Mapping Natural Carbonation in Basalt Rocks Using Remote Sensing, Geophysics and Machine Learning

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Background

1. Introduction

- Rising atmospheric CO_2 levels necessitate scalable mitigation strategies, with mineral carbonation in basalt offering a natural and permanent solution (Sikurajapathi et al., 2025).
- CCS projects, such as CarbFix in Iceland (Snæbjörnsdóttir et al., 2020) and the Wallula basalt project (McGrail et al., 2011), demonstrate CO_2 storage efficiencies of up to 75% within a few days.
- Recent laboratory experiments also show rapid mineralisation in basalts, thereby illustrating the feasibility of storage via carbonation process (eg, Ferreira et al., 2024).
- Young basalts in northern Kenya Rift offer ideal CO_2 mineralisation conditions, yet storage potential remains unassessed (Okoko & Olaka, 2021); this study uses remote sensing, geophysics, and ML to map favourable zones.

2. Problem statement

- Okoko and Olaka (2021) highlight the potential of CO2 storage in KRV basalts with emphasis on the Central and South rift segments as more viable sites.
- However, field data to constrain the petrophysical or geochemical properties of these basalt is limited.
- This study leverages remote sensing and newly acquired geophysical data to assess storage in some of the earlier identified basalt areas by Okoko and Olaka (2021).

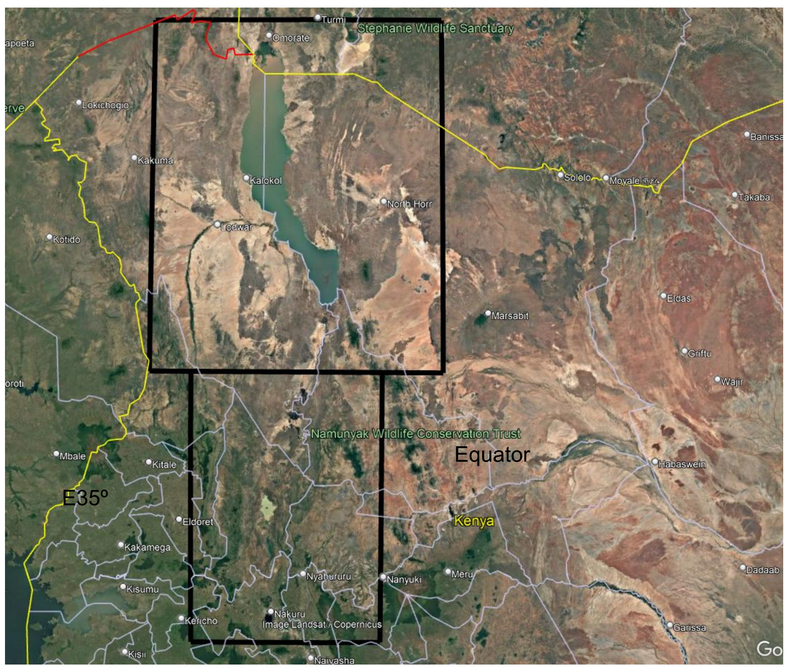

Fig. 1 Study Area Map.

Current Work

1. Objectives

- To map surface carbonate and alteration zones using multispectral satellite imagery
- To identify subsurface lithological structures using ERT and magnetometer surveys,
- To classify basaltic lithologies using machine learning models (SVM, MLP)
- To predict carbonation-prone zones using deep learning (CNN) and integrated geospatial data.

3. Expected Results

- Surface carbonation map from Remote sensing
- Subsurface lithological models using ERT.
- Machine learning-based lithologies.
- Carbonation potential index for CCS planning, ranking zones by CO_2 suitability.

2. Methodology

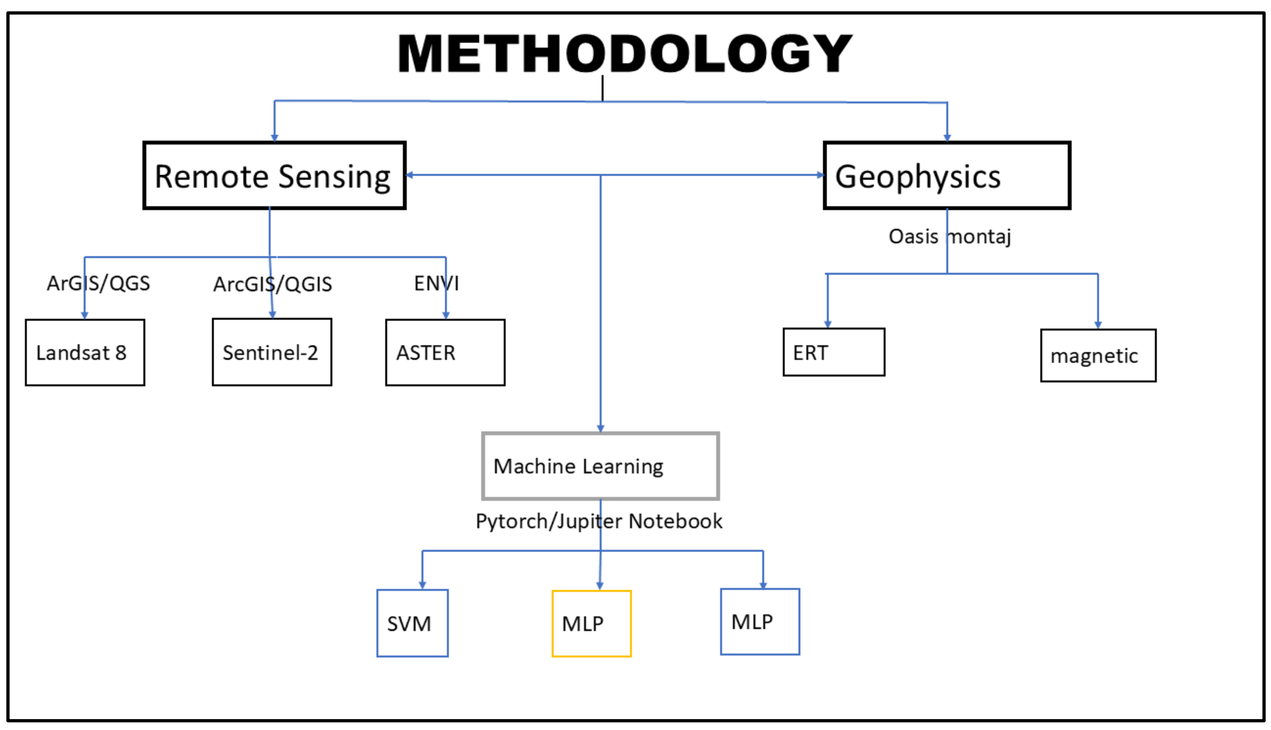

Fig. 2 Project Methodology

Conclusion

This study aims to demonstrate the potential of combining remote sensing, geophysics, and machine learning to identify carbonation-prone basalt zones.
It offers a scalable and cost-efficient approach for undertaking carbon capture and storage (CCS) initiatives in the Kenyan Rift and other volcanic terrains.

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