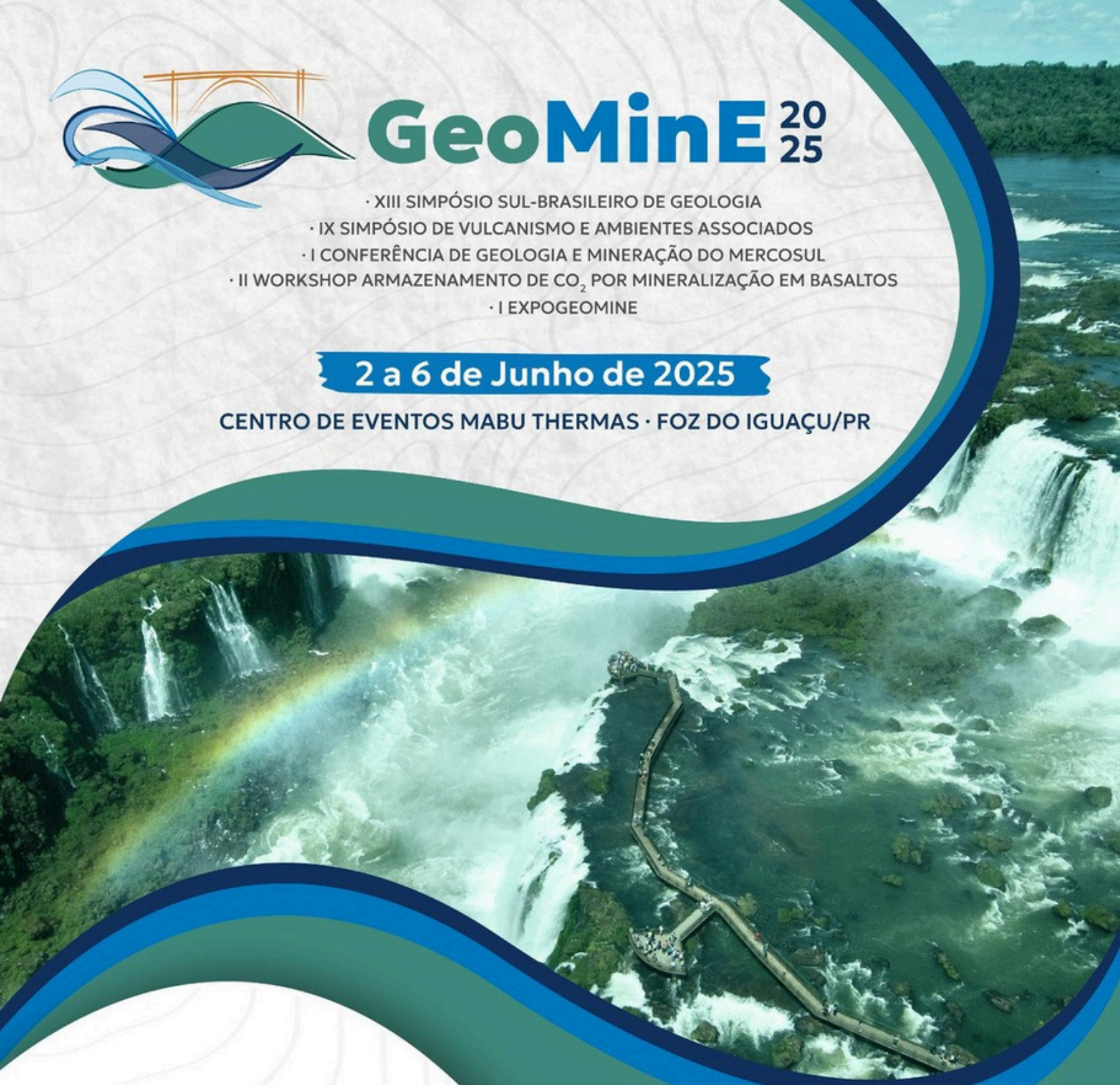
GeoMinE 2025

· XIII SIMPÓSIO SUL-BRASILEIRO DE GEOLOGIA
· IX SIMPÓSIO DE VULCANISMO E AMBIENTES ASSOCIADOS
· I CONFERÊNCIA DE GEOLOGIA E MINERAÇÃO DO MERCOSUL
· II WORKSHOP ARMAZENAMENTO DE CO_2 POR MINERALIZAÇÃO EM BASALTOS
· I EXPOGEOMINE

2 a 6 de Junho de 2025

CENTRO DE EVENTOS MABU THERMAS · FOZ DO IGUAÇU/PR



ANAIS
2025

SOCIEDADE BRASILEIRA DE GEOLOGIA
DESDE 1946

Núcleo Paraná

Núcleo Rio Grande do Sul - Santa Catarina

Dados Internacionais de Catalogação na Publicação (CIP)
(Câmara Brasileira do Livro, SP, Brasil)

Simpósio Sul-Brasileiro de Geologia. Simpósio de Vulcanismo e Ambientes Associados. Conferência de Geologia e Mineração do Mercosul. Workshop Armazenamento de Co2 Mineralização em Basaltos (13. : 9. : 1. : 2. : 2025 : Foz do Iguaçu, PR)
Anais GeoMinE 2025 [livro eletrônico]. -- 1. ed. -- Foz do Iguaçu, PR : Sociedade Brasileira de Geologia - SBG, 2025.
PDF

Vários autores.
Vários colaboradores.
bibliografia.
ISBN 978-85-99198-37-7

1. Geologia 2. Minas e mineração 3. Mineração I. Título.
25-283606 CDD-551

Índices para catálogo sistemático:

1. Geologia 551

Aline Graziele Benitez - Bibliotecária - CRB-1/3129

ISBN: 978-85-99198-37-7
CBL
9 788599 198377

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Textural and compositional record of crystal-melt segregation in a "*dynamic mush*" preceding large, caldera-forming eruption(s)

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As proposed by the classical mush model, the origin of crystal-poor, high-silica rhyolitic magmas (>75 wt.% SiO_2), and their plutonic equivalents, has been attributed to the fractionation of intermediate-to-silicic parental magmas at high crystallinities in shallow reservoirs. This process is critical for understanding the formation of silica-rich rhyolitic melts and associated ore deposits, as well as the origin of the most catastrophic eruptions on Earth. However, the silicic cumulates complementary to these high-silica magmas remain missed in the mid- to upper crust, potentially hidden within felsic plutons. This contribution introduces the "dynamic mush model" to explain the textures and compositional patterns recorded within the Campo Alegre-Corupá plutonic-volcanic system in southern Brazil. Using quantitative textural analysis and thermodynamic modeling, we demonstrate that high-silica rhyolitic melts originated from the fractionation of a magma mush in the upper crust (~200 MPa). This process produced a residual granitic cupola in the plutonic record and a thick pyroclastic sequence associated with a caldera volcano in the volcanic realm. Syenites and subordinated melasyenites represent their complementary silicic and mafic cumulates, the former being formed at relatively lower initial crystal contents (~15-33 vol.%) after the extraction of high amounts of interstitial, high-silica rhyolitic melts (~47-80 vol.%). While previous studies suggest optimal crystal-liquid segregation at ~50–70 vol.% crystallinity under static conditions, our results indicate early fractionation in a dynamic, turbulent magma chamber. Low crystallinities and high magma accretion rates facilitated the formation of alkali feldspar aggregates through *synneusis*, later repacked during magma replenishment. These aggregates, the building blocks of the silicic cumulates, sank to the lower crystallization front at high settling rates owing to elutriation, enabling efficient crystal-melt segregation. This dynamic process explains the formation of large volumes of eruptible, crystal-poor magma and the rapid assembly of magma reservoirs in the upper crust. Enhanced volatile content in the extracted rhyolitic melts increased the likelihood of primary magma fragmentation, linking the syenitic-granitic pluton to the crystal-poor volcanic sequence and the development of a caldera volcano. Therefore, the herein proposed mechanism provides new insights into the evolution of magma reservoirs and its role in caldera-forming eruptions.

Keywords: Melt extraction, Crystal accumulation, Dynamic Mush Model, Crystal Size Distribution (CSD), Quantitative textural analysis, Caldera-forming eruptions

Financial Support: Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), processos 2015/03737-0; 2023/06771-0; 2022/03365-9, e ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), processo 163208/2021–2.