

September 7, 2004

Professor Dr A G Journel
Assistant Editor
Journal of Mathematical Geology
By email

Dear Sir,

Your reluctant reply of October 15, 1992, to *JMG*'s Editor, and his letter of October 26, 1992, to me, continue to make perplexing reading. You concluded that my reading is, "*too encumbered by classical "Fischerian" (sic) statistics*" whereas *JMG*'s Editor conceded, "*Your feeling that geostatistics is invalid might be correct*". Paradoxically, Professor Dr Robert Erhlich is no longer *JMG*'s Editor whereas you remained one of *JMG*'s multitude of Associate and Assistant Editors who are entrusted with the enforcement of geostatistical dogma.

Classical statistics offers many tools and techniques but none are as powerful as analysis of variance (ANOVA). Fisher's F-test, the essence of ANOVA, is applied to verify whether two variances are statistically identical or differ significantly by comparing the ratio between the highest and lowest variances with tabulated values of F-distributions at 5% and 1% probability, which are given as a function of the degrees of freedom for each of these variances. The F-test can also be applied to verify the *absence* or *presence* of spatial dependence by comparing with tabulated values the ratio between the variance of a randomly distributed (randomized) set and the variance terms of an in situ ordered set. A set of n independently measured values with equal weights has $df_r=n-1$ degrees of freedom, and the first variance term of an in situ ordered set has $df_o=2(n-1)$ degrees of freedom. Degrees of freedom are positive integers for measured values with equal weights but become positive irrationals for measured values with variable weights.

A sampling variogram is a chart in which are plotted the variance terms of the in situ ordered set, the variance of the randomized set, and the lower limits of the latter's asymmetric 95% and 99% confidence ranges. Sampling variograms are graphic interpretations of Fisher's F-test that show where orderliness in sample spaces dissipates into randomness. They are described in several ISO standard methods including those developed by ISO/TC69-*Applications of Statistical Methods*. There is no ISO Technical Committee on applications of geostatistical methods.

We postulated in "*Precision Estimates for Ore Reserves*" that the intrinsic variance of gold could be estimated by subtracting extraneous variances such as those associated with selecting bulk samples of crushed ore from an adit or drift, or with dividing whole core samples into halves. This application of analysis of variance was instrumental in unraveling Bre-X's salting scam. In contrast, geostatistics continued to convert Bre-X's bogus grades and Busang's barren rock into the world's largest phantom gold resource. And amazingly, analysis of variance continues to trouble geostatistical scholars and practitioners alike.

In your letter to *JMG*'s Editor, under *1 – Data and degrees of freedom*, you assert, “*The very reason for geostatistics or spatial statistics in general is the acceptance (a decision rather) that spatially distributed data should be considered a priori as dependent one to another, unless proven otherwise*”. Who made this decision and when? Was it decided by consensus? Did anyone oppose this bizarre decision? And how do you propose to prove “*otherwise*” anyway?

Your statement, “*In presence of dependence the classical notion of degrees of freedom vanishes; n spatially dependent data do not provide n degrees of freedom*”, misinterprets mathematical statistics in the extreme. A functionally dependent value such as a central value (the arithmetic mean or some weighted average) of a set of independently measured values is not accorded a single degree of freedom but the set itself is so rewarded. I agree with you that, “*n spatially dependent data do not provide n degrees of freedom*”; for *n* spatially dependent data will always provide $df_0=2(n-1)$ degrees of freedom for the first variance term of an in situ ordered set of measured values with equal weights, and $dfr=n-1$ for the randomly distributed set.

Index A of Mining Geostatistics does not refer to associative, functional or spatial dependence. Nor does it mention the variance of the arithmetic mean (David's famous central limit theorem) or its homologue for weighted averages, or degrees of freedom for that matter. But it does refer to *Deconvolution, Smoothing effect (of kriging), Unbiasedness*, and an abundance of neologisms and kriging-inspired eponyms that have removed geostatistics far from its roots in mathematical statistics. And *JMG*'s Associate and Assistant Editors deem themselves qualified to review papers on applications of mathematical statistics? Surely, they must be joking!

The Excel template with the interactive kriging game shows that the variance of a distance-weighted average converges on the central limit theorem as the weighting factors of all measured values in the set converge on $1/n$. Do you agree or disagree that each distance-weighted average has its own variance? Do you agree or disagree that the variance of a set of distance-weighted averages is a valid measure for variability, precision and risk? Do you agree or disagree that the covariance of a set of distance-weighted averages is a valid measure for spatial dependence?

Three months ago I asked Krige similar questions but his investigation is ongoing. You and your colleagues ought to investigate when the variance of the distance-weighted average vanished without a trace. Was it a human error? Or did the early krigers believe that too many distance-weighted averages went to waste? Who decided that the variances and covariances of sets of distance-weighted averages are statistically sound, and not a scientific fraud. When, where, why, and by whom was the variance and covariance of a set of distance-weighted averages accepted, and the variance of a single distance-weighted average rejected. Since the early 1990s I have questioned the validity of geostatistics, and have been served a steady diet of convolution, evasion and prevarication. All I ever wanted are answers that make scientific sense. Please do not assume that I shall not continue to pose questions.

Yours truly,
Jan W Merks