August 18, 2004

Dr John L Hennessy
President
Stanford University
Stanford, CA 94350

Dear Dr Hennessy,

I wish to point out once more that several scholars at Stanford University apply, endorse, teach, or otherwise support, geostatistics, a fundamentally flawed variant of mathematical statistics. Geostatistics is applied in geology, mineral exploration, mining, oil reservoir forecasting, hydrology, environmental, geotechnical and health sciences, and other fields where sparse data sets occur in large sample spaces, and additional data is expensive to measure or impossible to obtain.

Last year I failed to persuade you that geostatistics merits more scientific scrutiny than it has so far been accorded. So I want to explain in even greater detail the crux of my crusade against the junk science of geostatistics. One of the cornerstones of geostatistics is Journel's doctrine that spatial dependence may be assumed. Some of his thoughts form part of the attachments to this letter. A copy of Journel's reluctant response of October 15, 1992, to the Editor of the *Journal of Mathematical Statistics (JMG)*, and of the Editor's accompanying letter of October 26, 1992, to me, are also posted under *Correspondence* on my website at ***geostatscam.com.***

My letter of March 21, 2003, to *JMG*'s Editor presents a synopsis of my case against geostatistics and its partial peer review process (see *JMG20030321* under Correspondence). *JMG*'s current Editor, unlike its 1992 Editor, appears reluctant to give his opinion on geostatistics on *JMG*'s letterhead.

Since it was Journel who either accepted or decided that *"spatially distributed data should be considered a priori as dependent one to another,* ***unless proven otherwise"*** (my emphasis), he ought to know how to prove **otherwise** by verifying that a significant degree of spatial dependence **does in fact not exist**. In our paper on "*Precision estimates for ore reserves"* we applied Fisher's F-test to prove that an in situ ordered set of independently measured values either displays a significant degree of spatial dependence, or is randomly distributed in its sample space. When Journel reviewed this paper in 1992, he presumed that we misread geostatistical theory, or that our reading is "*too encumbered with classical* ***Fischerian*** (sic!) *Statistics."* It appears that Journel's' investigation into whether to test or not to test for spatial dependence remains ongoing.

Paradoxically, geostatisticians themselves have shown that interpolation by *kriging* between independently measured values 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, every distance-weighted average had its own variance but when the distance-weighted average metamorphosed into a *kriged estimate* in the 1960s, its variance vanished without a trace. Incredibly, the *kriging variance* and the *kriging covariance* of a ***set*** of *kriged estimates* became the heart and soul of geostatistics. Incredible indeed because the kriging variance is as meaningless a measure for variability, precision and risk as the kriging covariance is for spatial dependence. All I want to know who lost the variance of a **single** distance-weighted average when it was reborn as a kriged estimate, and who found both the variance and the covariance of a **set** of distance-weighted averages. Time has since fogged the minds of early plotters of kriged estimates.

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

In the rarefied world of geostatistics, kriging variances are plotted in variograms or semi-variograms in which they rise to a maximum and then converge on zero. The shrinking of kriging variances so troubled geostatistical thinkers that they cautioned against oversmoothing. In spite of such inspired tinkering, kriging variances shrink because every kriged estimate is a functionally dependent variable.

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 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 proves 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's tinkering all about?

Armstrong and Champigny, in their long overdue 1989 paper entitled "A s*tudy on kriging small blocks"*, noticed not only the shrinking of kriging variances but also the rising of kriging covariances. In his 1977 "*Geostatistical ore reserve estimation"* (see Figure 203 on page 286), David makes it perfectly clear that all of his sixteen points are **calculated**, rather than estimated, from the same nine boreholes, and claims that *"writing all the necessary covariances for that system of equations might be a good test to find out whether one really understand geostatistics*. Kriging covariances of sets of kriged estimates make no scientific sense in any discipline but geostatistics because the requirement of functional independence is violated and the concept of degrees of freedom is ignored.

Twelve years after this first textbook on geostatistics was published, Armstrong and Champigny finally cautioned against oversmoothing. Meanwhile, some scholars may have smoothed much too little, others a little too much but the odd one may have smoothed to perfection. It is truly remarkable that a paper on perfect smoothing was published in *CIM Bulletin*. Sir Cyril Burt would have been quite amused.

Geostatistics is extremely popular not only because spatial dependence may be assumed but also because two or more independently measured values with different coordinates define an infinite set of kriged estimates. Kriging is the equivalent of perpetual motion in data acquisition because degrees of freedom, too, have vanished in whimsical ways. Despite Bre-X's phantom gold resource, and despite scores of shrinking reserves and resources, geostatisticians persist in assuming spatial dependence, interpolation by kriging and perfect smoothing with the same single-minded fanaticism as Trofim Lysenko preached his variant of genetics.

I learned in the early 1990s that geostatistical peer review is a blatantly biased, shamelessly self-serving sham when *"Precision estimates for ore reserves"* was reviewed and rejected by *CIM Bulletin*, *Journal of Mathematical Geology* and *IMM Transactions* before *Erzmetall* praised and published our paper. Perhaps ironically, my son and I were unaware that we had written a "geostatistical" paper until David, the author of *"Geostatistical ore reserve estimation*" and one of the reviewers for *CIM Bulletin*, deemed our paper deficient in references to the geostatistical literature. Numerous encounters with Sinclair, *CIM Bulletin*'s second reviewer, before and after the Bre-X fraud, are posted on my website under *Correspondence*.

Whenever dissenting opinions 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 as the weighting factors of all measured values in the set converge on ***1/n***. Geostatistics is so richly embellished with neologisms and Krige-inspired eponyms

that even a simple question triggers a tortuous reply, if any at all. In my letter of June 9, 2004, in response to Krige's of June 8, 2004, I pose three simple but fundamental questions. As soon as I receive a reply it will be posted under *Correspondence* on ***geostatscam.com***. Apparently, Krige's investigation, too, is ongoing.

Armstrong, David, Dowd, Froideveaux, Journel and Sinclair reviewed and rejected *"Precision estimates for ore reserves"* several years before classical statistics proved that Busang was a salting scam, and several months before Bre-X's brass was honored for its discovery. Analysis of variance proved the intrinsic variance of gold to be indeterminate, or statistically identical to zero, as it ought to be in a phantom gold resource. Fisher's F-test proved that BSSE198, Bre-X's glory hole, was the only one to display a significant degree of spatial dependence between gold assays of in situ ordered core samples. Sir Ronald A Fisher would have been proud.

All these geostatistical scholars, and scores of others, refuse to accept the irrefutable fact that every distance-weighted average has its own variance simply because it is a functionally dependent variable. Perhaps it was a human error that this variance went missing, and that the kriging variance and the kriging covariance of a set of kriged estimates became the pillars of geostatistics. But when an academic clique is blinded by ambition, pride or priority, and perseveres in denying an incontrovertible truth, a human error does indeed become a scientific fraud.

The passage from the soundness of mathematical statistics to the madness of geostatistics is unparalleled in the history of science. It is true that replacing the missing variance with a meaningless kriging variance, and contriving an equally meaningless kriging covariance, are trivial matters that do not merit an independent interdisciplinary inquiry. In time, regulatory agencies are bound to investigate how the practice of geostatistics impacts mineral and oil inventories. It is inevitable that the science behind geostatistics will be scrutinized and judged in a court of law.

Stanford's geostatistical scholars will attend the Seventh International Geostatistics Congress in Banff, Alberta, Canada, from September 26 to October 1, 2004 (see ***geostats2004.com***). This spectacular venue offers you a unique opportunity to meet and mingle with geostatistical scholars from around the world and find out whether doing more with less is science, art or fraud. Alternatively, you may want to have one of your outstanding mathematical statisticians attend this geostatistics congress, and report to you how much Stanford's students stand to benefit from assuming, kriging, smoothing and rigging the rules of classical statistics.

Yours truly,

Jan W Merks
President