CPT-pro - Powerful CPT graphing and interpretation software for Geotechnical Engineers

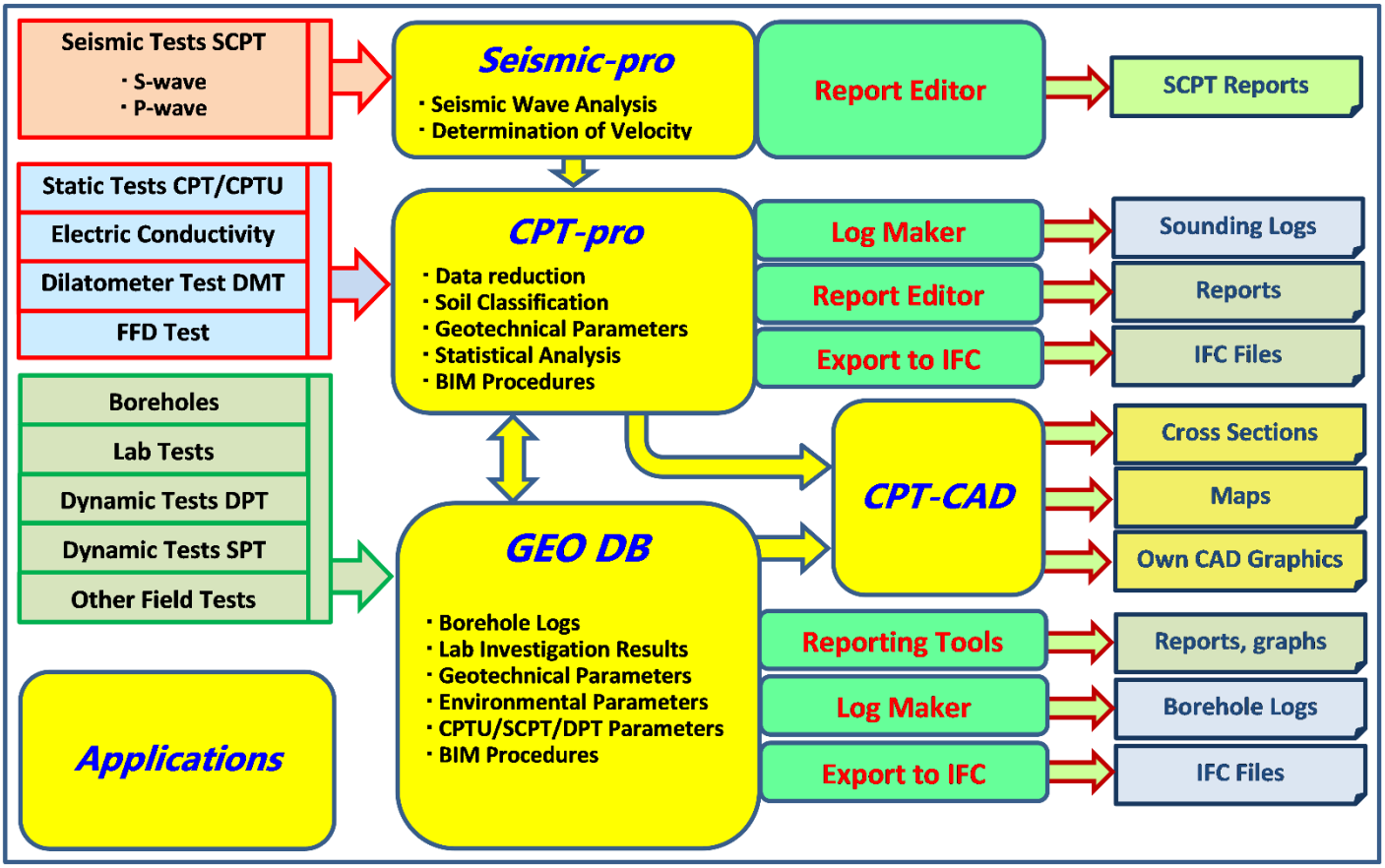
CPT-pro is a multi-module program designed for complex analysis, interpretation and presentation of **CPT** soundings, and also for elaborating geotechnical documentation. Methods of **CPT** sounding interpretation along with formulae and graphs have mostly been extracted, with the knowledge and consent of the authors, directly from the monograph of:

Lunne, T., Robertson P.K. and Powell J.J.M.
Cone Penetration Testing in Geotechnical Practice.
Published by Blackie Academic & Professional. 1997.

CPT-pro consists currently of six modules:

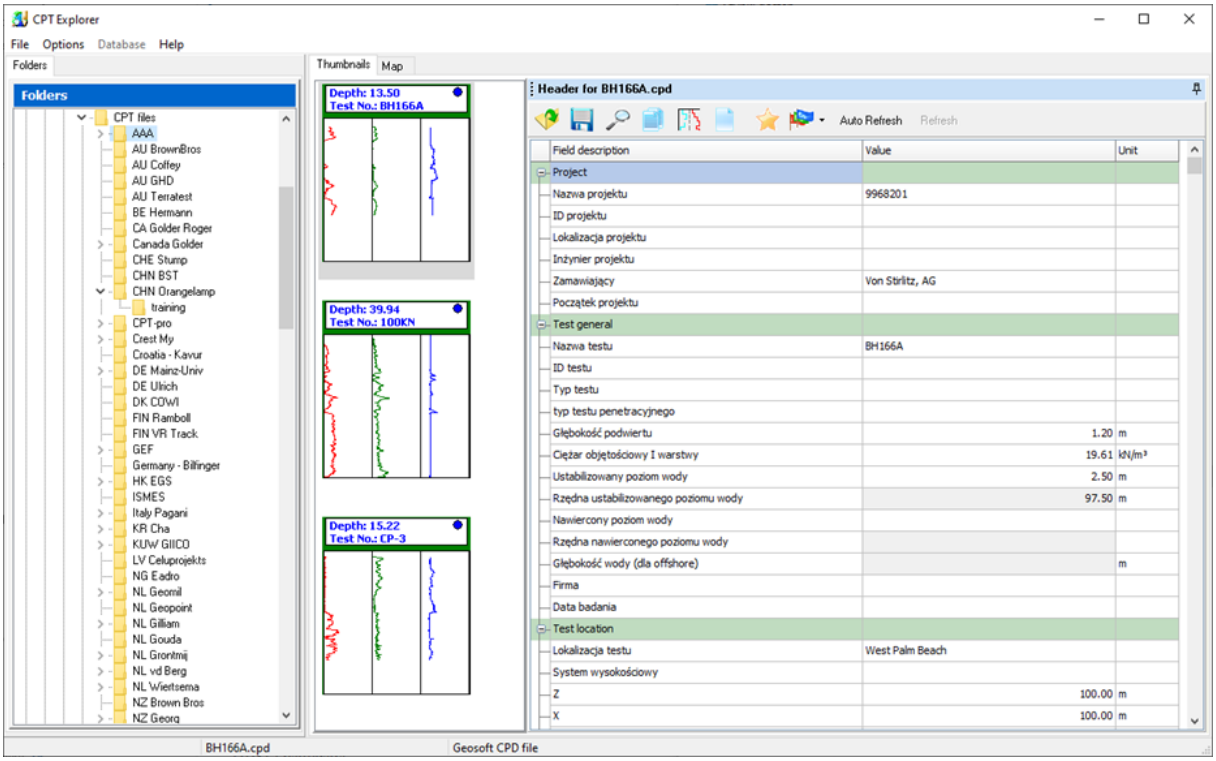
1. **CPT Explorer**
2. **Interpretation**
3. **CPT-CAD**
4. **GEO DB**
5. **VANE-pro**
6. **Seismic-pro**

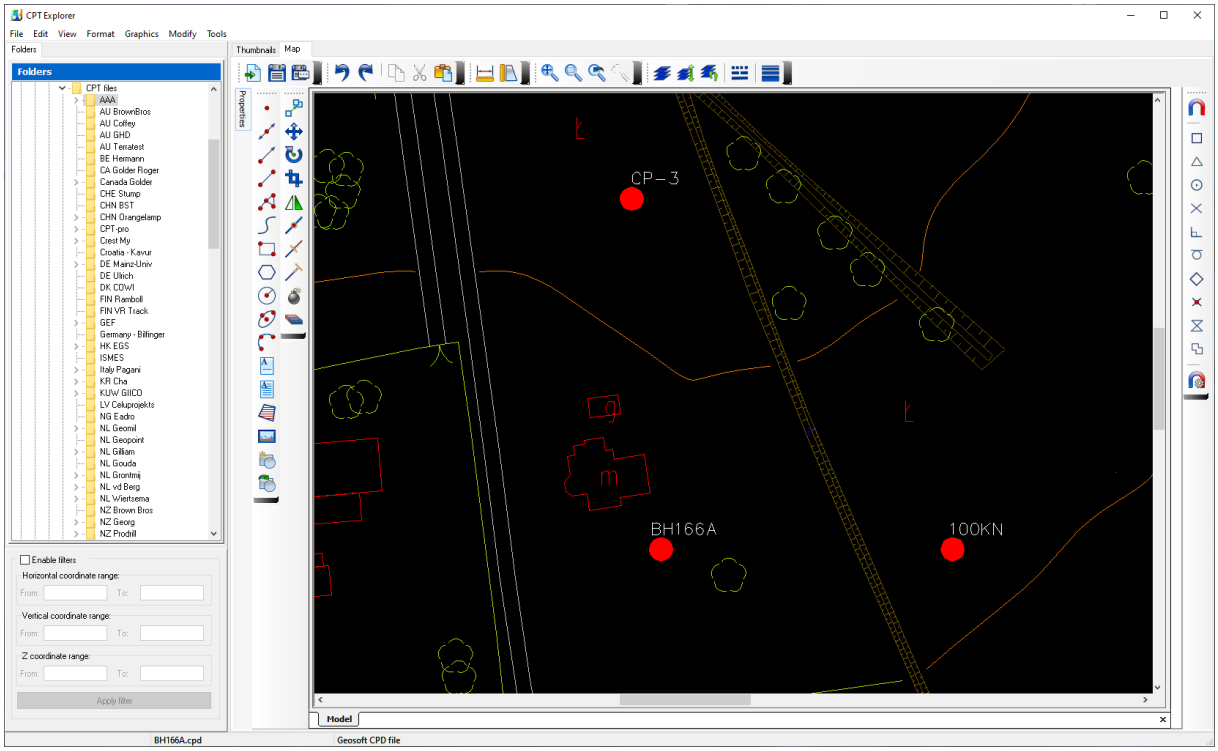
The functions of CPT-pro modules and relations between them is shown on diagram below



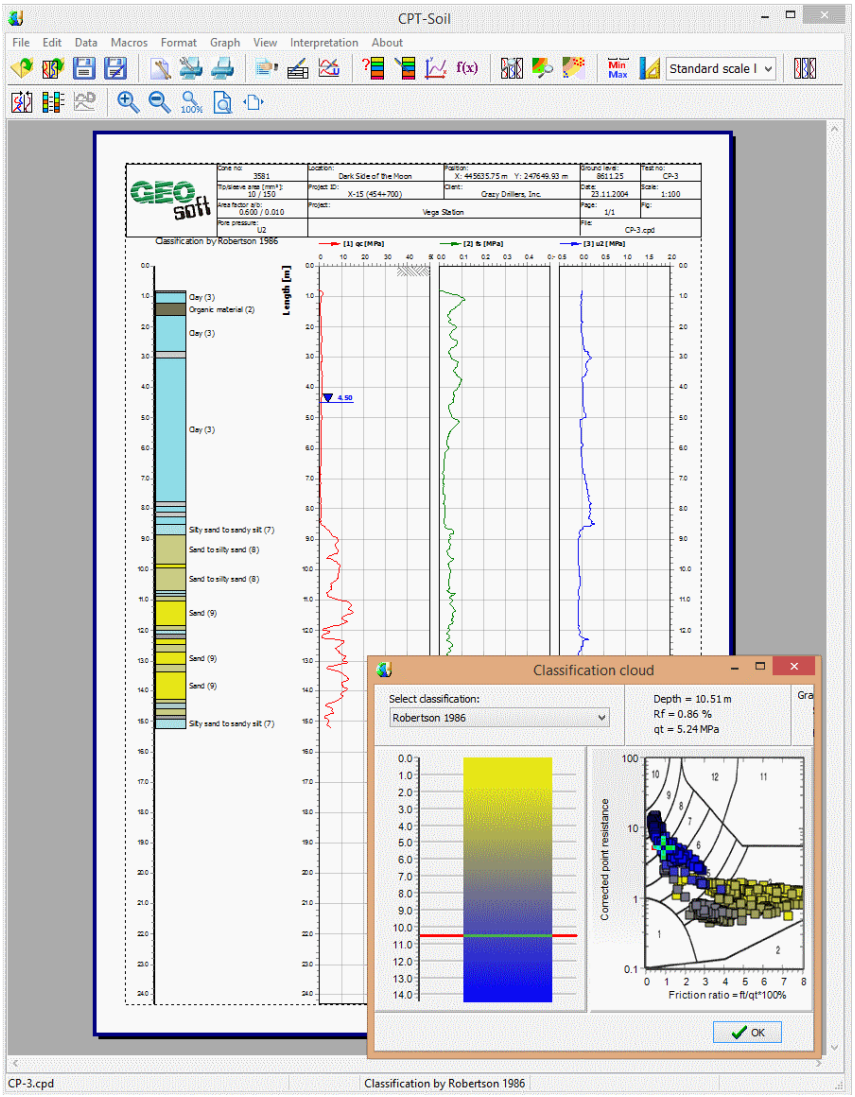
CPT Explorer module is designed for managing, converting and selecting CPT data, containing:

- Browser with directory tree
- ***Map Project*** structure (tools and tree)
- ***Thumbnails*** with charts of selected parameter
- Header info with full edition
- Generation of map with CPT tests locations (only with CPT-CAD)
- Preview selected data file
- Edition of header info (test no, co-ordinates etc.)
- Procedure of entry seismic wave velocity $\mathbf{V_s}$ and $\mathbf{V_p}$
- Conversion of CPT data file to format *.XCPD
- Reporting tool with basic statistics





Interpretation



Main features and options of ***Interpretation*** module:

- Creation of sounding logs with basic parameters and results of interpretation
- Import of CPT files in various formats, including AGS, GEF and CSV
- Conversion to Exchange formats **AGS** and **GEF**
- Analysis and correction of sounding results
- Classification of soils and evaluation of soil parameters
- Grouping of separated layers into geological-engineering layers
- Estimation of characteristic values of parameters in geological-engineering layers based on advanced statistical methods
- Creation of probing cards with parameter graphs and classification results
- Text reports
- Statistics of individual tests and summary statistics
- Presentation of open piezometers
- Analysis and presentation of dissipation tests
- Analysis, interpretation and presentation of DMT tests
- Tracking of parameter values and presentation of relevant points on classification diagrams
- Application of BIM technology – export to IFC format

For each depth selected with crosshair cursor, the values of parameters and position on classification diagram are presented. Independently, all points on classification chart may also be generated and marked with colours according to depth.

The following classification methods are already implemented:

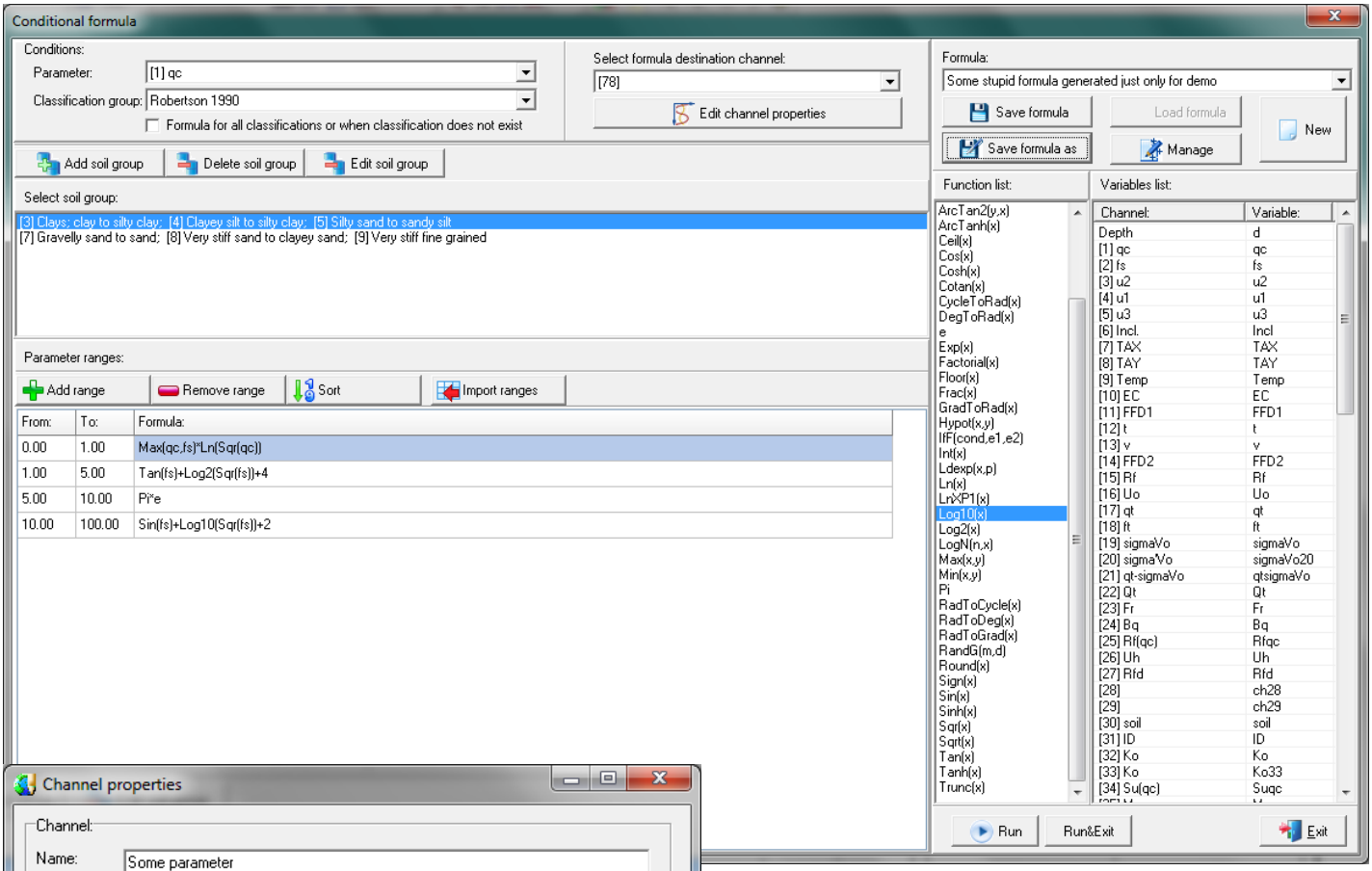
- ***Robertson 1986 (q_t vs. R_f and Q_t vs. B_q)***
- ***Robertson 1990 (Q_t vs. F_r and Q_t vs. B_q)***
- ***Robertson 2010 (q_c/p_a vs. R_f)***
- ***Robertson 2016 (Q_{tn} vs. F_r)***
- ***Polish Standard PN-B-04452***
- ***Geosond (Karl Joseph Witt)***
- ***Meigh 1987***
- ***Senneset & Janbu 1985***

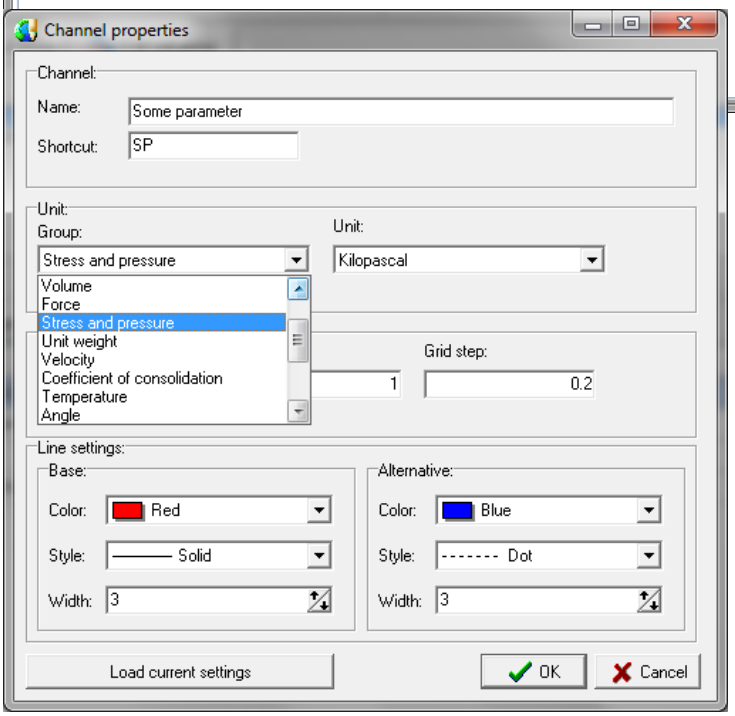
Formula Editor (optional in Interpretation module)

An add-on powerful ***Formula Editor*** allows user defined conditional interpretation functions. Conditions may concern:

- Range of depth or values of selected parameter,
- Soil type.
- Most of mathematical functions used in engineering practice are available.

Each formula can be saved with own name and used exactly in the same way as all evaluations implemented in software. A large number of user channels (300) allows you to create and save 300 own formulas.

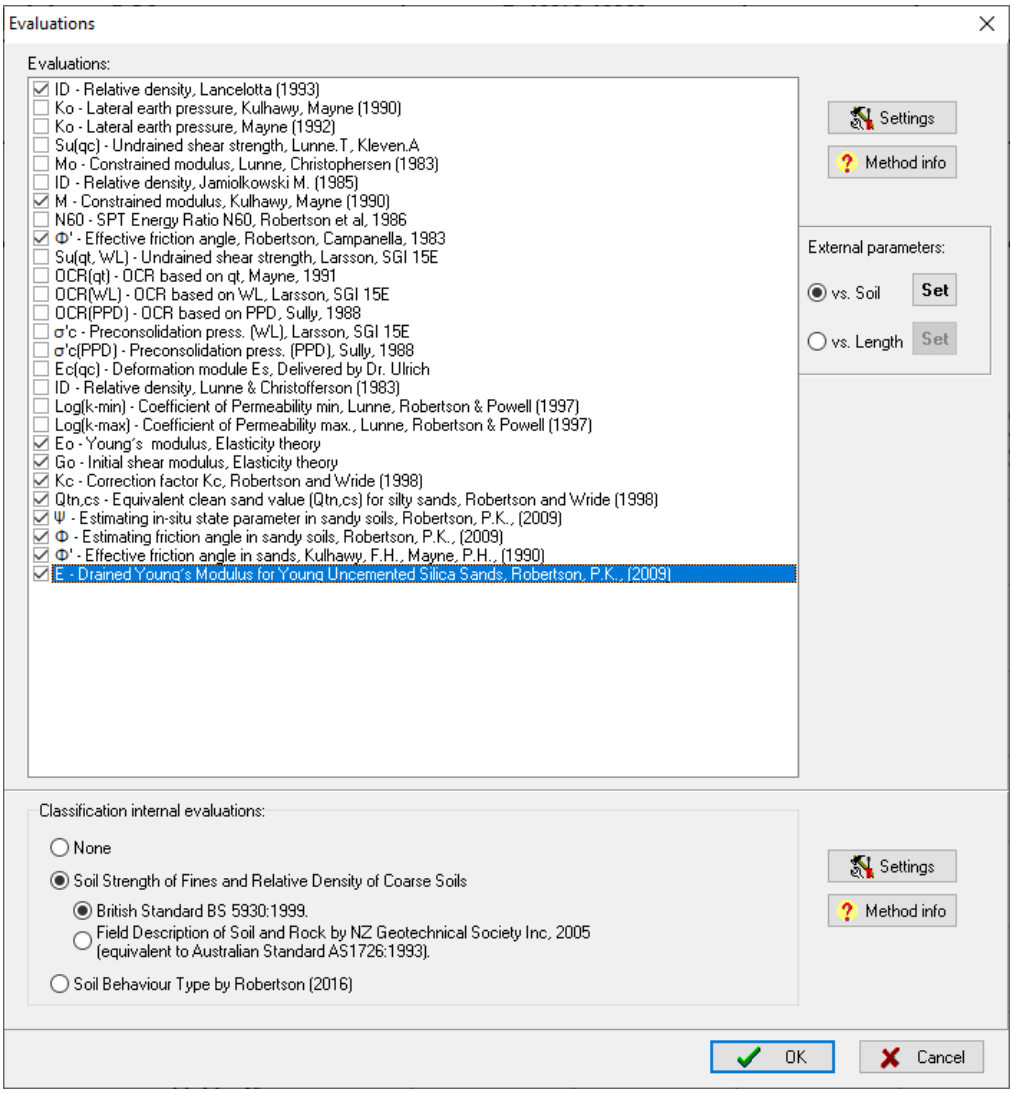




The result of calculation can be saved on User selected channel with own name, shortcut and basic properties, like color of graph, thickness and style of line, grid step and horizontal scale (minimum and maximum).

The ***Unit Group*** as well as ***Unit*** can be freely selected.

All User formulas are saved in configuration files with all settings. The large number of User channels allows you to save 300 custom formulas, which goes beyond the standard needs.



Evaluations implemented in ***Interpretation*** module.

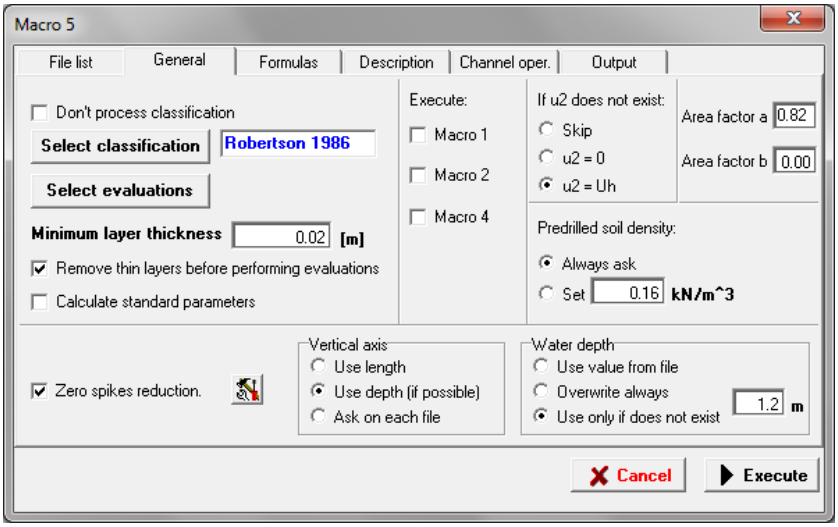
Each implemented method comes from widely known monographs and papers. Some of them are based on CPT parameters only, however, there are some of them which are based also on external parameters like ***Cone Factor*** **Nk**, ***Liquid Limit*** $\mathbf{W_L}$, ***Poisson's Ratio*** etc. These ones may be defined for each soil type separately or may be a function of depth.

The description of each formula with source, formula and – if exists – graph/diagram is attached and available by clicking [***Method info***] button.

Nr	Parameter name	Shortcut	Physical quantity	Display unit	Decimal
[1]	Point resistance	qc	Stress and pressure	Megapascal	2
[2]	Sleeve friction resistance	fs	Stress and pressure	Megapascal	3
[3]	Pore pressure behind cone	u2	Stress and pressure	Kilopascal	4
[4]	Pore pressure on cone	u1	Stress and pressure	Pound/square foot	3
[5]	Pore pressure behind sleeve	u3	Stress and pressure	Pound/square inch	3
[6]	Inclination	Incl.	Angle	Meter of water	1
[7]	Inclination X	TAX	Angle	Kip/square foot	3
[8]	Inclination Y	TAY	Angle	Kilogram/square centimeter	3
[9]	Temperature	Temp	Temperature	Ton (metric)/square meter	3
[10]	Przewodnictwo EC	EC	Conductivity	Siemens/meter	2
[11]	Fuel Fluorescence Detector 1	FFD1	Reference	Value	3
[12]	Time	t	Time	Second	3
[13]	Speed of penetration	v	Velocity	Milimeter/second	3
[14]	Fuel Fluorescence Detector 2	FFD2	Reference	Value	3
[15]	Friction ratio = ft/qt*100%	Rf	Percent	Percent	2
[16]	Dissipated pore pressure	U0	Stress and pressure	Megapascal	3
[17]	Corrected point resistance	qt	Stress and pressure	Megapascal	3
[18]	Corrected local friction	ft	Stress and pressure	Megapascal	3
[19]	Total overburden stress	σVo	Stress and pressure	Megapascal	3
[20]	Effective total overburden stress	σ'Vo	Stress and pressure	Megapascal	3
[21]	qt-sigmaVo	qt-σVo	Stress and pressure	Megapascal	3
[22]	Normalized cone resistance	Qt	Reference	Value	3
[23]	Normalized friction ratio	Fr	Percent	Percent	3
[24]	Pore pressure parameter	Bq	Reference	Value	4

Different unit systems.

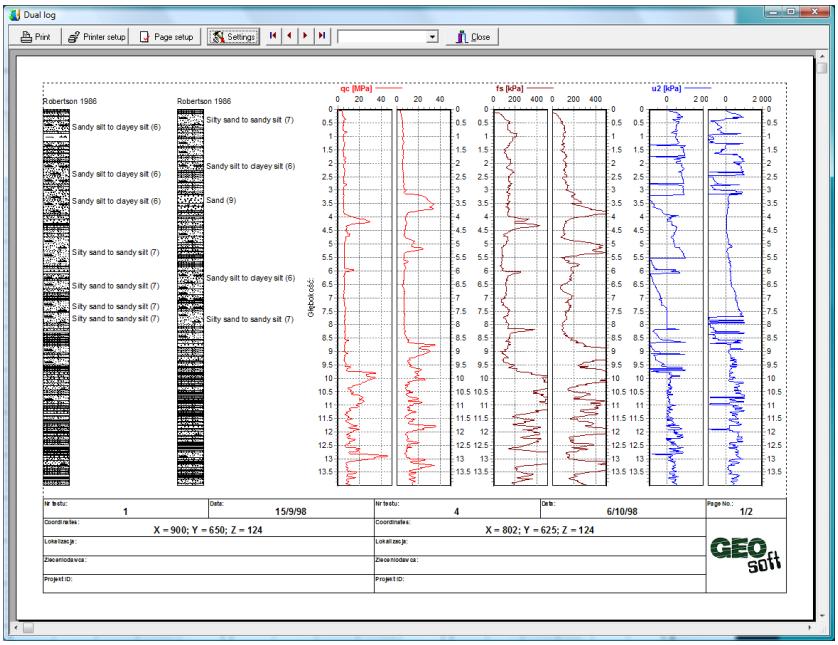
All parameters, native and all results of interpretation, can be presented and exported in reports in freely chosen unit system.



Batch processing

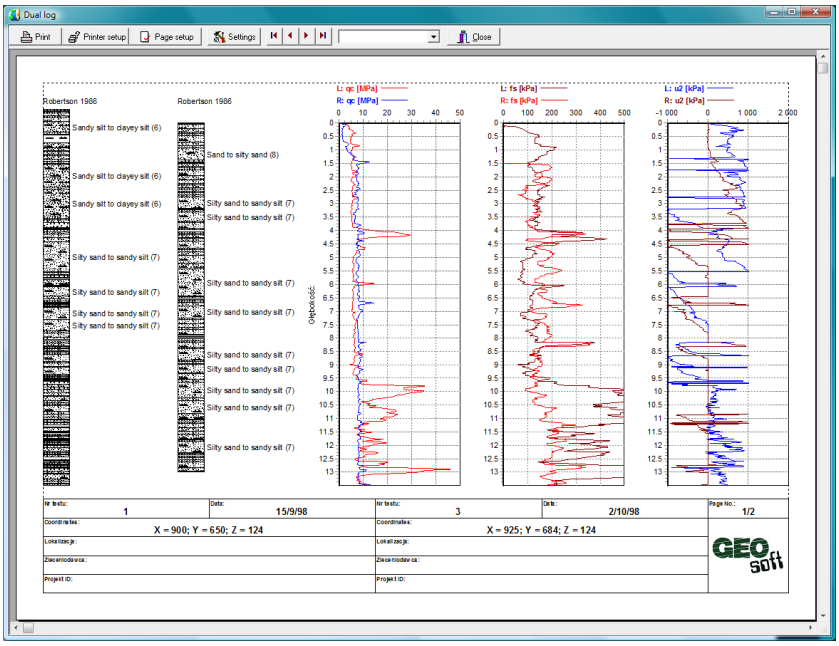
Batch processing settings window. This option allows batch interpretation and reduction of as many CPT files as necessary. Additionally, completion of all descriptions (Location, project name etc.) is available at the same operation

Own interpretation formulas are available like evaluations implemented in application.

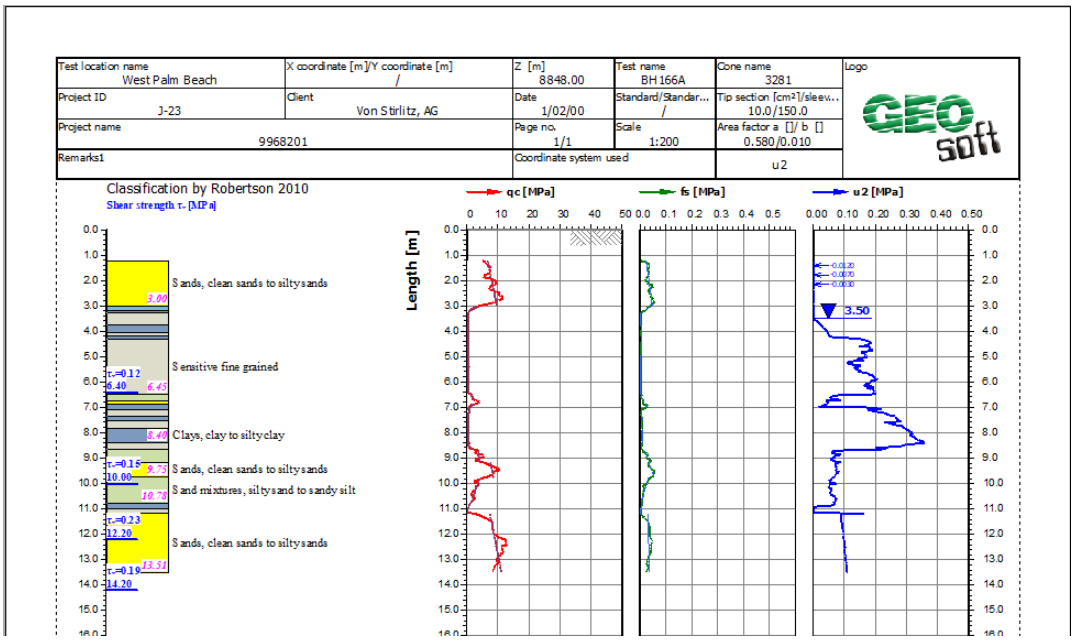


Dual log

Dual log option allows to compare two different tests (soil sticks and graphs of parameters), for instance - before and after compaction. Graphs of selected parameter can be generated in separate graphic fields (each for different test as on the left) or in the same one (see next page).

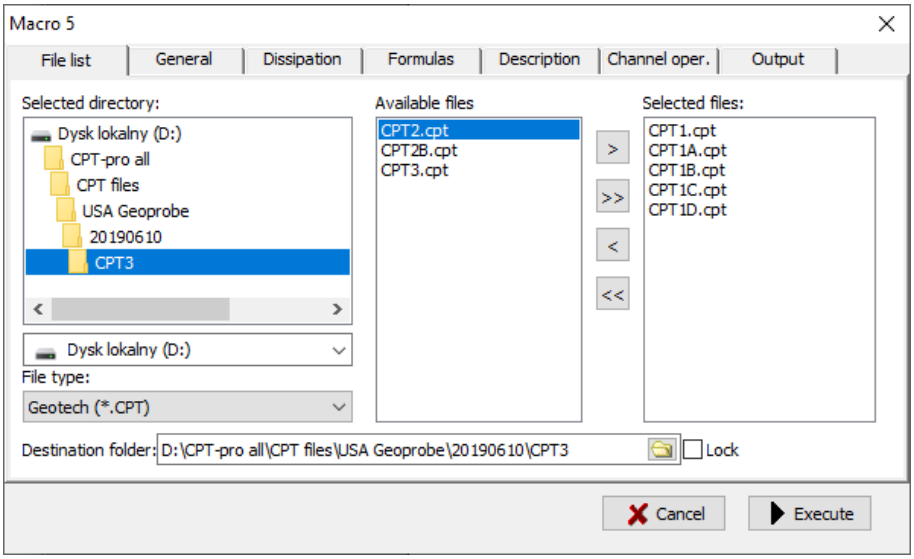


Dual log with two graphs of parameters of different test in the same graphic field.

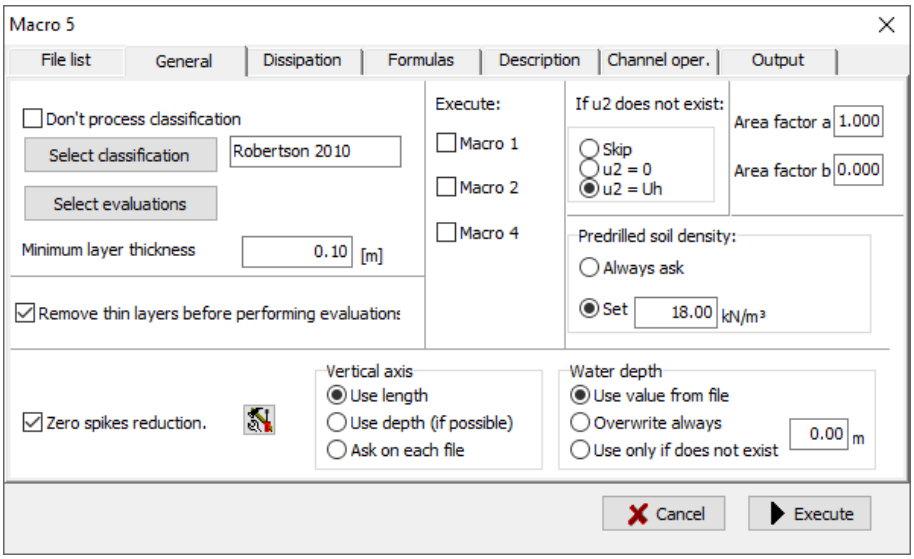


Integration with ***VANE-pro*** software allows to present values of ***shear strength*** estimated in ***Field Vane Test (FVT)*** together with CPT results.

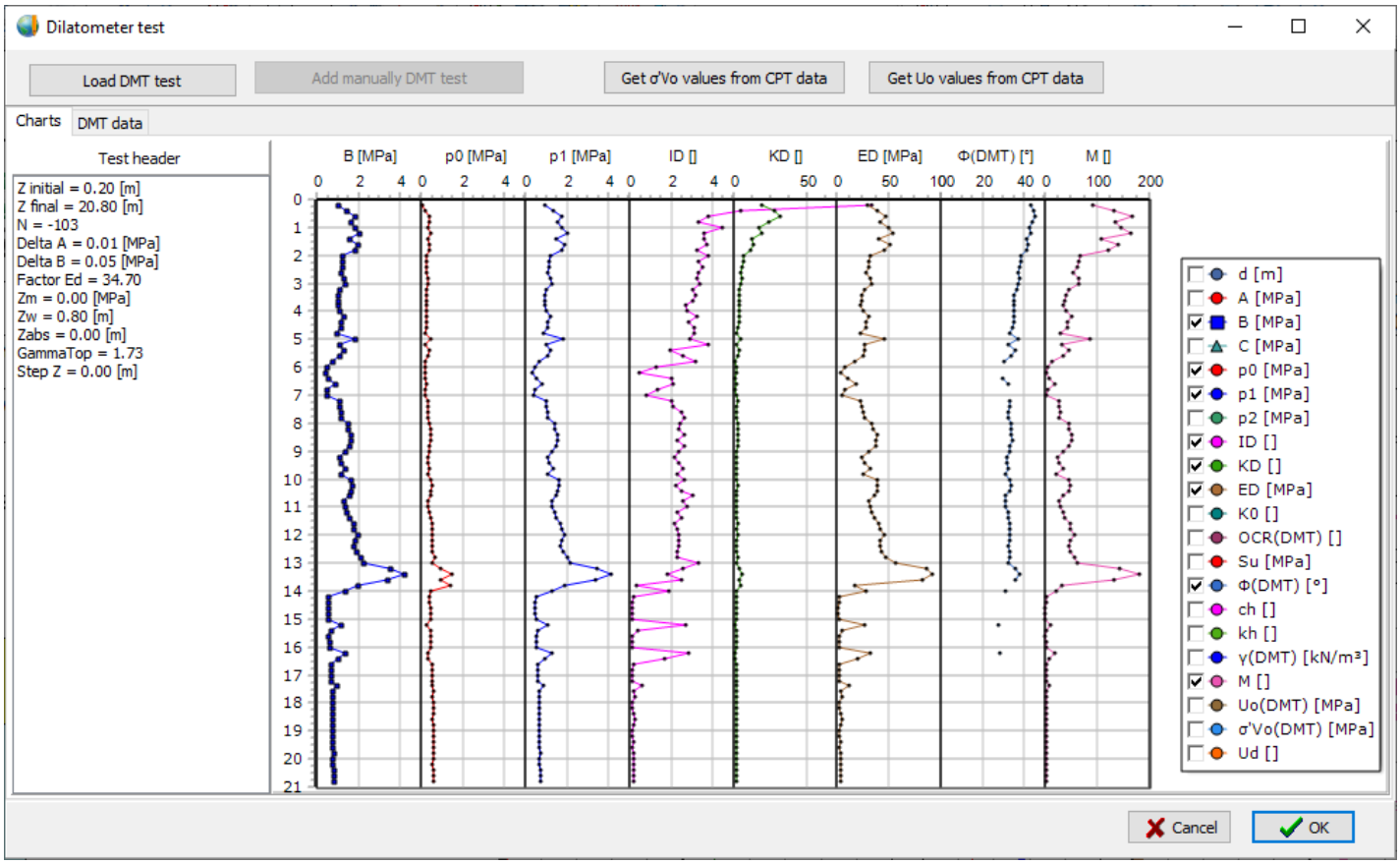
The values of CPT parameters and interpreted parameters can also be presented on the charts as average values in ranges in ranges defined by the type of soil and as trends in these ranges.

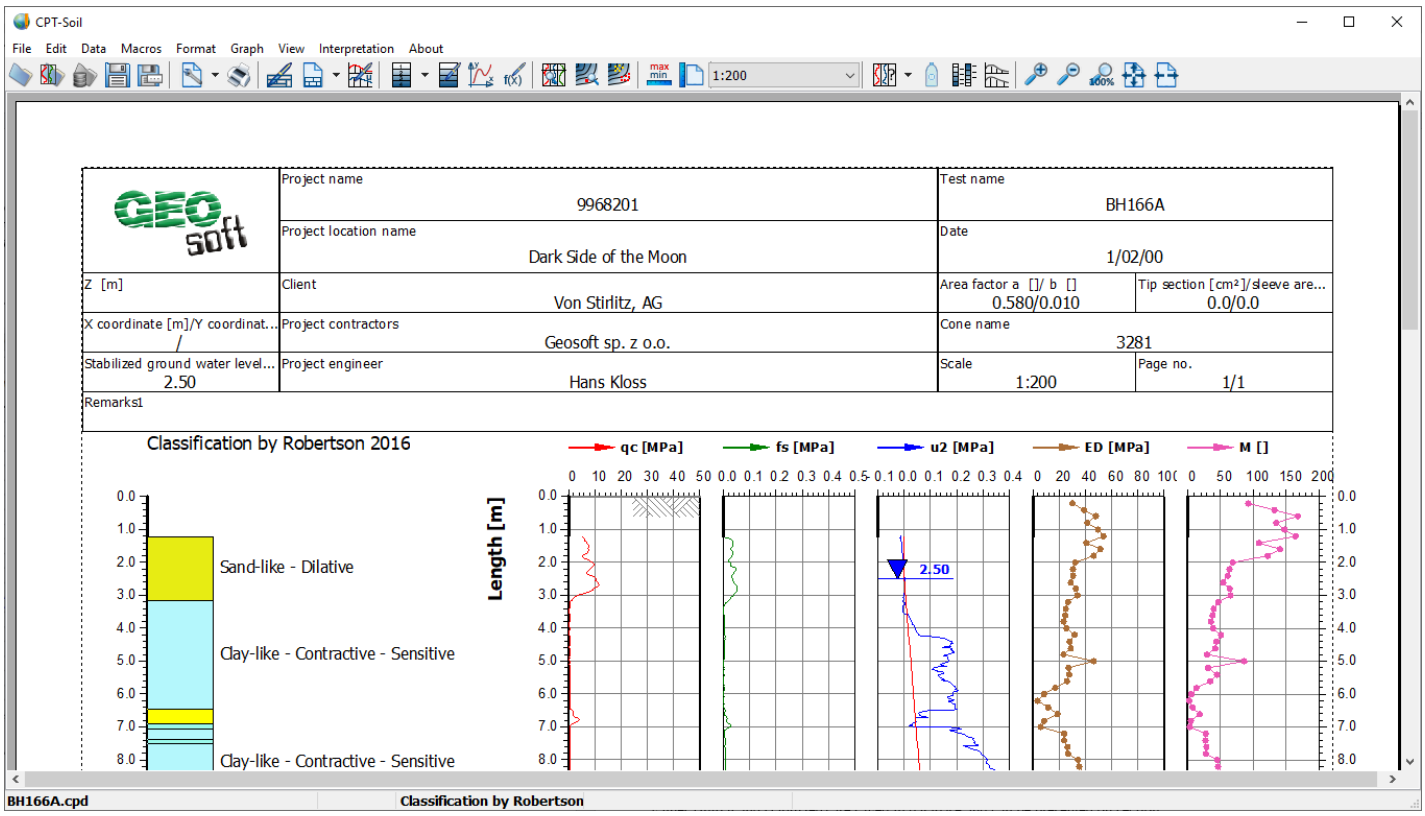


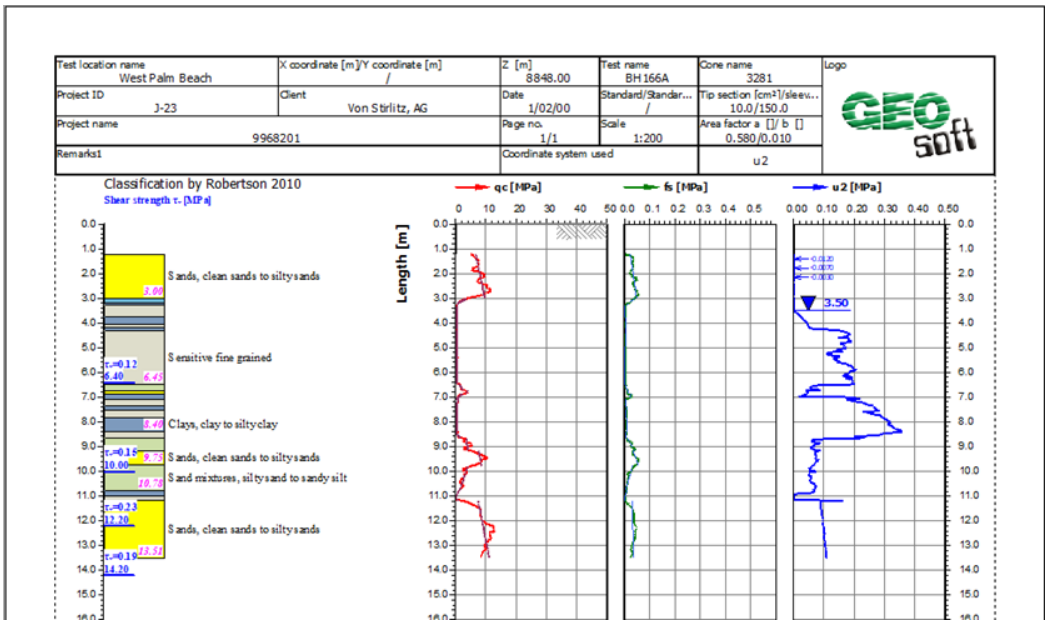
The implemented macros enable the automation of a number of procedures performed on a selected set of files, which allows for significant time savings.



DMT test results can be entered into the program and interpreted in accordance with the methods and correlations developed by prof. Silvano Marchetti. Each of the graphs of native or interpreted parameters can be presented on the sounding log separately or together with the selected CPT test.







Integration with **VANE-pro** (for the interpretation of **FVT** shear tests) allows the presentation of shear strength **τ** values together with **CPTU** results.

Generating tabular summaries of parameter values and basic statistics for selected soil types, selected parameters and selected sounding package. Exporting results to Excel **XLS** format.

Soil type	Ceiling	Floor	Parameter	Mean value **μ**	Standard deviation **σ**	Variability coefficient **V [%]**
Sand mixtures, sands	0.04	0.14	Relative density, ID [%]	134.60	2.00	1.70
			Internal friction angle, Φ' [°]	48.00	0.00	0.00
Fine sands to silty sands	0.14	0.38	Relative density, ID [%]	107.60	4.60	4.40
			Internal friction angle, Φ' [°]	48.00	0.00	0.00
Fine sands to silty sands	0.52	1.38	Relative density, ID [%]	77.40	3.50	4.50
			Internal friction angle, Φ' [°]	46.49	0.83	1.81
Fine sands to silty sands	1.62	2.54	Relative density, ID [%]	56.00	6.00	10.80
			Internal friction angle, Φ' [°]	41.53	1.20	2.93

Generating tabular summaries of classification results for a selected probe package. Exporting results to Excel **XLS** format.

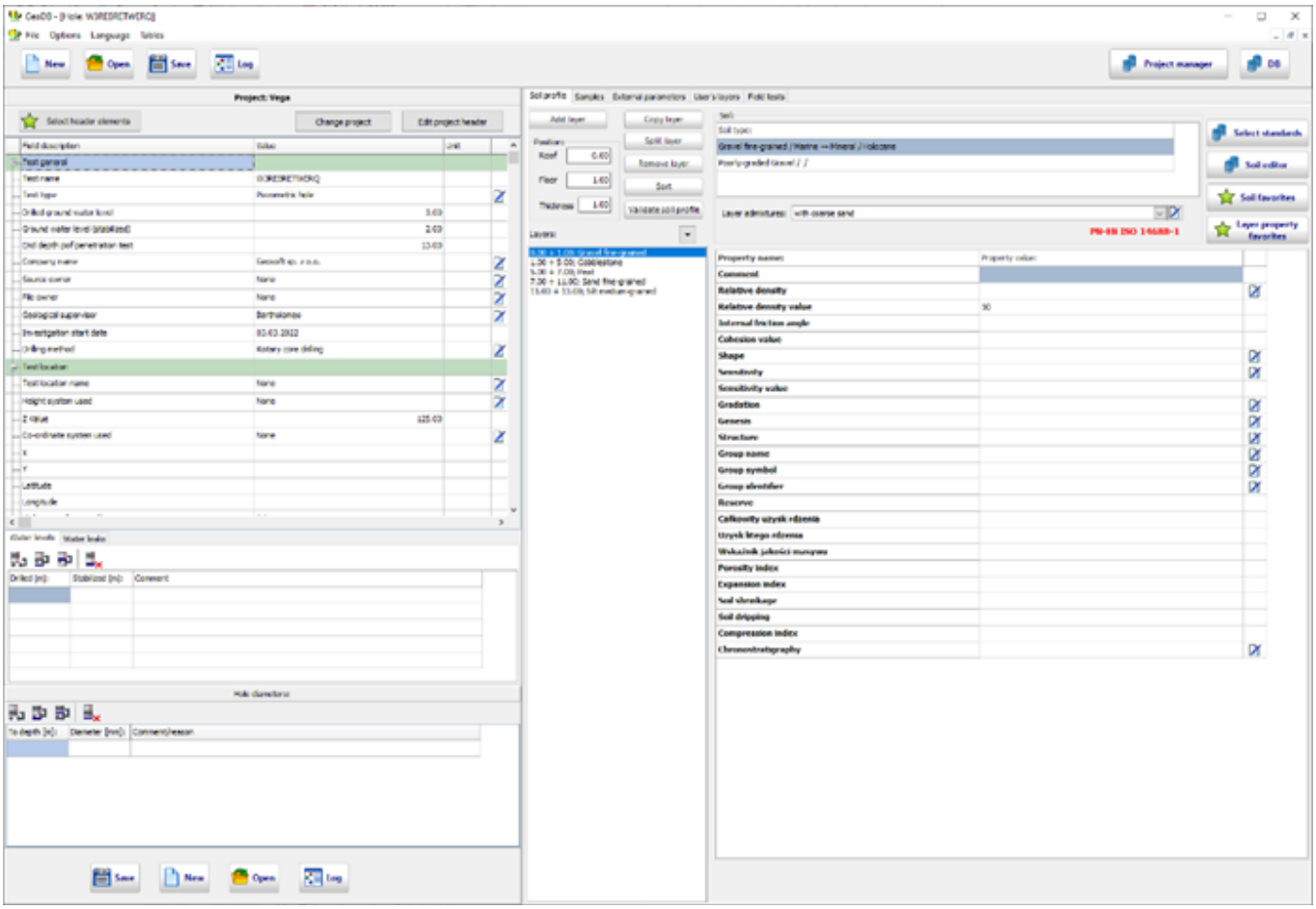
Test number	**Silty clays to clays, clays**		**Silts**		**Silts to silty sands**		**Medium sands to silty sands**		**Gravels, gravely sands**		**Total**	
	[m]	**[%]**	**[m]**	**[%]**	**[m]**	**[%]**	**[m]**	**[%]**	**[m]**	**[%]**	**[m]**	**[%]**
1	7.44	23.47			10.70	33.75	13.26	41.83	0.30	0.95	31.70	3.93
2	0.72	1.56	0.92	1.99	9.42	20.42	33.24	72.04	0.46	1.00	46.14	5.72
3	11.21	25.28			23.50	53.00	9.55	21.54			44.34	5.50
4	25.52	53.34	1.10	2.30	5.88	12.29	10.82	22.62	4.52	9.45	47.84	5.93
5	112.98	14.01	26.21	3.25	280.37	34.76	341.72	42.36	22.68	2.81	806.66	100.00

Geo DB

for creating database containing information on User's borehole logs and geotechnical parameters which have structure [**Value vs. Depth**]. All results are saved in local database, however, due to structure of ***Data Editor***, database file can be shared in local network. Project structure included in ***Data Editor*** enables grouping of data sets, so data managing is very easy and effective.

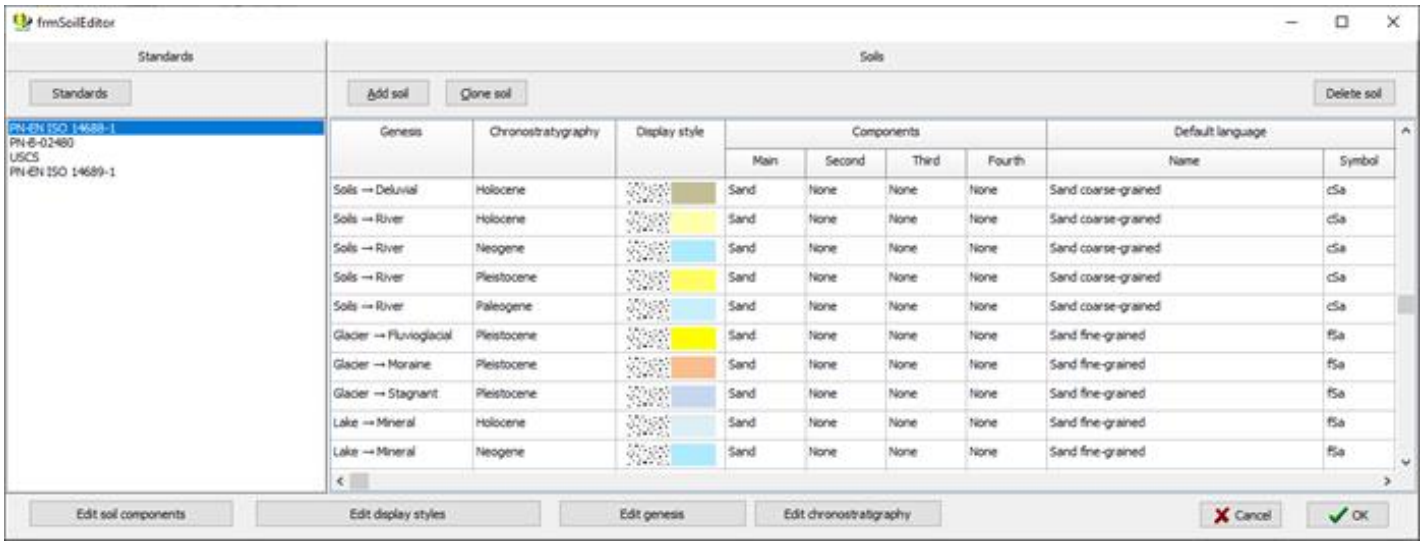
Each log and parameter value should include co-ordinates X, Y and Z, so it can be automatically presented on map generated with ***Map*** module (as relevant symbol with description) and on geotechnical cross section, generated with ***Cross Section*** module (borehole log as a soil stick with symbol/color filling and parameter as a graph).

All descriptions (soil type, consistency, moisture content etc.) are selected from User defined lists (see example on left), so adding new borehole logs to database is very easy and efficient. Each soil layer can be saved in database with own graphic symbol and representing color, which are used on cross sections as a filings of soil sticks. Water level values (initial and stabilized) are saved in database and can be presented on section.



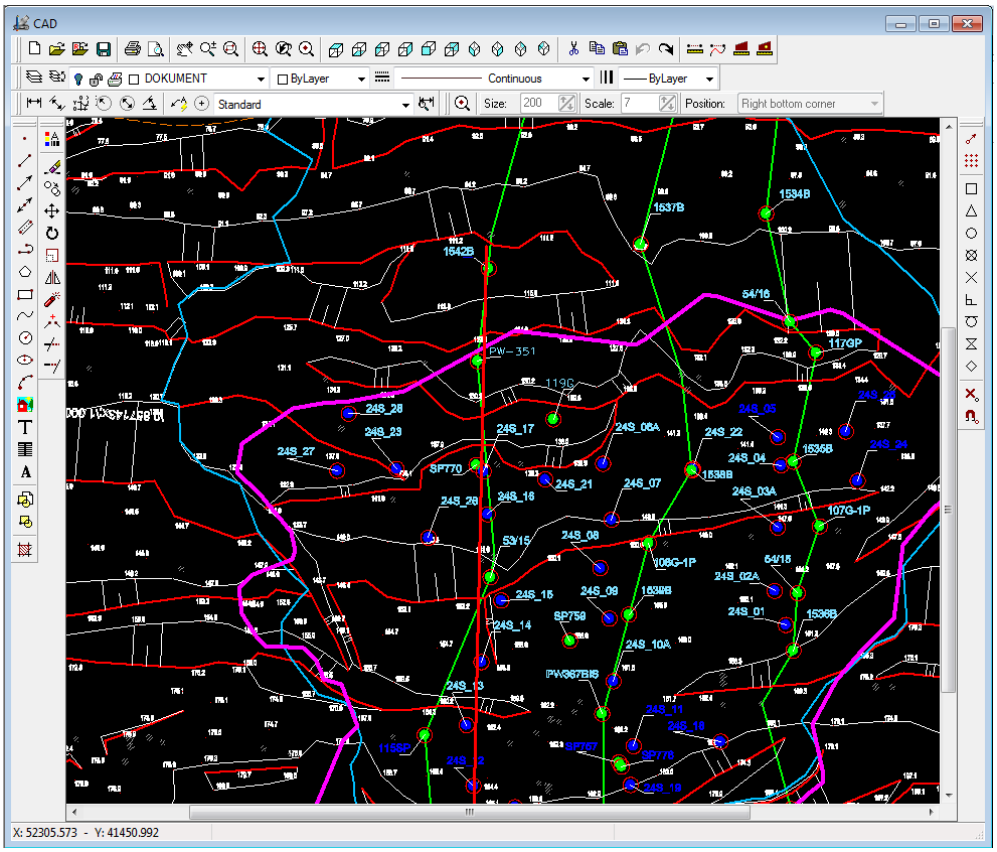
Graphs of parameters can be automatically included to geotechnical cross sections generated with Cross Section module.

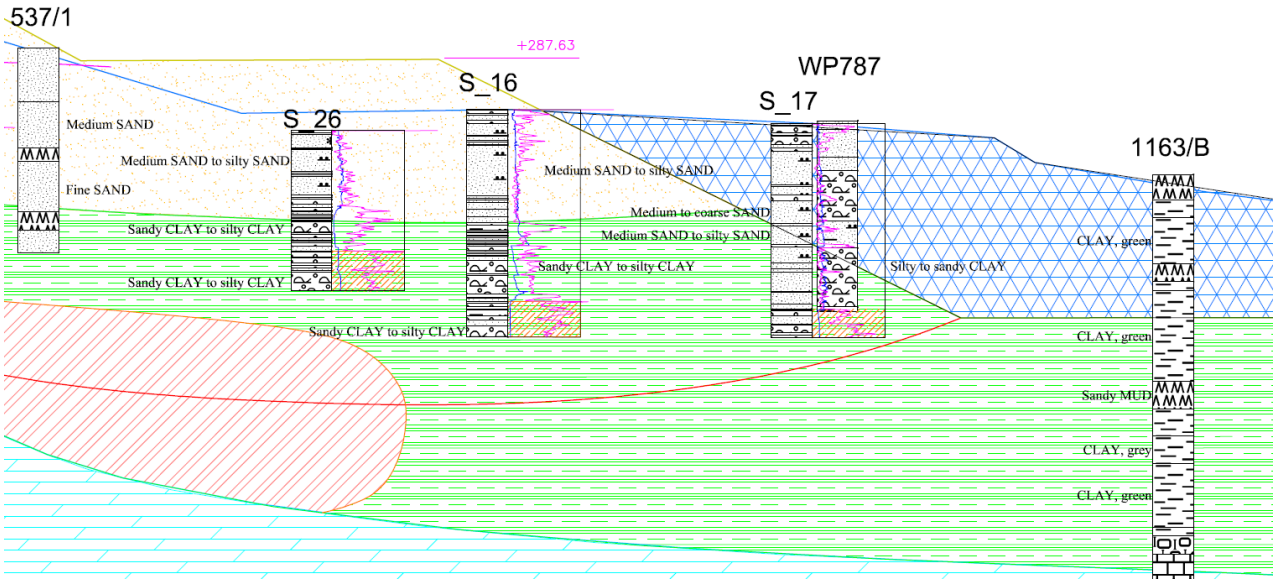
All geotechnical parameters which have a structure [**Value vs. Depth**] can be saved in the same database as a relevant values connected to investigation hole. Soil type description of such hole is not required, so parameters can exist only as a "values on certain depths".



CPT-CAD for creation of geotechnical cross sections and maps. Sections may have different vertical and horizontal scale, and contain:

- Charts/diagrams of CPT parameters
- Interpretation results of soil classification shown on section as soil sticks filled with geological patterns or colours
- Water level symbols with elevation (imported from CPT file)
- Borehole logs from external sources (see ***Data Editor*** module)
- Interpretation results of values of selected soil parameters in the form of charts of such parameters
- Graphic objects that represent geotechnical layers and structures
- Additional descriptions and comments
- Additional graphic objects generated with advanced CAD type graphics





A section line can be defined as a *straight line* or a *polyline* onto which selected holes are projected, or a *polyline* from point to point. Scales of section, vertical and horizontal, can be selected independently and arbitrarily. Built-in CAD type graphic is compatible with DWG and DXF formats. Implemented layer structure of drawing, as well as a number of advanced graphic functions standard for CAD software, make drawing procedure easy and effective. Sections generated in CPT-CAD may be saved as fully editable *.CPTCAD file with whole structure and all objects of section, PDF file (with PDF printer software) and DWG/DXF files that can be opened in AUTOCAD or MICROSTATION software.

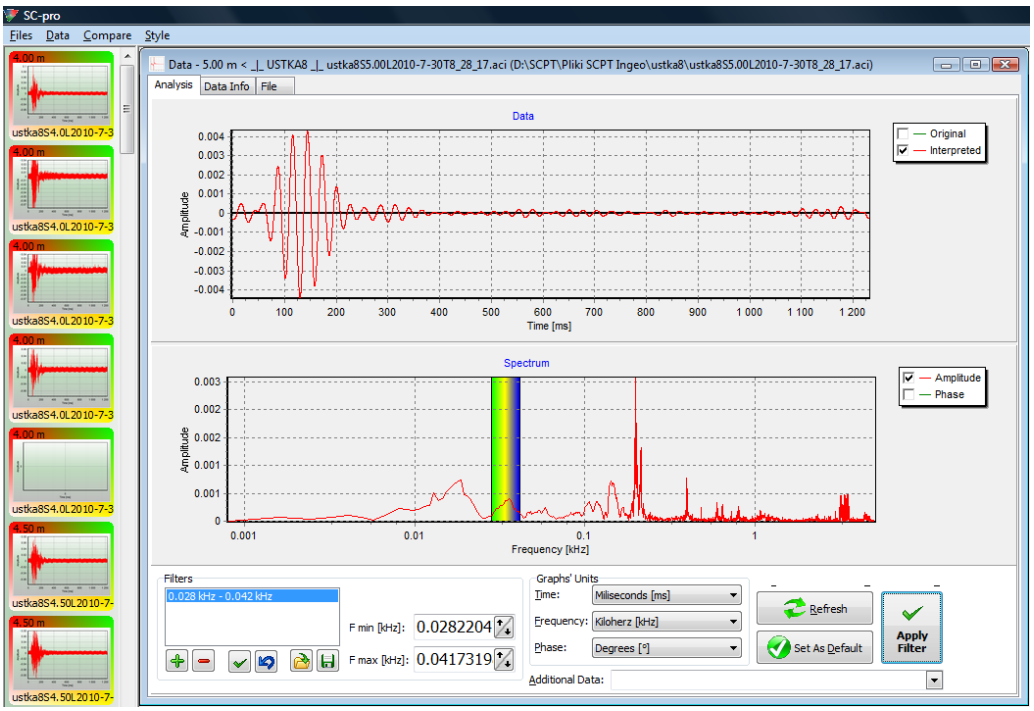
CPT-CAD has implemented mapping functions and enables presentation of CPT and VANE tests, as well as boreholes saved in database. Location of objects like boreholes, CPT tests, dynamic soundings etc. is generated automatically, based on co-ordinates saved in relevant data files or in geological database.

The **CPT-CAD** module allows to run the following mapping tasks:

- To provide automatic display of selected **CPT** sounding, **VANE**-type tests, other soundings (**SPT**, **DPT** etc.) and boreholes against a background of area map. Vector maps saved in **DWG** and **DXF** formats may be used as the map background.
- To run full editing of vector maps stored in **DWG** and **DXF** formats
- To create **DWG** or **DXF** customer's own vector maps.
- To print out the map on any printing device operating within **Windows** System.

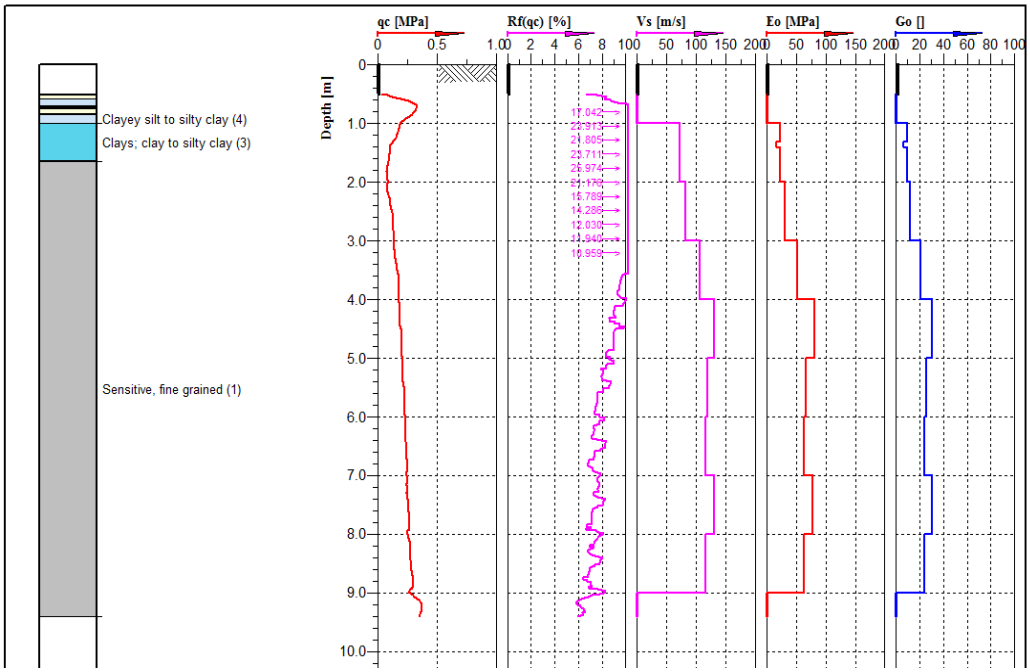
CPT-CAD has also implemented standard "drawing window" that can be used for own CAD drawings. All - standard for CAD software – functions, including layers, lines, hatches, snapping, blocks, single and multiline texts etc. are implemented, so **CPT-CAD** can be easily and affectively used for any type of own drawings.

SCPT module



For reduction, analysis and interpretation and plotting logs of SCPT measurements concerning both **S-wave** and **P-wave**. Implemented advanced mathematical tools, including customizable filtering procedures make analysis very efficient. Advanced graphic interface and unique procedure of manual moving the selected graphs against the former ones make the process of calculating the velocity very easy and accurate. The values of interpreted velocity can be plotted vs. depth with graphic tools implemented in SCPT module or automatically exported to ***Data Editor*** database to further analysis provided in that module.

Compatibility of ***Seismic*** and ***Interpretation*** modules allows to enter seismic wave velocity interpreted in ***Seismic*** module to data structure of ***Interpretation*** and further common interpretation and presentation. Sounding log generated in Interpretation module may include graphs of all parameters that refer to CPTU and SCPT soundings.



Log generated in ***Interpretation*** module with imported seismic wave velocity channels for further analysis.