CHAPTER I

INTRODUCTION

Geomatics is a useful new term for the use of advanced information technologies for the recording, storage, manipulation analysis of geographical imagery and mapping. It includes remote sensing, global positioning systems (GPS) and computer-based image manipulation and analysis. The high technology geomatics has tended to concentrate analyse, recently developed, land-based peoples to use geomatics in pursuing land claims and such as geophysical, environmental monitoring. This information technology makes it possible to satellite-sensing capabilities in light-aircraft based systems that are more appropriate for local applications. It has adopted an applications-driven approach and built a complete system that can act as an alternative or complement to satellite systems. The capabilities are consistent with expressed needs of many land-based communities such as river, stream road, political boundaries , rock formation and with the implementation priorities .

Global Positioning System (GPS), originally designed to locate themselves more accurately. It comprises a net of 24 satellites that emit signals that can be picked up by GPS receiver. When three signals are received, the GPS unit automatically computes and displays its geographic position. In the world of mapping, GPS technology is exerting an impact equivalent to that of the transistor in the world of communications. Location point can be compared with any other kind of geocoded data, including topographic maps, geological map and satellite images. It facilitates local-global data trade. Geocoded information is also acquiring a degree of legal acceptance, useful in responding to incursions on Indigenous lands.

There are used two main sources of satellite image data,one is the Landsat TM and another is ASTER data. These new datasets are used in conjunction with data collected from Thailand Mineral Resource Department, geology of Burma and laboratory analyses of rock classification. Second, application of ASTER SWIR bands to mineralogical mapping is analysized in this paper and compare with the two band ratio ,true colour and false colour are differentiated in using software.

The spatial resolutionof ASTER varies with wavelength: 15 m in the visible and near-infrared (VNIR), 30 m in the short wave infrared (SWIR), and 90 m in the thermal infrared (TIR). Each ASTER scene covers an area of 60 x 60 km. The geometric system correction primarily involves the rotation and the coordinate transformation of the line of sight vectors of the detectors to the coordinate system of the Earth.

The image used in this project was extracted from a Landsat TM (Thematic Mapper) scene taken on 10 February, 1989. Ground resolution for this image is 28.5 meters. Landsat TM records data in seven different bandwidths. These bandwidths are broken down into portions of the visible, infrared, and thermal infrared regions of the electromagnetic spectrum. From these various bandwidths, a great deal of information about the rock units can be displayed and analyzed.

The Landsat TM bands used for differentiating the alteration zones from the host rock are (R,G,B); (6,2,1), (7,4,2) and (5,4,3) and optimum combinations of band ratios are (R,G,B); (4/2,4/5,5/6) and (5/7,4/5,4/7), (3/1,5,7); respectively. Color composite images are used to differentiate the gossans and alteration zones from the host rock. R-G-

B combinations of bands and band ratios used to produce the color composite images are quantitatively evaluated using the Reference.

Regional lithological classification and mapping based on existing maps and satellite imagery. Signature differences were studied and compared at different multispectral wavelengths and between Landsat TM and and ASTER images. Landsat TM images has been successfully used for mapping the Sagaing-Panluang-Taunggui fault Zone and related small faults within the Mae Sariang-Mae Ping- Three Pagoda Fault Zone.

Remotely sensed data preprocessing generally refers to geometric and radiometric corrections by data providers, to varying degrees, as well as subsequent image registration, rectification or orthorectification . Integrating remotely sensed data into a geographic information system provides valuable input for geological thematic map modeling much the same way ancillary data has been used within image classification and change detection. This preprocessing requirement is increasingly important given developments in sensor technology and the increasing data stream of high resolution remotely sensed data.

Spatial data can be collected in many different ways such as from paper map, digital data in different format, and satellite images. One way to get the data is from multispectral image. Scanned maps or image don't usually contain information as to where the area represented on the map fits on the surface of the earth; the locational information delivered with satellite imagery is often inadequate to perform analysis or display in proper alignment with other data. Thus, in order to use these types of raster data in conjunction with other spatial data, we often need to align for georeference and it to a map coordinate system.

Geo-Referencing is the process of defining how raster data is situated in a map coordinates. That includes assigning a coordinate system that associates the data with a specific location on the earth. Georeferencing raster data allows it to be viewed, and analyzed with other geographic data.

There are many approaches to change detection including post-classification comparison, image ratioing, multifractal analysis,and reference.. etc. Despite of their differences in change identification algorithms, accurate spatial registration of the various imageries are requirement for all these methods. There are essentially two different categories of image rectification approaches, and the statistical approaches. The approach relies on data of the terrain information, and is effective when types of distortion are well characterized. The statistical approach, by means of a topographic data set, establishes mathematical relationship between image coordinates and their corresponding map coordinates using standard statistical procedures.

1.1. Rationale and Theory

To determine the most responsive wavelength, the reflectance spectral data were organized across different wavelength ranges. Spectral signatures are useful for distinguishing minerals and certain rocks of homogeneous composition. Absolute intensity of reflectance which varies with wavelength and gives rise to variations in amplitude of signal. The surface of every object such as mineral or rock unit has its own spectral signature.

Optimum combinations of Landsat TM bands used for differentiating the alteration zones from the host rock are 6-2-1, 5-4-3 and optimum combinations of band ratios are 4/2-4/5-5/6 and 5/7-4/5-4/7, respectively. Color composite images are used to differentiate the gossans and alteration zones from the host rock. R-G-B combinations of bands and band ratios used to produce the color composite images are quantitatively evaluated using the Optimum Index Factor.

The use of basic color such as blue, green and red to distinguish between true color and their band ratio ,false color compare with spectral sensitivity of color are illustrated. A compare with of between two kinds of images is of interest to note what determines the 'boundaries' of the spectral sensitivity of object or rock materials.

DEM generated from ASTER image and topographic (1:50,000 Scale) map are used to visualize stream channels, terrains in the critical area. Consequently, the drainage network is all the more dependent on the DEM orientation and rock types of their location area. The mapping of geologic structure lineaments , regional linear features are caused by the linear alignment of geomorphological features , landforms such as igneous landform, fault-controlled landform, and landforms developed on horizontal strata .. etc. The detection of lineaments and other topographic features of geologic significance will be several using factor. Remote sensing techniques could be used successfully to extract the structural geological information (lineaments) generally from any area. The interpretated lineaments are closely correlated to the faults shown published geological map of Thailand and Burma. There indicate that the digitized data and remote sensing data could confirm most of the previously mapped fault.

Almost rocks and their outcrops are covered by forest . The study area consists of fourteen rock formations. Igneous rocks, sedimentary rocks , and metamorphic rocks are occurred in the study area. So minerals and rocks of results will be several analyzed compared with two types of Landsat TM and ASTER images band combinations , band ratio, their composition of spectral signature patterns, and image classification. These results will be overlaying Geological map of Thiland 1:50,000 scale (et.al.) and Geology of Burma .

1.2. Objective

The main objective is the technical capacitation in the characteristics and geological application of advanced remote sensing data. The first goal is the utilization of latest generation satellite data such as Advanced Spaceborne Thermal Emission and Reflection Radiometer-ASTER, in order to produce multispectral signature to geological maps and thematic maps for 3-D modelling. The second goal is the utilization of landsat TM data, such as geomorphology, structure lineaments in areas study.

This project is to classify geological feature,Mineral spectral signature pattern, lithologic content within a given geomorphological field using high-resolution multispectral and hyperspectral remote sensing data. Evaluate classification geological map product that includes:

a) Rock unit results are collected from geological map (Geological Survey Division Department of Mineral Resources, Geological map of Thailand 1:500,000 and Geology of Burma 1:200,000 map).

b) Using published NASA's Global Orthoretified Landsat data Set , the Land Processes DAAC was established as part of NASA's Earth Observing System (EOS) Data.

c).Examine feature extraction methods for classification of multipectral data sets using Multispec software and digitizing .

d).Generate a written report containing methodology, classification results, accuracy assessment,

maps, and other pertinent graphical or numerical information to support the conclusions.

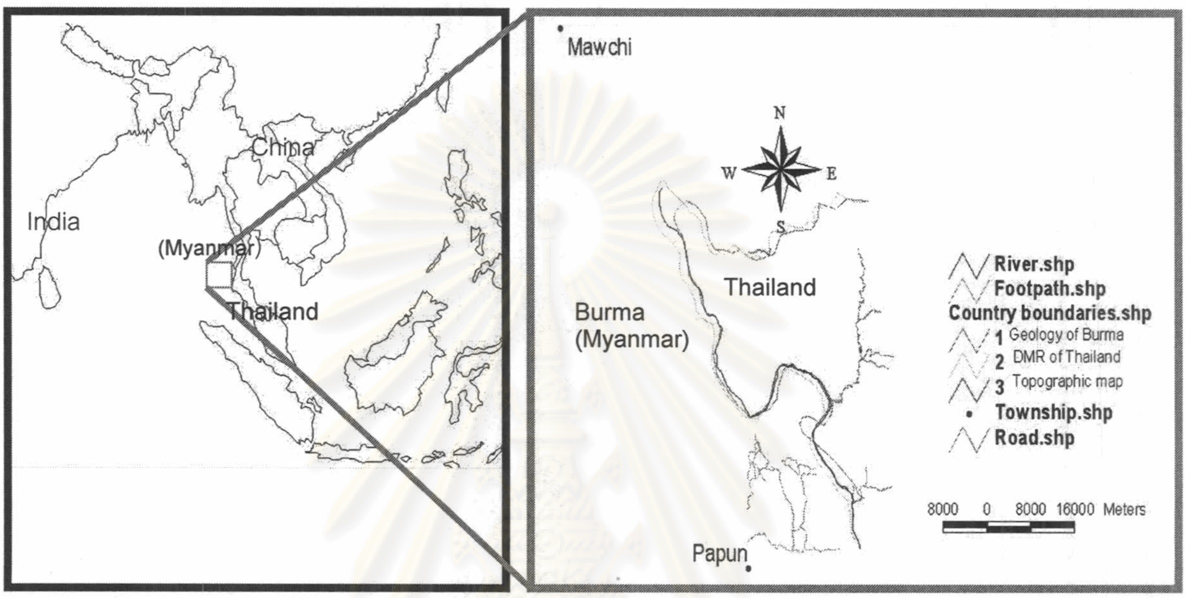

Figure-1.1. Map showing the location of study area

1.3. Scope of work

The present work has been undertaken:

1.Rectified different scale geological maps (Geological Survey Division Department of Mineral Resources, Geological map of Thailand 1:500,000 and Geology of Burma 1:200,000 map), topographic map 1:50,000 (Edition 1-NIMA, Series L7018, Sheet 4545 III & IV), and Satellite image.

2. In order to evaluate the possibility of using mineral spectral signature by MultiSpec software , ASTER DEM using by ASTER Opener, ENVI.4 and topographic DEM using by ArcView GIS .

A Geological database has been constructed using a Geographic Information System, based on a direct mapping approach with detailed information derived from 1:50,000 scale topographic map, Thailand mineral resource map (1:500,000) and geology of Burma (1:2,000,000 scale,Friedrich Bender with contributions of Dietrich Bannert, jorn Brinckmann, Franz Gramann and Dietrich Helmcke 1981) . This spatial database is connected to an attribute database, containing information on the lithology, geomorphology and rock unit classification by Maximum Likelihood with supervise classification .

3.Geological structure lineaments, rock characteristic of each object are classified by using band combination or band ratio method ,and compare with true color image and false color image .

1.4. Uses of Software

1.4.a. ASTER opener-It is the tool in order to transform from ASTER HDF dataset to binary BSQ file format data. Output data will be Band separated file format data and Selected 3-band BSQ file format (if available).

1.4.b. MultiSpec - The spectral signatures of different area types, objects are to be measured by MultiSpec software. The surface of every object such as mineral, rock has its own spectral signature.

1.4.c. Envi 4 - The importance of the criteria of fracture density and the density of lineaments depend on object or mineral of surface. We can describe by two aspects:

i. Determination of significant directional intervals and retention of only the major features of a region, based on a predetermined trial using a special procedure(Sawatzky and Rames,1980).

ii. Possibility of drawing the lineament groups and lineament intersections, this term being used in the sense of "concentration of lineaments".

Combined with geological and geophysical maps, the lineament density map enabled the investigators to focus prospecting on highly fractured zones in which high concentrations of rock minerals were found.

1.4.d. ArcView GIS Version 3.3 - Each layer and layer of thematic data on the area of interest such as stream , river, and rock unit represented as a shape file in ArcView, has a map view and an attribute table. The map view is thematic layer where coordinates of points, lines, and polygons are used in display.

1.5.Colour Combination

Landsat TM data, ASTER data were loaded and processed on the workstation using ENVI. The first choice for processing the data was to produce a 3-2-1 image, the band selection is in red-green-blue (RGB) order. Figure- 1.2 illustrates the end product of choosing bands 7-4-2 and 6-2-1 in combination to produce false color images.

Sabins (1996) says that the 7-4-2 band combination, while better for temperate to arid regions, yields maximum spectral diversity. He further notes that the 7-5-4 combination offering maximum spatial resolution is best suited for humid regions. According to Sabins (1996), ratio images combined in RGB offer greater contrast between geologic units than do individual TM band false color images. There depicts the ratioing of 5/7-4/5-3/1.Commonly , a ratio image is used as a component in a set of color composites.It has found direct practical applications in mapping vegetation and delineation of alternation zones. Suitable ratio features may be conceived by physically understanding the situation.

As a structural analysis is a greater priority than lithologic mapping for this study, the ratio images proved less useful than the false color image based on three bands.This true-color TM band (R,G,B); (3,2,1)combination creates a natural-looking image. Precise land-water boundaries are more readily delineated using band combinations which include the infrared wavelengths. The TM image combines near-infrared Band 4 with visible Bands 3 and 2. Using Band 4 results in more defined water boundaries than in the 3,2,1 image, yet the two visible bands still reveal some water detail and give information about the wetlands and flooded areas.

Band combination	Type of field	References
741	Gold field	F.Kuehn,T.King,B.Hoerig,D.Peters,2000
742	Dominant vegetation cover Alternative to the standard Arid region	S.A.DRURY, 1987-1993 F.Kuehn,T.King,B.Hoerig,D.Peters,2000 David Williamson
(RGB) , 4,5,3	Land cover types	Photo Science, Inc. 2670 Wilhite Drive Lexington, KY 40503
543	Vegetation and soil type	Photo Science, Inc. 2670 Wilhite Drive Lexington, KY 40503
321	bathymetric and coastal studies	Franklin & Marshall College
754	Humid region	David Williamson
432	Vegetation is of less interest than geology	F.Kuehn,T.King,B.Hoerig,D.Peters,2000
531	High-grade metamorphic terrain with granite	S.A.DRURY, 1987-1993

Table 1.1(a). Band combination

Band Ratio	Type of field	References
3/1-5/4-5/7	Alternation pattern in gold field	F.Kuehn,T.King,B.Hoerig,D.Peters,2000
7/4-1/5-1/7	Potential waste and exposed rock	F.Kuehn,T.King,B.Hoerig,D.Peters,2000
3/4-3/1-5/7	High in iron oxides	F.Kuehn,T.King,B.Hoerig,D.Peters,2000
5/4-3/1-7/5 or 5/7	Ferric minerals and hydroxide-bearing minerals	S.A.DRURY, 1987-1993

Table1.1(b). Band ratioing

Figure -1.2.Image showing the limestone or dolomite area is distinctly occurred Landsat TM band combination (R,G,B): (3/1, 5,7); and other band combinations (6,2,1); (7,4,2); (5/7,4/5/,4/7).

This composition is from the same Landsat scene shown using bands 3/1, 5, and 7 (displayed in Red,Green,Blue respectively). In this composition Limestone appears in bright magenta while some of the forest are displayed in a green color. Also, there is a considerable amount of sedimentary rock and metamorphic rocks in this scene that is displayed with a combination of the green and pink colors.This combination of near-infrared Band 4, mid-infrared Band 5, and visible Band 3 offers added definition of land-water boundaries and highlights subtle details not readily apparent in the visible bands alone. The 5,4,3 (RGB) band combination demonstrates moisture differences and is useful for analysis of soil and vegetation conditions. Generally, the wetter the soil, the darker it appears.

This image is a combination of mid-infrared Band 7, near-infrared Band 4, and visible Band 2. The 7,4,2 (RGB) combination retains the benefits of the infrared bands yet presents vegetation in familiar green tones. Mid-infrared Band 7 helps discriminate moisture content in both vegetation and soils.

1.6. Topography and Background of Regional Geology

1.6.1. Background and Topography

The study area is located on the Sino- Burman Range (Eastern Highlands) of Burma and the northern highland of Thailand.The area considered covers approximately 60 square kilometers.The northern part of Thailand is a mountainous or upland areas consisting of high terraces, hills and mountain range. Most of the mountain ranges strike in N-S direction following the structural setting of the region (See figure-1.3).

The south west of the study area has a hot and humid climate because of the mountain ranges that lie in its backdrop and its location, which is near the sea, in the tropics. The main river is Salween (Thanlwin).The north west of the study area has the wet climate of mid-hot regions and the low-lying areas have the climate of Savana and monsoon climate of the tropical regions.

The area's geomorphic features were mapped mainly by interpretation of 1: 50,000 scale topographic map , Landsat TM data , ASTER image and ASTER DEM check of the defined landforms. The structural origin unit is the elevated hills which are higher than 100 meter.

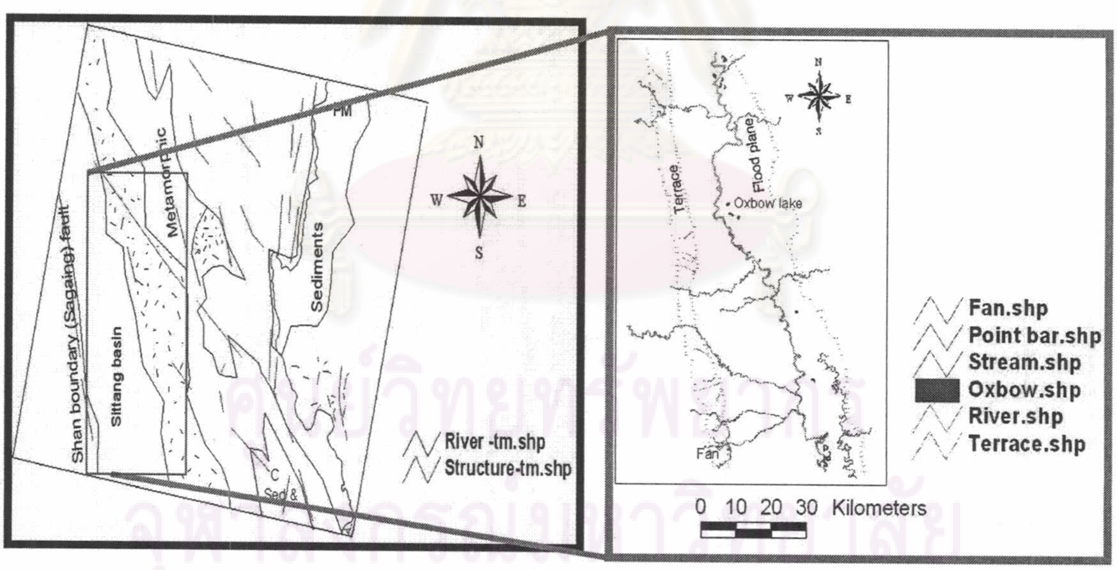

Fig-1.3. Map showing the geomorphology of geocoverage area and Sittang basin.

1.6.2. Geomorphology

1.6.2.(a) Igneous landform

The Burma granitoids can be subdivided into three N-S trending, major belts. There are western granitoid belt, central granitoid belt and eastern granitoid belt (see fig-1.3). The study area lies on the central granitoid belt. The central belt granitoids are mostely Miocene. granitoids are occurred at east of Taungoo and Mawchi .The Mawchi granitoid is a very small body.

1.6.2.(b) Tectonic and Fault-controlled landform

As a result of plate tectonic evolution, Burma has been divided from west to east into four major geotectonic units. There are Arakan Costal Zone, Indo-Burman Rranges, Inner-Burman Basin and Sino-Burman Ranges. The study area is situated in an area of Sino-Burman Ranges. The Mawchi-Mergui series is clastic series of two in this region. The strike-slip fault is major type of displacement in the west of study area.

1.6.2.(c) Fluvial landform

Fluvial landforms are created by the weathering, erosion, transportation , and deposition of materials by water. It is important when interpretating fluvial landforms in image to understand the characteristics of rock types within the drainage basin and the drainage pattern.

A small section of the Sittang river shown in figure-1.4 provides examples of several composite floodplain features.The landsat TM near-infrared bands are ideal for identifying the oxbow lakes and the more geologically recent flooded meander scar. The sand and point bars are visible on all images.

Mendering channels form where streams are flowing over a relatively flat landscape with a broad floodplain (see figure1.4).Point bars develop where stream flow is locally reduced because of friction and reduced water depth In a meandering stream, point bars tend to be common on the inside of a channel bend. Floodplains can also contain sediments deposited from the lateral migration of the river channel.

Oxbow lakes are the abandoned channels created when meanders are cut off from the rest of the channel because of lateral stream erosion. Point bars are depositional landform which originates as a meandering stream channel migrates back and forth across its flood plain. As the water flows around a curve in the channel it will cut away material from the outside of the turn, and deposit material on the inside of the turn. If we look carefully at the image we can identify older point bars which are now covered with farm land.

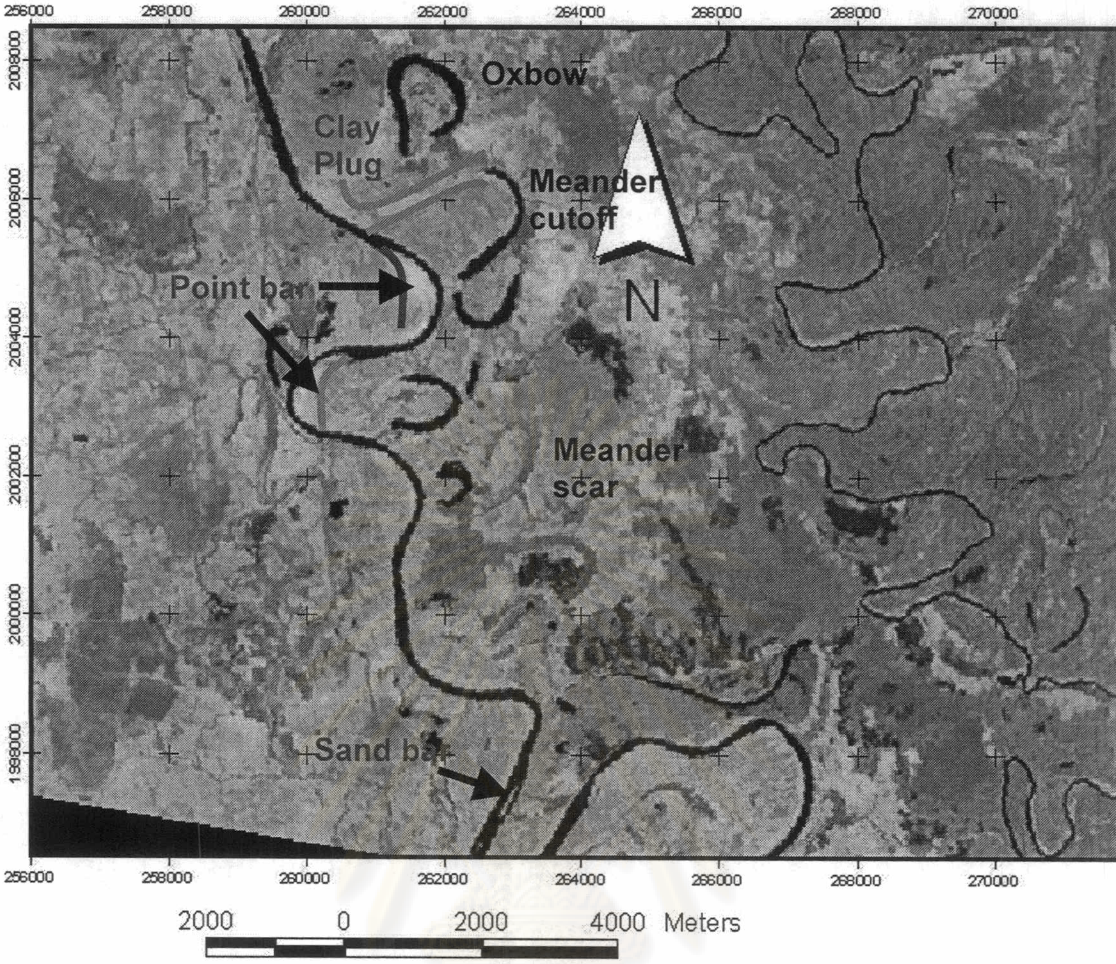

Figure-1.4. Landsat TM image showing meandering channel formed and maintained by erosion of banks and deposition , the spatial expression of fluvial geomorphic processes as channel, network and Sittang basin morphologies .

Oxbow lakes form from the meandering of the stream channel. As the bends in a meandering stream become more and more convoluted, eventually the stream will break through the narrow neck of land at the base of the mander loop, forming a cutoff meander . As sediment fills in along the bank of the new channel, the old channel is isolated from the stream and becomes an Oxbow lakes.