Application of Convolutional Neural Networks for Aeromagnetic Anomaly Classification in the Kenyan Greenstone Belt for Gold Exploration

AKsang Joseph Ng'iro 1 Dr. Aaron Khutukulu Waswa1 Prof. Christopher Munyao Nyamai1
School of Science and Technology
Department of Earth and Climate Sciences
University of Nairobi.

Background

1. Introduction

●The use of Machine learning (ML), particularly deep learning models like Convolutional Neural Networks (CNNs), offers an efficient and scalable alternative for anomaly detection and classification in geospatial data.

●The use of CNN in aeromagnetic data analysis and interpretation can help so much in exploration of greenfield prospect that may not be delineated when traditional manual interpretation methods are applied.

2. Problem statement

•Manual interpretation of aeromagnetic anomalies is time consuming and prone to inconsistencies.

•There is a lack of automated systems tailored for aeromagnetic data analysis in Kenyan contexts.
•Identifying subtle geophysical signatures indicative of gold and base metals mineralization remains challenging

Current Work

1. Objectives

•To pre-process and convert raw aeromagnetic survey data into interpretable grids.
•To apply and evaluate CNN-based models for classifying magnetic anomalies associated with mineralized structures.
•To develop a reproducible ML pipeline that supports future mineral exploration efforts in similar greenstone terrains.

2. Methodology

Data Acquisition: Aeromagnetic, Geochemical, Maps
↓
Data Preprocessing: RTP, Filters, Normalization
↓
CNN Model Design: VGG/ResNet Architecture
↓
CNN Training: Cloud Platform
↓
Model Validation: ROC, Accuracy, Confusion Matrix
↓
Multi-Source Integration: Geochemical Data
↓
Generate Probability Maps: Mineral Prospectivity
↓
Interpretability Analysis: XAI (Grad-CAM)
↓
Collaboration & Dissemination: Share Results, Publish

Fig. 1 workflow

3. Results

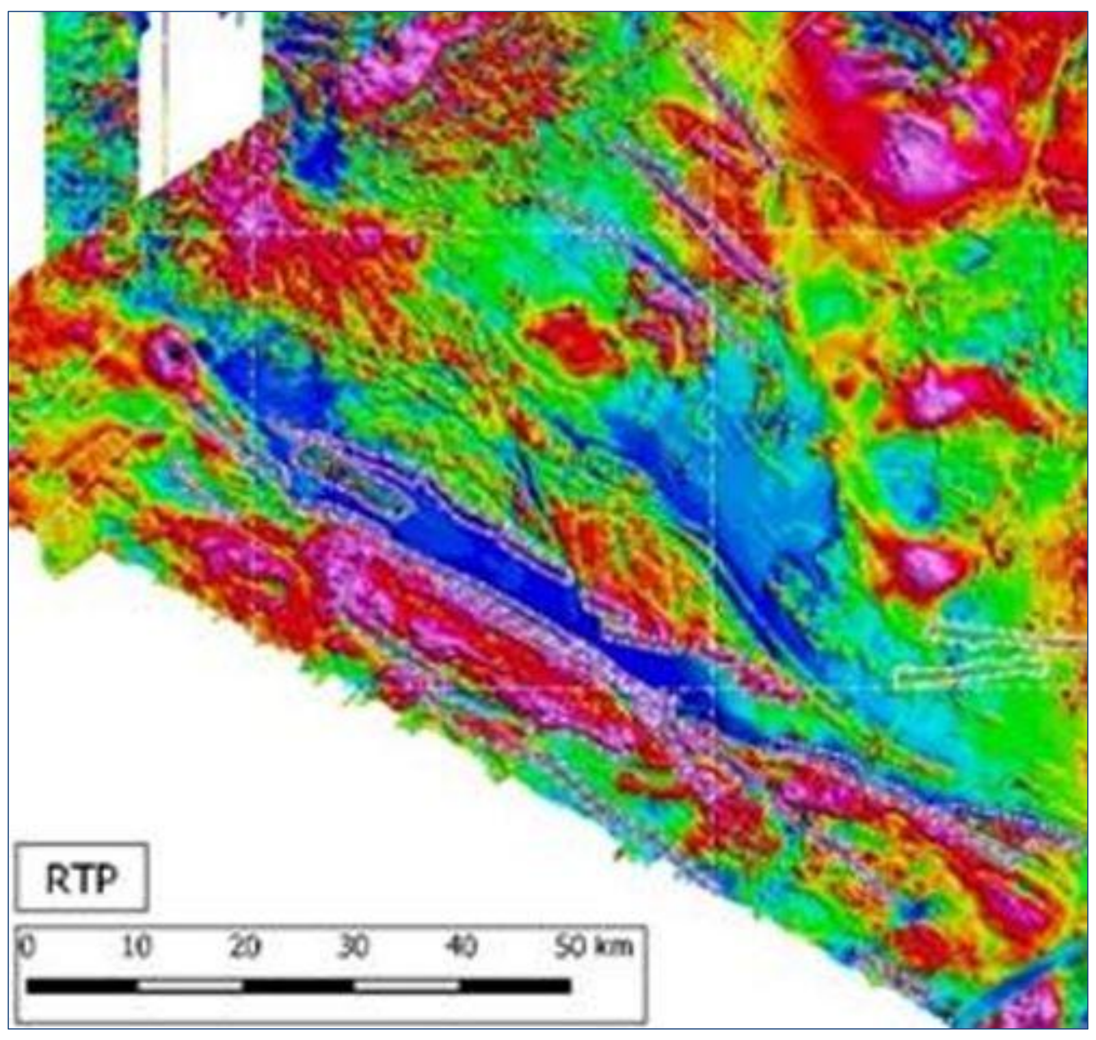

Fig. 2 RTP image

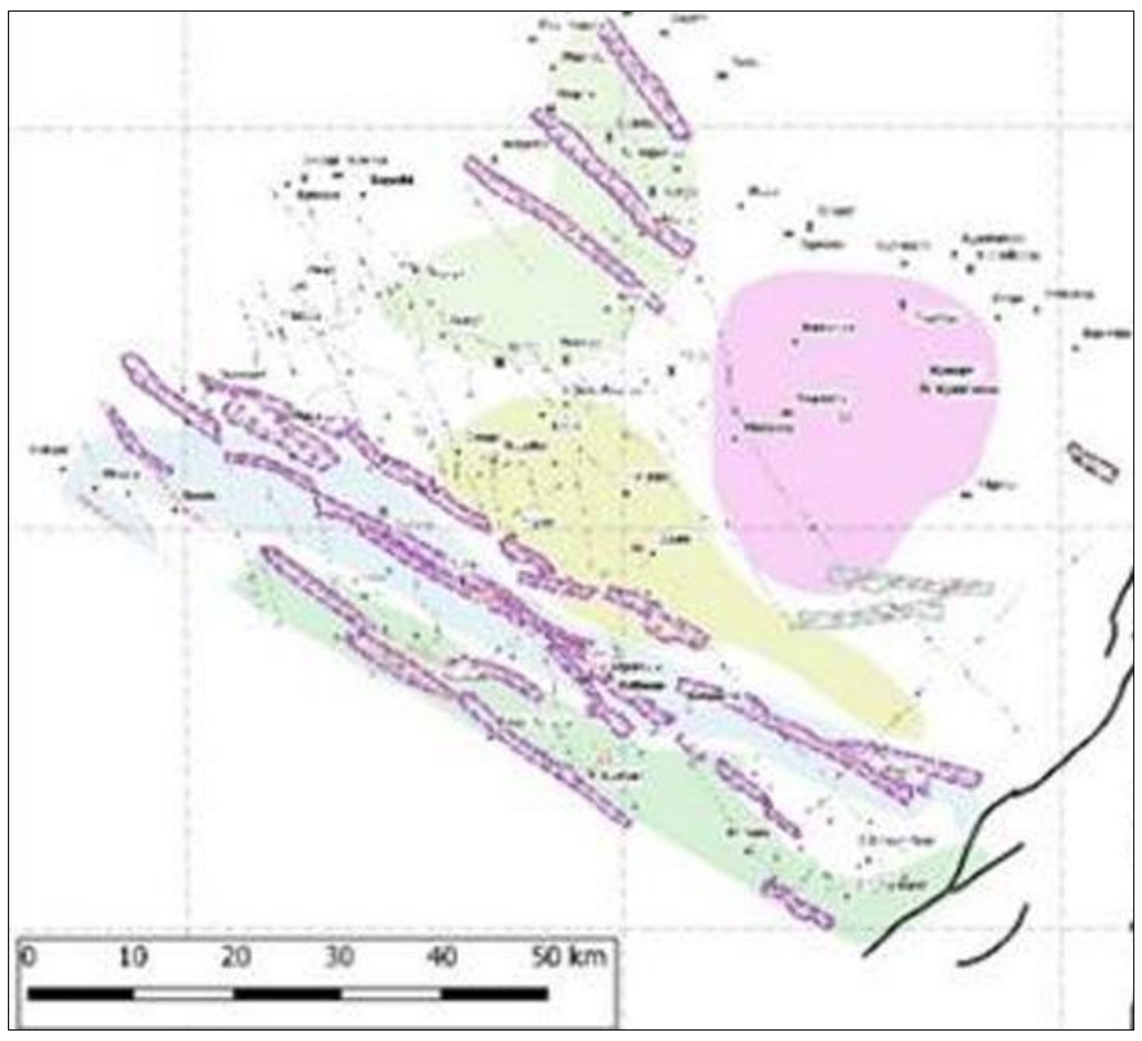

Fig 5. Manual interpretation output

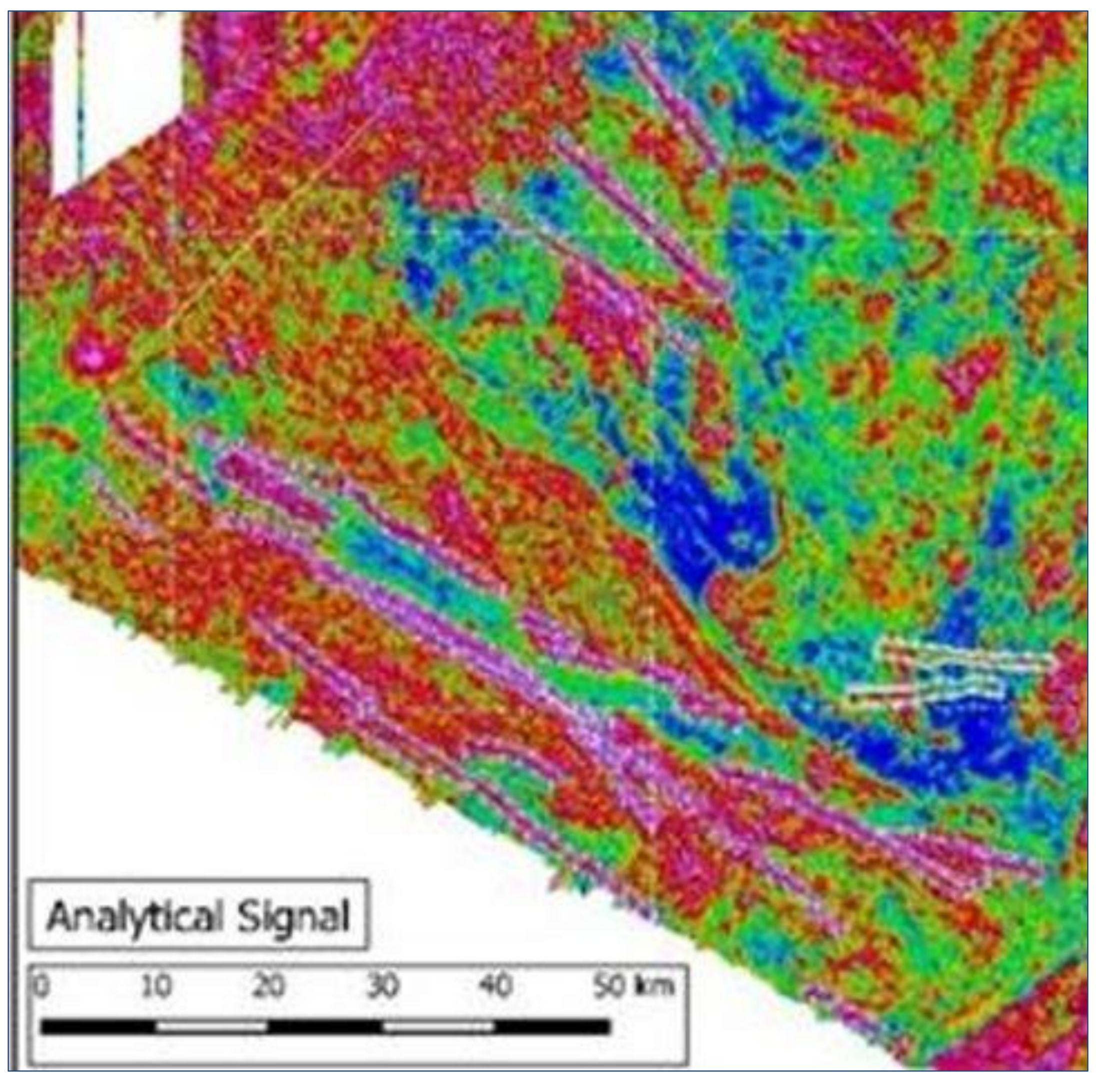

Fig. 3 Analytic Signal

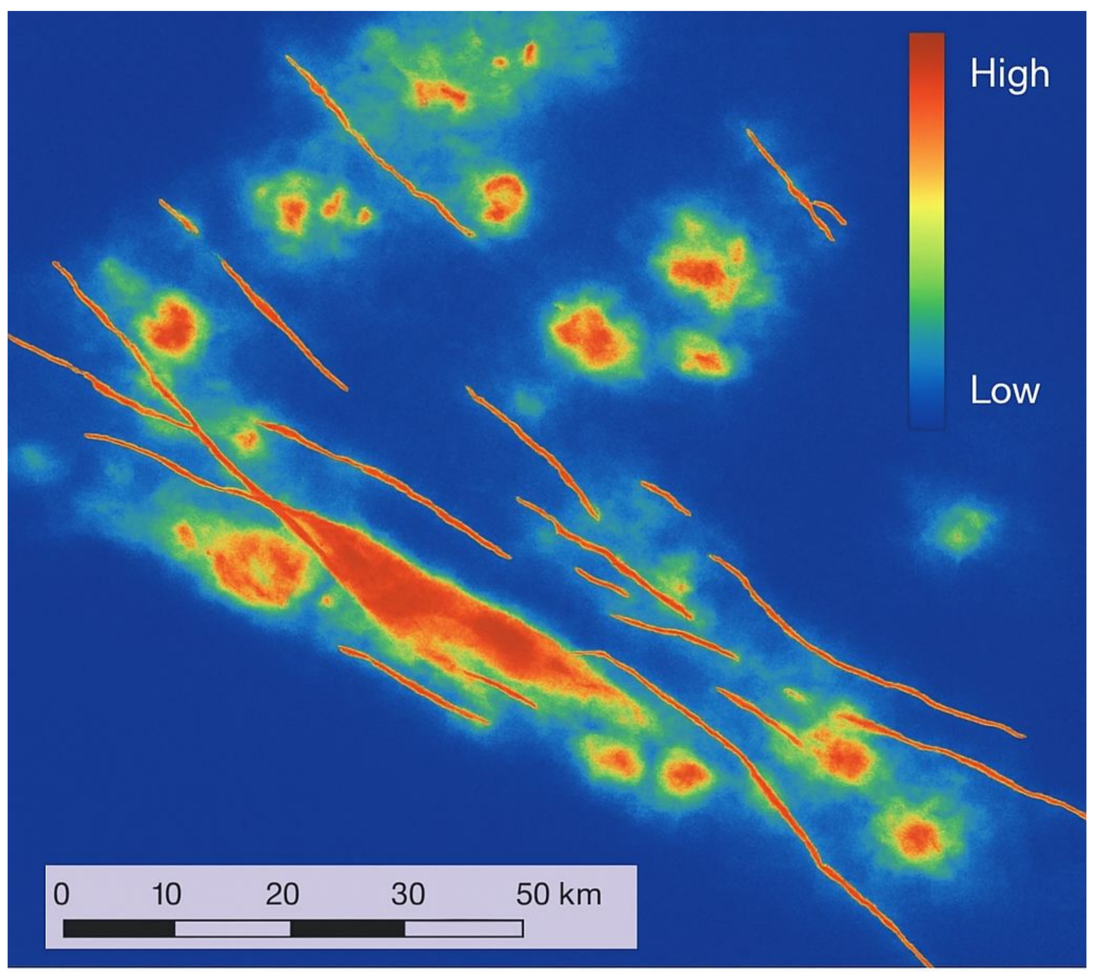

Fig 4. Possible CNN output map

Conclusion & Expectations

•CNNs are viable tools for automated classification of aeromagnetic anomalies in mineral exploration settings.

•This approach provides a faster and more consistent method for highlighting greenfield prospective zones in under-explored regions and remote areas.

•Future work includes: Expanding the dataset to include other geological formation in Kenya and geophysical parameters (e.g., gravity).

References

•LeCun, Y. et al. (1998). Gradient-Based Learning Applied to Document Recognition. Proceedings of the IEEE
•Ministry of Mining, Kenya. Aeromagnetic Survey Data Repository.
•Smith, J. et al. (2020). Deep Learning Applications in Geophysics. Journal of Applied Geophysics.

Acknowledgment

•Special thanks to Professor Christopher Nyamai and Dr Aaron Khutukulu Waswa for their support throughout this research

•I also thank the sponsors of the EASY-ML for giving me opportunity in this training that is in line with my research.

In partnership with
UNIVERSITY OF NAIROBI

Contact:ngirosang@gmail.com