

18188**Digital field geology**

***I. M. Bubniak** (*Institute of Geodesy National University Lviv Polytechnic*), **A. M. Bubniak** (*Consulting Geologist*), **O. D. Gavrilenko** (*D. Serikbayev East-Kazakhstan State Technical University*)

SUMMARY

Field geological studies are an important source of information about upper most of crust that is available for direct observations. With the development of modern technologies, traditional methods and approaches are been replaced by modern ones. This paper evaluates the experience of using digital technologies during collection, processing and presentation of geological information from numerous geological site. Field Move and Clino are the most common software today among field researchers. They may be easily installed on tablets and cell phones respectively. The toolkit fully supports the researcher's work in the field. A significant benefit is the processing of all collected information using digital technologies. Advantage and disadvantages of digital technologies and technical devices are analyzed. The presence on market of alternative software is indicated.

Introduction

Field exploration is an important part of geological research. Technological advances have not gone beyond our industry. Today, digital technologies are applied not only to such high-tech fields of geology as, for example, geophysics, but also in conducting traditional field studies

The purpose of field surveys is to collect geological information for geological mapping or for specific surveys. These include the determination of the geographical location of observation points, the description of outcrops, the macroscopic description of rocks, the detection of lithological boundaries, the spatial fixation of planar and linear objects (folds, joints, faults, linear position of minerals, etc).

Methods

For several centuries, traditional tools for the geologist have been the map (topographical and geological) on which points and observation results have been recorded; notepad in which the descriptions of outcrops, rocks, structures were recorded; sample hammer; compass to determine the spatial position and fixation of structures. Over time, to these tools were added cameras (analog and digital) and then such devices as GPS. One of the important points in conducting field research is to determine the position of the observation point. In the traditional approach, a topographic map and compass were used to solve this problem. Sometimes the distance was measured using steps. The accuracy of such measurements was poor. The ability to use GPS significantly (it happened in the early 21st century) accelerated this process.



Figure 1 Traditional geological tools for field observations - notepad, geological map, compass.

An important turning point in conducting field geological research was the creation of compact personal computers. The creation of compact PCs (tablets, and especially rugged laptop) made it possible to use them in the field. At the same time, software for these electronic devices was created. The most popular among field geologists are Middle Land Valley software (now Petroleum Experts). Petroleum Expert created applications for phones called Clino and Field Move for tablets (Whitmeyer et al, 2020). The Clino has slightly less power than the Field Move. It allows the use of a cell phone as an effective field geological survey tool. It can help you determine your location on the map, take pictures of objects of interest to the researcher, using a built-in compass. There are also a number of tools that allow you to draw lines and polygons. In new versions it is possible to display the measurement data on the stereo grid.

Prior to conducting field studies, all important maps must be prepared. The maps must be georeferenced and have a single coordinate system for the whole project. Clino and Field Move

makes it possible to use several types of maps as a base. The accuracy of locating the observation point is 2-3 m, which is quite acceptable for field geological observations. Quite convenient is the ability to stack maps one and one and use the Transparency tool.

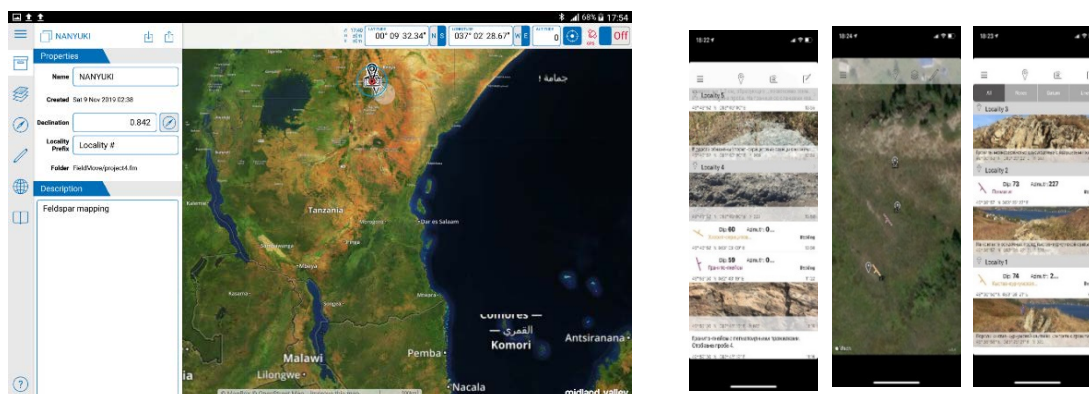


Figure 2 Field Move and Clino – alternative of traditional field tools.

The compass tool simulate the work of a traditional compass. It only works if there is a magnetic sensor in the device. Field Move has the ability to manually enter measurements made by a standard compass. As our experience shows, when carrying out a large number of measurements, it is more appropriate to use an iPhone or a smartphone with Clino. Because magnetic sensors are sensitive to metal objects, they should be avoided when carrying out measurements. Special studies have shown that smartphone and especially iPhones can be used as geological compasses (Pavlis et al. 2010) (Novakova and Pavlis 2019).

Drawing is done with the tool directly on the screen. You can choose the thickness, style, color of the line. The same applies to polygons. It is also possible to edit them. Lines or polygons can be tied to different stratigraphic levels.

An extremely handy tool is a Stereonet. With this tool you can plot all measurements made on the grid, and you can already have some information about the spatial distribution of geological features in the field. Data for stereo plot can be filtered by stratigraphy, data type (layers, cracks, linear elements, etc.), locations of measurements.

All field observation information is stored in a notepad. It allows you to view all the locations, data, made measurements, view photos and check measurements. Some data can be deleted or edited as needed. The notepad contains the Photo tool. This tool lets you take individual photo notes, take photos with your phone or tablet, view a photo gallery, take a screenshot as needed, and use the sketch feature to make a sketchy picture just like it does in a field notebook.

Data is exported using the Export tool. It is possible to export data from Clino and Field Move in mve format (own Move format), kmz format and csv format. Exported data can be successfully processed in other applications. You can use virtual globes to represent your data in 3D. The most famous and used is Google Earth. The other two (World Wind and Microsoft's Virtual Earth) are not as common as Google Earth (Whitmeyer et al, 2010).

The UK Geological Survey has its own field research software based on Arc GIS (Jordan, 2009). A single approach and requirements allow you to create maps already in the field.

An alternative to Clino is Stereo Mobile (Allmendinger et al, 2017). But this application can only be installed on iPhones.

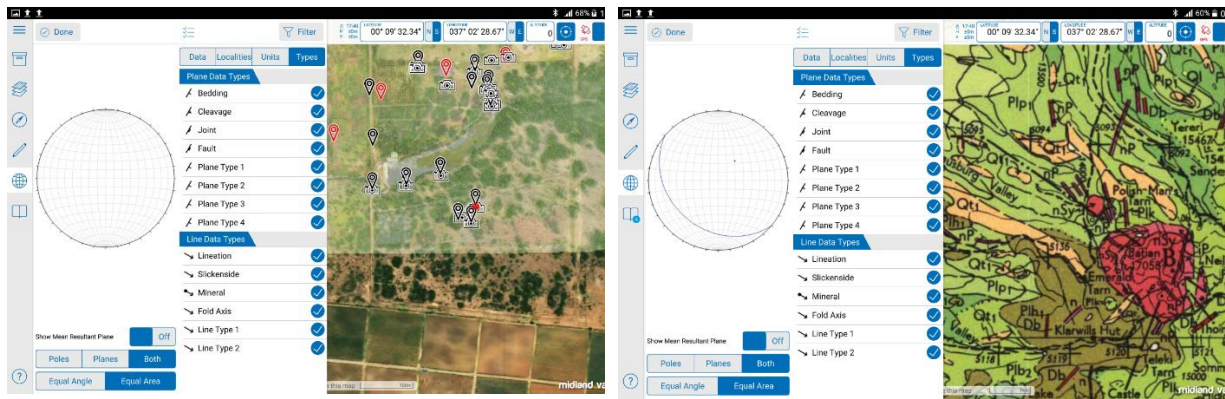


Figure 3 Stereonet tool for presentation of measurements.

Conclusion

The described gadgets completely imitate the work of the geologist in the field, are easy to use and allow you to store all the necessary information in digital form. The received data in digital format gives wide possibilities for their storage, processing, distribution, use in other software.

Like all technical gadgets, phones, tablets, and rugged laptop have their limitations. First of all, this concerns the battery charging time. Field devices must be well protected from moisture and dust. Electronic devices can be affected by the electromagnetic fields and by the presence of metallic objects. Despite a number of technical problems, traditional geologist tools in the field can be successfully replaced by electronic devices and information can be stored digitally.

References

- Allmendinger, R. W., Siron, C. R., & Scott, C. P. [2017]. Structural data collection with mobile devices: Accuracy, redundancy, and best practices. *Journal of Structural Geology*, 102, 98-112.
- Jordan, C. J. [2009]. BGS Sigma Mobile: the BGS digital field mapping system in action.
- Novakova, L., & Pavlis, T. L. [2019]. Modern Methods in Structural Geology of Twenty-first Century: Digital Mapping and Digital Devices for the Field Geology. In *Teaching Methodologies in Structural Geology and Tectonics* (pp. 43-54). Springer, Singapore.
- Pavlis, T. L., Langford, R., Hurtado, J., & Serpa, L. [2010]. Computer-based data acquisition and visualization systems in field geology: Results from 12 years of experimentation and future potential. *Geosphere*, 6(3), 275-294.
- Whitmeyer, S. J., Nicoletti, J., & De Paor, D. G. [2010]. The digital revolution in geologic mapping. *GSA Today*, 20(4/5), 4-10.