126948: Citizen-Scientist Digitization of a Complex Geologic Map

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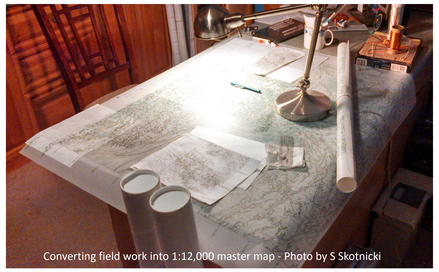
SUMMARY

Before 2015 no comprehensive geologic survey had been done of the McDowell Mountains, a small but geologically complex range in Scottsdale, Arizona. Based on his interest in these mountains, geologist Steve Skotnicki spent over 9 years and 2000 hours of personal time, including 1200 hours in the field, to produce a detailed hand-drawn survey map of the range and vicinity.

The McDowell Sonoran Conservancy (the Conservancy), which partners with the City of Scottsdale to manage the Preserve in which these mountains are located, funded the completion of Dr. Skotnicki's field mapping. The Conservancy also agreed to digitize the map at no charge using citizen scientists led by Dan Gruber, a volunteer familiar with geology and basic mapping techniques, and supported by geology consultant Brian Gootee of the Arizona Geological Survey (AZGS) and Conservancy staff.

A team of Conservancy citizen scientists successfully digitized the map, which is now available online sponsored by the AZGS. A version suitable for large-format printing is in progress. This project demonstrates the ability of trained volunteers to handle large, technically complex projects.

Field Mapping - Photo by S Skotnicki



Converting field work into 1:12,000 master map - Photo by S Skotnicki

APPROACH

The volunteer team was recruited from citizen scientists who had participated in previous geology projects sponsored by the McDowell Sonoran Conservancy Field Institute (the Field Institute), the Conservancy's research center. They were familiar with the mountain range and geologic terminology, and they also understood the importance of having a comprehensive geologic map of the area.

Infrastructure necessary to support the work was developed by Gootee and Gruber:

- Making high-resolution images of the hand-drawn maps and georeferencing the images to a base map in ArcMap from ESRI.
- Providing a USGS ArcMap toolbar modified by the AZGS for digitizing.
- Dividing the significant work effort into reasonable pieces whose status could be monitored.

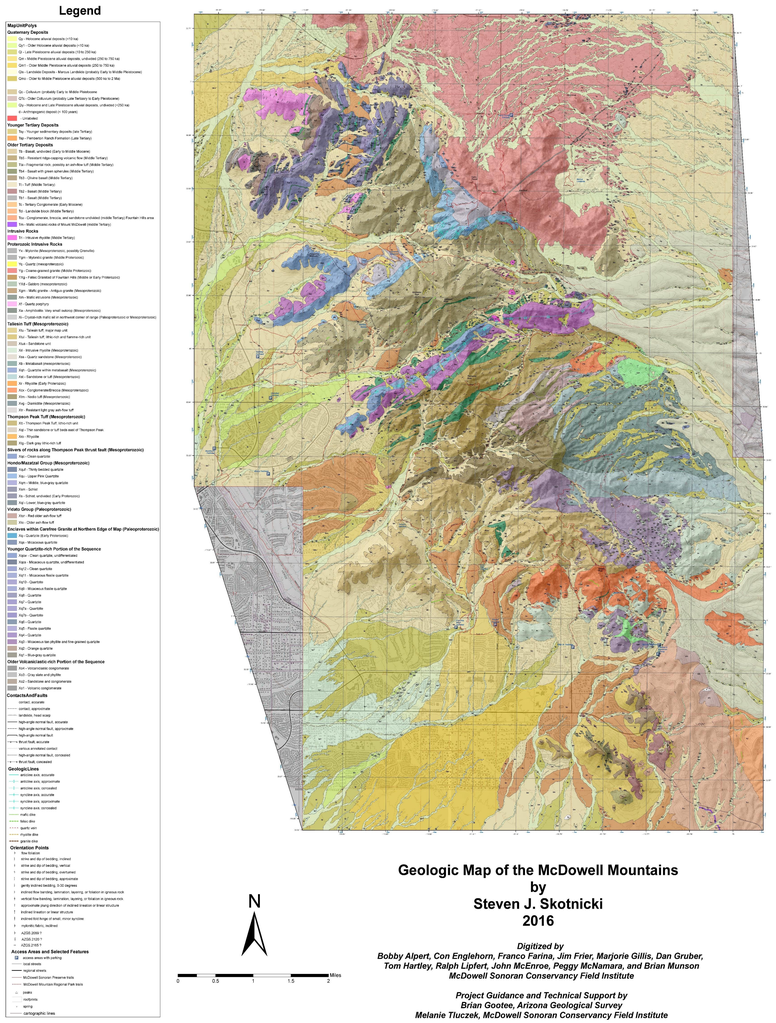
The digitization process involved separating the work into phases, developing instructions for each phase, and training the team. After each phase quality assurance was done by having team members review each other's work, followed by final review by Gruber.

Map layout included legend production using map unit descriptions and metadata from Skotnicki. A standard USGS color palette was modified based on discussions between Gruber and Skotnicki.

Gootee and GIS specialists at AZGS prepared the map for online digital access through ESRI ArcGIS Online. The digital map can be accessed on mobile devices.

ArcMap training session – photo by R Lipfert

Citizen scientists working on the digital map – photo by D Langenfeld



Draft geologic map produced by McDowell Sonoran Conservancy Field Institute citizen scientists from the work of Steve Skotnicki. Changes to the legend and the addition of cross-sections and other information are in progress.

RESULTS

A team of 10 citizen scientists produced the digital map and associated geodatabase in 900 hours of effort over 6 months. The time spent included 100 hours of education and training and 150 hours of quality checking. Project support and supervision from Skotnicki, Gootee, and Field Institute assistant director Melanie Tluczek totaled more than 100 hours.

Vital statistics of the completed map:

- 87 sections (square miles) covered entirely or in part
- 86 map units individually described with full metadata and colored
- ~3200 polygons – distinguishable rock units in the map area
- ~3000 points where orientation data about rock characteristics were recorded

QR code for digital map

The digital map is available at http://tinyurl.com/GeoMap-McdowellMtns, courtesy of the AZGS.

Webmap showing map area corresponding to actual view – Photo by D Gruber

SIGNIFICANCE

The work of Field Institute citizen scientists made a significant document – which added important information about the McDowell Mountains and raised interesting research questions – accessible to researchers, educators, and other interested parties.

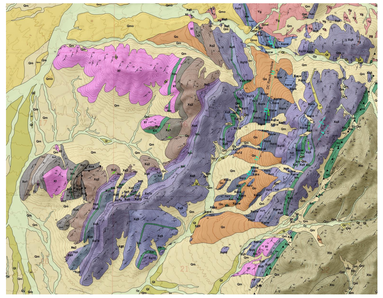
To our knowledge this is the largest such project done by a small conservancy. The scale of the effort and quality of the result demonstrate the ability of volunteers to perform professional-level work.

The digital map will:

- Allow users to understand the geology of what is seen on or from the trails in the McDowell Sonoran Preserve (the nation's largest urban preserve) and vicinity.
- Support interpretive hikes and field education about geology.
- Aid in site selection and provide background information for future ecological research.
- Allow area geology to be related to other features that reflect or depend on it like soil types and biotic communities.

Per Gootee, the project saved hundreds of hours of professional mapping assistance that would have cost tens of thousands of dollars. This important map by Skotnicki would not have been completed without support from the McDowell Sonoran Conservancy Field Institute and its citizen scientists.

A. Detail from hand-drawn map by Steven Skotnicki showing ~2.5 mile square area in northwestern McDowell Mountains.



B. Same area as hand-drawn map after digitization by Field Institute citizen scientists. Full map layout includes additional detail like streets, roofs, etc.

ACKNOWLEDGEMENTS

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We also appreciate the technical support provided by Melanie Tluczek, assistant director of the McDowell Sonoran Conservancy Field Institute, and the financial support provided by the McDowell Sonoran Conservancy under the leadership of Mike Nolan, executive director.

The field work required to produce the original hand-drawn map was conducted under permit from the City of Scottsdale preservation staff, and many of the data layers shown on the digital map were provided by the City of Scottsdale GIS staff. We are grateful for their continuing support.

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