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By Registered Mail

Mr Marc Boivin, géo
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Dear Mr Boivin,

On January 14, 2005, I brought to your attention that geostatistics is a fundamentally flawed variant of mathematical statistics. Despite Bre-X's phantom gold resource and several shrinking reserves, scores of professional geoscientists continue to use and promote the junk science of interpolation without justification. Geostatistics is applied in geology, mineral exploration, mining, oil reservoir forecasting, hydrology, environmental, geotechnical and health sciences, fish abundance estimation, and other fields where sparse data sets in large sample spaces are encountered and additional data is expensive to measure or impossible to obtain. A synopsis of my crusade against geostatistics is chronicled in my letter of March 21, 2003, to the Editor of the *Journal of Mathematical Geology (MG)*, which is posted under *Correspondence* (see JMG20030321.pdf) on my website at ***geostatscam.com***.

A fundamental principle of geostatistics is Journel's doctrine that spatial dependence may be assumed. His mind numbing thoughts are also posted under *Correspondence* (see SU19921015.pdf). Since it was Journel who accepted, or rather decided, that *"spatially distributed data should be considered a priori as dependent one to another,* ***unless proven otherwise"*** (my emphasis!), he ought to explain how to prove **otherwise** by showing that spatial dependence **does not exist**. Journel never did, *MG's* Editor wrote on October 26, 1992, "*Your feeling that geostatistics is invalid might be correct"*, a heresy that may have caused his replacement.

In our paper titled *Precision estimates for ore reserves* Fisher's F-test is applied to prove whether test results for gold of in situ ordered rounds in a drift display a significant degree of spatial dependence, or are randomly distributed in this sample space. When Journel reviewed our paper in 1992, he presumed that we misread geostatistical theory, or that our reading was "*too encumbered with classical* ***Fischerian*** (sic!) *Statistics."* In time, our paper was reviewed, praised, published by *Erzmetall*, and is posted on my website. Whether to test or not to test for spatial dependence is an irrelevant question amongst statistically challenged scholars. Perhaps ironically because rumors from an inside source have it Journel himself does not use geostatistics anymore.

Paradoxically, geostatisticians have demonstrated that interpolation by *kriging* between independently measured data of in situ ordered sets creates an illusion of spatial dependence. *Kriging* is an eponym to recognize Dr D G Krige, formerly an Honorary Professorial Research Fellow at the University of Witwatersrand and the pioneering plotter of distance-weighted averages in South African gold reefs.

When Sir Ronald A Fisher was knighted in 1952, each and every weighted average had its own variance but when geostatistics was hailed as a new science in the 1960s, the distance-weighted average turned out to be the first and only weighted average that shed its variance during an honorific rebirth as a "*kriged estimate*". Incredibly, *kriging variances* and *kriging covariances* of ***sets*** of *kriged estimates* are the heart and soul of geostatistics. Incredible indeed because the kriging variance is as inane a measure for variability, precision and risk as the kriging covariance is for spatial dependence. So who decided that the variance of a **set** of distance-weighted averages makes more scientific sense than the variance of a **single** distance-weighted average. Regrettably, nobody seems to remember because time has since muddled the minds of early plotters of kriged estimates.

In the real world, Fisher's F-test is applied to the variances of randomly distributed sets and the variance terms of in situ ordered sets to verify whether and where orderliness in a sample space dissipates into randomness. A sampling variogram is a chart in which the variance terms of the ordered set are plotted against the variance of the randomly distributed set and the lower limits of its asymmetric 95% and 99% confidence ranges. Sampling variograms are incorporated in various ISO standards such as those developed by ISO TC69 – *Applications of statistical methods*.

In the rarefied world of geostatistics, however, kriging variances are plotted in a variogram or a semi-variogram in which they rise to a maximum before converging on zero. The shrinking of kriging variances so troubled geostatistical thinkers that they cautioned against oversmoothing. In spite of such inspired tinkering, the kriging variance shrinks because kriged estimates are functionally dependent values.

Sir Cyril Burt, eminent British psychologist and Editor of the Journal of Statistical Psychology, reported a correlation coefficient of 0.771 for his 1955 IQ data for 21 pairs of identical twins separated at birth. Surprisingly, Burt reported the same correlation coefficient of 0.771 in 1958 for 30 pairs, and in 1966 for 53 pairs. The *British Psychological Society* concluded in 1982 that the sameness of his correlation coefficients proved that Burt committed a scientific fraud. How he augmented his IQ data sets remains unclear but it is highly improbable, if not practically impossible, that Burt did indeed add independently measured data in stages and obtained exactly the same correlation coefficient. It becomes even more curious in retrospect because the correlation coefficient of 0.771 for his 1955 IQ data for 21 pairs of separated twins already implied a highly significant degree of associative dependence at 99.9% probability. So what was Sir Cyril Burt thinking?

And what was David thinking when he wrote his textbook? In Figure 203 of his 1977 *Geostatistical ore reserve estimation*, he shows 16 points *"estimated"* (read **calculated!**) from the same 9 holes and proclaims, *"writing all the necessary covariances for that system of equations might be a good test to find out whether one really understand geostatistics*." Had David grasped degrees of freedom, he would have known that the kriging covariance of a **set** of kriged estimates is as murky a measure for spatial dependence as the kriging variance is for variability.

Twelve years after David's first textbook on geostatistics was published, Armstrong and Champigny's caution against oversmoothing in *A study on kriging small blocks* cracked the rise of kriging covariances and the fall of kriging variances. In the interim, under performing scholars may have smoothed much too little, audacious krigers a little too much but the odd gifted pundit may have smoothed to perfection. Amazingly, a paper on perfect smoothing was also reviewed by and published in *CIM Bulletin*. Sir Cyril Burt would have been quite amused.

Geostatistics is extremely popular because spatial dependence may be assumed but even more so because two or more independently measured data with different coordinates define an infinite set of kriged estimates between these coordinates and beyond. Of course, interpolation by kriging is the equivalent of perpetual motion in data acquisition. Despite Bre-X's infamous phantom gold resource, and despite scores of shrinking ore reserves and resources, geostatisticians persist in assuming spatial dependence, interpolation by kriging and smoothing to perfection with the same single-minded fanaticism as Trofim Lysenko preached his variant of genetics.

We found out in the early 1990s that geostatistical peer review is a blatantly biased, shamelessly self-serving sham when *Precision estimates for ore reserves* was rejected by *CIM Bulletin*, *Mathematical Geology* and *IMM Transactions* before *Erzmetall* praised and published our paper. As luck would have it, my son and I were not even aware we had written a *"geostatistical"* paper until David, the author of *Geostatistical ore reserve estimation* and one of CIM Bulletin's reviewers, deemed it deficient in references to geostatistical literature. Encounters with Dr A J Sinclair, PEng, PGeo and CIM Bulletin's second reviewer, both before and after the Bre-X fraud, are chronicled and posted under *Correspondence*.

Whenever dissenting views demand censure, elite enforcers of geostatistical dogma are summoned into action. A case in point was my email about the kriging game to the Councilors of the *International Association of Mathematical Geology*, and to *JMG*'s Editor and his Associates and Assistants. Predictably, Krige himself was drafted to investigate how a missing variance of a reborn distance-weighted average (that ubiquitous kriged estimate) could possibly converge on the central limit theorem when the weighting factors of all measured values in a set converge on ***1/n***. Geostatistics is so richly embellished with neologisms and Krige-inspired eponyms that even this simplest of questions triggered a tortuous semi-response of sorts.

Armstrong, David, Dowd, Froideveaux, Journel and Sinclair rejected *Precision estimates for ore reserves* long before mathematical statistics proved that a salting scam was in progress at Bre-X's Busang property, and did so several months before Bre-X's brass was honored for its discovery and Busang's boss salter jumped into the Kalimantan jungle. Analysis of variance proved that the intrinsic variance of gold was indeterminate (statistically identical to zero), as it ought to be in a phantom gold resource. Sir Ronald A Fisher would have been proud.

All those geostatistical scholars and scores of others refuse to accept the irrefutable fact that each and every distance-weighted average has its own variance simply because it is a functionally dependent **(calculated!)** value. In mathematical statistics, one-to-one correspondence between weighted averages and their variances is sine qua non. In geostatistics, however, one-to-one correspondence between distance-weighted averages and their variances is null and void.

Perhaps it was a human error that the variance of a single distance-weighted average was overlooked, and that the kriging variances and covariances of sets of kriged estimates became the heart and soul of geostatistics. But when an academic clique is blinded by ambition, pride and priority, and persists in denying an incontrovertible truth, a human error does indeed become a scientific fraud. The regression from the soundness of mathematical statistics to the madness of geostatistics is unparalleled in the history of science. The metamorphosis of the distance-weighted average into a kriged estimate does not make the latter any less functionally dependent. In time, professional associations and regulatory agencies are duty bound to investigate how geostatistics impacts mineral and oil inventories in annual reports. Inevitably, the validity of geostatistical theory and practice will be judged in a court of law.

Fairness, honesty, truth, trustworthiness and the protection of the public rank high among desirable attributes of professional geoscientists. Similar attributes inspired and sustained my crusade against geostatistics since the early 1990s. I urge you to call on statistically gifted members to assist in verifying whether it makes sense to assume, krige, smooth and rig the rules of mathematical statistics. Or you may wish to consult a recognized authority such as Dr Nathan Divinsky, a UBC Professor Emeritus of Mathematics, whether or not the requirement of functional independence can be violated and the concept of degrees of freedom can be ignored. I would expect your inquiry into my allegation that geostatistics is a scientific fraud be completed before March 21, 2005. Meanwhile, I look forward to this ruling, and to the course of action taken by the Canadian Council of Professional Geoscientists.

Yours truly,

J W Merks
President