



# GOING FOR GOLD IN EGYPT

THE LAND OF THE PHARAOHS WAS LEGENDARY FOR ITS GOLDSMITHS. BUT WHERE DID THE GOLD THEY WORK COME FROM? AND IS THERE ANY LEFT TO FIND? SUSAN PARKS REPORTS ON HOW REMOTELY-SENSED IMAGERY AND IMAGE ANALYSIS TECHNIQUES MAY PROVIDE ANSWERS

Remotely sensed imagery provides up-to-date, accurate information about geographic areas of interest and is of critical importance in many oil, gas and mining applications. Information extracted from imagery is used by professionals in these industries to address problems ranging from the selection and development of exploration areas to the analysis of spill mitigation and remediation efforts. Data derived from imagery targets field work, reduces costs and helps achieve faster results.

Researchers from Saint Louis University wanted to utilise imagery and geological information to evaluate traditional methods and develop new methods for finding gold deposits in specific areas of the world, while keeping costs low and field work to a minimum. In order to effectively identify and map areas with a high likelihood of gold, the researchers needed a way to quickly and easily extract valuable information contained in imagery.

## Pilot study

Dr. Wasit Wulamu, Assistant Research Professor in the Department of Earth and Atmospheric Sciences at Saint Louis University, and his colleagues performed a pilot study to develop a cost-effective method for using remotely sensed imagery to find gold in regions such as the Abu-Marawat area in the Egypt's Eastern Desert. "We knew that we needed remotely sensed imagery to conduct our research because it would provide us with information about our target area that we couldn't gather without it," said Dr. Wulamu.

Dr. Wulamu acquired ASTER imagery from NASA and Landsat

imagery from the U.S. Geological Survey depicting the Abu-Marawat region. Knowing that manually digitising and analysing their imagery to extract the meaningful information they needed would be tedious, costly and prone to errors, Dr. Wulamu and his colleagues chose ENVI image analysis software as their solution. ENVI combines the latest spectral image processing and image analysis capabilities in a user-friendly interface, allowing the user to obtain accurate results that are produced fast and efficiently.

"We chose ENVI over other image analysis packages because the easy-to-use workflows in the software walk us through image analysis processes and allow us to quickly get the results that we need," says Dr. Wulamu. Step-by-step workflows in ENVI guide users through advanced image processing tasks while maintaining scientifically proven accuracy. "We also chose ENVI because of its ability to be easily modified using IDL and its integration with ArcGIS." Since ENVI is developed using the powerful IDL development language, its advanced image analysis tools can be easily customised and additional features and functionality can be added. In addition, information extracted from imagery can be easily added to a GIS to provide a complete picture of a geographic area of interest that includes pertinent, current information. ArcGIS users have seamless access to ENVI image analysis tools directly from an ArcGIS toolbox.

## Good indicators

To identify areas in eastern Egypt with the highest likelihood of gold

deposits, Dr. Wulamu's primary objective was to find and map hydrothermal alteration zones or areas where hot water has altered specific minerals on the ground that prove a good indicator of gold deposits. They needed to not only identify alteration zones associated with gold but also discriminate between alteration zones associated with minerals other than gold.

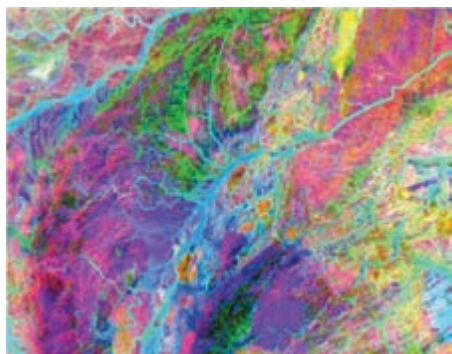
"We have found that analysing remotely sensed imagery using ENVI provides us with the best prospects for success," said Dr. Wulamu. "Remotely sensed imagery is typically up-to-date, whereas, man-made geology maps are often outdated. ENVI is able to provide a complete picture about the spectra and geology of our targeted areas that is not achievable or feasible performing just field work."

In order to develop the most effective method for using remotely sensed imagery to find gold, Dr. Wulamu and his colleagues first evaluated the performance of several traditional hyperspectral image analyses methods designed to find alteration minerals associated with gold. The methods were evaluated by determining if they could accurately identify known gold deposits in the Sukari Gold Mine in eastern Egypt. Existing methods that were evaluated in ENVI included various classification methods, Principle Component Analysis, band ratios and a constrained energy minimisation technique. These methods are designed to reduce noise, categorise data, and enhance and separate spectral signatures from the background image information.

### New methods

Dr. Wulamu and his colleagues tested the traditional methods and found that they were only somewhat effective at identifying the gold deposits, since the methods were initially developed for use with hyperspectral imagery instead of the multispectral imagery they were using. As a result, Dr. Wulamu and his colleagues developed and investigated new methods to more accurately identify the gold alteration zones in multispectral imagery by applying advanced image analysis techniques and statistical methods in ENVI.

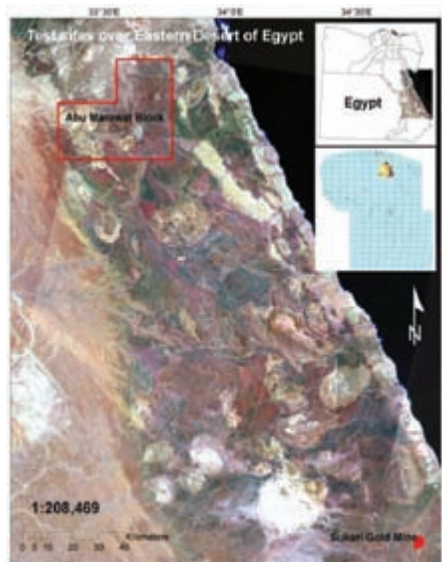
One new method expanded on the



Different methods are tested in ENVI for finding gold deposits – Principle Component Analysis

traditional methods by incorporating the Mixture Tuned Matched Filtering (MTMF) spectral unmixing method in ENVI into their analysis workflow to further reduce noise in the data and derive the probabilities and abundances of alteration zone minerals. Additionally, they visualised and plotted this data in n-dimensional spectral feature space, allowing them to isolate the anomalies in the rule image data.

Dr. Wulamu and his colleagues found that identifying areas in the data that were not correlated with one another proved to be a good indicator of alteration zone minerals that might be associated with gold. The revised methods produced results that were sharper, more focused and more easily used to discriminate between alteration zones.



Location map of Sukari Gold Mine and Abu Marawat concession block on a Landsat ETM+ (7, 4, 2) false color mosaic image of eastern desert of Egypt

### Promising locations

After the newly devised image analysis methods proved effective at identifying gold alteration zones from imagery of the Sukari Gold Mine, the methods were further evaluated using imagery from an area in Abu-Marawat that had not previously been tested for the presence of gold. Dr. Wulamu and his colleagues used the new image analysis methods in ENVI and identified and mapped alteration zones associated with gold in the region. They then considered the geology from the region to reaffirm the most promising locations for gold and rule other possibilities out. Geologic indicators, such as tectonic movement, are often favorable to the formation of gold.

After the imagery was analysed in ENVI, the team integrated the results into ArcGIS. "By adding our image analysis results to our GIS we were able to add critical information to the other layers of geologic information we had from the region," said Dr. Wulamu. With the most promising areas for gold identified

## KEY BENEFITS

- Using ENVI to analyse geospatial imagery greatly benefited exploration efforts, which reduced the need for field work and ultimately saved money and produced faster results.
- Testing various image analysis methods in ENVI was helpful to determine the most effective one for identifying hydrothermal alteration zones associated with gold.
- The integration of ENVI and ArcGIS allowed the team to add critical information extracted from imagery to other layers of geologic information in their GIS, providing a complete picture of a geographic area of interest.

in ENVI and mapped in ArcGIS, Dr. Wulamu's colleague went to Egypt to perform field testing and validate the results. The field testing confirmed that the newly developed image analysis methods were successful at identifying areas in Abu-Marawat with alteration zones associated with gold deposits.

Dr. Wulamu and his colleagues have achieved promising results using the image analysis methods they developed for finding gold alteration zones. Their work was published in *Ore Geology Reviews* in 2010. They are hopeful of securing additional grant funding to conduct additional field verification in Egypt as well as continue their work in other parts of the world.

"Using ENVI to analyse remotely sensed imagery and test various image analysis techniques for finding gold has proven very effective," says Dr. Wulamu. "In addition it has saved us time and money by focusing our field work on specific target areas. We are excited with what we have achieved to date and want to continue validating the new methods."

### References

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