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Density Correction Model for Gamma-Gamma Geophysical Logging Applied to Phosphate Deposits.

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Introduction

The global agricultural market has faced significant disruptions in fertilizer distribution in recent years, primarily due to military conflicts involving key phosphorus suppliers—phosphorus being an essential component in fertilizer production. This scenario underscores the critical need for accurate mineral reserve estimates, which rely on representative sampling of deposit densities. In Brazil, formation density is traditionally measured using hydrostatic balance methods on drill cores; however, these are less effective for poorly consolidated rocks and offer limited sampling resolution. Gamma-gamma geophysical logging has emerged as a more efficient alternative, providing high-resolution and rapid density data. For safety, measurements are typically conducted in boreholes stabilized with steel casing, which can distort density logs due to the casing's contribution to the measured volume. This study assesses the magnitude of such distortions by directly comparing gamma-gamma logging data from cased and uncased boreholes.

Method and/or Theory

To identify the primary factors affecting gamma-gamma readings, logging data from cased and uncased boreholes were directly compared. Based on these comparisons, a correction workflow was proposed to adjust density measurements influenced by steel casing. Data were acquired from four boreholes drilled in the Tapira Mining Complex, Minas Gerais, Brazil. A linear correction model was developed and validated, producing synthetic density logs that align closely with uncased measurements and are supported by borehole diameter information from caliper logs.

Results and Conclusions

The corrected synthetic density logs exhibited RMSE and MAPE values below 5% relative to reference measurements, with further validation from caliper-derived borehole diameter data. These results demonstrate that, with appropriate corrections, gamma-gamma logging in cased boreholes is a reliable and accurate method for density estimation in phosphate deposits, particularly in friable mineralized zones such as those composed of Isalterite.