TopoDroid USER MANUAL

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TopoDroid is an Android app for cave surveying. TopoDroid takes the raw data, helps you to organize them, and produces the line map of the survey on the spot. You can further draw sketches around the line map while you are surveying, thereby reducing the probability of error entering in your sketch, and helping you to detect errors in the data while you are still in the cave. TopoDroid has many functions to help you get the most out of your work in the cave. In this way a working map is almost ready as you are ending the survey trip.

TopoDroid makes the time you spend surveying in the cave more effective. It is designed to handle a survey at a time, not to manage complex cave survey projects that include several different surveys. This is because the purpose of TopoDroid is to help a surveyor to collect the data with more accuracy as well as to make the surveying task more pleasant, not to produce the final map of the cave. For that purpose good PC programs already exist.

Nevertheless TopoDroid includes a *Cave project Manager* that can be used to compose surveys into a cave/karst project.

TopoDroid is specifically designed to work with the DistoX, SAP5, and BRIC4. However, survey data can be manually entered.

By default TopoDroid has unspecified screen orientation, but it can be fixed to portrait or landscape through a global setting.

TopoDroid quick guide

DISCLAIMER
TopoDroid is an open-source free app and it is ad-free. It comes with no warranty: by using it you agree that the authors are not responsible for any loss of data you might incur or damage whatsoever, in particular to the DistoX, SAP5, BRIC4. While the authors do their best to provide a bug-free app, this is not guaranteed.

Survey data

Survey data and sketches are saved in the "TopoDroid" folder. This folder is in the "primary external

memory" (/sdcard) for Android up to v. 9, and in "Documents" starting with Android v. 10.
The survey data and sketches are not removed when the app is uninstalled.

Hardware features

TopoDroid uses the following hardware features: "bluetooth", "camera", "microphone", "GPS", "multitouch". Functions of TopoDroid that require a feature not present in your Android device, are automatically turned off.
Internet connection is used only to install translations of the user manual.
Android permissions

Errors and crashes

Due to limited resources, the apk cannot be fully tested. It is advisable to install TopoDroid updates with an apk-manager that keeps the apk of previously installed versions. By this means you can safely revert to a version you are comfortable with, in case you find problems with the latest apk. Do not forget to report your problems so that they will be taken into account in the next version. Bug-reports are promptly considered, and the app is frequently updated.

- Please set up your Android system to automatically report crashes (see details on the webpages).
- Crashes after the choice on an option can be due to incomplete translations of a list. Run the app with English language; if the crash disappears contact the translation maintainer.
- If you find an error or the app does not behave as you expect, send me an email. **Include the app version**.
- If you have a general question or a feature request, send an email to TopoDroid mailing list.

App translations:

- V. Georgiev (Bulgarian)
- H.J. Luo (Chinese)
- D. Ros (French)
- M. Keller (German)
- B. Holl (Hungarian)
- F. Toso (Italian)
- K. Borgiel (Polish)
- R. Severo (Portuguese)
- A. Pologea (Romanian)
- A. Kozhenkov (Russian)
- M. Jurecka - J. Hetesi (Slovak)
- M. Guerrero - J. Pardo (Spanish)

Website: https://sites.google.com/site/speleoapps/
Sources: https://github.com/marcocorvi/topodroid

User manual translations

- A. Kozhenkov - Russian: https://github.com/akozhenkov/TD_manual_RU

- M. Guerrero - Spanish: https://github.com/xguerrero/Topodroid_manual_es
- F. Toso - Italian: https://github.com/fato63/TopoItMan
- D. Ros - French: http://souterweb.free.fr/
- B. Holl - Hungarian: https://github.com/BalazsHoll/TopoDroid_manual_hu

User manual translations are installed by choosing the translation language in the appropriate setting of the main window. (internet connection required).

If a manual translation is installed, when the app is updated and there is an updated version of the translation, the user is prompted to install the new manual translation.

TopoDroid QUICK GUIDE

This page covers the basics of TopoDroid. Refer to the user manual for more details.

[1] Pair the device with Android
The device must be paired with the Android. This should be done also for bluetooth Low-Energy devices (SAP5, BRIC4). Do that with the "Settings" app. Go to "network | bluetooth", turn the device on, and scan for devices. Your device should be found. Select it and enter the PIN "0000" (four zeros) to pair it with Android if asked to. If your device repeatedly asks the pin, set the socket to "insecure" in TopoDroid settings.

[2] Select the device in TopoDroid
Start TopoDroid. To tell it to work with your device, tap the *Device* button. The name and address of your device should appear in the list. To select it tap its address, so that it appears in the top row.

[3] Calibrate the device
If your device is not calibrated, you need to calibrate it. For the DistoX this can be done with TopoDroid: refer to the user manual.
For the SAP5 and the BRIC4 this is done by the device, with no need of TopoDroid.

[4] Create a new survey
Tap on the *plus* button in the main window, and enter a name for the survey in the dialog. Close the dialog tapping "Save".

[5] Open the survey
Tap on the survey name in the list of the main window, and go to the survey data window.
This step can be skipped if you press "Open" in step [4].

[6] Take shots and download them
Take the survey shots: go to the first station, take the splay shots, them measure the leg at least three times. Move to the next station and repeat this procedure.
Tap the *download* button, the leftmost, in the survey data window. The download should start and the shots appear in a list. Stations are automatically assigned. Make sure TopoDroid did not make any mistake. In case correct them by editing the shot.

[7] Create a sketch
Each TopoDroid sketch consists of a plan view and an extended profile view. Tap on the the *sketch* button (the fourth), and tap on the *new sketch* button: enter the name of a station that serves as sketch origin in the second field. Tap *OK* to open the sketch window for the new sketch.

[8] Draw the sketch
TopoDroid displays a canvas with the midline, the splays, and the stations. This is the plan view. Select the "draw" mode (leftmost button) and start drawing (lines). Switch off the "draw" mode tapping it again, and go to the profile view (sixth button). Draw the profile. Close the canvas and return to the shot list.

[9] Complete the survey
Repeat from point [6], Take a couple more legs. At step [7] tap the sketch name to re-open it in the sketch window.

[10] Export the sketch
When you are done, export your work so that you can polish the cave map on the PC. In the sketch window open the menu (rightmost button) and select *Export*. Pick you favourite format, and tap *Save*.

[11] Export the data
Go back to the data window, open the menu, and select *Survey Info*. Then open the menu of the survey info window and select *Export*. Pick the format you prefer.

[12] Make a ZIP
Do "export" again in the survey info window, and select the *ZIP* format: this creates a zip archive of your survey with, among other things, all the files you have exported so far. It is in the folder /sdcard/topodroid/zip. Transfer to the PC and finish your cave map.

[1] INTRODUCTION

Activity levels

The TopoDroid interface has activity levels, differing by the number of actions that are enabled.

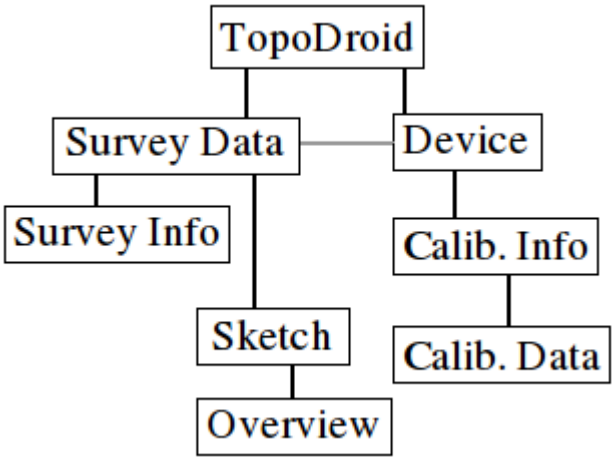
- At the **basic** level [B] drawing is limited to lines, with no editing actions.
- The **normal** level [N] contains all the functions for a detailed cave survey.
- The **advanced** level [A] has also advanced functions.
- The **expert** level [E] has all the functions.
- The **tester** level [T] is only for development test. It has untested features enabled. These features are partly debugged and may crash the app. Please report any problem with them.

By default TopoDroid has only the **normal** functions enabled, but you can switch level, according to your needs, without exiting from the program. This manual describes the complete TopoDroid. Features at a level above "basic" are marked with the level initial, [N], [A], [E], or [T].
The settings displayed in the preferences window depend on the activity level.

Windows

TopoDroid has a main window from which you can move to other app activities. The main activities are:

- **Survey** data management (survey info and data windows).
- **Sketch** drafting, drawing window, is a sub-activity of the Survey activity.
- **Device** functions, device window
- **Calibration** of DistoX (calibration info and data windows) is a sub-activity of the Device activity.



TopoDroid windows have a scrollable button bar at the top, for the most frequent actions, and a menu button at the top-right. Dialogs usually have a confirmation button (*OK* or *Save*). If there are both, *OK* saves the input data and closes the dialog, while *Save* saves the input data and keep the dialog open for a new input. Dialogs can have also a *back* (or *cancel*) button. If not present, the Android *BACK* button saves the changes and closes the dialog. Otherwise it just closes the dialog.

Help and user manual

TopoDroid windows have a menu button (three vertical dots) at the top-right. The last menu opens a quick help about the actions of the window buttons and menus. The quick-help dialog has a "book" button at the top-right which opens the user manual at the relevant page. A long tap on the icon opens the manual at the first page.
If your Android has a *Menu* key, you can use also that to open the man page.

For the dialogs the hardware *Volume Up* key opens the *User Manual* at the relevant page. If your Android has a *Menu* key, you can use that as well.
For the dialogs with the row of the action buttons of a slightly darker color, the man page can be opened by a long tap on that row.

Settings

TopoDroid has a large number of settings. These are divided in categories and subcategories:

- General
- Survey data
- Sketches
- Devices and calibration
- Import/Export

The number of settings displayed by the "Settings" interface depends on the activity level.

More esoteric settings (Geek) are marked with [G]. They are collected under the *Custom settings* section [T].

Text and Buttons size

The "Text Size" setting specifies the dimension of the list text entries, in particular the list of surveys, that of shots, and that of calibration data.
There are five choices for the size of buttons: "small", "normal", "medium", "large", and "huge". The

"normal" size is suitable for cell phones (5' screen), and is the default. The "large" size is for tablets (7' screen).

Drawing tools (palette)

TopoDroid comes with a considerable number of drawing tools bundled in. By default only the most basic tools are enabled. You can enable more tools as the need arises, with the *palette* button on the main window. By this means you can get used to the TopoDroid "iconography" a bit at a time.

Additional drawing tool sets can be installed in the palette. Custom tools can be also created and added to the palette, and tools with no use can be removed.

TopoDroid subdirectories
TopoDroid databases
TopoDroid ecosystem

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[2] MAIN WINDOW

The main window has four buttons at the top, and the list of the surveys underneath. This list is empty until you create a survey.

The first time you start the app a welcome message is shown. You can go back to it any time later with the *About* menu.

To exit TopoDroid main window double tap on the hardware *BACK* button.

ACTIONS

- tap on a survey: survey data window
- long tap on a survey: survey info window

BUTTONS

-  device window. The button displays the device currently in use
-  new survey
-  import a survey or a ZIP archive
-  drawing tools palette.
-  Cave Project Manager window [T].
-  Cave 3D viewer. It requires the app Cave3D [T].

MENUS

- Palette [A/G] opens a dialog to load additional drawing tool sets, or to reload the drawing tools.
- Logs settings [E]. Logging is mostly for debugging app error
- Clear sketches backups [G]
- About: the program welcome message
- Settings: all the program settings
- Help shows a brief descriptions of buttons and menus. At the top-right corner there is a button that opens this user manual. Each TopoDroid window has a similar Help menu

SETTINGS

- working folder [default "TopoDroid"]
- *Text size* of the lists items [default 14, min 1]
- *Buttons size*: small, normal (for 5" screen), medium, large (for 7" tablets), huge. [default small]
- *Activity level*: basic, normal, advanced, expert, tester. [default normal]
- *Keyboard* enables or disables the TopoDroid keypads.
- *No cursor* disables or enables the cursor for TopoDroid keypads [T]
- *Translated Manual* enables or disables Translated User Manual
- Language selects the app language

The working folder is in the "primary external memory" (sdcard) for Android up to v. 9, and in "Documents" from v. 10.

From the settings dialog of the main window you can go to the other settings dialogs

- Import/Export
- Survey data
- Sketching
- Devices
- *Custom settings* [T]

At "expert" level, or more, you can also export the current settings to file (saved in "TopoDroid" folder).

If **bluetooth** is not on, the app asks whether to turn it on. Without bluetooth it cannot communicate with the device and the survey data can only be entered manually. In this case the *Download* button in the Shot window is hidden, and that in the sketch window is replaced by the *Add* button.

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[3] DEVICE WINDOW

Before surveying you need to connect and pair Android with your device and calibrate it. Tap the *Device* button in the main window to open the *Device Window*. The list of known devices is shown in the middle. The supported devices are: DistoX, DistoX2, SAP5, and BRIC4.

TopoDroid works with one device at a time. To select it tap on its entry in the list. The name of the selected device is shown at the top, just below the buttons. If no device is selected, there is a red message saying "Device not selected".

If the device list is empty, your device needs to be connected and paired with the Android. This can be done with the *Settings* app.
If it does not pair automatically the DistoX PIN is "0000", four zeros.
If it does not pair automatically the SAP5 PIN is "000000", six zeros.

Device nickname
By default TopoDroid uses the bluetooth MAC address as name for a device. The devices can be given nicknames to distinguish among several devices more easily.

Note. Buttons and menus marked with [*] are specific for the DistoX and need the device to be on.

ACTIONS

- tap on a device entry makes it the active device
- long tap on a device antry sets the nickname or set the "second" DistoX

BUTTONS

-  reset bluetooth connection.
-  device information [N,*]
-  DistoX or BRIC4 memory functions [*]
-  toggle the DistoX calibration mode on and off [*]
-  calibrations of the DistoX.
-  read and display the calibration coefficients from the DistoX [A,*]

For the DistoX all the buttons are active.
For the BRIC, the first three buttons are active.
For the SAP only the first button is active.

MENUS

- Disconnect clears the active device [A]
- Dump and upload firmwares to the DistoX2 [E,*]
- Display log of DistoX packets [T]
- Settings
- Help

DEVICE SETTINGS

- *Bluetooth*: whether to enable, disable, or check on start-up [default "check"]
- *Number of new data*: get the number of new data before downloading them (on-demand mode) [default "no"]

The following settings apply only to the DistoX (which uses classical bluetooth).

- *Connection mode*: either "on-demand", "continuous", or "multi" [default "on-demand"]
- *Socket* type: either normal or "insecure" [default is device-dependent]
- *Z6-workaround* Fixes a download timeout error on a Z6 phone, and possibly other devices. It is safe to leave this enabled [default "on"]

DistoX connection modes

There are three connections modes for the DistoX.

- in *on-demand* mode data are downloaded in burst, and when there is no more data to download the connection is closed.
- in *continuous* mode TopoDroid remains connected to the DistoX and the shots are downloaded as soon as they are taken. When the DistoX and Android get disconnected, TopoDroid repeatedly tries to reconnect. Otherwise, the bluetooth connection is closed.
- the *multi* mode is like the "on-demand" mode, but a long-tap on the "download" button, in the *Shot* window or in the *Sketch* window, changes the DistoX. It you have set a "second" DistoX (in the *Device* window) it is swapped with the current DistoX. Otherwise, you get a dialog to pick one among the paired DistoXes.

With the "multi" mode, the current DistoX is shown in the title of the *Shot* and *Sketch* windows.
The connection mode applies only to the data download. Other DistoX functions use a one-shot query mode.

SAP and BRIC are always connected in *continuous* mode.

Custom settings: *Connection delay*, *Second DistoX*, *Data pause*, *Data-ready wait*, *Laser pause*, *Shot pause*.

Devices
DistoX troubleshooting
DistoX functions
BRIC4 functions
SAP5 functions

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[4] DistoX CALIBRATION WINDOW

Tapping the *Calibration* menu in the device window shows the lists of the calibrations of the active device. You can open a calibration or create a new one. In both cases you are led to the calibration window.

The calibration window has text fields for

- the name. Each calibration must have a unique name
- the date.
- a description

and radio buttons for the calibration algorithm. By default this is set to "auto" (ie, let TopoDroid decide which algorithm to use).

BUTTONS

-  save the calibration informations to the database
-  go to the calibration-data window
-  display the calibration coefficients stored in the database

MENUS

- Calibration export
- Delete the calibration and its data from the database (non-recoverable action)
- Settings
- Help

CALIBRATION SETTINGS (DistoX only)

- *Group policy*: how to split the calibration data into groups [default "all in groups of 4 data"]
- *Group tolerance*: threshold to highlight calibration data with large angle distance from the group-mean [default 40 min 0]
- *Error*: the computation of the coefficients ends if the variation of every coefficient during an iteration step is smaller than this value [default 10^{-6}, min 0].
- *Iterations*: the maximum number of iteration of the calibration algorithm [default 200, min 50].
- *Remote data* immediate download.
- *Raw data*: by default TopoDroid displays the azimuth, inclination, and roll. Select if you want to see also the raw calibration data (the components of G and M), either decimal or hex. [default "no"]
- *Algorithm*: can be 0 (auto), 1 (linear), 2 (non-linear). If a calibration algorithm is left "auto", and this setting is not "auto", then the algorithm of the settings is used to calculate the calibration. If they are both "auto" the algorithm is chosen automatically by TopoDroid depending on the DistoX model and firmware. [default "auto"]

Calibration howto

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[5] DistoX CALIBRATION DATA

The calibration-data window displays the list of calibration data. If the calibration has no data, the window is empty but for the top buttons. Each calibration data line contains the following data informations:

- index: incremental index that identifies the data
- group: number of the group the data belongs to
- azimuth, inclination, and roll, computed from the raw values without any calibration correction
- error: the difference between the calibration-corrected direction and the group average direction, in degrees
- optionally the raw calibration data values, ie, the components of G and M in the DistoX frame, either as decimal or hex values

Colors

The calibration data are displayed with yellow and blue text-color, alternating between even and odd group numbers. Data with no group are grey.

The background color:

- violet: incomplete data (not used in the calibration, but used for the groups)
- brown: saturated data
- gray: deleted data (only if deleted data are displayed)
- red: data with error larger than 1°
- green: data differing from the other data if the group by more than the *group distance* on average

ACTIONS

- tap on a data: calibration data edit dialog

BUTTONS

-  toggle the DistoX calibration mode on and off
-  reset BT, or control DistoX remotely
-  download calibration data from the DistoX
-  assign group numbers to the data, or reset the group numbers
-  compute the calibration coefficients
-  direction distribution of the calibration data
-  read and display the coefficients stored in the DistoX

-  write the calibration coefficients to the DistoX. Enabled only after the calibration coefficients have been computed. The coefficients can also be written directly from the dialog showing the result of the computation. A warning is issued in the data direction coverage is below 95% or the average error is above 0.5°

At the moment only on-demand data download is active for the calibration data. The downloaded data are added to the current calibration. Therefore you can take some calibration measurements, download the data, check if you are satisfied with them, if not take further data and download them, and so on until you are happy with your calibration data. Downloaded data can be "disabled" (by setting the group number to "0" (zero); disabled data are not used in the computation of calibration coefficients), or deleted (usually not shown in the list of data). Deleted data are not taken into account in the group-number assignment and in the computation of the calibration.

Bluetooth

This button resets the TopoDroid bluetooth connection.
It also lets the user control the DistoX remotely [A]: turn on or off the laser, and take a calibration shot. The data is immediately downloaded if the related setting is selected.

The bluetooth button is disabled while TopoDroid is taking a calibration shot.

Calibration computation

The "gear" button starts the computation of the calibration coefficients.
When the computation ends, the coefficient dialog is shown.
If there are not enough data or data groups the computation is not carried out and a warning message is displayed.
The calibration fails if the limit of the iteration is reached before the computation ends. This usually happens if the group numbers have been set wrongly. In this case a message is displayed.

Warnings

- **saturated data**: data with abnormal magnetic field value. A possible cause of this is the presence of spurious magnetic fields. Saturated data have a red background
- **zero data**: incorrectly received calibration data. The data has zero values, and by default it is not assigned a number, although it is used in computing the groups. Zero data have a violet background

MENUS

- Display: whether to display all data including the deleted data
- Validate: validation of this calibration with another one
- Settings: same as for the calibration window
- Help

[6] SURVEY DATA WINDOW

The survey data window displays the list of the shots of the survey.

The title displays the survey name, and, in multi/double device mode, the active device. The title color depends on the current station assignment policy:

- blue: foreshot policies
- dark blue: backshot policies
- pink: "tripod" policy
- violet: "backsight" policy
- red: "magnetic anomaly" policy
- orange: "toporobot" policy

TopoDroid distinguishes four kinds of shots (displayed with different colors): "leg", "repeated-leg", "splay", and "blank". Splays can be further classified as "cross" (X), horizontal (H), vertical (V), and "scan" (shots acquired in scan mode). Splay classes X-H-V can be enabled with a custom setting.

Important shot properties are shown through the background color of the shot data and station names.

Shot data foreground color:

1. [white] "leg" (the first shot of a group of repeated measurements): this shot has both the "From" and the "To" station set
2. [grey] repeated-leg data (the following shots of a group of leg shots): these shots do not need to have the stations set
3. [blue] splay: it has only one station, usually the "From" station
4. [green] X-splay
5. [dark blue] H/V-splay
6. [light green] scan splay
7. [orange] blank shots, i.e, shots with the stations not set yet
8. [yellow]: back-leg (backsight policy)
9. [violet]: blank leg

Station name foreground color:

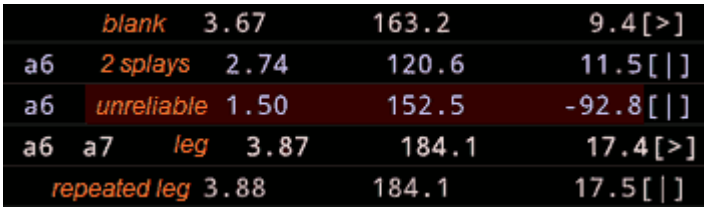
- [bright green] current station

Shot data background color:

- [reddish] unreliable shots, i.e. shots with "abnormal" field intensities (only DistoX2)
- [orange] short leg
- [gray] commented shot

Station names background color:

- [dark green] last downloaded shots
- [gray] shot in multiselection set
- [dark yellow] DistoX backsight data



ACTIONS

- tap on the shot data opens the shot edit dialog
- tap on a station: show/hide splays at the station
- long tap on a station: select/deselect the "active" station

BUTTONS

-  Data download
-  Bluetooth
-  Data display mode
-  Sketches
-  Survey notes
-  Insert manual shot data
-  Saved stations
-  Extend reference azimuth
-  Station/Leg search
-  Refresh data list

Long taps

- "Download": device switch (only for multi device modes)
- "Sketch": immediately open the most recent sketch
- "Manual data": instruments calibration dialog
- "Search": move to the next result

Multi-shot selection buttons:

- set shots extend to *left*
- flip shots extend

- set shots extend to *right*
- special actions [T]
- *delete* the shots
- *close* the multi-shot selection

Sketch dialog

Through the "sketch" dialog you create a new sketch or open an existing one. There is a button to create a new sketch, and a two-column list of the current survey sketches. Items in the left column open a sketch in plan view, those in the right column open it in profile view. You can also switch between sketches from within the sketch window.

MENUS

- Survey info: survey information window
- Recover: deleted item (shot or sketch) recovery
- Photo: pictures taken for this survey
- Sensor: sensor data taken for this survey
- 3D: 3D survey display (requires Cave3D)
- Device: switches to the device window
- Settings
- Help

SURVEY SETTINGS

- *Team*: the default surveying team. If the value is not empty, it is used to set the "Team" field when you create a new survey. Write your name and that of the cavers you usually survey with. [default unset]
- *Stations policy*: select the automatic station naming policy. [default "splays+foresight"]
- *Station names* specifies the type of the station names, either alphanumeric or numeric [default "alphanumeric"]
- *Start station*: the default first station name for new surveys. Can be overridden in the *New survey* dialog. [default unset]
- *Thumbnail size*: size of the photo thumbnails [default 200, min 80, max 400]
- *Data auto-export*: whether to export the survey data whenever the data window is closed [default no]
- *Sketch origin*: whether to suggest always the same origin or not [default no]
- *Shared x-sections*: whether at-station x-section should be shared by default [default no]
- *DATA UNITS*
    - *Length units*: either meters or feet [default meters]
    - *Angle units*: either degrees or grads [default degrees]
    - *Sketch grid-cell unit*: either meters, yards, 2-ft, or 0.1 meter [default meters]
- *SHOT DATA*
    - *Leg tolerance*: the angle tolerance (percent) between consecutive shots of a leg [default 0.05, min 0]. The length tolerance is the product of the angle tolerance and the length.
    - *Max shot length*: longer shots are marked as "deleted" [default 50 m, min 20 m]
    - *Min leg length*: shorter legs are highlighted with an orange background [default 0.5 m]

        - *Min leg shots*: minimum number of close consecutive shots for a leg.[default 2, min 2, max 4]
        - *Backshot DistoX*: DistoX in "backshot" mode [default no]
        - *Splay vertical threshold* defines how the splay "extend" is set [default 10, min 0, max 90]
        - *Leg WENS threshold* (Therion "vthreshold"): the LRUD for manually entered shots are considered West-East-North-South when the shot inclination exceeds the vertical threshold [default 80, min 0, max 90]
        - *Shot extend*: either fixed or relative to the extend reference azimuth [default relative]
        - *Loop closure* error compensation. It is advisable not to do the compensation, as this allows to see graphically the misclosures, and spot possible survey errors [default "none"]. The special loop compensation based on "triangles" is for trilateration [E].
        - whether to show *prev/next* buttons in the shot edit dialog [default yes]
        - *Backsight* fields in the shot manual input dialog [N] [default no]
        - *Timer*: seconds of delay before measuring directions with the Android sensors [default 10, min 0]
        - *Beep volume*: timer beep volume [N] [default 50, min 10, max 100]
    - *LOCATION settings*
    - *ACCURACY settings*

Custom settings: *Latest shots and their timeout*, *Fractional extend*, *Splay classes and coloring*, *Diving mode*, *Sensors*.

To exit the survey data window double tap on the *BACK* button of your device.
If the automatic backup is enabled and the default data file format is set, the data are exported whenever the data window is closed.

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[7] SHOT LIST

The shots are shown in a list. The list has no header to save space. The shot informations are

- Index (optional: it is shown only if the related choice in the *display mode* dialog is checked)
- From station
- To station
- Distance
- Azimuth
- Inclination
- Extend direction: either left (<), right (>), vertical (|), or ignore (a blank space). The "extend" of splays is present only if explicitly set by the user in one of the shot edit dialogs.

There can be additional characters for the flag, and the presence of a photo (#). Finally the beginning of the comment if any. The flag can be: duplicate shot (²), surface shot (÷), only-profile (§), only-plan (_).

Blank shots, and repeated-legs can be hidden. Splay shots can also be hidden to unclutter the list of shots. However, even if splays are not shown, you can see those at a station by tapping on the station name in a leg shot. To hide them tap again on the station name (even a tap on the name in a splay will do).

TopoDroid can set the station names automatically according to the station assignment policy.

Shot item taps

- a tap on a station name puts it in *editing-mode*, and the station is underlined. If inline station editing is enabled the station name can be edited. The station name edit must be finished with the ENTER key to take effect.
- when the station is underlined, a couple of tap toggles the display of splays at that station (only if splays are globally hidden).
- a tap on the shot data opens the shot edit dialog, in which you can set the stations as well as other attributes of the shot.
- a long tap on a station name makes it the active station (it is highlighted green)
- a long tap on a shot starts the multi-shot selection

If you use TopoDroid automatic station naming, you are likely to need the shot dialog only to enter the comment, and to change the "extend" direction. These two actions can be done also from the sketch window, by selecting the shot in "edit" mode [A] and picking the *Note* button. The extend can be changed also graphically on the sketch. These actions are described in the section on the sketch window.

Multi-shot selection
The selected shots have a gray background (possibly only in the back of the stations). Tapping a shot adds/removes it from the selection. The button bar changes to buttons for the multi-shot actions:

- set the shot extend to "left"
- flip the shot extends
- set the shot extend to "right"
- special actions dialog [T]
- delete the selected shots. Warning: hidden secondary-leg shots are deleted when the corresponding leg shot is deleted
- close the multi-shot selection

The special actions dialog includes [T]:

- renumber the selected shots
- swap the stations of each shot
- set the sketch color of the selected splay shots
- mark the splays as X-splay or H/V-splay (or make them normal)
- compute the strike and dip of the plane containing the shots

The stations of the first shot are used to seed the renumbering. They can be changed in the dialog. If both stations are entered the first selected shot is a leg and the following selected shots are renumbered consistently. If only the FROM station is entered (and the TO station is left empty), all the shots are renumbered as splay.

Setting the color of splays is enabled if only splays have been selected, otherwise it is disabled.
The computation of strike and dip of the bedding plane requires that all the selected shots have the same FROM station. Otherwise it is disabled. The result is shown in the dialog and added to (replaced if already present) the comment of the first selected shot.

[8] SURVEY INFO WINDOW

The *survey* menu of the data window opens the survey info window. Alternatively you can open it with a long tap on the survey entry in the main window.

The displayed survey info are:

- name (not editable)
- date
- team names
- magnetic declination (if set)
- survey description
- whether the x-sections are *shared* among sketches or not
- whether the data-mode is *normal* or *diving* [T]

The magnetic declination must be entered in decimal degrees. The allowed range of values is [-360°, 360°]. Values outside this range are considered as "unset".

BUTTONS

-  survey annotations
-  survey statistics
-  3D display (need Cave3D app) [A]
-  location [A]
-  photo list. Tap on an entry to edit the description or delete the photo [A]
-  sensor measurements. Tap on an entry to edit the comment or delete the measurement [T]

MENUS

- Close
- Export
- Rename [T]
- Delete [A]
- Clear color: clear the custom splay colors [T]
- Instruments calibration [E]
- Calibration-check shots [E]
- Settings (same as the data window settings)

- Help

Export dialog

The export dialog has a selection-list of export-formats: *Compass*, *cSurvey*, *Survex*, *PocketTopo*, *Polygon*, *GHTopo*, *Grottolf*, *Therion*, *Topo*, *VisualTopo*, *Walls*, and *WinKarst*. Furthermore the data can be exported as *DXF (LibreCAD)*, *CSV* text file, and *shapefile (QGIS)*. If the survey has a fixed station it can be exported as *KML (GoogleEarth)*, *GeoJSON*, and *track* file (PLT). This export fails if no the survey station is fixed. Finally you can export a *ZIP* archive which includes all the data of the survey.

There are a number of export settings, that control the way TopoDroid writes the survey data in the various export formats.

Delete dialog [A]

The delete dialog ask for confirmation to delete the survey. Deleting the survey is unrecoverable: the survey and all associated data (photos, notes, sketch files, etc.), except the zip archive, are deleted. Make sure to export a backup *ZIP* archive before you delete the survey.

Rename dialog

With this dialog you can rename the survey. Renaming fails if there is already a survey with the specified name.

The info in the database, the file of the notes, the binary sketch file, and the image and audio directory are renamed. However reference to section "scrap" in the sketch files are not updated until the files are opened again. Therefore it is advisable to go over and "open and close" all the sketches.

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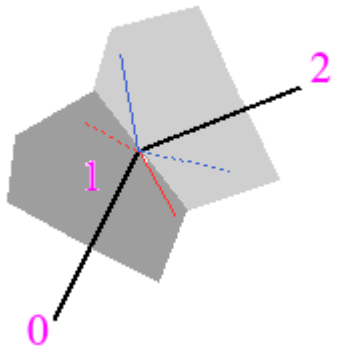
[9] SKETCH WINDOW

The *sketch* button of the data window opens the dialog with the list of sketches, besides the *New Sketch* button. Tap on this button to create a new survey sketch.

Each sketch is made of two sketch files: one for the plan view, the other for the profile view (either extended or projected). X-sections have only one file. A new sketch is opened in the plan view. Afterwards the sketch dialog shows two columns, one for the plan, the other for the profile view, and you can choose which one to open from.
Each sketch can contain multiple scraps.

The extended profile view displays the midline with the shots drawn left or right, or vertical, according to their "extend". If a leg has the "extend" not set, the midline is not displayed from that leg on. Splays are projected on the vertical plane of the shot that is closest in azimuth, unless the user has set a given "extend" through the shot edit dialog. For example, for the plan view in figure, the splays in the light region are projected on the vertical plane of shot 1-2, those in the dark region on the vertical plane of 0-1.

The projected profile view displays the midline and the splays projected in the vertical plane perpendicular to the projection azimuth.



Legs
The leg colors are

- normal: white
- anomalous field values: red
- inconsistent with siblings: orange

Splays
Splays can be displayed as segments or as dots [G]. If displayed as dots they cannot be selected.
The splay colors are [E/G]

- commented: dark green
- x-splay (LRUD): green
- h-splay: deep blue (plan), dark blue (profile)
- v-splay: dark blue (plan), deep blue (profile)
- others: light grey

It is possible to set a transparency level for splays [G].
Splays can be assigned different colors, individually.
A splay is not shown if the shot is marked for no-display in plan or profile view.

If splay dashing [G] is not disabled, they can be displayed with a dashed line.
If the splay-dashing is set to *azimuth* the splay is dashed if the angle with the "closest" leg in azimuth is above the dash azimuth-threshold, [default 60°]
If the splay-dashing is set to *clino* the splay is dashed if the splay clino is above the dash clino-threshold: dotted (positive clino) and dashed (negative clino).
If the splay-dashing is set *by the view* the splayis dashed by the clino in the plan view and by the azimuth in the profile view.

Furthermore, in the plan view the splay is not displayed if the inclination of the splay is over the plan-view threshold [default 80°]
For x-sections:

- x-splays (LRUD) are green
- other splays are blue: dark at TO station, light at FROM station
- finally, if splay-dashing is enabled, they are dotted or dashed if the angle between the splay and the normal to the x-section plane is below the dash angle-threshold [default 60°] (dotted if in the direction

of the normal, dashed if opposite).

Stations
The station colors are

- violet: default
- green: active station
- red: stations beyond which the midline is hidden
- blue: stations before which the midline is hidden
- yellow: saved stations [T/G]

Interaction modes
The sketch window has four interaction modes:

- **move**: you can shift the canvas, and zoom in/out. If the "fixed references" box in the references dialog is set, shifts affect only the drawings [T]
- **draw**: in this mode you add iconic symbols (points, including labels), and trace lines and areas (closed regions filled with a color or a pattern).
- **erase**: to erase items, and lines/areas, or portions of them, from the sketch.
- **edit** [A]: for pointwise changes and item properties editing, including item deleting.

Shift and zoom are possible even in **draw** and in **erase** mode using two fingers. If "side-drag" is enabled, the sketch can be shifted by "dragging" it from the left, right and bottom sides of the canvas. Side bands are displayed as transparent gray.
Zoom controls can be enabled (either temporarily or permanently). If temporary, they show up when you tap at the bottom of the canvas in the middle.

BUTTONS

The modes are represented by the three green buttons on the left: *draw*, *erase*, and *edit*. When one of them is "on" the relative button has a bright green color. If none is on the mode is *move*.

When a green button is "on", a long tap on it, opens the dialog to edit the settings relevant to the mode of the button.

The remaining buttons differ by the mode. In the **move** mode they are

-  data *download*. If no device is selected, this button is hidden. By default splays and legs are refreshed when a leg is downloaded (and identified). Use the refresh button to force a centerline refresh. The last download shots can be highlighted blue to help distinguish them from the others [G].
-  Bluetooth reset/controls
-  survey notes

-  drawing references: legs, splays, stations, metric grid, scalebar, and sketch outline.
-  *plan/profile* switch. *Splay-display mode*, for x-sections
-  "extend" reference
-  refresh the centerline

The **draw** mode has four buttons besides the green ones:

-  removes the last items you have drawn, one at a time.
-  puts the removed item back in the sketch, one at a time. The list of removed items is emptied when you draw something new. Pointwise editing actions may also affect the list of redo.
-  Drawing tool switcher / picker
-  Line *joining* or continuing

The **erase** mode has three buttons besides the green ones:

-  *undo*
-  *redo*
-  type of erasable items: all, points, lines, areas
-  eraser size [S, M, L]

The **edit** [A] mode has, besides the green buttons:

-  type of selectable items: all, points, lines, areas, shots, stations
-  size of the selection tool [S, M, L]
-  pointwise and special actions
-  item properties edit
-  delete the item from the sketch (it asks for confirmation, and can be "undone").

-  range selection: either pointwise or local (only for lines and areas).

When there are selected items the first two buttons become *previous/next* navigation buttons in the set of the selected items.

The buttons are somewhat different for x-section sketches. In the **move** mode the buttons "switch", "azimuth", and "refresh" are not shown, but there is a button to select which splay to show. It cycles thru four states: "both", "viewed station", "behind station", "none". Accordingly, the drawing references dialog has no box for the splays.

Long tap actions

- A long tap on each *mode* button opens the relevant settings dialog [A].
- The *download* button switches the device, in multi device mode [E].
- In plan view, a long tap on the *extend reference* button makes the reference azimuth graphically editable by sliding the finger across the display. The button turns green [E].
- In the extended profile view, a long tap on the *display mode* button flips the sketch [N].
- With x-sections it toggles the display of splays that are off the section plane [T].
- A long tap on the *tools* button reverts the order of rotation of the bottom toolbar. Ineffective for the triple toolbar.
- A long tap on the *delete* button removes the selected line/area point [N].

MENUS

- Switch to another sketch or close.
- Export: the sketch can be exported as *Therion* th2, *cSurvey*, PNG, DXF (*LibreCAD*), SVG, xvi (*xtherion*, and shapefile (*QGIS*). All exports generate two files, one for plan the other for profile, except *cSurvey*, which has both in one file.
- Statistics. For x-sections this computes the section area.
- Reload the sketch from a backup copy.
- Zoom-fit: dialog to fit the sketch into the screen, and to select the portrait or landscape presentation
- Rename/Delete/Split the sketch. Deleted sketches can be recovered (*recover* menu in data window)
- Scraps dialog [T]
- drawing tools palette
- Overview window, showing all the survey sketches together. [Only for plan and extended profiles]
- Settings
- Help

SKETCH SETTINGS

- *Drawing tool picker*: list, grid, or triple-grid view [default: list]
- *Bottom toolbar*: single or triple [default: single]
- *Side drag*: enable panning by side-drag
- *Zoom controls*: specifies how zoom controls are displayed on multitouch devices [B]. The zoom controls can be hidden, displayed only for a short interval when the user tap the lower part of the

screen in the middle, or shown all the time
- *Horizontal x-sections* leg-clino threshold for horizontal x-sections (profile view).
- *Midline check*: check if all the legs are attached to the midline [disabled]
- *Extend check*: check if all the legs have the "extend" defined [enabled]
- *POINT TOOLS*
    - *Non-zoomed point*: point items stay of fixed size when zooming
    - *Drawing units* for point symbols
    - Label *text size* [24 pt]
- *LINE TOOLS*
    - Line *pen width* (NB wall-lines are twice as wide) [1 px]
    - *Drawing units* for lines with "path effect"
    - Line *style*: fine, normal, coarse, "splines" (interpolated-curve), simplified
    - Line *point spacing*: distance between line points in normal style [5 px]
    - *Direction tick length* for x-section lines [5 px]
    - *Section points*: whether to add a "section" point automatically for "section" lines [default yes]
    - Line *default join mode*: none, start, end, both, "continue"
    - Area *border* default visibility
- *SKETCH ITEMS*
    - Survey line *pen width* (midline/splay)
    - Station name *text size* [18 pt] [N]
    - Size of *green dots* displayed in **edit** mode [5 px] [A]
    - *Selection* radius for fine-editing a sketch; [16 px] [A]
    - Base size of the *eraser*
    - *Shift sensitivity*: maximum stepping when moving a sketch [60 px] [E]. Increase it if sketch shifting is jaggy
    - Radius of *pointing*: to select you must not move the finger more than this [A]
    - *Splay transparency* (alpha) [0-100, default 80]

Custom settings: *sketch shift/scale, sketch split/merge, Leg verticality threshold (over threshold LRUD become WENS), saved stations coloring, minimum angle of corners when a line is streightened Bezier interpolation accuracy, and corner threshold, Line simplification distance, length, and buffer zone, Pointwise actions flags (Line/Area snap, Smooth/Straighten segment, Multiselection, Composite actions), Splay dashing (mode, clino threshold, azimuth thresholds), Backup number and interval, Backup clearing menu, auto x-section in exports (csx, svg, dxf, xvi) Auto-walls settings*.

Sketch cache

Once opened the sketches are kept in memory, in a cache. This speeds up switching between the data window and the sketch window, as the sketch do not need to be read from file. The sketch cache is cleared when the survey is closed.

Sketch file format

Each sketch is saved to file whenever it is modified, or when the sketch window changes to a different view. For performance TopoDroid saves the sketches in a binary format.

Point selection [A]

To do some editing you must select a point: either a point item, a line/area point, a station, or a shot midpoint. To this aim you tap near the point you want. However if there are several points close where you tap, they are all selected, but only one of them is being edited. You change the "edit" point among the selected set with the *previous/next* buttons.

Line style

TopoDroid has five line styles. With the normal style [default] the lines are drawn as polylines. With the fine style the polyline segments are shorter, while with the coarse style they are longer. In the fourth style lines are interpolated replacing the segments with cubic Bezier curves (splines). These segments pass through the two endpoints and have two control points used define the curvature. With the fifth line style the traced lines are simplified using a point-weeding algorithm. If you export the drawing in dxf with DXF version 6 do not use splines because they get exported as polylines.

Line joining

The *join* button is a multi-state button. Line joining can be done only with other lines of the scraps. The lines that are joined must belong to the same group. If you need to "join" two points of lines of different groups you should move one point to coincide with the other.

- *off*: the lines of the current type cannot be joined
- *no*: the current type line will not be joined
- *start*: the current type line will be joined to a line if its start-point is close to one of that line endpoints
- *end*: the current type line will be joined to a line by its end-point
- *both*: the current type line will be joined to a line by both its start and its end-point
- *continue*: the current type line will continue a line if its start-point is close enough to an endpoint of that line

When the joining is set to "continue" the last line that has been drawn can be modified as in Adobe Illustrator, ie, redrawing a piece of the line.

Composite actions [T]

Composite actions are pointwise long-tap actions.
At the moment the only long-tap action is to *insert a point* for a line/area and snap it to a nearby point at the same time. The selected point is first moved to the nearby point, next it is duplicated and the new point is put after it in the line/area. This allows to retrace a path by selecting the last point and inserting points backwards.
To retrace the path forward switch the selected point after each insertion.

Portrait/Landscape presentation

In portrait presentation the North and the Vertical are upward in plan and profile view, respectively. In landscape presentation they are leftward so that the East is upward in plan view and the Right is upward in profile view.
In landscape presentation the iconic symbols are rotated so that they appear natural holding the device in portrait mode.
The sketches are always saved and exported with the North and the vertical upward.

Warning. If the sketch disappear from the display, switch between plan and profile to force TopoDroid to refresh it.

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[10] SKETCH DRAWING

The canvas shows the midline with the splay shots. It can be moved around dragging it with one (or two) finger(s), zoom in/out with two fingers. The plan-view North and the profile-view vertical are upward. It is not possible to rotate the canvas.

Tap the *draw* button: the app goes in **draw** mode and the button is highlighted with a bright green. Now you can draw with your finger (two fingers still pan and zoom). With the *undo* and *redo* button you cancel the last drawn or deleted objects and put them back again.

There are three types of drawing tools: point (icons), line, area (shaded region). Labels are a "point" tool.

The list of the six most recently used drawing tools is shown in the toolbar at the bottom of the screen. If the triple toolbar setting is enabled, there are three toolbars, for points, lines and areas. To select a tool tap on its icon in the bottom toolbar. With the single toolbar, a tap on the *tools* button cycles through "points", "lines", and "areas".
A long-tap on this button reverts the order of rotation of the bottom toolbar

While in draw mode, the sketch can also be moved by dragging it from the side of the canvas and zoomed with zoom controls if these function have been enabled through the settings. This lets you work with a stylus without the need for two-finger actions.

Point tools
Point tools are iconic symbols. To add a symbol to the sketch touch the canvas where you want to put the point.
If the point is orientable, it is drawn with the set orientation (selectable with the slider in the icon picker dialog). This orientation can be overridden with a touch of the display slightly dragged in the desired orientation.
With "labels" you must also enter the text in the coming dialog.

Line tools
Line tools are line-drawing styles. Lines have an orientationi: when a line is selected, in edit mode, its orientation is shown by a yellow tick pointing to the lefti side.

The line thickness is one of the *settings*. There are separate options for the centerline/splays and the drawing line thickness.

Section lines
The "section" line is special as it is always made into a straight segment with a short tick showing the direction of view. A "section" point is automatically added connected to the end of the section line. This point has the "scrap" option preset to the line scrap and is deleted when you delete the section line.

"Section" lines cannot be erased with the *eraser* tool. To remove a "section" line, select it with the *edit* tool and delete it with the "delete" button.

Its points cannot be moved in the canvas, like for points of other lines, neither they can be removed. The pointwise actions do not apply to the endpoints of "section" lines.

Area tools
Area tools are region shaders. To draw an area trace its contour. You do not need to be very precise as TopoDroid will close it.
The water area is special because it can be "closed horizontally" in the profile sketch and in the x-sections, because the surface of a pond is usually horizontal. To draw a water area (in the profile sketch) trace only the lower bottom line of the pond.

Undo, redo, erase and edit

Drawing mistakes can be corrected. The *undo* button removes the last item. To erase a line or a symbol drawn long ago, without loosing all the intermediate work, there are two choices: the *erase* mode and the *edit* mode.

The *eraser* is very intuitive: it cancels everything you pass your finger over, except stations, shots, and section lines. Just like a real eraser on the paper: if you pass it in the middle of a line it erases only the central portion (thus leaving two lines). However erasing can be filtered to erase only items of one type: points, lines, or areas.

The *edit* [A] button is not so intuitive, but it is very powerful, as it allows pointwise editing operations. In this mode all the drawn items are shown as little green dots. To select the item to edit tap on one of its green dots (icons have only one dot). If there are several dots close together, they will all be selected (and shown with a pink circle), but only one will be chosen for editing (big green circle). If it is not what you wanted, cycle through the selected points with the *previous/next* buttons.
Except for the endpoints of "section" lines, the points of the the drawn items can be moved on the canvas by dragging them.
The edit tool can be filtered to select only dots of one type: points, lines, areas, shots, or stations.

The size of the green dots and the selection radius are two *settings*.

Segments of Bezier lines have two control points. These are stored with the segment end-point and when this is the selected editing point the two control points are shown as pink circles. Each of them can be moved around by dragging it with the finger.

To clear the selection tap somewhere else in the canvas. The item can be deleted (removed) or its properties changed ("tool" button). Editing applies also to shots and stations.

Editing an orientable point, its icon can be rotated also with the side-drag (if enabled).

A survey shot (leg or splay) has a green dot in the middle to select it. When a leg is selected in the profile view, a horizontal yellow segment is also displayed on the side opposite to the leg "extend", or on both sides if the leg is extended vertically. The leg extend can be set by tapping the left or right end of this segment, or the middle.

Pointwise edit actions [A]

The pointwise edit actions (fourth to the right button) apply only to drawing items. The button has a drop-down menu of editing actions, for either points [P], lines (except "section" lines) [L], and areas [A]:

- *Snap to nearby point* [P,L,A]: move the point to coincide with the nearest point of the current scrap. No action if there is no nearby point
- *Snap to nearby splays/line* [L,A:T]. Lines are deformed to pass through the splay endpoints that are close enough. If an area point is close to a line point, and the pieces of the area border before and after it are replaced with pieces that follow the line path. This feature requires the proper setting enabled
- *Insert* point(s) [L:A]. When a single point is selected, the new point is inserted "after" the selected point, and it is added to the selection set, and you can select it with the Prev-Next buttons. When a range is selected, new points are inserted between every two points of the range. A long-tap moves the selected point to the nearest point and inserts another point, "after" the selected point [T/G]
- *Cut* [L] the line at the point, thus making two lines
- *Straighten* [L:T] the line segment removing the control points
- *Smoothen* [L:T] the line segment inserting control points at 1/3 and 2/3 the segment length. Further editing can move them and give any wanted curvature to the segment
- *Remove* [L:A] the line/area point. The selected line/area point can be removed also with a long-tap on the "delete" button.
- *Append* [L:T, except "section"] to another line of same type. Only for line end-points and the other line end-point must be close to the selected point.
- enter *multiselection* mode [P,L,A:T]

Multiselection mode [T]

Drawing items multiselection is disabled by default. It can be enabled in a "Sketch | Line" custom setting. The multiselection mode allows to select several objects of the same type (point/line/area) and act on them all:

- *Delete* the selected items [P,L,A]
- *Reduce* the number of points of the selected items [L,A]
- *Join* the selected item [L]
- *Exit* multiselection mode

Range selection

Lines and areas points can be selected individually (point selection mode) or as a range. To select a range on a line, the last button in the "edit" button-bar must be either "soft" or "hard" range. Select first one endpoint of the range, then the other endpoint.
The range is highlighted orange. Its midpoint gets the big green dot, and it controls how the line range is deformed. The range can have hard or soft bounds. With hard bounds the range is moved as a whole. With soft bounds the points at the ends of the range are moved by an amount proportional to their distance from the end.

The range can also be "item-wise", ie, the whole item. In this case you select a point on the line/area, and act (eg, shift) on the whole item.

Stylus-only sketching

Stylus-only sketching allows you to hold a finger on the screen while drawing with a stylus.
To enable this feature you must set a positive "stylus size". A value of 1 is enough for a fine-tip stylus. A

value about 5 might work with a fat-tip stylus. Larger values will confuse your finger for a stylus.

Sketch station editing
Drawing tools
Auto walls

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[11] CROSS-SECTIONS

X-sections are kind of special because they do not belong to the sketch but are independent sketches associated to either the plan or the profile. TopoDroid has two types of x-sections: leg x-sections and station x-sections. The former cross a leg, the latter are defined at a station.

A plan x-section is always in a vertical plane and the upward direvtion is the vertical.
A profile x-section is in a plane with the inclination defined by the section-line. The upward direction is the azimuth of the crossed leg. However, if the inclination of the x-section plane is above a "horizontal threshold", the section is considered "horizontal" and the upward direction is the magnetic North.

You can assign a comment to an x-section.

Leg x-sections

To tell TopoDroid that you want to draw a x-section you have to draw a "section" line, either in the plan view or in the profile view. The section line defines the position of the x-section and its orientation.

A x-section is the shape of the cave in a plane that cuts it. The orientation of the x-section is the orientation of this plane, i.e., the direction of the line perpendicular to the plane, and pointing in the direction of sight. You define the orientation of the x-section by the way you trace the section line. As an indicator the section line has a tick pointing from the line to the direction of view of the x-section.
The size of this "tick" can be adjusted in the *settings* dialog.

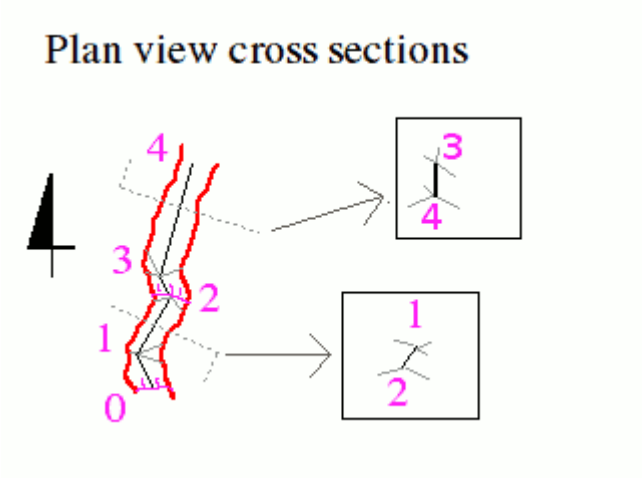
You can choose between a photo x-section, and a sketch x-section. In the first case just take a photo that will remind you of the shape of the gallery when you will be drafting the cave map. Make sure to have a fellow caver in the picture who will serve as a size reference.

In the second case you sketch the x-section on a canvas with the usual drawing tools of TopoDroid. As a reference TopoDroid displays the leg shot traversed by the x-section and the splay shots at its endpoints. The station in front (the one that the x-section is looking at) is centered in the grid. The splay shots in front are light grey, those behind are thinner darker grey. All the shots are displayed projected on the plane of the x-section. A white dot marks where the section plane intersects the leg [T].

Leg x-sections can be re-opened and modified by selecting, in "edit" mode, the section line or the section point, and tapping the *edit* button.

X-sections in the plan view
X-sections defined in the plan view are always "vertical" (zero inclination). Their orientation (ie, the azimuth of the x-section plane) is determined by the angle of the section line. Very often the section plane is perpendicular to the gallery, but can be at any needed angle. For example, a section line drawn from left to right(e.g. horizontal, angle 90° from the vertical) has a direction of view to the North (up, azimuth 0). If drawn slightly downwards at an angle of 120, it will have a direction of view to an azimuth of 30°.

The crossed leg is displayed vertical when the x-section has the same azimuth as the leg. Otherwise it is tilted right or left.



X-sections in the profile

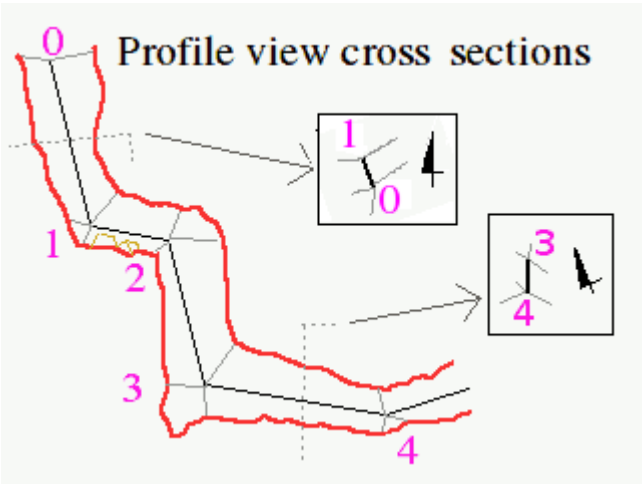
X-sections in the profile view can be either "horizontal" (on vertical shots in pits) or "vertical" (on more or less horizontal galleries). They are considered "horizontal" if their inclination exceeds the value of the H-threshold setting.

The azimuth of vertical x-sections is determined by that of the crossed leg.

"Horizontal" x-sections are displayed always with the North up. Furthermore, a reference line 5 m long, oriented to the North, is added to them. The leg is shown at its azimuth

"Vertical" x-sections always have the azimuth of the crossed leg (or the opposite one if the direction of the section line is the opposite of that of the leg). The crossed leg is displayed vertical as the x-section has the same azimuth as the leg.

If the section line is traced from the right to left, the x-section is oriented downwards and has -90° inclination. This is a "horizontal" x-section as seen from above. Most of the times you will want to draw "horizontal" x-sections this way, as it is more natural to lay a map on a surface and look down at it. If you trace the section line from left to right the x-section is oriented upwards (inclination +90°).



Section points

If the setting for the "auto section points" is checked, when you insert a x-section, either by drawing a section-line or inserting it at a station, the corresponding section point is added to the sketch. Section points

are displayed as white squares and and orange line connecting them to the relative section line or station.
If the x-section is deleted, the corresponding section point is also deleted.

X-section files
Each x-section is saved in a separate file in the "tdr" subfolder. The files get consecutive names "MySurvey-xx0.tdr", "MySurvey-xx1.tdr", etc. The "xx0" numbering part of the name is also displayed in the Section dialog that pops up when you create or edit a section.
The file is deleted when a x-section is deleted.

X-sections can be exported in other formats just like the other sketches, except in *cSurvey* format. X-sections are included in the sketch exports in the DXF, SVG, *cSurvey*, provided there is the associated section point.

Station x-sections [E]
This is another way to insert x-sections. The "Station" dialog, that you get by tapping on a station point in *Edit* mode, displays the station coordinates and has some buttons:

- "Continue" the survey from the station. Set the station as the "active station", ie, that to which the next shot will be attached
- "Reset" the centerline display after the station.
- "Toggle" the display of the splays at the station.
- "X-Section" [E] opens a sketch window to draw a x-section at the station.

If the mean clino of the legs at the station is smaller than the "vertical threshold", the x-section at a station is drawn in a vertical plane passing through the station, otherwise it is horizontal. The station x-section is useful when you take several splay shots around the station to describe the shape of the gallery. The x-section plane can be oriented with the *compass* button. If the station has only two legs the plane can be oriented along the bisectant of the angles formed by the (horizontal projections of the) legs. If there is only one leg it can be oriented orthogonal to that. If there are more than two legs you have to use the *compass* button.

Station x-sections can be re-opened and modified by selecting, in "edit" mode, the station or the section point, and tapping the *edit* button.

See also
Sketch station edit dialog,
Sketch line edit dialog.

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[12] OVERVIEW WINDOW

You get into the overview window from the *overview* menu of the sketch window.

The overview window displays all the sketches together, either in plan or in extended profile view depending on the view of the sketch window. The overview window can be either in normal mode (canvas shift and zoom), or in measure-mode.

BUTTONS

-  toggles the window in "measure mode"
-  references dialog, through which you can switch on/off the display of midline, splay shots,

station names, metric grid, and scalebar. There is also a checkbox to hide the cave details and show the outline only.

-  If "angle", you measure the distance and angle between two points. If "polyline", you measure the total length of a polyline traced by tapping the positions of the nodes
-  undo: remove the last point of the polyline

When the window is in *measure mode* the first button has a bright green color. In this mode the drawing can be translated with the side-drag (if enabled) and zoomed with the zoom buttoms (if enabled).

Segment measure

When the overview window is in measure-mode you can measure the distance between two points on the canvas. To do this you tap first on the first point: this is displayed as a pink circled cross. Next you tap on the second point: this is shown with a blue cross and the 2D distance is shown in the title bar, together with the differences along the X and Y axes, and the bearing (plan) or inclination (extended profile). The distance units is the the sketch grid units (meter, yard, 2-ft, or dm). The angle is in the current angle units (degrees or grad).
Any further tap changes the second point (and the measure values).

To end the measure tap on the "measure-mode" button.

The distance is computed in the plane of the canvas. In plan view, this is the horizontal distance. In extended profile view the Y-axis difference is the difference in elevation.

Polyline measure

The "polyline" measure is useful to get an estimate of the "length" of the cave, more sensible than the length of the midline. You tap on the start of the polyline and the additional taps mark the nodes of the polyline. If you make a mistake tap the *undo* to remove the last points one at a time.

The title displays the distance between the two end points, the polyline length, the X-Y displacement between the endpoints, and the angle.

MENUS

- close the window
- export [T]
- settings
- help

Export
The overview can be exported in the following formats:

- *Therion*
- SVG
- DXF (*LibreCAD*)
- shapefile (*QGIS*)
- xvi (*xtherion*)

Each sketch is mapped to a "scrap" in the Therion export. For the other export formats, the sketches are put in a single drawing.
Station points are not included automatically in the therion export; only user defined station are added.
The stations are added automatically to SVG, DXF, shapefile, and xvi exports.
If there are "section" points, the x-sections are included.

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[13] IMPORT EXPORT

When you are done, export the survey in your favourite format and make a zip archive.
After you have downloaded the zip to your PC and unzipped it, you can complete the cave map with whatever program you are used to.

The zip archive contains the command to restore the survey data and other information in the database. The zip archive is a complete backup of your survey and its exports. You can use it to transfer the survey to another Android.

Survey data, and zip archive, are exported from the survey info window.
Survey sketches are exported from the sketch window (single sketch) and from the overview window (all sketches in one file).

File for survey import are searched in the *import* folder.
Zip archives for import are searched in the *zip* folder.

Default export formats
TopoDroid has two settings to set a default export format for the survey data and one for the sketches. By default these are both set to "none", ie, no export.

When the default survey data export format is set, TopoDroid exports the survey data in that format before creating a zip archive, so that the export is included in the archive.

When the default sketch export format is set, the sketches are exported in this format whenever they are closed from the sketch window.
For cSurvey x-sections are saved as PNG images.

SURVEY IMPORT

TopoDroid imports survey data from the following formats:

- Compass
- Survex
- Therion. Only data
- VisualTopo
- CaveSniper
- PocketTopo, including sketches

A file import fails if a survey with the same name is already in TopoDroid.

Zip import fails if the zip has a database version that is too old or is newer than the one in TopoDroid.

On import from file formats that have LRUD values, these are converted to x-splays (shown in green).

SURVEY DATA EXPORT

TopoDroid exports survey data to the following cave-program formats:

- Compass
- cSurvey
- Survex
- Therion
- TopoRobot
- VisualTopo
- Walls
- WinKarst
- GHTopo
- Grottolf

- PocketTopo
- Polygon
- Topo

Furthermore it exports survey data as

- CSV
- DXF
- KML
- GeoJSON
- trackfile
- shapefile

If the survey is not georeferenced the survey data cannot be exported in the last four export formats.

Georeference points are exported with coordinates latitude-longitude [decimal degrees] and altitude above mean sea level [m].
H/V-splays are treated as normal splays in the exports.

Compass (.dat)
Compass data file are supported both in import and in export.
Import compass files must have extension either ".dat" or ".DAT".
Supported data format are "normal" and "diving".
Data units are 'feet' and 'degrees' (converted to meters and degrees inside TopoDroid).

Settings:

- Station prefix
- splays
- L/R swap

cSurvey (.csx)
The cSurvey export files require cSurvey v. 1.20 or later.
The *cSurvey* export from the survey info window includes only the survey data, and does not have any sketch.
The make a *cSurvey* export with a sketch (both plan and profile), you should export from the drawing window.

The *cSurvey* export includes the calibration-check shots and media files (audio and photo).

Settings:

- station prefix whether to add a prefix to the station names

Survex (.svx)
Survey data can be exported as *Survex* files.
Data units follow the user options.

Import Survex files must have extension ".svx".
Settings:

- line termination can be either Unix or Windows

- named TO station for splay shots (the TO name is the FROM station with a letter appended)
- add LRUD to export

Therion (.th)
Survey data are exported in *Therion* format, using the data "normal" form.
Data units follow the user options.
The team names are listed but the command is commented.
Station comments and marks (fixed, painted) precede the centerline data.
X-splays are exported with station "-" (dash), the others with station "." (dot).
Commented shots are exported under comment (#).

Fixed points coordinates (longitude latitude and altitude a.s.l.) are exported commented. If the point has custom CRS coordinates, these are included as well, preceded by the CRS name.

Furthermore "input" of the th2 files and definitions of maps for each scrap are added at the end, but are commented.

The *Therion* export includes the calibration-check shots, as comment.

Settings:

- Therion thconfig: if enabled a basic "thconfig" file is created in the "thconfig" folder.
- Therion maps: if enabled the "map" commands are placed before the survey centerline.
- add LRUD to export

thconfig
The generated "thconfig" file contains the basic commands to create the pdf of the plan and extended profile maps.
Basically you can see the Android "sdcard" from your PC, you can create the pdf's executing therion with the generated *thconfig* file.

The TopoDroid survey name is used for the Therion cave name, with underscore '_' replaced by space.
The TopoDroid team string is splitted into the Therion *team* commands: team persons must be listed with the lastname possibly preceeded by the firstname initial(s). For example the team string "A.W. Smith, B. Ford" becomes *team "A.W. Smith"* and *team "B. Ford"*.
WHen the thconfig is enabled the input of the sketch files are not commented.

For the extend the syntax "extend <flag>" is used before any leg, with flag equals to "left", "right", or "vert".
For splays that do not have extend, TopoDroid writes "# extend auto", as a comment because it is not a valid Therion command.
Fractional extend is supported in Therion since v. 5.2.2 and it is exported if it is set.

Import Therion files must have extension ".th".
TopoDroid parsing of *Therion* data syntax is very limited. Basically only data in "normal" form are understood. The Therion data commands "units", "flag", "extend", "mark" and "station" are supported.
Fixed points ("fix") are parsed but not taken into account as "cs" is not supported.

TopoRobot (.trb)
Survey data can be exported as *TopoRobot* files. The *TopoRobot* station naming policy must have been selected. If the station names follow TopoRobot convention "series.number", they are used.

VisualTopo (.tro)
VisualTopo data file are supported both in import and in export.

Import VisualTopo files must have extension either ".tro" or ".TRO".
VisualTopo splays are included if enabled.
By default LRUD are at the TO station, but they can be set at the FROM station.
Data units are 'meters' and 'degrees'.

Settings:

- splays
- LRUD at From

Walls (.srv)
Survey data can be exported as *Walls* files (partially tested).
Data units follow the user options.

WinKarst (.sur)
Survey data can be exported as *WinKarst* files (untested).

PocketTopo (.top)
TopoDroid supports *PocketTopo* both in import and in export.

PocketTopo export contains only the survey data.

If the station naming policy is set to "TopoRobot" and the station names follow TopoRobot convention "series.number" these are used in the export, otherwise the names are converted to numbers. Alphabetic characters are replaces each character with two digits. More precisely 'a' goes to '00', 'b' to '01' and so on, 'A' to '50', 'B' to '51', and so on. Every other character (i.e., non-alphanumeric) goes to '99'.

Import PocketTopo files must have extension either ".top" or ".TOP".
The "outline" and "profile" sketches are imported. *PocketTopo* uses only a few colors to differentiate line types. Therefore a mapping from colors to TopoDroid types is used. The mapping can be changed through a setting.

It may happen that the imported sketch is not aligned with the survey data. In this case you can shift the sketch in the sketch window, to fit the centerline.

Polygon (.cave)
TopoDroid can export survey data in *Polygon* format. Fixed points are exported as lat-long.

GHTopo (.gtx)
TopoDroid can export survey data in *GHTopo* format (partially tested).

Grottolf (.grt)
TopoDroid can export survey data in *Grottolf* format (untested). If the first station has geographical coordinates these are exported, otherwise local coordinates are used. The profile at the stations are computed by projecting the splay shots onto a vertical plane perpendicular to the leg.

Topo (.cav)
Survey data can be exported as *Topo* files.

Settings (under "Survex" settings):

- line termination can be either Unix or Windows

CSV (.csv)

Survey data can be exported as a list of records with comma-separated fields:

- "from" and "to" stations
- distance, azimuth, clino
- flag

Shot comments are not exported. A brief header is prepended to the data list.
The survey raw data can be exported in CSV format. In this case each record (line) has

- shot id
- "from" and "to" stations
- distance, azimuth, clino, roll
- acceleration, magnetic field, dip
- timestamp, type (device or manual), device-address
- extend, flag, leg_type, status, comment

In the raw data export the leg shots are not averaged, but exported individually.

Settings:

- raw data: whether to export the raw data
- separator: fields separator (comma, pipe or tab)
- EOL: record separator (lf or cr+lf)

DXF (.dxf)
Survey data are exported as 3D DXF (*LibreCAD*) with layers

- stations
- legs
- splays

Data are corrected with the magnetic declination.

Settings:

- Splay endpoints: if enabled they are marked with crosses

PLT (.plt)
Survey data can be exported as track file (*OziExplorer*) if you have georeferenced a station. If the survey contains disjoint pieces, the track file includes all the pieces with a georeferenced station. Data are corrected with the magnetic declination.

KML (.kml)
Survey data can be exported as KML file (*Keyhole Markup Language*) if you have georeferenced at least a station. If the survey contains disjoint pieces, the KML export includes all the pieces with a georeferenced station. Data are corrected with the magnetic declination.

Settings:

- stations
- splays

GeoJSON (.json)
Survey data can be exported as GeoJSON file (*RFC 7946*) if you have georeferenced at least a station. Shots are exported as *LineString*, stations as *Point*. If the survey contains disjoint pieces, the GeoJSON export includes all the pieces with a georeferenced station. Data are corrected with the magnetic declination.

Settings:

- stations
- splays

Shapefile (.shp .shx .dbf)
Survey data can be exported as shapefile. There is a shapefile for the stations and one for the shots (both legs and splays). If the survey contains disjoint pieces, a shapefile is exported for each pieces with a georeferenced station. Data are corrected with the magnetic declination. Each shapefile consists of three files: the data file (shp), the index file (shx), and the attributes file (dbf). The files are zip-compressed and the zip is saved in the folder "shp" with extension ".shz".

If you have georeferenced at least a station and checked the appropriate checkbox in the export dialog, the data are exported in the WGS84 reference system, and corrected with the magnetic declination.
Otherwise the data are exported in local coordinates and the magnetic declination correction is not applied.

The "stations" DBF contains only the field "name".

The "shots" DBF contains the fields

- *type*: either "leg" or "splay"
- *from* station
- *to* station ("-" for splays)
- shot *flag* as hex: 1-surface, 2-duplicate, 4-commented
- shot *comment*

Settings:

- stations: whether to export the stations
- splays: whether to include the splays

SKETCH EXPORT

TopoDroid exports survey sketches to the following formats:

- cSurvey
- Therion
- Tunnel
- xtherion
- Cave3D

- DXF
- PNG image
- shapefile
- SVG

cSurvey (.csx)
The cSurvey export files require cSurvey v. 1.20 or later.
These exports contain both the plan and profile sketches, as well as the survey data. When "section" points are define the section drawings are added at the point.
The cSurvey "cave" attribute is set with the survey name, and the "branch" attribute with the sketch name (without the suffix 'p' or 's'). The midline legs and splays and the sketch items share these attributes.

If your survey has only one sketch this is a complete export of your work (except for the x-sections). If the survey has more than one sketch, you must export each sketch individually and merge the exports with *cSurvey*.

The sketch items are distributed on suitable *cSurvey* layers.

Settings:

- station prefix whether to add a prefix to the station names
- point spacing maximum distance between interpolating points on smooth lines

Therion (.th2)
Sketches are exported in Therion format as one sketch per file, if exported from the sketch window, or as a file containing all the sketches with the same view, plan or extended, if exported from the overview window. In the latter there is a scrap for each sketch, and x-section scraps are included if the automatic "section" points are enabled.

The Therion *scrap* names are composed of the survey name, the sketch name and a suffix, either 'p', for plan, or 's', for profile.
For multi-scrap sketches the Therion *scrap* names of the scraps, beyond the first, are appended also a scrap number, beginning with 1.
X-section Therion *scrap* names are composed of the survey name, a two letter code, 'xx', and a number.

When a sketch with section points is exported through the export dialog, the x-sections of the section points are also exported.

It the sketch contains symbols that are not included in the Therion set, you must prepend the prefix "u:" to the unsupported symbol names, before using the th2 file.

Settings:

- automatic station-points. [default: yes].
- add splays to the scrap (as lines of type "splay") [default: no].
- add a xtherion command to read the XVI image of the sketch [default: no].
- export scale. Default 1:100
- point spacing minimum distance between points on polylines. Intermediate points are not exported. Default 20 cm

XVI images are not automatically exported with the Therion "th2" file, even if a xtherion command to include it is added to the therion file, because it would not contain more information than the therion file. The command can be used to load in xtherion an XVI image created by another program.

Tunnel (.xml)
Sketch can be exported in Tunnel XML format. The files are saved in the "tnl" subdirectory.
The following lines are mapped to Tunnel lines: wall, presumed, pit, chimney, and slope. All the other lines are mapped to Tunnel line "details".
Area borders are mapped to Tunnel line "filled".
The following points are mapped to Tunnel points: air-draught, archeo, blocks, clay, column, curtain, flowstone, gradient, guano, mud, pebbles, popcorn, sand, soda-straw, stalactite, stalagmite, water, water-flow. All the other points are mapped to Tunnel point "bedrock".

Xtherion (.xvi)
The "xvi" export can be inserted as background image in xtherion.
Lines of type "wall" are red, "slope" orange, "section" gray, all others are brown. Area borders are black.
Point icons are rendered in a simplified way. Label rendering supports only latin characters and digits and a few characters ('+', '-', '/', '_', '>', '<', '?'). Other characters are replaced by a "diamond".
The grid cell are 1 m.

The XVI settings are among Therion settings:

- Drawing section-point: if section points are automatically added to section lines, the section drawing is inserted in the xvi file, at the "section" point
- grid lines added to the export (cell size in the current grid units). Default no
- export scale. Default 1:100

Cave3D (.c3d)
Sketch exported in "c3d" format can be lifted in the 3D model inside Cave3D.

DXF (.dxf)
Sketches can be exported as 2D DXF files with layers for each point, line and area type in addition to the layers of the survey data. The sketch items in the 2D DXF lie in the Z=0 plane.

Sketches can be exported as DXF *9* AC1009, *12* (R13) AC1012, and *14* (R14) AC1014. For DXF-9 areas are exported with only the border and are not colored inside.

It is possible to include in the DXF file, the x-sections (for which the sketch contains a "section" point), and the X-Y axis.

Settings:

- DXF version: 9 (dxf-9), 12 (dxf-13), or 14 (dxf-14). Default "9"
- section-point: if a section line has the relative section point, the drawing of the section is inserted in the export, at the "section" point
- XY reference: whether to insert the XY axes reference
- stations: whether to insert station points
- interpolated curves: whether to draw cubics as interpolated polylines
- point spacing maximum distance between interpolating points on smooth lines. Default 20 cm

PNG (.png)
Image file in PNG format is used only to export sketches.

Settings:

- image resolution (1 means that 1 m = 40 pixels). The PNG resolution that fits therion th2 export is 5.0. If the system does not have enough memory to create the image at the set resolution, TopoDroid

uses a smaller resolution until the export succeeds (or it gets so small that the program gives up trying).
- background color: three numbers between 0 (black) and 255 (saturated) for red, green, and blue, respectively.
- grid: whether to include or not
- splays: whether to include or not
- stations: whether to include or not

Finally the setting "levels" affects PNG exports: if levels are used the export will include only visible items.

Shapefile (.shp)
Sketches can be exported as shapefile, with stations, shots, and lines. Each item has three files: the shape data file, the shape index file, and the database file. The files comprising the shapefile export are zip-compressed and the zip file is saved in the folder "shp" with extension ".shz".

If you have georeferenced at least a station and checked the appropriate checkbox in the export dialog, the data are exported in the WGS84 reference system, and corrected with the magnetic declination.
Otherwise the data are exported in local coordinates and the magnetic declination correction is not applied.

The "point" DBF contains the fields

- point *name*
- *orientation*
- *level*
- *scrap*
- optional *text* (truncated to 128 characters)

The "extra" DBF contains the fields

- point *name*
- *orientation*
- *level*
- *scrap*
- optional *text* (truncated to 128 characters)
- *file*

The "line" and "area" DBF contain the fields

- *type* that distinguishes between line and area
- line or area *name*
- *level*
- *scrap*

The "station" DBF contains the fields

- *name* of the station

The "shot" DBF contains the fields

- *type*: either "leg" or "splay"
- *from* station
- *to* station ("-" for splays)
- shot *flag* as hex: 1-surface, 2-duplicate, 4-commented

SVG (.svg)
Sketches can be exported as SVG files.
Items are organized in layers: *grids*, *stations*, *legs*, *splays*, *points*, *lines*, and *areas*.
These layers are under a global *canvas* layer.
Each "scrap" has its *points*, *lines*, and *areas* layers.

The export scale is 1:100.

If splay classes are enabled, the splays are colored be the class: normal splay are gray, horizontal are light sea-green, vertical light steel-blue, and xsection light sky blue. Splay-classes are not supported in "round-trip" export.

Note. Sketch SVG export has been verified with *Inkscape* and *Firefox*.

Settings:

- Drawing section-point: if section points are automatically added to section lines, the section drawing is inserted in the export, at the "section" point
- automatic station-points: if enabled all stations are included in the export, otherwise only the user-chosen stations are included
- point spacing maximum distance between interpolating points on smooth lines
- round-trip: sketches are exported ready for Walls/Compass round-trip. Default no
- grid lines added to the export (cell size in the current grid units). Default no
- line orientation tick. Default no
- lines width: labels, icons, lines (and area borders), grid lines, shots, orientation stroke
- station size: station names text-size. Default 20

CALIBRATION EXPORT

Calibrations can be exported and imported as CSV files (.ccsv).

IMPORT/EXPORT SETTINGS

- **PocketTopo** *import color-map*: map of PocketTopo colors to sketch item types.
- *Estimate LR extend*: on import of **Compass/VisualTopo** files [yes]
- *Default data export format*: defines the default format to which data are exported. This file is automatically generated and inserted in the ZIP export.
- *Default sketch export format*: defines the default format to which sketches are exported. These files are automatically generated whenever a sketch is closed. This puts some extra load on the system, so you may opt for explicitly exporting sketches after the survey session.
- **Therion** *map commands* before or after the centerline block [after]
- **Therion** *auto-stations*: automatically add station points to the therion sketch file(s) [yes]. If you want to use the sketch files in therion they must have station points to define their scale. You can choose manually which point to add (by editing the sketch drawing), or let TopoDroid add the stations. The program will add all the stations that are "inside" the drawing (inside the drawing convex hull).

- **Therion** *splays* lines in Therion scraps [yes]
- **cSurvey/Compass** *survey prefix* to the stations [no]
- **Compass/TopoRobot/WinKarst/Polygon/VisualTopo**
    - minimum *splay-leg angle* for LRUD computation [0.0] This is also used in **Survex/Therion** if LRUD are required.
    - minimun clino of splays used for up/down LRUD [0]
    - maximum clino of splays used for left/right LRUD [90]
- **Compass swap LR**: Swap L and R on Compass export.
- **Survex/Topo** *line termination*: either Unix or Windows [Unix]
- **Survex** export with *named splay* TO stations [no]
- **Survex/Therion** export with *LRUD* lines [no]
- **SVG** export with *grid* [no]
- **SVG** export line orientation ticks [no]
- **SVG** stroke widths (labels, icons, lines, grids, shots, orientation ticks)
- **KML/GeoJSON** export with *stations* [yes]
- **KML/GeoJSON** export with *splays* [no]
- **PNG** *resolution* [1.5]. It can be a number between 1 and 10. The higher the bigger the image (if you set it too high the system may not have enough memory to create the PNG).
- **PNG** *background color*: you can set the background color of PNG images by specifying the RGB values (three integers between 0 and 255).
- **DXF** sketch export *scale* [1.0]
- **DXF** export with *splay endpoints* [no]
- *DXF version* for the DXF export: either 6, 12, or 16. In version 6 DXF export bezier curves are replaced by polylines and areas do not have hatches. Version 12 and 16 DXF exports use splines and hatches, but they are still buggy.

The final map

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[14] CAVE PROJECTS

CAVE PROJECT MANAGER

This window is accessed from the button of the *Main Window*.

A cave project aggregates surveys that are in the TopoDroid database. The "cave projects" are stored in Therion-like files in the "tdconfig" folder of TopoDroid. A project file is saved whenever the project is closed. Projects can be exported as Therion or Survex files; exports are saved in the "th" and "svx" folders, respectively. When you start TopoDroid Manager it displays the list of cave projects in the "tdconfig" folder. The project list is empty if you have not created any project yet.

BUTTONS

- *New cave*: opens a dialog to create a new cave project

MENU

- *Close* the Cave Project Manager window
- *Help* this help

Tapping on a project name opens the *Project Window*.

CAVE PROJECT

The project window lists the surveys included in the cave project. When a cave project is first created it does not have any survey, and the list is empty. To the left of each survey there is selection a checkbox.

BUTTONS

- *Add surveys*: opens a dialog to select the surveys from TopoDroid database, that must be included in the cave project.
- *Drop surveys*: remove from the cave project the selected surveys.
- *View surveys*: displays the selected surveys in plan view.
- *List equates* between surveys of the cave project
- *3D viewer*

MENU

- *Close* the Cave Project window
- *Export* the cave project (as Therion or Survex)
- *Delete* the cave project
- *Help* this help

The plan view of the selected surveys is displayed in the *Surveys View Window*.

SURVEYS VIEW WINDOW

The survey are displayed in plan view, with midline and station names. Each survey has a different color. After a while the colors repeat therefore you should display only two or three surveys at a time. Equates are shown as dashed red lines, and equated stations have a round background. The view can be panned and zoomed. A survey can be grabbed (tap on a station: it gets circled) and dragged around while the other surveys do not move. In this way you can overlap stations of different surveys that you want to equate. When they overlap circle them both by tapping the point: you can then insert the equate between them with the menu "add equate".

BUTTONS

- *Add equate*: opens a dialog to manually add an equate between surveys of the cave project.
- *List equates* between surveys of the cave project

MENU

- *Close* the Cave Project window
- *Help* this help

You can drop an equate by tapping its entry in the dialog listing the equates of the cave project.

TopoDroid SETUP

TopoDroid has a large number of settings.
The setup dialogs lead the user to choose the most important ones:

- **text size**: this affects the size of text in the list displays as well as the size of station names and labels in the sketches
- **button size**: this is the size of buttons in the windows action bars and in the dialogs
- **icon size**: this is the size of icons in the sketches

TopoDroid SUBDIRECTORIES

Here is some background about how the survey data, the calibration data, and the sketches are stored.

The app creates its default base directory, named "TopoDroid", in the primary external memory (usually /sdcard), or, since Android 11, in the primary public external memory (usually /sdcard/Documents). This directory is not removed when you uninstall the app. In this directory the app creates two SQLite databases. The first is "device10.sqlite", where the calibration data, the DistoX informations, and other data are stored. The second is "distox14.sqlite" and stores the surveys data. The app also creates subdirectories for the different types of files. These subdirectories are created only in the "TopoDroid" base directory:

- **bin**: firmware files (DistoX2 only)
- **ccsv**: CSV text files of exported calibrations (DistoX only)
- **dump**: memory dump files (DistoX only)
- **symbol**: drawing tools files (points, lines, areas)
- man: user manual translation

"bin" is used to store firmware files, both the factory files included in TopoDroid and the firmware dumps read from a DistoX2.

The following subdirectories can be created in each working directory (in bold those that are always created):

- **audio**: *audio* comments
- cave: *Polygon* files
- cav: *Topo* files
- csv: CSV text files of exported surveys
- csx: *cSurvey* files (exported surveys and sketches)
- dat: *Compass* files (exported surveys)
- dxf: DXF (*LibreCAD*) files (exported surveys and sketches)
- grt: *Grottolf* files (exported surveys)
- gtx: *GHTopo* files (exported surveys)
- **import**: survey files to import (*Therion*, *Compass*, *VisualTopo*, *Survex*, *PocketTopo*, and *CaveSniper*

format)
- kml: *GoogleEarth* exports [A]
- **note**: survey annotations text files
- **photo**: survey pictures (each survey with its own subdirectory)
- plt: *OziExplorer* track file exports [A]
- png: PNG image files (exported sketches)
- shp: *shapefile* exports [T]
- srv: *Walls* files (exported surveys)
- svg: SVG files (exported sketches)
- sur: *WinKarst* files (exported surveys)
- svx: *Survex* files (exported surveys)
- **tdr**: binary sketch files
- th: *Therion* files (exported surveys)
- th2 for *Therion* scrap files (saved sketches)
- tmp: for temporary files. Any file leftover in this directory can be safely deleted.
- top: *PocketTopo* files (exported surveys)
- tro: *VisualTopo* files (exported surveys)
- **zip**: survey ZIP archives (exported and importable)

Some of these subdirectories are used only to store exported files (cav, cave, csx, dat, dxf, png, svx, th, th2, top, tro). Others are used to store data (tdr, th3, note, photo). The subdirectory "zip" is used to store zipped archives as well to read them and uncompress in TopoDroid. When you want to import a survey made with another program (*Therion*, *Compass*, *VisualTopo*, *Survex*, *PocketTopo*, *CaveSniper*) you must place it in the subdirectory "import".

Android PERMISSIONS

Storage

TopoDroid saves the survey data and sketches, and the calibrations, in the external storage.
It cannot work without read/write access to the storage.

Internet

The network connection is necessary only if you want to install a translation of the user manual.
TopoDroid does not uses the network in any other way, and it is safe to disable this permission.

Bluetooth

TopoDroid requires bluetooth access to communicate with the devices.
If the survey data are entered manually, it can be used without bluetooth.
TopoDroid uses also bluetooth pairing, to pair with newly discovered devices. Discovery and pairing can be done with the "settings" app.

Camera

TopoDroid can use the camera to take pictures, or it can forward the task to a "camera" app.
TopoDroid camera management is not so feature-rich as that of a "camera" app, but it stores the direction of view (azimuth and inclination) in the pictures.
It should be safe to use TopoDroid without this permission.

Audio

TopoDroid uses the microphone to record audio notes (for shots and audio points).
If this permission is not granted, audio recording is disabled.
It should be safe to use TopoDroid without this permission.

Location
TopoDroid uses the device GPS to get the geographical position of a point, but it can import it from *MobileTopographer*.
It should be safe to use TopoDroid without this permission.

TopoDroid DATABASES

It is useful to have a rough idea about the organization of the information and the data in the databases. The units of work in TopoDroid are the surveys and the calibrations. A survey is a single survey session of a piece of cave. A calibration is a single DistoX calibration.
Surveys are stored in the "distox14.sqlite" database. There is one such database in every work directory.
Calibrations are stored in the "device10.sqlite" database, together with the device information. This database is global and is present only in the "TopoDroid" directory.

Accordingly, the most important table in the survey database is:

- **surveys**: survey informations

The surveys records store the survey name, date, team, magnetic declination, initial station name and possibly a comment.
Related to the surveys are the tables for:

- **shots**: survey data
- **stations**: saved stations
- **plots**: 2D sketches; plans, profiles, x-sections
- **photos**; pictures associated to survey shots
- **audios**; audio comments associated to survey shots
- **sensors**: measurements associated to survey shots
- **fixeds**: (geolocalized stations)

The most important tables in the device database are

- **devices**: devices informations
- **calibs**: calibrations informations

The calibs records contain the calibration name, date, DistoX device, algorithm, and the results of the last computation: coefficients, average error, maximum error, number of iterations.

Related to the calibrations is the data table

- **gms**: calibration data

Finally each database has the table

- **configs**: configuration values

You can learn more about the data organization in the database by looking at it with a SQLite viewer.

TopoDroid ECOSYSTEM

When working with TopoDroid, you might find useful some complementary and auxiliary apps:

- *Cave3D* is a 3D viewer used by TopoDroid for the 3D display
- *Proj4* is a (very simple) coordinate converter app, used by TopoDroid to convert long-lat values to other coordinate systems
- *MobileTopographer* is a geolocation app. You can use it to take the point coordinates and have TopoDroid read them from the point file in MobileTopographer pointlist.
- *CrowdMag* is an app by NOAA National Geophysical Data Center, useful to get informations about the current state of the Earth magnetic field.
- an app to take pictures (usually there is a *Camera* app)
- a File Manager (eg. *MiXplorer*) is definitely useful to look at the files (and to make backup copies)
- *SQLiteViewer* (or any other SQLite manager app) can be helpful to inspect the TopoDroid databases

In addition, depending how you process your surveys, you may want to install

- a image viewer/editor (usually there is a preinstalled image viewer, *Gallery*)
- a DXF viewer/editor
- a spreadsheet viewer/editor (eg. Google *Sheets*)
- a SVG viewer (eg. *SVG viewer*)
- a ZIP archiver (eg. *MiXArchive*)
- *GoogleEarth*
- *AndroWish* if you really want to use *xtherion* on Android (but it will not execute Therion)
- a track file viewer (eg, *Androzic*)

Finally a *wakeup-touch* app turns out to be very convenient during the survey session in the cave. In order to save battery you may want to set the display sleep timeout very short (eg, half a minute). With a wakeup-touch app you do not have to press the power button to wake up your android, but just need to touch the proximity sensor. I use to keep my device in a protective box opening only the cover lid. The power button on the side is therefore not accessible when the device is in the box, and the wakeup-touch app is really handy.

Proj4

TopoDroid stores point coordinates in the reference system geographical long-lat WGS-84. Altitudes are stored both referred to the ellipsoid and to the geoid.

The app Proj4 is used by TopoDroid in two ways to transform coordinates between WGS-84 and other coordinate systems.

- to convert the coordinates of a point from long-lat (WGS-84) to another coordinate reference system.
- to enter the coordinates of a point in a different coordinate system.

Color codings

Station naming policy

- forward leg [default]: blue
- backward leg: dark blue
- foresight + backsight: violet
- tripod: pink
- magnetic anomaly: red
- TopoRobot: orange

Survey data

Foreground color:

- white: leg shot
- grey: leg repeated shot
- blue: splay
- green: x-splay
- dark-blue: h-splay
- deep-blue: v-splay
- orange: blank shot
- violet:
- others: user-assigned color

Background color:

- black: normal
- red: unreliable shot
- grey: commeneted shot
- orange: short leg

Survey stations

Foreground color:

- green: active station

Background color:

- black: normal
- dark green: latest data
- grey: multiselection
- dark yellow: DistoX backsight

Sketch legs

- white: normal
- red: unreliable
- orange: inconsistence with siblings

Survey splays

- blue: normal
- dark-green: commented
- green, dark-blue, deep-blue: splay classes
- others: user-assigned color

Survey stations

- violet: normal
- green: active station
- red: midline hidden after the station
- blue: midline hidden before the station
- yellow: saved station

Calibration data

Foreground color:

- blue, orange: data groups
- grey: unused data

Background color:

- violet: partially downloaded data (not used)
- red: error above 1 degree
- green: large difference from group average
- brown: saturated data
- grey: deleted data (group -1)

TopoDroid HELP

The help-dialog is opened from the *Help* menu of the TopoDroid windows.

It contains a brief explanation of the window buttons and menus.

The *book* button at the top right opens the user manual at the section about the current window. The user manual page can be opened also with the Android hardware *MENU* button.

A long tap on the *book* button opens the user manual at the first section.

TopoDroid SETTINGS

GENERAL SETTINGS

- Work directory. Default "unset" (ie "TopoDroid")
- Text size: size of the text in lists. >= 1. [14]
- Buttons size {small, normal, medium, large, huge}. [normal]
- Activity level {basic, normal, advanced, expert}. [normal]
- Keyboard. Enable custom keyboards instead of Android default keyboard.
- Custom keyboard cursor
- User manual translation
- App language {default,bg,cn,de,fr,en,es,hu,it,pg,pl,ro,ru,sk}. Default "default" (i.e. locale)
- Screen orientation (unspecified, portrait, landscape) [unspecifed]
- Settings export to, and import from file "settings.txt" in the TopoDroid folder.
- Custom settings:
    - Additional palettes menu
    - Backup clear menu
    - Packets logging

Import and export of settings

Settings can be exported to the file "settings.txt" (in TopoDroid folder). This is a text file listing the values of all the settings.

Settings can be imported from the same file. It is possible to choose whether to import all the settings or only the functional ones.

If there is a problem parsing the file, the settings are not changed.

Some interface settings (like the buttons size) need to restart the app to become effective.

IMPORT/EXPORT

- General:
    - Default data export type {cave,cav,csv,csx,dat,dxf,grt,gtx,srv,sur,svg,svx,th,top,tro} [none]
    - Default sketch export type {none,th,csx,dxf,svg,png,xvi} [none]
    - Compass LRUD splay angle. LRUD minimum splay-leg angle.
    - Up/Down minimum splay clino. [0°]
    - Left/Right maximum splay clino. [90°]
    - Point spacing: distance between line points
- Import:
    - PocketTopo color map Map of PocketTopo colours to TopoDroid types
    - Estimate LR extend on import of Compass and VisualTopo files. [yes]
    - Import datamode: normal or diving. Diving applies only to Compass. [normal]
- Survex:
    - Survex/Topo line termination {Linux,Windows}. [Linux]
    - Splays TO station. [no]
    - LRUD. Add LRUD to Survex/Therion export. [no]
- Therion:

        - Maps first: export therion maps before survey data. [no]
        - Stations: Add station points to Therion scraps. [yes]
        - Splays: Add splay lines to Therion scraps. [yes]
        - LRUD. Add LRUD to Survex/Therion export. [no]
        - Scale. Export scale. [1:100]
        - xvi reference: insert reference to xvi image in th2 files
- Compass:
    - Compass station prefix. [no]
    - Compass splays: add splays to Compass files
    - Compass swap LR. Swap L and R on Compass export. [no]
- VisualTopo:
    - VisualTopo splays: add splays to VisualTopo files
    - LRUD at the FROM station
- SVG:
    - Grid. Add grid to SVG export. [no]
    - Line orientation. [no]
    - Splays. Include splays. [no]
    - Point stroke. [0.1]
    - Label stroke. [0.3]
    - Line stroke. [0.5]
    - Grid stroke. [0.5]
    - Shot stroke. [0.5]
    - Orientation tick. [2.0]
- DXF:
    - DXF splay endpoints. [yes]
    - DXF version {6,12,16}. [6]
- PNG:
    - Image resolution [0.5, 100]. Default 1.5 [x200 px]
    - Background color (RGB in 0-100). [0 0 0, ie, black]
    - Grid: add metric grid
    - Splays: add splay lines
    - Stations: add stations
- KML/GeoJSON:
    - Stations. Add stations to KML/GeoJSON export. [yes]
    - Splays. Add splays to KML/GeoJSON export. [no]
- CSV:
    - Raw data: export raw data to csv. [no]
    - field separator
    - line separator
- Custom settings:
    - Zipped symbols in zip archives
    - Diving mode

SURVEY DATA

- Team. Default survey team. Default "unset"

- Stations Policy: Survey stations naming policy {none, splay+fore, splay+back, fore+splay, back+splay, back+splay+fore, tripod, magn.anomaly}. The number of options varies with the activity level. Default "splay+fore".
- Station names {alphanumeric,numeric}. [alphanumeric]
- Initial station name. Default "unset"
- Photo thumbnails size [80,400]. [200 pxl]
- Data auto-export
- Sketch origin
- Shared x-sections

UNITS

- Length units {m, ft}. [m]
- Angle units {deg, grad}. [deg]
- Sketch grid units {m, yd, 2ft, dm}. [m]

SHOT DATA

- Leg tolerance. Tolerance among the shots of same leg > 0%. [0.05, ie, 5%]
- Maximum shot length [50 m]
- Minimum shot length [30 cm]
- Minimum number of shots per leg. [3]
- Backshot DistoX. [no]
- Shot vertical threshold. Region around 90°, where shots are extended "vertical" [0,90]. [10°]
- Leg WENS threshold. Leg V threshold [0,90]. [80°]
- "extend" reference. Settable or fixed extend L/R reference. [no]
- Prev/Next buttons. [yes]
- Backsight in user entered shot dialog. [no]
- Shot direction delay (timer). [10 s]
- Custom settings:
    - Diving mode
    - Recent data highlight
    - Recent data timeout
    - Splay classes
    - Splay coloring
    - Fractional "extend"
    - Plane interpolation
    - Leg-shot bell
    - Sensors
    - Loop closure. Default "none"
    - Android compass/clino
    - Shot direction timer countdown. [10 s]
    - Shot direction timer beep volume [10,100]. [50%]

LOCATION

- Location units {ddmmss, dec.deg}. [ddmmss]
- CRS. Name of CRS, as used in Proj4. [Long-Lat, ie, geographic WGS84]

ACCURACY

- Acceleration tolerance > 0. [1%]
- Magnetic field tolerance > 0. [1%]
- Magnetic Dip tolerance > 0. [2.0°]

SKETCHING

- Drawing tool picker {recent,list,grid,triple grid}. [most-recent]
- Recent tool number {3, 4, 5, 6}. [4]
- Side drag. Enable side drag in sketch window. [no]
- Zoom controls {off,temporary,permanent}. [off]
- x-section horizontal threshold
- Midline check. Check if stations are attached to midline. [yes]
- Leg "extend" check. [yes]
- Custom settings:
    - Sketch shift/scale
    - Sketch split/merge
    - Splay plan-view threshold. [80°]
    - Splay dash-mode: none, by azimuth, by clino, by the view. [none]
    - Splay dash clino threshold. [50°]
    - Splay dash azimuth threshold. [60°]
    - Splay dash angle threshold. [60°]
    - Backup number. [5]
    - Backup interval. [60 s]
    - Auto x-sections in exports
    - Saved station coloring
    - Layers. [no]
    - Auto-walls:
        - Wall type. [none]
        - Plan splay clino
        - Profile splay clino
        - Minimum separation along the shot
        - Concavity
        - Point separation on the wall

POINT TOOLS

- Non-zoomed point icons. [no]
- Point tools scale. [1.2]
- Labels size. [24 pxl]

LINE TOOLS

- Lines width (N.B. wall line are twice this). [1 pxl]
- Line style scale factor
- Line style {Bezier,fine,normal,coarse, simplified}. [normal]

- Line-point spacing. Minimum distance between line points. [10 pxl]
- Section lines "direction tick" size [1,20]. Default 8 [x unit]
- Section points. Add Therion section point to section line. [yes]
- Line default join {none, start, end, both, continue}. [none]
- Area border default visibility. [yes]

- Custom settins:
    - Straightening angle
    - Interpolation accuracy (Bezier)
    - Cornet threshold (Bezier)
    - Max point/segment distance for simplification. [0.5 m]
    - Max segment length for simplification. [2.0 m]
    - Point weeding segment buffer
    - Line/area snap. [no]
    - Smooth/straighten segments
    - Streighten lines
    - Path multiselection

SKETCH ITEMS

- Survey line width [0.5,10]. [1 pxl]
- Station name size. [24 pxl]
- Green dots radius [0.5,100]. [5 pxl]
- Selection radius. [24 pxl]
- Eraser size. [36 pxl]
- Shift sensitivity. [60 pxl]
- Pointing radius. [16 pxl]
- Splay transparency. [80%]

DEVICE

- Bluetooth. Check if BT is enabled on start. [yes]
- New data number: get the number of new data before batch download
- BT socket type {normal,insecure}. [device dependent default]
- Z6 workaround. [yes]

- Custom settins:
    - Connection delay
    - Data pause
    - Data ready wait delay
    - Laser pause
    - Shot pause

DistoX CALIBRATION

- Default group policy {TopoDroid, PocketTopo). [TopoDroid]
- Group tolerance. [40°]

- Calibration algorithm error. [0.000001]
- Calibration maximum iterations. [200]
- Download remote calibration data immediately
- Show calibration raw data. [no]
- Default calibration algorithm {auto,linear,non-linear}. [auto]

PocketTopo COLOR MAP

This dialog is opened selecting the *PocketTopo* color-map setting (in the Import/Export section).

It displays a table with three columns.

- PocketTopo color
- associated TopoDroid line (Therion name)
- associated TopoDroid point symbol (Therion name)

The symbol names used in the color-map are the "Therion names", ie, the filenames of the symbol files.
A few symbols are hardcoded in the program: *user*, *wall* (line), *water* (area), and *section* (point and line).
Also *label* is hardcoded. It cannot be used in the color-map because is rendered with a text.

The color-map is used in the import of ".top" files, to map PocketTopo colors to TopoDroid drawing items.

CUSTOM SETTINGS

Custom settings are for TopoDroid esoteric features.
They are accessible only at tester level.
However, their effects can be visible at a lower level (denoted in square brackets).
By default, the flags are disabled.

General settings

- Additional *tool sets*: to install tools from other sets than the basic cave-tool set
- Sketch *backup clearing*: the shot window has a menu to clear the sketch backups.
- *Packet logging*: raw data packets are copied into the packed database

Data settings

- *Diving mode* enables data "diving-mode" - distance, azimuth and depth
- *Recent shots* can be highlighted in blue, and selectively displayed
- Recent shots timeout: the time after which a shot is no longer "recent"
- *Fractional extend* for legs in the extended profile
- Swap stations for *DistoX backsight* data
- *Direction and dip* of the plane of a set of splays
- *Sensors* measures [A]
- *Loop closure* [E]
- Using Android *compass/clino* [A]
- Remote control shot *timer* [E]

- Remote control timer *volume* [E]

Splay settings

- *Splay classes*: classification of splays in classes (H,V,X, and normal)
- Splay *coloring*
- Display splays *as dot* at the endpoint [T]
- Maximum *clino* of splays in plan view [80°] [A]
- *Splay dash mode*: none, by clino, by azimuth, by the view. [none]
- *Splay dash clino threshold*: splay shots with inclination above this threshold are dashed [50°]
- *Splay dash azimuth threshold*: splay shots with azimuth off more than this threshold are dashed [60°]
- *Splay dash angle threshold*: splay shots making an angle smaller than this threshold are dashed, in x-sections [60°]

Sketch settings

- Sketch *shift and scale*
- Sketch *split/merge*
- *Stylus size* [0: ignore]: filter finger touch when drawing with a stylus [T]
- Number of sketch *backups*, kept in a round list [5] [A]
- *Minimum interval* between two backups [60 s] [A]
- Automatic inclusion of x-sections in exports [yes]
- *Saved stations* colored orange in the sketches
- *Leg-only refresh* recompute (and redraw) the midline only when a leg is downloaded (in continuous data-download mode) [not T]
- *Affine transform* enable the sketch affine transformation
- *Canvas levels*: none, by item, by type [none]

Leg-only refresh does not affect *on-demand* data-download mode. It is also not used at tester level, because, at this level there is an experimental incremental refresh.

Line settings

- Minimal *corner angle* in making lines straight (fourth button of line-item edit dialog) [45°]
- *Interpolation accuracy* for cubic Bezier segments [1.0]
- *Corner threshold* for cubic Bezier segments [20.0]
- Maximal *point/segment distance* for weeding points [0.5 m]
- Maximal *segment length* for weeding [2.0 m]
- *Line/Area snap* actions
- *Smooth/straighten segment* actions
- whole line *straigtening* action
- *Multipath* actions
- *Composite actions*

Auto wall settings

- *Auto-wall type* (none, convex, Delaunay) [none]
- *Maximum clino* for plan-view splays [70°]
- *Minimum clino* for profile-view splays [45°]
- *Maximum separation* of wall points along the shot [0.1]
- *Maximum concavity* [0.1]
- *Distance* between points in the wall-line [1.0]

Device settings

- *Connection delay*: delay [1/10 sec] before trying to connect to the device [0, no delay] [B]
- *Second device*: whether to work with two devices (DistoX only)
- *Data pause*: pause after the download of each data [250 ms] [A]
- *Ready data*: wait time for the data to get ready [500 ms] [A]
- Pause after the remote *Laser-on command* [1000 ms] [A]
- Pause after the remote *shot command* [2000 ms] [A]
- *Firmware* sanity check [yes] [A]
- *BRIC4 mode*: either primary data only or all data. With all data TopoDroid uses as shot index the value from the BRIC4. [all] [T]

Import-Export settings

- Include *tool files* in zip archive
- Survey *datamode* on import (normal, diving) [normal]
- Export csx in *cSurvey-transfer* format (required cSurvey 1.20)

WORK DIRECTORY

TopoDroid does not manage complex cave survey projects. However it is possible to specify a different work directory (folder) for the data files. The base folder of the TopoDroid folder is the primary external memory (/sdcard) for Android up to v. 10, and the public folder (/sdcard/Documents) since Android 11. Up to Android 10 the "base folder" can be changed [T].

Each work folder is a subfolder of the "base folder", and it is created if it does not exists. The name of the current work folder must begin with "TopoDroid". If you specify a name not beginning with "TopoDroid", it will be prepended automatically.

The drawing symbol files and the files related to the devices (database, firmware, memory dumps, calibrations) are installed only in the default folder "TopoDroid". The other current work folder contain only the survey database and survey-related files.

You can use different folders, named "topoDroid-Cave", for different cave survey projects, and switch to the one you need.
Alternatively you can have a "TopoDroid" folder for each project and switch to the one you must work on when you need by renaming folders with a file manager. In this way the common utility files are replicated in each folder. It may be useful if you have different drawing tools for each project.

The choice of the current work folder is one of the general settings of the app in the main window.

TopoDroid KEYPADS

TopoDroid comes with a numerical keypad and a simple "qwerty" keyboard.

The numerical keypad is used for numerical values (lengths, angles, etc.). It has the ten digits, the decimal point, and the plus/minus sign. For the input of coordinates it has also the degree (°) and minute (') keys.

The qwerty keyboard is used for station names. It has the ten digits, the 26 letters of the latin alphabet (lowercase and uppercase), and the period ('.').

These keypads are enabled by default. They can be enabled/disabled through a settings of the main window.

Note. TopoDroid keypads are not Android IME (Input Method Editor). If the no-cursor setting is not enabled, the cursor position is at the right end of the input and is denoted by an underscore '_'.

LANGUAGES

By default TopoDroid uses the system default language if TopoDroid contains the proper translation. Otherwise English is used. You can override this choice selecting another language among the supported ones:

- English
- Bulgarian (V. Georgiev)
- Chinese (H.J. Luo)
- French (G. Chardin, F. Martin, D. Ros)

- German (M. Keller)
- Hungarian (P. Suru)
- Italian (F. Toso)
- Polish (K. Borgiel)
- Portuguese (A. Rocnolato, R. Severo)
- Romanian (A. Pologea)
- Russian (A. Kozhenkov)
- Slovak (M. Jurecka, J. Hetesi)
- Spanish (M. Guerrero, J. Pardo)

The choice of the language is one of the general settings of the app.

Warning
Setting the language with the "Settings" app changes the language of TopoDroid, however items already loaded using the TopoDroid language setting (menu lists, dialogs, ...) are NOT reloaded with the system language.

TopoDroid LOGGING

Logging is important to solve problems when the program does not behave as expected. For example when the outcome of a computation does not agree with that obtained by other means, or a user input is not properly parsed.

Logging is controlled fron the "Log" menu of the main window.
The log messages can be sent either to *system* log-stream, or to a log file, which is save in the base TopoDroid folder. The sytem log can be inspacted from a PC via USB with programs such as "adb". The log file can be opened in "append-mode", with log messages appended to the existing logs, or "overwrite mode".

There are several log-flags to limit the logs to those necessary to find the cause of the problem. By default only "error" (i.e., when the program detects something that should not have happened) are logged.

Logs [E] are different from software crashes. Crashes are due to the program misbehaving in the system, and are detected by the system, that ends the program. You should report crashes (and ANR) via Google Play so that a stack trace is attached and they can be fixed more easily.
Refer to TopoDroid website for how to have crashes and ANR reported.

Log flags

- Debug
- Error
- Main window
- Permissions
- Preferences
- User input
- File paths
- Sketch i/o
- Bluetooth
- BT communication
- BT device

- BT protocol
- Device window
- Calibration
- Database
- Units
- Shot data
- Shot management
- Station namings
- Survey note
- Statistics
- Data reduction
- Fixed points
- Geolocation
- Photo
- Sensors
- Sketches
- Bezier curves
- Therion import/export
- cSurvey export
- PocketTopo import
- ZIP archives

DEVICE NICKNAME

This dialog is opened long-tapping on a device entry in the device window.

It displays some info about the selected device and has a text field to enter the **nickname**

. If the second-device setting is enabled there is a checkbox to set the device as second device (DistoX only).

OK save the nickname to the database and closes the dialog.
If the checkbox is selected the device is set as second device (DistoX only).

DEVICE SELECT

TopoDroid supports the following device:

- DistoX (first version)
- DistoX2 (second version)
- SAP5 (Shetland Attack Pony), only models with bluetooth
- BRIC4 (Bluetooth Ruggerized Integrated Cartographer)

All devices must be paired with the Android.

Normally TopoDroid works with only one device. The data can be downloaded continuously (*continuous* mode) or in batch (*on-demand* mode). The difference between the two modes is that the *continuous* mode remains active when the data download is finished, or the connection with the device is lost, while the *on-demand* mode is closed.

SAP5 and BRIC4 download the data only in continuous mode.

With DistoX's TopoDroid can work with more than one device at once, although the data are still downloaded from only one device at a tine.
The *data download mode* must be set to *multi*. When it is so a long-tap on the *download* button brings up a dialog to choose from which DistoX to download the data.

Shetland Attack Pony
TopoDroid supports the model of the Shetland Attack Pony, version 5 (SAP5), with bluetooth.
The device must have been previously "paired" with Android, using the *Settings* app. The PIN is "000000" (six zeros).
Afterward the SAP is listed among the known devices in the *Device Window*. It appears as "SAP XX MAC-address", where "XX" is the two-letter code of the SAP, for example "HG".
To select the SAP as current device tap on the its entry in the list.

While connected, the SAP5 will transfer the reading of a shot values to the app, whether or not the shot data are stored or discarded on the device.

The SAP5 data transmission protocol does not include acknowledgment of the reception of the data. Therefore

- if SAP5 is not connected the shot values are not transferred to the app.
- upon reconnection the SAP5 does not transfer the shot data stored while not connected.

The SAP keeps in its internal memory the data that have been "stored". These can be retrieved as a Survex file, using the SAP PonyTrainer program.

The calibration of the SAP5 is done by the device and does not require an external program.

BRIC4
TopoDroid supports the BRIC version 4.
The device must have been previously "paired" with Android, using the *Settings* app.
Afterward the BRIC4 is listed among the known devices in the *Device Window*. It appears as "BRIC4 code MAC-address", where the code is the four-digit code of the BRIC4, for example "0039".
To select the BRIC4 as current device tap on the its entry in the list.

Once connected to a client, the BRIC4 remembers the connection, even if turned off, therefore it stays "always connected".
When TopoDroid is connected, shot readings are immediately transferred to the app. If TopoDroid is not connected, the data are kept in memory, and transferred to the app when it is next connected.

The BRIC4 data transmission protocol includes acknowledgment by Android, but it does not include acknowledgment of the reception of the data by the app. The protocol has a few seconds delay between the connection and the first data transfer, and TopoDroid has a one-second delay after the last data, for closing the connection. By this means usually no shot is lost, although there is no guarantee.

The BRIC4 stores the data in internal memory in CSV files. If connected to a PC via USB, the device appears as external memory and the CSV files can be copied to the PC.

The calibration of the BRIC4 is done by the device and does not require an external program.

The BRIC4 can be controlled from the app. In particular it is possible to turn the laser on/off, and to take

shots. The BRIC4 has also a "scan mode" in which readings are taken continuosly, about two every second.

TopoDroid can follow two different data protocols (accprding to a setting in the "custom" set). Receive only the primary data (distance, azimuth and clino), or receive the complete data. The former do not include the BRIC4 data ID number, and TopoDroid assign an incremental ID to the shots. The complete data include the BRIC4 ID number and TopoDroid uses it as ID in its database.

When the complete data are received TopoDroid records the BRIC4 error codes and values in the shot comment.

BLUETOOTH

The *Bluetooth* button is present in the shot data window, in the sketch window, and in the calibration data window.

For the **DistoX**, and the **SAP5** the *Bluetooth* button resets the Bluetooth connection.

For the **DistoX2** it open a drop-down menu [T]:

- *Reset* the Bluetooth connection
- turn on/off the laser
- take a shot or a calibration data
- take three shots in a row, ie, a leg (data or sketch window)

In the data and sketch windows, the shots are downloaded immediately if the device communication mode is "continuous".
In the calibration data window, the data is downloaded immediately depending on a setting.

After turning on the laser there is a short pause before taking a shot. Similarly there is a pause between shots when three are taken. The lengths of these pauses are defined in settings.

For the **BRIC4** the *Bluetooth* button open a drop-down menu [T]:

- *Reset* the Bluetooth connection
- turn on/off the laser
- take a shot readings
- starts a scan mode (only if the BRIC4 connection is set to receive the complete data)
- turn off the device
- reset the shot counter of the BRIC (only if the survey has no data)

Device TROUBLESHOOTING

Device pairing
Before TopoDroid can connect to a device, this must be paired with the Android.
You can pair Android with the active DistoX through the *pair* menu or you can use the *Settings* app to pair the DistoX.

If Android asks the DistoX PIN enter 0000 (four zeros).
For the SAP5 PIN enter 000000 (six zeros).
Android should not ask the BRIC4 PIN.

Once paired with the DistoX, the Android should keep the pairing, and not request the PIN again. If it keeps requesting the PIN every time you download data from the DistoX, try using the *insecure* socket setting.

If you have problem connecting and downloading the data with a DistoX device try enabling the *Z6 workaround* setting.

DistoX A3 INFO

This dialog is opened from the *Info* button of the device window.

DistoX A3 informations:

- device code
- angle units
- compass and clino (on/off)
- normal/calibration mode
- silent mode (on/off)

The dialog has a button that *clears* the DistoX memory, ie, it clears the hot-bit that marks the data to transmit. After clearing, the DistoX must be switched off and on for the action to take effect.

DistoX X310 INFO

This dialog is opened from the *Info* button of the device window.

DistoX X310 informations:

- device model
- device code
- firmware version
- hardware version

DistoX PACKET LOGS

This dialog is opened from the *Packets* menu of the device window.

It displays the list of logged packet. The most recent packets are at the top of the list.

Items with a black background are packets received from the DistoX. Those with a lighter background are sent to the DistoX.
The text color depends on the type of the packet:

- white: data packet (D)
- grey: vector packet (V)
- brown: G packet (G)
- orange: M packet (M)
- green: command packets (C)
- yellow: other packets (X)

DistoX packets are logged only if the *Packet* setting is enabled.

The dialog has two buttons to clear the log of the packets older than a day or than a week, respectively.

DistoX REFERENCE GUIDE

Here is a summary of the DistoX functions.
The official user manuals are available at http://paperless.bheeh.ch

PIN code:
If the Distox does not pair automatically use PIN "0000" four zeroes.

Error codes:

- 252: too high temperature
- 253: too low temperature
- 255: too weak signal
- 256: too strong signal
- 257: too much background light
- 260: interrupted laser beam

- DIST: power on / start laser / measure
- CLR: cancel current operation, switch laser off
- CLR (2 secs): switch device off
- MEM: memory entries
- REF: toggle distance reference

DistoX2 - X310

- TIMER (laser on): start timer (automatic measurement)
- TIMER (laser off): set timer interval (with PLUS/MINUS)
- SMART: extra measure info
- FUNC: device info

Two seconds:

- DIST (with laser on): measure
- CLR: power off
- CLR+SMART: toggle calib. mode
- CLR+MEM: clear unsent memory
- CLR+FUNC: toggle bluetooth
- CLR+MINUS: locked power off
- REF: front reference
- REF+FUNC: back reference
- REF+PLUS: toggle display light
- REF+MINUS: toggle beep

- MEM: distance units
- MEM+SMART: angle units (deg/grad)
- MEM+FUNC: toggle silent mode
- MEM+MINUS: toggle backsight mode [2.4]
- SMART+MINUS: toggle triple-shot check [2.4]

Five seconds:

- FUNC+SMART: change battery type
- FUNC+CLR+MEM: factory reset
- DIST+PLUS+MINUS (switching on): bootloader mode

Extra measure info:

1. azimuth, H distance, V distance, distance
2. roll, dip
3. M, G
4. on-board accel. raw x,y,z (*)
5. separate accel. raw x,y,z (*)
6. magnetic raw x,y,z (*)

1. combined accel. x,y,z
2. magnetic x,y,z
3. on-board accel. x,y,z (*)
4. separate accel. x,y,z (*)

Device info:

1. battery
2. hw/fw version, serial number
3. display light level (1:10) [2.3]
4. beep tone (0:5) [2.6]
5. endpiece offset (-126:127) [2.3]

DistoX - A3

- AREA (back ref.): continuous display of azimuth+clino (*)
- AREA+REF (front ref.): continuous display of roll+dip (*)
- AREA*2: firmware version and serial number
- UNITS: toggle display light
- AREA*2+REF*2+CLR: toggle silent mode

(*) Do not take measurements in this mode

Two seconds:

- UNITS (in back ref.): distance units
- UNITS (in front ref.): cycle angle units / BT
- MEM*10+UNITS: toggle calib. mode

Five seconds:

- CLR+PLUS: toggle beep

"Angle units / BT" cycle

- compass off, BT off
- compass on (deg), BT off
- compass on (grad), BT off
- compass on (deg), BT on
- compass on (grad), BT on

DistoX MEMORY

This dialog is opened from the *Memory* button of the device window.

Memory dump

The *Dump* button reads the content of the DistoX memory. Reading the DistoX memory directly is a slow process, and the DistoX must be kept "ON" while doing it. It is advisable to read a small portion of memory, say 20 entries, at a time: enter the initial and final data memory index in the two text fields to the right. Data are read from the initial index up to one before the final index. For the DistoX2 the memory indices range from 0 included to 1064 excluded.
For the DistoX version 1 the memory they range from 0 included to 4096 excluded.

If you have entered a filename the memory dump is also saved to a file (in the "dump" folder).

The result of the memory dump is shown in a list at the bottom of the dialog. Each line contains

- the memory location
- a letter-code: foresight shot ('d'), backsight ('b'), calibration data ('g' or 'm')
- the values of the memory.

Uppercase letter code denotes data that have not been downloaded yet.
Shot are shown as length (meters), azimuth and clino (degrees).
The "accuracy" data of the DistoX2 are not shown.
For the calibration data, the raw values are shown. The 'm' data are not shown for the DistoX2.
Entries without a recognized type are marked with a question-mark ('?') code.

Only for DistoX A3

- **Read** the memory cursors
- **Store** the memory cursors

- **Reset** a portion of memory, ie, marks it "to-be-downloaded"

DistoX FIRMWARE

TopoDroid includes the DistoX2 firmwares v. 2.1, 2.2, 2.3, 2.4, and 2.5, which are all compatible with hardware 1.0.
Only v. 2.5 is compatible with hardware 1.1.
TopoDroid includes also firmwares v. 2.6.1, 2.6.3 and 2.6.4 which are compatible with hardware 1.2.

WARNING.
UPLOADING AN INCOMPATIBLE FIRMWARE MAKES YOUR DistoX UNUSABLE.
READ CAREFULLY ALL THE MESSAGES BEFORE UPLOADING A NEW FIRMWARE.

Through the firmware dialog you can save a copy of the current firmware of your DistoX2, or upload a new firmware file. Before uploading a new firmware TopoDroid checks that it is compatible with the hardware version. Unfortunately there is no sure way to read the firmware version from the file content; To prevent uploading a bad file, compares a signature block in the file (the first block after the bootloader blocks) and on the file checksum, against the known values.

The check result codes are (negative for failure):

- 2100: firmware 2.1
- 2200: firmware 2.2
- 2300: firmware 2.3
- 2400: firmware 2.4
- 2412: firmware 2.4c
- 2500: firmware 2.5
- 2501: firmware 2.51
- 2512: firmware 2.5c
- 2610: firmware 2.6.1
- 2630: firmware 2.6.3
- 2640: firmware 2.6.4
- -200: failed either 2.1 or 2.2
- -230, -2300: failed 2.3
- -240, -2400: failed 2.4
- -250: failed either 2.5 or 2.51
- -246, -2412: failed 2.4c
- -256, -2512: failed 2.5c
- -99: generic failure

The DistoX2 must be booted in **bootloader mode**. Refer to the DistoX2 documentation for details.
The device must be turned on in bootloader mode because TopoDroid reads the signature block from the firmware that is already installed on the DistoX, before uploading a new firmware.
If the hardware versions are not compatible there is a warning.

Beware that TopoDroid does not warn against uploading a firmware pre 2.5 on hardware 1.1.

Upon uploading a firmware, TopoDroid displays a message saying how many bytes have been written to the DistoX. If these are less than the firmware file size, the upload has failed.

Firmware update procedure

1. Make sure the DistoX is the selected active DistoX in TopoDroid
2. Open the firmware dialog ("Firmware" menu) and select the firmware file to upload
3. Check version of hardware and firmware of your DistoX: make sure laser is switched off (CLR) and press FUNC twice to show the version. You may also check the DistoX firmware and hardware versions with TopoDroid device info dialog.
4. Switch off the DistoX, and switch it on in bootloader mode: press PLUS, MINUS and DIST together. The display illumination switches on, but the screen remains empty.
5. Upload the new firmware with TopoDroid
6. Switch off the DistoX by pressing CLR
7. Switch the DistoX on and check the new firmware version.

If the DistoX does not turn on after a firmware upload, you ned to restart it in bootloader mode and try to upload a firmware again. To restart it in bootloader mode you must open it and jump two pins: see the docs on internet for details.

Note
The firmware updates are always logged in the TopoDroid log file.

BRIC4 REFERENCE GUIDE

Here is a summary of the BRIC4 functions.
The official user manuals are available at http://www.caveexploration.org/gear/bric4

To turn the BRIC4 on press the external button three times quickly in a row. To turn it off press and hold the external button. The BRIC4 goes off by itself after 90 seconds on incativity.

Menu functions
The main menu is enetered by pressing any of the four inner buttons. A press of the external button exits the menu and return to normal mode.

Options:

- *Dist*: meters or feet
- *Temp*: Celcius or Fahrenheit
- *Shot delay*: between 0 and 5 seconds
- *Change curr(ent)*: 100 mA or 500 mA
- *Err(or) sens(itivity)*: from 0.2° to 2.8° in steps of 0.2° [1.0°]

Error info: reports the errors info of the last ten measurements.

Calibration:

- *Display report*
- *Loop test*
- *CAL quick AZM*: quick azimuth calibration
- *CAL full INC&AZM*

- *CAL range finder*

Set Clock (scroll down beyond *second* to confirm)

- *Year*
- *Month*: from 01 to 12
- *Date*: day of the month, from 00 to 31
- *Hour*: from 00 to 23
- *Minute*: from 00 to 59
- *Second*: from 00 to 59

Bluetooth

- *Name*: eg BRIC4_0039
- *MAC address*: eg D52FDE2E98DE
- *Connected to*: client MAC address
- *Reset BLE*
- *Advanced*

The advanced bluetooth has three options

- *RST to AT mode*
- *RST to Run Mode*
- *Curr Comm*: CPU

Display

- *BL light*: 0 to 5
- *Color*: white, red, blue, green, purple, cyan
- *Contrast*: 0 (invisible) to 30 (completely dark) [16]

Advanced Menu

- *Sersor Raw Data*
- *Firmware CPU*: firmware and hardware versions - *Bootloader mode* option
- *Firmware BLE*: firmware version - *Update* option
- *Reprocess full Cal(ibration)*
- *Reprocess AZM Cal(ibration)*
- *Backlight Manual*: set Red, Green, Blue
- *Charger info* (debug)

Error codes
The BRIC4 reports up to two errors with the shot data. The error code are recorded in the shot comments together with the error value. Nothing is recorded if there is no error (code 0).

0. no error
1. first accelerometer high value [normal 1]
2. second accelerometer high value [normal 1]
3. first magnetometer high value [normal 1]
4. second magnetometer high value [normal 1]
5. accelerometers disparity in an axis (1:X, 2:Y, 3:Z)
6. magnetometers disparity in an axis (1:X, 2:Y, 3:Z)
7. rangefinder calculation error
8. rangefinder weak signal
9. rangefinder strong signal
10. rangefinder pattern error
11. rangefinder response timeout
12. rangefinder error
13. rangefinder wrong message id
14. inclination disparity
15. azimuth disparity

BRIC4 calibration

The BRIC4 calibration is done on-board.
There are two calibration procedures for the orientation: a complete calibration, and a quick calibration that updates the correction of the magnetic sensor values.

Complete calibration

The complete calibration requires to acquire four data at different roll in several directions (at least 14), covering all possible orientations.

Go to *Menu, Calibration, CAL: Full INC&AZM*.
A message with instructions appears. Press any button to continue.
The display shows status and group distribution while performing the calibration.
Take four shots for each point rotating the device about 60 degrees around the laser direction.
Four dots show the number of shots taken for the group.
The markings in two horizontal bars show where the distribution of the completed groups magnetic and accelerometric values. Cursors under the bars show the position for the group that is being taken.

- The device automatically detects when a new group is started
- If fewer than four shot are taken the group is not saved
- If more than four data are taken, only the last four are used
- It is possible to *Reset* the current group and restart it

When 14 groups are taken the *Done* key appears. Pressing it starts the computation of the calibration. More groups can be taken before computing the calibration.
After the computation of the calibration a report is displayed.

Quick azimuth calibration

Go to *Menu, Calibration, CAL: Quick AZM*.
A message with instructions appears. Press any button to continue.
A grid with a cross-hair is displayed.

The device must take samples of the sensor values that cover all directions.
Turn the device slowly around in every direction. When the device need to take a sample the backlight turns off and sampling for that point begins. When the sample is taked there is a beep.
When the grid is full the calibration computation begins and a report is displayed.

Note. The calibration can be interrupted at any time by pressing *Abort*.

Distance calibration
Go to *Menu, Calibration, CAL: Rangefinder*.
A message with instructions appears. Press any button to continue.
Place a target at a specified distance of 1 m, or 3 ft, from a station point. The distance must be measured with an accurate instrument.
Take four shots and ensure their values are equal.
Press *Done*. A calibration report is displayed.

BRIC4 INFO

This dialog is opened from the *Info* button of the device window.

BRIC4 informations:

- Device address
- Device name
- BLE firmware
- Firmware
- Hardware
- Battery level

BRIC4 MEMORY

This dialog is opened from the *Memory* button of the device window.

With this dialog you can

- **reset** the BRIC4 last time (year, month, day, hour, minute. second)
- **clear** the BRIC4 memory

BRIC4 last time
After resetting the BRIC4 last time the device will resend all the stored data more recent than the "last time". TopoDroid will refuse to reset to a time in the future.

The fields of the last-time are shown above the "Reset" button.

The minutes and seconds of the Android are shown on the right below the last-time fields to help set the BRIC4 time in agreement with the Android time.

Clear memory
Clearing the memory erases all the old data from the memory and resets the shot counter to 1.
The old surveys remains on the BRIC4 internal sd-card.

SAP5

The SAP5, Shetland Attack Pony, has a single button. It is turned on and off by tapping two times in a row quickly on the button.

The SAP5 needs to be paired with the Android before it can be used in TopoDroid. Open your Android' *Settings* app, and go to "Connected Devices". If the SAP5 is not listed, turn it on and select "Pair a new device". The SAP5 should appear in the list of available devices. Tap on it and enter the PIN "000000", six zeros.

When the SAP5 is switched on, the laser is on. To take a shot point is on the target and "press and hold" the button, until the laser light has a glitch, or turns off. The readings are shown on the screen, either one at a time (azimuth, clino, distance, and plane extension) or all three at once. You cycle through the displays by tilting back and for the device. If you press the button when a value is on the display the laser turns on and the device is ready to take the next shot.

After the display of the readings, the screen shows the menus:

- *Store*, to assign stations to the shot and save it in the internal memory
- *Discard* goes back to take another shot
- *Main menu*, with
    - the device *Settings*
    - *Measure* goes back to take a measurement
    - *Calibrate* enters the device calibration procedure
    - *Visualize* a rough survey plan view
    - *Info* displays (among others) info on the shot, the device hw/fw, the battery charge, and sensor readings in real-time
    - *Off* turns off the SAP5

The battery level is shown on screen. The SAP5 has a micro USB socket on the back. When it is connected to the PC it charges and the data can be downloaded using the "PonyTrainer" program.

When it is connected to TopoDroid, each shot is automatically transferred to the app as soon as it is taken. If the connection is interrupted, the shots taken when not connected are *not* transferred when the connection is re-established. Therefore the SAP5 is suitable for surveys in which it can always remain in connection with the Android.

Refer to the SAP5 documentation for further details about the device.

DistoX CALIBRATIONS

This dialog is opened from the *Calibration* button of the device window.

Buttons:

- *new calibration*
- *import* a calibration from the CSV export
- factory *reset* of the DistoX calibration coefficients

Underneath there is the list of the calibrations of the active device.

Open a calibration

Tap the calibration entry in the list to open it in the calibration window.

New calibration opens the calibration window, where you can enter the data for the new calibration, and create it. After it is saved to the database you can open it (ie, the calibration data window), download the calibration data, compute the calibration coefficients and upload them to the DistoX.

DistoX CALIBRATION DATA

This dialog is opened tapping a data entry in the calibration data window.

- *azimuth, inclination, roll*
- calibration *error*
- *group* number entry field
- *Save* the changes

The buttons are

-  reassign the groups from this data onward
-  mark the data "deleted"

The item group can be set or changed.

- *positive*: the data takes part to the computation of the calibration coefficients
- *zero*: the data does not enter the computation

Data with the same positive group number form a group.

Deleted data are not removed from the database.
They are not usually shown in the calibration data list, are not taken into account in the automatic group assignment, and do not enter to the computation of the calibration coefficients.

DistoX CALIBRATION DATA GROUPS

This dialog is opened from the *Group* button of the calibration data window.

Before computing the calibration coefficients the calibration data must be subdivided in groups of data having the same azimuth and inclination (but different roll).
Beware that a wrong group assignment can result in a failure to compute the calibration coefficients (usually due to too many iterations in the algorithm).

The groups are identified by an integer number starting with 1.
A data with number 0 is listed but excluded from the coefficients computation.
Deleted data have negative group number, therefore setting group number -1 amounts to mark the data as "deleted".

You can assign the group number to each calibration data by hand (with the *Calibration data edit* dialog), or let TopoDroid assign the group numbers for you. There are two automatic group assignment policies:

1. *TopoDroid*: four data at a time for each group;
2. *PocketTopo*: four-at-a-time for the first 16 data (four groups), then each data is a group by itself;

Actions:

- *Reset groups*: all the data groups are reset
- *OK*: groups are assigned (only to non-deleted data without a group)

DistoX CALIBRATION DATA DISTRIBUTION

This dialog is opened from the *Distribution* button in the calibration data window.

It displays the distribution of the calibration data, in azimuth and inclination, i.e, on a 3D sphere.

The sphere is cut on the horizontal plane, and the upwards and downwards hemispheres are displayed as two circles. The center of the circles are the vertical direction, while the points on the border are the horizontal directions. On each circle, North is upward, South downward, East to the right and West to the left.

Green areas indicate directions covered by the data. Red zones are directions for which data are missing. The dialog can show either the direction distribution of the raw data, or that of the data corrected with the calibration.

Eval computes the distribution using the raw direction values.
Eval. w clib. computes the distribution after correcting the data with the calibration coefficients.
G displays the distribution of the data acceleration vectors in the frame of the DistoX
M displays the distribution of the data magnetic field vectors in the frame of the DistoX

A proper calibration data set should have no red spot in all the distributions.

DistoX CALIBRATION COEFFICIENTS

This dialog displays the 24 coefficients of the calibration linear transformations for the **G** and the **M** vectors (12 coefficients each) and 3 coefficients of the non-linear terms (only DistoX2 v. 2.3 or higher).

It is used in three different situations:

- The *Read* button of the device window display the coefficients read from the DistoX.
- The *Read* button of the calibration window displays the coefficients stored in the database
- The *Compute* button of the calibration data window displays the computed coefficients

In the last case the dialog displays also an histogram of the residual errors of the calibration data, the average error (and the "delta" of the original algorithm), the std deviation, the maximum error, and the number of iterations taken by the calibration computation.

The error of a calibration data is the angle between the data direction and the average direction of the group the data belongs to, after having taken the calibration correction into account. The errors are reported in

degrees.

The histogram has ticks on the horizontal axis at 0.5° (yellow line), 1.0° (red line), and 1.5°.
On the vertical axis the tick marks are 10 and 20.

The "delta" of the original algorithm is the square-root average of the residual differences between calibrated G-M vectors and the vectors that satisfy the minimization condition. It gives an estimate of the calibration accuracy (precision of the instrument): "delta" is roughly 5/4 of the accuracy in degrees.

This dialog has a button to **write** the coefficients to the DistoX.
A warning is given if the data direction distribution is below 95%, or the calibration average error is above 0.5°.

DistoX CALIBRATION VALIDATION

A calibration can be validated against another calibration of the same DistoX.

Calibration list

With the Validation menu you get the list of the other calibrations of that DistoX, and you choose which one to validate with, by tapping its entry.

Calibration validation result

The validation result dialog displays

- (blue) "accuracy" of the second calibration on the data of this calibration. For each group of data the direction of the average of the group data is computed, as well as those of individual data. The accuracy is reported as average and std deviation of the difference between the directions of individual data and that of the average [degrees]
- (red) "accuracy" of the current calibration on the data of the second calibration.
- (grey) "precision" of the calibrations, measured as average, std deviation and maximum of the angle differences between the direction computed with the two calibrations, on the data of both.

The yellow vertical line marks 0.5°, and the red line 1.0°.

DistoX CALIBRATION IMPORT

This dialog is opened from the *Import* button in the *Calibration* list dialog.

This dialog displays the list of calibration CSV files.

Tap the entry you want to import.

The import fails if the file does not contain a calibration, or the calibration is already present.

Calibration CSV export
The calibration CSV export format contains the calibration details (name, date, device BT address, comment, algorithm), followed by the calibration data.

Each data line contains:

- data index

- G and M values (six integers)
- group
- azimuth, clino and roll
- error
- status

HOW TO CALIBRATE A DistoX

The DistoX needs to be calibrated before using. The calibration is a transformation of the data that accounts for the non-perfect orthogonality of the axis of the sensors, their misalignment with the laser direction, and effects of the electronics on the magnetic field.

To compute the coefficients of this transformation, you must take a number of "accurate" calibration data recording the raw readings of the sensors. This occurs when the DistoX is in "calibration mode".

The calibration data must be taken in a place free from magnetic influences, eg, in a cave or in a wood. Beware of metal objects and electronic objects that might affect the DistoX.

The data must cover all directions and for each direction you must take a group of four data at different rotation about the laser axis.
The best way is to take 14 groups of four data each, eight groups in the directions of the corners of a cube, and six in those of the centers of the faces. The four data in each group should be taken rotating the DistoX by 90° between one and the next. You can take more than 14 groups of data; the more the better.
At a minimum you must take four groups of four data (with different roll) in four directions at 90° in the horizontal plane, as if these directions were going from the center of a cube towards the center of four side-faces. The other 40 data do not have to be taken very carefully if the *PocketTopo* group policy is used, because they are treated as individual data. You can take more individyual calibration data.

The calibration data that will form a group must be taken with care. Inaccurate group data will result in a bad calibration. Therefore use fixed points (eg, a point in the wall, or on a tree) and far apart (a few meters) so that the accuracy of pointing the laser is better than the wanted calibration accuracy (2 cm at 5 m are about 0.2°).

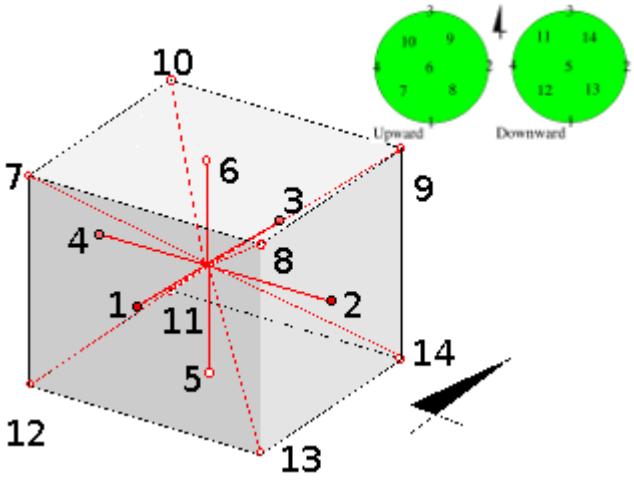
After you have taken the calibration data, download them with TopoDroid. You do not need to wait to take all the calibration data to download them: when you download some data these are added to those already in the calibration. Therefore if, by mistake you take five data instead of four, download the data and delete one of them in TopoDroid.

Before computing the calibration you must tell TopoDroid how the calibration data are divided in groups, i.e., how groups are assigned to data. The groups are denoted with positive numbers. A data with group number zero or no group, is not used to compute the calibration. Deleted data have group -1 and are usually not shown in the list.

TopoDroid implements two policies to assign groups automatically:

- *TopoDroid*: all data divided in groups of four data. This is the default policy
- *PocketTopo*: four groups of four data, followed by individual data

The group numbers can be assigned or changed by editing the calibration data. Tap on a data entry in the list to open the data editing dialog.
When the groups are defined, you can compute the calibration. Besides the calibration coefficients, the dialog shows the average error (and the "delta" of the original algorithm), the standard deviation of the error, and the maximal error. Furthermore there is a histogram with the distribution of errors for the calibration data. This plot has two vertical lines: a yellow mark at 0.5° and a red one at 1.0°



To summarize, to calibrate the DistoX you need to:

- turn the DistoX in calibration mode
- take the data of the calibration data
- download the data to the app
- assign the groups to the data (automatically or manually)
- compute the calibration coefficients
- upload the coefficients to the DistoX
- revert the DistoX to normal mode

NEW SURVEY

This dialog is opened from the *Add* button in the main window.

Information for the new survey:

- *name*
- *date*
- *team*
- *initial station*
- magnetic *declination*
- survey *description*
- at-station *x-sections*, shared or private
- diving *data-mode* [T]

The *name* is mandatory. The survey names are used to list surveys in the main window and TopoDroid distinguishes surveys by their name (although each survey has a unique numerical id in the database).

The name must be unique in the database. Names that differ only by the characters case are not different because the filesystem is case insensitive. TopoDroid raises a warning if the new survey name coincide with the name of an existing survey except for the characters case.

WARNING. The name of the survey cannot contain the character '/' (slash), which is the pathname separator. Slashes are replaced with dashes '-'.

The *date* is written with format "yyyy.mm.dd". For example January 6, 2015 is "2015.01.06". It is preset to the current date.

Team and *description* are empty (unless you have set a default team in the app settings). They can safely be left so, although it is a good practice to take the time to fill them.

The *magnetic declination* is "unset" by default. If you know it you can enter it here, otherwise you can look it up in the web after you have found the coordinates of a fixed point (say, the cave entrance) with the GPS [A]. The declination must be entered in decimal degrees. The accepted range of values is [-360°, 360°]. Any value outside this interval is considered as "unset".

At-station *x-sections* can be either shared among the survey sketches, or private to each sketch. This choice must be made when the survey is created and cannot be modified later because it affects the existing sketches.

Buttons
Save: the new survey name is added to the database.
Open: saves and starts the *Shot list* activity immediately.

Diving data-mode
The diving data-mode is an experimental feature. Data can be entered only manually, and in the following format:

- FROM station
- TO station
- depth at the FROM station
- azimuth of the direction FROM-TO
- distance between the FROM and the TO station
- LRUD at the FROM station (optional)

Backshot data are not supported in "diving" data-mode.

SURVEY IMPORT

This dialog is opened from the *Import* button in the main window.

It displays the list of files that can be imported in the app.

TopoDroid can import the survey files in the following formats:

- *Therion*: ".th" data files, with simple data format ("normal from to length compass clino" and optionally LRUD). Therion scrap are not imported.
- *Compass* ".dat" files (not fully tested)

- *Survex* ".svx" files with "normal" non-interleaved data format (not fully tested)
- *VisualTopo* ".tro" files (not fully tested)
- *PocketTopo* ".top" files. Data and drawings are imported (not fully tested)
- *CaveSniper* ".csn" text files (untested).
- TopoDroid ZIP archives. These are special zip files with the information to repopulate the database, the drawings (".tdr" files), the annotation file, and the media files (photo/audio).

Zip archives are searched in the zip directory (that is where TopoDroid saves them). Survey files are searched in the import directory. Therefore you must copy the survey file you want to import in this directory.

If the survey name of the file to import already exists in the database the file is not imported.

Therion import
Only Therion survey files with data in "normal" datamode are importable.
TopoDroid does not import Therion scraps.

PocketTopo import
TopoDroid imports both the survey data and the sketches. This import maps PocketTopo colors to TopoDroid drawing tools (points and lines). The mapping can be modified through a setting.

Compass import
TopoDroid converts imported compass survey from *normal* datamode to *diving* datamode [T], if the reletive setting is enabled [G].

N.B. Import may fail (and crash the app) due to failure on the database that TopoDroid cannot intercept. If this happens delete the partially imported survey and retry to import it.

Import Compass Dialog

This page allows to set the options to import a Compass file.

Options:

- *LRUD* if enabled LRUD values are imported and converted to splay shots
- *Leg first* if enabled LRUD splays are placed after the leg
- *Diving datamode* enable for data diving mode in the Compass file [T]

Import VisualTopo Dialog

This page allows to set the options to import a VisualTopo file.

Options:

- *LRUD* if enabled LRUD values are imported and converted to splay shots
- *Leg first* if enabled LRUD splays are placed after the leg

CALIBRATION-CHECK SHOTS

This dialog is opened from the *Calib. check* menu in the survey info window.

The dialog shows the calibration check legs. Tapping on a leg-shot it displays the distribution of the angle differences between the shots of the leg and the average leg direction.

If there is the opposite leg, the distribution of the angles between any two shots, one for each leg, is displayed on the right in light gray color.
The yellow line is 0.5° and the red line is 1.0°

If there are two other calibration check shots that make a triangle with the selected one, the distribution of the misclosure errors is shown on the right in gray color.
The misclosure error is computed (approximately) as the ratio between the misclosure distance and the radius of the circle enclosing the triangle.
The yellow line is 0.5% and the red line is 1.0%.

LOCATIONS LIST

This dialog is opened tapping the GPS button in the survey info window.

The dialog shows the list of locations, and has three buttons to create a new point.

- GPS gets the position with the GPS (if "Location" parmission has been granted)
- Add enter the coordinates manually
- Import the position from *MobileTopographer* (only for Android up to 10)

Tapping a location entry in the list opens the Location edit dialog.

Internally TopoDroid stores the coordinates in decimal degrees. In the coordinate dialogs you can type them either in decimal degrees or as "dd:mm:ss.ss". The TopoDroid keypad has special keys for "degree" and "minute". If you use a keyboard that does not have semicolon ':', use the space instead. If the keyboard does not have the decimal point '.' use the slash or the comma instead.

Location settings

- *Location units*: either dd.mm.ss or decimal degrees [A]
- *C.R.S.* coordinate reference system [default is long-lat] (disabled)

LOCATION INSERT

This dialog is opened from the *Add* button in the Locations dialog.

This dialog has four text fields:

- longitude
- latitude
- ellipsoidic altitude
- orthometric altitude

To the left of the *longitude* there is button to specify whether the longitude is east (positive) or west (negative). Tapping the button toggles between "E" and "W".

To the left of the *latitude* there is button to specify whether the latitude is north (positive) or south (negative). Tapping the button toggles between "N" and "S".

Longitude and latitude can be entered as degrees-minutes-seconds (dd:mm:ss.ss) or as decimal degrees. Alternative separators for colon are space, single quote, and the degree symbol. Alternative separators for the decimal point are comma and slash.

Longitude and latitude can have a negative sign.

Altitudes are entered in meters. When longitude and latitude are specified, entering one of the two altitudes causes TopoDroid to automatically compute and display the other.

Buttons:

- **Clipboard**: the coordinates saved to clipboard as "lat,long[,alt]" are copied from the clipboard to the respective text fields. With this button you can use the app *GPS-Impetus* to get the coordinates (altitude must be entered manually).
- **View** invokes a map app (provided you have one installed) to display the point.
- with **Proj4** you can enter the coordinates in another Coordinate Referernce System. The app *Proj4* is invoked, and you must select the CRS and enter the coordinates on the left side: longitude/East, latitude/North, and geoid altitude. Units of altitude and cartographic coordinates are meters. Units of geographical coordinates can be either decimal degrees or degree-minute-seconds. Next you tap the conversion arrow and the coordinates are converted to geographical WGS84 and sent back to TopoDroid.
- **Save** saves a record with the fixed station data in the database.

LOCATION GPS

This dialog is opened from the *GPS* button of the Locations dialog.

To use the GPS the Android Location must be enabled. For security reasons a generic app, like TopoDroid, cannot enable the GPS. If it is not enabled, TopoDroid shows a dialog asking whether you want do enable it (through the "Settings" app). Remember to disable it when you are done, to save battery life.

Fields:

- **station** name
- **comment**

Buttons:

- **GPS** starts/stops the location
- **View** the point in a map app
- **Save** the point

While searching for satellites the "GPS" button becomes red (or green) displays the number of satellites in sight. When enough satellites are in view the button becomes green and the coordinates are displayed underneath. You should wait until the coordinate values are stable and the location error is small enough.

Then stop the GPS location tapping the button again.

LOCATION IMPORT

This dialog is opened from the *Import* button of the Location dialog.

With this dialog you can import in TopoDroid the coordinates of a point from a *MobileTopographer* point list file.

1.  Open *MobileTopographer* and find the point coordinates.
2.  When you have reached a sufficient accuracy in the coordinates, save the point.
3.  You can also enter the point coordinates by hand (and save the point).
4.  Save the point list. The list is saved in "MobileTopographer/pointlist"
5. Import the coordinates in TopoDroid. The saved points are shown in a list; tap on the point to import.

 Optionally, you can go to the list of saved points in *MobileTopographer*, and move the point you just got to the top with the arrows.

LOCATION EDIT

This dialog is opened tapping a fixed point entry in the Locations list dialog.

The dialog shows

- longitude, latitude and geoid altitude. WGS84 ellipsoid altitude in square brackets
- point **name** and **comment**
- magnetic **declination** at the point (at the current date)

Buttons

- **View** the point in a Location app (provided you have one installed)
- **Clear** converted coordinates. This action is immdiate.
- **Convert** the position to another reference system (using the app Proj4)
- **Delete** the location record

If the coordinates of the fixed point have been entered manually, they can be edited. Coordinates taken with GPS or imported from *MobileTopographer* cannot be changed.

The orthometric altitude is computed from the ellipsoidic altitude using the geoid model EGM2008.

The **Convert** button computes the point coordinates in another Coordinate Reference System, using the app Proj4. The geoid altitude is used in the conversion. The converted coordinates are displayed and stored in the database with the fixed point.

The magnetic declination is computed using the World Magnetic Model for 2015-2020 (this will be replaced with WMM 2020-2025 in Jan. 2020). The uncertainty of the WMM model declination can be as large as 0.4 degrees in temperate ragions.
Check the **save** box to set it to the survey.

The **Save** button commits the changes to the database.

SURVEY NOTES

This dialog is opened from the *Notes* button of the survey data window, the survey info window, and the sketch window (in "moving" mode).

With this dialog you can write and edit a generic text with notes that integrates the data and the drawing of your survey.

Buttons:

- **Save**: save the changes and close the dialog
- Back key: close the dialog without saving the changes

The notes are saved in a text file in the "txt" subdirectory of the current work directory, which by default is "TopoDroid".
You can also edit this file with other text editors.

SURVEY RENAME

This dialog is opened from the *Rename* menu of the survey info window.

It has only one text field for the new survey **name**.

Buttons:

- **OK** closes the dialog are renames the survey in the database and all the relevant files.

Warnings The "section" points have the the survey prefix written in the option "-scrap". The survey prefix is automatically updated the next time the sketch is opened in TopoDroid. The survey prefix in names inside exported files are not renamed. Therefore, you can either rename them accordingly by hand, or open the sketches in TopoDroid and export them again.

SURVEY SPLIT / MOVE

This dialog is opened from the *Split/Move* button of the shot secondary edit dialog.

You can split the current survey and create a new survey. The the shots for the one being edited included to the end are moved to the new survey.
Alternately you can move the shots to an already existing survey. For this there is a selector to choose the survey to which the shots are moved.

Buttons:

- **Split** split the shots into a new survey
- **Move** move the shots to the selected survey
- **Cancel** closes the dialog without doing anything

SURVEY STATISTICS

This dialog is opened from the *Statistics* menu of the survey info window.

The survey statistics are

- number of (regular) legs, their total length and projected length (on horizontal plane)
- number of duplicate legs
- number of surface leg
- number of splay shots
- number of stations
- number of cycles in the midline graph
- number of disconnected surveys (this is 1 if the legs are all attached together in one survey)
- std. deviation of the absolute value of the magnetic field (percent)
- std. deviation of the absolute value of the acceleration field (percent)
- std. deviation of the magnetic dip angle (degrees)

The last three are also displayed as histograms.

Length are in the units set in the app settings.

MULTISHOT EDIT

This dialog is opened by the "light bulb" button from the survey data window in multishot mode.

It has the following actions

- renumbering the shots stations. The first selected shot must be a leg
- swapping stations
- coloring. Only if all selected shots are splays
- computing the plane that fits the shots
- hide the shots in either the plan, or the profile view, or both. Only if all selected shots are splays

THE FINAL MAP

This section describes the use of *Therion* or *cSurvey* to draft the final map.

Therion

If you want to compile the *Therion* project you must supply a *thconfig* file which can be as simple as

```
source my_survey.th
export map -proj plan -o my_cave_p.pdf
export map -proj extended -o my_cave_s.pdf
```

You need to have exported the survey data as Therion ".th" file, and the survey sketches as Therion ".th2" files.
The data file contains commands to input sketch files. However they are commented and you need uncomment them.
The data file contains commands to define a map for each sketch (scrap). For simple surveys you can leave these commented.

Alternatively you can export the sketches as Therion ".xvi" files and retrace them using *xtherion*.

cSurvey
Export the sketch as cSurvey ".csx" file.
Open the exported file with *cSurvey*: you will have the data sheet filled with survey data and the sketches properly aligned in the drawing canvas of *cSurvey*.

PHOTO LIST

This dialog is opened from the *Photo* button in the survey info window, or from the *Photo* menu in the survey data window.

It display the list of the photos of the survey, both those taken for shots and those taken for sketches.
Each entry has

- the number of the photo
- **shot** to which photo was assigned, if the photo was taken for a shot
- photo **comment**

Tapping an entry in the list opens the *Photo edit* dialog.

SHOT PHOTO

This dialog is opened from the *Photo* button in the secondary *Shot edit* dialog.

It has a text field for the **comment** to the photo you are going to take.

Uncheck the box **TopoDroid camera** if you want to use a Camera app instead of the TopoDroid camera.

Buttons:

- **OK** closes the dialog and starts to take a photo.
- **Cancel** closes the dialog.

TopoDroid camera
This is a simple implementation of a camera. Its unique feature is that it stores the azimuth and inclination of the device in exif tags in the image file. The azimuth is stored as GPS_LONGITUDE and the inclination as

GPS_LATITUDE (with sign).
The following exif tags are set by TopoDroid:

- *Software*: "TopoDroid" and its version, separated by a space
- *Orientation*:
- *Datatime*: timestamp
- *GPS latitude*: inclination
- *GPS latitude ref*: "N"
- *GPS longitude*: azimuth
- *GPS longitude ref*: "E"
- *Image description*: azimuth and inclination in 1/100°, separaated by a space

The camera has three buttons on the lower right.

- **camera**. Red: ready, tap to take a picture. Blue: on hold, tap to turn camera active.
- **save** saves the picture
- **back** closes the window

Zoom buttns are brought up by tapping the screen in the lower mid. To go through large zoom steps tap the zoom buttons repeatedly fast.

PHOTO EDIT

This dialog is opened tapping an entry in the *Photo list* dialog.

- **thumbnail** of the photo
- **orientation** (azimuth and clino) of the photo, for photos taken with TopoDroid
- **date and time** of the photo
- **comment** (editable)

Buttons:

- **Save** saves the changes to the comment
- **Delete** deletes the photo (if the photo is for a shot)

The image is displayed when you tap on the thumbnail. The full image is not reoriented to portrait.

The Android *BACK* button closes the dialog.

Note
Photo taken for sketch points can be viewed also through the item edit dialog, and are deleted when the photo point is deleted.

PHOTO DISPLAY

TODO This page needs writing.

SENSOR MEASUREMENTS LIST

This dialog is opened from the *Sensor* button of the survey info window.

It displays the list of the sensor measurements.

A tap on an item in the list opens the sensor data edit dialog.

SENSOR MEASUREMENTS

This dialog is opened from the *Sensor* button in the secondary *Shot edit* dialog.

It has list a checkboxes to select a builtin sensor, or an external sensor (in this case you must enter the "sensor" name).

There are three text fields

- **name** of sensor. Either one of the listed builtin sensors, or it must be typed in if if you select an "external" sensor
- **values** Automatically updated for builtin sensors. Manually entered for "external" sensors.
- **comment**

Save stores the measurement in the database.

The Android *BACK* key closes the dialog without saving.

SENSOR MEASUREMENT EDIT

This dialog is opened tapping a sensor measurement entry in the *Sensor list* dialog.

It displays some info about the measurement (title, type, shot, and value) and a field to change the sensor **comment**.

Buttons

- **OK** saves the changes and closes the dialog
- **Delete** deletes the measurement

Delete does not remove the sensor measurement from the database, but marks it as "deleted". It can be recovered with a *SQLite* app.

DATA DOWNLOAD

The *Download* button starts a connection with the device to download data. While the connection is active it stays red. If you are using the *on-demand* download-mode the connection is closed when there are no more data to retrieve. With the *continuous* download-mode the connection remains open (and data are continuously downloaded as soon as they are taken) until the device and the Android lose the Bluetooth connection. Which mode is best suited for you depends on your habits. With the *on-demand* mode you can concentrate on

sketching and other tasks without being bothered by incoming data, and when you download the data you can focus on them (they are highlighted blue). On the other hand *on-demand* download requires pauses to get the data, and these are especially long if you took several shots in the between.

When the Bluetooth connection with the device is broken (eg. the device gets too far from the Android, or it is switched off) in *on-demand* mode, the data download is interrupted. In *continuous* mode TopoDroid retries to connect to the device every few seconds.

When the survey data window is closed the data download connection is terminated. The download connection is not interrupted when the window is paused (the display switches off). If you open a sketch while the download connection is active in *continuous* mode, the connection is maintained and the data are downloaded (and displayed in the sketch).

For the *SAP5* and *BRIC4* data are always downloaded in *continuous* mode.

MANUAL DATA INPUT

If you do not have a bluetooth device you can still enter the shot data manually. The *Add* button opens the dialog for the shot data input. You must enter the station names and the shot data (length, azimuth, and clino). The *reverse* button swaps the stations, ie, reverse the shot.

If only the backward fields are filled in (the forward fields are left empty) the shot is entered with the backward data.

To add a splay shot enter "." (period) or "-" (dash) in the TO station. LRUD can be added to a splay shot, thus providing additional splay shots. In this case the LRUD refer to the FROM station.

There is a warning if, upon editing a leg shot, it differs from another leg between the same stations more than one fourth in length, or 15°.

Buttons:

- **Save** inserts the shot into the survey, and updates the station names incrementing them so that the dialog is ready to input the next shot
- **OK** inserts the shot in the survey, and closes the dialog.

Using Android for the direction

Azimuth and clino can be set using the Android sensors [G]:

 the reference axis is the direction of the long side of the device. A timer (10 s by default) lets you point the device before measuring.

 the reference axis is the normal to the display: look at the TO station on the screen and start the timer when the station is in the middle of the cross-hair.

LRUD

If LRUD are specified the respective splay shots are also inserted. Additionally you can select whether these refer to the FROM station (default) or to the TO station.

If the shot clino is smaller than the *v-threshold* setting, the LRUD are in a vertical plane: U is upwards, D

downwards, L horizontal to the left of the shot (i.e., with azimuth that of the shot minus 90°), and R horizontal to the right of the shot.

If the shot clino is greater than the *v-threshold* setting, the LRUD are in a horizontal plane: L is west, R is east, U is north, and D is south.

Units
Data must be entered in the current units. For example if the length units are "feet", distances must be entered in "feet".

Diving mode
In diving mode the shot data are depth, azimuth, and distance. The azimuth is assumed taken with a normal compass, with graduation increasing clockwise. The azimuth entries are converted as if taken with a caving (geological) compass. For example an entry of 340° is converted to 20°.

INSTRUMENTS CALIBRATION

This dialog is opened from the *Calibration* menu of the survey info window.

It is used to define "calibration" for the instruments of manually entered data. The calibration values must be written in the current units. For example if the length units is "feet", the tape calibration must also be in "feet".

- **Tape**
- **Compass**
- **Clino**
- **LRUD**: whether the tape calibration affects LRUD or not

Buttons:

- **Save** records the calibration and closes the dialog.

Note.
The instruments calibration is not stored in the database, and is reset when the survey data window is opened.

SHOT ACCURACY

Together with each shot, the DistoX2 records and transmits also the values of the intensity of the magnetic field (arbitrary units), that of the gravitational field (arbitrary units), and the dip angle, that is the angle the magnetic field makes with the horizontal plane.

By comparing these values with their average values TopoDroid can detect whether a shot might be affected by some anomaly, and should therefore be redone. These unreliable shots are displayed with a red background.

The amount these values can differ from their averages before the shot is declared unreliable are specified by the accuracy settings.

Accuracy settings

- *Acceleration*: percent difference of the acceleration from its mean value, above which a shot is signalled anomalous (only DistoX2)
- *Magnetic*: percent difference of the magnetic field from its mean value, above which a shot is signalled anomalous (only DistoX2)
- *Dip angle*: difference of the magnetic dip from its mean value, above which a shot is signalled anomalous (only DistoX2) [units degrees]

SURVEY DATA DISPLAY MODE

This dialog is opened from the *Reference* button in the survey data window.

- **shot id**
- **splay**: shots with only one station
- **blank**: shots with no stations
- **repeated leg**: shots close to the preceding leg

The shot id's are unique increasing indices assigned by TopoDroid to the shots of the survey.

If the splay shots are hidden it is still possible to show the splay shots for an individual station. Tapping on the station name in a leg shot, makes the splay shots at that station visible. Tapping again on the station name (even in a splay shot) hides them.

SHOT EDIT

This dialog is opened by tapping on a shot data entry in the survey data window.

It displays

- **length, azimuth, inclination**. Editable for manually entered shots; not editable for downloaded shots
- differences of acceleration, magnetic field, and magnetic dip from the respective average values. Only for DistoX2 shots
- **stations**
- **left arrow**: load previous leg
- **reverse**: swap stations
- **right arrow**: load next leg
- shot **comment**
- profile "extend" choice: "left", "vertical", "right". "Unset" if none is checked

Buttons:

-  "duplicate" flag
-  "surface" flag

-  "commented" flag
-  the shot belongs to the immediately preceding leg.
-  the shot belongs to the immediately following leg.
-  the shot is a backsight leg.
-  renumber shots from this leg onward following the current station naming policy. Both stations must have been specified
-  apply the station change to all splays in the group of the splay shot. It applies only to the splays with same station as the edit shot. Only FROM station must have been specified. (A group of splays is the set of splays between two legs)
-  hide the splay in either the plan, or the profile view, or both (splay only)
-  clear (or set) splay class for this splay, and possibly the previous splays.
- **OK**: save the changes and close the dialog
- **Save**: save the changes without closing the dialog
- **More**: switch to the secondary edit dialog
- **Cancel**: close the dialog without saving

The shot flags, "duplicate", "surface" and "commented", are mutually exclusive. Shots with a flag do not count for the survey statistics. The export of the shot is also affected by the shot flag, either with a flag, if the format supports it, or as comment.

There is a warning if, upon editing a leg shot, it differs from another leg between the same stations more than one fourth in length, or 15°.

Station cut-n-paste
Station names can be 'cut', 'copied', and 'pasted' across the app, in any dialog where there is a station entry field.

Long-tapping the station entry field opens the drop-down menu with the three options

- cut
- copy
- paste

Splay classes
Splay classes are enabled with a "custom setting". There are four classes:

- *normal*, generic, splays. Blue
- *x-section* splays. Green

- *horizontal*, plan-view, splays. Dark blue
- *vertical*, profile-view, splays. Violet

The *Splay class* button cycles through these four classes. The splay shot is set to the chosen class, when the data are saved. If the "all splay" button is checked, the class is set also to all previous contiguous "normal" splays.

Splay claases can also be set with the multiselection "special actions" button. In multiselection you can select splays that are not contiguous and assign them all a splay class.

If you take splays shots in a consistent way, splay classes can be set editing the leg shot and ckecking the splay group button. You must take first the x-section splays starting with +90 and going around in circle. Next you take the H-splays. Finally you take the splays in the vertical plane starting again with +90.

SHOT EDIT (2)

This dialog is opened from the *More* button of the first shot edit dialog.

It shows the shot stations and data (length, azimuth, inclination).

At an activity level "Basic" or "Normal" this dialog has only a button to *delete* the shot.

At higher activity levels it has six or seven buttons:

-  photo dialog
-  audio comment
-  Sensor measurement dialog
-  add a shot before this (manually entering the data)
-  split the survey at this shot (creating a new survey or append to another survey)
-  delete the shot
-  mark the shot as calibration-check

The **delete** button does not remove the shot from the database. The shot gets marked as "deleted" and can be later recovered with the Recovery dialog. If the shot is the first shot of a leg you can also delete all the shots of the leg, by checking the checkbox besides the buttons.

Leg shots have also a **calibration** button. This button marks the shot as "calibration-check". These shots are not used in the survey, and their data should be taken at different roll angles. They are recorded in the database, and are a record of the reliability of the device calibration when the survey was done. They can be displayed with the Recovery dialog.

Survey split

This button opens a dialog for the new survey info. Next the survey data are assigned to the new survey,

beginning with this shot. Afterwards the program continues with the new survey. You may need to split surveys when you have data from two (separate) survey pieces stored in the device: these are downloaded to a single survey which must be then split accordingly.
At tester level you get also the option to **move** the data to another survey. Select the target survey from the pull-down option set, and tap the "Move" button.

Warning. It is advisable to make a zip archive before splitting/moving the survey and back it up to a safe place.

At-station LRUD
LRUD shots, at either the FROM or the TO station, are added by filling the four LRUD edit boxes and tapping the *Add LRUD* button.
It is also possible to add "intermediate" LRUD entering the distance (in the current units) along the shot, between the LRUD point and the FROM station.
For splay shots there is only the FROM station.
"Intermediate" LRUD are appended to the data list, the others are added before the shot.
The manual LRUD are marked as "x-splays".

DATA AUDIO COMMENT

This dialog is opened from the *Audio* button of the secondary *shot edit* dialog, or when you add a point *audio* to a sketch.

There are three icon-buttons:

-  plays the audio comment
-  records the audio comment (if there is already one this is overwritten)
-  deletes the audio comment (if any) and closes the dialog

When you delete the audio for a sketch point, the point is also delete.

Audio files are saved in "wav" format in the audio directory.

The *Cancel* button closes the dialog.

AUDIO LISTING

This dialog is opened from the *Audio* menu *survey window*.

It contains a list of the survey audios.

A short tap an entry plays the audio.
A long tap brings up the audio dialog, where you can play or change the recording.

EXTEND REFERENCE

This dialog is opened from the Azimuth button either in the survey data window or in the sketch window.

The extend reference is used to assign the profile "extend" direction to the midline legs.
The "extend" direction is not automatically set for the splays.

The *Azimuth* button displays either a long arrow inside a circle, oriented to the current extend reference direction, or a short arrow directed left or right (for fixed "extend").
When the profile "extend" is compute using the "extend reference" it is set to right if it differs from the reference by less than 90°. Otherwise it is set to left.

When the *Fixed extend reference* setting is enabled, the *Azimuth* button has only two states, either LEFT or RIGHT. Tapping the button toggles between them. The new shots extend is set according to the state of the button.

This dialog has

- "extend reference" **azimuth**
- slider to change its value between -180 and 180°
- **text field** to enter the azimuth numerical value, between 0 and 360
- **compass** sets the value using the Android magnetic sensors
- **left** forces "extend" to LEFT (-1)
- **right** forces "extend" to RIGHT (+1)
- **ok**: use the azimuth for the "extend"

Sketch extend reference mode

The extend reference azimuth can be changed also in the plan view of a sketch [E]. A long tap on the *Azimuth* button turns the window in "extend reference" mode. In this mode an finger slide across the display rotates the reference azimuth (the canvas is not shifted). To get out of this mode lift the finger from the screen.

Leg extend

When a new shot is downloaded TopoDroid sets its "extend" automatically. This holds also for shots entered manually, if the "extend" in the shot dialog is left "unset". By default the "extend" is either LEFT, RIGHT, or VERT (vertical), depending on the angle the shot makes with the reference azimuth.
If the angle is smaller than 90° minus the *extend vertical threshold* the leg is extended RIGHT. If it is larger than 90° plus the *extend vertical threshold* the leg is extended LEFT. Otherwise it is extended VERT.

The *Extend Reference* dialog allows to change the reference azimuth, by rotating it clockwise or counterclockwise. Alternatively, the reference azimuth can be set using the Android compass sensors.

It is also possible to fix the "extend" for coming shots to either LEFT or RIGHT, by selecting the appropriate buttons in the dialog.

Splay extend

The "extend" of splay shots is determined according to that of the legs at the splay station and the azimuth between the splay and the legs. The splay is extended as if it were projected on the closest of the vertical planes passing through the legs.

STATION NAMING POLICIES

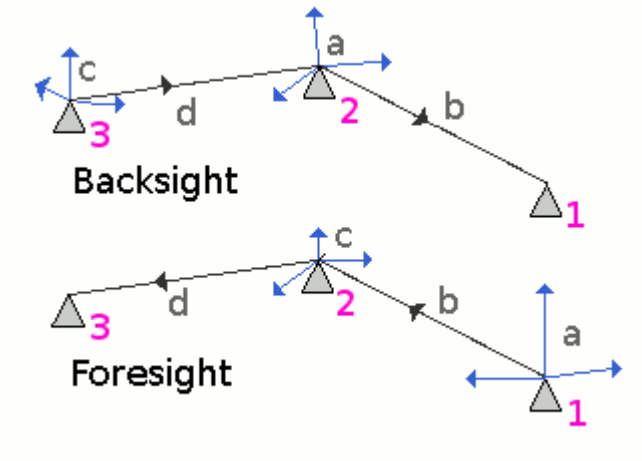
When you download data TopoDroid can automatically assign them station names. A repeated measurement is considered a leg shot, the others are splay shots. If you stick to a convention taking measurements TopoDroid automatic station naming can be very handy. TopoDroid supports a number of conventions to automatically assign stations to shots. You can select the one that fits your habits through the settings.

1. **splays+foreshot**. At the FROM station: you take splays first and then forward leg shots. This is the default convention.
2. **splays+backshot**. At the TO station: you take splays first and then backward leg shots
3. **backsight**
4. **tripod** [A]
5. **magnetic anomaly** compensation [E]
6. **foreshot+splays**. At the FROM station: you take the forward leg shots first, and then the splays
7. **backshot+splays**. At the TO station: you take backward leg shots first and then splays
8. **TopoRobot** [T]

Examples of the conventions (shots taken at the same station are grouped in parenthesis):

1. ... (1-. 1-. 1-. 1-2) (2-. 2-. 2-3) ...
2. ... (2-. 2-. 2-. 2-1) (3-. 3-. 3-2) ...
3. ... (2-1 2-. 2-. 2-3) (3-2 3-. 3-. 3-4) ...
4. ... (2-1 2-. 2-. 2-3) (4-3 4-. 4-. 4-5) ...
5. ... (2-1 2-. 2-. 2-3) (3-2 3-. 3-. 3-4) ... (same as "3")
6. ... (1-2 1-. 1-. 1-.) (2-3 2-. 2-.) ...
7. ... (2-1 2-. 2-. 2-.) (3-2 3-. 3-.) ...
8. ... (1-. 1-. 1-. 1-2) (2-. 2-. 2-3) ... (same as "1")

Sequence a-b-c-d for the first (foreshot) and the second (backshot) policies.



Backsight policy

At each station you take the backshot to the previous station, next the splay shots, and finally the forward

shot to the next station.
Backsight shots are checked: if a shot is not close to the opposite of the previous leg, it is not considered a backsight shot.
The backsight shots are marked "duplicate".

Tripod policy
At station "1" you take splays and then shots to the station "2". Then you move into station "3", take shots to station "2", then splays, then shots to station "4". Move to station "5" and so on.

Magnetic anomaly compensation [Tester level]
The magnetic anomaly compensation is done estimating at each station the "local" magnetic declination by comparing the azimuths of the leg reaching to the station and the backsight leg. The azimuth of all the shots at the station are then corrected with the "local" declination. An overall declination remains because the declination at the first station cannot be determined. Furthermore the survey azimuth angles become relative as in a traverse, therefore the angle errors add up instead of compensating.
The magnetic anomaly compensation requires taking basksight shots. However, with magnetic anomaly compensation the check whether a shot is a backsight does not take the azimuth into account. The magnetic anomaly compensation is carried out during the data reduction (for the sketches).

TopoRobot policy
The "TopoRobot" policy is just like the first, but station names follow the TopoRobot convention.

Station naming policy and activity levels
Certain station naming policy are disabled at high activity levels:

- "Tripod" requires "advanced" level
- "Magnetic anomaly" requires "expert" level
- "TopoRobot" requires "tester" level

Reducing the activity level when one of these is active, automatically set the station policy to the default policy (splays + foreshot). The policy is automatically reinstated again if the activity level is raised to the required value or above.

STATION SEARCH

This dialog is opened from the *Search* button of the survey data window.

It has a text field to enter the name of the station to search, and a checkbox to include also the splay shots in the search result.

The **search** button closes the dialog and move the first result shot to the top of the display.

There are also three buttons to search for legs [T]:

- duplicate shots
- surface shots
- legs with extend not set

The search is carried out only on the displayed data, and the search results are highlighted yellow.

A long tap on the *Search* button moves the following result to the top on the display.
The search is cleared by tapping any button.

ACTIVE STATION

The "active" station is the station from which the survey will continue. If you have set the "active" station, TopoDroid will continue numbering stations from it. If the "active" station is not set, the last one is used.

Thus you can start a branch in the middle of the survey by selecting the station you want to attach as "active" station. Alternatively, you can replace the FROM station of the first shot of the branch, afterwards.

The "active" station is highlighted green in the survey data window and in the sketch window. A long tap on another station switches the "active" station to that. A long tap on the "active" station itself turns it off. The "active" station can be set in three ways

- with a long tap on the station name in the survey data window.
- from the *Saved stations* dialog (button *Active"*)
- through the *Station edit* dialog in the sketch window.

SAVED STATIONS

This dialog is opened from the *Station* button in the survey data window, or from the *edit station* dialog of the sketch window.

The "saved stations" are stations saved for later reference, eg, at a crossway, to go back and continue the survey from there, or to mark a possible lead to check in a future trip.

The dialog displays the list of saved stations. You select one by tapping it.

The selected station is shown in the text fields. Opened from the survey data window, the text field contains the last station, or the active station if this is set. Opened from the edit-station dialog, the text field contains the station.

Each saved station must have a brief description (comment) or a flag set.

- selected **station**
- station **flag**, if any ("fixed" or "painted")
- station **comment**

Buttons:

- **Clear** the station fields: name comment and flag
- **Save** the station into the database
- **Active**: set the station as the "active" station
- **Delete** the station from the database (non recoverable)
- **Close** closes the dialog

ITEM RECOVERY

This dialog is opened from the *Recover* menu of the survey data window.

It is used to recover the survey deleted items, shots or sketches, as well as "overshoot" data, and "calibration-check" data.

The "Status" button tells which items are displayed. Tapping it cycles through "deleted" shots, "overshots", "celibration-check" shots, and "deleted" sketches.
Select the items to recover by tapping their checkboxes. To finish and recover the selected items tap the "OK" button..
Only the selected items of the type on display are recovered.

DANGLING SHOTS

This dialog lists the unattached shots.

For each shot it displays the index, the stations (FROM and TO), and the data (distance, azimuth, clino).

TRILATERATION

Trilateration is a special "loop compensation" applied to triangles. It can be used in short surveys in disuniform magnetic environment as the azimuths are computed by measuring the sides of triangles, relying on the fact that the angles of a triangle are determined by its sides. The values measured by the device are used for the inclinations.

Trilateration is enabled by setting the *Loop compensation* to "Triangles".

The survey should be made of a net (or a ladder) of triangles. Therefore you measure 0-1, 1-2, and 0-2; then 2-3 and 1-3, and so on.

The trilateration algorithm carries out a global estimate for the angle azimuths, and is rather slow. Therefore it is advisable not to use it for large surveys.

NEW SKETCH

This dialog is opened from the *New sketch* button in the *Sketch list* dialog.

It has two text field and a confirmation button.

- **name** is the name assigned to the sketch.
- **reference station**
- **extended/projected** profile view checkbox
- **projection azimuth**, for projected profile view
- **dangling** sketch (origin not attached to midline)

You can use either the **name** suggested by TopoDroid (an increasing integer number) or enter a mnemonic name. Each sketch is saved with two files, one for the plan, the other for the profile. The filenames are obtained composing the survey name, the sketch name, and a suffix ("p" for plan, "s" for profile). For

example the sketch "2" of the survey "cave" is saved in the two files "cave-2p.tdr" and "cave-2s.tdr".

TopoDroid will give a warning if the name coincides with the name of an existing sketch. In particular it is not possible to have two sketches with names differing only by the characters case since the two sketches would have the same file because the filesystem is case insensitive.

WARNING. The name of the sketch cannot contain the character '/' (slash), which is the pathname separator. Slashes are replaced with dashes '-'.

Reference station
The reference station (origin) defines how the sketch is translated with respect to the survey midline. The survey midline defines the sketch scale (the drawing is scaled at 40 canvas units per meter) and rotation, but leaves undefined how the drawing is translated with respect to the midline. This uncertainty is resolved by specifying the reference station to be at (0,0) in the reference frame of the sketch canvas.

The reference station also determines the survey midline **data reduction** for the sketch. From the sketch point of view the midline is built starting from the reference station and continuing as long as data can be attached. The resulting midline forms a tree, rooted at the reference station. In order to make the canvas less cluttered, is possible to hide the display of portion of the midline, either after a station, or before it (i.e., between the reference station and the station). This is explained in the "Sketch station" dialog.

If the survey has "fixed station origin", TopoDroid prefills the "reference station" with the first survey station. Otherwise it uses the last station or the active station if this is set. You can change it if you want another station as sketch reference.

The app signals an error if the reference station does not exist in the survey data. It can be forced to use an non-existing station by checking the "dangling" checkbox.
In this case the sketch may not have a midline reference, neither splays nor stations.

If the **extended** checkbox is checked the sketch profile is extended, and **projection azimuth** is not shown. Otherwise the sketch profile is projected with direction of view the projection azimuth.

In **landscape** mode the North and the vertical are towards the left side of the screen, in plan and profile views, respectively. Likewise, the x-sections have the vertical to the left side.

SURVEY SKETCHES

This dialog is opened from the *Sketch* button in the survey data window.

It has a button to create a new sketch and the list of the existing sketches of the survey.

New sketch creates a new sketch. It takes you to another dialog, where you can enter the sketch information, before opening the sketch window.

The list of the existing sketches has two columns:
plan views on the left
profile (either extended or projected) views on the right

Each sketch consists of a plan and a profile view, and is listed in both columns.

Tap on one sketch entry to open it. If you tap the left-hand-side entry the sketch is opened in the plan view. If you tap the right-hand-side entry the sketch is opened in the profile view.

PROJECTED PROFILE AZIMUTH

This dialog is opened when you create a new sketch with a projected profile.

The central canvas display the survey midline. It can be translated and zoomed.

The direction of view of the projected profile is set by dragging the seekbar at the top. The midline display rotates about the sketch reference station.

The *OK* button creates the sketch and opens it in the sketch window.

The *BACK* button closes the dialog without creating the sketch.

SKETCH REFERENCES

This dialog is opened from the *Reference* button of the sketch window.

The column contains the sketch references,

- **legs**, survey midline (white)
- **splays** (grey)
- **latest** splays [G]
- **stations** names (violet)
- **grid**, metric or yard
- **scalebar**, reference scalebar and North/Upward arrow
- **outline**, outline of another sketch

The "latest" splays can be highlighted in light blue color [G]. With *on-demand* download mode, these are the splays that have been downloaded most recently. With *continuous* mode, these are all the splays downloaded during the last highlighting interval.

There are three grids,

1. a grid at 1 unit spacing (dark grey)
2. a grid at 10 units spacing (grey)
3. a grid at 100 units spacing (light grey)

The grid units can be 1m, 1y, 2ft, 0.1m. The default is 1 m.
TopoDroid shows only the grids that are appropriate for the zoom of the sketch display.

The scalebar is adapted to the grid units (m, y, ft, dm) and has a small arrow indicating the North/Upward direction. The legend on the scalebar has the same size as the station names.

If there are other sketches, the outline of another sketch can be displayed (in grey) to help drawing the sketch. Checking the box opens a new dialog to pick the sketch to display, or to clear the outline display.
The outline of an x-section can be displayed at the relative section point. The display of the outline is turned on and off through the edit dialog of the section points.
The display of all the outlines is cleared when the sketch is closed.

Sketch shift and scale
A further checkbox [E/G] specifies whether the reference should be held fixed when shifting the drawing with a two-finger touch. This is used to adjust a sketch imported from PocketTopo to the reference in the case it gets imported with a translation. The sketch can be zoomed with a three-finger touch.

Canvas views (levels)
When canvas views are enabled [G], there is another column, on the right, to switch the views on and off. A drawing item is displayed if it belongs to at least a view that is ON.
The **Base** (B) view is always ON. The other views are

- **Floor** (F)
- **Fills** (D)
- **Ceiling** (C)
- **Artifacts** (A)

The views are denoted by an uppercase letter, B, F, D, C, and A, as indicated above.

SKETCH OUTLINE

This dialog is opened checking the sketch *Outline* button of the *Drawing References* dialog

Tapping a sketch on the list, displays its outline in the drawing canvas.

The *Merge* button [T] includes into the drawing the sketch displayed in the outline.

The *Clear* button removes the sketch outline from the canvas

DRAWING TOOLS PALETTE

The drawing tools bundled in the program include about 9 areas, 16 lines and 46 points.

When the app starts the first time it installs the drawing tools files in the "symbol" directory. There are files for points (iconic symbols, like "entrance", or "stalagmite"), lines (like "wall", or "pit"), and areas (regions shown with a transparent color).

New versions of the drawing tools are not automatically installed, but there is button to update them. The coming dialog tells you the installed and the current version and asks whether to update the drawing tools.

It is likely you do not need many of them, or maybe you need different ones. You can customize the drawing tools and the way you select them in four ways:

- with the choice of drawing tool dialog
- at the level of the sketch
- at the level of the project (directory)
- on the file system

Drawing tool dialog
The tools buttom bar contains only six drawing tools (for each type). If you need another tool, you must go to the drawing tool dialog. There are three different interfaces,

- a tabbed list of the tools with their names [default]
- the tools arranged on a tabbed grid
- all the tools arranged on a triple-grid

For each tool it is displayed the iconic symbol, the tool name, and the tool-group if any.

Sketch palette
Each sketch has its own palette. When you close the sketch it is saved with a header listing its palette. When you reopen it, the palette is set to the sketch palette. If the sketch contains items which are not in the palette they are added. If a item is not among the drawing tools it is replaced with the "user" tool. The "user" tools (point, line and area) are always in the palette.

The sketch palette is specified through the *PALETTE* menu of the sketch window. This opens a dialog that lets you decide which tool enable in the sketch palette. You switch on and off the tools to your needs then close the dialog (with the *BACK* button) to save the changes. You have to do this independently for points, lines and areas.

Global palette
Except for the "system" tools, TopoDroid loads the drawing tool from files stored in the "symbol" subdirectory of the base "TopoDroid" home. The system tools are the "user" and "label" points, "user" and "wall" lines, "user" and "water" areas. These are always enabled.

The *palette* button of the main window defines the drawing tool files to load. In the coming dialog you select the tools that are loaded. The list of files to load is saved in the project database. As for the sketch-level palette, you have to do this independently for points, lines, and areas

When the drawing tools are updated, TopoDroid does not install the new tools, automatically.

Custom drawing tools
At a even higher level, namely that of the base "TopoDroid" directory, you can customize the tool files. You can modify them, delete those you do not need, and add new ones (for tools not included in the program). Even if TopoDroid comes with many drawing tools preinstalled, it can happen that it does not contains the tools you need (or you do not like the provided ones). The tool files are plain text files, and you can write your own tool file(s). After you put them in the symbol subdirectories, TopoDroid will see and use them. The syntax of the tool files is described in a page on the website.

The "system" drawing tools cannot be modified, nor deleted.

LIST AND GRID TOOL PICKER

This dialog is used to select the current drawing tool.
It is opened with a longtap on the *Tools* button in the sketch window (in "drawing" mode), or with the rightmost button (with double-arrow) in the bottom toolbar.

The "triple grid" layout displays all the types at the same time. The "list" and "grid" layouts have three tabs at the top, **Point, Line, Area** to switch among the three types of tools.

The dialog displays the tools of the selected type,

- either as a **list**, with a selection checkbox, tool icon and name [default]
- or a as a **grid** with the tool icons

- or a as a **triple grid** (points, lines and areas) with the tool icons

To select a tool

- check its box in the list, and close the dialog (Back key)
- tap its icon in the grid, and close the dialog

A shortcut for these is a double-tap on the check-box or the icon.

The **Slider** sets icon orientation (orientable point tools, and area tools).

The +/- button changes the (global) default icon size cycling through XS, S, M, L, XL.

When canvas views [G] are enabled and the selected tool is associated only to disabled views, it is replaced by the corresponding "user" tool.

DRAWING TOOL SETS

The drawing tools are divided in three *types*: points, lines, or areas (regions).

TopoDroid comes with one default set of drawing tools, and other eight additional sets [T]. Overall that makes more than 200 points, 60 lines, and 30 areas. The basic speleology set has about 40 points, 15 lines, and less than 10 areas.

The drawing tool files are stored in the subfolders of *TopoDroid/symbol*. These files can be edited and modified, or even deleted. Furthermore, if other custom tool files are placed in the proper subfolder, TopoDroid will load and use them.

Eight *system* tools are always present: the three "user" symbols, points "label" and "section", lines "wall" and "section", and area "water". These tools are not stored as files, and cannot be changed. A custom tool file with the same name as one of these tools is skipped.

By default only the speleology tools are installed. The installation of additional tools is enabled through a setting [G]. A few tools are included in more than one set. The additional symbol sets are provided mostly as examples of custom symbols.

To install additional tool sets tap the the *PALETTE* menu [G] of the main window. The coming dialog lists the sets of tools. Check the tool sets you want to add and press the button *Install*.
If you press the button *Replace* the currently installed tools are removed before installing the tool sets you selected.

After installing new tool sets you must enable the tools you need, using the *Palette* button of the main window. The choice of enabled tools is stored in the database and is not lost when tool files are removed, therefore you will find them enabled if you re-install the set later.

Tool groups The tools of each type are further divided in *groups* (classes). A tool can belong to a group or have no group.

Groups are used in two ways.

1. when a sketch is opened, and an item type is not found, TopoDroid tries to substitute it for another type in the same group. If there is none, the "user" tool is used.
2. line continuation and joining can occur only with lines of the same group.

The tools groups are displayed in the tool enabling dialog. Group names are in English.

SKETCH RELOAD

This window is opened by the Reload menu of the sketch window.

TopoDroid maintains backup copies of sketch files, from which the sketch can be recovered.
TopoDroid keeps a set of backup copies for each sketch file. These are named with suffixes "bck", "bck0", "bck1", and so on. They are stored in the *tdr* subdirectory (binary sketch files). Whenever a sketch is saved the backup copies are rotated (eg, "bck1" is renamed "bck2", and so on; "bck" is renamed "bck0"), the old "tdr" file is renamed with suffix "bck", and the sketch is saved to a new "tdr" file.

A sketch is saved whenever it is closed, or you toggle between plan and profile view, or open a x-section, or switch to another sketch.
It is also saved whenever it is modified (eg, a new item is added, or part of the sketch is erased) while it is open. Upon a modification a timer is started and when it expires the sketch is saved. The wait-time is a setting (default 60 seconds).
The number of backups is another setting.

The Sketch Backup window displays a preview of the sketch backups. One backup at a time is displayed. Some info about the backup are shown in the title:

- how long ago it was written, with suffixes for minutes (m), hours (h), days (d), months (M) and years (Y)
- size of the file, in square brackets, in bytes
- backup number

There are two buttons to move back and forth in the backup list.

The menus are

- *close* the window without reloading the sketch from a backup
- *reload* the sketch from the displayed backup (and close the window)
- *help*

THE UNDO STACK

TopoDroid implements undo/redo with a stack of draw/erase/edit actions. When you draw something a draw action is put at the top of the stack. Undoing amounts to moving the stack pointer down the stack (beside affecting the sketch drawing). Redoing moves the stack pointer up (and add the drawing to the sketch).

The effect of the "continuation" drawing on the undo stack is that a new line is not created, and the line that has been continued is moved on top of the undo stack.

Erase and edit actions can also be undone/redone. However their effect on the stack is not as straightforward as for drawing.

Erasing is a raster operation while the drawing is made of vector items. The points of the vector items that come under the erased region are removed. This affects the undo stack in two way. Is an item is completely erased (eg, a point item), it is dropped from the stack. Undoing the erase action puts the item back, but at the top of the stack. Erasing the middle of a line remove the line object from the stack and replaces it with two lines that are added on the top of the stack.

For example, erasing can change the position of a line in the undo stack. Erasing the middle of a line drops the line from the stack and puts the two end pieces at the top of the stack. A following "undo" removes the two pieces and puts the line back, however at the top of the stack.

POINT TOOLS

The "point" tools are defined in text files.

Two point tools, "user" and "label" (text), are built in the programs. The others are loaded from the TopoDroid subdirectory *symbol/point*. This directory is populated with the point tools packaged in the distribution apk. You can delete the tools you do not need, edit the ones you want to change, and add new ones that are not provided in the apk.

The point tool file contains lines specifying the property of the drawing tool.

- "symbol point" [mandatory]
- "name NAME", where NAME is the point default name [mandatory]
- translated names, eg, "name-es ..." [translated names are optional]
- "th_name NAME", where NAME is the Therion name. The filename must be the same as the Therion name, witout the possible prefix "u": [mandatory]
- "color rgb" (rgb in hex format, for example red is '0xff0000') [mandatory]
- "orientation FLAG" [optional, false if missing, true if FLAG is '1' or 'yes']
- "has_text FLAG" [optional, false if missing, true if FLAG is '1' or 'yes']
- "roundtrip VALUE" [optional, for SVG-roundtrip, VALUE can be 1 (walls_shp), 2 (walls_sym), 3 (detail_shp), 4 (detail_sym) - default 4]
- "level" view_flag [optional, viewing level of the point; if missing level is set to 1]
- "path" begins the point symbol path. This is specified with the following commands
    - "moveTo X Y"
    - "lineTo X Y"
    - "cubicTo X1 Y1 X2 Y2 X Y"
    - "addCircle X Y R": (X,Y) center, R radius
    - "arcTo X0 Y0 X1 Y1 FROM_ANGLE SPAN_ANGLE": (X0,Y0 - X1,Y1) bounding rectangle, angles in degrees, 0 along X-axis, direction is CW
- "endpath" marks the end of the tool path
- "endsymbol"

Name

The English point "name" is mandatory.
Translation of the name in otther languages are optional.
Names must not contain spaces; use underscore '_' in their place.
The Therion name must coincide with the filename. This may cause a problem when the Therion name contains a dash '-' and this is an illegal character in filenames. In this case use the equal character '=' in the

filename, the script that creates the zip archive of the symbols files replaces '=' with '-' in the filenames. Therion names and filename must not contain spaces.

Orientation
If the attribute "orientation" is set, the point symbol can be drawn at an angle, and it can be rotated.

Level
The "level" attribute takes value the flag for the views enabled on this point items.
The flag is a number sum of 1 (base), 2 (floor), 4 (fills), 8 (ceiling), and 16 (artifacts).

LINE_TOOLS

The "line" tools are defined in text files.

Two line tools, "user" and "wall", are built in the programs. The others are loaded from the TopoDroid subdirectory *symbol/line*. This directory is populated with the line tools packaged in the distribution apk. You can delete the tools you do not need, edit the ones you want to change, and add new ones that are not provided in the apk.

The line tool file contains lines specifying the property of the drawing tool.

- "symbol line" [mandatory]
- "name NAME", where NAME is the line default name [mandatory]
- translated names, eg, "name-es ..." [optional]
- "th_name NAME", where NAME is the Therion name. The filename must be the same as the Therion name, witout the possible prefix "u": [mandatory]
- "group GROUP", specifies the group this line belongs to [optional, default no group]
- "color rgb alpha" (rgb and alpha in hex format, for example '0x00ff00' is green, and '0xff' is fully opaque) [rgb mandatory, alpha is optional, if not specifed 0xff is taken]
- "width SIZE", line width in units of the *line width* setting [optional, default 1]
- "dash PATTERN", example "15 5" [optional dash pattern]
- "style STYLE" where STYLE can be 'straight' or 'xN' [optional]
- "effect" begins the line path-effect and is followed by path commands, and closed by
- "endeffect"
- "roundtrip VALUE" [optional, for SVG-roundtrip, VALUE can be 1 (walls_shp), 2 (walls_sym), 3 (detail_shp), 4 (detail_sym) - default 3]
- "level" view_flag [optional, 1 if missing]
- "endsymbol"

Name
Refer to the Point Tool for how to specify the names.

Group
Line tools in the same group can be joined together by "continuation".

The "group" attribute is used to specify that the various "wall" line types can be joined together.

Dash
The "dash" directive specifies that the line is drawn with a dashed scheme. For example, "dash 15 5" means that the line is drawn with segments of 15 units, separated by 5 units spaces.

Style
The "style" directive is used to draw lines using sparse points.
A "style x3" means that the line is drawn using one every three points. The effect is that the line is less "curvy".
If you want straight segments us "style straight".

Effect path
This option is used to define lines with complex style.

Level
The "level" attribute takes value the flag for the views enabled on this line items.
The flag is a number sum of 1 (base), 2 (floor), 4 (fills), 8 (ceiling), and 16 (artifacts).

AREA TOOLS

The "area" tools are defined in text files.

Two area tools, "user" and "water", are built in the programs. The others are loaded from the TopoDroid subdirectory *symbol/area*. This directory is populated with the area tools packaged in the distribution apk. You can delete the tools you do not need, edit the ones you want to change, and add new ones that are not provided in the apk.

The area tool file contains lines specifying the property of the drawing tool.

- "symbol area" [mandatory]
- "name NAME", where NAME is the area default name [mandatory]
- translated names, eg, "name-es ..." [optional]
- "th_name NAME", where NAME is the Therion name. The filename must be the same as the Therion name, without the possible prefix "u": [mandatory]
- "color rgb alpha" (rgb and alpha in hex format, for example '0x0000ff' is blue, and '0x99' is semi-transparent) [mandatory]
- "close-horizontal" [optional, false if missing]
- "orientable" [optional, false if missing]
- "level" view_flag [optional, 1 if missing]
- "bitmap WIDTH HEIGHT X_TILE Y_TILE" starts of the bitmap pattern. The tile modes can be M (mirror) or R (repeat). This line must be followed by HEIGHT lines of length WIDTH with the bitmap pixels (1: foreground, 0: background).
- "endbitmap" marks the end of a bitmap
- "roundtrip VALUE" [optional, for SVG-roundtrip, VALUE can be 1 (walls_shp), 2 (walls_sym), 3 (detail_shp), 4 (detail_sym) - default 3]
- "endsymbol"

Name
Refer to the Point Tool for how to specify the names.

Close-horizontal
If this attribute is set the area border is closed horizontally in the profile view and in the x-sections.
If the Y coordinate of the last point of the drawn line is close to that of the first point, the area border is interrupted at the first point that has Y coordinate close to that of the first point. By this means you can draw

areas with a flat horizontal top (or bottom) profile.
If the Y coordinates of the drawn line endpoints differ too much, the border is closed with a slant segment.

Currently, this attribute it is only set for the built-in "water" tool.

Bitmap pattern
With this option you can specify a background pattern, eg, for differentiating rock formations.

This attribute is not used in any tool packaged in the apk.

Orientation
If the attribute "orientable" is set, the area pattern can be rotated through the area edit dialog.
Area patterns are not used in the default symbol set. Shading is preferred for performance.

Level
The "level" attribute takes value the flag for the views enabled on this area items.
The flag is a number sum of 1 (base), 2 (floor), 4 (fills), 8 (ceiling), and 16 (artifacts).

SKETCH ITEM PROPERTIES EDITOR

The sketch item properties editor dialog is opened by selecting a point (or the point) of the sketch item and from the *Note* button.

Point items properties:

- **size** (one of XS, S, M, L, XL)
- **orientation**, if the point item is orientable
- **layers**, the canvas views on which the point is displayed [T]
- **text**, for "label" points
- generic Therion **options**

Line items properties:

- line **type**
- **outline** (either "out" or "in")
- **direction**, i.e. whether the line is directed or reversed
- **layers**, the canvas views on which the line is displayed [T]
- a polycubic line can be made polyline, i.e., composed of segments instead of cubics
- the line can be **subsampled**, by removing intermediate points
- the line can be **closed**, by appending a last point at the position of the first
- generic Therion **options**

Area items properties:

- area **type**
- **visibility** of the area border
- **orientation**, if the area is orientable
- **layerx**, the canvas views on which the line is displayed [T]
- generic Therion **options**

Survey stations properties (see also sketch station editing):

- make the station the **active** one, i.e. to continue the survey from it
- show the hidden midline (only if applicable)
- toggle the display of **splays** at the station (overriding the global choice of splay display)
- adding the station to the Therion export (if "therion auto-station" option is disabled)
- at-station **x-section** buttons

Survey shots properties:

- **stations**
- shot **comment**
- the **extend** value
- the **flags**: "duplicate", "surface", or "commented"
- midline hiding
- **auto-walls** generation [E]
- custom **color** (for splays) [T]

The custom color is associated to the survey splay in the list, and is used to identify the splay in the sketches. It is saved in the database, but it is not exported in the ZIP.
The custom splay colors are cleared by a menu in the survey info window.

SKETCH STATION

This dialog displays the station position (East, North, and vertical) relative to the sketch origin, and the station comment (editable field) [T].
Actions:

- enter or edit the station comment and save it [T]
- make the station "active", ie, continue the survey from this station.
- show the hidden midline (if applicable)
- force showing/hiding the display of the splay shots at the station
- at-station x-section buttons
- go to the saved-station dialog [A]

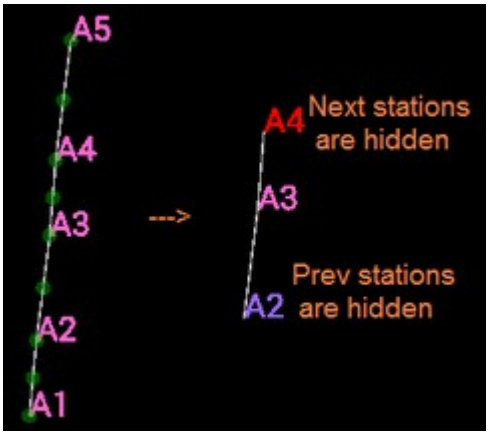
Active station

The "active" station is where the next downloaded shots will be attached. When a leg is downloaded (or inserted) the new station becomes the "active" station. By changing the "active" station you can continue surveying from a station in the middle of the survey. The active station is shown green in the shot data list.

Midline hiding

Hiding parts of the midline is useful when the survey is complicated or goes over itself. In this case it is useful to see only the relevant portion of the midline, by hiding what lies beyond a station. If the midline beyond a station is hidden, the station is highlighted: violet if the hidden midline lies between them and the sketch origin station, red otherwise. Stations in the part of midline behind a "red" station, are not

automatically saved as Therion station points. Therefore, by choosing the sketch origin station inside the scrap and marking stations as barrier you can avoid spurious stations in the scrap file.
The display of the midline can be limited through the property edit dialog of leg shots. When the midline beyond the station is hidden, there is a button to revert and show it in the station edit dialog.



Station splays
The display of the station splays can be forced to override the global setting of the sketch. If showing is forced, the splays are shown even when they are hidden globally. If hiding is forced, the splays are not shown even when they are displayed globally.
This flag does NOT affect the edit-selection of splays; the selection green dots are always displayed according to the global setting.

At-station x-section
X-sections can be created at stations. In plan view they are in the vertical plane (their plane is determined by the azimuth). In profile view, x-section can have an inclination. However when selected through the "stations" checkboxes they are vertical if the legs inclination is below a specified value (a setting), otherwise they are horizontal.
If the station has only two legs attached the plane of the x-section can be inferred by TopoDroid (the bisecant of the angle between the two legs, or perpendicular to the leg of there is only one). There remains only the ambiguity about from which side of the plane the x-section is looked at. This is resolved providing two buttons that specify the direction of view with a pair of stations.
With the last button the user can pick the x-section direction pointing with the android camera.

At-station x-sections can be "private" to the sketch in which they have been defined or shared among all the sketches. In the latter case, in all the sketches the edit dialog of the station opens the same x-section. In the former case, an at-station x-section is re-opened only thru the station edit dialog in the sketch where it has been defined.

In either case the x-section is exported only in the sketch that contains the section point, ie, in the sketch where is has been defined.

The choice between "private" and "shared" at-station x-sections is made when the survey is created and cannot be modified afterward. When at-station x-sections are private, you may enter a nickname to distinguish x-sections at the same station in different sketches.

The name of an at-station x-section in the plan view is composed of the "survey_name", "xs", the "station_name" and, if the x-sections are private, the "sketch_name". For example, "survey-xs-0-1p". The name of an at-station x-section in the profile view has "xh" instead of "xs".

The at-station x-sections can have a comment, just like the section-line x-sections.

Therion STATION POINTS

Therion scraps must have a scale defined or at least two stations so that *Therion* can compute their scale.i

TopoDroid has an option to automatically write into the scrap file all the stations that fall in the convex hull of the sketch. This is enabled by default, and for simple cave maps it is ok.

However this may not be convenient if you work with xtherion and stations from other portions of the survey fall inside the scrap and there are many "spurious" station points. In this case you might want to disable this option and decide by yourself which station to add to the scrap. When the "Therion station points" option is disabled, the sketch edit dialog of stations has an option to mark the station as "Therion station point".

Alternatively, you can let the "Therion station points" option enabled, and mark "barrier" stations to limit the automatic station points. In fact TopoDroid does not add to the Therion file stations that are beyond a "barrier" station.

SKETCH SHOT

This dialog is opened when you select a survey shot and tap the Item button in the sketch window (in "edit" mode).

Shot properties:

- length, azimuth, and inclination
- **stations** and shot type (D forward, B backward, M manual)
- **comment**
- profile **extend**: "left" (-1), "vertical" (0), or "right" (+1)
- profile **fractional extend** slidebar (legs only) [T]
-  "duplicate" flag
-  "surface" flag
-  "commented" flag
- checkboxes to **hide** the midline (legs only)
- color, if enabled (splay only)

Save confirms the changes and closes the dialog.
There is a warning if, upon editing a leg shot, it differs from another leg between the same stations more than one fourth in length, or 15°.

Cancel and the Back key close the dialog without saving the changes.

Midline hiding

Leg shots have checkboxes to hide the display of the midline on the side of either stations. The hiding stations are displayed either red or violet in the drawing. The hiding is reverted through the edit dialog of the

station.

Leg extend [E]
In the extended profile legs are usually drawn either to the left, or vertical, or to the right (or not drawn at all). The choice among these options is the "extend" value, that specifies whether the leg is extended left (-1), vertically (0), or rith (+1). When a leg is selected in the extended profile view a horizontal bar is drawn through its middle point. by swiping from the midpoint along the bar the user can quickly change the "extend" of the leg.

Shot fractional extend [T]
It is also possible to set a "fractional extend": a value between -1.5 and 1.5, instead of only the integer values -1 (left), 0 (vertical), and 1 (right). By default the "extend" has an integer value and the fractional part is zero. The slider below the "extend" checkboxes changes the integer part and the fractional part of the shot "extend".

The fractional part of the shot "extend" is set to zero when

- the shot extend is set with a multishot action (except for the "flip" action)
- the shot extend is changed in the sketch window using the yellow extend line
- the shot extend is changed in the shot edit dialog (of the survey data window)
- the shot extend is assigned by TopoDroid

To set a fractional extend you must enable the relative setting. As most map-drawing programs do not support fractional "export", this setting is disabled by default.

Splay color [T]
It is possible to assign a color to each splay shot. The color is stored in the database and is thus shared among the sketches.
The color dialog has a button to clear the splay color.

SKETCH POINT

This dialog is opened when you select a point symbol and tap the *Edit* button in the sketch window (in "edit" mode).

Point properties:

- **size** (XS, S, M, L, XL)
- **orientation**, if the point is orientable
- **layers**, the canvas views on which the point is displayed [T]
- **text**, if the point has text associated
- additional Therion **options**

The canvas views are presented as checkboxes with the view letter-code. You can change the views the point belongs to. The point icon is not displayed if all its views are OFF. The selectable point will nevertheless be shown in edit mode, so that the point edit dialog remains accessible.

Cancel closes the dialog.
Save confirms the changes and closes the dialog.

With *side-drag* enabled, the point orientation can be changed also by sliding up and down on the left and right sides of the canvas.

The *BACK* key closes the dialog without saving the changes.

Section point dialog

DRAWING LABELS

This dialog is opened when you insert a label, in drawing mode of the sketch window.

Label properties:

- **size**: one of XS, S, M, L, XL
- **text**
- **layers**, canvas views [T]
- additional Therion **options**

Labels are orientable.

The canvas views are presented as checkboxes with the view letter-code. By default labels belongs to the "base" and "artifact" views. It is possible to switch off some views. Beware that, if the label is not assigned to a visible view, it will not appear in the canvas even if it is actually added to the sketch.

SKETCH SECTION POINT

This dialog is opened when you select a section-point item and tap the *Edit* button in the sketch window (in "edit" mode).

Point properties:

- **size** (XS, S, M, L, XL)
- **layers**, the canvas views on which the point is displayed [T]
- Therion **options**: the sketch point has always the "-scrap" option followed by the name of the x-section
- **x-section** checkbox to display the xsection outline in the sketch

The canvas views are presented as checkboxes with the view letter-code. You can change the views the point belongs to. The point icon is not displayed if all its views are OFF. The selectable point will nevertheless be shown in edit mode, so that the point edit dialog remains accessible.

Cancel closes the dialog.
Save confirms the changes and closes the dialog.

The **Sketch** button to open the x-section sketch, if it exists. Changes to the xsections sketch are not

propagated to the outline in the sketch: to update it, close the outline and open it again.

The *BACK* key closes the dialog without saving the changes.

DRAWING PHOTO ITEM

This dialog is opened when you insert a photo, in drawing mode in the sketch window.

Photo properties:

- **comment**

Other properties are stored in the exif tags of the image file.

PHOTO-ITEM EDIT

This dialog displays the properties of sketch points of type "photo".

- **thumbnail** of the photo
- **orientation** (azimuth and clino) of the photo, for photos taken with TopoDroid
- **date and time** of the photo
- **comment** (editable)

Buttons:

- **Save** saves the changes to the comment

The image is displayed when you tap on the thumbnail. The full image is not reoriented to portrait.

The Android *BACK* button closes the dialog.

SKETCH LINE

This dialog is opened when you select a point of the a line, in editing mode of the sketch window, and tap the *Edit* button.

You can change the line type by selecting it from the scroll-down list. The type cannot be set to "section" line.

Line properties:

- line **type**
- **outline**: "in" or "out", or "unset"
- **layers**, canvas views
- additional Therion **options**

With this dialog you can also

-  reverse the line direction
-  make the line more straight
-  reduce the number of line points (decimation)
-  make the line with sharp-corner
-  mark the line closed or open

The second, third, and fourth are mutually exclusive.
Finally you can change the canvas views to line belongs to. The views are presented as checkboxes with the view letter-code. The line is not displayed if all its views are OFF. The line points will nevertheless be shown in edit mode, so that the line edit dialog remains accessible.

OK saves the changes.

Point decimation
The line points can de be reduced either keeping one point every two (single check), or one every four (doble check).

Section line dialog
Section lines are special as they are associated with x-sections (both sketch and photo). Therefore they have different fields:

- "section comment" (text field)
- the photo thumbnail and info (orientation and date), if the x-section has a photo.
- four action button: take a photo, open the sketch, delete the x-section, save the comment.

Tapping the thumbnail displays the photo.

The *BACK* key closes the dialog.

SKETCH AREA

This dialog is opened when you select a point of the border of an area (in edit mode of the sketch window), and tap the *Edit* button.

You can change the type of area, by selecting it from the scroll down list.

Area properties:

- **visibility** of the area border
- **layers**, canvas views the area belongs to

The area border visibility is written in the Therion export, so that it can be used when the survey map is generated.

TopoDroid displays the area shaded region without a border if the visibility is off. Otherwise a light grey border is shown.
The default value of the area border visibility is a setting.

Point decimation
The number of border points can be reduced by either keeping one point every two (single check) or one every four (double check).

Layers
Finally you can change the canvas views to area belongs to. The views are presented as checkboxes with the view letter-code. The area is not displayed if all its views are OFF. The border points will nevertheless be shown in edit mode, so that the area edit dialog remains accessible.

The *BACK* key closes the dialog.

AUTO-WALLS

At experimental level the *autowall* button is present in the shot edit dialog of the sketch window.

Auto-walls is a technique to quickly get a rough map of a simple cave, consisting only of the walls outline. It is not a substitute for a good sketch of the cave.

A better result can be obtained with the 3D model reconstruction, provided you have a dense set of splay points. Project the outline on the horizontal plane for the plan view, and slice a vertical profile curtain for the profile view.

With auto-walls you tell TopoDroid to draw walls to the right and left of a shots interpolating through the end-points of the splays. You must choose an auto-wall mechanism thru the settings. At the moment there are two auto-wall algorithms: *convex* and *Delaunay*.

For the *convex* walls, a polyline is traced connecting the outermost end-points of the splays. To create a wall there must be at least one splay end-point on the side of the shot. In this case, two wall lines are traced, one on each side of the shot, if possible.

The *Delaunay* wall is based on a Delaunay triangulation of the splay endpoints (plus eigth points "at infinity"), and the associated Voronoi cells. Each splay endpoint is associated to the farthest center of the cells it belongs to. From the cells at infinity a convex hull is build. This is then shrinked with the splay endpoints for which the associated center lies outside the hull. A single closed wall border is traced, usually containing the shot.

Auto-walls applies to one shot at a time, and it does not take into account the nearby shots. Therefore it is likely that an auto-wall "enters" the nearby piece of gallery or misses it. You should then edit the auto wall adjusting for these drawbacks, i.e., inserting points for the missing pieces and deleting, or moving, points that fall in the nearby gallery.

Through the settings you can specify the upper clino limit of the splays taken into account for walls in plan view, and the lower clino limit for profile view. Other settings let you pick the amount of allowed concavity, and the minimum distance [in m] between splay points on the wall.

- *Walls type*: the type of auto-walls. Default is "none" (disabled).
- *Splay plan threshold*: maximum inclination of splays used in auto-walls in the plan view.
- *Splay profile threshold*: minimum inclination of splays used in auto-walls in the profile view.
- *Point separation*: minimum separation of splay points along the shot direction. If two splays are closer than this value only the splay with largest distance from the shot is used.
- *Point step*: maximum distance along the walls between two line-points. If a wall segment connecting two splays is too long it is splitted interpolating points in the between
- *Concavity*: amount of accepted wall concavity.

Warning
If you draw auto-walls twice for the same shot you get two copies of the wall line(s).

SKETCH STATISTICS

This dialog is opened from the *Statistics* menu of the sketch window (plan or profile view). It displays both data statistics and sketch data statistics.

The survey statistics are

- number of (regular) legs, sketch legs, their total, profile, and plan lengths
- number of duplicate legs, sketch duplicate legs, and their total length
- number of surface leg, sketch surface legs, and their total length
- number of splay shots, and sketch splay shots
- number of stations, and sketch stations
- number of shots not attached to the sketch if any, and their total length. Tapping this line opens the dialog with the list of unattached shots.
- number of cycles (including the backshot-cycles) if any.
- number of disconnected survey componentss if greater than 1. (This is 1 if the legs are all attached together in one survey)

Other sketch related statistics are

- origin station (zero station)
- the midline length
- profile-view (3D) midline length
- plan-view midline length
- the sketch extension (West, East, North and South)
- the sketch depths, both positive (above the zero station) and negative (below the zero station)
- average angle error between shots of the same leg [degrees]
- the number of loops

For each loop:

- closing shot
- number of loop shots
- closing error: 3d length over total loop length
- horizontal and vertical error lengths

- percent error: ratio between error and loop length
- estimated shot angle error [degrees]. This is the error times the square root of the number of shots and divided by the length. The result, in radians, is converted to degrees.

Length are in the units set in the app settings.

Tapping on the loop closure entry toggles between the closure error, and the list of loop stations.

SKETCH FLIP AND SHIFT

Profile sketch flip [E]
When viewing the profile, a long tap on the *Plan/Profile* button opens a confirmation dialog to flip the profile sketch horizontally.
The dialog has a checkbox to reverse the "extend" value of the shots as well. This is enabled by default. Only the shots that are displayed in the profile, are reversed, ie, their "extend" is changed. Therefore shot hidden behind a station are not affected. By this means you can reverse only a portion of the survey data.
Shots "extend" can also be reversed with a multi-selection in the survey data window.

Sketch transform [E]
Shifting, scaling and arbitrary affine transformations are enabled by custom settings [G].

The drawing can be shifted as a whole by selecting the *Fix ref* checkbox in the sketch reference dialog. Then in *move/zoom* mode the drawing can be shifted by dragging it with two fingers.

Scaling and affine transformation are accomplished by touching the screen with three fingers. The motion of the fingers defines the parameters of the affine transformation. In this way the sketch can be arbitrarily scaled, rotated and skewed.
If the general affine transform is not enabled, the sketch is only scaled.

WARNING
Sketch transformation is CPU intensive, expecially for large sketches, because it changes the coordinates of every drawing point, and the app may appear unresponsive if the sketch is big.

SKETCH RENAME/DELETE/SPLIT

With this dialog you can change the name of a sketch. It is opened from the *Rename* menu of the sketch window.

It has a field for the new name of the sketch, and a text box with the sketch reference station (sketch origin). The reference station can be modified only at "Tester" level.

Type the new sketch name in the edit box, and tap the *Apply* button to confirm.

The *Split* button [T] lets you cut a portion of the sketch and save it as a new sketch. You must write the name of the new sketch in the edit box. Then you select the portion of the sketch by tracing a line around it.
With the check box you choose whether to copy or to move the selected items to the new sketch.

The base station of the new sketch is the same as that of the current sketch.

The *Delete* button marks the sketch as "deleted". It can be recovered with the survey data window *recover*

menu.

Close the dialog with the *Cancel* button to cancel.

SKETCH SCRAPS

With this dialog you can add a scrap to a sketch or switch among the scraps of a sketch.
It is opened from the *Scraps* menu of the sketch window.

A sketch can be divided in more scraps.
Only one scrap is active at a time, the others are shown only in outline (the walls).

The New button add a scrap to the sketch. The newly added scrap becomes the active scrap.

With the Next and Prev button you can switch to another scrap, to work on that.
These buttons are greyed out when the active scrap is the last or the first, respectively.

The *Back* button closes the dialog witout doing anything.

SKETCH MERGE AND SPLIT

In the *Sketch rename/delete* dialog you can either rename or delete the opened sketch.

If *split/merge* [G] is enabled there are also buttons to split the sketch (ie, extract part of the drawings creating a new sketch), and merge the drawings of another sketch in the current sketch.

Sketch split
There is also a button to split the sketch. This creates a new sketch populated with items selected from the current sketch. To select these items trace a border surrounding them in the sketch window.
You can specify the name of the new sketch. However its origin is the same as that of the current sketch.
Likewise it has the same type of profile view as the current sketch.
If the sketch window is displaying the plan view, the new sketch plan view is populated with the selected items, and the profile view is empty. The converse, if the sketch window is displaying the profile view.
Only visible items are selected for the split.

You can choose whether to move the selected items to the new sketch of to copy them to it.

After this operation the sketch window displays the new sketch.

Sketch merge
If the outline of another sketch is being displayed you can merge it within the current sketch.
The items of the outlined sketch are copied in the current sketch.

SKETCH ZOOM-FIT

This dialog is opened by the menu "Zoom fit".

With this dialog you can

- Choose the orientation of the presentation, and fit the drawing into the display
- Set a graph-paper grid or a metric grid

- Center the drawing at a given station

Orientation
This orientation refers to the presentation of the drawing by TopoDroid and is not related to the *Portrait/Landscape* orientation managed by Android.

The orientation applies only to the plan/profile views. You can choose to display the drawing with the North/ Upward direction to the top of the screen or to the left.

Graph-paper grid
Instead of the metric grid, with cells corresponding to the selected grid units, it is possible to have a graph-paper grid with cells of 1 mm size.
In this case the sketch scale must be chosen among 1:100, 1:200, 1:300, 1:400, and 1:500.

Close the dialog with the *Cancel* button to cancel any action.

SKETCH EXPORTS

Sketches are stored in TopoDroid binary format, and can be exported as

- *Therion* ".th2" file
- *cSurvey* ".csx" file
- *Tunnel* ".xml" file
- 2D DXF (*LibreCAD*)
- SVG (*Inkscape*)
- shapefile (*QGIS*)
- *xtherion* image ".xvi"
- PNG image file

In addition to the export, there is an option to automatically save a sketch in one of the supported export formats whenever it is closed.

The **cSurvey** export file contains both the plan and the profile sketches. If the "section" points are defined, it has also the x-sections. X-sections are not exported as cSurvey files.

The resolution of **PNG** images is an adjustable setting. However a larger and more detailed image requires more CPU time and may fail due to memory limits. If it fails TopoDroid tries reducing the resolution until it succeeds exporting the sketch as PNG image file.

Sketches can be exported as 2D **DXF** files. Supported DXF versions are 9, 12, and 14.

The **shapefile** export includes stations, shots, and drawing. All the drawing objects are converted to linestring. The attribute tables contain the object data (eg, point type, orientationn, etc.). The files comprising a shapefile export are compressed in a zip archive.

A few export settings, specific to the selected format, can be overridden in the export dialog.

Overview export

Sketches can be exported also from the "Overview Window" in the following formats

- *Therion* ".th2" file
- 2D DXF (*LibreCAD*)
- SVG
- shapefile (*QGIS*)
- ".xvi" file (*xtherion*)

The export of the overview window includes all the sketches of the current view (either plan or profile). If there are "section" points, the x-sections are also included.

OVERVIEW REFERENCES

This dialog is opened by the *Reference* button of the overview window.

- **legs**, survey midline (white)
- **splays** (grey)
- **stations** names (violet)
- **grid**, metric or yard
- **scalebar**
- **Outline** only

There are three grids,

1. a grid at 1 m spacing (dark grey)
2. a grid at 10 m spacing (grey)
3. a grid at 100 m spacing (light grey)

TopoDroid shows only the grids that are appropriate for the scale of the sketch view.

TopoDroid Manager - Project window

The *Cave Project Window* displays the list of surveys in the cave project.

Buttons
Add more surveys
Drop selected surveys
View selected surveys
Display the list of the *equates*
Display 3D view (with Cave3D)

Menus
Close the window
Export the cave project (Therion or Survex)
Delete the cave project
Help

TopoDroid Manager - Project dialog

The cave *Project Dialog* ...

TopoDroid Manage - New equate dialog

This dialog is opened by the *New equate* button of the cave *Project Window*

You can manually add an *equate* between stations of the project surveys by entering the ...

TopoDroid Manager - Equates dialog

This dialog is opened by the *Equates* button of the cave *Project Window* or of the *Surveys display Window*.

The dialog lists the project displays.
You can remove an *equate* by tapping it. There is a confirmation dialog.

TopoDroid Manager - Surveys dialog

This dialog is opened by the *Add surveys* button of the cave *Project Window*

The dialog lists the surveys in the TopoDroid database.
To add one or more surveys to the project, check the box to their left and click the *OK* button.

[15] 3D VIEWER

Cave3D is a 3d viewer for Therion projects, Loch files, Compass files or projects, and VisualTopo files. TopoDroid uses it to display the 3D model of the survey. When you select 3D menu of the survey data window, the survey data is saved to a Therion file, which is opened in Cave3D displaying the 3D model.

The model is shown with a reference grid (blue north, green east) or triplet (pink upward).

BUTTONS

- *Tilt - Move*: green arrow switches the view between rotation and move modes.
- *Stations*: button displays and hides station numbers.
- *Splays*: button will display and hide splay shots. Splays are shown as lines or as endpoints.
- *Walls*: button will display or hide wall models if there is any.
- *Projections*: display the plan view built from the wall 3D reconstruction, projected on the grid plane, and/or the profile curtain
- *Surface*: button will display surface. Works only if ASCII surface data is specified in .th file.
- *Color*: button will change color-coding of centreline from all grey to survey and depth.
- *Grid*: button will switch between underlying grid or X, Y, Z axis.

MENU

- *Open file*: opens a dialogue to select a .th file from th subfolder in TopoDroid working directory.
- *Export*: opens the export dialogue. Model can be exported into Therion, KML, STL or STL-bin formats, CGAL and LAS. There are options to include splays, walls, stations and surface in export. The model can be also serialized in a text file.

- *Info*: will display survey statistics
- *Rose diagram*: displays 2D azimuth rose diagram
- *3D rose diagram*: displays 3D direction diagram
- *Reset*: center the 3D model in top-view and zoom to fit it in the screen
- *Viewpoint*: will let you select a point of view
- *DEM* Digital Terrain Model: opacity, overlay, file-load
- *Wall models*: create or clear a wall 3D reconstruction.
- *Options*
- *Help*

OPTIONS

- *Base path*: Directory containing the Therion/Loch files
- *Text size*: Station label text size
- *Buttons size*: Buttons size
- *Selection radius*: Radius of selection
- *Top grid*: Show the grid on the top
- *DEM extent* around the survey
- *Projections*: Whether to use precompute projections
- *All splay*: Whether to use all the splays for the walls
- *Split triangles*: Whether to split intersecting wall triangles
- *Randomize points*: Add a small random vector to splays
- *Stretch walls*: Shift wall points by a small quantity along the leg

Wall model

The wall envelope is not computed automatically when the file is opened, but it must be requested by the user thru the *Wall models* menu. There are two models: pseudo conevx-hull, and powercrust. The first is good when the splay are not dense. The second is for dense splays.
After the wall has been computed it can be displayed with the "wall" button.

Station actions

When the stations are displayed, they can be selected tapping on the station. The selected station can be set as origin of the model ("center"), or the distance from another station can be measured.
If the model as a DEM the depth below surface is shown.

DEM (Digital Elevation Model)

Cave3D handles DEM included in Therion or loch files.
If the TopoDroid survey has a georeferenced station, a DEM can be added to the model by loading from an external file (supported formats: ascii and therion grid). The georefenced station must have also the coordinates transformed in the DEM Coordinate Reference System through the app Proj4.
