



## OVERVIEW FROM THE PRESIDENT



Greetings to the GAA members from the incoming 2003 committee. It is fantastic to see the ongoing interest shown by GAA members, with almost the entire 2002 committee standing for re-election –welcome back, everyone, and welcome aboard to Selina Broun. I would like to thank Stuart Masters, who had to stand down due to work commitments, but whose help on the 2002 committee was invaluable. It will be hard for the Perth branch of the committee to give up the spectacular views that Stuart provided from the Central Park office tower. I would also particularly like to thank Mark Noppé and Ian Lipton, past presidents who leave a hard act to follow, and John Warner, who as membership secretary and webmaster, has put an enormous amount of time and effort into the GAA. Lastly, thanks to Dr John Henstridge and Data Analysis Australia who host our website.

This year, the committee intends to follow-up on the excellent start made by outgoing president, Mark Noppé, in regards to mentoring. Members of the GAA are encouraged to attend mentoring evenings held by the AusIMM and AIG in various cities across Australia – details will be provided in upcoming newsletters.

The committee is also targeting the GAA website for review. Upcoming projects include adding recommended reading lists for various geostatistical applications, and short biographies of our Life Members. The GAA has also been fortunate to obtain a previously unpublished paper, courtesy of Michael Pycz and Clayton Deutsch of the University of Alberta, on simulation of the hole effect,

which will be posted in full to the website. The committee hopes to be able to add further papers during the year. Member-authored papers, or suggestions for links to other geostatistical sites from members, are always welcome.

On the promotional trail, the GAA is planning to produce a polo-shirt with the organisation's logo for mid-year distribution. Further details, including how to purchase and final cost, will be circulated through the newsletter and website.

Jennette Binns, our newsletter editor, has sourced a number of geostatistical and geological volumes through Elsevier Press for review, and we hope to include new titles and the reviews in the newsletter as soon the volumes are received by Elsevier. My thanks to both Elsevier and Jennette for organising the reviews, the first two of which are in this newsletter.

Finally, the GAA is planning a significant presence at the AusIMM/AIG sponsored Mining Geology Conference in Bendigo in October 2003. Dr Simon Dominy is the conference co-chair, while Mark Noppé is the GAA representative on the Bendigo organising committee. Simon and Mark have allocated a booth for the GAA, and the committee is intending to put together a poster display on a number of areas of

### Contents:

[Overview from the President](#)

[Outgoing Presidents Report](#)

[Letters to the Editor](#)

[Whole Story on the Hole Effect](#)

[Application of Neural Networks to the Earth Sciences](#)

[Practical examples of resource reporting](#)

[Student Research Grants in Mathematical Geology](#)

[Book Reviews](#)

[MEGWA](#)

[5th International Mining Geology Conference](#)

[MODSIM Conference 2003](#)

[Membership Matters](#)

[GAA Website](#)

[Calendar of Events](#)

[GAA Committee 2003](#)

[From The Editor](#)

[Top](#)

immediate relevance or interest to both mining statistics practitioners, and the general mining industry. The (very) preliminary poster titles and topics are: "polygonal estimates – what you can and can't do with them"; "kriging – is it a black box?"; "block sizes", "estimation and simulation", "other factors". There will also be an information poster on the GAA and its aims. If any member is interested in adding material to the posters, please contact [secretary@gaa.org.au](mailto:secretary@gaa.org.au) or myself at [bateleur@iinet.net.au](mailto:bateleur@iinet.net.au).

Thanks again to the 2002 committee and welcome again to the 2003 committee members. And to all the GAA members, please continue to support the GAA. Even if you are not on the committee, the GAA is your organisation, and your forum for geostatistical ideas and practice.

Stella Searston  
President  
[bateleur@iinet.net.au](mailto:bateleur@iinet.net.au)

## OUTGOING PRESIDENTS REPORT AT AGM, 27 FEB 2003-03-04

Welcome to an elite (small) group at this evening's AGM.

I would like to thank the committee for their assistance last year, particularly Stella and Ian for their support. This is the second year that we have operated with a geographically diverse committee: Perth, Brisbane, Townsville and Kalgoorlie, and this is set to continue with monthly conference call meetings.

The GAA had a reasonably active year last year, ending and starting with the Symposium on Quantifying Risk and Error immediately prior to last years AGM. The CDROM from this is still in demand and the effort and time that Stella and John Warner dedicated to this project was exceptional.

Three newsletters were issued during the year, in May, August and December and we are on track for a fourth in the calendar year. Thanks to all who contributed and particularly to Jennette Binns as editor for pulling these together in a professional manner. Jennette has kindly offered to assist again this year.

Four technical talks were held during the year in Brisbane, Townsville and Perth. We

hope to continue our association with the AIG and AusIMM in arranging joint technical talks were suitable.

John Warner arranged the move and re-establishment of our website. Thanks to Data Analysis Australia (John Henstridge) for hosting the site and the AIG for allowing us to use its framework.

During the year we have increased our commitment to the development and awareness of spatial statistics to students and new graduates by offering our members as mentors to the AIG and AusIMM mentor programs. We will also pursue corporate sponsorship this year to increase the profile of the GAA in industry.

The committee has supported the MODSIM2003 conference through marketing and we are part of the organising committee for the Mining Geology Conference to be held in Bendigo, Victoria from 14 to 17 November 2003.

Best wishes to Stella and the new committee for the coming year.

Mark Noppe  
President 2002/2003

## LETTERS TO THE EDITOR

Dear Editor,

The article on p 5 of the Dec 2002 GAA newsletter has been noted by some members of the JORC Committee.

The particular passage noted is :

"It is expected that in the near future, the National Codes for resource/reserve reporting **will require a geostatistical**

**quantification** of the geological uncertainty of resource/reserve estimates". [my emphasis]

There is certainly no such requirement contemplated for JORC's next revision (due to be adopted in mid – 2003), and I am unaware of this being the case for any other proposed national code/instrument.

[Top](#)

The proposed 2003 revised JORC code does, however, have some new comments that encourage reporting of quantification studies, but there is certainly no requirement, and no specification of geostatistical methods. The draft release of the code is available on <http://www.jorc.org>, and I encourage interested members to read this.

I am sure that this is a simple misunderstanding of the position of JORC. Can I suggest that it would be a good idea to clarify this matter for GAA members in the next newsletter?

John Vann  
**AIG representative JORC, MGAA**

**President's response:**

Dear John, thanks for the comments on the GAA's article. It is great to see that the newsletter is read with such attention, particularly by JORC Committee peers.

With regards to the passage noted, the author at the time was reflecting on changes to the JORC Code that **might potentially** be required, following deliberations on reserve and resource reporting globally. Certainly, there is a feeling amongst practitioners in the US/Canada that such a requirement may be included in national codes in the near future.

I take your point, however, that the revision is not part of the 2003 code, and there is currently no requirement within JORC for geostatistical quantification or reporting of geostatistical methodology.

Stella Searston  
President GAA

## THE WHOLE STORY ON THE HOLE EFFECT

**Article contributed by Michael Pyrcz and Clayton Deutsch  
précis by Stella Searston.**

With the sudden increase in activity on the share market that has resulted in a number of floats, and dusting-off of numerous previously mothballed projects, the GAA has targeted for review some areas within resource estimation that consistently produce unusual effects. One of these, frequently encountered in lensoidal gold resources for example, is the "hole effect".

Michael Pyrcz and Dr Clayton Deutsch of the Centre for Computational Geostatistics at the University of Alberta have kindly allowed the GAA to reprint an internal Centre paper on the hole effect. The paper in its entirety is too long for the newsletter, so only the original abstract and a précis by the GAA are included below. Full details of the authors, including voice, snail and email contacts will be posted to the GAA website, along with a full copy of the article. If there are any difficulties, please contact [secretary@gaa.org.au](mailto:secretary@gaa.org.au). Any errors in the précis are not due to errors in the original article, please download the entire paper before contacting the authors!

Michael is a PhD student, currently researching methods to inject geologic information into stochastic subsurface models. Professor Deutsch teaches and conducts research into better ways to model heterogeneity and uncertainty in petroleum reservoirs and mineral deposits. He is well known in geostatistics circles as the senior author of the GSLIB guide, published through Stanford University.

### **Abstract**

The spatial continuity of the variables we model in geostatistics is dependent on the modelling and reproduction of the variogram. The variogram defines the relationship between variability (or geologic distance) and the lag distance (or Euclidian distance).

As the magnitude of the lag separation vector increases, we typically expect the variogram to also increase. This is generally observed. The majority of variogram model structures are monotonic increasing. Nevertheless, non-monotonic structures may have a physical interpretation, provide valuable information, and may be modelled with positive definitive models for more accurate geologic models. Non-monotonic variograms that show cyclic patterns are called "hole effect" variograms.

The theory and application of hole effect structures is explored in this paper. Efforts are made to illustrate and provide examples of the hole effect structure. The generation of

simulated realisations in the presence of hole effect structures is investigated, with special attention paid to the reproduction of the histogram and variogram and their ergodic fluctuations. Hole effect variograms are commonly encountered and may be used in geostatistical simulation. The variogram structures are reproduced together with the histogram and the local conditioning data.

### Précis

Although experimental variograms often increase with lag distance, cyclic forms do occur, termed "hole effect" variograms. Two examples are shown (Figure 1), one derived from a number of lenses, the second from regular horizontal beds. Such cyclic structures can be bounded by a sill, or not bounded, be either dampened or undampened, and may be anisotropic or isotropic.

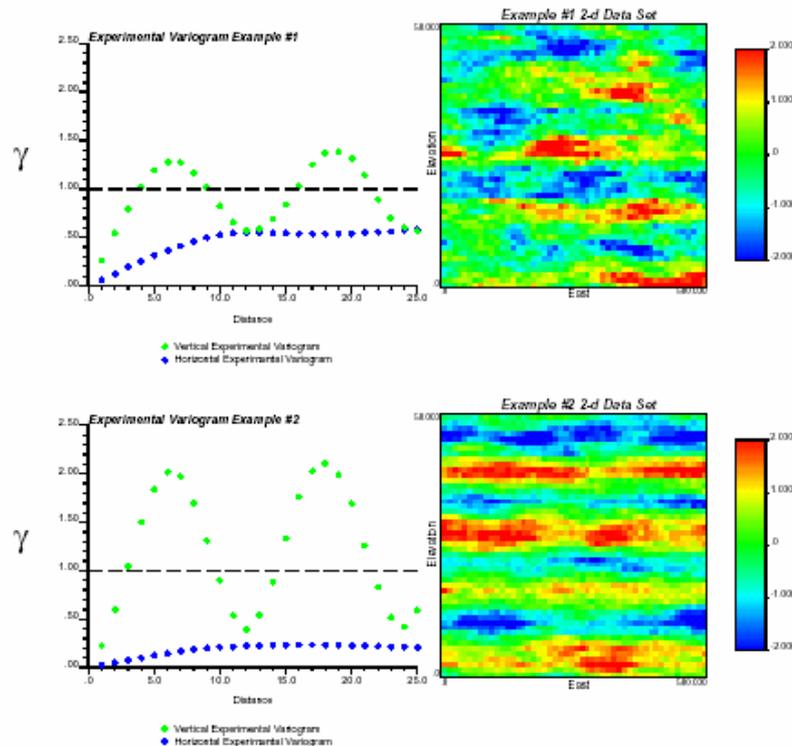


Figure 1: Two example data sets with non-monotonic continuity structures

After examining a number of hole effect variograms, the authors have defined five separate categories, each indicative of the spatial setting of the hole effect. These are: regular clustered lenses, regular strata, nonclustered or randomly located lenses, clustered irregular lenses and irregular strata. To build an accurate geostatistical model of a hole effect, all such structures need to be reproduced. Considerations in developing such a model using GSLIB software code include:

- (i) positive definite models, to ensure that the variance is non-negative. Good choices for nested structures are the sine and cosine functions. A sine model is generally positive definite in 3D, while the cosine is only positive definite in 1D. Sine models, based on mathematical theory, can be used in one or two dimensional space, whereas the cosine model has to be restricted to one dimension;
- (ii) the variogram has to honour the correct sill;
- (iii) isotropy/anisotropy;
- (iv) model dampening and non-dampening.

The variogram modelling, kriging and simulation components of GSLIB software currently utilise an undampened cosine model. In effect, the model used by GSLIB has a number of limitations, ranging from minimal to serious.

[Top](#)

Firstly, the hole effect nested structure may exist only in one direction, meaning the variogram is dependent on only one component of the lag vector. This is not considered serious by the authors, as most empirical hole effects are only observed in one direction.

Secondly, the absence of a dampening effect is a serious limitation. Empirically, dampening is always observed, due to superimposition of continuous multiple structures. Dampening can be added using the exponential structure as the multiplier.

Thirdly, the hole effect nested structure forms a zonal anisotropy in all other principle directions equal to the contribution of the hole effect. This may be a serious limitator, as empirical results are generally not restricted to the specific hole effect/zonal anisotropy configuration. Attempts to work around the problem by adding an additional structure that is not present in the hole effect direction have led to artefacts produced in the off-diagonal directions.

Kriging and simulation studies were undertaken on a synthetic dataset that contained a perfect hole effect variogram. Globally, kriged maps did not reproduce the one or two point statistics. Although the general form of the hole effect was reproduced in the kriged models, the variogram was distorted by kriging's smoothing effect. Ordinary kriging performed better than simple kriging, due to the assumption of global stationarity inherent in the simple kriging algorithm.

Simulation did better, correctly reproducing the one and two point statistics. Generally, as the strength of the hole effect increased, so did the ergodic fluctuations in the variogram. The authors noted that during the search, the variogram was also affected by the search parameters. They concluded that it was essential to incorporate a sufficient range, and number of original data points and previously simulated nodes to ensure the auto-correlation between simulated nodes actually reproduced the hole effect. Too small a search radius led to truncated model structures in the variography.

In conclusion, the authors indicated that the hole effect could be modelled and reproduced in simulation. The modelling was most important where the hole effect contributed more than 20% of the total variance. The authors stressed that it was most important to validate one and two point statistics to ensure that they were adequately reproduced in expected forms, a process that might require a number of iterations of the search parameters.

Michael Pyrcz, the senior author, can be contacted at [mpyrcz@ualberta.ca](mailto:mpyrcz@ualberta.ca) .

## THE APPLICATION OF NEURAL NETWORKS TO THE EARTH SCIENCES

**A presentation to the Geostatistical Association of Australasia,  
27 February 2003.**

Dr Warick Brown, who recently completed his PhD dissertation on neural networks, was the guest speaker at the GAA's Annual General Meeting in Perth in February. Warick can be contacted at:  
Centre for Global Metallogeny  
Dept. of Geology & Geophysics  
The University of Western Australia  
35 Stirling Hwy, Crawley WA 6009

### **Abstract**

Two different of neural networks are described; the probabilistic neural network (PNN) and the Self-Organizing Feature map (SOM, also known as a Kohonen neural network). Both these networks have been successfully used to analyse geoscience data

sets in exploration. However, the two types of network involve quite different methods of training. The PNN requires supervised training involving examples of inputs paired with the correct outputs, whereas an unsupervised approach is used for the SOM. Instead of being supplied with target values or patterns, the SOM network forms its own classification of the patterns. A brief explanation of the way in which these two types of network function is given together with some examples of applications in mineral exploration.

### **Background**

Neural networks are a type of adaptive computing system that can learn from data and generalize from stored knowledge to

[Top](#)

produce appropriate outputs in response to new data. Although neural networks were inspired by studies of biological neurons they are more closely related to mathematical models like non-parametric pattern classifiers, non-linear filters and cluster algorithms, than models of neural or cognitive phenomena. Neural networks consist of simple processing elements, called neurons, interconnected by links associated with numeric coefficients or weights indicating the strength of each connection. Neural networks are suitable for problems with the following characteristics;

- non-linearities,
- high dimensionality; for example, large number of input parameters,
- noisy data due to imperfect measurements,
- inadequate conventional approaches due to problem complexity,
- problem dependence on multiple interacting parameters, and
- no known mathematical algorithm to determine the solution.

#### **Probabilistic neural networks**

The probabilistic neural network (PNN) is a three-layer, multilayer, feedforward network like the MLP, which is based on a statistical algorithm developed by Meisel (1972). Specht later re-formulated the algorithm as a neural network (Specht, 1990). The network includes a Parzen PDF estimator to determine the sum of small multivariate spherical Gaussian basis functions centred on each training vector. The advantage of the PNN is that it directly implements Bayes' decision strategy and is guaranteed to approach an optimal solution (Bayes' optimal decision surface) as the number of training samples increase (Masters, 1993; Zaknich, 2003). In contrast, MLP networks rely on heuristic approaches to determine the network topology (i.e. the number of hidden nodes), optimal values of system parameters (e.g., learning rate and momentum), and require long training times. In addition, training may lead to a local rather than a global minimum. PNNs are best suited to pattern classification problems whereas MLP networks, which can be used for classification, are generally used as function approximators.

Singer and Kouda (1997a & b) used a PNN to classify mineral deposits into deposit types defined by ore-deposit models based on the presence or absence of 58 ore and alteration

minerals. In a later study, Singer and Kouda (1999) compared the performance of PNN and weights-of-evidence methods for the prediction of mineral potential for VMS deposits. Studies by both Singer and Kouda (1999), and Harris and Pan (1999) found that PNNs gave significantly better results than weights of evidence, logistic regression, MLP and general regression neural networks.

#### **Self-organizing feature maps**

The self-organizing feature map (SOM), also known as a Kohonen network, uses an unsupervised training scheme (Kohonen, 1982; 1988; 1990). Instead of presenting both inputs together with the correct outputs to the network during training (as in supervised training for MLP and PNN networks), just input patterns are used and the network develops its own clustering of the data.

Classification of an unknown pattern is based on the identity of the training examples that are nearest to the input in multidimensional feature space. The effect of this form of training is to create regions in the output layer that are sensitive to clusters or classes of input patterns. Once the network has been trained, clusters on the output grid must be labelled to indicate the classes so unknown input patterns can be classified. This is done using training patterns for which the class is known. The SOM network is useful as a clustering algorithm since the number of features in the input feature vector is reduced to clusters represented graphically on the two-dimensional output grid.

There are a number of applications of SOMs in the geosciences. Maurer and others (1992) used an SOM in combination with a fuzzy logic inference system to identify classes of seismic events as part of an attempt to automate monitoring networks used to verify nuclear test ban treaties. Fung (1995) was able to classify six lithologies from wire-line log data using a combination of an SOFM and a Learning Vector Quantization (LVQ) algorithm. Clare and Cohen (2001) compared an SOM and a K-means clustering algorithm to perform a cluster analysis on regional stream sediment analyses (comprising 33 elements and 1677 sub-catchments). They found that although the two methods produced similar results, the SOFM was relatively unaffected by the presence of outliers and non-normal populations. A series of maps for each

[Top](#)

cluster identified by the network were produced by colouring catchment areas according to the degree of similarity between the patterns (i.e. feature vector) for that catchment and the patterns associated with the clusters identified the trained network.

Two commercial systems are based on SOMs. The PROSPECT EXPLORER software package produces anomaly maps, which are coloured according to the similarity of patterns associated with grid cells in the study area map and the cluster type representing anomalous patterns associated with mineralization. STRATIMAGIC is another commercial system that incorporates an unsupervised neural network classifier similar to an SOM (Neri, 1999). The system produces seismic facies maps based on trace shapes (characterized in terms of phase, frequency and amplitude) in seismic reflection data. Textural classes are identified and labelled using patterns associated with wells where the lithologies are known.

#### References

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**Singer, D. A., and Kouda, R., 1999,** A comparison of the weights-of-evidence method and probabilistic neural networks: *Natural Resources Research*, v. 8, no. 4, p. 287-298.

**Specht, D., 1990,** Probabilistic neural networks, *Neural Networks*, v. 3, p. 109-118.

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## PRACTICAL EXAMPLES OF RESOURCE REPORTING

Of interest to all geostatistical practitioners is how to deal with changes that arise in a resource statement between one statutory report and the next, and how to convey such changes to the general investing public. A couple of selections from corporate annual reports illustrate these points. The first example is examples of "positive reconciliation", the next two, unfortunately, deal with decreases in reserves/resources, and even more unfortunately, are potentially due to insufficient statistical and geostatistical rigour being applied to the reserve/resource estimation, while the final example is a great generalist explanation of two aspects of resource methodology.

It is planned to continue these selections as an irregular series on the practical application of the JORC code to statutory reporting by corporate entities.

The Emperor gold mine, situated in Fiji, and operated by Emperor Mines Ltd, ([www.emperor.com.au](http://www.emperor.com.au)) is a refractory epithermal deposit. The company has previously won awards from the AusIMM for its reserve and resource reporting (1997 and 1998).

[Top](#)

Mineralisation is developed in relatively narrow shear and fault structures in andesitic volcanics of the Tavua Caldera. Gold can occur within tellurides, arsenopyrite, and pyrite and spectacular, or bonanza, gold grades are not uncommon. In 2002, Emperor had the unusual situation where nearly a third of its production was sourced from material not included in either reserve or resource estimates – see extract below.

RESERVES RECONCILIATION	PROVED		PROBABLE		TOTAL ORE RESERVES	
	TONNES	OUNCES	TONNES	OUNCES	TONNES	OUNCES
2001 RESERVES	1,420,200	470,800	849,800	276,800	2,269,900	747,600
DEPLETION due to mining	-190,000	-59,700	-73,900	-21,500	-263,900	-81,200
ADDITION due to cut-off grade changes	96,000	19,900	181,200	35,200	277,300	55,100
ADDITIONS and other ADJUSTMENTS	408,800	106,800	1,077,600	196,200	1,486,300	303,000
2002 RESERVES	1,735,000	537,800	2,034,600	486,700	3,769,600	1,024,500
OVERALL CHANGE	314,800	67,000	1,184,900	209,900	1,499,700	276,900

43% of ore mined during the year was mined from Ore Reserves, 26% was from Resources and 31% was mined from neither category.

*Source: 2002 Annual Report to the Australian Stock Exchange, Emperor Mines Limited, page 24.*

Sons of Gwalia ([www.sog.com.au](http://www.sog.com.au)) has a number of gold mining operations, in the Leonora, Laverton and Southern Cross areas, in addition to tantalum/tin mines at Wodgina and Greenbushes, all in Western Australia. The company also has an interest in the mineral sands of the Murray Basin of NSW/Victoria. The large openpit Tarmoola deposit, part of Sons of Gwalia's Leonora operations, had produced 1.1 million ounces by June 2001. Gold mineralisation is developed partly in granite, and partly in ultramafic lithologies. At Tarmoola, not only did the company have to contend with a decrease in production due to a pit wall failure, but head grades within the Tarmoola operations were found to be positively statistically biased, leading to an overstatement on grade of about 5%. Sons of Gwalia took the hit on the chin, and reclassified about 70% of the reserves at Tarmoola openpit to resources. The figure represented about a 150 000 oz Au loss in reserves.

Since the acquisition, the Company has undertaken a rigorous geological and operating analysis of the Tarmoola open pit and surrounding satellite resources. While this review is not complete it does appear that some of the historical data used to model the orebodies was subject to statistical bias that has tended to overstate head grades in the order of 5%. As a consequence of correcting this bias and after reviewing the associated economics of extracting some of the deeper, lower grade ore zones it is anticipated that the reserve for the Tarmoola open pit will be downgraded by approximately 150,000 ounces from PacMin's June 2001 assessment. Approximately 70% of the reserve reductions will be reclassified into resources, reflecting future underground potential. Similarly, the Wonder North reserve is expected to be downgraded by approximately 100,000 ounces.

In its assessment of the Tarmoola assets prior to acquisition, the Company assumed lower reserves of 100,000 ounces. Therefore the estimated loss of 250,000 ounces represents a net 150,000 ounces loss against the Company's acquisition model.

*Source: Report on activities for the quarter ended June 2002, Report to the Australian Stock Exchange, Sons of Gwalia Limited.*

Sons of Gwalia also continued re-evaluation of assets acquired through the takeover of PacMin Mining Corporation Limited in the 2001 financial year.

The Carosue Dam project was developed by PacMin on the basis of three principal open pit sources being Karari, Whirling Dervish and the smaller Luvironza pit. A detailed review of geological models by the Company is anticipated to downgrade average grades across the Karari and Whirling Dervish orebodies by approximately 0.3g/t. The estimated net loss of gold of 200,000 ounces is substantially from deeper, marginal zones and as a consequence, has a lower proportional economic impact. The Company identified the potential for a reserve downgrade in the range 100,000 ounces at the time of the acquisition. This remodelling exercise has meant that the optimum development schedule is for the deeper stages of Karari and the Whirling Dervish deposits deferred to the latter part of the plan and be replaced by the high grade, lower cost satellite sources. To achieve the revised plan, a significant amount of pre-development and waste stripping is required over the Old Plough Dam and Safari/Deep South open pits in the 2002/03 year. Cash operating costs are anticipated to be high in the December half of 2002 until such time as higher grade Karari ore at the base of the Karari Stage II pit is exposed. Lower cost Old Plough Dam sources are included in the schedule commencing the December quarter.

[Top](#)

*Source: Report on activities for the quarter ended June 2002, Report to the Australian Stock Exchange, Sons of Gwalia Limited.*

Harmony Gold Mining Company Ltd ([www.harmony.co.za](http://www.harmony.co.za)) also, unfortunately, had to report a decrease in reserves during 2001–02. The company operates the Hill 50, New Celebration/Jubilee and Big Bell mines in Western Australia through a subsidiary, Harmony Gold (Australia) Ltd. The Big Bell gold operation was one of a portfolio of mines acquired through a hostile takeover of New Hampton Goldfields Ltd. A massive downgrading of the resource/reserve inventory at Big Bell was announced in June 2002. This included Harmony reclassifying much of the reserve base, including reclassification of mineralization beneath the then current \$9 million development program.

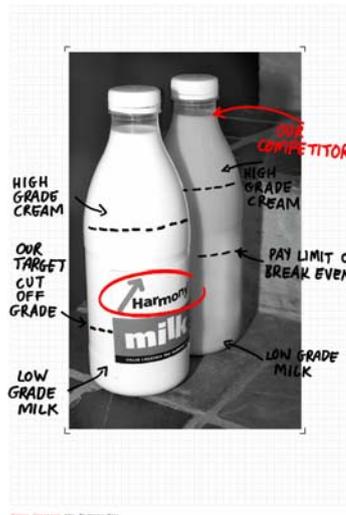
However, the main issue at Big Bell is the grade of the underground mine.

Harmony, having completed the redevelopment programme for the mine in the previous quarter, has for the first time, been producing from the "core" of the main ore body. A study of geostatistical parameters and historic mine records indicate an over optimistic projection of grade.

It has been deemed prudent to reduce the grade estimates for future production. This gave rise to a severe cut in the underground reserves at this mine (and put the gold mineralisation beneath the current development back into the "currently uneconomic resource" category at current gold prices). This has resulted in a significant impairment to the carrying value of this asset in Harmony's balance sheet.

*Source: Quarterly report for the quarter ended June 30, 2002, Report to Johannesburg Stock Exchange, Harmony Gold Mining Company Limited*

The last example also comes from Harmony. The company has expended considerable thought in explanations of resource methodologies for potential investors. The examples below use conventional items to explain the concepts of "ore-blocking" and "cut-off grades".



*Source: Annual report for 2002, Report to Johannesburg Stock Exchange, Harmony Gold Mining Company Limited.*

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[Top](#)

## STUDENT RESEARCH GRANTS IN MATHEMATICAL GEOLOGY

### ANNOUNCEMENT AND PROPOSAL SOLICITATION:

The International Association for Mathematical Geology (IAMG) is pleased to announce the availability of the 2003 Student Grants program. The Student Grants Program supports graduate student research in broad areas of mathematical geology for the purposes of advancing the development and application of quantitative methods in the geosciences. Recipients of the awards, which typically amount to \$2,000 US, must be enrolled in a formal university program in which they are pursuing a graduate degree (i.e., masters or doctoral students). The competition is not restricted to students sponsored by members of IAMG. The 2002 recipients and their projects, as a guide, were:

**Ning Liu**, University of Tulsa, Conditional simulation of facies distributions with truncated pluri-gaussian model  
**Carolina Guardiola-Albert**, Universidad Politécnic de Valencia, Stochastic inverse modeling for the improvement of the reservoir characterizations accounting for the heterogeneity of relative permeabilities  
**Hiroataka Saito**, University of Michigan, Multiphase sampling strategy for geosciences: application to selective remediation of contaminated sites

Project proposals and requests for support should include the following:

- Applicant's name
- Applicant's contact information (postal address, home address, telephone, fax, email address, etc.)

- University in which the applicant is enrolled, degree being pursued, and planned completion date of degree
- Transcripts of undergraduate and graduate course work completed to date (or a statement from the applicant's academic advisor that details the applicants academic credentials)
- Lists of prior awards and honors received by the applicant
- Professional and work experience, as well as extra-curricular activities
- Title of the project proposal, an abstract of no more than 500 words, and the target completion date for the project
- An endorsement of the project signed by at least one faculty member from the academic department in which the student is enrolled
- Detailed project budget

All proposals will be evaluated on the basis of the applicant's academic record, endorsement from the sponsoring university and faculty, relevance and feasibility of the project, and financial need. Additional guidelines concerning the competition can be found on the Internet at [www.iamg.org](http://www.iamg.org).

Written proposals for 2003 funding, which must be received no later than close of business on July 31, 2003, should be submitted to:

Donna Dennison  
Student Grants Committee, IAMG Office  
4 Cataraqui St., Suite 310  
Kingston, ON K7K 1Z7 Canada

## BOOK REVIEWS

### **Simulation, (3<sup>rd</sup> edition) by Sheldon M. Ross**

*December 2001, ISBN 0-12-598053-1, Academic Press.*

Sheldon Ross is a prolific statistical texts author, with some 100 articles and

publications on aspects of applied probability and statistics. Dr. Ross is a professor in the Department of Industrial Engineering and Operations Research at the University of California at Berkeley. He received his PhD in statistics from Stanford University in 1968 and has been at Berkeley ever since.

[Top](#)

"Simulation" was first updated in 1997. The text rapidly became a pre-requisite for most post-graduate probability courses, and is definitely aimed at practitioners with more than the "point and click" knowledge of simulation gained from some of the geostatistical programs used in the mining industry. A copy of the GSLIB bible, "Geostatistical Software Library and Users Guide" by Clayton Deutsch and Andre Journel, is a strongly recommended accompaniment to this volume.

The first chapter outlines elements of probability, random variables, Poisson processes and conditional expectations and variance. This is followed by a concise explanation of random numbers, random number generation and the use of random numbers to evaluate integrals. Chapter 3 discusses the generation of random variables in some detail, and includes acceptance/rejection techniques, and vector generation. The next two chapters deal with generation of discrete random variables and continuous random variables respectively. With the background firmly established, the author then begins discussion of discrete event simulation. Using an example of customer service within a petrol station, Ross explains the concepts of single-server, multiple-server, in-series and in-parallel queueing. In Chapter 7, statistical analysis of simulated data is explained. Chapters 8 and 9 deal with variance reduction and statistical validation techniques. The Markov chain Monte Carlo method of simulation is discussed in Chapter 10, while the final section outlines more specialised techniques such as Alias methods.

Ross set out to provide a practical introduction to computerised simulation theory, using examples of applications of simulations to real problems in a variety of scientific fields. In common with many mathematical textbooks, the writing style is dense, jargon-filled and difficult to follow, although not as "dry" as some. However, it's generally difficult going, and clarity of understanding is not helped by the annoying use of "we" at every step.

Both reasonable mathematical and computer programming skills are assumed, which basically negate the "introduction" portion of the book's aim. A reasonable knowledge of C or C++ by the reader is recommended, and familiarity with Matlab would also help. In addition, the set

exercises are frequently impenetrable, and no worked examples are included.

Where the book is useful, however, is when it focuses on variance reduction and statistical validation. The descriptions of Monte Carlo and Gibbs sampler methodologies are also good, although why do so many American authors assume that explanations of a theory using baseball analogies render the theory more comprehensible? The final chapter on Alias methodology is clear, and concise. The index accompanying the book is ordered by subject, is detailed and very useful.

Overall, the book can be classed as a useful adjunct to the understanding of simulation theory, written in typical textbook style. Given the number of citations/recommended reading/set text entries from various university courses worldwide, there is an obvious answer to why no worked exercises are included, but the volume for the non-student would benefit from at least selected worked examples.

However, many of the "introductory" items are actually better dealt with by the author in his "Introduction to Probability Models", 7<sup>th</sup> edition (Elsevier, 2000), while one of the better outlines of the Markov chain Monte Carlo methods is found in a collection of papers edited by Gilks, Richardson and Spiegelhalter entitled "Markov Chain - Monte Carlo in Practice" (CRC Press, 1995).

Simulation, 3<sup>rd</sup> Edition, can be purchased from Elsevier Science Customer Service. Contact details are: toll free number 1800 263 951, fax (02) 9517 2249, and email [service@elsevier.com.au](mailto:service@elsevier.com.au) The book retails for approximately \$154.

### **Applying Contemporary Statistical Techniques by Rand R. Wilcox**

*Jan 2003, ISBN 0-12-751541-0, Academic Press.*

Rand Wilcox is the author of a number of basic statistical texts for students. He is based at the University of Southern California, where he is affiliated with the Department of Psychology. His specialities include statistics and quantitative methods, with a particular interest in group comparisons and relationships between variables.

[Top](#)

The volume under review is designed as an outline of basic statistical methods that incorporates contemporary approaches to statistical problems, primarily dealing with issues in the life sciences. The first chapter deals with the S-PLUS software package. S-PLUS and a freeware software R, are recommended statistical programs for use with the Wilcox book. Tips for downloading the software, data entry and data utilisation are reasonably clear, and after following the instructions, the software from the freeware site, and Wilcox's recommended ftp site downloaded satisfactorily.

Probability fundamentals are discussed in Chapter 2. Examples and explanations are provided for such basic concepts as probability, population variance, normal curves, non-normality, skewness and Pearson's correlation. Although strongly slanted toward an American audience, the examples are clear, and well explained.

Chapter 3 deals with summary notations. The descriptions included in the chapter include measures of location (mean, median and mode) including weighted and trimmed means, variance measurement techniques such as sample variance, Q-Q ranges, median deviations, midvariance estimates and outlier discrimination. Along with each description is an example of the application in S-PLUS. A number of the S-PLUS functions are specifically written for the book, including the functions for winsorized variance, percentage bend variance and biweight midvariance. Histogram, kernel density and stem-and-leaf plots are also described.

Sampling distributions and confidence intervals are addressed in Chapter 4. Wilcox points out a number of problems with standard t-tests particularly when dealing with skewed, heavy- or light-tailed distributions. These include unsatisfactory probability coverage, the population mean not reflecting the actual population under study, and the fact that departures from normality in the sample population can lead to inflated confidence intervals. The author notes that the tendency in many empirical studies to discard outliers and heavy-tailed distributions can lead to the t-test becoming an invalid technique. A theoretical resolution to the problems, the Tukey-McLaughlin confidence interval that utilises a population trimmed mean, is explained in careful detail. Wilcox adds that the technique of data

transformation, often utilised in non-normal datasets, is also problematic, as effects of outlier data still remain.

Hypothesis testing is explained in Chapter 5. Concepts such as null-hypotheses, p-values, and two-sided tests are discussed with excellent practical examples. Problems that can arise from incorrect interpretations, such as power, Type 1 and Type II errors are outlined, and the consequences of correct and incorrect decisions clearly defined.

Two common aims of statistical examination are determining how, and whether, sample variables are related. Chapter 6 reviews least-squares regressions and Pearson's correlations and discusses the concepts of hetero- and homoscedasticity, and includes some indicators as to errors that can creep into the use of such standard techniques.

Having completed the basic statistical outline, Wilcox then goes on to discuss fundamental "bootstrap" statistical tools, including percentiles, standard errors, symmetric confidence intervals, and uses of trimmed means in Chapter 7. Specific functions relating to the bootstrap tools in S-PLUS are also defined. Chapter 8 relates to evaluating two independent groups of variables. Techniques reviewed include comparing variables using measure of location, testing hypotheses relating to assumptions of identical distributions, determining probabilities that randomly sampled variables from one group will be less than a random sample from the second group, and finally, comparison of variations and other measures of scale.

Chapters 9 through 12 evaluate various ways of comparing more than two datasets, based on some measure of location. The primary technique discussed for comparing independent groups is analysis of variance, using, for example, f-tests and two-way ANOVA designs. For dependent sample groups, paired t-tests, and various bootstrap methods are evaluated. In Chapter 13, Wilcox returns to the problem of outliers, and treatment of confidence limits when dealing with outlier variables, in particular focussing on "replots" and other derived plotting techniques. In addition, there is a good discussion of various common regression estimators. Chapter 14 goes on to cover more regression methods, including smoothers, tests for linearity, identification of

[Top](#)

best predictors, and testing of data interactions. A discussion of the analysis of co-variance techniques is also included. The final chapter covers basic non-parametric and rank-based evaluation methodologies, in particular related to non-normal distributions.

Overall, this is a great introductory/refresher text. The author assumes no prior statistical knowledge, and includes a set of exercises relating to the information discussed at the end of each chapter. What is unusual about the book is that the "no statistical knowledge assumption" is firmly kept at the forefront of the writing technique, and the explanations are clear and readily understandable. Unlike many others currently on the market, the author has included solutions to selected exercises within each chapter, which is also extremely helpful. In addition, the number

of practical case studies illustrate the statistical exercises points exceptionally well. In contrast to many current statistical texts, it is easy to see correlations between the examples given and normal mining/environmental geostatistical problems, and a number of chapters, particularly the regression and outlier chapters are exceptionally relevant. A further plus was the inclusion of a number of advances in statistical theory over the past 50 years and the constant reader referrals to either more in-depth papers, or other statistical texts. Conclusion: one to keep handy on the bookshelf.

The book, which has a list price of \$A187 (including GST), can be obtained from Elsevier Australia Customer Service on 1800 263 951, fax (02) 9517 2249, or email [service@elsevier.com.au](mailto:service@elsevier.com.au)

## **MEGWA**

### **(MINING & EXPLORATION GROUP OF WESTERN AUSTRALIA)**

#### **INFORMAL AND INFORMATIVE GATHERINGS, OPEN TO ALL ON THIRD TUESDAY OF EVERY MONTH**

- Relevant geological presentations for mining and exploration geoscientists.
- Forum for interaction of ideas and contacts in the geoscientific community.
- Regular short 30 min talks with time for questions and discussions.
- Meeting place for WA geoscientists and interstate and international visitors.
- Pre – talk drinks sponsored by AIG, WA Branch.

Next Talk: St Ives Region Exploration, by Ed Ainscough, Gold Fields Australia May 20th

#### **FUTURE TALKS PLANNED:**

- |  |                                 |
|--|---------------------------------|
| ➤ Antamina Skarn Deposit, Peru           | Peter Roley, Teck Cominco       |
| ➤ Prominent Hill Discovery, S. Australia | Tony Belperio, Minotaur         |
| ➤ Latest Lihir Epithermal Models         | Greg Corbett                    |
| ➤ Paulsens Deposit Geology, Pilbara      | Graham Miller, St Barbara Mines |

Sponsored and organised by the AIG, WA Branch.

Please advise [aigwa@aig.asn.au](mailto:aigwa@aig.asn.au) if you would like your email address to be added to the contact list

[Top](#)

## 5TH INTERNATIONAL MINING GEOLOGY CONFERENCE (CO-SPONSORED BY GAA)

**17-19 November 2003  
Bendigo, Victoria**

Topics Include:

- *The Role of the Mine Geologist*
- *Drilling, Sampling and Analysis*
- *Mapping and Geology Modelling*
- *Structural Geology and the Resource Estimation Process*
- *Metallurgy and Ore Characterisation*
- *Ore Reserves and Mineral Resources*
- *Geostatistical Applications*
- *Grade Control and Reconciliation*
- *Dealing with the Nugget Effect*
- *Geological Risk Management*
- *Management, Education and Training*

The conference is being organised by a committee drawn from The AusIMM, AIG, Geostatistical Association of Australasia (GAA), International representatives, and aided by the Conference Team at The AusIMM.

GAA members are invited to consider attending the event, and/or participation in the exhibition and trade display. A first circular has already been issued (see [www.gaa.org.au](http://www.gaa.org.au)). If you missed out, and are interested, please contact me. Note that the call for abstracts has closed, with a considerable number of interesting paper outlines received.

Dr Simon C Dominy, GAA Committee, and Conference Co-Chair  
Email: [simon.dominy@jcu.edu.au](mailto:simon.dominy@jcu.edu.au)

## MODSIM CONFERENCE 2003

From the 14 to 17th July 2003 the Modelling and Simulation Society of Australia and New Zealand will hold their MODSIM 2003 conference in Townsville, Queensland. Based at the Jupiters Hotel & Casino Complex, attendees will enjoy a tropical setting on the seafront overlooking Magnetic Island. The overall theme of the meeting is the *Integrative Modelling of Biophysical, Social and Economic Systems for Resource Management Solutions*.

Conference website: <http://mssanz.cres.anu.edu.au/modsim2003.html> for registration and submission details.

Simon Dominy, JCU [simon.dominy@jcu.edu.au](mailto:simon.dominy@jcu.edu.au)

[Top](#)

## MEMBERSHIP MATTERS

Membership dues invoiced in August for the current financial year 2002-2003. The invoices (in 'pdf' format) were sent via email where possible. The membership dues have remained unchanged from last year, the membership categories being.

- Life Member - Nil
- Ordinary Member - \$35
- Associate Member - \$15
- Student Member - \$5

If you are unsure of your membership category, please check our web site or email John Warner ([rj.warner@bigpond.com](mailto:rj.warner@bigpond.com)).

If you have not already done so, please play your part in the development of geostatistics

in the region by becoming a financial member of the GAA. The GAA has a bright future and your committee would like you to be a part of it!

The GAA is actively seeking **corporate sponsors**, in either a Major or Minor Sponsor capacity. Inducements planned for our sponsors include advertising in the GAA newsletter, and mentions during GAA-sponsored events. Letters will be posted out shortly, but if your organisation is willing to sponsor the GAA, please contact [secretary@gaa.org.au](mailto:secretary@gaa.org.au) for further information

## ON THE MOVE

**Mike and Jennette Binns** are in Brisbane, Mike having joined Hatch's Brisbane office

**Selina Broun** has moved to Snowden Mining Industry Consultants Perth office from Auriongold

**Roger Cooper** has moved from BFP Consultants to Placerdome in Kalgoorlie

**Mike Humphreys** has moved from SRK Consulting to Ok Tedi, in PNG

**Murray Rayner** has joined Argyle Diamond Mines from Maptek

**John Warner** has moved to Harmony Gold's Big Bell operations in Cue

## GAA Website: [www.gaa.org.au](http://www.gaa.org.au)

The GAA's website has been recently re-designed, using the initial format of the Australian Institute of Geoscientists website. Prominently featured are links to the GAA's newsletters, order forms for the symposia volumes, the aims of the GAA, current committee details, and most importantly, membership application forms. Information on upcoming events is also displayed. Please take some time to view the website, and let the committee know ([webmaster@gaa.org.au](mailto:webmaster@gaa.org.au), or [secretary@gaa.org.au](mailto:secretary@gaa.org.au)) if you would like to see any other items of interest, or if you note any discrepancies or errors.

[Top](#)

## CALENDAR OF EVENTS

**2003 MAY 14-16**

**31<sup>ST</sup> INTERNATIONAL SYMPOSIUM ON COMPUTER APPLICATIONS IN THE MINERALS INDUSTRIES.** Cape Town, South Africa. For Details: The South African Institute of Mining and Metallurgy. Email: [apcom@saimm.co.za](mailto:apcom@saimm.co.za), URL: [www.saimm.co.za/apcom](http://www.saimm.co.za/apcom)

**2003 MAY 20-24**

**ABUJA CONGRESS:** Hosted by the Geological Society of Africa and UNESCO. Abuja, Nigeria. For Details: Email: [geoscafr@wanadoo.fr](mailto:geoscafr@wanadoo.fr) Web: <http://www.geoscafr.com>

**2003 MAY 22-23**

**NSW MINERAL EXPLORATION & INVESTMENT 2003 CONFERENCE.** Four Seasons Hotel, 199 George Street, Sydney. For Details: Minerals Liaison Officer, NSW Dept of Mineral Resources, Phone: (02) 9901 8654. [www.minerals.nsw.gov.au/invest/conference](http://www.minerals.nsw.gov.au/invest/conference).

**2003 MAY 25-28**

**ON THE EDGE: EARTH SCIENCE AT AMERICA'S WESTERN MARGIN.** Vancouver, Canada. Joint meeting of Geological Society of Canada, the Mineralogical Association of Canada and the Society of Economic Geologists. For Details: [www.gca.ca/annmeet](http://www.gca.ca/annmeet)

**2003 June 19 4.30 - -7pm**

**THE SMEDG-EXPLORATION NSW DATA RELEASE:** for the Cargelligo, Goulburn and Lachlan Fold Belt Projects. Anzac Club, Cammeray [Details from Lindsay Gilligan Ph: +61 2 9901 8301](mailto:Lindsay.Gilligan@smedg.org.au)

**2003 June 26**

**HERITAGE GOLD NZ LTD: EXTENDING KNOWN MINERALISED ZONES AND TESTING CONCEPT-BASED GEOPHYSICAL TARGETS:** Ralph Stagg Rugby Club, Sydney, 5.30 for 6.0pm see [www.smedg.org.au](http://www.smedg.org.au)

**2003 July 10**

**2003 SEG REGIONAL VP LECTURER, DR TIM BAKER:** Intrusion Related Gold Deposits: Classification, Characteristics and Exploration Rugby Club, Sydney, 5.30 for 6.0pm see [www.smedg.org.au](http://www.smedg.org.au)

**2003 JULY 22-24**

**MAGMAS TO MINERALISATION.** Macquarie University, Sydney. For Details: Mel Jones [deremetallica@bigpond.com](mailto:deremetallica@bigpond.com).

**2003 September 9-12**

**AUSIMM 2003 – MANAGING RISK IN MINING PROJECTS,** Sydney, NSW For Details: Chris Sabin, Tel: (02) 9416 0448, Fax: (02) 9416 0617

**2003 SEPTEMBER 7-12**

**ANNUAL CONFERENCE OF THE INTERNATIONAL ASSOCIATION FOR MATHEMATICAL GEOLOGY:** University of Portsmouth, UK. For Details: Conference Secretariat, IAMG 2003, School of Earth and Environmental Sciences, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL, UK Email: [iamg2003@port.ac.uk](mailto:iamg2003@port.ac.uk) Web: <http://www.iamg2003.com>

**2003 SEPTEMBER 7-11**

**6<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL GEOCHEMISTRY.** University of Edinburgh, Edinburgh, Scotland. For Details: [www.ISEG2003.com](http://www.ISEG2003.com)

[Top](#)

**2003 SEPTEMBER 22-26**

**CONFERENCE OF THE SPECIALIST GROUP TECTONICS AND STRUCTURAL GEOLOGY OF THE GEOLOGICAL SOCIETY OF AUSTRALIA:** Held at Kalbarri, WA. **For Details:** contact Alan Collins [alanc@lithos.curtin.edu.au](mailto:alanc@lithos.curtin.edu.au) Pre-conference fieldtrip - Pinjarra Orogen - 17th-21st Sept 2003, Post-conference fieldtrip - Capricorn Orogen - 26th Sept - 3rd October

**2003 October 10**

**"EXPLORATION IN ASIA — PUT A TIGER IN YOUR TENEMENT"** The SMEDG–AIG Symposium 2003 at Shore School, North Sydney. Speakers, Sponsors, Trade Displays, Posters, Students, Work-shoppers, Attendees - Be One! Details from Committee Chairman Phil Hellman Phone: +61 2 9858 3863

**2003 November 17-19**

**MINE GEOLOGY 2003.** For Details: AusIMM Events Department, Tel: (03) 9662 3166, Fax: (03) 9662 3662

**2003 NOVEMBER 2-5**

**GEOSCIENCE HORIZONS: GEOLOGICAL SOCIETY OF AMERICA ANNUAL MEETING AND EXPOSITION.** SEATTLE, WASHINGTON. **For Details:** [www.geolsociety.org/meetings](http://www.geolsociety.org/meetings)

**2004 FEBRUARY 8-13**

**17<sup>TH</sup> AUSTRALIAN GEOLOGICAL CONVENTION. DYNAMIC EARTH: PAST PRESENT FUTURE.** Hobart, Tasmania. **For Details:** see this issue of TAG or [www.17thagc.gsa.org.au](http://www.17thagc.gsa.org.au)

**2004 AUGUST 20-28**

**32<sup>ND</sup> INTERNATIONAL GEOLOGICAL CONGRESS. International Union of Geological Sciences,** Fortezza Da Basso, Italy. **For Details:** Chiara Manetti [cmanetti@geo.unifi.it](mailto:cmanetti@geo.unifi.it) Website: [www.32igc.org](http://www.32igc.org)

**GAA COMMITTEE 2003**

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[Top](#)

## FROM THE EDITOR

Greetings from the Editor. Mike and I have moved to Brisbane. Please don't hesitate to contact me via the contact details above with letters, articles, upcoming events of interest to the membership and photos. Anything over 1 MB please use snail mail and copy to a CD, Disk or Zip. All will be returned after the Newsletter Publication. **Or** contact the President who can organise download onto a server for collection

**If you would like to advertise in this Newsletter please contact the Secretary for rates. [secretary@gaa.org.au](mailto:secretary@gaa.org.au). If you are a like minded group interested in exchanging information please contact the President. [president@gaa.org.au](mailto:president@gaa.org.au)**

[Top](#)