A Spatial Statistical Approach to Geomorphotectonics of the Karbi-Shillong Plateau Outlier

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Abstract

This study explores the geomorphotectonics of the Karbi-Shillong Plateau outlier in northeast India through a spatial statistical approach. Spatial statistics, encompassing pattern analysis and model predictions based on geographic relationships, reveal significant insights into geological structures and their dynamics. The Karbi-Shillong Plateau, distinct from the main Indian peninsula, exemplifies geological outliers characterized by unique tectonic settings influenced by compressive forces and numerous faults. Positioned away from the central Peninsular Block, its geological composition includes Proterozoic and Mesozoic-Tertiary rocks, emphasizing its complex evolution. This research challenges the notion of the plateau as merely an extension of the Indian peninsula, instead highlighting its identity as a significant and separate geological entity within the Great Himalayan system. Ultimately, the study advocates for a nuanced understanding of such outliers, underlining their critical role in regional geoscience and tectonic research.

Spatial Statistical Approach

Spatial statistics that utilise spatial relationships (e.g. distance, area, volume, length, height, orientation, centrality) in mathematical computations, are used for a wide range of analyses, including pattern analysis, shape analysis, surface modelling and prediction, spatial regression, statistical comparisons of spatial datasets, statistical modelling, and spatial interaction prediction. Spatial statistics are classified as descriptive, inferential, exploratory, geostatistical, or econometric.

In a larger sense, an outlier is someone who deviates greatly from the average in some regard, something (such as a geologic structure) that is situated away from or classed differently from a main or related body. In statistics, an outlier is a data point that stands out from the others. For example, on a graph with dots, most of the dots are clustered together, but the one, the outlier that stands out. It is important not to mix geological outliers and inliers. Geological outliers are areas of younger rock that are fully surrounded by older rocks, a phenomenon that often forms when sufficient erosion of surrounding rocks occurs, while an outlier in statistics is an observation that lies an abnormal distance from other values in a random sample from a population.

Outliers are an extremely significant part of spatial analysis. In purely statistical terms, an outlier is an observation point that is separated from the others. Outliers are values that appear at the extremes of a dataset. Some outliers indicate genuine values resulting from natural population variance. Other outliers may be caused by improper data entry or measurement errors, equipment problems, or even judgemental human (Geologists') errors.

The Seven Sisters in the north-east India

The northeastern states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura make up India's Seven Sisters. The Seven Sisters are connected by a 5,182-kilometer international border with China, Myanmar, Bangladesh, Bhutan, and Nepal. This makes the region geopolitically sensitive and strategically crucial for India. The Silliguri Corridor, sometimes known as the "chicken's neck," connects India's mainland and northeastern states, facilitating trade and travel. It connects to significant international trade routes, including access to Bhutan and Nepal. A detailed examination of the agglomeration of these seven states reveals three geographic entities with distinct geotectonic qualifiers: 1. the Ganges-Brahmaputra alluvium graben of Assam in front of the Himalaya in the north, 2. the Indo-Burmese Ranges next to Myanmar, and 3. the Karbi-Shillong hotspot of intense tectonic seismicity zone near the inverted V-shaped core symptomatic with the Namcha-Barwa syntaxial bend in the northeast Himalayas.

The Study Area

Shillong was nicknamed the "Scotland of the East" because to the rolling hills around the town, which reminded the British of Scotland. The Shillong Plateau, located in the Himalayan foreland, is prone to earthquakes due to its lofty elevation and numerous faults and shear zones. The plateau, which lies between the Himalayan belt in the north and the Indo-Myanmar mobile belt in the east, has been subject to compressive tectonic forces. Meghalaya Shillong and Karbi Anglong are separated from the main Peninsular Block. The Shillong Plateau has an average elevation of 1 km and is surrounded by the E-W-oriented Dauki Fault to the south and the E-W-oriented Brahmaputra River Fault/graben to the north. Shillong Peak, the highest point at 6,433 feet (1,961 meters), is located 3 miles (5 km) south of Shillong. The Dauki fault, an east-west trending reverse fault inclined northward, extends along the southern edge of the Shillong Plateau and is responsible for the Shilling horst and the corresponding Rangpur (B'Desh) graben. Shillong plateau is divided from peninsular India by the Tertiary Ganges-Brahmaputra alluvium and Cretaceous Rajmahal Volcanics.

The plateau is dominantly composed of Proterozoic basement granite gneisses, granites (sensu lato), migmatites, granulites, the Shillong Group metasedimentary cover sequence, and Mesozoic-Tertiary igneous and sedimentary rocks. Cambrian granite plutons of various sizes intrude the basement granite gneisses, the Shillong Group, and at a few places the Khasi Greenstone.

Is the Karbi-Shillong plateau an extension of the main Indian peninsular plateau?

It would be unfair to the British contribution to Indian geology to refer to the Karbi-Shillong plateau as an extension of the main Indian peninsular plateau, especially because scientific study instruments were still in their infancy. But, while we are proud of digital India today, have we made any unique achievements in geosciences since then, other than a few tweaks here and there?

Fig. 1. Karbi-Shillong Plateau Outlier

Spatial statistical analysis is the process of investigating the evolution of geographical objects/entities (such as geological features: Shillong outlier) based on knowledge of their position in relation to other geographical objects/entities (main Peninsular Plateau) by inspecting, assessing, evaluating, and modelling spatial data characteristics such as locations, traits, and their relationships, geotectonic settings, which reveal the data's geometric or geographic properties. Spatial analysis finds patterns or correlations in recorded data of a process that occurs over a distance. Using the same comparison, how can the Karbi-Shillong plateau, which is more than 1000 kilometres from the nearest border of the main peninsular plateau, be considered an extension of the main Indian peninsular plateau? The geomorphotectonic evolution of the Karbi-Shillong plateau outlier

stands out as a distinct hotspot in North-East Indian geology. Finally, Nature performs a symmetrical balancing act, as evidenced by the two outliers—Kuchch-Kathiawar at the western end and Karbi-Shillong at the eastern end—both of which are associated with the Great Himalayan system of orogeny (Amitabha Roy, 2024).

Conclusions

In conclusion, the study underscores the importance of spatial statistical analysis in comprehending the unique geological characteristics of the Karbi-Shillong plateau and its distinct geomorphotectonic evolution. The findings challenge the notion of the Shillong plateau located 1000 km away from main Peninsular plateau, as a mere extension of the main Peninsular Plateau, prompting reevaluation of its evolution and classification as a separate geological structure. It is imperative for current geological advancements to acknowledge these distinct entities as individual hotspots within India's geological narrative, building upon previous contributions while embracing a heightened awareness of their significance.

References

[1].   Amitabha Roy, 2024. Geomorphotectonics of the Kathiawar (Saurashtra)- Kutchch outlier: A spatial statistical approach. J. Appl. Geol. & Gehys (Isor-Jagg), V. 12, Issue 6, Ver. I, pp. 44-48