

PS Bitumen Deposits in Middle Magdalena Valley, Colombia, South America*

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Abstract

The Middle Magdalena Valley is an intermountain basin in Colombia, South America. The Valley, was a region of highest oil production country until 1990, and remained at the top of the production thanks to the discoveries that occurred early in the last century, within which one is the most important areas of the country called La Cira-Infantas field. In the foothills surrounding the basin, gilsonite bitumen dikes are known to occur for long time but only during the last decade, there has been some commercial production of gilsonite. The bitumen occurs as veins in Mesozoic and Cenozoic rocks. The veins are related to extensional fractures originated by the left lateral movement of the Santa Marta Fault, a large structural feature of NE Colombian Andes. It is important to note that bitumen has highly variable characteristics, with softening temperatures between 30°C to 450°C. The geometry of the gilsonite dikes are predominantly lenticular, dikes up to 30 meters wide by 500 meters long and at least 150 meters deep have been determined by shallow core drilling. The distribution and shape of these dikes as well as its origins are been investigate by integrating several geophysical methods (gravimetry, magnetometry, seismic, and ground penetrating radar (GPR)), field geology with geochronology and geochemical analysis (Apatite fission track analysis, vitrinite reflectance of the encasing rocks and chromatography of the bitumen) to determine the chemical process and timing of the gilsonite formation.

BITUMEN DEPOSITS IN MIDDLE MAGDALENA VALLEY, COLOMBIA, SOUTH AMERICA.

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ABSTRACT

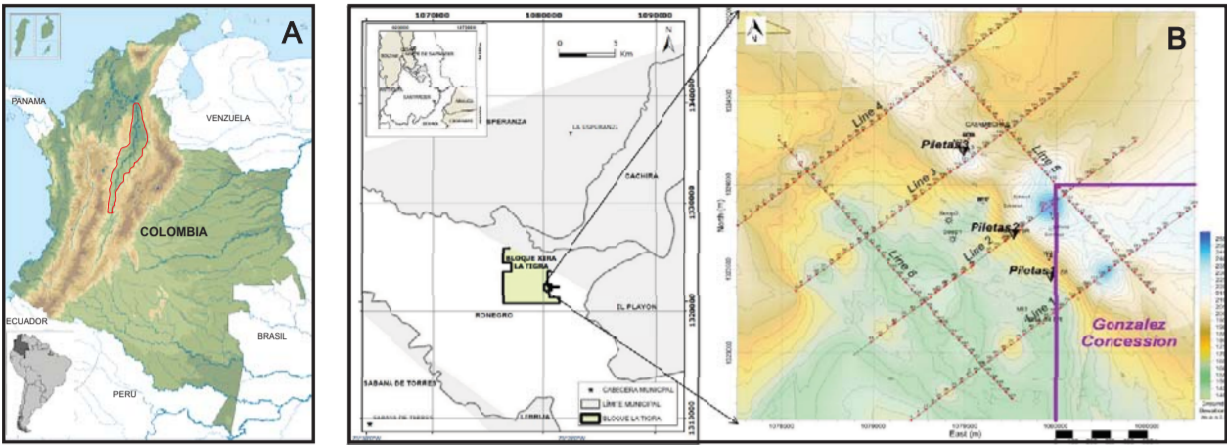


Fig 1. Location map

The Middle Magdalena Valley is an intermountain basin in Colombia, South America. The MMV was the basin with of highest oil production in country until 1990, the main oil field, La Cira-Infantas, with an estimate original oil in place ca. 3.5 x 10⁹ barrels was discovered early in the last century and is still producing about 60 thousand barrels of Oil a day. In the foothills surrounding the basin, bitumen dikes and oil seeps are very common but only during the last decade there has been some commercial production of bitumen. The bitumen occurs as veins in Mesozoic and Cenozoic rocks. The veins are related to extensional fractures related to the Santa Marta Fault, a large, active wrench fault in NE Colombian Andes. The bitumen has highly variable thermal characteristics, with softening Temperatures (ASTM norm D36/D36M-09) between 30 Celsius degrees to above 290 degrees Celsius (maximum temperature for this test). The geometry of the bitumen dikes is predominantly lenticular, dikes up to 30 meters wide by 500 meters long and at least 150 meters deep have been determined by shallow core drilling. The distribution and shape of these dikes as well as its origins are being investigated by integrating several geophysical methods (gravimetry, magnetometry, seismic, and ground penetrating radar (GPR)), and field geology, sampling and thermal and chemical analysis, including measurements of vitrinite reflectance of the encasing rocks and chromatography of the bitumen to determine the origin and timing of the bitumen veins.

Keywords:

GEOLOGY

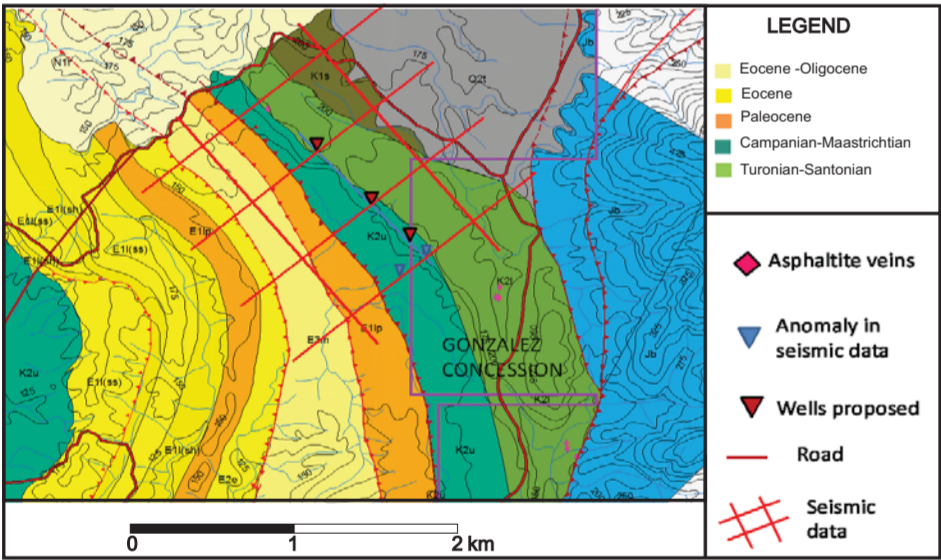


Fig 2. Geological mapping in study area

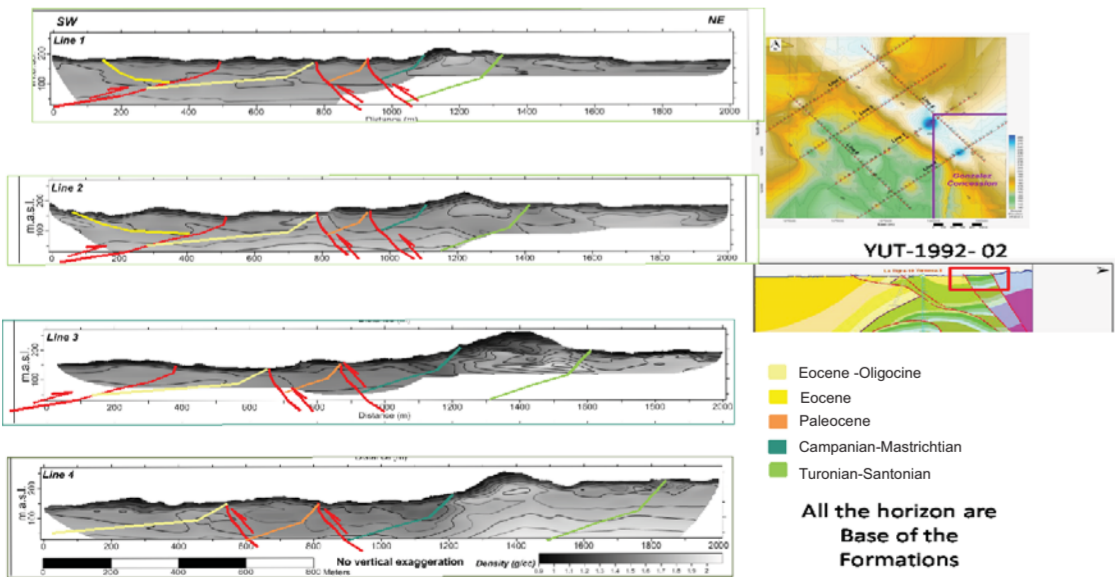
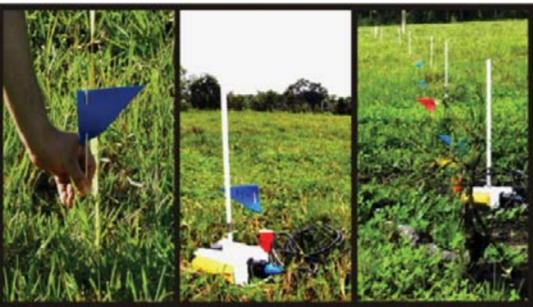


Fig 3 Structural profiles based in geological mapping. At the horizons are base of the units. Seismic line YUT-1992-2 shows same structures in the area.

SEISMIC ACQUISITION



SEISMIC PROCESSING

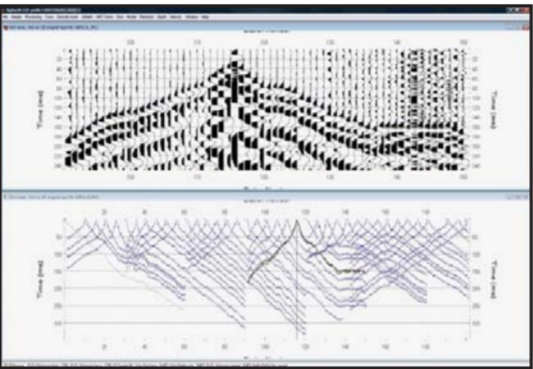


Fig 3. First arrives picking of the acquired seismic logs for line 4

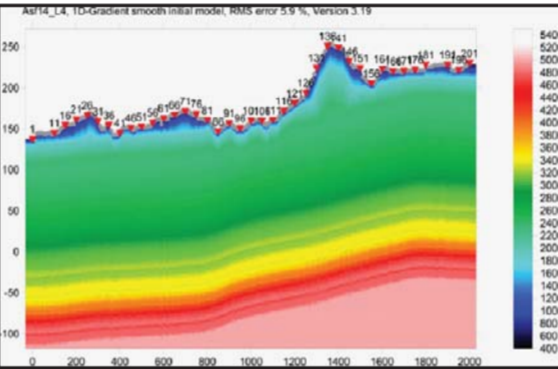


Fig 4. "P wave" velocities initial model (m/s)

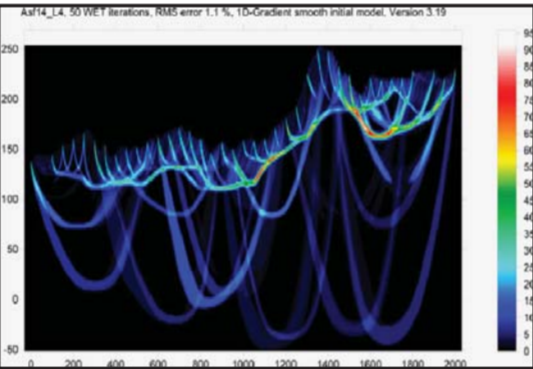


Fig 5. Ray tracing of refracted waves

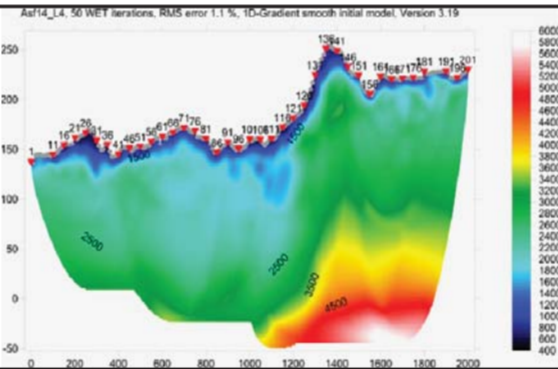


Fig 6. Profile of P wave velocities (m/s) obtained after 20 iterations.

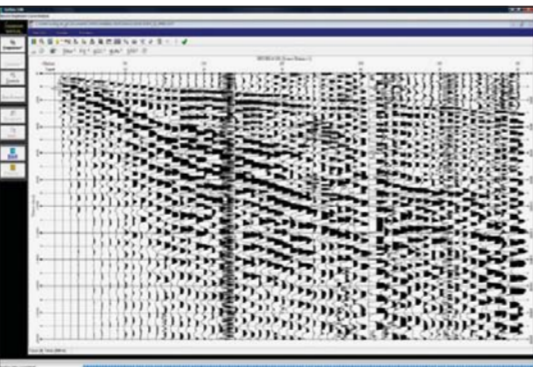


Fig 7. Seismic logs of Line 4 shot

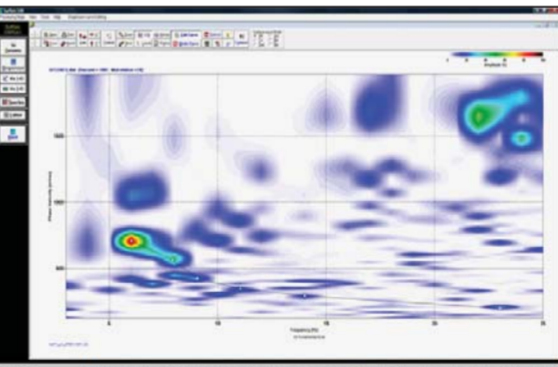


Fig 8. Profile of P wave velocities (m/s) obtained after 20 iterations.

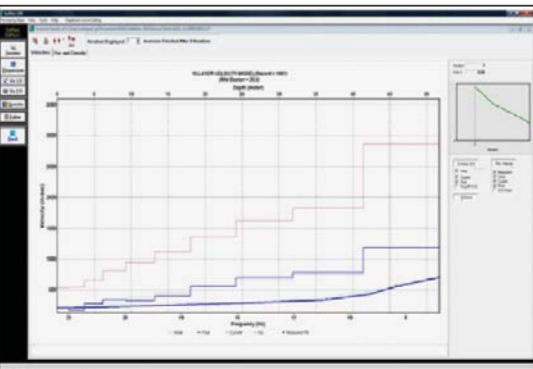


Fig 9. Dispersion curve for a shot obtained by spectral analysis of surface wave recorded

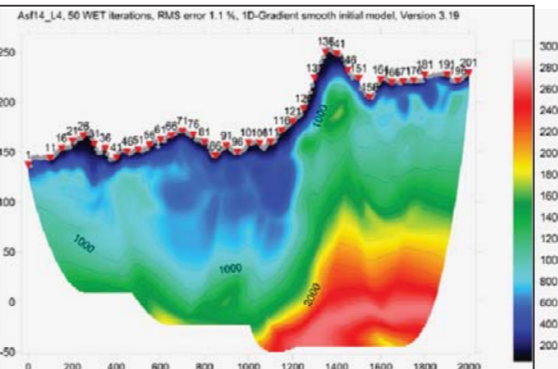


Fig 10. Profile of P wave velocities (m/s) obtained after 20 iterations.

RESULTS

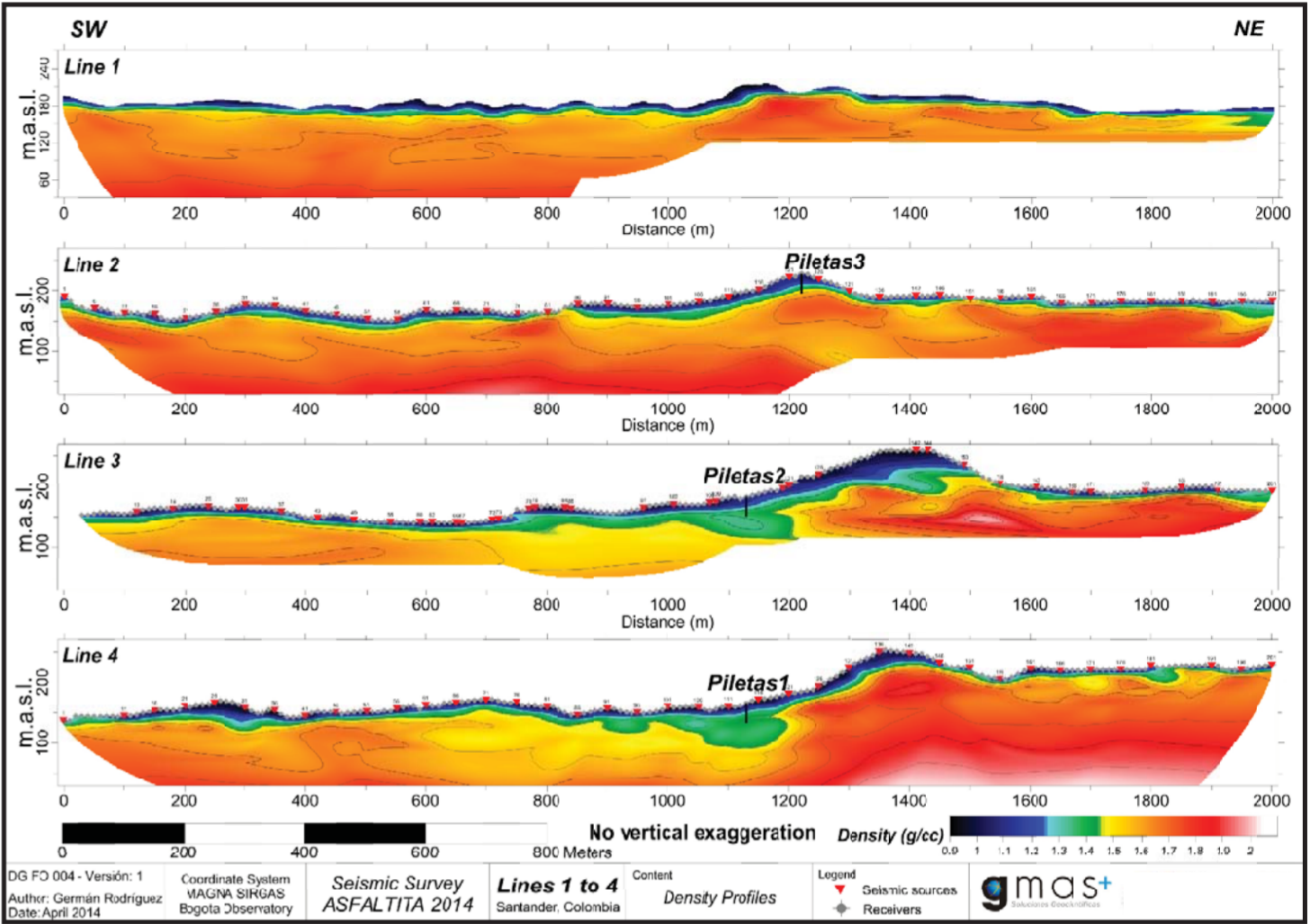


Fig 11. Bulk density profiles, where the layers of weathering and sub-weathering are identified, and possible bitumen veins.

Six 2 km seismic lines were acquired in the area of interest (12 km total), which were processed using seismic refraction tomography (Figure 3) and Surface Analysis of Surface Waves MASW (Figure 9) to obtain P and S velocity profiles for each line. The MASW also provides a density profile for each model, where some low-density anomalies were clearly identified in two of the six lines (Figure 11).

In the six seismic lines were observed a relatively uniform weathering layer of about 10 meters thick with lower density to 1.25 g / cm³, a sub-layer weathering of 8-10 meters thick with densities between 1.25 g / cm³ and 1.45 g / cm³ and a competent rock whose densities are greater than 1.45 g / cm³. In the seismic lines 3 and 4 (Figure 11), three low density anomalies correlated quite well between the two lines. Low density anomalies were associated with the presence of bitumen veins, some more than 500 meters long and 100 meters thick as seismic profiles. Three wells was proposed to test the hypothesis that the low density anomalies corresponded to areas where bitumen veins exist.

Records acquired for the three lines were also processed by common midpoint reflection (CDP stacking). The aim of this processing is to identify the stacked sections reflectors that allow viewing the vein (or veins) of asphaltite found in the study area and also viewing the encasing rocks to define its geometry. However, after performing such processing, is difficult to identify reflectors that really help describe the geometry of the asphaltite vein and rocks that encased them.

Based on the results of seismic refraction the thickness of the regolith and the regolith and the phreatic level can be seen, important areas to define before an estimate of the resources. For future projects it is recommended to implement a tended design spacing between sources and receivers smaller than the one implemented on this project. This to achieve a better resolution on the velocity Figure 4. Settings from the first arrivals from all seismic records on line 1. models obtained through tomography refraction.

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