

# ENGINEERING GEOLOGY & GEOSPATIAL APPLICATIONS



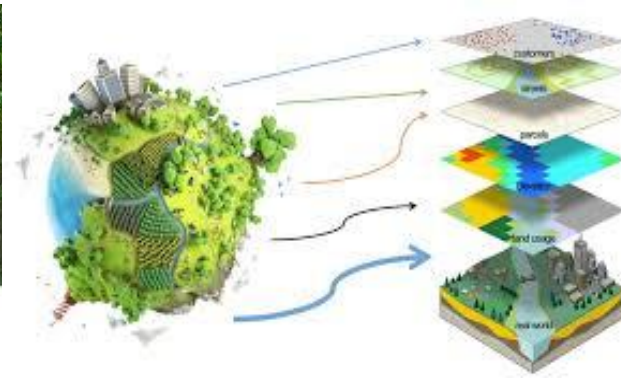
DEPARTMENT OF CIVIL ENGINEERING  
SESHADRI RAOGUDLAVALLERU ENGINEERING COLLEGE  
**An Autonomous institute with permanent affiliation to**  
**JNTUK, Kakinada SESHADRI RAO KNOWLEDGE VILLAGE:**  
**GUDLAVALLERU**

**II B.Tech I Semester**  
**(2021-22)**

Name : .....

Regd. No : .....

Year & Semester : .....



# ENGINEERING GEOLOGY & GEOSPATIAL APPLICATIONS

LABORATORY MANUAL - R20

Civil Engineering

### **Vision of the Department**

To provide quality education embedded with knowledge, ethics and advanced skills and preparing students globally competitive to enrich the civil engineering research and practice.

### **Mission of the Department**

- To aim at imparting integrated knowledge in basic and applied areas of civil engineering to cater the needs of industry, profession and the society.
- To develop faculty and infrastructure making the department a centre of excellence providing knowledge base with ethical values and transforming innovative and extension services to the community and nation.
- To make the department a collaborative hub with leading industries and organizations, promote research and development and combat the challenging problems in civil engineering which leads for sustenance of its excellence.

### **Programme Educational Objectives**

1. Exhibit their competence in solving civil engineering problems in practice, be employed in industries or undergo higher study.
2. Adapt to changing technologies with societal relevance for sustainable development in the field of their profession.
3. Develop multidisciplinary team work with ethical attitude & social responsibility and engage in life - long learning to promote research and development in the profession.

### **Program outcomes**

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Department of Civil Engineering

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Programme specific outcomes (PSOs)**

Students will be able to

1. Survey, plot and prepare layout plans for buildings, dams, canals and highway alignments and conduct geotechnical and geological investigations of the project.
2. Test, analyze and design various substructures and superstructures by considering the environmental and societal issues.
3. Organize various construction projects considering modern construction techniques, equipment and management issues.

<i>Experiment</i>	<i>Program Outcomes</i>	<b>Program Outcomes</b>	<b>Course Outcomes</b>
1. Identification of Minerals			
2. Identification of Rocks			
3. Study of geological structures using wooden models			
4. Demo of Resistivity Meter for geophysical measurements			
5. Creating layers in a GIS and digitising scanned images			
6. Adding attribute data in tables and overlaying layers to extract information			
7. Finding x,y,z coordinates of given points using hand-held GPS/smartphones.			
8. Geocaching, retrieving hidden objects using GPS receivers			
9. Loading a satellite image and switching the bands on and off.			
10. Rectification and Referencing of satellite images.			
11. Feature identification from Aerial Photographs.			
12. Observing depth of field in stereo-pairs.			

**INDEX**

<b>S.no</b>	<b>Date</b>	<b>Name of the Experiment</b>	<b>Marks</b>	<b>Signature</b>
1		Megascopic Identification of Minerals.		
2		Megascopic Identification of Rocks.		
3		Study of geological structures using wooden models		
4		Demo of Resistivity Meter for geophysical measurements		
5		Geo referencing of images SOI - OSM map.		
6		Adding attribute data in tables and overlaying layers to extract information		
7		Creating layers in GIS and digitizing scanned images.		
8		Adding attribute data in tables and Calculating geometry.		
9		Feature identification from Aerial Photographs.		
10		Observing depth of field in stereo-pairs.		

Experiment no. \_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

### **Megascopic Identification of Minerals**

#### **MINERAL:**

Minerals are the building blocks of rocks. A mineral

- is a naturally occurring inorganic crystalline solid
- has an ordered internal arrangement of atoms
- has specific physical properties that are either fixed or that vary within some defined range.
- has a definite chemical composition that may vary within specific limits

#### **Formation of minerals:**

The processes involved in the genesis of minerals are

- i) Solidification: Hot molten magma solidifies through cooling
- ii) Sublimation: The gaseous form of minerals are formed through evaporation and precipitation
- iii) Evaporation: Materials dissolved in water crystallize on precipitation
- iv) Recrystallization: Minerals are formed due to recrystallization during metamorphism.

**Solidification:** Magma is a natural hot melt solidifies through cooling leading to the formation minerals known as solidification. This process is also called as crystallization. The composition and physical properties of minerals thus formed are governed by the rate of cooling and surrounding geological environment of magma. Since the earth's crust is made dominant of alumino-silicates most minerals formed are rich in silica & feldspar.

**Sublimation:** This process is generally associated with volcanism. In the process of sublimation, the mineral is formed through evaporation and precipitation directly from gaseous state, because of the sudden cooling of the vapors emanating from volcanoes. Since the emanating gases are about 2% of magma, very little minerals are derived from it. It is a rare process.

**Recrystallization:** It is a phenomenon which the mineral grains which have been already crystallized are placed for recrystallization due to changes in temperature and pressure (Metamorphism).

**Evaporation:** In this process, the materials dissolved in water solution precipitate under suitable environmental conditions.

Property	Feldspar	Hornblende	Mica Muscovite	Asbestos	Flint	Olivine
<b>Form</b>	Massive	Prismatic	Lamellar	Fibrous	Massive	Massive
<b>Colour</b>	White, grey, green, red etc.	Dark green	Silver white in book form colourless in this layers	White or any other colour	Brownish or greyish generally	Olive green
<b>Streak</b>	White	White	White	Pale body colour	White	White
<b>Lustre</b>	Vitreous	Vitreous	Pearly	Silky	Resinous	Dull
<b>Fracture</b>	Uneven	Uneven	Uneven	Hackly	Conchoidal or sub conchoidal	Uneven
<b>Cleavage</b>	Two sets	Present	One set, excellent	Present	Absent	Absent
<b>Hardness</b>	6	5_6	2_3	_	7	6_7
<b>Transparency</b>	Translucent along sharp edges	Nearly opaque	Transparent in thin layers	Translucent in thin fibres	Translucent along sharp edges	Nearly opaque



Property	Talc	Pyrite	Hematite	Graphite	Quartzite Smoley	Mica Biotite	Chlorite
<b>Form</b>	Foliated	Massive, cubic or crystal aggregate	Massive	Massive	Massive, crystals	Lamellar	Foliated
<b>Colour</b>	White, green etc.	Brass yellow	Dark steel grey	Black	White, colourless or any colour	Black	Dark grassy green
<b>Streak</b>	Pale body colour	Black	Cherry red	Black	White	Brownish	Pale green
<b>Lustre</b>	Pearly	Metallic	Sub-metallic	Greasy lustre	Vitreous	Pearly	Pearly
<b>Fracture</b>	Uneven	Uneven	Uneven	Uneven	Uneven	Uneven	Uneven
<b>Cleavage</b>	1 set	Present	Absent	Absent	Absent	One set of cleavage	One set
<b>Hardness</b>	1	5_6	5_6	< 1	7	2_3	2_2.5 (scratched by finger nail)
<b>Transparency</b>	Translucent along thin edges	Opaque	Opaque	Opaque	Transparent, or translucent	Translucent in thin layers	Nearly opaque

Experiment no. \_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## **Megascopic Identification of Rocks**

Rock or stone is a natural substance, a solid aggregate of one or more minerals or mineraloids. For example, granite, a common rock, is a combination of the minerals quartz, feldspar and biotite. The Earth's outer solid layer, the lithosphere, is made of rock.

Many rocks contain silica ( $\text{SiO}_2$ ) a compound of silicon and oxygen that forms 74.3% of the Earth's crust. This material forms crystals with other compounds in the rock. The proportion of silica in rocks and minerals is a major factor in determining their names and properties.

### **Igneous rock**

Igneous rock (derived from the Latin word igneus, meaning of fire, from ignis meaning fire) is formed through the cooling and solidification of magma or lava. This magma may be derived from partial melts of pre-existing rocks in either a planet's mantle or crust. Typically, the melting of rocks is caused by one or more of three processes: an increase in temperature, a decrease in pressure, or a change in composition.

Igneous rocks are divided into two main categories:

1. Plutonic or intrusive rocks result when magma cools and crystallizes slowly within the Earth's crust. A common example of this type is granite.
2. Volcanic or extrusive rocks result from magma reaching the surface either as lava or fragmental ejecta, forming minerals such as pumice or basalt.

### **Sedimentary rock**

Sedimentary rocks are formed at the earth's surface by the accumulation and cementation of fragments of earlier rocks, minerals, and organisms or as chemical precipitates and organic growths in water (sedimentation). This process causes clastic sediments (pieces of rock) or organic particles (detritus) to settle and accumulate, or for minerals to chemically precipitate (evaporite) from a solution. The particulate matter then undergoes compaction and cementation at moderate temperatures and pressures (diagenesis).

### **Metamorphic rock**

Metamorphic rocks are formed by subjecting any rock type—sedimentary rock, igneous rock or another older metamorphic rock—to different temperature and pressure conditions than those in which the original rock was formed. This process is called metamorphism, meaning to "change in form".



Property	Sandstone	Shale	Limestone	Laterite
<b>Nature of the rock</b>	Cementing material present; some specimens may show bedding, ripple marks, fossils etc. rough feeling to touch	Lamination present: fissility, fossils, cross bedding may occur, du appearance. Some may show sub conchoidal fracture	Extremely fine grained, dense, compact. May exhibit nodular, concretionary, pisolitic, oolitic etc. forms. Ripple marks may occur; may have solution cavities. Shows conchidal fracture	Porous, concretionary, pisolitic, or spongy, dull looking
<b>Colour</b>	Generally yellow, red, dirty white or pale green	White, red, grey, black, brown etc.	May be black, grey, red, green, brown, dirty white etc.	patches of different colours (brown, red, yellow etc.)
<b>Texture</b>	Coarse, medium or fine grained	Extremely fine grained	Very fine grained, types formed out of evaporation may have crystals of calcite	Very fine grained
<b>Acid test</b>	Calcareous sand stones only react, other types do not react	No reaction	Vigorous reaction; dolomitic limestones may not show reaction	No reaction
<b>Minerals present</b>	Mainly Quartz; Feldspars, garnet, mica etc. may occur	Too fine to identify	Too fine to identify. Pyrite may occur	Too weathered to identify

<p><b>Inference</b></p>	<p>1. Presence of cementing material indicates that this is a sedimentary rock. Ripple marks, fossils, cross bedding if present, support this evidence.</p> <p>2. Predominant occurrence of sand particles indicates that this is an arenaceous rock. Based on these the rock is called as sand stone. Type of cementing material, grain size help in detailed naming of sand stone (E.g.: Siliceous coarse grained sand stone)</p>	<p>1. Presence of lamination (fossils, cross bedding indicates sedimentary origin of the rock.</p> <p>2. Absence of reaction with acid indicates that this is not a calcareous rock.</p> <p>3. Extreme fine grain size, dull appearance indicates that this is an argillaceous rock and product of weathering</p> <p>4. Based on these, the rock may be inferred as shale.</p>	<p>1. Absence of diagnostic characters of igneous and metamorphic rocks indicates that this may be a sedimentary rock</p> <p>2. Peculiar forms, ripple marks, fossils if present suggest this as a sedimentary rock</p> <p>3. Vigorous reaction with acid indicates that this is a calcareous rock</p> <p>4. Absence of crystallisation and presence of conchoidal fracture indicates that this is not a metamorphic rock (i.e. marble)</p> <p>5. Extreme fine grain size indicates that this has formed out of compaction of CaCO<sub>3</sub> precipitate - Based on these, the rock may be called limestone</p>	<p>1. Porous and concretionary appearance indicates that it is a sedimentary rock</p> <p>2. Dull appearance soft nature indicates that it is a product of weathering</p> <p>3. Absence of reaction with acid indicates that it is not a calcareous rock</p> <p>4. Based on these and the characteristic appearance of patches, of different colours, the rock may be inferred as laterite</p>
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Property	Quartzite	Marble	Slate	Gneiss
<b>Nature of the rock</b>	Dense and compact, Fresh appearance	Dense and compact; exhibits twinkling appearance when the specimen is turned	Slaty cleavage present; cleavage surface has shining	Gneissose structure present. Sometimes garnet may occur
<b>Colour</b>	White, red, green or pale colour	White, red, green, grey etc.	Usually black, but may have shades of other colours	Greyish or pinkish
<b>Texture</b>	Fine, medium or coarse grained; Granulose structure	Fine, medium or coarse grained; granulose structure	Extremely fine grained along with slaty cleavage A long the sides dull appearance	Fine, medium or coarse grained. Shows alternating bands of dark and light coloured minerals
<b>Acid test</b>	No reaction	Vigorous reaction	No reaction	No reaction
<b>Minerals present</b>	Quartz is the most predominant mineral, garnet, mica, magnetite may occur	Calcite is the most predominant mineral olivine, garnet, quartz etc. may occur	Too fine to identify. Pyrite occurs often presence of mica can be inferred by the shining along cleavage planes which is the net result of light reflected by fine innumerable mica flakes which have parellely aligned along such planes.	Feldspars (white, pink, cleavage present) Quartz (colourless, vitreous lustre, cleavage absent) Biotite (black, cleavage present, pearly lusture) Hornblende (greenish back, cleavage indistinct) Garnet (Similar to quartz but with red colour

<p><b>Inference</b></p>	<p>1. Absence of characters of igneous and sedimentary rocks indicate that this may be a metamorphic rock</p> <p>2. Absence of reaction with acid indicates that this is not a calcareous rock</p> <p>3. Based on these and predominant occurrence quartz the rock may be described as quartzite</p>	<p>1. Absence of characters of igneous and sedimentary rocks indicates that this is a metamorphic rock.</p> <p>2. Vigorous reaction with acid indicates that this is a calcareous rock</p> <p>3. Presence of cleavage in the mineral indicates that this is a crystalline rock. Based on these the rock may be called as marble</p>	<p>1. Slaty cleavage, which is the consequence of parallel alignment of very fine mica flakes, suggest that this is a metamorphic rock</p> <p>2. Absence of reaction with acid indicates that this is not a calcareous rock</p> <p>3. Dull appearance of the particles and their extreme fine grain size indicates that this is argillaceous rock. Based on these the rock may be called as slate</p>	<p>1. Alignment of the minerals indicates that this is a metamorphic rock</p> <p>2. Predominant occurrence of feldspar and quartz indicates that it is like granite.</p> <p>3. Based on these and the gneiss structure present, the rock may be described as granite gneiss</p>
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Property	Pegmatite	Granite	Dolerite	Basalt
<b>Nature of the rock</b>	Interlocking Texture present	Interlocking Texture present	Interlocking texture present, but indistinct due to fine grain size	Vesicular or amygdaloidal structure, rarely massive
<b>Colour</b>	Leucocratic, nearly white	Generally leucocratic, often pink or grey	Melanocratic, black or dark greenish black	Melanocratic, cement colours with shades of grey brown or pink
<b>Texture</b>	Phanertic, very coarse grained	Phaneric, coarse, medium or fine some may have porphyritic texture sometime Graphic texture	Phaneric, fine, equigranular or inequigranular, porphyritic	Aphanitic
<b>Acid test</b>	Dense and compact	Dense and compact	Dense and compact	Vesicular or amygdaloidal or massive i.e. dense and compact
<b>Minerals present</b>	<b>Feldspars</b> (White, green or brown colour, vitreous lustre, 2 sets of cleavage, translucent along thin edges <b>Quartz</b> (Vitreous lustre, colourless, cleavage absent Mica ( Muscovite or Biotite), rare minerals	<b>Feldspar</b> (Pink or White, Vitreous lustre, cleavage present <b>Quartz</b> ( Colourless, vitreous lustre, cleavage absent <b>Hornblende</b> (dark greenish black, sub vitreous lustre) <b>Biotite</b> (Black, cleavage present, bright lustre	<b>Feldspars</b> (White or dark grey, vitreous lustre, cleavage present) <b>Augite</b> (Black, indistinct cleavage, sub vitreous lustre) any other minerals may occur in very small quantities only	Primary minerals are too fine to identify. Amygdales are generally zeolites or quartz, amethyst, agate, chalcedony or calcite



<b>Inference</b>	<ol style="list-style-type: none"> <li>1. Interlocking texture indicates that it is igneous rock</li> <li>2. Phanertic coarse grained texture indicates that it is a Plutonic igneous rock</li> <li>3. Leucocratic colour indicates that this is an acidic igneous rock</li> <li>4. Presence of quartz indicates that this is an over saturated rock. Based on these and abnormal sizes of minerals, it may be identified as pegmatite</li> </ol>	<ol style="list-style-type: none"> <li>1. Interlocking texture indicates that this is igneous rock</li> <li>2. Phaneric coarse grained texture indicates Plutonic origin</li> <li>3. Leucocratic colour indicates acidic nature</li> <li>4. Occurrence of quartz indicates it as over saturated rock</li> <li>5. Predominant occurrence of feldspars and quartz indicates that it is granite.</li> </ol>	<ol style="list-style-type: none"> <li>1. Interlocking texture occurs but because of fine grain size needs close observation</li> <li>2. Phaneric fine grained texture indicates hypabyssal origin</li> <li>3. Melanocratic colour indicates basic composition</li> <li>4. Predominant occurrence of feldspars and augite and typical colour indicates that it is dolerite.</li> </ol>	<ol style="list-style-type: none"> <li>1. Absence of characters of sedimentary and metamorphic rocks and occurrence of vesicular/ amygdaloidal structure indicates igneous origin</li> <li>2. Aphanitic texture indicates volcanic origin</li> <li>3. Mesocratic to melanocratic colour indicates basic composition.</li> <li>4. Absence of reaction with acid indicate that it is not calcareous - Based on these it is described as basalt</li> </ol>
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Experiment no. \_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## Study of geological structures using wooden models

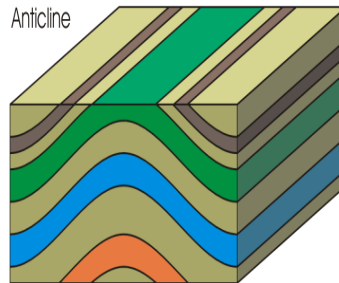
### Folds

Folds are one of the most common types of geological structures found in rocks. When a set of horizontal layers are subjected to compressive forces they bend either upwards or downwards.

### Types

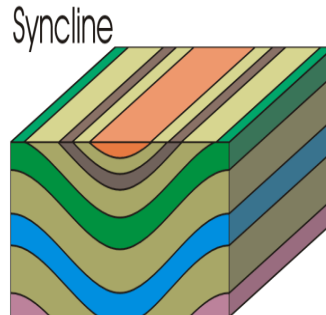
#### Anticline

When the beds are bent upwards the resulting fold is called as anticline.



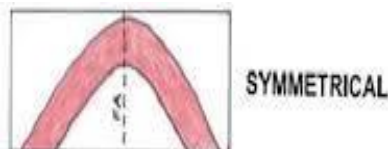
#### Syncline

When the beds are bent downwards the resulting fold is called as syncline.



#### Symmetrical folds

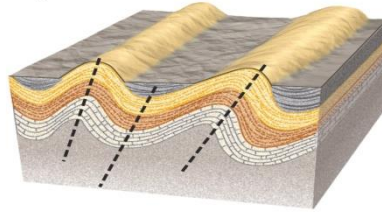
When axial plane divides a fold into two equal halves, i.e. one half is mirror to other. Then it is called symmetrical folds.



#### Asymmetrical folds

If two halves are not mirror images then the fold is called asymmetrical folds.

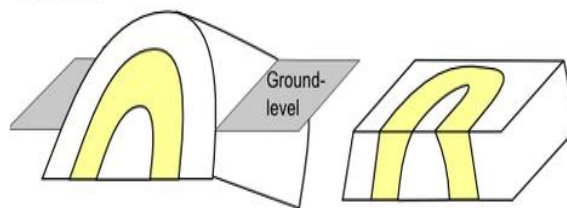
### Asymmetrical folds



### Plunging Folds

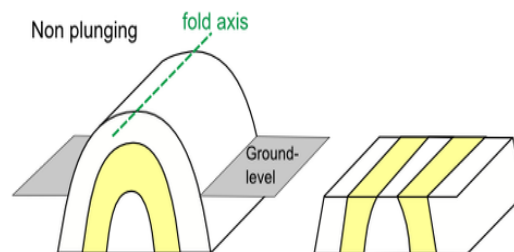
The plunge of a fold has already been described as the inclination of the fold axis to the horizontal plane.

#### Plunging



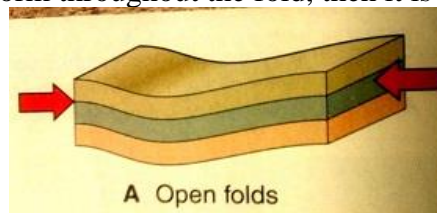
### Non Plunging Folds

Based on whether the axis of fold is inclined or horizontal, the folds are grouped as plunging folds or non plunging folds



### Open Folds

If the thickness of bed is uniform throughout the fold, then it is called as open fold.

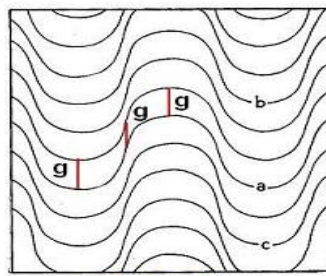


### Closed Folds

If the beds are thinner in limb portions and thicker at crests and troughs, such folds are called closed folds.

### Similar Folds

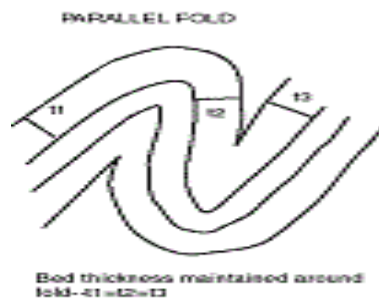
In similar folds the shape or pattern of folds remains the same at depths also.



Similar folds

### Parallel Folds

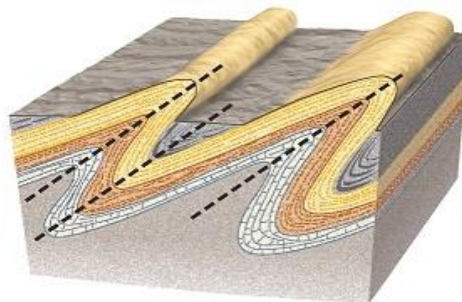
The crest and trough become pointed or angular.



### Over Turned Folds

When one of the limbs is overturned the order of superposition of beds in that limb will be in reverse order and such a fold is called over turned fold.

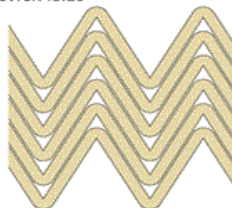
Overturned folds



### Chevron Folds

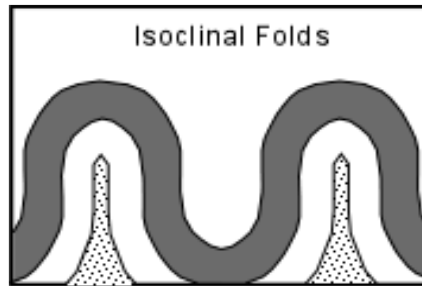
The crest and troughs of beds are smooth curved. But some folds have sharply bent angular crests and troughs, such folds are called chevron folds.

(b) Chevron folds



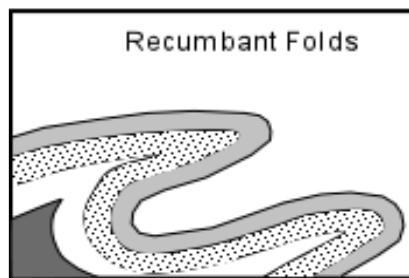
### Isoclinal Folds

The folds are inclined limbs. The limbs are mutually diverging or converging with reference to axial planes but in some folds, the limbs will mutually parallel to a great extent such folds are called Isoclinal folds.



#### Recumbent folds

These folds are vertical, inclined or horizontal. The horizontal isoclinic fold is called recumbent folds.

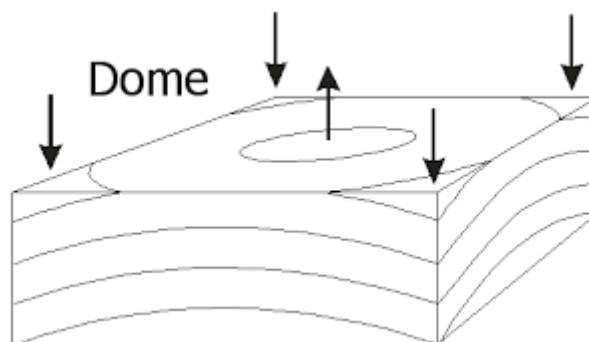


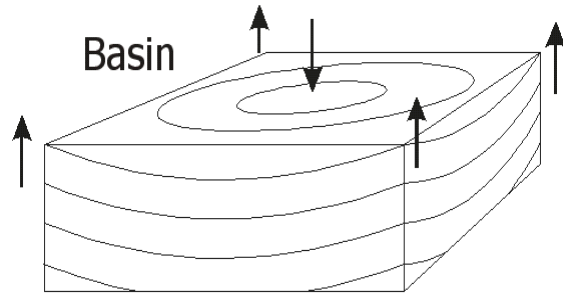
#### Fan Folds

In fan folds the limbs dip towards each with reference to their axial plane.

#### Domes and basins

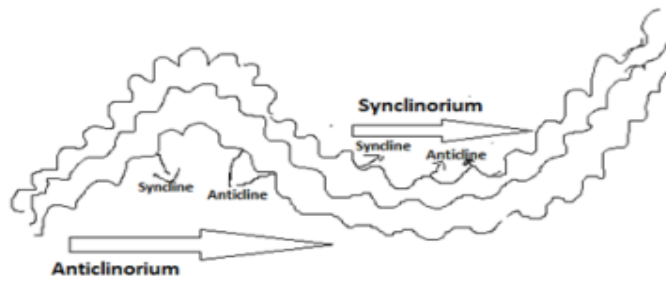
In dome which resembles on upper hemisphere the dips are found in all sides from common central top point. In basin which is like a bowl, the slopes are just opposite dips are found towards a common central bottom point from all sides.





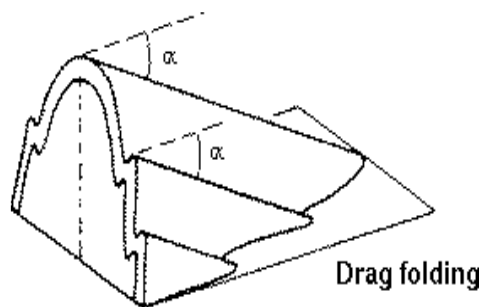
### Anticlinorium And Synclinorium

When the limbs of folds are not plain but characterized by the appearance of other minor folds on them the major folds are called anticlinorium and synclinorium.



### Drag Folds

These are minor asymmetrical folds with in major folds but confined only to incompetent beds, which are sandwiched between competent formations.



## FAULTS

Faults are most unfavorable and undesirable geological structures at the site for any given purpose i.e, for location of reservoirs and foundation site for dams and bridges.

## TYPES:

1) Type of displacement along the fault plane:

Based on this the faults are divided into transitional fault and rotational fault.

### TRANSITIONAL:

The type of displacement of the foot wall with reference to the hanging wall is uniform along the fault plane.

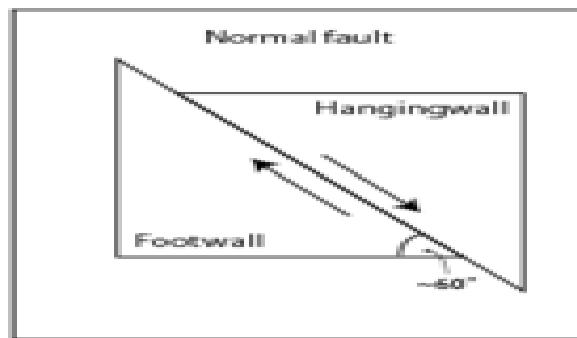
### ROTATIONAL:

It varies from place to place the displacement gradually increases or decreases. In these the foot wall and hanging wall appear to be hinged.

## 2) ROTATIVE MOMENT OF FOOT WALL AND HANGING WALL:

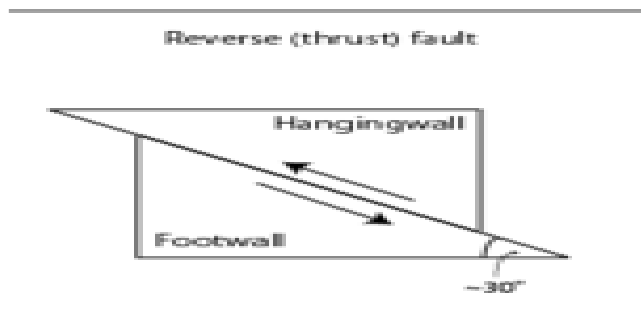
### NORMAL FAULTS:

If the hanging wall goes down with reference to the foot wall it is called normal fault.



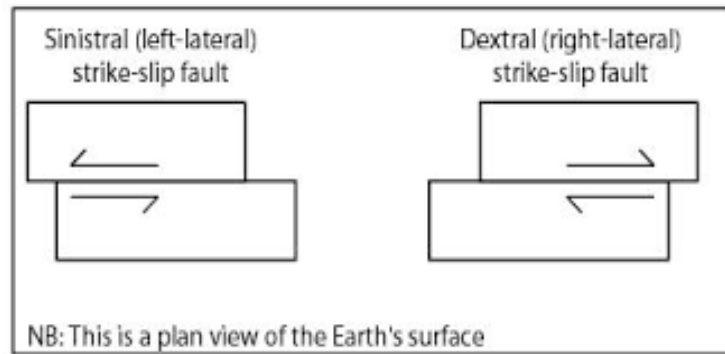
### REVERSE FAULT:

If the kind of relative displacement of the hanging wall is opposite to this the fault is called reverse fault.



### DEXTRAL FAULTS OR SINISTRAL FAULTS:

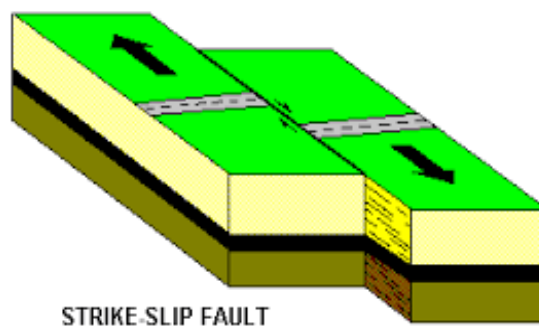
If the relative displacement of the hanging wall is neither upwards nor downwards with reference to the inclined fault plane, but side wards then such faults are described as dextral or sinisterly faults.



### 3) TYPE OF SLIP INVOLVED:

#### STRIKE SLIP FAULT:

If the displacement is only along the strike direction of the plane such a fault is described as strike slip fault.



#### DIP SLIP FAULT:

If the displacement is completely along dip direction of the plane, it is called Dip slip fault.





#### OBLIQUE SLIP FAULT:

The displacement occurs partly along the strike direction and partly along the dip direction.



#### 4) MUTUAL RELATIONSHIP OF ATTITUDES OF FAULT PLANE & ADJACENT BEDS:

##### STRIKE FAULT:

The strike direction of the fault plane and that of adjacent bed are same.

##### DIP FAULT:

The strike direction of fault plane is parallel to the true dip direction of the adjacent strata such fault is described as dip fault.

##### OBLIQUE FAULT:

The strike direction of the dip direction of adjacent beds the fault is called oblique fault.

##### BEDDING FAULT:

If a plane is parallel to the fault is called bedding fault.

#### 5) INCLINATION OF FAULT PLANE:

##### HIGH ANGLE FAULTS AND LOW ANGLE FAULTS:

This is a simple classification which takes in to account the dip amount of the fault plane. If it is steep more than 45 degrees, the fault is called high angle fault and if it is gently sloping < 45 degree, then it is called low angle fault.

#### 6) MODE OF OCCURRENCE:

##### RADIAL FAULTS:

When a set of faults occur on the surface and appear to be radiating from a common point, then it is radial fault.

##### ENCHELON FAULTS:

These refer to a series of minor faults which appears to be overlapping one another.

##### ARCUATE OR PERIPHERAL FAULTS:

These also refer to a set of relatively minor faults. Which have curved out crops and arranged in a peripheral manner enclosing more or less a circular area.

##### MISCELLANEOUS:

##### STEP FAULTS:

When a set of parallel faults occur at regular intervals they give a step like appearance and are called step faults.

#### PARALLEL FAULTS:

As the name indicates these are a set of parallel normal faults with strike and dip.

#### HORSTS AND GARDENS:

When normal faults with mutually diverging or converging fault planes occur then a few wedge shaped blocks called “horsts” are displayed upwards and few others are called “gardens” are displayed downwards.

Experiment no. \_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## Demo of Resistivity Meter for geophysical measurements

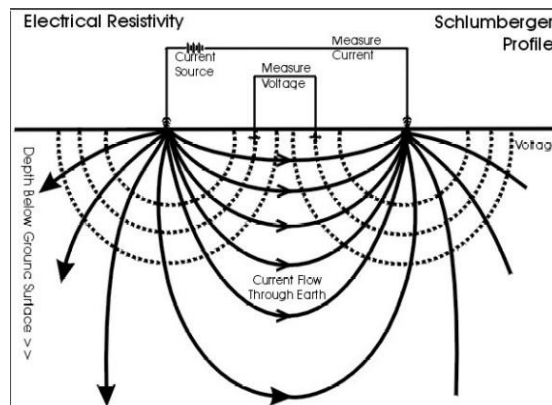
AIM: To identify the type of rocks and to determine the bed rock depth.

APPARATUS: Direct reading digital resistivity meter stainless steel electrodes, potential electrodes, field cables, empty winches, D. C – power source.

This soil exploration is based on the principal that each soil has different electrical resistivity depending upon the type of soil. It's water content, compaction and composition. Thus saturated soil has tower electrical resistivity as compared to loose dry gravel or solid rock.

In this method 4 electrodes are driven into the ground at equal distances apart and in a straight line the distance between two electrodes being the depth of exploration are driven up to which the ground resistance is to be measured. Current is passed between the two outer electrodes and the potential drop between inner electrodes is measured by using the formula

$$\rho = 2\pi A (E/I)$$



- Where  $\rho$  = Mean resistivity (Ohm cm).  
D = Distance between electrodes (Cm)  
E = potential drop between electrodes (Volts)  
I = current flow between outer electrodes (Amp)

Average values of resistivity for various types of soils have already been established based on tests. Thus, on knowing the value of changing mean resistivity of sub soil at sight. It is possible to establish the nature & distribution of different types of soils in the formation.

RESULT: The mean resistivity is  $\rho = \dots\dots\dots$  Ohm.m

Experiment no. \_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## **Georeferencing of SOI Toposheet**

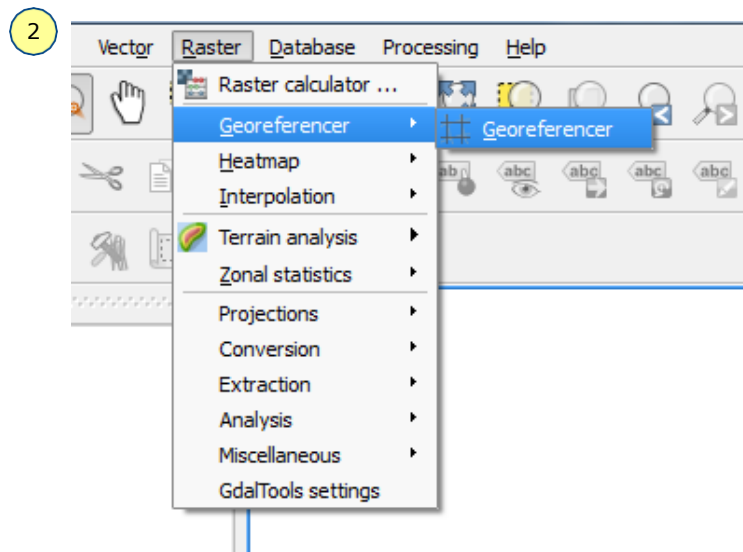
**Objective:** To georeference a toposheet by using graticule intersections in a known coordinate system and datum.

### **Introduction**

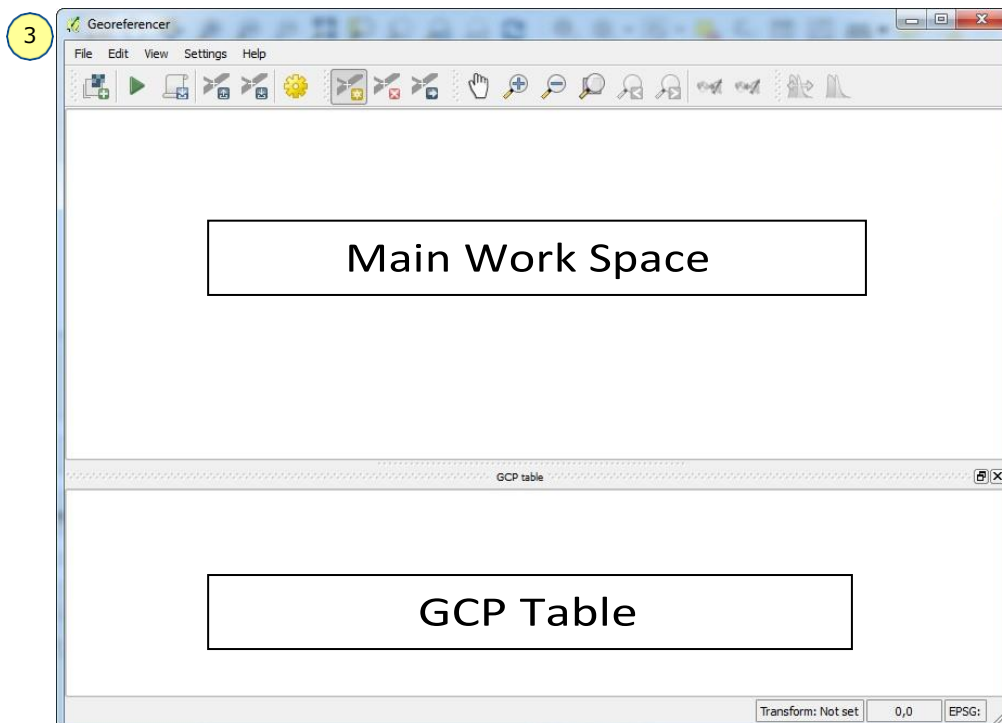
Georeferencing is a process of establishing a mathematical relationship between the image coordinate system and the real world spatial coordinate system. This mathematical relationship can be assigned by any one of the transformation settings, viz. Polynomial order 1, 2 or 3, Linear, Projective and Thin Plate Spline etc. Polynomial order 2 is the most widely used transformation in Georeferencing. Recently Thin plate Spline gaining popularity due its ability of incorporating the local deformations in the data, this is very useful when we are dealing with low resolution data. However in this practical we are using traditional polynomial order 2 transformation to perform georeferencing/rectification of the Toposheet.

In this exercise, we will use a topographic Map of South Pune, prepared by Institute of Environment Education and Research(IEER), Bharati Vidyapeeth University(BVU), Pune. This map is in the Universal Transverse Mercator(UTM) projection based on WGS 84 Datum.

1. First, we open Quantum GIS (QGIS) via the Start menu. (Start → All Programs → QGIS → QGIS Desktop)
2. We then open QGIS Georeferencer via the menu bar. (Raster → Georeferencer → Georeferencer).



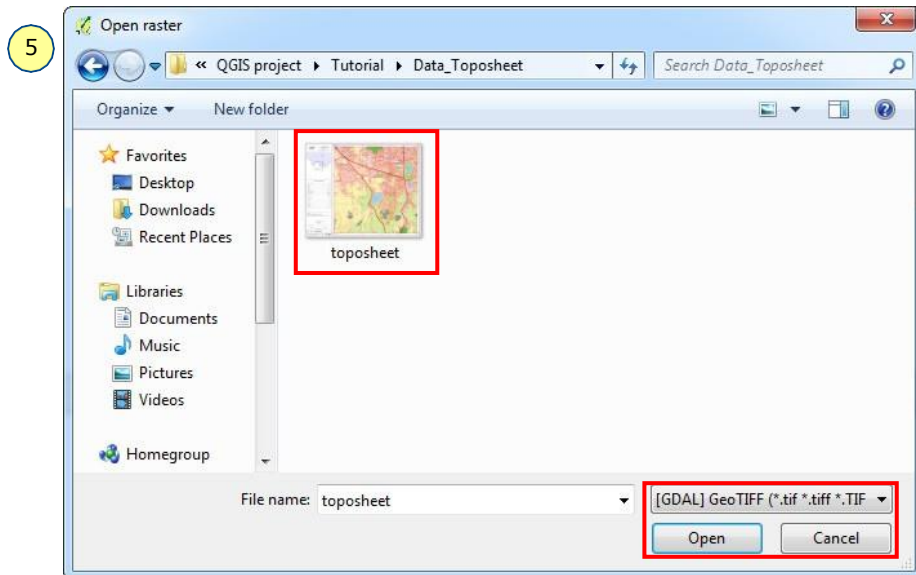
3. The Georeferencer is in the form of a window with two parts to it. The upper part is called as 'Main Work Space' dedicated to display the Raster Map to be georeferenced and it allows the user to input the geographic or projected coordinates of control points. The lower part, titled 'GCP table', is where the Ground Control Point data and residuals will be displayed.



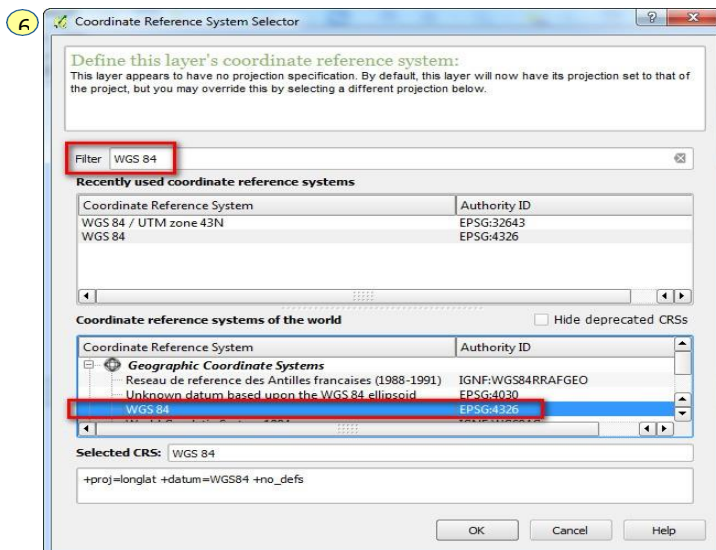
4. Add the toposheet to the Georeferencer by clicking on the 'Open

*Raster*' button or from the *File* menu (*File* → *Open Raster*).

5. You will then be presented with a popup window, navigate to the tutorial data folder in which the '*toposheet.tif*' file is kept. Click on the drop down menu right to the '*File name*' and select '*[GDAL] GeoTIFF (\*.tif \*.tiff \*.TIF)*'. Now select the '*toposheet.tif*' and click '*Open*'.



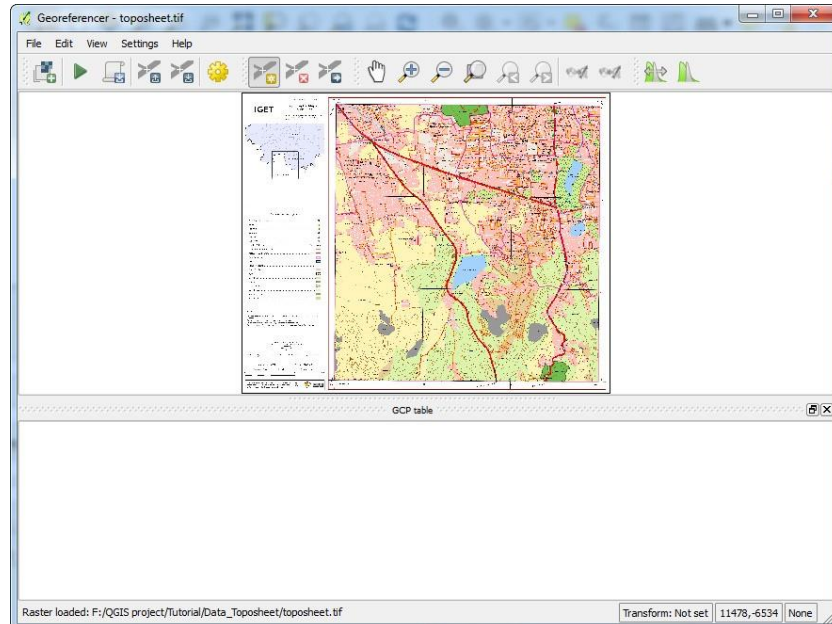
6. You will then be presented with the '*Coordinate Reference System Selector*' window, from which we will select the '*WGS 84*' under *Coordinate reference system of the world* section.





Tip: Type in 'WGS 84' in the filter space as shown in above picture. This will

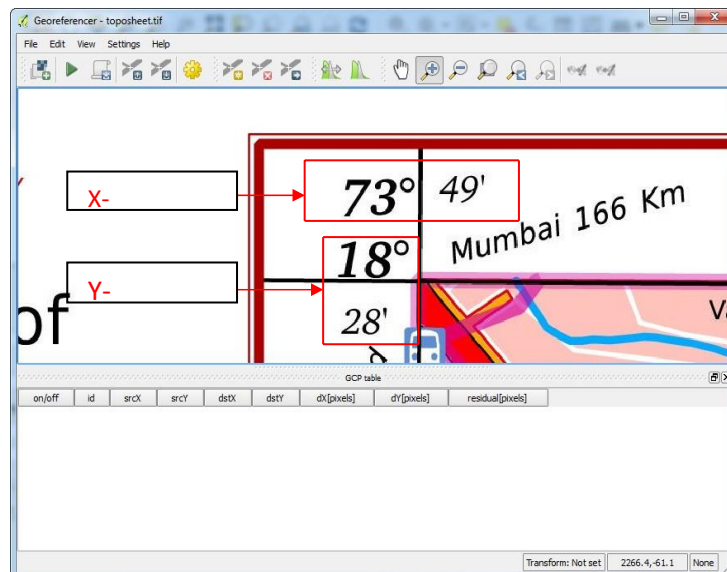
bring up all the CRS using WGS 84 ellipsoid.

7. The toposheet will be loaded in the Georeferencer window and should look like below

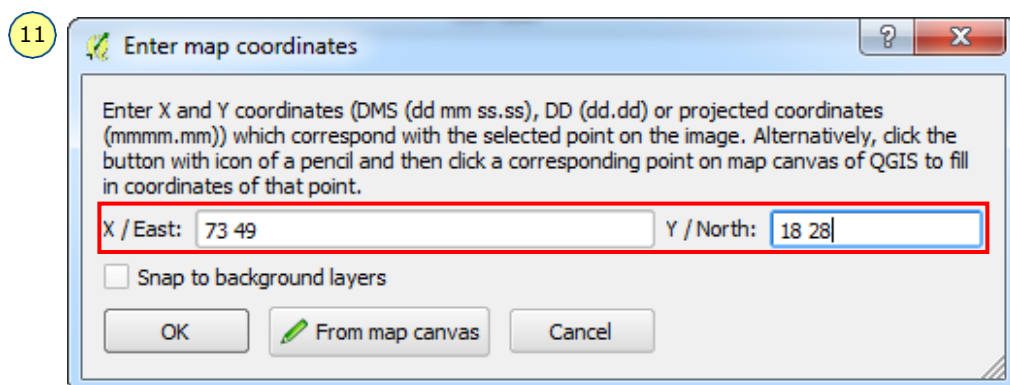


8. To georeference an image we use Ground Control Points (GCPs). GCP is a location on the earth's surface with known coordinates on both earth and Toposheet/ imagery, i.e., geographic and pixel coordinates respectively. In this tutorial we use graticule intersections as GCPs.
9. To start adding GCPs to our map, we first zoom to a corner of the map where we can easily identify the intersection of the latitude and longitude. Use the scroll wheel of the mouse to zoom in and out of the map. Use the  'Pan' Button when needed.
10. To add a GCP click on the  'Add point' button, or go via the menu (*Edit* → *Add Point*). The mouse will transform into a '+' sign, which we use to click on the centre of the intersection. Use 'View tool' when needed.






11. A window 'Enter map coordinates' will pop up where we enter the coordinates of the point which we take from the map. Always enter 'Longitude or Easting' in X field and 'Latitude or Northing' in Y field. Use 'space bar' in the key board to separate the Degree value from Minutes value and then click 'OK'.

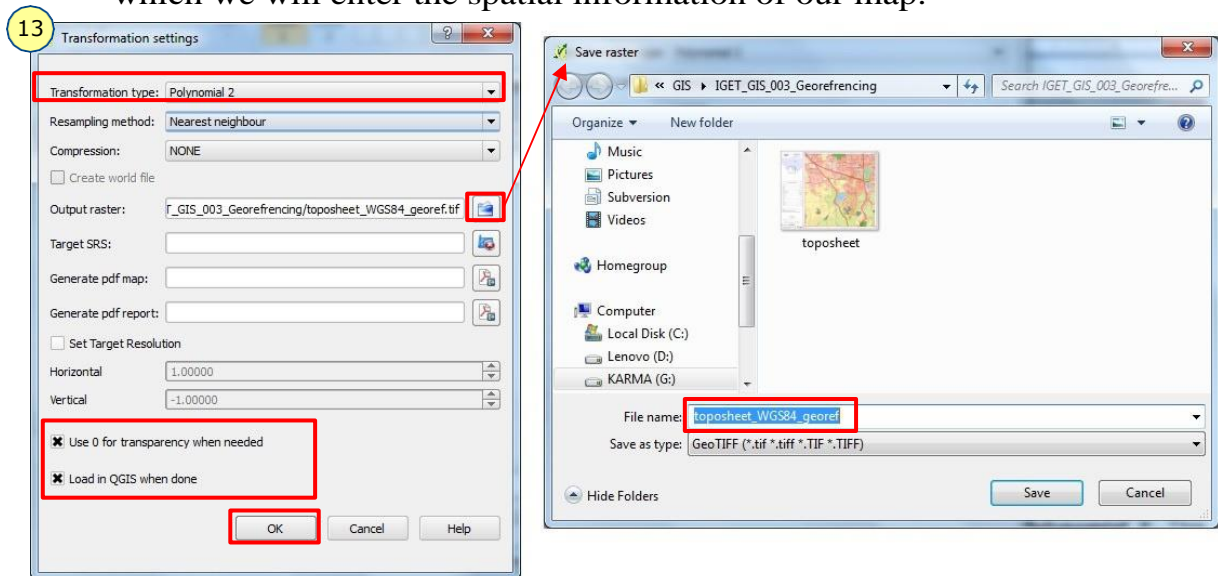


12. In this exercise we are using the '*Polynomial 2*' transformation to georeference the image. For the '*Polynomial 2*' transformation we will require minimum 6+1(for check) i.e., 4 GCPs or more GCPs on the map.




Therefore, we need to mark at least 4 GCPs. The GCPs locations should be spread out as much as possible and they should not be co-linear at the same time they should enclose our whole area. Use the above procedure to mark six more central points.

13. We now set the spatial reference settings for the toposheet by clicking on the  'Transformation Settings' button. The 'Transformation Settings' window pops up in which we will enter the spatial information of our map.



14. Click on the 'Transformation type' drop-down menu and select 'Polynomial 2'. This means we will be using a second order polynomial transformation.

15. Click on the  button next to 'Output Raster'. A dialogue box will appear in which we enter the name of our output file. It is recommended to include the name of the original file in this file for example 'Toposheet\_WGS84\_georef.tif', This helps us to keep track of our work.

16. 'Check' the check box 'Load in QGIS when done' and 'Use 0 for transparency when needed', leave the reset of the values as default and click 'OK'.



17. After Click 'OK', the last column 'residual [pixels]' displays some values. These are the error values associated with the GCPs. An error value of 1 or less would be satisfactory.


17

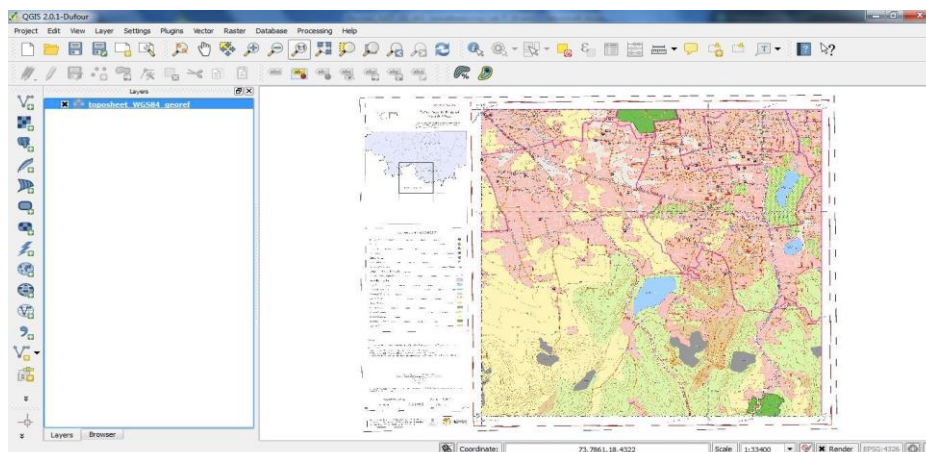
on/off	id	srcX	srcY	dstX	dstY	dX[pixels]	dY[pixels]	residual[pixels]
<input checked="" type="checkbox"/>	0	2239.98	-274.97	73.82	18.47	0.01	-0.00	0.01
<input checked="" type="checkbox"/>	1	8479.98	-315.04	73.87	18.47	-0.06	-0.10	0.11
<input checked="" type="checkbox"/>	2	8439.00	-6853.96	73.87	18.42	-0.01	0.00	0.01
<input checked="" type="checkbox"/>	3	2197.00	-6813.99	73.82	18.42	0.06	0.10	0.11
<input checked="" type="checkbox"/>	4	4306.02	-2467.98	73.83	18.45	-0.05	0.02	0.05
<input checked="" type="checkbox"/>	5	6385.97	-2481.03	73.85	18.45	0.20	0.28	0.35
<input checked="" type="checkbox"/>	6	4292.03	-4648.00	73.83	18.43	-0.14	-0.30	0.34

Transform: Polynomial 2 Mean error: 0.510613 4285.50,-4650.05 None

18. Double check and adjust the GCP locations if the value is greater than

1. To adjust a point click on the 'Move  GCP Point' button, and then click and drag the point to the desired location. Use  'Delete Point' button to delete an erroneous GCP. We can also enable and disable the GCPs by using check boxes under 'on/off' column in 'GCP Table'.

19. Once the error is around or below 1, click the  'Start Georeferencing' Button. The processing will take at about 2 minutes. The georeferenced image will be found at the location specified for the 'Output File' in step 15. You can also notice, the out put file loaded in QGIS canvas.



20. It is useful to save the GCPs for later use if the georeferencing needs to be done again, or if corrections are required. To save them, click on the



'*Save GCPs as*' button. In the pop up window enter an appropriate name for the GCP file, preferably the same

as that of the image. This file can be loaded later on by clicking on the



'*Load GCP points*' button in 'Georeferencer' window after adding toposheet, and selecting it from the pop up window.

Experiment no.\_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## Supervised Classification of a satellite image

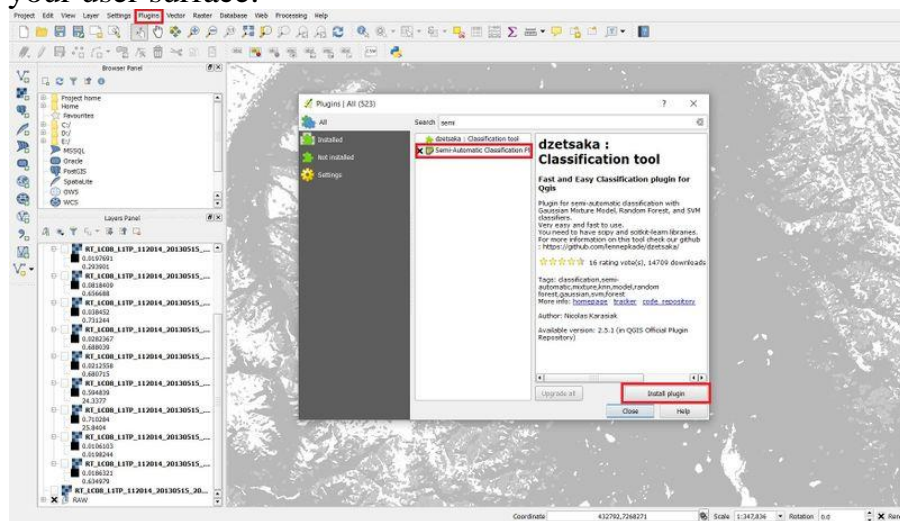
Objective: To perform Supervised Classification of a satellite image using Quantum GIS.

### Introduction

Every day thousands of satellite images are taken. To work with these images they need to be processed, e.g. they need to be classified. Since Remote Sensing software can be very expensive this tutorial will provide an open-source alternative: the Semi-automatic-classification plugin (SCP) in QGIS. The tutorial is going through a basic supervised land-cover classification with Sentinel-2 data. It is one suggestion to use the SCP. After running through the following workflow you will know the SCP better and you will be able to discover more opportunities to work with remote-sensing Data in QGIS.

### Process

After installing the software the Semi-automatic classification Plugin (SCP) must be installed into QGIS. Navigate to the menu at the top to Plugin and select Manage and Install Plugins. Following the picture, the SCP can be found while typing "semi" in the search bar. Click install plugin and now you should be able to see the SCP Dock at the right or left side of your user surface.

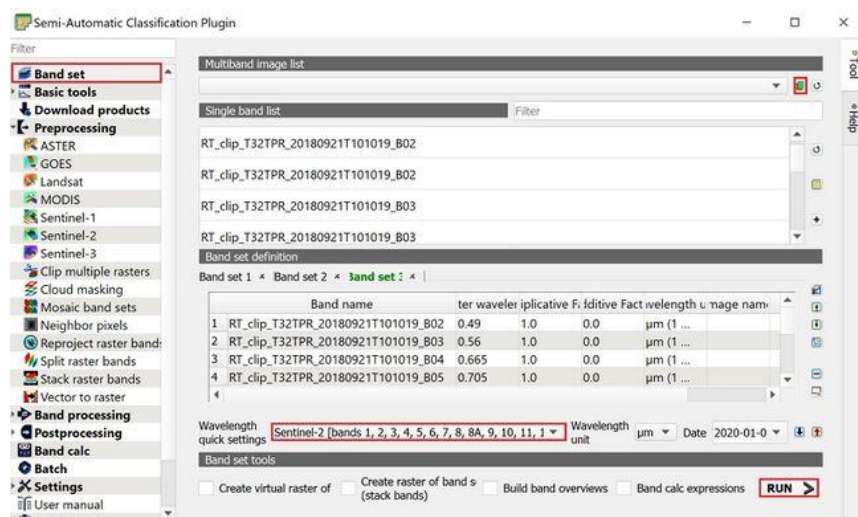


### Load the Data into QGIS and Preprocess it

To load the data into QGIS navigate to Layer at the top your user surface. Choose Add Layer, and then Add Raster Layer.... You should see the Data Source Manager now. Leave "File" selected like it is in default. Under Datasets you can navigate to the directory described above where you find the imageries. Make sure to load all JPEG files into QGIS except the file of band 10: T32TPR\_20180921T101019\_B10. Band 10 is the Cirrus band and is not needed for this approach.

## Creating a Band set

The next step is to create a band set. Navigate to the SCP button at the top of the user surface and select Band set. Under Multiband image list you can load the images into SCP and then into the Band Set 1. Select Sentinel-2 under Quick wavelength units. As you can see, the layers are seen under Band Set 1 (e.g. Band 2 - Blue (10 m)). Make sure the bands are in the right order and ascending. The picture below should help to understand these steps.



If you do not want to see a grayscale image navigate to the SCP toolbar at the top of your surface to RGB and choose 4-3-2 to see a composite image. Additionally you can also create a virtual raster layer by selecting at the top of your toolbar Raster → Miscellaneous → Build Virtual Raster.... Once the tool is open select bands 2, 3, and 4 under Input layers click OK and select the Place each input file into a separate band box then click Run. Next, double click on the Virtual layer you just created to open up the Symbology tab and for the Red, Green, and Blue bands select bands 3, 2, 1 respectfully.

Note: bands 2, 3, and 4, (blue, green, and red) change to bands 1, 2, and 3 in the virtual raster layer.

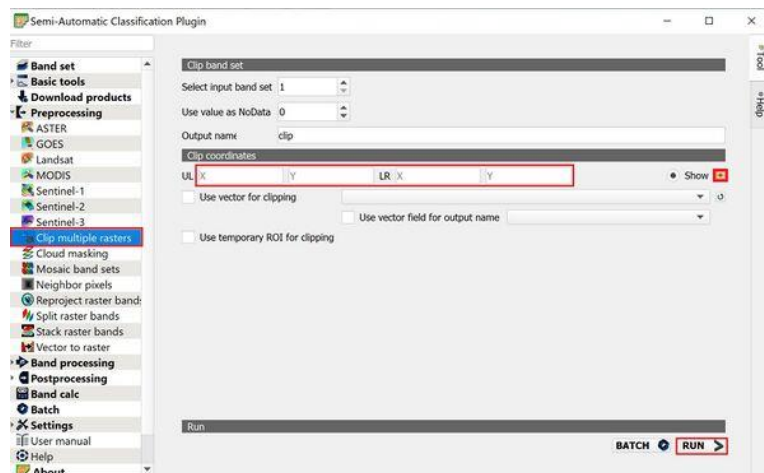


Note: You should deselect all the layers besides the virtual layer you created to speed up the various processes that will be done in the next steps.

## Clip the Data

Since the area of the picture is very large it is reasonable to work with just a section of the image. Therefore, the SCP allows us to clip the data and only work with a part of the picture. Navigate to the SCP button at the top of the user surface, under Preprocessing you find clip multiple Raster. Your surface should look similar like in the picture below. Choose Band set 1 which you defined in the previous step.





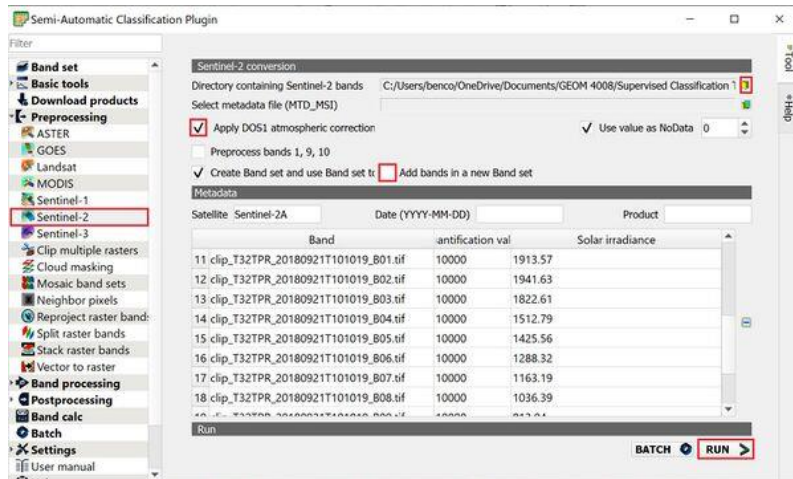
To clip the data press the orange button with the plus. Minimize the SCP window and you can now define the area you want to work with while clicking with the right button on your mouse or by manually entering the UL (upper left) and LR (lower right) coordinates of the desired clip area. I suggest defining an area south of the mountains to avoid dealing with mountain shadows in the classification. In addition, in the south of the picture, the scenery is cloud-free. For instance, choose an area like this:



After defining the section, under Clip coordinates there should be coordinates for the area you just defined. Click run and define an output folder. In the Layer Dock, for each Band (1-9,11,12) a separate resized Raster Layer occurs. Once your clip layers have been created, you may remove the original band layers to free up some space in your layers legend.

## Automatic Conversion to Surface Reflection

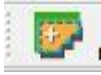
The last preprocessing step is to run an atmospheric correction. Go to SCP, Preprocessing, Sentinel-2 and choose the directory where you saved the clipped data. Check Apply DOS1 atmospheric correction and uncheck Add bands in a new bandset as you will only need to update the current bands you have, and not create new ones. The solar radiance should be recognized automatically. Click run and define an output folder.



The output files will be named e.g. like this: RT\_clip\_T32TPR\_20180921T101019\_B03.

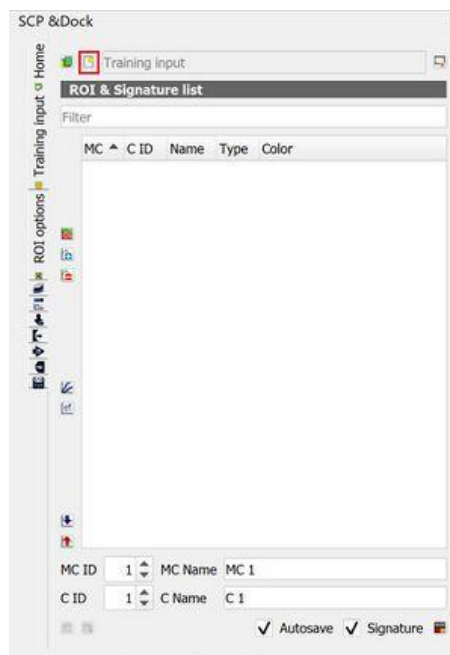
### Supervised Classification

We can now begin with the supervised classification. Make sure you see the SCP &

Dock at your surface. If not, clicking this button  in the toolbar will open it.

### Set Region of Interests (ROI)

First, you must create a file where the ROIs can be saved. To do so, click Training input then this button:

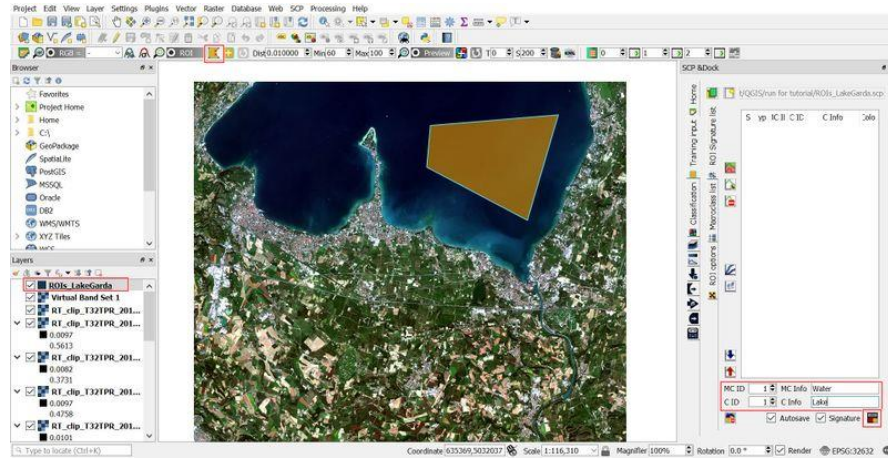


Click the Create a ROI button to create the first ROI. You can define the ROI with mouse clicks, to complete it, click right.

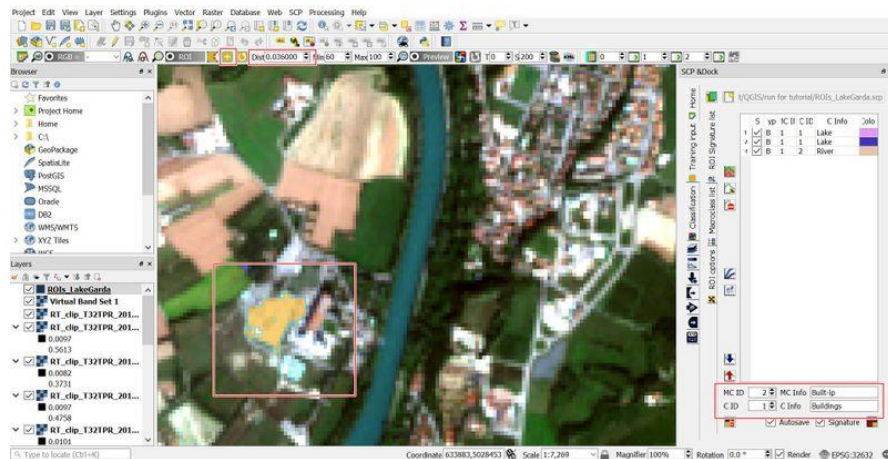


Note: Save often when creating ROI's. This is a time consuming process and if the program were to crash you could loose many minutes of your time.

In the following picture, the first ROI is in the lake. You can see that the macro class (MC ID) is named Water and the subclass (C ID) Lake. Make sure to change the MC ID name when creating ROI's for different land classes. In this tutorial, only the macro classes will be significant, since it is a basic classification with only five different classes. If you want to have more specific classes you can use the subclasses. Save the ROI.

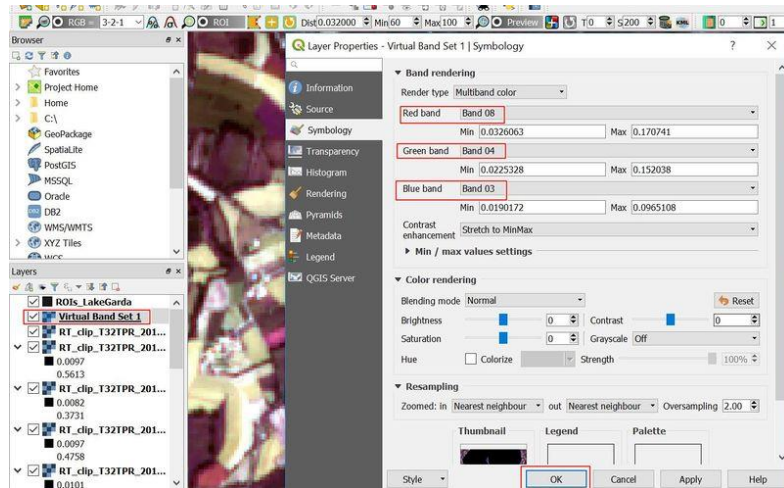


A second option to create a ROI is to activate a ROI pointer. This can be done while clicking the plus in the red box (see the following picture) and defining the radius where the SCP should look for similar pixels. The ROI pointer is fast and works well but you have to be cautious not to include too many unnecessary features. Your ROI could look like this:



In this tutorial, 5 macro classes will be defined: water, agriculture, vegetation, urban, and roads. Since vegetation is reflecting light in NIR (Near infrared), we can visualize it in an image with false colours and therefore distinguish between healthy and unhealthy vegetation. To do so, click right on the layer Virtual Band Set 1 and choose Properties. Define Band 08 (NIR) as red, Band 04 (Red) as green and Band 3 (green) as blue like in the image below.





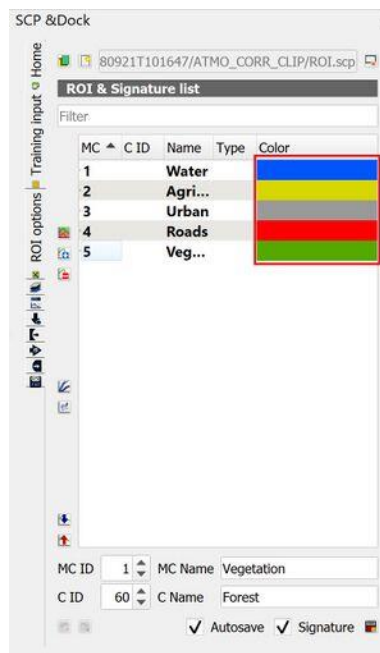
If you look closely at the screenshot below, many of the agricultural fields (bottom centre) have a similar reflectance to the roads and urban environment (turquoise/grey). It is important to create an adequate amount of ROIs for each class to ensure accurate classification.



Keep going setting ROIs for the five classes, you should set at least 10 ROIs per class. Try to be as accurate as possible, to make sure that pixels are assigned to the proper class. In the following picture an example of several ROIs is shown:



Before we run the classification we can change the colours of the macro classes in the SCP Dock. You can collapse the classes by double-clicking on their names then by double-clicking on the colour fields to change their colours.

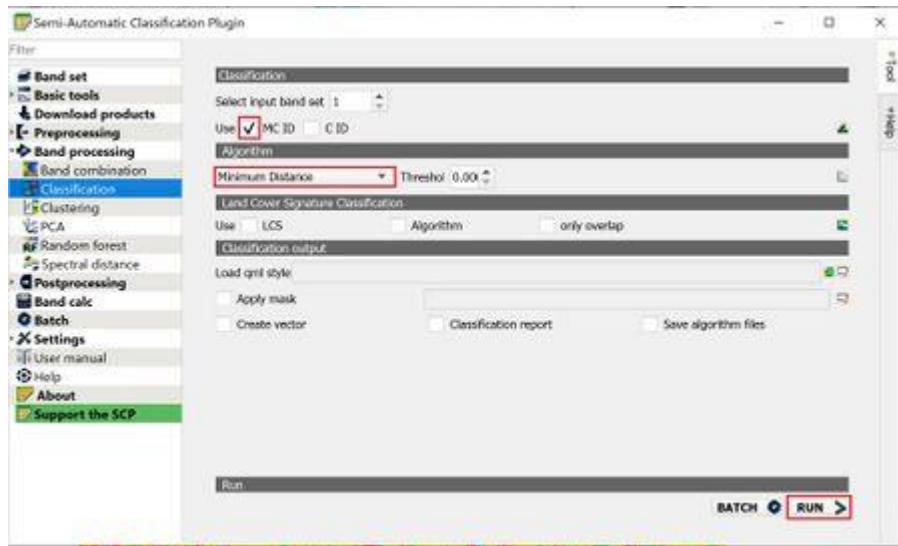


Choose an appropriate colour for every class.

### Running the classification

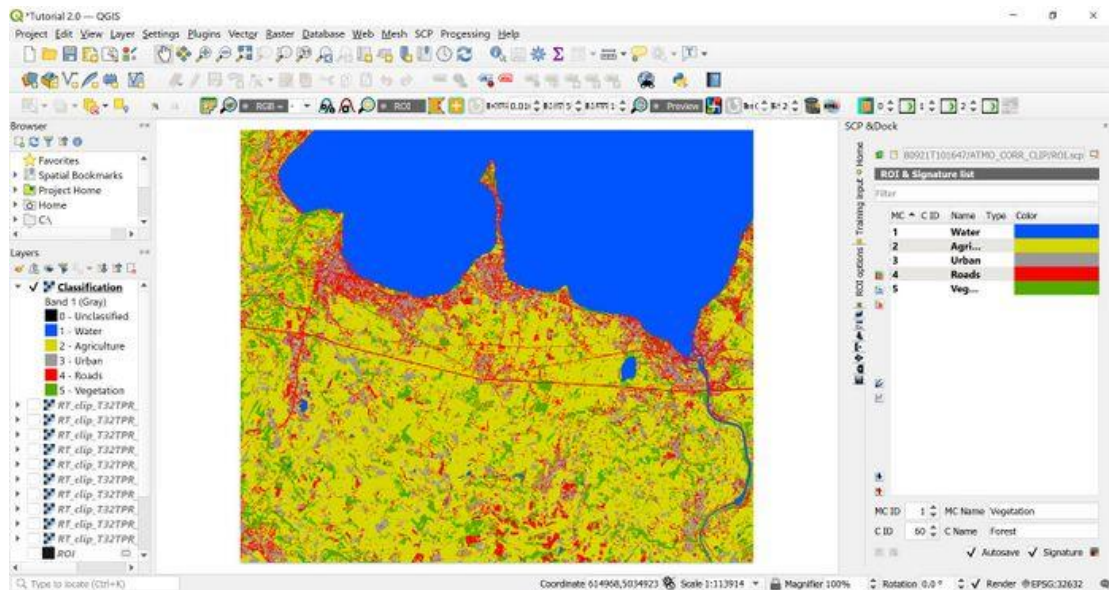
Now go to the Classification tab in the SCP window under Band processing. You will notice that there are various options to run the classification. For instance, there are different classification algorithms: Minimum Distance, Maximum Likelihood or Spectral Angle Mapper. Feel free to try all three of them. It always depends on the approach and the data which algorithm works the best. If you check LCS, the Landcover Signature classification algorithm will be used. If you uncheck it, the chosen algorithm above will be

used. In the classification of this tutorial, the Minimum Distance Algorithm and Spectral Angle Mapping came out as the best classification algorithms.



Check MC ID to use the macro classes and uncheck LCS. Click run and save the classification in your desired directory. If areas occur unclassified go back and set more ROIs.

The output can look like this:



Experiment no.\_\_\_\_

Date: \_\_/\_\_/\_\_\_\_

## **Creating layers in a GIS and digitizing scanned images.**

Objective: To digitize (Vectorization) a toposheet using Quantum GIS.

### **Introduction**

Digitization is the process of converting analog data into digital data sets. In GIS context digitization refers to creating vector datasets viz., point, line or polygon from raster datasets. It is a way of tracing/recording geographic features in vector format from georeferenced images or maps. With the help of digitization we can create different set of layers Viz. Rivers, roads, schools, ward boundaries and building blocks from a single map; this process is known as *Vectorization*. Vector data is easy to edit, update and is more accurate as compared to raster data. Vector data is more efficient for GIS analysis. Due to these reasons *Vectorization* is the first step in many GIS projects. However it is a time consuming process and needs a lot of attention to prevent introduction of errors in the datasets. Vector data is mainly of three types

- **Point:** It consists of single points having (X, Y) coordinates, for example lamp posts, bus stops and postbox positions etc.
- **Line:** It consists a series of (X, Y) coordinates in a sequence (from start node to end node with a number of vertices joining these two nodes). For example roads, power lines, ward boundaries and contours etc.
- **Polygon:** It is a series of (X, Y) coordinates in a sequence closing a figure where first and last points are the same. For example lakes, building blocks, village blocks, ward areas and forests etc.

Open the raster layer of georeferenced toposheet or satellite image

click on  icon from the toolbar

browse and select the georeferenced raster layer in tutorial data

Click on ‘Open’ in the popup window.

## Point Layer Creation

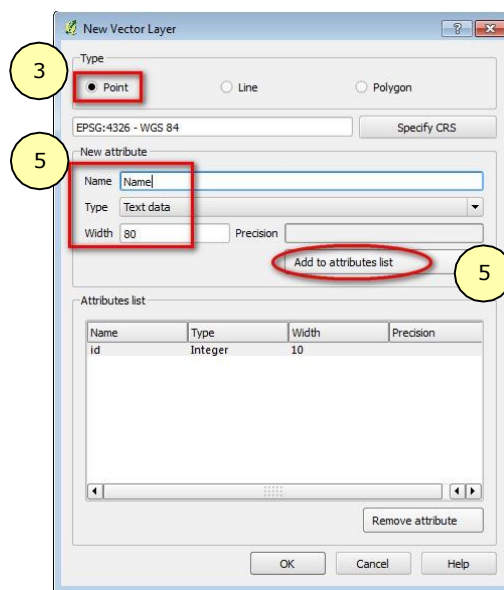
1. To create new point layer, go to main menu bar in QGIS interface and select 'Layer'  
'New'  
'New Shape file Layer'.
2. Now the 'New vector Layer' window will popup. Select 'Type' as 'Point' as we are interested in creating a point layer.
3. Specify CRS same as original layer, i.e., as 'EPSG:4326 - WGS 84'. To do this click on 'Specify CRS'
4. Select the 'WGS 84' under Coordinate reference system of the world and Click on 'OK'



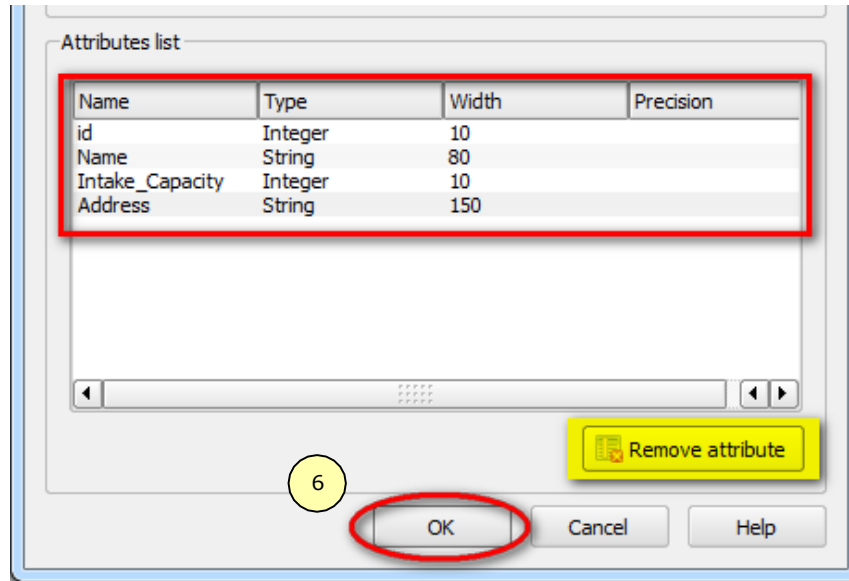
## Adding attribute data in tables and overlaying layers to extract information

Objective: To create attribute data in tables and overlaying layers to extract information.


1. We can add new required attribute fields to the vector layer that we have created. For example if we are creating point vector layer of all hospitals we can add ‘Name’ of the hospital as new field and ‘intake capacity’, ‘Address’ etc. as other fields.

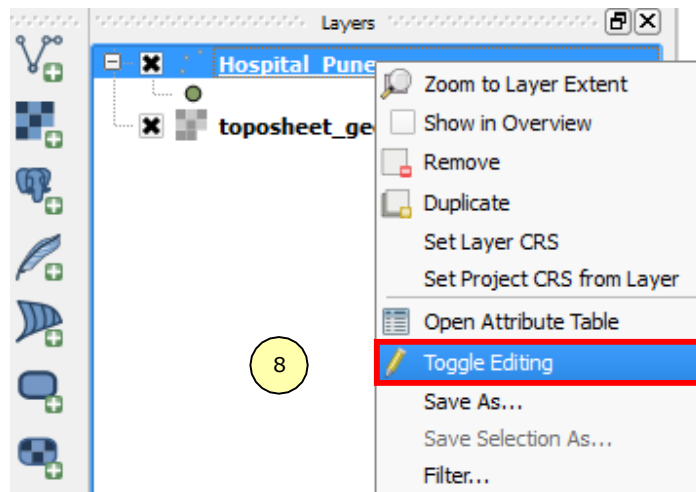


2. For Each New attribute added, an appropriate name, type of the variable (like text, whole number, decimal number and date) and width must be selected. Click on ‘Add to attribute List’ and the attribute will be added to the list. Now add the attributes details shown in the below figure.




\*Note: If you want to remove the added attribute from the list, select the attribute you want to delete and click on 'Remove attribute' in 'New Vector Layer' window.

3. Once the required attributes are added, click on 'OK'.
4. Now you will be presented with 'Save As' window, save the file in appropriate drive with appropriate name for example: Hospitals\_Pune.shp. Once the layer is saved it opens up as point data layer under map legend.
5. To start digitization, we have to enable the editing mode of the corresponding vector layer. Right click on 'Hospital\_Pune.shp' point layer and click on 'Toggle Editing' or select the layer and click on  icon from 'Digitizing1' toolbar.



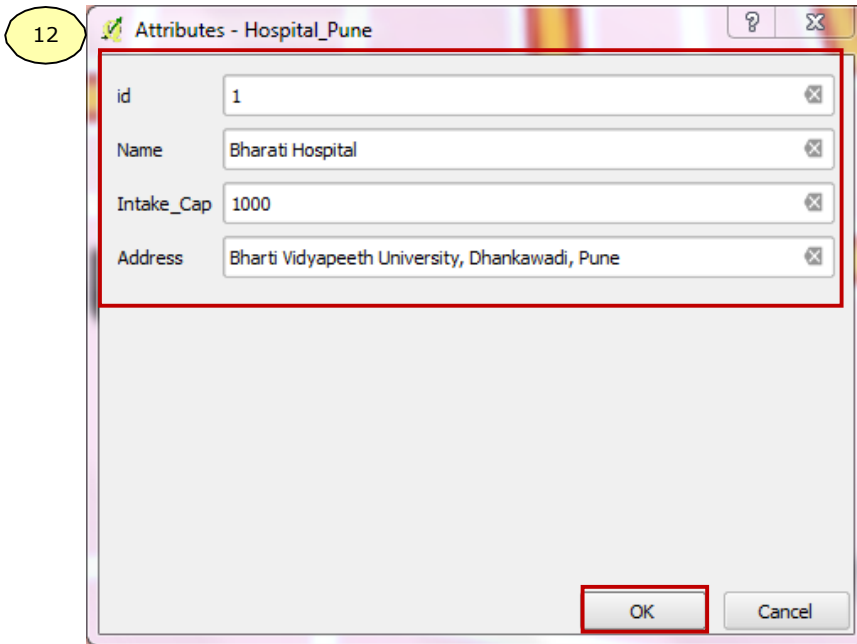
6. You will notice a pencil symbol on left side of the layer name. This tells you that the layer is ready for editing.



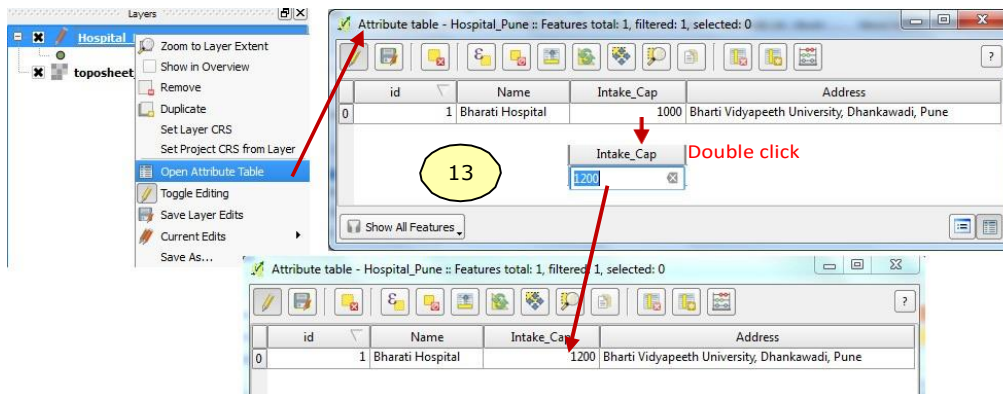
7. Zoom into the toposheet where hospitals are present, the symbol of hospital in the given toposheet is . Click on Add feature icon from digitizing toolbar.


8. Place the pointer at the center of the feature of interest and click.
9. You will be presented with an 'Attributes' window. Fill the required attribute information like 'id', 'Name' and 'Intake\_Cap' (Intake Capacity), 'Address'. Click 'OK'.

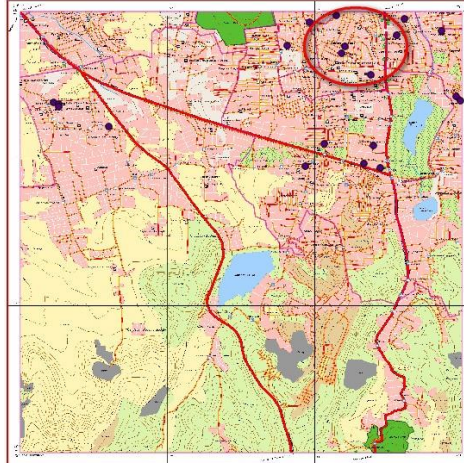




10. The point will be created with the specified attributes at the specified location. Now open the attribute table of 'Hospital\_Pune.shp' by right clicking on the hospital layer and selecting 'Open Attribute Table'. If you want to change any details, then simply select the attribute by double click and edit it. For example change the intake capacity of Bharati Hospital from 1000 to 1200.



11. Similarly digitize the other hospitals in the toposheet. Click on 'Save Layer Edits'  icon in 'Digitizing' tool bar, to save the edits. After saving click once again on the toggle button to stop editing. This will save the point layer along with its attributes.

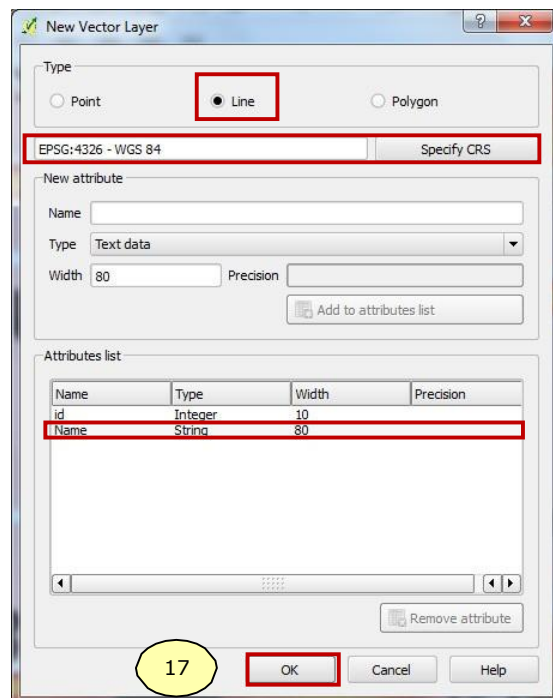




12. Go to attribute table of 'Hospital\_pune.shp' to check if the attributes are added properly or not. If not properly added, edit them as described in step 9.

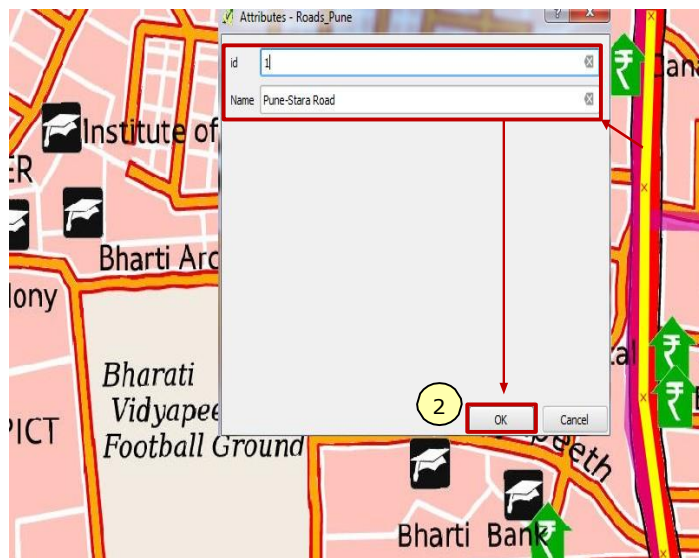
#### Line Layer creation:

Line is basically used to represent any linear network such as road, railways and drainage etc.

13. To create line layer, go to 'Layer' € 'New' € 'New Shapefile Layer'. The 'New vector Layer' window will open up. Select 'Type' as 'Line' as we are interested in creating Line layer of roads and Specify CRS as 'EPSG: 4326 – WGS 84'.

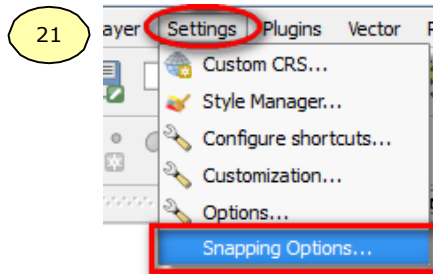


14. Add required attributes, for example 'Name' as shown in above figure and click 'OK'. 'Save As' window will open up. Browse to an appropriate location and give an appropriate name for example 'Roads\_Pune' € click on 'Save'.
15. The layer is created and will be listed in Map legend. Right click on layer, click on 'Toggle Editing' or click on  icon from 'Digitizing' toolbar.
16. Zoom into the toposheet where roads are seen. Click on 'Add feature' icon  from 'Digitizing' toolbar.
17. Now trace cursor along the middle of the road by using left mouse button to insert vertices when you think the road changes its profile, this means you have to insert more vertices while digitizing bends to get smooth curve. When you reach a junction or at the end of the road click on the right mouse button to stop. Now 'Attributes' window will open, fill in the appropriate attributes for example Name is 'Pune-Satara Road' and click 'OK'.

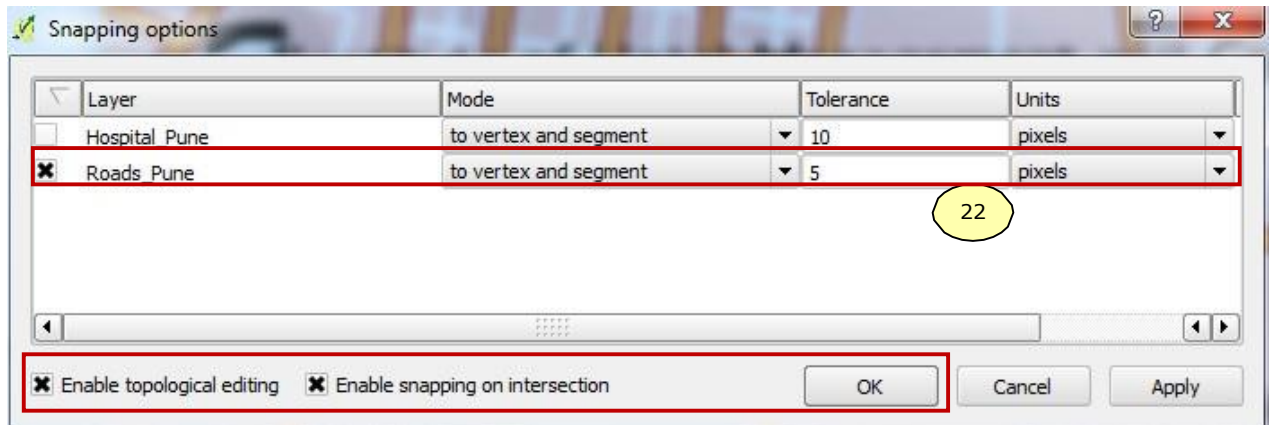


Note: Once you are done with digitizing one road, try and digitize the road network by using the snapping the tool which is very effective and reduces errors like Overshoot and Undershoot. It helps to find out location of one feature in relation to other feature

18. Snapping tolerance can be set manually. Go to 'Settings' 'snapping Options'



19. Check the box to the left side of road network layer and set 'Mode' to 'vertex and segment'. Specify tolerance as '5' pixels. Check on 'Enable topological editing'. And click 'OK'



Note: Figure below shows the use of snapping feature. When a pointer is brought near to the neighboring feature within the tolerance limit the pointer tries to snap to the neighboring feature.



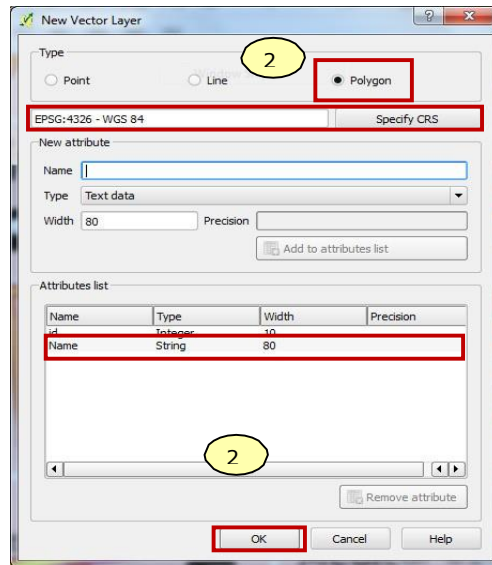
The green cross in the figure shows the snapping tool functionality.

20. So by use of the snapping tool it is possible to get an accurate intersection of roads. Once you finish digitizing all roads in the toposheet save the edits and stop editing by clicking on 'Toggle editing' button. Now the road network along with its attributes will be saved.

Polygon Layer creation:

Polygon is basically used to demarcate areas such as administrative parcels, forests, buildup areas and water bodies etc.

21. To create Polygon layer, go to 'Layer' 'New' then click on 'New Shapefile Layer'. The 'New vector Layer' window will open up. Select 'Type' as 'Polygon' and Specify CRS as 'EPSG: 4326 – WGS 84'.

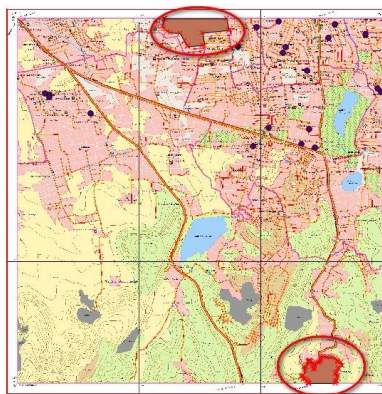


22. Add required attributes for example 'Name' and click 'OK'. 'Save As' window will open up, save the file at appropriate location, for example 'Reserved Forest.shp'.
23. The layer will be created and listed under Map Legend. Right click on layer and click on 'Toggle Editing'.
24. Zoom into the toposheet where Reserve forests (RF) are located. Click on 'Add feature'



icon from digitizing toolbar.

25. Make sure that the snapping option for RF layer and also other required layers consisting of the features that are following RF boundary is also enabled.
26. Start digitizing the reserve forest polygons by using left mouse button to insert vertices and right mouse button to finish. Once you finish digitizing all reserve forest areas, save edits and de-select the 'Toggle editing' button.



### **Feature Identification from Aerial photographs**

Aim : To identify the feature from the given aerial photographs.

Apparatus : Stereo pairs, pencil, scale, tracing paper, double tape.

Procedure :

1. Arrange two given aerial photographs side by side .
2. Mark each corner of two photographs with a pencil on a tracing paper placing on the top of each photograph.
3. Using a scale, draw the two diagonal lines joining the points marked at corner on each tracing paper.
4. Mark the intersection points as Principal points PP1 and PP2 on respective tracing papers.
5. Now identify PP1 feature in second tracing paper as Conjugate Principal point CPP2. And identify PP2 in first tracing paper as CPP1.
6. Now takeoff the tracing paper and move the Aerial photographs right or left until the particular feature is seen as a overlapped image, when seen through stereo pairs.
7. By seeing through stereo pairs, the particular feature will be seen as a 3-d image.

Result : The identification of a feature in Aerial photographs is done.

### Observing depth of field in Stereo pairs

Aim : To findout the depth of the feature/building from the given aerial photographs.

Apparatus : Stereo pairs, pencil, scale, tracing paper, double tape, Parallax bar.

Procedure :

1. Arrange two given aerial photographs side by side .
2. Mark each corner of two photographs with a pencil on a tracing paper placing on the top of each photograph.
3. Using a scale, draw two diagonal lines joining the points marked at corner on each tracing paper.
4. Mark the intersection points as Principal points PP1 and PP2 on respective tracing papers.
5. Now identify PP1 feature in second tracing paper as Conjugate Principal point CPP2. and identify PP2 in first tracing paper as CPP1.
6. Draw a line joining both principal point and conjugate principal point on two tracing papers.
7. The distance between PP1 and CPP1 IS P1. Similarly distance between PP2 and CPP2 is P2.

$$P = P1 + P2 / 2$$

8. Now takeoff the tracing paper and move the Aerial photographs right or left until the particular feature is seen as a overlapped image, when seen through stereo pairs.
9. Now using doubletape, make sure the photographs are not moving.
10. By seeing through stereo pairs the base point and top point of feature from right and left side should be marked as a point.
11. By using Parallax bar, the distance between base of building/feature and top of building/feature should be measured and should be taken as 'dp'.
12. While measuring the distances the mainscale reading should be set as 0 mm.
13. And the Vernier scale reading should be multiplied with 0.01 and the obtained value will be in cm.
14. Atlast, the Depth/Height of feature can be calculated using a formula

$$h = H \times dp / ( P + dp)$$

Result : The depth of feature/ building is calculated using Stereo pairs and the height is .....