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The Satellite Derived Digital Elevation Models of Mikir Hills, Karbi Anglong, Assam, India

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Abstract: **Digital Elevation Model (DEM) data are used for geological analysis when other data are not accessible for morphology and structure identification. DEM data due to its quick availability and less expense is used for enhancing accuracy. Three-dimensional (3D) inputs are added to the two-dimensional (2D) data for a better interpretation of topography, relief, and geology. The present paper explicates the potential of DEM for modeling of Mikir structural hills of Assam - a highly dissected and geologically important region generated from Shuttle Radar Topography Mission (SRTM) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images.**

Index Terms: **Assam, ASTER, DEM, GIS, India, Mikir Hills, SRTM.**

I. INTRODUCTION

Digital Elevation Models (DEMs) are an excellent tool that helps geologists easily observe how the topography, geomorphology, and geology of terrain are related to each other (Sabins, 1999; Rivard, 2009; Lillesand, et al. 2015; Gupta, 2017;). The scientific tools using geo-referenced cartographic data need good expertise and understanding of the topography and relief of the Earth's surface (Singhroy, and Wightman, 1980; Drury, 1987; Sabins Jr, 1987; Onorati et al. 1992; Toutin, 2006; Sanjeevi and Bhaskar, 2008; Reuter, et al. 2009; Lollino, et al. 2014). A better interpretation is achieved when three-dimensional (3D) information is added to the two-dimensional (2D) data, (Spark and Williams, 1996; Hu, 2003; Hapke, 2005; Reuter, et al. 2009; Lollino, et al. 2014).

It is a fact that geologic maps are the most important source of topography and geology-related information. Teaching to understand geologic maps is a fundamental goal of any geology program. Most of the available maps are in 2D nature, it may be difficult for a novice to relate the geology to the topography of a region. Geomorphological details of the terrain, when interpreted properly, can give more geologic details than those provided by other methods (Hu, 2003; Hapke, 2005; Caumon, et al. 2012; Lollino, et al. 2014).

The standard DEM comprises a standard array of elevations cast on a designated coordinate projection system (Hu, 2003; Hapke, 2005). The sources of DEMs are topographic surveys, GPS surveys, aerial photographs, and satellite images. (Hu, 2003; Hapke, 2005; Smith, et. Al., 2006; Sanjeevi, S. and Bhaskar, A.S., 2008; Reuter, et al. 2009; Caumon, et al. 2012)

The present work aims to illustrate the significance of DEM images in presenting important geological information of the area. In this study, DEM-derived surfaces have been made using an SRTM and ASTER DEM of a part of Mikir Hills and the software used is ERDAS Imagine and ArcGIS (Rowan and Mars, 2003).

II. GEOLOGY OF THE AREA

The Assam-Meghalaya twin plateau (Shillong Plateau) is a large geomorphic feature marking the eastern culmination of the Indian Peninsula. The Assam part of the Shillong Plateau is partly represented by the Mikir Hills, which is now separated from the main Meghalaya Plateau by the NNW – SSE trending Kopili lineament. The geological map of the area surveyed is presented here (Fig-1. a-b). The pre-Tertiary stratigraphy of the Mikir Hills is marked by a multiplicity of intrusions of basic and acid igneous rocks – their metamorphosed equivalents forming the basement (Gneissic Complex), meta sedimentaries (Shillong Group), and post-

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Shillong Group of intrusives. Besides the multiplicity of intrusions, the area bears the imprints of various episodes of deformations. The granitoid of the western-most study area disposes of folding of four episodes, while, the eastern-most area bears the imprints of only two episodes of deformation.

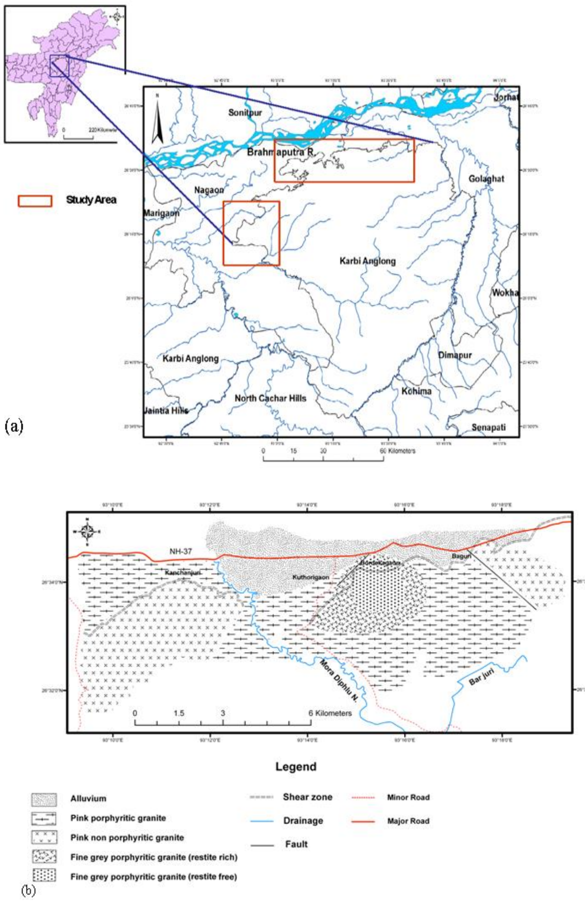


Fig. 1 (a) Map showing the locations of the study sites in Mikir structural hills of Assam, India. It is a highly dissected and geologically important region. (b) Detailed geological map showing the lithology and sedimentation of the area.

III. METHODOLOGY: GENERATING DIGITAL ELEVATION MODELS

A. DEM Derived Surfaces

The software provides functions that can display different kinds of DEM derive surfaces. The software allows us to combine a maximum of three DEM images. This kind of image can be useful to enhance a particular geological feature that cannot be visible using a single DEM-derived surface. For example, a combination of slope, flow direction, and basin is very useful to show stream networks. The great usefulness of 3-D images is that they can visualize the geology of an area from any vantage point.

B. Interrelation between Geological Maps and DEM Derived Surfaces

An important characteristic of DEM images is the removal of both, vegetation and most man-made constructions. This reality allows DEMs to distinguish geological structures, topography, and relief of the area. To show the close relationships between geological maps and DEM-derived surfaces, the poorly exposed area of Mikir hills has been examined using the DEM having geological maps at scales of 1:50,000.

IV. RESULT AND DISCUSSION

A. Khutori-Baguri Area

The relationship between a shaded topographic relief image and the geology of *the Khutori-Baguri* area can be observed in Fig. 2 (a-d). The DEM image enhances all the major faults and the minor lineaments that cross-cuts the whole area. Shaded Relief Map of *Khutori-Baguri* area and the 3D image view of DEM of *Khutori-Baguri* area demonstrate the geological features of the area more noticeably and clearly.

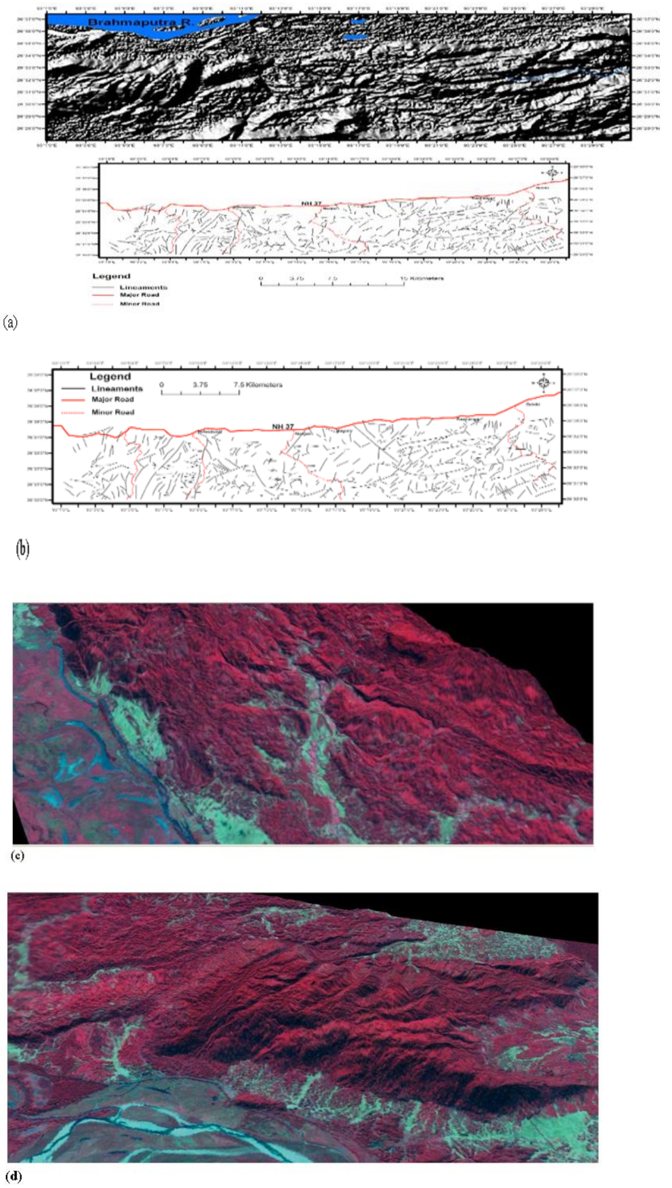


Fig. 2 (a) Shaded Relief Map of *Khutori* area, (b) Lineaments map of *Baguri* area prepared using shaded relief map, (c) 3D view of DEM of *Khutori* area, (d) 3D view of DEM of *Baguri* area.

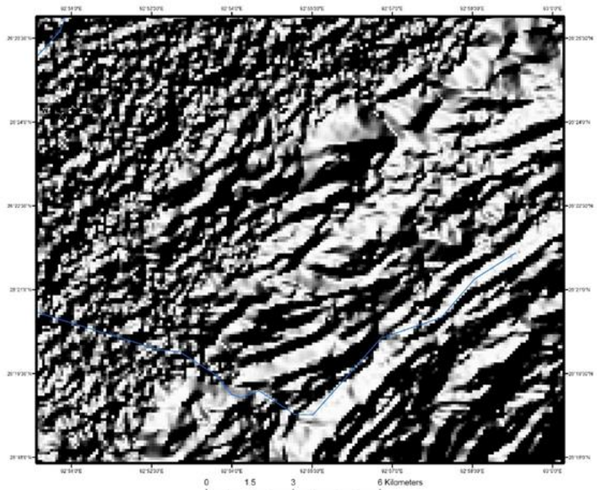
B. KATHAGURI AND DIJU VALLEY AREA

Nearly 90 % of this zone is covered by vegetation, which, in most cases, makes direct geological observation impossible. The faults shown on the geological map (Fig 3 b), are visible in the shaded topographic relief map (Fig. 3 a). These structures get enhanced in slope, aspect, or shaded topographic relief images.

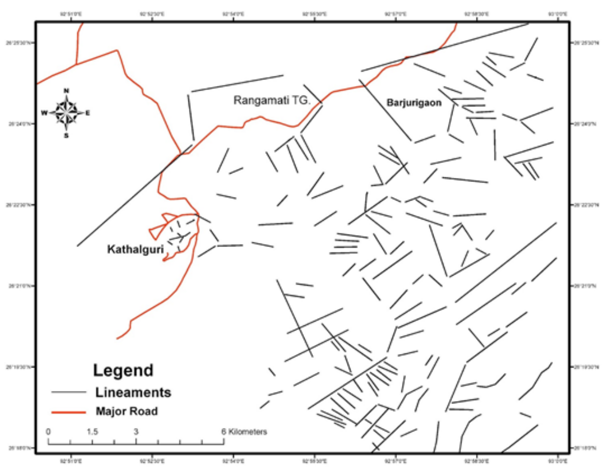
A shaded topographic relief image draped over a 3D view of the area (Fig 3 c) displays the relief of the whole zone and enhances the main geological characteristics shown in the geological map (Fig 3 b). The steep ridge and the hills respectively located at the top and the lower part of the picture define the main fault of the zone.

C. Kalyani Shear Zone

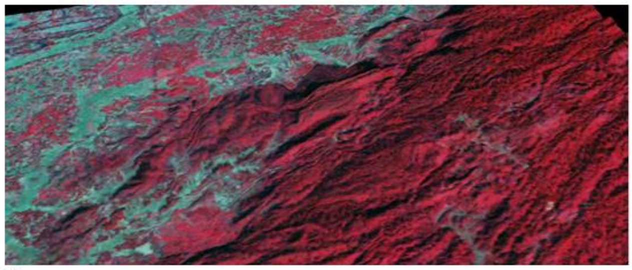
The Kalyani shear zone is seen in the aspect map, shaded relief, geological map, DEM, and stream extracted from DEM map using ArcGIS toolbox (Fig. 4 a-e). The shaded topographic relief image draped over a 3D view of the area through DEM displays the relief of the whole zone and enhances the main geological characteristics shown in the geological map.



(a)

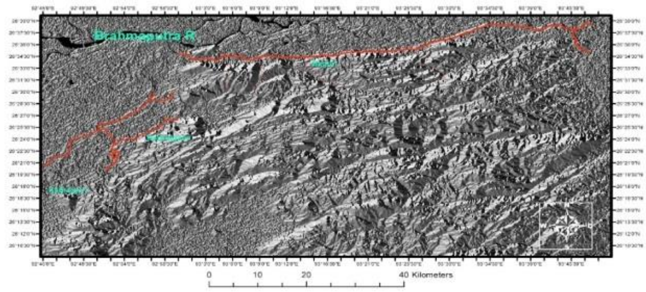


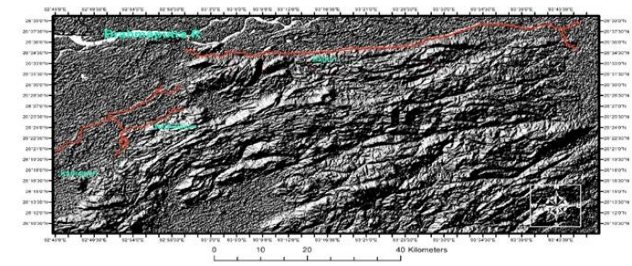
(b)



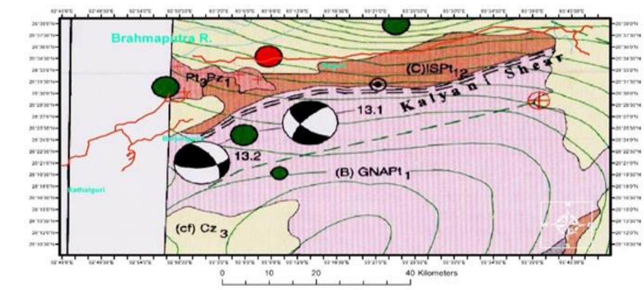
(c)

Fig. 3. (a) Shaded Relief Map of Kathaguri and Diju Valley area, (b) Lineaments map of Kathaguri and Diju Valley area prepared using shaded relief map. (c) 3D view of DEM of Kathaguri and Diju Valley area.

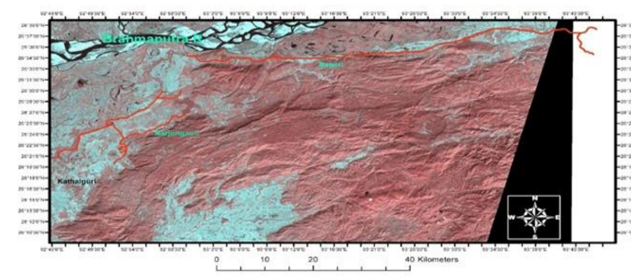




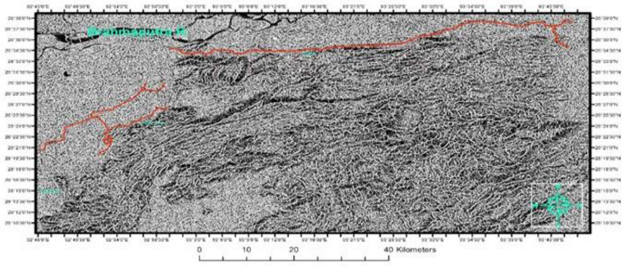
(b)



(c)



(d)



(e)

Fig. 4 Kalyani shear zone is seen in (a) the aspect map, (b) shaded relief (c) geological map (d) DEM, and (e) stream extracted from DEM map using ArcGIS toolbox

CONCLUSION

Working with DEMs, the entire mapping area can be analyzed in a relatively short period and it is possible to work interactively with digitized geological maps and databases. Besides, DEM images may also improve already published geological maps because they can depict lithological or tectonic boundaries not easily detected by conventional mapping methods.

The use of DEMs has a marked interest in geological mapping of highly vegetated terrains and urban areas as well as for young faults and late Tertiary or Quaternary deposits. DEM images eliminate vegetation and most man-made constructions and display the geology covered by plants or hidden by cities.

The figures shown in this study point out that, on the examined areas, the 30 m DEM reflects the major geological features observed on the 1:50, 000 geological maps. High-resolution DEM can provide accurate geological details and should be used as a base for geological mapping projects at such scales (Caumon, et al. 2012)

This paper has given a brief idea about the high potential of DEM in geologic mapping. The success of the SRTM and ASTER sensors in providing an economical opportunity for visualizing the landscape for efficient geological mapping at medium scales (1:100,000 and 1:50,000) has been demonstrated here (Rowan and Mars, 2003). The higher resolution DEMs offered by the Indian satellite sensor CARTOSAT-1 can be of immense value to geologists and students of geology in the country.

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