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Geological mapping of the Schuppen belt of north-east India using geospatial technology

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ABSTRACT

A revised geologic map of the Schuppen belt of northeast India has been prepared based on interpretation of digitally enhanced satellite images. The satellite image interpretation is supported by limited field work and existing geologic maps. Available geological maps of this fold thrust belt are discontinuous and multi-scaled. The authors are of multiple opinions regarding the trajectory of formation boundaries and fault contacts. Digital image processing of satellite images and limited field surveys have been used to reinterpret and modify the existing geological maps of this fold thrust belt. Optical data of Landsat Thematic Mapper, Enhanced Thematic Mapper and elevation data of ASTER have been used to prepare this revised geological map. The study area extends from Hajadisa in south to Digboi oilfield in north, bounded by Naga thrust in the west and Disang thrust in the east. PCA, Image fusion, Linear Contrast stretch, Histogram Equalization and Painted relief algorithms have been used for the delineation of major geological lineaments like lithological boundary, thrust and strike slip faults. Digital elevation maps have enabled in the discrimination between thrust contacts and lithological boundaries, with the former being located mostly in the valleys. Textural enhancements of PCA, colour composites and Painted relief algorithm have been used to discriminate between different rock types. Few geological concepts about the terrain have been revisited and modified. It is assumed that this revised map should be of practical use as this terrain promises unexploited hydrocarbon reserves.

1. Introduction

A powerful feature of space imagery is the reproduction of regional pictures. Since geological elements like fold, faults and rock exposures are commonly spread over large areas, geological studies and mapping using remote sensing has become an essential tool in such studies. In areas with accessibility problems, geological fieldwork is usually done in transacts. Correlation between the traversed section and interpolation in the areas in between can be easily achieved by remote sensing and digital image processing technique. The 300 km long belt of Schuppen has been mapped by previous workers from A.O.C., OIL and O.N.G.C. in transacts, during different times in the 20th century. The trajectory of different geological elements differs spatially in these maps. In fact, the only continuous and detailed geological map of the Southern Schuppen zone, available to the academia is that prepared by A.O.C. in the early 20th century. A lineament map covering the same area has been later prepared by Ganju and Khar, 1985. The northern Schuppen area from Dilli Ghat to Digboi has a good data control and has been mapped by OIL. We have consulted all the available geological maps of the terrain (Corps, 1949; Ganju and Khar, 1985; Kent et al., 2002; Kunte, 1988; Ranga Rao and Samanta, 1987) and digitally enhanced satellite images from Landsat and ASTER, collated structural data from previous literature, and limited field surveys for the preparation of this map. Digital techniques like PCA, relief enhancements, contrast enhancements, texture enhancements, colour composites inbuilt in *Erdas Imagine* 9.1 software have been used on the satellite images to extract geological lineaments and discriminate between different lithology of this foreland fold thrust belt. Overlay technique of ArcView GIS 3.2a has been used to bring together the different outputs of the enhanced satellite image and maps of the previous workers. Geological integration of different thematic maps and satellite images with field data has been used to determine the thrust trajectory and formation boundaries. Areas previously unmapped have also been added in this revised map based on satellite data and the conducted field

Abbreviations: NFTB, Naga fold thrust belt; TM, Thematic Mapper; ETM, Enhanced Thematic Mapper; PCA, principal component analysis; A.O.C., Assam Oil Company; B.O.C., British Oil Company; DEM, Digital Elevation Model; FTB, Fold thrust belt; OIL, Oil India Limited; O.N.G.C., Oil and Natural Gas Corporation.

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surveys. Thrust trajectory and nomenclature has been changed wherever necessary, based on the continuity of its hanging wall anticline. Trajectory and spatial dispositions of the formation boundaries have also been modified in this new map. Several geological interpretations important for structural modeling have been derived from the revised map.

The Schuppen belt of north east India has several important hydrocarbon deposits in the adjacent Assam shelf, in the sub thrust, and up thrust blocks, in areas like Geleki, Borholla, Champang or Digboi, Pengri, Kharsang respectively. However, the few seismic surveys and drilling on other exposed anticlinal blocks of the Schuppen belt in Nagaland remained inconclusive, mostly due to lack of quality data. An investigation including mapping would prove to be useful for any successful exploration strategy in this region. The map prepared in this communication may be useful in this perspective. The methodology of geological mapping from satellite images developed for this study can be replicated in similar structurally complex areas with poor data control.

2. Study area and geological setting

The Schuppen belt of north-east India forms the outermost fringe of the mobile belt of the Assam–Arakan basin (Ranga Rao and Samanta, 1987). This NE–SW trending belt is bounded by Naga thrust in the north-west and Disang thrust in the south–east (Evans, 1964). It extends from Maibong (Assam) in south to Mishmi Hills (Arunachal Pradesh) in north. The area spreads for about 4500 sq. km and has a length of about 300 km with width varying between 10 km and 22 km (Ranga Rao and Samanta, 1987). The area falls under the administrative states of Nagaland, Assam and Arunachal Pradesh. The study area lies between 93°20′56.42″E, 25°31′39.31″N and 93°28′11.02″E, 25°23′00.12″N in the south to 95°42′07.40″E, 27°25″37.42″N and 95°42′29.18″E, 27°24′11.38″N in the north. The Schuppen belt crosses Kohima, Dimapur, Wokha, Mokokchang, Tuensang and Mon districts of Nagaland. The FTB has been formed due to the collisional orogeny between Eurasian, Indian and Burmese plates during Tertiary period (Kent et al., 2002). This belt has several closely spaced easterly to south-easterly dipping thrusts which join and splay off from each other. Regional anticlines are exposed on the hanging walls of the thrusts. The axial trend of the anticlines are largely parallel to the outcrop trace of the thrust sheet, except in few places (Fig. 1). Several NW–SE and E–W trending strike slip faults (Evans, 1964; Lohmann, 1995) displace the belt along the transport direction of the thrust.

2.1. Lithology and environment of deposition

Assam–Arakan basin is essentially a Tertiary basin. A stratigraphic succession of Schuppen belt (Mathur and Evans, 1964) is described in Table 1. During Eocene, a general shallowing of the Assam Arakan basin took place. In the shallower part, the Jaintia group was deposited and Disang was deposited in a deeper part of the basin. **Disang** is a group of thick dark grey coloured argillaceous sequence with sandstone towards top, which are exposed along Dilli River section in Upper Assam. Evans, 1932 excluded sandstones from this group and concluded that this unit is

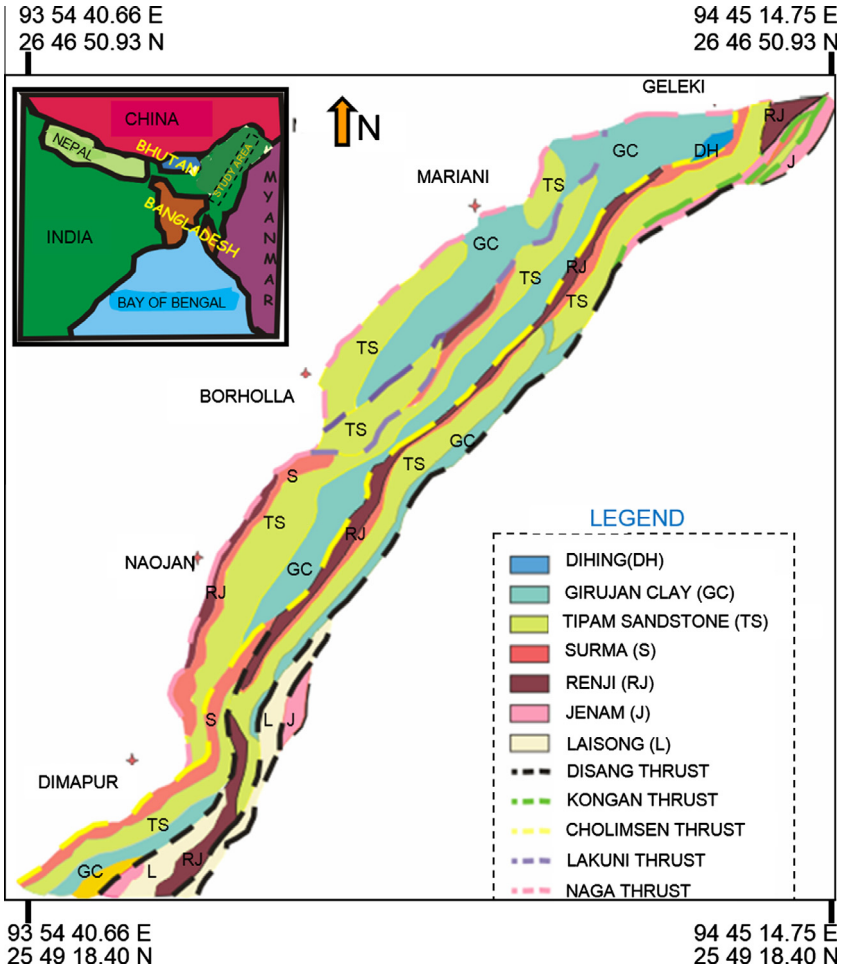

Fig. 1. Geological map of southern Schuppen zone (adapted from A.O.C., in Ranga Rao and Samanta, 1987).