



## Data Article

# Conversion of vintage seismic reflection profiles of the ViDEPI dataset crossing the Gondola Line seismogenic fault (offshore Apulia, Adriatic Sea, Southern Italy) to SEG-Y

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IMAGE2SEGY

Mattinata–Gondola fault system

## ABSTRACT

Three files have been created in SEG-Y format after conversion from the raster images of selected parts of the ViDEPI open project: seismic reflection profiles D-445, D-451 and D-452, crossing the Mattinata–Gondola fault system. This dataset was obtained using the freely downloadable MATLAB® program IMAGE2SEGY. The program requires input TIFF and TXT files containing the image and specific parameters for the seismic reflection profiles to convert the raster images to the SEG-Y file format. The TIFF file of each profile was made using Adobe Photoshop®; the TXT format file was created with comma-separated number values and has a three-row and six-column structure, according to the program requirements. Once the raster images were converted to the SEG-Y file format, a light processing using DELPH Seismic® software improved the obtained seismic images. Creating this freely available dataset overcomes the problem of poor-quality representation of the original raster seismic reflection profiles. Hence, this dataset allows geologists to better interpret these profiles, especially by using dedicated software that can modify the colours of the reflectors as de-

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sired. Thus, these data are useful for researchers who want to investigate the deeper structures associated with the seismogenic Mattinata–Gondola fault system.

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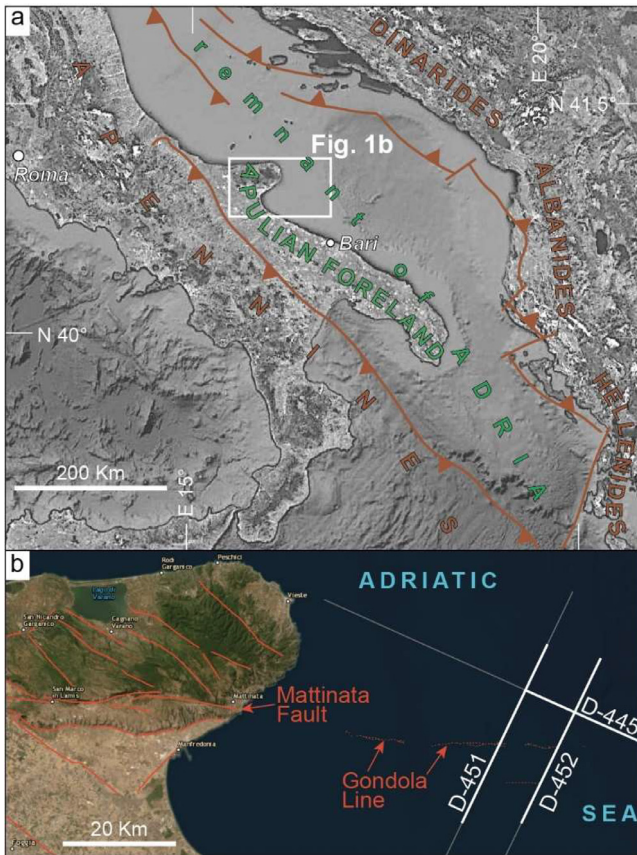
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## Specifications Table

Subject	Earth and Planetary Sciences
Specific subject area	Geology and geophysics
Type of data	Processed raw data in SEG-Y file format Raw data in ASCII file format
Data collection	For each seismic reflection profile, the PDF files were downloaded from the ViDEPI project website. Using Adobe Photoshop®, each raster image underwent horizontal straightening, merging, cropping and adapting. The resulting image was saved in TIFF format. The parameters file in TXT format contained a three-row and six-column structure. The IMAGE2SEGY program was launched in MATLAB®, the fields in the automatically opened window were filled, the TIFF and TXT files were uploaded, and the destination folder for the SEG-Y output file was chosen. Finally, the SEG-Y file benefitted from light processing operations using DELPH Seismic® software.
Data source location	ViDEPI project, at <a href="http://www.videpi.com">www.videpi.com</a> , of the Ministry for the Economic Development of the Italian Government
Data accessibility	Repository name: Mendeley Data Data identification number: <a href="https://doi.org/10.17632/8bj7pz2wvh.1">10.17632/8bj7pz2wvh.1</a> Direct URL to data: <a href="https://data.mendeley.com/datasets/8bj7pz2wvh/1">https://data.mendeley.com/datasets/8bj7pz2wvh/1</a>
Related research article	None

## 1. Value of the Data

- The coastal areas of Apulia are densely populated zones and the location of the most important production activities in the region. Increasing knowledge of seismogenic and possible tsunamigenic faults in the surrounding marine areas of the Apulian Foreland (which corresponds to Apulia) (Fig. 1a) represents a challenge for understanding geological hazards, other than for pure research objectives. Therefore, these SEG-Y seismic reflection profiles are now freely available for geologists who want to achieve these goals.
- The SEG-Y file format is a data standard developed by the Society of Exploration Geophysicists for storing, accessing and exchanging georeferenced geophysical data. With the use of varied programs for specific geophysics applications, this file format allows the processing and manipulation of data, which greatly assists their interpretation. The importance of the present dataset lies in its public availability. The original seismic reflection profiles consist of grayscale raster images with poor-quality representation.
- The choice of parts of the seismic reflection profiles D-445, D-451 and D-452, for a total length of 95,545.3 m, was dictated by their location. According to observations by [1] and [2], they fall in the most promising area to detect the structures associated with the Gondola Line (Fig. 1b).
- After first transforming the data from a raster image to the SEG-Y format, the data consisted of a matrix of grayscale-filled pixels representing the original var-wiggle display. For this type of data, only the removal of low- and high-frequency noises and the gain control is possible, but a significant improvement in the quality of data representation was obtained. These SEG-Y data may be reused for further processing attempts, limited only by frequency cut-offs. The main usefulness of the obtained SEG-Y seismic reflection profiles is their interpretation, especially with the use of dedicated software, which allows further improvement of the seismic



**Fig. 1.** a) Structural sketch map of the Apulian Foreland, which corresponds to Apulia, between the Apennines and Dinarides–Hellenides orogenic belts (modified after [3]). b) Structural sketch map of the Mattinata–Gondola fault system (modified after the open access catalogue of hazards from capable faults, ITHACA, <https://sgi.isprambiente.it/ithaca/viewer/index.html>); the traces of the seismic reflection profiles discussed in this work are indicated.

image by modifying the colours of the reflectors as desired (impossible on the former raster images).

- The present data result from pioneering project development, which could inspire the future transformation of the many vintage seismic reflection profiles of the relevant ViDEPI dataset into the desirable SEG-Y format.

## 2. Background

The Mattinata–Gondola fault system is one of the most important tectonic structures in southern Italy; it is active and responsible for the most relevant historic seismic events in the northern Apulian Foreland (e.g. [4]), i.e., the foreland of the southern Apennines (westwards) and Dinarides–Hellenides (eastwards) orogens ([3], and references therein) (Fig. 1a). This fault crops out in the southern Gargano Promontory, where it is called the Mattinata Fault and strikes roughly W-E in map view; its continuation toward the east has been documented by several studies in the adjacent Adriatic Sea area, where it has been named the Gondola Line (Fig. 1b). These studies dealt with the interpretation of both deep and shallow seismic reflection data ac-

quired on the present-day continental platform surrounding Apulia (e.g. [1,2]). The related seismic data are not freely accessible; however, they can be interpreted in various ways, especially regarding the deeper structures associated with the fault. In this respect, the recent tendency to interpret halokinetic structures, such as the Burano Formation anhydrites, associated with the main faults around and within the Apulian Foreland is established [5–8].

The largest public database of seismic reflection profiles and exploration well logs in the Mediterranean region is the Visibility of Petroleum Exploration Data in Italy (ViDEPI) project, which includes data collected since 1957. In particular, the seismic reflection data within the marine zones pertaining to Apulia were obtained from the 1960s to the beginning of the 2000s. The contents of the project, made available by the Ministry for the Economic Development of the Italian Government, have been freely accessible since 2007 from the website ([www.videpi.com](http://www.videpi.com)), where scanned analogue documents can be downloaded as PDF files. The ability to freely access these subsurface data significantly stimulated research on the tectono-sedimentary evolution of the Apulian Foreland-foredeeps system during the Cenozoic involvement of the Adria plate in the Dinarides–Hellenides (to the east) and Apennines (to the west) orogens (Fig. 1a) [3,5–7,9–19].

The ViDEPI dataset comes from rasterising original paper copies of data given to the Italian Government by oil companies. Rasterisation results in a variety of data display types (i.e., wiggle trace, variable area, variable area wiggle trace and variable density) and a wide range of image qualities and resolutions mainly coming from “brute stack” processing produced only for on-board rapid quality control. Sometimes, the original paper copy was of poor quality. However, the poor-quality representation of the seismic reflection profiles can be overcome by the converted SEG-Y files.

### 3. Data Description

Three files were obtained and delivered after the conversion of the selected parts of seismic reflection profiles D-445, D-451 and D-452 (Fig. 1b) to SEG-Y (i.e., D\_445.sgy, D\_451.sgy and D\_452.sgy, respectively).

For each SEG-Y file, a parameters file in ASCII format, that is, a TXT file, was necessarily created with comma-separated number values and a three-row and six-column structure, as required by the MATLAB® program IMAGE2SEGY [20] used for the conversion. For the first row, the following six data columns were compiled: TLP, L, ML, REV, DSF, and ZUTM. In detail, TLP is the length in pixels of the seismic reflection profile image; L is the identification number of the seismic profile; ML is the location zone type of the profile, that is, offshore (value 0) or onshore (value 1); REV is the SEG-Y revision format (values 0 or 1, but value 1 is recommended by the program); DSF is the SEG-Y numeric format (value 1 for 32 bits IBM floating point, value 3 for 16 bits IBM floating, value 5 for IEEE format, but value 3 is recommended by the program); ZUTM is the UTM zone of the acquired seismic reflection profile. For the second row, the following six data columns were compiled: px1, py1, X1, Y1, TD, and TL. In detail, px1, py1 is the top first (i.e., top left) pixel position of the TIFF file image; X1, Y1 is the UTM position of the above top first pixel; TD is the time, in milliseconds, over the datum plane (value 0 for offshore seismic reflection profiles); TL is the time interval in milliseconds (3000 ms has been considered for the inexpressive, isotropic seismic signal at greater depths). Finally, the following six data columns were compiled for the third row: px2, py2, X2, Y2, TD, and TL. Here, px2, py2 is the top last (i.e., top right) pixel position of the TIFF file image; X2, Y2 is the UTM position of the above top last pixel; TD and TL are as in the second row. Each SEG-Y file benefitted from light processing using DELPH Seismic® software.

For the selected part of seismic reflection profile D-445, the obtained data file is D\_445.sgy. In particular, the length from shotpoint 7813 (SE) to shotpoint 7627 (NW) is 23,333.2 m, as reported in the original PDF image. To obtain this SEG-Y file, the following input values were entered for the parameters in the ASCII-format TXT file: TLP = 4682, L = 445, ML = 0, REV = 1, DSF = 3, ZUTM = 33, px1 = 0, py1 = 0, X1 = 642,632, Y1 = 4,620,474, TD = 0, TL = 3000,

$px2 = 4682$ ,  $py2 = 0$ ,  $X2 = 663,916$ , and  $Y2 = 4,610,970$ . In the processing step, the high pass filter and the low pass filter were set at 16 and 312 Hz, respectively; the linear method and the value of 1.28 ms for the window vertical length were applied with a value of 30 % for the “strength”.

For the selected part of the seismic reflection profile D-451, the obtained data file is D\_451.sgy. In particular, the length from shotpoint 6090 (SW) to shotpoint 6373 (NE) is 37,471.4 m, as reported in the original PDF image. To obtain this SEG-Y file, the following input values were entered for the parameters in the ASCII-format TXT file:  $TLP = 7488$ ,  $L = 451$ ,  $ML = 0$ ,  $REV = 1$ ,  $DSF = 3$ ,  $ZUTM = 33$ ,  $px1 = 0$ ,  $py1 = 0$ ,  $X1 = 630,539$ ,  $Y1 = 4,595,374$ ,  $TD = 0$ ,  $TL = 3000$ ,  $px2 = 7488$ ,  $py2 = 0$ ,  $X2 = 646,711$ , and  $Y2 = 4,629,063$ . In the processing phase, the high pass filter and the low pass filter were set at 25 and 374 Hz, respectively; the linear method and the value of 1.28 ms for the window vertical length were applied together with the value of 100 % for the strength.

For the selected part of the seismic reflection profile D-452, the obtained data file is D\_452.sgy. In particular, the length from shotpoint 3390 (SW) to shotpoint 3135 (NE) is 34,740.7 m, as reported in the original PDF image. To obtain this SEG-Y file, the following input values were entered for the parameters in the ASCII format TXT file:  $TLP = 6928$ ,  $L = 452$ ,  $ML = 0$ ,  $REV = 1$ ,  $DSF = 3$ ,  $ZUTM = 33$ ,  $px1 = 0$ ,  $py1 = 0$ ,  $X1 = 641,739$ ,  $Y1 = 4,595,237$ ,  $TD = 0$ ,  $TL = 3000$ ,  $px2 = 6928$ ,  $py2 = 0$ ,  $X2 = 656,846$ , and  $Y2 = 4,626,419$ . During processing, the high pass filter was set at 23 Hz; the linear method and the value of 1.28 ms for the window vertical length were applied together with the value of 100 % for the strength.

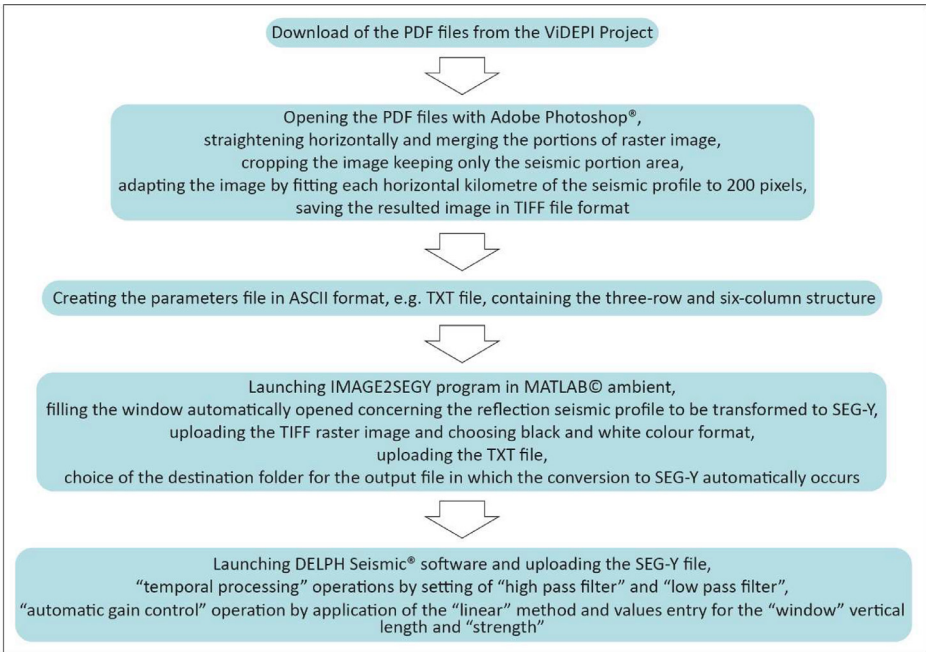
#### 4. Experimental Design, Materials and Methods

The MATLAB® program to convert images of seismic reflection profiles to georeferenced SEG-Y formatted files, IMAGE2SEGY [20], was used in this study. It is freely available from the website <http://gma.icm.csic.es/ca/image2segy>. TIFF and TXT files are the fundamental input files for this program related to the image and specific parameters of the seismic reflection profiles, respectively (Fig. 2).

The first step, obtaining the data, consisted of downloading the PDF files related to the seismic reflection profiles D-445, D-451 and D-452 from the ViDEPI project (Fig. 1b). Each of these profiles was originally portioned into different PDF files. Horizontal straightening and merging of the relevant portions of the raster images were used to assemble each seismic reflection profile with Adobe Photoshop®. Using the same software, the mosaic of images was cropped to the seismic reflection profile area, removing the original frame that contained the heading, legend and other information on data acquisition and processing. Furthermore, the criterion that each horizontal kilometre of a seismic reflection profile must correspond to 200 pixels was maintained. Finally, a TIFF file was obtained for each profile. To highlight the poor-quality representation of the original data, Fig. 3a shows a portion of the unmigrated, monochannel and brute stack greyscale raster image of the seismic reflection profile D-445 in TIFF format.

Therefore, the parameters files in ASCII format (the TXT file) were created containing the three-row and six-column structure (the detailed values of the parameters are reported in the previous “Data description” section).

Once IMAGE2SEGY was launched in MATLAB® ambient, the required fields in the first window, which opened automatically, were compiled with information concerning the seismic reflection profile to be transformed to SEG-Y, including the survey name, survey line number, survey date, first trace offset, institution/company that acquired the seismic data, and timelines removal (a value between 0 and 4; 3 is recommended by the program). The TIFF raster image was uploaded in the black and white colour format in the next window. Consequently, the related TXT file was uploaded. With the choice of the destination folder for the output file, the file was automatically converted to SEG-Y. The output of the SEG-Y is a grayscale pixel representation of the raster copy; it is not a reconstruction of the original var-wiggle display. Nevertheless, the frequency content is suitable for processing.



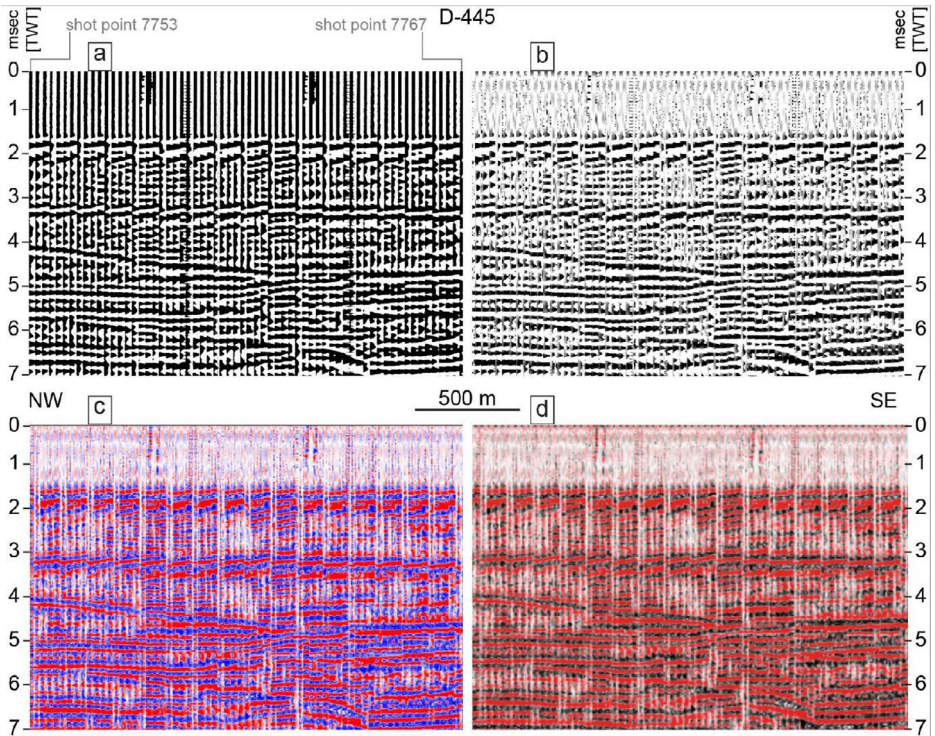
**Fig. 2.** Flow diagram of the conversion to SEG-Y file format and light processing operations for each seismic reflection profile.

Light processing of each SEG-Y file using DELPH Seismic® software improved the obtained seismic images. Several attempts at various filtering frequencies were made using the “Temporal processing” operations, and applying the “high/low filter” gave the best results. The high pass filter was set for all three seismic reflection profiles, whereas the low pass filter was set only for seismic reflection profiles D-445 and D-451 (the detailed values are reported in the previous “Data description” section).

The “automatic gain control” function was activated; after several attempts at method selection and the window vertical length and strength value choices (detailed values are reported in the “Data description” section), the linear method was used.

In summary, the SEG-Y files D-445.sgy, D-451.sgy and D-452.sgy, converted using the IMAGE2SEGY program in MATLAB© ambient and processed with DELPH Seismic® software, represent the database associated with the present paper. In order to show the improved quality of the seismic data in these files, Fig. 3b refers to the same portion of the seismic reflection profile D-445 as Fig. 3a and shows the processed seismic data in the SEG-Y format.

Finally, an attempt with the use of Move™ software was applied to the processed SEG-Y files to further improve the seismic signal. The results are displayed for the demonstration purposes in Fig. 3c and d, which refer to the same portion of the seismic reflection profile D-445 as Fig. 3a and b. As shown, the colours of the reflectors were modified to better visualise the seismic signal.



**Fig. 3.** Portion of the seismic reflection profile D-445 between shotpoints 7753 and 7767. a) Unmigrated, monochannel and brute stack greyscale raster image in TIFF format. b) SEG-Y file format after conversion and light processing. c and d) Attempts to improve the visualisation of the seismic signal by modifying the colours of the reflectors.

## Limitations

The SEG-Y format is a representation in greyscale pixels of the original copy; it is not a reconstruction of the var-wiggle display of the original seismic reflection profiles.

## Ethics Statement

This work does not involve the use of human subject, does not involve animal experiment and does not involve data collected from social media platforms.

## CRedit Author Statement

**Marianna Cicala:** Methodology, Data curation, Writing, Validation. **Francesco De Giosa:** Methodology, Data curation, Validation. **Arcangelo Piscitelli:** Validation. **Giovanni Scicchitano:** Conceptualization, Review. **Vincenzo Festa:** Conceptualization, Writing, Review.

## Data Availability

SEG-Y files from reflection seismic profiles of the ViDEPI dataset (Gargano offshore, Adriatic Sea, Southern Italy) (Original data) (Mendeley Data).

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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