



**ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO**

**DEPARTAMENTO DE ENGENHARIA DE MINAS E DE PETRÓLEO**

# **The University of Newcastle Australia**

## ***Sampling and Reconciliation in the Mining Industry***



**Profa. Dra. Ana Carolina Chierigati**

**Novembro 2019**



## 1. INTRODUÇÃO

Este relatório apresenta um resumo das atividades desenvolvidas pela Profa. Ana Carolina Chierigati durante o período de afastamento compreendido entre 31 de outubro e 8 de novembro de 2019. As atividades compreenderam a ministração de curso de pós-graduação intitulado “*Sampling and Reconciliation in the Mining Industry*” e a participação em reuniões visando à discussão sobre o convênio acadêmico internacional entre a EPUSP e a *University of Newcastle Australia* (UoN) e os projetos de pesquisa em andamento no Laboratório de Amostragem e Manuseio de Sólidos Granulados (LAM) do PMI. A carta-convite da instituição australiana e a carta de agradecimento são apresentadas em anexo.

## 2. CONVÊNIO ACADÊMICO E PROGRAMA DO CURSO

O convênio acadêmico internacional da EPUSP com a Universidade de Newcastle Australia (UoN) prevê o intercâmbio de alunos de pós-graduação e docentes credenciados no PPGEMin visando à cooperação em atividades de pesquisa conjunta, participação em seminários e reuniões acadêmicas, cursos e escolas de verão e inverno, conforme Cláusula 2ª do referido convênio.

Entre 2016 e 2019, três professores da UoN – Prof. Dr. Mark Jones, Prof. Dr. Kenneth Williams e Prof. Dr. Dusan Ilic – ministraram duas disciplinas de pós-graduação no Departamento de Engenharia de Minas e de Petróleo da USP, intituladas “Manuseio e Estocagem de Sólidos Granulados” (PMI-5928) e “Projeto de Simulação de Chutes de Transferência” (PMI-5936).

Conforme Cláusula 4ª, que prevê a reciprocidade nas atividades contempladas pelo convênio, e conforme carta de cooperação de dezembro de 2016, o Departamento de Engenharia de Minas e de Petróleo da EP-USP se comprometeu a oferecer 4 cursos de 32 horas cada no período de 2 anos para o *ARC Training Centre in Mining Technologies*, na área de manuseio avançado de sólidos granulados.

A viagem da Profa. Dra. Ana Carolina para a Austrália para ministrar o segundo curso para o *ARC Training Centre in Mining Technologies*, intitulado “Amostragem e Reconciliação na Indústria Mineral” e cujo programa se encontra a seguir, justificou-se pelo convênio acadêmico e comprometimento de cooperação descritos nos documentos supracitados.



1. Concepts
  - Constitutional and distribucional heterogeneities
  - Random and systematic errors
2. Pierre Gy's Theory of Sampling
  - Concepts of precision, accuracy and representativeness of samples
  - How to minimize or eliminate sampling errors
  - Calculation of minimum sample mass in exploration, mining and minerals processing
  - Optimization of sampling and sample preparation protocols
3. The sampling process
  - Characteristics of sampling equipment in mining and minerals processing
  - Characteristics of splitters in physical laboratories
  - How to design correct sampling equipment
4. QA-QC (Quality Assurance-Quality Control)
  - How to establish a QA-QC program
  - The importance of correct data collection
  - Control tools and statistical analysis of results
5. Reconciliation
  - The influence of sampling and the importance of QA-QC in reconciliation results
  - The sources of errors and the risks of 'illusory reconciliation'
  - Proactive reconciliation × reactive reconciliation

### 3. CONCLUSÕES


O curso ministrado na Universidade de Newcastle Austrália incluiu diversos tópicos da disciplina de graduação em Engenharia de Minas "Amostragem e Controle de Qualidade da Mineração" (oferecida pela docente desde 2018) e das disciplinas de pós-graduação "Amostragem na Indústria Mineral" (oferecida pela docente desde 2012) e "Controle de Qualidade e Reconciliação na Indústria Mineral" (oferecida pela docente desde 2016). Visto ser uma área de pesquisa nova na UoN, já que nesta universidade não existe o curso de graduação em Engenharia de Minas, os alunos e pesquisadores do *Centre for Bulk Solids and Particulate Technologies* através do *Advanced METS (Mining Equipment, Technology and Services) Doctoral Training Centre* do NIER (*Newcastle Institute for Energy and Resources*) tiveram a oportunidade de conhecer os conceitos de Amostragem e de Reconciliação e de realizar exercícios práticos nesta área tão importante para a mineração.




ANEXOS



**DTC** | Doctoral Training Centre  
For Advanced METS



**SAMPLING AND RECONCILIATION IN THE MINING INDUSTRY**




MONDAY 4 NOVEMBER & TUESDAY 5 NOVEMBER, 2019  
UNIVERSITY OF NEWCASTLE, CALLAGHAN CAMPUS

**PRESENTATION HANDOUTS**

NEWCASTLE | CENTRAL COAST | PORT MACQUARIE | SYDNEY | SINGAPORE  
The University of Newcastle  
Callaghan NSW 2308 Australia  
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**SAMPLING AND RECONCILIATION IN THE MINING INDUSTRY**



MONDAY 4 NOVEMBER & TUESDAY 5 NOVEMBER, 2019  
UNIVERSITY OF NEWCASTLE, CALLAGHAN CAMPUS

Short course presented by the Advanced METS (Doctoral Training Centre) and the University of São Paulo (Brazil)

This course introduces sampling principles with applications in the mining industry based on Pierre Gy's Theory of Sampling. This includes the concepts of accuracy, precision and sample representativeness, their interrelation and practical applications.


The course provides a comprehensive understanding of the sampling process, issues arising from inadequately designed sampling equipment and how to minimise or eliminate sampling errors, in addition to presenting basic principles associated with Quality Assurance/Quality Control and mine reconciliation.

**VENUE**  
Training Room, Level 5, NIER BLOCK A  
70 Vale Street Shortland

**DATE & TIME**  
Monday 4 November and Tuesday 5 November, 2019  
9am to 4pm  
Lunch will be provided

**REGISTER**  
<https://www.eventbrite.com.au/e/sampling-in-the-mining-industry-tickets-77421532889>

**DR ANA CAROLINA CHEREGATI**



Dr. Ana Carolina Chieragati is a Mining Engineer professor at the University of São Paulo, Brazil, and has a master's and a PhD degree in Mineral Engineering from the University of São Paulo, and a postdoctoral degree in Mine Reconciliation and Sampling from Aalborg University, Denmark. She is also a lecturer at the Department of Mining and Petroleum Engineering, of USP, teaching Mineral Exploration, Mine Reconciliation, Quality Assurance/Quality Control, and Sampling in the Mining Industry.

With 16 years of experience in sampling and reconciliation, she taught in South America and Australia, published several technical papers and book chapters, and participated in many projects in Brazil, Argentina, Chile, Honduras, New Caledonia, and Mongolia, most of them related to the quality control of mining operations and the optimization of sampling protocols in gold, zinc, copper, nickel, niobium, phosphate and bauxite mines.

**DTC** | Doctoral Training Centre  
For Advanced METS

**ASSOCIATE PROFESSOR KENNETH WILLIAMS  
CENTRE FOR BULK SOLIDS AND PARTICULATE  
TECHNOLOGIES  
SCHOOL OF ENGINEERING**



1<sup>st</sup> of August 2019

Dear Professor Ana Carolina Chierigati,

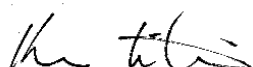
It is with pleasure that I formally invite you to visit the University of Newcastle in order to conduct collaborative research in the area of effective sampling within materials handling systems. I understand that you will be able to visit the University from 1<sup>st</sup> of November 2019 to the 9<sup>th</sup> of November 2019. The research activities will be in conjunction with the students and staff from the Centre for Bulk Solids and Particulate Technologies and the Advanced METS Doctoral Training Centre at The University of Newcastle and will include:

- Presenting basic and advanced sampling theories for analysing the bulk materials handling systems, and
- Research collaboration on materials handling sampling simulation and experimental techniques on bulk material handling systems.

This particular research is of significant interest to the University of Newcastle, given the importance of bulk materials handling to the Australian mining and minerals processing industries.

You will be provided an allocation of office space, use of personal computer and access to research and instructional facilities and equipment during your stay. The visiting appointment does not carry any entitlement to salary or other departmental resources not listed.

It should be noted that intending visiting scholars need to ensure that they have appropriate medical insurance for the duration of their stay in Australia and that their home organisation provides appropriate public liability, professional indemnity, and workers compensation insurance. The University of Newcastle is not liable for the provision of coverage for these insurances



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**ASSOCIATE PROFESSOR KENNETH WILLIAMS  
CENTRE FOR BULK SOLIDS AND PARTICULATE  
TECHNOLOGIES  
SCHOOL OF ENGINEERING**



07 November 2019

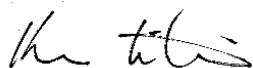
Dear Professor Ana Carolina Chierigati,

On behalf of the Centre of Bulk Solids and Particulate Technologies and NIER (Newcastle Institute for Energy and Resources) we would like to thank you for your visit to the University of Newcastle and for conducting the short course on Sampling and Reconciliation for the Mining Industry. This course forms a part of the Advanced METS Doctoral Training Centre's calendar and had the participation of researchers and students from NIER and the Australian Research Centre Research Hub for Advanced Technologies for Australian Iron Ore. The course comprised the following:

- Presenting basic and advanced sampling theories for analysing the bulk materials handling systems;
- Practical applications of sampling theory through exercises;
- Basic concepts of reconciliation.

We also appreciate the discussions held on research collaboration between USP and the University of Newcastle, and the teaching plans for the next year. We look forward to welcoming your colleagues as well in the future.

Yours sincerely,



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