THE STATISTICAL INTERPRETATION OF MINERAL DATA

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THE PROBLEM AND PRESENT TREND OF PROCEDURE

In these days of war preparation, it is imperative that we have as complete statistical information concerning minerals as possible. It is especially true since war involves machines and munitions, the production of which utilizes great quantities of minerals as well as technically trained men. Production of minerals has been increased enormously to meet such demands. The Minerals Yearbook attests to this increase:

> "The physical volume of production rose 11 per cent above that in 1939 and exceeded the previous peak of 1937 by 5 per cent; it was 10 per cent higher than the predepression record established in 1929 and 45 per cent above production levels of the World War of 1914-18. A further increase is indicated for 1941. All classes of minerals shared the advance — metals, nonmetals, and the fuels — solid, liquid, and gaseous."[1]

It must be remembered that while using mineral resources intensively much thought must be given to conservation and the avoidance of waste. Some minerals which cannot be replaced may be exhausted through unwise use. The Minerals Yearbook cautions against waste:

> "Although the present emergency requires that, regardless of cost, every effort be made to make our country impregnable, the fact that minerals are so vital to national defense emphasizes the need for conservation more strongly than ever."[2]

Bain (1928) emphasizes further the necessity for conservation of minerals:

> "Unlike the products of the animal and plant kingdom, minerals are not reproducible. Whatever of them we are to have is already here in the earth under our feet. There is no known way of increasing the quantity or renewing a supply once exhausted. One crop, and one crop only, exists."

Government agencies[3] are engaged in planning for wise mineral consumption. The Department of Interior includes (1) Bureau of Mines, (2) Geological Survey, and (3) Petroleum Control Administration. The independent commissions performing like functions are (1) Federal Oil Conservation Board, (2) Mineral Policy Board, and (3) National Resources Board.

Huntington and Williams (1926) expressed the production of minerals in three chief mineral-producing countries as a per cent of world total. No further statistical treatment was attempted by these authors. In general it is true that mineral data are listed in the form of tables with little or no attempt at statistical interpretation with the exception of the employment of the mean in most instances. Adequate information must be available concerning mineral resources in order to safe-guard supplies for the future. The application of statistical methods will aid in giving added significance to the data beyond what is available in the usual form.

As a suggestion for providing a more adequate statistical interpretation of mineral data the studies of the following pages are presented.

NATURE OF DATA AND PLAN OF STUDY

The Yearbook gives the value of mineral products by states in millions of dollars which is not very useful information in the raw form. If the values were stated as per capita or per square mile, a better basis would be provided on which to compare Nature's gifts of minerals to the various states. Per

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[1]U. S. D. I. 1940
[2]Ibid.
[3]National Planning Board, 1933-34

capita value of mineral products indicates more nearly what part mineral wealth might play in the support of the population. Because the states vary so much in area the per square mile value of mineral products furnishes a more equitable basis for comparing the mineral resources of the states than for states as a whole. The relating of data to population and to areal unit is not necessarily new and different, but the writer is not aware that the value of mineral products have been considered in this way.

In order to make a statistical study of the data involved it is proposed: (1) to interpret the value of mineral wealth per capita by the computation (a) of quartile distributions, (b) of a measure of disparity, and (c) by the construction of an isoplethic map to show geographic distribution; (2) to interpret the value of mineral production per square mile by the computation (a) of quartile distributions, (b) of a coefficient of disparity, and (c) by the making of an isoplethic map to show geographical concentration of per square mile value of mineral production; (3) to show contrasts in evenness of distribution between per capita and per square mile value of mineral production by the use of a coefficient of evenness; and (4) to compare per capita and per square mile value of mineral production by logarithmic graphical analysis.

SIGNIFICANT RESULTS OF STUDY

The use of certain statistical methods will reveal the characteristic meanings of per capita and per square mile value of mineral production and also provide a basis for comparison.

Distribution Per Capita. How was the per capita value of mineral production distributed among the states? Here is an unusual way of expressing the distribution. Three-fourths of the states had a per capita value of mineral products of \$4.15 or more; one-half of the states had a per capita value of \$15.15 ± (\$6.557) or more; and one-fourth of the states had a per capita value of \$71.45 or more.

The mean (\$47.39) is more than three times the median which indicates that mineral wealth tends to be concentrated in a few states. Is there a numerical measure of this concentration? Yes, the numerical measure of this disparity stated as a coefficient is 143 and positive.[4]

The median as a measure of central tendency is representative of a larger number of states in per capita value than is the mean. This is because the median is not influenced by the high values per capita in a few states as is the mean.

Are there areas of the United States where mineral production per capita was concentrated in 1938? An isoplethic map, commonly used by geographers, may be used to answer this question. Such a map has not been used for this purpose before. The data used on the map represent conditions in each state for 1938. Two areas (Fig. 1) of concentration of mineral wealth per capita are shown: (1) the greater in the southwestern, and (2) a lesser concentration in the east central part of the United States. The political divisions ranking highest in order of value of mineral production per capita were Alaska and Nevada. No other divisions approached these values. Those lowest in per capita value of mineral production in order, lowest first, were: (1) District of Columbia, (2) Delaware, (3) Rhode Island, (4) Massachusetts, and (5) Connecticut (Table I). The low population of the two areas ranking highest is the main factor that makes possible a high per capita value but it does not necessarily indicate a high total value for the political divisions studied. To give a clearer picture of mineral wealth, a study of the values per square mile is presented.

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[4]Coefficient of disparity equals 2 (mean - median) divided by the interquartile range.

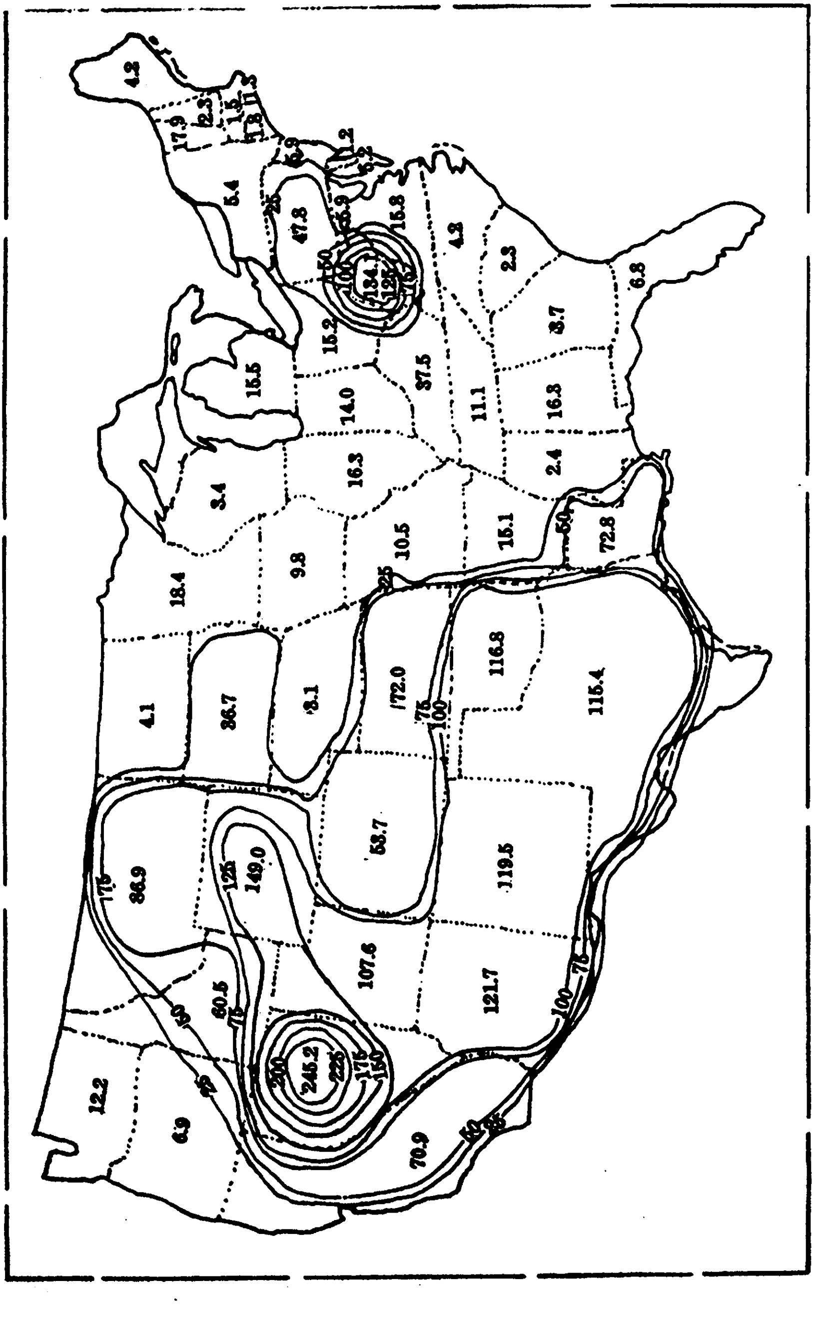


FIGURE 1. *Value in Dollars of Mineral Products in the United States, per Capita, 1938*

Distribution Per Square Mile. It is proposed now to relate mineral wealth to an areal unit — the square mile. It will be shown where the mineral wealth is, rather than its relation per capita. There are many factors other than mineral wealth that influence the distribution of population.

What was the nature of the distribution of per square mile value of mineral products among the states in 1938? Three-fourths of the states had a per square mile value of mineral products of $274.00 or more, one-half of the states had a per square mile value of $504.05 (±$276.86) or more, and one-fourth of the states had a per square mile value of $1,445.80 or more.

The median per square mile value is $504.05 (±$276.86) in comparison with a mean value of $1,475.79 (±$220.00). The probable error is large here as in the case of per capita value which indicates that the mean and median may not be considered reliable for these distributions. The relation of the mean and median in terms of a coefficient of disparity is 231 and positive. A much higher degree of disparity is indicated here on a per square mile basis than on a per capita basis (143). The geographer may have recognized this disparity before but not quantitatively, in terms of a numerical coefficient.

The median represents a larger number of the measures in this instance than the mean as is true also in the case of per capita mineral wealth. The mean is apparently greatly influenced by a few states with especially high value of mineral products per square mile. West Virginia had the highest per square mile value of mineral products of $10,550.10 and North Dakota had the lowest value of $37.50. It is clearly shown that there is a great contrast in the value of mineral products among the states on the basis of equal areal units.

The isoplethic map (Fig. 2) shows the value of mineral products per square mile in 1938. Do certain parts of the United States show concentrations of value of mineral production when considered on an areal basis? The isoplethic map presents a different picture from that of the previous map (Fig. 1), showing concentrations of mineral wealth in east central, south central, and southwestern parts of the United States. West Virginia and Pennsylvania ,in the order named, have the greatest values of mineral wealth per square mile. The political divisions lowest in mineral production per square mile are North Dakota, Alaska, and Oregon, in the order named, lowest first.

Contrast as to Evenness. Is there a marked difference in evenness of distribution of values of mineral products among the states per capita as contrasted with that per square mile? It will be noted that with few exceptions the per square mile value of mineral products is greater than the per capita value of mineral products. A coefficient of evenness of distribution of per capita value for all the political divisions was 30 per cent and the coefficient for per square mile value of mineral products was 35 per cent. The coefficient would have been 100 per cent in the event of the theoretically even distribution. However, the slightly more even distribution per square mile seems insignificant.

These measures are probably useful because they indicate that some states have more taxable mineral wealth in proportion to population than others do and are better able to support educational and governmental functions.

Graphical Analysis. How does the value of mineral production per capita for a state compare with that of the per square mile value? A semi-logarithmic graph (Fig. 3), because of the extreme range in values, furnishes a method of comparing the per capita and per square mile value of mineral production by states. It is possible thus to present the two graphs on one sheet where they may be compared. Alaska, Arizona, Colorado, Idaho, Mon-

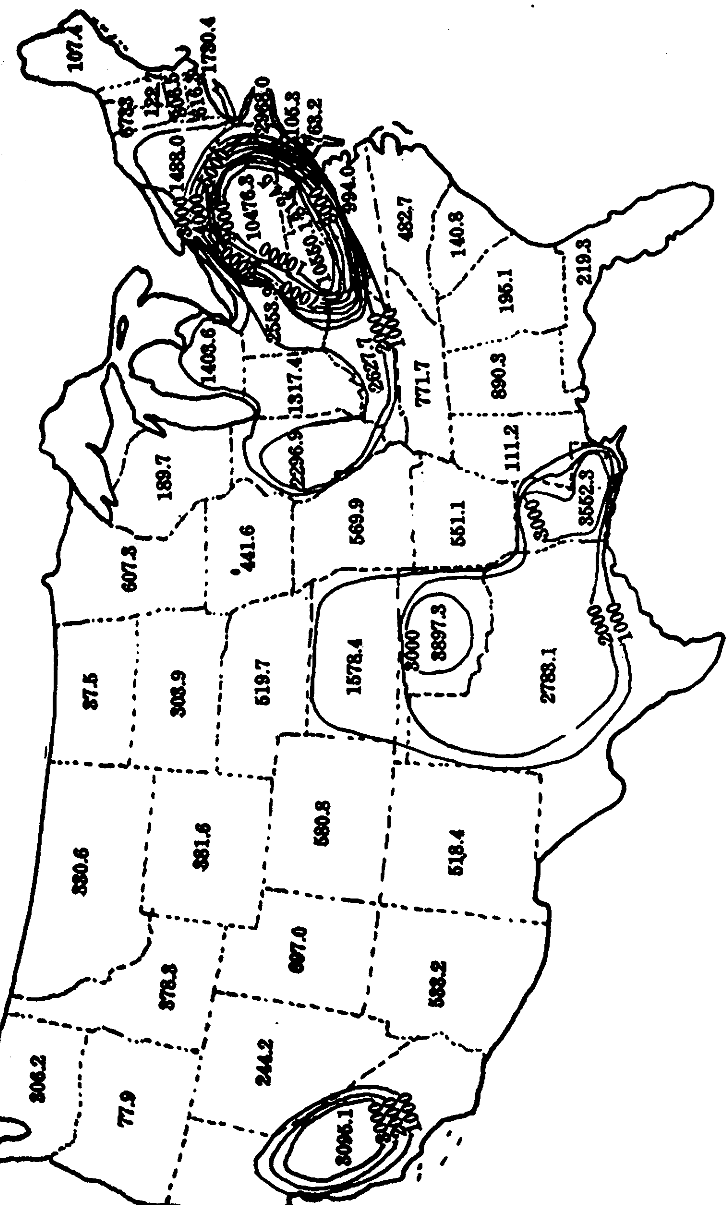
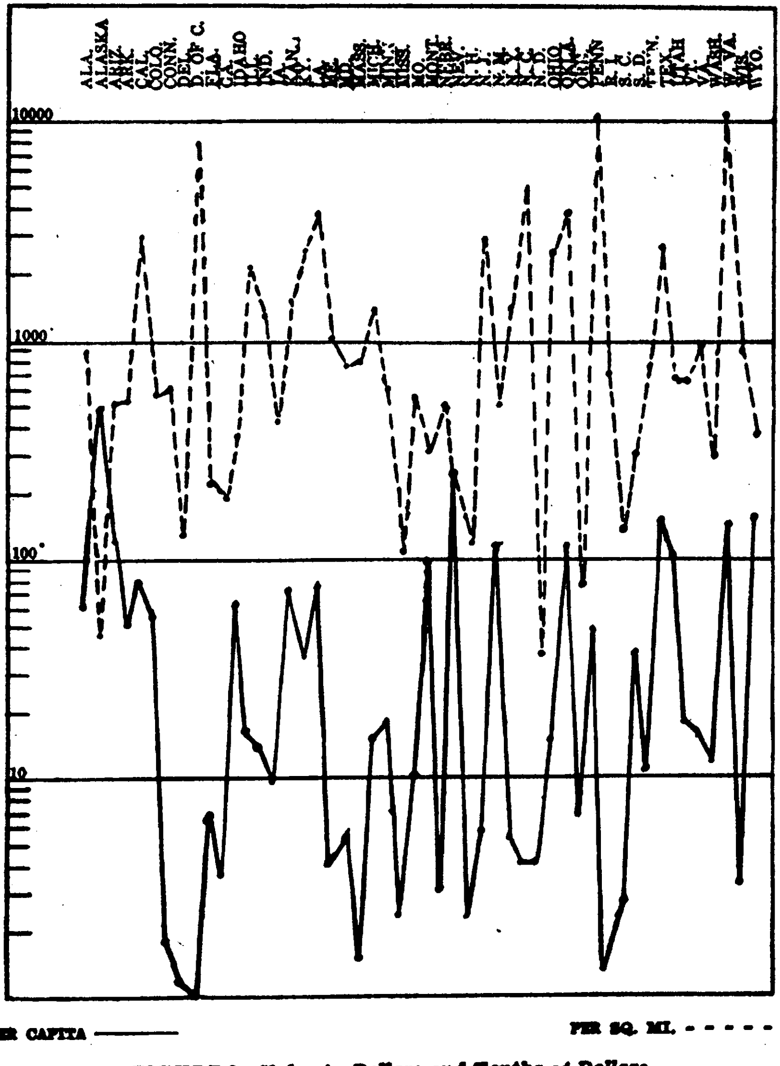


FIGURE 2. Value in Dollars of Mineral Products in the United States, per Square Mile, 1938

tana, Nevada, New Mexico, and Wyoming ranked much higher in per capita mineral production than in mineral production per square mile. These political divisions have considerable mineral wealth but a low density of



PER CAPITA —————— PER SQ. MI. - - - - - -

FIGURE 3. Value in Dollars and Tenths of Dollars

population. Connecticut, District of Columbia, Massachusetts, New Jersey, New York, and Rhode Island ranked much higher in mineral production per square mile than per capita. These divisions have comparatively dense populations, small production, and small areas. Mineral wealth should not be considered as among the important bases of financial support for the

TABLE I

Value of Mineral Products by States in the United States, 1939.

(Data from the Minerals Yearbook, 1940)

State	Value	Per Capita	Per Square Mile
Alabama	$ 46 296 289	$ 16.30	$ 890.30
Alaska	28 796 758	406.70	47.20
Arizona	60 756 253	121.70	533.20
Arkansas	29 395 066	15.10	561.10
California	490 108 428	70.90	3 095.10
Colorado	60 369 440	53.70	580.80
Connecticut	3 059 688	1.80	616.30
Delaware	320 621	1.20	135.30
Dist. of Columbia	568 717	.90	8 124.50
Florida	12 866 961	6.80	219.30
Georgia	11 598 421	3.70	195.70
Idaho	31 738 606	60.50	378.30
Illinois	130 155 083	16.30	2 296.10
Indiana	47 892 364	14.00	1 317.40
Iowa	24 794 056	9.80	441.60
Kansas	129 675 438	72.00	1 578.40
Kentucky	106 654 903	37.50	2 627.70
Louisiana	172 306 761	72.80	3 552.30
Maine	3 548 638	4.20	107.40
Maryland	9 407 723	5.20	763.20
Massachusetts	6 666 281	1.50	806.50
Michigan	81 380 602	15.50	1 403.60
Minnesota	51 425 289	18.40	607.30
Mississippi	5 209 547	2.40	111.20
Missouri	39 560 739	10.50	569.90
Montana	48 602 547	86.90	330.60
Nebraska	4 028 712	3.10	519.70
Nevada	27 031 281	245.20	244.20
New Hampshire	1 146 606	2.30	122.70
New Jersey	24 408 545	5.90	2 968.00
New Mexico	63 568 953	119.50	518.40
New York	73 217 430	5.40	1 488.00
North Carolina	14 959 228	4.20	482.70
North Dakota	2 653 473	4.10	37.50
Ohio	104 812 531	15.20	2 553.90
Oklahoma	272 869 078	116.80	3 897.30
Oregon	7 536 091	6.90	77.90
Pennsylvania	472 773 327	47.80	10 476.20
Rhode Island	911 590	1.30	730.40
South Carolina	4 364 034	2.30	140.80
South Dakota	23 583 359	36.70	303.90
Tennessee	32 428 512	11.10	771.70
Texas	740 147 465	115.40	2 783.10
Utah	59 236 355	107.60	697.00
Vermont	6 439 562	17.90	673.30
Virginia	42 370 160	15.80	994.00
Washington	21 167 004	12.20	306.20
West Virginia	264 995 309	134.10	10 550.10
Wisconsin	10 636 741	3.40	189.70
Wyoming	37 364 363	149.00	381.60

latter states. Other states are similar in both respects having about the same value of mineral products per capita as per square mile.

CONCLUSIONS

The choice of a basis for comparison of the value of mineral wealth, per capita or per square mile, depends upon the angle of approach and the type of information desired. A ranking may be determined on either basis, or, if one wishes to minimize the influence of the extremes, a composite ranking may be set up. This may be done by adding the ranks per capita and per square mile and rearranging the sums in order to obtain a composite rank. If small areas were highly mineralized, the value per square mile would be high as in the case of Oklahoma. If large areas with few people had few minerals, per capita mineral value might be rather high as illustrated by Alaska. The per capita and per square mile distributions of values of mineral production are unique but are even more meaningful when quartile distributions are computed to aid in interpretation. This is shown by one-fourth of the states having $71.45 or more per capita value of mineral production.

Knowledge of per capita and per square mile value of mineral products should be valuable in distributing federal tax loads among the states, based on ability to pay. An understanding of this relationship is contributed to by percentile measures, measures of central tendency, and coefficients of disparity and evenness. Where numerical data are available, similar investigations can be made by counties for any state. Such a study would provide measures applicable to problems involving the distribution of public funds, for example, funds from school lands. This knowledge along with similar measures concerning other resources would help the people of a state to adjust public expenditures to ability to pay.

Within the United States, there is no problem of exchange of minerals among the states as among the countries in Europe. Minerals cross border lines of states in the United States without any tariff restrictions. However, the profits from mineral exploitations tend to accrue to those states endowed with natural mineral resources. This condition enables some states to support a higher standard of living in terms of a better educational system and agencies of social service than others, resulting in a vexing problem of inequality among the states. Accurate knowledge concerning mineral resources will serve as a basis for attack upon such problems as ability of a state to provide support for education and governmental functions. The areal differentiation between mineral products per capita and per square mile is of special significance. Such studies may be augmented by the use of graphs, maps, and statistical analysis, namely logarithmic charts, isoplethic maps, and statistical measures already mentioned.