

# PAPERLESS SURVEYING UPDATE

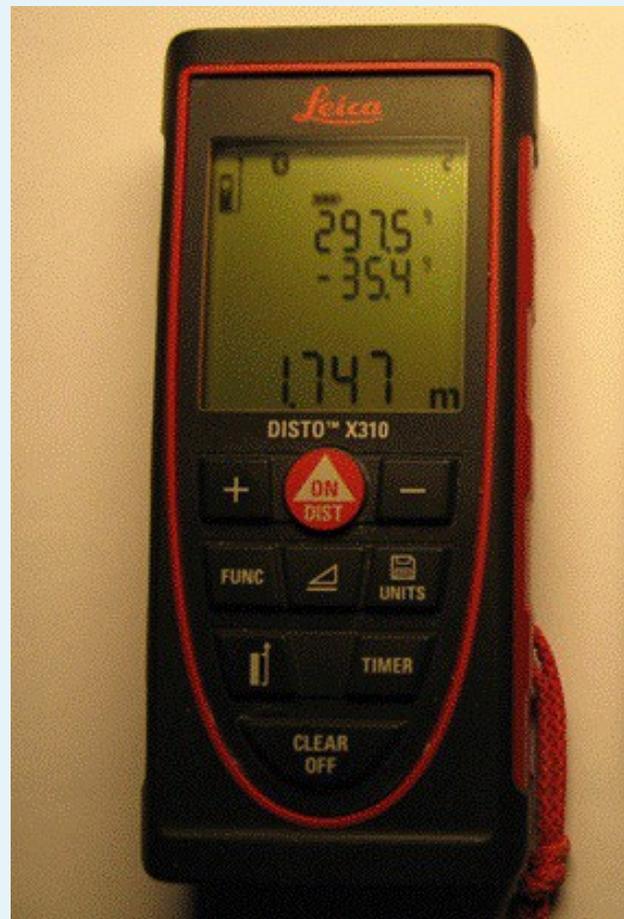
Easier DistoX2 Calibration, TopoDroid Software, Tablet and Stylus Options, Technical Lessons Learned

It is still early in the paperless cave survey game, but, with the aid of a DistoX surveying instrument, **PocketTopo** (for Windows PC), **Auriga** (for Palm PDA) , and **TopoDroid** (for Android phones & tablets) can all create in-cave working maps.



*"He thinks he's so cool, ever since he got that new tablet!"*

The DistoX2 is a modified Leica laser rangefinder, model E7400x (X310 in Europe) that measures distance, azimuth, and inclination with a single click and transfers the data to a tablet, smartphone, or PDA via Bluetooth. The earlier Distox (A3) does the same.



It turns out that for unknown reasons, a few DistoX and DistoX2s are unable to pair properly with specific computing devices.

I have a DistoX and an X2 that will pair with both Windows PC and Android devices, but also another DistoX that will not pair with Android devices.

I have also seen an X2 that will pair with an Android tablet but not transfer data. It works fine with a Windows 7 PC.

The DistoX2 should be re-calibrated, and/or checked on a test range, before each survey trip. There is a quick, accurate, and relatively easy method to do the calibration chore. This also works with the DistoX (A3)

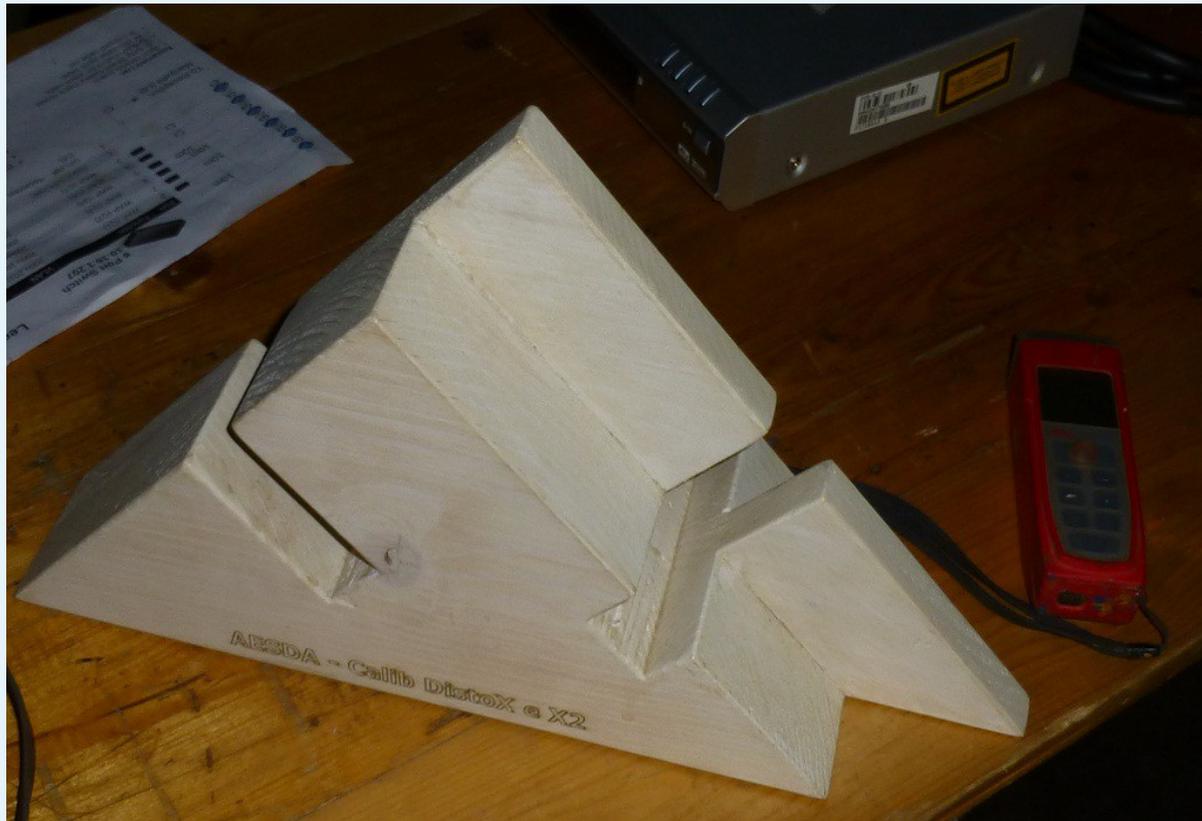


Another version of the AESDA, from Rob Gill

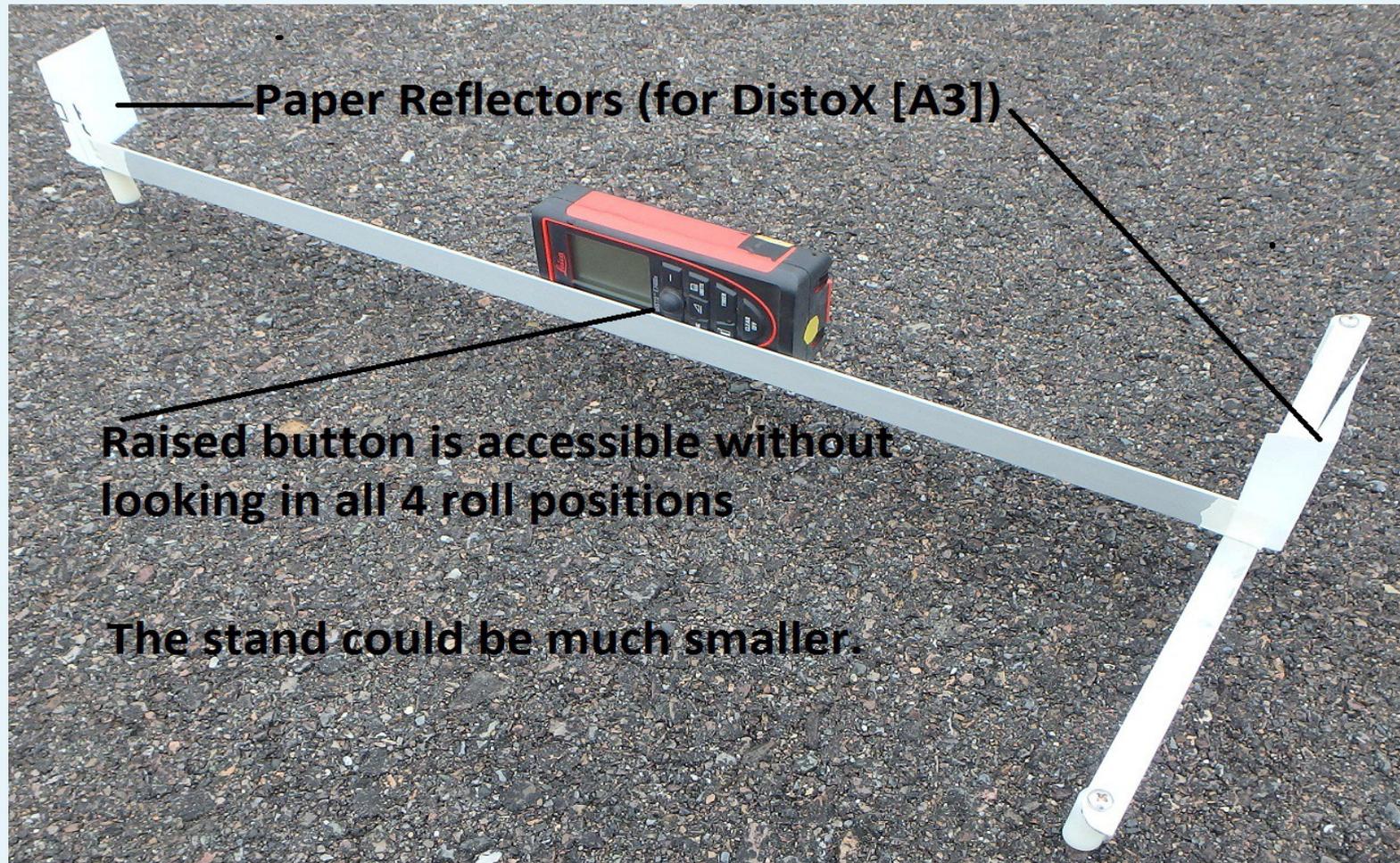
**AESDA Cal Stand  
Europe**



The use of a stand for DistoX calibration has become common. There may soon be as many frame designs as there are different mousetraps! There are also different opinions on accuracy when using a frame. Ted Lappin showed a simple wood frame at the 2016 convention.



My simple stand holds the DistoX2 firmly in any orientation while allowing easy access to the shot button. It relies on the laser beam being parallel to the sides of the case, which may not always be true.



Prior to the first calibration with the frame, the case should be aligned with the laser by shimming the case with electrical tape or similar.

## DistoX (A3)



Tape "shims" to align case with laser

I aligned the laser with a 60 inch straightedge, but a flat surface such as a granite counter top is better and easier. Alignment is good when the spot moves neither up nor down as the Disto is moved away from the target.

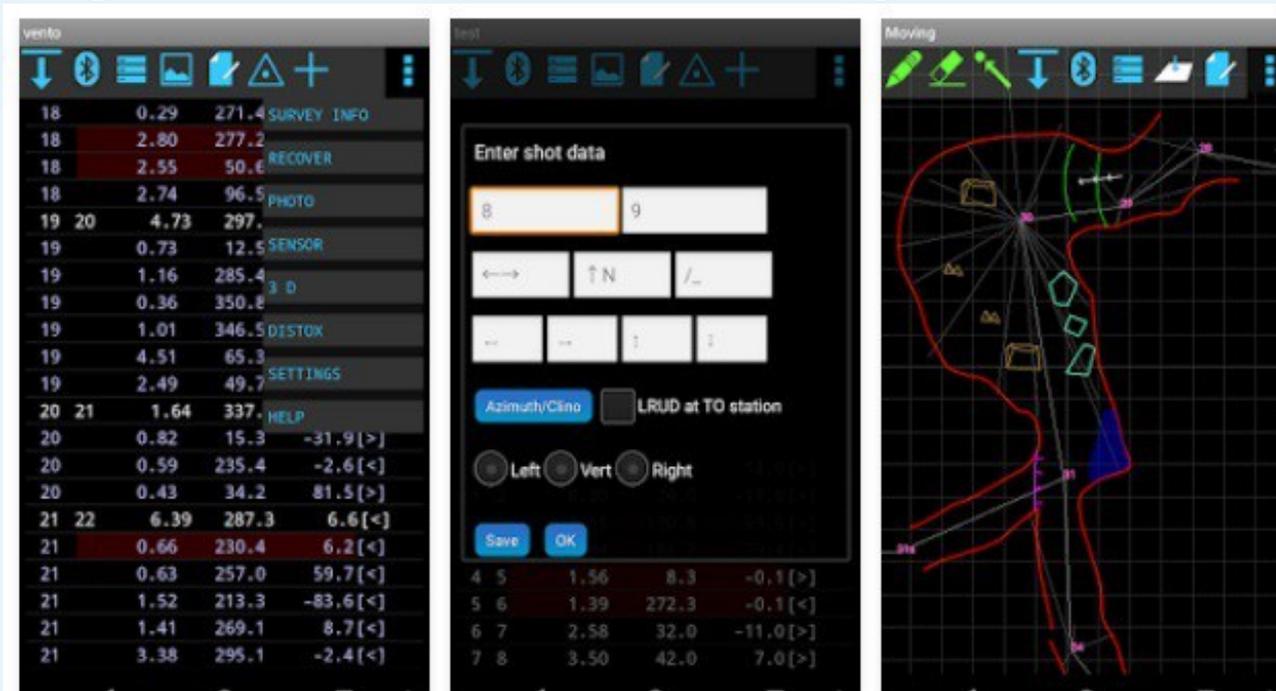


The 56 shots needed for calibration can now be taken without targets, hand-holding, or a tripod. The hardest part is waiting a few seconds prior to each shot for the DistoX readings to settle down.



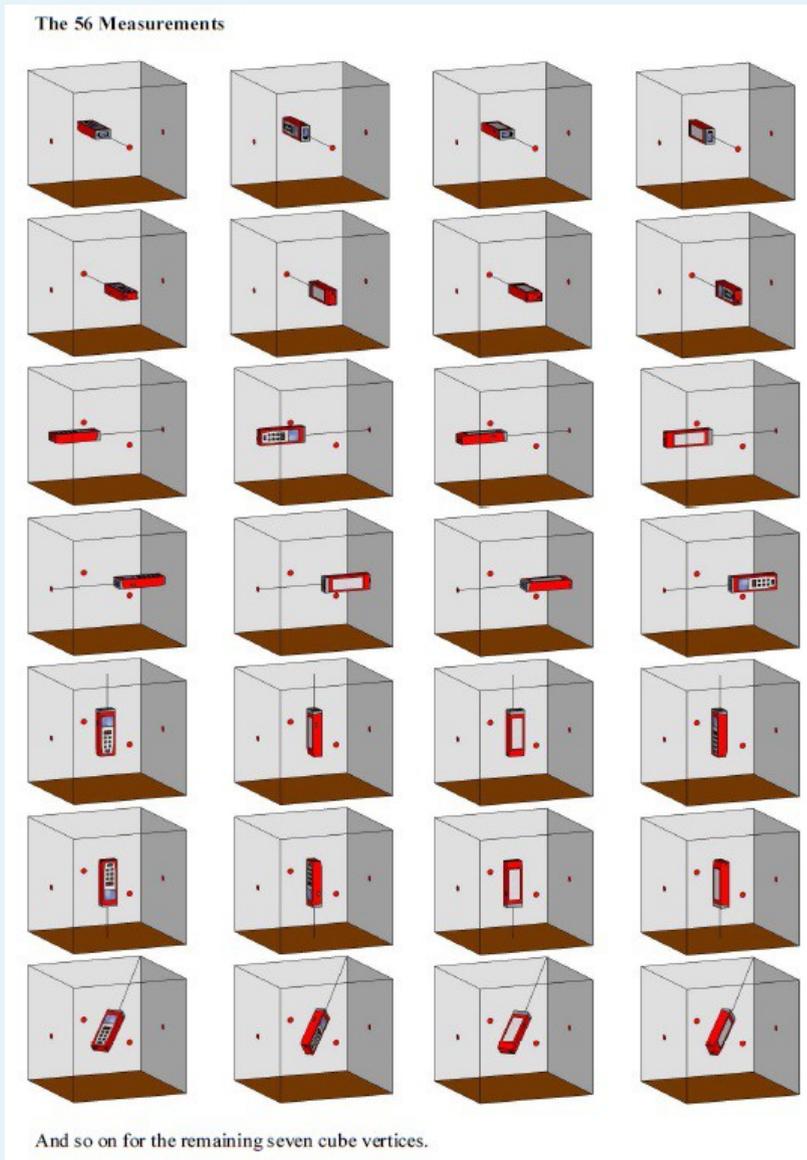
Soft ground and a tree for support works better.

I have found **TopoDroid** Cave survey software by Marco Corvi to be fairly easy to use. It is free on *Google Play* and runs on nearly any Android device. It includes firmware updates (V2.5) for the DistoX2 along with the calibration routines. I chose to break all of the data into groups of 4, rather than just the first 16 shots.

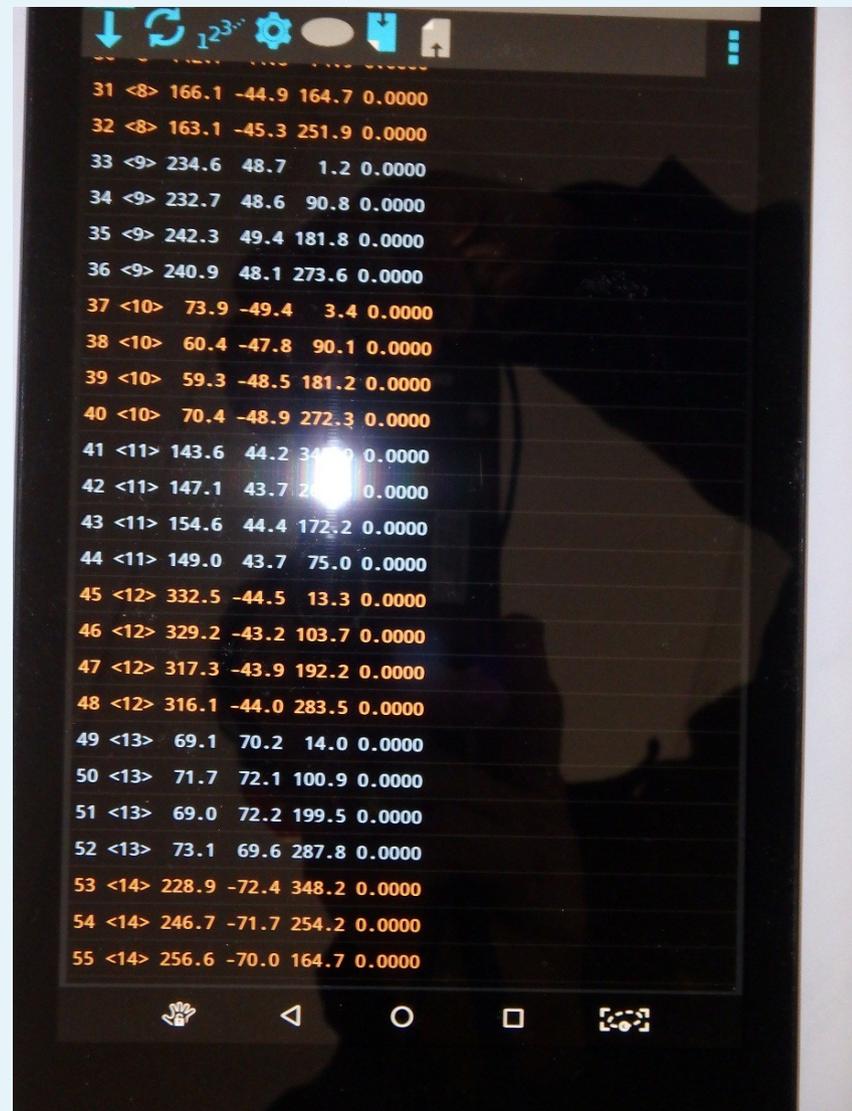


TopoDroid - Cave surveying on Android

The suggested groups-of-4 shots (4 roll orientations in exactly the same direction), in no particular order.



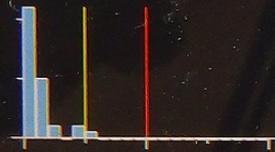
The data are transferred to the Tablet and marked in groups of 4. This is a DistoX2.



The calibration coefficients are computed & uploaded to the DistoX2. Here the average error is 0.1 degree.

### Calibration coefficients

bG	0.0007	-0.0039	0.0025
aGx	0.9821	-0.0111	0.0157
aGy	-0.0207	0.9753	0.0013
aGz	0.0248	0.0013	0.9978
bM	0.0449	0.0500	-0.0182
aMx	1.2143	-0.0001	0.0117
aMy	0.0023	1.2811	0.0072
aMz	-0.0077	-0.0052	1.2345
nL	-0.0025	-0.0068	0.0132



Average error: 0.1058 degrees

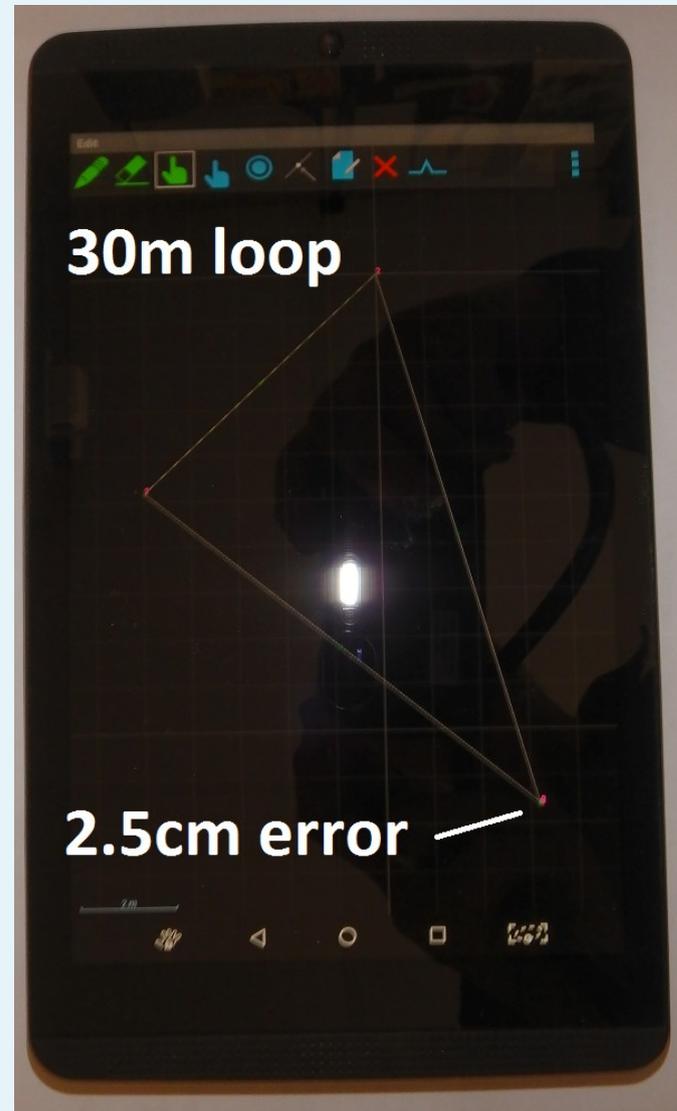
Error stddev: 0.0986 degrees

Max. error: 0.5447 degrees

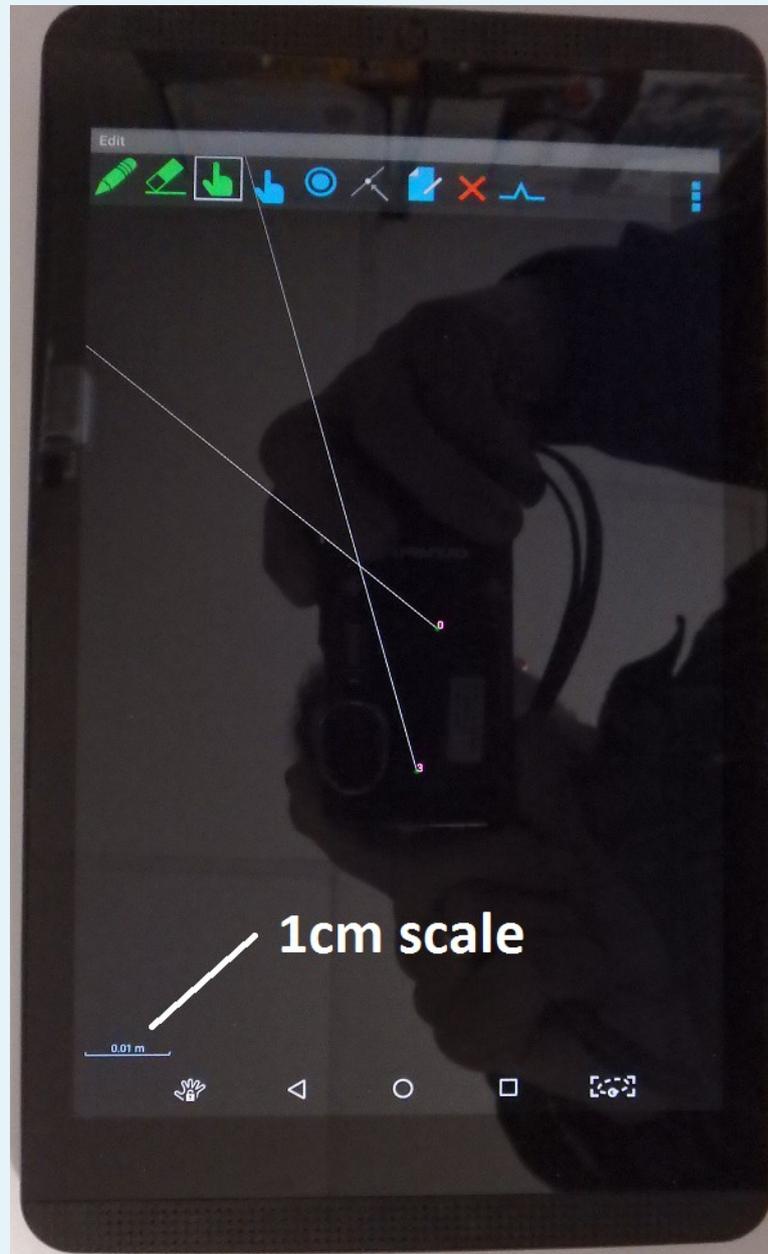
Iterations: 27

Upload

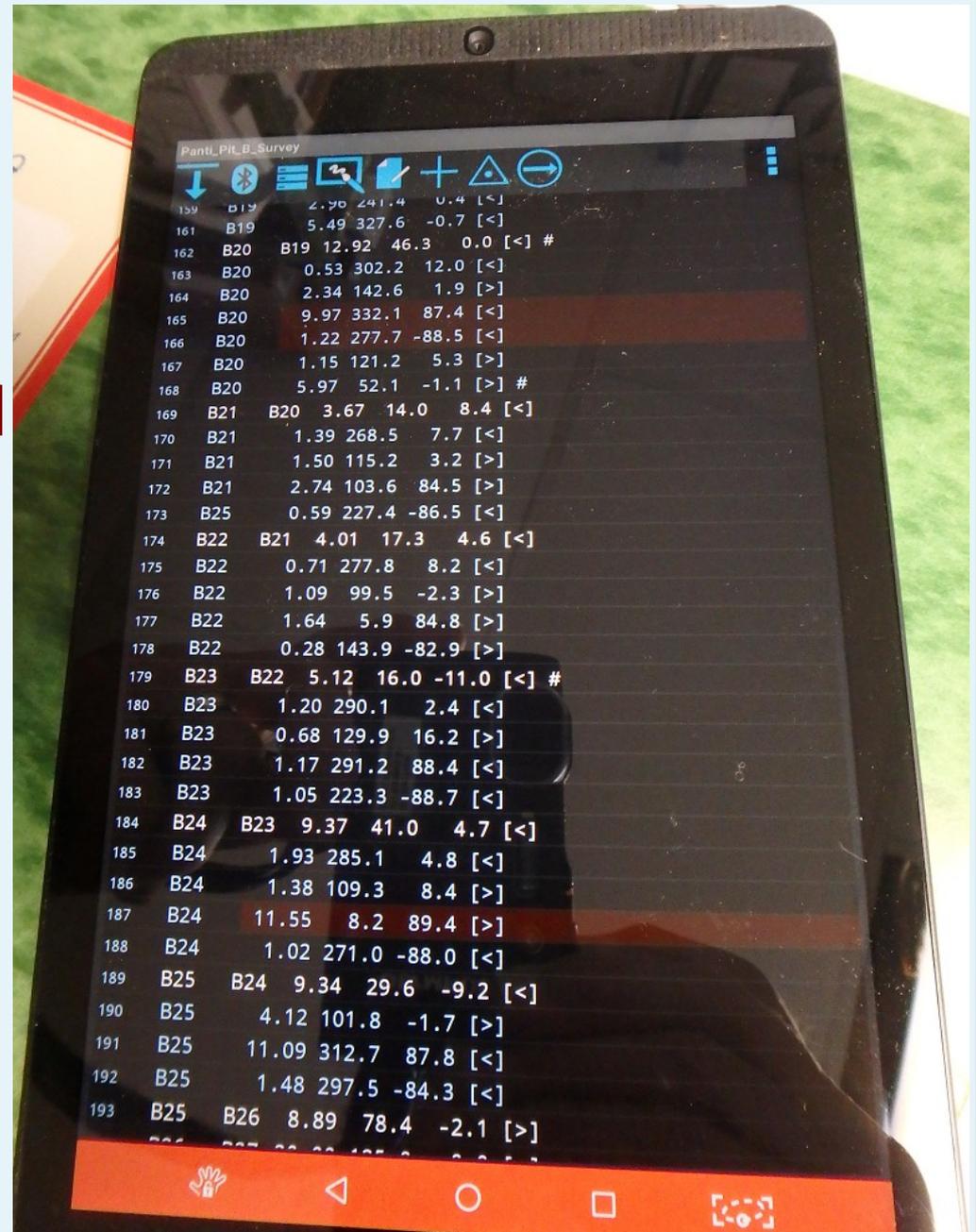
After calibration, a typical horizontal closure error in a 30 meter (100 foot) triangular loop is  $<2.5\text{cm}$  (1 inch).



~2cm Loop error zoomed-in



**TopoDroid** has some remarkable features to help avoid surveying errors. It will detect when you have done an accurate backsight, and it monitors the dip angle and strength of the Earth's magnetic field to spot and flag shots where there is a magnetic anomaly, which it marks in red, as shown here.



I found the NVIDIA **Shield** K1 8" Android tablet to work particularly well for sketching due to its DirectStylus2 technology. It has a super-sensitive touch screen plus a fast processor & graphics intended for video games. Note: Another option, not explored, are recent Samsung Galaxy Note tablets with an active s-pen fine-tip stylus.

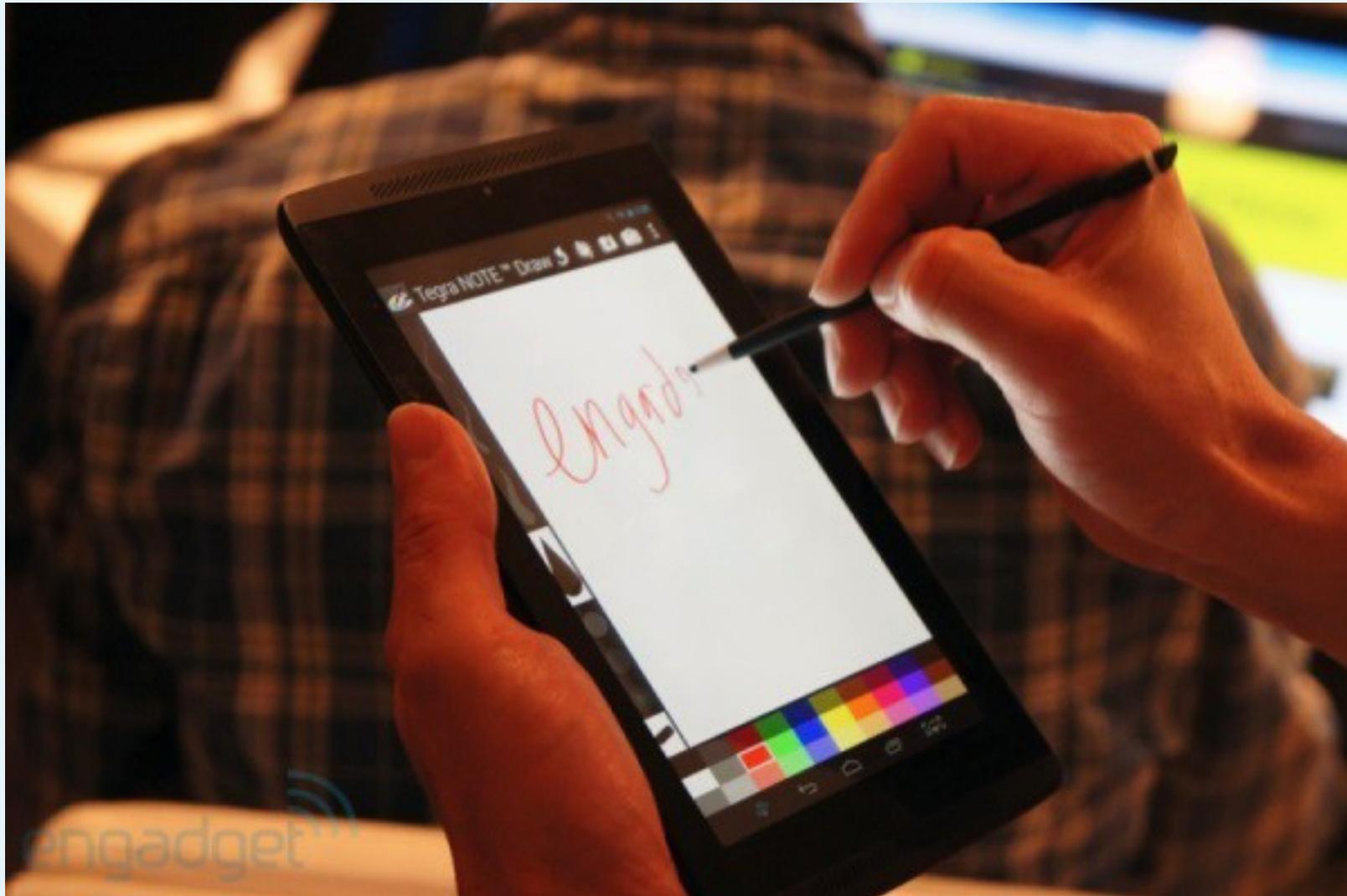


It is possible to sketch on the **Shield** using an ordinary #2 wood pencil, but a solid graphite pencil works best. This pencil will work through a waterproof pouch. In one mode it is possible to sketch with your hand resting on the screen! (Finger touch is shut off). The original rubber-tipped stylus is too fragile for cave use.



**Solid Graphite Drawing Pencil**

I had initially bought an older HP Slate7 tablet which had the similar DirectStylus1 technology and a nice 7" size, but it was a disaster! A pox on the KitKat OS!



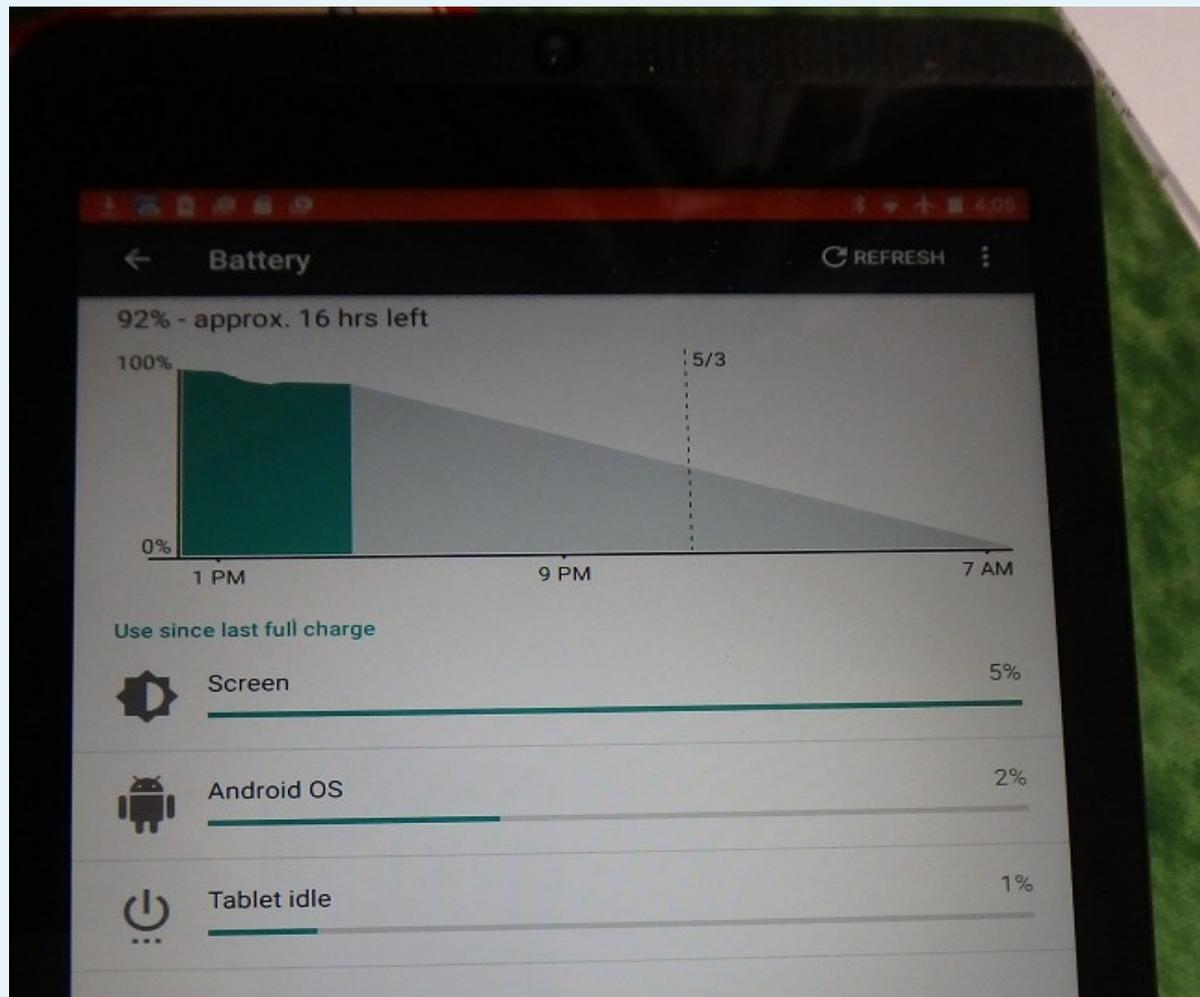
An alternative stylus that may (or may not!) work with your existing tablet or phone with a capacitive touch screen is the IOGEAR active small-tip stylus, which generates a  $\sim 6\text{kHz}$  square wave to a wire in the plastic tip. It is not waterproof as delivered.



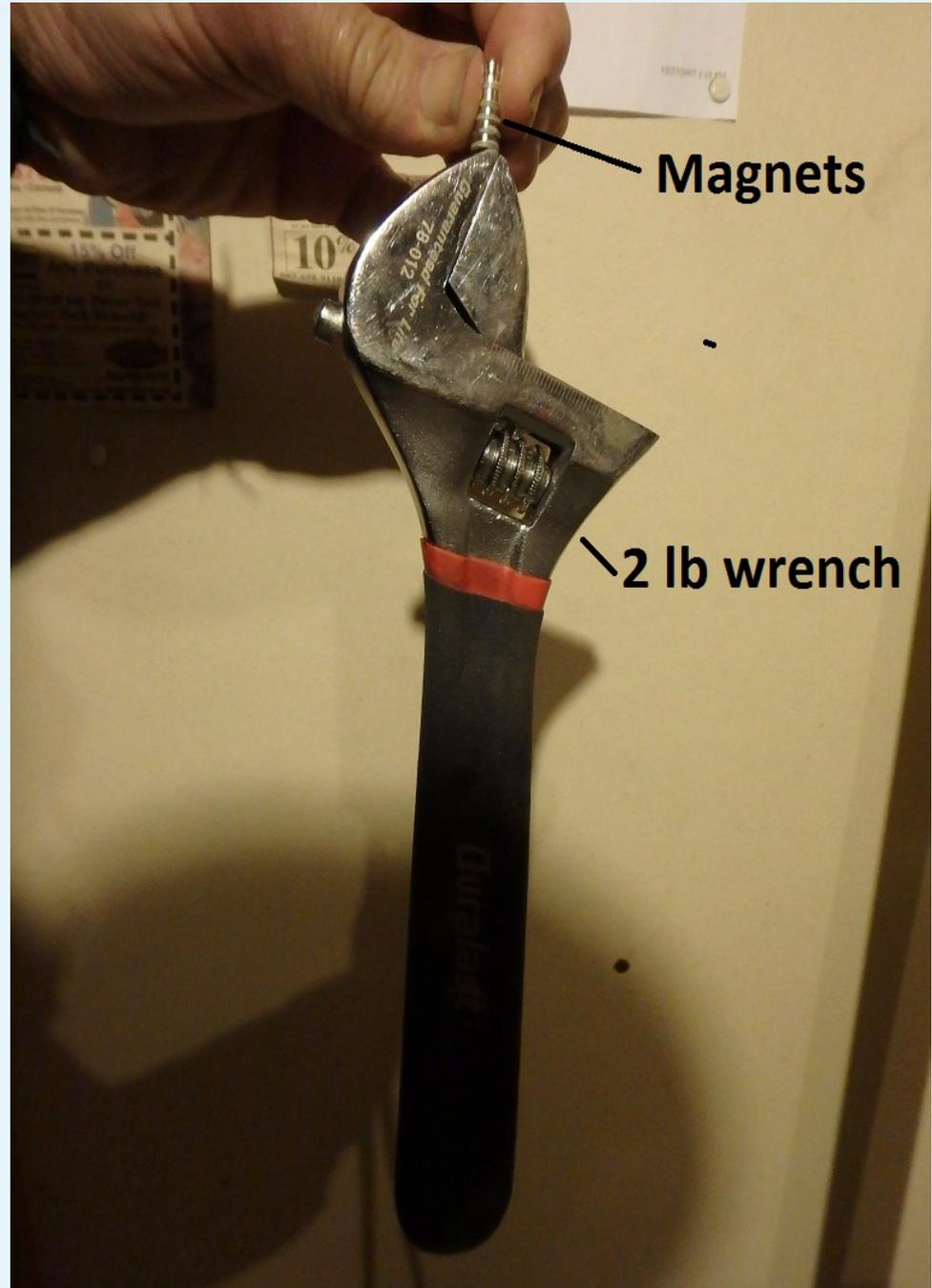
A flat external 5 Volt rechargeable battery pack such as the Motorola P4000 4AH unit will work with almost any phone or tablet (and the DistoX2) and will fit in the waterproof pouch.



For reasonable battery life, GPS and WiFi should be turned off in the cave. Sleep mode should be set for just a couple of minutes of inactivity, because the screen consumes most of the power.



Tablets such as the **Shield** have some drawbacks. The **Shield** contains 6 magnets that should be removed. The speaker magnets can still affect the DistoX. The **Shield** is too long to fit the nice Pelican 1055 hard case. Noise from the tablet charger can decrease touch screen sensitivity, especially with the **Shield**.



I calibrated my DistoX2 in Vermont (44.5 deg Lat), then measured a 2.2cm horizontal closure error on a 30 meter loop in Belize (17 deg Lat). The drastically different latitude did not appear to degrade accuracy.

This makes sense because the 3-axis magnetometer detects the horizontal direction of the magnetic field vector regardless of dip angle.

Traveling with the DistoX stored close to a tablet with those super-magnets still installed might have resulted in a different outcome!

The automatic screen brightness feature of your tablet may not function properly if the waterproof pouch hides the front camera, dimming the screen.



Backing up the survey data and sketches while in the cave may or may not be possible depending on your device and operating system, even if an external SD card is installed. The **Shield** with Android 5 or 6 works with a file manager app, but not Android 4.2.2



With **Topodroid**, you can export data and sketches in several formats, including the native TopoDroid files, all combined in a zip file for transfer to a PC or tablet.

## DATA FILES

Therion: .th

Compass: .dat

Walls: .srv, .wpg

Survex: .svg

Visual Topo: .tro

OziExplorer: .plt

Google Earth: .kml

PocketTopo: .top

3D with layers: .dxf

## SKETCHES

Therion: .th2

cSurvey: .csx

2D drawing with layers: .dxf

SVG drawing files: .svg

PNG sketch image: .png

Screen shots

## Native TopoDroid

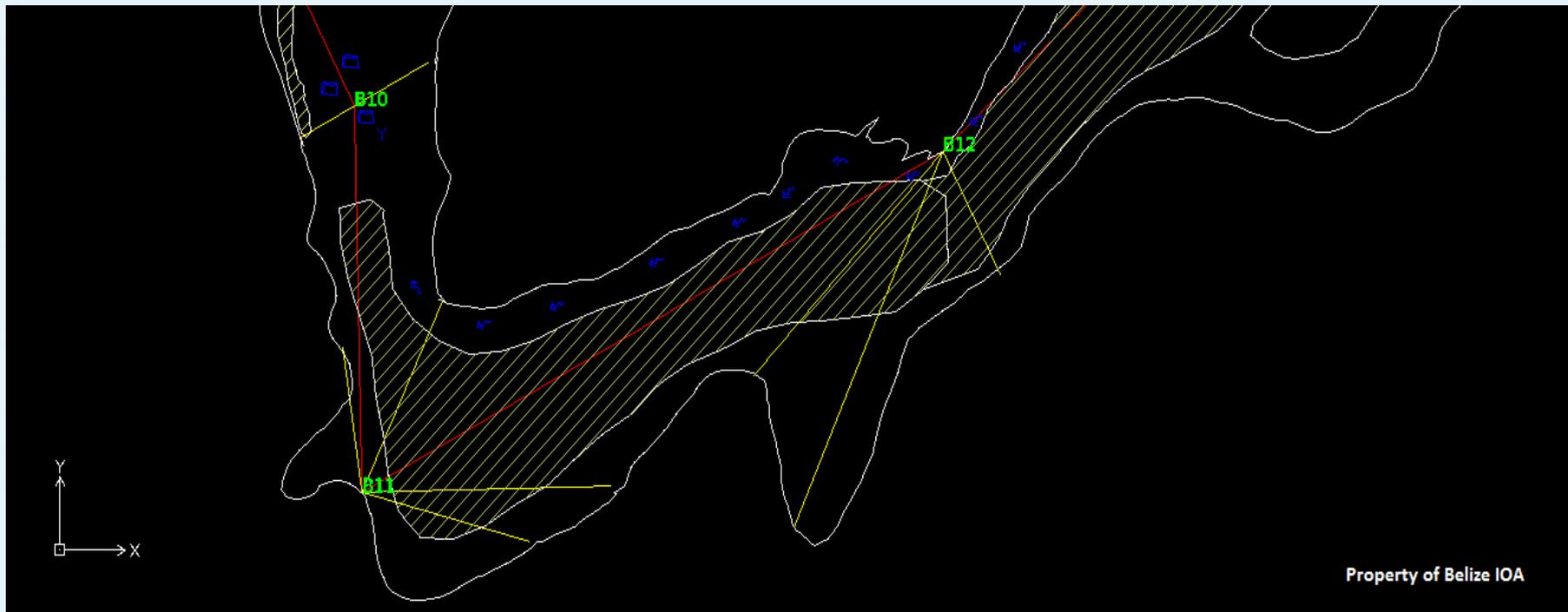
Cal & other data: device10.sqlite

All survey info: distox14.sqlite

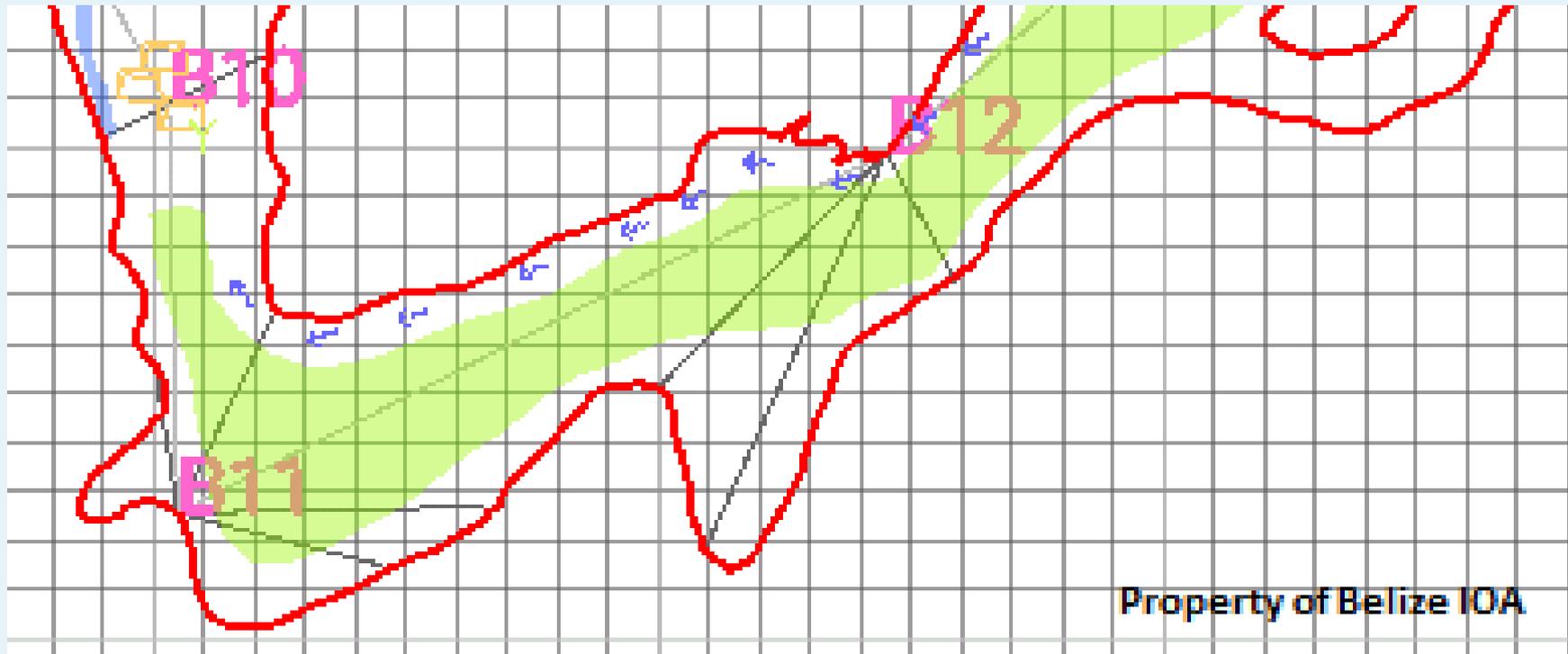
Some of the **TopoDroid** exported formats are works in progress.

**PocketTopo** is better in this respect.

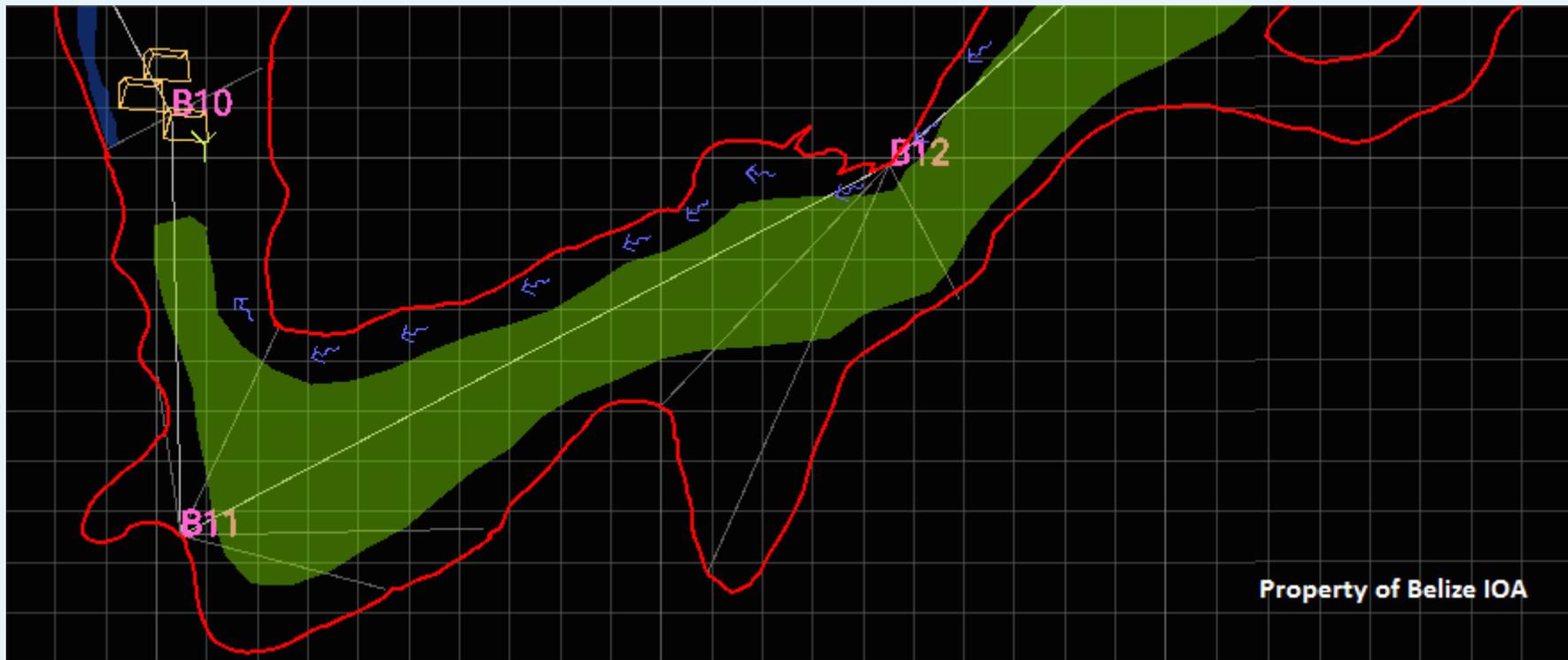
2D .dxf is vector graphics with some layers, but all freehand lines are the same white color.



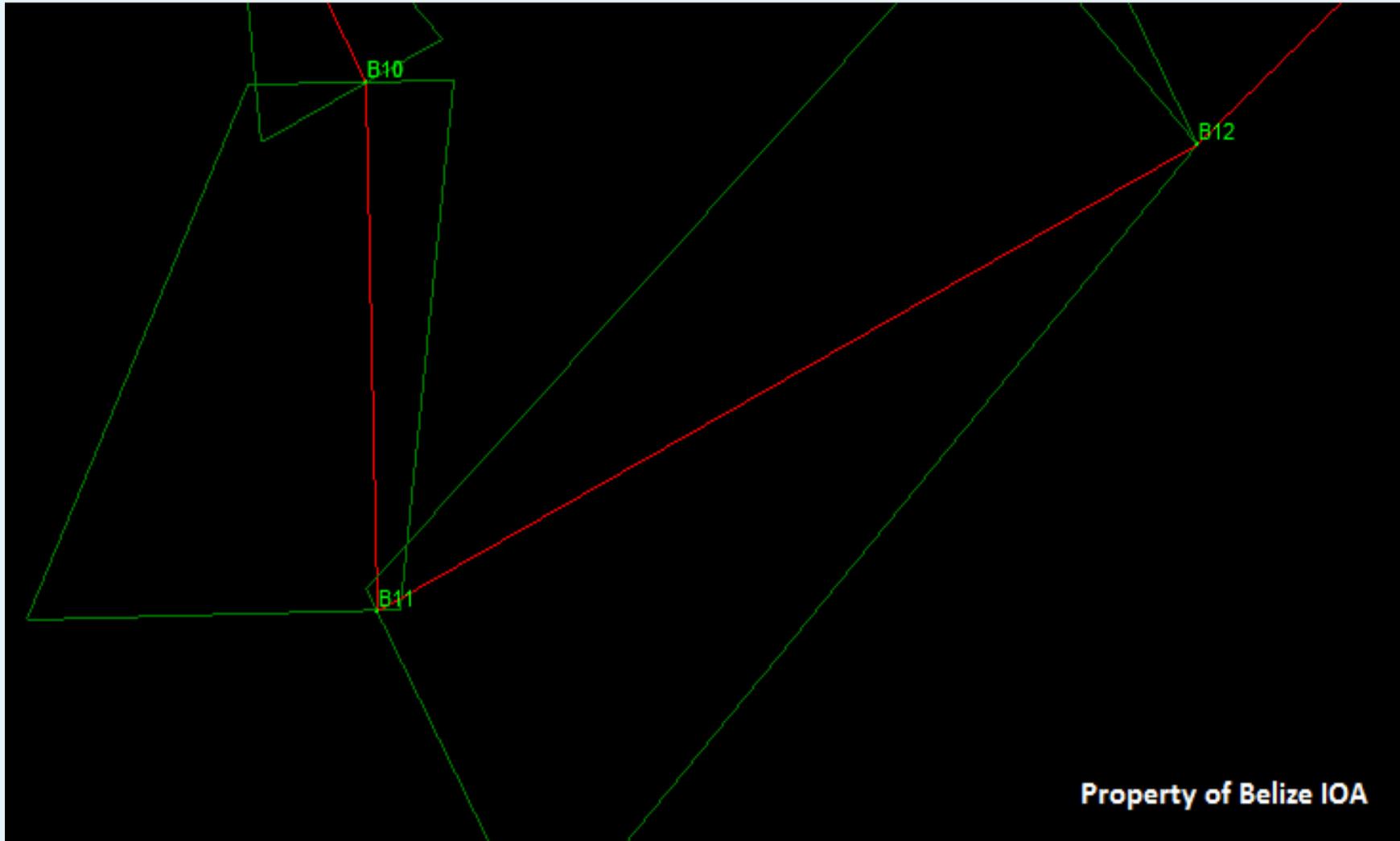
The .png output works, but has low resolution even when set as high as possible.



Screenshots of the actual **TopoDroid** sketch look great and could be opened in Compass Sketch Map Editor.



The Compass .dat file is correct  
(LRUD walls are shown)



Property of Belize IOA

**TopoDroid** will likely run on the Android phone in your pocket, so beg or borrow a DistoX and give Paperless Cave Surveying a try.

