
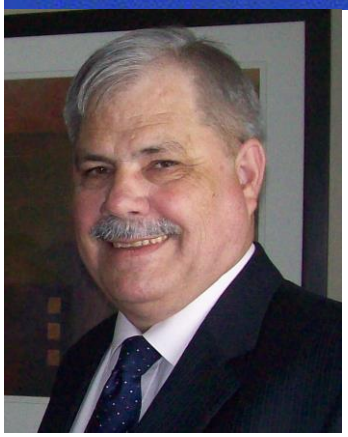


## Norman Owen Lotter

B.Sc.(Chem.)(Natal), M.Sc.(Chem. Eng.)(Cape Town), Ph.D.(Met. Eng.)(McGill)
P.Eng (Ontario), Pr.Eng. (South Africa), C.Eng. (United Kingdom), F.I.M.M.M., F.S.A.I.M.M.
CIM Distinguished Lecturer 2010-11
Designated Consulting Engineer

904 Connaught Avenue
Sudbury, Ontario
Canada P3E 5Y2
Home: 1-705-673-4037
Norman.Lotter@gmail.com
Skype : Norm.Lotter
http://www.linkedin.com/pub/norman-lotter/11/822/794
Work: 1-705-586-1551
Mobile: 1-705-507-2629
Tech.Flowsheets@gmail.com
www.flowsheets.ca


**December 2016**

**Consulting Engineer** with 44 years of experience, including 10 years in management of concentrator operations. Total of 34 years of experience in technical support of mineral processing projects and operations. Relevant management experience in team development, training, project selection and successful value delivery. Pioneer and founder of a specialist Process Mineralogy Group at Falconbridge (1997-2008) with high-value capabilities and solid practical track record for originality and success in flowsheeting for sulphide ores in operations and projects. Author of, and consultant for, *High Confidence Flotation Testing* and *Statistical Benchmark Surveying*. Specialist skills and experience in sampling, reagents for sulphide flotation, and quality assurance. Awarded CIM Distinguished Lecturer 2010/11 for the method development and achievements of this group. Appointed as Designated Consulting Engineer by PEO June 2014.

**Total of 39 publications**. Reviewer for Minerals Engineering journal since 2006. Total of 101 papers reviewed to date. External Examiner for 6 theses, and Supervisor for 1 dissertation.

**Extensive professional training record**, including leadership, business, technical, and regulatory fields (see Appendix 1).

**Languages.** First language: English. Other languages: Afrikaans, French, and Spanish at various levels.

**Specific Interests:** Team development, professional training, collaborative innovation, statistics, sampling, measurement, quality assurance, high-impact project delivery, and flowsheeting for mineral processing.

**General Interests:** Languages, cultures, photography, gardening, classical music, golf.

**Naturalised Canadian Citizen** (2001).

## Table of Contents



## Present Employment:

*President, Flowsheets Metallurgical Consulting Incorporated: 1 January 2016-Date*

Appointed as President, Flowsheets Metallurgical Consulting Incorporated, to lead the startup and development of a small consulting business based in Sudbury. Flowsheets has had a successful startup, and is positioned for a promising work pipeline in 2017. Appointed by the IMPC to lead and organize the Asset Management theme for the 2016 IMPC meeting, Quebec City, September 2016.

## Past Employment:

*XPS Consulting & Testwork Services, Glencore: Consulting Metallurgist: June 2013-Dec 2015*

This position has continued unchanged in the new Glencore organization from mid-2013. I was appointed as Designated Consulting Engineer by the PEO in June 2014, and retired from Glencore in December 2015.

At the request of the management of Kinross Gold Corporation, I have presented a short course on sampling for presentation at their professional development meeting in late September 2014. This was the sixth external presentation of this course material. I am presently preparing a short course on Sampling and Flotation Testing for the Indian Engineering association, at their request through a broker company called DataCode.

My publication with co-authors entitled "Modern Practice of Flotation Testing for Flowsheet Development" (Lotter et al., 2014) in the Minerals Engineering journal was placed 16th in the top 25 papers of 2014 in that journal. It received a total of 721 requests for copies from the Elsevier website.

I have successfully managed $2.8 million of project work for the Kamoa project in Ivanhoe Mines Ltd since 2011, and have controlled the expenditure to within 0.5% variance of budget.

In Q1.2014, I formulated and negotiated the Phase VI Flowsheet Development module for the Kamoa project, as a flowsheet improvement initiative scoped at Cdn. $843,500. The specific objectives are to simplify the flowsheet and at the same time improve the metallurgical performance. At the time of writing (February 2015), this new testwork has successfully simplified the flowsheet, implying lower capex cost for the project and a lower opex because there are less grinding and regrinding mills in this layout. At the same time this work has broken the project standing records of grade and recovery three times. The project status is presently that, the optimum flowsheet has been selected and demonstrated on reference geomet unit samples for design purposes. The results show that the selected flowsheet is robust. The performance gains demonstrated from the new flowsheet

were a 3% rise in copper recovery, a 9% gain in concentrate grade (absolute terms), and a reduction in silica grade of saleable concentrate from 26 to 14%. The project budget was completed at $36,000 under budget, on time, and on scope.

In 2013, I formulated and negotiated the Phase IV and Phase V scope for the Ivanhoe Kamoa project as a variability testing module, two contracts worth $957,000 in total. These projects were completed on schedule, within budget and on scope.

In this role I was asked to formulate and lead a new approach to training for young technicians, since the business needed to recruit to replace retirements, and bench strength in the team had to be provided for. As a core piece of the plan I studied the values and vision of Generation Y, and used this information to understand how this generation thinks and communicates. Their work dynamics are very different to those of the older generation, and I developed a hybrid approach that successfully engaged their bright minds and interest. As a result their training progressed at a pace that surpassed the expectations of many, resulting in a capable core skill set in approximately half the time that the conventional training model used to take. Additionally these trainees brought many of their own contributions to the safety and efficiency of the project work.

*Xstrata Process Support: Consulting Metallurgist: Dec 2011-May 2013*

General Accountability and Scope

Reporting to the Director, XPS, the Consulting Metallurgist markets and consults to projects, using and advancing the specialist and general methods that form the knowledge and best practice of Process Mineralogy and associated engineering, or other discipline group in XPS, delivering niche value to the client. The basis of this marketing is by reputation, experience and expertise. Apart from serving existing markets, the incumbent develops and implements tailored strategies to penetrate and sustain new market segments, thus diversifying the XPS market share. S/he develops and maintains a supportive working relationship with the Manager Process Mineralogy, and also contributes to the training and development of the team in Process Mineralogy and associated engineering at several levels whilst recognizing and using the specialized skills of known individuals. Especially, s/he leads the development and validation of niche products that advance the competitive edge of the business, and uses these in the business marketing activities.

A leader in his/her field of work, the incumbent formulates and develops relevant new methods and products that contribute to the competitive edge of the business, whilst selling contracts to existing and new clients on the basis of specialist expertise that delivers unique value to the client. S/he consults to the project management of these sold contracts to ensure successful delivery. Whereas the incumbent communicates and consults with senior management as a matter of proper internal governance, for the most part s/he works independently in the formulation and execution of strategies and plans. S/he directly influences senior management and executive in client companies by his/her international reputation and track record.

The incumbent also attends relevant conferences, and contributes to selected conference proceedings, engineering journals and chapters in books at a highly visible level. This activity is intended so as to stay close to the leading edge of the developments in his/her discipline, as well as to keep the XPS brand visible and in good reputation. Writes and presents selected engineering short courses for internal and external (commercial) use. In the latter case, this is to elevate the XPS profile internationally and demonstrate and advertise some of our niche technical capabilities. The

incumbent must have a superior aptitude for practical innovation, and the ability to engage others in this process, as well as the ability to read outside his/her formal discipline and engage others in discussions and project work that harness relevant extra-disciplinary tools and methods to synergise value delivery.

S/he leads the training and development of junior and intermediate staff in the knowledge and best practice of the discipline. Additionally s/he works with people in the team during the new product development so as to engage their interest, capabilities and contributions. S/he engages new clients and peers in the other discipline groups of XPS with suggestions towards further contract work that may be added to the XPS revenues over and above the Process Mineralogy contracts that s/he has won.

Appointment and Activities

Appointed Dec 2011 as Consulting Metallurgist in recognition of successful market development, niche product innovation and successful project delivery in Africa 2009-2011. In this new role I continue the development, marketing and sale of niche technologies such as sampling and mixed collectors for XPS Process Mineralogy and Xstrata.

I formulated and negotiated two Phase III project budgets for Ivanplats Limited, South Africa, for execution in 2012-13, addressing the flowsheet development for their Platreef and Kamoa projects. These budgets amount to Cdn. $ 2.3 million, and have been executed within scope, on schedule and within budget. At Mt Isa, Australia, I successfully negotiated and delivered a short course on sampling, and have negotiated a first contract on mixed collector formulation for the lead circuit to enhance selectivity.

The series of short courses that I have prepared on sampling has seen a total of 5 deliveries to external clients and 2 to Xstrata Process Support.. I have written two chapters of the new book entitled "Modern Process Mineralogy" to be published by the JKMRC in 2012. I continue to manage flowsheet development projects for Xstrata and domestic and international clients, for example the Kamoa copper flowsheet for Ivanplats, which has successfully delivered on saleable concentrate grade at a viable recovery despite the known challenges of ultrafine copper sulphide grain structure and the range of secondary copper sulphides. This work is a good example of the influence of the toolbox now available in modern Process Mineralogy. Part of this work will be published in November 2012 at the MEI conference "Process Mineralogy '12", and the complete paper, to the national meeting of the Canadian Mineral Processors, Ottawa, January 2012. While supporting XPS in the training and mentoring of new and existing employees towards the succession plan, I continue to serve on the management team and board of XPS as a director.

*Xstrata Process Support: Manager, Business Development: April 2009-Dec 2011*

In this assignment I reported to the Director of Xstrata Process Support. I focused on growing and diversifying the company's market share, developing new products, and consulting to the Process Mineralogy Group of Xstrata Process Support on specialist technical themes such as sampling, platinum mineral processing, mixed collectors for high-performance sulphide flotation, and statistics. I have formulated, and did successfully engage, market penetration strategies into South African platinum, Southern African base metals, South American copper, and North American gold. To date the South African platinum and base metals strategies, which were the first in this series, has developed to approximately $1.1 million p.a. of sustainable new market share with further growth

opportunities. In this market segment, significant advances for both the copper and platinum projects in metallurgical performance have been made as a result of specialist flowsheeting work performed at XPS. We have completed a first project in South American Copper, and have performed one project in North American Gold.

The use of mixed collectors in sulphide flotation is not new, however in practice their formulation is seldom optimized, leaving untapped metallurgical performance in the operations. This offers a business opportunity. In 2009, together with Prof. Dee J. Bradshaw, (SMI, University of Queensland), I initiated and am leading the new mixed collector programme, now nicknamed *Reagent Sudoku*, for the formulation of high-performance flotation reagent suites. A new, modern, integrated platform has been developed as a result, with superior predictive capabilities in the identification and ranging of candidate collectors in a synergistic mixed collector suite. It has grown from scratch to a series of projects that straddle a range of ore types, and is rapidly gaining a reputation for solid value delivery from improved paymetal recoveries and grades. For example, the project for Eland Platinum, South Africa, has delivered 2.5% PGE recovery and a 16% increase in concentrate grade from the novel mixed collector Exp 820. This gain is worth approximately $7 million p.a. to the mine as extra process revenue. In 2011, I have been working on the formulation of a new mixed collector suite for the Strathcona Mill to improve the metallurgical performance of the copper circuit. To date the results show promise by way of markedly improved selectivity between copper and nickel flotation. *Reagent Sudoku* is a novel, original product of a modern integrated approach to reagent formulation that derives synergies not attainable in single reagent suites or in heuristically formulated mixed collector suites. This new product has gained solid acceptance by operations managers, and is engaging a bigger market.

Sampling is a core skill set in mineral processing, yet few undergraduate schools teach this as a course. In January 2011, I wrote and presented, together with colleague Jorge Oliveira, P.Geo., a short course on Gy's fifty-piece experiment for minimum sample mass, distribution modelling and primary sample processing at the national meeting of the Canadian Mineral Processors in Ottawa. This was well-received, and I have been requested by SMIKT, the knowledge transfer group in JKTech, to enlarge the course to two days and offer it to various international conferences.

*Xstrata Process Support and Falconbridge Limited: Superintendent: Mineral Processing, and Manager, Process Mineralogy: April 1997-April 2009*

Initially appointed as Superintendent of Mineral Processing, I was promoted to Manager: Process Mineralogy in December 2003 in recognition of our successes in establishing and developing the new Process Mineralogy Group from scratch, and successful value delivery to operations and projects. Additionally I was given an executive cash award in recognition of these achievements. This group is a modern hybrid of sampling, geology/mineralogy, and mineral processing, and has developed novel flowsheeting capabilities that add considerable value to operations and projects. From 1997 on, I led this group through two five-year plans to identify and acquire specialist equipment, and to develop listed and desirable capabilities, formulating and delivering successful projects through innovation first in current operations, and then in new mine projects from drill-core. Project selection was also key. We selected our first few projects on a degree of difficulty-potential impact grid, and ranked these. This also involved a fair amount of innovation, now totalling 16 new methods and equipment modifications, for example developing a method whereby QEMSCAN could measure polished thin sections (a world first), and identifying and using the appropriate geostatistical model for the data interpretation. It also involved developing and validating a suitable method whereby representative

sample suites could be extracted from an operating concentrator for mass and value balancing, and subsequent measurement by QEMSCAN. This was successfully done, and led to a Ph.D. thesis at McGill University sponsored by Falconbridge (see Appendix 2: Theses). Especially, it did involve negotiation with internal Falconbridge clients for contracts on the proposed projects, selling the new ideas. I was then listed by the CEO Falconbridge as an Eminent Candidate High Potential (ECHP) for professional development, and attended two of his business schools with the Rotman School of Business, Toronto.

Examples of the successful projects delivered from this programme are described in detail in my publications (Appendix 3), but a short list of these follows:

- Surveying and flowsheet reformatting of Raglan Concentrator
- Predictive Future Ore programme for Raglan with formulation of Geomet Units
- Sampling, characterization and flowsheet prediction for Montcalm project, Timmins
- Surveying of Montcalm Concentrator post-commissioning and retrofitting flowsheet improvements with sustainable performance gains
- Sampling, characterization and flowsheeting for Nickel Rim South project, including formulation of GeoMet Units

*Rustenburg Platinum Mines Limited and Amplats, South Africa: 1981-1997: Metallurgical Superintendent and Manager, Divisional Metallurgical Laboratory*

Originally assigned as Divisional Metallurgist, and later, as Manager, Divisional Metallurgical Laboratory, 1986-1997, I was appointed to provide programme structure and practical technical services to eight operating platinum concentrators from a sampling and flotation testing programme. The key objective was reliable scale-up from laboratory to plant operations. This immediately required the development and validation of a method whereby reproducible flotation tests could be performed for the mineralogically complex and variable Merensky and UG2 ore types of the Bushveld, and led to the development and evolution of High-Confidence Flotation Testing (see Appendix 2: Theses). This assignment delivered several reagent strategies to the concentrators, especially the identification and optimal dosage of niche gangue depressants, as well as the delivery of a unique mixed collector suite for the Merensky flotation circuit in Rustenburg, culminating in Cytec's International Excellence Award in 1989. Additionally this resource was appointed to be the sampling team for surveying the concentrators and supplying representative sample material to the QEMSCAN laboratory. The project prospectus for the Potgietersrust Platinum Mine used my laboratory scale grades and recoveries predicted from work on their drill core, and the plant commissioned with good agreement to these figures.

Earlier, as Metallurgical Superintendent of Technical Services in Rustenburg Section, I was part of the core team for the design and commissioning of the retrofit 7.2 MW Waterval Regrind and Scavenger Flotation Circuit, a project that advanced the PGE recoveries to record highs in that operation's history. My role in this project was the sizing of the regrind mills and modelling the final size distribution and recovery gains that would result from the retrofit. The circuit was successfully commissioned in November 1986.

## Earlier Assignments: Prior to 1981

*Consolidated Murchison Limited, Gravelotte, South Africa: 1978-1981: Senior Plant Metalurgist and Plant Superintendent*

Senior Plant Metallurgist, and later, Plant Superintendent of the concentrator and leach plant, where I was part of the core team leading a breakthrough in the depression of arsenopyrite flotation, improving the recovery and saleability of final antimony concentrate. This flowsheet breakthrough was a combination of regrinding the scavenger concentrate before cleaning and the dosage of cyanide to depress the arsenopyrite. The arsenic grade of saleable concentrate was reduced from 0.5-0.6% As to 0.2-0.3% As, whilst this enabled the shutdown of the Franco-Wyoming reverse float, and gained approximately 10-12% Sb recovery at the saleable concentrate level.

*Shangani Nickel Mine, Zimbabwe: 1977-1978*

Plant Metallurgist for the concentrator, responsible for the technical and metal accounting programmes.

*Rio Tinto: Empress Nickel Mine, Zimbabwe: 1972-1977*

Full plant operator learnership, then Plant Metallurgist for concentrator and smelter.

## Appendix 1: Professional Training

| Year | Institute | Course |
|---|---|---|
| **2006** | MICA | Leadership During Uncertain Times |
| **2005** | Rotman School of Business, University of Toronto | Strategic People Leadership - Coaching |
| **2004** | McQuaig Institute of Executive Development | Strategic Hiring (Behavioural Event Interviewing (BEI)) |
| | Six Sigma | Yellow Belt |
| | | Stage Gate Process |
| **2003** | Rotman School of Business, University of Toronto | Corporate Competencies Development Programme |
| | Collège Boréal | Français – Niveau Avancé |
| **2002** | MASHA | Due Diligence |
| **2001** | Strategic Decisions Group | Strategic Decision Making |
| | University of Western Ontario | Financial Management |
| **2000** | Collège Boréal | Français – Niveau Débutant |
| | Caltech, Los Angeles | Management of Technology and Innovation |
| **1999** | Niagara Institute | Niagara Institute for Leadership |
| | Conflict Management Group | Negotiation Skills |
| **1998** | IAPA | Ontario Health and Safety Certificate |
| **1996** | Business Process Re-Engineering | Project Evaluation and Management of Change |
| **1993** | Witwatersrand University | From Zero to Kriging in Thirty Hours |
| **1983** | Johannesburg Consolidated Investment Co. Ltd., Johannesburg, South Africa | Industrial Relations Management |
| **1981** | | Management Principles I : Organisational Development |
| **1978** | | Management Principles II : Planning and Control |

## Appendix 2: Theses

### M.Sc.(Chemical Engineering)(Cape Town)(1995)

A Quality Control Model for the Development of High-Confidence Flotation Test Data

Supervisor: Prof. C.T. O'Connor, Department of Chemical Engineering, University of Cape Town, South Africa

My thesis studied the evaluation bias errors of Platinum Group Elements (PGE) in Merensky ore, using laboratory scale flotation tests. A model was developed from first principles, for the sampling of ore from underground working stopes and for subsequent use in such flotation testwork, to control and minimise these bias errors within ± 3.27 % in the PGE balance. Small PGE recovery changes are thus visible in the test data at the 95% confidence level. The model also successfully interfaces the exploration discipline, using drill-core as study material, where the metallurgical performance of the ore reserve may be reliably described. Additionally, a graphical model for the estimation of gravity-recoverable Platinum-Group Minerals (PGM) was developed and validated. This thesis was written on a part-time basis in 15 months, and has been implemented as a working standard at Falconbridge since 1997.

### Ph.D.(Metallurgical Engineering)(McGill)(2005)

Statistical Benchmark Surveying of Production Concentrators

Supervisor : Assoc. - Prof. AR Laplante, Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

My thesis addressed the problem of obtaining representative sample suites from an operating concentrator for various diagnostic purposes, including flowsheet optimisation. The problem of residual lognormality and autocorrelation in concentrator data had to be addressed in the development of the sampling model. The sampling model is based on the grade of ore treated by the concentrator, and uses independent reference distributions to adjudicate representativity at the 95% confidence level. This work also produced a diagnostic graphical method for the estimation of recoverable paymetal values in final tailings from a data mining technique using compound distributions (see Publications). This thesis was written on a part-time basis in 4 years. The associated coursework and compulsory seminars were awarded a GPA of 4.0. The surveying methodology has been accepted as a working standard at Falconbridge since 2004.