HYDROCARBON SEEPAGE DETECTION THROUGH GEOBOTANIC AND MULTISPECTRAL AND MULTI-TEMPORAL REMOTE SENSING

Carlos Roberto de Souza Filho, Vagney Augusto, Talita Lammoglia, Wilson Oliveira

Geosciences Institute, University of Campinas, PO Box 6152, 13083-970, Campinas-SP, Brazil

Escapes of gaseous hydrocarbons (HCs) at surface (i.e., seepages) are processes recorded in several parts of the world. The reservoirs of oil are not completely sealed, allow fluid escapes, mainly gases, which migrate and form seeps at surface. This process occurs mainly as a result of highly distinguishing pressures in the reservoirs. The migration occurs by different means, through faults, fractures, bedding plans and through rocks with high porosity. The gases, when close or at surface, interact with soils producing a set of chemical alterations. These alterations provoke the dissolution and precipitation of minerals, mobilization and immobilization of chemical elements, consequently generating indirect physiological alterations in the superjacent vegetation. The main resultant factors of these processes and that influence the development of the vegetation are: oxygen availability; CO2 concentration; availability of heavy metals and the reduction of the ground porosity. The effect observed in the plants in soils rich in HCs are: weak growth; change in the structures of leaves, followed by a variation in their coloration; leaf falls; lesser density of plants, which are generally atrophied; and in extreme cases, the death of the vegetation may occur.

This work focus on the spectral characterization of a set of vegetation comprised in the Sao Francisco Basin, particularly in an area known as Remanso do Fogo (Minas Gerais State), where seepages have already been detected visually and by geochemistry. The main objective was to evaluate the likely correlation between areas rich in hydrocarbons and geobotanical anomalies.

Geologically, the area comprises Fanerozoic sediments of the Sao Francisco Basin, including siltstones, black-shale, limestones, dolomites, arkoses, which in turn are covered by areno-argillaceous colluviums and arenaceous fluvial sediments.

The investigation was based on multitemporal (dry and wet seasons) and multispectral ASTER images and gasometrical data. The processing included: (i) statistical evaluation of gasometrical data, (ii) spectral characterization of vegetation in tracts inside and outside hydrocarbon geochemical anomalies, and (iii) ASTER imagery spectral classification using n-dimensional spectral angle and multi-criteria partial spectral unmixing methods, which were applied with the ultimate purpose of remote detection of areas with hydrocarbon seepages, mainly guided by vegetation spectra.

Spectral analysis of image pixels in areas with known HC anomalies make it possible to distinguish areas affected or not by HCs seeps. Vegetation spectra collected within HC anomalies indicate key signatures in ASTER bands 2 (0.63-0.69 μm), 3 (0.76-0.86 μm), 4 (1.60-1.70 μm) and 6 (2.18 - 2.22 μm), strengthening the spatial association of geochemical and geobotanical anomalies. Furthermore, areas mapped remotely as spectrally anomalous showed evidences of seeps in numerous sites verified in the field, proving the efficiency of the detecting model.

The research strategy here introduced in a unique case study reveals its vast potential for detection and characterization of seepages, which are important vectors for of oil and gas resources.