APPLICATION OF LANDSAT DATA TO PROSPECT THERMAL FEATURES CAUSED BY PETROLEUM ACCUMULATIONS IN SUBSURFACE

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RESUMO: Temperature measurements are widely used in the petroleum industry. Modeling thermal conditions in a sedimentary basin through time is a critical step in assessing the maturity of petroleum source beds, the timing of petroleum generation, likely fluid migration paths, and reservoir locations. Conversely, few studies have been devoted to prospect petroleum, which normally use temperature measurements in wells, and near the surface. In part this lack of attention is related to the limited applicability in the exploration efforts of the methods of classical heat-flow determination because of the nature of the thermal data that the explorationist has to work with (bottom-hole temperatures -BHT's, and temperature profiles). In addition, they lack detail and present logistical difficulties in collecting concurrent field temperature data over extensive areas. In this context, satellite-borne remote sensing is a powerful tool, as temperature data over millions of pixels are collected in a few minutes and solar illumination and atmospheric-meteorological conditions can be considered to be uniform for all practical purposes over the scene. Many studies have utilized satellite imagery to identify thermal anomalies and to better constrain the underground temperature contribution associated with volcanic systems, geothermal fields and shear zones. However, comparatively few studies have focused on attentional temperature anomalies in satellite-based thermal infrared remote sensing over petroleum deposits. Likewise, the sign of the thermal anomaly, whether positive or negative, raises doubts. For more than 50 years, researchers have observed an association between hydrocarbon occurrences and positive temperature anomalies or higher local geothermal gradients relative to the regional gradient. Though the idea appears to possess much commercial significance, exploration field geoscientists have also reported the existence of negative thermal anomalies over gas and oil fields. This apparent dichotomy between positive and negative temperature anomalies over hydrocarbon accumulation remains to be understood. Moreover, a thermal-anomaly map, in general, contains spatially overlapping signatures from a potentially large number of causative bodies of widely varying size, shape, depth of burial, and heat intensity and direction. The map will also contain noise principally from annual and diary fluctuations caused by the solar radiation. To better reveal the geometry and thermal properties of the causative subsurface structures, and to reduce the noise, a number of image-enhancement filtering operations (e.g. Fast Fourier Transform; horizontal, vertical and tilt gradient) have been developed by geophysicists. Based on this background, this study aimed to determine whether negative or positive breaks mapped in Landsat 8 TIRS data derivatives correlate with the presence of petroleum fields. We also use these thermal data to explain local variations in the geothermal gradients in relation to lithological variations, basement configurations and structure geology. Our research has concentrated on two established petroleum system sites – Parnaiba Basin, Brazil and Upper Magdalena Valley, Colombia. In both cases, negative breaks mainly mapped in vertical derivatives are associated geographically with petroleum fields. These results are interpreted that the presence of hydrocarbon in a reservoir would change the thermal conductivity, thus causing spatial variations in heat transfer, resulting in relatively subtle temperature relative breaks over oil fields.

PALAVRAS-CHAVE: THERMAL FEATURES, LANDSAT, PETROLEUM EXPLORATION.