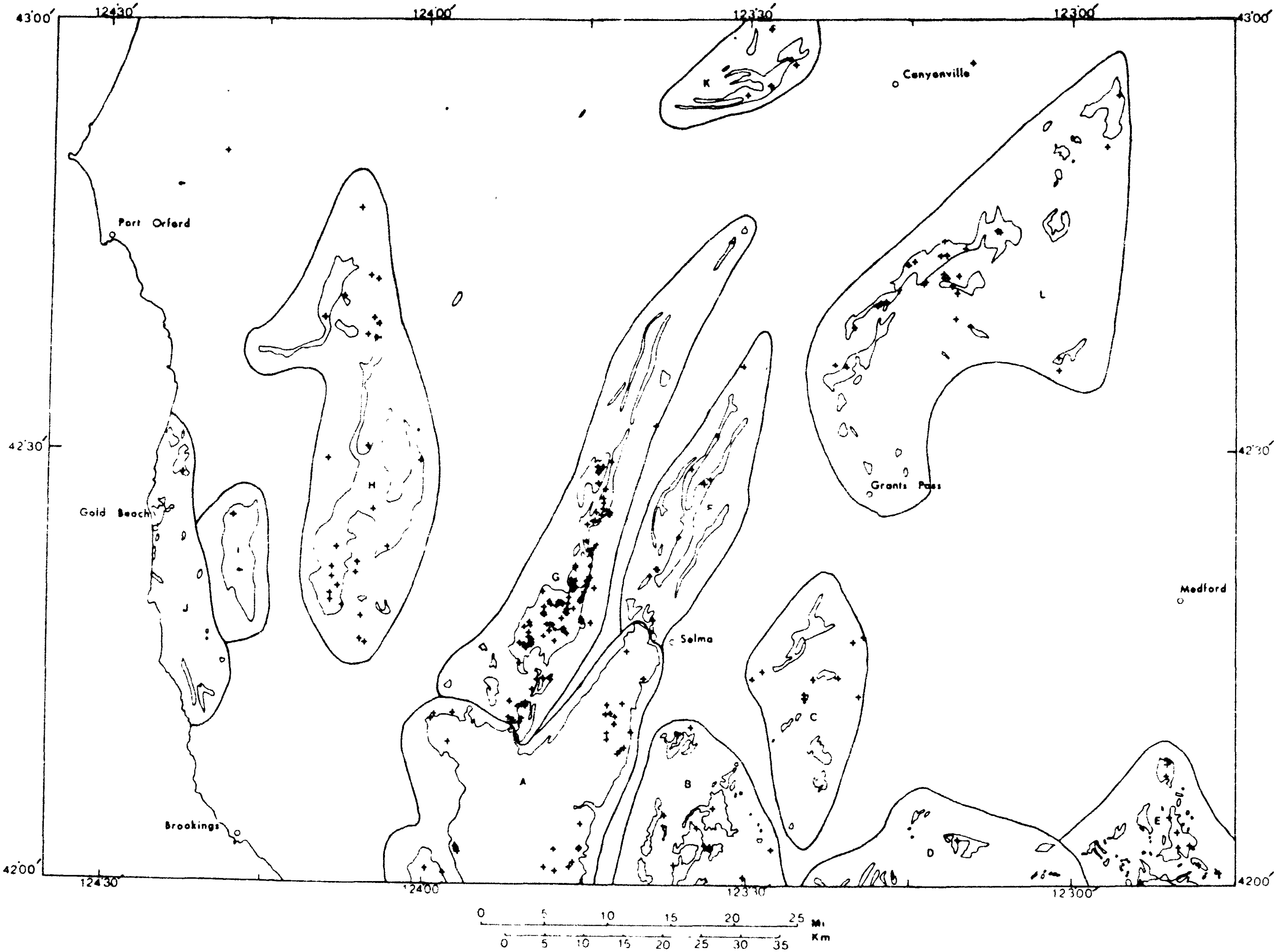

Figure 1.--Map showing the distribution of chromite occurrences and ultramafic masses in the Medford-Coos Bay quadrangles, southwestern Oregon. Distribution of ultramafic masses modified from Page and others (1975). Lode deposits = +, placer deposits = ←, ultramafic masses shown by outlines.

Over 86 percent of the 182 chromite occurrences where rock type is reported occur in dunite or serpentinite and 14 percent in peridotite (harzburgite or lherzolite). Dunite (normally highly serpentinized) is the major immediate county rock and thus suggests that only surface areas or projections of dunite in the subsurface should be considered for prospecting. The textural and structural types of the chromite deposits include those that are disseminated, layered or banded, massive, nodular or orbicular and sheared; but all the deposits belong to the podiform chromite type as defined by Thayer (1960). Form or shapes of the chromite pods range from linear or pencillike shapes to planar or tabletlike shapes, but most of the pods could be described as pseudotabular lenses that approximate flattened ellipsoids.

Various features of the geologic distribution of the chromite deposits can be illustrated by closer examination of area G, which contains the largest number of deposits per km and the only major chromite mine in southwestern Oregon. This area encompasses the central Illinois River and Chrome Ridge areas mapped and described by Ramp (1961). A simplified geologic interpretation of the area based on previous geologic mapping by Wells, Page, and James (1940), Wells, Hotz, and Cater (1949), Ramp (1961, 1975) and N. J Page (unpub. data, 1974-76) and on modern geologic concepts is given in figure 2. Symbols representing chromite deposits with different amounts of production are also shown. All of the deposits occur in ultramafic masses separated by thrust and normal faults from adjacent rock units. The ultramafic rock masses, locally, appear to be sheetlike in shape. The complicated fault tectonics of the area postdate the formation of the chromite pods and therefore are not a controlling factor in the distribution patterns except where one deposit may be the faulted extension of another. The distribution of the chromite deposits bears no relation to the distribution of rocks other than the ultramafic ones, for example, gabbro or the Chetco complex, because the association of adjacent rocks is due to the fault patterns that postdate the concentration of chromite.

Nearby to the southwest in the Vulcan Peak area (area *A*), Loney and Himmelberg (1976; see also Himmelberg and Loney, 1973) demonstrated that similar ultramafic rocks underwent a high-temperature and deep-seated, multiple, plastic deformation that resulted in a metamorphic foliation and scattered folds. A similar type of deformation probably affected the ultramafic rocks in area G. Evidence for this consists of a few scattered isoclinal folds found during recent reconnaissance mapping and from analysis of the layering attitudes of the ultramafic rocks. Attitudes of layering formed by alternating chromitite and dunite and by alternating dunite and harzburgite were measured and their poles contoured on lower hemisphere equal area nets (fig.3). Poles to both types of layering yield patterns of incomplete girdles with the most frequent attitude of layering having a northeast strike and northeast dip. Although there is close correspondence in attitude

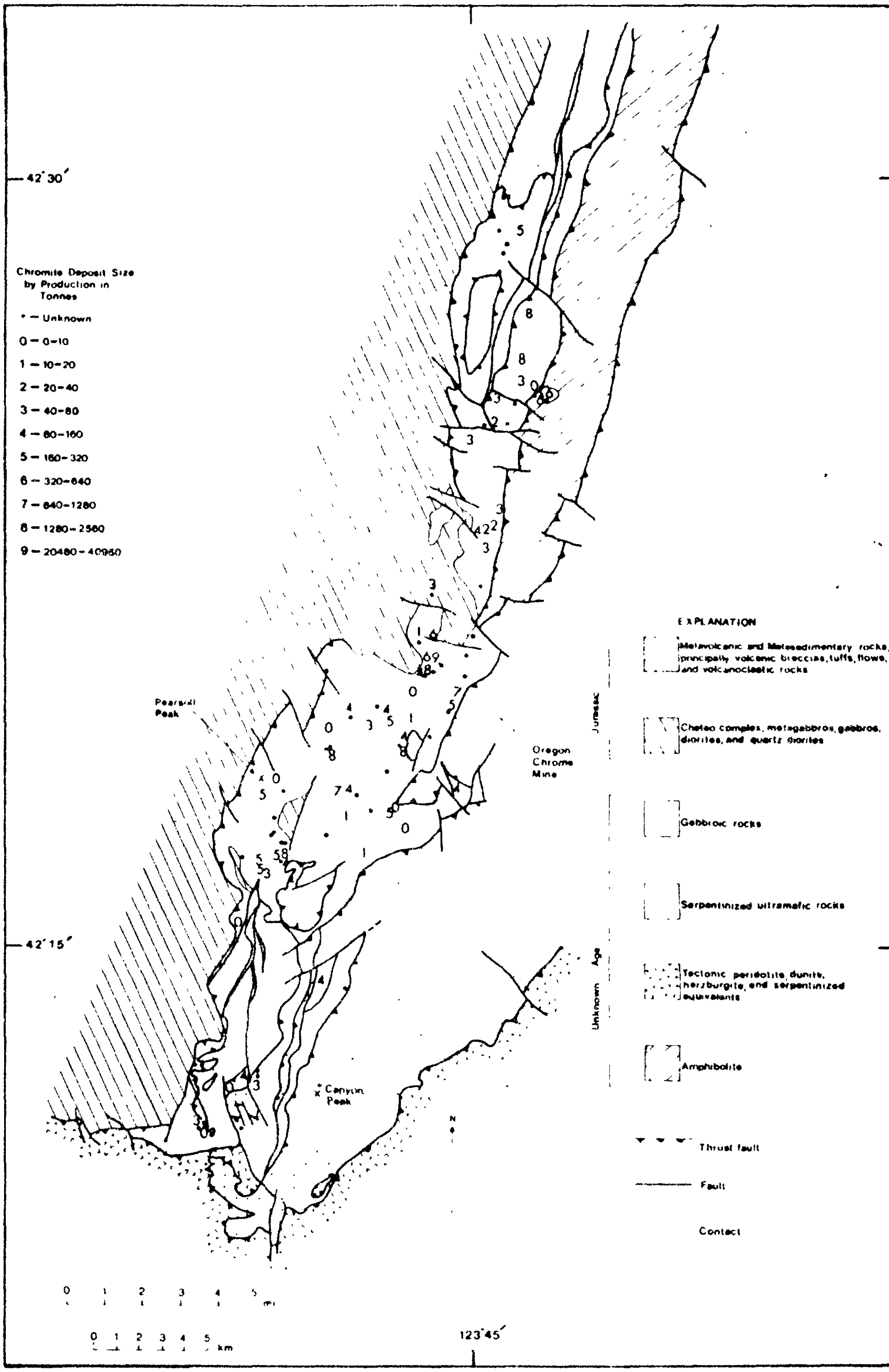

Figure 2.--Simplified geologic map of area G showing the location of chromite deposits by production class. Geology modified and interpreted from Wells, Page, and James (1940), Wells, Hotz, and Cater (1949), and Ramp (1961, 1975).

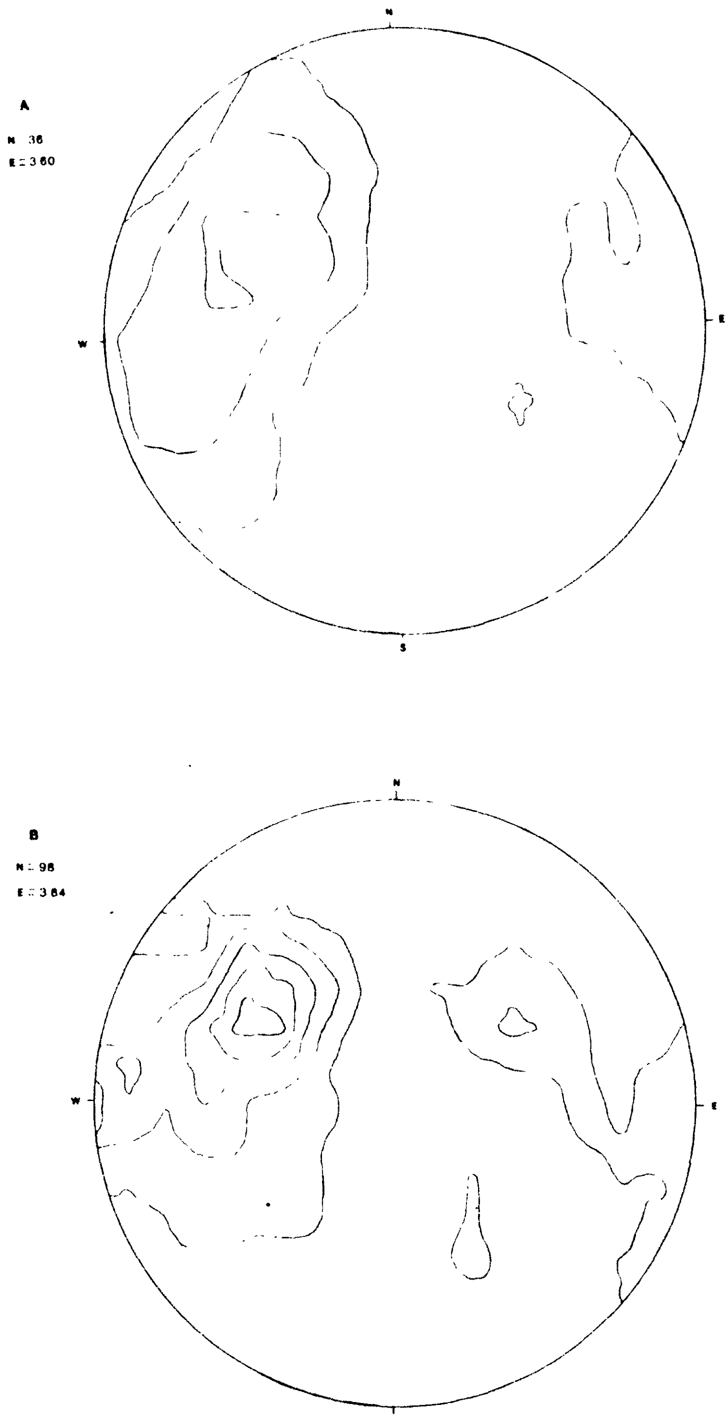

Figure 3.--Poles to layering contoured on lower hemisphere equal area nets. *A*, Poles to layering in serpentinized peridotites. N = 36, E = 3.60. *B*, Poles to chromite layering. N = 98, E = 3.84. Structural observations were computer plotted and contoured at 1E intervals where E is the expected number of points within the counting area for a uniform distribution across the sterogram using a method developed by Kamb (1959) and computerized by C. E. Corbató (written commun., 1970). N = number of observations.

of the two types of layering, there is not enough detailed structural information to formulate generalizations about structural control of the chromite deposits within area G. More detailed study might aid in guiding a chromite exploration program.

VERTICAL DISTRIBUTION OF CHROMITE OCCURRENCES

Some concept of the vertical distribution of chromite deposits can be derived from examining the altitudes of deposits. Figure 4 shows the number of occurrences in the 500-foot intervals of elevation above sea level. From the figure it would appear that ultramafic outcrop areas between 2,000- and 3,500-foot elevations should be favored in an exploration model. However, consideration of the distribution of the topography on the ultramafic rocks severely modifies this conclusion. Areas of outcrop between sea level and the 1,000-foot, the 1,000- and 2,000-foot, the 2,000- and 3,000-foot, and above 3,000-foot contours were measured with a planimeter to calculate the number of occurrences per km^2 between the various elevations. The number of deposits per km^2 within elevation ranges varies over a more restricted range than similar values for areal distributions (table 2) and the calculated average number of deposits per km^2 within elevation ranges is 0.20 per km^2 which is the same as that per square area. From this analysis of distribution by elevation, it might be inferred that the chromite pods would have a similar distribution in the subsurface as they do by elevation.

DISTRIBUTION OF SIZE AND TONNAGES OF CHROMITE DEPOSITS

Information on size of the ore bodies is rather limited (see table 1) compared with other physical characteristics, which in part is probably due to the highly irregular shapes of the podiform deposits. For many deposits only one dimension is given or is known. Figure 5 shows the distribution of lengths, widths, and thicknesses recorded for individual deposits. Their distributions are skewed toward the smaller size classes so that average values are not representative of the deposits as a whole. However, the average width (87 measurements), is 1.38 m; average length (43 measurements), 51.59 m; and average thickness (32 measurements), 1.02 m. As we will show below, based on tonnage information, these average size data are biased toward the larger deposits.

Of the 181 deposits with a total reported production of 69,485 tonnes[1], one deposit, the Oregon Chrome mine, accounted for 32,430 tonnes or about 47 percent of the total lode production. The other 53 percent was produced from 180 smaller deposits. Figure 6 shows the distribution of chromite production by geometric class intervals. About

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[1]Total production of 69,485 tonnes differs from the number cited by Ramp (1961) of 120,214 tonnes; he included 10,812 tonnes of chromite sand and 41,467 tonnes of reconcentrated chromite sand produced from the Government stockpile. We have considered only production tied to specific deposits.

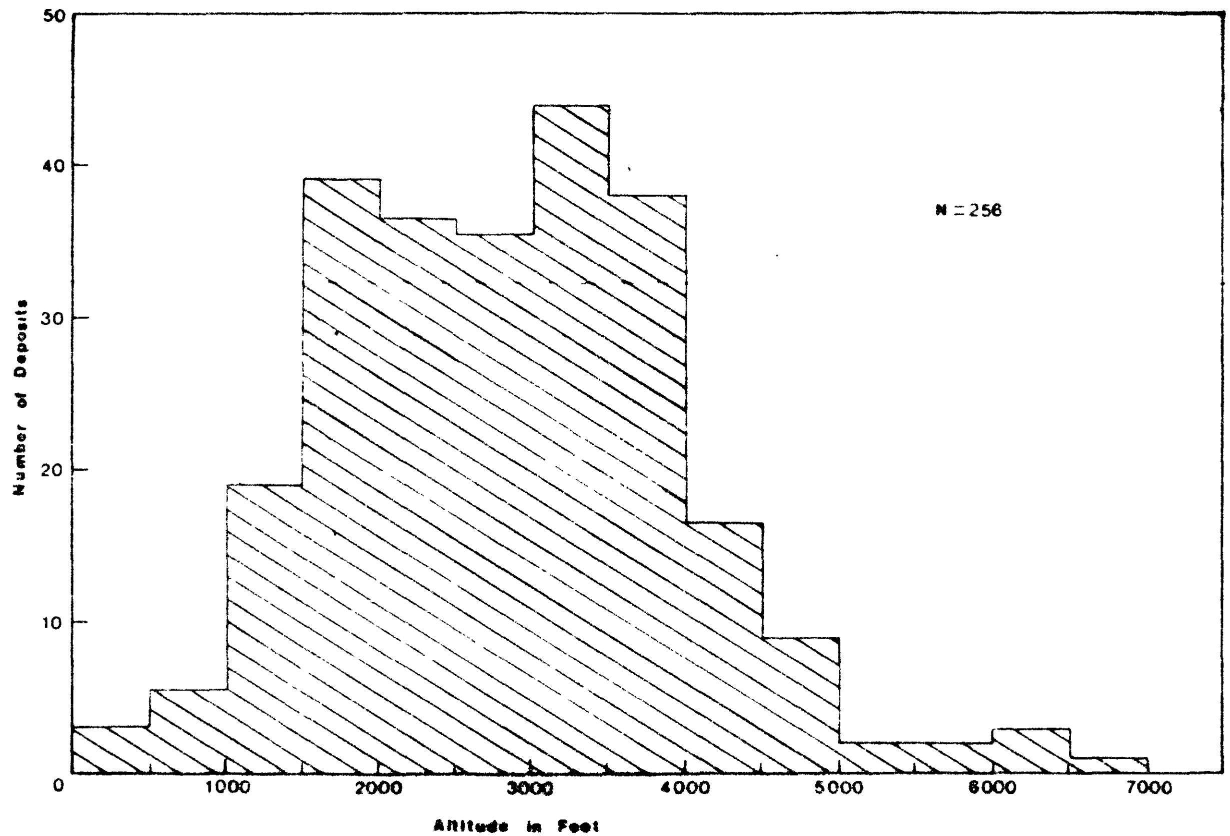

Figure 4. Histogram of chromite deposits in 500-foot intervals of elevation. N = number of deposits.

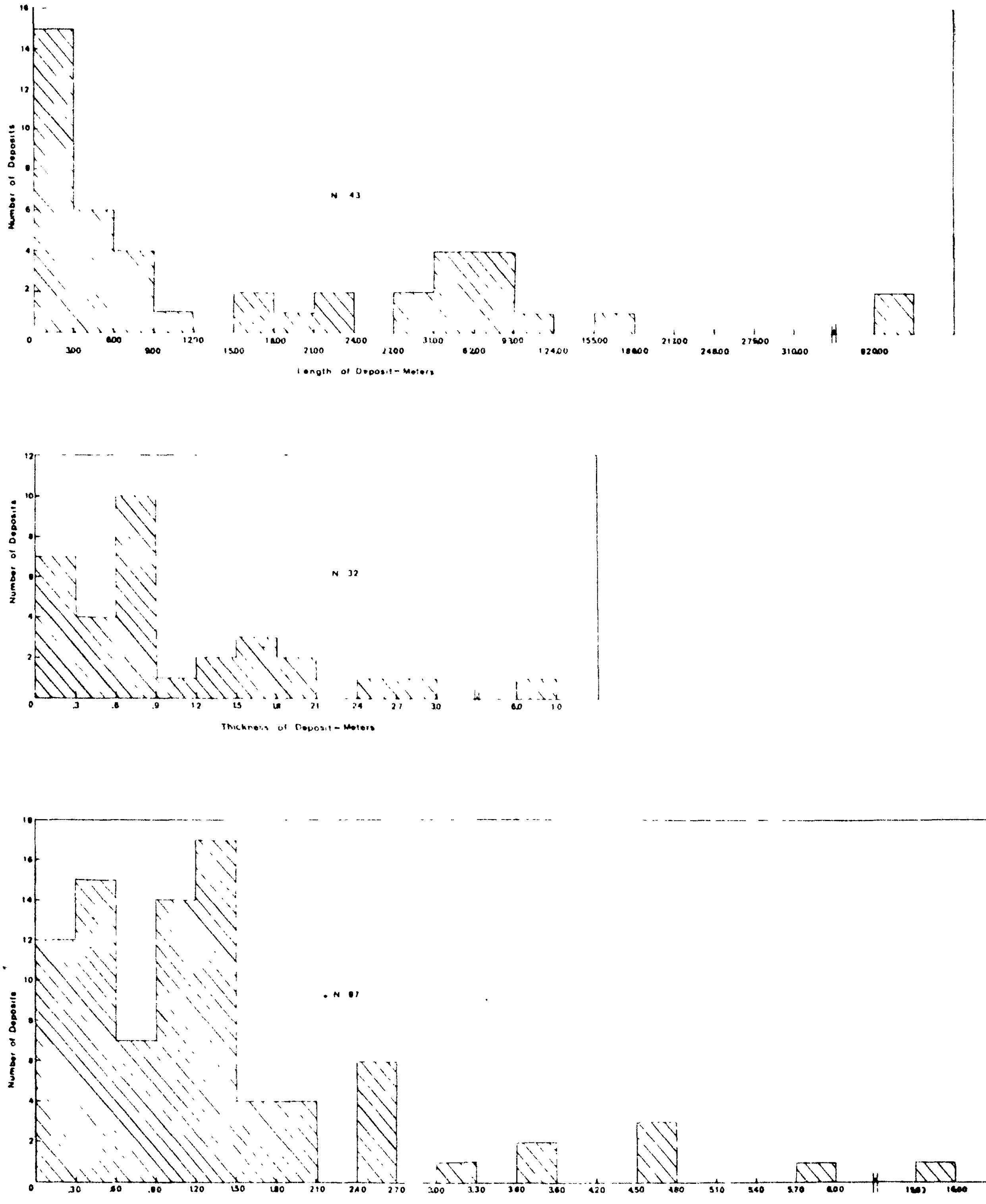

Figure 5.--Histograms of length, width, and thickness of chromite deposit. N = number of deposits.

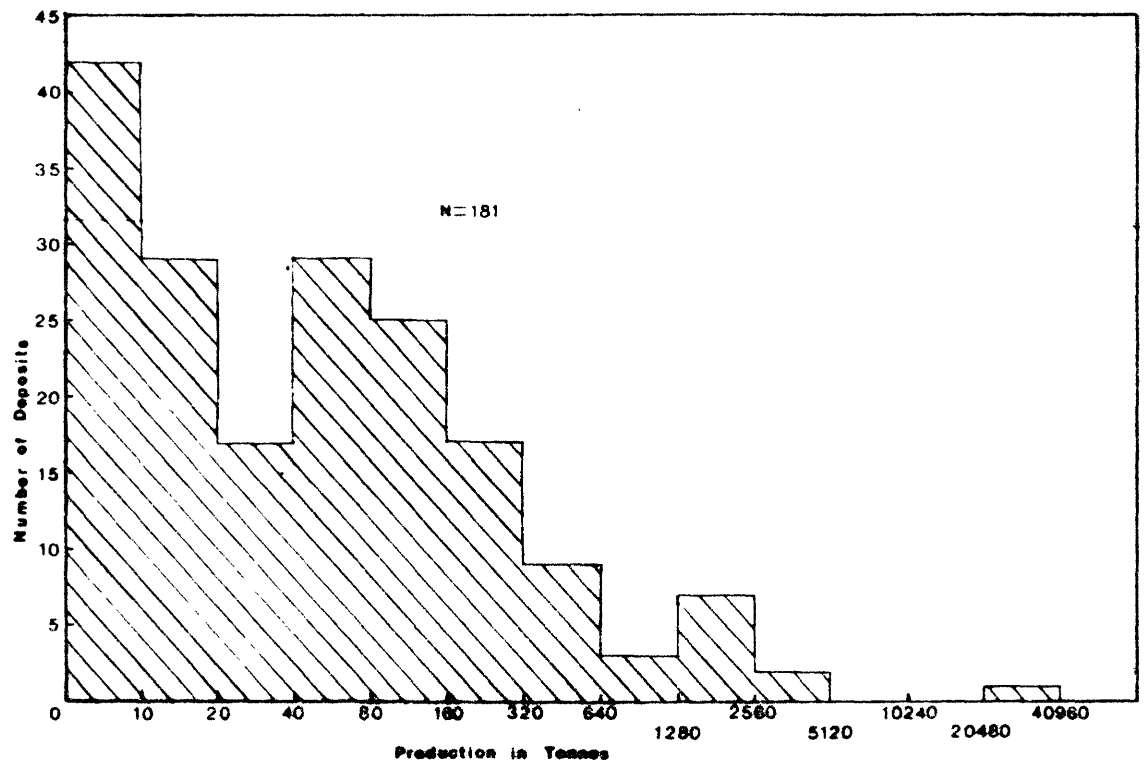

Figure 6. Histogram of chromite production from the Medford–Coos Bay quadrangles in long tons. N = number of deposits.

67 percent of all the chromite deposits produced less than 100 tonnes of chromite, 27 percent of the deposits between 100 and 1,000 tonnes, 5.5 percent of deposits between 1,000 and 10,000 tonnes, and about one-half percent of deposits over 10,000 tonnes. The average production for a chromite deposit, excluding the Oregon Chrome mine, is about 206 tonnes. Using a specific gravity of 4.7 for chromite, this amounts to a mass of chromite with a volume of 4.46 m^3 or 1.05 m to a cube. Assuming that an ore body consists of 50 percent by volume chromite, this tonnage could come from a mass with a volume of 8.93 m^3 or 207 m on a side. A more realistic shape would be a flattened ellipsoid with an average ratio of semiaxes of about 51:1.4:1 based on reported measurements from the previous section. Using a volume of 8.93 m^3 this would yield an average ellipsoid with semiaxes of 0.39(6), 0.55(5) , and 20.24 m. These size estimates are 20 times less than volume estimates based on known average length, width, and thickness, and they support the inference that the size information is biased.

DISTRIBUTION OF REPORTED Cr_2O_3 GRADES

Reported grades of Cr_2O_3 in chromite ores range from 20 to 57 weight percent from the deposits in the Medford-Coos Bay quadrangles. Figure 6 summarizes the grade information for 151 deposits and shows that the majority of the deposits produced ore with a grade between 43 and 51 percent Cr_2O_3. The grade data given in figure 7 are average values for a deposit weighted according to tonnages reported for specific grades.

THE AVERAGE CHROMITE DEPOSIT AND THE EXPLORATION PROBLEMS

No correlations between spatial position, tonnage, or grade could be found; therefore no single physical characteristic can be used as a key to subsurface exploration. The average podiform chromite deposit in the Medford-Coos.Bay quadrangles has a tonnage of 206 tonnes, a volume of 8.93 m and a grade between 43 and 51 percent Cr_2O_3; it occurs mostly with dunite or its serpentinized equivalent at the rate of about one deposit per 5 km^2 of ultramafic outcrop area. In addition, in any 5 vertical km there would also be about one deposit of this size. Since the chromite deposits occur mostly in dunite and dunite makes up a small fraction of the ultramafic outcrop area, the distribution of chromite per square km of outcrop may be misleading. But the distribution of chromite deposits per square km probably reflects the distribution of dunite to a certain extent.

Subsurface exploration should be concentrated in area G and probably focus on a search for the few pods that may be present of over 1,000 tonnes. Even in area G only 4 pods were found on the surface that contained over 1,000 tonnes and only one deposit within this entire area contained over 30,000 tonnes. The likelihood of greatly increasing the reserved of chromite in this region is small.

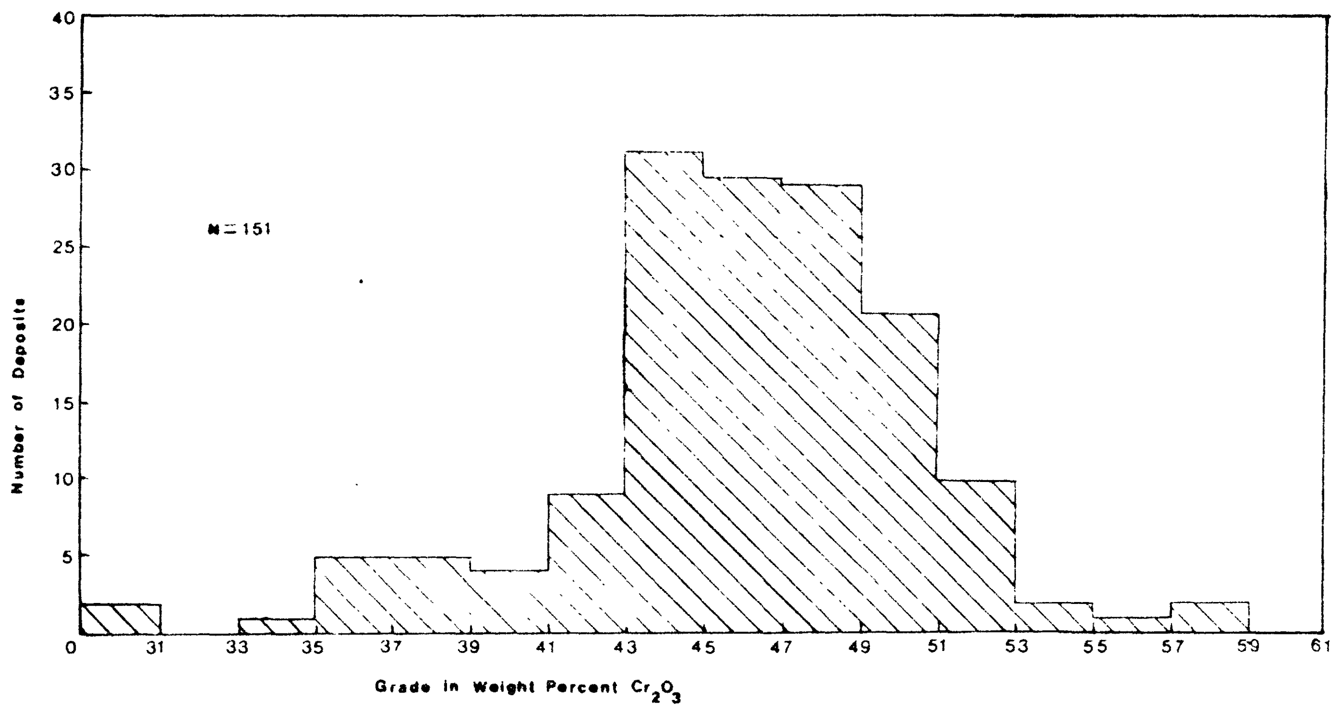

Figure 7. Histograms of grades of Cr_2O_3 percentages in chromite from the Medford-Coos Bay quadrangles. N = number of deposits.

REFERENCES CITED

Calkins, J. A., Kays, Olaf, and Keefer, E. K., 1973, CRIB--The mineral resources data bank of the U.S. Geological Survey: U.S. Geol. Survey Circ. 684, 39 p.

Calkins, J. A., Keefer, E. K., Ofsharick, R. A., Mason, G. T., Tracey, Patricia, and Atkins, Mary, 1977, CRIB--The mineral resources data bank of the U.S. Geological Survey--Users guide for public users--1976, part A: U.S. Geol. Survey Circ. 755a [In press]

Himmelberg, G. R., and Loney, R. A., 1973, Petrology of the Vulcan Peak alpine-type peridotite, southwestern Oregon: Geol. Soc. America Bull., v. 87, p. 259-274.

Kamb, W. B., 1959, Ice petrofabric observations from Blue Glacier, Washington, in relation to theory and experiment: Jour. Geophys. Research, v. 64, no. 11, p. 1891-1909.

Keefer, E. K., and Calkins, J. A., 1977, CRIB--The mineral resources data bank of the U.S. Geological Survey--Users guide for public users--1976, part B: U.S. Geol. Survey Circ. 755b [In press]

Loney, R. A., and Himmelberg, G. R., 1976, Structure of the Vulcan Peak alpine-type peridotite, southwestern Oregon: Geol. Soc. America Bull., v. 87, p. 259-274.

Page, N. J, Johnson, M. G., Haffty, Joseph, and Ramp, Len, 1975, Occurrence of platinum group metals in ultramafic rocks of the Medford-Coos Bay 2° quadrangles, southwestern Oregon: U.S. Geol. Survey Misc. Field Studies Map MF-694.

Ramp, Len, 1961, Chromite in southwestern Oregon: Oregon Dept. Geol. ogy and Mineral Industries Bull. 52, 169 p.

______1975, Geology and mineral resources of the Upper Chetco drainage area, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 88, 47 p.

Thayer, T. P., 1960, Some critical differences between alpine-type and stratiform peridotite-gabbro complexes: Internat. Geol. Congr. 21st, Copenhagen, pt. 13, p. 247-259.

Wells, F. G., Hotz, P. E., and Cater, F. W., 1949, Preliminary description of the geology of the Kerby quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 40, 23 p.

Wells, F. G., Page, L. R., and James, H. L., 1940, Chromite deposits in the Sourdough area, Curry County, and Briggs Creek area, Josephine County, Oregon: U.S. Geol. Survey Bull. 922-P, p. 461-496.