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Unsupervised machine learning driven Prospectivity analysis of REEs in NE India

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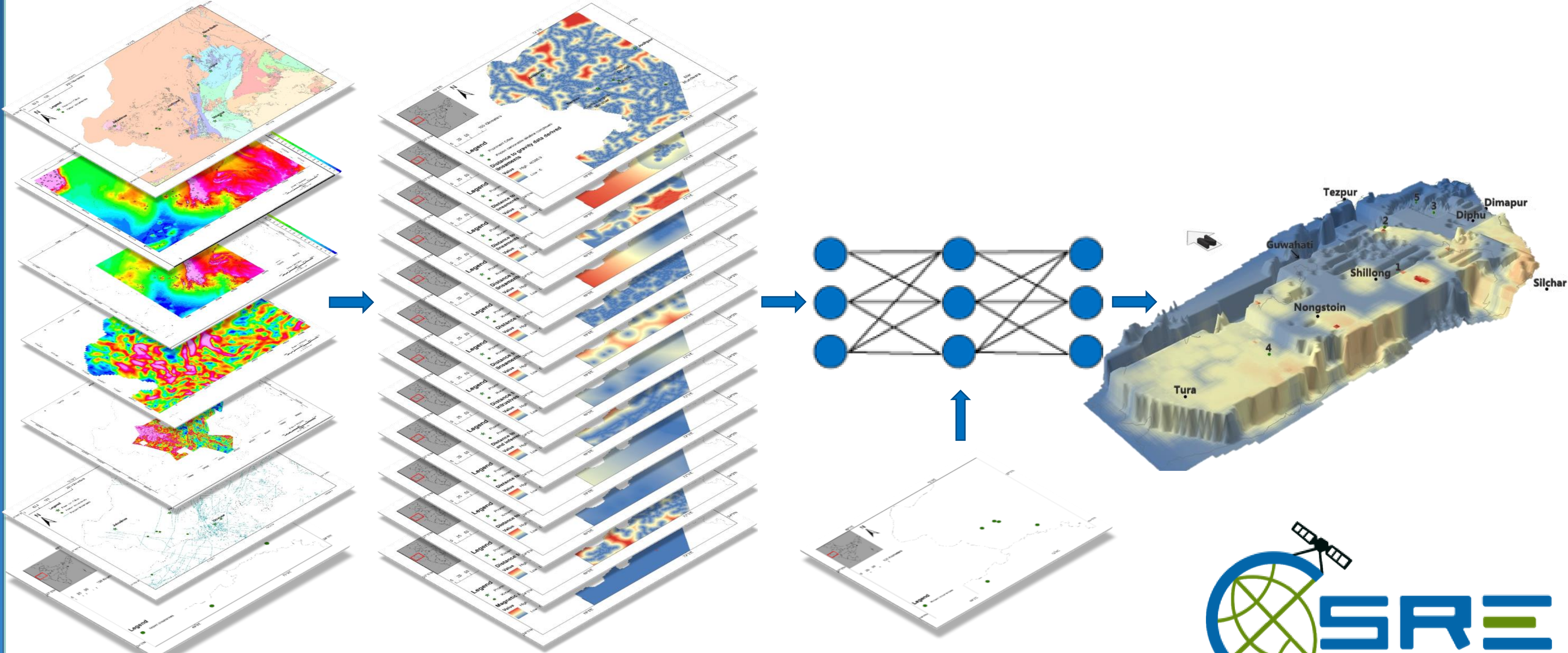
Standard prospectivity modelling workflow

Most machine learning use **human-designed (hand-crafted) representations** of input data

PRIMARY DATASETS | MANUALLY EXTRACTED FEATURES | LEARNING ALGORITHM | OUTPUT



ML simply involves **optimisation of parameters** to make the best prediction

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Primary data

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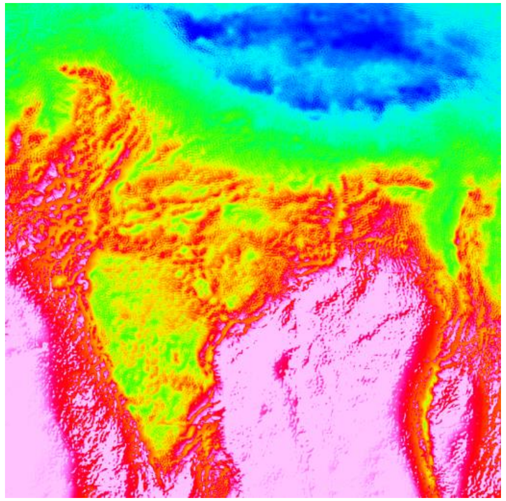
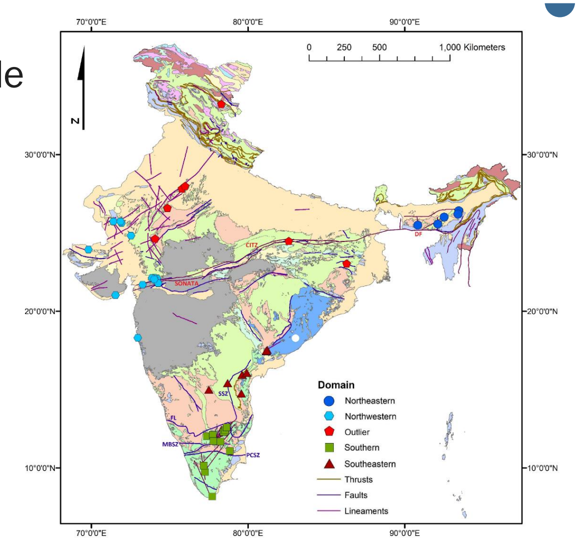


Public-domain data

Typically 1:50,000 to 1:250,000 scale

Two types:



- Directly measured, uniformly sampled, gridded
- e.g., air-borne magnetics, gamma rays spectrometric, remote sensing, SRTM
- **Low degree of abstraction**
- **Low uncertainty**

- Interpreted from sparse measurements/observations, non-uniform sampling, vector
- Geology, structures
- **High degree of abstraction**
- **High uncertainty**

Subjective bias

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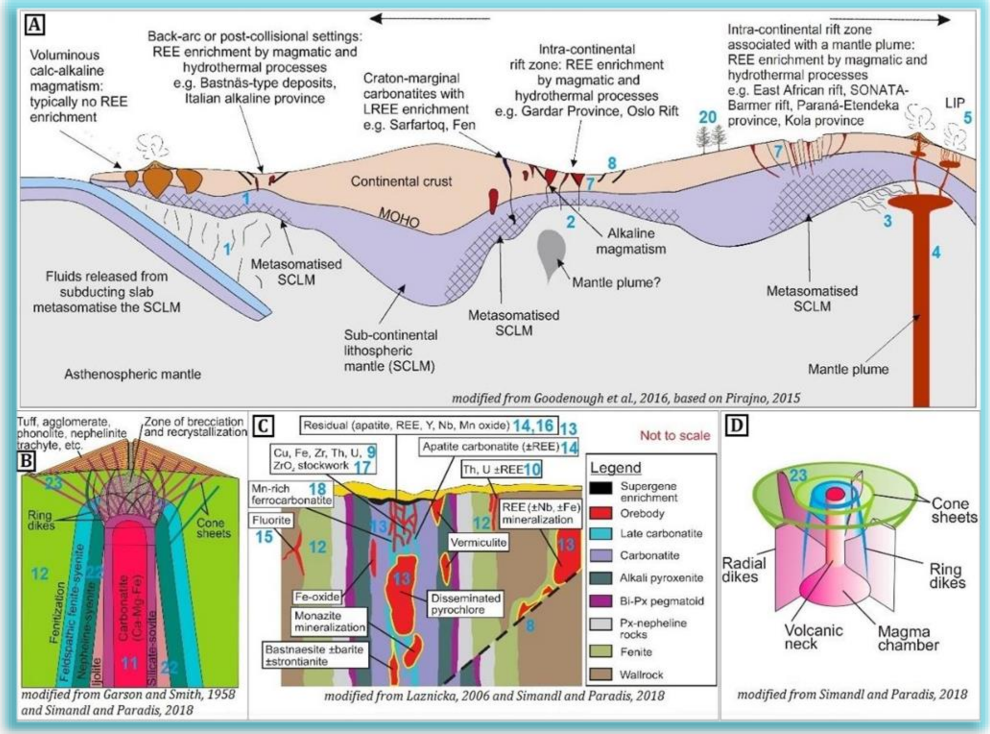
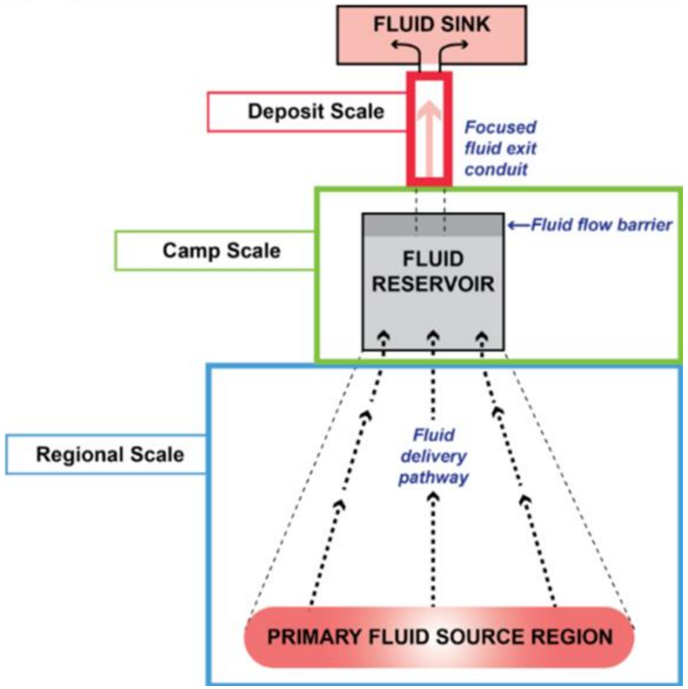
Mineral-systems-guided feature engineering: Issues

Mineral systems model: compiles mineralization processes across scales (translithopsheric to ore-body scale)





Deposit location is controlled by these processes

Most public-domain data (1:50,000 to 1,250,000 scale) map these processes

(McCuaig and Hronsky, 2014)

- Handcrafted features are biased towards camp-scale features (e.g., transportation pathways, sources)
- Metal deposition features are under-represented
- Possible response of metal-deposition processes in gridded geophysical data, not easy to interpret visually?

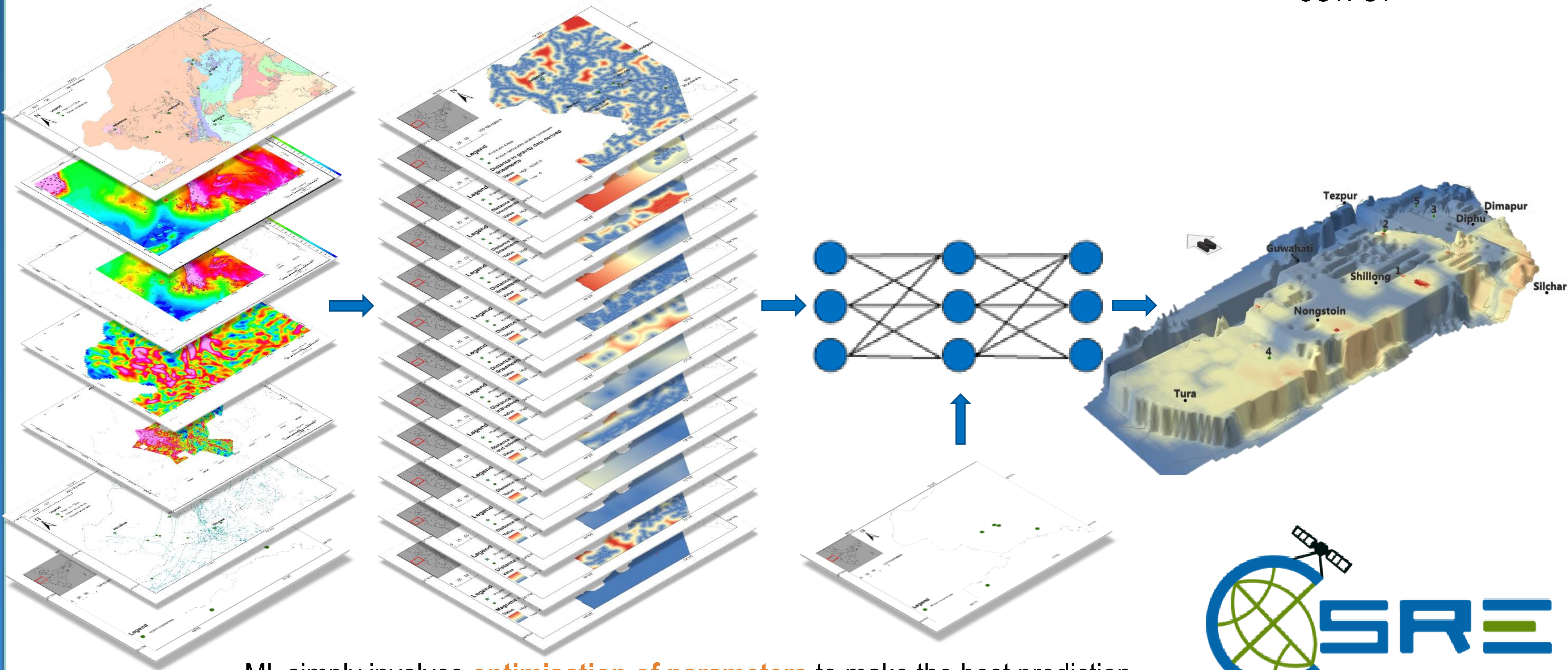
Are we using right data for training?

Exploration targeting of deposits or fertile geology?

Inputs to ML: hand-crafted features

Most machine learning use **human-designed (hand-crafted) representations** of input data

PRIMARY DATASETS | MANUALLY EXTRACTED FEATURES | LEARNING ALGORITHM | OUTPUT



ML simply involves **optimisation of parameters** to make the best prediction

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Input primary data directly to ML?

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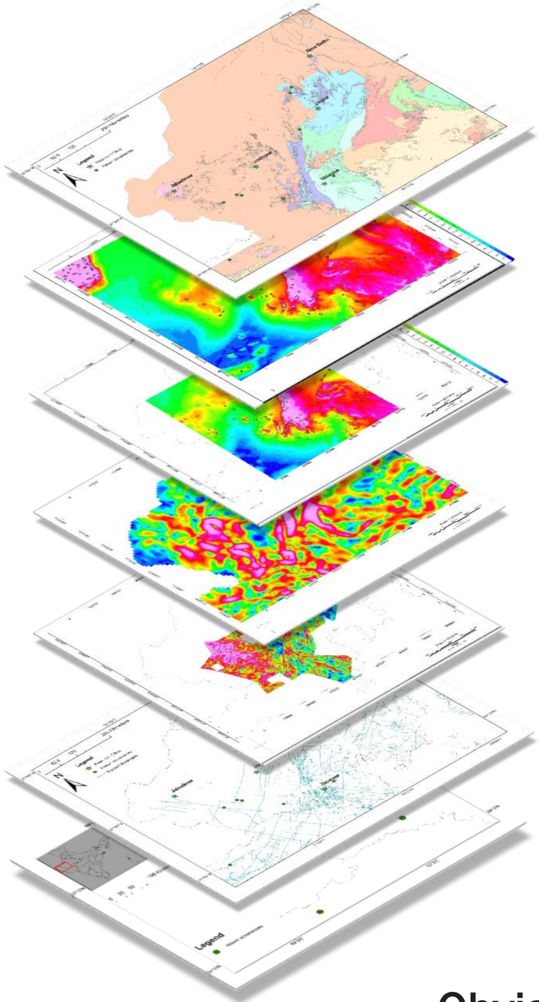
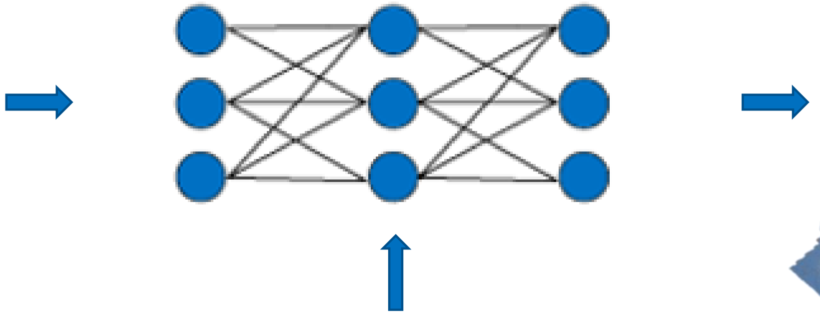
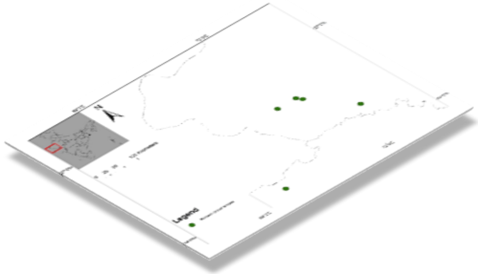
PRIMARY DATASETS

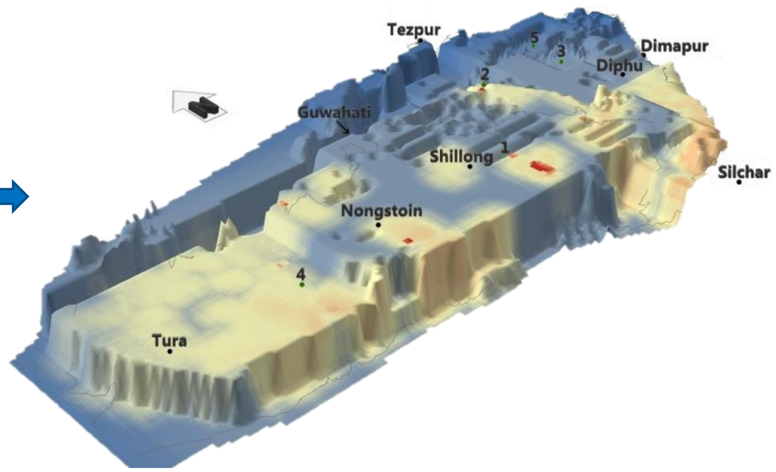


LEARNING ALGORITHM





OUTPUT



Obviate the need for hand-crafting features

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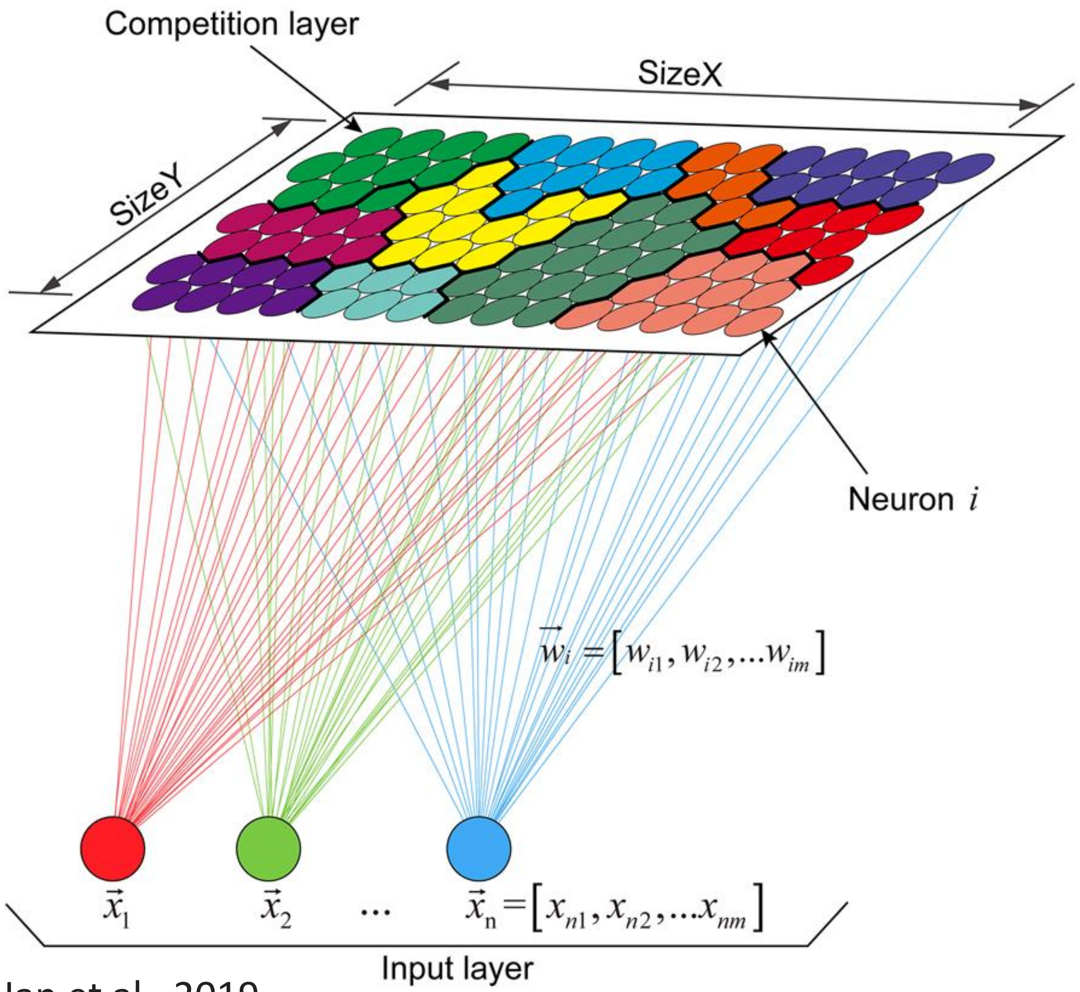
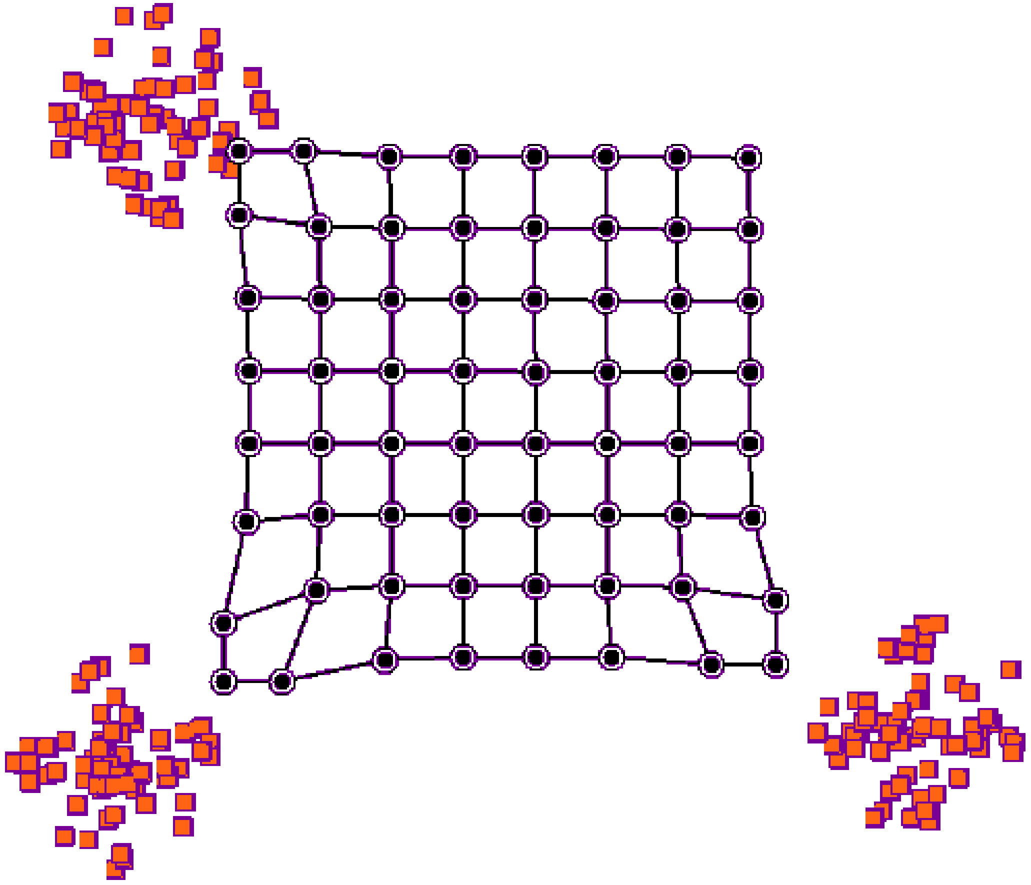
Unsupervised machine learning: Learn features from primary data!
Self organising maps



Han et al., 2019



Chompinha, 2019

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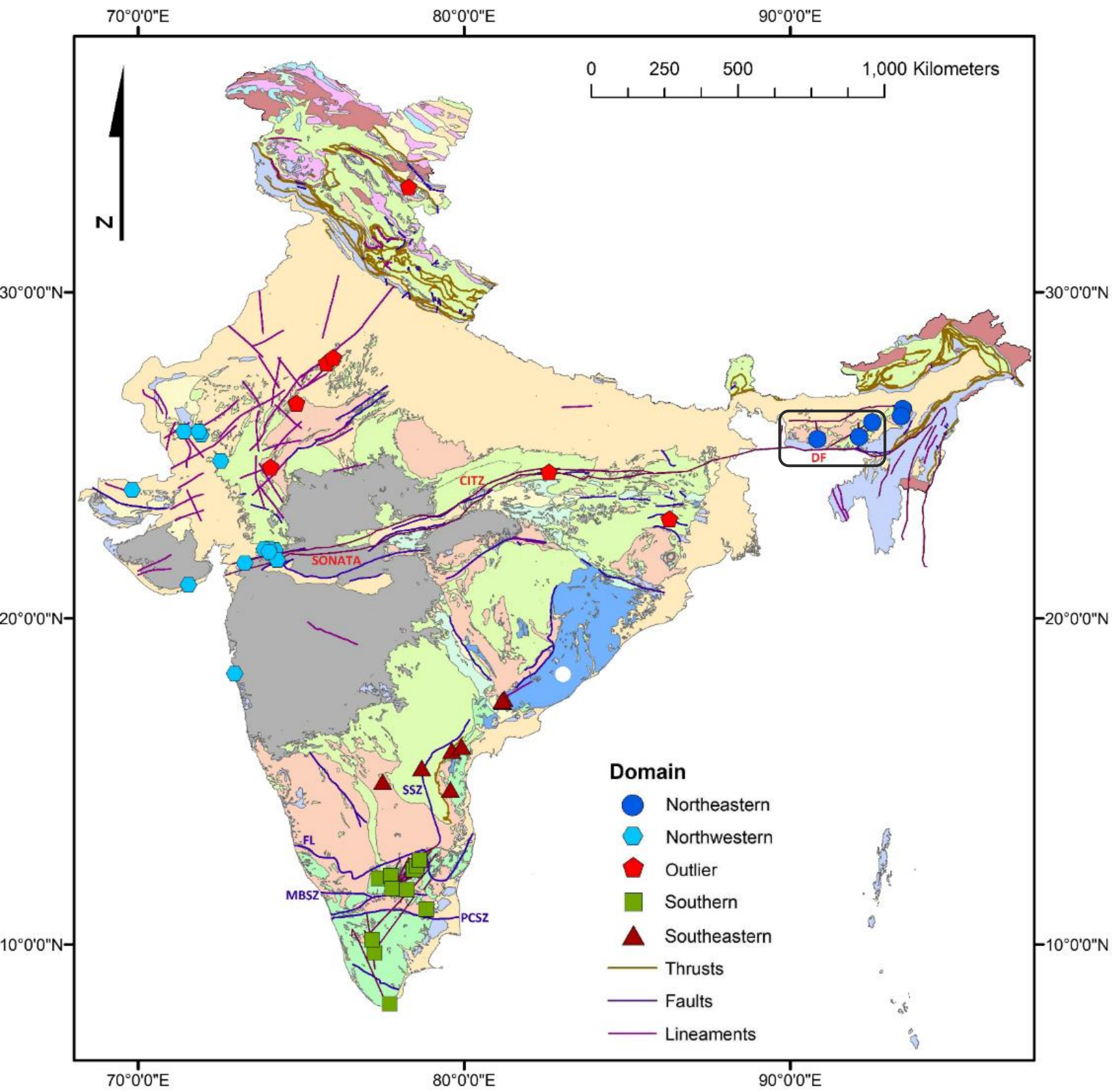

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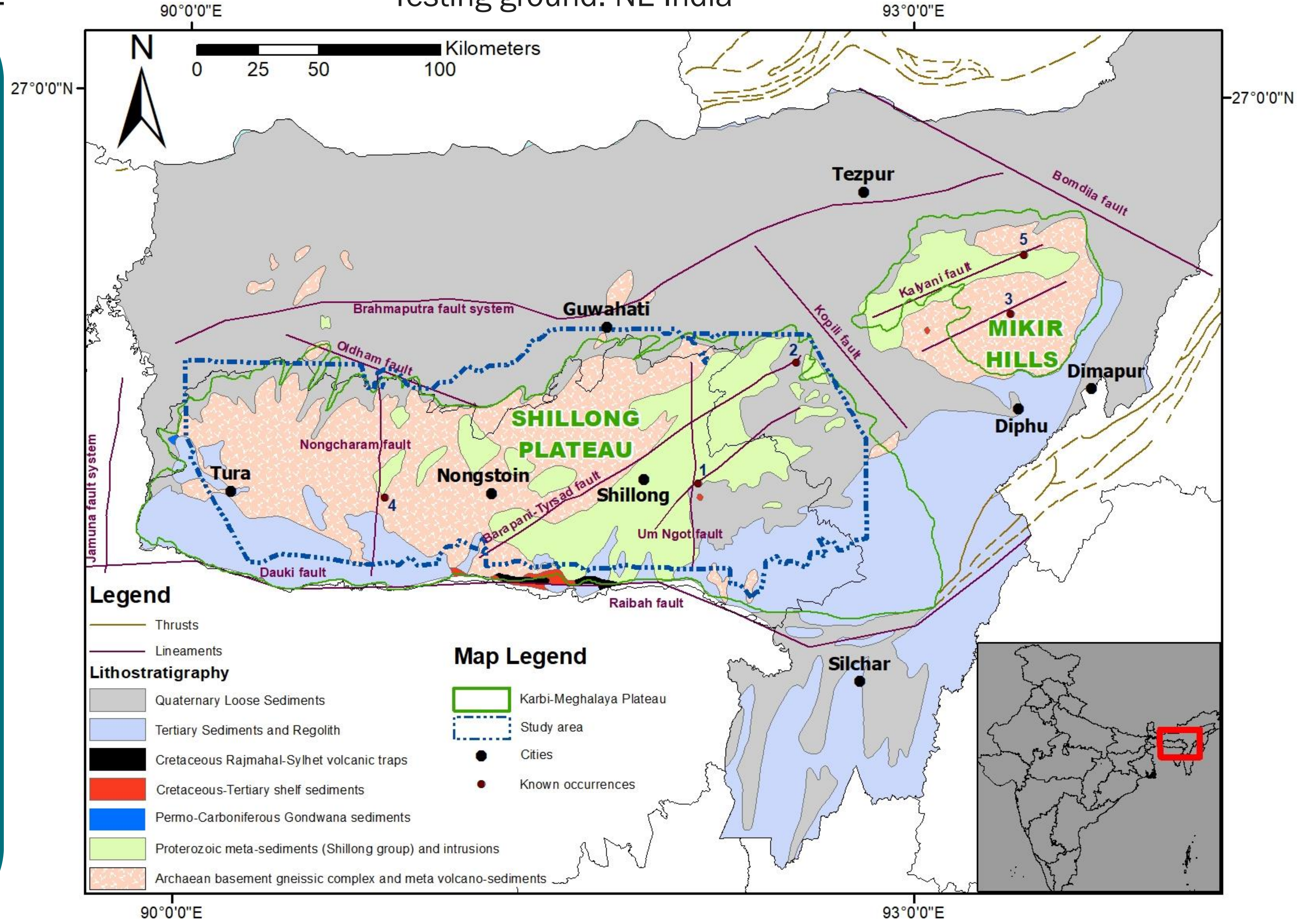
Study area

Case study : REE prospectivity mapping in NE India

Rationale

- Area consists of the second youngest and well-preserved kerguelen hotspot-related carbonatite province.
- Higher density of known occurrences in a smaller area.
- Well studied genesis
- Better coverage of geochemical data with decent geophysical data coverage over the province.
- Field knowledge

Testing ground: NE India



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SOM Clusters

FIS Study

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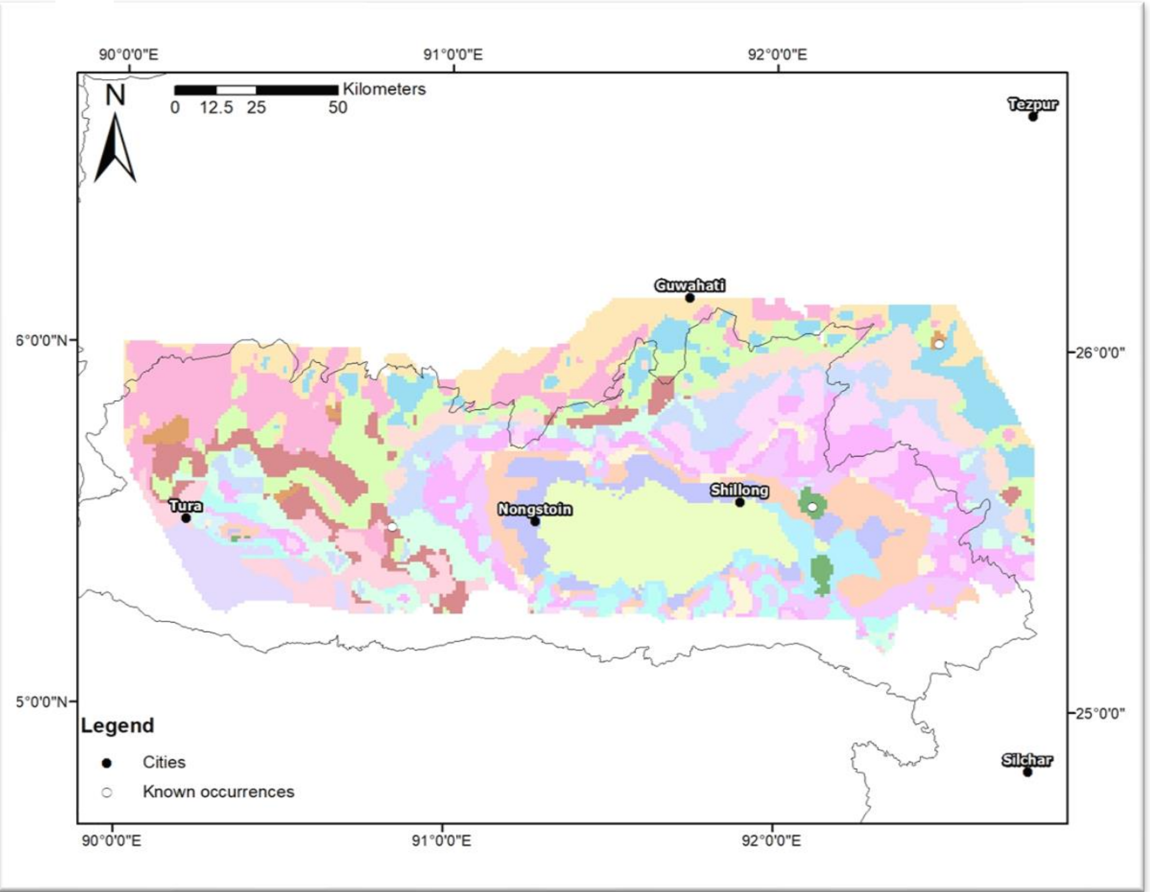

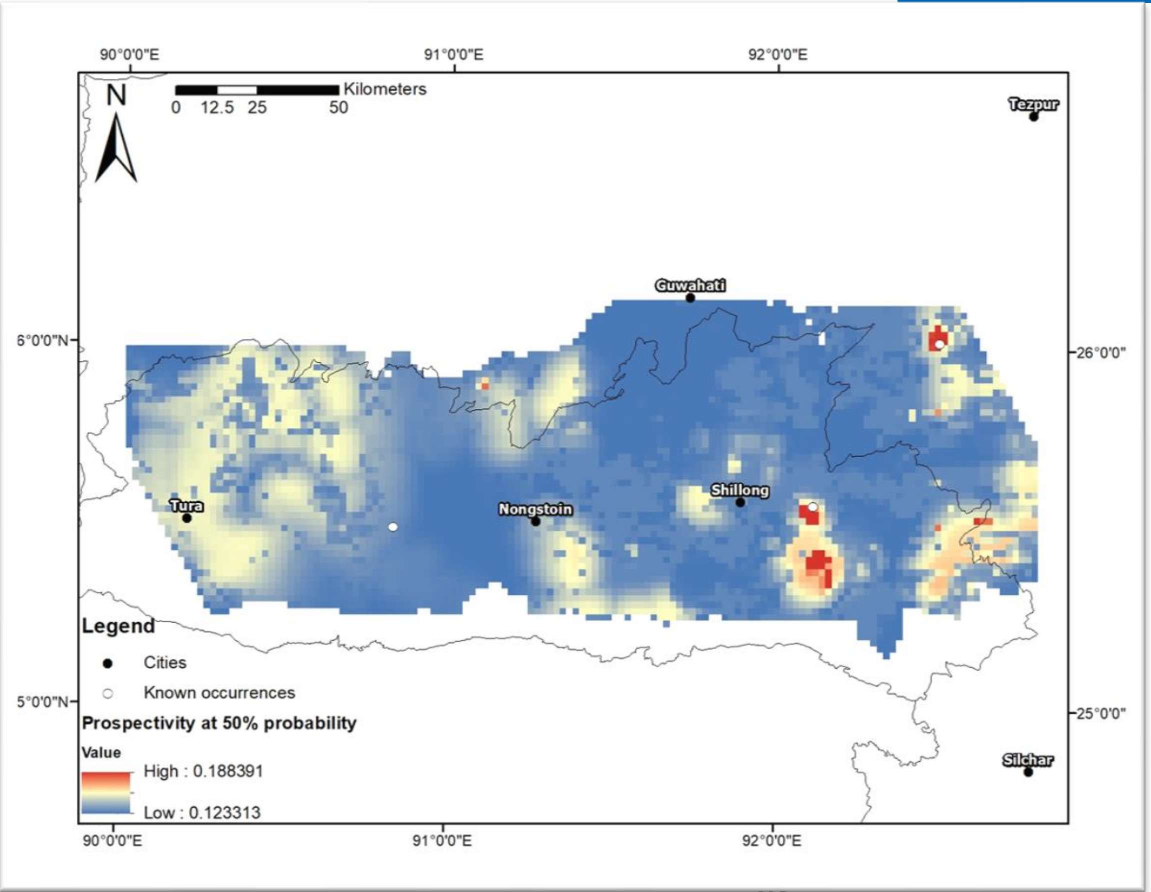

Gravity

RTP Magnetics

Topography

CSRE

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To sum up....

Prospectivity models use input features that are hand-designed from primary data - typically using mineral systems approaches.

Manual feature extraction from interpreted geoscience data is subject to uncertainty

Unsupervised machine learning algorithms offer robust alternatives to traditional prospectivity modelling particularly in unexplored terrains geological knowledge is limited

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