# ORE GRADATION AND RESERVE ESTIMATION OF MAGNESITE DEPOSITS OF CHALK HILLS OF SALEM (TAMIL NADU)

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In this paper, a method has been suggested for processing the chemical data by utilizing the computer for application of grade prediction and reserve estimation of magnesite ore by the polynomial functions. This method can also be applied in the case of other ores.

Chemical analyses of 52 magnesite samples collected from the known localities of the area under investigation were considered.

Data based on MgO %, $SiO_2$ % and iron percentage were separately considered as *Z*-Parameter. Percentage of all the three data were separately mentioned for 52 samples. Different values of MgO, $SiO_2$ and iron were represented in the terms of alphabets from A to H and three separate computer programme were processed for these data.

*X*-and *Y*-parameters have been chosen as geographic co-ordinates for the location of the points from where the samples were collected.

The processed results of MgO %, $SiO_2$ % and iron percentage were printed. The alphabetic maps obtained by this method show the location of different percentages of all the three data separately in the whole area under consideration. The advantage of this study is that localities of poor grade ore and rich ore containing different percentage of $MgO_2$ $SiO_2$ and iron can be directly known from the alphabetic map.

Fourth computer programme was processed by taking into consideration all the three data together at all the 52 localities of the area. Specified percentages of MgO, $SiO_2$ and iron in rich grade ore and poor grade ore were represented by alphabets from A to H. In this way, the alphabetic map obtained show directly the presence of poor grade ore and rich grade ore containing the specified percentages of MgO, $SiO_2$ and iron.

In the alphabetic map, each alphabet has represented the volume of magnesite ore upto the given depth. Weight of magnesite represented by each alphabet has been calculated and its reserve has been estimated.

## INTRODUCTION

Before mining can be taken up and during the course of mining activity, one is constantly confronted with decisions as to what is to be mined out and what has to be left out and what may be the ore reserve. In the present work, this type of problem has been tried to be solved by taking an example of gradation of magnesite ore. Chemical analyses of the ore deposits have been obtained and locations have been noted on a gridded map.

From the chemical analysis, silica, iron oxide and magnesia percentages are determined for each sample of magnesite. These values have been used as dependent

$Z$-parameter and $X$ and $Y$ geographic coordinates have been used as independent parameters and for each parameter, $Z$ value at each point in the map was computed using the trend surface programme. Using the conditional FORTRAN statement, a series of specifications are introduced so that at every point, the grade of the ore is characterized as alphabetic symbols and line by line punched card of a continuous symbol contour map is accomplished.

For the whole area, first grade, second grade, third grade and discarded ore deposits can be mapped out by using this technique.

Reserve of the ore deposit can be estimated by counting the alphabets present in the continuous symbol contour map obtained after data processing.

Grading of the deposit is afirst requsite for commencement of mining activity. On the basis of production schedule, one has to decide whether to mine a single grade ore or to mine poor grade ore also for the blending of the material.

Grading of the ore deposit helps in estimation of available ore for the determination of the period for which mining activity can be carried on and for designing of a proper mine layout. The mineralization itself does not follow a particular pattern. The characterisation of the profitable ore into different sub-divisions should be done on the basis of mineralization encountered. The ores may be vein type (Weaver 1964), the disseminated type (Preston *et al.* 1966) and the homogeneous type (Hewlett 1963). For the gradation of different types of ores, different techniques of the surface response should be used.

## Surface Fitting Method for Grade Prediction

The usage of polynomial functions in data processing can be used in many ways such as :—

1. By the use of polynomial function, the data can be split into trend and residual components. This method of surface response is called as variance analytical technique.

2. Polynomial function can be used as interpolation method (Weaver 1964). In this method of surface response, least square summation is used. Coefficient of polynomial can be determined by this technique. The dependent parameter can be predicted within particular confidence limit by coefficient of polynomial.

In the present study, $X$ and $Y$ parameters represent the distance and for their different values the value of chemical parameter $Z$ changes. Following equation has been used for the present study—

$$Z = a_0 + a_1 X + a_2 X + a_3 X + e$$

(Here $Z$ is a function of $X$ with usage of 3rd degree terms).

$$Z = a_0 + a_1 X + a_2 X + a_3 X^2 + a_4 X^2 + a_5 X Y + a_6 X^3 + a_7 Y^3 + a_8 X^2 Y + a_9 X Y^2 + e$$

(Here $Z$ is the function of $X$ and $Y$ with usage of 3rd degree terms).

In these equations, $Z$ is the dependent parameter, $X$ and $Y$ are independent parameters. '$a$' is the constant and '$e$' is the error term.

In the terms of the concept of surface response ($Z$ — $e$) forms the trend component and '$e$' forms the residual component of the data. This type of statistical study has been applied in the ore gradation of one of the magnesite mines of Salem Magnesite Private Company, Salem, Tamil Nadu. 56 chemical analyses of magnesite samples have been considered. By measuring the distance of $X$ and $Y$ parameters, the location of every magnesite sample on the gridded map has been noted.

Percentage of silica, magnesia and iron oxide were chemically determined. For each location (i.e., value of $X$ and $Y$ parameters), the percentage of silica magnesia and iron oxide have been mentioned separately in three maps. Thus, the value of $Z$ parameter in the three maps are in the following order—(*i*) Silica (*ii*) Magnesia and (*iii*) Iron oxide.

Using above values, the data have been run on a computer so as to find the four polynomial surface values—linear, quadratic, cubic and fourth degree. In the present example, only 4th degree values are considered for getting the best interpretation of the computed result.

Using the conditional FORTRAN statements, a series of specifications have been introduced so that at every point, the grade of the ore is represented by alphabetic symbols and line by line punched card of a continuous symbol contour map is accomplished. The polynomial surface fitting is done by Sampson-Davis computer programme (1966) and the continuous symbol map has been obtained using the programme specifically written by the Junior author to suit the needs of this type of computational work.

For the present work, an area of 660 $\times$ 360 sq meters has been studied. The whole area has been represented by 1430 alphabets. The values of $SiO_2$, MgO and iron oxide have been computed as $Z$ parameters. Silica and Iron oxide occur as major impurities in the magnesite ore, therefore, if these constitutents increase in percentage, the percentage of magnesia decreases so as to render it as an impure ore.

## Ore Gradation Maps

Fig. 1 is an index map of the area.

In Fig. 2, magnesia have the following values in terms of alphabets—
A — Below 38%; B — 38% to 40%; C — 40% to 42%; D — 42% to 44%; E — 44% to 46%; F — 46% to 48%; G — 48% to 50%; H — Above 50%.

For the whole area values of magnesia have been plotted from 38% to 50%. Area which is having magnesia percentage more than 48% is of economic value for magnesite and it has been plotted as H on the map. Area showing such points can be mined for magnesite.

Fig. 3 shows gradation of percentage of silica from 1.5% to 10.5% and above are also denoted by alphabets from A to H. A and B represent from 1.5% to 3.0% of silica in magnesite and such type of magnesite is of economic value. C to H show 3.0% to 10.5% and above silica. This is of uneconomic value.

Fig. 4 shows gradation of percentage of iron oxide from 0.5% to 4.5%. They are denoted by alphabets from A to H. Alphabets A, B, C show iron percentage from 0.5% to 1.5%. It is of economic value. D to H show from 1.5% to more than 4.5% iron oxide and it is of uneconomic value.

Fig. 5 shows gradation of magnesite. It has been plotted by taking following specificationist—

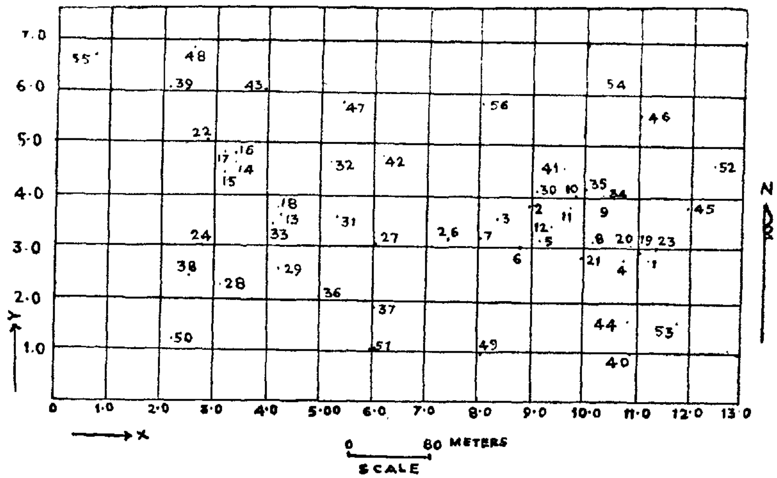


FIG. 1. Index Map of Main Magnesite Mine, Salem Magnesite Ltd.

A — Silica less than 2.00%; Magnesia more than 47.50%; Iron oxide less than 1.00%.
B — Silica 2% to 4%; Magnesia 45% to 47.5%; Iron Oxide 1% to 2%.
C — Silica 4% to 6%; Magnesia 45% to 47.5%; Iron Oxide 2% to 3%.
D — Silica 6% to 8%; Magnesia 40% to 42.5%; Iron oxide 3% to 4%.
E — Silica 8% to 10%; Magnesia 38% to 40%; Iron oxide 4% to 5%.
F — Silica more than 10%; Magnesia less than 38%; Iron oxide more than 5%.

Points represented by alphabets A and B in figure 5 have economically useful deposits of magnesite and C to F have uneconomic magnesite deposits.

A close examination of this map reveals that the better quality deposits are found at two places at the central region of the area. These deposits are rich in magnesia and they have less percentage of impurities.

*Reserve Estimation* — The dimension of the area is 16.5 × 9 cms and is drawn to a scale 1 cm to 40 meters and hence the total area represented by the map is 237600 square meters. It is presumed that magnesite ore persists upto the depth of 2 meters. There are 1430 points represented by alphabets in the present area so the deposit available at any of these points is approximately 332.3 cubic meters. If the specific gravity of magnesite is 3.00, each alphabet represents 996.9 kilotons. It can be shown in the following way—

1 cm = 40 meters.

Area of the map is (16.5 × 40) × (9 × 40)
(Length Breadth)
= 2,37,600 sq. meters (Area)

Volume = 237600 × 2 = 4,75,200 cubic meters.
(Area) × (Depth)

There are 1430 alphabet points on the map.

$$\text{Each alphabet represents} = \frac{475200}{1430} = 332.3 \text{ cubic meters}$$

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.ECHHHHHHHHHHHHHHHHHHHGFF EDDCBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA A.
.ACDEFGHHHHHHHHHHHHHGFFEED CC BB AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA.
.AAABDEFFGGHHHHHGGGGFFEEDD CC BB AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA.
.AAAABCDEFFFFGGGGGFFFEEEDDCCCBBAAAAAAAAAAAAAAAAAAAAA AAAAAAAAAAAAAAAA.
.AAAAACCD EEFFFFFFFFFF EE DDD CCC BBBB AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA.
.AAAAAA BCCDEE  FFFFFFFFF  EEEEDDD  CCC  BBBBB  BBBBBBBBBBBBB  CCCCCCCC  BBBB AA.
.AAAAAAABCDDEEFFFFFFFFFFEEEEDDDDDBBBBCCCCCCCCCCCCCCCDDDDDDDDDDDCCBBA.
.AAAAAAA BCDD  EE  FFFFF FFFFFFF EEEEEE DDDDDDDDDDDDDDDD EEEEEE EEEEEDDD CCB.
.AAAA  AAAA  CCDE EFFFFF  GGG FFFF  FFFFEEEEEE EEEEEE EEEE EEEE FFFFF FFFF EEE DD CB.
.AAA AAAAA B C D EE FFFF GGGGGGG FFFFF  FFFF EEEEEEEEE FFFF  FFF  FFFF FFFFFF EEE DCB.
.AAAAAAAA B C D EE FFFF GGGGGGGGG FFFFFFFFFFFFFFFFFFFFF  GGGGGGGGGG FFF EEDCB.
.AAAAAAAA B  C DD EE FFF GGGGGGGGG FFFFFFFFFFFFFFFFFFF GGGGGGGGGGGGFFFEEDCB.
.AAAAAAAA B C DD EEFFFFF GGGGG FFFFFFFFFFFFFFFFFFFFF  GGGGGGGGGGG  FFF EEDDCB.
.AAAAAAAA  BBCDDEFFFFFFFFFFFFFFFFFFFFFFFFFFFFF  FFFFF   GGGGGGG FFF  EE  DD  C B  A.
.AAAAAAAAA B C DD  EEEE  FFFFFFFFFFFF   EEEEEEEEEEEE  FFFFFFFFFFFFFFFF EEE  D  CC B  A.
.AAAAAAAAA B CC DD EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE FFFFFFFFFFFFF EEE DD C B AA.
.AAAAAAAAA B CC DDD EEEEEEEEEEEEEEEEDDDDDDDDDDEEEEEEEEEEEEEFFFEEEEE DD C BB AA.
.AAAAAAAAA B CC DDDD EEEEEEEEE DDDDDDDDDDDDDDDDDD EEEEEEEEEEEEEEE DDDCBAAA.
.AAAAAAAAA B CC DDDEEEEEEEEE  DDDDDDDDDDDDDDDDDDD  EEEEEEEEEEEEEEEE  DDCBBAA.
.AAAAAAAA  B  CC  DDD EEEEEEEEEEEE  DDDDDDDDDDDDDEEEEEEEE  FFFFFFFFFEEEDD CBAA.
.AAAAAA B  CC  D  EEE  FFFFFFFFF EEEEEEEEEEEEEEEEEEEE  FFFFFF GGGGGGGGG FFF E DD C A.
.AAAA B CDEEFFGGGGGGGGGGGGGGFFFFFFFFFFFFFF GGGGGGHHHHHHHHHHHHHHFFFED.
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FIG. 2. Magnesite Quarry, Chalk Hills, Salem 4th degree trend surface magnesia percentage. Below 38 Percent = A; Between 38 and 40% = B; Between 40 and 42% = C; Between 42 and 44% = D; Between 44 and 46% = E; Between 46 and 48% = F; Between 48 and 50% G; and Above 50 percent = H.
Scale 1 cm = 40 meters.

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.AAAAAAAAAAAAAAAAB CDFGHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGGFFGG.
.FDBAAAAAAAAAAAAABC DEFGHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGGGHH.
.HHGHGFEDCCBBCCCDDEFFG HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGGHHHH.
.HHHHGFEDCCBBCCCDD EEFG HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHCCGGGHHHH.
.HHHHHHGFEDDCCCCDDEEFFGGHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGGGGGGGHHHH.
.HHHHHHHGFEDDDDDDDDDEFFFGGHHHHHHHHHHHHHHHHHHHHHHHH GGGFFFFFFFF GHHHH.
.HHHHHHHHGFEDDDCCCDDDDEEFFFGGHHHHHHHHHHHHHHHHHHH GGGFFFEEEEEEEEFFG HHH.
.HHHHHHHHHFEEDCCCCCCCCDDDEEFFFF GGGGGGGGGGGG FFFFEEE DDDDDDDDEFFGHHH.
.HHHHHHHHHGFEEDCCCBBBBCCCCDDDDDDEEEEFFFFFFFFFEEEE DDDDCCCCCCCCDDEFGHHH.
.HHHHHHHHH G F E CCBBBBBBBBB CCCCDD DDDDEEEEF DDDDDD CCCC BBBBBBB CCDD EFHHH.
.HHHHHHHHH G F E D C BBBAAAAAAABBBBBCCCCCDDDDDD CCCCCC BBBBBBBBBBB CCD EFHHH.
.HHHHHHHHHH F E D C BB AAAAAAAAAA BBBBB CCCCCCCCCCCBBBBBBAAAAAAA BB CCDEFHHH.
.HHHHHHHHHH G E D CCBBAAAAAAAAAAA BBBBBBBCCCCC BBBBBBB AAAAAAAAA BB CCDEFHHH.
.HHHHHHHHHH GFE DCBBAAAAAAAAAAA BBBBBBBB CCC BBBBBBBB AAAAAAAAA BBCC DEGHHH.
.HHHHHHHHHHH FEDC CBBB AAAAAA BBBBBBB CCCCCCCCC BBBBBBB AAAAAABBBCDDFG HHH.
.HHHHHHHHHHH G FEDCC BBBBBBBBBBB CCCCCCCCCCCCCCCCCCCCBBBBBBBBBBBCC DEFGHHH.
.HHHHHHHHHHHH GFEDD CCCCCCCCCCCCDDDDDDDDDDDDDDDDCCCCCCCBBBBCCDDEFGHHH.
.HHHHHHHHHHHH G F EEE DDDDDDDDDDDDEEEEEEEEEEEEEEEDDDDCCCCCCCCDDEEFGHHH.
.HHHHHHHHHHHHH GG FF EEEEEEEEEEFFFFFFFGGGFFFFFFFF EEEEDDDDDDDDDD EEFGHHH.
.HHHHHHHHHHHHHHH GGFFFFFFFF GGGGGHHHHHHHHHHGGGFFFFEEEDDDDDDEEEFGHHH.
.HHHHHHHHHHHHHHHHGGGGGG HHHHHHHHHHHHHHHHHHHHHH G BB EFFEEEEDDDDEEFFGH.
.HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGFFEEEDDDDDDEEFGHH.
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FIG 3. Magnesite Quarry, Chalk Hills, Salem 4th degree trend surface Silica percentage
Below 1.50 percent = A; Between 1.50 and 3.00% = B; Between 3.00 and 4.50% = C; Between 4.50 and 6.00% = D; Between 6.00 and 7.50% = E; Between 7.50 and 9.00% = F; Between 9.00 and 10.50% = G; Above 10.50% = H.

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.HHHHHHHHHHHHHGFEEDDCCC BBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA.
.HHHHHHHHHHHHHHFFEDDDDCCCCBBBBBBBBBBBBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAA.
.HHHHHHHHHHHHHGFEDDDDCCCCCCCCCCCCCCCCCCCCCC BBBAAAAAAAAAAAAAAAAAAAAAA.
.HHHHHHHHHHHHGFEDDDCCCBBBBBBCCCCCCDDDDDDDDDDD CCCCCBBBAAAAAAAAAAAAABBC.
.HHHHHHHHHHHHGFEDDDCBBBBBBBBBBCCCCCDDDDDDDDDDDDDD CCCCCCBBBBBCCCDDD E.
.HHHHHHHHHHHGFEDDCBBAAAAAAAABBBBCCCCDDDDDDDDDDDDDDDDDCCCCCCC DDDDDEFF.
.HHHHHHHHHHHFEDDCBBAAAAAAAAAAAABBBCCCCCDDDDDDDDDDDDDDDDDCCDDDDDDDEFFG.
.HHHHHHHHHHHFEDDCBBAAAAAAAAAAAAAABBBBCCCCCDDDDDDDDDDDDCCCCCCCDDDDDDEFFG.
.HHHHHHHHHHHHFEDDCBBAAAAAAAAAAAAAABBBB CCCCCCC DDDD CCCCC CCCCCC DDDDDEFFG.
.HHHHHHHHHHHGFEDDCBBA AAAAAAAAABBBB CCCCCC CCCCCCCCCCCC CCCCCCCC DDDDEFFG.
.HHHHHHHHHHHGFEDDDC BBBBAAABBBBBB CCCCCCCCDD DDCCCCCCCCCCCCCCCCC DDD E FF G.
.HHHHHHHHHHHHGFEDDDCCC BBBBBB CCCCCCC DDDDDDDDDDDDCCCCCCCCCCCCCDDDDEFG.
.HHHHHHHHHHHHHHFFE DDDDDCCCCCCDDDDDDDDDDDDDDDDDDDDDDDCCCCCCCCCCCDDDEFG.
.HHHHHHHHHHHGFFEE DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD CCCCCCCCCDDDDEF.
.HHHHHHHHHHHHHHG FFEEE DDDDDDDDD EEEEEEEEEEEE DDDDDDDDDDD CCCCCC DD EEF.
.HHHHHHHHHHHHHHGFFF EEEEDD EEEEEEEEE FFFFF EEEEEE DDDDDDDDDDDDDDDDDD E FF G.
.HHHHHHHHHHHHHGFFEEE DDDDDDD EEEEEEE FFFFFFFFF EEEEE DDDDDDDDDDDDDDDD EFFG.
.HHHHHHHHHHH E FF E DDDDDDDDDDDDDDD EEEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDEFF.
.HHHHHHHGFEDDCBBBAAAAABBBCCCCDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDCDDDDDDDEFFG.
.HHHH FE DD AAAAAAAAAAAAAAAAAAAAAAAA BBB CCCCCCCCCCCCCCCCCC BBBB CCCC DDD EFG.
.GEC AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA BB C DDEF.
.AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA B DD.
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FIG. 4. Magnesite Quarry, Chalk Hills, Salem. Fourth degree trend surface iron percentage map.
A = Below 0.50%; B = Between 0.50% and 1.00; C = Between 1.00 and 1.50%; D = Between 1.50 and 2.50%; E = Between 2.50 and 3.00%; F = Between 3.00 and 4.00%; G = Between 4.00 and 4.50%; H = Above 4.50.% Scale 1 cm = 40 meters.

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.FFFFFFFFFFFFFEEDCCCC D EFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF.
.FFFFFFFFFFFFEE DDCCCDD E FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF.
.FFFFFFFFFFFFEDD CCCDDEFFFFFFFFFFFFFFFFFFFFFFFF FFFFFFF FFFFF FFFFFF FFFFFFF FFFFF.
.FFFFF FF FFF EE D CCCC DD E E FFFF FFFF FFFF FFFF FF FF FFFF FF FF FFFF FFFF FF FF FFFF.
.FFFF FFF FFF E D CCC CCD DD EE FFF FFF FFFF FFFF FFFF FFF FF FFFF FFFF FF FFF FFFE FFF.
.FFFFFFFFF EEDCCCCCCCC DDD EEEF FFF FFFF FFFF FFFF FFFF FF FFF FEE EEE DDD EEE FFFF.
.FFF FFF FFF EDC CCCCCCCC DDD EEE FF FFFF FFFF FFFFF FFFF EEEE DDDDDDDDDDE FFFF.
.FFFFF FFFF E DD CC BBBBB CCCCC DDDD EEEEE FFFF FFF EEE EEE DDDD CCCC CCCC DDE FFF.
.FFFFFFFFF E DD CC BBBBBBBBB CCCCC DDDDDD EEEEE DDDDDD CCC CCC BBBBBCCC DDFEFFF.
.FFFFFFFFF EE DCC BBB AAAA BBB BBB CCCC CCC DDD DD CCCC CCC BBBBBB BBBBB CCC DEFFF.
.FFFFFFFFFFEDDCCBBBAAAAAAAAAAAAABBBBBBBCCCCCCCCCCCCBBBBBBBBBBBBBBBBCCDEFFF.
.FFF FFF FFF FEE D CC BBBBB AAA AAA BBBBB BBBBB BB BBB BBBBB BBBBB BBBBB BB CC DE FFF.
.FFFFFF FFFFF E DD CCC BBBBBB BBBB BBBB BBBBB CC BBBB BBBB BBBB BBBB BBBB CC D E FFF.
.FFF FFF FF FFF EE DD CCC CC BBBB BBB CCC CC CCCCC CCC CCCBBB BBBBB BBB BBB CC DE FFF.
.FF FFF FFFF FFF EE DD CCCCC CCCCC CCCCC CC CC CCCC CCCCC CCC BBBB BBB BBB CC DFFF F.
.FFFFFFFFFFFF EE DDD CCCCCC CCCCCC CCCC DDDDD CCCC CCC CCCC BBBBBBBB C CDDEF FF.
.FFFFFFFFFFFF E DD CCCCCCCCCCCCCCCCC DDDD DDDDD CCCCCCCCCC BBBBBB CCC D EE FFF.
.FFFFFFFFFFFFF E DDD CCCCCCCCCCC DDDDDDDDDDDDDDD CCCCCCC BBBBB CCC DD E FFFF.
.FFFFFFFFFFFFFF EE DDDDDDDDDDDDD EEEEE EEEE EEEE DDDDDD CCCCCCCCCC DD E FFFF.
.FFFF FFFFF FFF FFF EEE EEEEE EE EEE FFF FFFF FFFF FFF EEEE DDD DD CCC CCC DDD EE FFF.
.FFF FFFF FFFF FFFFF FFF FFFFF FFFF FFFF FFF FFFF FFF FFF EE EE DDDDD CC CC DDD E FFF.
.FF FFF FFF FFFFF FFF FF FF FFF FFFF FFF FFFF FF FF FFF FF FFF EEE DD DD CCC CCC DD EE F.
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FIG. 5. Magnesite Quarry, Chalk Hills, Salem. Map Showing the Grade of Magnesite.

*Grade specifications* : A = Si less than 2.00%; Mg more than 47.5%; Fe less than 1.00%; B = Si less than 4.00%, more than 2.00%; Mg less than 47.5%, more than 45%; Fe more than 1%, less than 2%; C = Si less than 6%, more than 4%; Mg less than 45%; more than 42.5%; Fe more than 2% less than 3%; D = Si less than 8.0% more than 6%; Mg iess than 42.5%, more than 40%; Fe more than 3% less than 4.00%; E = Si less than 10% more than 8%; Mg less than 40.0%, more than 38%, Fe more than 4% less than 5.00%; F = Si more than 10%, Mg less than 38%, Fe more than 5.00%. Scale 1 cm = 40 meters.

$$\frac{\text{Mass}}{\text{volume}} = \text{Specific gravity. Specific gravity of magnesite} = 3.00$$

$$\frac{\text{Mass}}{332.3} = 3.00$$

Thus Mass = 996.9 Kilotons.

Therefore, every alphabet represents 996.9 kilotons of magnesite. In this way, for calculating a particular grade of ore, one can count the same type of alphabet and if the number of alphabets may be multiplied by 996.9, ore reserve of magnesite can be obtained in tons. This is the chief reason for making a continuous symbol map than a contoured map.

*Utility of the computed maps* — It may be mentioned here that the grade map requires continuous revision when new sets of data are available because of progressive quarrying. By making such series of new grade maps, one can actually find out the robustness and the predictability of grade map in terms of time factor during a period of continuous mining activity.

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