

# *Integration and Pedagogical Efficacy of Digital Field Methodologies in a Full-Year Sed/Strat and Structure Course*



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*GSA Rocky Mountain Section Meeting, June, 2017*

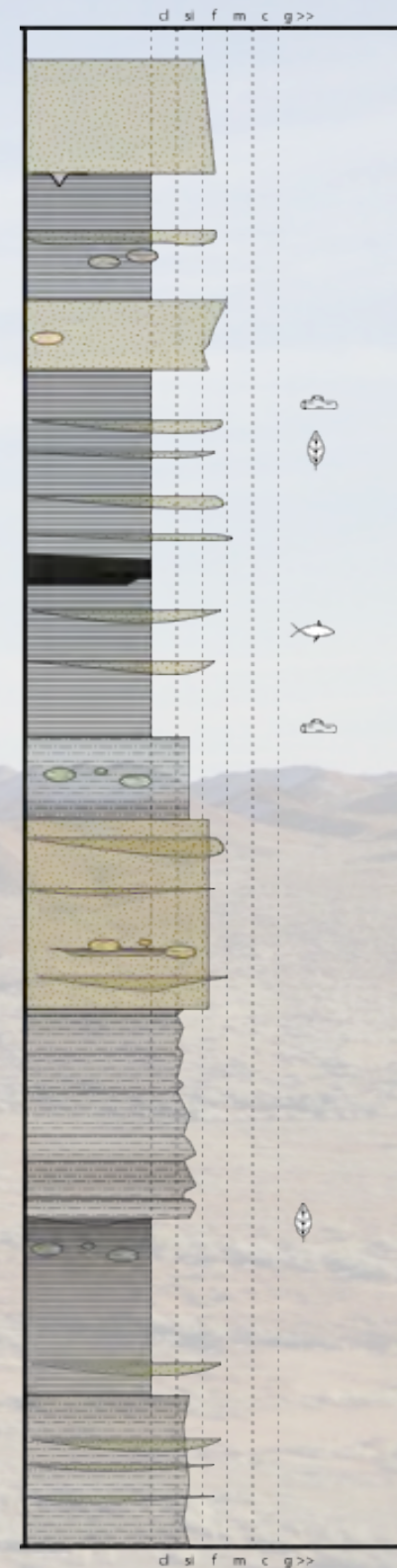
# What and Why

- How many of you drove part... or all of the way here?
- How many used your vehicle's onboard or phone navigation App?
- When was the last time (if ever) that you use paper maps to navigate while driving?



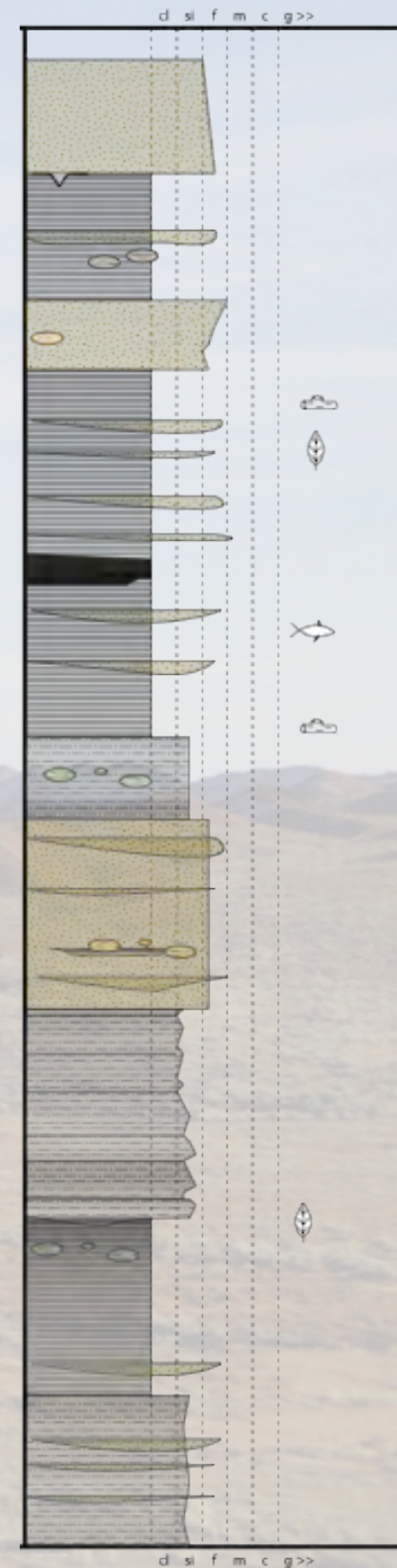
# Here We Go...

- Our Geology Educational Setting (somewhat unique)
- Curricular Initiative
- Issues
- Digital Solutions
- Preliminary Assessment
- Field Issues



# Lafayette College

- Undergraduate
- Highly selective
- 2500 students
- 8 to 15 geology graduates/year
- No field camp requirement
- Substitute: field/laboratory projects in all courses



# Holistic Approach

## Depositional & Deformational Analysis

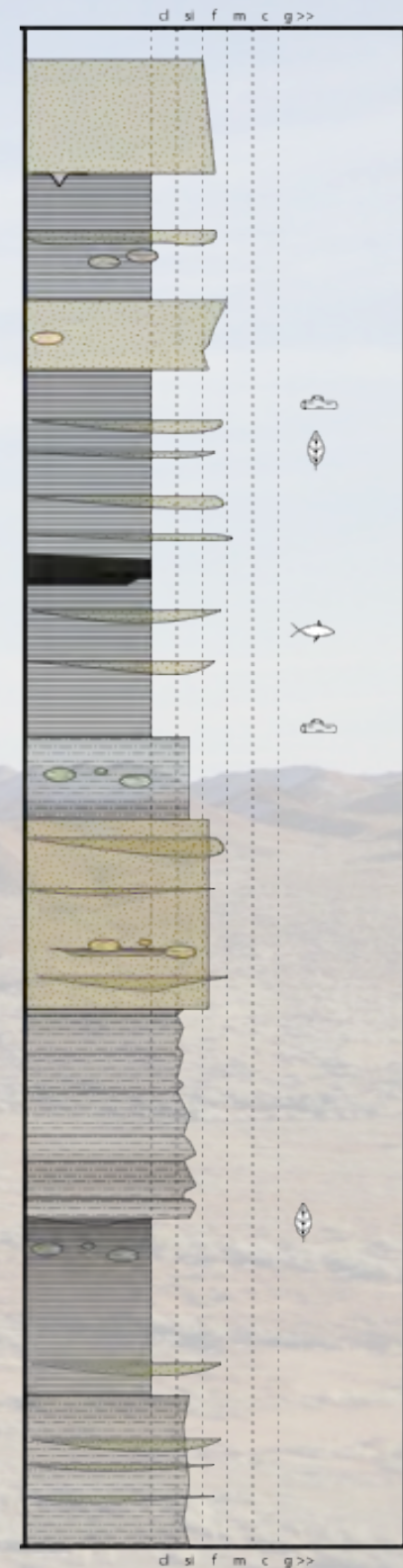
- Combined Sed/Strat & Structural Geology into full-year sequence
  - 8 to 20 students per year
- Why?
  - Nothing happens in isolation (think accretionary wedges)
- How? (curricularly)
  - Focus on Basin Evolution
- How? (logistically)
  - share course time: 3 weeks each semester)



# Semester 1 (GEOL 215)

## Deposition

- **Topics:**
  - Sediment genesis -- fluid dynamics -- trans/erosion/dep -- processes & products of dep environments
    - tectonics
    - orogenesis/basin genesis/types
    - correlation/dating
- **Skillsets:**
  - Grain/deposit description -- microscopy/sed pet -- rock ID -- field description/data collection/interpretation -- literature research
- **Products:**
  - Field reports of ~6-8 local units w/ lit research -- geologic history



# Semester 2 (GEOL 317)

## Deformation

- **Topics:**

- Relationships between Global Tectonics, mountain belts and basins -- **sequence stratigraphy, petroleum generation** -- stress & strain -- brittle vs ductile -- superimposed structures -- **cycles of deposition and deformation**

- **Skillsets:**

- structural field skills -- interpreting/constructing geologic maps
- ability to qualitatively and quantitatively evaluate structural features

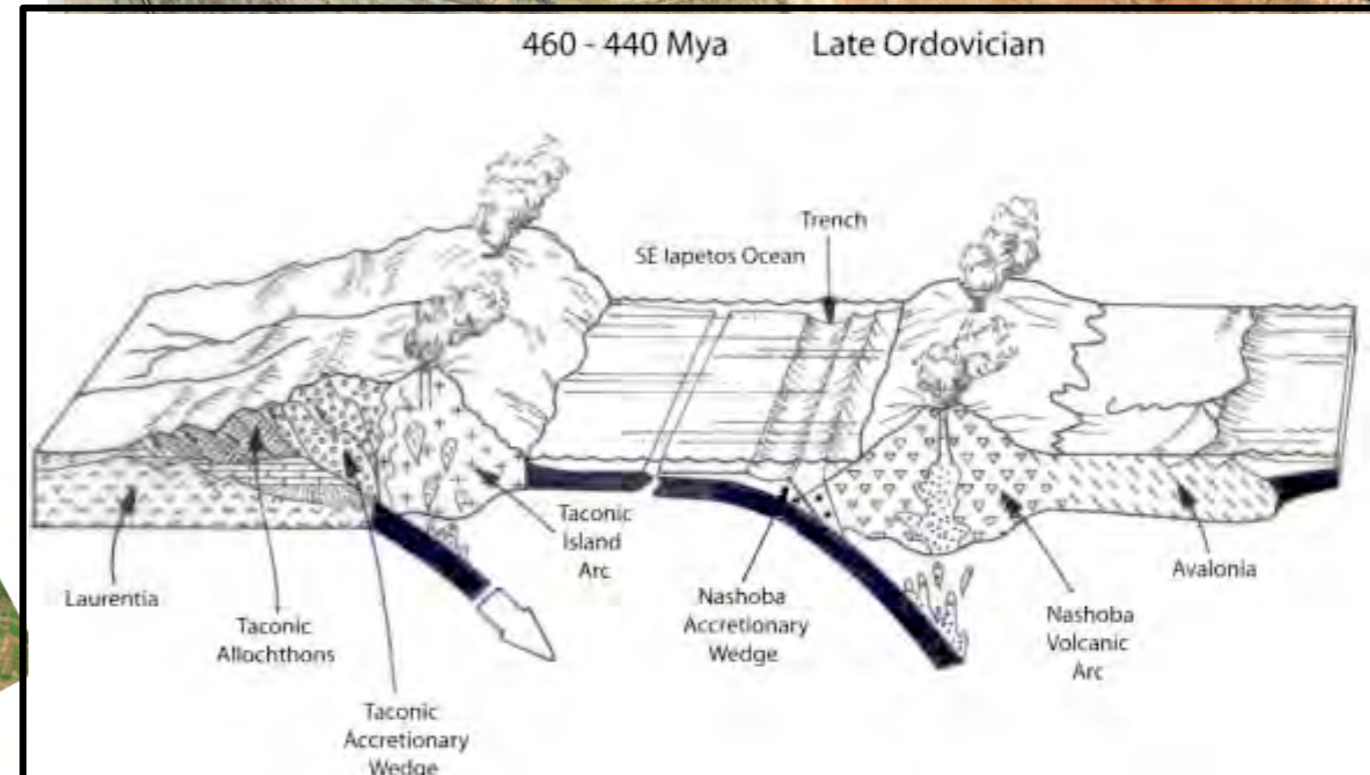
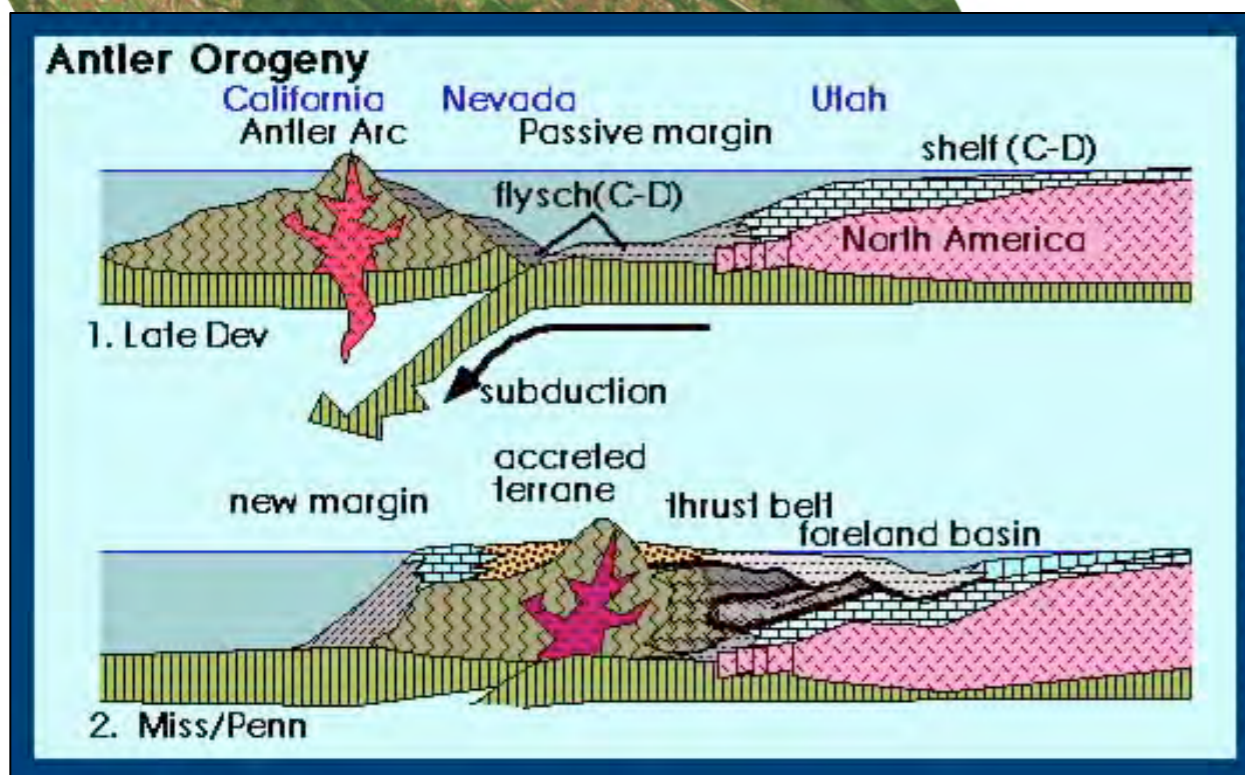
- **Products:**

- synthesized into a comprehensive report:
- Regional → local relationships
- Depositional/Deformation sequences
- Strat columns -- stereoplots -- geologic maps -- cross-sections



# Capstone: Field Project/Report

- Location: Bighorn Basin Wyoming
- Tectonics, Stratigraphy & Structure similar to PA, except for “green” stuff

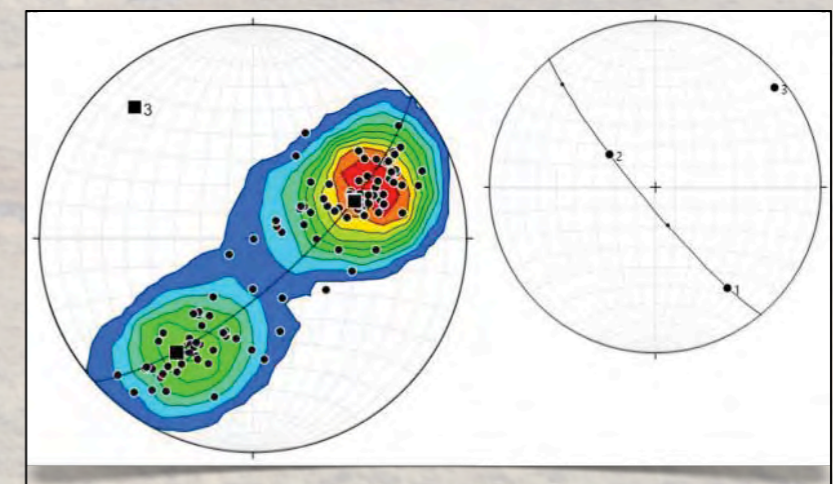
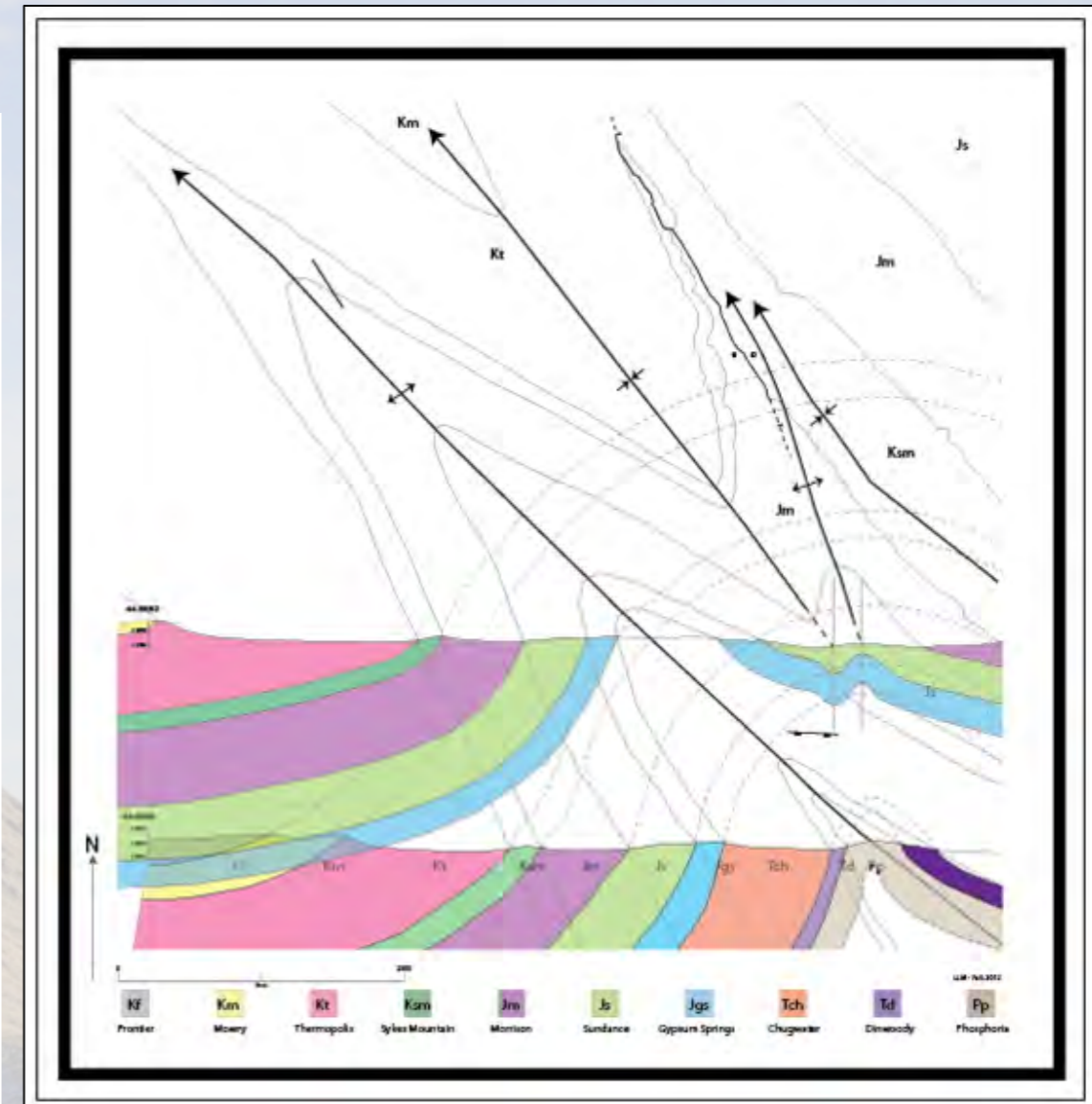
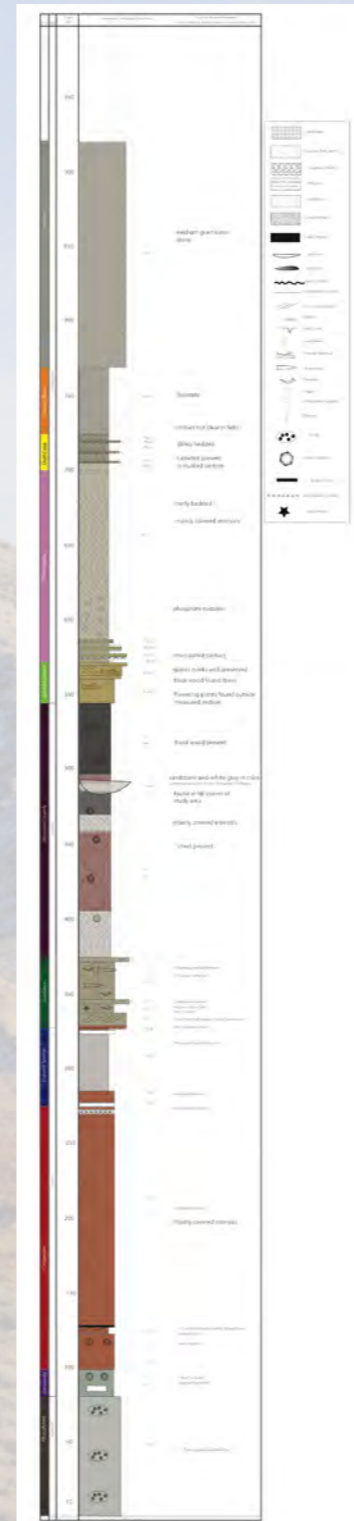
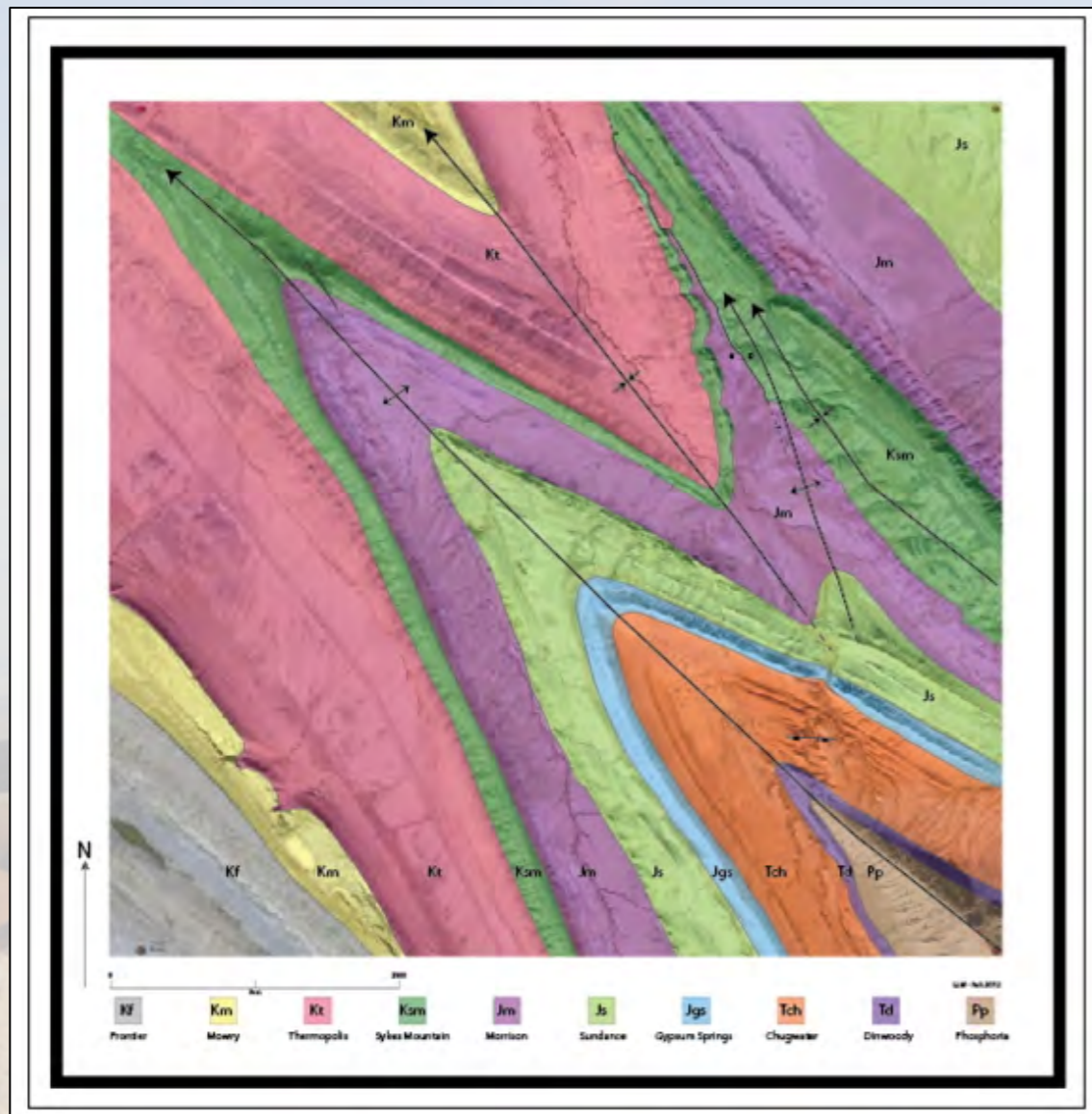


# Field Project

- Plan: 5 field days -- 2.25 mi<sup>2</sup>, student driven field plans
- After 16 field projects in the previous 20 weeks



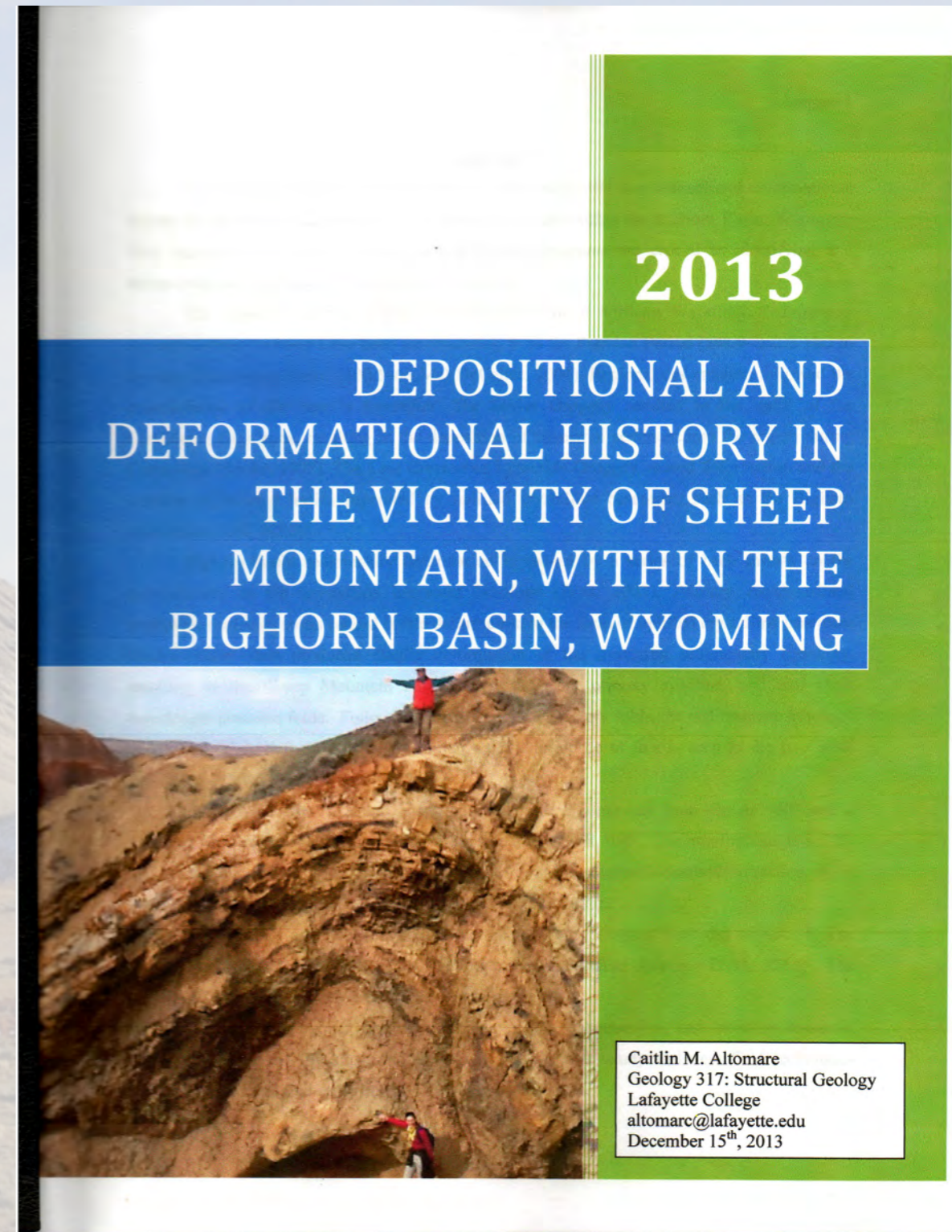
# The Ultimate Product



# *The Ultimate Product*

80 to 120 page report:

- Geologic map
- Cross-section
- Strat column
- Stereoplots
- Sequence stratigraphy analysis
- Local and regional stress
- Regional tectonic history
  - Antler through Laramide
- Depositional and deformational sequence



# App Development Background & Rationale

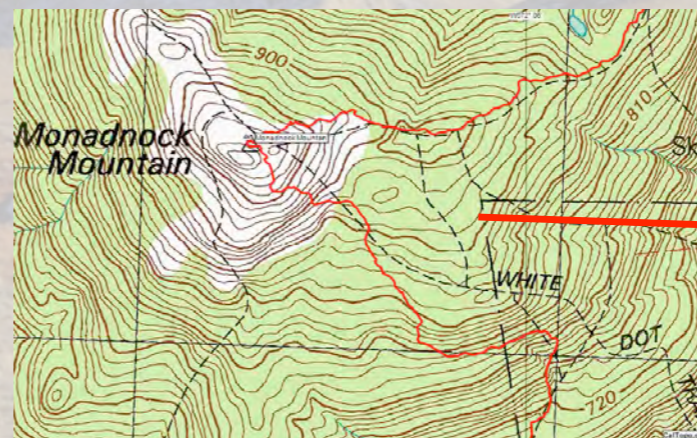
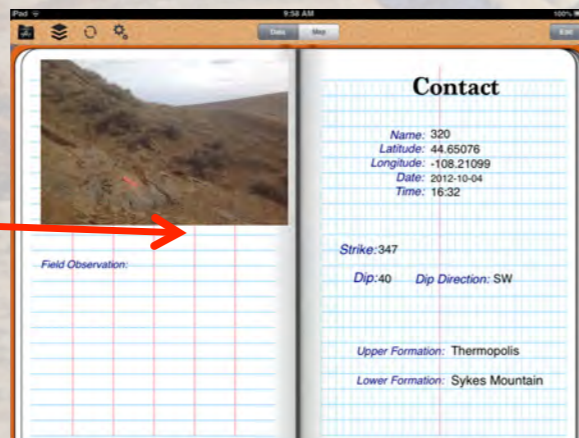
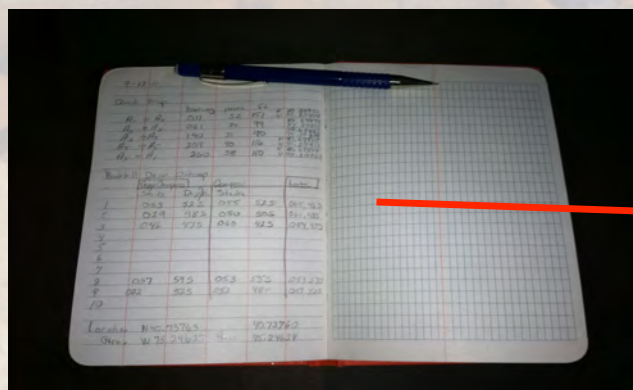
- Much of geology is a field science, yet interpretation has become very digital.
- Question is how to bridge analog field acquisition (field book and paper maps) with digital acquisition and processing?
- How to effectively use image bases that are widely available
- What benefits might this have?



# Objectives

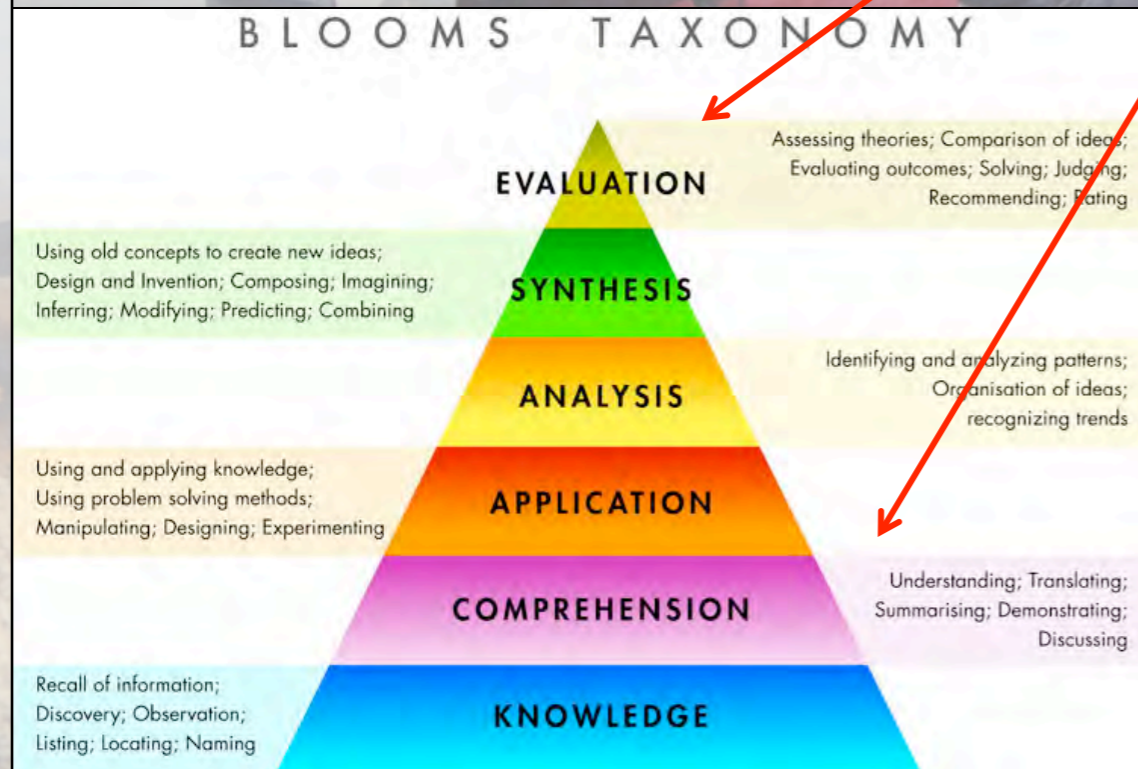
- To develop digital methods for recording field data
  - Structural: **GeoFieldBook**
  - Sed/Strat: **StratLogger**
- Use rapidly evolving tablet technology that could mimic, and possibly replace the use of traditional field notebooks.
  - Apple iPad
- Record ---> Transcribe ---> Excel ---> Google Earth --->
- Record ---> Map ---> Excel

## Geologic map & Interpretation

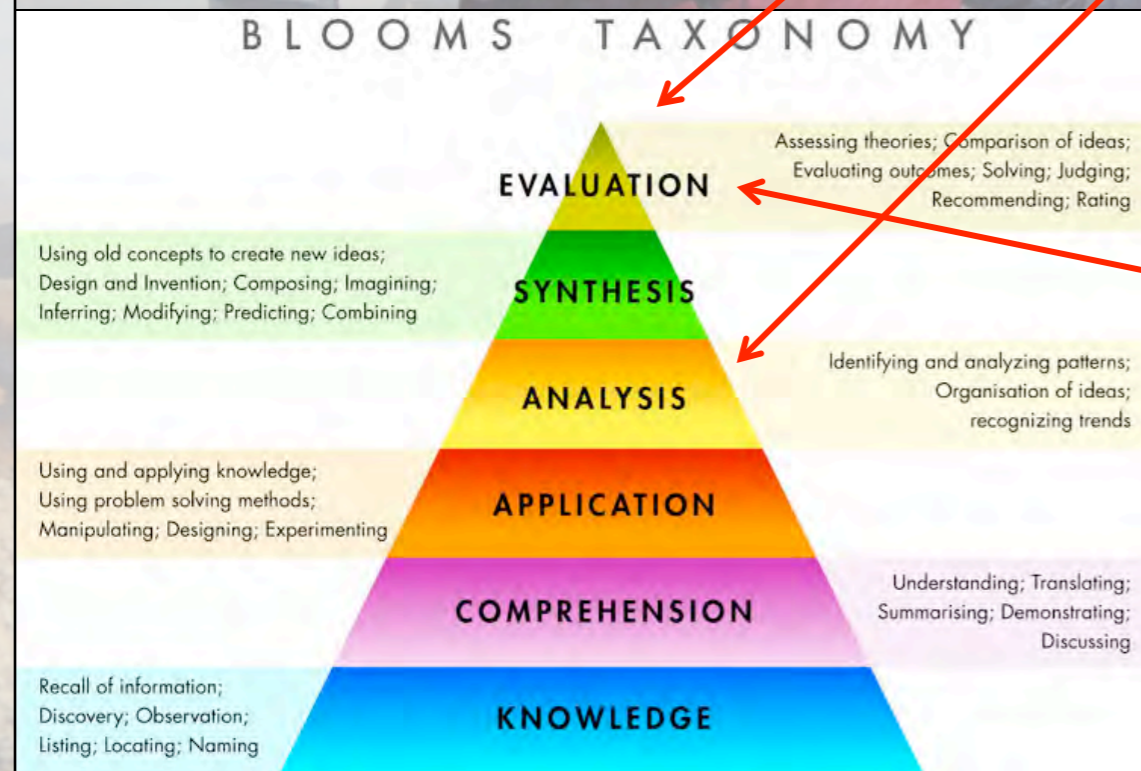


# Assumptions

- *Smooth & accurate data transfer into mapping & processing programs*
- *Faster data collection & presentation -- more time for analysis & synthesis*
- *Increase iterative hypothesis capabilities in the field*
- *Pedagogical value in guiding student field observations and getting student feedback*



- Every day, *during* and *after* field work
- Hypothesis
- Data set adequate?
- Support the hypothesis?
- Data Gaps
- Revised hypothesis
- Cognitive Domain



# App Development Process

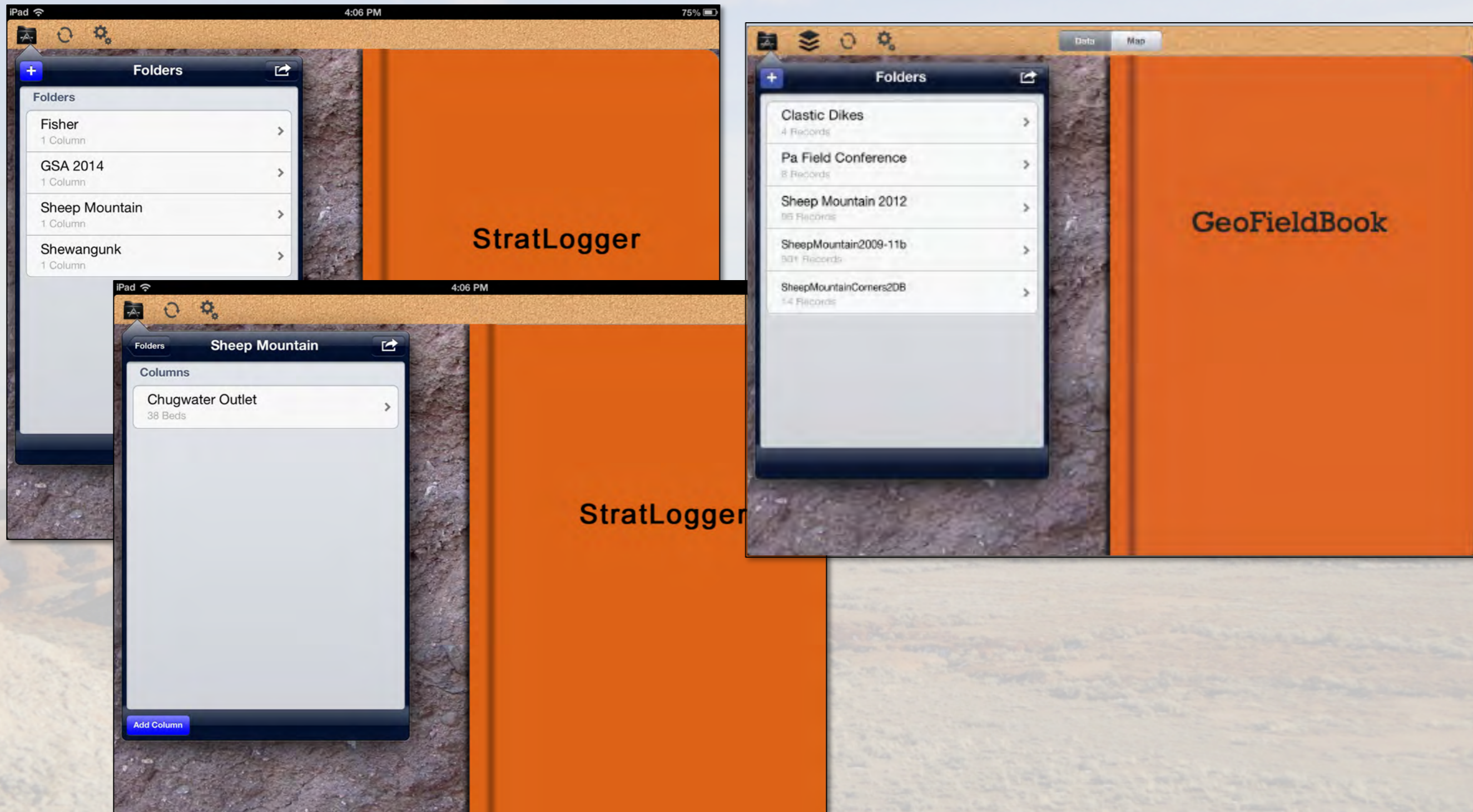


LAFAYETTE  
GEOLOGY

- NSF *Computation in the Curriculum* project through Prof. Chun-Wai Liew (Lafayette) w/ current support from ITS
- Geology/Computer Science iterative collaboration process – real world experience for CS students
- Programmers
  - Andrew Ho, Kumera Bekele, Kien Hoang, Prabhat Rimal, Carter Tillquest, Lucy McKnight, Franceska Xhakra, Emilie Grybos, Nicholas Escalona, Samuel Courtney, Raymond Machiria, Huy Nguyen, & Tim Yale

# Common Features: GeoFieldBook & StratLogger

- *Projects organized in Folders*

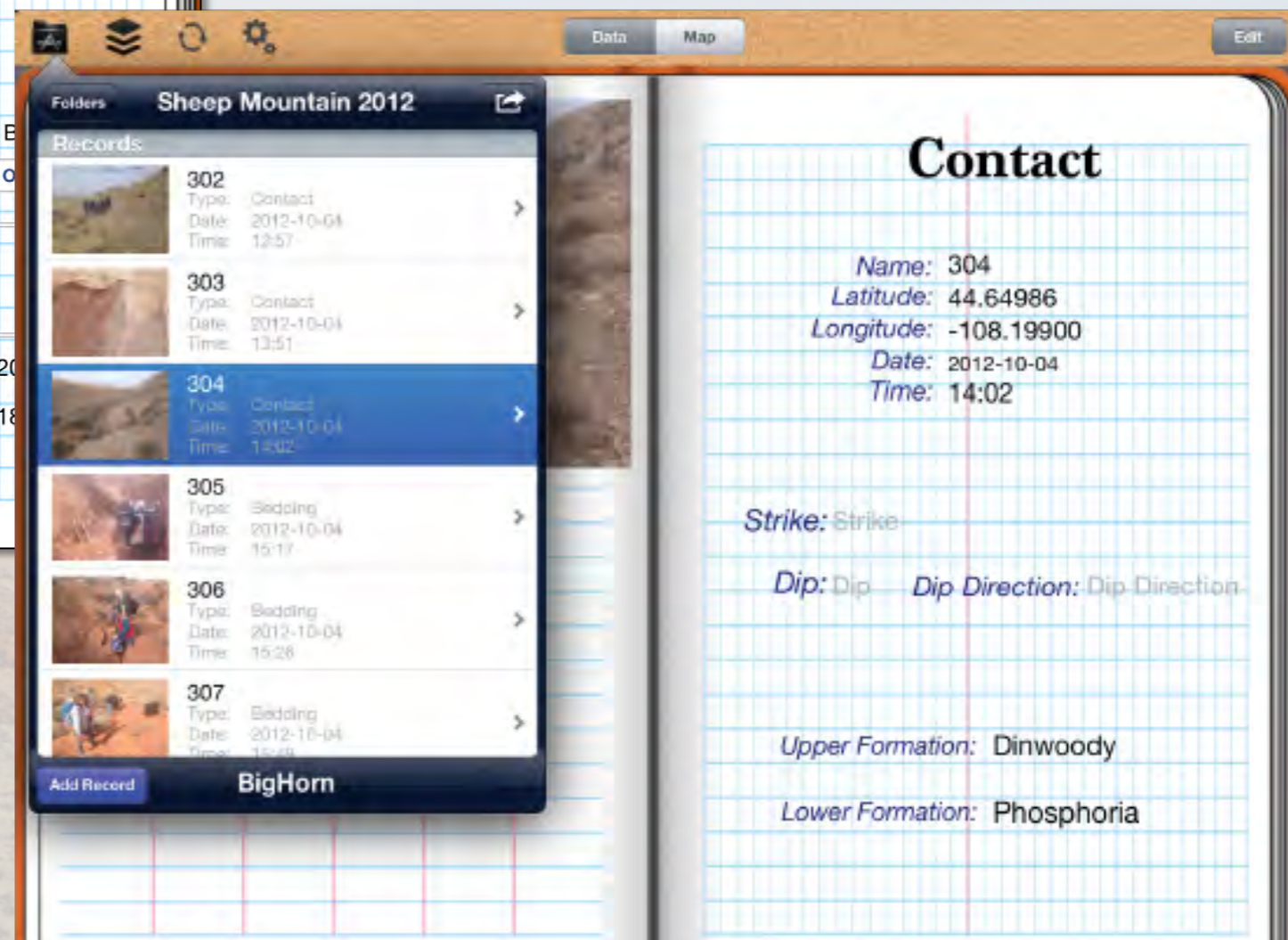


# Common Features: GeoFieldBook & StratLogger

- *Observations stored by lithology*



- *Observations stored within folders*



# Common Features: GeoFieldBook & StratLogger

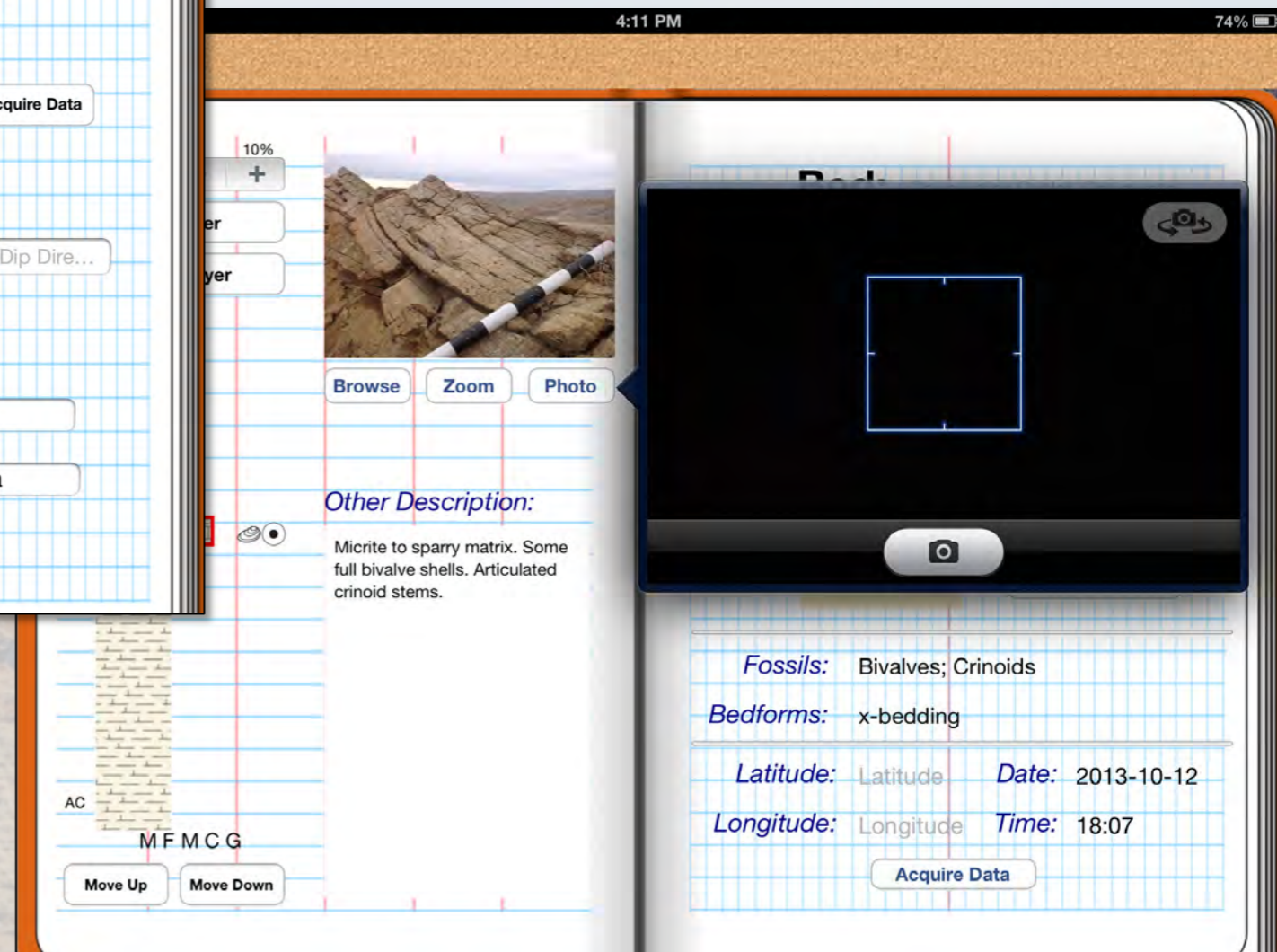
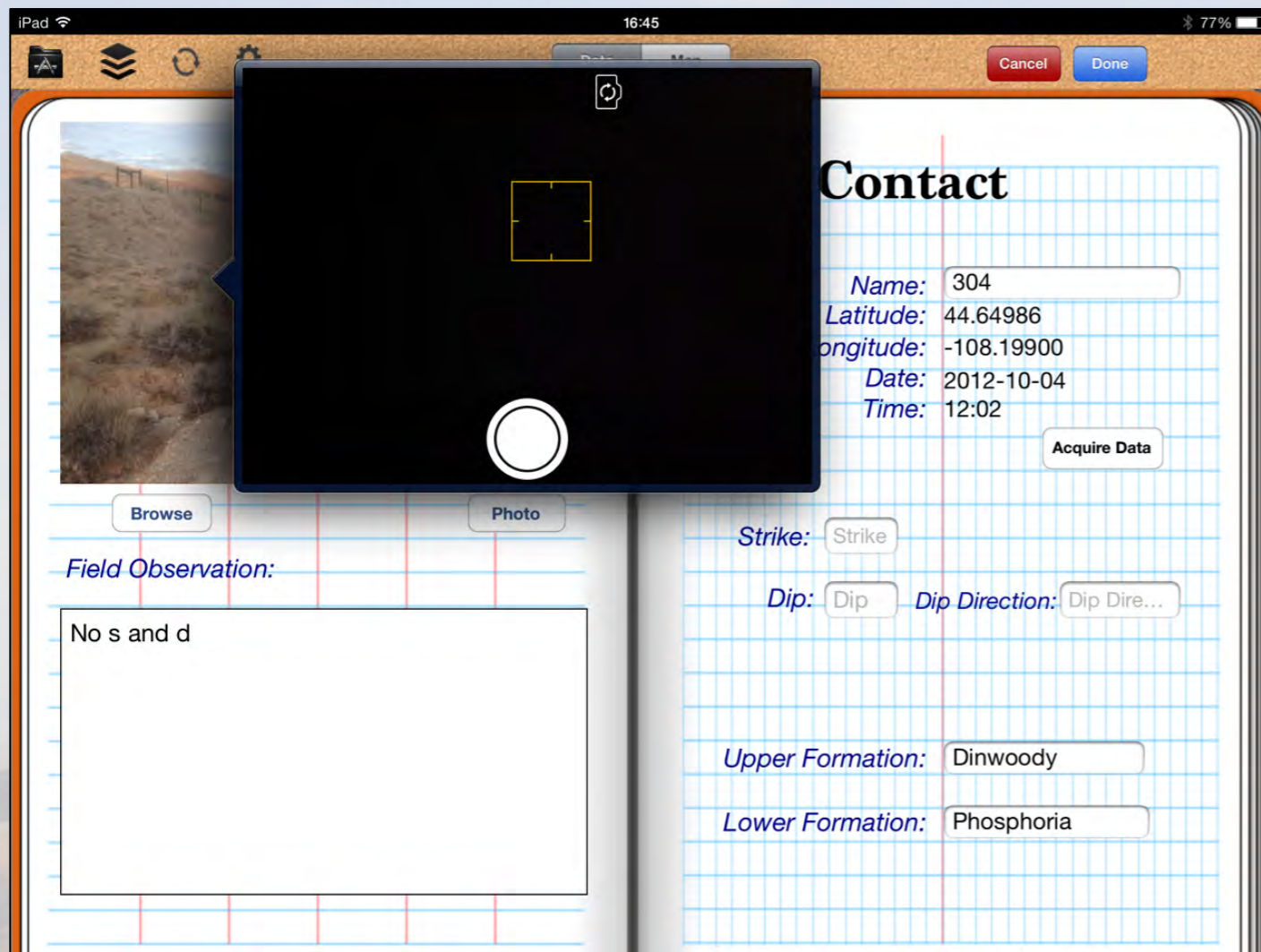
- Onboard GPS for location and time/date record

The screenshot shows the GeoFieldBook app interface. On the left, there is a photo of a rocky outcrop. Below the photo are buttons for 'Browse' and 'Photo'. A text box labeled 'Field Observation:' contains the text: 'Just in the Sykes Mountain, measurement on the first sand layer.' The main area is titled 'Contact' and contains a red-bordered box with the following fields: 'Name: 374', 'Latitude: 40.70670', 'Longitude: -75.20389', 'Date: 2012-11-02', and 'Time: 09:25'. Below this box is an 'Acquire Data' button. Further down are fields for 'Strike: 280', 'Dip: 25', and 'Dip Direction: NE'. At the bottom are 'Upper Formation: Sykes Mountain' and 'Lower Formation: Morrison'.

The screenshot shows the StratLogger app interface. At the top, it displays '4:08 PM' and '75%' battery. The main area is titled 'Bed: Chugwater Outlet-Chugwater...'. Below this are fields for 'Thickness: 80', 'Lithology: Bioclastic Limestone', 'Facies: D', 'Basal Contact: Abrupt', 'Grain Size: VC Sand', and 'Formation: Sundance'. There are also fields for 'QFL: QFL' and 'Carb Grains: Bioclasts'. A 'Color:' field is shown with a yellow color swatch and a 'Reuse Old Color' button. Below these are 'Fossils: Bivalves; Crinoids' and 'Bedforms: x-bedding'. At the bottom, there is a red-bordered box with the following fields: 'Latitude: Latitude', 'Longitude: Longitude', 'Date: 2013-10-12', and 'Time: 18:07'. Below this box is an 'Acquire Data' button. On the left side of the app, there is a photo of a rock outcrop with a scale bar. Below the photo are buttons for 'Browse', 'Zoom', and 'Photo'. At the bottom left, there is a stratigraphic column with a red box around a specific layer, and buttons for 'Move Up' and 'Move Down'.

# Common Features: GeoFieldBook & StratLogger

- Camera



# StratLogger

- Bed-by-bed record for stratigraphic data
- Stratigraphic column built as lithologies are entered
- Fields prompt students to record complete data set

iPad 4:08 PM 75%

Zoom: 10%  
Add Layer  
Delete Layer

AJ  
AI  
AH  
AG  
AF  
AE  
AD

M F M C G

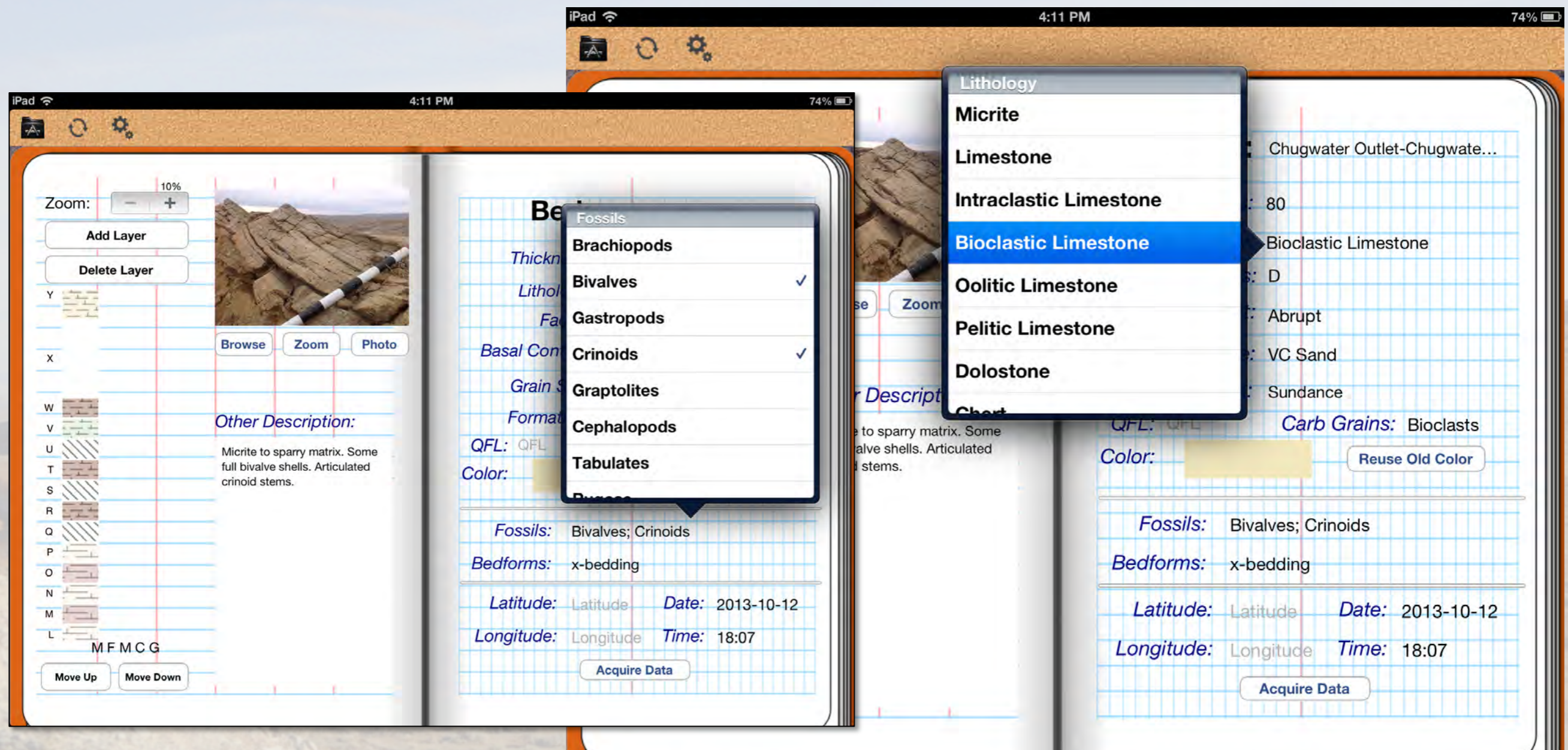
Move Up Move Down

Other Description:  
Micrite to sparry matrix. Some full bivalve shells. Articulated crinoid stems.

Bed: Chugwater Outlet-Chugwater...  
Thickness: 80  
Lithology: Bioclastic Limestone  
Facies: D  
Basal Contact: Abrupt  
Grain Size: VC Sand  
Formation: Sundance  
QFL: QFL Carb Grains: Bioclasts  
Color: Reuse Old Color  
Fossils: Bivalves; Crinoids  
Bedforms: x-bedding  
Latitude: Latitude Date: 2013-10-12  
Longitude: Longitude Time: 18:07  
Acquire Data

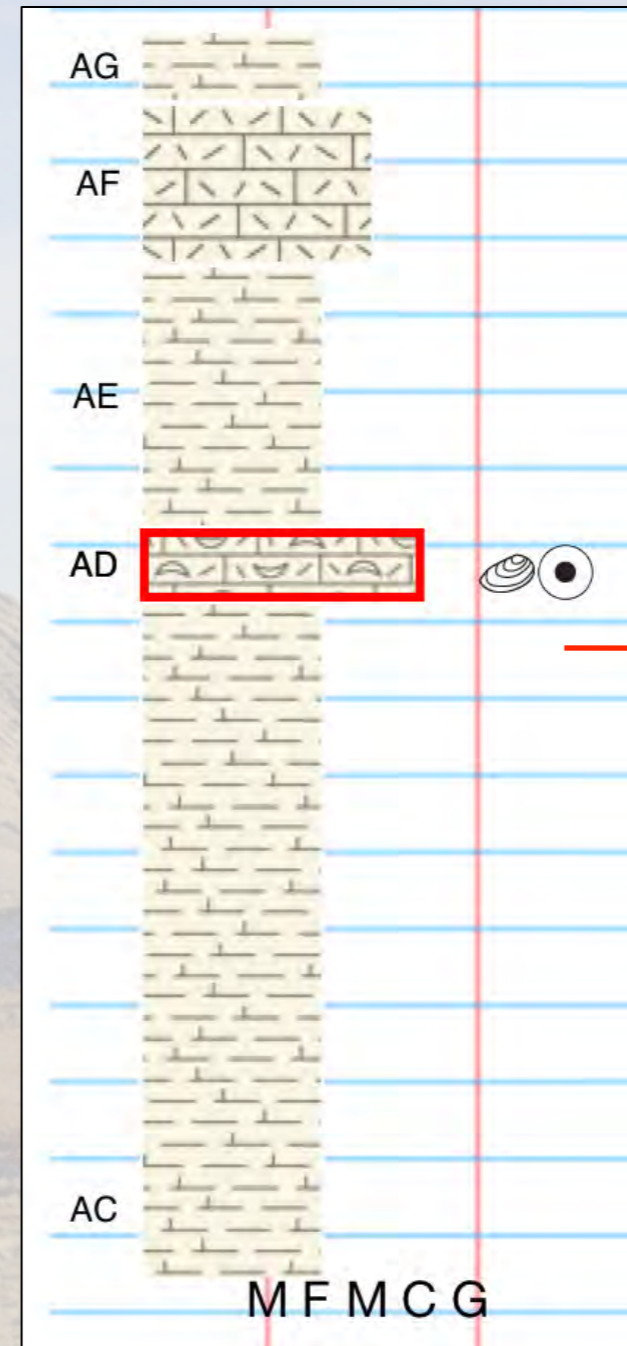
# StratLogger

- Preset but modifiable lists for fields requiring input
- Promotes consistency



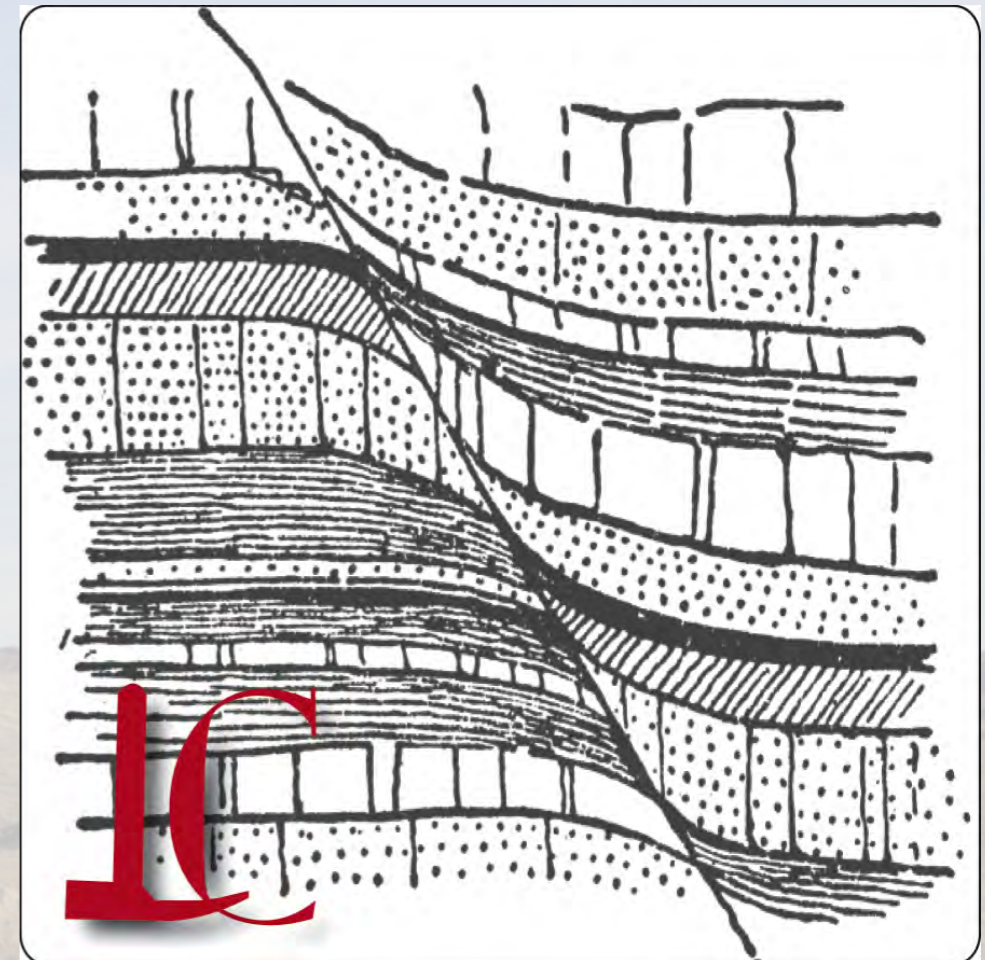
# StratLogger

- Goal is to build a stratigraphic column in the field
- Allows students to:
  - hypothesize depositional environments while in the field and
  - test interpretations with subsequent observations
- The column can be exported in jpeg format or data can be used to construct column in Illustrator



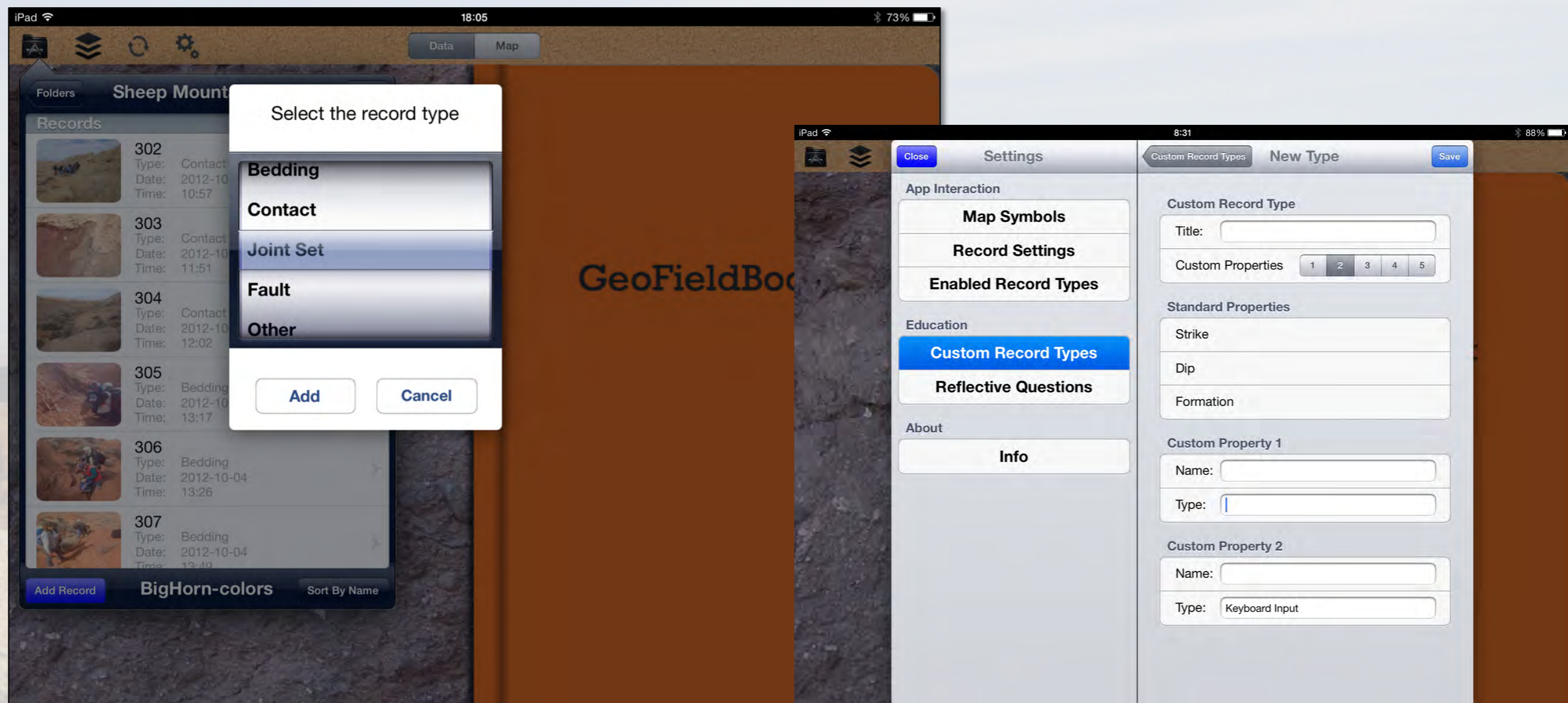
# GeoFieldBook

- Point-based approach for collection and mapping of structural data with the goal of creating a geologic map externally
- Field book replacement with field prompts
- Image base with real-time presentation of oriented data
- Objective is to get students to imagining structural relationships while they are still in the field



# GeoFieldBook

- Currently select from 4 record types plus “Other”
- Also an ability to custom design 5 additional types



# GeoFieldBook

- Page for each type: prompts for appropriate information
- Especially important for beginning field students
- Like StratLogger, preset but modifiable lists for fields requiring input

iPad 18:13 72%

Cancel Done

**Bedding**

Name: 327  
Latitude: 44.66325  
Longitude: -108.21611  
Date: 2012-10-05  
Time: 10:36

Acquire Data

Strike: 306 Formation: Sykes...  
Dip: 41 Dip Direction: NE

Field Observation:

Beautiful asymmetric ripples in middle Sykes sand. Steep side to the SE, shallow side towards the NE. Crest trend 295.

Also has worm burrows.

Pictures 5583 & 5584.

iPad 18:13 72%

Cancel Done

**Bedding**

Name: 327  
Latitude: 44.66325  
Longitude: -108.21611  
Date: 2012-10-05

Acquire Data

Strike: 306 Formation: Sykes...  
Dip: 41 Dip Direction: NE

Field Observation:

Beautiful asymmetric ripples in middle Sykes sand. Steep side to the SE, shallow side towards the NE. Crest trend 295.

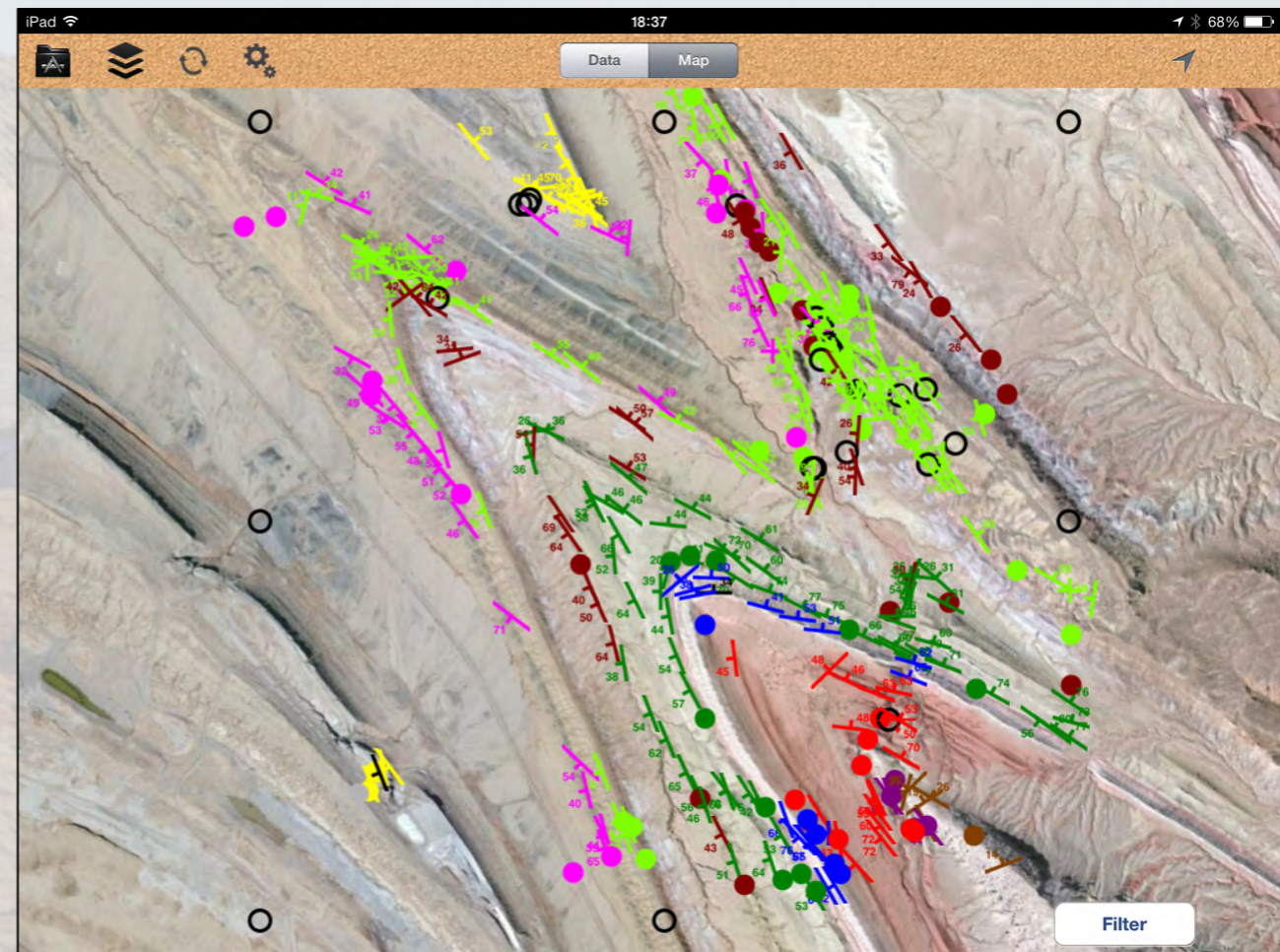
Also has worm burrows.

Pictures 5583 & 5584.

Shell Creek  
Thermopolis  
Sykes Mountain  
Morrison  
Sundance

# GeoFieldBook

- Collected data are then instantly displayed on the image base in correct orientation
- While not a geologic map with drawn contacts, the increasing number of observations allow students to visualize the map
- Can filter on record type...possible to show only contacts



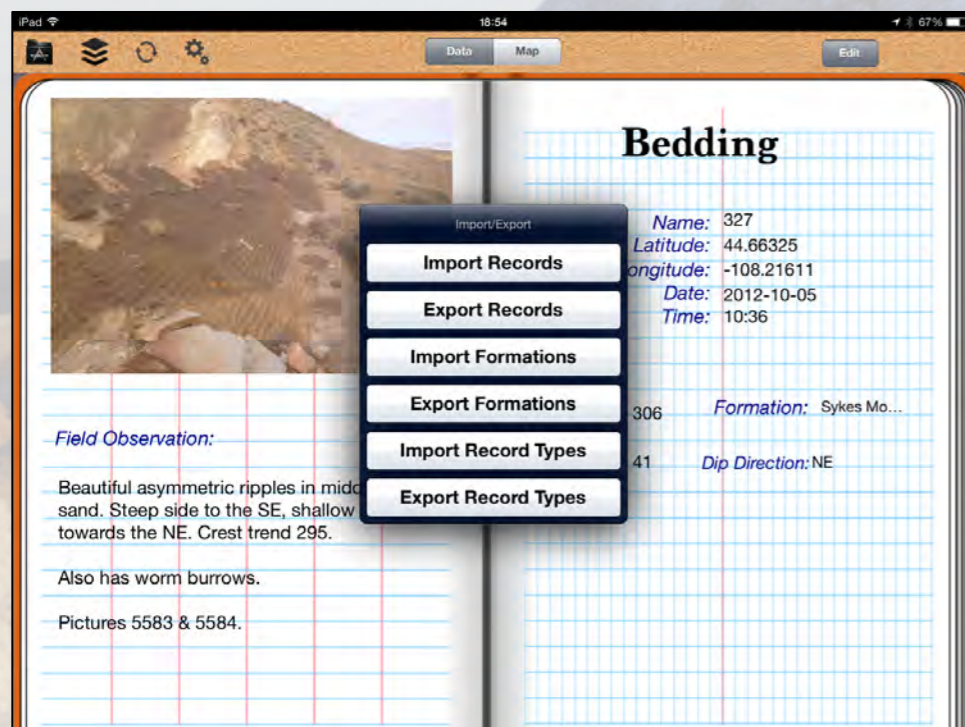
# GeoFieldBook

- Image base is also used as the mapping platform (no paper maps) – gps dot shows current location relative to all collected data...allows for field collection decisions!
- Instant access to previously collected information



# Common Features: GeoFieldBook & StratLogger

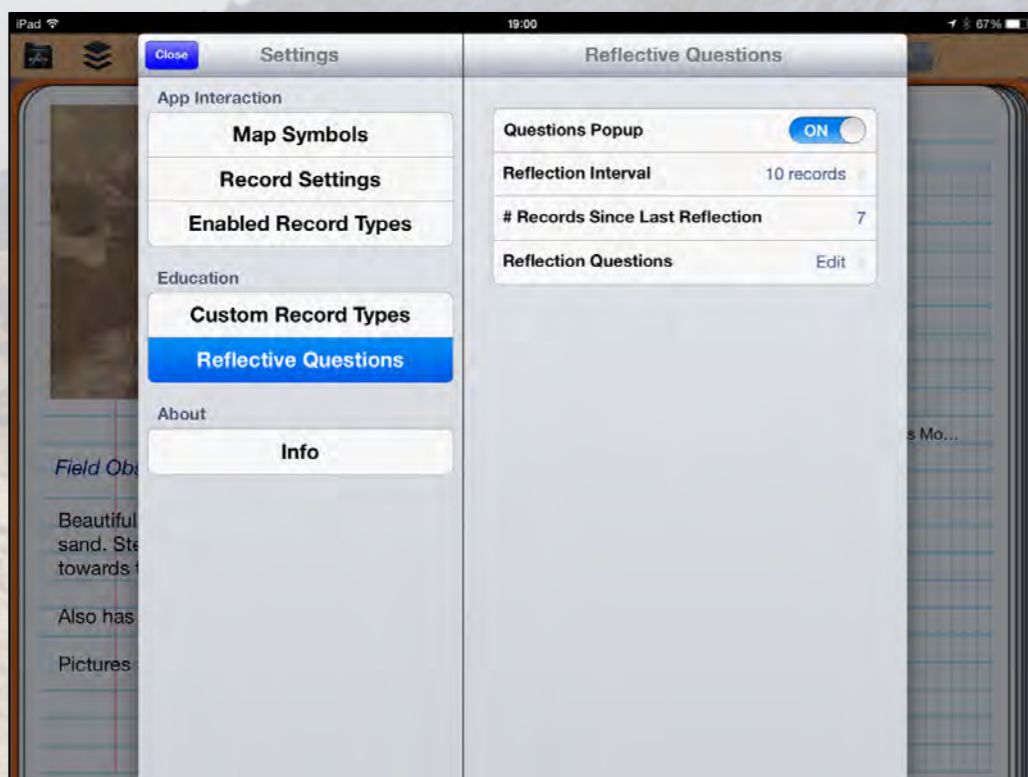
- Export data files in csv format for use in other analysis or mapping programs (like Google Earth)
- Images are exported with reference within the csv file
- It is also possible to reimport data files and images



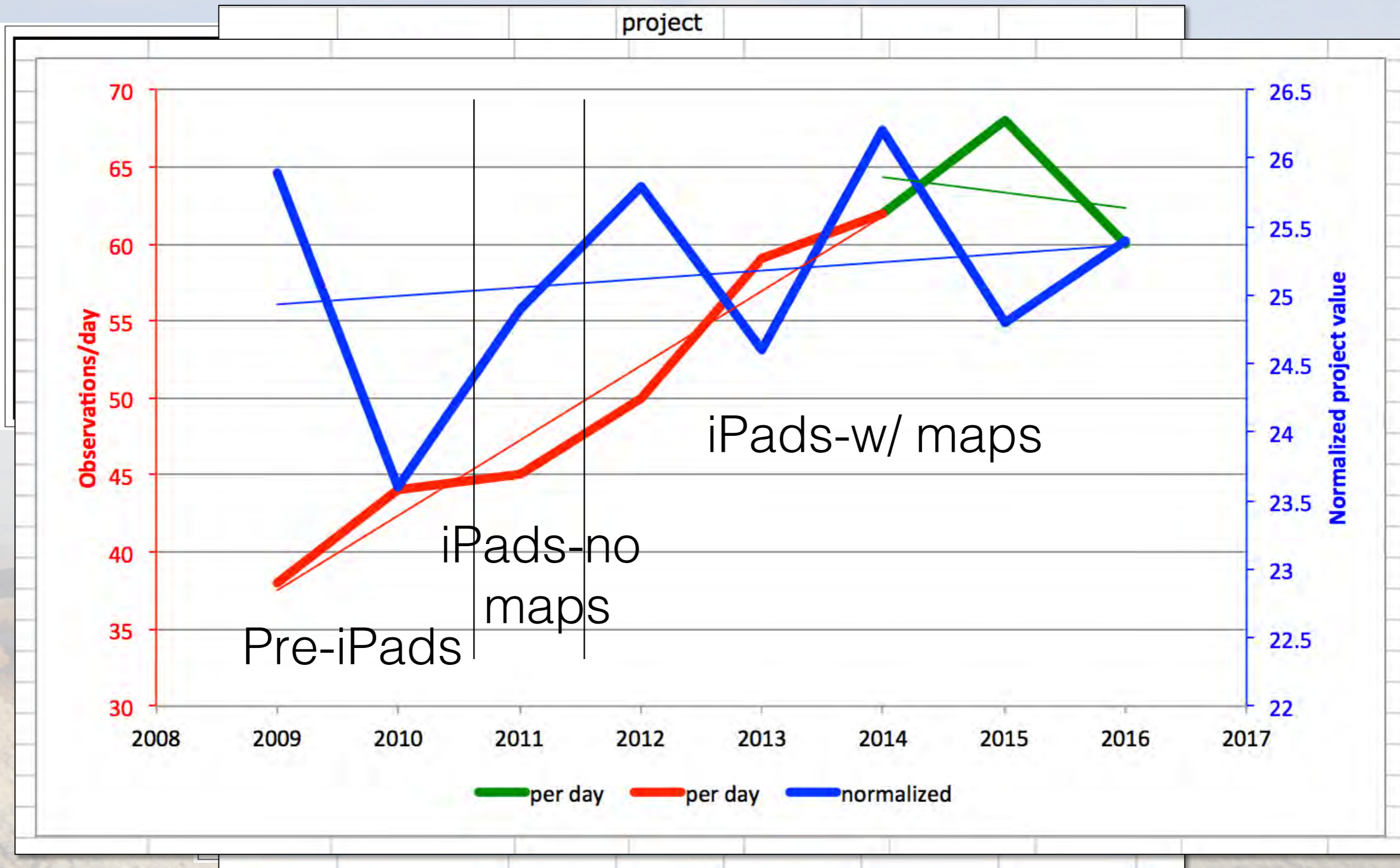
Name	Type	Longitude	Latitude	Date	Time	Strike	Dip	Dip Direction	Observations	Formation	Lower Formation	Upper Formation	Trend	Plunge	Image file name
302	Contact	-108.20622	44.64964	10/4/12	12:57:26	333	43	SW	No s and d	Formation	Sundance	Morrison			Sheep Mountain 2012_302.jpeg
303	Contact	-108.19945	44.64971	10/4/12	13:51:42				No s and d	Dinwoody	Chugwater	Dinwoody			Sheep Mountain 2012_303.jpeg
304	Contact	-108.199	44.64986	10/4/12	14:02:13				No s and d	Phosphoria	Chugwater	Dinwoody			Sheep Mountain 2012_304.jpeg
305	Bedding	-108.20064	44.64988	10/4/12	15:17:15	322	72	SW	Asymmetric cross beds in sandy layers. Extra photo taken.	Chugwater					Sheep Mountain 2012_305.jpeg
306	Bedding	-108.20063	44.64957	10/4/12	15:26:37	322	72	SW	Appearance of isolated gypsum layers.	Chugwater					Sheep Mountain 2012_306.jpeg
307	Bedding	-108.20153	44.6489	10/4/12	15:49:27	318	59	SW	No s and d	Chugwater		Gypsum Springs			Sheep Mountain 2012_307.jpeg
308	Contact	-108.20203	44.64867	10/4/12	15:58:18										Sheep Mountain 2012_308.jpeg
309	Bedding	-108.20226	44.64884	10/4/12	16:09:40	329	62	SW		Gypsum Springs					Sheep Mountain 2012_309.jpeg
310	Bedding	-108.20256	44.64837	10/4/12	16:15:08	330	64	SW		Gypsum Springs					Sheep Mountain 2012_310.jpeg
311	Contact	-108.20292	44.64823	10/4/12	16:18:07				Gypsum Springs Sundance contact. No strike and dip. Lower most sandy layer in the Sundance formation.		Gypsum Springs	Sundance			Sheep Mountain 2012_311.jpeg
312	Bedding	-108.203	44.64819	10/4/12	16:25:51	330	53	SW	Shells appear between lower and middle sandy layer.	Sundance					Sheep Mountain 2012_312.jpeg
313	Bedding	-108.2041	44.64852	10/4/12	16:36:18				Location of middle sandy layer (along strike).	Sundance					Sheep Mountain 2012_313.jpeg
314	Bedding	-108.20451	44.64903	10/4/12	16:49:53	342	64	SW	Middle Sand of Sundance formation	Sundance					Sheep Mountain 2012_314.jpeg
315	Bedding	-108.20579	44.64898	10/4/12	16:46:00	342	51	SW	Upper sand Sundance formation. May also be top of the Sundance.	Sundance					Sheep Mountain 2012_315.jpeg
316	Bedding	-108.2068	44.65041	10/4/12	16:53:46	343	46	SW	Top sand in Sundance formation. May be contact with Morrison.	Sundance					Sheep Mountain 2012_316.jpeg
317	Bedding	-108.20745	44.65119	10/4/12	17:37:58	335	65	SW	Upper sand in Sundance formation very near the contact.	Sundance					Sheep Mountain 2012_317.jpeg
318	Contact	-108.2094	44.64985	10/4/12	18:07:26				Contact Morrison Sykes Mountain. No strike and dip. Sand layer near the top of Sykes Mountain.		Morrison	Sykes Mountain			Sheep Mountain 2012_318.jpeg
319	Bedding	-108.21048	44.65123	10/4/12	18:25:15	338	44	SW		Sykes Mountain					Sheep Mountain 2012_319.jpeg
320	Contact	-108.21099	44.65076	10/4/12	18:32:06	347	40	SW	Rare sandy bed within the Thermopolis.		Sykes Mountain	Thermopolis			Sheep Mountain 2012_320.jpeg
321	Bedding	-108.21034	44.64932	10/4/12	18:49:39	340	65	SW	Near top contact with Morrison.	Thermopolis					Sheep Mountain 2012_321.jpeg
322	Bedding	-108.21296	44.65914	10/5/12	11:35:49	344	36	SW	Very near the nose of the anticline.	Sundance					Sheep Mountain 2012_322.jpeg
323	Bedding	-108.21278	44.65974	10/5/12	11:42:40	80	26	N	NE limb of anticline. very near the top of Sundance. Looks like aeolian cross-beds.	Sundance					Sheep Mountain 2012_323.jpeg
324	Bedding	-108.21244	44.65976	10/5/12	11:47:56	295	36	NE	Pic 5579 in Canon camera. Excellent contact location Morrison-Sykes. Beautiful	Sundance					Sheep Mountain 2012_324.jpeg

# *GeoFieldBook & StratLogger: Digital Efficacy*

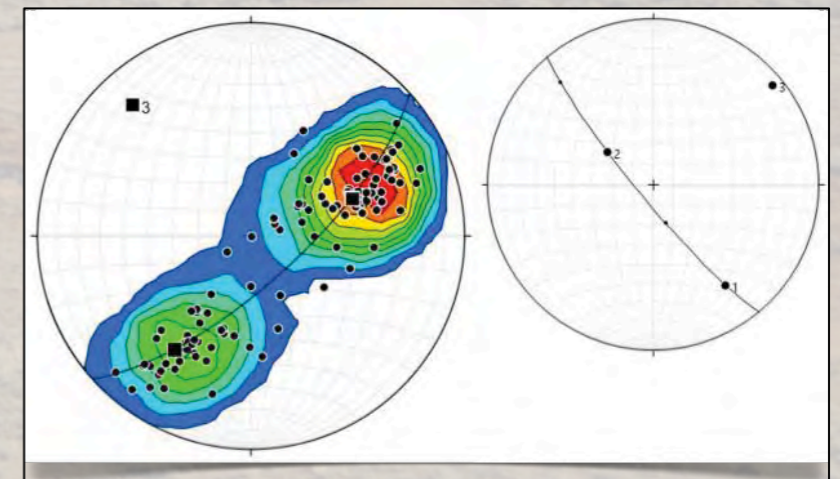
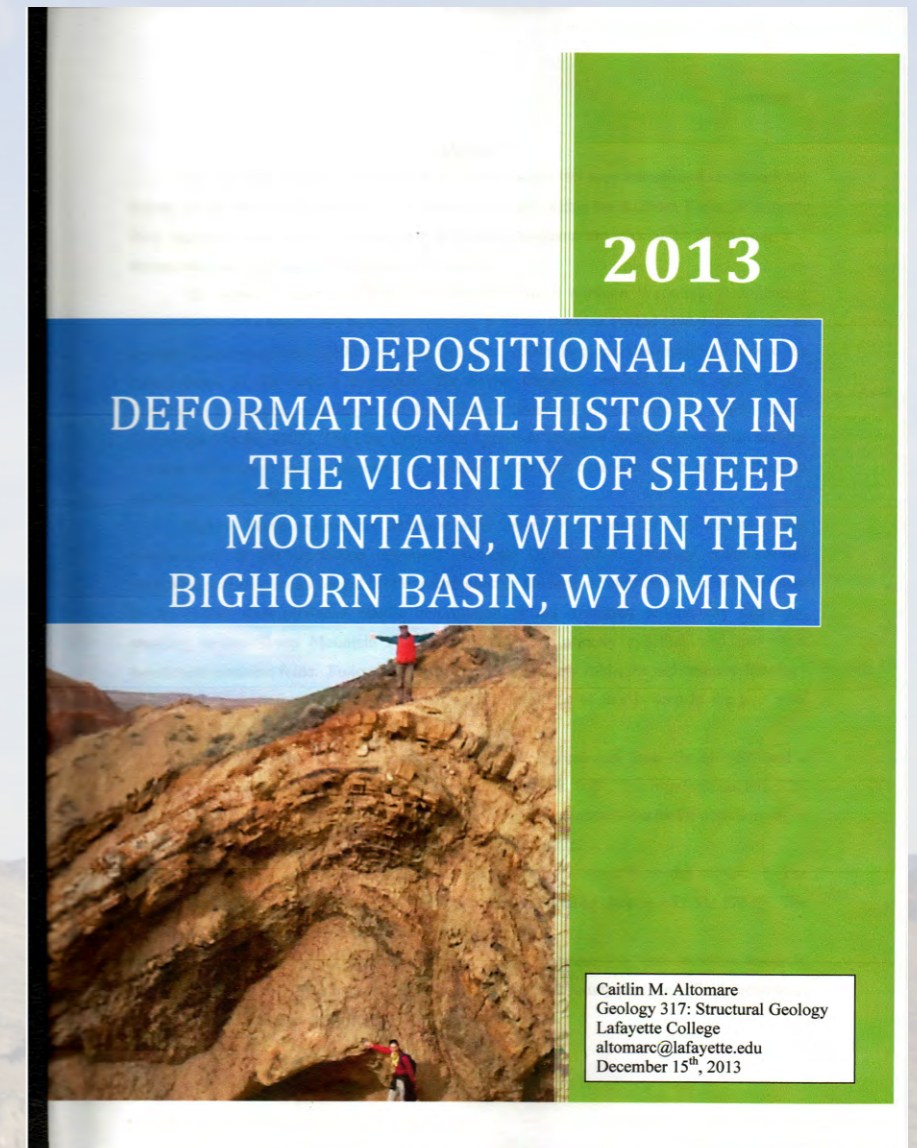
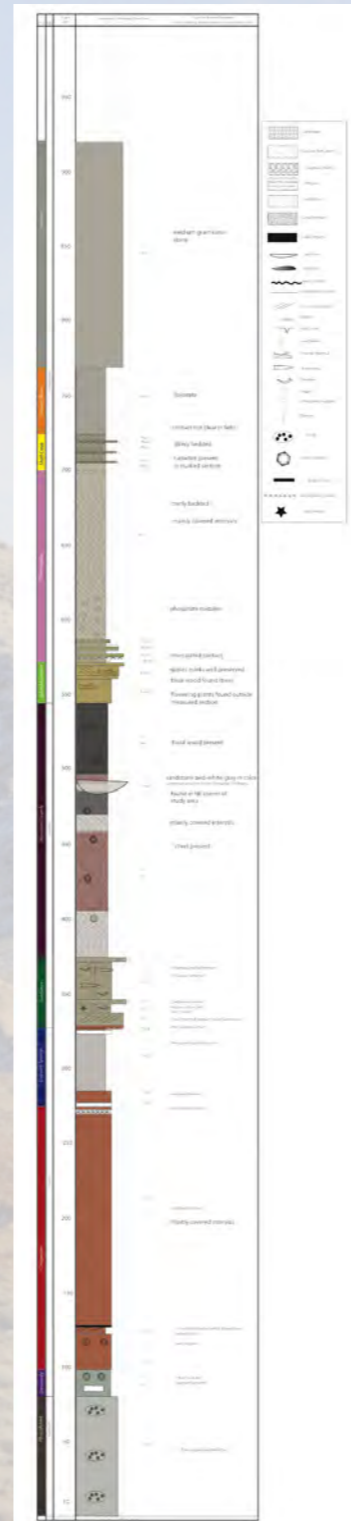
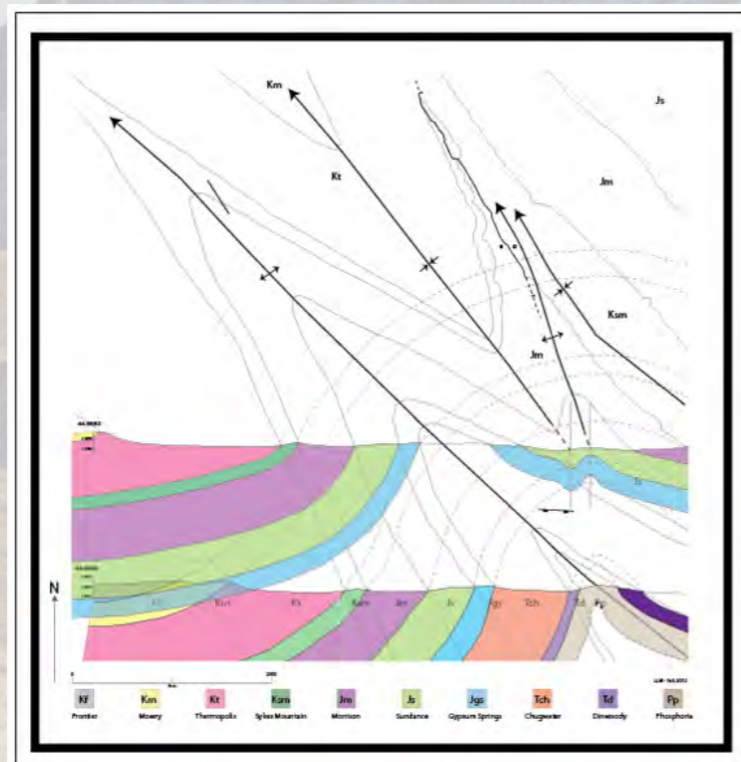
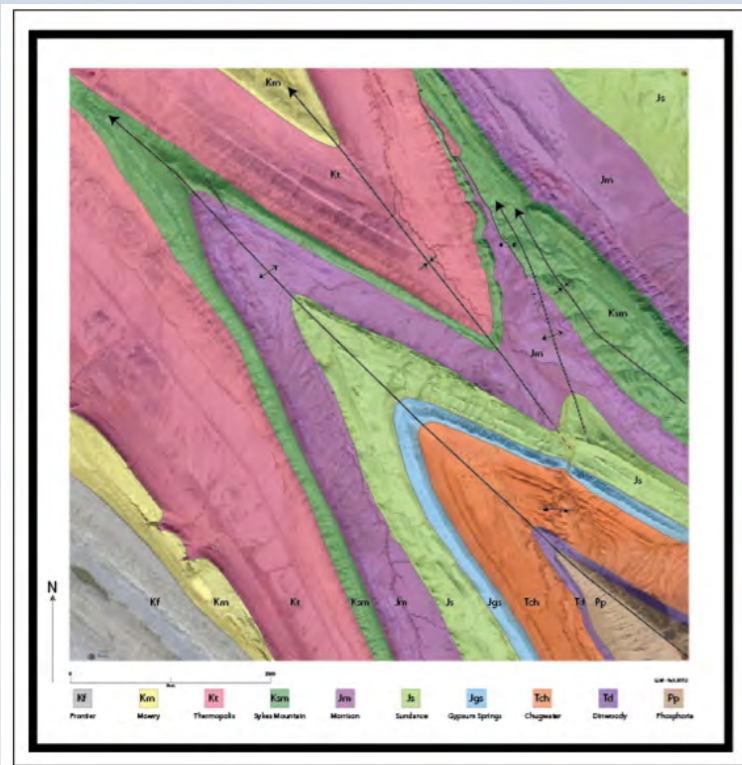
- Issue: what is the pedagogical efficacy of these methods
- Reflection Questions – customizable by user (professor)
- We are collecting data on:
  - data collection efficiency ✓
  - student learning – field functionality ✓
  - student perception of their learning (?)
  - how did this prepare you for future geologizing – post project evaluation (?)



# *The Ultimate Product*



# Data to Products



# Field Issues and Upgrades

## Anecdotal

- *“I can’t imagine not using the collection and mapping App”*
- *A student from this past fall was required to use paper maps on a large field board for a semester abroad program: “We were 10 times less efficient gathering our data”*
- *Petroleum professional who also teaches masters students: “...report and maps equivalent to or better than theses I have supervised”*



# Field Issues and Upgrades

## Questions to be answered

- *Screen visibility in bright sun - adequate*
- *Durability – covers & field vests*
- *Heating up*
- *Enhancements:*
  - *Real-time cloud backup*
  - *Line drawing?*
- *Longevity?*
  - *iPad2s – purchased in 2011 – just retired (battery)*
  - *iPad3s – purchased in 2012 – still going strong*
- *Continued iOS support*



# Field Issues and Upgrades

## FAQs

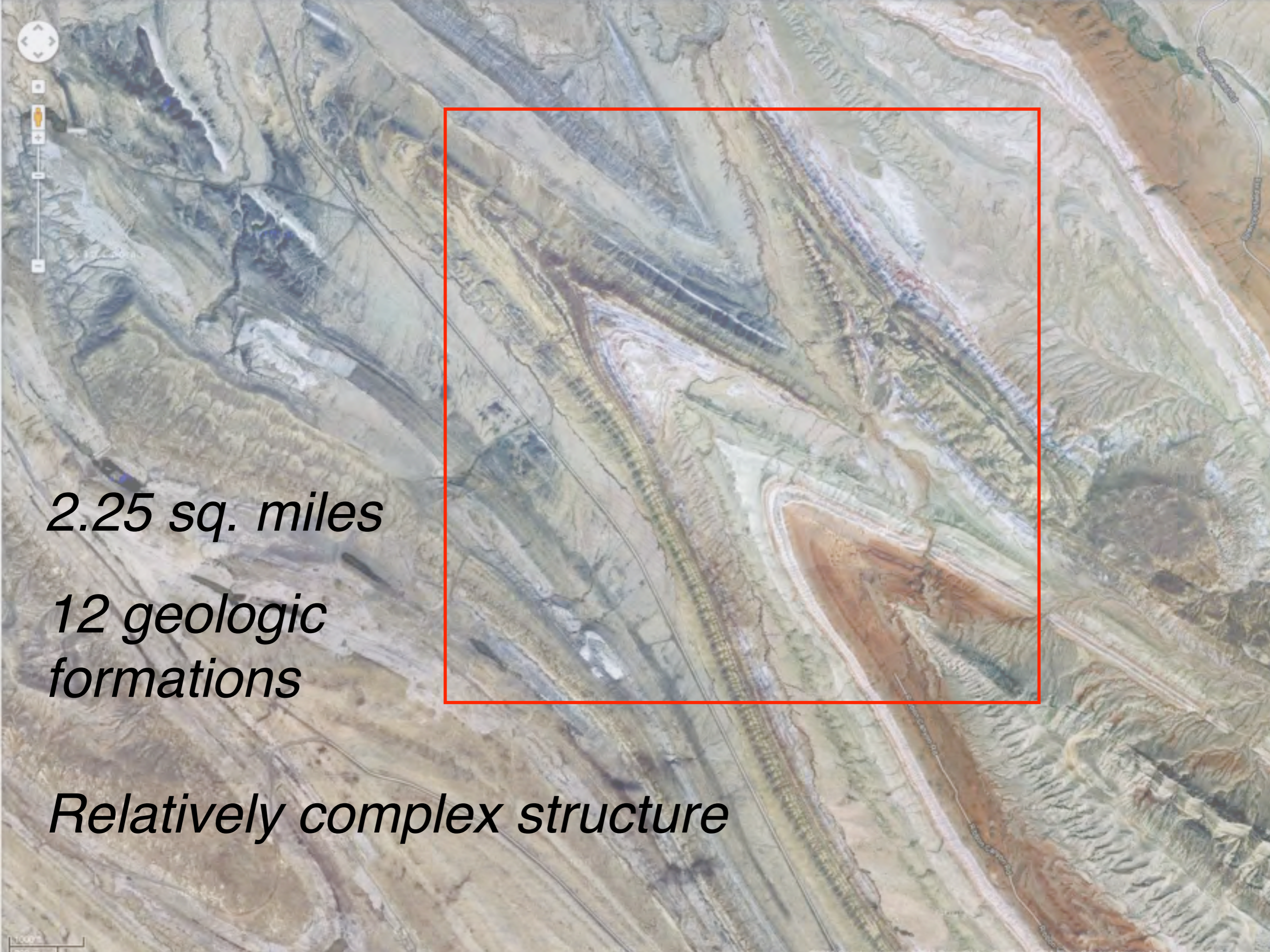
- *How about loss of data?*
  - *“Export” saves a copy of .csv file in different space on the iPad*
  - *Real-time cloud backup coming in next version → probably Goolge Drive*
- *Enhancements:*
  - *Line drawing?*
  - *On maps, images?*
- *Do we use digital platforms for other applications?*
  - *Image Annotation*



# Questions?

- **GeoFieldBook and StratLogger are available for Free at the Apple App Store**
- iPads will be available during the break and at the end of the session





*2.25 sq. miles*

*12 geologic  
formations*

*Relatively complex structure*

