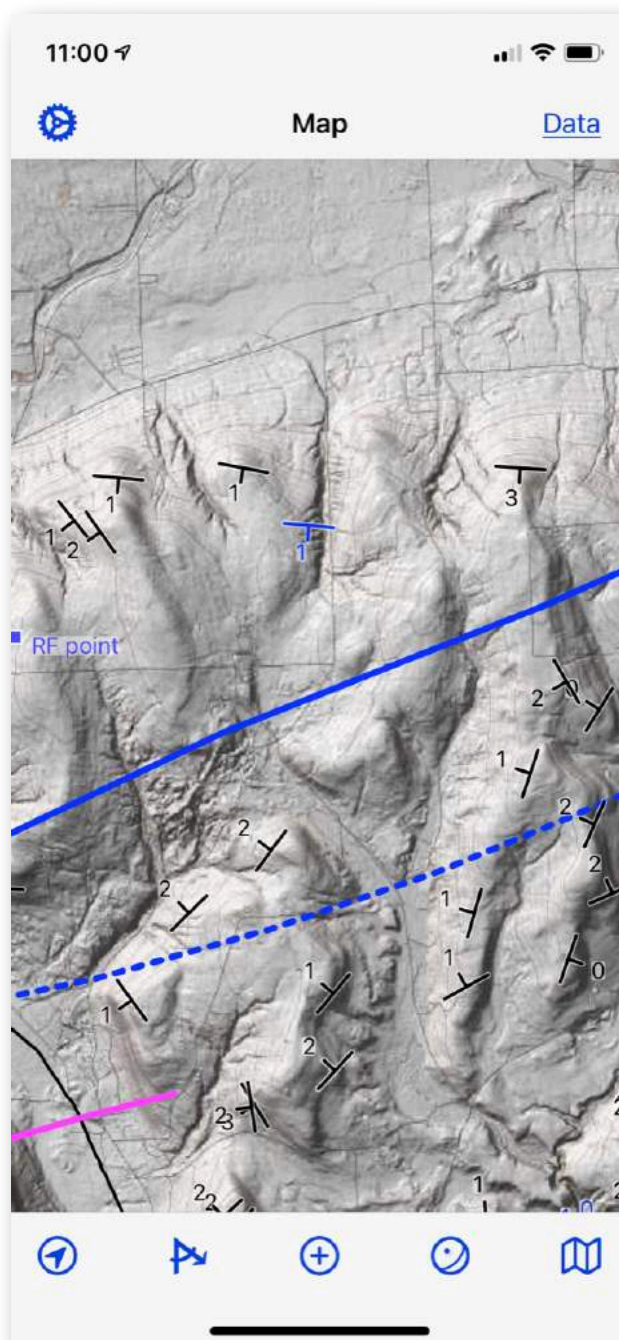


GMDE Lite for iPhone & iPad v. 2.3

by Richard W. Allmendinger © 2021



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Disclaimer

GMDE Lite is provided “as is” without any warranty, explicit or implicit. The author will not be liable for direct, indirect, incidental, or consequential damages resulting from any defect in this software or this user's manual, even if he has been previously been made aware of the defect. Furthermore, I make no systematic effort to inform all users of either bug fixes or upgrades. Recall that your iOS device is very sensitive to magnetic fields and the compass bearings can easily be off by 10-21°! Use this app at your own risk. This program should not be used as a sole source of navigation data. This program may not be sold or offered as an inducement to buy any other product.

Introduction

GMDE Lite is a companion program to my GMDE Mobile program and has been designed with small phone-sized screens in mind although it also works equally well on iPads. The basic idea is to borrow the best from both GMDE Mobile and Stereonet Mobile and present that functionality in a clean, simple, map-centric interface. The idea is that many users will use GMDE Lite as a more convenient satellite program to GMDE Mobile or Desktop. Both Mobile and Lite now use the same database format for data storage and GMDE Desktop can also read and write that database format.

Things GMDE Lite CAN do

- Set a point of interest (POI) at your current location or anywhere on the map which is immediately tagged with location time and date and to which you can attach a photo and an extended description
- Enter an orientation by any of three methods: (1) using the device orientation, (2) tapping three points on the map and having the device calculate the orientation, or (3) type typing in the orientation at the location that you specify.
- Enter contacts by recording a GPS track, dragging a path on the screen with your finger or pointing device (e.g., Apple Pencil), or by projecting an orientation. You can edit contacts by lassoing and deleting vertices or by tapping and dragging on individual vertices.
- Read in and display POIs, orientations, and contacts on the map data from Stereonet Mobile, GMDE Mobile, or GMDE Desktop.

- Use the device camera/orientation as a rangefinder and plot a point of interest at the sighted location. Rapidly use the rangefinder to determine azimuth, inclination, slope, horizontal, and vertical distance to the sighted location.
- Display orientation data on an equal area, lower hemisphere projection which can be filtered by data type. Mean vectors, cylindrical best fits, poles to planes, and rose diagrams can be displayed in this Stereonet Screen.
- Plot topographic profiles along contacts, recorded or dragged paths, or along a straight line.
- Upload or download data from your StraboSpot account, assuming your project was initially defined as using the StraboSpot lexicon.
- If you have a data connection, GMDE Lite can display a subset of your data closest to you on Apple Maps within the program.
- Use a variety of icons and colors to represent different types of data.
- Access all of your data on your device from, and upload to and download from, the Files app on the device. From the Files app, data can be sent to other programs.

Things GMDE Lite CANNOT do

- While you can draw and save contacts within the program, you probably do not want to do so, at least on an iPhone. The iPhone screen is too small and the finger too clumsy a pointing device to draw contacts accurately. Plotting contacts on an iPad with Apple Pencil in GMDE Lite works splendidly.
- There are a variety of advanced orientation calculations that can be done in Stereonet Mobile but cannot be done in GMDE Lite. However, you can copy and paste between Stereonet Mobile and GMDE Lite to carry out those calculations.
- GMDE Lite has more limited data filtering capabilities than either GMDE Mobile or Stereonet Mobile.

Skills you need to take full advantage of GMDE Lite

- Produce base maps from whatever source you want in MBTiles format. Because you are producing your own base maps you can use whatever you want (existing geologic maps, USGS Topo Maps, LiDAR hill shade images, etc.) and not just the few option available from online mapping companies. See the appendix regarding how to produce MBTiles files.

- Download and format digital elevation models (DEMs) in GridFloat format. Having a DEM on the device is what allows GMDE Lite to perform its magic, whether calculating an orientation from three points or acting as a pretty accurate rangefinder. See the appendix for more information about producing DEMs.
- Know enough about your digital devices to understand how to move files onto or off the device from/to your desktop computer. Apple provides a variety of technologies, especially if you use a Mac desktop computer. If you use a Windows computer with your iPhone, you will probably use iCloud on the web, or install Apple's iCloud software on your PC to move the files around.

The Map Screen

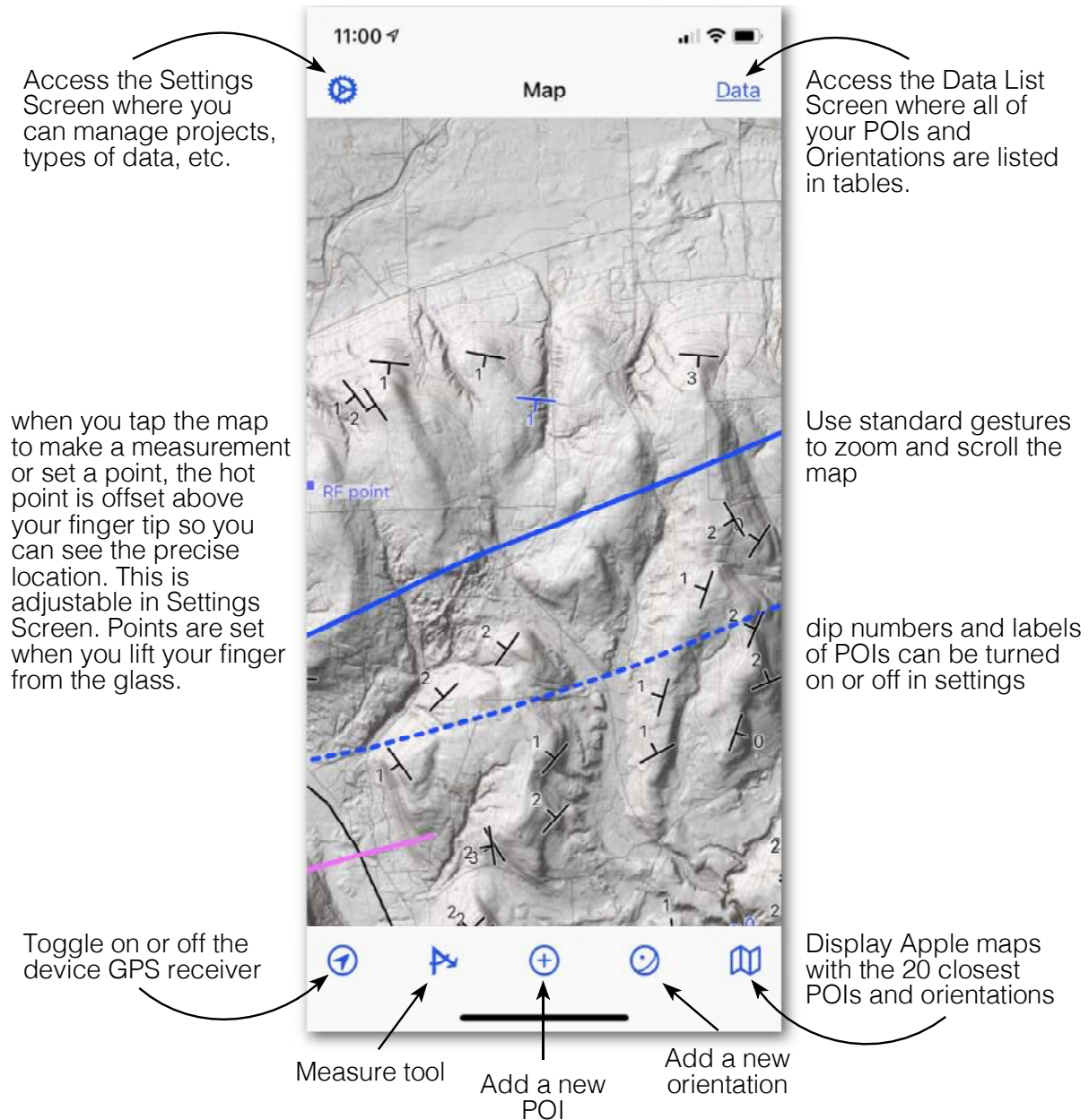


FIGURE 1. THE MAP SCREEN

The “home” view of GMDE Lite is the Map Screen. If you have not entered a base map in MBTiles format, you can still turn on the Apple Maps view and collect data but the display is very limited. You manage items related to the entire project with the buttons at the top of the view. The toolbar at the bottom enables entering data and measuring

things. While a toolbar button is active, it is displayed as solid whereas its normal appearance is in outline as you see in Figure 1.

GPS Button

Tapping the GPS button will display the users current position and elevation in a bar at the top of the map. That location will also show the accuracy which will improve for a few minutes after turning it on. Leaving your device GPS running for a long time will rapidly deplete your battery so get in the habit of turning it off after making your measurement. The three central buttons display message boxes giving you options before proceeding.

Measure Button

The Measure Tool gives you access to a variety of functions. For **Get Location**, **Measure Distance**, or **Draw Path**, after making your selection you will tap and hold your finger down on the glass. A target icon will appear above your finger and the latitude and longitude will be displayed for the point under the target (not under your finger!). As you move your finger around on the glass, the location will change.

To **Measure Distance** and slope, tap, drag and then release your finger when the target is over the point where you want your measurement to start. Tap again and a red line will be drawn between the first point and the current position of the target. The distance and slope will be displayed at the top of the screen. When you lift your finger, a message box will appear with the final results and giving you the option of seeing a topo profile along the line that you just drew.

You can draw an arbitrary path on the map by selecting **Draw Path**. Just tap and drag your finger or other pointing device such as an Apple Pencil on the map. The length will be reported interactively. When you lift your finger off the screen, a message box will appear with the final length and giving you

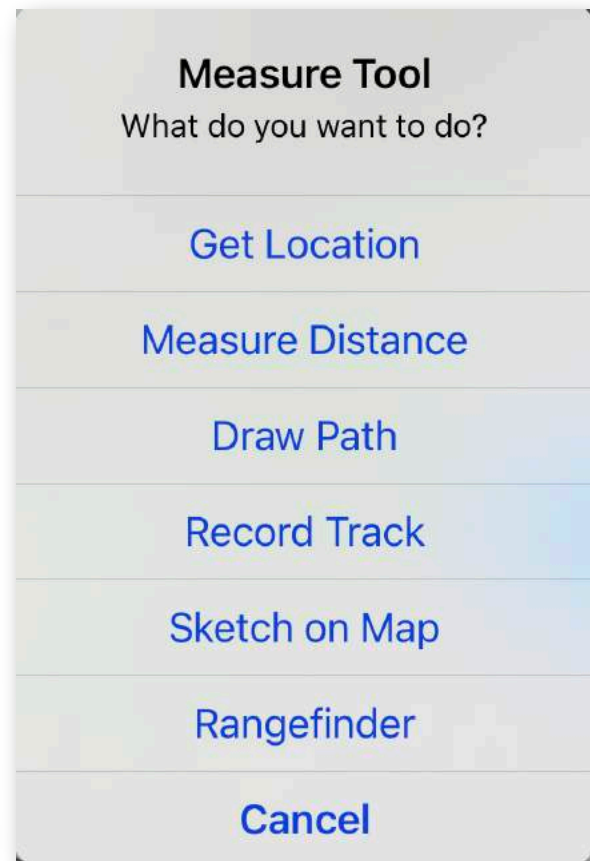


FIGURE 2. MEASURE TOOL MESSAGE BOX

the option to save the dragged path as a contact or see a topo profile along the path the you dragged. If you want to do both, first save the contact and then tap the Profile button in the [Contact Details](#) screen. *If you just tap Show Profile, you will see the profile BUT the path will NOT be saved!*

The **Record Track** button will enable you to use your device's GPS receiver to continuously record your position as you walk along. Some people call this collecting digital breadcrumbs. You might want to record a track if you were walking out a contact or digitizing a trail that you want to be able to follow again at a different time. Recording a track will automatically turn on your GPS receiver, but you will get a better result if you turn on the GPS receiver first and let the position error diminish for a few moments before tapping the Measure Tool and selecting Record Track. While recording a track, the measure tool icon on the toolbar will flash, reminding you that track recording is going on. ***Note that track recording prevents your device from going to sleep and runs the GPS receiver continuously, both of which can deplete your device battery very quickly if left on for a long time.***

To stop recording a track, tap the measure tool again. A message box will appear with the final length of the track and giving you the option to save the track as a contact or see a topo profile along the path the you just walked. Saving the contact will take you to the [Contact Details](#) screen where you can give the track a more descriptive name, change its type attribute, etc. If you want to save and contact and see the profile, first save the contact and then tap the Profile button in the [Contact Details](#) screen.

The **Sketch on Map** button will enable you to make an impromptu, temporary sketch on the map, a great way to illustrate a point to students or show your tentative ideas or plans to other members of your field party. You turn off sketching mode by tapping the Measure Button on the toolbar again.

The **Rangefinder** allows you to sight through the device camera and, using the device orientation and DEM, it calculates the azimuth, inclination, and distance to the position on the ground you are sighting. [The rangefinder is described in more detail later in this manual](#)

Add POI Button

To add a new Point of Interest (POI), tap this button and you will see the message box in Figure 3. Two options will always be present: to place the POI at your current location or where you tap the map. If you choose Current Location and the GPS is not already on, it will be turned on automatically and you will be taken to the POI Details screen. If you select Tap Map, the app will wait for you to set the position on the map before dis-

playing the screen. In the [POI Details screen](#), you will have several options for adding photos and sending POI details to someone else as described [later in the manual](#).

GMDE Lite also scans the system pasteboard to see if there is location text on it and, if so, offers you a third option: to add from the clipboard. *iOS warns you that the app is accessing the pasteboard with the brief message that you see at the top of Figure 3.* The Clipboard option is convenient if you are working with someone else and you would like to quickly exchange the location and text of a POI. The first person would use the email function in the POI Details Screen to email the POI to their field partner. The field partner would open the email, copy the text in the mail program, then switch to GMDE Lite where they would tap the new POI tool then tap “From Clipboard”, creating a new POI with the same text. Note that attached photos cannot be imported via the clipboard. However, the field partner can save the photo to their Photos library on the device and then, in the POI Details Screen, use the Import Photos button on the toolbar to add the photo from the email to the POI.

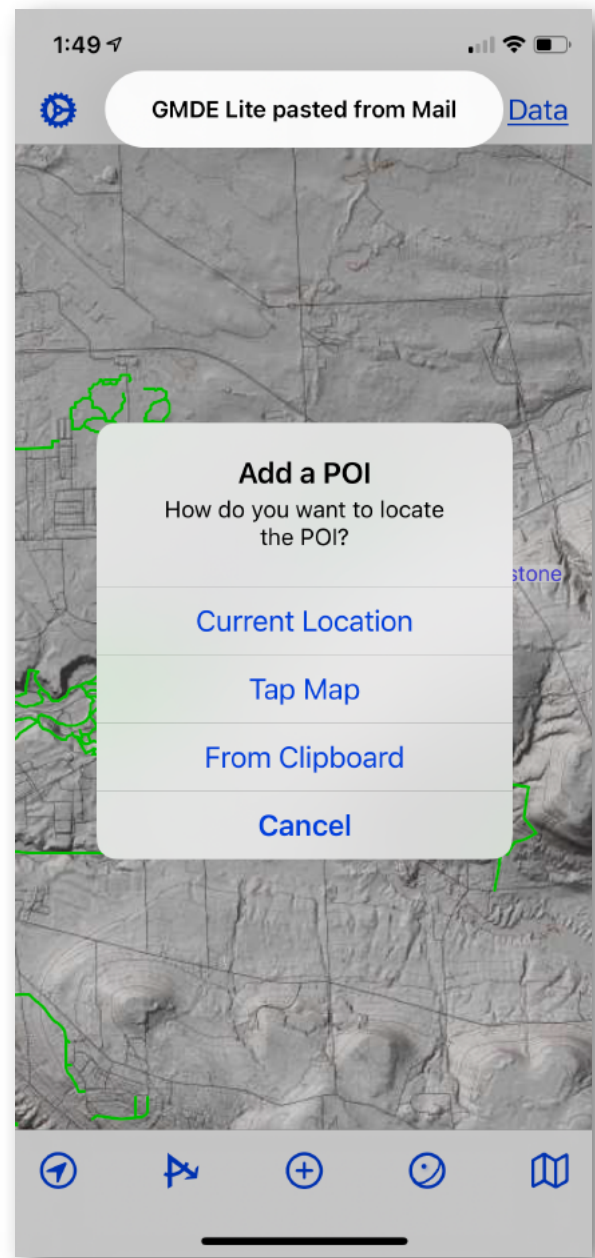


FIGURE 3. ADD POI MESSAGE BOX

Add Orientation Button

You have several different ways to enter orientations, but all begin with setting one (or more) locations on the map. Figure 4 shows your choices for setting locations.

If you want to set three points on a plane and have GMDE Lite calculate the orientation, use **Tap 3 Points**. The program will then wait for you to tap three different points. The point is set when you lift your finger off the glass, so you can tap and drag to position each point most accurately. An open circle will temporarily be displayed at each point for your convenience. When you tap and release to set the third point, the strike and

dip will be calculated and the Orientation Details screen displayed where you can enter additional information automatically. Note that the strike and dip symbol and the orientation location is displayed at the position of the 2nd of the three points tapped.

Like the previous tool you can, alternatively, set the position for the orientation at your **current location** or at a position that you identify by tapping the map. Once the location is set, the Orientation Details Screen will be displayed, waiting for you to enter the data. In the Orientation Details Screen, you will have the option of using the device orientation to measure the strike and dip of a plane or trend and plunge of a line as described later in this manual.

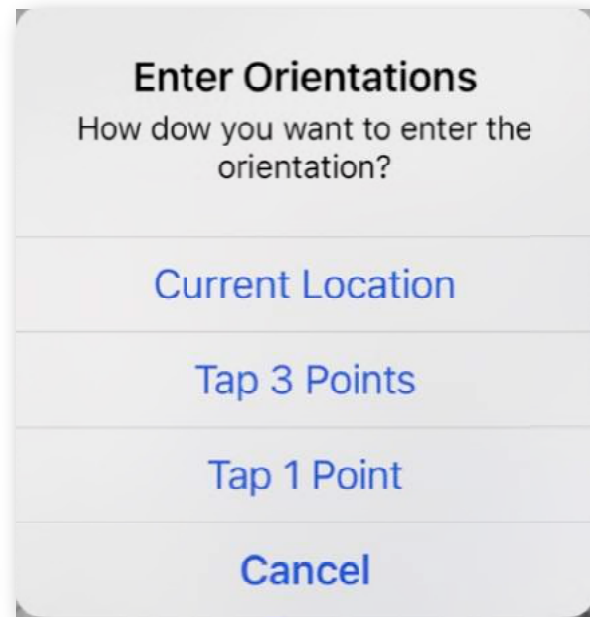


FIGURE 4. ADD ORIENTATION MESSAGE BOX

Display Apple Maps™ Button

The Apple Maps button will display Apple Maps for your region if you have a cellular or wireless data connection. ***If you have a data limit, be aware that displaying the maps image will consume some of your data allocation and could cost you significant money in foreign countries!*** Apple Maps display is included for your convenience in navigation and to give you an alternative view. ***It is not intended nor will it function well as your primary base map!***

The Apple Maps display has a button to allow you to switch between road, satellite, and hybrid views and will display your position if the GPS receiver is turned on with the GPS Button. The display will also include icons for the ten POIs nearest to you and strike and dip (or lineation) symbols for the ten nearest orientations. You can tap an icon or symbol in the maps display and the details screen will be displayed.

Limitations with the Apple Maps Display

As stated above, the maps display is not meant to be your primary base map and is mostly included for your convenience. Please note the following limitations:

- Although, you can rotate the map with your fingers, the orientation symbols DO NOT rotate and thus are only accurate when the map has north at the top of the screen!
- You can add POIs or Orientations while the Apple Maps display is showing, but you can only do so at your current location.
- Symbols do not show up on the map until after you close and reopen the display.
- The measure tool is disabled and non-functional while Apple Maps is showing.

Data Button

The Data button in the upper right corner of the screen shows the Data List Screen where you will find all of your POIs and Orientations listed in tabular form. From that screen, you can access the details of any observation or orientation or delete them by swiping left. It also provides access to additional import, and display functions as described in the section on the Data List Screen.

Settings Button

The Settings Screen is the nerve center for the app and is described in full, below.

Sketching on the Map

There are times when a field geologist just wants to make a quick sketch on the map: maybe they want to illustrate an interpretation for students on a field trip or perhaps they want to show other members of their field party where their traverse will take them or what they are currently thinking about the region. These sketches are commonly impromptu and ephemeral; they do not involve the careful, precise plotting that mapping

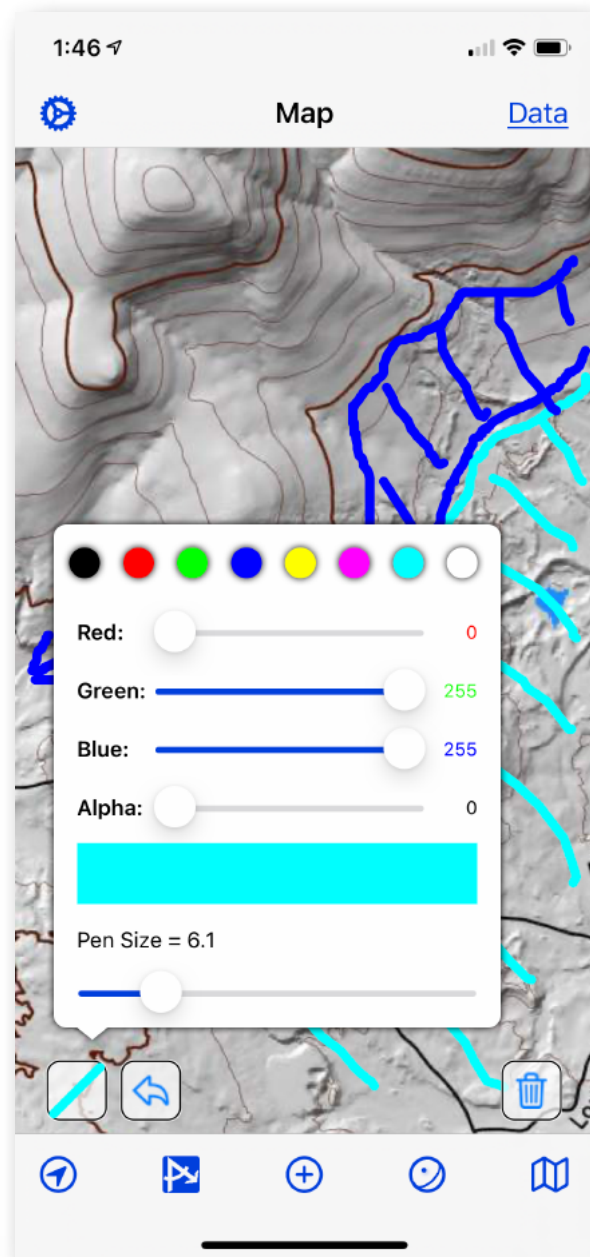


FIGURE 5. SKETCHING ON A MAP

contacts require. GMDE Lite enables quick temporary sketches on the map where the field geologist can easily select pen color, alpha channel transparency, and weight, and can just as quickly clear the map of these temporary sketches (Fig. 5). Needless to say, these sketches are easier to make and more accurate when the geologist is using an iPad with Apple Pencil but a finger on iPhone screen also works, albeit more crudely.

The user initiates sketching on the map by tapping the Measure Button on the Map Screen toolbar and then selecting Sketch on Map in the ensuing message box (Fig. 2). Three new buttons appear at the bottom of the map. The leftmost button brings up the Pen color, transparency, and size picker (Fig. 5) and the button immediately to the right undoes the last stroke on the map sketch. The trash can icon will erase the sketch completely but still leave you in sketching mode. While in sketching mode, any tap and drag on the map will produce a stroke in you sketch with the currently defined pen. You can change the pen characteristics at any time.

To leave sketching mode, tap the **Measure button** on the toolbar again and the sketching buttons will disappear and you will be back to normal mapping operations. Any sketch that you have made on the map will remain plotted on the map until either (a) you tap the trash can icon while in sketching mode, or (b) the system kicks GMDE Lite out of memory in order to make room for another program (or heaven forbid the app crashes). Map sketches cannot be saved, except by using the standard system button clicks for making a screen capture. Sketches are intended to be quick and ephemeral, otherwise you would plot a contact more carefully!

The Settings Screen

The Settings Screen (Fig. 6) is where you manage what happens in the app, both what is displayed and how you

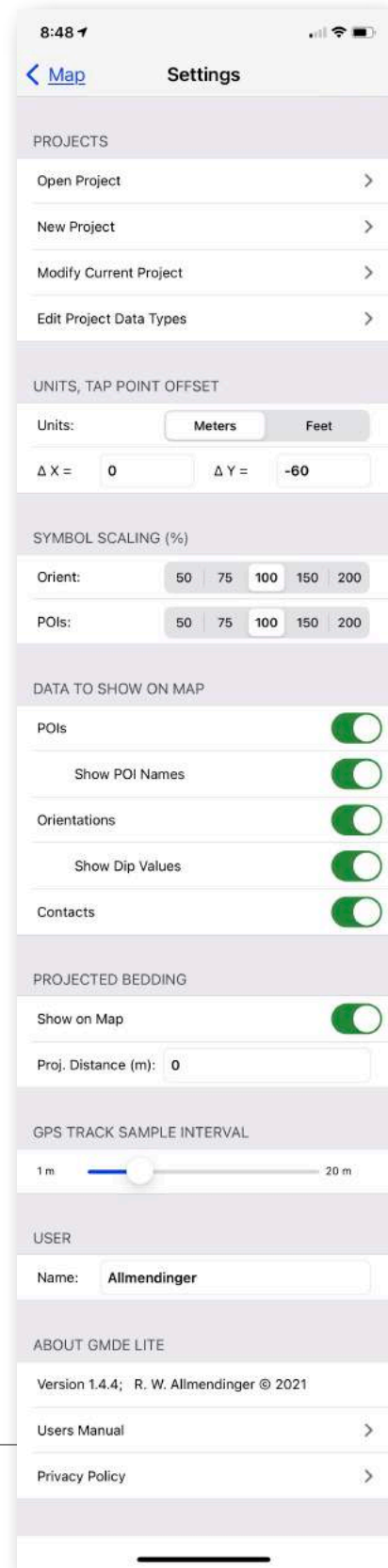


FIGURE 6. THE SETTINGS SCREEN

manage individual projects. Please see the section [“Setting Up and Managing Projects”](#) below for a description for the options available in the Projects section of the Settings Screen. Here, we will just address the subsequent options in the screen.

In the Units, Tap Point Offset section, you can set whether distances are displayed in feet or meters. This choice affect the display of both distances and elevations. Internally, all of your data and measurements are maintained in meters in the project database.

The ΔX and ΔY numbers define how far the target cursor is offset from the actual finger tap position. The target cursor is the location that is reported, not your finger position. The default setting is 60 pixels above the finger tap. Because screen coordinates are positive downwards on the screen, this is entered as a -60 . Above and to the left of the finger tap, as a right handed person might prefer, would be a $-X$ and $-Y$, whereas a lefty might prefer above and to the right ($+X$, $-Y$). If you are using an Apple Pencil on an iPad, you might want to set this to (0, 0).

You can set the relative size of symbols on the map in percent with the segmented buttons in the Symbol Scaling section. 100% is the default size. 200% for example would be twice the size of the default whereas 50% would be half size.

In the next section, Data to Show one Map, you can set what features you want the app to plot on the map on the map.

Each project database records the name of the geologist who collected the data. You set that name in the User section (and, no, “Allmendinger” is not the default 😊).

You toggle on or off entire categories of data in the Data to Show on Map section. Turning off or on individual types of data (e.g., show bedding but not cleavage) is managed in the “Edit project types” section.

The final section contains information about the app, including access to this manual.

Setting Up and Managing Projects

Your work in GMDE Lite is centered on projects and the data for those projects is stored within the GMDE Lite Document folder that you can access from the device's Files app. If you have several projects, you will probably want to store the data for each one inside a separate folder in the Documents folder. A single project is composed of the following files:

- An MBTiles base map file (or more than one with different types of base maps for the same area). When you set up a new project, this is typically the first file that you will identify.
- Three files for the digital elevation model (DEM). DEMs must be in Grid-Float format, which means 3 files, all with the same root name: (1) the binary elevation data is contained in the file with the suffix “.FLT” or “.flt”. (2) The DEM header information is contained in the “.hdr” file, and (3) the projection information is contained in the “.prj” file.
- A single SQLite database file, created by the program, that contains all of the data, photos, and symbol definitions in a single non-proprietary format file. This file can be imported into GMDE desktop and desktop can write a project file that GMDE Lite can use.

See “[Using the Files App to Move Data Around](#)” to learn about how to install files.

Starting a New Project

To begin a new project, open the [Settings Screen](#) and tap New Project in the Projects section. The New Projects Screen (Fig. 7) will appear. Give your project a name (required), geologist and description (optional), and then tap the **Base map** button. A file browser will appear showing the contents of the Documents folder for GMDE Lite. If you have moved all of the files for your project into a separate folder, tap the folder to open it. Once you have located the MBTiles file that you want to use as a base map, tap it and you will be returned to the New File Screen.



3:56

< [Settings](#) **New Project** [Save](#)

Name: my new project

Geologist: Allmendinger

Description:

This is an example of the new projects screen for the manual

[Base map:](#)

[DEM File:](#)

Your data for this project will be stored in the file: ProjectName.sqlite

If necessary, you can retrieve this file from the Files App>On My Phone>GMDE Lite Folder. SQLite files can be opened by many desktop programs, including GMDE Desktop, and can also be opened by the GMDE Mobile iPad app.

FIGURE 7. THE NEW PROJECT SCREEN

After you have selected the base map, follow the same procedure to identify the Grid-Float DEM. Tap the **DEM File** button. The file browser will only show the “.FLT” file(s) in the folder but the folder must also contain the .hdr and .prj files.

To finalize setting up the new project **tap the Save button in the upper right corner**. The project will not be saved unless you do so. By default, the project is saved in the same folder in which the MBTiles base map file is located. You can at a later point in the Files app move all of the project related files into a new or different folder in the GMDE Lite Documents folder. The next time you run GMDE Lite, the app will not find them automatically but you can simply use Open Project in the Projects Section of the Settings Screen.

You may then return to the map screen by using the Return (<Settings, <Map) buttons in the upper left corner and your map will be displayed ready for you to start making observations. Alternatively, you may wish to customize your data types as the start of the project...

Customizing Data Types

You can have several different types of points of interest and orientations (i.e., POIs or orientations with different attributes in GIS speak). GMDE Lite allows you to choose from unlimited colors and an array of symbols for different types. The app comes with its own built in types and you can modify their characteristics and, with a few exceptions, you can delete the ones that you don't want. For POIs, you cannot delete or rename the “Lith/Fm”, “General”, or “Photograph” types. For orientations, you cannot delete or rename the “Bedding” or “Lineation” type.

If you choose a type to delete, the app will ask you if you (a) just want to delete the type or (b) delete the type and all of the data as-

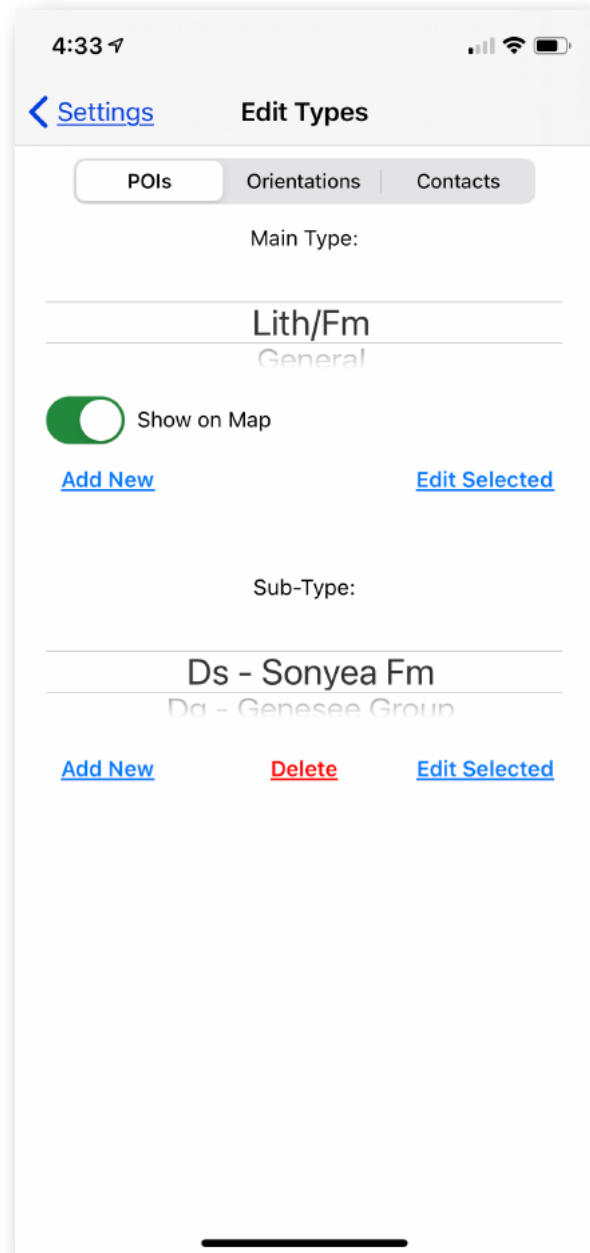


FIGURE 8. SELECTING WHICH POI DATA TYPES TO EDIT. SHOWING THE SPECIAL LITH/FM TYPE.

sociated with the type. If you choose (a) any data associated with the deleted type will automatically be assigned to the first type in the types list. Be very careful about choosing (b) because, not only will the type be deleted, but all of the data assigned to that type will immediately be deleted from the app and the project database. **There is no Undo for (b)!!**

You can define as many additional orientation or POI types as you want. All will be stored in the Project database.

The “Lith/Fm” type deserves special mention: this type gives you a set of subtypes that you can use to tag POIs with a specific lithology type that you define or with a specific formation name or abbreviation. You can define as many of these as you wish. For POIs that have been designated as “Lith/Fm” the symbols that are displayed are the different lith/fm symbols that you set up.

You access the data types editing interface by tapping Edit Project Types in the [Settings Screen](#). This brings up the Edit Types selector screen (Fig. 8). Notice that this is where you select which data types to display on the map and which to hide by toggling the **Show on Map** switch. Tap the **Add New** button to add a new data type or use the rotating spinner selector(s) to select the data type you want to edit and then tap the **Edit Selected** button. If the selected type is not one of the few protected types, you can also delete the type from this screen using the **Delete** button. You will be warned that deletion is permanent and giving you a chance to back away slowly!

Tapping either the **Add New** or **Edit Selected** buttons will display the screen in Figure 9. Here you can change the name of the type (unless protected) and for all types you can change the icon/symbol and color used

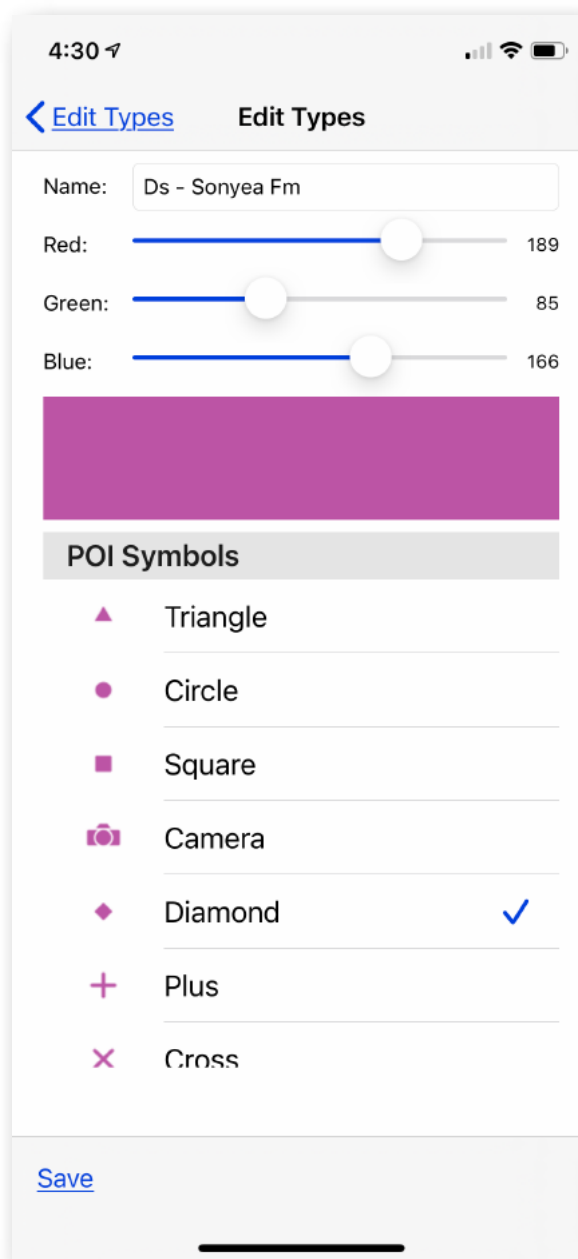


FIGURE 9. THE EDIT/ADD TYPE SCREEN.

on the map and in the [Data List Screen](#). Of course, if you are editing an orientation type, orientation symbols will be shown instead of that shown in Figure 9.

Be sure to tap the [Save](#) button before returning to previous screen or your changes will not be recorded! Data type definitions are saved in the project database and will be imported into GMDE desktop when you read a GMDE Lite project database into the desktop program.

Modifying a Project

The Modify Project Screen (Fig. 10) looks a lot like the New Projects screen but it has more buttons for managing an existing project. In this screen, you can change the name of the active project or switch base maps or DEM files.

You can import a different GMDE Lite data-base file, either one created by a different user of GMDE Lite or one generated by GMDE Desktop, from this screen. First, you must have moved the database file into the GMDE documents folder in the Files app. Then, tap the [Import Data](#) button to get the File browser screen within GMDE Lite. Select the database file to be imported and the app will read the database and import **ONLY** those data that are (a) inside the map area of the current project, and (b) do not already exist in the project. To accomplish (b), behind the scenes every datum is time stamped with the so-called Unix time stamp (the number of seconds since 1970) and each time you modify the observation the modified time stamp is changed. When you import a data file, you are first asked if you want to import the most recently modified datum or if you want to skip importing duplicates entirely. All imported data, including any photos, are incorporated into the current

The screenshot shows the 'Modify Project' screen in the GMDE Lite app. At the top, the status bar shows the time 3:47 and signal strength. The app bar has a back arrow, 'Settings', 'Modify Project', and a 'Save' button. The form contains the following fields and buttons:

- Name:** strabo test.sqlite
- Geologist:** Allmendinger
- Base map:** NAIP.mbtiles
- DEM File:** PokerPeakMosaic.flt
- Description:** (empty text area) [Import Data](#)
- StraboSpot:** Download | Upload
- Remove Data By Type** (red text)
- Close this Project** (blue text)

At the bottom, a note states: 'Your data for this project are stored in the file: strabo baby.sqlite'. Below this, it explains that SQLite files can be opened by many desktop programs, including GMDE Desktop, and can also be opened by the GMDE Mobile iPad app.

FIGURE 10. MODIFY PROJECT SCREEN

project database file immediately; you do not need to tap Save. Other changes that you make in this screen are temporary (i.e., are not recorded in the database) until/unless you choose **Save**.

You may import data of a type that you don't need in which case you can delete it with the **Remove Data by Type** button. ***This will allow you to remove all POIs, Contacts, or Orientations in one fell swoop so be careful!*** You might want to do this if you just imported a database file from the desktop but in fact have no need for the contacts in the database.

If you enabled the StraboSpot Lexicon when you set up your new project, you will see the StraboSpot upload and download buttons immediately beneath the description field. These are described in greater detail in the [StraboSpot Integration section](#).

The final button on this screen is the **Close this Project** button. Normally, you do not explicitly need to close a project because the app does so automatically and safely when you open a different one or create a new project. However, there may be times when you want to use the app with Apple Maps with no project active at all. This button will allow you to do that. It will completely save the current project, close it, and when you return to the Map Screen the Apple Maps display will be open. Now, however, would be a good time to [review the limitations of the Apple Maps display in GMDE Lite!](#)

This is a good time to bring up the...

RandomObservations.sqlite Database

You may want to make observations or measurements that are not attached to any project to begin with. GMDE Lite will allow you to do so and will show you the nearest of those observations in the Apple Maps display (be sure to read about the [limitations of the Apple Maps display](#)). Those observations are automatically stored in the RandomObservations.sqlite database at the root level of the GMDE Documents folder. If, at a later time, you do set up a project, you can [import](#) the RandomObservations.sqlite database file in Modify Project screen and incorporate those observations into your project.

In the RandomObservations.sqlite database gets too large or unwieldy, and you don't need the observations any more, you can delete the database completely and GMDE Lite will just create a new empty one the next time it runs. If you want to extract the observations from that database, just move or copy it to your desktop computer and open it in any of a number of freeware or commercial programs that can read .sqlite data-

bases. I use the excellent free, open source DB Browser for SQLite that can be downloaded for Mac, Windows, or Linux from <https://sqlitebrowser.org>.

Open a Different Project

At any time, you can open a different project by selecting Open Project from the Projects section of the Settings Screen.

GMDE Lite will safely close your current project before opening a different one. The project that you open can be inside a different folder and refer to completely different maps and DEMs than the current project or it can just be a different view of the same project area as the old project. When you tap the option, the built in file browser for GMDE Lite will appear.

POI Details Screen

When you tap on an existing POI or set the location for a new POI, the POI Details Screen opens (Fig. 11). The location, date and time are set for you and you can add a description and/or a photo. When adding a description, you can type it in or dictate it. If you are on an iPad with an Apple Pencil you can also just write the description with the pencil.

You can add a photo to the POI either by importing one from the Photos Library on the device or by tapping the Camera icon and taking the photo in the app. if you take a photo from the app, a copy of the photo is automatically placed in your Photos library and the original is stored in your project database. Under some conditions, the photograph may get rotated by 180° so a button is provided to turn the photo right side up if

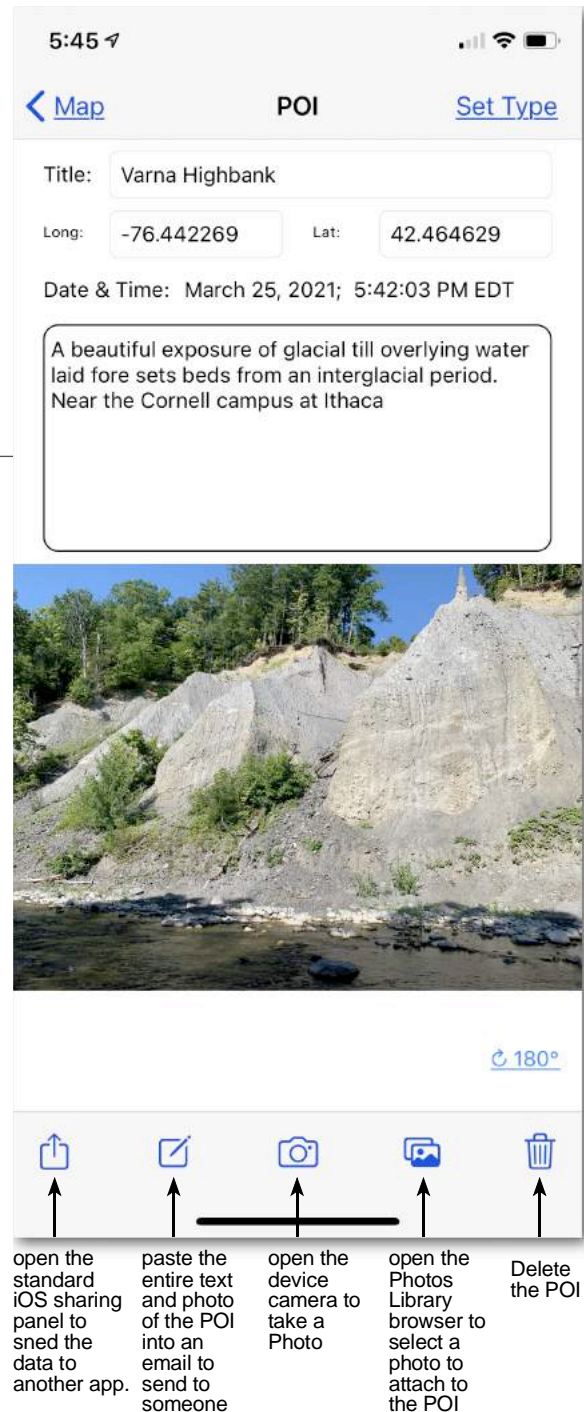


FIGURE 11. THE POI DETAILS SCREEN

this happens. **A POI can have only one photo assigned to it** and if you try to add a second, it will overwrite the first. Instead, add two POIs at the same spot, one for each photo.

You set the POI type by tapping the **Set Type** button in the upper right corner. A new model screen will slide up with a scrolling control allowing you to set your preferred type. You can name and add a new type from this screen as well, although if you don't like the default color and symbol, you will have to change them in the Edit Types screen. Your data type selection is recorded automatically when you close the view by swiping downward on it.

One of the most useful things about the POI Details screen is the ability to send the POI and any included photo as an email (Fig. 12). Imagine that you are doing field work someplace and come across an amazing outcrop that you want to share immediately with a colleague or maybe your thesis advisor. Just tap the email button (Fig. 11) and a new email will be prepared for you with the complete text of the POI plus the photograph. Because it is a regular email, you can add additional text as you wish. All you have to do is fill in the To: address, which should autocomplete if it is someone you mail regularly. If you have a cellular data connection the email will be in your colleague's inbox before you leave the outcrop! As described above, the receiving user can import an emailed POI by copying the text and then tapping the **Add POI button** on the Map Screen toolbar.

Finally, you can delete the POI by tapping the trash can icon. A message box will warn you that the action is permanent.

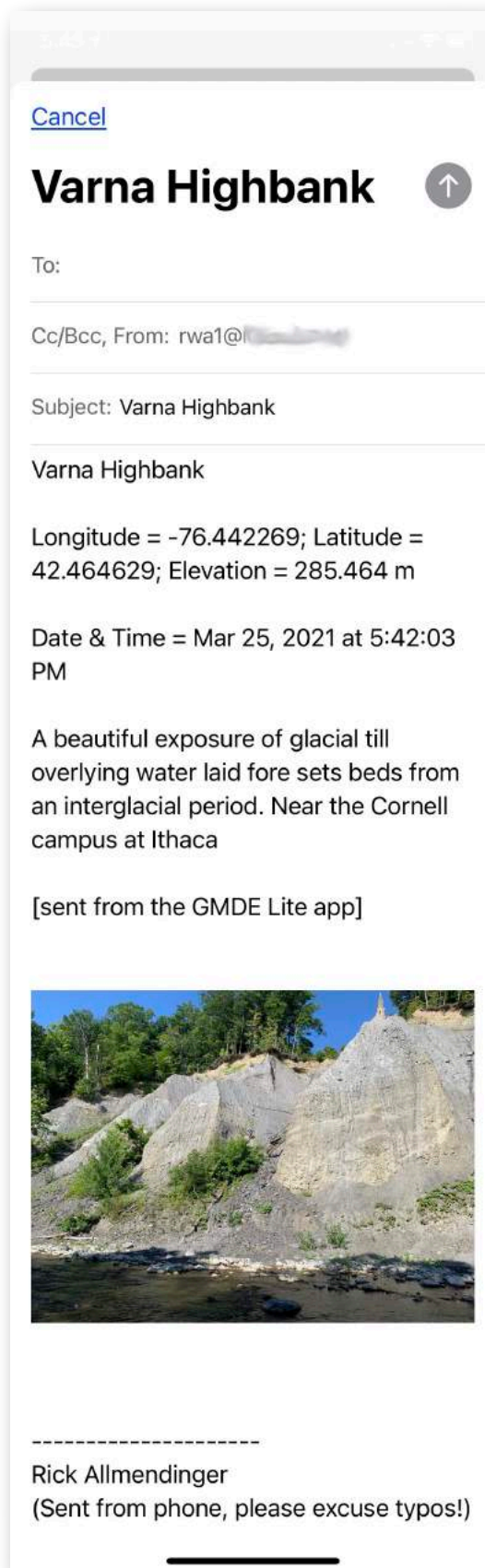




FIGURE 12. EMAILING A POI AND PHOTO

You may be wondering where the Save button is. There isn't one. ***The POI and any changes you make are automatically saved to the project database when you close the screen*** and return to the map view.

Annotating a Photo

Any photo that you have added to a POI can be viewed and annotated simply by tapping the photo thumbnail in the POI Details Screen. To zoom or pan the photo, use the usual pinch and tap and drag gestures.

Photo annotation works extremely well on an iPad with an Apple Pencil. On an iPhone, the finger is a pretty crude pointing device for accurate placement of lines, circles, etc.

To put the photo into annotation mode, tap the  button on the toolbar; it will turn solid to let you know that you are ready to annotate. While in annotation mode, you cannot zoom or pan the photo. The next tool button to the right brings up the pen color and size picker, shown in Figure 13. There are eight preset colors at the top, but you can use the RGB sliders to make any color you want. Additionally, you can set the alpha channel to determine the transparency of the pen stroke which can be useful for highlighting features without covering them up. An alpha of 0 is fully opaque and 255 is completely transparent. Your changes are reflected in real time in the stroke in the toolbar button. Any strokes you make while annotating the photo can be undone, one stroke at a time, with the  button as long as you have not saved the annotations; once you save, the annotations become a permanent part of the image.

The **Trash Can button** *will delete not just the annotations but the entire image (or sketch) so you are warned that the action cannot be undone*. To save the annotations as part of the image, tap the **Save Button**. After that, the annotations will no longer be editable. The **Close Button** closes the screen and returns you to the POI Details view. Any annotations you might have made will be lost if you did not tap the **Save Button** before closing the view.

Digital Sketching

If you do not have a photo attached to a POI, you can attach a freehand sketch simply by tapping the blank space below the notes box. A message box will appear asking if you want to enter a sketch. If you answer Yes, you will be taken to a blank screen with digital graph paper ruling (Fig. 14). The tools and buttons at the bottom are identical to those described in the [annotating photos section](#), above. Tapping the **Save Button** will save your sketch as part of the POI.

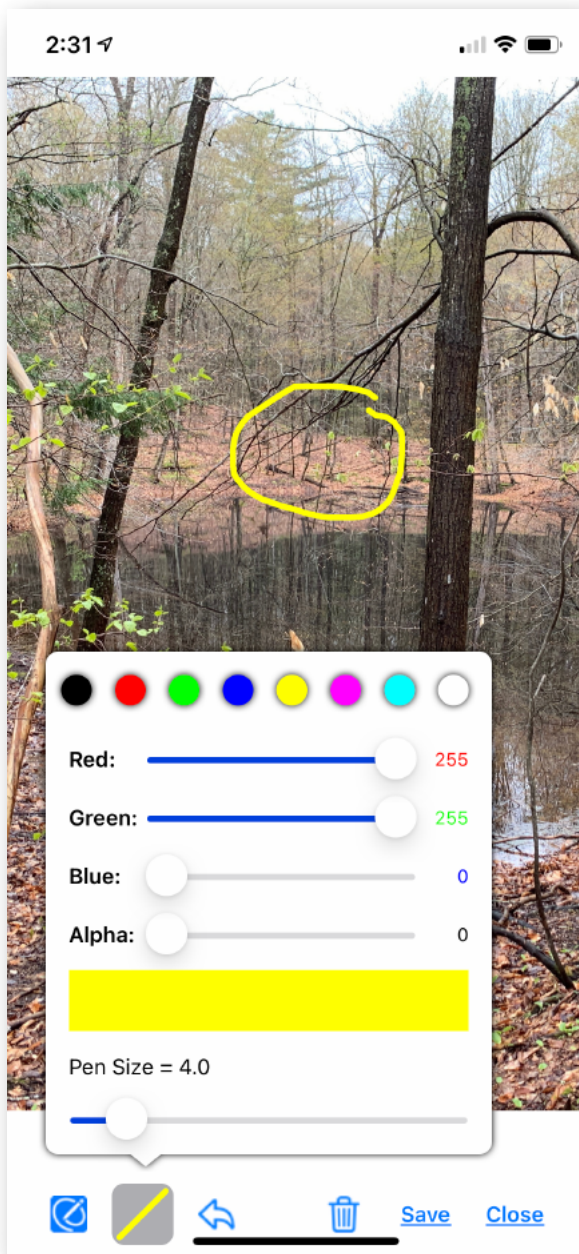


FIGURE 13. ANNOTATING PHOTOS WITH THE PEN
COLOR AND SIZE PICKER DISPLAYED

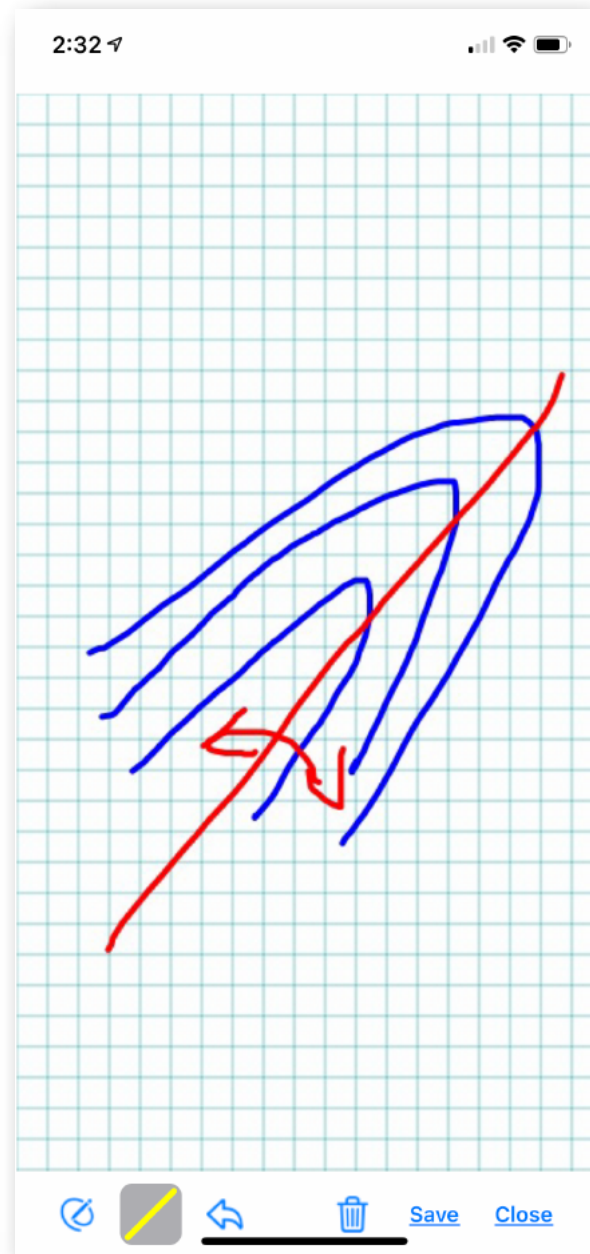


FIGURE 14. A SIMPLE FIELD SKETCH IN NOTE-
BOOK SKETCHING MODE

The Rangefinder Screen

One way to add a POI, especially one that you cannot physically reach, is to use the Rangefinder screen (although you can also use the rangefinder without setting a POI, too!). The rangefinder (Fig. 15) works by projecting a line-of-sight from your current position, as determined by the device GPS, to the point on the ground in the cross hairs of the sight. We can make this calculation because we have an onboard DEM so we

know exactly where the ground surface is. [Obviously, it does not work on trees, buildings, etc., because those are not represented in the DEM.] The azimuth and inclination of the line of sight are calculated from the device orientation. The calculation is only as accurate as the device orientation. Thus you are likely to get your best results when the slope you are measuring to is facing you and worst when the line-of-sight barely grazes the topography. Our experience with Stereonet Mobile suggests that the iPhone orientation can be determined reasonably accurate to within a few degrees under good conditions. However, bear in mind that a few degrees error propagated over a long distance will result in a large positional error (the same is true of any rangefinder system). Also, be aware that your GPS position can be off by several tens of meters, especially if you are in a valley or at the base of a cliff with limited sky view and thus a suboptimal number of satellites. So, ***where possible, always verify that any POIs you set make sense and, where you have doubts, try calibrating the device magnetometer by rotating the phone in a figure 8 pattern.***

The first time you use the rangefinder, you will need to enter your eye-height in meters (or feet if you have choose feet as the display units). The default for the app is 1.75 m (about 5 ft 9 in). You set this value by tapping in the eye-height text box in the lower left, erasing the 1.75 and then typing in the correct value. To get a more accurate “shot”, it helps to increase the digital zoom of the camera through which you are sighting using the \pm button in the lower right corner. Everything else is automatic. If you want to set a POI at the sighted point, just tap the **Set POI** button. In fact, you can set several in a row to set a string of points that can be connected to form a contact. If the device camera is aimed above the topography



FIGURE 15. THE RANGEFINDER SCREEN

such that there are no intersections with the ground surface in the area of the DEM, the Range, Δ Horiz and Δ Vert text boxes will turn red and show an infinity sign (∞).

Orientation Details Screen

The Orientation Details Screen operates in a similar manner to the POI Details Screen just described. Figure 16 shows the screen captured in the process of using the device orientation to measure strike and dip directly. To get to this point, in the Map Screen, the user tapped the Add Orientation button and then chose either tap to locate or at current location. Once in this screen, they turned on the **Auto Switch** in the upper right corner and the iPhone immediately started measuring the orientation, using the same code that Stereonet Mobile uses. While held in a stable position on the outcrop, the strike and dip is measured every 100 milliseconds until the user switches off the Auto switch or taps anywhere within the stereonet display. The latter is very useful for overhanging outcrops where the user cannot actually see the face of the phone. The standard deviation of the accumulated measurements are shown in the text boxes but are not recorded in the project database. They exist only to give you a sense of how stable the measurement is. Note, too, that they can tell you nothing about systematic errors (e.g., a magnetized rock hammer located too near the phone) which are the bane of all smart-phone compass apps.

If you had asked the app to calculate the strike and dip from three points, the strike and dip would have already been filled in when the screen appeared and the assigned location would have been Point #2. GMDE Lite will remember that the orientation was calculated from a three point problem,

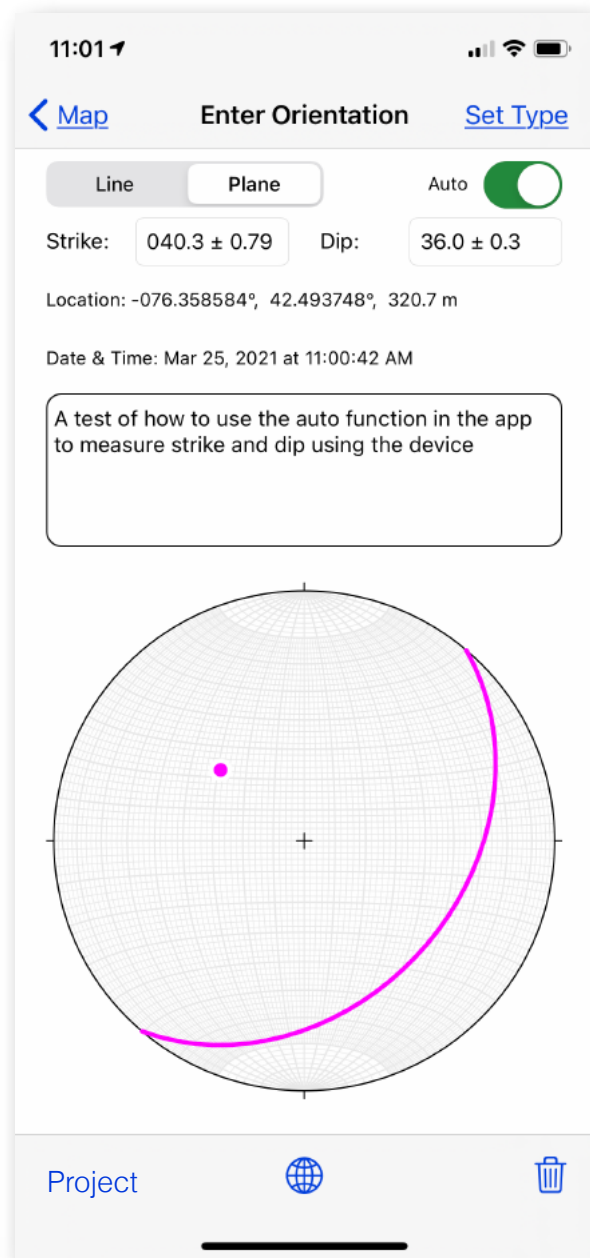


FIGURE 16. ENTERING A STRIKE AND DIP IN THE ORIENTATION DETAILS SCREEN

and records all three points for use in other programs in the GMDE family. Of course, if you are measuring/entering lines, you would have used the segmented button in the upper left to select that category of orientation.

Use the **Set Type** button in the upper right to set the orientation type. After you have set the type, swipe downward to make that screen disappear and the type will be recorded automatically.

The **Project** button on the left side of the bottom toolbar will cause the app to calculate and display a contact on the map which is projected across the topography by calculating the intersection between the plane defined by the orientation and the surface. This functionality exists just to verify the fit of the orientation to topographic features (particularly useful on LiDAR data). The displayed contact is not persistent and cannot be saved within GMDE Lite. If you want to draw contacts using this function, you should be using GMDE Mobile (or GMDE Desktop). The projection length and display of the temporary contacts can be set in the Settings Screen. If you are using a very detailed DEM or a long projection distance, *contact projection can take anywhere from several seconds to several tens of seconds* so (please) be patient. After all, as slow as it may seem, your phone is doing several million calculations to show you this projection.

The equal area lower hemisphere projection only shows the current orientation. In order to see all of the orientations that have been entered, tap the Stereonet button icon (globe) to bring up the Stereonet Screen, described in the next section. You can also get to the Stereonet Screen from the Data List Screen.

Finally, to delete the orientation, tap the Trash Can icon. Deleting a datum cannot be undone so you are warned and given a chance to reconsider!

Just like the POI details screen, there is no Save button. Instead, ***your measurement is***

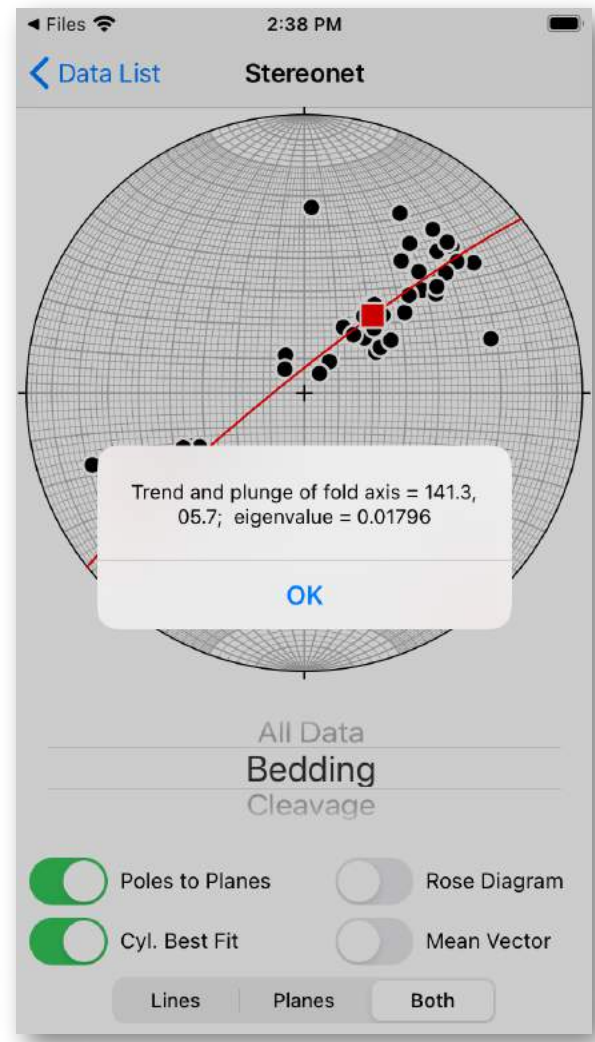


FIGURE 17. THE STEREONET SCREEN

recorded in the database automatically when you close this screen by returning to the Map Screen (or the Data List screen).

Stereonet Screen

Structural geologists like to see their data plotted on an equal area, lower hemisphere projection colloquially called a “stereonet”. GMDE Lite is equipped with a simple Stereonet Screen (Fig. 17) with some additional basic functionality and filtering capabilities. This is not a replacement for a desktop stereonet program (though I can recommend a good one 😊) nor is it even as capable as that found in Stereonet Mobile.

To see your data plotted on a stereonet, tap the Stereonet icon button (i.e., globe icon) in either the Orientation Details Screen or in the Data List Screen.

You can filter your data by type with the scrolling control immediately beneath the stereonet. The **Poles to Planes** switch will cause any planes in your data set to be plotted as the pole to the plane rather than the great circle of the plane itself. **Cyl. Best Fit** is useful for identifying fold axes and, as shown in Figure 17, reports the fold axis orientation and the value of the smallest eigenvalue in the analysis. **Rose Diagram** will plot a rose diagram for each data type in the dataset unless, of course, filtered by data type in which case you will see a single rose diagram. Finally, **Mean Vector** will calculate and plot the mean vector for any lines (or poles to planes) data set.

Contacts

The Contact Details Screen

The Contact Details Screen (Fig. 18) contains information about contacts that you have imported into GMDE Lite or have entered directly into the app via collecting a GPS track, Dragging a Path with your finger or pointing device, or projecting a contact from an orientation. Of course, a “Contact” can represent any path that you want; one of the contact types I use is actually called “Trails” which helps to inform about accessibility.

In the details screen, you can change the name of the contact, enter notes, set the quality or tap the **Set Type** button to change the assigned type. You will likely use the Set Type function with some frequency: recorded GPS tracks and Dragged Paths are initially assigned the types, “Recorded Track” and “Dragged Path” which will probably not be very useful to you in the long term! The Quality scrolling tool at the bottom of the

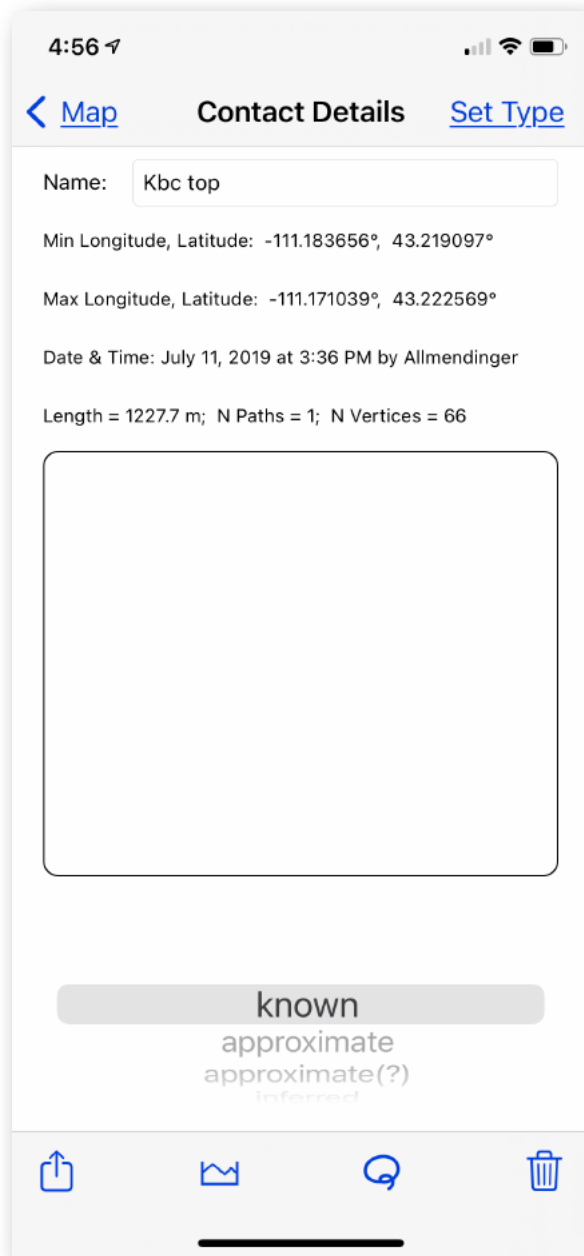


FIGURE 18. THE CONTACT DETAILS SCREEN

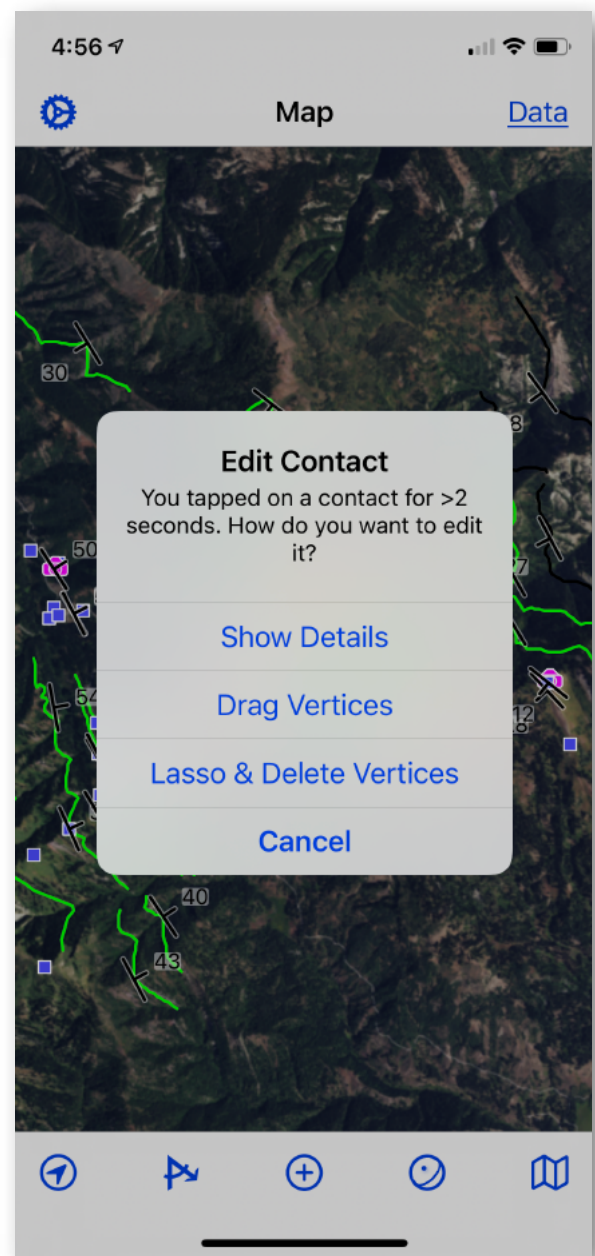


FIGURE 19. CONTACT EDITING FROM THE MAP SCREEN

screen controls whether the contact is mapped as a solid line (“known”), short dashes (“approximate”), short and long dashes (“Inferred”), or dotted (“concealed”).

The toolbar at the bottom of the Contact Details screen allows you to delete the contact (trash can icon), share the contact (box and arrow) or draw a profile along the contact, or lasso and delete contact vertices, which brings us to...

Editing Contacts

There are two types of contact editing that you can do in GMDE Lite: (a) lasso and delete vertices from a contact or (b) tap and drag a contact vertex to a new location. Both of these operations are best carried out on an iPad with an Apple Pencil as your pointing tool. If you are using an iPhone and have the tap point offset from your finger tap (the default), you are likely to find contact editing a frustrating process at best!

From the Contact Details screen, you can access lassoing and deleting vertices by tapping the Lasso Button on the toolbar (Fig. 18). Doing so will immediately return you to the Map Screen where you will see the contact selected with vertices marked by small boxes along the contact. Tap and drag your pointing device around the contacts that you wish to delete. A message box will appear telling you how many you have selected for deletion. Once you tap delete, those vertices are gone! There is no undo!

A second, shortcut way to editing contacts can be accessed directly from the Map Screen. Long tap (> 2 secs) on the contact you want to edit. This will display a message box (Fig. 19) which will enable you Lasso and Delete vertices or tap on and drag individual vertices. The latter operation is really only feasible with a pointing device like an Apple Pencil with zero offset of the tap point specified in the Settings Screen. You can keep tapping and dragging individual vertices until you tap away from the contact at which point it will become deselected.

If you just want to see an entire contact's extent, select either drag or lasso and the contact will be displayed in red with boxes at the vertices. When you are satisfied, tap on the screen anywhere away from the selected contact which will then be deselected.

Topo Profile Screen

You can have the app draw a topographic profile (Fig. 20) along an existing contact, a straight line (from the measure distance tool), a dragged path, or a recorded track. A topo profile can help you visualize and calculate the slope variations along a planned hike or any topographic anomalies or scarps that might have geological significance. The track, path, contact or measured line is automatically resampled to the resolution of your input DEM; if you are using a very detailed DEM (e.g., from LiDAR), the path will be sampled at a 2.5 m spacing so the app remains responsive. Topo profiles are plotted from left to right on the screen in the order in which the original polygons were ordered/digitized. Thus, if a contact was originally digitized from east to west, the topo profile along it will be plotted with east on the left side and west on the right side.

The +/- stepper button in the lower left corner of the Profile Screen allows you to change the vertical exaggeration. If you tap and hold the plus or minus, the vertical exaggeration will increase or decrease automatically, slowly at first and then more rapidly, until you lift your finger.

Tap and slide your finger horizontally anywhere within the profile bounds and two red dots will appear, the first where you first put your finger on the glass and the second at your current finger position. The elevation, position, and the differences in map distance, slope distance, slope angle, and percent grade between those two points are displayed at the top of the screen.

The **Set Point on Map** button is useful if you observe a feature on the profile and would like to see where that feature is on the map. When you tap that button, a cross icon appears on the profile; drag it to the feature that you are interested in. When the profile screen is closed, GMDE Lite will automatically add a POI entitled "Pt on Profile" to the map at the exact point that you identified on the cross section. You can then rename the POI to something more useful or delete it if the POI was only a momentary curiosity.

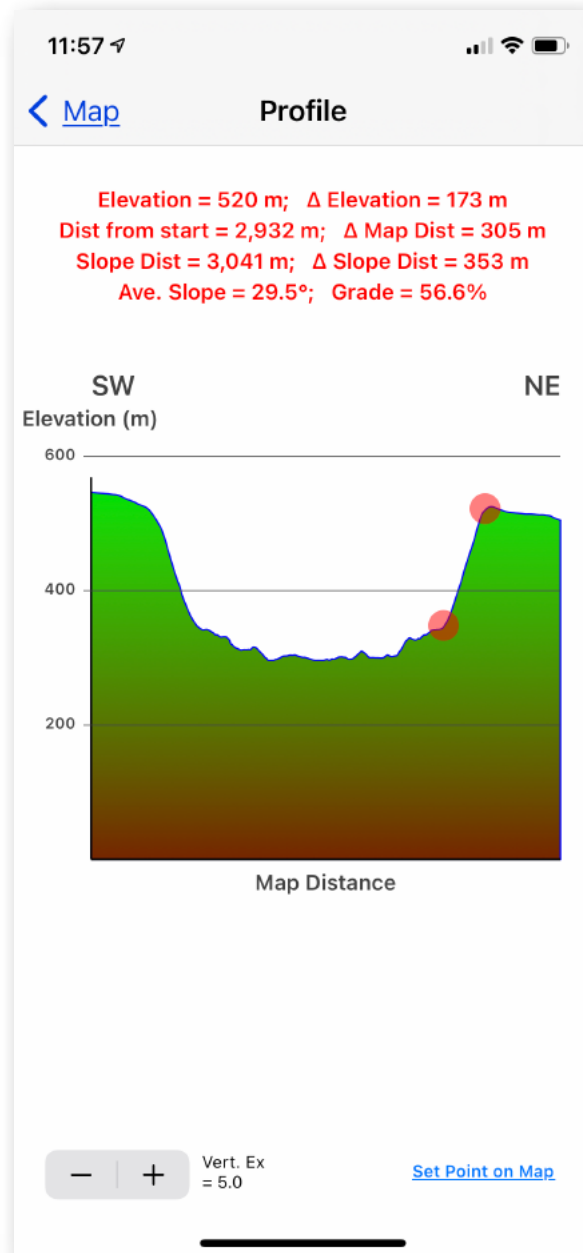


FIGURE 20. THE TOPO PROFILE SCREEN



Data List Screen

All of your POIs, Orientations, and Contacts are listed in tabular form in the Data List Screen (Fig. 21) that can be accessed by tapping the **Data** button in the top right corner of the Map Screen. Tap the segmented button at the top of the screen to choose which data type is displayed. The icons in each row show the data type and, in the

case of Orientations, are correctly rendered to show the actual orientation of the datum. Tap a row to go directly to the Details Screen for the observation. You can also swipe left on any row as a rapid way to delete, show details, or return to the map at the position centered on the observation.

Immediately above the table is a search field which will cause the table to show only those data in the project that match the text entered there. The search looks for text in the POI title or contact name; as orientations do not have names or titles, any text in the orientation notes field will be matched to the search text. These three classes of data can have three separate search terms. Only items matching the search will be displayed on the Map Screen. If you want to go back to showing everything on the map, you must first clear the search in the Data List Screen by deleting the text in the search field!

Swiping left on any row in the table will give you three options: a shortcut for deleting the item, a button to return you to the Map Screen with the map centered on that item, or going to the details view for the item.

The toolbar at the bottom of the Screen provides quick access to a few key functions. If you have copied your orientations in Stereonet Mobile, you can quickly paste them into your GMDE Lite data set using the **Paste** button. The  button will open the Stereonet Screen for you to examine your orientations in that projection. The sharing button  will enable you to share your data with other apps.

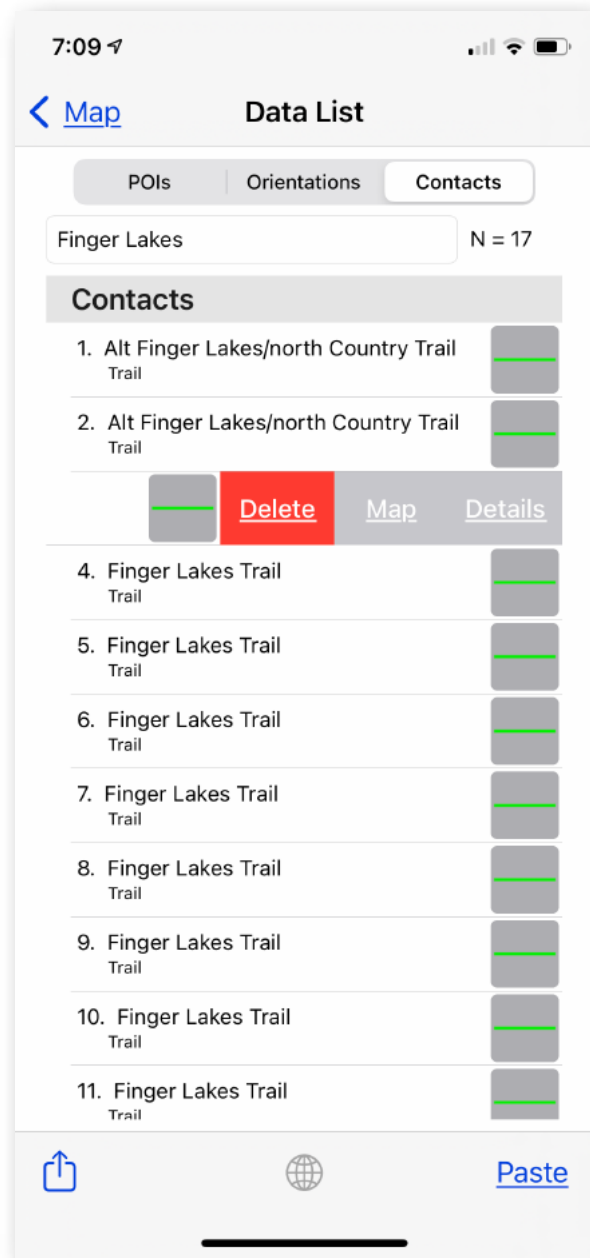


FIGURE 21. THE DATA LIST SCREEN WITH THE SEARCH FIELD IN USE.

3:50

< [Back](#) **StraboSpot Upload**

User Name:

Password:

[New Project](#) (optional)

Dataset Name:

All POIs Orientations Contacts

Select a Project:

Adirondacks
GMDE new
SE Idaho
Candelaria 2
SE Idaho 3

[Log In](#) [Upload](#) [Cancel](#)

FIGURE 22. THE STRABOSPOT UPLOAD SCREEN

3:49

< [Back](#) **StraboSpot Download**

User Name:

Password:

Projects:

New Trial Project
GMDE test project
Candelaria
GMDE Poker Pk
Adirondacks

Datasets:

update test 6/19
Candelaria.txt

All POIs Orientations Contacts

[Log In](#) [Download](#) [Cancel](#)

FIGURE 23. STRABOSPOT DOWNLOAD SCREEN

StraboSpot Integration

GMDE Lite v. 2.0 is completely integrated with [StraboSpot](#), the free community database funded by the US National Science Foundation. For any project that you initially defined as using the StraboSpot Lexicon, you can now both upload data to, or download data from, your StraboSpot account. While GMDE Lite enables you to incorporate data easily to or from StraboSpot, it is not the ideal tool to manage your StraboSpot data. That is better done in your account on the StraboSpot website, or using the Stra-

boSpot app. You access your StraboSpot data from the Modify Project Screen, accessible from the Settings Screen. If your project has StraboSpot enabled, you will see a segmented button enabling either StraboSpot upload or download. Tap the one that you want. The first time, for either upload or download, you will need to enter your credentials and log in to your StraboSpot account. For the rest of your session in the GMDE Lite, you will not have to log in again. GMDE Lite saves your StraboSpot log-in name to the project database so, after the first time, you will not have to enter your user name again. Your password is never saved for security reasons.

Upload

A StraboSpot project can have multiple datasets, which are composed of individual spots. In the Upload Screen (Fig. 22), you have the option of defining a completely new project. To do so, enter the new project name into the text box next to the **New Project** button and then tap the button. Your new project will appear selected in the spinner control beneath the Select a Project label.

Any data that you upload to StraboSpot is always entered as a new Dataset. The dataset name, by default, is the name of your GMDE Lite project with a suffix after the underscore identifying the type of data. You select the data to upload using the segmented button.

Once you have selected the project (either new or existing) and entered a dataset name, tap the **Upload** button on the toolbar. A progress wheel will appear immediately above the button. Depending on the strength and speed of your data connection, as well as the amount of data you are uploading, an upload can take anywhere from a few seconds to several minutes so be patient!

Download

To download data to the current GMDE Lite project, in the StraboSpot Download Screen (Fig. 23), first select a project and then the datasets within that project will populate the Datasets spinning control. From the Datasets control, select the dataset that you want to download. If you only want to download a single class of data, select it from the segmented button control. Finally, tap the **Download** button on the toolbar. A progress wheel will appear indicating that the download is in progress. Like uploads, downloads, too, can take considerable time so be patient.

GMDE Lite tracks StraboSpot ID numbers of each datum. Thus, if you have already downloaded data from your account and then choose to download the same dataset again, only data that were newly added since the first download will be downloaded

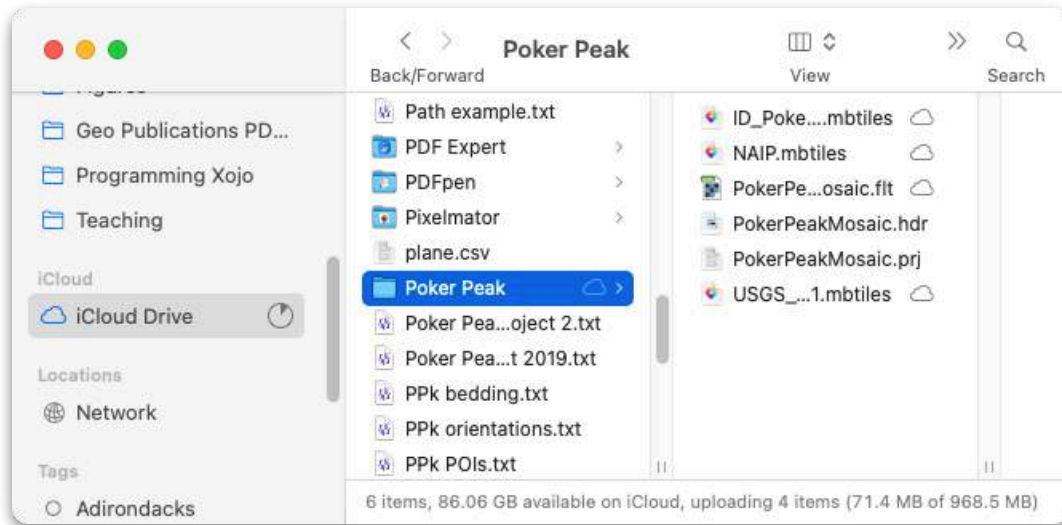


FIGURE 24. ON THE MAC DESKTOP, THE iCloud DRIVE FOLDER OPEN WITH THE FILE THAT I JUST DRAGGED ONTO IT. THE LITTLE CLOUD ICONS NEXT TO THE FILES MEANS THAT THEY ARE STILL UPLOADING

again so that your GMDE Lite project doesn't accumulate a bunch of duplicate observations. Also, the data will only be downloaded if they are located inside the current GMDE Lite project

Using the Files App to Move Data Around

Although getting files onto a mobile device is easier than it used to be, the process is still not straightforward. The keys to this process are your iCloud account and the Files app (by Apple) which is already installed on every iOS device. All of GMDE Lite's files can be accessed from the Files app.

Desktop to GMDE Lite

Place the files you want to load on your iCloud Drive

Assemble all of the files that you want to upload to GMDE Lite into a folder on your desktop. The folder should include an MBTiles base map and three files associated with the GridFloat DEM at a minimum. In addition you might want to export data from the desktop project that you want to have on your iPhone as a GMDE Lite Database.

If you use a Mac for your desktop computer, you probably already have an iCloud Drive icon in the side bar of your Finder Windows. Drag the folder with all of the files to upload onto the sidebar icon (or click the sidebar icon and then drag the folder into the iCloud drive window). The window should look something like Figure 24.

If you use a Windows computer, you have two options: You can install the iCloud Desktop software for Windows (available in the Windows app store), or you can upload your files via a web browser by logging onto your iCloud account in the browser (Fig. 25). Go to <https://www.icloud.com> and log in with your iCloud credentials. You will see the top screen in Figure 25. Click the iCloud Drive icon to go to your iCloud Drive. Once in iCloud Drive, click the upload icon, a small cloud with an upward pointing arrow (red circle in the lower screen of Fig. 25). A dialog box will open allowing you to select files for upload; you may not be able to upload the entire folder all at once.

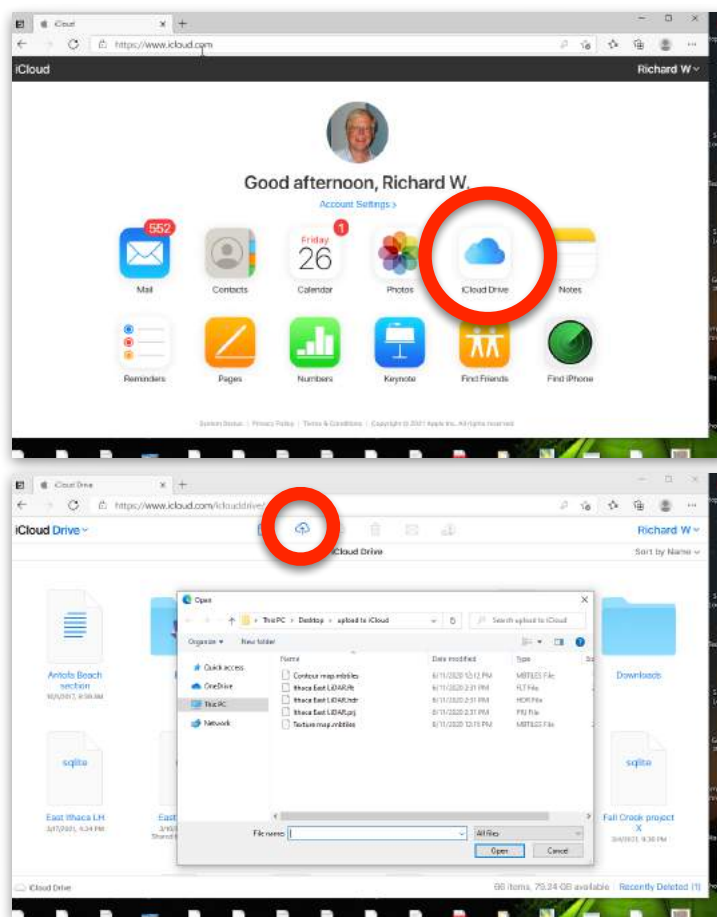


FIGURE 25. THE iCloud INTERFACE IN THE WINDOWS EDGE BROWSER.

Open the Files app on your device

All remaining steps are carried out on your iPhone (or iPad). The Files app on every iOS device has a simple folder icon (Fig. 26); open it. Navigate to the Browse folder and tap on the iCloud Drive row/icon (Fig 27).

Select the files you just moved to iCloud Drive

Find the folder that you just copied from the desktop computer in the list of files under iCloud Drive. (a) In the most recent iPhone operating systems, you can tap and hold down on the folder and you will get a popup menu listing operations you can do (Fig. 28). Tap Move in that menu. Alternatively, (b) in older versions, tap the button with three



FIGURE 26. THE FILES APP

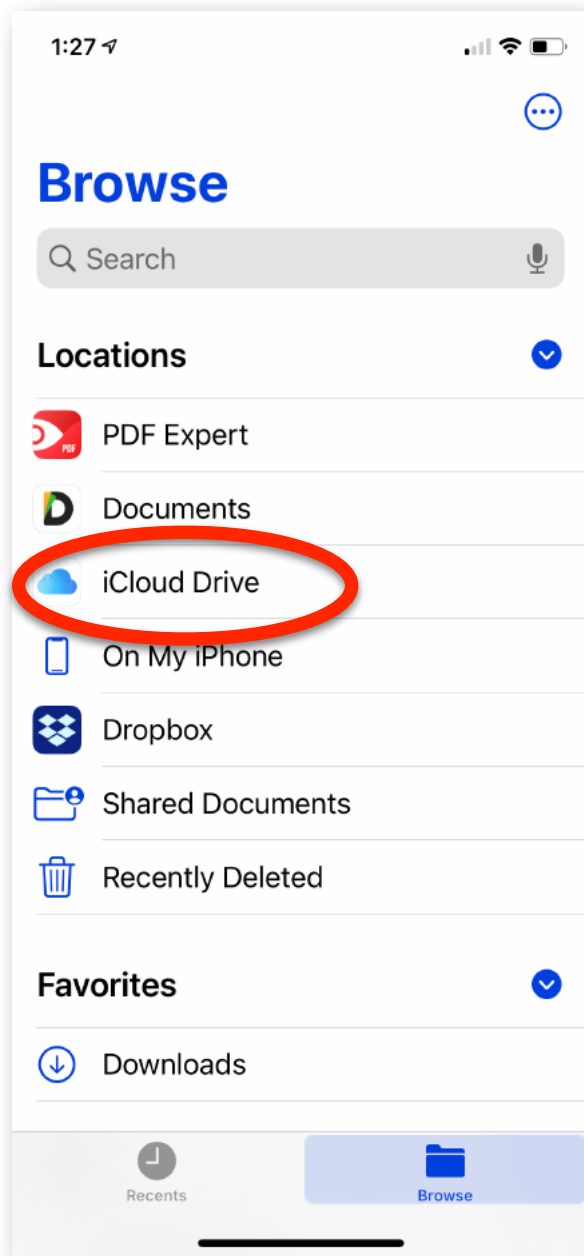


FIGURE 27. ACCESSING iCloud DRIVE

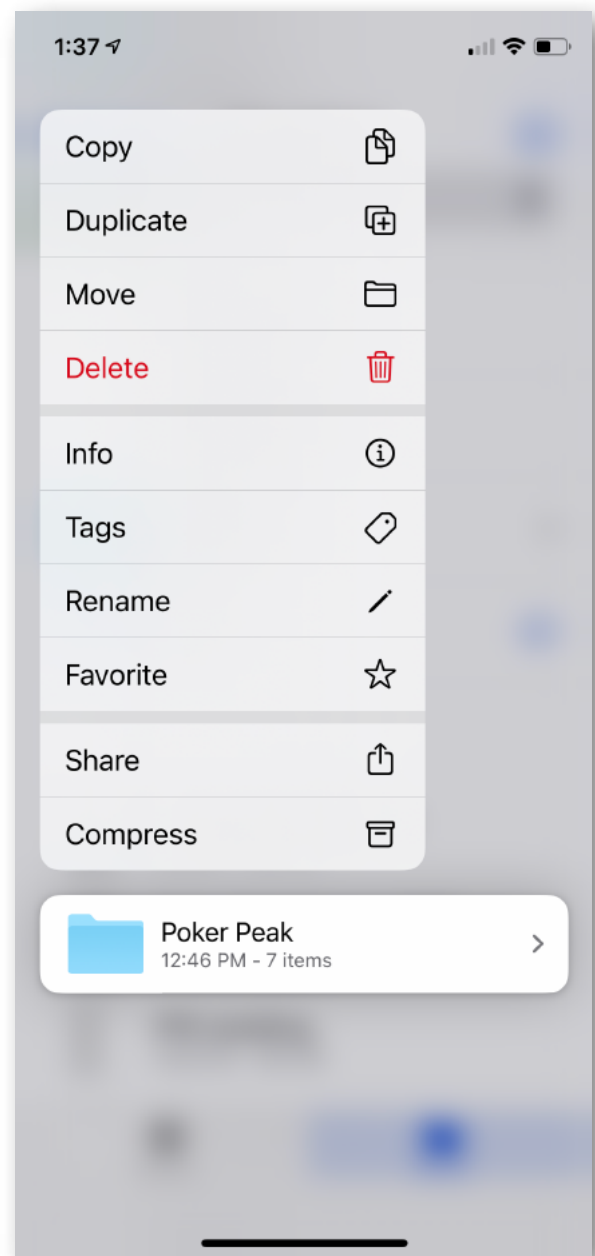


FIGURE 28

dots in a circle, choose Select from that menu, and then tap the folder you want to move to GMDE Lite. A check mark in a solid circle will appear to the left of the folder showing that it has been selected. Tap the folder icon in the Toolbar at the bottom of the screen. Either way will bring up the screen enabling you to select where to move the folder (Fig. 29).

In that screen, tap On My iPhone and then select the Folder GMDE Lite. Finally, tap the **Copy** button at the top right corner (Fig. 29) and your file will be copied into the GMDE

Lite folder where the app can now access it. You can delete the original copy of the folder from iCloud Drive once the copy is complete if you want to save space.

GMDE Lite to iCloud Drive

To make GMDE files available to other apps, or to copy the project database file to a place where it can be accessed by GMDE desktop, follow the above procedure in reverse: Go to On My iPhone>GMDE Lite folder, select the file that you want, and then use the Move or Copy command to put the file in iCloud Drive where it can be accessed from anywhere.

An Alternative Way of Accessing GMDE Lite Files

iOS (iTunes) file sharing is the oldest way of moving files to or from your iOS device and is still functional in the latest version of the operating system. This method bypasses iCloud completely:

Connect your iPhone (or iPad) to your computer using the Lightning cable that you use to charge the device. On the two most recent Mac OS operating systems (Catalina and Big Sur), the device will show up in the sidebar of a Finder window. Select the device and from the horizontal menu bar within the window, click on Files. You will see a list of all of the apps on your phone. Toggle the disclosure triangle for GMDE Lite and you will see all of the files and folders in its document folder. Unfortunately this view goes only one level deep: you cannot see inside folders that are inside the document folder. Drag whatever folder you want onto GMDE Lite in this view to upload files. To go the other direction, just drag a file that you want to copy to your computer out of the Window and onto your desktop.

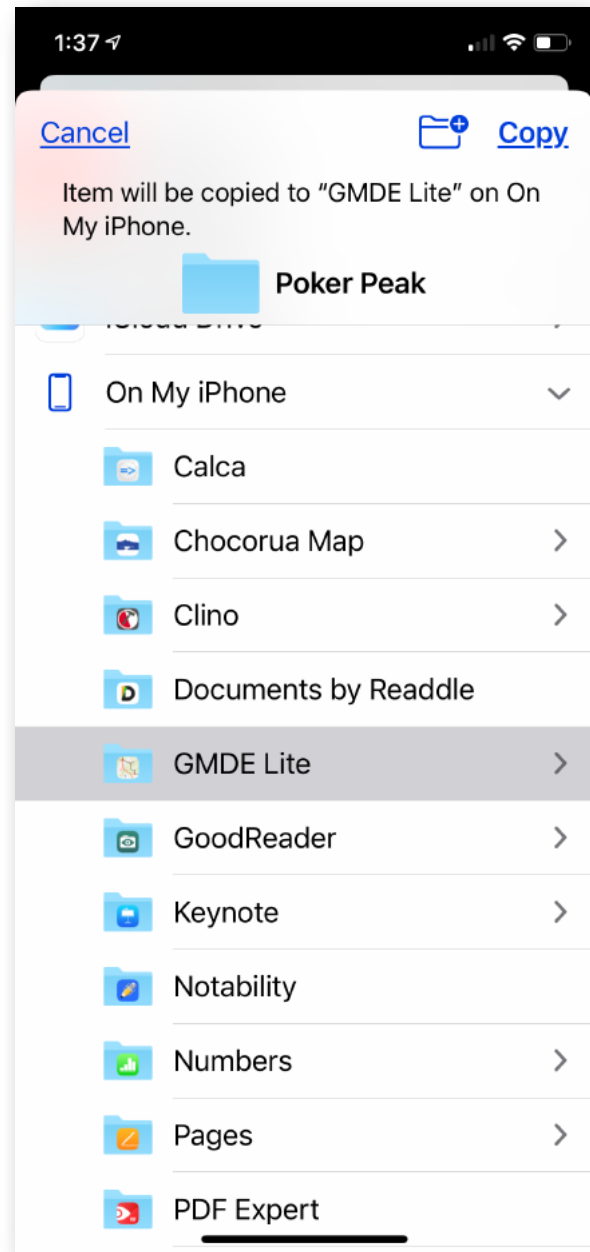



FIGURE 29

In Windows, and in older versions of the Mac OS, you will need to access GMDE Lite files using iTunes File Sharing. The old iTunes interface was very cluttered making it hard to find your device but it can be done!

How to...

Visualize Stereonet Mobile Data in GMDE Lite

If both Stereonet Mobile and GMDE Lite are running on the same device, this one is easy:

1. In Stereonet Mobile, go to the Data List Screen and tap the Sharing Panel button  on the toolbar. When the Sharing Panel appears, tap copy.
2. Now, go to GMDE Lite, open the Data List screen and tap **Paste** on the toolbar. The Stereonet Mobile data will be appended to any orientation data that you already have in GMDE Lite. Data that are located outside of the GMDE Lite current project map area, or data that have the same Unix time stamp will NOT be imported.

If the two programs are not running on the same device, you will have to use the Files app as an intermediary as described next...

Open a GMDE Mobile database from iPad in GMDE Lite on an iPhone

When the apps are on two different devices you will use AirDrop and the Files app to move the file. You can use AirDrop even if you are not on a cellular data or wireless network. You do need to have Bluetooth enabled on both devices and they need to be close enough to each other to be in Bluetooth range. You may have to set up AirDrop to enable transfers between two different people. The following procedure — for moving a file from an iPad to GMDE Lite on an iPhone — works the same in either direction and, likewise, also works to transfer Stereonet Mobile files.

1. On the Files app on the iPad, tap Browse until you see On My iPad. Tap On My iPad and Navigate to the GMDE Mobile documents folder, or to the subfolder that has the file you wish to copy.
2. Tap and hold down on the database that you want to share until you see the dropdown menu. Tap the Share item in the menu. The Sharing Panel will appear (Fig. 30).

3. Tap the AirDrop button (red circle, Fig. 30) and a new panel will appear showing you all of the nearby devices to which you can AirDrop the file. Tap the device that you want.
4. On the iPhone, a menu will appear asking you what program you want to open the file with. Although GMDE Lite may appear in this list, tap Files for the Files app.
5. The Files app will give you an opportunity to rename the file if you wish. The way to find the file once you have saved it in the Files at is to go to the Recent Files list.
6. Tap and hold down on the file that you just saved. Tap Move in the dropdown menu that appears. Navigate to On My iPhone>GMDE Lite and move the file into the GMDE Lite folder.
7. Finally, launch GMDE Lite if it is not already running, go to the Settings Screen and tap the **Import Data** button.

You can also use AirDrop to move your database files to your desktop computer where you can read them in GMDE desktop.

Control what you see plotted on the screen

You may be panicking because it seems like the app must have eaten your data because it is not showing up on the map anymore. Don't worry, the data is almost certainly still there, but you turned off plotting of it at some point. *There are three different*

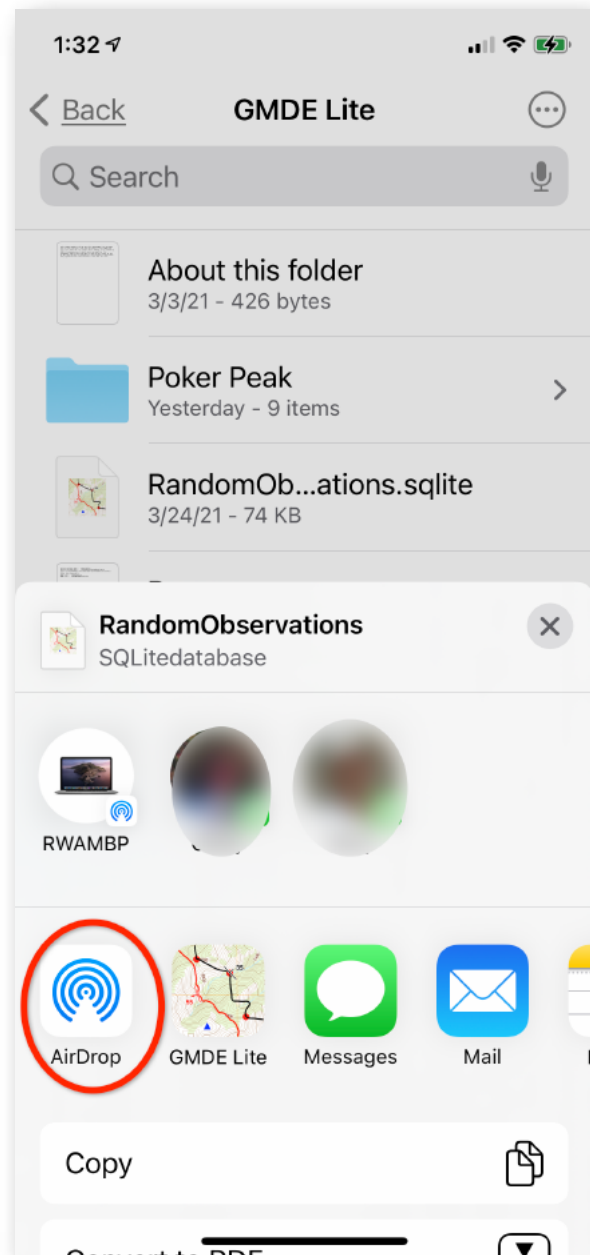


FIGURE 30. AIRDROPPING A FILE FROM THE SHARING PANEL

places in the program when you can determine what gets plotted on the map: the Settings Screen, the Edit Types Screen, and the Data List Screen.

The Settings Screen (Fig. 6) give you the coarsest level of control. In the “Data to Show on Map” section, tap the switches next to POIs, Orientations, or Contacts to turn off or on an entire class of observation all at once. The Settings Screen also has a section to allow you to show or hide POI name or dip value labels.

A finer level of control is provided by the Edit types Screen (Fig. 8). Here, you can toggle on or off the switch “**Show on Map**” to hide certain types within a class of observation. For contacts, as an example, you might wish to show all faults but hide intrusive contacts, etc. The plotting decisions that you make in these two places, Settings and Edit Types screens, are persistent and are saved with the project.

The most detailed level of control comes from searching in the Data List Screen. Whereas in the two previous cases, you select types to eliminate from view, when you search in the Data List Screen, ***you identify data that you want to see on the map, hiding everything else!*** The items that you search for are the only ones that will be plotted on the screen. To show everything again, cancel the search by deleting the search term entered in the search field. By the way, there are separate search terms for POIs, Orientations, and Contacts. GMDE Lite cannot search across classes of data.

“Fix” the Rangefinder

First, let's be clear about how the rangefinder works. It uses the azimuth and inclination reported by the device to calculate a line-of-sight (LOS) to the place at which you are pointing the device camera (Figure 31). The calculation iterates along the LOS and, the first place where the elevation along the LOS is less than the elevation of that point on the ground (as recorded in the DEM) is taken as the position of the sighted point. What this means is that only features that are represented in the DEM can be used as targets for the rangefinder; Buildings, trees, etc., do not work as targets.

It may be that a POI that you set with the rangefinder seems “off”. The most likely reason is that your device is reporting an azimuth that has a large error because the device magnetometer is less accurate than its accelerometer and gyroscope that measure gravity. The standard way to deal with this situation is to remove all objects that generate a magnetic field from your vicinity (rock hammers, laptops, etc.) and then “calibrate” the magnetometer by waving your device around in a horizontal figure-eight pattern.

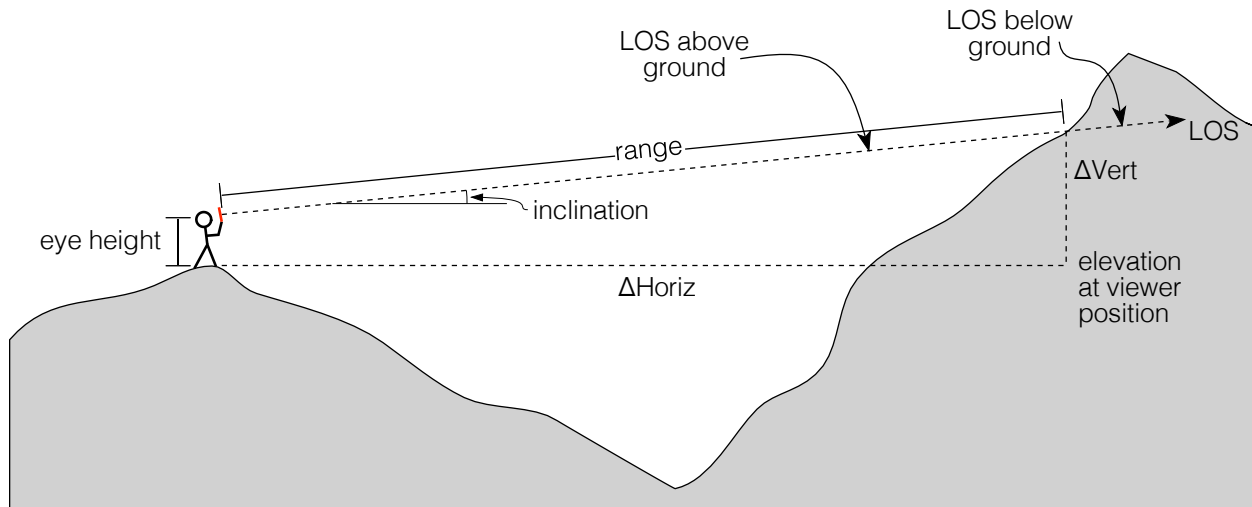


FIGURE 31. HOW THE RANGEFINDER WORKS. LOS = LINE OF SIGHT

Be aware that long sights will always have a larger error than short sights. Sighting to something 50 m away with a 1° error produces a positional error of less than 1 m; a 1° error over an LOS of 5 km produces a positional error of close to 100 m. Errors can be further amplified by a sight which is at a low angle to the land surface. Thus your most accurate “shots” with the rangefinder are those that are not too far away (tens to hundreds of meters) and pointing at slopes that are facing you at a high angle.

If the rangefinder still is not working, it may be that your elevations are off...

Restore elevations if you no longer see them in the app

If your project becomes detached from its digital elevation model, it can cause all sorts of things not to work: the rangefinder, three point orientations, contact projection, topo profiles and more all depend on having accurate elevations.

One common cause for this happening is when the iOS appends a number to the end of a file name. This can happen when you either intentionally copy, or you mistakenly tap and launch one of the files associated with the DEM in iCloud Drive, the Files app, or perhaps attached to a different app. For elevations to work in GMDE Lite, all three files associated with the DEM must have exactly the same root name and their suffixes must end in “.FLT”, “.HDR”, and “.PRJ” (or their lower case equivalents).

To fix this problem, open the Files app and navigate to the GMDE Lite folder. Verify that the three DEM files all have exactly the same root name. If one or more have a variation on the name (e.g., with a number or a number in parentheses, etc.), long-tap on the file until a popup menu appears. Select “Rename” from that menu and then edit the name so that it matches the other files. Be sure not to erase the file suffixes.

If GMDE Lite Crashes on Startup

This situation can be worrying to the user at any time but especially when they are in the field. Fortunately, you can deal with this situation and get back to collecting data fairly quickly, particularly if you have read this section before the crash happens (a word to the wise...)

Startup crashes happen for one of two reasons: either the small Resume.txt file that the app looks for when it is starting up fresh has been corrupted in some way or the last used database has been corrupted. Here is a troubleshooting procedure to follow:

1. Open the Files app on your device and go to On My iPhone>GMDE Lite folder.
2. Delete the Resume.txt app (you probably will not see the “.txt” suffix).
3. GMDE Lite should now startup with a blank screen. In the app, go to the Settings Screen and choose Open Project.
4. Select the project that you were last working on.
 - a. If the app displays the project as normal all is fine. The Resume file will be recreated automatically. There is nothing more you need to do.
 - b. If the app crashes, it means that the database has some corrupted information in it.
 - i. DO NOT delete the database! Chances are very good that you can use a dedicated SQLite browsing program on your desktop computer to extract your precious data.
 - ii. Instead, restart GMDE Lite and make a new project with the same base map and DEM. Then go about collecting data as you normally would.
 - iii. When you get back to the office, rescue your data from the corrupted database with the free, open source DB Browser for SQLite that can be downloaded for Mac, Windows, or Linux from <https://sqlitebrowser.org> (or some other program).

Acknowledgments

I appreciate the beta-testing prowess of Kiera Crowley, Teresa Jordan, and Paul Karabinos. Jason King provided key insight into how to implement the true north reference frame for using the device orientation to make measurements possible. The Sighting View also uses code from his iOSKit.

The classes to do mbtiles math were originally written in Python by Copyright © 2008 Klokian Petr Pridal, all rights reserved, and have been translated and modified for use in GMDE Lite. Permission to use is granted by the original copyright holder as follows:

“Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the “Software”), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions: The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.”

The original Python code can be found at: <https://www.maptiler.com/google-maps-coordinates-tile-bounds-projection/>.

Any errors are mine but, remember, it is completely up to you to verify that the program is working and yielding reliable results for your purposes. All computer programs have bugs in them!

Steve Oriel, Gene Boudette, and Max Crittenden -- all great USGS field geologists now deceased -- taught me a great deal about geologic mapping many years ago and they have my deep gratitude. I hope they would have approved of this use of technology to make mapping better.

Privacy Statement

Asking Permission

GMDE Lite always asks your permission to access sensitive data on, or from, your device. This includes:

- Location Data — The app needs your location data to carry out its core functionality as a mapping program. The first time you turn on GPS, you will be asked for per-

mission to access location data while using the app; no background data are ever collected although if you open the Apple Maps screen you will be asked whether Maps can track you when the app is not frontmost. If you deny access to location information, you will not be able to use the device GPS to locate yourself or use the device orientation to measure geological orientations. Otherwise, the app will function normally. Location data for individual observations is stored in an unencrypted SQLite database in the GMDE Lite document folder which, thanks to sandboxing, is not accessible to any other program except iTunes File Sharing when you connect your device to your computer. If you choose to Share data, you will of course also be sharing the location data for each observation with whatever app or device you select.

- Access to the Camera — GMDE will ask for access to your camera the first time you tap the **Photo** button in the POI details screen. If you deny access, you will not be able to take photos from within the app. Photos taken within GMDE Lite are stored in an unencrypted SQLite database in the documents folder of the app, which is not accessible to any other program except iTunes File Sharing when you connect your iPad to your computer.
- Access to the iPad Photos Library — The first time you tap **Import from Photos** or **Share Photo** in the POI View, you will be asked permission to access your Photos Library. If you deny access you will not be able to import or share photos. Imported Photos are stored in an unencrypted SQLite database in the documents folder of GMDE Lite, which is not accessible by any other program except iTunes File Sharing when you connect your iPad to your computer.

If you deny access and then decide later that you want to enable the above features, you can do so by enabling GMDE Lite in the device Settings app under Privacy.

Internet Access

GMDE Lite can access the internet in the following way:

- When you use the Apple Maps function, GMDE Lite has to send your location to Apple as well as the location and titles/orientations of the 10 nearest points of interest and 10 nearest orientations so that they can be shown on the map. If you do not wish for this information to be sent to Apple, do not use the Apple Maps function.

Data Access

All of the data you collect using GMDE Lite is stored unencrypted in the app document folder and is accessible from within GMDE Lite, From the GMDE Lite folder in the Files App on the device or by attaching your iPad to your computer and using iTunes File Sharing. At present, the data are stored in a simple SQLite database which can be read by any number of commercial and freeware programs, even if GMDE Lite ceases to be developed. No proprietary binary files are currently used.

Programmer Access

GMDE Lite **never** sends ANY information to me, the programmer of the software. It has no ability to send me crash reports, copies of your data, location information, or anything else that you enter in the program or have on you computer. GMDE Lite does not use cookies or any other persistent tokens other than the files you save to the app documents folder. GMDE Lite is not supported by advertising and no data are shared with third parties.

Appendix A: Preparing Base Maps

Base maps are entered in GMDE Lite as MBTiles, a format that enables devices with limited RAM memory to display a large amount of data quickly. As the name implies MBTiles are a way of dividing up the base map into manageable tiles of different sizes and resolutions to serve them quickly. The set of MBTiles for the area is actually a SQLite database which enables rapid retrieval and display. An MBTiles set can be made from any georeferenced map or satellite image and you can load several different images into a single project in GMDE.

For users in the United States, the entire country is covered by images from the National Aerial Imagery Program (NAIP) which have resolutions of 0.6 to 1 m. They can be downloaded using the USGS Earth Explorer (<https://earthexplorer.usgs.gov/>). Detailed instructions are given, below, courtesy of Nathan Niemi, to convert these images to MBTiles for use in GMDE Lite.

Commercial Programs

Several software packages facilitate the production of mbtiles from original base materials (satellite images, topographic or geologic maps, etc.). Perhaps the easiest to use is the program MapTiler from Klokan Technologies (<https://www.maptiler.com/>), which is available for Windows and Mac operating systems. The free and low-cost “Starter” versions have an image size limit of 10,000 by 10,000 pixels which is sufficient for many projects. For bigger or higher resolution projects, you can use a commercial GIS system such as Global Mapper or ArcGIS. These packages can be expensive, have a steep learning curve, and usually only work on Windows computers.

GDAL: An Open Source Alternative

The open source Geospatial Data Abstraction Library, GDAL, can produce mbtiles that work very well in GMDE and have no restrictions on size. Here, are instructions graciously provided by Nathan Niemi (University of Michigan) to download and process NAIP images and to use GDAL on a Macintosh to produce mbtiles. Note that the steps in the terminal can be carried out by the applet (Macs only) referenced below.

1. Find the NAIP image tiles that you need using USGS Earth Explorer (<https://earthexplorer.usgs.gov/>)
 - 1.1.Set your search area
 - 1.2.Select NAIP under Aerial Imagery in Datasets

- 1.3. Confine search to last 3 years to get most recent images under Additional Criteria (NAIP flies each state every ~3 years)
- 1.4. Bulk download the imagery as GeoTIFF images (you will need a free account with the USGS), also a fair amount of disk space. Imagery ranges from 0.6 m to 1 m resolution, depending on state and time of acquisition
- 1.5. Each GeoTIFF images arrives in a zip archive that unpacks to include a .tif image and a .txt metadata file, inside a folder for each quarter quad
- 1.6. Move the .tif and .txt files for each quarter-quad that you want to mosaic and tile in to a single FOLDER. (You will have a folder full of .tif and .txt files)
2. Download and install the complete package for GDAL for your version of MacOS - <http://www.kyngchaos.com/software/frameworks/>
 - 2.1. Run the installer to install GDAL
3. Open the Terminal.app on your Mac (or use the applet described below)
 - 3.1. Using the command line, navigate to FOLDER
 - 3.2. Issue the following gdal commands
 - 3.3. `>gdalbuildvrt -b 1 -b 2 -b 3 tempraster.vrt *.tif`
 - 3.3.1. This creates a virtual raster from bands 1, 2, and 3 of all of the NAIP GeoTIFF quarter quads in FOLDER. NAIP images have 4 bands (4 is NIR), and the mosaic product fails if the 4th band is not explicitly excluded from the mosaic (this is what the -b 1 -b 2 -b 3 commands do, include only bands 1, 2, and 3). This command should not harm the process for any other 3 band (RGB) image, but could crash the process on a single band image (e.g., black and white air photo).
 - 3.4. `>gdal_translate tempraster.vrt outputfile.mbtiles -of mbtiles`
 - 3.4.1. This command “translates” the virtual raster file, composed of the FOLDER of GeoTiff images, in to mbtile format in a file called outputfile.mbtiles
 - 3.5. `>gdaladdo -r average outputfile.mbtiles 2 4 8 16 32 64 128 256`
 - 3.5.1. This command adds zoom levels to the mbtiles output file at 2x downsampling, 4x downsampling, etc. The -r flag defines resampling method.

The steps in the terminal (3.x, above) can be carried out using a small Mac OS X Automator applet, mbtiles using GDAL, which can be downloaded from my web page at:

<http://www.geo.cornell.edu/geology/faculty/RWA/programs/mbtiles-using-gdalapp.zip>

Just launch the applet and select the folder you made in step 1.6 above. The only notification that the script is running is a small revolving gear icon in the menubar (which you can use to kill the process if you need to). It is likely that it will take several minutes to complete, at which point a notification will appear and the gear icon will disappear.

Appendix B: Preparing Digital Elevation Models (DEMs)

The thing that makes GMDE unique is the ability to read high resolution DEMs that are stored on the device and thus accessible for offline use. When you have X, Y, and Z, there are all sorts of calculations you can perform while still in the field where the results can guide your field efforts.

DEMs come in a bewildering array of formats and there are even variations amongst standard formats. GMDE Lite accepts only a single, but widely popular format: GridFloat. This type of DEM used to be one of those offered by the U.S. Geological Survey¹ and other government agencies for direct download, and can be written by most popular GIS programs such as ArcGIS and Global Mapper. The GridFloat DEM consists of three files:

1. A small header file with the suffix “.hdr” which has information about the number of rows and columns in the DEM, the grid spacing, etc.
2. A second small file with the suffix “.prj” that has information about the datum and projection of the DEM
3. A large file with the suffix “.flt” that is a binary file containing the actual elevation file.

All three files should be uploaded to your iPad and must have the exact same root name or GMDE Lite will not be able to find them!

The GridFloat DEM comes in two basic flavors:

1. A grid spacing and bottom left corner specified in decimal degrees. The USGS releases its 1/3 arc second DEMs as 1° × 1° tiles. GMDE has no problem or restrictions with this format. The 1° × 1° tiles do tend to be much larger (~ 0.5 Gb)

¹ USGS DEMs are now available as web-enhanced geotiffs. These geotiffs can be read by most commercial programs and by QGIS. In QGIS you can convert a geotiff DEM to a .BIL DEM which the desktop version of GMDE can read. From GMDE Desktop, you can save a GridFloat DEM of your map area for import into GMDE Lite.

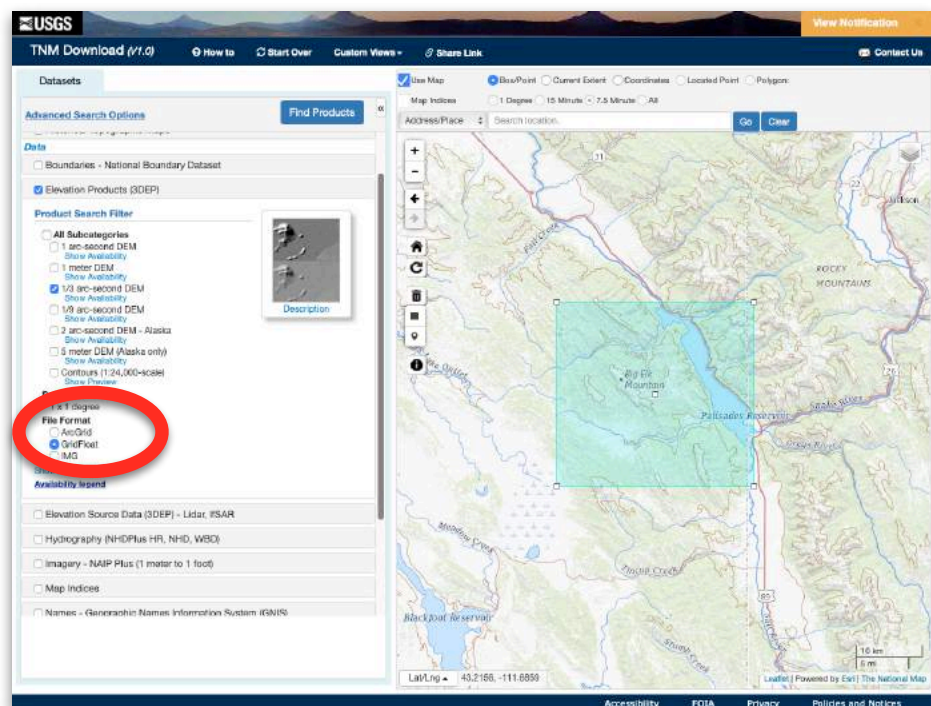
than necessary for any particular project and, if you are pressed for space, you can read these larger DEMs into the desktop version of GMDE and then use that program to save a new GridFloat DEM trimmed to your map area. Note that GMDE Lite does not read the DEM into RAM memory but instead does a direct read from the binary file when it needs an elevation.

2. A grid spacing and bottom left corner specified in meters. GMDE Lite can read these DEMs *as long as the central meridian of the DEM is a standard UTM central meridian*. Although this is usually the case, some GIS programs output DEMs with non-standard central meridians. You can determine whether or not this is the case by opening the “.prj” file in a text editor program and finding the central meridian. Add 3 to that number and then divide the result by 6. If there is no remainder (i.e., nothing to the right of the decimal point), then it is a standard UTM central meridian.

Finally, DEMs can be produced using a variety of map datums. GMDE Lite can recognize several different types of map datums and account for the difference with WGS84 which is the datum that mbtiles use. For example, older USGS DEMs used an NAD27 datum which can have an offset from NAD83/WGS84 of as much as 65 m, compromising the utility of the DEM considerably. GMDE Lite does recognize NAD27 and corrects for the offset meaning that you can use those DEMs in the app. If the app does not recognize the datum specified in the “.prj” file, it will default to WGS84 which might not be correct.

Bottom line: if you have control over the format of your GridFloat DEM, specify a format in decimal degrees and a datum of WGS84. That is the best way to ensure correct readability of the DEM.

In the United States, you will probably want to download your DEM from the



U. S. Geological Survey's the National Map website: <https://viewer.nationalmap.gov/basic/>. Be sure to select GridFloat for the DEM Format.

The USGS site allows you to download the 1/3 arc second DEMs as 1° × 1° tiles which are large, ~480 MB. GMDE Lite has no problem with DEMs that size but that could fill up the storage space on your device quickly. The GMDE Desktop program (v. 6) can read the large DEM and can save just that part of the DEM in the area of your map. The Desktop program can be downloaded from: <https://www.rickallmendinger.net/gmde>.