

**REPORT ON SEISMIC REFLECTION MEASUREMENTS CARRIED OUT IN 2015 WITHIN
THE FRAMEWORK OF THE PROJECT: INTEGRATED GEOSCIENCE OF THE MERIDA
ANDES (GIAME) (FONACIT G-2012002202)**

Venezuelan Foundation for Seismological Research

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Abstract		
<p>Within the framework of the GIAME project (Integrated Geosciences of the Merida Andes), seismic reflection measurements were carried out in 2015 with vibrators as a source. These measurements were carried out jointly by FUNVISIS, PDVSA (which placed the vibrators), IRIS-PASSCAL (which provided the Texan recording equipment), as well as the universities ULA, UCV and USB.</p>		
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INTRODUCTION

Within the framework of the GIAME project (Integrated Geosciences of the Merida Andes) (Schmitz et al., 2014), seismic measurements were carried out at different scales (Figure 1).

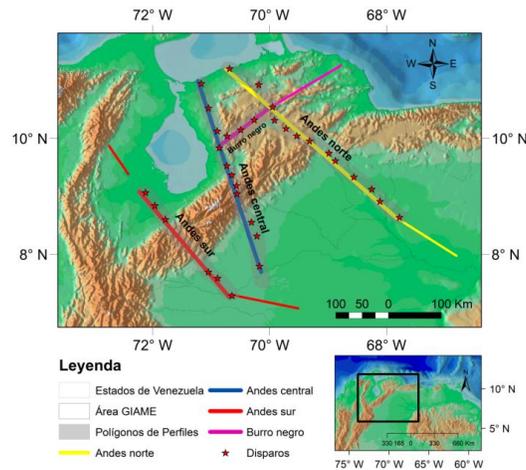


Figure 1. Location map of the seismic profiles of the GIAME project.

Between the months of February and March 2014, the wide-angle seismic data acquisition campaign for the GIAME project was carried out. This lasted 21 days, where three (3) main high-angle seismic profiles were acquired, located in the west of the country and crossing the most representative segments of the Andean chain, three (3) connection profiles parallel to the axis of the Andes chain of Mérida in the southern segment of it, in addition to a profile perpendicular to the Burro Negro structures which was carried out to clarify their importance at the crustal level, which covered lengths of approximately 320 to 400 km (Schmitz et al. al., 2015).

In the second year of the GIAME project, seismic reflection measurements were carried out with vibrators as a source (Schmitz et al., 2016), which are the subject of this report. These measurements were carried out with PDVSA personnel for the sources (vibrators) and registration, FUNVISIS (logistics and measurements), IRIS-PASSSCAL (registration and configuration equipment), as well as students from the ULA, UCV and USB universities (measurements).

SEISMIC ACQUISITION

Environmental Permitting (August – October 2015)

After having executed the justification and extension report that would allow the related activities to be carried out within the framework of the GIAME project, the official letter linked to the consignment of the Faithful Compliance Bond was received for the issuance of the Authorization of Natural Resources of the Project through the Approval of the Ministry of People Power for Ecosocialism and Water (Figure 2), based on the Environmental and Socio-Cultural Impact Study (Annex 6.1.4.1.01 in Schmitz et al., 2015) with the details of the activities to be carried out, which were developed during the recognition and permitting process together with the owners of the sites, regional representatives of the Ministry of People Power of the Environment, the drilling companies, CAVIM technicians (responsible for carrying out the blasting) and the FUNVISIS researchers.



Figure 2. Response to DGVA letter No. 214 dated 10/27/2015.

Data acquisition

To carry out the seismic measurements, 22 days were considered with 12 working groups (Figure 3). Start of the data acquisition campaign on 11/05/15, in the first phase of work until 11/16/15, recording the PV of the Southern Andes profile, from km 15 of the city of El Vigía to the reservoir The Vueltoza. In the second phase of the acquisition group, from 11/16/15 to 11/22/15, the seismic data of the Southern Andes profile were acquired from the other end of the reservoir to the town of Santa Bárbara de Barinas.

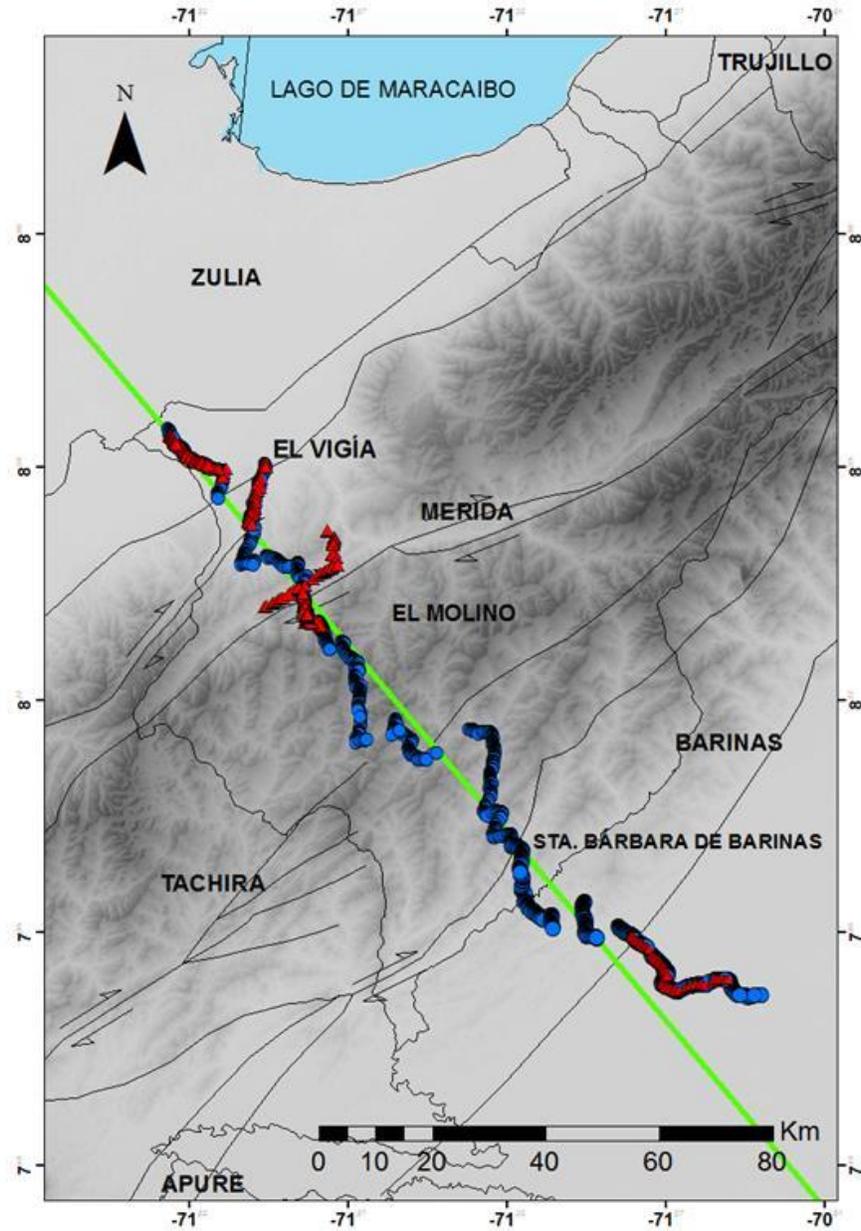


Figure 4. Location of Vibration Points (Red) and Receiving Equipment (Blue) from the GIAME project acquisition campaign.

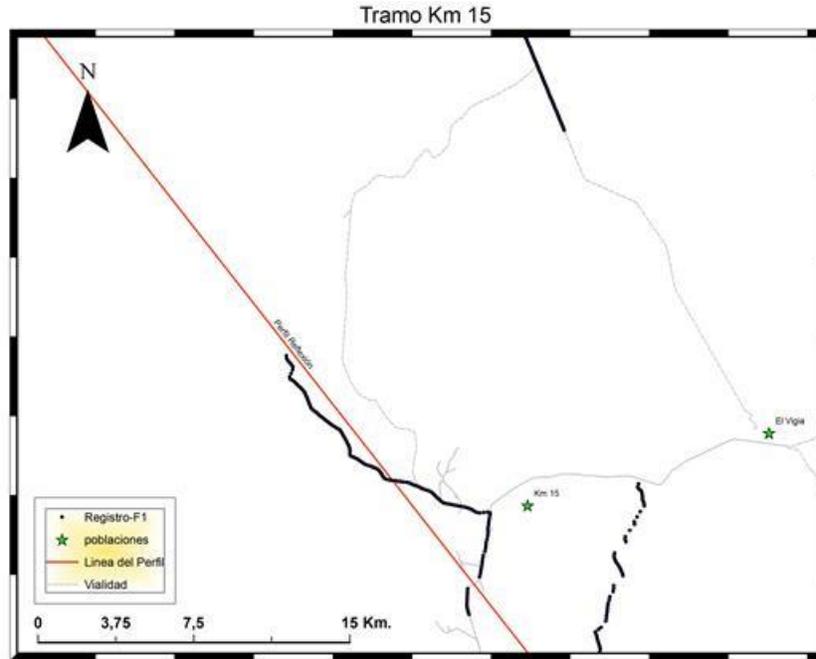


Figure 5. Registration route of the first Phase. Section Km 15.

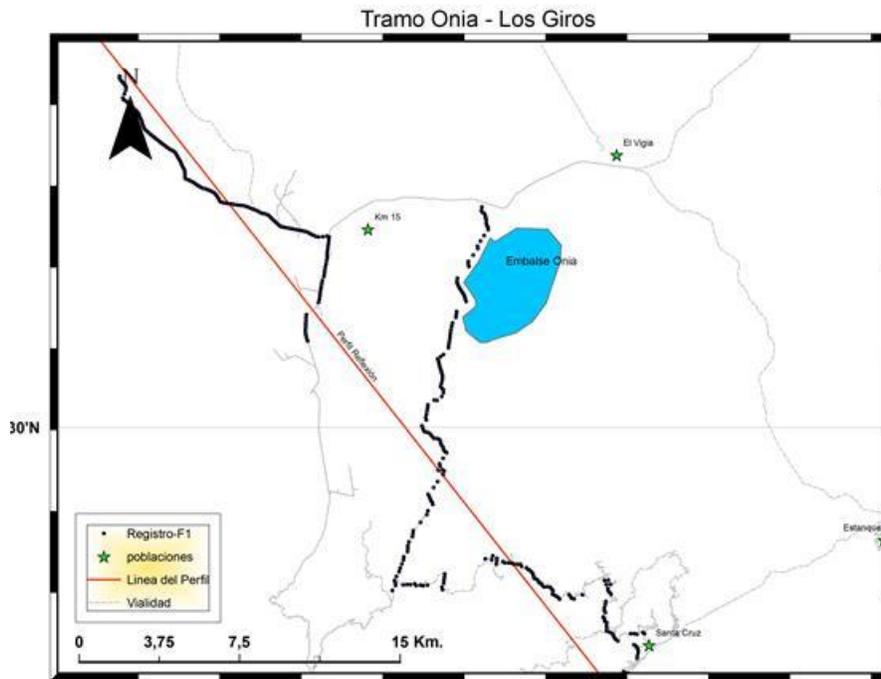


Figure 6. Registration route of the first Phase. Onia – Los Giros section.

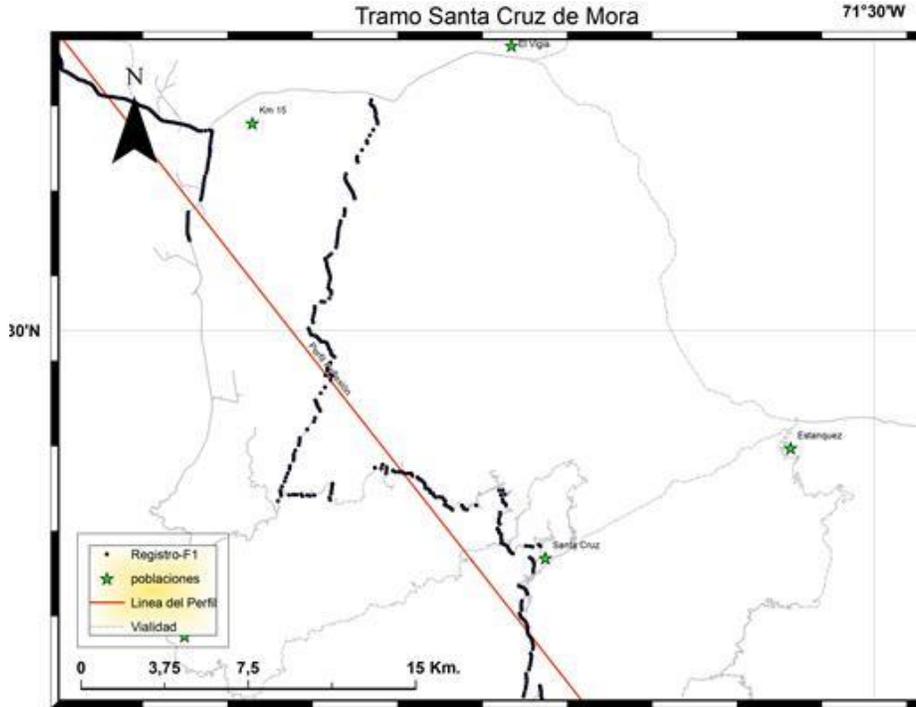


Figure 7. Registration route of the first Phase. Sta. Cruz de Mora section.

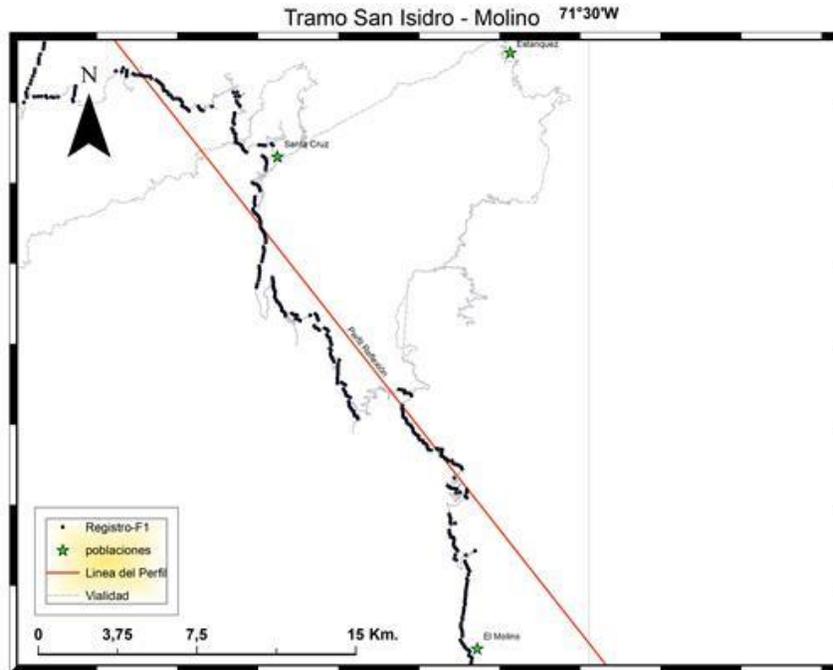


Figure 8. Registration route of the first Phase. San Isidro – El Molino section.

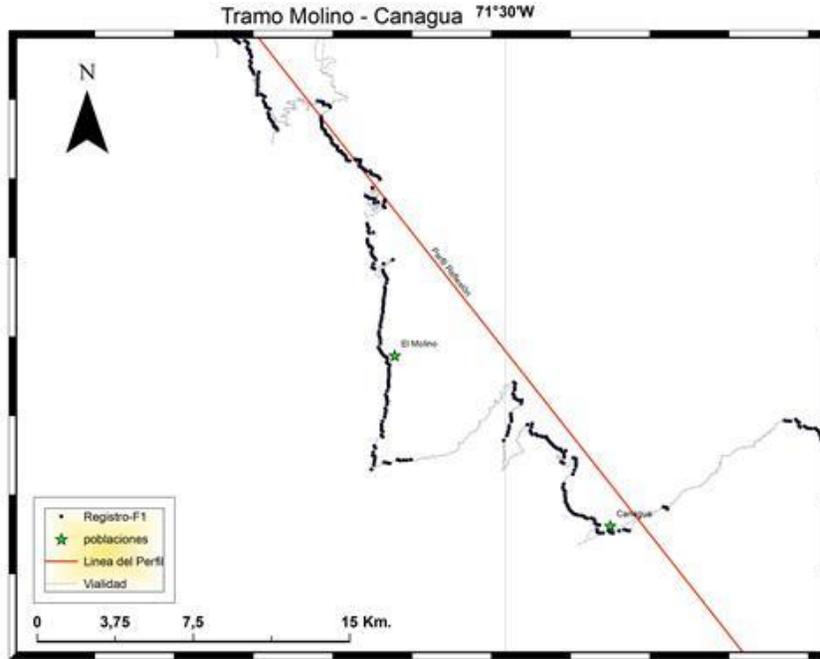


Figure 9. Registration route of the second Phase. El Molino – Canaguá section.

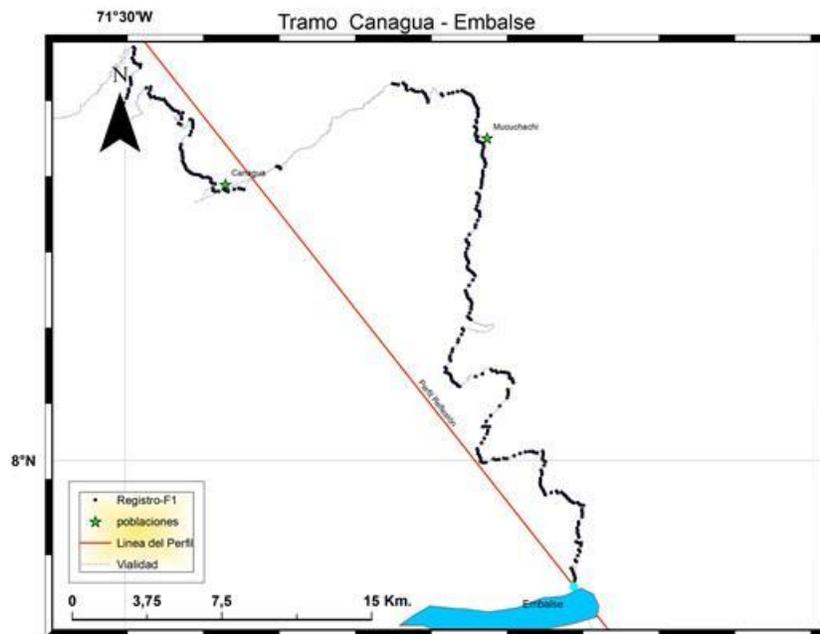


Figure 10. Registration route of the second Phase. Canaguá – Reservoir section.

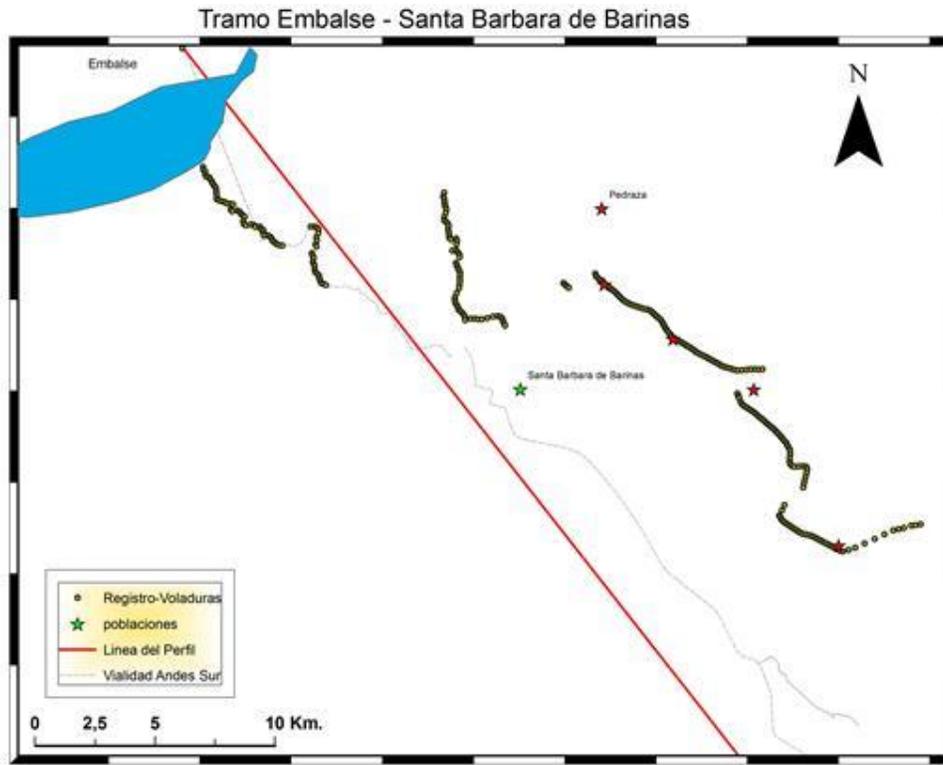


Figure 11. Registration route of the second Phase. Reservoir – Sta. Bárbara section.

PROCESAMIENTO DE DATOS

The data processing is similar to that applied in the refraction profiles, the first step consists of downloading data in the different databases once each acquisition day is completed, followed by the transformation of formats from .RAW to .SEGY, the exact determination of the “Zero” times and the preparation of seismic sections for each shot with the REFLEX and SEISPLOT programs. The Seisplot program (Arnaíz-Rodríguez et al. 2014) was developed within the framework of the GIAME project in order to facilitate the generation of seismic sections.

This study has Vibrating Trucks as an active source, the first stage allowed acquiring 244 Vibration Points (PV), while the second 139, for each PV 8 sweeps were generated if the 3 Vibrating trucks were working, and 22 sweeps when only 2 trucks were working. For each sweep it is necessary to obtain a zero time, this activity was carried out with the help of a student from the Simón Bolívar University (Isabel Espin) within the framework of the short internship.

The data acquired in the GIAME project was available for the two stages: El Vigía, Mérida and Santa Bárbara de Barinas. The data pre-processing was divided into 4 phases:

- Collection and organization of information
- Processing: Obtaining .RT files and filtering errors
- Obtaining the precise start time of the signal, manually or with the use of a program
- Assemble, review and reorganize information.

Data Grouping

The objective of this stage is the construction of the general database of the acquisition, this includes the integration of valuable information for the following steps, which classifies the acquisition in Nominal Order of the vibration points, Nom. Name of the original Vibration Point (PV) saved in the GPS, Name of the Vibration Point (PV) according to geodetic coordinates, Number of SWEEPs (sweeps) per point, Time at which each sweep was performed, Julian Day of the year, Time of the sweep in UTC (Coordinated Universal Time), Latitude, Longitude, Elevation, their respective change to UTM, that is, UTMN and UTME and a column of observations to write eventualities regarding the vibration points.

Programming commands

The PV data transformation routine requires converting the .TRD data into .RT, so that they could be displayed in the RTview program for analysis. The type of Texan used for data recording is called Texan 125a, this style of equipment is the one that directly provides the raw data in .TRD format. There are other styles that provide information more directly and quickly, however in this case, a 32-bit computer capable of executing the pertinent orders was necessary, since a higher capacity computer was tested and it was not possible to complete the process, which indicates that a computer with those specifications is strictly necessary. For this purpose, the following commands were used:

- 125_pas: Transforms data from .TRD to .DAT.
- Arcwrite: Organize data by year and Julian day in folders.
- Arcfetch: Windows of specific times are extracted, which contain the events of interest. Generates a .RT file that will contain the structure and amount of time specified with the command.

Viewing the .RT file

The RTview program displays the chosen time trace (Figure 12). This step is the most important since it is key to specify the records with the signals corresponding to the vibration points. Although this is not the final result of the work, its calculation is essential, since with these specified windows the start time of each signal is searched. In data acquisition, a manual method was used to mark the hours in which the truck began to vibrate, therefore when studying results there were problems fixing the discrepancies between the recording sheets of those days, human error and machinery error with the signals observed on the screen, especially because there was no constant error propagated throughout the signals, instead each one has its own associated error, among the most common were:

- Signal overlap.
- Time jump in the scheme to activate the vibroseis, resulting in empty spaces in the observed trace.
- Removal of the mobile texan (UPHOLE) from the point ahead of time, resulting in data loss.
- Difference in minutes between the wristwatch used to calculate times and the Texan's programmed time, which causes incorrect time cuts and displayed cut, run or missing traces

- Failure of some vibroseis, causing a difference in amplitude in the signals, greater loss of energy or marked attenuation of the wave. Not all of these errors are treatable, however, after fixing them as much as possible, complete PVs can be observed, significant to the type of soil and its characteristics.

Using the RT View program, it is possible to manually view the zero times for each sweep (Figure 13), however this procedure is a variable of human error, which is why Engineer Isabel Spin and Br. Amanda León developed a routine in which MatLab program that, through changes in slope in the signal, allowed us to obtain the zero times for each sweep more precisely.

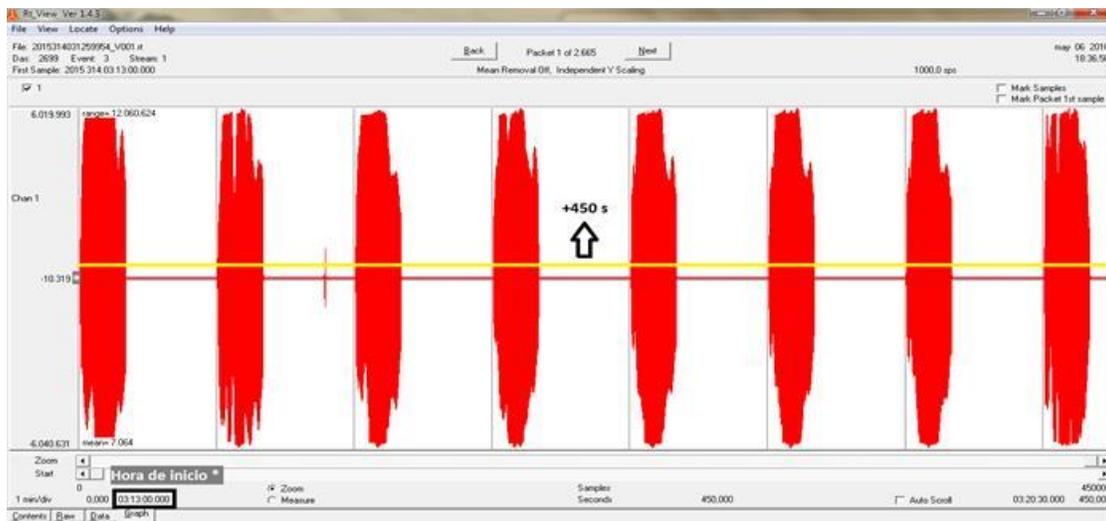


Figure 12. Vibration Point with 8 sweeps.

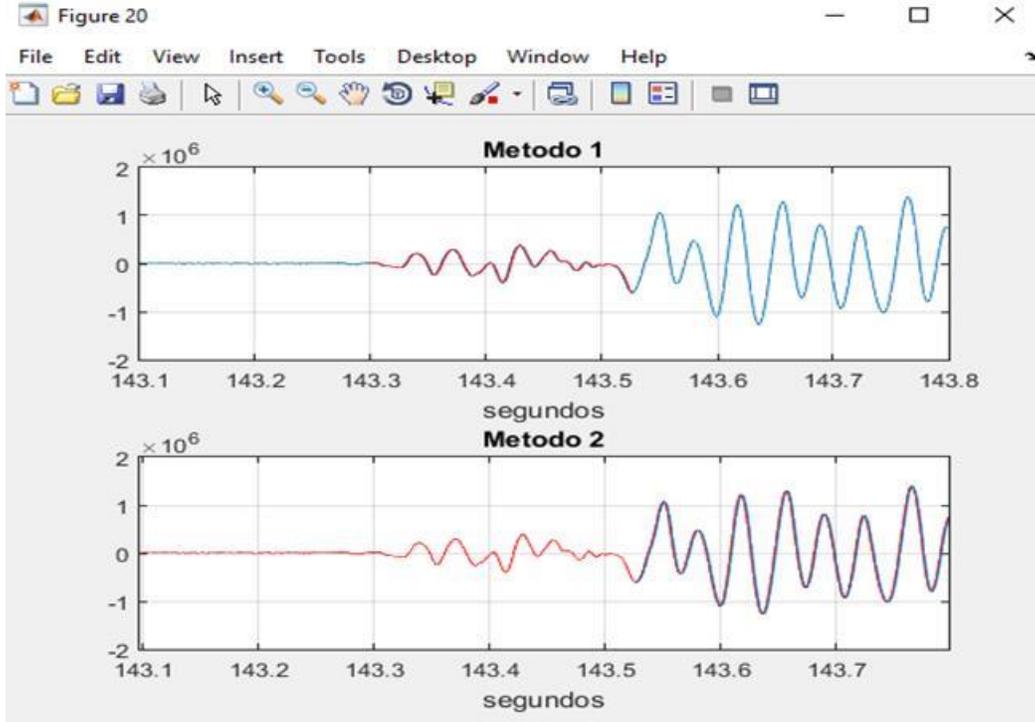
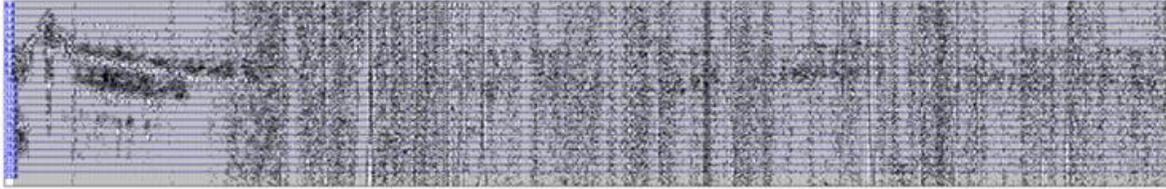


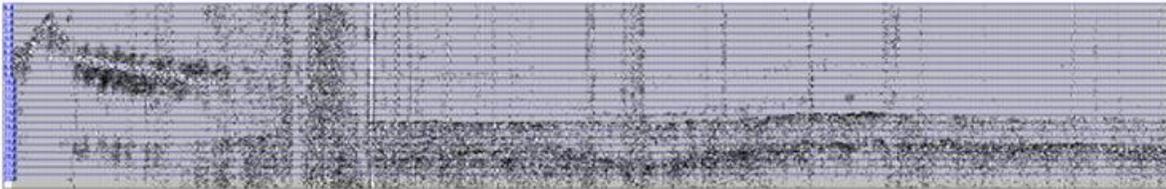
Figure 13. Obtaining zero times.

Subsequently, a working group has been established within the development of a Master's thesis and a Doctorate thesis with which meetings are held periodically to unify and standardize processing and interpretation parameters. This phase is followed by the interpretation of the first seismic phases in the seismic sections obtained. In Figure 14 the energy generated by the PVs is recorded until the end of the section. However, these results are only a reference of the product that is expected to be obtained, since a large amount of data still needs to be generated to allow the seismic sections to be recorded.

VIBRATION POINT #17 (km 15, EL VIGIA)



VIBRATION POINT #18 (km 15, EL VIGIA)



VIBRATION POINT #21 (km 15, EL VIGIA)

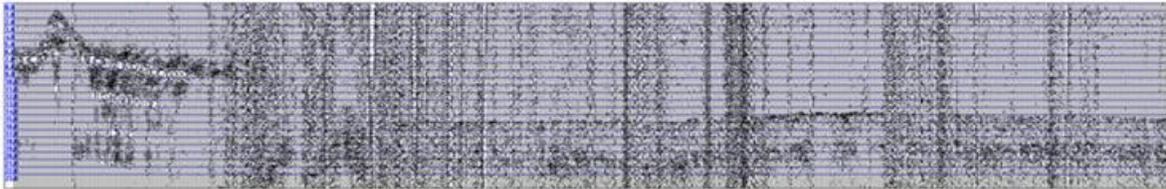


Figure 14. Energy generated by the PVs in the City of El Vigía, from the first day of acquisition.

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