



Airborne gamma-ray spectrometric domains in Guaratubinha Basin, southern Brazil: a tool for geologic mapping

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Abstract

The association of gamma-ray spectrometry with fieldworks it proved effective as a geologic mapping on areas with difficult access, like occur on Guaratubinha Basin. The gamma spectrometric response of basic radionuclides K, eTh and eU, provides a delineation of five radiometric domains, which related can be to a three distinct geologic units of the basin: Miringuava, Vossorooca e Serra do Salto formations. The volcanic and volcanoclastic infill of the Basin, affords a different response of gamma spectrometric data, thereby facilitating the characterization of geologic units presents on the basin.

Introduction

The Guaratubinha Basin is one of the transitional basins of southern Brazil (Almeida, 1969). It is located about 30 km of Curitiba city, State of Paraná (Fig. 1). This basin was first described during the 60's, initially named as a Guaratubinha Formation (Fuck et al., 1967). This basin was formed on high-grade metamorphic rocks of the Luiz Alves Terrain at the end of Neoproterozoic, dated on 604 ± 8.6 Ma (Siga Jr. et al., 2000). It is infill consists by immature sedimentary rocks, acid to intermediate volcanic rocks and volcanoclastic rocks (Castro et al., 1993). The volcanic rocks of the basin has an excellent response for airborne gamma-ray spectrometric data. The ratios of the radionuclides (eU/eTh, eU/K and eTh/K) highlight different radiometric domains. The separation of these domains contributed directly to definition of geologic units. The correlation of field works and the gamma-ray spectrometry it is show to be effective in the following working. This approach makes possible direct correlations between the radiometric signature of the basin rocks and the corresponding geologic units. It was possible recognized three stratigraphic units: Miringuava Formation (conglomerates sandstones and argillites), Vossorooca Formation (andesites) and Serra do Salto Formation divided on three members (Osso da Anta Member, Serra dos Castelhanos and Escudador Member), constituted by rhyolites and volcanoclastic rocks (Fig. 4).

Methods

The airborne radiometric data were acquired by Geological Survey of Brazil in 2011 (CPRM, 2011), along

north-south flight lines spaced at 500 m, with a mean terrain clearance of 100 m. The tie lines had 10 km spacing. From these data were generated the basic (K, eTh, eU) and ternary maps (Fig. 2), a three variables combination like described by several authors (e.g. Anderson & Nash, 1997; Wilford et al., 1997; Minty, 1997; Gunn et al. 1997; IAEA, 2003). After the creation of these maps, we separated five gamma spectrometric domains based on relative concentrations of the radionuclides in each domain (Fig. 3). These maps were correlated with data collected in the field works, like a rocks lithotype and structural information, to generate a geologic map on scale of 1:50,000. Finally, we compared the geologic map with the radiometric domains, proving the use of this tool to geologic mapping (Fig. 4).

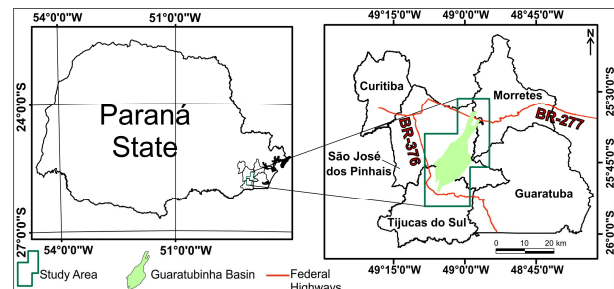


Figure 1 – Location of the study area.

Results

The five radiometric domains were obtained by the correlation between the K, eTh, eU and ternary maps (Figs. 3 and 4), which are described below:

A Domain: characterized by the rocks of Vossorooca Fm. covering large extension on north and southern region, marked by the predominance of K compared to others radionuclides (Figs. 2a and 3a). This response is related with the presence of amygdales filled by clay minerals.

B Domain: marked by high response of eU and average levels of eTh and K, different from the adjacent areas (Figs. 2 and 3).

C Domain: formed by rhyolitic rocks of Escudador Member, the domain has high concentration of K and eTh (Figs. 2 and 3), compatibles to mineralogical composition of these rocks. The average levels of eU are possibly associated with the sloping relief (Figs. 2 and 3).

D Domain: involved by southeast segment of domain A (Figs. 2 and 3) the D domain is marked by high concentration of K, eTh and eU. This response is the reflex of mineralogical composition of volcanoclastic rocks like lapilli-tuffs, tuffs and ignimbrites. This region has high

grade of weathering, in the form of clayey regolith, which retains radionuclides.

E Domain: it has the smallest area of the radiometric domains, formed mainly volcanoclastic rocks. Marked by average concentrations of K and eU, but high levels of eTh, this domain is possibly linked to clay minerals derived from surface modification of volcanoclastic rocks.

Discussion and Conclusions

The recognition of the gamma-ray spectrometric domains associated with the fieldwork it is an essential tool for geologic mapping, especially in areas with difficult access, dense vegetation and areas with steep slopes, as is the case of the Guaratubinha Basin. The radiometric domains (Fig. 3) shows the correlation of the radionuclides in each domain, based on the variation of concentration of the K, eTh and eU. Comparing the radiometric domains to geologic map (Figure 4), we visualize the correlation of the mapped units with domains, justifying the use of the method to geologic cartography.

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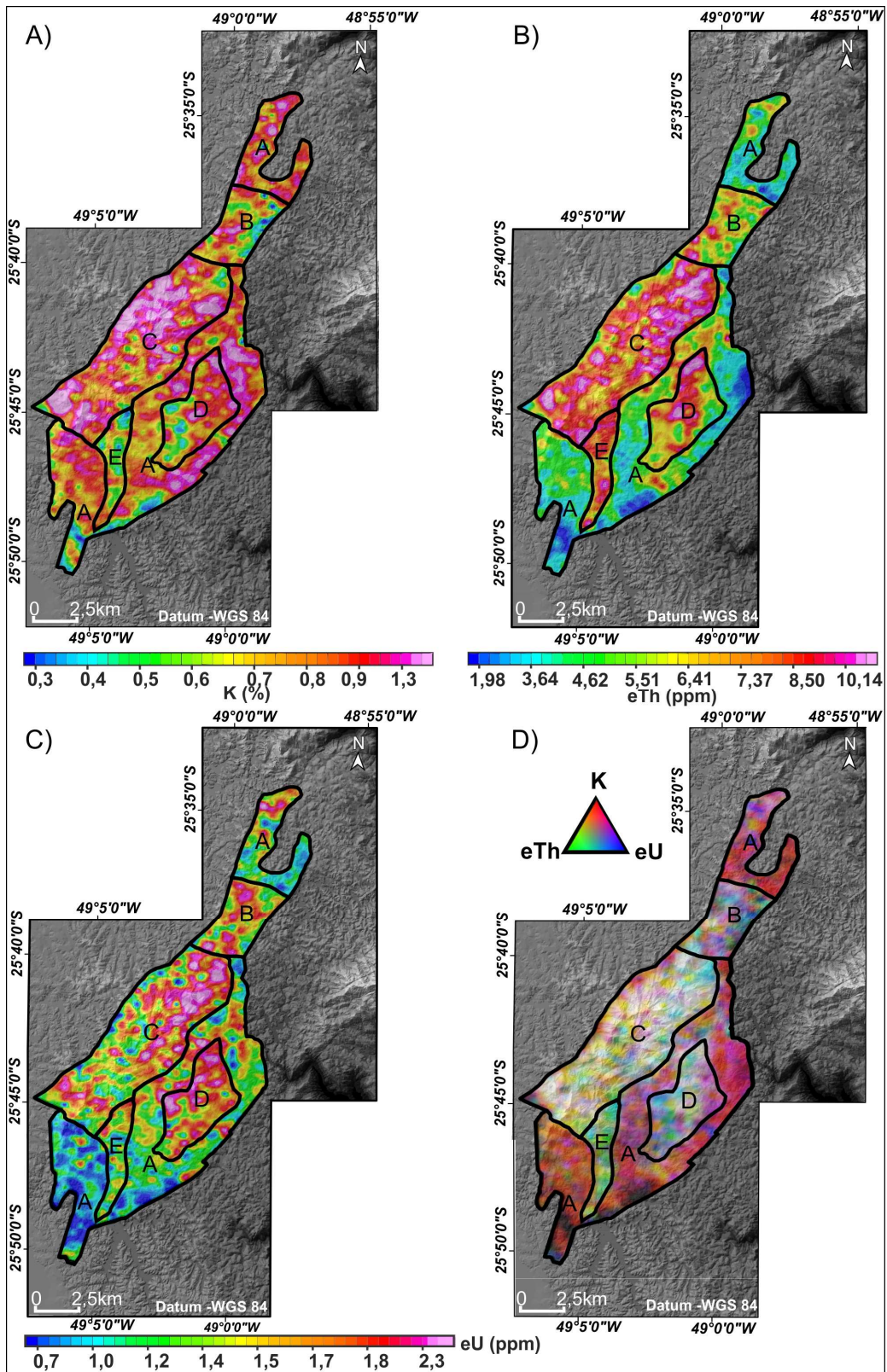


Figure 2 – Radiometric maps of the study area. A) K (%), B) eTh (ppm), C) eU (ppm), D) ternary.

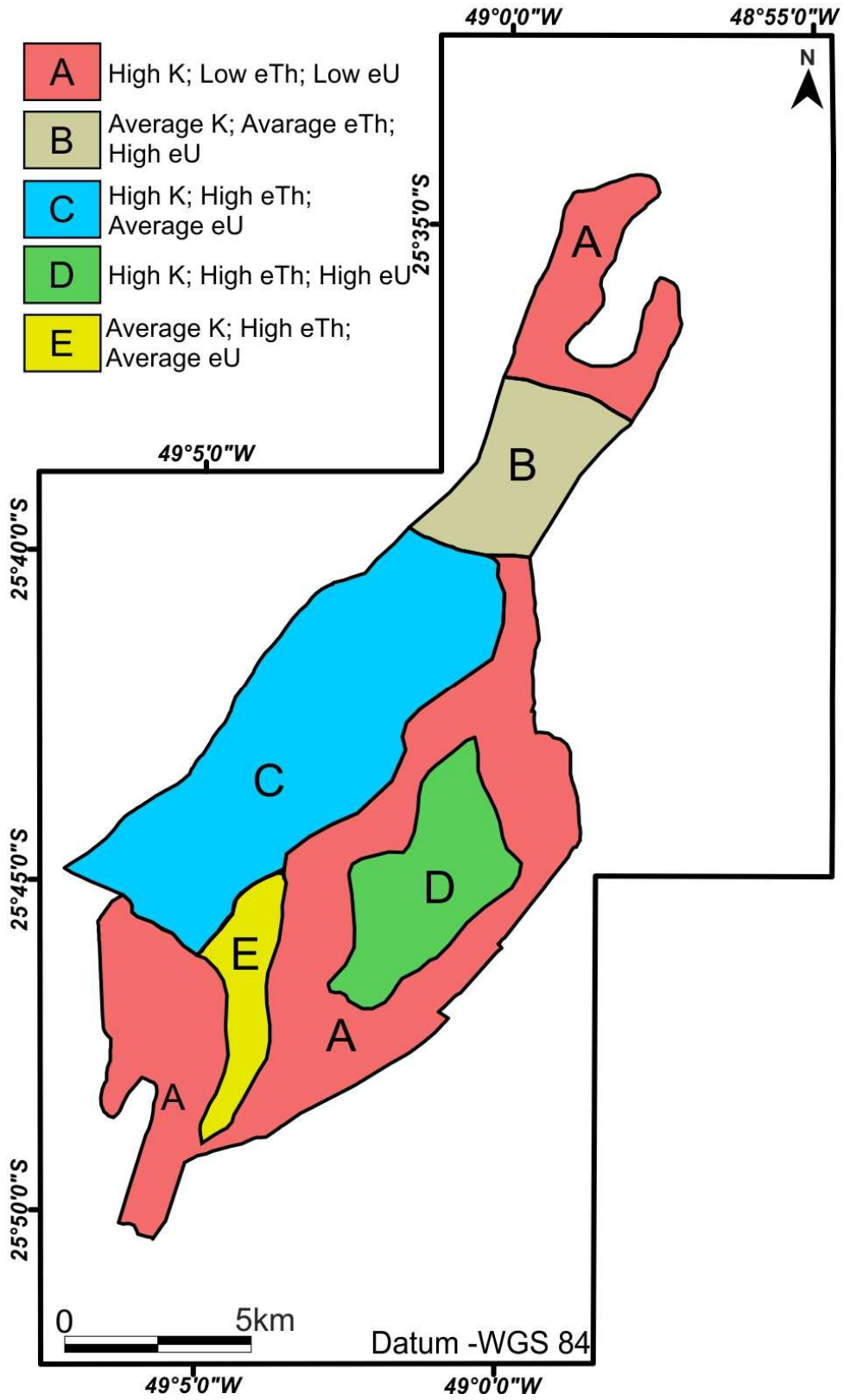


Figure 3 – Gamma-ray spectrometric domains of the study area.

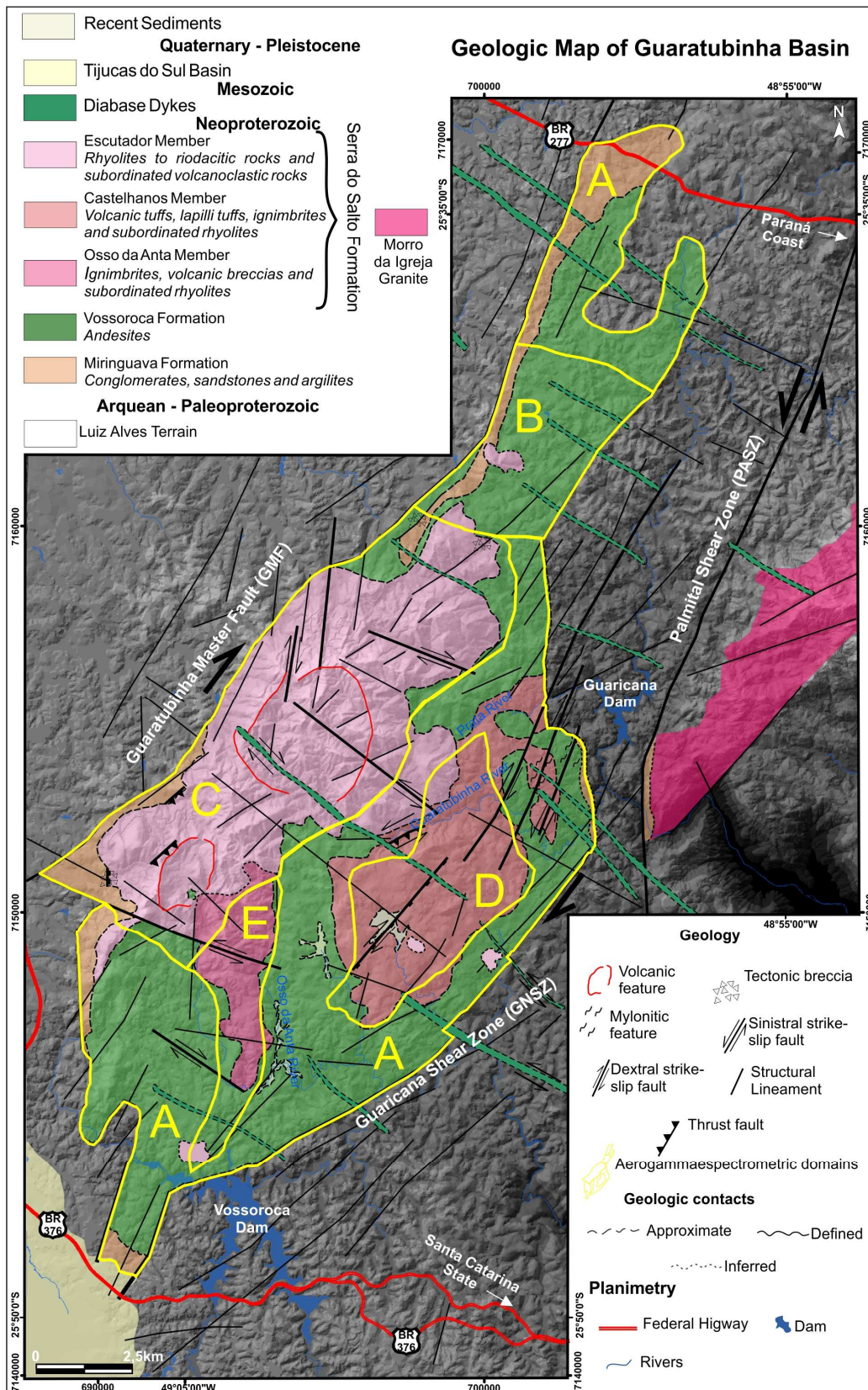


Figure 4 – Geologic map of Guaratubinha Basin correlated to the gamma-ray spectrometric domains.