# AMERICAN INSTITUTE OF MINERALS APPRAISERS

# N E W S L E T T E R

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**INTER-SOCIETY RELATIONS -- ASFMRA**

Our Committee Chairman for Inter-Society Relations, Michael Cartwright, did a good job in making connections with the American Society of Farm Managers and Rural Appraisers. This appraisal society, which counts approximately 1,800 appraisers and 1,200 farm managers, with some overlap, has headquarters in Denver, Colorado, at 950 South Cherry Street (phone (303) 758-3513).

Cartwright had originally contacted the ASFMRA to investigate areas of joint interest with our AIMA. Cartwright subsequently obtained an invitation for your President, John Gustavson, and Treasurer, Trevor Ellis, to attend the 24-25 January 1997 Executive Council meeting of the ASFMRA. Executive Vice President John W. Ross was our contact and discuss current problems.

John Gustavson briefly related the origin and history of the American Institute of Minerals Appraisers, describing events in the late 1980s and early 1990s which practically forced *real estate* appraiser approval of *mineral* properties. The roughly 20-man Executive Council of the ASFMRA recognized many of the same problems during the days after the S&L debacle, and also agreed with the substantial differences between the appraisal of surface real estate and depletable oil and mineral resources. At the same time, both parties agreed that there were many areas of direct comparison in the application of appraisal standards to the two broad sectors.

Gustavson also brought up the frustrations presently experienced by American Institute of Minerals Appraisers who with its very small specialized membership, could not afford to be a member of the Appraisal Foundation due to the performed by Michael Cartwright, the AIMA and the ASFMRA are now discussing a loose affiliation of some type

**"THE DRILL CORE PARADOX" -- GEOSTATISTICAL PITFALL?**

Sidney S. Alderman, Jr.

Mineral Appraisers are obligated to evaluate or "audit" ore reserve estimates. Most operating mines use commercial software packages such as *Datamine Mining Software, Minex Geological & Mine Planning Systems,* and *Micromine Exploration and Mining Software.* All of these programs create ore body models that can be manipulated to produce ore reserve estimates, pit plans, sections, or elegant 3-D graphics. From input sample data points, these programs assign grade data to un-sampled blocks, using some form of geostatistics, usually a type of "kriging".

We can all recite cases where erroneous results, ranging from embarrassing to catastrophic have been caused by poor sample or analytical methods, misinterpretation or disregard of geologic ore controls, inadequate sampling, or other user misdemeanors. in our ignorance, however, most of us, whether mining engineers or geologists, have had a warm and fuzzy confidence in the geostatistics that creates the models. We assume that if correct data is intelligently put in, the right answer is bound to come out.

Robert F. Shurtz*, a senior professional mining engineer who has the required understanding of mathematical statistics, has recently challenged the infallibility of the geostatistics that most of the commercial programs use to assign values to unsampled blocks. In an unpublished parer "The Geostatistics Machine and the Drill Core Paradox", he shows how a well known phenomenon called "declustering" can lead to seriously erroneous results in some cases, and he gives several examples. In his words, "Given a row of assayed samples - such as a series of contiguous sections of drill-core assays - the end assays take fictitiously large weights in *kriged* (least squares) estimates of ore grade at locations not on the row."

(cont'd. on Page 2)

Shurtz's paper is written for the mathematically illiterate, and he presents elegant analogies that make the "Geostatistics Machine" and the "declustering" problem understandable to the practical geologist and mining engineer.

In another paper entitled "The Mathematical Origin and Effects of Paradox in Geostatistics", Shurtz presents the mathematical analysis of the "drill core paradox". His summary states:

"Paradox in geostatistics appears in the form of impulse weights (Dirac functions, singularities) on the end points of a line segment in the Fredholf transform limits of "simple kriging" (SK) and "ordinary kriging" (OK) when the set of output (sample points becomes dense on the segment. Empirical studies show that such weights also occur in many other configurations of output points. The underlying problem is that the values of realizations are not homomorphic with the random variables of the fields that produce them. "Solutions" proposed for mitigating the effects of these singularities by hit or miss manipulation of configurations and calculations are indefensible both mathematically and as sampling practices."

Shurtz has submitted "The Mathematical Origin and Effects of Paradox in Geostatistics" to *International Association of Mathematical Geology* (IAMG) for publication two times, and has been rejected. He has also submitted this paper to *Society for Mining, Metallurgy, and Exploration* (SME), and has been rejected. He has attempted to have "The Geostatistics Machine and the Drill Core Paradox" distributed to members of *Mining & Metallurgical Society of America* (MMSA), and has been rejected.

I have seen reviews of both papers by eminent geostatisticians who acknowledge the "drill core paradox" (declustering problem) and Shurtz's mathematical analysis, but who maintain that the problem is inconsequential in most cases, and that factors (fudge factors?) have been developed that take care of it. The refusal of geostatisticians to allow publication of Shurtz's papers, I suspect, is rooted in his attack on the mathematical basis of kriging, and the fact that he does not have a PHD either in mathematics of geostatistics. Those who do not understand or agree with this analysis can easily take refuge in his lack of credentials, and this has led to an unfortunate controversy which leaves the uninformed practitioner in somewhat of a quandary.

I do not understand the details of Shurtz's mathematical analysis of the problem, but I am convinced that there is a problem and that "the drill core paradox" is real. It may be inconsequential in most cases, but I would like to see the problem aired in technical journals so that those of us who depend on geostatistical programs may at least be sure that there are no basic flaws in the system. We would like to know that if good data is correctly entered, we will ge the right answer, in all cases.

If any members of AIMA are interested in either or both of Shurtz's papers, call, write, or fax me, and I will be glad to mail you copies. (Sidney S. Alderman, 90 Harrison Avenue, Apt. F, Sausalito, CA 94965; phone (415) 331-5980, fax (415) 331-6278).

*Robert F. Shurtz, Mining Consultant, 1200 California Street, San Francisco, CA 94109, retired Vice President and Partner, Bechtel Corporation, Mining & Metals. During his career, Shurtz has participated in "due diligence" studies and ore reserve audits of many world class mining projets, and has been instrumental in uncovering flawed applications of geostatistics in a number of cases. He holds a Bachelor of Engineering, and Engineer of Mines degrees from Ohio State University, and Msc., in Mineralogy also from Ohio State. He has published extensively in the field of mathematics of mine sampling and geostatistics, and a few of his papers are listed below:

1959 The Electronic Computer and Statistics for Predicting Ore Recovery. Mining Engineering. October, pp. 1035-1044.

1982 Mathematics of Mine Sampling IV - An Analysis of Geostatistical Doctrine. A.I.M.E., Society of Mining Engineers. Transactions.

Vol. 272, pp. 1918-1927.

1984 A Stochastic Aberration - The Theory of Regionalized Variables. Presented. AAAS Annual Meeting, Pacific Division, Section L, History and Philosophy of Science. June, 13 pp.

1985 A Critique of A. Journel's "The Deterministic Side of Geostatistics". Mathematical Geology, Vol. 17, No. 8, pp. 861-868.

1992 Pseudo-Fractal Interpolation for Risk Analysis. Mathematical Geology. Vol. 24, No. 1, January, pp. 99-128.

## APPRAISAL FOUNDATION MEETING

The regular quarterly meeting of the Washington-based Appraisal Foundation will take place on 3 February 1997. Among numerous other items on the agenda, one is of specific interest to the members of the American Institute of Minerals Appraisers. Guidelines for minerals appraisals will be discussed and comments are solicited by the Appraisal Foundation from its member societies and institutes. Your AIMA is not a member of the Appraisal Foundation, partially because of very high membership costs, partially because the Foundation acts primarily as a representation of the real estate appraiser profession.

Yet, specialty areas of appraisal such as minerals inevitably become subjects of discussion from time to time and without true representation, our specialized sector is sometimes inadequately treated or protected.

Consequently, after the initial contacts had been made by our Inter-Society Relations Committee Chairman Michael Cartwright, your President, John Gustavson, arranged his business in such a way that he could participate in the upcoming Appraisal Foundation meeting in Washington at no cost to AIMA. Our purpose is two-fold, namely to listen to and learn about all subjects related to minerals appraisal which may be treated or discussed at the Foundation level, and to introduce the American Institute of Minerals Appraisers and our special concerns to the Appraisal Foundation.

## THREE CASE HISTORIES OF MINERAL VALUATION

L.T. Gregg, P.G., C.P.G., C.M.A.

Introduction

This paper presents, in summary form, three case histories of valuation of industrial minerals. In each case, there were different financial/economic/tax/political drivers that determined the valuation approach that was selected and used. The second case history presents a somewhat unusual, but not necessarily unique, example of a cooperative valuation. For the usual proprietary and confidentiality reasons no identification is made of any of the parties involved or of the minerals that were valued. All three valuations were personally conducted by the author during the period 1988 to 1994. DCF/NPV calculations were done using relatively simple LOTUS 1-2-3 spreadsheets (I recognize there are "better" and more powerful tools available) and the computer results were spot-checked with hand calculations.

What is the Value of the Minerals in the Ground?

This is probably the most commonly-asked question of mineral appraisers by lawyers, judges, Special Masters, tax assessors, real estate agents, condemnation authorities, and the like. The temptation is strong to respond by saying "Nothing - until they're mined, processed, and sold (or ready for market)". But as we all know that won't do, or very rarely will do. I told the essence of that privately to a judge one time (in camera) and he promptly told me to go back to the drawing board and not to get up until I had obtained a value for the minerals. So, needless to say, I did just that.

As geologists, mining engineers, and/or mineral economists I suspect we all have reservations to one degree or another about the value of minerals in the ground. A rank wildcat exploration prospect is one thing; drill-indicated resources with no mine/mill infrastructure in place [or with no permits (Editor's note)] are another; and a going concern with 50 years of history and 50 years of future proven reserves is yet another. The Comparable Sale method is what many or most of us would prefer to use - if there was any Comparable (truly comparable) Sale data available, which of course there seldom if ever is. So with that having been said, let's plow on.

Case History #1

This was a tax case. A large industrial firm held 50 percent of the mineral rights on a several thousand acre tract of woodlands and swamp which was situated in the middle of a "belt" of mines producing an industrial mineral. These rights were leased to a very experienced mining company which drilled several hundred holes, analyzed the cores, and came up with a reserve estimate. Sizable reserves, generally of good quality, were present. For various reasons, the lease was terminated. The mineral rights holder then assembled a team of experts who prepared valuations of the primary mineral and of a possible by-product/co-product mineral. The author was retained to critique the valuation of the primary mineral by the mineral rights holder's expert and, if necessary, prepare an alternate valuation for use in eventual negotiation and/or arbitration and/or adjudication proceedings.

Since the mineral rights holder was not in the mining business and, as

far as the record could establish, had never mined anything, I looked for Comparable Sales data. There were none. Yes, there were prior sales of this mineral (in place) from one mining company to another, but no comparable sales due to the circumstances of the case, primarily the characteristics and logistics of the tract of land and the size of the reserve estimate. I then reasoned that there were only three possible ways for the mineral rights holder to realize income from the minerals on the tract:

1. Lease the mineral rights to a mining company and receive annual production royalties for the life of the mine; or
2. Sell the minerals in the ground at a negotiated $/cubic yard or $/ton figure and receive a one-time up front cash payment; or
3. Mine the minerals itself and receive net profits.

Since alternatives 2) and 3) were out, alternative 1) was in.

Fortunately there was a reasonable amount of "reliable" royalty data for the primary mineral in this region of the country. There were also considerable published data (State Geologic Survey, U.S. Bureau of Mines, etc.) on industry production rates and production capacity, among other things. So I had the basis for constructing a hypothetical production model.

I did this by assuming a greenfields plant with the following features:

- Pre-production period: 4 years (permitting, environmental, mine development, and mill construction/shakedown). In retrospect this was probably optimistic.

- Annual production rate:

  Year 1 10 percent of total regional production by the industry in the previous year
  Years 2-4 15 percent
  Years 5-8 25 percent
  Years 9 end of mine life: 40+ percent

  Note: Because of the characteristics of the industry and of the mineral deposit itself, the above was felt to be an attainable market penetration rate.

- Production life: >20 years

I next assumed a royalty in line with the "going rate" for the region, a royalty escalation rate of 5 percent per year (tied to BLS statistics or etc.), and a discount rate which was equal to the Weighted Average Cost of Capital (WACC) of the mineral rights holder (this was furnished). I also assumed continuous compounding of royalty income rather than end-of-year compounding.[1] Putting all this in a spreadsheet resulted in the NPV of the discounted royalty income stream to the mineral rights holder. The report was submitted to the client and negotiation proceedings commenced. The case was eventually settled.

Note that this valuation did not have to assume anything about production costs, capital equipment costs, market prices, tax rates, depletion allowance, depreciation rates, and other imponderables for a 20+ year production model.

[1] The difference in NPV of the royalty income stream between these two income compounding approaches was about 6.5 percent. I will discuss this further in a subsequent technical note.

*L.T. Gregg's contribution will be continued in our next Newsletter. In the meantime, let us ponder on the probabilities that the property (a) would be leased, (b) would be produced as predicted, and (c) would actually pay the royalties. In other words, is a discount rate equal to WACC high enough?? For an oil and gas lease, maybe yes; but for an unpermitted, undeveloped mine? What is your opinion?*

**Inter-Society Relations...** (cont'd. from Page 1)

to allow us as minerals appraisers also to be heard at the national Appraisal Foundation level.

After several splinter sessions over lunch, an additional area of cooperation was discovered and discussed, namely in curriculum development. The ASFMRA provides numerous continuing education courses. Some of these appear to be of interest to our membership of the AIMA. We will shortly receive information about these courses as well as permission to attend in parallel with the ASFMRA members.

On the other hand, we have been asked to support the development of additional courses including oil and mineral specialization, since the ASFMRA would like to provide such educational opportunities to their members.

At the present time, only one five-day course touches on minerals being comprised of the broad overview of appraisal techniques in the sectors of water, timber and minerals. We herewith invite our AIMA members who might be interested in teaching one to two-day seminars to let your capabilities be known to our Education Committee Chairman, Ed Moritz (303/443-2209, or fax 303/443-3156). Moritz will coordinate with the Education Committee of the ASFMRA to generate more specialized oil and minerals appraisal seminars which may become a permanent part of the curriculum.

In short, this exploratory meeting resulted in increased understanding of the areas of common concern between the ASFMRA and the AIMA. Also, three specific action items are now being implemented, namely

1. The suitability or adaptation of the ASFMRA "affiliate" status for the AIMA to reach national levels of representation;
2. The development of specialized curricula by AIMA instructors to participate in and broaden the ASFMRA continuing education

program, and

3. The distribution of AIMA membership lists and specialty designations to ASFMRA members for networking and subcontracting in specialized oil and mineral appraisals associated with surface lands. □

**1997 ELECTIONS**

The Nominating Committee has delivered its nominations for the 1997 slate of candidates. The Committee consisted of Trevor Ellis, Michael Cartwright and Ed Moritz. The Nominating Committee has advised that they have provided one name for each of the four positions on the 1997 Board. However, our members are reminded that there are indeed spaces provided for write-in candidates.

The Nominating Committee further advises that it is its unanimous opinion that the Institute at this early stage of its existence is strongly dependent on the continuity which may be derived by re-election of some of its former officers; therefore, the Nominating Committee is presenting a slate of candidates which contains several of last year's officers.

Each of the nominated candidates has been asked if they will serve, and all have confirmed their willingness to serve, albeit several indicate a desire to see "new blood". Therefore, it is good to see Michael Cartwright as a nominee. Also, we thank Don Warnken for his several years of service.

The Nominating Committee urges other Institute members to become active in the furthering of the Institute, as well as in various committee positions during the coming year, so that the 1998 Nominating Committee may have a larger base for its nominations.

The ballot is enclosed. All members are kindly requested to submit their ballots to AIMA headquarters, 5757 Central Avenue, Suite D, Boulder, CO 80301, by 15 February. □

**DEFINITION OF FAIR MARKET VALUE FOR MINERALS**

Thomas B. Henderson, Jr.

There are words in the traditional, and generally defined by statute, definition of fair market value that require that "both the seller and the purchaser know of all the uses and purposes to which the property is adapted and for which it is capable of being used and of the enforceable restrictions on its use".

Unlike the value of a surface estate, the value of a mineral interest is not only virtually impossible of precise definition, but rather is quite often colored by romance. An almost depleted oil field, with junk and environmental problems all over the place, may have a "I'll pay you to take it" value to the seller and a "this one's a steal" value to a purchaser who has proprietary knowledge of an impending wildcat play involving deeper, untested formations.

Just as in the case of many surface sales in which the buyer may have knowledge that is not available to the seller, so, too, in many mineral sales the buyer may have similar knowledge. It is my point that the definition of fair market value needs revising to accommodate to the real world.

A sincere thanks to the officers and editor for the time and efforts expended on behalf of the AIMA. □

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