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AI-Enhanced Geophysical Modelling for Concealed Gold Deposits in the Shakiso Area, Ethiopia

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Abstract

Shakiso, southern Ethiopia, hosts **Lega Dembi** and **Sakaro gold mines** yet large parts of the Adola Belt remain underexplored. This study applies AI-driven geophysical modelling to reduce uncertainty in gold exploration by integrating gravity, seismic, magnetic, remote sensing, and geochemical datasets. Machine learning (RF, CNN, SOM, DNN) produced prospectivity maps, while InSAR tracked mining-induced deformation. Results reveal concealed shear zones and quartz veins >1 km depth, extending known ore bodies. AI-enhanced modelling improves anomaly detection, guides drilling, and supports sustainable resource development in Ethiopia.

Introduction

Gold exploration in Ethiopia's Shakiso district is challenged by concealed mineralization beneath Precambrian structures. Multi-sensor fusion (gravity, magnetics, seismic, geochemistry, remote sensing) improves resolution (Blakely, 1996; Carranza, 2009), while AI methods capture non-linear patterns missed by conventional workflows (Breiman, 2001; LeCun et al., 2015). Recent advances confirm this potential: Mamba-based prospectivity mapping (Zhou et al., 2026), unsupervised ML for orogenic gold (Mostafaei et al., 2026), and airborne geophysical/remote sensing applications (Geosystems & Geoenvironmental, 2024). This study applies Random Forest, CNNs, SOMs, and DNNs to integrate multi-source datasets into unified 3D prospectivity volumes, embedding InSAR-based risk screening to support sustainable exploration in the Adola Belt.

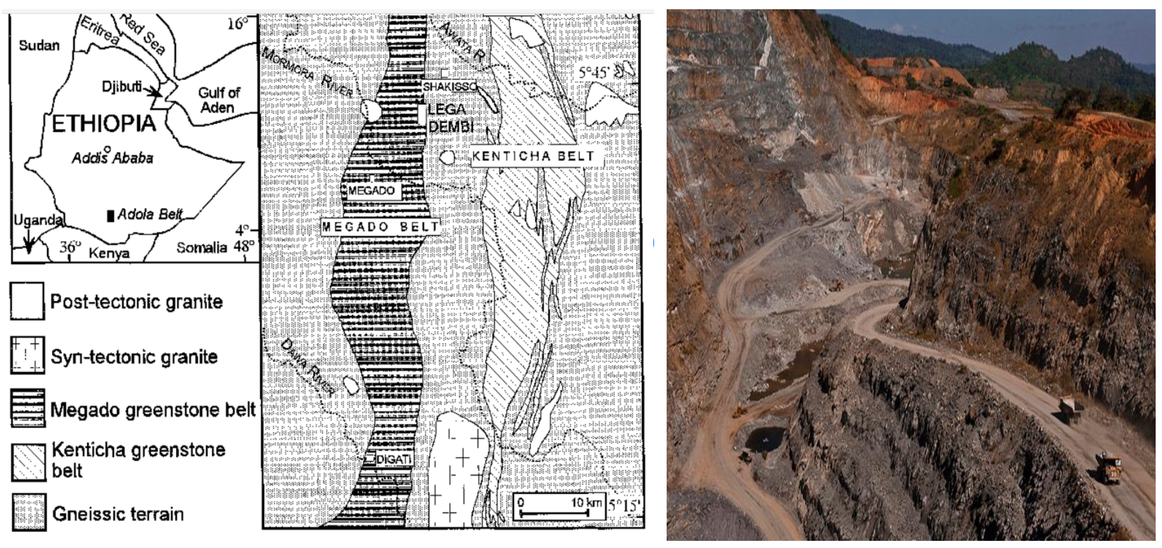

Fig.1. Location map and regional geological setting of the Adola granite-greenstone terrane modified after Beraki 1995)

Methodology and data

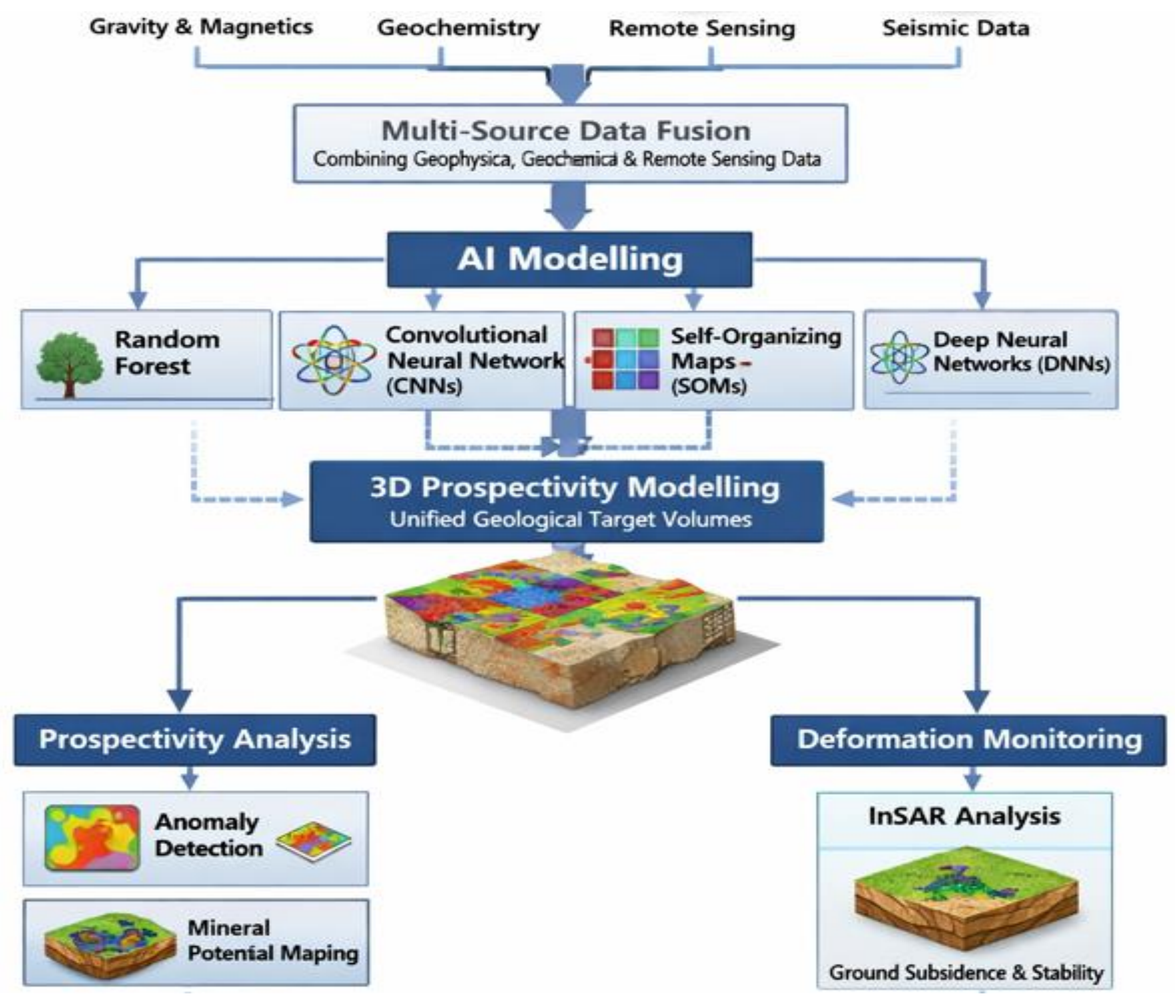

Fig.2. Methodology flowchart for AI-enhanced geophysical modelling in Shakiso

Result

Detailed geophysical outputs are withheld due to confidentiality. The AI-enhanced workflow successfully integrated gravity, magnetics, seismic, geochemical, and remote-sensing datasets, producing unified 3D prospectivity volumes. The modelling improved detection of concealed mineralization zones and, with InSAR monitoring, enabled sustainability-aware target ranking for exploration in the Adola Belt.

Conclusion

AI-enhanced multi-sensor integration improves detection of concealed gold systems, quantifies predictor importance, and embeds risk-aware screening. This reproducible workflow advances exploration in Ethiopia's Adola Belt and offers a transferable model for sustainable resource development.

Selected References

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