

## Predictive Geometallurgy and Geostatistics Lab Queen's University

### Annual report 2022

This report summarizes the ongoing research of the Predictive Geometallurgy and Geostatistics Laboratory at Queen's University in Kingston, Ontario, Canada. 2021 was a challenging year, with continuous restrictions to meetings and limited group interactions. Despite these difficulties, the lab completed important and novel work. The delay in the release of this report is just another sign of the strain of the last couple of years, however, results are encouraging and the lab is doing important contributions to research and industry.

This year, two students graduated, one Master of Applied Science and one Doctor of Philosophy, two new students joined the group. The following two theses were completed in this period:

- Kasimcan Koruk, M.A.Sc. (Aug. 2022), "[\*Definition of geological domains with an ensemble implementation of Support Vector Classification\*](#)"
- Alvaro Riquelme, Ph.D. (Sep. 2022), "[\*Multivariate simulation using a locally varying coregionalization model\*](#)"

The hold on Sebastian Avalos Ph.D. thesis has been lifted after the successful filing of a patent:

- Sebastian Avalos, Ph.D. (Sep. 2021), "[\*Advanced predictive methods applied to geometallurgical modelling\*](#)"

The research group is currently composed of:

- Sebastian Avalos, Post-Doc
- David Casson, Ph.D. student
- Soheil Kheirparast, M.A.Sc. student
- Paula Larrondo, Ph.D. student
- Tong Li, Visiting Ph.D. student
- Alvaro Mariño, M.A.Sc. student
- Noble Potakey, M.A.Sc. student
- Carlos Moraga, Ph.D. student

We continued collaboration with other faculty members and researchers, including:

- Asli Sari, Assistant Professor – The Robert M. Buchan Department of Mining (Queen's University). Dr. Sari and Dr. Ortiz co-supervised Soheil Kheirparast in his M.A.Sc.
- Raimon Tolosana-Delgado, Senior Scientist (Helmholtz-Zentrum Dresden-Rossendorf). Dr. Tolosana-Delgado hosted a research internship of Sebastian Avalos.

- Brian Frank, Professor – Electrical and Computer Engineering (Queen’s University). Dr. Frank and Dr. Ortiz co-supervise Paula Larrondo in her Ph.D.

Nine contributions are available this year, totaling 140 pages, with reviews on topics such as clustering methods, grade control, models for muck pile blast movement, generative adversarial networks (GANs), and interesting progress in non-Gaussian models, mineral prospectivity and bulk ore sorting. Industrial collaboration continues with SRK Consulting Canada and MineSense.

As always, we welcome industrial and academic collaboration. This provides opportunities to fund new graduate students and novel research, and directly benefits industrial partners. If interested, please send a note to [julian.ortiz@queensu.ca](mailto:julian.ortiz@queensu.ca).

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Queen’s University

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## Journal and Conference Publications and Presentations

Publications in book chapters, peer-reviewed journals and international conferences are listed below for 2021. These are not included in this report, since the copyright belongs to the corresponding publishers, but can be requested for personal use or research purposes directly to [julian.ortiz@queensu.ca](mailto:julian.ortiz@queensu.ca).

### Patent

1. Avalos SA, Ortiz JM (2022) ***Mine Scheduling Methods and Constructs***, Provisional Patent US 63/388,016, filed 07/19/2022.

### Book chapters

1. Ortiz JM, Silva JF (2022) ***Entropy***, in Encyclopedia of Mathematical Geosciences, Daya Sagar B, Cheng Q, McKinley J, Agterberg F (Eds.), Encyclopedia of Earth Sciences Series, Springer, Cham, 5 p. [https://doi.org/10.1007/978-3-030-26050-7\\_102-1](https://doi.org/10.1007/978-3-030-26050-7_102-1)

### Journal papers

1. Moraga C, Kracht W, Ortiz JM (2022) ***Process simulation to determine blending and residence time distribution in mineral processing plants***, Minerals Engineering, 187: 107807. <https://doi.org/10.1016/j.mineng.2022.107807>
2. Jelvez E, Morales N, Ortiz JM (2022) ***Stochastic final pit limits: an efficient frontier analysis under geological uncertainty in the open-pit mining industry***, Mathematics, 10(1): 100. <https://doi.org/10.3390/math10010100>

### Conference papers and presentations

1. Ortiz JM (2022) ***Predictive Modelling in Geometallurgy***, in Geomet-Procemin 2022, Santiago, October 5-7 2022.
2. Avalos S, Ortiz JM (2022) ***Spatial multivariate morphing transformation applied to geometallurgical attributes***, in Geomet-Procemin 2022, Santiago, October 5-7 2022.
3. Riquelme A, Ortiz JM (2022) ***Simulation of complex multivariate relationships based on a non-stationary coregionalization model***, in 21st Annual Conference of the International Association for Mathematical Geosciences – IAMG 2022, Nancy, France, Aug 29-Sep 3, 2022.
4. Koruk K, Ortiz JM (2022) ***Definition of geological domains with Ensemble Support Vector Classification***, in 21st Annual Conference of the International Association for Mathematical Geosciences – IAMG 2022, Nancy, France, Aug 29-Sep 3, 2022.

5. Ortiz JM, Avalos S, Frenzel M, Pereira L, Riquelme A, Tolosana-Delgado R, van den Boogaart KG (2022) ***Inferring parameters of 3D particles microstructures from 2D sections using statistical learning***, in 21st Annual Conference of the International Association for Mathematical Geosciences – IAMG 2022, Nancy, France, Aug 29-Sep 3, 2022.
6. Avalos S, Ortiz JM, Leuangthong O (2022) ***Multivariate morphing transformation: Fundamentals and challenges***, in 21st Annual Conference of the International Association for Mathematical Geosciences – IAMG 2022, Nancy, France, Aug 29-Sep 3, 2022.
7. Riquelme AI, Ortiz JM (2022) ***A Riemannian tool for clustering of geo-spatial multivariate data***, in 14th International Conference on Geostatistics for Environmental Applications – geoENV 2022, Parma, Italy, June 22-24, 2022.
8. Larrondo P, Frank B, Ortiz J (2022) ***Automated topical extraction to aid in complex problem-solving feedback consistency in engineering design courses***. Proceedings of the Canadian Engineering Education Association (CEEA).
9. Koruk K, Ortiz JM (2022) ***Ensemble based domaining informed with unsupervised classification of geochemical data***, CIM 2022 Convention, Vancouver, BC, May 1-4, 2022.
10. Ortiz JM (2022) ***Predictive Geometallurgy and Geostatistics Lab***, invited talk, XUST-Queen’s training program, December 1, 2022, online.
11. Ortiz JM (2022) ***Predictive Geometallurgy and Geostatistics Lab***, presented to Teck, November 2, 2022.
12. Ortiz J (2022) ***Geostatistics and geometallurgical Modelling***, in: Queen’s Engineering Research Networking Day 2022, Queen’s University, 12 October, 2022.
13. Ortiz JM (2022) ***Predictive Geometallurgy and Geostatistics Lab***, invited talk, Instituto de Ingenieros de Minas de Peru, March 14, 2022, online.

#### Conference posters

1. Tolosana-Delgado R, Avalos S, van den Boogaart KG, Frenzel M, Ortiz JM, Pereira L, Riquelme A (2022) ***Modelling microstructures with flexible Laguerre Mosaics***, in 21st Annual Conference of the International Association for Mathematical Geosciences – IAMG 2022, Nancy, France, Aug 29-Sep 3, 2022.
2. Riquelme AI, Ortiz JM (2022) ***Multivariate Simulation Using Locally Varying Correogionalization Models***, poster, CIM 2022 Convention, Vancouver, BC, May 1-4, 2022.

## Funding

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