Strat Mobile for iOS v. 2.0

by Richard W. Allmendinger © 2017-2018

Contents

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Strat Mobile is provided "as is" with no 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 10-20°! 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.

Privacy Statement

Strat Mobile will capture the location of the device, only with the users express consent the first time it is used, to tag observations with the place they were collected. The program is fully usable, though less convenient, without access to device location. Location data, if collected, remain on the device as long as the user chooses to leave it there but is not accessible to any other program on the device. The user may choose to send location tagged data to a different computer or person via the iOS sharing panel (email, iCloud Drive, etc.) or via iTunes File Sharing. *Strat Mobile* never sends any data to the author or to any other third party, except in the case where the user elects to display the position and orientation of a datum on an Apple supplied map or satellite image. For Map View functionality, *Strat Mobile* must request an image from Apple at your approximate location or that of your data.

Purpose

Strat Mobile is a program for iOS devices that enables you to measure and record stratigraphic sections right on your iPhone or iPad. Some of the basic tasks that one can perform with the app include:

- Real time plotting of the stratigraphic section as it is being measured.

- *Strat Mobile* offers five (5!) ways of measuring a stratigraphic section:

  1. Using your known eye height while sighting down-dip through the device camera.

  2. Using your phone attached to a monopod and sighting down-dip through the camera — a modern digital Jacob staff

3. Using a traditional Jacob staff. The device can determine the strike and dip of the bedding for you with the tap of a button

4. Using a tape measure. You enter the tape azimuth, slope, start and end point, as well as the strike and dip of bedding, and the device will calculate the correct thickness automatically.

5. Using your GPS position and strike and dip entered at the base and top of each measured interval

- Automatically record, latitude, longitude, time and date for every interval measured.

- You can define an unlimited number of lithology types (with corresponding colors and widths) to draw your section and tag your observations.

- Provide basic statistics on the section measured, including the thicknesses and percentages of each lithology

- See the locations of entire sections, measured intervals, and samples on a satellite image or road map.

- Provide basic input and output of data using standard iOS conventions

- Will work on iPhones or iPads. The program will work on iPods or iPads lacking a cellular data connection but those devices have fewer sensors and thus cannot be used in automatic data collection mode.

Conventions

Strat Mobile assumes that **you are measuring section from the base to the top**, which is the traditional way of measuring section. Each unit that you measure is assumed to be on top of the previously measured unit. In the first release of the program, at least, you cannot measure a section top-down.

The basic unit of data in *Strat Mobile* is the **measured interval**. The interval is determined by the input method. In the field, the measured interval might correspond to the length of the traditional Jacob staff used, but it might also be defined by the starting and ending points along a tape measured laid out across part of the section, or even your eye height. If you have a 30 m thick section of shale and are using a traditional Jacob staff that is, say, 1.5 m long you will have 20 intervals of shale. On the other hand, if you lay out a tape measure that is long enough to extend from base to top of the shale section, you would have only one interval (unless you choose to divide it up for some reason).

In *Strat Mobile*, your location is provided by the phone's GPS receiver. This can be toggled off using the GPS switch on most screens in order to keep from draining your battery. When you leave that screen after making a measurement, the GPS is automatically turned off so you will need to remember to turn it back on when you return to the screen to make your next measurement. For some types of measurements — all sighting measurements as well as GPS thickness measurements — the GPS is turned on automatically. For the others, if you forget to turn on the GPS when you press the Save Data button, a message box will appear asking you if you want to turn on the GPS. This will turn on and immediately record the GPS and then turn it off again; you will get a more accurate reading if you turn it on and let it sit for a few moments. If you leave GPS turned off and decide later that you want a GPS reading for that interval, you can go to the datum details view for that measurement and press the GPS button in order to capture the GPS coordinates where you are standing. These coordinates will be associated with the base of the measured interval. Using a switch in the Settings View ⓘ, you can also have the GPS automatically turn on whenever you open the section view (but then you will have to remember to turn it off!).

> **Dismissing the Keyboard**
> Most keyboards that appear when you tap in a text field have a "Done" button in the lower right that will allow you to dismiss the keyboard when you are done.
>
> *However, the Notes/Description fields in the Sample Entry, and Datum and Sample Details screens have keyboards that have a return key rather than a Done button.* To dismiss the keyboards in those cases, tap outside of the field in which your are typing. In recalcitrant cases, you may need to tap into a different, single line text entry field. The keyboard will change to one with a "Done" button that you can then tap to remove the keyboard. Sorry, this behavior is controlled by the system…

Assuming the GPS is turned on, for sighting methods or traditional Jacob staff measurements *Strat Mobile* **assigns a latitude and longitude to your position and the interval at the time that you press the Save Data button**. This position will usually be at the base of the measured interval. For tape or GPS measuring, you tap a button to define the GPS coordinates at the start (base) and end (top) of the measured interval. The app assumes that the top of one interval is the base of the next, but it allows you to set the base of the next interval manually should you decide to offset the section.

Samples are entered in a separate screen and are recorded in a separate list in the data file. For GPS and Tape measurements, one (or more) samples are entered by tapping the Sample button on the bottom toolbar before you record the observation. Although you can enter the sample afterwards, you will have to know independently where the sample is located within the section. For small intervals measured with tradi-

tional or digital Jacob staff or sighting using eye height, samples are entered after saving the measure using the button on the Interval Details view.

The app automatically saves your measurements to the device in a file labeled **RecoveryFile**. If for some reason the app crashes, or you quit the app and return to measure more intervals later, the recovery file is automatically read back into the app so you can pick up where you left off. Pressing the "New" button on the Data List View will cause the existing section to be cleared in order to provide a clean slate for a New section; the RecoveryFile is maintained in case you made a mistake in deleting the data. However, the RecoveryFile is automatically restarted new the first time you record a new observation after pressing the "New" button. Thus, you will want to save your section frequently with its own name and not depend on the RecoveryFile.

All methods for measuring section thickness require that you know the **true dip** and some (tape or GPS measurements) require that you know the **strike of bedding** as well. Strat Mobile can acquire these measurements for you. Place the back of the phone flush against a bedding plane in any orientation and press the "Auto-orientation" button. Once the phone is stable, you will see the strike and dip displayed. At that point, you can turn off auto-orientation and the strike and dip will be preserved for the thickness calculation. Strike and dip measured this way is subject to the artifacts and uncertainties of iPhone orientations as described in Allmendinger et al. (2017) You can, of course, enter strike and dip measurements made with a traditional analog compass. If you want to enter true thicknesses directly, just enter them as Jacob staff measurements where the length of the "staff" is variable and equal to the true thickness. In that case, you do not even have to enter true dip.

Entering Intervals

Strat Mobile enables five basic forms of data input. The method that you choose will depend on the scale and detail of your measured section:

1. Recording traditional Jacob staff measurements where you have a compass/clinometer on a staff of known length (thickness)

2. Entering measurements made along a tape and calculating the thickness for you

3. Using your GPS position at the base and top of each measured interval

4. Sighting through the device camera and calculating the interval thickness using your eye height.

5.   Mounting the iPhone on a monopod of known or adjustable length, while using the device camera to sight down dip (replacing the compass/clinometer).

The home view that you see when you first start the app is the Section View. Only traditional Jacob Staff measurements are actually entered on this screen but all methods are accessed from this screen. The fourth and fifth measurement types are accessed from the Sighting View, which can be activated with the navigation button at the top left of the Section View. Data input varies by which of the methods you are using and are described in more detail below.

Both of these views have a lithology button where you can assign a general lithology to the measured interval. You can switch between input methods at any time including right in the middle of measuring a section.

The Section View

In the Section View, which is the home screen, you see a real time graphical version of your section as you are measuring it. The very first time that you use the program, the left side of the section view will be blank because that is where your section will be drawn. After that, *Strat Mobile* displays the most recent section in that space. At any time, you can double tap on a unit in the section and you will be taken automatically to the Interval Details View that contains all of the pertinent details about the interval that you have entered. The units of the measured section are set in the Settings View, accessed by tapping the ⓘ icon on the bottom toolbar. You select whether you want to enter data using a traditional Jacob staff, a tape measure, or by GPS coordinates using the segmented control button on this screen.

You can expand or shrink the section on
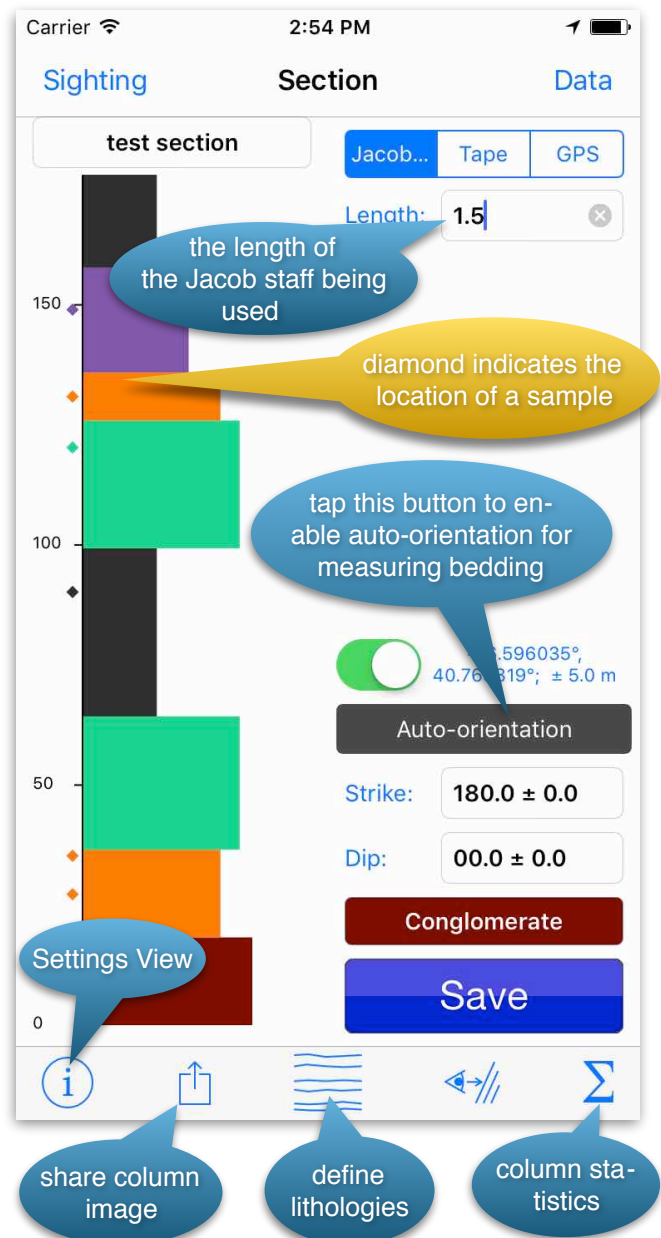
the left side of the screen using the traditional iOS two-fingered pinch gesture. In the expanded state, you can still double tap an interval to go to the details for that interval. When expanded or shrunk, use a single finger swipe up or down to scroll to the part of the section you want to examine in detail. Going to any other screen or view and then returning to the Section View will always return the section to the default scale so that you see the entire section filling the screen.

Traditional Jacob Staff Entry

In traditional Jacob staff entry, a clinometer is fixed at the top of the staff. The base of the staff is placed at the base of the unit to be measured and then tilted until the staff is perpendicular to bedding (i.e., the clinometer has the same reading as the dip of bedding). The Jacob staff should be tilted in the direction of the true dip of bedding. The thickness of the measured interval is the same as the length of the Jacob staff. That length is entered manually in the Length text field on the screen.

In this mode, the phone is just used as a recording device; it is not attached to the staff at all. You can use the app to measure the bedding orientation by placing the back of the phone flat against the bedding surface. Tap the auto-orientation button near the bottom of the screen to measure the strike and dip; tap it again to stop measuring and turn off automatic orientation recording. While auto-orientation is turned on, the GPS position is captured and maintained so that it can be recorded with the interval.

Either before or after using auto-orientation, you can tap the lithology button to assign a lithology to the measured interval. As described below, in the slide-up screen, you can select an existing lithology or define a new type of lithology. Each lithology is assigned a different color and width so they are easy to differentiate on the stratigraphic section.

When you are finished with a Jacob staff measurement, tap the Save button. You will automatically be taken to the Datum Details view (unless you have turned this off in Settings) where you can enter more details about the interval you just measured, or even change the measurements. You can add sample(s) by tapping the Add Sample button, and type or dictate notes into the Description text area. These notes can be as long as you want and are saved automatically with the datum. If you change anything else on the screen (reset the GPS, change the thickness, etc.), you will need to tap the save button at the bottom of the screen to record those changes.

When finished entering details about the just measured interval, tap the Section button at the top left of the screen to return to the Section View, ready to make the next measurement.

Using a Tape Measure

When measuring section with a tape measure, the geologist will usually lay out a long length of tape across part of the section to be measured. The tape may, or may not, be oriented perpendicular to strike and will have a tape slope angle with respect to the horizontal. The tape measure may stretch across multiple intervals to be measured and described. Thus, there are four measurements that characterize the tape: (1) the azimuth (or trend) with respect to north, (2) the slope angle of the tape (which may be different than the true slope angle if the tape obliquely crosses the topographic slope); (3) the tape reading at the start or base of the interval to be measured; and (4) the tape reading at the end or top of the interval to be measured. When you select "Tape" from the segmented control, the Tape Entry View (right) will appear.

Tape Entry View allows you to enter the tape azimuth, slope (positive upwards), beginning and ending readings on the tape as well as the strike and dip of the bedding in the interval to be measured (see illustration, next page). Strike and dip are required in order to calculate correctly the true thickness of the interval. As before, you can use the auto-orientation button by tapping on the Strike and Dip labels to capture bedding automatically.

While GPS readings for the top and bottom of the interval measured are not necessary for determining thickness, they are necessary if you want to show the locations on a map. The tape entry view provides two buttons, one to mark the base and the other the top of the interval measured. When all of the required measurements have been added, the thickness of the interval will be displayed near the middle of the screen.

If you want to add a sample that was collected somewhere along the tape, tap the sample button on the bottom right of the tool-bar **before** tapping the save button for the interval. The sample entry screen will slide up from the bottom allowing you the enter an ID number and sample description. Crucially, a textfield at the bottom of that screen is where you enter the distance along the tape where

Tape conventions: strike and dip given using right-hand rule. Tape azimuth given in the ***up-section*** direction with slope positive going uphill and negative going downhill. Section is measured from base to top.

the sample was located. *Strat Mobile* will then calculate the position of the sample within the stratigraphic section.

Select the lithology, tap the Record button and, as described above, the Interval Details View will appear automatically (unless turned off in <u>Settings</u>) enabling you to enter the details of your measured interval.

In making tape measurements, the app calculate the thickness in the following way: We assign the starting point along the tape as the origin of an East-North-Up (ENU) coordinate system. In this system, the endpoint along the tape then has coordinates of:

$$E = d\cos(\alpha)\sin(\beta)$$
$$N = d\cos(a)\cos(\beta)$$
$$U = d\sin(\alpha)$$

where α is the tape slope, β is the tape azimuth with respect to North, and d is the length along the tape ($d = top\ reading - base\ reading$). To calculate the thickness, we do a coordinate transformation into a coordinate system defined by the orientation of bedding: a Strike-Dip-Pole (SDP) system as described in Chapter 4 of *Modern Structural Practice*. From this transformation, the thickness is given by:

$$thickness = \sin(strike)\sin(dip)N - \cos(strike)\sin(dip)E - \cos(dip)U$$

Using GPS Coordinates to Calculate Thickness

If you are measuring a very thick section with large intervals, you may find GPS Entry useful. You simply set the GPS coordinates at the base and at the top of the interval to

be measured, as well as entering the strike and dip of bedding. Strat Mobile will calculate the thickness of the interval using the UTM coordinates of the base and top. Similar to the tape calculation, for GPS readings, the thickness is calculated from:

$$thickness = \left(\sin(strike)\sin(dip)\right)\left(t_N - b_N\right) - \left(\cos(strike)\sin(dip)\right)\left(t_E - b_E\right) + \cos(dip)\left(b_U - t_U\right)$$

GPS coordinates, especially the elevation can have significant errors. *Strat Mobile* uses the position errors provided by the device to calculate the uncertainty on the thickness of the unit. The minimum error provided by the device on position in E, N, and Up is 5 m in any direction. Thus, the minimum possible thickness error when using the GPS Entry will be 12.25 m but, of course, it could be much larger. The error propagation assumes random and uncorrelated errors with a Gaussian distribution on the input values. The calculation should be thought of as a minimum uncertainty because it assumes (incorrectly) that the strike and dip are perfectly known. Though we don't know what the errors on strike and dip are, they certainly do exist!

This uncertainty is the reason why you'll only use GPS measurements in reconnaissance mode or in very thick sections!

When you tap the GPS segment of the button on the Section View, you will be taken to the GPS measurement screen (Figure next page) to enter the readings. All you need to do is stand on the base of the section and tap the "Base GPS coords" button, walk to the top of the interval and then tap the "Top GPS coords" button. GPS coordinates are displayed in UTM format as the calculation is done in that coordinate system. As soon as you have viable values (i.e., you've already enter the strike and dip), the app will calculate the thickness (and uncertainties) as well as the azimuth and slope and display them on the screen.

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| Section | **GPS Entry** | Data |

Tap the buttons to enter the GPS coordinates of the base and top as well as the strike and dip of bedding in the interval being measured. The UTM coordinates along with the azimuth and slope between the two points will be displayed. Errors on the thickness are calculated from errors on position provided by the device.

Base GPS Coords	Top GPS Coords
356241.8m, 7380420.9m, 39.3m	356317.8m, 7380387.8m, 41.1m

Azimuth = 113.6°   Slope = 1.3°

Thickness = 51.38 ± 16.58 m

⬤ -70.409115°, -23.680923°; ± 5.0 m

Auto-orientation

Strike: 021.5 ± 0.18   Dip: 33.0 ± 0.76

Shale

Save

ⓘ   Sample

If you want to add a sample that was collected somewhere between the base and top, tap the sample button on the bottom left of the toolbar **before** tapping the save button for the interval. The sample entry screen will slide up from the bottom allowing you the enter an ID number and sample description. Make sure to grab the GPS coordinates of the same in this screen so that *Strat Mobile* can locate the sample correctly in the stratigraphic column.

The Sighting View

The Sighting View gives you a live image through your phone or iPad camera. For both types of measurements that you can make on this screen, the app assumes that you are looking down-dip in the true dip direction. That is, your eye (and the camera) is in the plane of bedding so that you see the bedding surface edge-on, looking in the true dip direction. This view has a lithology section button that functions exactly like the same button in the Section View.
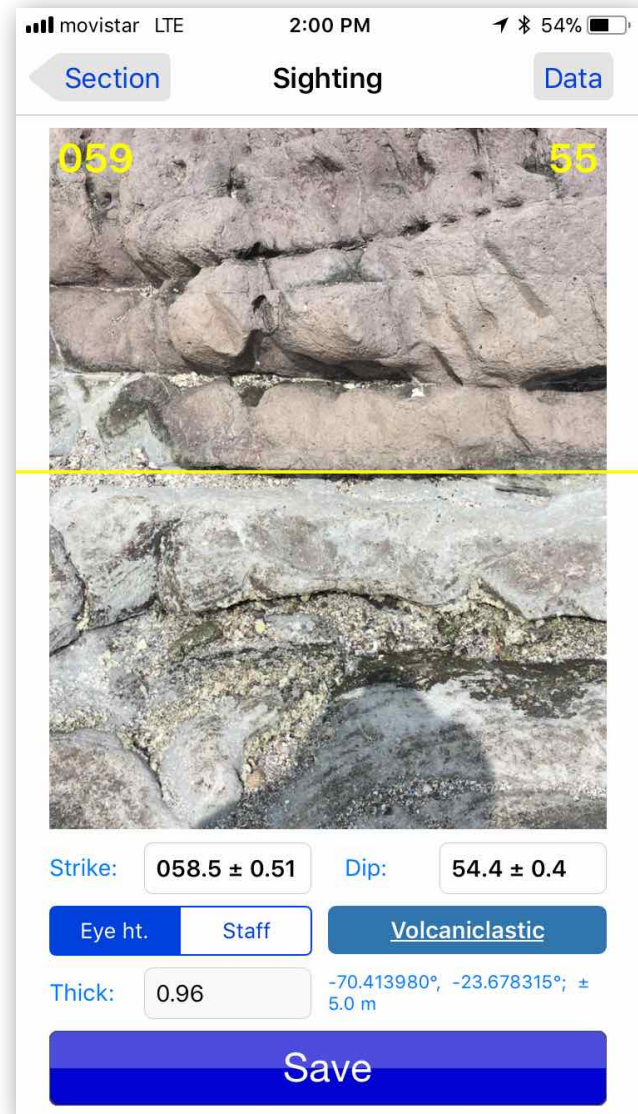
In the Sighting View, auto-orientation and GPS are turned on automatically for as long as you are in that view. When the phone is held stably for at least one second, and you are looking down-dip in the plane of bedding, the time-averaged orientation of bedding is shown in the strike and dip fields; the yellow numbers in the camera view show you the instantaneous bedding orientation. The phone must be held stably for one-second at least in order to record a measurement by tapping the Save button.

You select the input method to use with the segmented control.

Using Your Eye Height

It turns out that you don't need a physical Jacob staff at all as long as you know your eye height (with your field boots on!). Stand on the base of the interval to be measured,

hold out the phone in front of you so that you are looking through the camera down-dip, wait for the orientation to stabilize, then tap the Save button. The true stratigraphic thickness of the interval measured in this way is simply:

$$thickness = \left(eye\_height\right)\cos\left(dip\right)$$

It seems too easy to work but it does, and it works equally well sighting uphill or downhill! The thickness of the interval is displayed in the thickness text field below the segmented control. For the next interval, simply stand at the top of the previously measured interval and repeat the sighting procedure. Of course, you need to stand straight and your eye, the pole to the phone, and bedding all need to lie in the same plane.
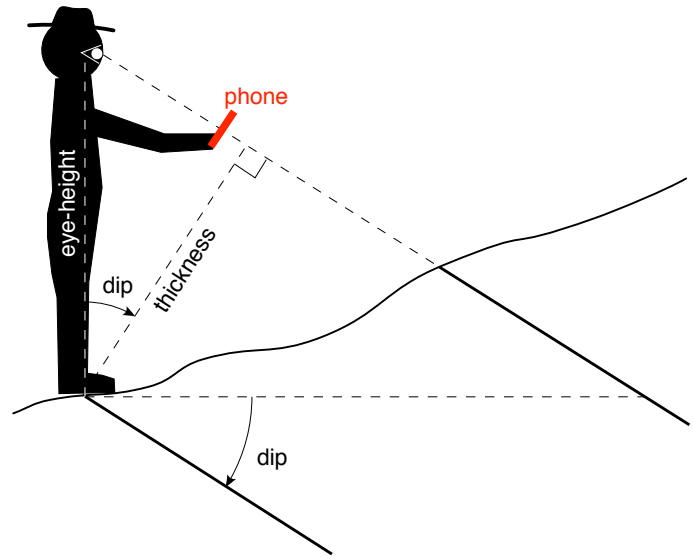
There are some caveats, though, the main one being, as you can see from the above equation, that the steeper the dip, the shorter the thickness interval that one can measure. When the dip reaches 90° you cannot measure any thickness at all! The maximum interval thickness is equal to your eye-height. Nonetheless for those times when you need to make a quick thickness calculation and don't have a physical staff or tape measure with you, it works great.

As with the other methods, when you tap the Save button, you will immediately be taken to the Datum Details view where you can record any samples collected and write/dictate your description of the unit measured.

Using the Phone on a Monopod

You can easily buy an adjustable height monopod with a traditional screw fitting for attaching a camera. Likewise, you can buy a holder for your phone with a female fitting for attaching the phone to the monopod; I use a small inexpensive device called a Glif which you can get from https://www.studioneat.com/products/glif. Attach the phone to the monopod and you have a modern, adjustable, digital Jacob staff!

Select the "staff" part of the segmented control. Enter the height of the monopod plus phone (to the camera on the phone), in the Length textfield. Pick the lithology, tilt the monopod until you are looking down dip through the camera, hold steady for 1 second

and tap the Save button. The interval thickness is the same as the length of the mono-pod+phone.

Entering Samples or Other Point Observations

"Sample" is really a shorthand for any point observation that you make within an interval. Point observations, of course, include various types of samples including those for geochronology, fossil collection, petrography, etc. But they can also include marking a place where you took a photograph, measured a feature like a paleocurrent direction, or any other unique observation. You don't have to use samples at all, of course. If you are measuring a section on a centimeter scale, your intervals are verging on point observations anyway: e.g., the tuff that you sampled for geochronology is the interval. However, if you want to note that you collected a volcanic tuff for geochronology that was in the middle of a 30 m thick section of monotonous foreland basin sandstones, you will want to use Samples.

There are two ways to enter samples and the manner that you choose will likely depend on the method you are using to measure sections (and the thickness of the interval being measured). In both cases, all samples must be connected to a particular interval.

During measurement of an interval

It is likely that you will use either tape or GPS measurements to collect a section with intervals on the scale of meters to tens or hundreds of meters. For these two measurements, Strat Mobile provides a button on the Tape or GPS View in the lower right hand corner that you can tap to enter a sample *during your measurement*, i.e., before you record the interval measurement. This is particularly important because Strat Mobile does not

record the tape measurements, themselves; once you press the record button, Strat Mobile only records the true thickness of the interval calculated from your measurements, and the height above the base of the interval (and base of section) for the sample. Thus, in the screen shot shown on the previous page, the total tape length for the interval was 40 m but the position on the tape of the paleocurrent measurement was at 29.3 m within the interval. When you tap the "Done" button, you are returned to the Tape (or GPS) view in order to complete measurement of the interval. ***If you do not record the interval by tapping the record button on the Tape (or GPS) View, the sample that you entered will not be recorded either!!***

After recording an interval

At any time after you record an interval, you can tap the "Add Sample" button on the Interval Details view to add a sample to that interval. This is the only way to add samples to jacob staff, eye height, or monopod measurements, but you can also use this for intervals measured with tape or GPS. The "Add Sample" button will bring up the Sample Entry screen (the same screen that you see on the previous page), but instead of "distance on tape" the bottom text entry will read "Thick. above base:". In the text box to the right, enter the height above the base of the interval that the sample was collected or observation was made. If you make no entry in this box, Strat Mobile will assign the sample to the base of the unit. In this case, your sample is recorded as soon as you press the "Done" button; it is not necessary to "Save" the interval.
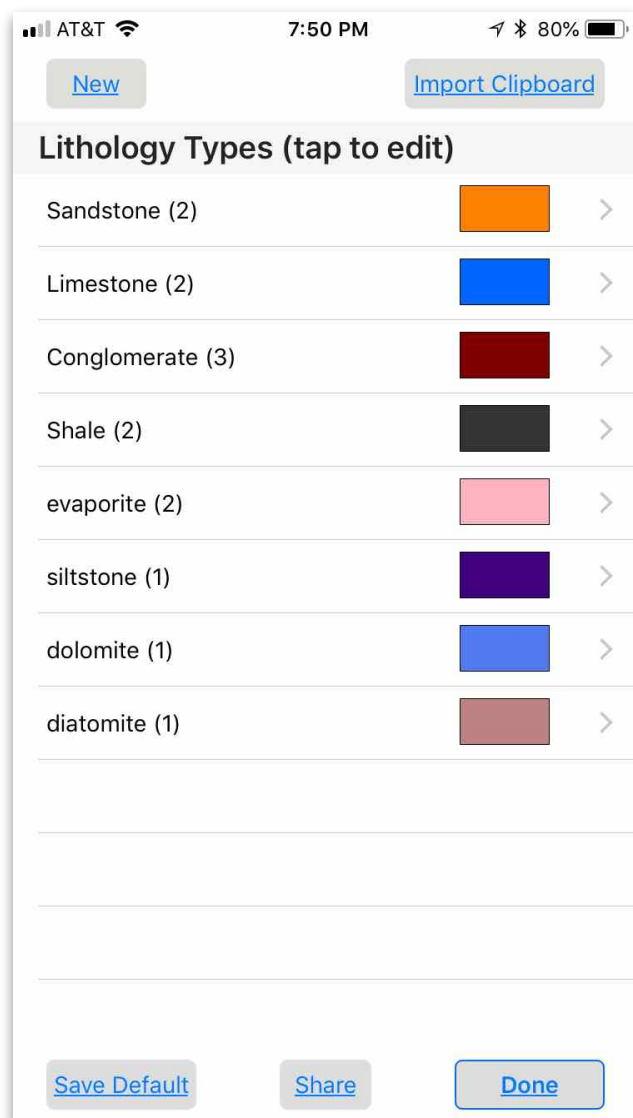
Lithology Types

You can define as many lithologies as you want for your measured section as well as editing the existing ones. To do so, tap the "stratigraphy" button (right) in the middle of the bottom toolbar on the Section view screen. This will bring up the lithology picker in the figure on the left, below. You see a version of this screen whenever you want to assign a lithology to an interval.

Adding or Editing Lithology Types

To edit an existing type, simply tap the name. To add a new lithology, tap the New button in the upper left corner. The view where you add or edit is shown below on the right. This screen has several parts including (a) a text field where you can type in or edit the name of a lithology, (b) three scrolling type, group, and name pickers or spinners, (c) sliders where you set the color and width of the lithology as it will appear in the column, and (d) a color bar showing you your selected color/width.
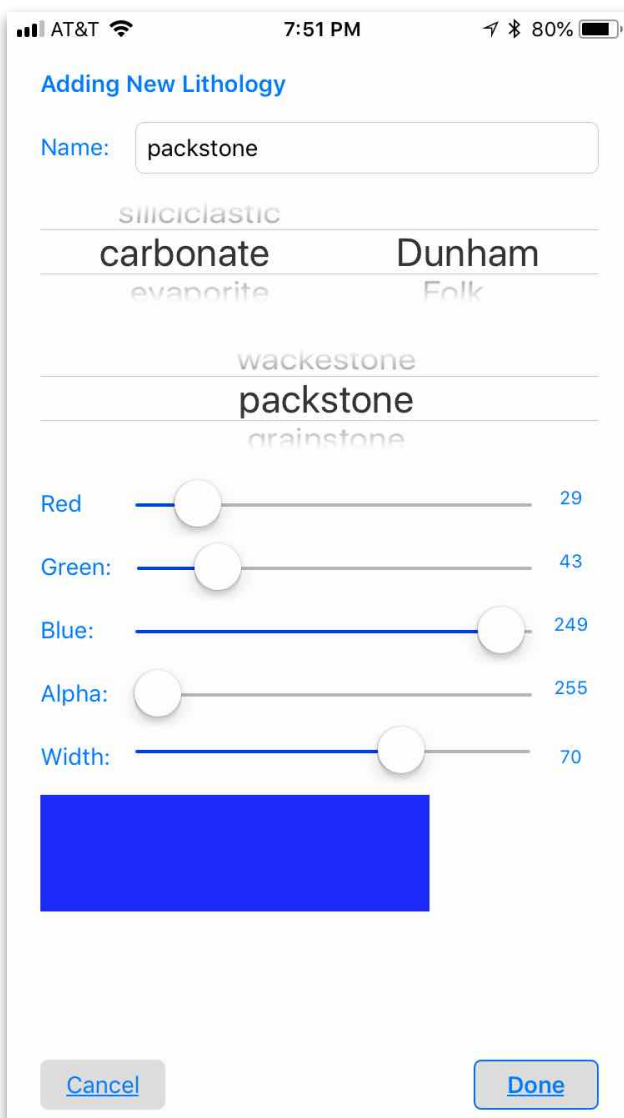
The lithology type view   **The lithology type edit/add view**

Parts (a) and (b) work together. The names in the scrolling pickers are from the sedimentary rock type, group, and names database at macrostrat.org. You drag your finger vertically over these scroll wheels to pick the type (upper left), group (upper right), and name. As you change the more general ones the more specific ones change to show you choices from just those groups. Some of the group categories have a blank line at the top where you will find the most general terms. As you change the names spinner, you choice will appear in the text field at the top.

If you don't want to search through all of the spinners to find the term you are looking for, you can simply start typing in the text field and matches will appear in the spinners automatically. For example, if you type "dolo", the spinners will automatically be set to carbonate:[blank]:dolomite. You are not in any way restricted to the macrostrat.org

lithologies; you can type whatever you want into the text field. Lithology names can contain spaces and or punctuation.

The macrostrat.org database defines standard colors for all of the lithologies it contains. As you type or use the spinners, those colors will be selected for you automatically. However, once you have set the lithology, you can change the colors to whatever your want. You change the color used to represent the data type by adjusting the Red, Green, and Blue sliders just below the name text field. The number to the right of each slider tells you the value in case you want to enter specific values. Each slider varies between 0 and 255. If all sliders are set to 0 (far left) you will get black; if they are all set to 255, you will get white. The Alpha slider controls the transparency of the color which, within the app, will simply lighten or darken the color but will not change it. The Width slider controls how wide the lithology will appear in the stratigraphic column, entered as a percentage of the maximum column width. The rectangle beneath the sliders changes color and width as you move the sliders to show you the results of your selection.

Combine or Delete Lithology Data Types

If you edit the name of the lithology to match another already defined lithology, when you tap the "Done" button, the app will ask you whether you want to **combine the two data types**. For instance, perhaps you have a "black shale" lithology and a "dark dark gray shale" lithology but then decide that you really only want all of the intervals lumped together under "black shale". Select "dark dark gray shale" to edit, change its name to "black shale" and press done. A message box will appear telling you that the type "black shale" already exists and asking you if you want to combine the two. If you answer "Combine", the program will put all of the "dark dark gray shale" intervals into "black shale" and will erase the "dark dark gray shale" lithology type.

The buttons at the bottom of the Editing Data Types screen determine what happens to the changes that you make. "Cancel" will return you to the previous screen with no changes, even if you had changed some of the settings. "Done" will apply the changes you have made to the data type that you originally tapped to get to this screen in the first place.

If you are editing a lithology type, a red "Delete" button also appears at the bottom of the lithology type edit/add screen. You can only delete lithology types that do not have any intervals assigned to them. To delete a type with intervals assigned to it, edit the name to match an existing type to which you want to assign all the intervals. The program will then delete the now empty type automatically.

Save Default Lithology Set

When you have a suite of lithologies that you like, you can save them as default so that all new sections will have them available. Simply tap the "Save Default" button at the bottom left of the Lithology Type view. This only affects new sections. Any sections that you have saved will use the lithologies that have been saved with them, including their colors and widths.

Exporting and Importing Lithology Types

You may want to have different suites of lithologies for different projects, classes, or to match different types of desktop software. To export a suite of lithologies that you have defined in the app, tap the Share button at the bottom of the lithology type view. The standard iOS Sharing Panel will appear, allowing you to save the lithologies to another app, copy to clipboard, send via email, or save to iCloud Drive, or transfer to another device using AirDrop. You might want to save different suites of lithologies in Notes or some other note-taking app where you can easily copy then to the clipboard for pasting back into Strat Mobile at a later time.

A lithology file is a text file with a simple structure that looks like the following:

```
No.  Lithology       Type           Red  Green Blue  Width
0    conglomerate    siliciclastic  255  192   0     80.000000
1    sandstone       siliciclastic  255  213   0     65.000000
2    volcaniclastic  siliciclastic  255  255   0     65.000000
3    Shale           siliciclastic  51   51    51    35.000000
4    gypsum          evaporite      243  168   179   65.000000
5    Siltstone       siliciclastic  64   0     128   50.000000
6    Limestone       carbonate      70   0     245   66.390045
```

Each column is separated by a tab character. Note that the lithology name is in the second column and the type is in the third column; group is not used. If you have only entered a name and have not entered a type, the app puts an underscore character "_" in the Type column. The RGB values are the same ones that you see on the sliders in the program. You can prepare this file in any text editing program, but it is probably easier to set it up in Strat Mobile or Strat Desktop, which can also export such a file.

To copy these values for importing back into the program, you must select the entire header line as well as the values for the individual lithologies and copy them to the system clipboard. In Strat Mobile, you import lithologies on the Lithology Type view by tapping the "Import Clipboard" button in the upper right hand corner of that view. The imported lithologies will not replace any lithologies that have intervals assigned to them but will erase any unused lithologies. If an existing lithology (with intervals assigned)

has the same name as one being imported, it will adopt the imported lithology color and width.


Inspecting Entered Data

Data List View

To see a list of the data that you have entered, tap the "Data" button at the top right of the Section, Tape, Sighting, or GPS View to see the Data List view. Each measured interval will be displayed in a list. You see the interval thickness, the cumulative thickness to the top of the interval and bedding orientation as well as the latitude and longitude, if available, and the date. The color dot on the right hand side corresponds to the lithology assigned to each datum. You can see a similar list for samples by tapping "Sample" in the segmented button at the top. This list is where you manage your sections.

The buttons at the bottom of this view allow you to <u>save, share, or open data files</u> as explained in a subsequent section. To save a file, you must have entered a name in the text box at the top. The Map button (folded map with pin icon) will take you to the <u>Map View</u> where you can see the section line plotted on a satellite image of your area. The "New" button will clear all entered data from the program in preparation for starting a new section. Any saved data, as well as data in the RecoveryFile will remain on the device and can be read back into the program. The RecoveryFile will continue to contain the old section until you enter your first interval from the new section.

You return to the Section View (or whatever view you came from) by tapping the "Section" button in the upper left corner.

Tapping on any datum in the list will bring up the…
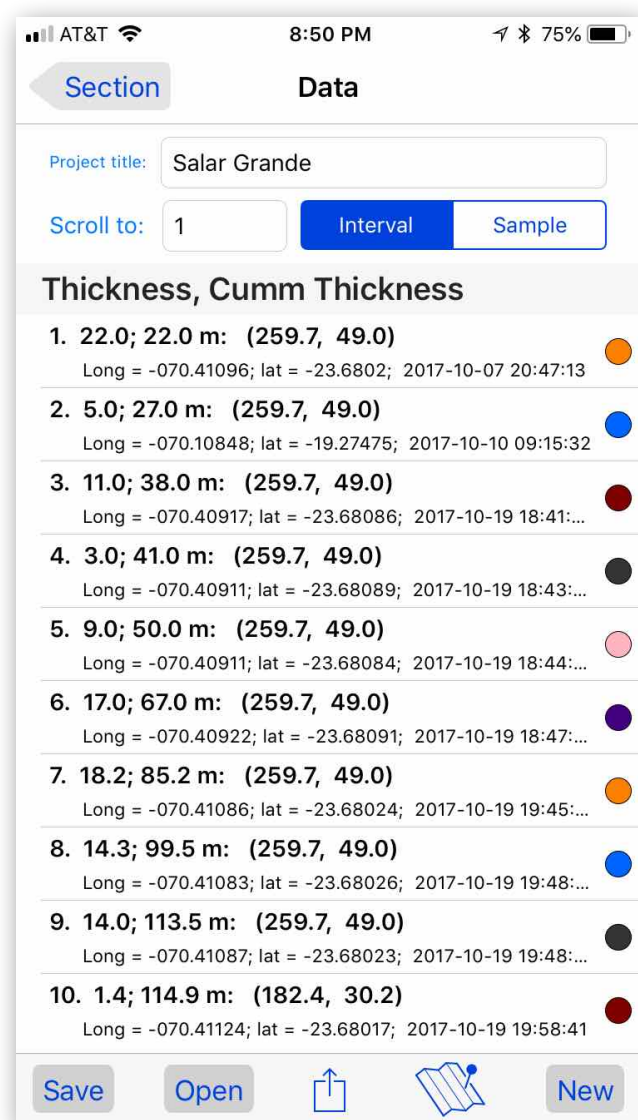
Datum Details View

Here you can see all of the details about a single measured interval or "datum". You can get to this screen by tapping a measurement in the Data List View. This will enable you to enter additional information in the notes field immediately for your most recent measurement.

The Trash Can button in the lower right hand corner will delete the datum (a message box will check to be sure). You can see the location and orientation of the measurement (if location data have been entered) in the Map View by tapping the Map button (folded map with pin icon) in the toolbar. The return to Datum Details button in the uppermost left corner in Maps will take you right back to where you were.

The "More" button in the upper right will take you to the More Details screen (next page) where you can enter the character of the basal boundary as well as the grain size at the base and top of the unit. The unit in the column on the section view will be drawn taking the grain sizes into account so you will see immediately the fining or coarsening upward nature of the interval. Changes in the More Details view are recorded immediately.

You can edit any of the text fields by tapping on them, erasing the existing information (if any) and then typing in the new information. If you change the number of the datum, the corresponding information will be displayed. Easier still is to use the slider control at the top of the screen to rapidly move through the different measurements. With the exception of the description and samples fields, any changes that you make are not recorded until you tap the "Save" button in the lower right hand corner. Anything that you type in the Samples and Description fields is attached to the measurement immediately without needing to press Save Changes. Note that you can use voice dictation in iOS even if you are not connected to the Internet.

The lithology type of the measurement can also be changed on this screen by tapping the colored data type button ("Limestone" in the above image). The Lithology picker view will slide up from the bottom of the screen. In that view, you can select a different existing data type or tap the New button to define a whole new data type. To have the data type change be recorded, you must tap the "Save" button in the lower left. The app attempts to remind you to this by drawing the outline of the lithology type button in the old data type color and the rest in the new data type color until you tap "Save".

The "GPS" button on the toolbar at the bottom of the screen when pressed will allow you to add the current location of the device to the longitude and latitude fields in case you forgot to turn on GPS on the Stereonet View. You must press the "Save" button for those to be recorded.

You return to the Data List view by tapping the Data List Button in the upper left corner.

Sample Details view

The sample details view appears when you tap a sample in the Samples List of

the Data List view. Here you see similar information to what you can see the Datum Details view. Most entries in this view (except for the description field) require you to tap the "Save" button in order to record your changes. You can set the GPS location at the current position of the phone for the sample by tapping the GPS button. If you change the thickness within the interval ("Thick. (m):") the position in section will be automatically recalculated. You should be especially careful about changing the Interval number ("In Int.:").

Map View

Strat Mobile can plot your data on a satellite image or road map within the program. You can access the map view using the "folded map and pin" icon button in the toolbar at the bottom of either the Data List View or the Datum Details view. If you access the map from the former view, it will show a polygon depicting where your line of section is locat-

ed. If you choose the Map View from the Datum Details View, it will show only a dot for the single datum that you were looking at in the details view.
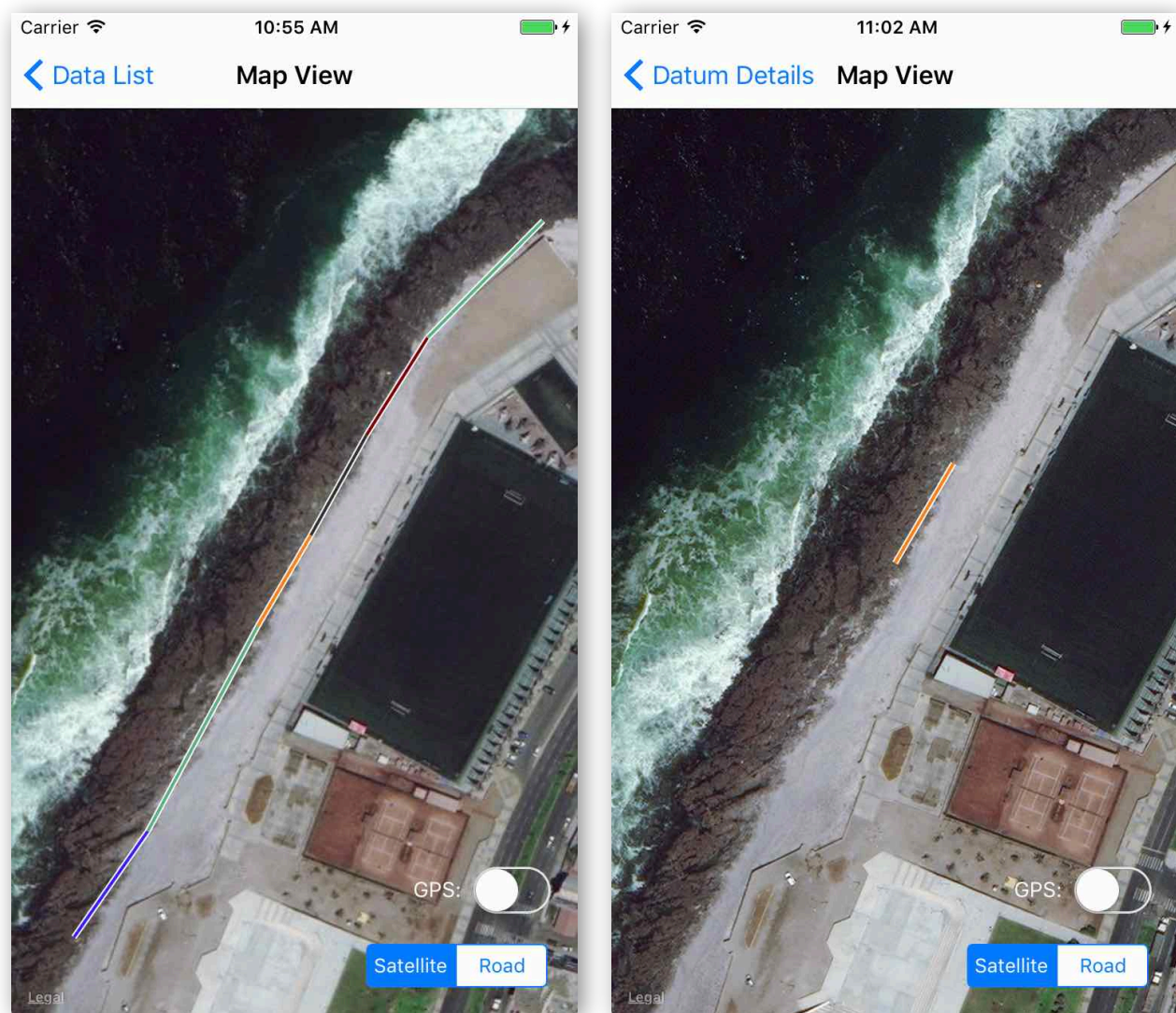
In the Map View (shown below), the buttons in the lower right corner allow you to select the map type and the switch button labeled "GPS:" allows you to show or hide your current position (if your position is within the area of the data depicted). The map can be zoomed in by double tapping where you want to zoom to, or you can use the standard iOS two fingered pinch gesture.

If the data you want to show have no location info, or you haven't entered any data, the Map View will still be shown. This will allow you to cache some of the images for offline use. *Strat Mobile* cannot control the size of the map image cache but this may be of some help if you anticipate doing field work in a region without cellular data coverage.

Getting Section Statistics

When you tap the "Σ" button from the tool bar at the bottom of the Section View *Strat Mobile* will show you some basic statistics about your section. These are limited to the cumulative thicknesses and percentages of each lithology as well as a summary of the samples collected.

Getting Data In and Out of the Program

Because iOS hides its file structure from the user, data I/O is not a straightforward as in desktop programs. There are two important habits that you should develop right away: (1) Save your data to the documents folder on the device frequently; and (2) move your data off the device whenever you have a data connection. **iPhones, get stolen, apps crash, and app updates can make previously collected data on the device unreachable!** Here are your current options:

The Document Folder on the Device

Each app in iOS has its own private document folder where it can store its files. To save your data to this private folder, navigate to the Data List View. At the top of the screen enter a "Section Name" that will become the name of the saved file. Tap the "Save" button on the toolbar at the bottom of the screen. A message box will confirm that you have saved the file. Note that this will overwrite any file of the same name that is already in the hidden documents folder. This allows you to re-save a file easily after entering more

data but it has the distinct drawback that you might inadvertently wipe out an unrelated file that has the same name (since the files are mostly hidden). You can avoid this by…

Getting a List of Files Already Saved to the Device

In the Data List View, tap the "Open" button on the toolbar at the bottom of the screen. A new view will slide up from the bottom listing all of the files saved in the hidden Documents folder on the device, along with their modification date and time. If you just want to see what's in there, tap the Cancel button at the bottom of the screen and you will return to the Data List View. You can also delete files from this screen by toggling on the "Delete Files" switch and then tapping on the file you want to delete. The file will be gone instantaneously so be sure you know what you are doing!

If you want to open one of those files, tap on the file name and it will be opened. If you have any data already entered, the app will give you the option of either replacing the entered data with the data in the opening file, or Appending the data in the file to the data already entered in the program. The "RecoveryFile" behaves just like any other file (except that you cannot delete if from within the program): just tap on it to recover your data from an unexpected operation.

Using iTunes File Sharing to Manage Data in the Documents Folder

At the present time, one of two ways to upload data to the device, or erase files from the device, is via iTunes file sharing; the other way, <u>via the iOS clipboard, is described below</u>. To use iTunes file sharing, you must attach your device to your desk/laptop computer and launch iTunes. In the apps pane for your device, you will see a list of all programs on the device, if you select *Strat Mobile*, you will see in the list on the right all of the files on the device that *Strat Mobile* can open. To save one of these files to the desktop just drag it out of the iTunes window to the desktop or other folder. Likewise, you can drag files that you have prepared on your desktop to the device but dragging those files to the *Strat Mobile* iTunes file sharing window. To erase a file from the device, select it in the Window and press the delete key. Yes, it is cumbersome, I know… See <u>Apple's web page for instructions on how to use iTunes File Sharing</u>.

Data Output via Sharing

Probably the most convenient way to access the data that you have entered in *Strat Mobile* is via the standard iOS Sharing Panel (see the graphic next page at right). From the Data List View, tap the "Share" button on the toolbar at the bottom. The standard sharing panel will slide up. From here, you can send the data to any program on your

device that can read text, including Mail, Notes, etc. You can also copy the text to the system clipboard and then paste it manually in whatever application you want that can accept text.

If you use a Mac on the desktop, you can also use either Air Drop or iCloud Drive to transfer files. For the former, select Air Drop and tap on the name of the person who you have permission to air drop files to (usually your self, but you can also use this to send a data file to another person). A file with a non-descriptive name like "text-8525A5A16D63-1 3.txt" will be saved to the Downloads Folder on the receiving Mac.

An option that is particularly useful if you use iCloud Drive is the option to "Add to iCloud Drive" (in iOS 11, this option is simply labeled "Save to Files" as shown in the figure to the right). This will place a text file wherever you specify in your iCloud Drive; I have set up a separate folder in iCloud Drive to receive these files. If a file of the same generic name already exists on iCloud Drive you will be given the opportunity to rename it what you want. In general, you will want to use this only for transferring rather than storing the data. I recommend adding a folder to your iCloud Drive called "Strat Mobile" Files" or some other equally clever name in which to save your data files.

If you have a Dropbox account and use the Dropbox app, you can add a save to Dropbox button by pressing the more button in the lower row (assuming that you have not already added it). Likewise, if you use Box.com…

In all cases, the data saved via Sharing is exactly the same format at the files stored in your hidden documents folder on the device and sharable via iTunes Sharing. If you use text pasted into Mail, for example, once you open the message in Mail copy the text that
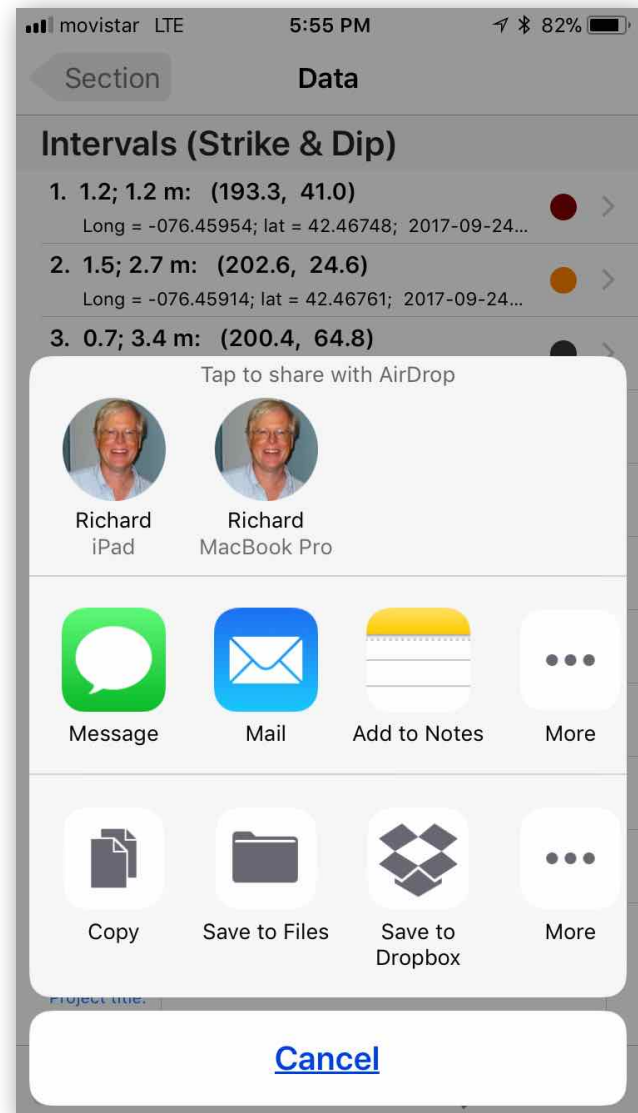
it contains (including the header line) and you can then paste it into a spreadsheet or into the Strat Desktop view program.

Data Input or Output via the iOS Clipboard

Using the Copy icon in the Sharing Panel, you can copy text output from *Strat Mobile* for pasting into any other iOS app that can accept text (e.g., Mail, Notes, Messages, Word Processing, etc.). The format of the copied text is identical to the format of the saved text files of data.

More interesting, perhaps, is that you can copy a data table that has the exact format as a saved text file from any application and paste it into *Strat Mobile*. You might want to do this if a coworker in the field emails you their data. The system Clipboard is the only way, other than iTunes file sharing, to enter data into *Strat Mobile*. To input data in this way, proceed as follows, using the Mail program as a starting point:

1. In Mail (or whatever app the text is currently in), select the entire data table, including the column headers. Tap "Copy" from the popup menu.

2. Switch to *Strat Mobile*, go to the Data List View.

3. Tap the Open button in the tool bar at the bottom.

4. In the File Browser that opens, tap the line that says "tap for Clipboard text" in the Clipboard" section (see image to the right).

5. *Strat Mobile* will attempt to read the text on the clipboard. If it cannot do so, it will display a message box saying that the text on the clipboard is not in the right format.
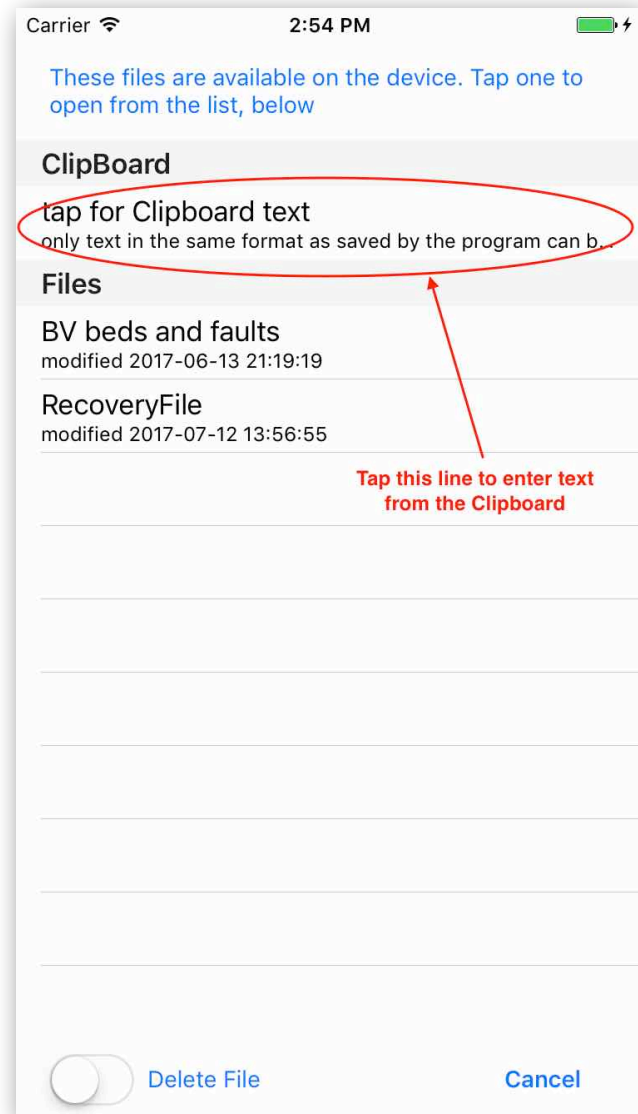
6. After successful reading to the clipboard text, the data will be displayed in the Data List View. If you want to save the data to the documents folder on your device, you will have to give it a name and then tap "Save".

Settings for the App

From the toolbar that the bottom of either the Section, Tape, or GPS View you can tap the Settings icon ⓘ to bring up a sheet where you can change some app related settings. These include:

• Strat Mobile can operate using any of four different units. If you change a unit, the app will change all of the existing measurements to reflect the new unit. For example, if you are measuring as section in feet (ft) and decide that you want to switch to meters (m), the program will divide all existing thicknesses by 3.281 so that, say, a 100 ft measured interval will become a 30.4785 m thick interval. Thus, **you should not use this option if you were measuring in meters all along and only just realized that the app was incorrectly set to measure in feet!**

• Although the app currently does not record the geologist, there is a space where you can specify a default value.

   • Settings is where you register your **eye height** for use when you are using your eye height measuring. **You should measure your eye height while wearing the field boots that you anticipate wearing during section measuring**. Your eye height should be entered using the same units selected above.

• Normally, Strat Mobile will automatically take you to the Datum Details View for a new measurement as soon as you
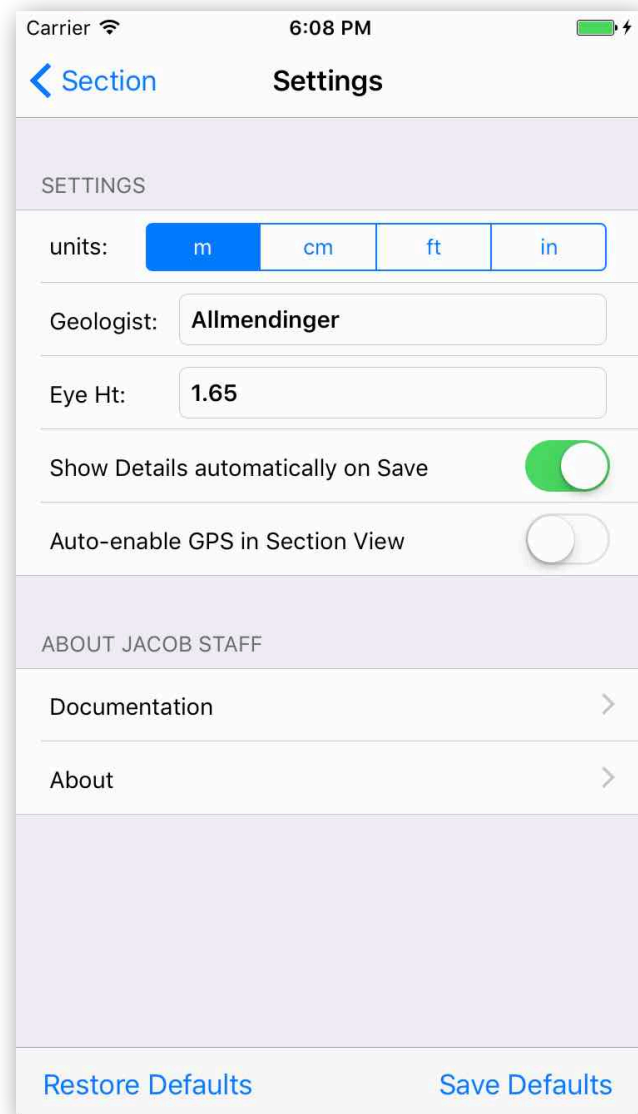
press the Save button so that you can enter a description of the interval. If you prefer to keep measuring without going to the details page, toggle off "Show Details automatically on Save". You can still go to the details view for an interval at any time by double-tapping the unit in the stratigraphic column of the Section View.

- By default, Strat Mobile only turns on the device GPS receiver in the Section View when you explicitly ask it to by toggling the GPS switch. This behavior will save your device battery from being drained quickly. However, you can toggle on "Autoenable GPS in Section View" to have the GPS receiver automatically turned on each time the Section view appears. Note that this will drain your battery more quickly unless you religiously turn off the GPS as soon as you are done with it!

- Documentation will load the online version of this document into Safari.

- About displays the current version, acknowledgments, and disclaimers

The settings screen can be scrolled by dragging a finger on the screen, which may be necessary to see all options while using an iOS device smaller than an iPhone 6.

Once you have everything the way you like it, tap Save Defaults and the next time you launch *Strat Mobile*, the app will use your preferred options rather than mine.

The Restore Defaults button will reinstate the app's built-in options for your current session. If you want to make those the permanent defaults, you must tap the Save Defaults button after restore the defaults.

The Strat Desktop App

Strat Desktop is a companion program — with versions available for Mac OS X, Windows, and Linux — that can read, display, modify, and plot Strat Mobile sections. Strat Desktop can save your plotted cross sections in .SVG (scalable vector graphics) format, an open source vector graphic format that is readable by most modern vector graphics programs. You can use Strat Desktop to make lithology files for import into Strat Mobile. Strat Desktop can be used to build sections from scratch but, why would you want to when you have Strat Mobile? 😉 Strat Desktop can be downloaded from:

```
http://www.geo.cornell.edu/geology/faculty/RWA/programs/strat-desktop.html
```

Acknowledgments

I appreciate the beta-testing prowess of Robert Hall and Teresa Jordan. 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. Any errors are mine but, remember, it is completely up to you to <u>verify that the program is working and yielding reliable results for your purposes</u>. All computer programs have bugs in them!