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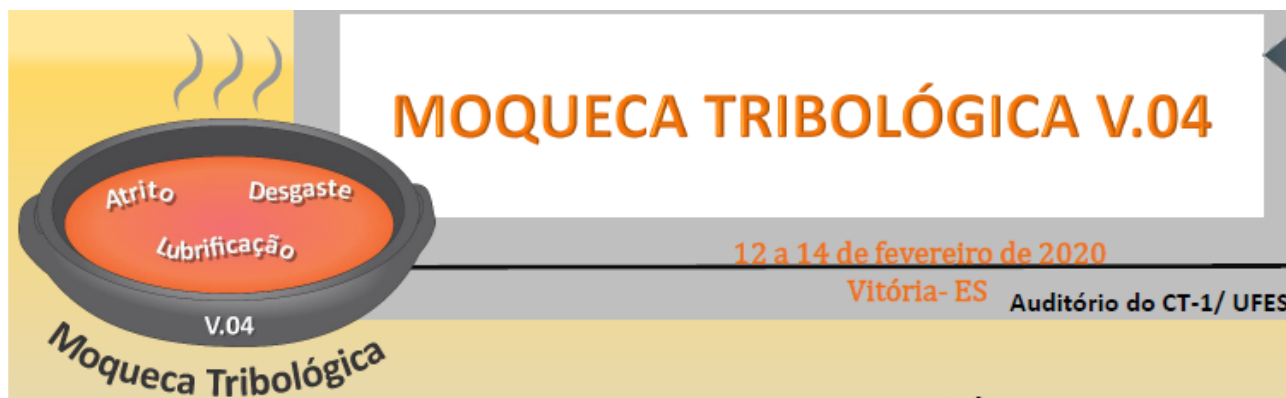


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ABRASIVIDADE DE PARTÍCULAS: DEFINIÇÕES E DESAFIOS



Giuseppe Pintaude

SUMÁRIO

- MOTIVAÇÃO
- DEFINIÇÕES
- CLASSIFICAÇÕES
- ESTUDOS DE CASO
- DISCUSSÕES FINAIS

MOTIVAÇÃO



DEFINIÇÕES

A) ASTM G40-17 Standard Terminology Relating to Wear and Erosion

abrasivity, n—the ability of a material or substance to cause abrasive wear

B) Plinninger, R. J., & Restner, U. (2008). Abrasiveness testing, quo vadis?—a commented overview of abrasiveness testing methods. *Geomechanik und Tunnelbau: Geomechanik und Tunnelbau*, 1(1), 61-70.

“The term “**abrasiveness**” describes the potential of a rock or soil to cause wear on a tool. As this potential significantly depends on the specific circumstances of the observed system (e.g. involved tools, mechanisms of excavation, temperature, applied loads) it should be kept in mind that rock abrasiveness can never be an intrinsic physical parameter.”

REVISÃO

Ensaio para análise da abrasividade:

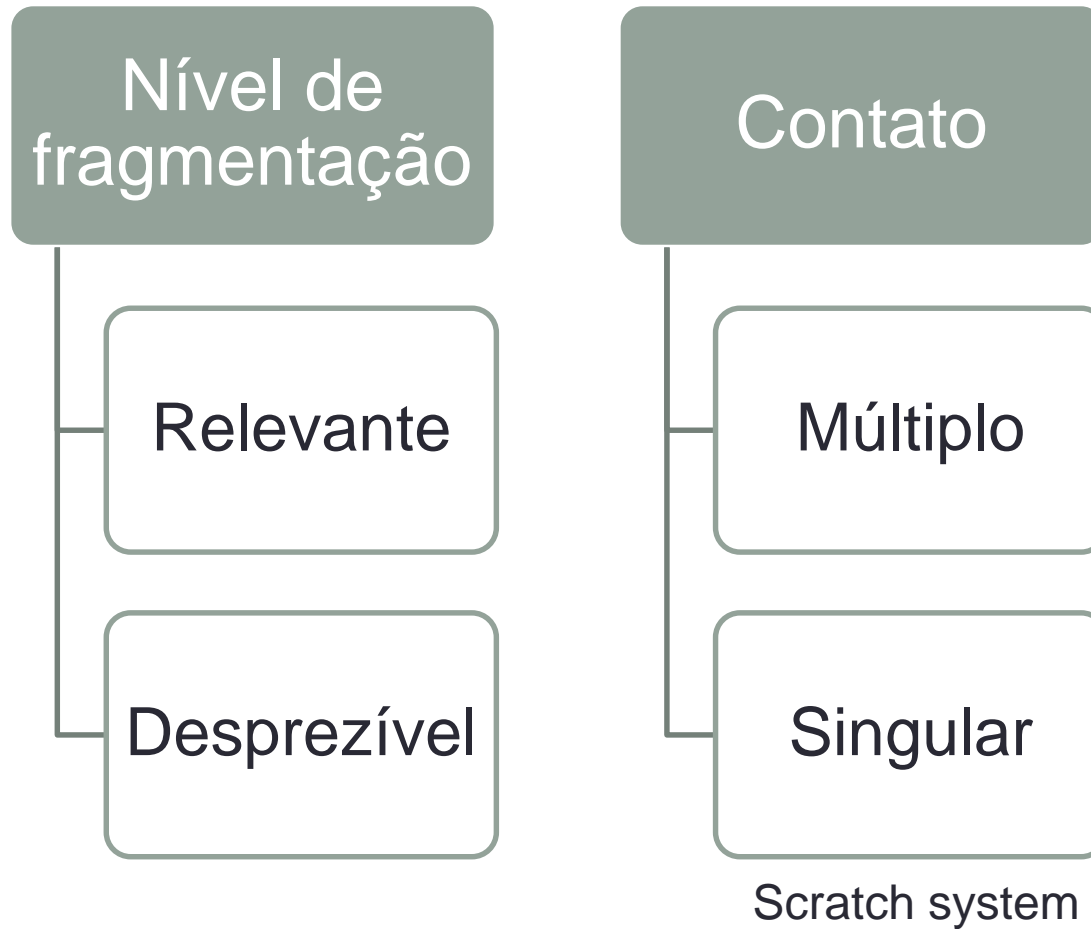
- Escala micrométrica
 - ensaio para determinação do número de Miller e do SAR (ASTM G75)
 - ensaios de roda de borracha (ASTM G65)
 - ensaios de micro abrasão
- Escala milimétrica
 - ensaio de britador de mandíbulas (ASTM G81)
 - ensaio de abrasão por impacto cíclico
 - ensaio de abrasividade Cerchar

REVISÃO

An Investigation of the Present and Future Testing Methods of Rock Abrasion Resistance International Journal of Mining Engineering and Mineral Processing 2014, 3(1): 10-19 DOI: 10.5923/j.mining.20140301.03

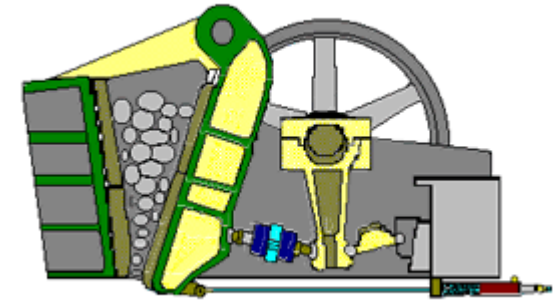
1. **Slake Durability and LA Abrasion Test** ASTM D4644 / ASTM C131
2. **Nordic Ball Mill Test and Micro-Deval Test**
3. **Gouging Abrasion Test**
4. **Abrasion Resistance Hardness Tester (ARHT)**
5. **Concrete Abrasion Testing Apparatus** ASTM-C779: Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces
6. **Miller Slurry Test** ASTM G75
7. **Rock Abrasion Tool (RAT)**

Tentativa de classificação



CASO 1: Britador de mandíbulas

Pintaude, G., & Bartalini, NM. (2018). Revisiting gouging abrasion test for jaw crushers. *REM - International Engineering Journal*, 71(1), 111-115.
<https://dx.doi.org/10.1590/0370-44672017710060>.

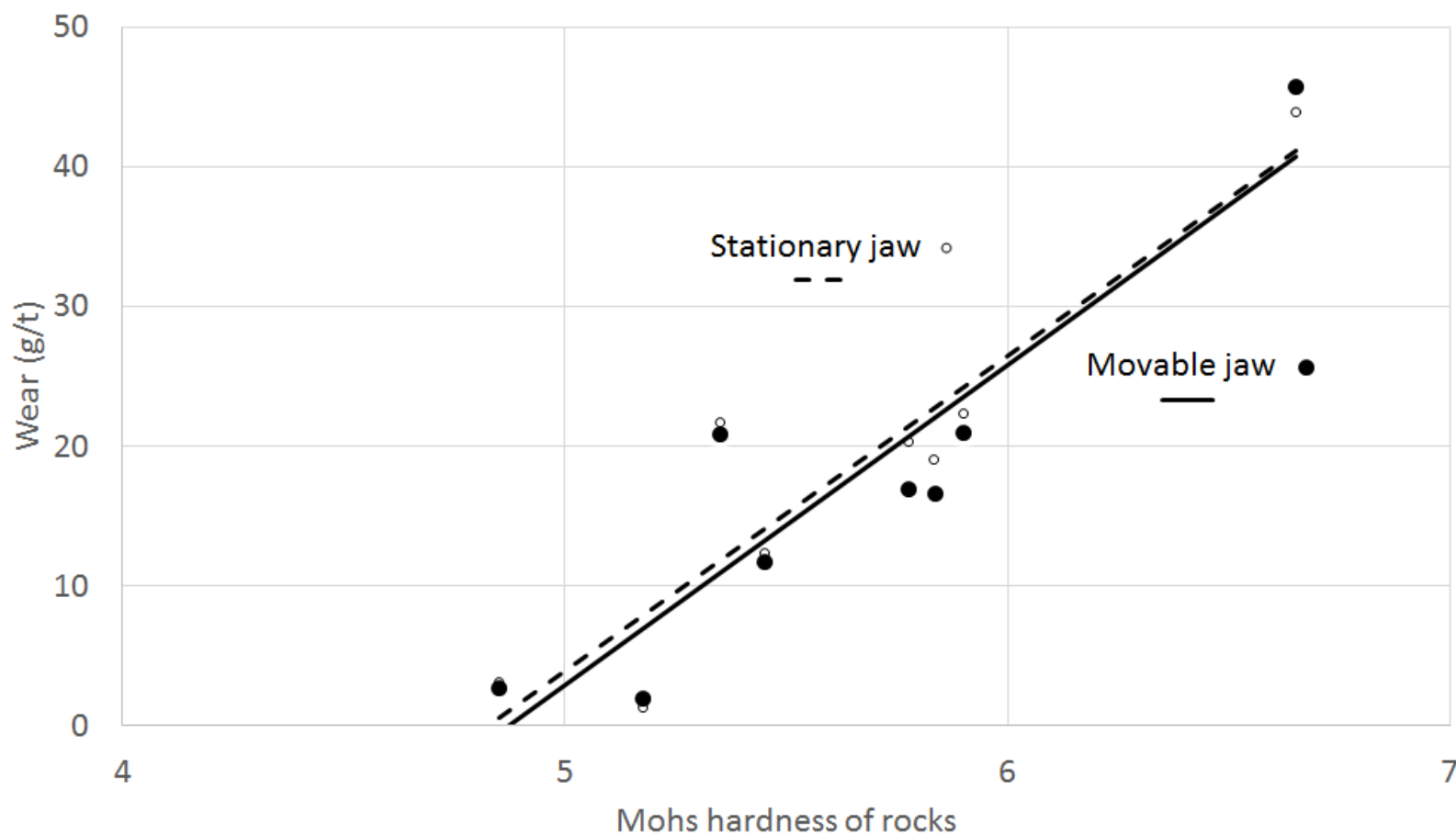


ASTM G81-97a(2013)

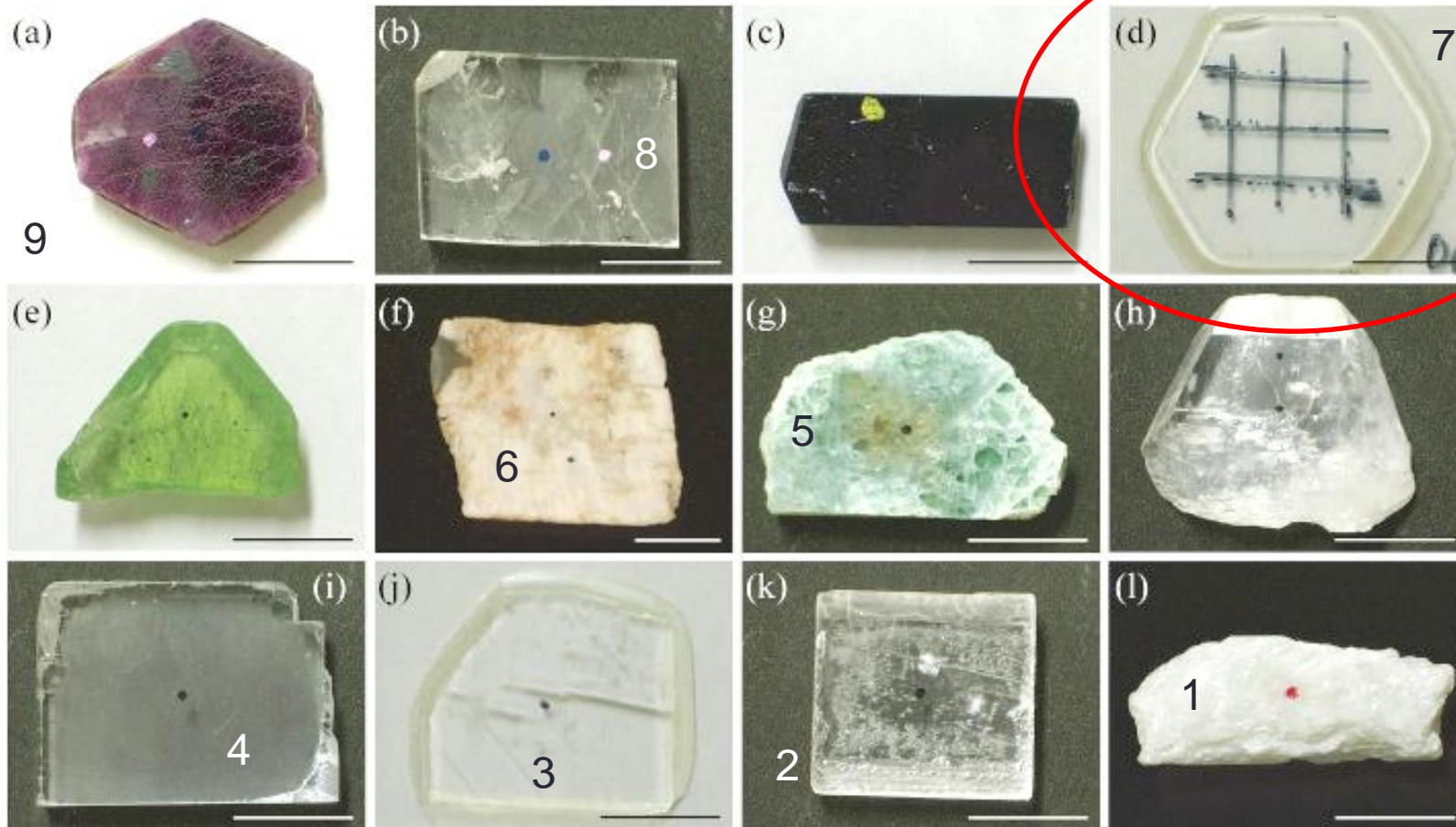


CASO 1: Britador de mandíbulas

Aço Hadfield x 8 tipos de rochas

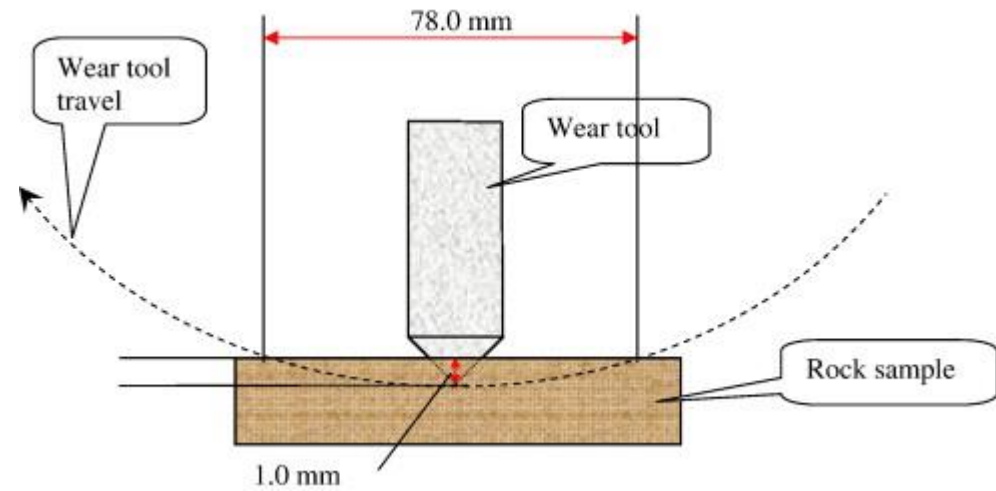


Escala Mohs de dureza



Masuda, Toshiaki, et al. "Loop energy: A useful indicator of the hardness of minerals from depth-sensing indentation tests." *Journal of Structural Geology* 117 (2018): 96-104.

Goivadura



Golovanevskiy, V. A., & Bearman, R. A. (2008). Gouging abrasion test for rock abrasiveness testing. *International Journal of Mineral Processing*, 85(4), 111-120.

CASO 2: Cerchar



Wear

Volumes 410–411, 15 September 2018, Pages 181–189



Identification of abrasion regimes based on mechanisms of wear on the steel stylus used in the Cerchar abrasiveness test

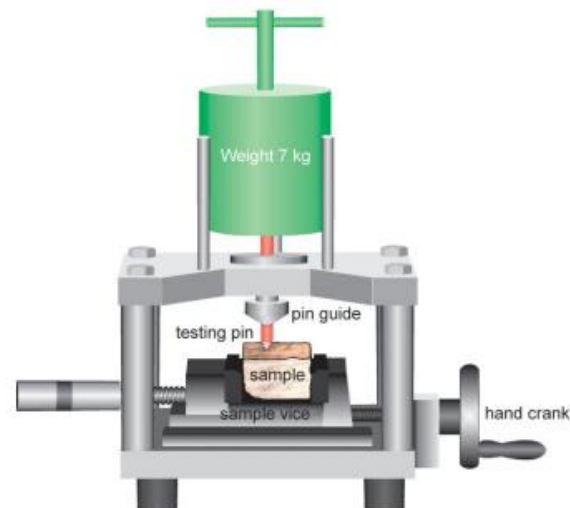
Gabriela Reis Piazzetta ^a, Leonardo E. Lagoeiro ^a, Isabella Franos
Gonalves Rabelo ^c, Giuseppe Pintaude ^d  

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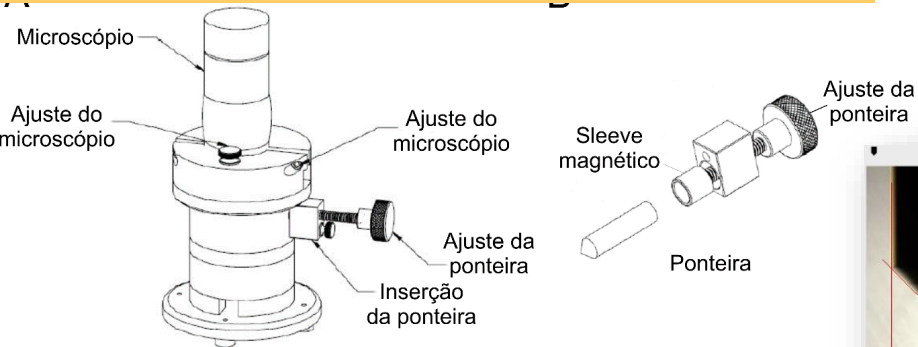
<https://doi.org/10.1016/j.wear.2018.07.009>



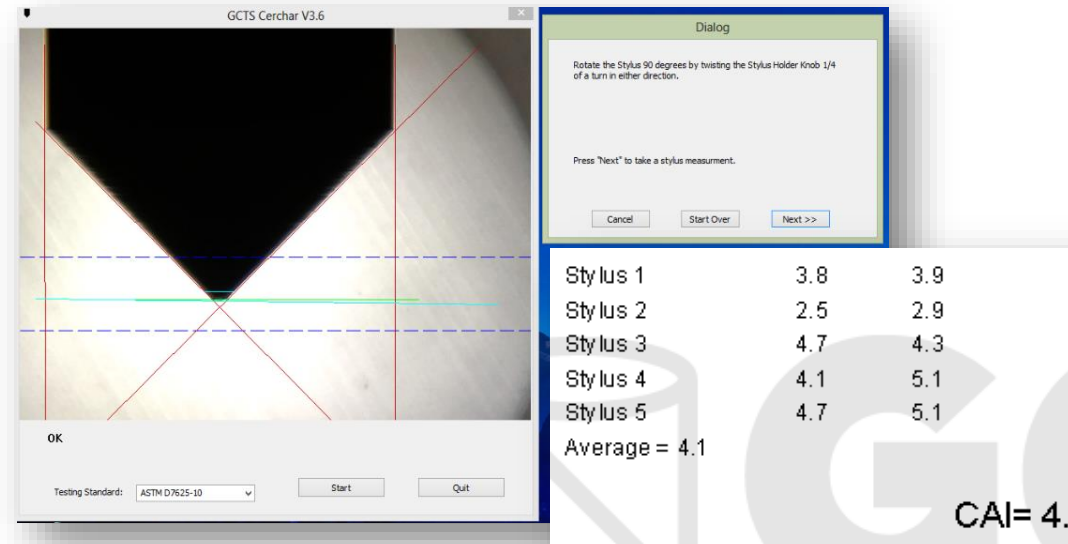
ASTM D7625-10



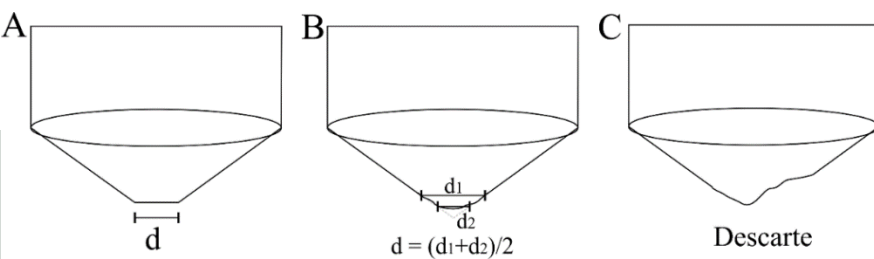
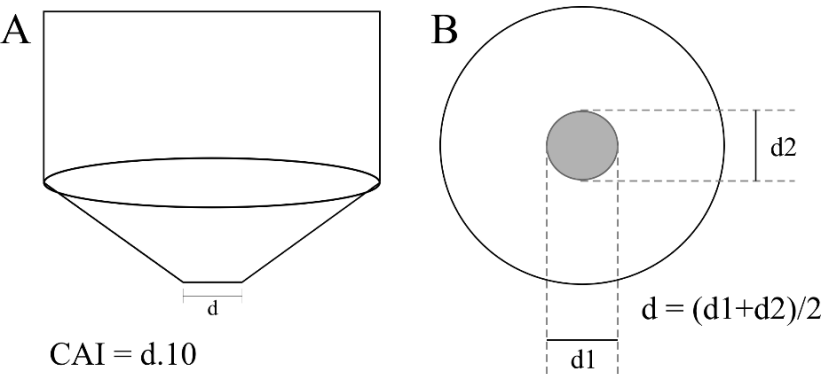
Colocação da ponteira no microscópio



Medida do desgaste no software e determinação do CAI



Métodos de medida do desgaste: lateral e topo

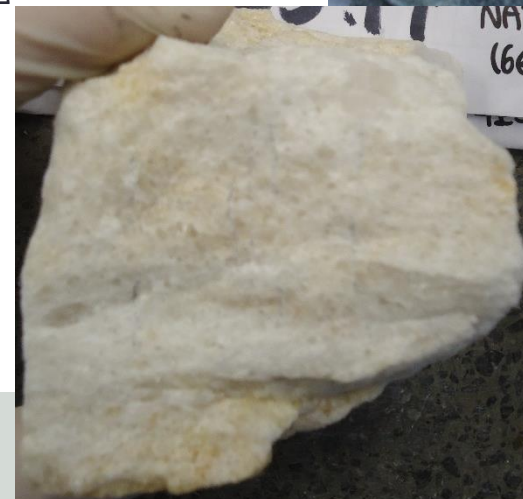
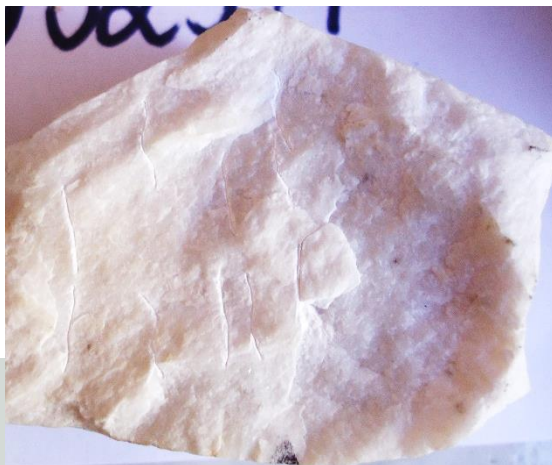


Classificação ASTM (2010)

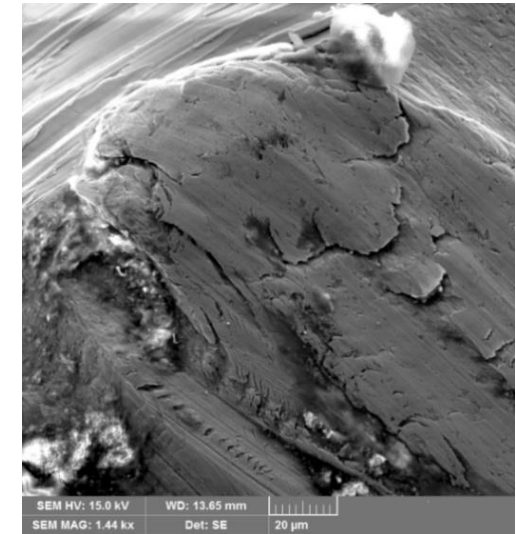
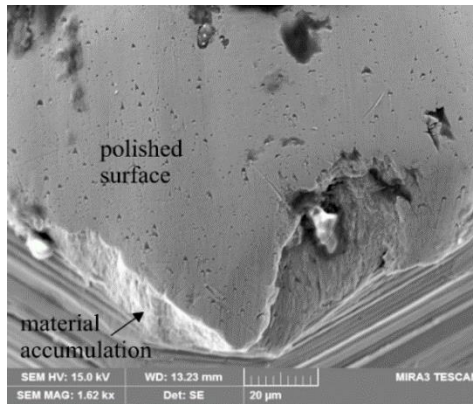
ASTM	HRC ₅₅
Muito pouco abrasiva	0,30 - 0,50
Pouco abrasiva	0,50 - 1,00
Abrasividade média	1,00 - 2,00
Muito abrasiva	2,00 - 4,00
Extremamente abrasiva	4,00 - 6,00
Quartzítica	6,00 - 7,00

CASO 2: Cerchar

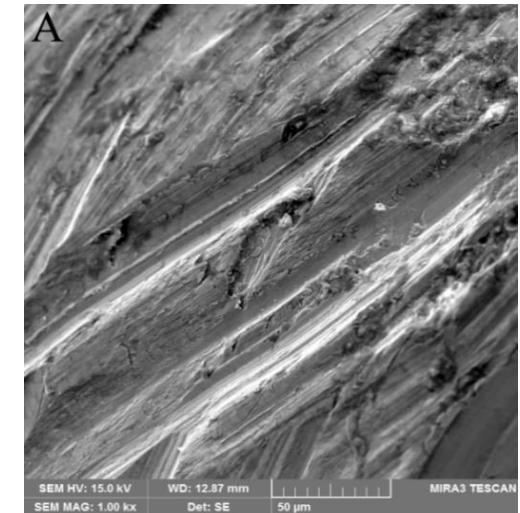
Type of rock	Classification	CAI	
		1 st	2 nd
Sedimentary	Sandstone	0.1	0.1
Metamorphic	Marble	0.3	0.3
Igneous	Basalt	1.1	1
Igneous	Syenogranite	1.9	1.7
Igneous	Basalt	2.1	2
Igneous	Alkali Feldspar Syenite	2.5	2.6
Igneous	Syenogranite	3	3.2
Metamorphic	Quartzite	5.5	5.7
Metamorphic	Quartzite	5.8	6



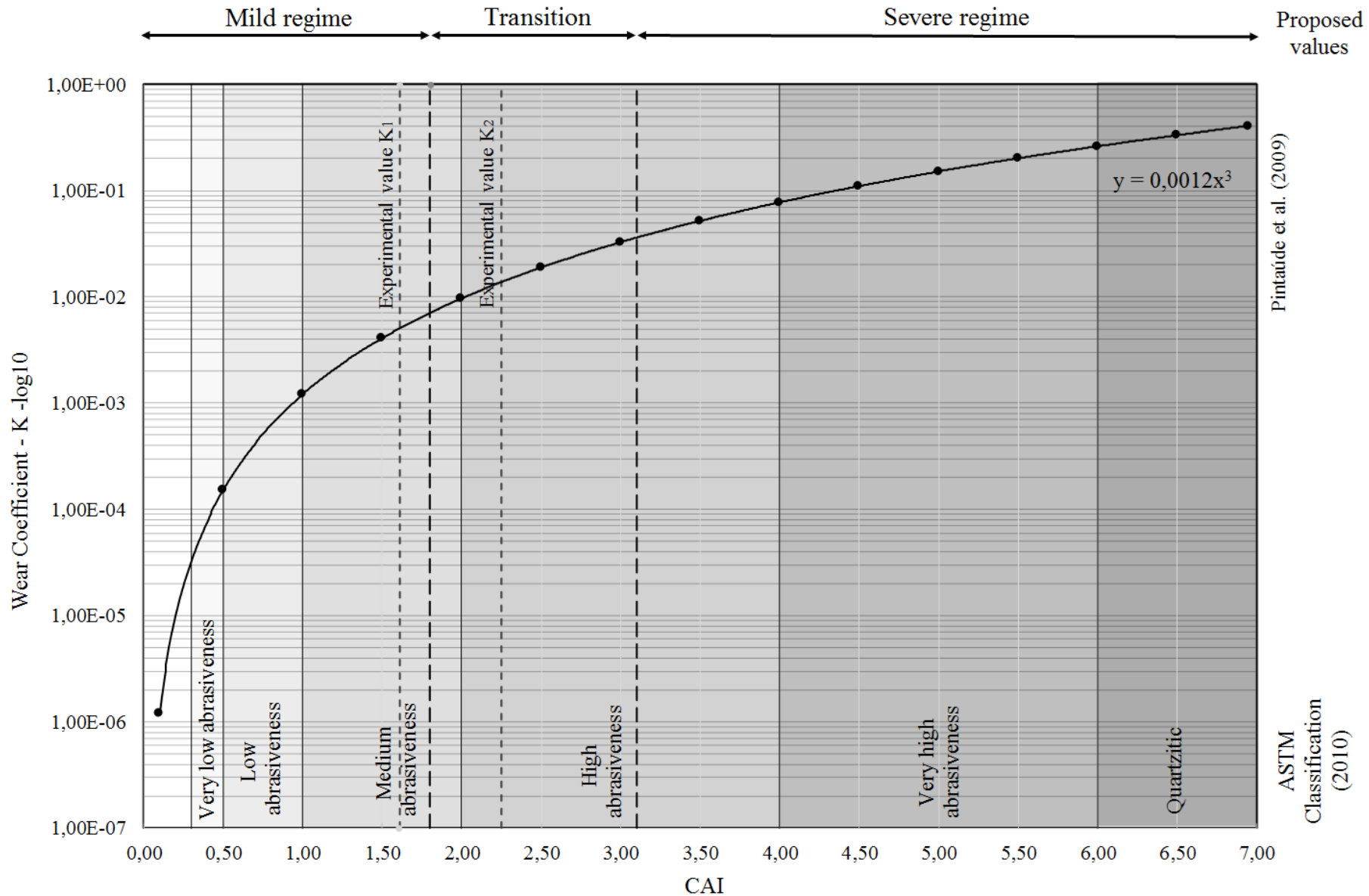
CASO 2: Cerchar



CAI	Wear regime	Wear mechanisms
0.1 – 1.8	Mild	Polishing, flattening and microploughing, low volume loss
1.8 – 3.1	Transitional	Microploughing and microfatigue
>3.1	Severe	Microcutting with well-defined grooves and microchip formation, high volume removal

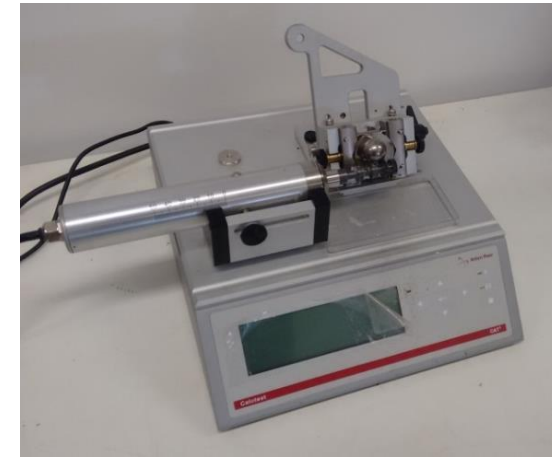


CASO 2: Cerchar



CASO 3: Microabrasão

A. Rovani, T. Rosso, and G. Pintaude, "On the Use of Microscale Abrasion Test for Determining the Particle Abrasivity," *Journal of Testing and Evaluation* 49 (in press). <https://doi.org/10.1520/JTE20180576>.



ISO 26424:2008



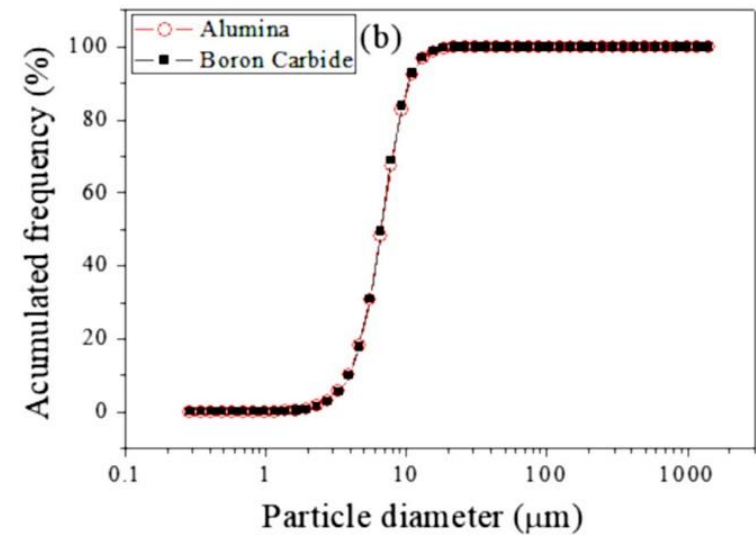
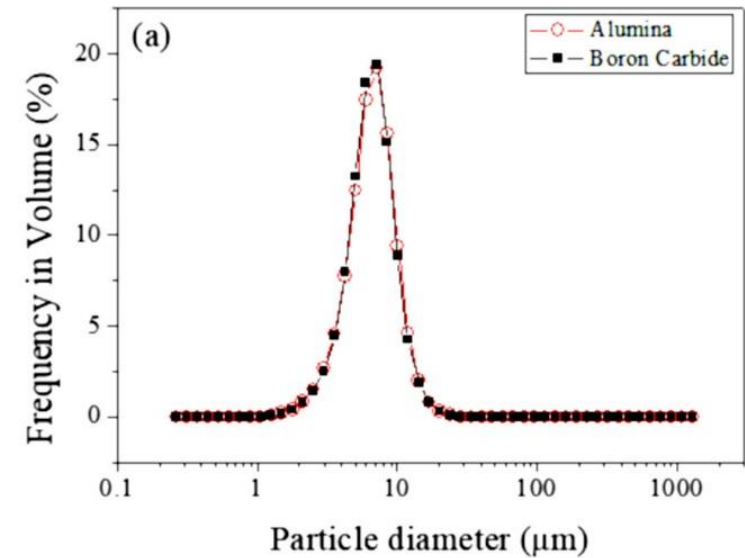
Metodologia

- **Corpo de prova:** aço AISI D2 temperado de acordo com a ASTM G65 – 59 HRC

- **Abrasivos:** carbeta de boro B_4C e alumina Al_2O_3

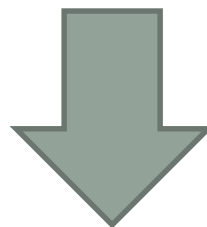
Rotação do eixo: 300 rpm

Vazão: 1gota/15s



Background

- **Kelly & Hutchings (2001)**: disco cilíndrico de nylon X amostra fixa de PMMA / abrasivos entre 2.39 a 152 micrometros.
- **Stachowiak & Stachowiak (2001)**: (glass beads, silica sand, quartz, and alumina [Al₂O₃]) x aço baixo C e FFBC 27% Cr. ABRASIVO FRAGMENTARAM



**FOCO EM GEOMETRIA DE PARTÍCULA
NENHUMA INFO SOBRE DISTRIBUIÇÃO GRANULOMÉTRICA**

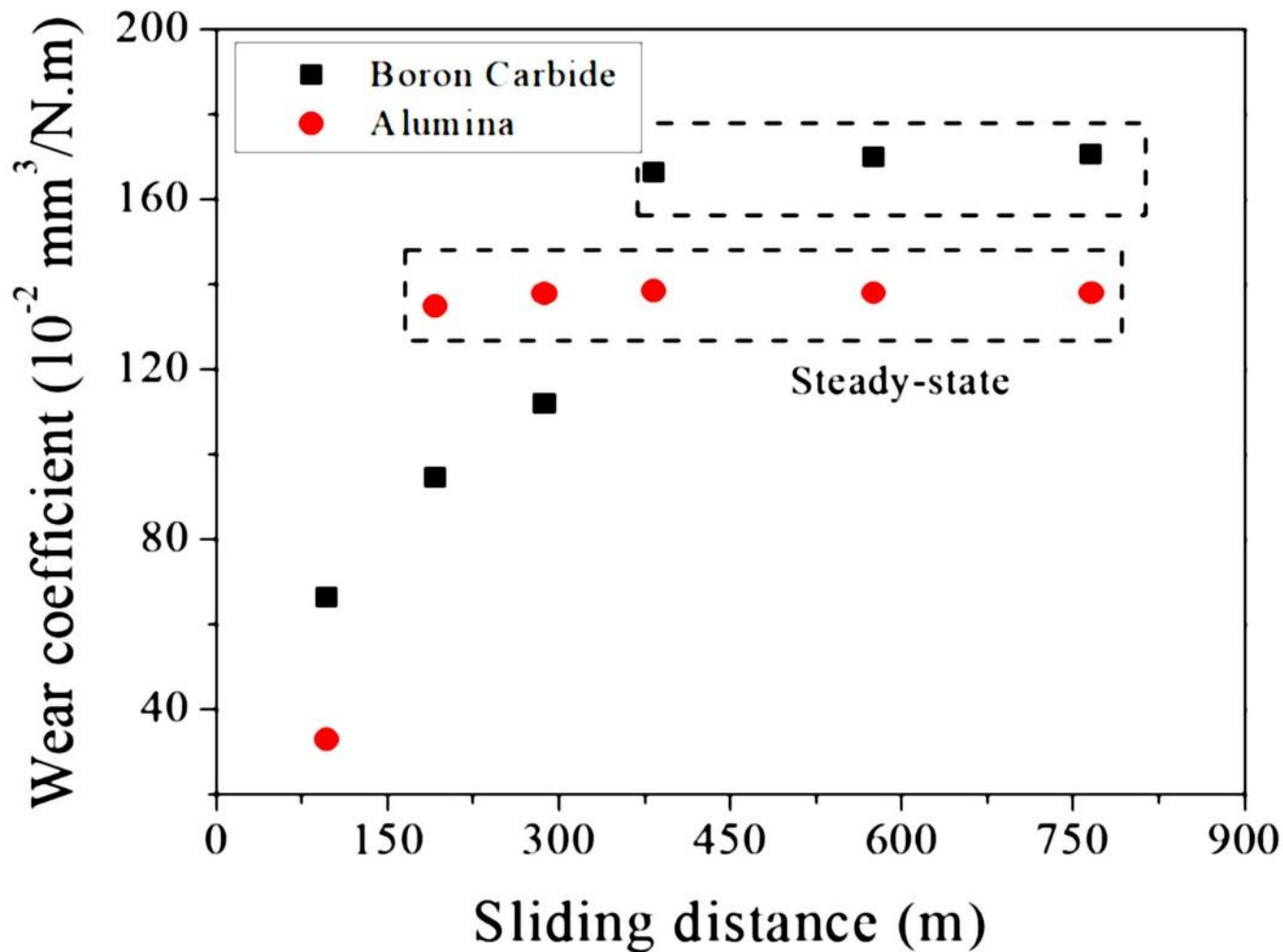
Resultados

Variações

Rugosidade da esfera ✗

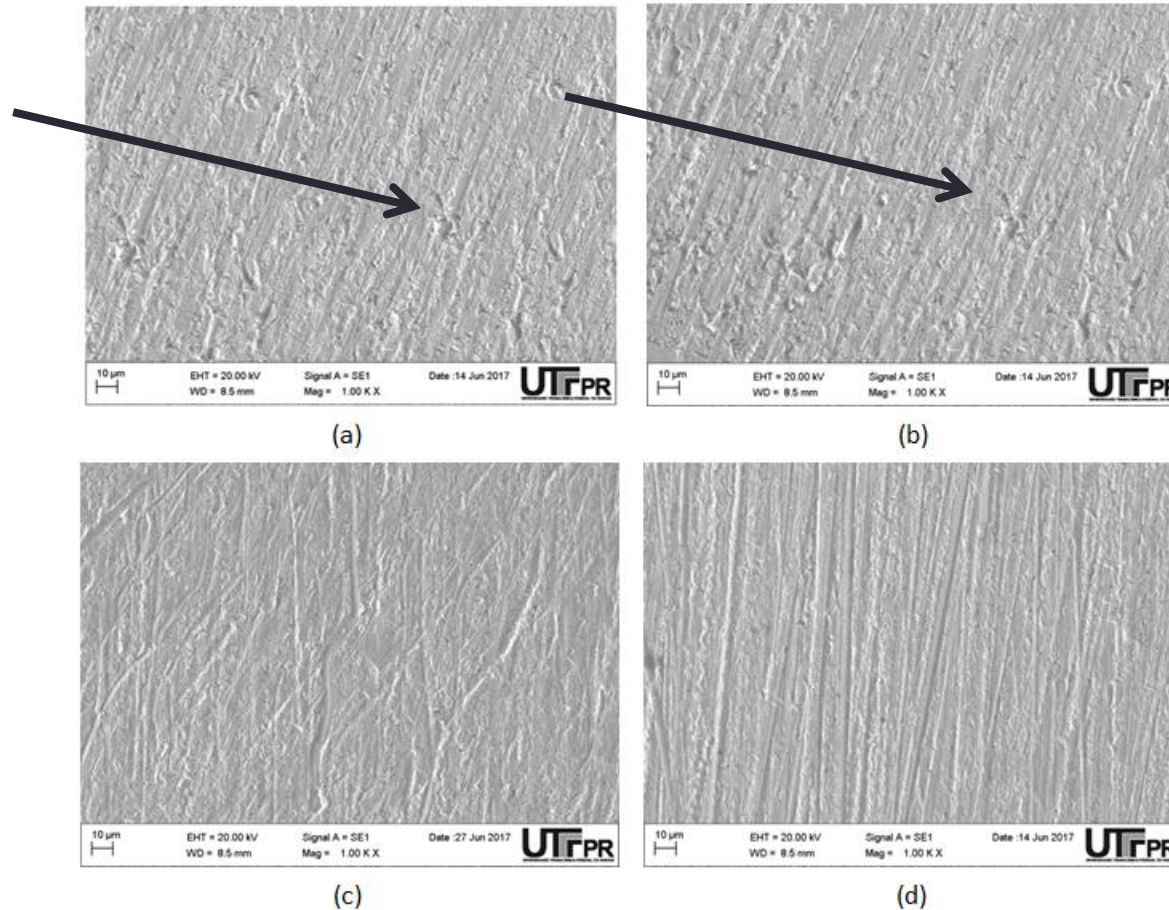
SPQ das partículas ✗

Potencial zeta ✗



Resultados

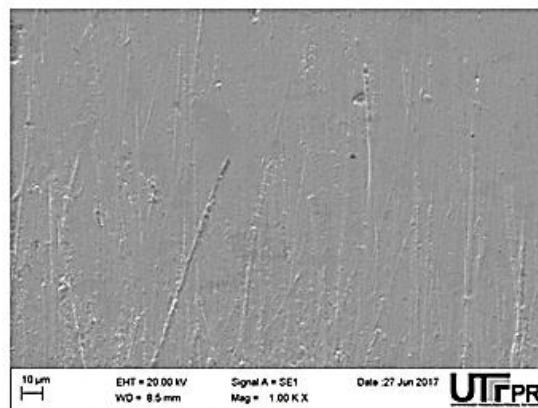
Mecanismos x Carbeto de Boro



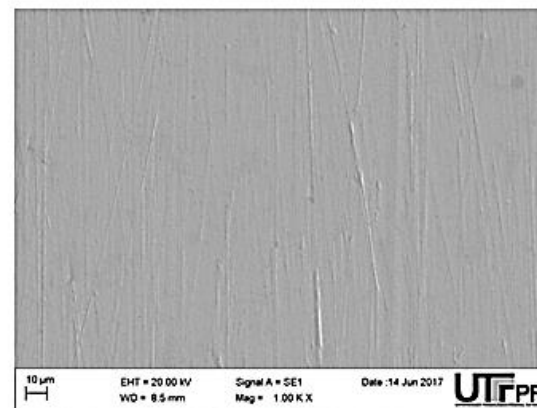
Marcas de desgaste abrasivo com partículas abrasivas de carbeto de boro para ensaio durante 4 minutos (a), 8 minutos (b), 12 minutos (c) e 16 minutos (d).

Resultados

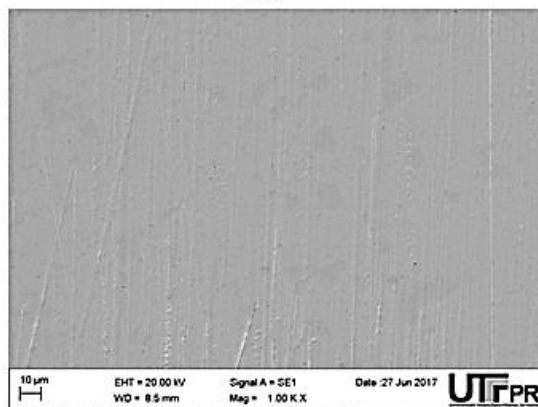
Mecanismos x Alumina



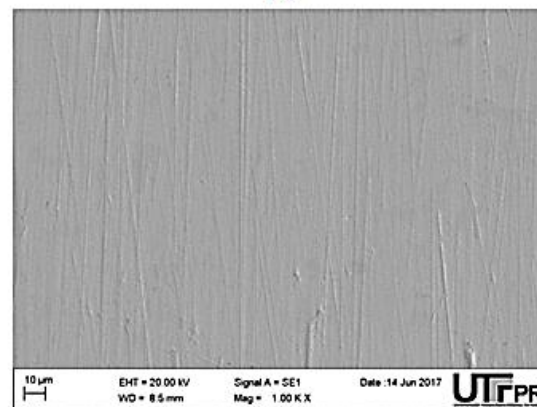
(a)



(b)



(c)

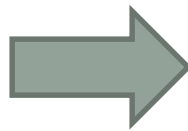
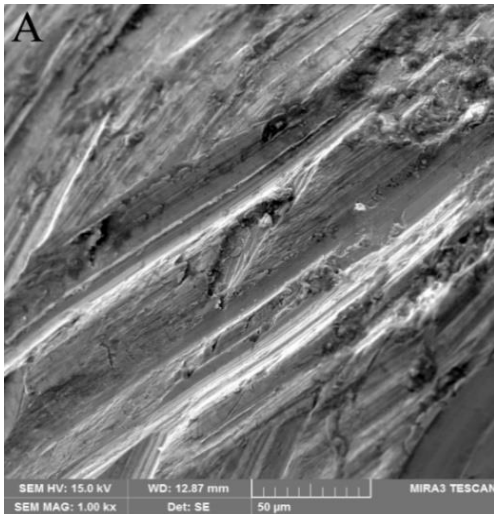


(d)

Marcas de desgaste abrasivo com partículas abrasivas de alumina II para ensaio durante 4 minutos (a), 8 minutos (b), 12 minutos (c) e 16 minutos (d).

DISCUSSÕES

- **Contato Múltiplo/Singular:** podem ser correlacionados? Se sustenta, como classificação?
- **Nível de fragmentação:** efeito de tamanho? Necessidade de novo conceito? (Máx tamanho efetivo de contato?) Por que usar d50? Ou d80?



Contato inicial: flat surface x pin

Contato final: múltiplos contatos

DISCUSSÕES

O'Connor, E. et al. "Assessing the abrasivity characteristics of the central Dublin fluvio-glacial gravels—A laboratory study." *Tunnelling & Underground Space Technol.* 96 (2020): 103209.

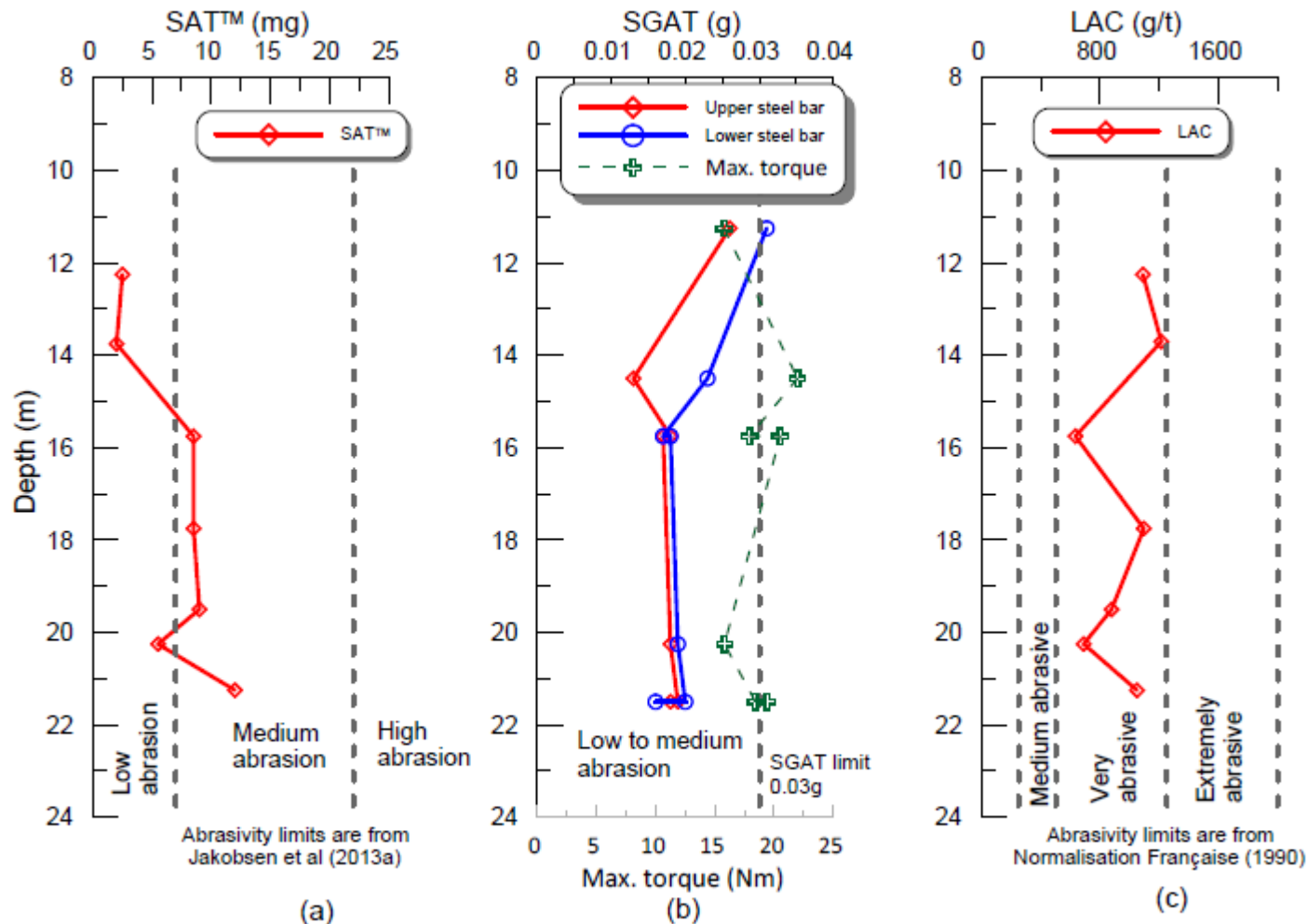


Fig. 9. Results of soil abrasivity tests (a) SAT™, (b) SGAT and (c) LCPC.

OBRIGADO!!

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