# 3D Mobile Visualization Techniques in Field Geology Interpretation: Evaluation of Modern Tablet Applications*

**Layik Hama[1], Roy A. Ruddle[2], and Douglas Paton[3]**

Search and Discovery Article #120157 (2014)
Posted February 25, 2014

*Adapted from extended abstract prepared in conjunction with oral presentation at AAPG Hedberg Conference, 3D-Structural Geologic Interpretation: Earth, Mind and Machine, June 23-27, 2013, Reno, Nevada, AAPG©2013

[1]Visualization and Virtual Reality Group, School of Computing, University of Leeds, United Kingdom (scs3l3h@leeds.ac.uk)
[2]Director of Research, School of Computing, University of Leeds, United Kingdom
[3]Institute of Geophysics & Tectonics, School of Earth & Environment, University of Leeds, United Kingdom

## Abstract

Higher education institutions still rely on traditional tools when taking students out for their fieldtrips such as geological notebooks and printed maps. These traditional methods have been and are creating difficulties for students and novice geologists comprehending geology they study in the field (Whitmeyer, Feely et al. 2009). However, an increasing number of higher education institutions worldwide are convinced that the use of geo-technologies such as Geographic Information Systems (GIS) and other technologies are fundamental to prepare students for their future careers (Kerski, 2008). A set of tasks carried out by professional geologist are deemed necessary for novice geologists to look out for and learn in the work by student geologists that demand high spatial skills (Kastens and Ishikawa 2006).

## Introduction

In their previous work, Kastens and Ishikawa (2004) acknowledge that many adults have difficulty with locating themselves on maps, which is an essential task in fieldwork. For more complicated tasks, novice geologists have to learn to visualize the third dimension from two-dimensional maps (Rapp, Culpepper et al. 2007; Whitmeyer, Feely et al. 2009). Liben and Titus (2012) mention three reasons for these difficulties by novice geologists: nature of geological data and representations, students arrive without developed spatial skills and educators fail to realize the second.

One of the most important remedies of these cognitive and sometimes practical difficulties have been and still is taking students out to the field (Whitmeyer, Feely et al. 2009) to improve their spatial skills. The importance of information technology to aid these cognitive and meta-cognitive skills have been acknowledged by (Herbert 2006). Therefore, modern digital field techniques may be able to assist novice geologists with these difficulties.

## Research Outline

This is a PhD scholarship funded by UK EPSRC. The study was started from three concrete and main problems student geologists face in the field published by (Whitmeyer, Feely et al. 2009) which are: (1) extrapolation of 3D features from 2D outcrops or maps, (2) applying small-scale observations to large scales and (3) visualization of formations of geological evolution.

This study is focused on the first two points in the context of using modern tablet and smart-phones in the field as the third is deemed outside the scope of the research. Therefore the aim of this study is to research mobile 3D visualization functionality to aid novice geologists (more specifically structural geologists) overcome fieldwork difficulties caused by traditional tools using smart-phones and tablets.

The background research suggests that requirements for a software application in the field is totally different from the requirements of desktop applications, therefore many of the enterprise and other software packages available on the university laboratories are not fit to be ported to mobile devices let alone be used as they are on portable devices.

## Evaluation of Tablet Applications

Current smart phone and tablet applications for geological fieldwork (digital field applications) can be categorised into data capture, data viewing and data analysis applications. Most of these applications have been developed based on one or a combination of the three. The analysis category is the focus of this research and the research was launched on the hypothesis that current software and hardware capabilities should be able to present more than what is currently available.

## Discussion

Therefore, the first step was an evaluation of functionality of current Android applications for tablets available on app stores. This evaluation was carried out in real fieldwork (Ingleton, England) environment over two separate student fieldtrips in October 2012. This evaluation was carried was attended by British Geological Survey (BGS) developers who had recently released their iGeology3D application.

The evaluation presents evidence that 3D virtual world applications such as Google Earth using Digital Elevation Models (DEM) on tablet devices can assist students interpret geological data compared to 2D maps at specific stops during their fieldwork and at certain scales of field view. Figure 1 shows the difference between interpreting 2D (Figure 1a) map view versus equivalent 3D DEM view (Figure 1b).

On the other hand, the results present evidence that finer resolution than the resolution of digital elevation model of virtual world applications used in the evaluation is useless to drape images or geological maps. It also shows that no smart-phone/tablet functionality have been found or may not be available for sub-meter outcrop level visualizations to aid students visualize geological data at such scale. The evaluation also concludes that the notion of developing an application (app) will not work for even a simple fieldwork like the evaluation case study.

## Summary

For the remainder of the research, one way forward is tablet-based use of outcrop level visualizations such as Digital Outcrop Models (DOMs). The challenge will be a) rendering DOMs on tablets/smart phones and b) to use them in conjunction with virtual world applications such as Google), and 3D geological models such as the recently released BGS Ingleborough proprietary 3D model to provide a seamless navigation from one scale to another and simulate natural scales variations(Jones, McCaffrey et al. 2009).

Another way forward is to evaluate the use of finer resolution data such as finer Digital Elevation Model (DEM) data, higher resolution satellite imagery and/or geological data. One option at this point is the use of (5m DEM) for the case study area. This is part of the ongoing collaboration between this study and BGS using their proprietary DEM data.

I seek feedback on my current research and/or any input by the specialist community into the requirements for a digital field application to assist teaching and assisting novice and student-geologists carry out their fieldwork in light of the capabilities of modern smart devices.

## Selected References

Herbert, B., 2006, Student understanding of complex earth systems: Geological Society of America Special Paper 413, p. 95-104.

Jones, R.R., K.J.W. McCaffrey, P. Clegg, R.W. Wilson, N.S. Holliman, R.E. Holdsworth, J. Imber, and S. Waggott, 2009, Integration of regional to outcrop digital data: 3D visualisation of multi-scale geological models: Computers & Geosciences, v. 35/1, p. 4-18.

Kastens, K., and T. Ishikawa, 2006, Spatial thinking in the geosciences and cognitive sciences: A cross-disciplinary look at the intersection of the two fields: Geological Society of America Special Paper 413, p. 53-76.

Kastens, K.A., and T. Ishikawa, 2004, Why some students have trouble with maps and spatial representations: An online tutorial for geoscience faculty: SERC Catalog Resource 22957, online resource https://serc.carleton.edu/resources/22957.html

Kerski, J.J., 2008, The role of GIS in Digital Earth education: International Journal of Digital Earth, v. ¼, p. 326-346.

Liben, L.S., and S.J. Titus, 2012, The importance of spatial thinking for geoscience education; insights from the crossroads of geoscience and cognitive science, in K.A. Kastens, and C.A. Manduca, eds., Earth and mind II; a synthesis of research on thinking and learning in the geosciences: GSA Special Paper, v. 486, p. 51-70.

Rapp, D., S. Culpepper, K. Kirkby, and P. Morin, 2007, Fostering students' comprehension of topographic maps: Journal of Geoscience Education, v. 55/1, p. 5-16.

Whitmeyer, S., M. Feely, D.G. De Paor, R. Hennessy, S. Whitmeyer, J. Nicoletti, B. Santangelo, J. Daniels, and M. Rivera, 2009, Visualization techniques in field geology education: A case study from western Ireland: Geological Society of America Special Paper 461, p. 105-115.

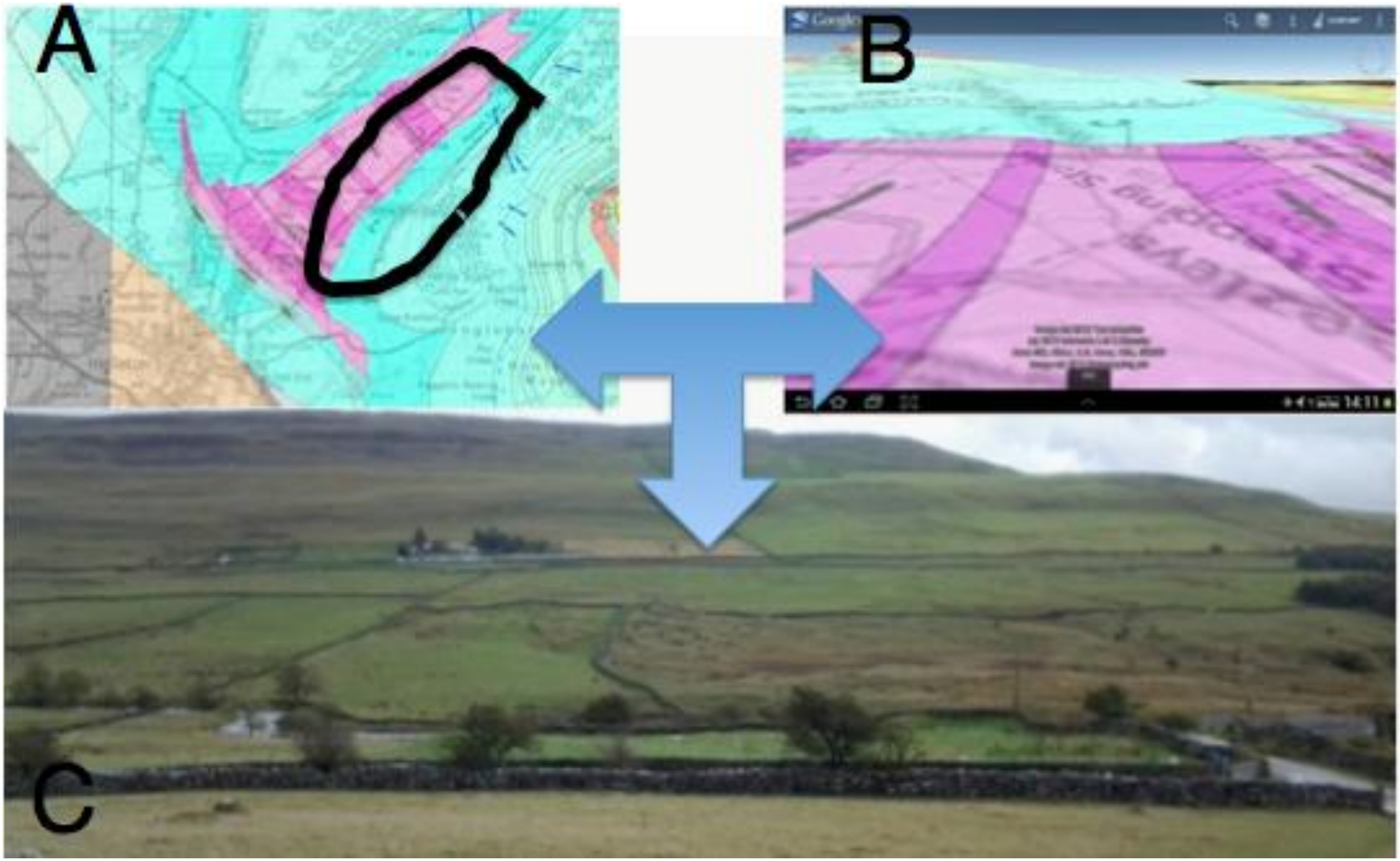


Figure 1. "Extrapolate feature" evaluation task. A) 2D geological map highlighting the unconformity. B) Same geological map draped over Google Earth DEM. C) Photograph of real world unconformity area