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COMMENTS ON
SOME STATISTICAL ASPECTS
OF A DRAFT REPORT
BY C M J V

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SOME STATISTICAL ASPECTS

OF A DRAFT REPORT

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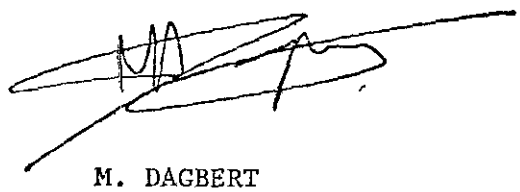
Respectfully submitted



M. DAGBERT
Montreal, July 10, 1978

COMMENTS

1 - Estimation of the average grade (sulphur, BTU) of 75 or 25m square blocks

.The same method has been used in the 14 sub-zones:

Values are assigned to the four corners of the block by a modified inverse square distance method: the eight holes closest to a corner and falling within a circle of radius 500m are selected and they are weighted according to the inverse square of the distance between them and the corner. However all the sample points closer than 100m from the grid point are weighted as if the distance to this point was 100m.

.In fact, the computation of variograms and geological studies show that continuity is not the same in all the sub-zones. Moreover, in the same sub-zone, continuity of sulphur and BTU may be quite different.

.The following example shows that the method used by C M J V is well suited to sub-zones and variables where the continuity is isotropic (the same in all the directions) and where variograms show a rather high nugget effect (substantial differences between samples even when the distance between them is small).

.In this example, the average grade of a 75m square block is estimated from holes on a 75m regular square grid. The estimation is done with the four holes at the corners of the square (inner ring) and the eight nearest holes (outer ring). Different estimation methods are used: the usual inverse square distance method, the modified version by C M J V and the kriging method with different isotropic variograms. Due to the symmetry of the sampling pattern around the block and the isotropy of the variograms, the weight of each hole in either the inner and outer ring are the same: they are called a_i and a_o respectively. Results are shown on Table 1.

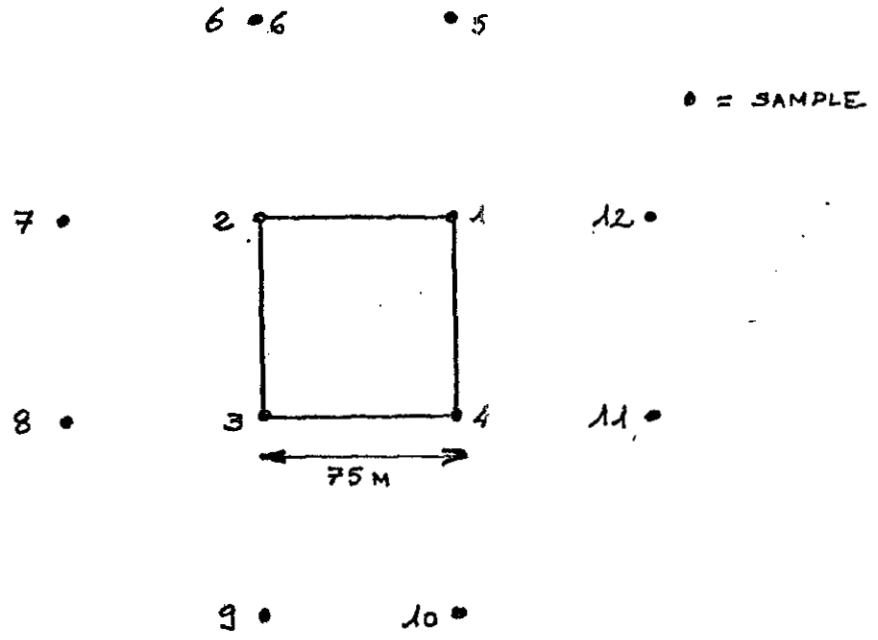
The following points emerge from these results:

- the usual I.S.D. method gives weights similar to kriging when there is not any nugget effect i.e. the continuity of grade values is good at small distances. Then, if variograms of BTU computed by MERI are considered, it means that this method should give better block estimates of BTU in A1-1, A1-3, A1-4, C2-1 and D1-3 zones.

- the modified I.S.D. method gives weights similar to kriging when the amplitude of the nugget effect is high i.e. about the amplitude of the linear variation for distance equal to 400m. Here again, the sub-zones where this condition is realized for BTU are mainly C1-1 and to a lesser extent A1-2, A2-1, B1-1, B1-2, C2-2, and D1-1. In these sub-zones, the method is rather well suited to the continuity of BTU shown by the experimental data.

- the situation which has been considered in the example is slightly artificial but it facilitates the kriging computations. In reality, the sampling grid at Hat Creek is rather of the order of 150m square and it is not complete everywhere. Thus the displacement of too close samples generally affects only one hole for each grid corner being estimated. Then the effect on estimated values may not be as strong as suggested by the example. Nevertheless, the general tendency remains: experimental data are smoothed and the method is well suited to sub-zones and variograms with a substantial nugget effect.

- anisotropy also affects the weights of neighbor samples and should be considered in the estimation procedure when it is present. If the same situation is still considered but with a variogram $\gamma(h) = 3\ 10^5 + 1500h$ along X (maximum continuity) and $\gamma(h) = 3\ 10^5 + 3000h$ along Y (minimum continuity), the weight of holes 1 to 4 (inner ring) becomes .151, it is .035 for holes 5, 6, 9, 10 and .065 for the remaining holes (7, 8, 11, 12).



Method	Variogram*	Weights of samples			
		a_i	sum of a_i	a_o	sum of a_o
Usual I.S.D.		.25	1.00	0	0
Modified I.S.D.		.118	.47	.066	.53
Kriging	$\gamma(h) = 1500h$	.25	1.00	0	0
–	$\gamma(h) = 10^5 + 1500h$	.195	.78	.028	.22
–	$\gamma(h) = 2.10^5 + 1500h$	.163	.65	.044	.35
–	$\gamma(h) = 3.10^5 + 1500h$	.145	.58	.052	.42
–	$\gamma(h) = 5.10^5 + 1500h$	.126	.50	.062	.50
–	$\gamma(h) = 10^6 + 1500h$	.107	.43	.071	.57
–	$\gamma(h) = 10^6$	.083	.33	.083	.66

* The distance h is expressed in meters. The last situation corresponds to a pure nugget effect (independent samples).

TABLE 1 : Estimation of a 75m square block from holes on a 75m square grid.

2 - Variograms

.Some variograms of sulphur are shown in the report (Figures 26, 27 and 28). They are average variograms which means that the directions along which pairs of samples are oriented are not taken into account. It should be good to compute also directional variograms so that anisotropies could be detected.

.Moreover, since the dip of the layers is varying, it is better to consider the real distance between holes rather than the projected distance. This recommendation is also valid for the estimation procedure.

.Comments about the variograms and thus the continuity of sulphur and BTU (p.59) should be tempered:

- "Zone A... exhibits a high variance in both sulphur and calorific value over short lateral distances".
This could be true for sulphur (the variogram that we have computed in A1-1 shows a large nugget effect) but we think that it does not apply to BTU in A1-1, A1-3 and A1-4 where we did not find any nugget effect at all.

- "D-Zone sulphur shows a random distribution with a relatively low variance". The variance is clearly low compared to the other sub-zones but we have also found a good continuity in the D1-3 sub-zone. The scale of the diagram of figure 28

is unappropriate and gives the wrong impression of a flat curve. However, tabulated values of the variogram in the upper part of the figure indicate that this function is regularly increasing with distance.

3 - Standard errors of estimation

Standard errors of estimation for the average BTU and sulphur grade in the different sub-zones are shown on Table 7-2. They have been computed by dividing the experimental standard deviation of sample values by the square root of the number of samples. This formula is the one to be used when sample values are independent i.e. there is no continuity at all for both variables in all the sub-zones. When such a continuity exists as it is the case in the Hat Creek deposit, the standard error is less important and can be computed from the variogram of each variable in each sub-zone. Approximate values for BTU can be obtained by dividing the standard error for 75m square block shown on Table 2 of our report of May 16, 1978 by the square root of the number of samples in each sub-zone.