SPIDER-6 user manual

Introduction

SPIDER-6 software is an application used to analyze recent tectonic stress directions based on the algorithm described in Jarosiński 1998. The interpretation is performed on the ground of geophysical logs measuring the difference in borehole diameter, such as a six-arm dipmeter tool (preferable) or six-arm microresistivity scanners (for example XRMI). To assign the azimuth of present-day maximum horizontal stress by identification of breakout structures, the program uses a doubled length of pads (so-called "calipers") of the tool and navigation parameters oriented to the north. Performing the breakout analysis requires loading of several basic parameters: measured depth (DEPT), length of six calipers (CAL1-6), relative bearing (RB), borehole deviation (DEV), hole azimuth (HAZi), and optionally azimuth of the first pad (Azi1).

The program is written in the Python (v. 3.9) programming language using basic packages such as NumPy, pandas, and matplotlib. The user interface was written using a Qt framework and icons were downloaded from the website: https://icons8.com. For better visibility of data within plots, it is recommended to use a high-resolution screen.

No installation is required to run the application. To use the software you in Windows system (10 or higher) the following actions need to be done:

- Go to the repository website: https://github.com/KingaB11/SPIDER-realese
- Click the blue “Code” button on right side and next “Download ZIP”
- Unpack the downloaded folder and go to the “SPIDER-6” folder
- Find the SPIDER-6.exe file and run the application

Main window

1.1. General view

Within the main window of the program, there are two rows of buttons, edit fields, and additional windows, which can be divided into four modules (Fig. 1):

a) Module of basic parameters with import button, save button and edit fields for filtration parameters (uppermost part of the window)
b) Module of additional windows (the second row of buttons, looking from the top)
c) Tabular module containing input dataset loaded from an external file (table and three buttons on left side of the main window)
d) Module of figures and message window containing three figures: 1. Plotted raw data of the logs, 2. plotted breakouts profile, and 3. rose diagram of breakouts azimuth with marked S_{Hmax} direction. In the message window, placed below the figure with the rose diagram, the program displays information about its current state, loaded data, and occurred errors.

Within the upper right corner of the main window are placed buttons to minimize and close the program. After clicking an "x" button, the dialog window asks the user to confirm the decision. This is especially important since the program does not save and restore sessions. Thus, closing the main window is tantamount with losing all data.

All modules of SPIDER-6 software will be described in an order consistent with breakouts analysis performed on a dipmeter tool logs from an anonymous borehole. The final view of the main window after performing a complete analysis should resemble the one presented in Fig. 2.

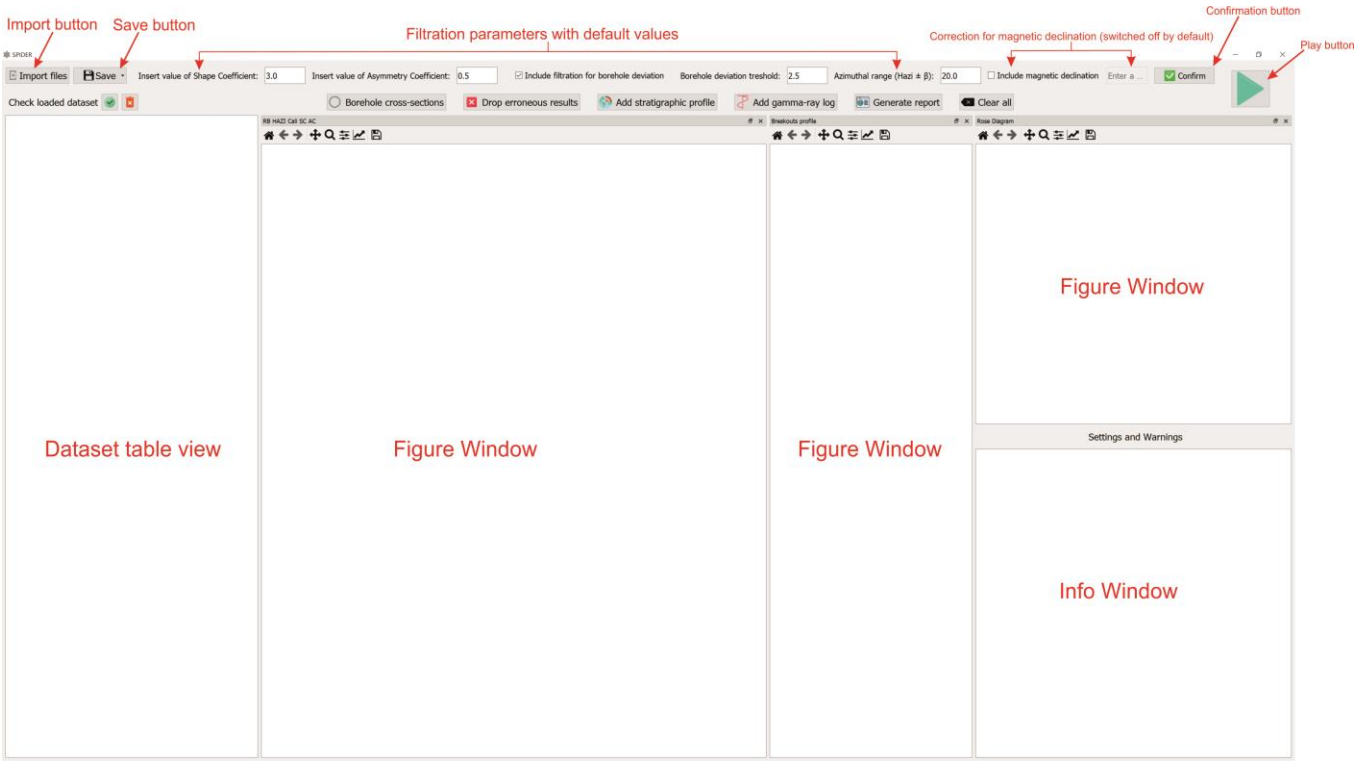


Fig. 1. Main window of SPIDER-6 software.

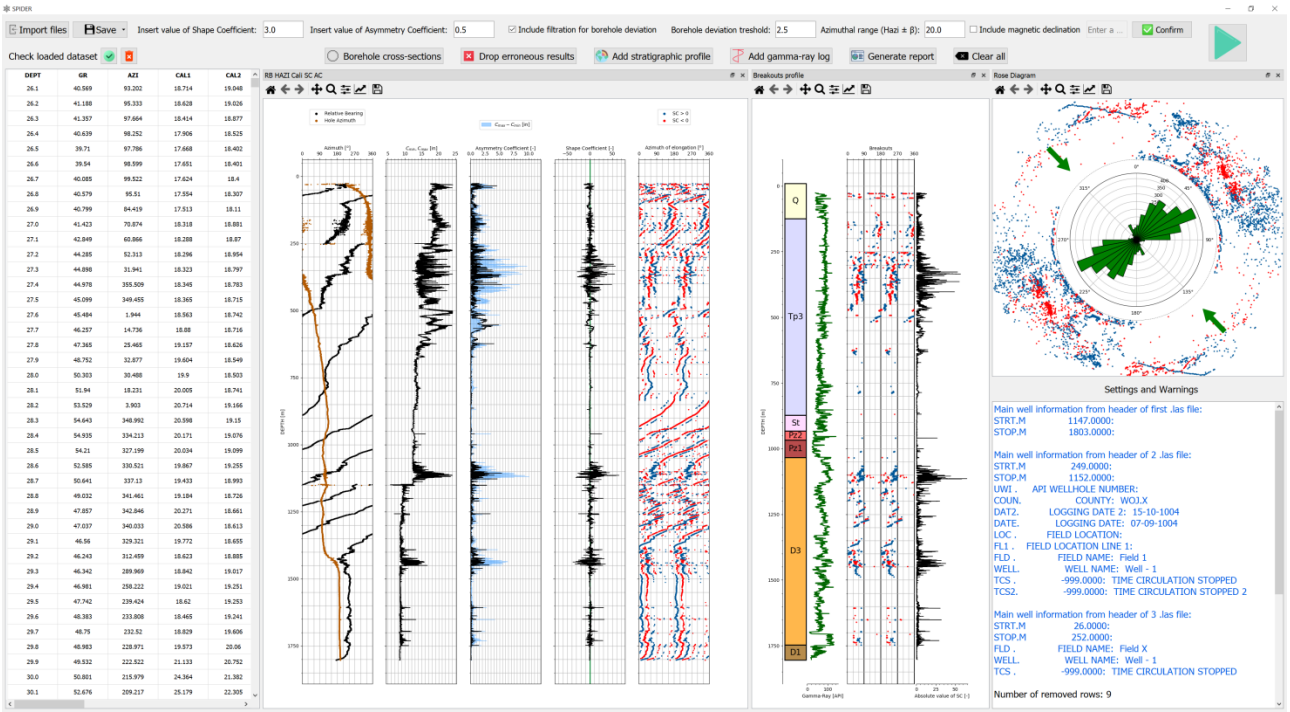


Fig. 2. A view of the main window after performing a complete breakouts analysis for an exemplary borehole.

1.2. Module of basic parameters

The module of basic parameters includes several buttons and text edit fields. Functions of this module are used for importing data from external files, quality control of imported data, and matching filtration parameters to eliminate the artifacts from final results. This module includes the following widgets:

1. Import button - allow importing logs from the dipmeter tool into a SPIDER database from an external file. After clicking a button field, the dialog window enabling choosing a file/files appear. The program allows

selecting files in American Logging Standard (*.las) or spreadsheets (.xls, .xlsx, .csv). If a dataset is loaded from the .las files, it should be preserved in the standard structure provided by a service company. In the case of loading a dataset from a spreadsheet, it can't contain any headers with the borehole information. In a spreadsheet, the first row has to contain the mnemonic appropriate for the log, and all remaining rows should contain only digital data representing the values of measurements. In the case of importing well logs, where particular depth intervals are saved in separate files, it is possible to select all those files at once. In such cases, logs will be merged and sorted according to the values of the depth log. In case of clicking "Cancel" in the dialog window or not choosing any file, the message: „WARNING: Data file was not selected!" will appear in the info window (described as „*Settings and Warnings*"). It is especially important to preserve the appropriate names of imported logs. Since there is no option to rename columns containing the name of a particular log, they need to be adjusted in an external file. To perform breakout analysis, it is required to load: (1) Measured depth (MD, DEPT or DEPTH) (2) Length of calipers with names: CAL1, CAL2, CAL3, CAL4, CAL5 and CAL6 (3) Hole azimuth (HAZI) (4) Relative Bearing (RB or ROT) (5) borehole deviation (DEV, DEVI, INC, INCE) (6) Azimuth of the first pad (AZI, AZI1, PAD1AZI). Additionally, if we want to include the gamma-ray log in the breakout profile, it needs to be loaded as GR, GRA, or GRP. If the .las file is damaged and can't be imported, the message will be displayed in a info window:

„ERROR: Data from selected file cannot be added. Possible reasons:
1. Standards typical for .las-type file are not preserved
2. There are some non-UTF signs within the loaded file (e.g.: /, [], *, &)
3. Some of the values within the file are not numbers.
Try to find a possible issue or convert dataset into an Excel-type file"

In such a case, the user should open a damaged file outside the program and perform an analysis of possible errors in the data structure. If records causing this error can't be identified, the .las file should be converted to a .csv or .xlsx file and imported again.

After the correct import of the log dataset, basic borehole information read from a .las header will be displayed in the info window, and digital data will appear in the table on the left side of the main window. In the case of loading a dataset from a spreadsheet file, which doesn't contain headers, the information: „INFO: Data loaded from a spreadsheet-type of file: No additional borehole info available" will be displayed in the info window. The program automatically removes depth intervals, where at least one of CAL1-6, HAZI, or RB logs contains invalid records, usually saved as -9999, -9999.00. Thus, aside from borehole information, also a message containing the number of removed rows will be displayed („*Number of removed rows:* „) in the info window.

2. Save button – button for saving the results of performed calculations. After clicking on the button area, a selection menu appears with 3 options for saving data: "Raw data", "Breakouts only" and "Raw and filtered" (Fig. 3). If the "Raw data" option is selected, only the corrected data, together with basic parameters such as shape coefficient, asymmetry coefficient, the difference between the maximum and minimum caliper and the azimuth of elongation are exported. In this option, the final results do not contain breakout structures. Thus, it is useful only to export data imported from a .las file to a spreadsheet for another use. The "Breakouts only" option saves the final results containing the designated breakout structures, while the "Raw and filtered" option saves both raw/revised log values, filter parameter values, and the finally distinguished breakout structures. All data is saved to .xlsx files located in a folder named "*Saved Files*" in the program path under appropriate names ("Raw data", "Breakouts only" or "Raw and filtered").

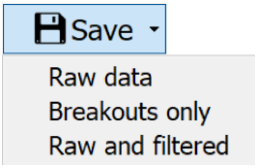


Fig. 3. Save options.

3. Toolbar to choose the filtration parameters according to: Jarosiński, 2006, 1999, 1998, 1994), enabling distinguishing breakout structures from diameter elongation, not related to the recent tectonic stress. The required parameters are listed as follow:

    - Shape Coefficient (*SC)* – determines the percentage of elongation of the borehole diameter. As a default value, the program takes the most typical value for breakouts equal 3% of elongation of diameter. However, the assumed value needs to be adjusted to a specific case and the number of visible artifacts. Usually, the shape coefficient do not exceed 6%.
    - Asymmetry Coefficient (*AC)* – determines whether the elongation of the borehole diameter is symmetrical, meaning it is present on both sides of the borehole wall. The lower value of this parameter assumes the higher symmetry of elongation. The default value of AC is equal to 0.5, which means that the elongation is at least half symmetrical. Standard values of AC vary between 0.3 and 0.6.
    - Filtration for borehole azimuth – optional filtration parameters that reject damage related to the borehole azimuth, which can be a result of abrasion of borehole walls by the drilling bit. Such effects usually occur in boreholes deviated from the vertical, and can't always be filtered out by the asymmetry factor, as they lead to an almost symmetrical extension of the borehole cross-section. This filtration is used by default in calculations for intervals of holes deviated from the vertical by at least 3°. In case of including this type of filtration, users need to determine the minimal deviation of the borehole from vertical (usually 3°) for which the filtration should be used, and the angular width of the filtrated azimuths counted for both sides of hole azimuth (default ± 20º). This filtering can be ignored by unchecking the symbol "✓", if the expected breakout azimuth may be similar to borehole azimuth.

The listed filter parameters can take any numeric values, which should be entered in the corresponding text fields. In case of entering an incorrect value or not providing any value, a message will appear (e.g. Fig. 4). If such a warning appears, click OK and enter the correct value of the parameter in the corresponding text field.

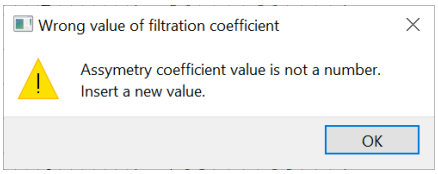


Fig. 4. A message informing about incorrect value of asymmetry coefficient.

4. Corrections for magnetic declination - in SPIDER-6 software, it is possible to take into account the value of magnetic declination for azimuthal data, which can affect the direction of breakout structures. In default settings, the declination is not taken into account due to its variability in time and space and the possibility, that this parameter is already included in the raw data. To include the correction, click the left mouse button on the "Include magnetic declination" field so that a sign "✓" appears. Then, the text box on the right will be activated (highlighted in white) and the default value, typical for the area of Poland (3E) will appear. The active text box takes the values xE or xW, where x stands for any numerical value in the range from 0 to 180°, and E or W for the direction - eastern (E) and western (W). By convention, selecting the E direction results in adding its value to the measured azimuths (RB, AZi, and Hazi) and breakouts directions, while with the W direction, the value is subtracted. After entering the appropriate values, confirm the selection by pressing the "Confirm" button on the right. If the provided value of magnetic declination correction is incorrect, two messages may appear: (1) If the specified value does not include an angle or direction (Fig. 5) or (2) the entered angular value is not in range between 0 and 180° (Fig. 6).

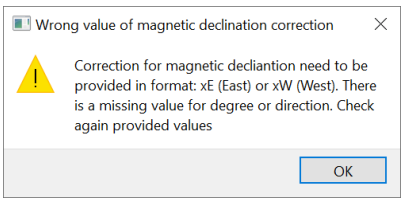


Fig. 5. Warning about incorrect value of magnetic declination.

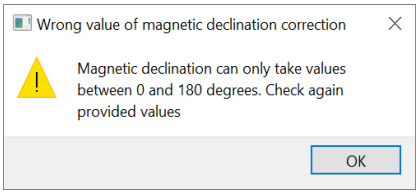


Fig. 6. Warning about incorrect angle of magnetic declination.

After setting all filtration parameters the "Confirm" button needs to be pressed to assign them an appropriate values. If none of the warning messages appear, the "Play" button (big, green on the rightmost side of the Main Window ☺) has to be pressed to perform calculations. If magnetic declination was included, after pressing the "Play" button the field containing its value will be turned off. This action prevents the user from including magnetic declination several times during testing different values of filtration parameters, and should not be turned on again. This field should be turned on again only to correct the previously provided value.

If the filtration parameters are too restrictive to detect breakout structures within the borehole, or there are no breakout structures at all, the following message will appear in the notification window: "WARNING: Filtration parameters are too restrictive or there is no breakout structures within the investigated borehole.", and no breakouts structure will appear at the profile. In such a case, look at the output data graphs (Fig. 11A) and modify the filtration parameters by providing less restrictive values. It is recommended to "tune" the filtration parameters individually for each investigated borehole.

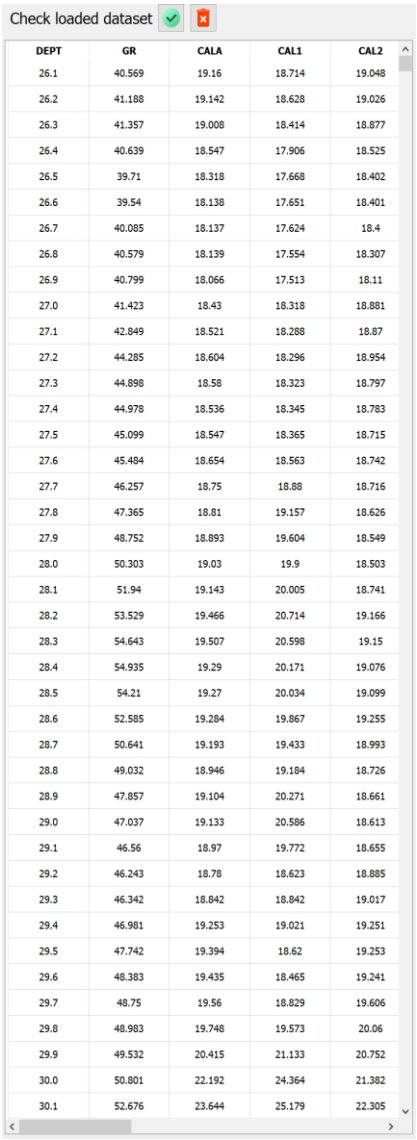
1.3. Tabular module

The tabular module consists of the data table ("Dataset Table View" in Fig. 1) and two buttons above the table view (Fig. 8). The table contains data read from .las files, or spreadsheets uploaded with the "*Import Files*" button, without values removed during import (rows containing -999, -9999.0 and so on). The number of deleted rows is displayed in the info window.

If measurement errors are detected, it is possible to correct the invalid records within the table. To edit a specific value double-click with the left mouse button on the selected field of the table. The selected field will be highlighted in blue, enabling editing. After changing all incorrect values, press the confirm button (the "✓" sign in the green box above the table, aside from the "*Check loaded dataset*" field - Fig. 7). If measurement errors cover a wider depth interval, it is also possible to delete entire rows of the table containing erroneous values. In this case, select the desired rows of the table with the left mouse button (they will then be highlighted in blue) and press the delete button (red garbage can above the table) or the delete button on the computer keyboard. The deletion of rows should also be confirmed with the confirm button. If you do not confirm and press the start button, a message will appear reminding you of this action (Fig. 8).

After deleting a value from the table and not providing a new one, or writing out a non-numeric value, a message will appear indicating that an erroneous value has been entered (Fig. 9). In this case, fill in the missing values or delete the row containing the errors and confirm the changes.

After checking the correctness of provided data, making all necessary editions, or deleting undesired depth intervals, the "*Play button*" has to be pressed to run the breakouts calculations.



DEPT	GR	CALA	CAL1	CAL2
26.1	40.569	19.16	18.714	19.048
26.2	41.188	19.142	18.628	19.026
26.3	41.357	19.008	18.414	18.877
26.4	40.639	18.547	17.906	18.525
26.5	39.71	18.318	17.668	18.402
26.6	39.54	18.138	17.651	18.401
26.7	40.085	18.137	17.624	18.4
26.8	40.579	18.139	17.554	18.307
26.9	40.799	18.066	17.513	18.11
27.0	41.423	18.43	18.318	18.881
27.1	42.849	18.521	18.288	18.87
27.2	44.285	18.604	18.296	18.954
27.3	44.898	18.58	18.323	18.797
27.4	44.978	18.536	18.345	18.783
27.5	45.099	18.547	18.365	18.715
27.6	45.484	18.654	18.563	18.742
27.7	46.257	18.75	18.88	18.716
27.8	47.365	18.81	19.157	18.626
27.9	48.752	18.893	19.604	18.549
28.0	50.303	19.03	19.9	18.503
28.1	51.94	19.143	20.005	18.741
28.2	53.529	19.466	20.714	19.166
28.3	54.643	19.507	20.598	19.15
28.4	54.935	19.29	20.171	19.076
28.5	54.21	19.27	20.034	19.099
28.6	52.585	19.284	19.867	19.255
28.7	50.641	19.193	19.433	18.993
28.8	49.032	18.946	19.184	18.726
28.9	47.857	19.104	20.271	18.661
29.0	47.037	19.133	20.586	18.613
29.1	46.56	18.97	19.772	18.655
29.2	46.243	18.78	18.623	18.885
29.3	46.342	18.842	18.842	19.017
29.4	46.981	19.253	19.021	19.251
29.5	47.742	19.394	18.62	19.253
29.6	48.383	19.435	18.465	19.241
29.7	48.75	19.56	18.829	19.606
29.8	48.983	19.748	19.573	20.06
29.9	49.532	20.415	21.133	20.752
30.0	50.801	22.192	24.364	21.382
30.1	52.676	23.644	25.179	22.305

Fig. 7. Tabular module of SPIDER-6 software.

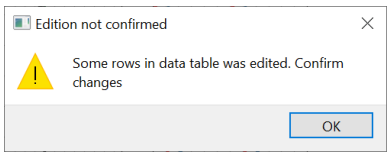


Fig. 8. Warning reminding the user to confirm changes.

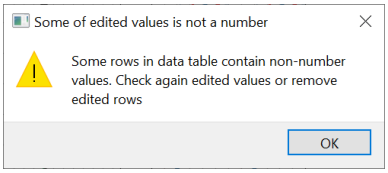


Fig. 9. Warning about a non-numeric value in the tabular module, which needs to be corrected.

1.4. Figures and info window

To the right of the tabular module, there are three figure windows and a notification window (*Info window* - Fig. 1), which illustrate the curves obtained from the raw data loaded from the data files and the results of the calculations used to determine breakout structures. The figures appear in the corresponding windows when the start button ("*Play button*") is pressed. The first figure window (leftmost) consists of 5 different graphs (Fig. 10a) containing values, respectively:

(1) Hole azimuth (H_{Azi}) – marked brown and Realtive Bearing (RB) marked black;
(2) Minimal and maximal calipers (C_{min} and C_{max}) with a black filling of the difference between them;
(3) The difference between the minimal (C_{min}) and maximal (C_{max}) borehole diameter – marked blue and the values of Asymmetry Coefficient (*AC*) – marked black;
(4) Shape coefficient (*SC*) with 0 value as a reference point, which is marked green;
(5) The azimuth of elongation of the borehole walls, for the case when the diameter elongation was recorded by one of the pairs of dipmeter tool pads (SC > 0 - marked in blue) and for the case when the elongations are wide enough to be determined by two pairs of dipmeter tool pads (SC < 0 - marked in red).

The second figure window (Fig. 10b) contains two plots illustrating the results of breakout interpretation in the form of diameter elongation direction, with color coding as in window 1, and the depth of breakouts represented by the value of the shape factor - marked black.

The third figure window (Fig. 10c) shows a rose diagram of the azimuths of breakout structures, based on the profile from the second figure window. The azimuths of breakout structures are rearranged in the angular range from 0 to 180º, and those are included in the statistics displayed in the info window (Fig. 10 d). The diagram shows the number of counts with the 10º classes from 0 to 180º (to convert them to the length of breakout structures in meters, these numbers must be divided by the number of records in 1 m). The counts visible on the diagram in the angular classes from 180 to 360º are a mirror image of the values collected in the interval from 0 to 180º and are not included in the statistics. The points visible on the diagram outside the rose diagram indicate the direction and value of C_{max} (SC > 0) or the bisector of the angle between the two longest calipers (SC < 0) and the relative length of breakouts. The dashed line indicates the nominal bore diameter. Green arrows outside the rose diagram point out the direction of recent S_{Hmax}, resulting from the average azimuth value of the detected breakouts. The notification window (Fig 10d) at this stage shows the basic borehole information downloaded from the .las file, the selected values of the filtration parameters, and the calculated statistical parameters. This information is not deleted when using the program, so it is possible to track changes in statistical parameters with given filtering parameters and return to the most optimal settings. Each figure window can be undocked from the main window and moved to any location on the screen by clicking the dock button ("Undock Window" marked with an arrow in Fig.10). Once a figure is undocked, it can be made larger as needed by dragging the appropriate edges of the window with the mouse cursor.

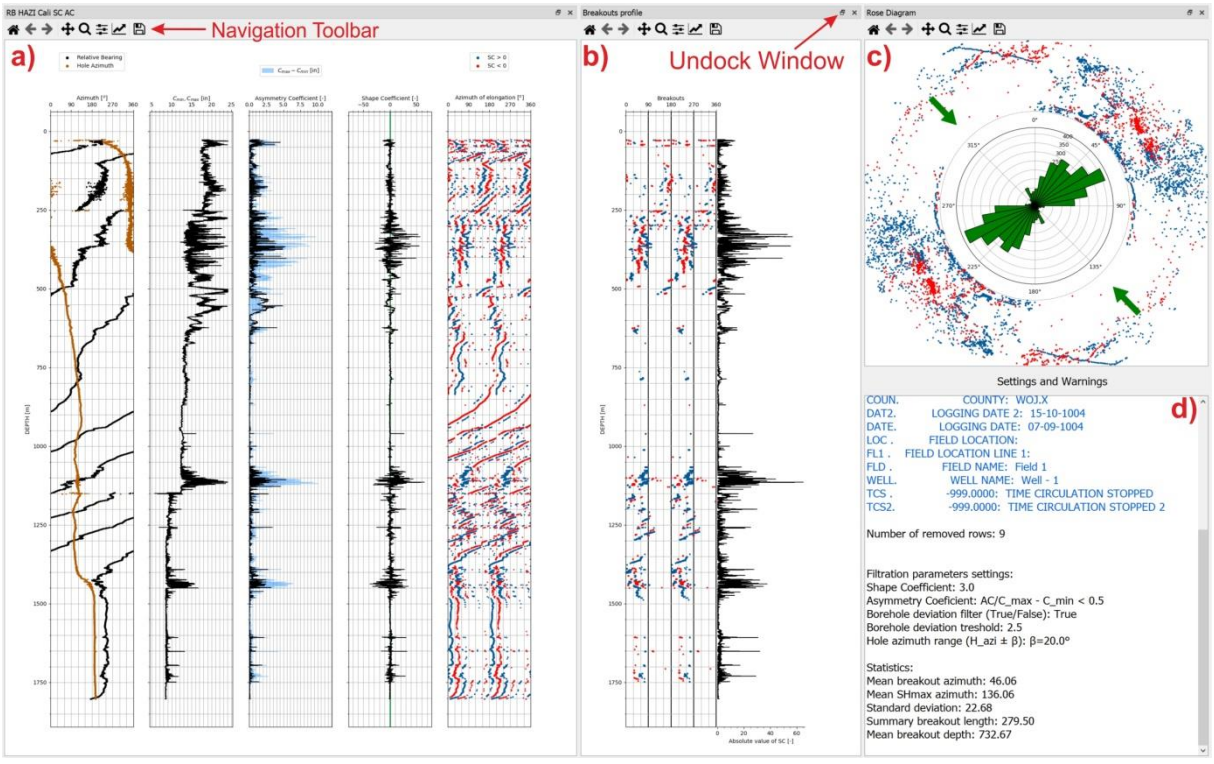


Fig. 10. Module of figures windows and info window.

Every figure window contains its navigation options in the toolbar menu, described as „*Navigation Toolbar*" ("Interactive navigation — Matplotlib 3.2.2 documentation," n.d. , Fig. 10). Navigation toolbar contains the following buttons (Fig. 11):

- *Home* – resetting the view to the default settings
- *Back & Forward* – buttons moving the plot view to settings made at some point in time - step back or step forward
- *Pan/Zoom* – changing the position of axes and zooming. Plot zooming is also possible with the mouse scroll button.
- *Rectangle Zoom* – zooming the plot in the area selected by the rectangle made by the user
- *Subplot configuration* – adjusting particular axes of subplots
- *Adjust axes* – set limits to particular subplot axes
- *Save plot* – save plots with used settings in one of selected formats: .eps, .jpg, .png, .pgf, .pdf, .ps, .raw, .svg, .tiff.

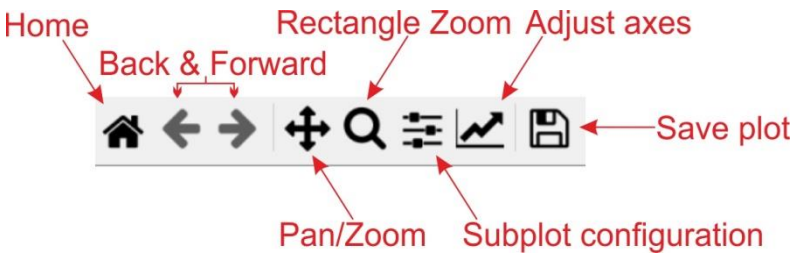


Fig. 11. Navigation toolbar of figure windows.

2. Borehole cross-section window

The borehole cross-section window is used to make a visualization of the dipmeter tool pads at a given depth interval in the borehole cross-section. To perform the visualization of the tool position within the borehole cross-section, the program uses an algorithm for fitting the circle within the four shortest calipers or provided nominal diameter. The cross-section window is launched from the main window after pressing the button described as "Borehole cross-sections" located on the left side of the Main Window. The borehole cross section window contains several fields (Fig. 12):

- *Depth fields* – fields, where the user has to provide a depth range, for which the visualization of pads records will be performed … - … (for example 1350 – 1360). A maximum of six depth intervals can be visualized at once.
- *Diameter fields*, in which the value of nominal diameter for a given depth interval is provided. If the nominal diameter is unknown, the field should remain empty. In such cases, the diameter is fitted to the four shortest pads of the dipmeter tool by the algorithm of the sum of least squares.
- *Info filed*, where information about given or fitted diameters is provided.
- *Figure filed*, in which the results of pads projection are plotted and displayed. The navigation toolbar, the same as in the main window figures is also available for this field. The figure field may be freely resizable.

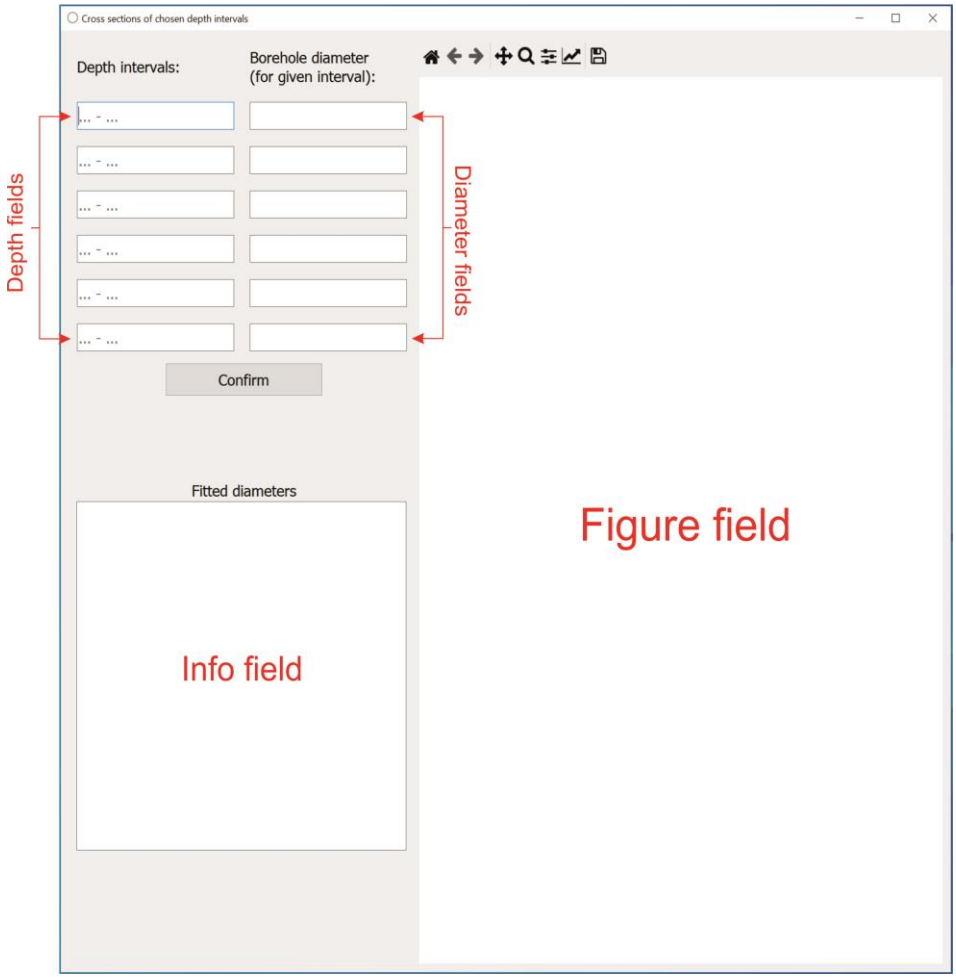


Fig. 12. An empty cross-section window in SPIDER-6 software.

After entering the depth intervals of interest and the corresponding diameters (optionally), press the "Confirm" button located below the depth ranges and diameter fields. Pressing the button will run an algorithm that matches the cross-section of the borehole to the positions of the dipmeter tool arms, which are located within the borehole space by using the center of mass of the hexagon created by calipers (Jarosiński, 2006, 1999, 1998, 1994). The borehole diameter for every provided depth interval is displayed in the info window, unchanged if it was provided by the user, or calculated if its value was unknown and fitted by the sum of least squares. If the calculated diameter does not match any of the known drilling diameters, it is probably elongated in the whole range and should be lowered to the nearest known value. Provided depth intervals are not cleared after running calculations, so fitting the appropriate diameter may be repeated. The results of calculations are displayed in form of cross-section plots for every given depth interval, where the projection of borehole walls is marked by a red circle, and the position of every pad of the dipmeter tool for every sample in the chosen interval is marked by a black dot, the center of mass of hexagon fitted within the pads is marked by violet dots, and borehole axis, fitted to the given diameter and four shortest pads is marked by a red cross (Fig. 13). Checking the plot results enable evaluation of the fitted diameter, which should be the nominal borehole diameter, assuming it is not additionally elongated. The used algorithm of fitting diameter enables us to avoid moving the borehole axis toward the unsymmetrical elongations, such as key seats (Jarosiński 1998).

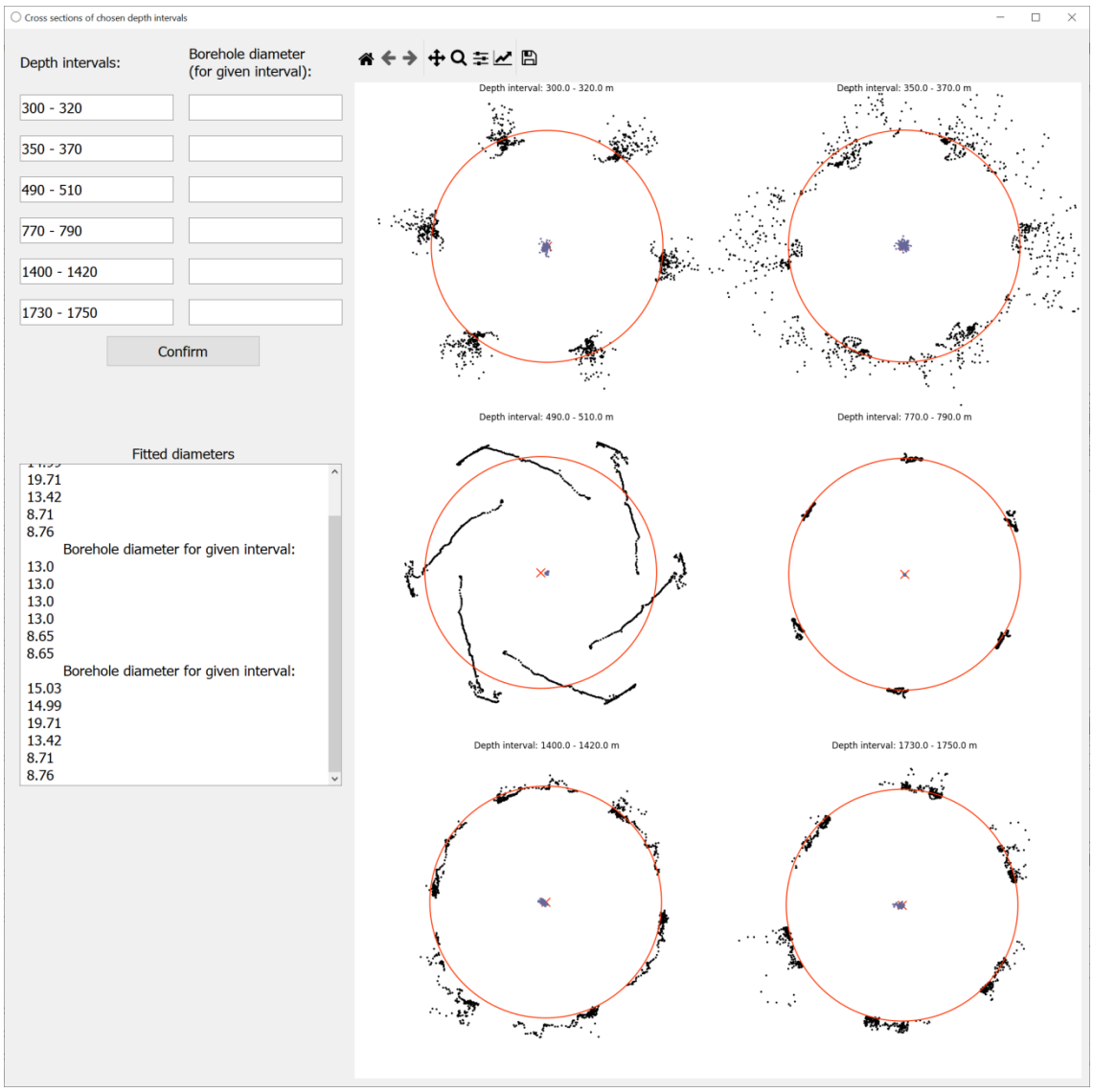


Fig. 13. Projection of dipmeter tool pads from the chosen depth intervals in exemplary borehole.

3. Window for dropping an erroneous results

Analysis of pads projections performed in a cross-section window can be used if we are not sure, whether the breakout structures detected after using appropriate filtration parameters are in fact breakouts. If the result of this analysis is negative, it is possible to manually remove structures, erroneously assumed to be breakouts. To do this, open the error cleaning window using the "Drop erroneous results" button located on the left side of the Main Window. After pressing the button, a dialog box with a text field will appear, in which the user has to specify which depth intervals containing erroneous breakouts should be removed (Fig. 14). The depth intervals should be given in the format: top - bottom (e.g., 350 - 356). If you wish to discard more than one interval, successive intervals should be separated by a comma - e.g. 350 - 356, 400 - 410, 500 - 515, and so on.

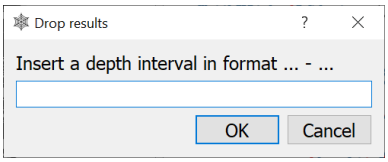


Fig. 14. Dialog window for dropping an erroneous breakouts.

In case of providing depth intervals in a format, that cannot be used, a dialog window with a warning message will appear, forcing to check the correctness of the entered data (Fig. 15). In this case, press OK and enter the correct values.

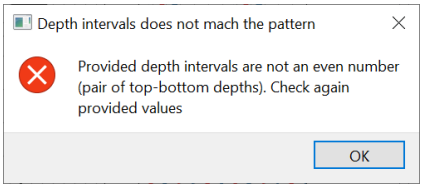


Fig. 15. Warning about wrong depth interval provided in dialog window.

4. Stratigraphy Window

It is possible to add a simplified stratigraphic (lithostratigraphic) profile with textual description to the figure window containing a profile of breakout structures (second figure window). To add a profile, press the button "Add stratigraphic profile" located in the second row of buttons in the center of the Main Window. Pressing the button will open an additional window consisting of three small buttons and a table containing four columns: Unit name (short), Top Depth, Bottom Depth, and Color (optional) (Fig. 16). Within the Unit name (short) column the short name of the particular unit should be provided, next, it's top (Top Depth) and bottom depth (Bottom Depth), and optionally the color of the filling (in the Color (optional) column). Color values should be given in hexadecimal ("HEX" designation - values for the selected color can be downloaded from: https://www.w3schools.com/colors/colors_picker.asp?color=%2300477e), but the program also interprets basic colors given literally, e.g. black, yellow, red, etc. If color is not specified for a particular unit, the filling will remain white. Values for individual units can be pasted into the table from external sources (text files of spreadsheets, where column division is specified) using the ctrl+v shortcut. All values entered in a given row can be cleared by selecting the table cells with the mouse and pressing the delete button on the keyboard. If the default number of rows in the table is too small to create a detailed stratigraphic profile, it is possible to add more rows using the "+" button placed above the table. If it is necessary to remove some unit from the chart, this can be done by deleting the corresponding row of data by selecting it and pressing the "-" button also placed above the table. After entering all the data necessary for the creation of the stratigraphic profile, press the confirmation button - the green sign "✓" located above the table (Fig. 16).

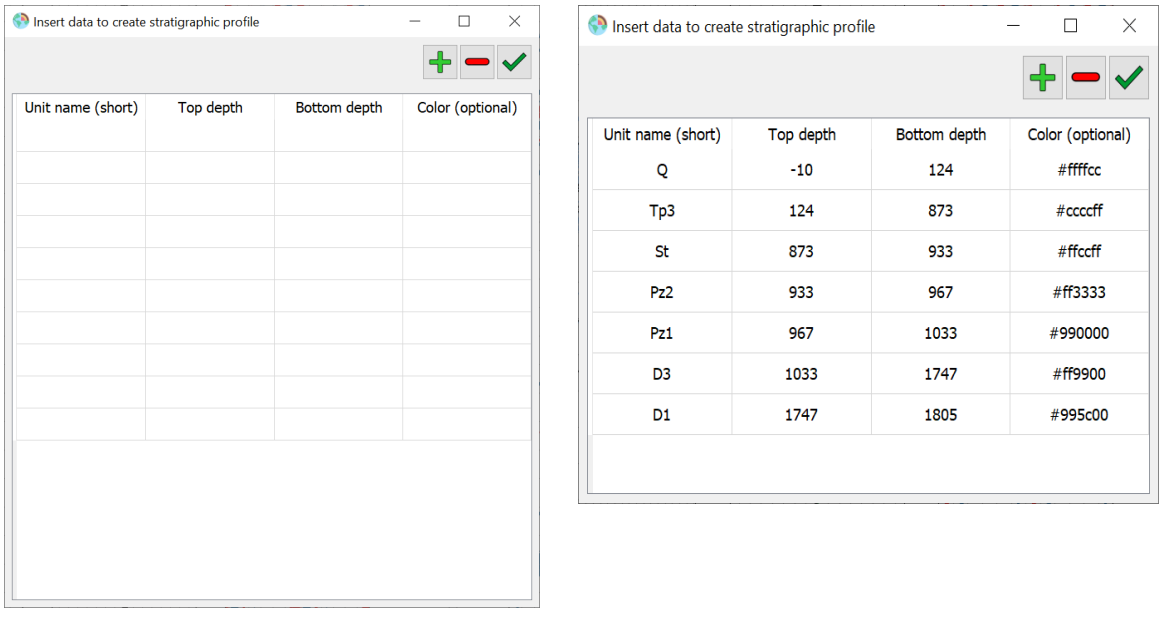


Fig. 16. Window to add stratigraphic profile. Default (left) and filled with exemplary data from test borehole (right).

After pressing the confirm button, a dialog window with a message informing you that all rows of the table left blank will be deleted will appear (Fig. 17). At this stage, make sure that all the desired units have been entered and there are no missing values (name, top or bottom depth). If you are sure that all the data have been entered, press the "Yes" button. If you want to add any more units or correct some cells, press "No" to cancel the operation and return to the table view.

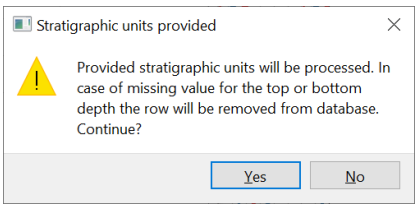


Fig. 17. Dialog window informing about deleting the blank fields from the table.

If the provided values are correct, after accepting the information about deleting rows with missing values, the simplified stratigraphic profile will be added on the left side of the breakouts profile (Fig. 18). If the entered values of the top or bottom depths cannot be interpreted as numbers, a dialog window with a warning message will appear (Fig. 19). Then, provided values should be checked again, and a possible errors corrected.

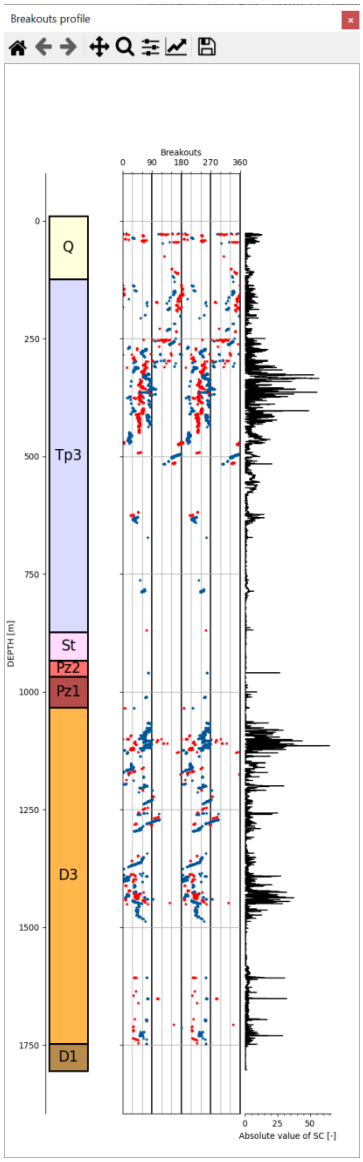


Fig. 18. An exemplary, simplified stratigraphic profile added to the breakouts profile from data provided to a table (Fig. 16)

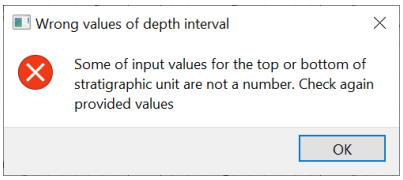


Fig. 19. Dialog window informing about incorrect top or bottom depths.

5. Adding a gamma-ray log

In addition to the simplified lithostratigraphic profile, it is also possible to add a gamma-ray log to the breakouts profile (second figure). This action allows us to verify in which lithological units breakout structures appear more frequently. To add a gamma log, use the button labeled "Add gamma-ray log" located in the center of the Main Window. After pressing the button, the program checks whether the gamma log has already been loaded, along with the 6-arm dipmeter data from a .las file or spreadsheet. If there is a column labeled GR, GRA, or GRP in the database visible in the tabular module, the program will interpret it as a gamma-ray log and display a dialog box informing the user that sought data are already available (Fig. 20). If you want to use the data found in the table, press the "Yes" button, while if you want to load gamma profiling from another file, press "No." If the "No" button is pressed, a dialog box will appear, allowing the user to choose a file containing a gamma-ray log. Similar like in case of loading dipmeter data, file formats such as a .las, .xlsx, or .csv are accepted. The same action will be taken if no gamma log will be found in the tabular module after pressing the "Add gamma-ray log" button.

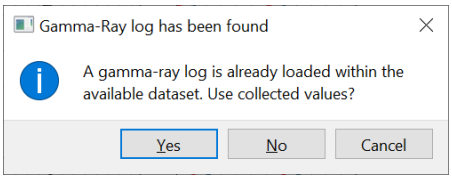


Fig. 20. Dialog window informing about finding a gamma-ray log in the loaded dataset.

If the data loaded from the database or an external file are processed correctly, the gamma log curve will be added to the left side of the breakouts profile (Fig. 21).

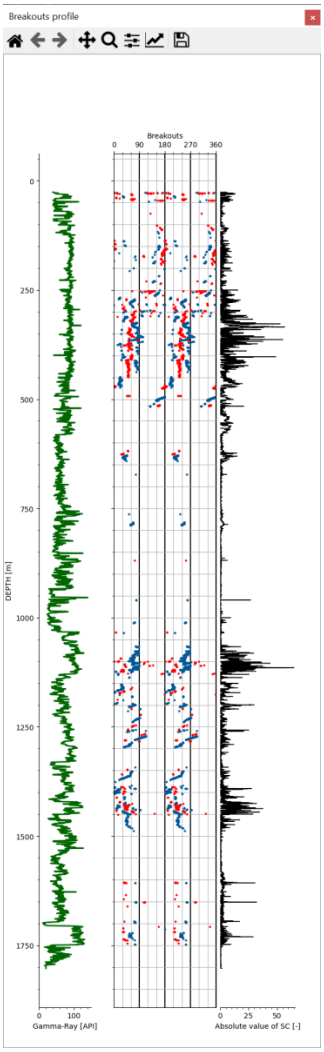


Fig. 21. A gamma-ray plot together with a breakouts profile received from using the gamma-ray adding module.

If the module for adding gamma log was used after adding the stratigraphic profile, which is already present beside the breakouts profile, the gamma-ray plot will be placed in between the stratigraphic and breakouts profiles (Fig. 22).

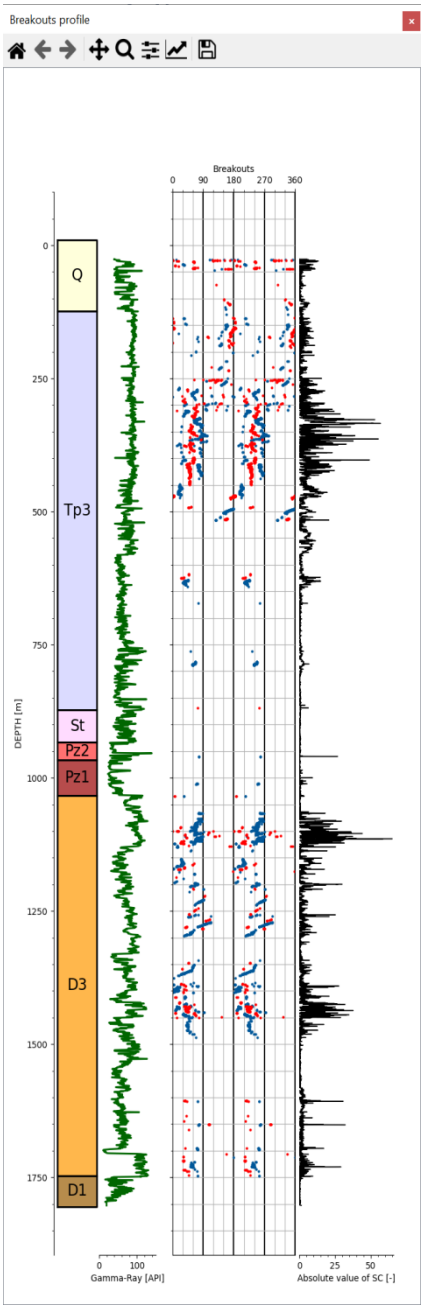


Fig. 22. The stratigraphic profile, gamma-ray log, and breakouts profile received by using described modules for the exemplary borehole.

6. Generating reports

Once the borehole data has been fully analyzed in terms of breakouts occurrence, it is possible to generate a report from the performed analysis and final results. To generate the report, use the button labeled "Generate report" located on the right side of the Main Window. After pressing the aforementioned button, a dialog box with text fields will appear, in which the listed borehole data must be entered (Fig. 23). The borehole data can be completed using the information displayed in the info window, downloaded from .las files during importing files. Below the line edits containing borehole information, there is a menu where you should select a saving option ("Save Settings") - editable .eps (.eps) format or non-editable .jpg (.jpg) format. After selecting the preferred saving option, press the "Save" button to perform the operation or "Cancel" to cancel (Fig. 23).

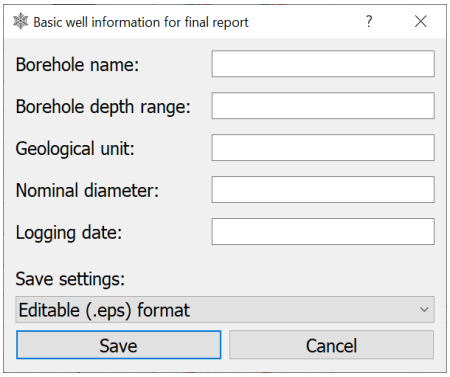


Fig 23. Okno generowania raportów w programie SPIDER-6.

If the report generation process works correctly, the entered hole name will appear in the titles of Figures 1 and 2 in the first two figure windows. The generated report consists of three figures saved in the location with the program distribution, in the "Figures" folder: RB_HAZI_CAL_SC_AC (always saved in .jpg format due to a bug in the package used in the program - this will be fixed in the future), Breakouts and Tables with an extension of .jpg or .eps depending on the selected saving format (editable format is preferred). After saving the figures in editable format, it is possible to combine them in any graphics program (e.g. CorelDraw) and save them as a single figure, like in figure 24.

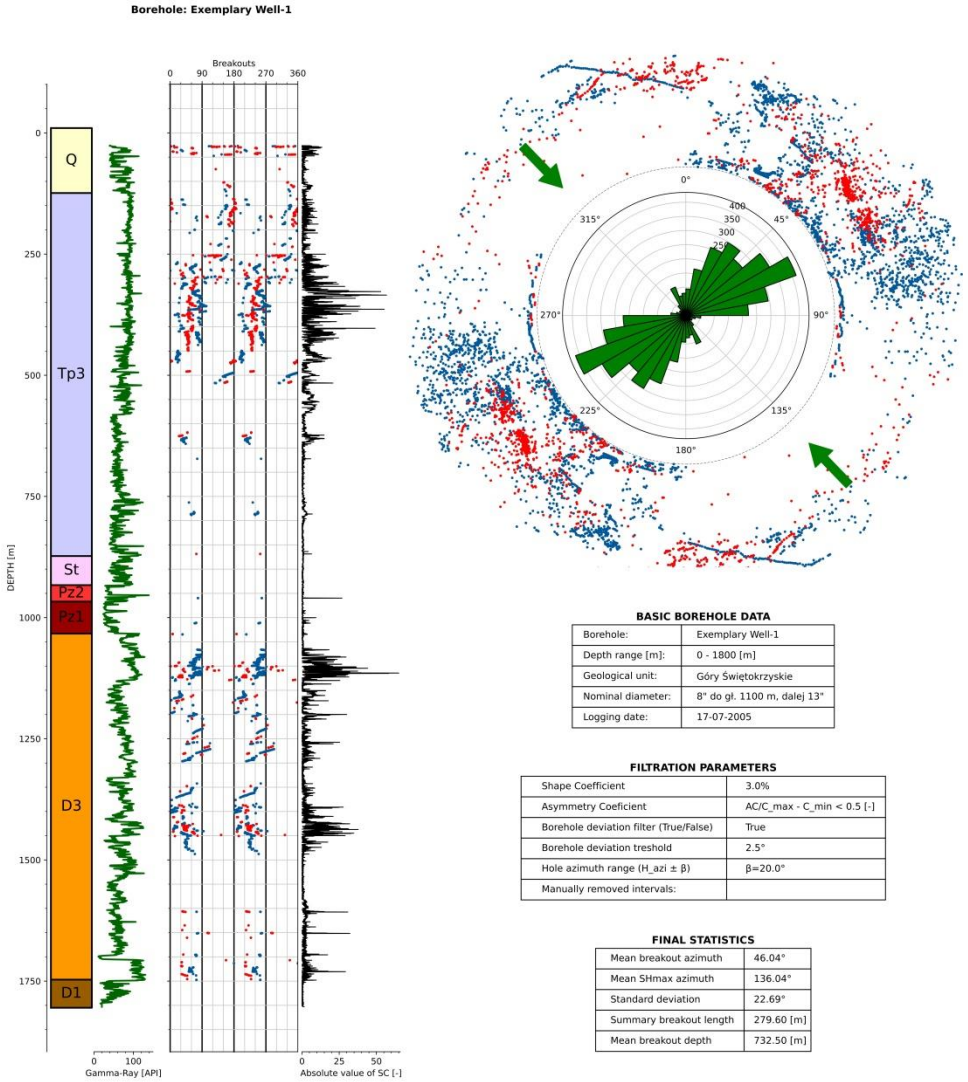


Fig. 24. Figures generated by a "Generate report" module for the exemplary borehole.

7. Clearing data

This option is used to clear the program of all stored data and calculations performed for a given borehole to enable analysis for subsequent boreholes without restarting the program. To clear all data, press the button named "Clear all", located on the rightmost side of the Main Window. After pressing the button, appears the dialog window with a message warning, that all data will be cleared (Fig. 25) - if you want to continue clearing operation, press the "Yes" button. Bear in mind, that this option clears all data and results, so if they were not saved by the save buttons or the report generation, they will be lost.

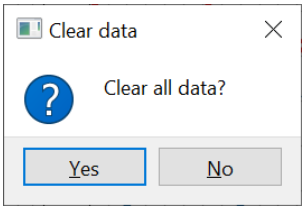


Fig. 25. Dialog window to confirm the clearing operation.

References

Interactive navigation — Matplotlib 3.2.2 documentation [WWW Document], n.d. URL https://matplotlib.org/3.2.2/users/navigation_toolbar.html (accessed 3.14.22).

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Jarosiński, M., 1998. Contemporary stress field distortion in the Polish part of the Western Outer Carpathians and their basement. Tectonophysics 297, 91–119. https://doi.org/10.1016/S0040-1951(98)00165-6

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