

# Digital field data capture: the Geological Survey of Denmark and Greenland experiences in Greenland

## Introduction

The Geological Survey of Denmark and Greenland (GEUS) is carrying out geological expeditions in Greenland during the short arctic summers. In the past, field diaries together with sample tag books were used to record field data, observations and information about samples collected. The field notes and the information from the sample tag books were then entered into spreadsheets or digitized after the field work. In order to record field data efficiently and consistently in a digital format and to reduce field based paper-work, GEUS recently decided to use a digital field data capture system. The system was tested in southern Greenland in the summers of 2008 and 2009 (Schlatter & Larsen 2010). Positive results were immediate as compared to the traditional method. A system for digital field data capture makes the release of geological data and maps faster. This paper aims to summarize the GEUS experiences of digital field data capture in Greenland and to describe the data flow from the data captured in the field to the central relational (Oracle®) GEUS master database and the reporting of the field data.

## Personal digital assistant versus personal computer

Since early 2000, new technologies have been used to capture data directly in the field or to digitally make

geological field maps using a personal computer (PC) or tablet PC. These new technologies have the advantage of avoiding data input errors into a computer system after the field season (Brimhall & Vanegas 2001; Gilbert et al. 2001; Buller 2002; Brodaric 2004; Colm et al. 2008; Curtis et al. 2008). The advantages and disadvantages of personal digital assistants (PDAs) versus tablet PCs are discussed in detail by Clegg et al. (2006). One of their conclusions is that PDAs are best used for field work involving mainly data collection from outcrops, but in cases where geological mapping is the purpose of the field work, a tablet PC is recommended. As GEUS is working in remote areas, often where access to the outcrops is only on foot, it became apparent that lightweight PDAs were more convenient to use than larger and weighty tablet PCs. Furthermore, Clegg et al. (2006) also state that PDAs are suitable for simple data collection tasks which were the main objective for the southern Greenland expeditions in 2008 and 2009. Following the recommendations of Clegg et al. (2006), GEUS chose PDAs for field data capture.

## Equipment and Methodology

### *Hand held device*

During field work, GEUS typically establishes a centrally located base camp for each expedition that supports, via helicopter, up to ten field teams. Each field team was comprised of two to four geologists who were equipped with an HP iPAQ 214 Enterprise Handheld PDA (Fig. 1a). Each PDA is wirelessly linked to a GPS via a Bluetooth® connection (Fig. 1b). The PDA and GPS are of a relatively small size and weight, for portability, but having a screen size of 8.5 x 6.5 cm, the PDA allows display of maps and data in a readable manner (Fig. 1a). The screen is pressure-sensitive and a stylus pen is used for input and writing of text and data. Following our field investigations, this type of PDA was found to be water resistant (not waterproof) and to be visible in strong sunlight, however, in severe working conditions such as snow and heavy rain it becomes difficult to read the screen. The unit needs to be recharged every day or second day. The digital field data capture system also includes a spare battery (Fig. 1c), replacement stylus pens (Fig. 1d) and a spare secure digital (SD) memory card (Fig. 1e). In order to prevent scratches on the screen, protector-films were applied. In total, a digital field data capture system costs about 450 € (exclusive of VAT; Fig. 1) which is about six times cheaper than a tablet PC. Power for the PDA and the GPS receiver were supplied by a solar energized power generator (Fig. 2) or a petrol engine generator.

### *“GanFeld” and ArcPad*

Geological field work usually comprises a sequence of activities that are carried out in a similar way at each outcrop. Such a sequence normally starts by the determination of the geographic location commonly using a GPS receiver. Once the position is recorded, the rock type is determined and described, and then other information

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## Digital field data capture... continued from page 3

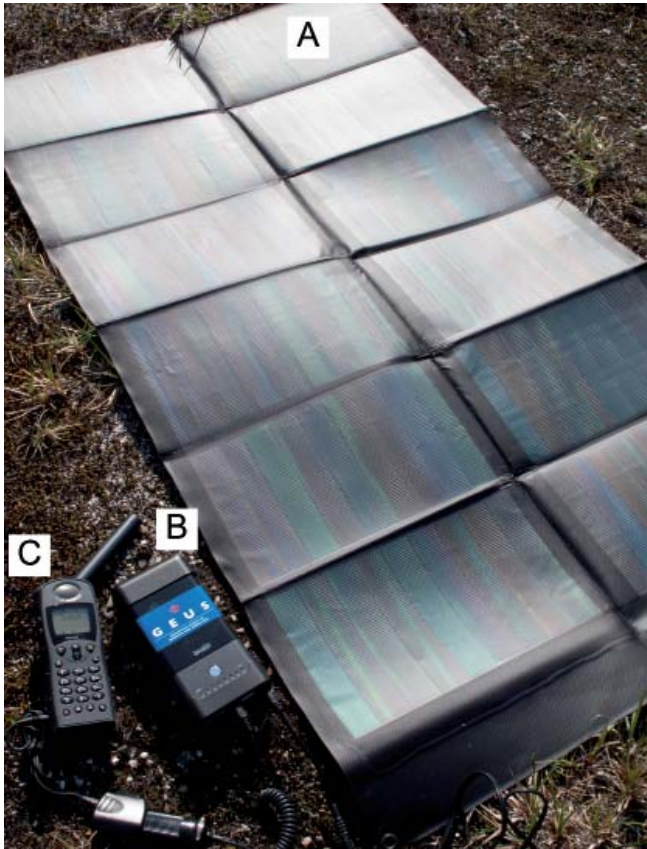


Figure 2. Equipment used for charging the digital field data capture system: a) solar panels (62W P3 Powerpack from Select Solar Ltd.) were used to generate power; b) an external battery (myPower ALL Plus MP3750 from Tekkeon, Inc.) was charged by the solar panel; c) charging an external device, in this example a satellite phone.

such as structural measurements on the outcrop are taken. Bedrock samples are collected and described and photographs are taken and annotated for documentation. Additionally, stream, soil, or scree sediment samples are collected. The “GanFeld” software developed by the Geological Survey of Canada (GSC) (Buller 2004, 2005) allows systematic capture of field data in an organized and modular manner. Table 1 summarizes the type of information that is digitally captured while performing field work. Although some of the data entry is compulsory and entered via predefined look-up tables (LUTs) as drop-down lists (e.g. “Station”; and “Earth Material”), other information is optional and consists of both LUTs and in some cases free-text description. The compulsory data entries ensure that all of the field data critical for GEUS are captured while keeping field work efficient. The predefined drop-down lists allow geologists to capture information in a consistent manner in which pre-defined classifications and descriptions

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**Note:** This EXPLORE article has been extracted from the original EXPLORE Newsletter. Therefore, page numbers may not be continuous and any advertisement has been masked.

## Digital field data capture... continued from page 4

Table 1. Field data are captured using the six "GanField" modules: "Station", "Earth Material", "Rock Sample", "Structure", "Photo", and "Sediment sample" and each of these modules consists of two to seven pages. (Note: "short notes" refer to text string up to 254 characters and "large notes" to text entry of unlimited length.)

Module:	Page number:	Pages:
"Station"	1	Coordinates (provided via GPS in three different coordinate systems)
	2	Elevation; observation type; team partner; camp ID
	3	Station "short note"; since last station "short note"; "large note"
"Earth Material"	1	Rock class; rock type; rock name; colour
	2	Minerals; abundance and size of minerals; metamorphic facies
	3	Alteration; ore minerals; abundance and size of minerals
	4	Textures (three different textures can be captured)
	5	Lithological map unit; "short notes" for material description; "large notes"
	6	Chronostratigraphy; era, period, epoch
	7	Fossils
"Rock Sample"	1	Sample type; purpose; GEUS sample number
	2	Sample orientation; sample depth, "short notes", "large notes"
"Structure"	1	Class; type; detail
	2	Method (right hand rule or dip dip direction); Azimuth and dip measurement
	3	"Short notes"; "large notes"
"Photo"	1	Category; File ID from digital camera; direction of picture; time of picture
	2	Photo caption (possibility to load previous caption); "large note"
"Sediment sample"	1	Stream Sediment (sub-module with 4 pages)
	2	Soil Sediment (sub-module with 3 pages)
	3	Scree Sediment (sub-module with 3 pages)

are used resulting in a consistent description of localities and geology amongst geologists. This last point is of particular interest to GEUS, as many of the field campaigns are carried out with external Danish and international collaborators with different backgrounds and expertise. Furthermore, because much of the data are selected from LUTs, GEUS has the ability to define these lists following international standards for describing rocks, minerals, textures and other geological information. Figures 3 and 4 demonstrate how the data are captured in the field: after capturing the location (Table 1, "Station"), the module "Earth Material" is activated by clicking on a hammer icon (Fig. 3a) and *page one* of the module "Earth Material"

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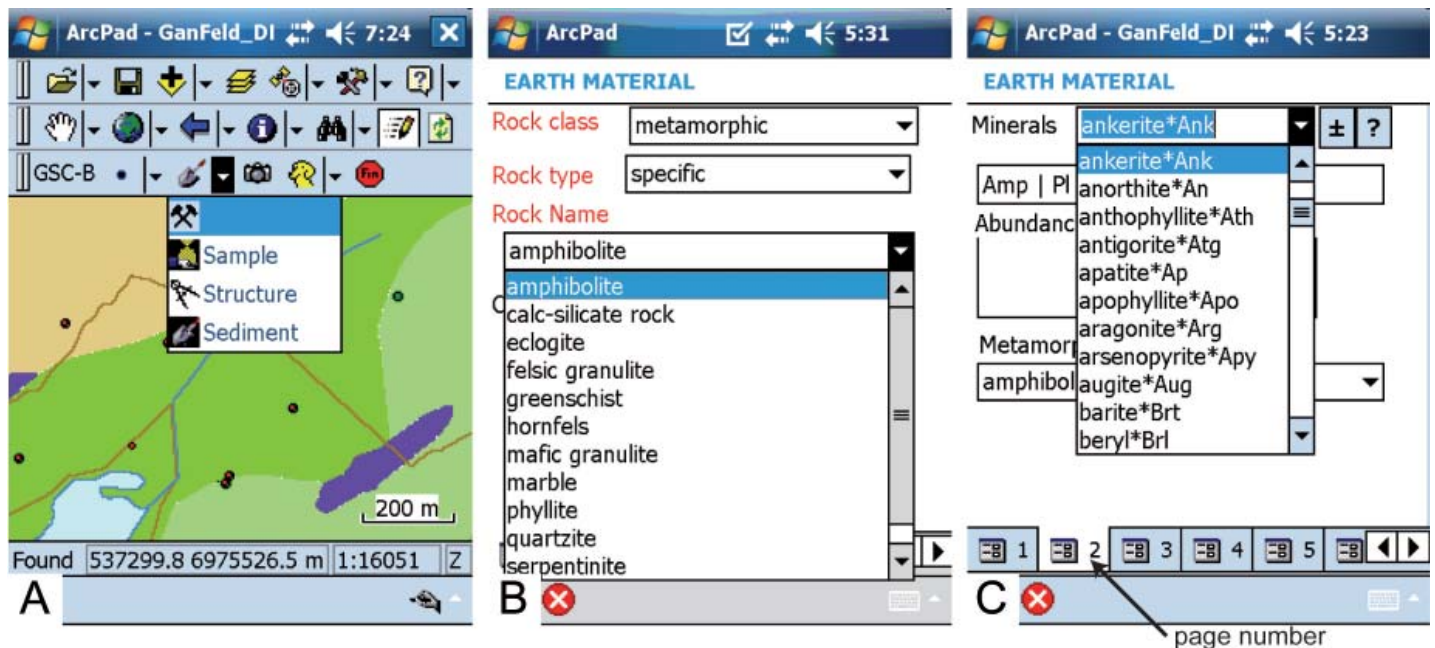


Figure 3. Sequence of digital field data capture for "Earth Material": a) a small hammer icon is activated to capture the field data seen at an outcrop. Other icons are sample bag (for samples), compasses (for structures) and shovel (for sediment samples). The location of the outcrop has already been captured previously and corresponds to one of the small dots on the geological map; b) the field data of the earth material is captured; c) the minerals identified at the outcrop are captured using the drop-down list with predefined minerals. Several minerals can be selected one by one and are concatenated into a series or string of words in a single box.

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opens in a new window (Fig. 3b; Table 1, "Earth Material"). Page two of the module "Earth Material" (Fig. 3c) includes the "Minerals" field populated with all minerals observed at the outcrop. Minerals are selected one after the other from a drop-down list (Fig. 3c). Subsequently, "GanFeld" guides the geologist through a step by step process to ensure that all necessary rock outcrop description information, following

GEUS standards for Greenland, is captured. Figure 4 shows how the information for a sediment sample is captured. One of three sample types can be selected: stream sediment, soil sediment or scree sediment (Fig. 4a). Several drop-down lists within the sediment sample form (Figs 4b and 4c) facilitate the field data capture with little free-text being entered.

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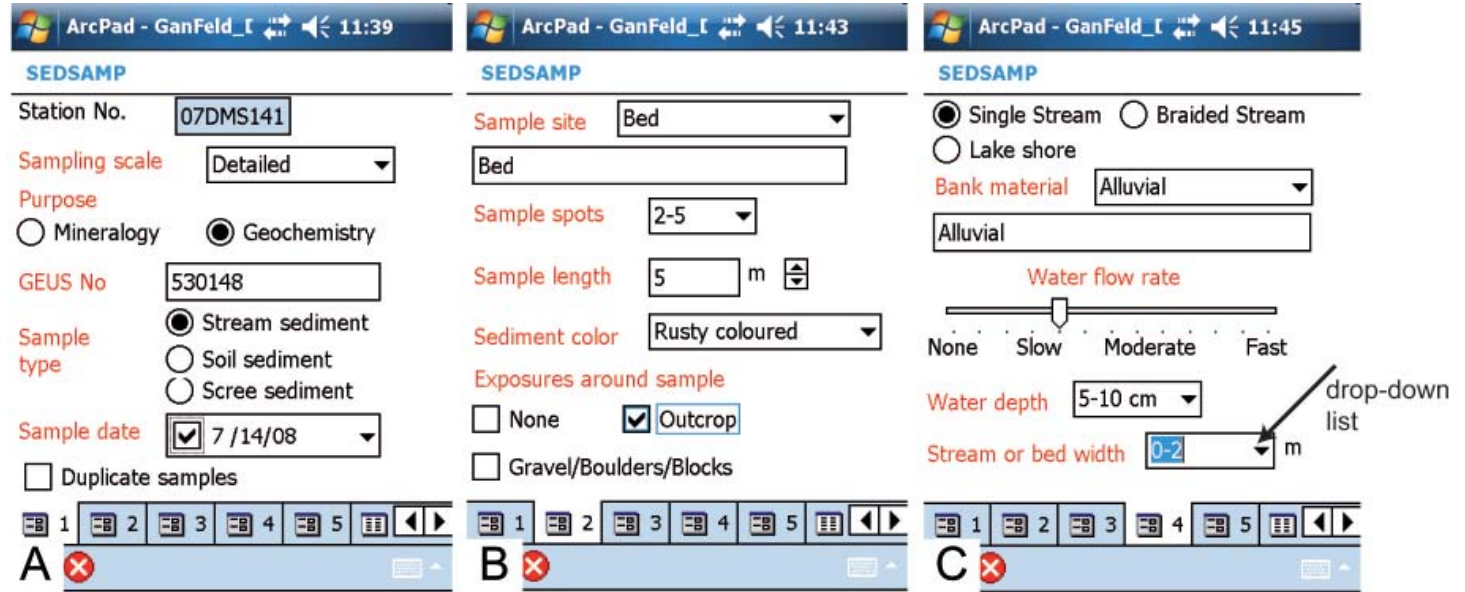


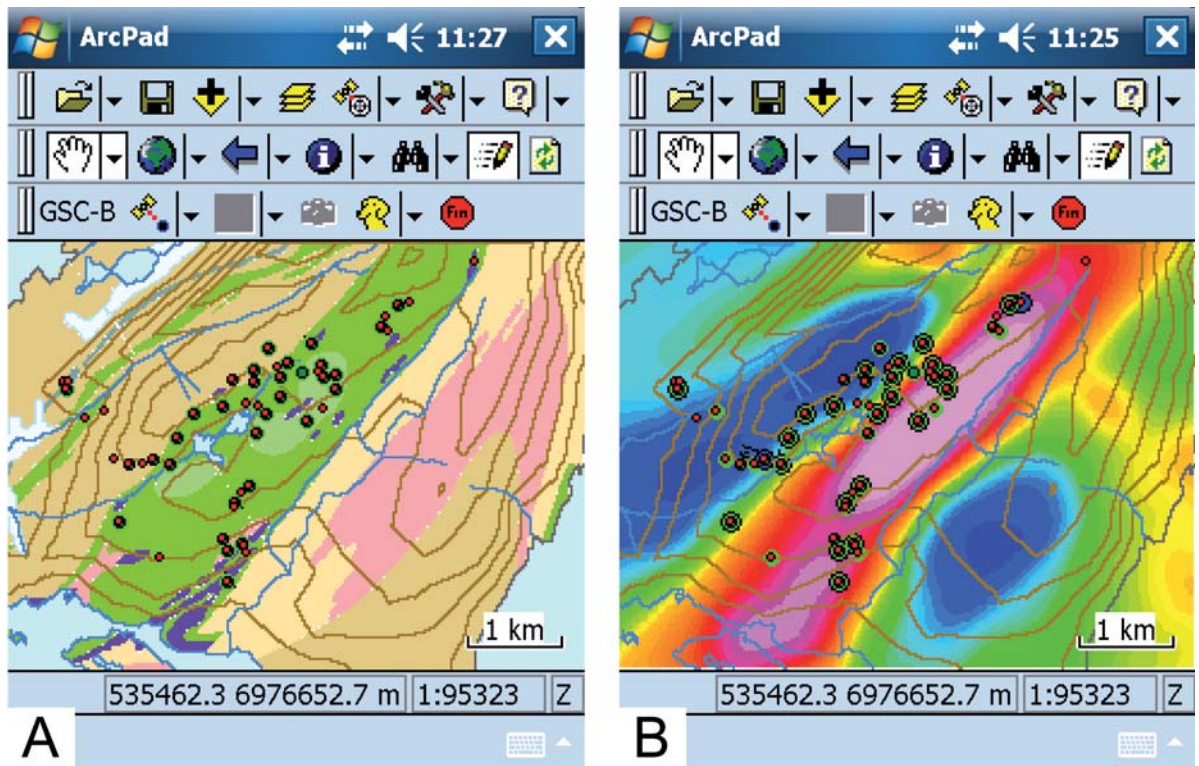
Figure 4. Sequence of digital field data capture for "Sediment sample": a) three types of sediment samples can be recorded: stream, soil and scree sediment samples; b) the sample site and sample collected are described using drop-down lists which are activated by clicking inside the small black arrows (on the right side of the combo boxes); c) the stream from which the sample is taken is described including water flow rate, which is characterized using a scale bar.

## Digital field data capture... *continued from page 6*

“GanFeld” uses the ArcPad application, an Environmental Systems Research Institute Inc. (ESRI®) product that GEUS is already familiar with and thus has the necessary licenses. “GanFeld” leverages the geographic information system (GIS) capabilities of ArcPad by gathering information for a single point in an electronic format. The different groups of information (e.g. “Station”, “Earth-Material”, “Rock Sample”, etc.; Table 1) are each recorded in separate shape files and therefore, have their own geographically referenced location that is plotted on the map when collecting data. The “GanFeld” software is simply a set of forms and menu items that are written in XML (Extensible Markup Language) which then use VBScript

(Visual Basic Scripting Edition) code for producing a variety of functionality for each form. These forms and scripts simply act as an add-on to the existing ArcPad application. The captured data are stored in the database file (dbf file) of the shape files that makes it possible to directly access the data easily via spreadsheet or database applications. Furthermore, data can be plotted in the field directly into a GIS platform such as ArcMap, which is also an ESRI® product, or any other GIS software which can read shape files. The ability to produce maps based on captured field data while still in the field is a remarkable advantage recognized by other geological surveys such as the Geological Survey of Finland (Kauniskangas et al. 2008).

Figure 5. Geographically referenced base layers can be added by clicking the “plus” icon in the top row: a) the stations visited and the geological map from an area in southern West Greenland are superimposed. Circles of different colours indicate the type of data that was captured (Table 1 provides a list of the categories); b) same area as in (a) with the regional vertical gradient of the total magnetic intensity field (line spacing 500 m, draped 300 m) as a background base layer and position of the captured stations (small dots). The geographically referenced maps are stored on a SD memory card that is inserted in the PDA.



### Base layers and examples from field work

Geographically referenced base maps such as bedrock geology maps (Fig. 5a) and geophysical maps (Fig. 5b) can be added as a layer in ArcPad® and displayed directly on the screen of the PDA. This ability to display maps helps to provide a precise location in the field and to easily find areas of interest; for example, the edges of a geophysical anomaly (Fig. 5b). Furthermore, field work progress can be seen at a glance, because the stations visited, the samples taken and any other captured field data are directly displayed on the screen using different symbols for each activity (Figs. 5a and 5b). Individual geologists can add and remove maps by connecting the PDA to a computer or by simply storing map data files on the SD memory card which is part of the field capture system (Fig. 1e). If the maps are not available as shape files, georeferenced tiff-image files can be used. However, it is recommended that maps and images of small memory size are used because the memory available on a PDA is limited and the speed of the processor is slow compared to a desktop computer. Depicting a large map or

image on a PDA in the field could be time consuming.

At the end of each field day, geologists can download and back-up the PDA data onto a laptop computer to avoid the data loss. Digital field data from the field teams are sent

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## Digital field data capture... *continued from page 7*

to base camp on SD memory cards on a regular basis to allow base camp staff to compile and analyse all captured data (Fig. 6). The outcrops visited are plotted on a geological map (Fig. 6a) which allows the quality of the information and the progress of the field work to be verified. Geologists at base

camp can interpret the data while in the field and plan field activities accordingly. The activities carried out by a given field team can be plotted on an even more detailed map (Fig. 6b).



Figure 6. Maps produced at the base camp: a) Field activities carried out in southern West Greenland. Locations of the base camp in 2008 and of the first camp of field team number 3 (Team 3, camp 1) are shown. Distance from Nuuk to base camp is about 50 km; b) the field activities carried out by team 3 at their camp location 1 are listed (E="Earth Material", S="Rock Sample", St="Structure").

### Data processing after the field season

#### Data flow in the office

Immediately after the field season, the digital field data will be verified by a software routine that cross checks the

"GanFeld" field data with the reference database containing the permitted entries. This routine generates an error list (Fig. 7) which facilitates the detection of mistakes and omissions and the necessary corrections within the field data to be made efficiently. Often, these minor typographical errors occur because text was entered directly in the text boxes instead of using the predefined drop-down lists. Such errors can be corrected easily. After corrections are made, the reviewed data will be cross-checked once more with the routine in order to have an error-free data set. Subsequently the field data are transferred into the central relational master database and a preliminary data report is generated via Crystal Reports which is also an ESRI product (Schjøth 2009). In detail, six dbf files ("Station", "Earth Material" etc., see Table 1) are linked to the station number and a report with all the field data from a given station is generated (Table 2).

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The screenshot shows the 'Ganfeld Dataset' software window. It contains several input fields for project information:

- Project ID: 71
- Initials: NNH
- Geologist Name: Niels Nørd Hedensted
- Project Name: Greenland SW 200
- Project Leader: DMS
- Camera Prefix: (empty)
- Database name: \_bck\WIVH\GanFeld\_revised\GanFeld\_vivh\_14Jul09
- Ganfeld Datum: D\_WGS\_1984
- Upload Date: 09-03-2010 10:11:20
- Last Check Date: 09-03-2010 10:11:48
- Transferred to Oracle Date: (empty)
- Errors: Y

Below the form is an 'Error Log' table with the following data:

Error No	Error message	identification
1	Teampartner: no team partner is not found in list	Locality=09VIVH057
2	MINERAL, value : "Mca" is not found in list	earthmatid=09VIVH017B
3	MATERIAL, value : "bivalve" is not found in list	earthmatid=09VIVH084B
4	MATERIAL, value : "bivalve" is not found in list	earthmatid=09VIVH087D
5	Mineral, PI does already exists	earthmatid=09VIVH087D
6	TEXTURE, value : "" is not found in list	earthmatid=09VIVH108A
7	Sample, 09VIVH009B-04 does already exists	sampleid=09VIVH009B-04

On the right side of the error log table, there are four buttons: 'Check', 'Error Log to Excel', 'Valid values (Excel)', and 'Transfer'.

Figure 7. A software routine cross checks the field data with the database and detects inaccuracies which are then listed in an error report. This list helps the geologist to revise and edit the field data.

### *Maintenance of drop-down lists and system*

In the "GanFeld" software, drop-down lists are populated directly from pre-defined LUTs in the form of dbf files. Table 3 shows a part of the LUT which is used to describe the mineral assemblage of an earth material. Because the LUTs are stored as dbf files, the content can easily be modified by geologists in DBF viewer which is a free software utility (HiBase Group USA) that allows minor modifications to a dbf file. After modification, the altered file can be copied back into the "GanFeld" software. The next time that "GanFeld" is turned on, the updated mineral list will be used to populate the mineral drop-down list (Fig. 3c). Typically after each field season, it becomes apparent that certain datafields or types are missing from the lists (e.g. a mineral or rock texture not contained in the list). Consequently, the content of these lists needs to be updated before the next field season. The process of the modification of these lists is overseen by a panel of geoscientists who are appointed by GEUS. Modification of LUTs, even in the field, provides a certain flexibility to "GanFeld" reflecting the complexity and variability of the geological information. Another advantage of using ArcPad is that new pages can be easily added and existing pages can be easily modified via the ESRI ArcPad Application Builder. The sizes and appearances of the combo boxes and the text of the combo boxes can also be changed easily with the ArcPad Application Builder.

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Table 2. Example of a Crystal report which was generated directly from the "GanFeld" data. At station 09DMS011, one rock was described ("Earthmat"), a sample was taken ("Sample"), a measurement of a structure was carried out ("Structure") and a photo was taken ("Photo"). (Station 09DMS011 is located in southern West Greenland and corresponds to one of the dots on Figure 5).

### Station

09DMS011	Latitude=	62,90738	Entry type=	GPS
	Longitude=	-50,27065	Pdop=	2
	Easting=	537060	Sat used=	10
	Northing=	6975480	Visit date=	01-07-2009
	Elevation=	555	Elevation method=	altimeter
	Altimeter=		Visit time=	11:16:07 AM
	Obs type=	outcrop	Partner=	Yong Chen

Profile id=

Camp id= Camp 2

Station note:

same large shear zone as seen in station  
09DMS009

### Earthmat

09DMS011	Earthmat letter=	A
09DMS011A	Material:	metamorphic specific amphibolite
	Colour:	yellow brownish
	Map unit:	
	Mineral assemblage:	Qtz
	Metamorphic grade:	amphibolite
	Alteration:	Qtz   Phl
	Notes:	amphibolite hosts 50 cm zone with veinlets of qtz carbonate, rusty

### Sample

09DMS011	Sample number:	1
09DMS011A	Sample type:	rock hand RS
09DMS011A-01	Sample orientation:	
GGUno = 511907	Sample dep:	0
	Purpose:	geochem WR   geochem assay
	Notes:	composite sample

### Structure

09DMS011	Structure number:	1
09DMS011A	Class:	planar
09DMS011A-01	Structure type:	shear zone
	Detail:	
	Method & readings:	Dip azimuth / Dip 151 / 80
	Sym ang:	61
	Relative age:	0
	Notes:	same shear zone is sampled as in station 09DMS010
	Symbol:	0
	Intensity:	strong

### Photo

09DMS011	Photo number:	1
09DMS011P01	Category:	outcrop
	File number:	536
	File name:	IMG0536.jpg
	Direction:	0
	Caption:	picture of outcrop
	Photo date:	01-07-2009

## Digital field data capture... continued from page 11

Table 3: The “minerals list” is stored as a dbf file and can easily be altered and modified by using the free software “DBF viewer” from HiBase Group USA.

EARTH MATERIAL		
Page 2	carbonate	Cb
Minerals	(undifferentiated)	Cst
other minerels are listed above	cassiterite	Cls
ankerite	celestite	Cc
anorthite	Ank chalcocite	Ccp
anorthoclase	An chalcopyrite	Chl
anthophyllite	Ano chlorite	Cld
antigorite	Ath chloritoid	Chr
apatite	Atg chromite	Ctl
apophyllite	Ap chrysotile	Clay
aragonite	Apo clay (undifferentiated)	Cpx
arsenopyrite	Arg clinopyroxene	Czo
augite	Apy clinozoisite	Crd
barite	Aug cordierite	Crn
beryl	Brt corundum	Cv
biotite	Brl covellite	Cum
boehmite	Bt cummingtonite	Dsp
bornite	Bhm diaspore	Dick
Ca-clinoamphibole	Bn dickite	Di
Ca-clinopyroxene	Cam diopside	Dol
calcite	Cpx dolomite	En
cancrinite	Cal enstatite	
	Ccn other minerels are listed below	

### The way forward

A central relational (Oracle®) master database is used to store all captured data from all the expedition members. About half of the Greenland expedition members are Danish or international collaborators and are not permanently based at GEUS. Because an application was needed that enables the geologists to quickly assess the quality of captured data, generate data reports and plot data, an application that is accessible via the Web was developed. This allows “GanFeld” users to review and to edit their data after the field season. Figure 8 shows how this application is structured. The field data can be accessed with a password. By searching for a given station number, any other set of information attached to that field station can be edited (Fig. 8). After completing the review and edits, the master database is updated and the “GanFeld” data can then be linked to other data sets (e.g. geochemical data which are stored in the GEUSGREEN database; Tukiainen & Christensen 2001).

### Discussion and conclusions

The past two GEUS field seasons have shown that PDAs are suitable devices for capturing digital data during field work in Greenland. Although a tablet PC is more powerful

Home [FielLocalityList](#) [Browse data](#) signed in as: ctt [Logout](#)

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**StationId: 08DMS062**

**Geologist:** Schlatter, Denis

**Visit Date:** 7/5/2008

Longitude	Latitude	Entry Type	PDOP	Number of satellites	Elevation	Elevation Method	Altimeter Reading	Traverse Ilo	Air Photo	Observation Type	Camp ID
-50.071708	63.948398		3.2	6	1149.1		1150	9			

**Station Note** **Since Last station**

**Edit**

**Team Partners:** Kolb, Jochen, **Edit**

- Earth material: gneiss (schist>1cm) »
- Sample: 508339 »
- Structural measurement: 08DMS062A-01 »
- Structural measurement: 08DMS062A-02 »
- Earth material: gneiss (schist>1cm) »

Figure 8. A web based application allows the user to browse and edit the “GanFeld” data. The GEUS master database is updated after edits are completed.

and has a larger screen than a PDA, the latter fits into a vest or a pocket and is thus more suitable for field work in remote arctic alpine terrain with variable field conditions (Figure 9) and when no detailed mapping is involved. For industry and/or government organizations, the use of these devices facilitates the monitoring of field work progress, some quality control in base camps and efficient and fast post-field work data treatment. Also, it allows the field geologist to review the data on a daily basis, as the generated dbf files can be easily transferred and backed-up onto a laptop at the end

of each day in the field. Avoiding loss of digital field data is critical. Therefore, a very strict backup procedure must be established. The field data must be downloaded daily to a laptop computer and/or onto a SD memory card (Fig. 1e) by the individual field team. In addition, base camp should store the field data of all the teams centrally and keep track of the reporting of these data (Fig. 6).

Future PDA development will include the ability to add point data information from already existing GEUS databases onto the PDAs (e.g. previously analysed rock

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*Figure 9. Field work is performed by the first author in steep and rough terrain in southern West Greenland. GEUS is now using the digital field data capture system on many of their expeditions. The wireless GPS can be seen on the rock outcrop (Photo: Jochen Kolb).*

samples, locality descriptions, remote sensing anomalies, etc). Furthermore, the web application for editing and reviewing data can be developed to allow plotting and analysis of data on existing maps or on web applications such as Google Earth®. Digital mapping carried out with a tablet PC might be developed and used by GEUS in the future in cases where extensive geological mapping will be carried out.

It might be possible to add the “GanFeld” component as a function directly into a digital mapping system of a PC tablet. Handheld portable X-ray fluorescence (XRF) analyzers are improving rapidly and can potentially be used in the field with the PDAs in order to capture not only all the relevant field data, but also the analysis provided by the handheld XRF analyzers.

In order for GEUS to use a digital field data capture system, comprehensive and complete instructions for the system and how to use the “GanFeld” software have to be supplied to all users prior to the field season (Schlatter & Larsen 2009). As part of standard field preparation, “GanFeld” training exercises should be completed by all users. It was also necessary to convince geologists to use the digital field data capture system in the field.

Advantages of the use of digital field data capture for GEUS include faster reporting of the field season because the field data are already digitally available and geologists do not need to spend time entering data manually into spreadsheets from field diaries which is not only time consuming but can introduce errors. Furthermore, digital field data can easily be shared at the end of the field season. In summary, since digital field data capture using PDAs and “Ganfeld” has been introduced at GEUS, field data are neatly organized and reporting and sharing of data has become easier.

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## Digital field data capture... *continued from page 13*

### Acknowledgements

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### References

- BRIMHALL, G. & VANEGAS, A. 2001. Removing science workflow barriers to adoption of digital geological mapping by using the GeoMapper universal program and visual user interface. Open File Report U S Geological Survey, Report **01-223**, 103-114.
- BRODARIC, B. 2004. The design of GSC FieldLog: ontology-based software for computer aided geological field mapping. *Computer & Geosciences*, **30**, 5-20.
- BULLER, G. 2002. Capturing Digital Data in the Field - Ganfield: data integrity from field to final product. Workshop, British Geological Survey, Nottingham, England 25 & 26 April 2002.
- BULLER, G. 2004. GanFeld: Geological Field Data Capture. U.S. Geological Survey Open-File Report **2004-1451**, 49-53.
- BULLER, G. 2005. A conceptual approach to the development of digital geological field data collection. Open File Report U S Geological Survey, Open File Report No. **2005-1428**, 91-96.
- CLEGG, P., BRUCIATELLI, L., DOMINGOS, F., JONES, R.R., DE DONATIS, M. & WILSON R.W. 2006. Digital geological mapping with tablet PC and PDA: a comparison. *Computers & Geosciences*, **32**, 1682-1698.
- COLM, J., HOWARD, A. & BEE E. 2008. The British Geological Survey digital field data capture system: Better than pen and paper? 33<sup>rd</sup> International Geological Congress, Oslo, Norway (CD ROM).
- CURTIS, M., FLOWERDEW, M., RILEY, T. & TATE, A. 2008. Digital geological mapping and data capture within the British Antarctic Survey. 33<sup>rd</sup> International Geological Congress, Oslo, Norway (on CD ROM).
- GILBERT, C., PARLEE, K. & SCOTT, D.J., 2001: A Palm™-based digital field-data capture system; Geological Survey of Canada, Current Research **2001-D23**.
- KAUNISKANGAS, E., AHTONEN, N., RÖNKKÖ, T., & KURONEN, E. 2008. Digitalized field data capture as a part of GTK's data management process from field to geodatabase. 33<sup>rd</sup> International Geological Congress, Oslo, Norway (CD ROM)
- SCHLATTER, D.M. & LARSEN, U. 2009. GanFeld: introduction and news. In: KOLB J. & KOKFELT T. (eds). Annual workshop on the geology of southern West Greenland related to field work: abstract volume 1, Danmarks og Grønlands Geologiske Undersøgelse Rapport **2009/21**, 22-23.
- SCHLATTER D.M. & LARSEN, U. 2010. Using digital field data capturing in Greenland: Experience from 2008/9 GEUS field seasons. In: NAKREM H.A., HARSTAD A.O. & HAUKDAL G. (eds). 29<sup>th</sup> Nordic Geological Winter Meeting. Geological Society of Norway, 173-174.
- SCHJØTH, F. 2009. GanFeld: Reporting of collected field data. In: KOLB J. & KOKFELT T. (eds). Annual workshop on the geology of southern West Greenland related to field work: abstract volume 1, Danmarks og Grønlands Geologiske Undersøgelse Rapport **2009/21**, 24-25.
- TUKIAINEN, T. & CHRISTENSEN L. 2001. GEUSGREEN. GimmeX database relateret til GEUS' nummersystem for geologiske prøver fra Grønland. (GimmeX database related to the GEUS number system used for geological samples from Greenland. In Danish). Danmarks og Grønlands Geologiske Undersøgelse Rapport **2001/132**.

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