Unveiling the Potential of Gamma-ray Spectrometric Data Inversion for Geological Mapping and Selection of Potential Target Areas in the Carajás Mineral Province

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The Carajás Mineral Province, situated in the southeastern part of the Amazon Craton, stands out as one of Brazil's most significant mineral provinces. It hosts important deposits and occurrences of minerals such as iron, Cu-Au, Au-EGP, nickel, manganese. Airborne Geophysical data processing is pivotal for geological mapping and mineral exploration, aiding in the recognition of surface and subsurface structures and lithotypes across extensive areas, within relatively short timeframes, often imperceptible otherwise. The gamma-ray spectrometric method provides insights into the composition of different geological units through the mapping of the naturally occurring radioelements 40K, 238U, and 232Th. Before processing, airborne gamma-ray spectrometric data (AGRS) undergo various routine corrections, generally yielding established results in the literature. AGRS data inversion enhances the responses of radionuclides (K, eU, and eTh), mitigating footprint overlap and excessive smoothing in the data. Corrections applied to gamma-ray spectrometric data often overlook the effective sampling area (field of view) of a survey, especially the overlaps of detector field of views. This oversight is significant as a detector's sampling area varies depending on sensor diameter and flight height, resulting in radiation reception from various angles. Inversion tends to suppress these overlaps by considering the entire field of view, unlike sensitivity correction. In airborne gamma-ray spectrometry (AGRS), the inversion process holds significant importance in extracting subsurface geological information from measured radiation intensities. By enhancing both the acquired signal and the signal-to-noise ratio, it facilitates interpretation. This study compares the standard approach with inversion of AGRS data in two key areas of Carajás Mineral Province, employing advanced computational techniques to improve the accuracy and resolution of subsurface property estimation. Our research contributes to the advancement of AGRS inversion, offering valuable insights for enhanced subsurface characterization and resource exploration. The studied areas encompass three airborne geophysical projects (Western Carajás, Rio Maria and Tucuruí). These data were analyzed and processed through the standard processing and the inversion algorithm with positivity constraint. Basic maps (K, eU, and eTh), ternary maps, and secondary parameters such as F parameter, anomalous potassium (KD), and anomalous uranium (UD) were generated to identify hydrothermalized areas. The data obtained through standard processing exhibit considerable noise, particularly at project junctions and along flight lines. The inversion-based data suppressed noise, removed interpolation artifacts, and highlighted anomalies corresponding to potential target areas.