Combined Geochemical Methods for the Surface Exploration of the Neuquén Basin, Argentina*

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Abstract

The following discusses exploratory research of surface geochemistry in an area located 30 km west of Senillosa town, Neuquén Province, Argentine (Figure 1). The petroleum system is composed by Jurassic source rocks and Jurassic-Cretaceous clastic and carbonatic reservoirs.

The exploration survey comprised a number of transects with equidistant sampling stations where soil samples were taken for microbial (buthanotrophic bacteria) and trace elements analysis. In addition, vegetation indexes (Shannon Diversity (H) and Species Richness (S)) were obtained at each sample station (Figure 2). Several transects and maps were obtained to identify potential biomarkers of micro-leakages.

The results obtained from bacterial analysis show high background values (those less than 2,500 cfu/g), while those corresponding to the blocks (structures north middle and south) were in the range of 2,500 to 17,500 cfu/g (Figure 3). The fault-associated anomalies cover up to 180,000 cfu/g (Figure 4). Abnormally high background values could be due to the activity of deep petroleum systems that emit signals from both source rocks (Vaca Muerta and Molles Formations) and associated reservoirs (Larriestra *et al*., 2010a, b).

Soil trace elements like vanadium, nickel, chromium and copper were found related to elevated blocks and faults and they were associated with the oil generated in the Vaca Muerta Formation source rock, whose main feature is the presence of vanadium, nickel

and chromium and accessories such as copper, arsenic and zinc (Figure 5). In addition, mass spectrometry analysis performed on oil samples from a well in the area also detected high values of vanadium.

These results together with vegetation analysis (Figure 6), soil gas and a possible biomarker plant species *Acantholippia seriphioides*, were compared with digital processing of satellite images such as NDVI and Tassled Cap. *Acantholippia seriphioides* would represent a negative anomaly because the greatest number of individuals is related generally to a lower concentration of bacteria. This relationship is shown in the bacteria concentration histograms (Figure 7), where sample stations with less than three individuals have an average of 10,825 cfu/g bacteria concentration, while stations with more than three individuals have an average of 6,564 cfu/g.

The geostatistical integration of geothermal gradients measured in wells with satellite thermal images allowed the construction of a thermal gradient map. Those structures with higher thermal emission match with the anomalies mentioned above (Figure 8).

Finally, this research confirmed the existence of active petroleum systems, some of them investigated before while others remain unexplored. Areas of current and past microseeps were identified, setting new targets to explore.

References

Larriestra, F., F. Ferrer, C. Larriestra, and D. Lanussol, 2010a, Geochemical anomalies characterization by microbial and trace elements analysis related to hydrocarbon migration, Neuquén Basin, Argentina: AAPG International Conference and Exhibition, 12-15 September 2010, Calgary, Canada. AAPG Search and Discovery Article #40667 (2010), Web accessed 17 September 2012. http://www.searchanddiscovery.com/documents/2010/40667larriestra/ndx_larriestra.pdf

Larriestra, F., M. Vecchio, F. Ferrer, and C. Larriestra, 2010b, A modified method of microbial analysis for oil exploration and its application on five basins of southern and western Argentina: AAPG International Conference and Exhibition, 12-15 September 2010, Calgary, Canada. AAPG Search and Discovery Article #40672 (2010), Web accessed 17 September 2012. http://www.searchanddiscovery.com/documents/2010/40672larriestra/ndx_larriestra.pdf

Figure 1. Location of study area.

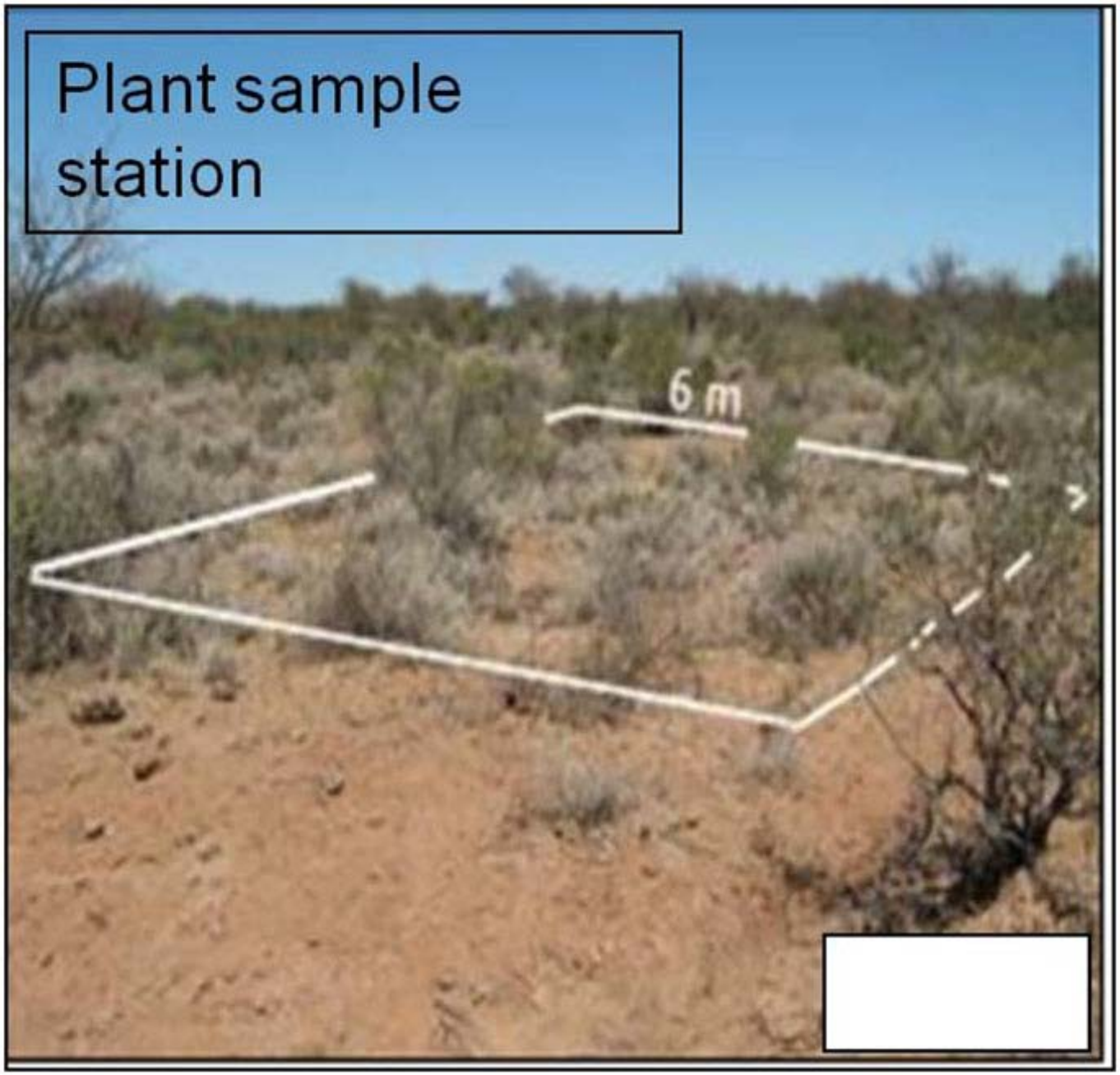

Figure 2. Example of plant sample station.

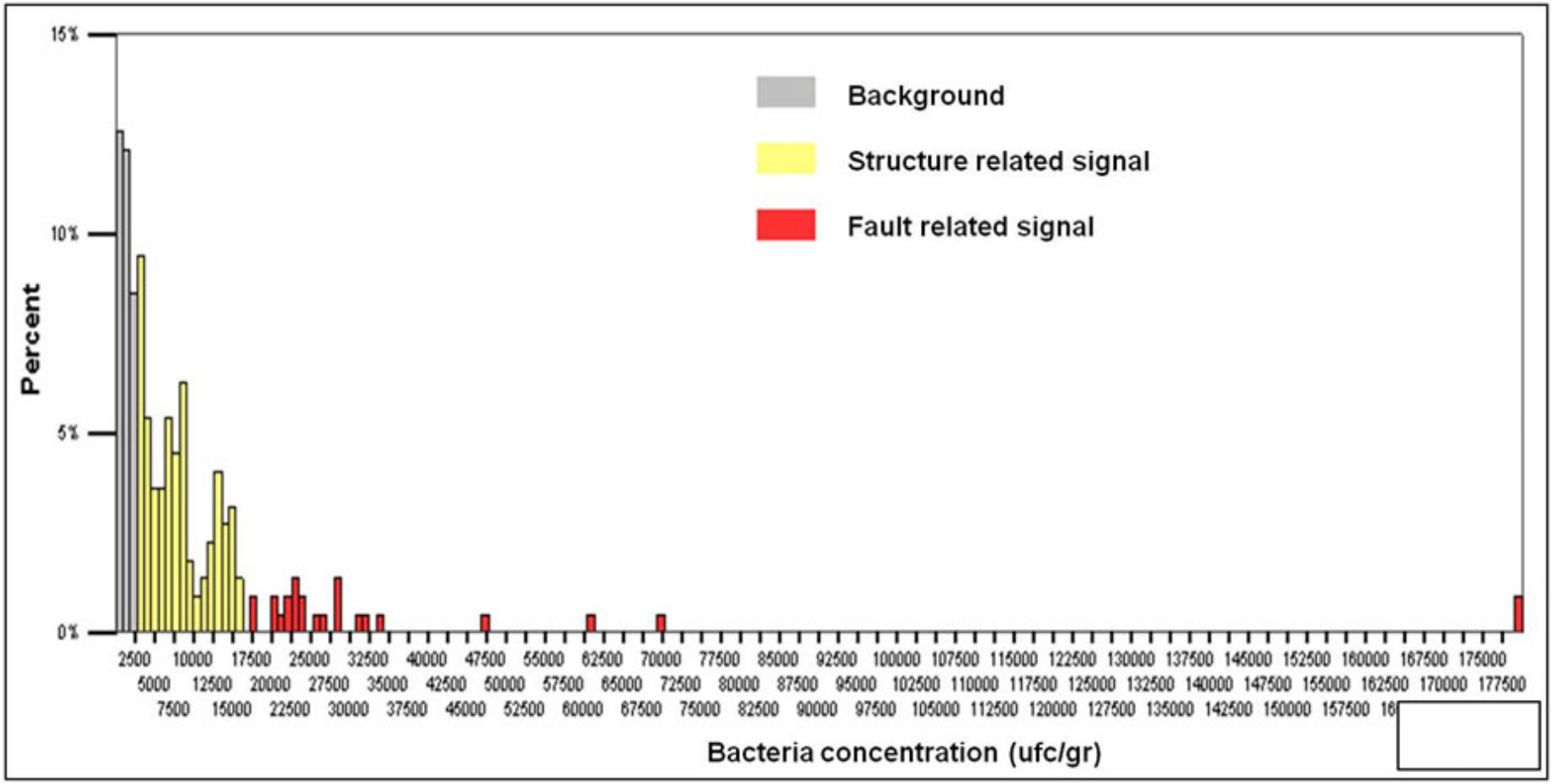

Figure 3. Bacterial analysis results.

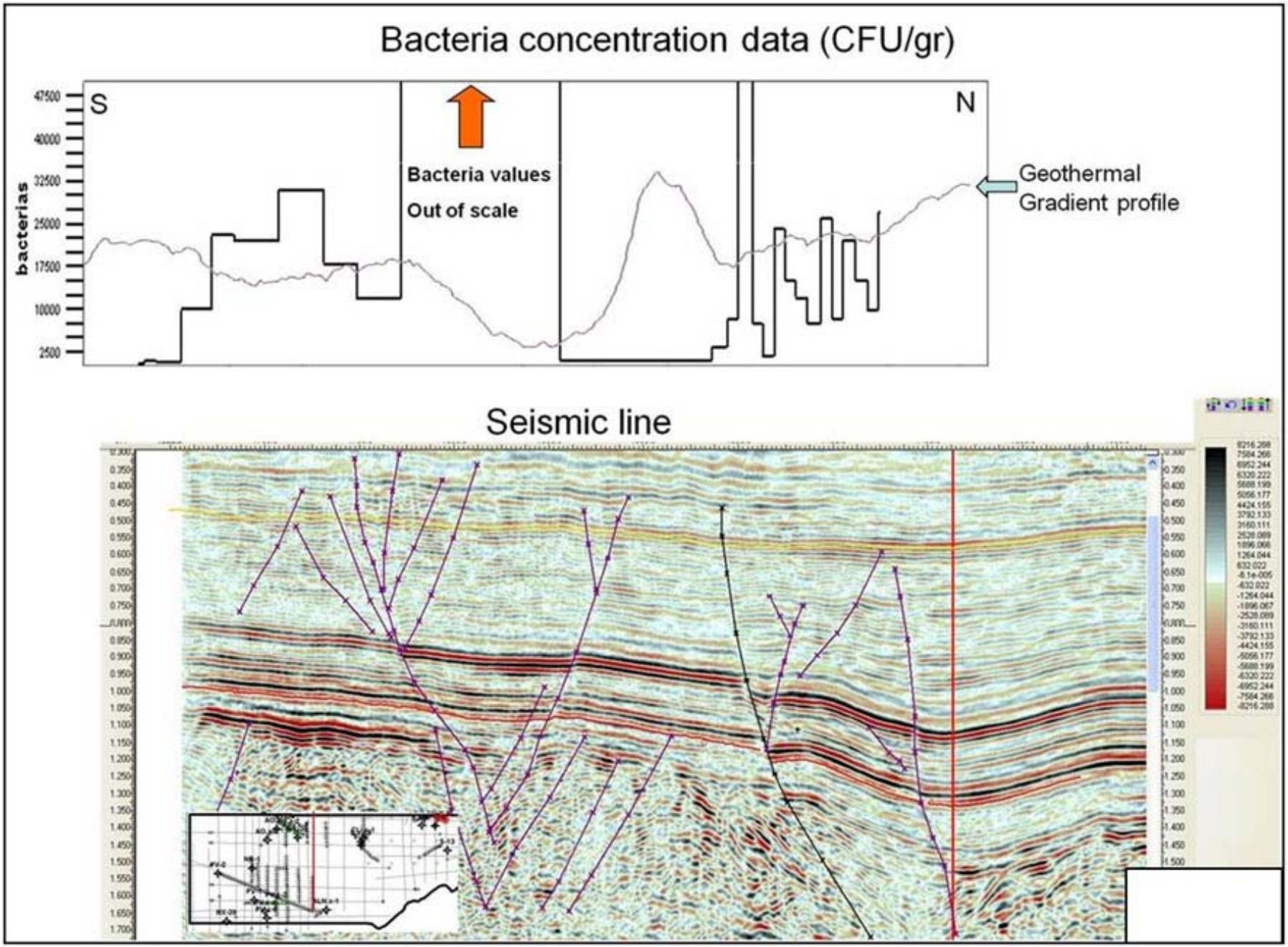

Figure 4. Bacterial concentration data.

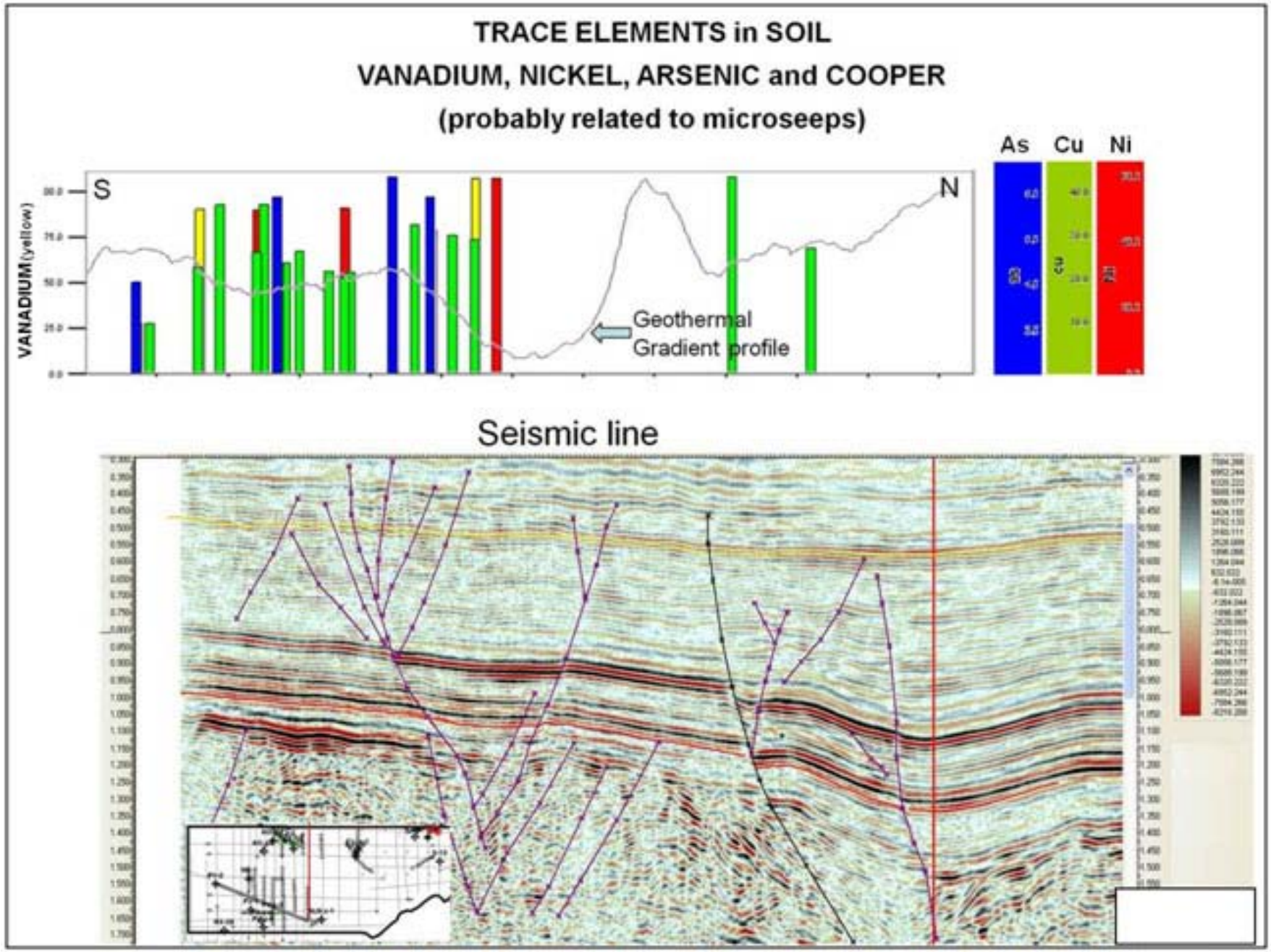

Figure 5. Trace elements in soil.

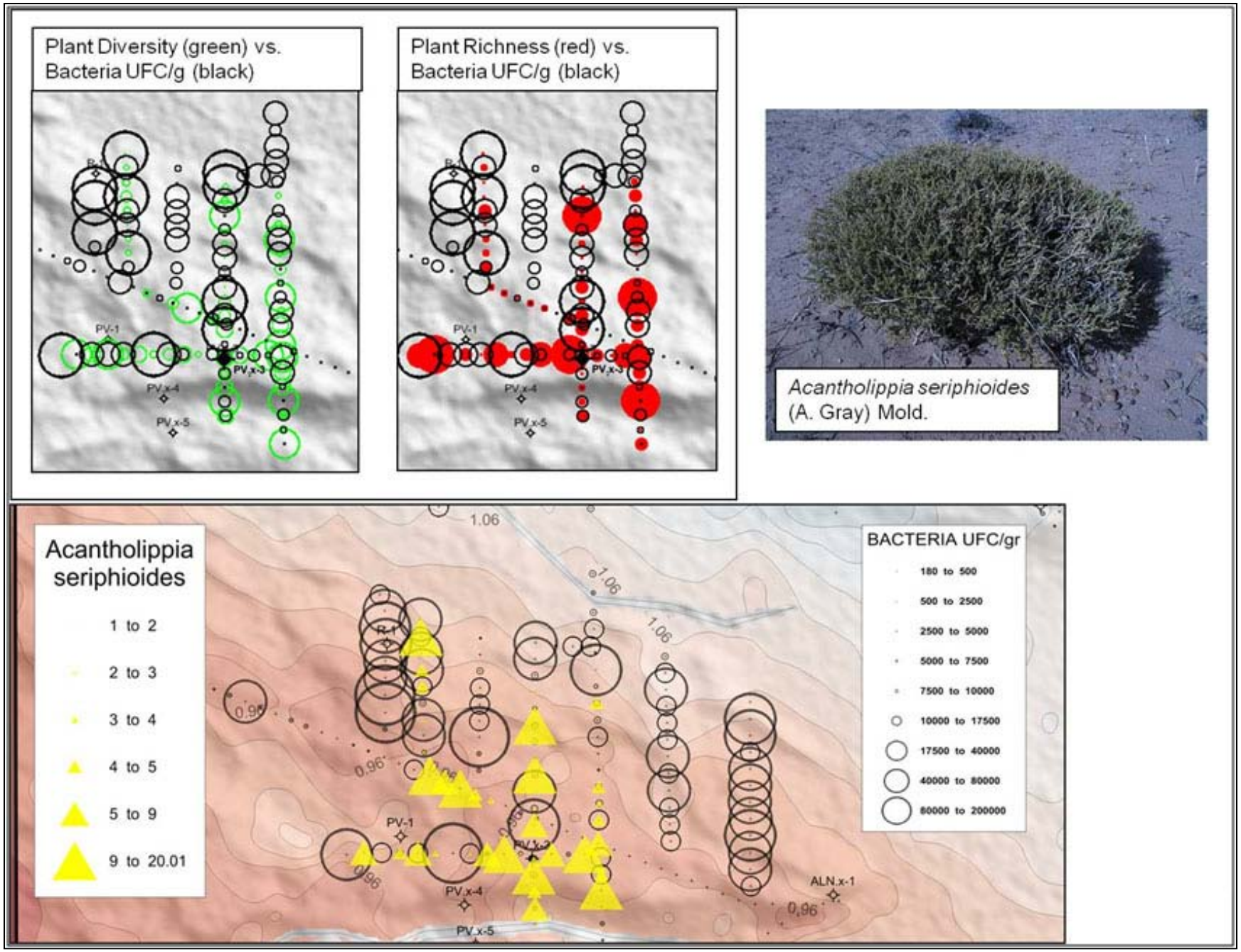

Figure 6. Vegetation analysis results.

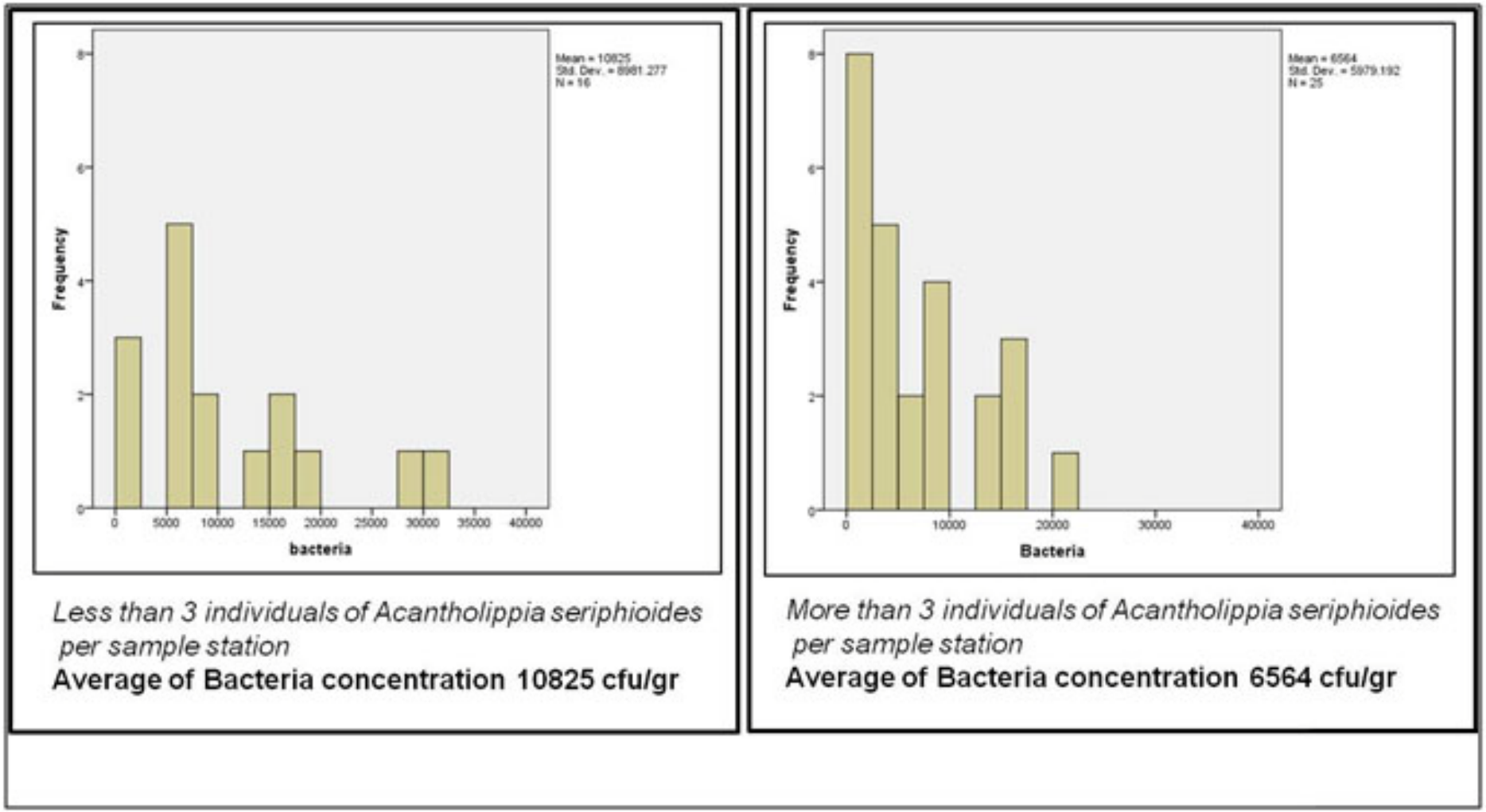

Figure 7. Average bacteria concentration results.

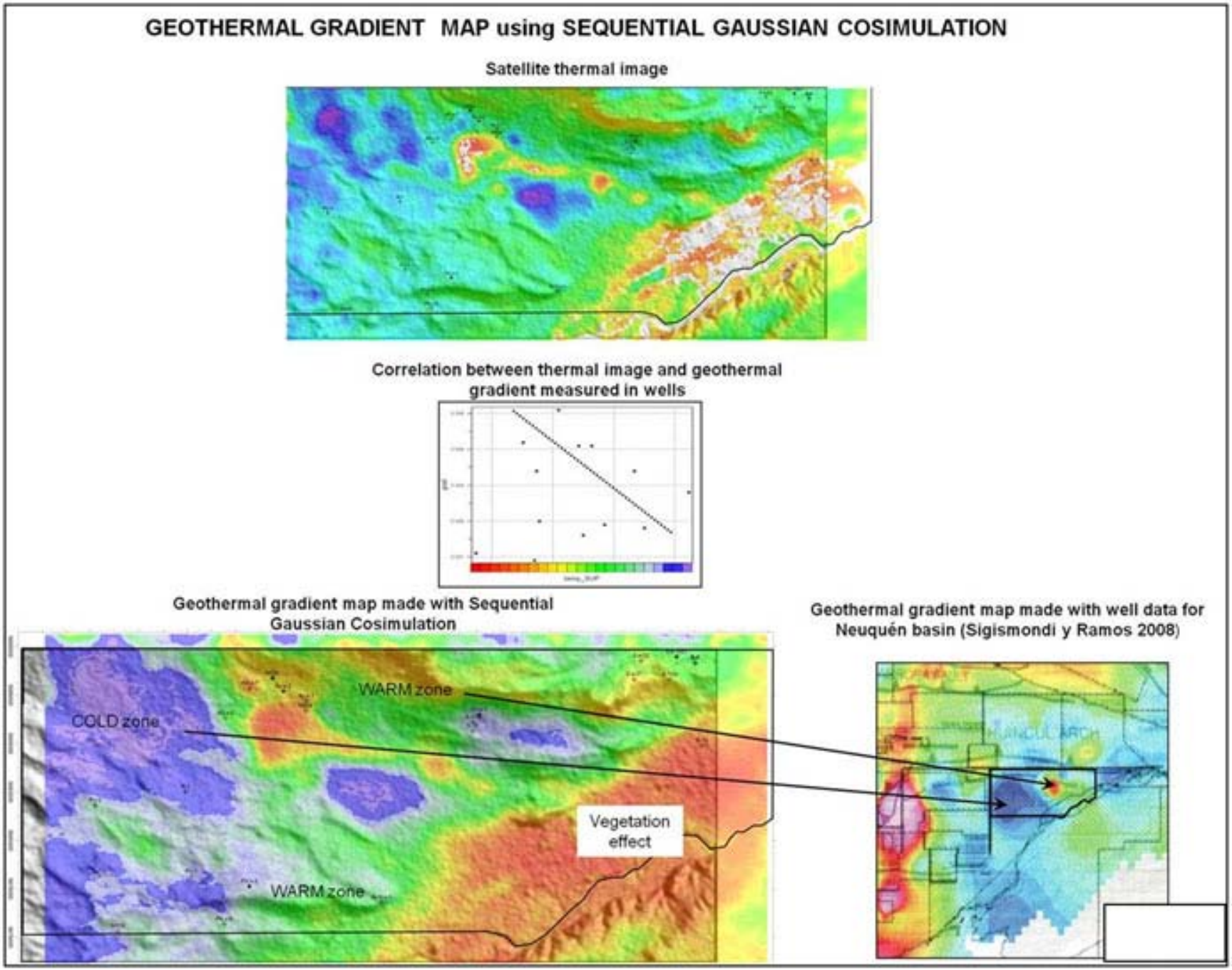

Figure 8. Geothermal gradient map.