FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF MINES AND ENERGY
PROFESSIONALS ADVISORY TASK FORCE

STANDARDS FOR REGIONAL GEOLOGIC MAPPING:

PROCEDURES AND GUIDELINES FOR WORK PROCESSES (PART I)

CONTENT AND DIGITAL ATTRIBUTES FOR PRODUCTS (PARTII)

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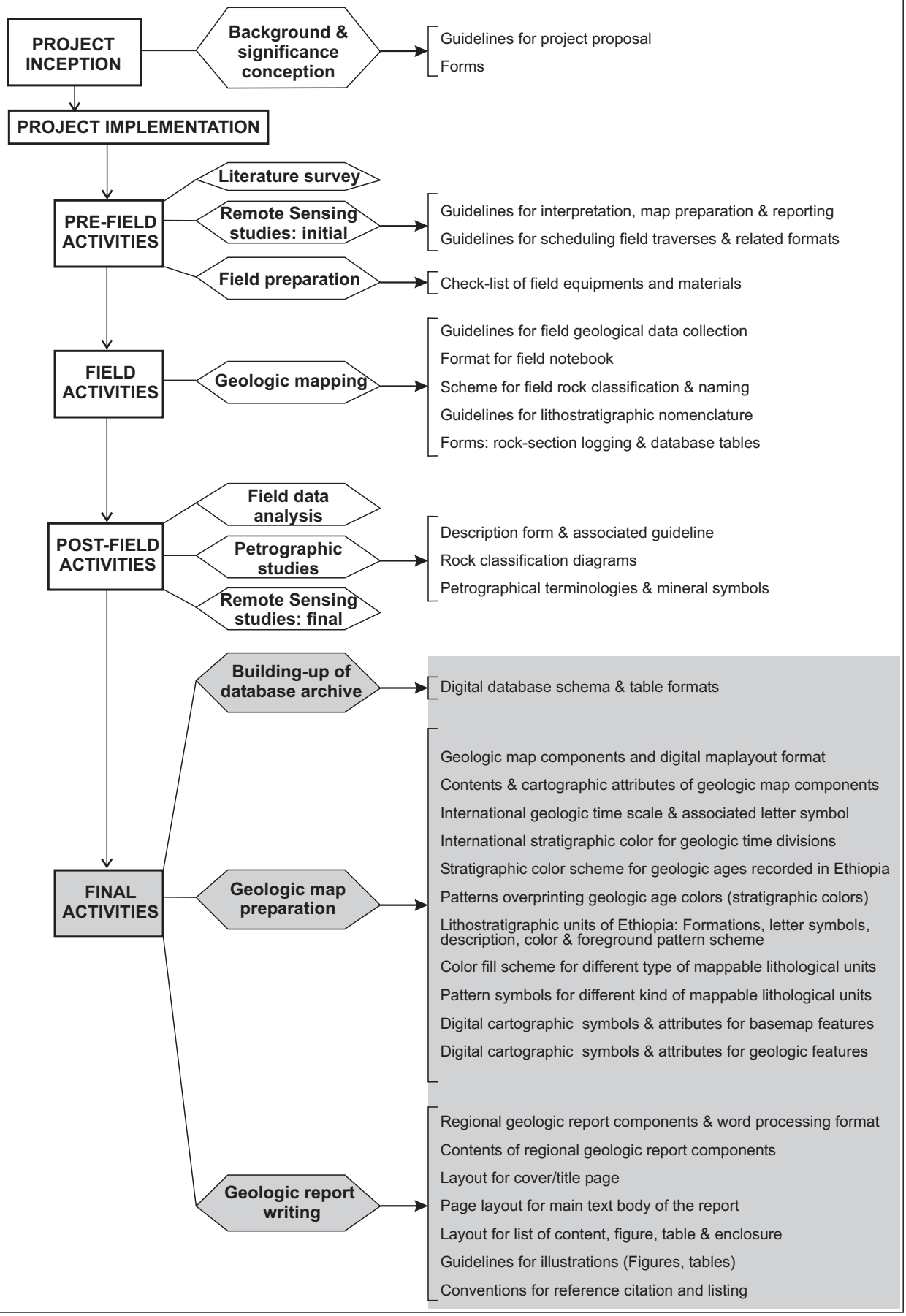
Main activities, technical processes and associated standards for regional geologic mapping project



PART I

STANDARD PROCEDURES AND GUIDELINES FOR REGIONAL GEOLOGIC MAPPING WORK PROCESSES (ACTIVITIES)

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I-1. PROCEDURES AND GUIDELINES IN REMOTE SENSING STUDIES (RS)

Geologic mapping involves remote sensing studies and is conducted repeatedly at the beginning and subsequent stages of the mapping project until a finished geologic map is produced. The study embodies extraction of geologic features through the analysis of images of the earth\s surface acquired by aerial cameras (aerial photographs) or landsat multispectral scanners. The Regional mapping division of the Geological Survey of Ethiopia has so far utilized hard copies of aerial photographs as main image source for its mapping activities. The department now extends the use of digital landsat (ETM +) and digital elevation (DEM/SRTM) data in conjunction with GIS system for facilitating the routine mapping activity and compilation work, and improve regional geologic map coverage of the country. For successful digital remote sensing studies, it is essential to have the required resources, and follow the working steps and guidelines indicated in the respective sections.

Code	Component name /content	Remark
RS-1	**Purposes and advantages of digital remote sensing data**	
1	Identification and mapping of different rock units (Lithostratigraphy)	
2	Marking of regional structural trends (lineaments, faults, foliation, folds and etc)	
3	Tracing of visualized geologic features directly on a computer screen	
4	Navigation during field geologic traverse	
5	Examine and interpret geologic features of large area from a single landsat scene or mosaics in few days	
6	Evaluate the association of morphology & drainage pattern to geologic features	
7	Easy interpretation of geologic features through various image enhancement facilities & 3D visualization of images overlaid on a topographic surface	
RS-2	**Main required inputs**	*DEM = digital elevation model* *ETM + = enhanced thematic mapper plus* *SRTM = Shuttle radar topographic mission*
1	Digital elevation model data (DEM)	
2	Hard copy of topographic maps: 1:50,000 and 1:250,000 scale	
3	Scanned and mosaic of aerial photographs	
4	Processed multispectral digital image (Landsat ETM, three or more bands)	
5	Previous geologic maps and reports on the area/adjacent, and/or the country	
6	Computer with latest advanced technological hardware	
7	GIS application softwares: for image processing, DEM extraction, image interpretation and geologic (vector) map production, etc.	
RS-3	**Preliminary works**	
1	Digitize base map features from topographic maps: Main & subsidiary roads, Major rivers, Places and localities, spot heights, contour lines (50 m interval)	*This involves building up of different databases for easy image interpretation.*
2	Extract geologic features from previous available geologic map: Geologic units, Geologic structures,lithostratigraphy and associated description	
3	Produce physiographic maps from processing of DEM data: Painted relief, Drainage network, Slope, Slope aspect	*The data has to be studied and take summary notes which will be also included in the remote sensing report.*
4	Thoroughly Examine and study the information acquired individually	
5	Make physiographic divisions, produce vector map & write their characteristics	*Proper analysis of physiographic information is essential to delineate structures & extent of lithologies*
6	Identify drainage pattern and note their attributes	
7	Overlay different maps and note important geologic information that may be visualized or observed	

RS-4 **Elements of image interpretation**

Extraction of geologic features from remote sensing imagery is based on visual interpretation and/or automatic processing of image data by the computer. Visual interpretation is the most intuitive way of mapping geologic features from remote sensing images, displayed either on screen or on hard copy. Visualization of different geologic features is achieved by closer inspection of the following image elements.

	Interpretation elements	***General characteristics***
1	*Tone*	*Relative brightness of black and white image and hue for colored pictures in HIS system*
2	*Shape*	*Form also height of an object (in 3D)*
3	*Size*	*Relative dimension of different objects*
4	*Pattern*	*Spatial arrangement of objects and implies characteristic repetition of certain forms or relationships. It can be described as concentric, radial, check board, etc*
5	*Texture*	*Relates to the frequency of tonal change and is expressed as coarse, fine, smooth or rough, even or uneven, mottled, speckled, granular, linear, wooly, etc*
6	*Site*	*Occurrence of an object to a particular easily identifiable feature*
7	*Association*	*Close relationships/links of different or combination of objects.*

I-1. PROCEDURES AND GUIDELINES IN REMOTE SENSING STUDIES (RS) *2 of 2*

Code	Component name /content	Remark
RS-5	**Interpretation and mapping procedure**	
1	Visualize geologic features by employing different functions of image analysis	
2	Note the band combination and GIS image analysis functions, which allows best visualization of geologic features	
3	Note the type and spatial location of geologic features that you may have spontaneously identified/recognized	
4	Note image properties of identified features and establish key properties for identification of other geologic features	*Record image attributes of interpreted geologic features, on the appropriate form*
5	Start actual on screen interpretation of lithologic boundaries and structures, i.e, digitizing identified contacts & geologic structures as line features	
6	Make lithologic polygons from the line features marking lithologic boundary	
7	Complete your map by providing map symbols for the lithologic units & Structural features	
RS-6	**Initial remote sensing map**	
1	Lithologic units	
2	Geologic structures	
3	Geologic cross sections	*Follow standards in part two for the geologic map*
4	Base map features	
5	Selected traverse routes and possible field camping sites	
6	Appropriate stratigraphic legend	
RS-7	**Attributes of Initial remote sensing report**	
1	ABSTRACT a) Location, b) tasks performed, c) Brief list and summary of interpreted geologic units and structures, d) General statement on pre planned field tasks,	*Provide brief idea on importance of the report*
2	OBJECTIVES AND SCOPE a) Statement on objectives and location, b) Materials, methods, techniques employed and time invested, c) General summary of the output and content of the report	*Present clear orientation into different section of the report (Add location map)*
3	BACKGROUND INFORMATION a) Statement on available previous works in the area/adjacent areas, b) Summarized description of lithologic units and structures in the area as identified by early workers or references from country wide geologic maps and reports	*Indicate additional basis of remote sensing interpretation (Add geologic map)*
4	PHYSIOGRAPHY a) Statement on the general morphology, relief and slope gradient, b) Physiographic divisions and their characteristic features, c) Drainage network and type of drainage pattern	*(Add physiographic map)*
5	LITHOLOGIC UNITS a) Brief list of interpreted lithologies, b) Preliminary stratigraphic outline & their position in a geologic time correlated to early works, c) Image and/or other characteristics of remotely sensed lithologic units, d) Distribution and physiographic expressions, e) Relationship among adjacent units	*(Add geologic map, lithology and structure)*
6	STRUCTURAL FEATURES a) General overview of interpreted geologic structures, b) Attributes of the structures, and c) Its influence on the landscape & distribution of lithologic units	
7	PRELIMINARY TRAVERSE ROUTES AND FIELD TASKS a) Summarized overview of the physiography, lithologic units and structures, b) Outline of geologic problem conceptualized/identified in the course of remote sensing study, c) Statement on proposed field traverses & purpose	*(Add traverse route map, and table of preplanned traverses, on the appropriate form)*

I-2. CHECK-LIST OF FIELD EQUIPMENTS, MATERIALS, TOOLS & OTHERS (FE)

1 of 1

Field preparation involves collecting of the necessary instruments, tools, materials and etc, which are listed below. Before departing to the field it is essential to make sure that all required items have been gathered from the appropriate store, section and office.

Code	Component name /content
FE-1	**Professional Instruments/equipment**
1	Geographic positioning system (GPS)
2	Geologic Compass
3	Geologic hammer
4	Hand lens
5	Pocket Stereoscope
6	Table Stereoscope
7	Altimeter
8	Meter tape
9	Photo camera
FE-2	**Base maps**
1	Copies of topographic map of the map sheet, and adjacent sheet at 1:250, 000 scale
2	Copies of topographic maps of the study area, 1:50, 000
3	Aerial photographs covering the map area
4	Copies of interpreted geologic map, 1:100,000 scale
5	Hard copies of remote sensing image/s covering the map area, 1:100,000 scale
FE-3	**Mapping guidelines, forms & supportive items**
1	Standard procedure & guideline for field mapping
2	Standard forms for lithostratigraphic section logging, and field data recording
3	Remote sensing report & pre-planned traverse table
4	Diluted HCL &other chemical stain for field tests
FE-4	**Stationary Materials/items**
1	Field note book
2	Note pad
3	Ball point Pen
4	Pencil/with refill
5	Colored pencil (full set)
6	Eraser
7	Sharpener
8	Marker (water proof)
9	Tracing paper
10	Millimeter paper
11	Typing paper
12	Rapidograph with ink
13	Ruler
14	Masking tape
15	Clipboard
FE-5	**Sampling tools & related items**
1	Sledge hammer
2	Chisel (both flat & sharp tipped)
3	Sample bag
4	Rack sack
FE-6	**Logistics and related materials/tools**
1	Four wheel Drive car
2	Fuel/copoun
3	Empty barrel
4	Shovel
5	Mattock
6	Axe
7	'Dijino'
8	Bush knife

Code	Component name /content
FE-7	**Camping materials/field luggage items**
1	Tent
2	Sleeping bag
3	Foam mattress
4	Folding cot canvas
5	Air mattress
6	Pillow
7	Mosquito net
8	Insecticide sprays
9	Duffle bag
10	Side bag
11	Aluminium water flask
12	Field shoe
13	Water jerican
14	Field table
15	Field stool
16	Flash light (hand battery) with extra batteries
17	Butagas cylinder
18	Gas lamp with extra glasses
19	Shower bag
FE-8	**Kitchen items/materials**
1	Cooking set
2	Frying pan
3	Kerosene stove & Kerosene (gas)
4	Butagas stove & Butagas cylinders (filled)
5	Matches and/or lighters
6	Can opener
7	Tea kettle
8	Kitchen ladles, forks and knifes
9	Spaghetti Strainer
10	Dinning plates, ladles & forks
11	Water & tea cups and tea spoon
12	Water filter 3" with extra candles
13	Water canvas
14	Washing basin
15	Plastic bucket
FE-9	**First Aid kit box**
	Bandage Medicinal Alcohol/dettol Iodine and/or GV Medicinal cotton Medicated Plaster Antipain medicine Cutting knife and scissor Sewing needle &
FE-10	**Field work Information**
1	Letter of cooperation to Wereda/Kebele office, written from the GSE & Regional government office

I-3. GENERAL PROCEDURES AND GUIDELINES IN FIELD GEOLOGIC MAPPING (FM)

Many of the geological problems currently under investigation (either using the modern laboratory facilities) are basically originated from field studies. The sophistication of the problems narrows, if one gives regard to field data, and devoted his time and energy to collect much geological information as possible. For many reasons, however, field activities (example, procedures of field data collection) have not always been respected.

Field work may seem at times routine, unproductive or even boring, especially when traversing a monotonous rock unit that extends for several tens of kilometers in the region under consideration. Our knowledge on the geology of the country will advance more effectively if we can be able to produce or collect significant geological data in the field itself.

Field work include the observation, study and investigations of natural materials, features, phenomena and processes in their natural setting, mainly by using our eyes and walking several kilometers on our feet. In general field geologic mapping involve surprises and complications, so it requires patience and demand decision. If field mapping is conducted with keen interest, awareness of many of the facts on the ground, synthesis and systematic interpretation, it is likely to have a map showing the real relationships between geological units, their structural setting and write a comprehensive geological history at the end. The main objective of this brief guide is to provide a working check-list of major geological features that should be assessed, analyzed and described during field regional geologic mapping.

Code	Component name /content	Remark
FM-1	**Equipment and materials**	
1	Hand held GPS	*These are the main mapping instruments, to navigate, locate, describe, sample and sketch the geological information that can be obtained in the field. and should be held in day-to-day activity of any field traverses*
2	Altimeter,	
3	Aerial photographs and topomap,	
4	Geological compass,	
5	Pocket stereoscope,	
6	Hand lens,	
7	Geological and Sledge hammer	
8	Field note book, pencil, colored pencils, pen and marker	
9	Meter scale	
10	Chisel (both flat and sharp edged),	
11	Masking tape and plastic sample bag	
FM-2	**Field note book format & main notes**	
1	Write field notes on hard covered note book: 14cm wide and 18cm long	*Do not use pencils for writing field notes*
2	Use waterproof ink for writing field notes	
3	The first inside page of the note book must have the following information: A) Name and address of the geologist making the observation, B) Name and index of topomap sheet, subsheets and year of project, and C) Names and addresses of field party members	
4	The right side page (description page) of the notebook should be used to write field attributes of observed geologic features.	
5	The left side page of the note book should be used for the following purposes: A) Sketching outcrop features, B) Recording structural measurements (in both symbol and numerical figures), C) Information on rock samples, and etc.	
FM-3	**Field traverse line & order of information record**	
1	Start of each daily traverse should contain the following information written on the top of the description page: A) Date and time, B) Serial and strip number of aerial photograph/s, C) Name of traverse and intended purpose D) Name/s of professional partner (if any)	*The observed and written records at each observation point need be comprehensive and legible to be of use to any other geologist*
2	Record the spatial attribute of each observation point/station along field traverse lines: A) Station number (number preceded by two initial letters of geologist's name) B) Geographic location (Easting and northing) in UTM units, C) Spot elevation in meters, and D) Specific locations with respect to localities or permanent landmarks	
3	Briefly describe attributes of geologic features as they appear on the outcrop, at each field observation point	*Do not leave a gap of information between stations along a traverse route.*
4	Label the station number at the back of the aerial photograph	
5	Color mark lithologies & structures continuously on the topographic base map	*Cross-sections should also be made at a point, where the geology is complex*
6	At the end of each traverse write summary notes and make general cross-sectional overview of geologic features observed along the traverse line	

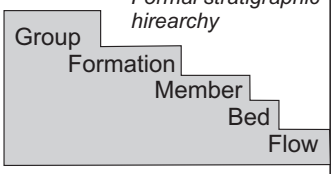
I-3. GENERAL PROCEDURES AND GUIDELINES IN FIELD GEOLOGIC MAPPING (FM)

Code	Component name /content	Remark
FM-4	**Preliminary (reconnaissance) field work**	*This is to familiarize with ground attributes of geologic features and find-out access routes to reach outcrops of interest identified by remote sensing study*
1	Make road geological traverse in the first few days of the field work	
2	Collect information on available motorable roads or foot paths	
3	Plan main traverses ahead, based on the acquired actual information and pre-planned purposes identified during remote sensing study	
4	Take short notes of the geologic observations made	
5	Write outlines of the new traverse plan and changes made to previous schedule	
FM-5	**Outcrop analysis and record**	
1	Note the morphology of the outcrop area: hill, flat, river, creek, road, cliff, etc	
2	Note the nature of exposure: continuous, partly covered, blocky, fragmental	
3	Note the homogeneity and heterogeneity of exposed rocks	*Keep observations or facts on the ground distinct from interpretations*
4	Inspect for color, textural and mineralogical variations occurring in a relatively homogeneous outcrops	
5	Closely examine the lithostratigraphic relationships among different kind of rocks in heterogenous outcrops	
6	Describe each identified rock type: color, texture/grain size, mineralogy, etc	*It is desirable to make as much observations on good outcrops*
7	Note the economic significance of exposed lithologies	
8	Note appearance of rocks on weathered surfaces	
9	Describe the type of contact in adjacent rock units: sharp, gradational	
10	Note the nature of structural features on the outcrop: simple, complex, etc	
11	Identify structures in each of rock units: primary (formational), secondary (deformational)	
12	Describe identified structures: type, attitude, geometry, age	
13	Make sketches/photographs of outcrops with significant information on the geologic history	
14	Conclude the outcrop analysis with interpretation remarks on the genesis, lithostartigraphy, structural history and/or problems of interpretation	
15	Take rock samples for comparisons with other similar outcrops, further microscope characterization of rock units and/or solving particular problems noted on the outcrop	
FM-6	**Sampling**	
1	Based on the outcrop analysis, decide what to sample (rock, fossil or mineral) and its purpose	*Fresh unaltered samples are required for petrographic study of components of lithologies*
2	Mark the position of sectioning of specimens for simple petrographic study	
3	Samples for specific petrographic/polished section studies (ex. structural study) should have compass orientation marks and attitude of geologic feature to be studied	
4	Write the station number on the sample, on the wrapping masking tape, and on the plastic bag	
5	Record specimens collected and reasons for further study on the note book	
FM-7	**Field sketches and photographs**	
1	Outcrops with significant geologic information have to be sketched and/or photographed	
2	Sketched or photographed features must show appropriate scale and compass orientation	*In most cases it is essential to make rough sketch of all photographed features*
3	Write down the locality, direction of view, attitude of the topographic surface and attributes of sketched/photographed geologic features in the note book	
FM-8	**Compilation of field data**	*The weekly field data has to be evaluated & summarized at the field camp*
1	Transfer observation points on the topographic base map and color mark sample locations	
2	Delineate contacts of lithologies on the base map	
3	Summarize acquired field data and identify problems to be worked out	

I-4. GUIDELINES FOR FIELD IDENTIFICATION & NAMING OF LITHOSTRATIGRAPHIC UNITS (LU)
(adapted from international commission on stratigraphy)

This section provides basic international stratigraphic principles and guidelines for definition, characterization and establishment of lithostartigraphic units in the course of mapping.

Lithostratigraphic units are bodies of rocks, bedded or unbedded, may be sedimentary, or igneous, or metamorphic in origin. They are defined and characterized on the basis of their lithologic properties and their stratigraphic relations observed in the field, and/or recognized by a combination of both. The geographic extent of a lithostratigraphic unit is controlled entirely by the continuity and extent of its diagnostic lithologic features.

Code	Component name /property	Remark
LU-1	**Procedures for establishing lithostratigraphic unit**	
1	Identify stratigraphic types based on detailed mapping in certain localities	*Boundaries of designated lithostratigraphic units can cut across time surfaces, fossil ranges, etc*
2	Determine the type locality where the stratigraphic unit is best exposed	
3	Supplement the lithostratigraphic designation by mapping other reference sections with similar lithologic character	*Local or minor hiatuses, within a similar stratigraphic sequence (lithologic units) should not be used for designation of more than one lithostratigraphic unit*
4	Note and designate lower and upper stratotypes, in poorly exposed areas	
5	Decide on where to place the lithostratigraphic boundar: lithologic change, or arbitrarily based on vertical/lateral lithologic gradation, or intertongung	*Avoid terms such as "lower", "middle", and "upper for formal subdivisions of lithostratigraphic units*
6	Desiginate separate names for similar stratigraphic types separated by unconformities or major hiatuses	
7	Derive simple lithologic term from the predominant lithologic type to name designated lithostratigraphic unit	*Do not use compound lithologic terms for naming*
8	Extend the use of lithostratigraphic designation to stratified volcanic rocks and metamorphic rocks with little deformational history	*Use local geographic term combined with either a unit-term or a simple field lithologic term, such as gneiss, schist, etc or complex, ophiolite, melange to metamorphic stratotypes*
9	Define a separate criteria for lithostratigraphic designation of non-layered intrusive units or metamorphic rocks with complex deformational history	
10	Use supplementary geographic locality to accommodate lateral changes in lithostartigraphic character	*Avoid the use of non-lithologic terms and adjjectives such as volcanics, metamorphics, etc*
LU-2	**Lithostratigraphic rank terms**	*Formal stratigraphic hirearchy* 
1	GROUP: Employed to a succession of two or more contiguous or associated formations with significant and diagnostic lithologic properties in common. The component formations need not be the same everywhere. Aggregation of formations simplifys lithostratigraphic divisions in certain localities	
2	FORMATION: Primary formal unit of lithostratigraphic classification. Its establishment varies with the complexity of the geology of a region and the detail needed for geologic mapping and to work out its geologic history. This is the only formal lithostratigraphic unit into which the stratigraphic column everywhere should be divided completely on the basis of lithology. Its thickness may range from less than a meter to several thousands.	*Thickness of a succession is not a criteria for grouping formations* *Ranking of stratotypes as formation is done to successions that can be mapped at the scale of mapping*
3	MEMBER: Possesses lithologic properties distinguishing it from adjacent parts of the formation. No fixed standard is required for the extent and thickness of a member. Some formations may be completely divided into members; others may have only certain parts designated as members. A member may extend from one formation to another. Specially shaped forms of members (or of formations) are lenses and tongues. A lens is a lens-shaped body of rock of different lithology than the unit that encloses it. A tongue is a projecting part of a lithostratigraphic unit extending out beyond its main body.	*Division of formation into members should be made for a particular purpose*
4	BED: The smallest formal unit in the hierarchy of sedimentary lithostratigraphic units, e.g. a single stratum lithologically distinguishable from other layers above and below.	*Ranking into distinctive beds (key beds, marker beds) should be made to serve particular stratigraphic purpose.*
5	FLOW: A discrete extrusive volcanic body distinguishable by texture, composition, or other objective criteria.	*The designation and naming of flows as units is limited to those that are distinctive and widespread*

I-4. GUIDELINES FOR FIELD IDENTIFICATION & NAMING OF LITHOSTRATIGRAPHIC UNITS (LU)
(adapted from international commission on stratigraphy)

Code	Component name /property	Remark
LU-3	**Miscelaneous lithostratigraphic ranking terms**	
1	SUPER GROUP AND SUBGROUP: Commonly used for several associated groups or for associated groups and formations with significant lithologic properties in common. Exceptionally, a group may be divided into subgroups.	*Do not designate lithostratigraphic name for succession that are not fully described and characterized*
2	COMPLEX: A lithostratigraphic unit composed of diverse types of any class or classes or rocks (sedimentary, igneous, metamorphic) and characterized by irregularly mixed lithology or by highly complicated structural relations.	
3	LITHOSTRATIGRAPHIC HORIZON (LITHOHORIYON) A surface of lithostratigraphic change, commonly the boundary of a lithostratigraphic unit, or a lithologically distinctive very thin marker bed within a lithostratigraphic unit	
LU-4	**Procedures for extending lithostratigraphic units and Correlation**	
1	lithostratigraphic unit and its boundaries are extended away from the type section or type locality only as far as the diagnostic lithologic properties on which the unit is based may be identified	
2	Where lithologic identity is difficult to determine because of poor or no outcrops, a lithostratigraphic unit and its boundaries may be identified and correlated on the basis of indirect evidence: geomorphic expression, wire-line logs, seismic reflections, distinctive vegetation, etc	
3	Use the top or the base of a marker bed as a boundary for a formal lithostratigraphic unit where the marker bed occurs at or near a recognizable vertical change in lithology	

I-5. PROCEDURES AND GUIDELINES IN SEDIMENTARY ROCK TERRAIN MAPPING (SR)

Sedimentary rocks occur in the southeast, central-west and northwest parts of the country, overlying basement rocks. They range from terrigenous clastic deposits to marine calcareous rocks. The general lithostratigraphy has been previously established by early workers based on surface mapping and drill cores in certain localities. The lateral and vertical variation in the sedimentary succession is not yet known at many places. In view of this, the regional geologic mapping is expected to provide additional data for better understanding of the sedimentary rocks exposed in the areas of mapping. The task includes establishment of proper lithostratigraphic units, their depositional arrangement/organization and origin.

Code	Component name /content	Remark
SR-1	**Remote sensing studies**	
1	Look for any sedimentary bedding and note its frequency & spatial variation	*Use base map information, morphology and slope of the area to select good exposures that are fairly accessible*
2	Define certain image analysis key and delineate contacts of different sedimentary formation	
3	Note any tilting of beds and investigate for related tectonic structures	
4	Select sections for field logging	
SR-2	**General field working steps & observation record**	*Selected sites can be stream course, cliff faces, hill or ridge sides & artificial excavations (road cut, quarry)*
1	Make measured stratigraphic section logs at different localities where the succession is very well exposed	
2	Carefully note the type of lithologies, facies change, occurrence of fossils and primary sedimentary structures, in both lateral and vertical section	
3	Examine the contact relationship of adjacent layers, and measure thickness & attitude of individual beds	
4	Record attitude of observable secondary structures such as joint, fault, etc.	
5	Sample lithologies for further petrographic study	
6	Take small chips of the setion logs for comparison with other sections	
7	Make sketches or take photograph of the section and other essential details	
8	Note lithologies of economic significance	
9	Summarize the observation and make interpretation of the provenance, mode of transport & depositional environment of the sequence	
10	Correlate stratigraphic sequences logged at different localities in the area	
11	Based on the correlation establish lithostratigraphic units	
12	Extrapolate the clearly identified sequence to localities with poor outcrops	
SR-3	**Steps of outcrop analysis in clastic sedimentary sequence**	
1	Classify the sequence according to grain size to determine the root name	
2	Look at the composition of classified units and note the proportions of gravel, sand & mud	
3	Closely inspect the texture of individual layers: grain morphology & sorting	
4	Note the colour, look for important clastic grains/mineral and name the layer	
5	Identify type of sedimentary structures and record their geometrical properties: A) Soft sediment (load-casts, flames, sand volcanoes, mud cracks, rain pits) B) Depositional (planar bedding, planar lamination, ripples, cross bedding, cross lamination, graded bedding, imbrication bedding) C) Erosional (sole, marks, scour marks, flute casts, tool marks, furrows & rills, channel scars and slump scars), and/or D) Impressions of organic or skeletal forms (tracks, trails, & burrows)	
SR-4	**Steps of outcrop analysis in calcareous sedimentary sequence**	
1	Classify the sequence according to proportions of carbonate mud with respect to larger grains; very fine-grained carbonate grains versus allochems (intraclast, oolite, pelloid & fossil fragment) to determine the root name	
2	Closely inspect the structure of individual layers	
3	Note the colour, look for important fossils and alterations	
4	Record the distribution of fossils with respect to bedding	
5	Look for any depositional or diagenetic structures and record their properties	

I-6. PROCEDURES AND GUIDELINES IN VOLCANIC ROCK TERRAIN MAPPING (VR)

Volcanic rocks are widespread in the country. They vary mainly from felsic to mafic lava flows and pyroclastic rocks. Alternation and intertonguing of different types of volcanic rocks is common in most places. Besides there are layers of volcano-clastic sediments (tuff, lacustrine & alluvial fan deposits) & patches of paleo soils making part of the volcanic formation in some places. Recent volcanic rocks form prominent caldera, plugs, cinder cones, etc. Their formation is associated with the development of the East African Rift System in Cenozoic Era.
Regional geologic mapping on this terrain began much recently & will be continuing in the future. The mapping is expected to reveal the type & distribution of lithologies and tectonic structures, stratigraphy, nature of Cenozoic basins and their relation to extensional faults.

Code	Component name /content	Remark
VR-1	**Remote sensing studies**	
1	Identify prominent volcanic landforms/features within or adjacent areas	
2	Delineate volcanic lithologies based on image properties & volcanic features	
3	Note any observable faults and tilting of lithologies	
4	Select accesible traverse routes for closer field study of the lithologies and also the faults	
VR-2	**General field working steps & observation record**	
1	Make lateral and vertical logs at different localities where thick volcanic formation is very well exposed	
2	Examine the volcanic sequence for any lateral and vertical variations in the type of lithology or intertonguing and note the nature of contact	
3	Examine for the slightest tilting of the volcanic sequence and note attitude of volcanic layering	
4	Closely inspect nature of volcaniclastic sediments and/or paleosoils, which may occur in a volcanic sequence	
5	Note type of jointing and its geometrical properties: Columnar, platy/slabby, ramp (shape, dimension and orientation)	
6	Sample lithologies for further petrographic study	
7	Take small specimens of lithologies from the sequence for comparison with other sections	
8	Look for any displacement of contacts (from far distances) to identify faults	
9	Look for collapse & eruption structures in a caldera, crater, spatter cones/ramparts	
10	Make sketches or take photograph of any importantvolcanic features	
11	Note lithologies of economic significance	
12	Summarize the observation and make interpretation	
13	Correlate the different sections logged in the area	
14	Establish lithostratigraphic units based on field data	
VR-3	**Steps of outcrop analysis in volcanic lava flows**	
1	Classify volcanic rocks based on color & texture	
2	Note the type & proportion of phenocrysts in a porphiritic rock	
3	Look for primary/secondary volcanic structures & note their properties: A) Lava flows; ropy, smooth, blocky or flow folding (shape and dimension) B) Vesicles & amygdules	
4	Inspect the outcrop area for any variation in grainsize, texture or color	
VR-4	**Steps of outcrop analysis in pyroclastic volcanic rocks**	
1	Classify pyroclastic volcanic rocks based on grainsize	
2	Note the relative proportion of component grains and name the rock	
3	Record the composition of different clasts and other physical attributes	
4	Note the nature of welding	

I-7. PROCEDURES AND GUIDELINES IN METAMORPHIC ROCK TERRAIN MAPPING (MR)

Wide exposures of metamorphic rocks occur in the south, west and north peripheries of the country, underlying Phanerozoic rock formations. The metamorphic rocks are comprised of simple to composite high-grade gneisses, low grade ophiolite sequences & associated metasediments. Different generation of acidic to intermediate intrusives puncture the metamorphic formation at various stages of Neoproterozoic orogenic activity.

Much of the metamorphic terrain has been covered by regional mapping in the past three decades. There are still some localities and unmapped metamorphic exposures in deeply excavated valleys. Field mapping in metamorphic rock terrain represent quite a very difficult task and demands a variety of technique that cannot be explained in a very simple manner. The mapping activity involves identification of metamorphic lithologies, fabric, regional structures and understanding of the origin, complex deformational & intrusion history.

Code	Component name /content	Remark
MR-1	**Remote sensing studies**	
1	Identify metamorphic fabric and note its strength & spatial distribution	*Use form*
2	Delineate localities with strong fabric	
3	Mark major structural trends	
4	Outline image properties & define metamorphic fabric keys to differentiate metamorphic lithologies	
5	Look for any intrusive body & mark its outline	
6	Compare trends of intrusive bodies with the metamorphic fabric to characterize their relative age	
7	Delineate suitable traverses for further field study	
MR-2	**General field working steps & observation record**	
1	Look for outcrops with moderate metamorphic fabric & recognize the type of rock association	
2	Measure/Estimate their relative size, proportion & establish their relationship in detail	
3	Identify metamorphic mineral assemblage in each of the rock types	
4	Note the main fabric elements (texture & structure|): their orientation, symmetry and relative age	
5	Determine sequence of deformation, vein types & intrusion events Record stable mineral assemblages for each event being established	
6	Make sketches of outcrop features with significant geologic information	
7	Cross check the established metamorphic events at other outcrops and expand or modify it based on new observations	
8	Continue with the analysis of other outcrops until no important addition or modification to the expanded scheme of events is required	
9	Establish lithostratigraphic units based on field association & visuallized scheme of metamorphic evolution	
MR-3	**Outcrop analysis and record of lithologic data**	
1	Note & describe all the variation in colour, grain size, fabric and mineralogy of relatively monotonous metamorphic rock exposure and analyze the factors, which possibly govern this variation.	
2	Examine the nature of banding/layering (frequency, gradation, sharp), its continuity both along and across the strike of gneissic rocks.	
3	Describe and also sample any veins and pegmatites that possibly occur in a sequence of metamorphic rock and massive intrusives. Their aerial extent, attitude, contact relationship (chilled/normal margin) and relative age should also be clearly identified and noted. Check for the presence of any kind of zoning (mineralogical or texture) and any structural fabric. Compare the attitude of the preferred orientation with that occurring in the host.	
4	Make note of xenoliths/roof pendants or inclusions of a different type of rock occurring in a metamorphic formation. Describe their abundance, geometry, orientation with respect to the local tectonic fabric, boundary relationship with the host rock and their physical properties. The nature and geometry of the internal fabric of individual xenoliths is also an important notable feature.	

I-7. PROCEDURES AND GUIDELINES IN METAMORPHIC ROCK TERRAIN MAPPING (MR)

Code	Component name /content	Remark
MR-3	**Outcrop analysis and record of lithologic data**	
5	In regions where an alternation of massive, coarse grained intrusive pods occur note the changes in the mineralogical composition as well as structural fabric of the host rocks towards the intrusive (both across and along the strike). It is also desirable to note the physical properties and other parameters that can be observed within the intrusive rock.	
6	All locally assumed minor constituent rocks (example, lenses or layers of rocks from few mm to several meters thick) should be properly described and their relationship correctly identified.	*Minor rock types occurring in any metamorphic terrain are potential marker horizons for structural as well as petrogenetic studies and their occurrence shall be recorded on the face of the airphoto and/or topographic base map.*
7	Gbbroic rocks should be carefully examined for any kind of compositional (magmatic) layering both in outcrop scale as well as in a regional scale. Any supposedly minor constituents (dikes, sills etc.) should be noted and sampled.	
MR-4	**Outcrop analysis and record of structure data** The deformation history of a metamorphic rock is recorded by: foliation, lineation, fold, boudinage, joint and etc. A detailed (reliable) data of any structure can be obtained from an outcrop surface showing the three dimensional picture of the structure. The most important features of the common structures in a metamorphic rock that need careful attention are listed below.	
1	**Foliation** A) Note the morphological characteristic of foliations (when hammered): Continuous, Spaced/fracture cleavage & Crenulation B) Measure and note the attitude of foliation (dip direction/amount of dip). C) Check and note any slight variation in the intensity/attitude of foliation in different bands or layers. Also analyze why the intensity of foliation varies between different layers. D) Closely inspect for overprinting relationship of foliations.	*In a layered sequence of schists, certain layers may show two or more foliations and in others not.*
2	**Lineation** A) Note the type of lineation: mineral (preferred orientation of mineral grains), stretching (stretched mineral grains or aggregates of deformed grains), rods (preferred orientation of elongated bodies of quartz), etc. and the minerals that best define it. B) Measure and note the attitude of lineation (direction of plunge and amount of plunge) or pitch.	*Using stereographic net check if the lineation plots on the great circle defined by the foliation plane in which the attitude of lineation is measured.*
3	**Folds** A) Note the geometrical feature (cylindrical/noncylindrical) of the fold. B) Determine direction of closure (antiform, synform, recumbent, etc.) and style of folding (tightness, curvature, symmetry, etc.) C) For folds where the hinge zone is clearly exposed, measure the attitude of the axis (direction of plunge/amount of plunge) and axial plane (direction of dip/amount of dip). D) Record wavelength and amplitude of cylindrical folds E) For folds with unclear hinge zone, measure orientation of axial trace. F) Note any development of foliation (axial planar) associated with the folding.	*Care must be taken using the vergence of folds for any structural interpretation. Assigning of asymmetric folds into S, Z or M folds can be made if the exposure surface allows the measurement of the axis and axial plane. This also applies in regions where the foliation appears vertical.*
4	**Boudinage** A) Make note of the rock types that show the boudinage structure B) Note the geometrical features of the boudins (pinch & swell, detached, etc.) C) Measure the orientation of the axis D) Note any structures or growth of minerals (veins) along boudin necks E) Determine any relationship between the boudinage structure and other type of structure	
5	**Joints (fractures)** A) Note the distribution of joints (random/sets) B) For every set of joints record their frequency, lateral dimension and orientation (dip direction/amount of dip) C) Determine the relationship between the joint sets and other structual fabrics (foliation, folds, etc.)	

I-7. PROCEDURES AND GUIDELINES IN METAMORPHIC ROCK TERRAIN MAPPING (MR)

Code	Component name /content	Remark
MR-5	**Outcrop analysis and record of high deformation zones** Natural deformation of the Earth\s crust is usually concentrated along narrow planar zones commonly referred as SHEAR ZONES. High strain zones are marked by grain size reduction & development of an associated structural fabric different from adjacent undeformed part of a certain lithologic unit. Analysis of shear zones includes recognition of set of structures & establishment of the deformation path.	
1	Note the approach of highly deformed rock along traverse line, either on exposed metamorphic sequence or any other rock formation	
2	Look for outcrop surfaces that allow 3 dimensional view of sets of structures	
3	Identify relatively highly deformed & undeformed parts of the same rock, note variations in grain size, texture & mineral assemblage/components, and orientation of fabric elements along their boundary	
4	Classify the highly strained part according to grain size & texture: Cataclasite or mylonite	
5	Look for the occurrence of different planar fabric elements, record their characteristic relationships and measure their attitude	
6	Look for the occurrence of linear fabric elements, record their characteristic relationships and measure their attitude	
7	Closely inspect the high strain zone for porphyroclasts, broken mineral grains, folds and other deformational structures, and record their properties and relationships with the main fabric elements	
8	Assess the nature & direction of displacement based on direct observation of displaced marker layer/lithology or asymmetry of porphyroclasts or geometric arrangements of sigmoidal vein arrays	
9	Summarize the outcrop analysis with interpretation remarks on deformation path, relative age & metamorphic grade/depth of development	
10	Make 3D sketches and/or photographs of all notable shear zone features	
11	Take oriented samples for further microstructural study and/or proper visual structural analysis from polished slabs	

I-8. PROCEDURES AND GUIDELINES IN PETROGRAPHIC STUDY OF ROCK SECTIONS (PS)

Petrographic study of rock thinsections is an essential tool to name rocks according to their major components and also decipher their petrogenesis provided that all the textural attributes are properly investigated. The textural attribute of a rock includes: grainsize, morphology and the general fabric or relationship between the constituents. These features are controlled by the physicochemical and dynamic processes/environment by which rocks formed/evoloved.

Most thinsection descriptions are limited to enumerating the constituents and their relative percentages and generally lack a proper textural description of the rock section examined. For appropriate analysis of the petrogenesis of rocks it is essential to follow the procedures and guidelines outlined below.

Code	Component name /content	Remark
PS-1	**General steps of petrographic study**	
1	Identify main components contained in thinsection	*Use form*
2	Determine the relative percentage proportion of the components	
3	Note and record textural attributes: grain size & grain morphology	
4	Note & identify nature of crystal zoning & twining in individual grains	
5	Closely examine individual grains for any dicontinuty	
6	Inspect grain boundaries, note relationship of adjacent grains & outline the various relationships a grain has	
7	Note & record the overall fabric of the rock	
8	Name the rock	
9	Describe the petrographic characteristics of the rock with conclusion remarks on the petrogeneses & solved field interpretation problems	
10	Make sketches of important textural relationships	
PS-2	**Petrographic steps & main attributes of clastic sedimentary rocks**	
1	Determine the modal average grain size & define the root name of the rock	
2	Identify the type of main components: Mineral grains,lithic fragments, matrix	
3	Estimate percentages of the individual principal components & classify the rock	*Calculate proportions of the main components summed to 100% & use QFL diagram to classify the rock*
4	Look for the distribution of grain size and note the degree of textural maturity	
5	Inspect for the occurrence of other important mineral grain/s (accessory)	
6	Name the rock based on the composition, textural maturity & its grain size	
7	Closely examine the individual form & textural relationship of the components	
8	Note & describe notable sedimentary structures	
9	Briefly describe the petrographic observation with remarks on the mode of sediment provenance, transportation & deposition	
PS-3	**Petrographic steps & main features of calcareous sedimentary rocks**	
1	Assess the thin section & determine percentages of the principal components:	
2	Allochems (depositional products), sparite & micrite	
3	Identify the types of Allochems & estimate their relative proportions	
4	Name the rock based on proportion of identified components	
5	Look for other detrital components & primary porosity, estimate their percentages and use as adjective modifiers to given name	
6	Closely examine for diagenetic products: cementation, dissolution, mineral replacement & fracturing of the component grains	
7	Briefly describe the petrographic observation with remarks on the mode of formation & subsequent diagenetic processes	

I-8. PROCEDURES AND GUIDELINES IN PETROGRAPHIC STUDY OF ROCK SECTIONS (PS) *2 of 2*		
Code	**Component name /content**	**Remark**
PS-4	**Petrographic steps & main features of volcanic lava flows**	
1	Note the primary texture and classify the rock: Aphanitic or porphyritic	
2	Identify the type & crystal property of phenocryst minerals & estimate their percentages	
3	Assess the thin section & determine the composition of matrix	
4	Look for vesicle s & amygdules, note their characteristic features & estimate their percentages	
5	Name the rock based on mineralogy of matrix and add adjective modifiers using one or more of minor components	
6	Inspect the relationship between phenocrysts and matrix	
7	Look for magmatic flow structures	
8	Briefly describe main petrographic features with interpretation remarks on the volcanic processes and later alterations	
PS-5	**Petrographic steps & main features of pyroclastic volcanic rocks**	
1	Determine the modal grainsize & classify the rock	
2	Identify the type of components & estimate their percentages	
3	Name the rock based on dominant component type & grainsize	
4	Identify the composition of clasts	
5	Note the relationship between matrix and clasts	
6	Briefly describe main petrographic features with interpretation remarks on the extrusive volcanic process and later alterations	
PS-6	**Petrographic steps & main features of intrusive igneous rocks**	
1	Determine the modal grainsize & classify the rock: Hypabysal or plutonic	
2	Identify the type of components & estimate their percentages	
3	Name the rock based on dominant component type & grainsize	
4	Note textures and properties of individual crystals	
5	Identify the relationship between main minerals & accessories	
6	Briefly describe main petrographic features with interpretation remarks on the magmatic crystalization process and later alteration effects	
PS-7	**Petrographic steps & main features ofmetamorphic rocks**	
1	Identify & note the overall metamorphic fabric	
2	Make list of stable mineral assemblages & estimate their percentages	
3	Determine composition of important mineral phases such as plagioclase	
4	Note grain size, shape, orientation and relationships of main mineral grains	
5	Look for other textural features such as coronas, overgrowths & pseudomorphs and establish sequence of mineral growth & deformation events	
6	Determine the metamorphic grade based on index minerall/principal mineral paragenesis and metamorphic fabric	
7	Give appropriate name accounting field relations	
8	Briefly describe overall petrographic features with interpretation remarks on the type of parent rock, conditions of metamorphism & deformation, and later alterations	

I-10. STANDARD FORMS FOR RECORDING MAJOR STUDY OUTPUTS (RGM-F)

LIST OF FORMS

	Page number
RGM-F1. STANDARD FORM FOR RECORDING IMAGE ATTRIBUTES OF GEOLOGIC FEATURES	I-C1
RGM-F2. STANDARD FORM FOR RECORDING PRE-PLANNED FIELD TRAVERSES	I-C2
RGM-F3. STANDARD FORM FOR FIELD LITHOSTRUCTURAL LOGGING	I-C3
RGM-F4. STANDARD FORM FOR RECORDING FIELD DATA	I-C4
RGM-F5. STANDARD FORM FOR PETROGRAPHIC DESCRIPTION OF THINSECTIONS	I-C5

MINISTRY OF MINES AND ENERGY
GEOLOGICAL SURVEY OF ETHIOPIA
REGIONAL GEOLOGICAL MAPPING SECTION

STANDARD FORM FOR RECORDING IMAGE ATTRIBUTES OF GEOLOGIC FEATURES

RGM-f1	Page	of

Project Name				**Mapsheet & subsheet index**	
Remote sensing Image type & Properties	**Scanned Aerial photographs**	**Year acquired**		**Strip No/s**	
	Landsat ETM +			**Path/Row/ ETM + bands**	
Previous Works					

Ser. No.	**Remote sensing image attributes**							**Interpreted Geologic unit/ feature**
	Tone/hue	**Shape**	**Texture**	**Size**	**Site/ location**	**Pattern**	**Association**	

Interpreted by: _____ **Date:** _____

MINISTRY OF MINES AND ENERGY
GEOLOGICAL SURVEY OF ETHIOPIA
REGIONAL GEOLOGICAL MAPPING SECTION

STANDARD FORM FOR RECORDING PRE-PLANNED FIELD TRAVERSES

RGM-f2	**Page**	**of**

Project Name		**Mapsheet & subsheet index**	

Ser. No.	**Traverse number (id)**	**Location/Locality**	**Distance (km)**	**Purpose**

Planned by: _____ **Date:** _____

MINISTRY OF MINES AND ENERGY
GEOLOGICAL SURVEY OF ETHIOPIA
REGIONAL GEOLOGICAL MAPPING SECTION

STANDARD FORM FOR LITHOSTRATIGRAPHIC SECTION LOGGING

				RGM-f3	**Page of**
Project Name		**Mapsheet & subsheet index**		**Date:**	
Place/ Locality		**Geographic coordinate (UTM zone:)**			
Elevation (meters)		**East**		**North**	

Code	Grain size: Gravel	Sand: v.coarse	Sand: coarse	Sand: medium	Sand: fine	Sand: v. fine	Silt	Clay	Lithology	Texture	Colour	Thickness	Fossils/ mineral/ clast	Sedimentary structures	Other data	Description/Remarks/ Interpretation

Logged by: _____ **Date:** _____

MINISTRY OF MINES AND ENERGY
GEOLOGICAL SURVEY OF ETHIOPIA
REGIONAL GEOLOGICAL MAPPING SECTION

STANDARD FORM FOR RECORDING FIELD DATA

RGM-f5	Page of

Project Name		Mapsheet & subsheet index	

Ser. No.	Station number	Geographic coordinate UTM zone:		Lithology	Structure			Sample	
		East	North		Type	DD/PD	DA/PA	Number	Purpose

Recorded by: _____ Date: _____

MINISTRY OF MINES AND ENERGY
GEOLOGICAL SURVEY OF ETHIOPIA
REGIONAL GEOLOGICAL MAPPING SECTION

STANDARD FORM FOR PETROGRAPHIC DESCRIPTION OF THINSECTIONS

RGM-f6

Sample Number		**Mapsheet/ subsheet index**		**Originator**	
Place/ Locality		**Geographic coordinate (UTM zone:)**			
		East		**North**	

Field occurrence & name

Petrographic components in thinsection and rock identification

Major constituents (%)	
Accessories (% or trace)	
Secondaries (% or trace)	
Name of rock/ lithology	

Petrographic description of rock texture & grain relation/sketch

Described by: _____ **Date:** _____

PART II

STANDARDS FOR REGIONAL GEOLOGIC MAPPING PRODUCTS:
DIGITAL DATABASE MODEL,
DIGITAL CARTOGRAPHIC ATTRIBUTES FOR GEOLOGIC MAPS AND
CONTENT AND LAYOUT FOR REGIONAL GEOLOGIC REPORTS

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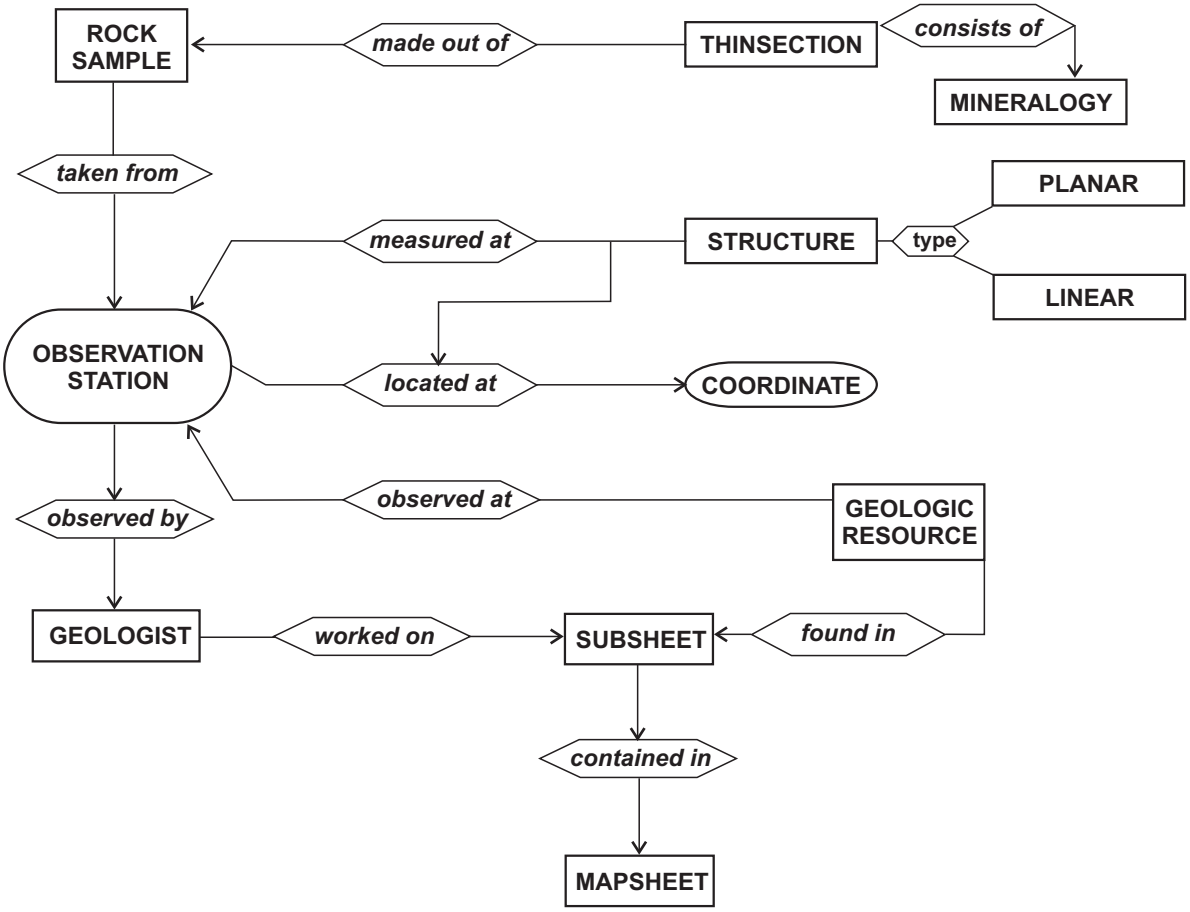
DIGITAL DATABASE MODEL

I-1) Relational data model for regional geologic mapping

A) Relational schema (ER-diagram)

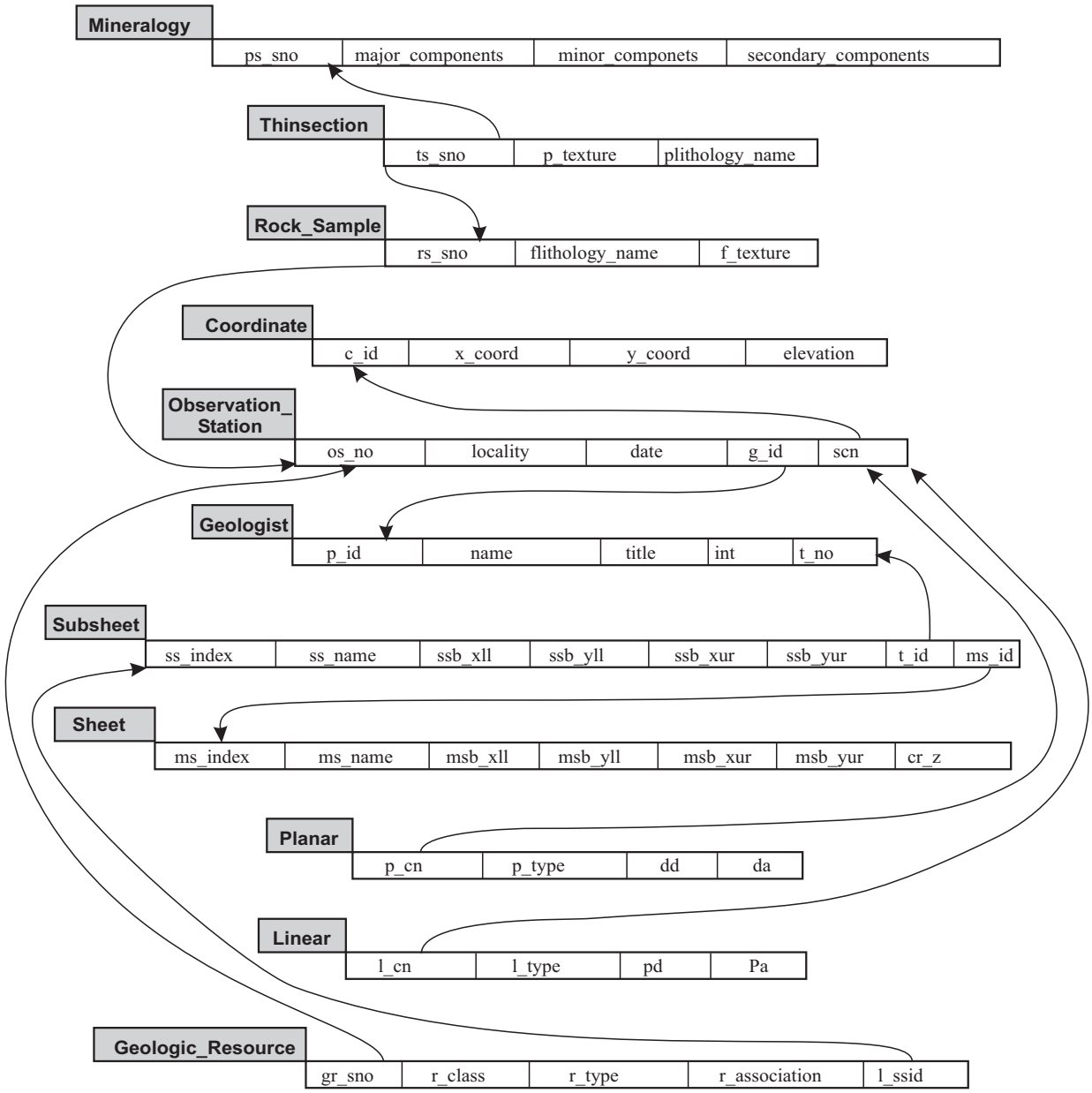


B) Main features of relation instances in the data model

S.no.	Name of relation	Definition	Number of fields
1	Mineralogy	Mineralogical content of rock determined after petrographic study of thinsection	4
2	Thinsection	A very small portion of rock slice on a glass slide for microscopic investigation	3
3	Rock_Sample	A very small portion of rock representing lithological units exposed in an area	3
4	Coordinate	Positional reference of a point on the earth's surface	4
5	Observation_Station	A point along traverse route where one make a note of geological features	5
6	Geologist	Professional earth scientist assigned for geological mapping of a certain region	5
7	Subsheet	Topographic base map of scale 1:50,000	8
8	Sheet	Topographic base map of scale 1:250,000	7
9	Planar	Planar structural features measured during field geologic traverse	4
10	Linear	Linear structural features measured during field geologic traverse	4
11	Geologic_Resource	Indications of geological resources identified in the course of field geologic traverse	5

I-2) Fields of relation instances and referential integrity of regional geologic mapping data model

A) Diagram showing fields (domains) of individual relations & their relationship



B) List of linked relationships

S.no.	Linking reference	Connected (linked) relation instances	Related domains
1	consists of	Mineralogy & thinsection	ps_sno ts_sno
2	made out of	Thinsection & rock sample	ts_sno rs_sno
3	taken from	Rock sample & observation station (obst)	rs_sno os_no
4	located at/measured at	Planar, linear & coordinate via observation station	p_cn scn l_cn scn
5	located at	Observation station & coordinate	os_no scn c_id
6	observed by	Geologist & observation station	os_no p_id g_id
7	worked on	Geologist & subsheet	t_no t_id
8	found in/observed at	Geologic resource & subsheet/ observation station	gr_sno os_no l_ssid ss_index
9	contained in	Subsheet & sheet	ms_id ms_index

I-3) Domain names and associated data type for regional geologic mapping database schema

S.no.	Name of relation (Entity set)	Domain (Field)	Definition	Data type (Attribute)	Constraint
1	Mineralogy	ps_sno	Petrographically studied sample number	CHAR (8)	KEY
		major_components	Main identified constituents in %	VARCHAR (20)	
		minor_components	Minor identified constituents in %	VARCHAR (20)	
		secondary_components	Alteration products identified in % or other	VARCHAR (20)	
2	Thinsection	ts_sno	Thinsection identification number	CHAR (8)	KEY
		p_texture	Texture of rock under thinsection	CHAR (12)	
		plithology_name	Petrographically determined lithology name	CHAR (20)	
3	Rock_Sample	rs_sno	Rock sample identification number	CHAR (8)	KEY
		flithology_name	Name of lithology given in the field	CHAR (20)	
		f_texture	Texture of lithology given in the field	CHAR (12)	
4	Coordinate	c_id	Coordinate identification number	INTEGER (4)	KEY
		x_coord	Longitudinal position of a point in meters	INTEGER (8)	
		y_coord	Latitudinal position of a point in meters	INTEGER (8)	
		elevation	Vertical height of a point in meters	INTEGER (4)	
5	Observation_ Station	os_no	Observation station identification number	CHAR (8)	KEY
		locality	Name of locality at or close to station	CHAR (12)	
		date	Day, month & year of observation	DATE (10)	
		g_id	Geologist identification number	INTEGER (4)	KEY
		scn	Coordinate identification number	INTEGER (4)	KEY
6	Geologist	p_id	Geologist identification number	INTEGER (4)	KEY
		name	Geologist name	CHAR (20)	
		title	Position/work title of geologist	CHAR (12)	
		int	Station initial bearing geologist's name	CHAR (3)	
		t_no	Mapping team identification number	INTEGER (2)	KEY
7	Subsheet	ss_index	Index number of 1:50,000 scale topomap	VARCHAR (10)	KEY
		ss_name	Name of 1:50,000 scale topomap	CHAR (15)	
		ssb_xll	Lower left longitudinal boundary point	INTEGER (8)	
		ssb_yll	Lower left latitudinal boundary point	INTEGER (8)	
		ssb_xur	Upper right longitudinal boundary point	INTEGER (8)	
		ssb_yur	Upper right latitudinal boundary point	INTEGER (8)	
		t_id	Assigned mapping team identification no	INTEGER (2)	KEY
		ms_id	Topomap sheet in which subsheet found	VARCHAR (8)	KEY
8	Sheet	ms_index	Index number of 1:250,000 scale topomap	VARCHAR (8)	KEY
		ms_name	Name of 1:250,000 scale topomap	VARCHAR (15)	
		msb_xll	Lower left longitudinal boundary point	INTEGER (8)	
		msb_yll	Lower left latitudinal boundary point	INTEGER (8)	
		msb_xur	Upper right longitudinal boundary point	INTEGER (8)	
		msb_yur	Upper right latitudinal boundary point	INTEGER (8)	
		cr_z	Projected coordinate reference (UTM) zone	CHAR (3)	
9	Planar	p_cn	Coordinate number of planar structures	INTEGER (4)	KEY
		p_type	Type of planar structure	CHAR (12)	
		dd	Dip direction (azimuth) of planar feature	INTEGER (3)	
		da	Amount of dip (inclination) of the plane	INTEGER (2)	
10	Linear	l_cn	Coordinate number of linear structures	INTEGER (4)	KEY
		l_type	Type of linear structure	CHAR (12)	
		pd	Plunge direction (azimuth) of linear feature	INTEGER (3)	
		pa	Amount of plunge of linear feature	INTEGER (2)	
11	Geologic_ Resources	gr_sno	Station no. where resource observed	CHAR (8)	KEY
		r_class	Resource class	CHAR (12)	
		r_type	Resource type	CHAR (10)	
		r_association	Resource association	CHAR (20)	
		l_ssid	Subsheet index where the resource found	VARCHAR (10)	KEY

LAYOUT AND MAJOR COMPONENTS OF GEOLOGIC MAPS

II-1) Essential geologic map components and layout information

A) Names, codes & elements of map components

Ob. ID	Row index	Component Code	Component name	Map elements
1	R2-2	SMC-1	Main map area, Base map features	P, L, S, T
2	R2-3	SMC-2	Main map area, Geologic features	P, L, S, T
3	R4-1	SMC-3	Cross sections	P, L, S, T
4	R2-4	SMC-4	Map key (Legend)	P, L, S, T
5	R2-1	SMC-5	Inset maps area	P, L, S, T
6	R1-1	SMC-6	Country & Organization	T
7	R1-2	SMC-7	Map title	T
8	R1-3	SMC-8	Report number	T
9	R1-4	SMC-9	Logo	R
10	R3-1	SMC-10	Base map information	T
11	R3-2	SMC-11	Map scale	T, L
12	R3-3	SMC-12	History of geological mapping & map preparation	T
13	R4-2	SMC-13	True & magnetic north arrows	L, T
14	R4-3	SMC-14	Geologic map information	T

Codes of map elements

ID	Code	Feature Type
1	P	Polygon
2	L	Line
3	S	Symbol
4	T	Text
5	R	Raster

B) Map paper format

1) Map paper size; International A0 = 1189 X 841 (mm), Landscape.
2) Maplayout size = 1126 X 753 (mm).
3) Margins: Left & right = 31.5mm, Top & bottom = 44mm.
4) Map origin (reference): Lower left corner of map paper.

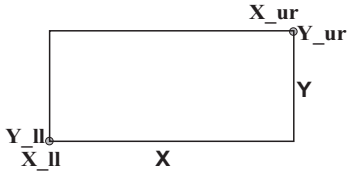
C) Size and positional attributes of map components

Ob. ID	Row index	Comp. Code	Dimension (mm)		Distance from paper margin (mm)			
			Length (X)	Length (Y)	Top	Bottom	Left	Right
1	R2-2	SMC-1	696.00	443.00	64.00	254.00	246.50	246.50
2	R2-3	SMC-2	666.00	443.00	79.00	319.00	261.50	261.50
3	R4-1	SMC-3	800.00	200.00	597.00	44.00	194.50	194.50
4	R2-4	SMC-4	210.00	613.00	79.00	152.00	947.50	31.50
5	R2-1	SMC-5	210.00	733.00	64.00	44.00	31.50	947.50
6	R1-1	SMC-6	75.00	15.00	44.00	782.00	261.50	852.50
7	R1-2	SMC-7	130.00	15.00	44.00	782.00	529.50	529.50
8	R1-3	SMC-8	40.00	15.00	44.00	782.00	887.50	261.50
9	R1-4	SMC-9	30.00	30.00	44.00	767.00	1037.50	121.50
10	R3-1	SMC-10	200.00	50.00	542.00	249.00	261.50	727.50
11	R3-2	SMC-11	256.00	50.00	542.00	249.00	466.50	466.50
12	R3-3	SMC-12	200.00	50.00	542.00	249.00	727.50	261.50
13	R4-2	SMC-13	50.00	40.00	692.00	109.00	1027.50	111.50
14	R4-3	SMC-14	158.00	60.00	737.00	44.00	999.50	31.50

D) Boundary limits of map components from origin (lower left & upper right corner points)

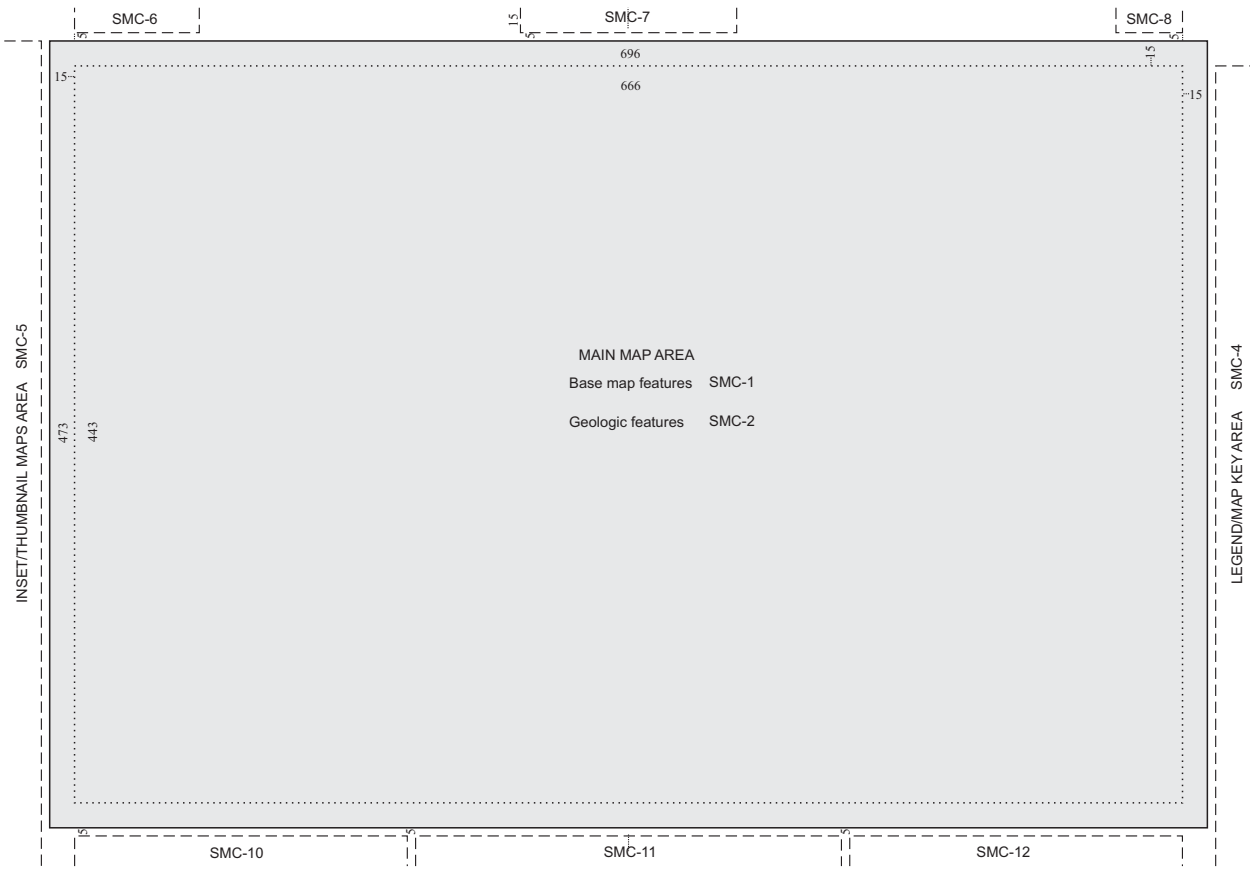
ID	R_index	C_Code	Corner points from origin (mm)			
			X_ll	Y_ll	X_ur	Y_ur
1	R2-2	SMC-1	246.50	254.00	942.50	777.00
2	R2-3	SMC-2	261.50	319.00	927.50	762.00
3	R4-1	SMC-3	194.50	44.00	994.50	244.00
4	R2-4	SMC-4	947.50	152.00	1157.50	765.00
5	R2-1	SMC-5	31.50	44.00	241.50	777.00
6	R1-1	SMC-6	261.50	782.00	336.50	797.00
7	R1-2	SMC-7	529.50	782.00	659.50	797.00
8	R1-3	SMC-8	887.50	782.00	927.50	797.00
9	R1-4	SMC-9	1037.50	767.00	1067.50	797.00
10	R3-1	SMC-10	261.50	249.00	461.50	299.00
11	R3-2	SMC-11	466.50	249.00	722.50	299.00
12	R3-3	SMC-12	727.50	249.00	927.50	299.00
13	R4-2	SMC-13	1032.50	109.00	1072.50	144.00
14	R4-3	SMC-14	999.50	44.00	1157.50	104.00

X_ll - Lower left (X)
Y_ll - Lower left (Y)
X_ur - Upper right (X)
Y_ur - Upper right (Y)



II-3) General layout and major elements of main map area components

A) General layout (reduced format)



NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) List of major map elements and feature group in the main map area

SMC-1) BASE MAP FEATURES

Map Element	Feature Type
POLYGON	Water bodies/Wetlands
LINE	Map frame Coordinate grid Elevation contour Stream/drainage Transportation Boundaries
SYMBOL	Places

NB. 1) Detailed component list with cartographic attribute is shown in section IX

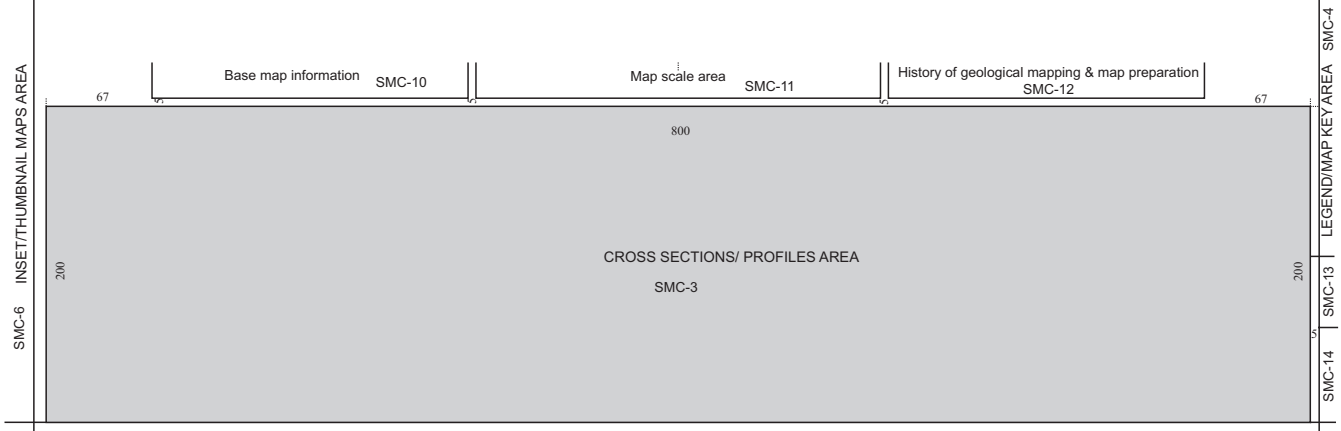
SMC-2) GEOLOGIC FEATURES

Map Element	Feature Type
POLYGON	Lithostratigraphic/ Lithologic unit
LINE	Lithologic contact Megascopic fault structure Megascopic fold structure Lineament Miscellaneous geologic features
SYMBOL	Field measured planar structures Field measured linear structures Volcanic features Fluvial/alluvial features Paleontological/fossil features Geologic resource indication sites

NB. 2) Detailed component list with cartographic attribute is shown in sections III-VIII and X

II-4) General layout, content and cartographic attributes for geologic cross sections/ profiles

A) General layout (reduced format)

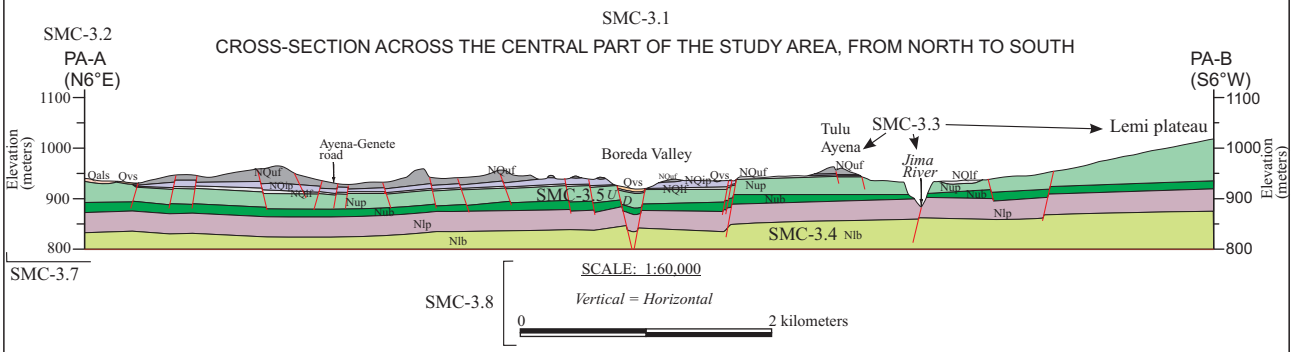


NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) Content and cartographic attributes

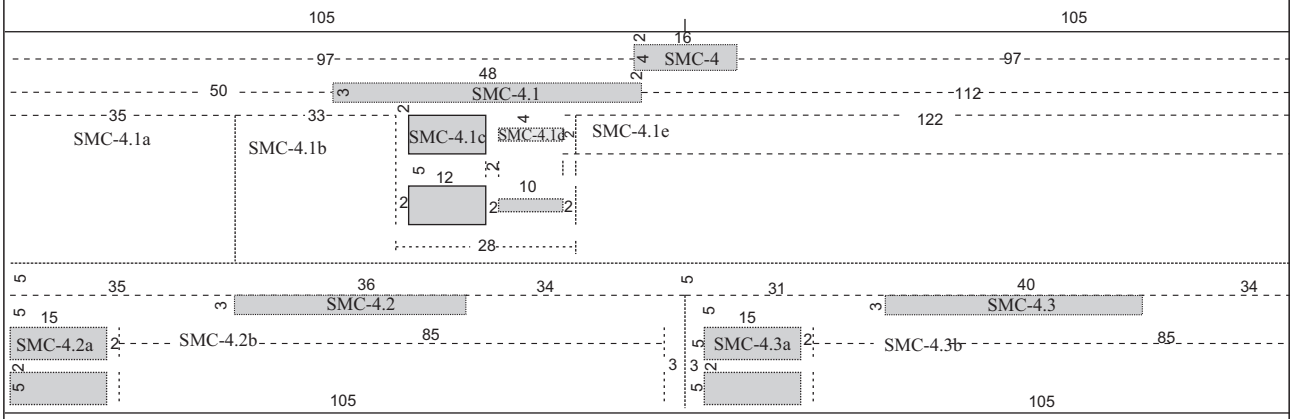
CODE	COMPONENT NAME/CONTENTS	FEATURE TYPE	ATTRIBUTE
SMC-3	Cross section		
	1) Title for the profile section	TEXT	1) Arial, normal 7 & capital
	2) Compass direction for section ends	TEXT	2) Arial, bold 7 & capital
	3) Reference localities, rivers, roads, etc.	TEXT	3) TNR, normal 6-7 & rivers in italics
	4) Lithology polygons with letter symbols	REGIONS, TEXT	4) Similar to map area, reduce font size to 5 where appropriate
	5) Direction of relative displacement along faults	SYMBOLS, TEXT	5) Similr to map area, TNR, normal 7
	6) Stratigraphic and/or structural correlation lines	LINES, TEXT	6) Line weight 0.2-0.3mm & black, TNR, normal 6
	7) Vertical elevation scale marks at section ends	LINES, TEXT	7) Line weight 0.175-0.2mm & tick marks 1-2mm, TNR, normal 6
	8) Horizontal and vertical scales, in both numeric and visual format	LINES, TEXT	7) TNR normal 6, lineweight 0.15mm, scale distance range 0-5km (for 1:250,000 geologic maps)

C) Example



II-5) General layout, content and cartographic attributes for legend (map key) components

A) General layout (reduced format)



NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) Content and cartographic attributes

CODE	COMPONENT NAME	FEATURE TYPE & ATTRIBUTE	CONTENT & APPEARANCE	REMARK
SMC-4	Title	TEXT Arial bold, underlined, 10 & capital	**LEGEND**	Align text center
SMC-4.1	Sub title	TEXT Arial normal, 9 & capital	LITHOSTRATIGRAPHIC UNITS	Align text center
SMC-4.1a	Geologic time scale 1) EON 2) ERA 3) Period 4) Epoch 5) Age (Stage)	TEXT & LINE 1) Arial normal, 10 & capital 2) Arial bold, 9 & capital 3) Arial bold, 9 4) Arial normal, 8 5) Arial normal, 7	PHANEROZOIC MESOZOIC Jurassic Lower Jurassic	The first three geologic ages should be aligned vertical and the last two horizontal Geologic time scale according to recommendation of International Union of Geological Sciences (IUGS) as shown in section III.
SMC-4.1b	Formation/Group	Times New Roman normal, 8 (Formal) *Times New Roman italics, 8 (Informal)*	Lower Hamenli	Include both formal (Previous) and informal (New) names
SMC-4.1c	Lithology Box	REGION Color filled Rectangle, 12mm long (horizontal) 6mm wide (vertical) and boundary line weight 0.15 mm		Color fill is inherited from the map area, following schemes in section IV
SMC-4.1d	Lithologic symbol	TEXT Times New Roman normal, 7	J1h	Lithologic symbol is inherited from the map area
SMC-4.1e	Lithologic description	TEXT Times New Roman normal, 7	Grey brown, shaly limestone & fine grained skeletal limestone	Describe main property of lithologies not rock type
SMC-4.2	Sub title	TEXT Arial normal, 9 & capital	GEOLOGIC SYMBOLS	Align text center
SMC-4.2a	Symbol	SYMBOL With or without text		Symbol attribute as in the map area, following standards in section X
SMC-4.2b	Symbol explanation	TEXT Times New Roman normal, 7		Follow standards of map features
SMC-4.3	Sub title	TEXT Arial normal, 9 & capital	GEOGRAPHIC SYMBOLS	Align text center
SMC-4.3a	Symbol	SYMBOL With or without text		Symbol attribute as in the map area, following standards in section IX
SMC-4.3b	Symbol explanation	TEXT Times New Roman normal, 7		Follow standards of map features

II-6) General layout, content and cartographic attributes for inset map components

SMC-5 **INSET MAPS**

SMC-5.1 **LOCATION**

SMC-5.1A
Location map
(Graphics)
1:20,000,000
(95X85)

SMC-5.1A1
Index of adjacent topographic maps
(Graphics)
1:10,000,000

1) Boundaries of 8 adjacent topomap sheets
2) Location of the study area
3) Name of each map sheet
4) Index no. of each map sheet
5) Geographic coordinate
6) Map scale (Numeric & visual)

1) Horn of African regions
2) Location of the study area
3) Main & secondary acess routes to the area
4) Main places along the routes including capital city
5) Coordinate frame
6) Legend
7) Map scale (Numeric & visual)

SMC-5.1B Explanation (Text)

1) Relative location of the study area in refernce to capital city
2) Region/s in which the study area is found
3) Limits of the area in both geographic and UTM coordinates
4) Size of the area in sqkm, specifying measuring system (spherical / cartesian)

SMC-5.2 **PHYSIOGRAPHY**

SMC-5.2A
Physiographic map
(Graphics)
1:1,250,000
(140X95)

1) Phsiographic divisions
2) Drainage system & basin
3) Coordinate frame
4) Legend
5) Map scale (Numeric & visual)

SMC-5.2B Explanation (text)

1) List of physiographic divisions
2) Morphological characters of each division
3) General feature of drainage basin and related stream courses
4) Type of drainage network & relation with geology-structure

SMC-5.3 **LITHOLOGIC DOMAINS**

SMC-5.3A
Lithologic domains map
(Graphics)
1:1,000,000
(180X120)

1) Lithostratigraphic/lithotectonic divisions
2) Major structural trends
3) Crossection/profile lines shown in the main map area
4) Important places
5) Coordinate frame
6) Legend
7) Map scale (Numeric & visual)

SMC-5.3B Explanation (text)

1) Basis of division
2) List of divisions & typical characteristics
3) Significant stratigraphic features (discovered)
4) Stratigraphic correlation diagram, not shown in main map legend
5) Types and nature of significant structural features

SMC-5.4 **NATURAL RESOURCES**

SMC-5.4A
Natural resources map
(Graphics)
1:1,000,000
(180X120)

1) Regions/zones of major economic mineral deposits
2) Major rock alteration trends/zones with mineralization
3) Trends of mineralized veins, pegmatites, etc
4) Spot sites of economic mineral indications
5) Spots of spring, geothermal sites, etc
6) Coordinate frame
7) Legend
8) Map scale (Numeric & visual)

SMC-5.4B Explanation (text)

1) List of natural resources, metallic, industrial, construction, etc
2) Characteristics of the resources indicating dimension
3) Nature of alteration zones and relation to geology-structure
4) Characteristics of small scale intrusions and relation with host

SMC-5.5 **RELIABILITY**

SMC-5.5A
Reliability diagram
(Graphics)
1:1,500,000
(115X80)

1) Regions of variable traverse conditions/ data source (if any)
2) Traverses routes
3) Coordinate frame
4) Legend
5) Map scale (Numeric & visual)

SMC-5.6 **AIR PHOTO INDEX**

SMC-5.6A
Air photo flight diagram
(Graphics)
1:1,500,000
(115X80)

1) Principal points of aerial photographs
2) Flight paths
3) Scenes of landsat image covering the area
4) Coordinate frame
5) Legend
6) Map scale (Numeric & visual)

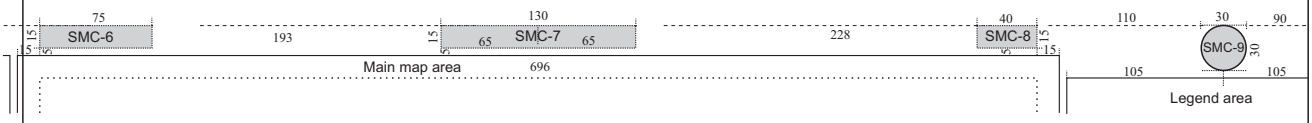
SMC-5.7 **SUBSHEETS INDEX**

SMC-5.7A
Topomap subsheets diagram (Graphics)
1:1,500,000
(115X80)

1) Regions of individual subsheets
2) Name of each subsheet
3) Index no. of each subsheet
4) Boundaries of each maaping team area
5) Coordinate frame
6) Legend
7) Map scale (Numeric & visual)

II-7) General layout, content and cartographic attributes for first row (top) geologic map components

A) General layout (reduced)



NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) Content and cartographic attributes

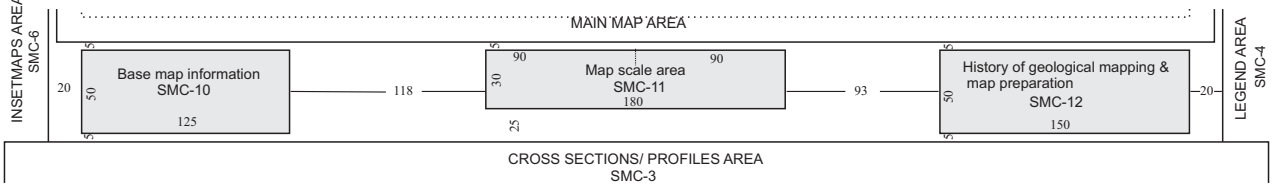
CODE	COMPONENT NAME	FEATURE TYPE and ATTRIBUTE	CONTENT AND APPEARANCE
SMC-6	Country and organization	TEXT Arial Normal, 8 Arial Normal, 9 Arial Normal, 11 All capital	FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA MINISTRY OF MINES AND ENERGY GEOLOGICAL SURVEY OF ETHIOPIA
SMC-7	Map title	TEXT Arial bold, 18 capital	**GEOLOGIC MAP OF XXXXXXX AREA**
SMC-8	Report number	TEXT Arial Normal, 9 Capital	ACCOMPANYING REPORT MEMOIR 000
SMC-9	Logo	RASTER Bitmap/Jpg format, colored (CMYK), 30 mm in diameter	

XXXXXXX Name of study area (topographic map sheet)

000 Memoir serial number

II-8) General layout, content and cartographic attributes for geologic map components, below main map area

A) General layout (reduced format)



NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) Content and cartographic attributes

COMPONENT NAME/CONTENTS FEATURE TYPE & ATTRIBUTE	COMPONENT NAME/CONTENTS FEATURE TYPE & ATTRIBUTE	COMPONENT NAME/CONTENTS FEATURE TYPE & ATTRIBUTE
SMC-10 Base map information 1) Base map provider and address 2) Map series, edition & year of publication 3) Sheet index no. & name 4) Horizontal & vertical datum 5) Projection & grid 6) Comments on amendments made (if any) 7) Disclaimer note on country/region boundraies (if any) All TEXT Use TNR normal 8-9	SMC-11 Map scale 1) Numeric scale (Ratio) 2) Visual scale (scale bar) in kilometers 3) Visual scale (scale bar) in miles TEXT Use TNR bold-underline/ normal 11 LINES, TEXT Use line weight 0.2 & 0.4 mm, TNR normal 8-9	SMC-12 History of geological mapping and map preparation 1) List of geological mapping teams & year of project 2) Compiler/s name & year of field checking 3) Draft map maker & year 4) Final map maker & year 5) Department/section All TEXT Use Arial bold/normal 8-9

C) Example

SMC-10

Base map from Ethiopian mapping Agency, P.O.Box , Addis Ababa, Ethiopia
Tel., , email: website:

Map series: EMA 3, Edition 1, 1979

Sheet Index: NB 37-15
Sheet Name: WACHILE

Horizontal Datum: Adindan
Vertical Datum: Mean sea level
Spheroid: WGS 1984
Projection: Universal Transverse Mercator (UTM)
Grid zone: 37 N

Amendments: Some place & river names has been modified from information provided by local people, during geological mapping

Disclaimer: The delineation of international or regional boundaries on this map is not authoritotive

SMC-11

SCALE

1:250,000

5 0 5 0 15 20 25 KILOMETERS

5 0 5 10 15 20 MILES

0.2mm 0.4mm

SMC-12

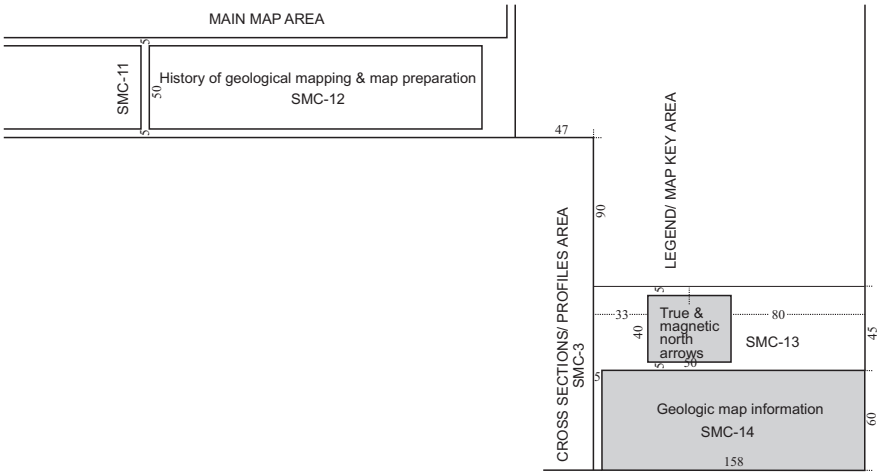
Geological mapping by: Tadesse Alemu, Ilfious Tesfaye, Ferede Chumbro, Lulu Tsige, Getahun Seid, Endashaw Hailu, Takele Chekole, Kinini Woldemariam, Tsegay Hailu, Aweke Neussie, Tsgaye Abebe, Daniel Meshesha, Bizuayehu Ayele, Solomon Gera, Wokineh Haro, Assaye Woldu, Tesfaye Demisse, Ezedin Abdulahi, Ashebir Wolde Giorgis (2000-2001)

Field geological checking by: Bedru Hussien and Tewodros Nigussie (2002-2003)
Draft mosaic geological map compiled by: Bedru Hussien and Tewodros Nigussie (2002-2003)
Geological map produced by: Bedru Hussien (2005)

REGIONAL GEOLOGY AND GEOCHEMISTRY DEPARTMENT

II-9) General layout, content and cartographic attributes for bottom-right geologic map components

A) General layout (reduced format)



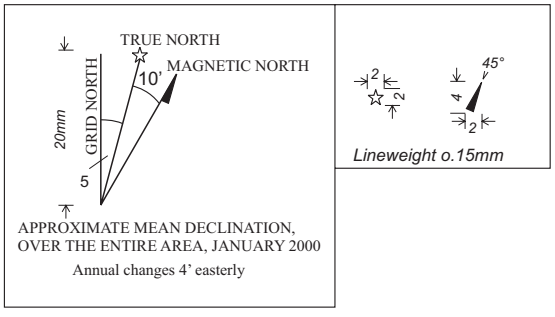
NB. 1) This map layout is not to scale of actual printing size.
2) Numeric figures are distance measurements in millimeter according to scale.

B) Content and cartographic attributes

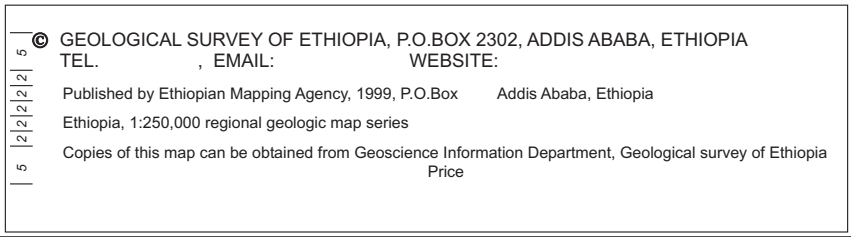
CODE	COMPONENT NAME/CONTENTS	FEATURE TYPE and ATTRIBUTE	
SMC-13	True & magnetic north arrows		
	1) Direction of grid north	LINE, TEXT	Line weight 0.2mm, length 20mm, TNR normal 6, capital
	2) True north arrow	ARROW, TEXT	Line weight 0.2mm, length 20mm, arrow head star sign (2mm diameter, line aeight 0.15mm), TNR normal 6, capital
	3) Magnetic north arrow	ARROW, TEXT	Line weight 0.2mm, length 20mm, half arrow (4x1mm, line weight 0.15mm) head facing future decliniation direction, TNR normal 6, capital
	4) Declination mark and angle	LINE, TEXT	Line weight 0.15mm, TNR normal 7
	5) Reference & year	TEXT	TNR normal 7 & capital
	6) Comments on further declination variation	TEXT	TNR normal 7
SMC-14	Geologic map information		
	1) Copy right symbol, organization & address	SYMBOL, TEXT	Line weight .15mm, 2mm in diameter, Arial normal 7 & capital
	2) Publisher, address & year		
	3) Geologic map series	All TEXT	Arial normal 6
	4) Price		
	5) Geologic map provider (sales) & address		

C) Example

SMC-13



SMC-14



INTERNATIONAL GEOLOGIC TIME SCALE AND COLOR SCHEME FOR GEOLOGIC AGE UNITS

III-1) International geologic time scale (modified from International Stratigraphic Chart)

1	2	3	4		5	Lower age
EON	ERA	Period	Epoch		Age	(My)
PHANEROZOIC (PH)	CENOZOIC (CZ)	Quaternary (Q)	Holocene (Q2)		Holocene	0.0118
			Pleistocene (Q1)		Upper Pleistocene	0.126
					Middle Pleistocene	0.781
					Lower Pleistocene	1.806
		Tertiary (T) Neogene (N)	Pliocene (N2)	L	Gelasian	2.588
					Piacenzian	3.6
				E	Zanclean	5.332
			Miocene (N1)	L	Messinian	7.246
					Tortonian	11.608
				M	Serravallian	13.65
					Langhian	15.97
				E	Burdigalian	20.43
					Aquitanian	23.03
		Tertiary (T) Paleogene (E)	Oligocene (E3)	L	Chattian	28.4 ±0.1
				E	Rupelian	33.9 ±0.1
			Eocene (E2)	L	Priabonian	37.2 ±0.1
				M	Bartonian	40.4 ±0.2
					Lutetian	48.6 ±0.2
				E	Ypresian	55.8 ±0.2
			Paleocene (E1)	L	Thanetian	58.7 ±0.2
					Selandian	61.7 ±0.2
				E	Danian	65.5 ±0.3
	MESOZOIC (MZ)	Cretaceous (K)	Upper Cretaceous (K2)	L	Maastrichtian	70.6 ±0.6
					Campanian	83.5 ±0.7
					Santonian	85.8 ±0.7
					Coniacian	89.3 ±1.0
					Turonian	93.5 ±0.8
					Cenomanian	99.6 ±0.9
			Lower Cretaceous (K1)	E	Albian	112.0 ±1.0
					Aptian	125.0 ±1.0
					Barremian	130.0 ±1.5
					Hauterivian	136.4 ±2.0
					Valanginian	140.2 ±3.0
					Berriasian	145.5 ±4.0
		Jurassic (J)	Upper Jurassic (J3)	L	Tithonian	150.8 ±4.0
					Kimmeridgian	155.7 ±4.0
					Oxfordian	161.2 ±4.0
			Middle Jurassic (J2)	M	Callovian	164.7 ±4.0
					Bathonian	167.7 ±3.5
					Bajocian	171.6 ±3.0
					Aalenian	175.6 ±2.0
			Lower Jurassic (J1)	E	Toarcian	183.0 ±1.5
					Pliensbachian	189.6 ±1.5
					Sinemurian	196.5 ±1.0
					Hettangian	199.6 ±0.6
		Triassic (T)	Upper Triassic (T3)	L	Rhaetian	203.6 ±1.5
					Norian	216.5 ±2.0
					Carnian	228.0 ±2.0
			Middle Triassic (T2)	M	Ladinian	237.0 ±2.0
					Anisian	245.0 ±1.5
			Lower Triassic (T1)	E	Olenekian	249.7 ±0.7
					Induan	251.0 ±0.4
	PALEOZOIC (PZ)	Permian (P)	Lopingian (P3)	L	Changhsingian	253.8 ±0.7
					Wuchiapingian	260.4 ±0.7
			Guadalupian (P2)		Capitanian	265.8 ±0.7
					Wordian	268.0 ±0.7
					Roadian	270.6 ±0.7
			Cisuralian (P1)	E	Kungurian	275.6 ±0.7
					Artinskian	284.4 ±0.7
					Sakmarian	294.6 ±0.8
					Asselian	299.0 ±0.8

III-1) International geologic time scale (contd.)

1	2	3	4		5	Lower age
EON	ERA	Period	Epoch		Age	(My)
PHANEROZOIC (PH)	PALEOZOIC (P)	Carboniferous (C)	Pennsylvanian (C2) L	U	Gzhelian	303.9 ±0.9
					Kasimovian	306.5 ±1.0
				M	Moscovian	311.7 ±1.1
				L	Bashkirian	318.1 ±1.3
			Missisippian (C1) E	U	Serpukhovian	326.4 ±1.6
				M	Visean	345.3 ±2.1
				L	Tournaisian	359.2 ±2.5
		Devonian (D)	Upper Devonian (D3) L		Famennian	374.5 ±2.6
					Frasnian	385.3 ±2.6
			Middle Devonian (D2) M		Givetian	391.8 ±2.7
					Eifelian	397.5 ±2.7
			Lower Devonian (D1) E		Emsian	407.0 ±2.8
					Pragian	411.2 ±2.8
					Lochkovian	416.0 ±2.8
		Silurian (S)	Pridoli (S4)		Pridolian	418.7 ±2.7
			Ludlow (S3)		Ludfordian	421.3 ±2.6
					Gorstian	422.9 ±2.5
			Wenlock (S2)		Homerian	426.2 ±2.4
					Sheinwoodian	428.2 ±2.3
			Llandovery (S1)		Telychian	436.0 ±1.9
					Aeronian	439.0 ±1.8
					Rhuddanian	443.7 ±1.5
		Ordovician (O)	Upper Ordovician (O3)		Hirnantian	445.6 ±1.5
					Stage 6	455.8 ±1.6
					Stage 5	460.9 ±1.6
			Middle Ordovician (O2)		Darriwilian	468.1 ±1.6
					Stage 3	471.8 ±1.6
			Lower Ordovician (O1)		Stage 2	478.6 ±1.7
					Tremadocian	488.3 ±1.7
		Cambrian (Ca)	Furongian (Ca3)		Stage 10	~ 492.0 *
					Stage 9	~ 496.0 *
					Paibian	501.0 ± 2.0
			Series 3 (Ca2)		Stage 7	~ 503.0 *
					Stage 6	~ 506.5 *
					Stage 5	~ 510.0 *
			Series 2 (Ca1)		Stage 4	~ 517.0 *
					Stage 3	~ 521.0 *
			Series 1 (Ca1)		Stage 2	~ 534.6 *
					Stage 1	542.0 ±1.0

NB. ***Tertiary (T)*** **(usage according to Geological Society of America)**

0	1		2	3	Lower age
	EON		ERA	Period	(My)
PRECAMBRIAN (PC)	PROTEROZOIC (PR)	L	NEOPROTEROZOIC (NP)	Ediacaran	630
				Cryogenian	850
				Tonian	1000
		M	MESOPROTEROZOIC (MP)	Stenian	1200
				Ecatasian	1400
				Calymmian	1600
		E	PALEAOPROTEROZOIC (PP)	Statherian	1800
				Orosirian	2050
				Rhyacian	2300
				Siderian	2500
	ARCHEAN (AR)	L	NEOARCHEAN (NA)		2800
		M	MESOARCHEAN (MA)		3200
			PALEOARCHEAN (PA)		3600
		E	EOARCHEAN (EA)		Undefined (> 3600)

NB. U-upper, M-middle, L-lower (Subdivisions of Epoch according to the convention of International stratigraphic commission)
L-late, M-middle, E-early (Subdivisions of Epoch according to the convention of Geological Society of America)

III-2) Color fill scheme for geologic ages (modified from world geologic map color)

SN.	Ob ID	Time Division	Name	Lower age (my)	Color Code	Color combination Red	Green	Blue	Color Sample	Letter Symbol
1	5	Age	Recent							
2	4	Epoch	Holocene	0.0118	SC-1	255	251	240		Q2
3	5	Age	Upper Pleistocene	0.126						
4	5	Age	Middle Pleistocene	0.781						
5	5	Age	Lower Pleistocene	1.806						
6	4	Epoch	Pleistocene	1.806	SC-2	255	247	176		Q1
7	3	**Period**	**Quaternary**	**2.588**	SC-3	**254**	**230**	**146**		**Q**
8	5	Age	Gelasian	2.588						
9	5	Age	Piacenzian	3.6						
10	5	Age	Zanclean	5.332						
11	4	Epoch	Pliocene	5.332	SC-4	255	255	153		N2
12	5	Age	Messinian	7.246						
13	5	Age	Tortonian	11.608						
14	5	Age	Serravallian	13.65						
15	5	Age	Langhian	15.97						
16	5	Age	Burdigalian	20.43						
17	5	Age	Aquitanian	23.03						
18	4	Epoch	Miocene	23.03	SC-5	255	255	0		N1
19	3	**Period**	**Neogene**	**23.03**	SC-6	**255**	**232**	**0**		**N**
20	5	Age	Chattian	28.4 ±0.1						
21	5	Age	Rupelian	33.9 ±0.1						
22	4	Epoch	Oligocene	33.9 ±0.1	SC-7	254	224	144		E3
23	5	Age	Priabonian	37.2 ±0.1						
24	5	Age	Bartonian	40.4 ±0.2						
25	5	Age	Lutetian	48.6 ±0.2						
26	5	Age	Ypresian	55.8 ±0.2						
27	4	Epoch	Eocene	55.8 ±0.2	SC-8	254	209	59		E2
28	5	Age	Thanetian	58.7 ±0.2						
29	5	Age	Selandian	61.7 ±0.2						
30	5	Age	Danian	65.5 ±0.3						
31	4	Epoch	Paleocene	65.5 ±0.3	SC-9	235	192	109		E1
32	3	**Period**	**Paleogene**	**65.5 ±0.3**	SC-10	**253**	**154**	**82**		**E**
33	2	**ERA**	**CENOZOIC**	**65.5 ±0.3**	SC-11	**250**	**253**	**1**		**CZ**
34	5	Age	Maastrichtian	70.6 ±0.6						
35	5	Age	Campanian	83.5 ±0.7						
36	5	Age	Santonian	85.8 ±0.7						
37	5	Age	Coniacian	89.3 ±1.0						
38	5	Age	Turonian	93.5 ±0.8						
39	5	Age	Cenomanian	99.6 ±0.9						
40	4	Epoch	Upper Cretaceous	99.6 ±0.9	SC-12	226	243	152		K2
41	5	Age	Albian	112.0 ±1.0						
42	5	Age	Aptian	125.0 ±1.0						
43	5	Age	Barremian	130.0 ±1.5						
44	5	Age	Hauterivian	136.4 ±2.0						
45	5	Age	Valanginian	140.2 ±3.0						
46	5	Age	Berriasian	145.5 ±4.0						
47	4	Epoch	Lower Cretaceous	145.5 ±4.0	SC-13	65	170	84		K1
48	3	**Period**	**Cretaceous**	**145.5 ±4.0**	SC-14	**197**	**229**	**71**		**K**
49	5	Age	Tithonian	150.8 ±4.0						
50	5	Age	Kimmeridgian	155.7 ±4.0						
51	5	Age	Oxfordian	161.2 ±4.0						
52	4	Epoch	Upper Jurassic	161.2 ±4.0	SC-15	179	226	230		J3
53	5	Age	Callovian	164.7 ±4.0						
54	5	Age	Bathonian	167.7 ±3.5						
55	5	Age	Bajocian	171.6 ±3.0						
56	5	Age	Aalenian	175.6 ±2.0						
57	4	Epoch	Middle Jurassic	175.6 ±2.0	SC-16	179	215	232		J2
58	5	Age	Toarcian	183.0 ±1.5						
59	5	Age	Pliensbachian	189.6 ±1.5						
60	5	Age	Sinemurian	196.5 ±1.0						
61	5	Age	Hettangian	199.6 ±0.6						
62	4	Epoch	Lower Jurassic	199.6 ±0.6	SC-17	0	160	198		J1
63	3	**Period**	**Jurassic**	**199.6 ±0.6**	SC-18	**226**	**244**	**224**		**J**

III-2) Color fill scheme for geologic ages (Contd.)

SN.	Ob ID	Time Division	Name	Lower age (my)	Color Code	Color combination			Color Sample	Letter Symbol
						Red	Green	Blue		
64	5	Age	Rhaetian	203.6 ±1.5						
65	5	Age	Norian	216.5 ±2.0						
66	5	Age	Carnian	228.0 ±2.0						
67	4	Epoch	Upper Triassic	228.0 ±2.0	SC-19	228	197	225		T3
68	5	Age	Ladinian	237.0 ±2.0						
69	5	Age	Anisian	245.0 ±1.5						
70	4	Epoch	Middle Triassic	245.0 ±1.5	SC-20	177	137	193		T2
71	5	Age	Olenekian	249.7 ±0.7						
72	5	Age	Induan	251.0 ±0.4						
73	4	Epoch	Lower Triassic	251.0 ±0.4	SC-21	152	57	153		T1
74	3	**Period**	**Triassic**	**251.0 ±0.4**	SC-22	**107**	**1**	**125**		**T**
75	2	**ERA**	**MESOZOIC**	**251.0 ±0.4**	SC-23	**103**	**197**	**202**		**MZ**
76	5	Age	Changhsingian	253.8 ±0.7						
77	5	Age	Wuchiapingian	260.4 ±0.7						
78	4	Epoch	Lopingian	260.4 ±0.7	SC-24	250	154	163		P3
79	5	Age	Capitanian	265.8 ±0.7						
80	5	Age	Wordian	268.0 ±0.7						
81	5	Age	Roadian	270.6 ±0.7						
82	4	Epoch	Guadalupian	270.6 ±0.7	SC-25	240	150	82		P2
83	5	Age	Kungurian	275.6 ±0.7						
84	5	Age	Artinskian	284.4 ±0.7						
85	5	Age	Sakmarian	294.6 ±0.8						
86	5	Age	Asselian	299.0 ±0.8						
87	4	Epoch	Cisuralian	299.0 ±0.8	SC-26	202	60	64		P1
88	3	**Period**	**Permian**	**299.0 ±0.8**	SC-27	**240**	**64**	**40**		**P**
89	5	Age	Gzhelian	303.9 ±0.9						
90	5	Age	Kasimovian	306.5 ±1.0						
91	5	Age	Moscovian	311.7 ±1.1						
92	5	Age	Bashkirian	318.1 ±1.3						
93	4	Epoch	Pennsylvanian	318.1 ±1.3	SC-28	153	196	181		C2
94	5	Age	Serpukhovian	326.4 ±1.6						
95	5	Age	Visean	345.3 ±2.1						
96	5	Age	Tournaisian	359.2 ±2.5						
97	4	Epoch	Missisippian	359.2 ±2.5	SC-29	103	148	109		C1
98	3	**Period**	**Carboniferous**	**359.2 ±2.5**	SC-30	**103**	**171**	**160**		**C**
99	5	Age	Famennian	374.5 ±2.6						
100	5	Age	Frasnian	385.3 ±2.6						
101	4	Epoch	Upper Devonian	385.3 ±2.6	SC-31	204	206	169		D3
102	5	Age	Givetian	391.8 ±2.7						
103	5	Age	Eifelian	397.5 ±2.7						
104	4	Epoch	Middle Devonian	397.5 ±2.7	SC-32	153	165	109		D2
105	5	Age	Emsian	407.0 ±2.8						
106	5	Age	Pragian	411.2 ±2.8						
107	5	Age	Lochkovian	416.0 ±2.8						
108	4	Epoch	Lower Devonian	416.0 ±2.8	SC-33	153	148	73		D1
109	3	**Period**	**Devonian**	**416.0 ±2.8**	SC-34	**203**	**140**	**55**		**D**
110	5	Age	Pridolian	418.7 ±2.7						
111	4	Epoch	Pridoli	418.7 ±2.7	SC-35	245	251	240		S4
112	5	Age	Ludfordian	421.3 ±2.6						
113	5	Age	Gorstian	422.9 ±2.5						
114	4	Epoch	Ludlow	422.9 ±2.5	SC-36	226	244	224		S3
115	5	Age	Homerian	426.2 ±2.4						
116	5	Age	Sheinwoodian	428.2 ±2.3						
117	4	Epoch	Wenlock	428.2 ±2.3	SC-37	197	232	195		S2
118	5	Age	Telychian	436.0 ±1.9						
119	5	Age	Aeronian	439.0 ±1.8						
120	5	Age	Rhuddanian	443.7 ±1.5						
121	4	Epoch	Llandovery	443.7 ±1.5	SC-38	153	215	179		S1
122	3	**Period**	**Silurian**	**443.7 ±1.5**	SC-39	**179**	**226**	**208**		**S**

III-2) Color fill scheme for geologic ages (Contd.)

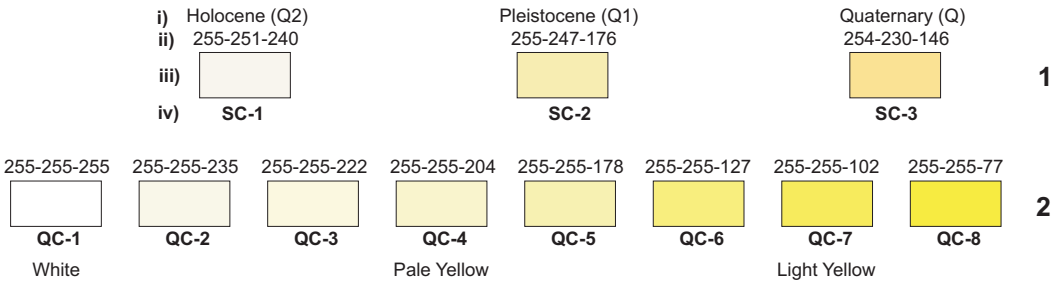
SN	Ob ID	Time Division	Name	Lower age (my)	Color Code	Color combination			Color Sample	Letter Symbol
						Red	Green	Blue		
123	5	Age	Himantian	445.6 ±1.5						
124	5	Age	Stage 6	455.8 ±1.6						
125	5	Age	Stage 5	460.9 ±1.6						
126	4	Epoch	Upper Ordovician	460.9 ±1.6	SC-40	102	192	146		O3
127	5	Age	Darriwilian	468.1 ±1.6						
128	5	Age	Stage 3	471.8 ±1.6						
129	4	Epoch	Middle Ordovician	471.8 ±1.6	SC-41	65	156	104		O2
130	5	Age	Stage 2	478.6 ±1.7						
131	5	Age	Tremadocian	488.3 ±1.7						
132	4	Epoch	Lower Ordovician	488.3 ±1.7	SC-42	1	128	85		O1
133	3	**Period**	**Ordovician**	**488.3 ±1.7**	SC-43	**0**	**146**	**112**		**O**
134	5	Age	Stage 10	~ 492.0 *						
135	5	Age	Stage 9	~ 496.0 *						
136	5	Age	Paibian	501.0 ± 2.0						
137	4	Epoch	Furongian	501.0 ± 2.0	SC-44	215	211	170		Ca3
138	5	Age	Stage 7	~ 503.0 *						
139	5	Age	Stage 6	~ 506.5 *						
140	5	Age	Stage 5	~ 510.0 *						
141	4	Epoch	Series 3	~ 510.0 *	SC-45	182	174	109		Ca2
142	5	Age	Stage 4	~ 517.0 *						
143	5	Age	Stage 3	~ 521.0 *						
144	4	Epoch	Series 2	~ 521.0 *	SC-46	102	169	75		Ca1
145	5	Age	Stage 2	~ 534.6 *						
146	5	Age	Stage 1	542.0 ±1.0						
147	4	Epoch	Series 1	542.0 ±1.0	SC-47	102	169	75		Ca1
148	3	**Period**	**Cambrian**	**542.0 ±1.0**	SC-48	**64**	**133**	**33**		**Ca**
149	2	**ERA**	**PALEOZOIC**	**542.0 ±1.0**	SC-49	**153**	**192**	**141**		**PZ**
150	1	EON	PHANEROZOIC	542.0 ±1.0	SC-50	154	217	229		PH

ID	AG	Division	Name	Lower age	Code	R	G	B	Sample	Symbol
151	3	**Period**	**Ediacaran**	**630**						
152	3	**Period**	**Cryogenian**	**850**						
153	3	**Period**	**Tonian**	**1000**						
154	2	**ERA**	**NEOPROTEROZOIC**	**1000**	SC-51	**254**	**179**	**67**		**NP**
155	3	**Period**	**Stenian**	**1200**						
156	3	**Period**	**Ecatasian**	**1400**						
157	3	**Period**	**Calymmian**	**1600**						
158	2	**ERA**	**MESOPROTEROZOIC**	**1600**	SC-52	**253**	**180**	**105**		**MP**
159	3	**Period**	**Statherian**	**1800**						
160	3	**Period**	**Orosirian**	**2050**						
161	3	**Period**	**Rhyacian**	**2300**						
162	3	**Period**	**Siderian**	**2500**						
163	2	**ERA**	**PALEOPROTEROZOIC**	**2500**	SC-53	**247**	**67**	**115**		**PP**
164	1	EON	PROTEROZOIC	2500	SC-54	251	154	148		PR
165	2	**ERA**	**NEOARCHEAN**	**2800**	SC-55	**249**	**155**	**197**		**NA**
166	2	**ERA**	**MESOARCHEAN**	**3200**	SC-56	**234**	**102**	**177**		**MA**
167	2	**ERA**	**PALEOARCHEAN**	**3600**	SC-57	**244**	**68**	**159**		**PA**
168	2	**ERA**	**EOARCHEAN**	**>3600**	SC-58	**218**	**2**	**127**		**EA**
169	1	EON	ARCHEAN	Undefined	SC-59	240	2	127		AR
170	0		PRECAMBRIAN	Undefined	SC-60	247	67	112		PC

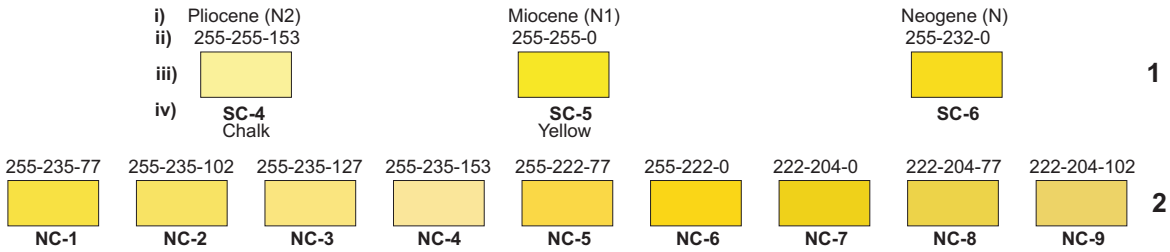
COLOR SCHEME FOR GEOLOGIC AGE UNITS RECORDED IN ETHIOPIA

IV-1) Color fill scheme for Cenozoic geologic time units of Ethiopia

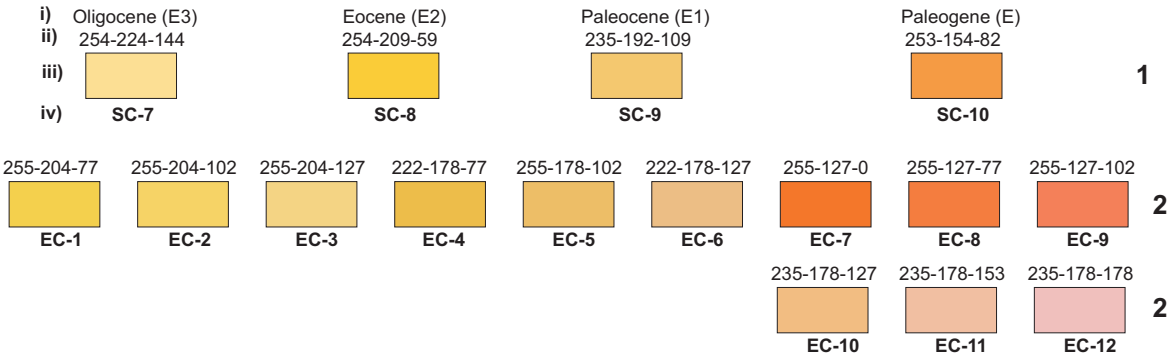
A) Quaternary



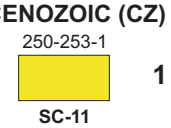
B) Neogene



C) Paleogene



D) CENOZOIC (CZ)

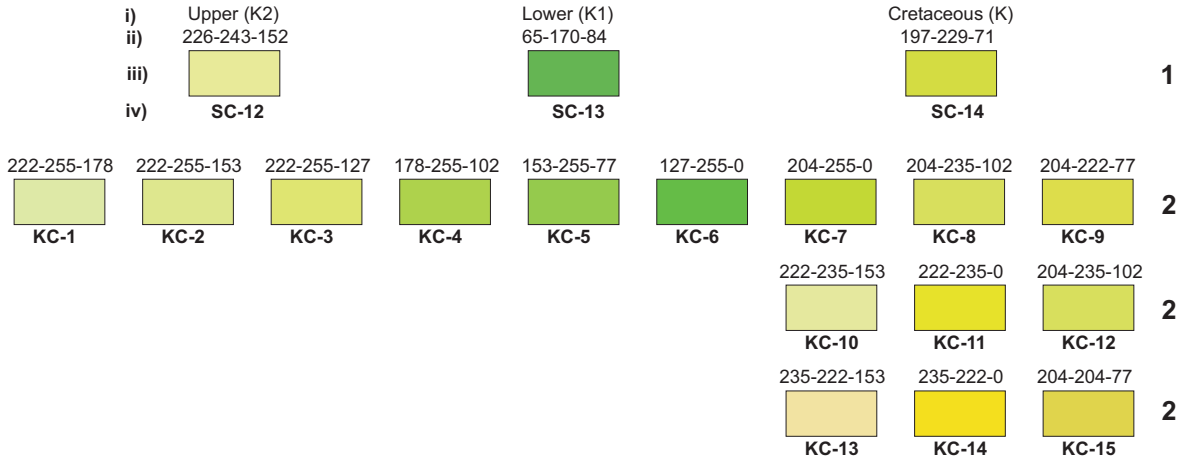


i) Lithology
ii) R-G-B combination
iii) Appearance
iv) Color code

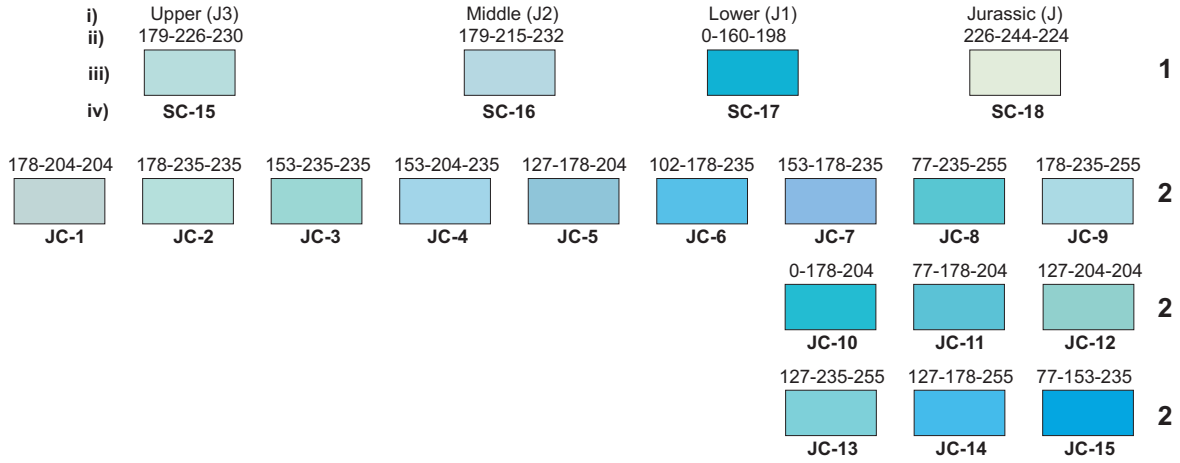
1- Color scheme, according to International Stratigraphic Commission
2- Color scheme, additionals

IV-2) Color fill scheme for Mesozoic geologic time units of Ethiopia

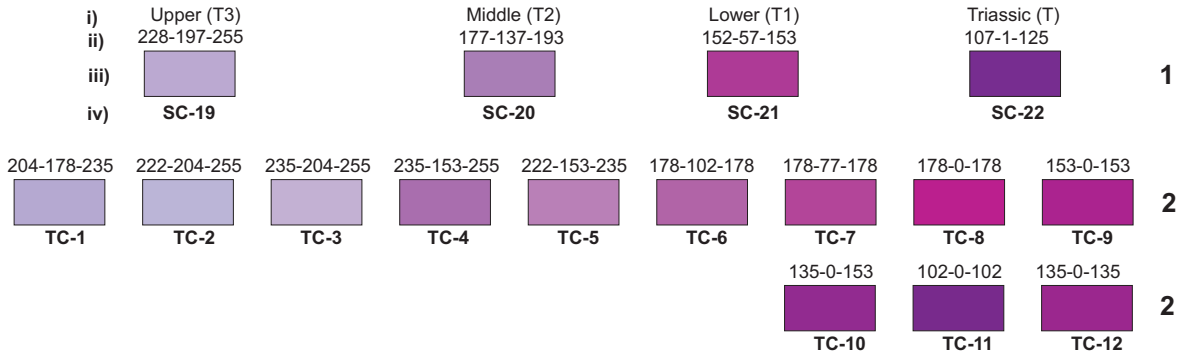
E) Cretaceous



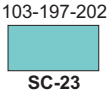
F) Jurassic



G) Triassic



H) MESOZOIC (MZ)



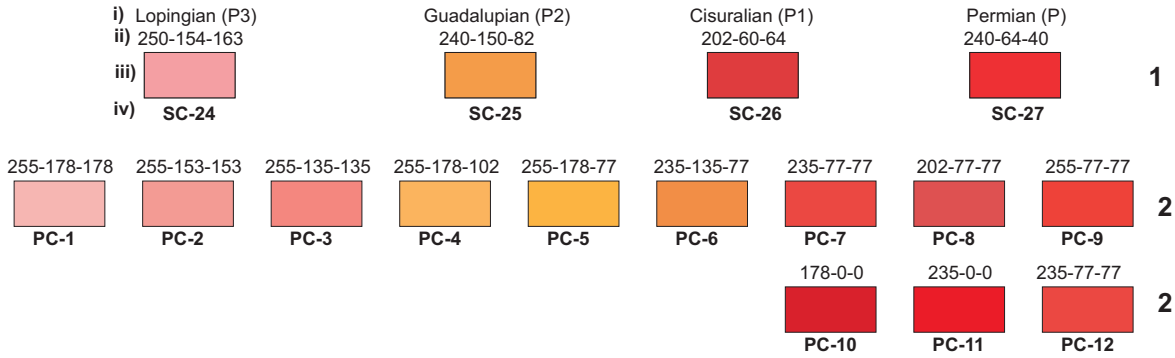
1- Color scheme, according to International Stratigraphic commission

2- Color scheme, additionals

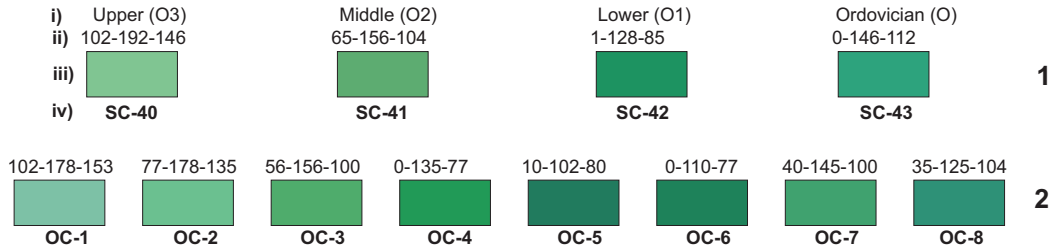
i) Lithology
ii) R-G-B combination
iii) Appearance
iv) Color code

IV-3) Color fill scheme for Paleozoic geologic time units of Ethiopia

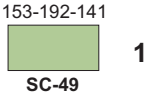
I) Permian



J) Ordovician



K) PALEOZOIC (PZ)



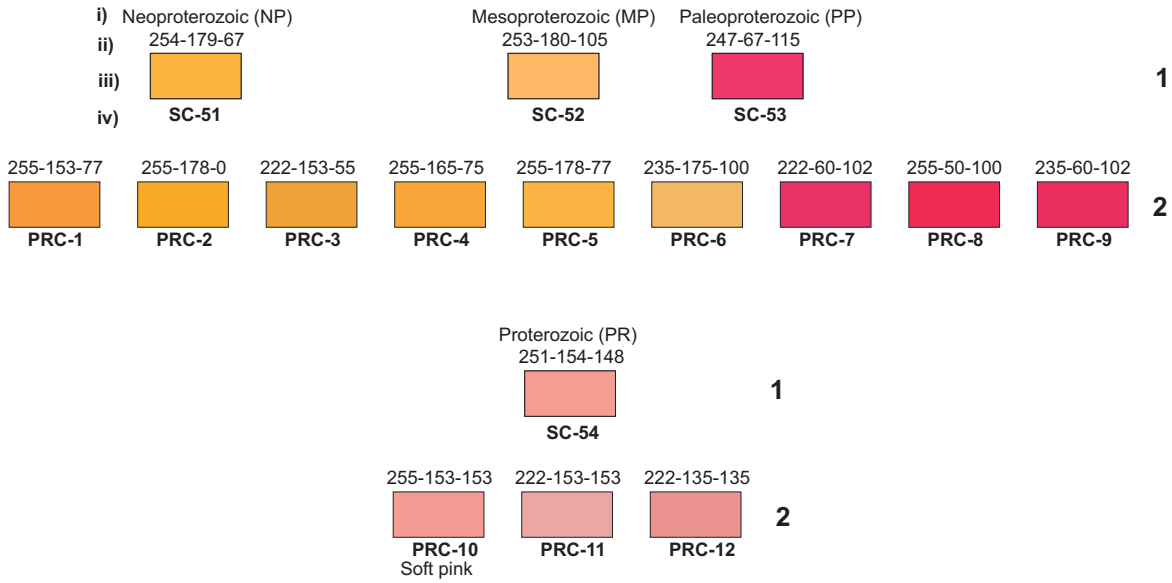
1- Color scheme, according to International Stratigraphic commission

2- Color scheme, additionals

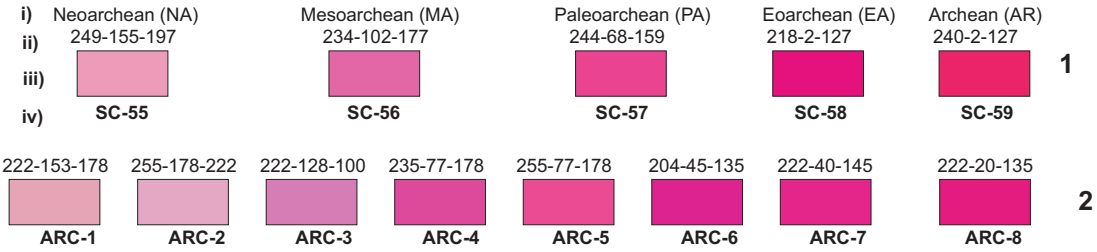
i) Lithology
ii) R-G-B combination
iii) Appearance
iv) Color code

IV-4) Color fill scheme for Precambrian geologic time units of Ethiopia

L) Proterozoic



M) Archean



N) PRECAMBRIAN (PC)

1- Color scheme, according to International Stratigraphic commission

2- Color scheme, additionals

i) Lithology
ii) R-G-B combination
iii) Appearance
iv) Color code

PATTERNS OVERPRINTING GEOLOGIC AGE COLORS OF ETHIOPIA

V-1) Foreground stipple & geometric pattern scheme overprinting geologic age colors

PATTERN TYPE AND ATTRIBUTE				PATTERN COLOR				REMARK
				Black-50b	Grey-20b	Cyan	Magenta	
Main feature	S.No.	Pattern type	Size (mm)	127-127-127	204-204-204	0-255-255	255-0-255	
Random, uniform size	1	Stipple	0.25	S1-b	S1-g	S1-c	S1-m	These are commonly used for unconsolidated superficial deposits, for both insitu weathering products and transported through much recent surficial processes. Fine stipples are suitable for smaller map units and coarser for larger map units. These patterns can also be applied to relatively consolidated clastic sedimentary rocks
	2	Stipple	0.50	S2-b	S2-g	S2-c	S2-m	
	3	Circle	1.00	S3-b	S3-g	S3-c	S3-m	
	4	Rectangle	1.00	S4-b	S4-g	S4-c	S4-m	
	5	Open, ellipse	0.5-0.6	S5-b	S5-g	S5-c	S5-m	
	6	Open, ellipse	1.25-0.75	S6-b	S6-g	S6-c	S6-m	
	7	Open, ellipse	1-1.4	S7-b	S7-g	S7-c	S7-m	
	8	Open, triangle	1 (at 60°)	S8-b	S8-g	S8-c	S8-m	
	9	Open, triangle	1.5 (at 60°)	S9-b	S9-g	S9-c	S9-m	
	10	Open, diamond	1-0.8	S10-b	S10-g	S10-c	S10-m	
Ordered, uniform size	11	Stipple	0.25	S11-b	S11-g	S11-c	S11-m	These patterns are suited for sedimentary rocks
	12	Stipple	0.50 (Heavy)	S12-b	S12-g	S12-c	S12-m	
	13	Stipple	0.50 (Light)	S13-b	S13-g	S13-c	S13-m	
	14	Open, ellipse	1-0.8	S14-b	S14-g	S14-c	S14-m	
Random, mixed shape	15	Stipples	0.25/0.50	S15-b	S15-g	S15-c	S15-m	These patterns are for metamorphosed sedimentary rocks
	16	Stipple/Circle	0.5/1.0	S16-b	S16-g	S16-c	S16-m	
	17	Open, ellipses	0.5/1.4	S17-b	S17-g	S17-c	S17-m	
Ordered, mixed shape	18	Open, ellipse/ circle	1-0.6/ 0.25	S18-b	S18-g	S18-c	S18-m	

V-2) Foreground line/rulling pattern scheme overprinting geologic age colors

PATTERN TYPE AND ATTRIBUTE				PATTERN COLOR				REMARK
				Black-50b	Grey-20b	Cyan	Magenta	
Main feature	S.No.	Pattern type	Size (mm)	127-127-127	204-204-204	0-255-255	255-0-255	
Uniform, equally alternate pattern	1	V. Fine	0.25	R1-b	R1-g	R1-c	R1-m	These are commonly used for alternating superficial deposits, sedimentary rocks and their metamorphosed equivalents
	2	Fine	0.50	R2-b	R2-g	R2-c	R2-m	
	3	Medium	1.00	R3-b	R3-g	R3-c	R3-m	
	4	Coarse	1.50	R4-b	R4-g	R4-c	R4-m	
	5	V. Coarse	2.00	R5-b	R5-g	R5-c	R5-m	
Non-uniform, unequally alternating pattern	6	V. Fine	0.5/0.25	R6-b	R6-g	R6-c	R6-m	The lines/rulling can be oriented vertically, at 45° or 135° depending upon outcrop pattern of map units
	7	Fine	0.75/0.25	R7-b	R7-g	R7-c	R7-m	
	8	Medium	1.00/0.25	R8-b	R8-g	R8-c	R8-m	
	9	Coarse	1.75/0.25	R9-b	R9-g	R9-c	R9-m	
	10	V. Coarse	2.75/0.25	R10-b	R10-g	R10-c	R10-m	
	11	Fine	1.0/0.5	R11-b	R11-g	R11-c	R11-m	
	12	Medium	1.5/0.5	R12-b	R12-g	R12-c	R12-m	
	13	Coarse	2.5/0.5	R13-b	R13-g	R13-c	R13-m	
Non-uniform, unequal shape	14	V. Coarse	1.5/1.0	R14-b	R14-g	R14-c	R14-m	
	15	Fine	0.5/ 0.5-0.25	R15-b	R15-g	R15-c	R15-m	
	16	Medium	1.0/ 0.5-0.25	R16-b	R16-g	R16-c	R16-m	
	17	Fine	0.25-0.5/ 0.25	R17-b	R17-g	R17-c	R17-m	
	18	Medium	0.5-1.0/ 0.5	R18-b	R18-g	R18-c	R18-m	

V-3) Foreground hachure and v's pattern scheme overprinting geologic age colors

PATTERN TYPE AND ATTRIBUTE				PATTERN COLOR				REMARK
Main feature	S.No.	Pattern type	Length & spacing (mm)	Black-50b 127-127-127	Grey-20b 204-204-204	Cyan 0-255-255	Magenta 255-0-255	
Uniform orientation	1	Hachure fine	2.0 H = 0.5 V = 1	Dh1-b	Dh1-g	Dh1-c	Dh1-m	
	2	Hachure medium	1.50 H = 1.0 V = 1.0	Dh2-b	Dh2-g	Dh2-c	Dh2-m	These can be applied for unconsolidated superficial deposits, sedimentary rocks and some may be used for welded tuffs.
	3	Hachure medium	1.0 H = 1.0 V = 1.0	Dh3-b	Dh3-g	Dh3-c	Dh3-m	
	4	Hachure coarse	1.0 H = 1.0 V = 2.0	Dh4-b	Dh4-g	Dh4-c	Dh4-m	Orientation of these hachures can be vertical, at 45° or 135°
	5	Hachure fine	1.0 H = 1.0 V = 1.0	Dh5-b	Dh5-g	Dh5-c	Dh5-m	
	6	Hachure fine	1.5-2.0 H = 1.0-0.5 V = 1.0	Dh6-b	Dh6-g	Dh6-c	Dh6-m	
Non-uniform orientation Ordered	7	Hachure fine	1.0 H = 0.8-1.0 V = 0.6-0.75	Rh1-b	Rh1-g	Rh1-c	Rh1-m	These hachures are mainly for pyroclastic rocks and may also be used for minor intrusive units
	8	Hachure medium	2.0 (variable)	Rh2-b	Rh2-g	Rh2-c	Rh2-m	
	9	Hachure fine	1.0 (variable)	Rh3-b	Rh3-g	Rh3-c	Rh3-m	
Non-uniform orientation Ordered	10	Hachure fine	1.0 H = 0.5-1.0 V = 0.5-0.75	Rh4-b	Rh4-g	Rh4-c	Rh4-m	These are mainly for intrusive/plutonic rocks, metamorphic hornfelses and granofelses
	11	Hachure coarse	1.0 (variable)	Rh5-b	Rh5-g	Rh5-c	Rh5-m	
	12	Hachure coarse	2.0 (variable)	Rh6-b	Rh6-g	Rh6-c	Rh6-m	
	13	Hachure fine	1.50 (variable)	Rh7-b	Rh7-g	Rh7-c	Rh7-m	
Uniform orientation Variable shape	14	Hachure special, fine	(variable)	Sh1-b	Sh1-g	Sh1-c	Sh1-m	These are mainly applied for metamorphic schists and gneisses. Note orientation can be vertical, horizontal or at 45°
	15	Hachure special, coarse	(variable)	Sh2-b	Sh2-g	Sh2-c	Sh2-m	
Non-uniform orientation	16	V's (60°) fine	1.0 (variable)	V1-b	V1-g	V1-c	V1-m	These are mainly applied for volcanic flows. Larger patterns are suited for lithologic units with larger aerial extent/older volcanic units and small patterns are for smaller volcanic map units/younger units
	17	V's (60°) medium	1.5 (variable)	V2-b	V2-g	V2-c	V2-m	
	18	V's (60°) coarse	2.0 (variable)	V3-b	V3-g	V3-c	V3-m	

LITHOSTRATIGRAPHIC UNITS OF ETHIOPIA AND MAP ATTRIBUTES

VI-1) Cenozoic lithostratigraphic units recognized in Ethiopia & associated map attribute

Geologic time 1	2	3	4	Formation	Letter Symbol	Description	International geotime color (1)	Color code 1	2	Local geotime color (2)
PHANEROZOIC	CENOZOIC	Quaternary	Recent (?)	*Unnamed*	Qus	Alluvial and lacustrine deposits: Sand, silt, clay, diatomite, limestone and beach sand		SC-3		
				Unnamed	Qub2	Transitional type between alkaline and tholeiitic				
				Unnamed	Qub1	Alkaline olivine basalt				
				Unnamed	Qub	Basalt flows,spatter cones and hyaloclastites				
				Plateau basalt	Qubp	Alkaline basalt and trachyte				
				Ghinir	Qg	Rhyolite with subordinate basalt				
			Holocene	*Unnamed*	Q2us	Undivided alluvial, lacustrine and beach sediments		SC-1		
				Unnamed	Q2ubt	Hawaiite, mugearite, trachyte, andesine basalt & ferrobasalt				
			Lower Pleistocene	*Unnamed*	Q1us	Alluvial, lacustrine and marine sediments:conglomerate, sand, clay, reef limestone, marl and gypsum		SC-2		
				Rhyolitic volcanic centers	Q1urc	Obsidian pitchstone, pumice, ignimbrite, tuff, subordinate trachytic flows (mainly peralkaline)				
				Dino	Q1d	Ignimbrite, tuff, coarse pumice, waterlain pyroclastic rocks with rare intercalations of lacustrine sediments				
				Bishoftu	Q1b	Alkaline basalt and trachyte				
		Neogene	Late Pliocene	Omo & Hadar	NQoh	Undivided Lacustrine and Fluvial Sediments: Sand, silt, gravel & conglomerate		SC-4		
				Mursi & Bofa	NQmb	Alkaline basalt				
			Miocene	Upper Chilalao	N1cu	Alkaline basalt		SC-5		
				Lower Chilalao	N1cl	Trachyte, trachy basalt, peralkaline rhyolite with subordinate akaline basalt				
				Danakil (Red Sea series)/ Chorora	N1dc	Conglomerate, sandstone, siltstone with intercalated basalt flows and lacustrine sediments				
				Nazret Series	N1ns	Ignimbrites,unwelded tuffs,ash flows, rhyolitic flows,domes and trachyte				
				Afar Series	N1as	Alkaline basalt with subordinate alkaline & peralkaline silicics (rhyolitic dome & flows, and ignimbrites)				
				Dalah	N1dh	Fissural basalts & hawaiites, minor intercalated detrital & lacustrine sediments, upper rhyolitic flows & ignimbrites				
				Tulu Wolele	N1tw	Trachyte with subordinate basalt				
				Mabla & Arba Guracha	N1ma	Rhyolitic domes,flows and pyroclastic rocks mainly peralkaline with lower minor trachyte and basalt flows				
				Teltele & Surma	N1ts	Flood basalts				
		Paleogene	Oligocene	Adwa	ENad	Trachyte and phonolite plug		SC-6		
				Arsi & Bale	ENab	Flood basalts often connected to volcanic edifices, silisic on top				
				Tarmaber-Megezez	E3tm	Transitional and alkaline basalt		SC-7		
				Tarmaber-Gussa	E3tg	Alkaline to transitional basalts (shield volcanoes) with minor trachyte and phonolite flows				
			Eocene	Alaje	E2aj	Transitional and subalkaline basalts with minor rhyolite and trachyte eruptives		SC-8		
				Makonnen	E2mn	Flood basalts, commonly directly overlaying the crystalline basement				
				Aiba	E2ai	Flood basalts with rare basic tuff.				
				Upper Jimma	E2ju	Rhyolite and trachyte flows and tuff with minor basalt				
				Lower Jimma	E2jl	Flood basalt with minor salic flows				
				Ashangi / Akobo	E2as	Deeply weathered, tilted alkaline and trasitional basalt flows with rare intercalations of tuff				
				Karkar	E2k	Limestone with marly intercalations		SC-9		
				Taleh	E2t	Anhydrite, gypsum, dolomite and clay				
				Auradu	E2a	Limestone				
				Jessoma	E2j	Sandstone				

VI-2) Mesozoic-Paleozoic lithostratigraphic units recognized in Ethiopia & associated map attribute

Geologic time 1	2	3	4	Formation	Letter Symbol	Description	International geotime color (1)	Color code 1	2	Local geotime color (2)
PHANEROZOIC	MESOZOIC	Cretaceous	Upper Cretaceous	Belet Uen	K2b	Limestone with some sandstone and shale		SC-12		
			Lower Cretaceous	Ferfer	K1f	Shale, dolomite and anhydrite		SC-13		
				Mustahil	K1m	Limestone, marl and sandstone				
				Upper Korahe	K1gu	Gypsum, shale, dolomite and anhydrite intercalation				
				Lower Korahe	K1gl	Shale and limestone with basal sandstone				
				Korahe (general)	K1g	Intercalation of shale, anhydrite & dolomite				
			Cretaceous	Amba Aradom	Ka	Sandstone, conglomerate and shale		SC-14		
		Jurassic	Upper Jurassic	Upper Gabredarre	J3gu	Limestone		SC-15		
				Lower Gabredarre	J3gl	Limestone with shaly and gypsiferous units				
				Gabredarre (general)	J3g	Limestone, pelletal, bioclastic & locally oolitic & reef forming				
				Agula	J3ag	Shale,marl and limestone				
				Urandab	J3u	Marl and shaly limestone				
				Upper Hamanlei	J3h	Limestone oolitic, skeletal & grainy				
			Middle Jurassic	Antalo	J2t	Limeston, oolithic, yellow with marl & calcareous shale		SC-16		
				Abay	J2b	Limestone,shale and gypsum				
				Middle Hamanlei	J2h	Evaporite with dolostone & dolomitized limestone				
			Lower Jurassic	Lower Hamanlei	J1h	Shaly limestone & bioturbated, fine grained to skeletal		SC-17		
			Jurassic	Hamanlei	Jh	Limestone and shale with beds of anhydrite & dolomite		SC-18		
		T	Upper Triassic	Adigrat	T3ag	Sandstone, fine to coarse & appears green to red with minor shale		SC-19		
	PALEOZOIC	Permian	Late Permian (?)	Gumbro	PTg	Sandstone, pink yellow to grey		SC-22		
				Gura	Pgu	Sandstone, shale, conglomerate and tillite.		SC-27		
				Gilo	Pgi	Sandstone with minor conglomerate & beds of siltstone				
				Bokh	Pb	Shale, green, redbrown to black, silty & locally sandstone				
		Ordovician		Edaga Arbi	Oea	Shales & siltstones with striated boulders		SC-43		
				Enticho	Oe	Sandstone with occasional beds of conglomerate & siltstone				
				Calub	OPc	Sandston, medium to coarse & contains feldspar				

VI-3) Precambrian lithostratigraphic units & intrusive rocks recognized in Ethiopia & associated map attribute

Geologic time 1	2	3	4	Formation	Letter Symbol	Description	International geotime color (1)	Color code 1	2	Local geotime color (2)
PRECAMBRIAN	PROTEROZOIC	Neoproterozoic		Shiraro	NPs	Sandstone and conglomerate		SC-51		
				Didikama	NPd	Slate and dolomite				
				Tambein	NPt	Chlorite, sericite and graphite phyllites, limestone, slate and dolomite				
				Tsaliet	NPl	Metaandesite, metadacite, metarhyolite, chlorite, sericite & graphite phyllites, green schist, limestone and quartzite				
		Mesoproterozoic		Tulu Dimtu	MPtd	Metabasalt, metaandesite, green schist, phyllite, metaconglomerate,quartzite and marble.		SC-52		
				Birbir	MPb	Metabasalt, metaandesite, metarhyolite, phyllite, graphiticschist, marble, quartzite, metaconglomerate, green schist, metasandstone, metachert and amphibolite				
				Kajimiti	MPk	Metaconglomerate and metasandstone				
				Adola	MPa	Amphibolite,quartzite and graphitic phyllite				
		Paleoproterozoic		Mormora	PPr	Biotite schist,gneiss,marble and graphitic schist		SC-53		
				Wadera	PPw	Metasandstone, quartzite, biotite and muscovite schists				
		PROTEROZOIC		*Unnamed*	PRu	Undivided metavolcanosedimentary sequence		SC-54		
	ARCHEAN			Baro	ARb	Biotite, hornblende-biotite, garnet-amphibole, garnet-sillimarite, calc-silicate and muscovite gneisses		SC-59		
				Yavello	ARy	Quartzofeldspathic gneiss and granulite				
				Awata	ARa	Biotite, hornblende, sillimanite-garnet, calc-sillicate & quartzofeldspathic gneisses, marble and granulite.				
				Alghe	ARi	Biotite and hornblende gneisses,granulite and migmatite with minor metasedimentary gneisses				
				Konso	ARk	Hornblende, pyroxene, garnet - pyroxene gneisses & amphibolite with minor metasedimentary gneiss				

Intrusives

Geologic time 1	2	3	4	Formation	Letter Symbol	Description	International geotime color (1)	Color code 1	2	Local geotime color (2)
PH	CZ	N	Oligocene	*Unnamed*	E3sy	Alkali granite and syenite		SC-7		
PR	NEOPROTEROZOIC			*Unnamed*	NPgsy	Post-tectonic granite and syenite		SC-51		
				Unnamed	NPgtl	Late to post-tectonic granite				
PROTEROZOIC				*Unnamed*	PRub	Ultramafic Rocks: Serpentinite, peridotite, dunite and talc schists		SC-54		
				Unnamed	PRgts	Syn-tectonic granite				
				Unnamed	PRgte	Pre-tectonic and syn - tectonic granite				
				Unnamed	PRgdtn	Granodiorite and tonalite				
				Unnamed	PRgd	Granodiorite				
				Unnamed	PRtn	Tonalite				
				Unnamed	PRdt	Diorite				
				Unnamed	PRgb	Gabbro				

COLOR SCHEME FOR VARIOUS TYPES OF LITHOLOGIC MAP UNITS

VII-1) Color fill scheme for surficial/superficial lithologic units (sf-c)

Class	i) Lithology	ii) R-G-B combination	iii) Appearance	iv) Color code
Weathered rocks (wr)	Soil (s)	255-255-204		Sf-c1
	Laterite (l)	255-235-178		Sf-c2
	Elluvium (el)	255-255-127		Sf-c3
Fluvial deposits (fl)	Gravel (gv)	255-255-77		Sf-c4
	Sand (sn)	255-255-102		Sf-c5
	Silt-clay (lc)	255-255-0		Sf-c6
	Alluvium (al)	255-235-0		Sf-c7
Lake deposits (lk)	Clay-silt (cs)	255-255-222		Sf-c8
	Epiclastic (ec)	255-255-235		Sf-c9
	Lacustrine (ls)	255-255-255		Sf-c10
Colluvial deposits (cl)	Rubble/scree (rb)	255-235-102		Sf-c11
Glacial deposits (gl)	Tillite (tl)	235-235-51		Sf-c12

VII-2) Color fill scheme for sedimentary lithologic units (sd-c)

Class	i)	ii)	iii)	iv)
Detrital deposits (dd)	Breccia (br)	178-102-102		Sd-c1
	Conglomerate (cg)	178-102-0		Sd-c2
	Sandstone (sd)	255-204-153		Sd-c3
	Coarse siliclastics (cs)	153-102-0		Sd-c4
Argillaceous/ pelitic deposits (ag/pl)	Mudstone/ claystone (md)	102-204-102		Sd-c5
	Shale (sh)	102-235-102		Sd-c6
	Fine siliclastics (cs)	51-255-51		Sd-c7
Carbonatel deposits (bc)	Limestone (lm)	0-204-255		Sd-c8
	Chalk (ck)	204-255-235		Sd-c9
	Dolomite (do)	153-255-235		Sd-c10
Bio-Inorganic chemical deposits (bc)	Chert (ch)	153-135-204		Sd-c11
	Phosphorite (pp)	153-202-128		Sd-c12
	Diatomite (dm)	153-202-128		Sd-c13
Inorganic chemical precipitates (Ip)	Gypsum (gy)	255-153-178		Sd-c14
	Anhydrite (ay)	255-153-153		Sd-c15
	Halite/ rock salt (hl)	235-235-235		Sd-c16
Organics/ bioclastic deposits (od)	Lignite (lg)	127-127-127		Sd-c17
	Coal (cl)	25-25-25		Sd-c18
	Oil shale (os)	102-77-35		Sd-c19

i) Lithology **ii) R-G-B combination** **iii) Appearance** **iv) Color code**

VII-3) Color fill scheme for volcanic/extrusive lithologic units (v-c)

Class	i) Lithology	ii) R-G-B combination	iii) Appearance	iv) Color code
Acidic (va)	Rhyolite (ry)	153-153-255		V-c1
	Rhyodacite (rd)	102-153-255		V-c2
	Dacite (dc)	102-102-255		V-c3
Intermediate (vi)	Trachyte (ty)	204-153-51		V-c4
	Latite (lt)	153-135-51		V-c5
	Andesite (ad)	51-102-102		V-c6
Feldspathoid (vf)	Phonolite (ph)	128-153-202		V-c7
	Basanite (bn)	128-202-128		V-c8
	Tephrite (tp)	153-202-128		V-c9
Basic (vb)	Basaltic andesite (bt)	153-204-51		V-c10
	Basalt (ba)	102-153-102		V-c11
	Lamprophyres (lp)	153-135-204		V-c12
Ultrabasic (vu)	Komatite (kt)	153-65-204		V-c13
Pyroclastics (py)	Tuff/ash (tf)	202-202-153		V-c14
	Agglomerate (ag)	222-178-135		V-c15
	Lapplistone (lp)	227-253-227		V-c16
	Ignimbrite (ig)	178-204-153		V-c17

VII-4) Color fill scheme for plutonic/intrusive lithologic units (p-c)

Class	i) Lithology	ii) R-G-B combination	iii) Appearance	iv) Color code
Acidic (pa)	Granite (gt)	255-255-0		P-c1
	Granodiorite (gd)	255-77-0		P-c2
	Tonalite (tn)	255-153-128		P-c3
Intermediate (pi)	Syenite (sy)	255-204-178		P-c4
	Monzonite (mz)	255-235-204		P-c5
	Diorite (dt)	255-204-255		P-c6
Feldspathoid (pf)	Foidmonzo-syenite (fms)	255-128-255		P-c7
	Foidmonzo-diorite (fmd)	255-77-255		P-c8
	Foidmonzo-gabbro (fmg)	255-0-255		P-c9
Basic (pb)	Anorthosite (an)	222-255-204		P-c10
	Gabbro (gb)	0-255-0		P-c11
	Norite (no)	102-255-102		P-c12
	Troctolite (to)	178-255-153		P-c13
Ultrabasic (pu)	Dunite (dn)	178-0-255		P-c14
	Peridotite (pd)	204-102-255		P-c15
	Pyroxenite (px)	178-102-204		P-c16

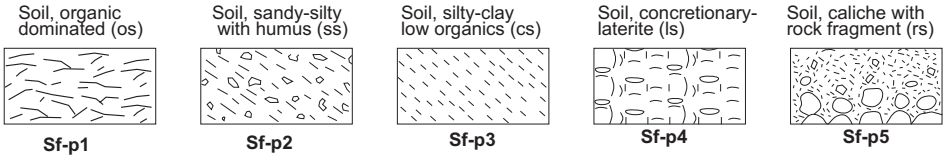
VII-5) Color fill scheme for metamorphic lithologic units (m-c)

Class	i) Lithology	ii) R-G-B combination	iii) Appearance	iv) Color code
Simple fabric and composition	Slate (sl)	222-222-235		M-c1
	Phyllite (ph)	202-178-202		M-c2
	Schist (sc)	178-235-235		M-c3
	Gneiss (gn)	178-153-0		M-c4
	Graphite schist (gsc)	178-178-178		M-c5
	Quartz-feldspar schist (qfsc)	235-222-204		M-c6
	Mica schist (msc)	222-235-235		M-c7
	Amphibole schist (asc)	153-178-178		M-c8
	Quartz-feldspar gneiss (qfgn)	178-153-102		M-c9
	Mica gneiss (mgn)	178-178-153		M-c10
	amphibole gneiss (agn)	178-178-102		M-c11
	Biotite-amphibole gneiss (bagn)	178-153-77		M-c12
Random fabric with simple composition	Quartzite (q)	235-235-204		M-c13
	Marble (m)	77-127-178		M-c14
	Calc-silicate (cc)	77-153-178		MMc158
	Serpentinite (ec)	178-222-178		M-c16
	Greenstone (gs)	204-222-153		M-c17
	Amphibolite (am)	128-178-77		M-c18
	Eclogite (ec)	153-153-51		M-c19
	Granulite (gu)	102-77-153		M-c20
	Felsic Granulite (fgu)	127-102-127		M-c21
	Mafic Granulite (mgu)	127-102-153		M-c22
	Banded Granulite (bgu)	153-102-153		M-c23
Mixed protholith	Migmatite (mg)	222-204-222		M-c24
	Injection Migmatite (mi)	235-204-204		M-c25
	Anatectic Migmatite (ma)	235-222-235		M-c26
Random fabric	Hornfels (hf)	178-102-0		M-c27
	Granofels (gf)	153-102-0		M-c28
High deformation zones	Cataclasite (ct)	77-0-77		M-c29
	Mylonite (my)	77-0-0		M-c30

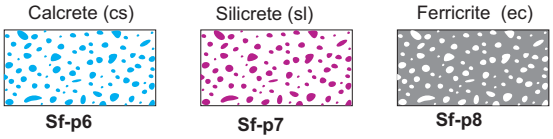
PATTERN/SYMBOL FOR VARIOUS TYPES OF LITHOLOGIC SECTIONS/LOGS

VIII-1) Surficial/superficial lithologic patterns (sf-p)

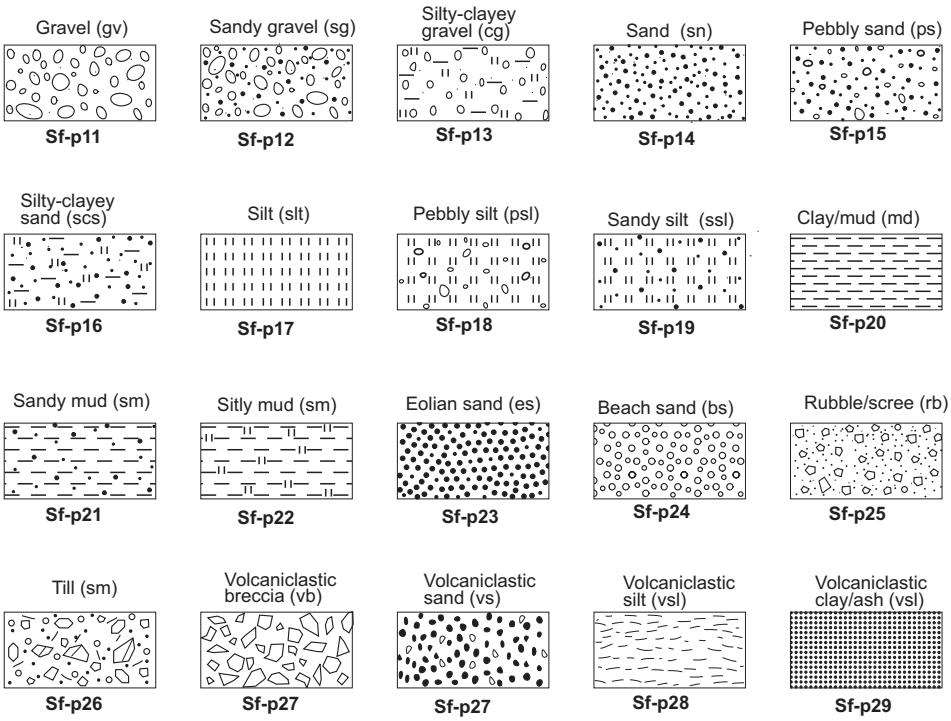
A) Insitu units



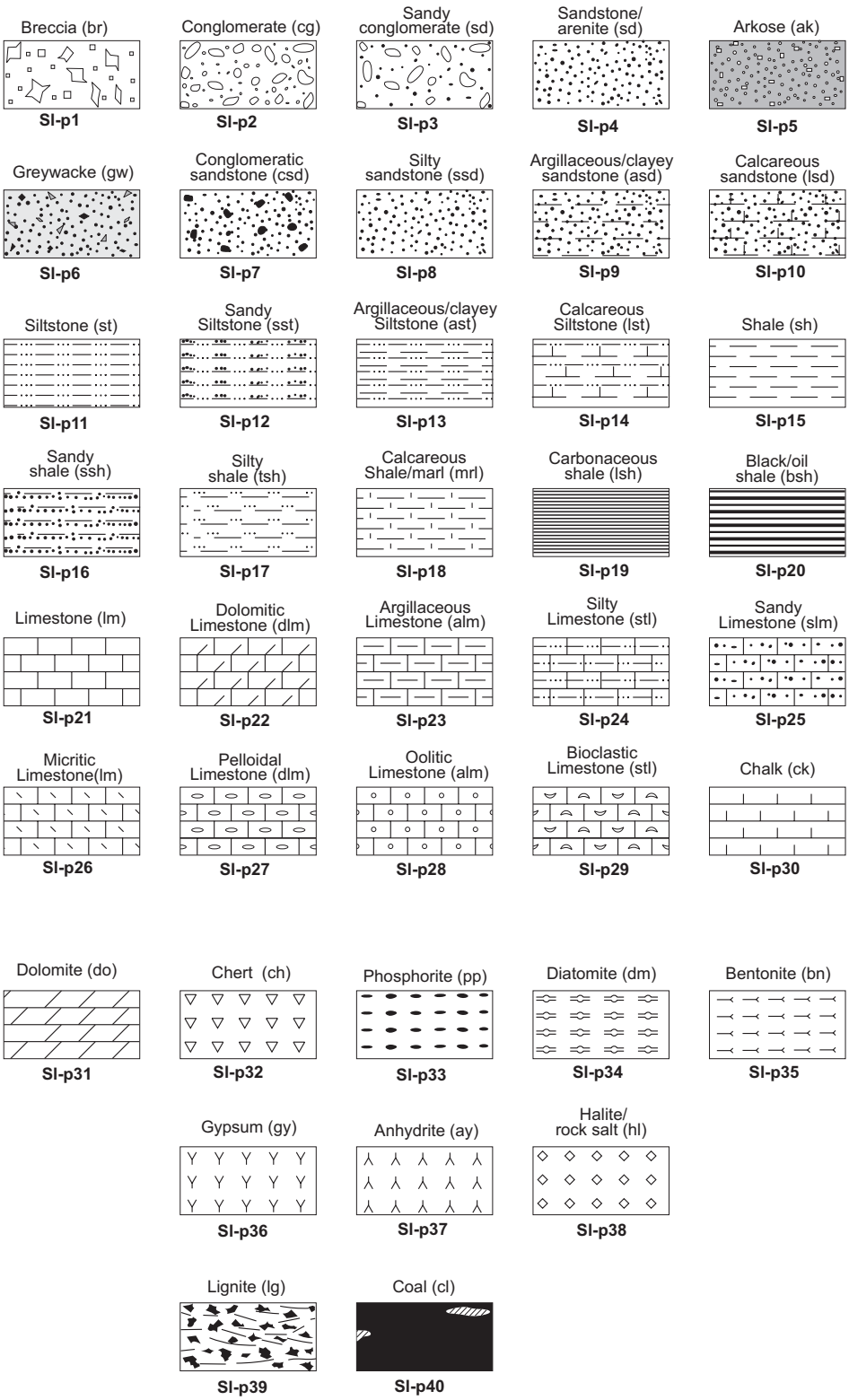
B) Amalgameted Insitu units



C) Transported units



VIII-2. Sedimentary lithologic patterns (sl-p)



VIII-3. Symbols for sedimentary deposition structures (sd-s)

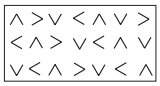
BEDDING	Flasser **Sd-s1**	Lenticular **Sd-s2**	Normal graded F **Sd-s3**	Reverse graded C **Sd-s4**	
CROSS BEDDING	Tabular **Sd-s5**	Trough **Sd-s6**	Herringbone **Sd-s7**	Low angle **Sd-s8**	
LAMINATION	Parallel **Sd-s9**	Wave-ripple **Sd-s10**	Cross **Sd-s11**	Convolute **Sd-s12**	
RIPPLES/ CAST	Symmetrical **Sd-s13**	Asymmetrical **Sd-s14**	Flute cast **Sd-s15**	Groove cast **Sd-s16**	
SOLE MARKS	Tool marks **Sd-s17**	Load casts) **Sd-s18**	Shrinkage cracks **Sd-s19**	Striations/lineations **Sd-s20**	
CONTACT	Sharp **Sd-s21** Unddulating **Sd-s25**	Scoured **Sd-s22** Inclined **Sd-s26**	Uncertain **Sd-s23** Normal, faulted **Sd-s27**	Gradational **Sd-s24** Thrust, faulted **Sd-s28**	
MISCELANEOUS	Mudcracks **Sd-s29** Borings **Sd-s33** Bioturbation, slight **Sd-s37**	Sheet cracks **Sd-s30** Stylolite **Sd-s34** Bioturbation, intense **Sd-s38**	Burrows, horizontal **Sd-s31** Imbrication **Sd-s35**	Burrows, vertical **Sd-s32** Slump structure **Sd-s36**	

VIII-4) Volcanic/igneous-extrusive lithologic patterns (Vl-p)

Class Symbol

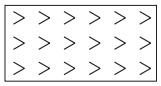
Lithological symbols

Volcanic flows (vfl)



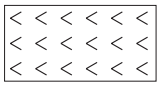
Vlf-p

Rhyolite (ry)
Acidic (va)



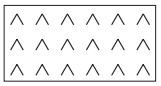
Vlf-p1

Basalt (ba)
Basic (vb)



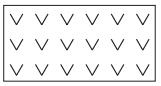
Vlf-p2

Trachyte (ty)
Intermediate (Vi)



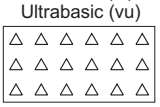
Vlf-p3

Phonolite (ph)
Feldspathoid (vf)



Vlf-p4

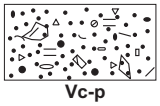
Komatite (kt)
Ultrabasic (vu)



Vlf-p5

Lithological symbols (size, type & texture of tephra)

Pyroclastics (vc)

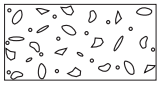


Vc-p

Agglomerate (ag)

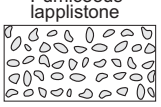
Vc-p1

Lapplistone (lp)



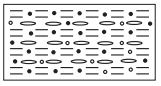
Vc-p2

Pumiceous
lapplistone



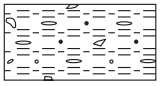
Vc-p3

Welded tuff (wt)



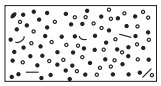
Vc-p4

Ignimbrite (ig)



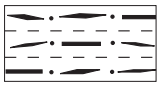
Vc-p5

Tuff/ash (tf)



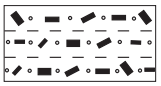
Vc-p6

Vitric tuff (tfv)



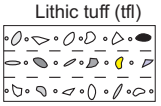
Vc-p7

Crystal tuff (tfc)



Vc-p8

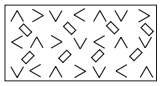
Lithic tuff (tfl)



Vc-p9

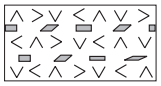
Additional volcanic texture symbols

Porphyritic1



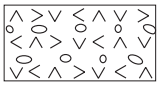
Vl-pt1

Porphyritic2



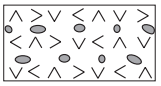
Vl-pt2

Vesicular



Vl-pt3

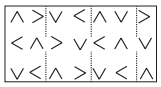
Amygdaloidal



Vl-p4

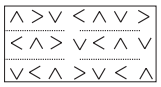
Additional volcanic jointing symbols

Vertical



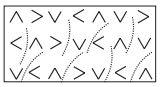
Vl-pj1

Horizontal



Vl-pj2

Radial



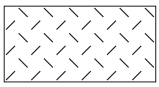
Vl-pj3

VIII-5. Plutonic/igneous-intrusive lithologic patterns (Pl-p)

Class symbol

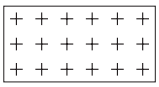
Lithological symbols

Acidic (pa)



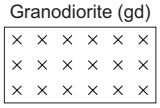
Pa-p

Granite (gt)



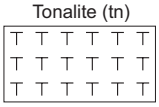
Pa-p1

Granodiorite (gd)



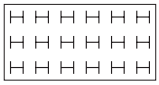
Pa-p2

Tonalite (tn)



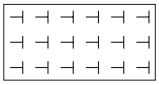
Pa-p3

Intermediate (pi)



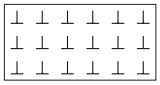
Pi-p

Syenite (sy)



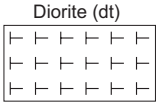
Pi-p1

Monzonite (mz)



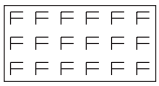
Pi-p2

Diorite (dt)



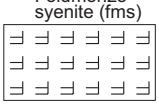
Pi-p3

Feldspathoid (pf)



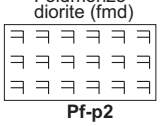
Pf-p

Foidmonzo-syenite (fms)



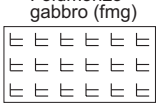
Pf-p1

Foidmonzo-diorite (fmd)



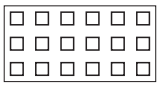
Pf-p2

Foidmonzo-gabbro (fmg)



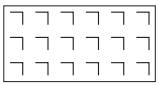
Pf-p3

Basic (pb)



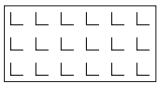
Pb-p

Anorthosite (an)



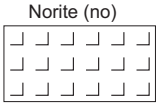
Pb-p1

Gabbro (gb)



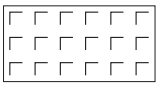
Pb-p2

Norite (no)



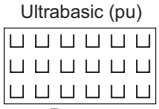
Pb-p3

Troctolite (to)



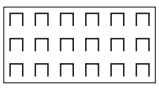
Pb-p4

Ultrabasic (pu)



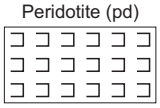
Pu-p

Dunite (dn)



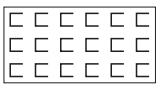
Pu-p1

Peridotite (pd)



Pu-p2

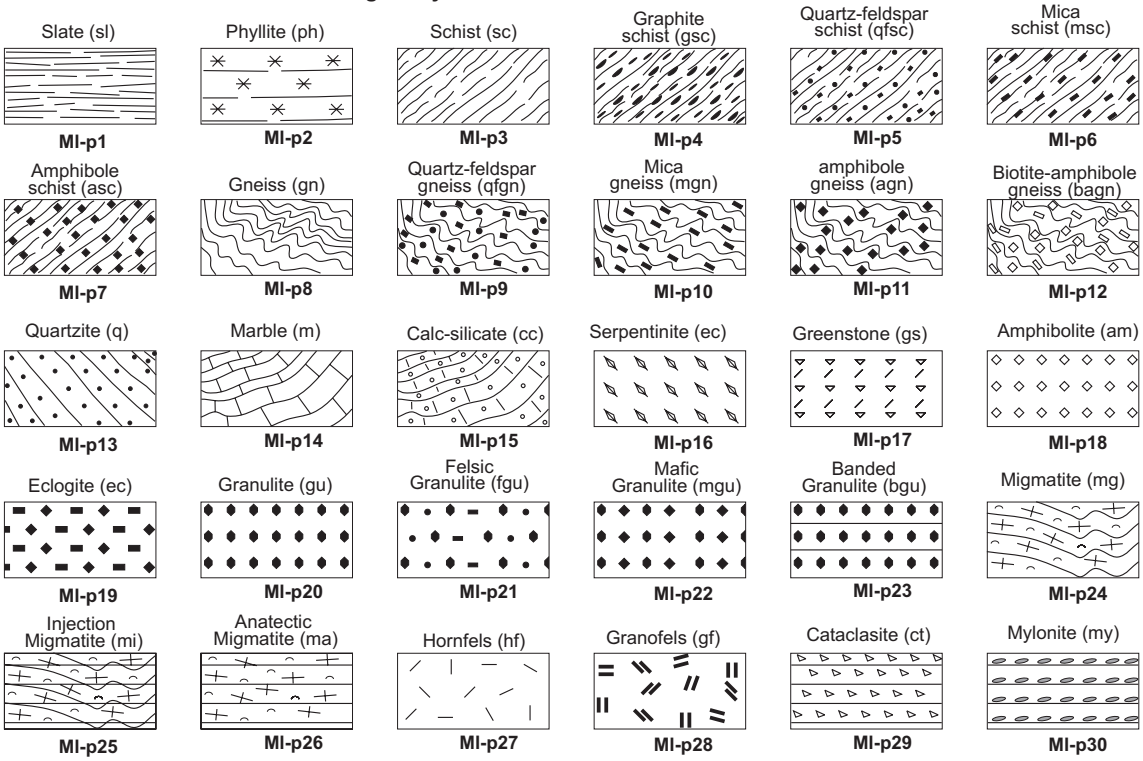
Pyroxenite (px)



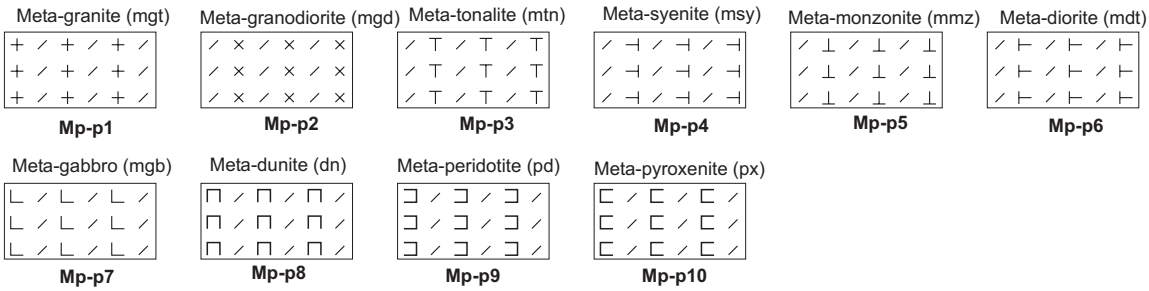
Pu-p3

VIII-6) Metamorphic lithologic patterns (ml-p)

Lithological symbols

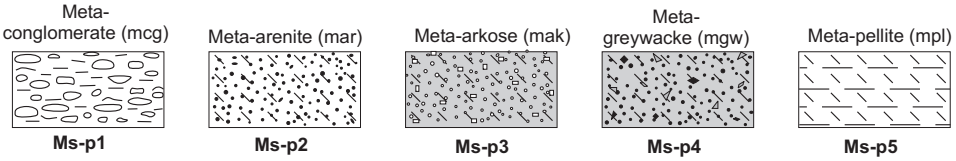


Meta-intrusives (mp)



Meta-Volcanics (mv)

Meta-sediments (ms)



COMPONENTS AND SYMBOL ATTRIBUTE FOR BASE-MAP FEATURES

IX) COMPONENTS AND SYMBOL ATTRIBUTE FOR BASE-MAP FEATURES

A) Polygon features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
WATER BODIES/ WETLANDS	**Natural lakes (Bp-1)** L. Zway	**Human-made lakes (Bp-2)** L. Koka	**Marshy areas (Bp-3)**	
	R-G-B = 51-102-204 *Line weight 0.2mm* *Label font = TNR 7, italics,black*	*R-G-B = 78-135-202* *Line weight 0.2mm* *Label font = TNR 7, italics,black*	*R-G-B = 153-202-235* *Line weight 0.15mm, doted*	

A) Line features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
MAP FRAME (NEATLINES)	**Inner (Bl-1)**	**Outer (Bl-2)**	**Road extension label (Bt-2)** Text object between frames	
	Line weight 0.2mm	*Line weight 0.3mm*	*Font = TNR 7, regular*	
COORDINATE GRID (MAP GRID TICKS)	**Geographic (Bl-3) (Degree)** 39° 15’ Inner frame *Font = Arial 9, regular*		**Projected (Bl-4) (UTM)** *Font = TNR 8, Italics* Inner frame *5000000*	
	Space b/n text & tip of tick = 1mm *Ticks every 15’, length 3mm* *Line weight 0.15mm*		*Space b/n text & inner frame = 1mm* *Tick length 2mm* *Line weight 0.15mm* *Put ticks every 10,000m*	
ELEVATION CONTOUR	**Index (Bl-5) (major)**	**Secondary (Bl-6) (minor)**	**Supplementary (Bl-7)**	
	Line weight 0.2mm *R-G-B = 102-51-0*	*Line weight 0.15mm* *R-G-B = 102-51-0*	*Line weight 0.15mm, dashed (0.75/0.75mm)* *R-G-B = 102-51-0*	
STREAM	**Perennial (Bl-7)**	**Seasonal (Bl-8)**	**Stream label (Bt-3)** *Dawa R.*	
	Line weight 0.2mm *R-G-B = 0-0-255*	*Line weight 0.15mm, dash 2mm long, dot 0.2mm, spacing 0.5mm*	*Font = TNR 8, Italics* *Color black/* *R-G-B = 0-0-255*	
TRANSPORTATION	**Railway (Bl-9)**	**Asphalt road (Bl-10)**	**Gravel road (Bl-11)**	
	Line weight 0.15mm *Cross line length 1.5mm, spacing 3mm*	*Line weight 0.75mm*	*Line weight 0.5mm*	
	Earth road (Bl-12)	**Trail/animal track (Bl-13)**	**Road label (Bt-4)** 6	
	Line weight 0.35mm, line length 3mm, spacing 1mm	*Line weight 0.2mm, line length 1mm, spacing 0.5mm*	*Rectangle 2x2, Line weight 0.176mm* *Font = TNR 8, Italics*	

IX) COMPONENTS AND SYMBOL ATTRIBUTE FOR BASE-MAP FEATURES (contd.)

B) Line features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
BOUNDARIES	**International (Bl-14)** ETHIOPIA KENYA	**Region (Bl-15)** OROMIYA SOMALI	**Zone (Bl-16)** Metagefersa Hudet	
	Font Arial 10, regular, capital *Line weight 0.4mm* *Line length 5/2mm, Spacing 1.5mm*	*Font = TNR 9, regular, capital* *Line weight 0.3mm* *Line length 4/1.5mm, Spacing 1mm*	*Font = TNR 8, regular, capital* *Line weight 0.25mm* *Line length 3, dot 0.3mm, Spacing 3mm*	
	National park/reserve (Bl-17)			
	Line weight 0.2mm *Line length 2mm, Spacing 0.75mm*			

C) Point features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
PLACES	**Capital city (Bs-1)** **ADDIS ABABA**	**Region city (Bs-2)** AWASA	**Zone town (Bs-3)** **Dila**	
	Filled rectangle 2.5mm *Font = Arial 8, bold, capital*	*Filled rectangle 2.0mm* *Font = Arial 8, regular, capital*	*Filled rectangle 1.5mm* *Font = Arial 7, bold, capital*	
	Woreda town (Bs-4) **WACHILE**	**Locality (Bs-5)** MELKA GUBA	**Mountain (Bs-6)** **Mt. Luchale**	
	Filled circle 2.0mm *Font = TNR 7, bold, capital*	*Filled circle 1.5mm* *Font = TNR 7, regular, capital*	*Filled circle 1.0mm* *Font = TNR 7, bold*	
	Spot height (Bs-7)(elevation) *1200*			
	Font = TNR 7, bold, italics *Inverted triangle 1mm (60°)*			

COMPONENTS AND SYMBOL ATTRIBUTE FOR GEOLOGIC MAP FEATURES

X-1) Line symbols for boundaries of lithologic units & geologic features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
LITHOLOGIC CONTACT (general)	**Observed/definite (lb-s1)** *Solid line* *Line weight 0.15mm*	**Approximate/Inferred (lb-s2)** *Dashed line 3mm, space 1.0mm* (1.5, 3)	**Concealed (lb-s3)** *Dashed line 1mm, space 0.75mm* (1, 1)	Contact lines are commonly printed in black Contact lines may be modified due to other geologic features simultaneously occurring at a particular location. Example bedding measurement, fault & etc.
LITHOLOGIC CONTACT, (gradational)	**Observed/definite (lb-s4)** *Contact hatchered, by 1.5mm long line, spaced 0.5mm* *Line weight 0.15mm* (1.5, 0.5)	**Approximate/Inferred (lb-s5)** *Contact hatchered, at intervals, spaced 3.5mm* (1.5, 3.5)	**Concealed (lb-s6)** *Contact hatchered, at intervals, spaced 2mm* (1.5, 2)	Hatches can be shown in other colors for clarity
LITHOLOGIC CONTACT, (miscellaneous)	**Indicating field location (lb-s7)** *Station* *Label TNR 8, italics* *Line weight 0.15mm, triangle 2mm high & 1mm wide* (1, 2, 30°)	**Indicating relative ages (lb-s8)** Y / O *Label TNR 8, capital* *Line weight 0.15mm*		This is to emphasis particular significant observation, such as type localities of lithostratigraphic units, age relationship among igneous rocks & etc
MARKER LAYERS (general)	**Observed/definite (lb-s8)** *ml* *Label TNR 8, italics* *Line weight 0.2mm*	**Approximate/Inferred (lb-s9)** *ml* *Dashed line 3mm, space 1.0mm* (1.5, 3)	**Concealed (lb-s10)** *ml* *Dashed line 1mm, space 0.75mm* (1, 1)	This is used when the marker layer is to narrow to be shown as polygon and has large aerial extent
MARKER LAYERS, (coal/other resource)	**Indicating outcrop areas (lb-s11)** *cs* *Show polygon in grey or black* *Line weight 0.3mm*	**Approximate/Inferred (lb-s12)** *cs* *Dashed line 3mm, space 1.0mm* (1.5, 3)	**Concealed (lb-s13)** *cs* *Dashed line 1mm, space 0.75mm* (1, 1)	The boundary can be printed in magenta, RGB=255-0-255 or cyan, RGB=0-255-255
MINOR INTRUSIONS	**Definite (lb-s14)** **Dyke, Basic** **Inferred (lb-s15)** **Definite (lb-s16)** **Dyke, Intermediate** **Inferred (lb-s17)** **Definite (lb-s18)** **Dyke, Acidic** **Inferred (lb-s19)** **Definite (lb-s20)** **Vein** **Inferred (lb-s21)**			*All line weight 0.4mm* *Spacing 4/5* *Dimensions 1.25*
MISCELANOUS	**Profile line (lb-s22)** A — A' A — A' *Line weight 0.2* *Label TNR 12, Italics*	**Map unit leader (lb-s23)** Qal — Qel *Line weight 0.18*	**Biostratigraphic (lb-s24)** *Trilobite* *Trilobite* *Line weight 0.35* *Label Arial 8, italics*	**Zone Metamorphic (lb-s25)** *Greenschist / Amphibolite* *Greenschist / Amphibolite* *Diameter & spacing = 0.5* *Label Arial 8, italics*	

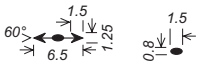
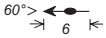
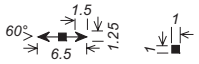
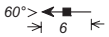
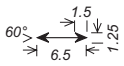
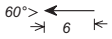
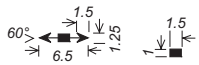
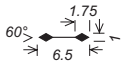
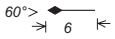
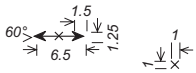
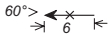
X-2) Symbols for penetrative planar structures measured in the field

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE				REMARK
SEDIMENTARY BEDDING (general)	**Horizontal (pp-s1)** *Circle 3mm diameter, crosses 3mm long*	**Inclined (pp-s2)** *Strike-line 6mm long dip-tick 1mm long*	**Vertical (pp-s3)** *Strike-line 6mm long dip-tick 2mm long*	**Overturned (pp-s4)** *Strike-line 6mm long curve 0.75mm radius, top tick 1mm long*	All symbols have same lineweight = 0.15mm & labeling font = *Arial 6, italics*
IGNEOUS LAYERING (general)	**Horizontal (pp-s5)** *Circle 3mm diameter, crosses 1.2mm long, spacing 0.6mm*	**Inclined (pp-s6)** *Strike-lines 6mm long dip-ticks 1mm long, spacing 0.6mm*	**Vertical (pp-s7)** *Strike-lines 6mm long dip-lines 2mm long, spacing 0.6mm*		
CLEAVAGE (general)	**Horizontal (pp-s8)** *Crosses 3mm long, ticks 1mm long*	**Inclined (pp-s9)** *Strike-line 6mm long dip-ticks 1mm long*	**Vertical (pp-s10)** *Strike-line 6mm long dip-ticks 1.5mm long*		
CLEAVAGE (crenulation)	**Horizontal (pp-s11)** *Crosses 3mm long, ticks 1mm long*	**Inclined (pp-s12)** *Strike-line 6mm long dip-ticks 1mm long*	**Vertical (Ipp-s13)** *Strike-line 6mm long dip-ticks 1.5mm long*		
FOLIATION (general)	**Horizontal (pp-s14)** *Circle 3mm diameter, diamond 1mm wide & 2mm high*	**Inclined (pp-s15)** *Strike-line 6mm long dip-triangle (60°), 1mm wide & 1mm high*	**Vertical (pp-s16)** *Strike-line 6mm long diamond 1mm wide & 2mm high*		
FOLIATION (mylonitic)	**Horizontal (pp-s17)** *Cross 4mm long, arrow head 0.45/0.25mm, (30°)*	**Inclined (pp-s18)** *Strike-line 6mm long dip-tick 1mm, arrow head 0.9/0.5mm, (30°)*	**Vertical (pp-s19)** *Strike-line 6mm long, tick 1mm*		

X-3) Symbols for localized planar structures measured in the field

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE	REMARK
MESOSCALE FOLD-AXIAL SURFACES	Anticline: Vertical (lp-s1); Inclined (lp-s2). Syncline: Vertical (lp-s3); Inclined (lp-s4). Fold-trains (general): Vertical (lp-s5); Inclined (lp-s6). Overturned (general): Vertical (lp-s7); Inclined (lp-s8). Overturned (Anticline): Vertical (lp-s9); Inclined (lp-s10). Overturned (Syncline): Vertical (lp-s11); Inclined (lp-s12). Z-vergence: Vertical (lp-s13); Inclined (lp-s14). S-vergence: Vertical (lp-s15); Inclined (lp-s16). M-vergence: Vertical (lp-s17); Inclined (lp-s18). W-vergence: Vertical (lp-s19); Inclined (lp-s20).	*For general use where facing of lithologies unknown*
MESOSCALE FAULTS	Strike-slip (dextral): Vertical (lp-s21); Inclined (lp-s22). Strike-slip (sinistral): Vertical (lp-s23); Inclined (lp-s24). Normal(lp-s25); Reverse (lp-s26); Thrust (lp-s27).	
MESOSCALE JOINTS	Horizontal (lp-s28): *Circle 3mm diameter, square 1.25mm*. Inclined (lp-s29): *Strike-line 6mm long rectangle 0.75 mm wide & 0.6 mm high*. Vertical (lp-s30): *Strike-line 6mm long rectangle 1.5 mm wide & 1.2 mm high*.	

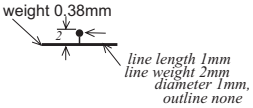
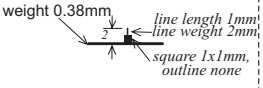
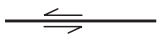
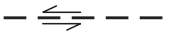
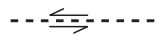
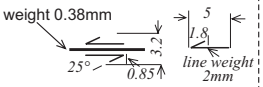
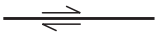
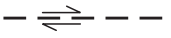
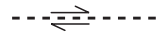
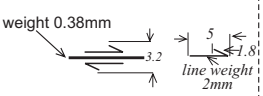
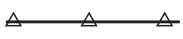
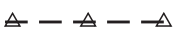
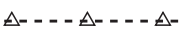
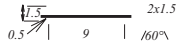
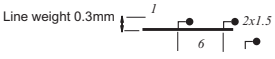
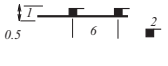
X-4) Symbols for penetrative linear structures measured in the field

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
FLUVIAL GRAVEL (ALLIGNMENT)	Horizontal (pl-s1)	Plunging (pl-s2)	Vertical (pl-s3)	
				
	Label font Arial 7, italics			
				
IGNEOUS CUMULATE GRAINS (ALLIGNMENT)	Horizontal (pl-s4)	Plunging (pl-s5)	Vertical (pl-s6)	
				
	Label font Arial 7, italics			
				
MINERAL LINEATION	Horizontal (pl-s7)	Plunging (pl-s8)	Vertical (pl-s9)	Size 5/5mm
				
				
STREACHING LINEATION	Horizontal (pl-s10)	Plunging (pl-s11)	Vertical (pl-s12)	
				
				
STRIATION LINEATION	Horizontal (pl-s13)	Plunging (pl-s14)	Vertical (pl-s15)	
				
				
INTERSECTION LINEATION	Horizontal (pl-s16)	Plunging (pl-s17)	Vertical (pl-s18)	
				
				

X-5) Symbols for localized linear structures measured in the field

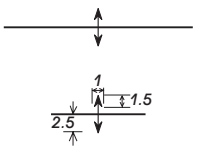
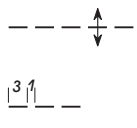
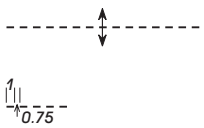
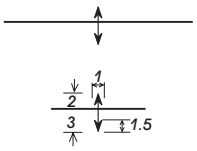
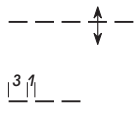
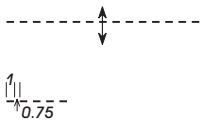
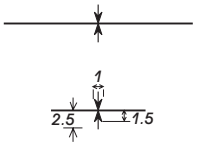
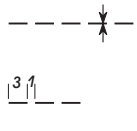
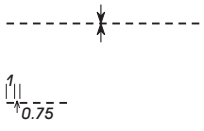
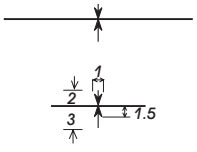
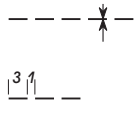
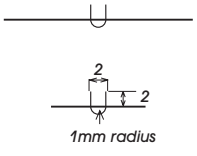
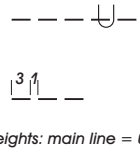
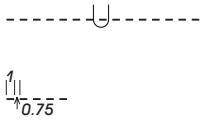
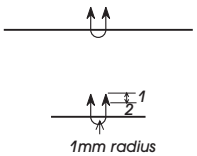
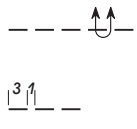
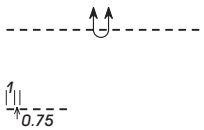
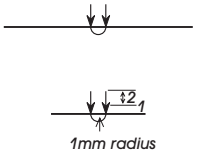
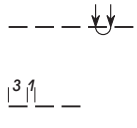
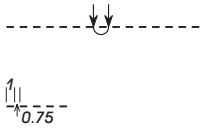
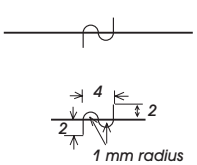
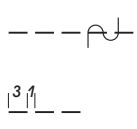
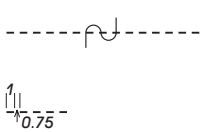
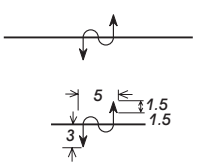
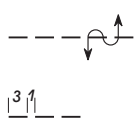
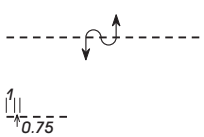
FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE	REMARK
MESOSCALE FOLD-AXIS	Horizontal (II-s1) Anticline; Plunging (II-s2) 30; Horizontal (II-s3) Syncline; Plunging (II-s4) 35	
	Horizontal (II-s5) Fold-trains (general); Plunging (II-s6) 30; Horizontal (II-s7) Overturned (general); Plunging (II-s8)	
	Horizontal (II-s9) Overturned (Anticline); Plunging (II-s10) 30; Horizontal (II-s11) Overturned (Syncline); Plunging (II-s12) 40	
	Horizontal (II-s13) Z-vergence; Plunging (II-s14) 60; Horizontal (II-s15) S-vergence; Plunging (II-s16) 50	
	Horizontal (II-s17) M-vergence; Plunging (II-s18) 25; Horizontal (II-s19) W-vergence; Plunging (II-s20) 25	
MESOSCALE FOLD-AXIS (miscelaneous)	Dome & basin (II-s21); Horizontal (II-s22); Sheath; Plunging (II-s23) 25	Size 5/5mm Circles 1.0mm diameter
BOUDIN AXIS	Horizontal (II-s24); Plunging (II-s25) 15; Vertical (II-s26)	
	Circle 3mm diameter, square 1.25mm; *Strike-line 6mm long rectangle 0.75 mm wide & 0.6 mm high* 15; *Strike-line 6mm long rectangle 1.5 mm wide & 1.2 mm high*	

X-6) Line symbols for megascopic fault structures

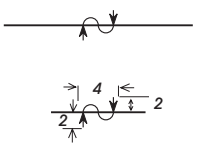
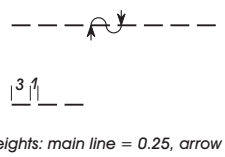
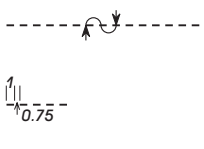
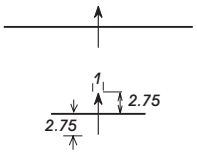
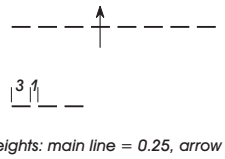
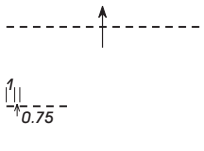
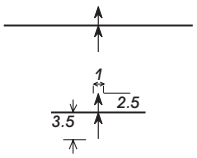
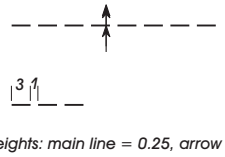
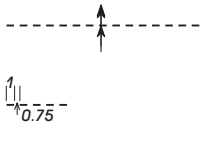
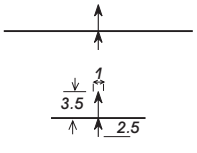
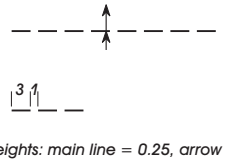
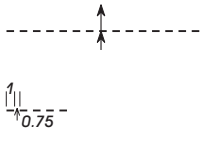
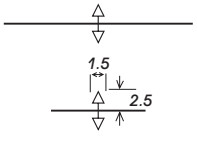
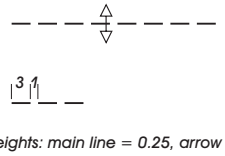
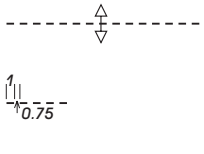
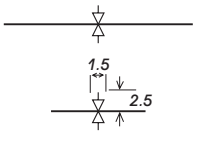
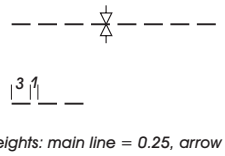
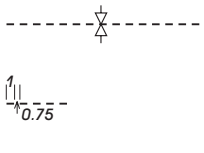
FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
NORMAL FAULT	Observed/definite (ft-s1)	Approximate/Inferred (ft-s2)	Concealed (ft-s3)	
				
	Line weight 0.38mm 	Dashed line 3mm, space 1.5mm 	Dashed line 1mm, space 1mm 	
REVERSE /OBLIQUE/ FAULT	Observed/definite (ft-s4)	Approximate/Inferred (ft-s5)	Concealed (ft-s6)	
				
	Line weight 0.38mm 			
STRIKE-SLIP FAULT, SINISTRAL	Observed/definite (ft-s7)	Approximate/Inferred (ft-s8)	Concealed (ft-s9)	
				
	Line weight 0.38mm 			
STRIKE-SLIP FAULT, DEXTRAL	Observed/definite (ft-s10)	Approximate/Inferred (ft-s11)	Concealed (ft-s12)	
				
	Line weight 0.38mm 			
THRUST FAULT	Observed/definite (ft-s13)	Approximate/Inferred (ft-s14)	Concealed (ft-s15)	
				
THRUST FAULT, DETACHEMENT	Observed/definite (ft-s16)	Approximate/Inferred (ft-s17)	Concealed (ft-s18)	
				
THRUST FAULT, OVERTURNED	Observed/definite (ft-s19)	Approximate/Inferred (ft-s20)	Concealed (ft-s21)	
				
				
FAULT TRACES	Dip-slip, normal (ft-s22)	Dip-slip, reverse (ft-s23)	Thrust (ft-s24)	
	Line weight 0.3mm 			

X-7) Line symbols for megascopic fold structures

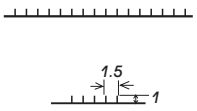
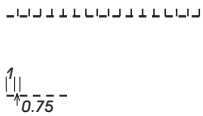
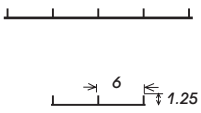
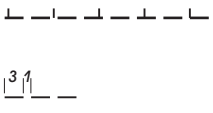
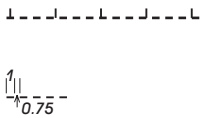
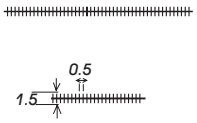
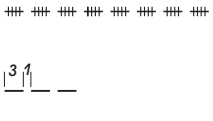
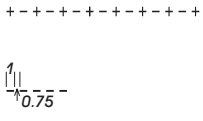
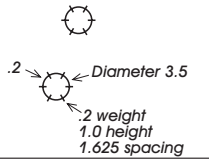
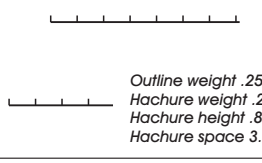
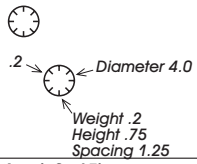
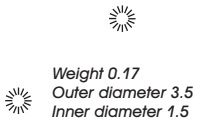
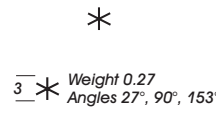
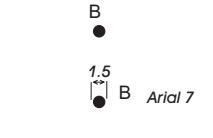
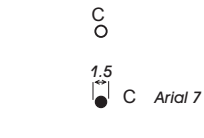
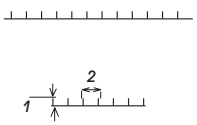
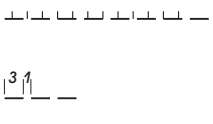
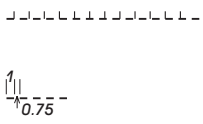
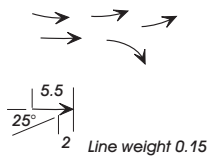
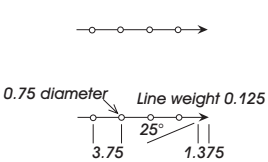
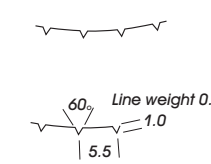
1 of 2

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
	Observed/definite (fd-s1)	**Approximate/Inferred (fd-s2)**	**Concealed (fd-s3)**	
ANTICLINE				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s4)	**Approximate/Inferred (fd-s5)**	**Concealed (fd-s6)**	
ANTICLINE (Asymetric)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s7)	**Approximate/Inferred (fd-s8)**	**Concealed (fd-s9)**	
SYNCLINE				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s10)	**Approximate/Inferred (fd-s11)**	**Concealed (fd-s12)**	
SYNCLINE (Asymetric)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s13)	**Approximate/Inferred (fd-s14)**	**Concealed (fd-s15)**	*For folds where facing of lithologies unknown*
OVERTURNED				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s16)	**Approximate/Inferred (fd-s17)**	**Concealed (fd-s18)**	*For folds in which younger lithologies located away from the center*
OVERTURNED (Anticline)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s19)	**Approximate/Inferred (fd-s20)**	**Concealed (fd-s21)**	*For folds in which younger lithologies located towards the center*
OVERTURNED (Syncline)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s22)	**Approximate/Inferred (fd-s23)**	**Concealed (fd-s24)**	*For folds with vertical axis, where younging of lithologies unknown*
RECLINED				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s25)	**Approximate/Inferred (fd-s26)**	**Concealed (fd-s27)**	*For folds with vertical axis, where younging of lithologies known*
RECLINED (Anticline)				
	Line weights: main line = 0.25, arrow = 0.15			

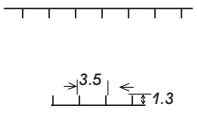
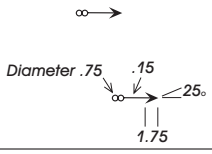
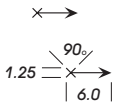
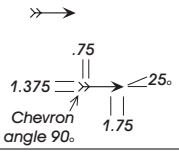
X-7) Line symbols for megascopic fold structures (contd.)

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
	Observed/definite (fd-s28)	Approximate/Inferred (fd-s29)	Concealed (fd-s30)	
RECLINED (Syncline)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s31)	Approximate/Inferred (fd-s32)	Concealed (fd-s33)	
MONOCLINE				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s34)	Approximate/Inferred (fd-s35)	Concealed (fd-s36)	
MONOCLINE (Anticlinal bend)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s37)	Approximate/Inferred (fd-s38)	Concealed (fd-s39)	
MONOCLINE (Synclinal bend)				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s40)	Approximate/Inferred (fd-s41)	Concealed (fd-s42)	
ANTIFORM				
	Line weights: main line = 0.25, arrow = 0.15			
	Observed/definite (fd-s43)	Approximate/Inferred (fd-s44)	Concealed (fd-s45)	
SYNFORM				
	Line weights: main line = 0.25, arrow = 0.15			

X-8) Symbols for volcanic features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
CRATER RIM	**Observed/definite (vf-s1)** 	**Approximate/Inferred (vf-s2)** 	**Concealed (vf-s3)** 	
	Line weights: main line = 0.3, hachure = 0.2			
CALDERA MARGIN	**Observed/definite (vf-s4)** 	**Approximate/Inferred (vf-s5)** 	**Concealed (vf-s6)** 	
	Line weights: main line = 0.35, hachure = 0.25			
FISSURE	**Observed/definite (vf-s7)** 	**Approximate/Inferred (vf-s8)** 	**Concealed (vf-s9)** 	
	Line weights: main line = 0.25, hachure = 0.15			
VOLCANIC CENTERS (Miscelaneous)	**Cinder/spatter cone (vf-s10)** 	**Spatter-rampart (vf-s11)** 	**Maar (vf-s12)** 	
	Recent (vf-s13) 	**Active (vf-s14)** 	**Inactive (vf-s15)** 	
VOLCANIC VENT	**Diatereme (vf-s16)**  *Line weight 0.15*	**Brecciated (vf-s17)**  *Line weight 0.15*	**Collapsed (vf-s18)**  *Line weight 0.25*	
LAVA FLOW	**Lobe, observed (vf-s19)** 	**Lobe, Inferred (vf-s20)** 	**Lobe, concealed (vf-s21)** 	
	Line weights: main line = 0.25, arrow = 0.15			
	Lines (vf-s22) 	**Tubes (vf-s23)** 	**Pressure ridge (vf-s24)** 	

X-9 Symbols for alluvial and fluvial features

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
ALLUVIAL FEATURES	**Terrace (af-s1)**  *Line weights: 0.2mm*	**Transport direction (af-s2)** 	**Fan (af-s3)**  *Boundary Line weight: 0.15mm*	
FLUVIAL DEPOSITIONAL DIRECTIONS	**Trends of imbrication (af-s4)** 	**Trends of crossbedding (af-s5)**  *Line weights: 0.17mm*	**Trends of flute casts (af-s6)** 	

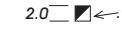
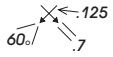
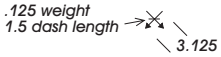
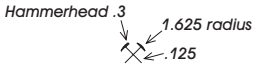
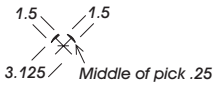
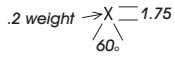
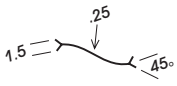
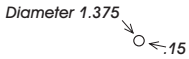
X-10) Symbols for paleontological features

FEATURE TYPE		FEATURE & SYMBOL ATTRIBUTE				REMARK
INVERTABRATE FOSSILS	Micro	Microfossils, in general	Microfossils, calcareous	Diatoms	Foraminifers, in general	
		Foraminifers, smaller and benthonic	Foraminifers, larger	Foraminifers, smaller and pelagic		
	IMacro	Acritarchs	Algae	Ammonites	Archaeocyathids	
		Belemnites	Brachiopods	Brackish-water fossils	Bryozoa	
		Calcareous nannoplankton (coccoliths)	Cephalopods	Charophytes	Chitinozoans	
		Conodonts	Corals	Crinoids	Dinoflagellates	
		Echinoderms	Echinoids	Fresh-water fossils	Gastropods	
		Graptolites	Hyoliths	Insects	Lamellibranchs (pelecypods)	
		Marine fossils M	Needles	Oncolites	Ostracods	
		Radiolaria	Rostroconchs	Rudists	Silicoflagellates and (or) ebridians	
		Spicules	Sponges	Sporomorphs	Stromatolites	
		Stromatoporoids	Trilobites			
PLANT FOSSILS		Leaves	Plant remains	Roots	Wood	
VERTEBRATE FOSSILS		Bones	Fish remains Fish scales	Teeth	Vertebrates	
MISCELANEOUS		Pollen and (or) spores	Trace fossils			
		Fossils, in general	Fossils, sparse	Fossils, abundant		

X-11) Symbols for indications of geologic resources

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
BUILDING MATERIALS	Massionary stone (GR-s1) I	Crush stone (GR-s2) B	Dimension stone (GR-s3) M	
	Natural gravel (GR-s4)	Sand-silt (GR-s5)	Silt-clay (GR-s6)	
MINERALS	Metallic, ferrous (GR-s7) *Cr*	Metallic, non-ferrous (GR-s8) *Cu*	Precious-metals (GR-s10) *Au*	
	Non-metal, gems (GR-s10) *Ol*	No-metal, salt (GR-s11) *Nc*	Non-metal, industrial (GR-s9) *F*	
ORGANICS	Oil showings (GR-s12)	Gas showings (GR-s13)	Oil and gas showings (GR-s14)	
	Diameter 1.5 *Weight .15*	*Diameter 1.5* *Line weight 0.15* *Ticks 0.625*	*Diameter 1.5* *Line weight 0.15* *Ticks 0.625*	
	Peat (GR-s15) P	Lignite (GR-s16) L	Coal (GR-s17) C	
GEOTHERMAL SITES	Thermal spring (GR-s18) T	Geyser (GR-s19)	Fumarole (GR-s20)	
	Arial 7 *Radius .5* *Weight .15* *Diameter 1.5* *2.0*	*Radius .5* *.375* *2.75* *.2* *Ellipse height 1.25* *Ellipse width 2.5*	*Lineweight .125* *2.5* *Inner ellipse height .45* *Inner ellipse width 1.7*	

X-11) Symbols for indications of geologic resources

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
EXPLOITATION SITES	**Vertical mine shaft (GR-s21)**	**Inclined mine shaft (GR-s22)**	**Abandoned mine shaft (GR-s23)**	
				
				
	Gravel, sand/ clay pit (GR-s24)	**Abandoned sand pit (GR-s25)**	**Quarry/glory hole (GR-s26)**	
				
				
	Abandoned glory hole (GR-s27)	**Placer panning site (GR-s28)**	**Abandoned placer panning site (GR-s29)**	
				
				
EXPLORATION/ PROSPECTING SITES	**Prospect pit (GR-s30)**	**Prospect trench (GR-s31)**	**Prospect drill hole (GR-s32)**	
				
				

X-12) General symbols for remote sensing interpretation (rs-s)

FEATURE TYPE	FEATURE & SYMBOL ATTRIBUTE			REMARK
BEDDING/ LAYERING/ FOLIATION (general)	Horizontal (rs-s1)	Inclined (rs-s2)	Vertical (rs-s3)	
BEDDING/ LAYERING/ FOLIATION (with relatively defined inclination)	Gentle, 0-30° (rs-s4)	Moderate, 30-60° (rs-s5)	Steep, 60-90° (rs-s6)	
REGIONAL FOLDS	Open (rs-s7) Anticline Tight (rs-s8)	Open (rs-s9) Syncline Tight (rs-s10)		*All line weight 0.13mm*
REGIONAL STRUCTURAL TREND	Lineament (rs-s11) *Dimensions 4/1* *Lline weight 0.35mm* *Spacing 0.5*	Metamorphic foliation (rs-s12) *Spacing 1* *Lline weight 0.13mm* *Dimensions 1.5*		

CONTENT AND LAYOUT FOR REGIONAL GEOLOGIC REPORTS

XI-1) Essential regional geologic report components and word processing attributes

A) Names & codes of geologic report components

Ob. ID	Component Code	Component name	Report elements	Remark
1	SGR-1	Report cover/title page	R, T	Preliminary part of the report. The first three section should be separated by a page break. Use roman numbers for page numbering. Numbering starts from second section.
2	SGR-2	Abstract	T	
3	SGR-3	Table of contents	T	
4	SGR-4	List of figures	T	
5	SGR-5	List of tables	T	
6	SGR-6	List of enclosures	T	
7	SGR-7	Introduction	T, I, R	Main part of the report. It is Separated from the above by section break. Each chapter should be again separated by a page break. Use standard numbers for page numbering. Numbering starts from first page.
8	SGR-8	Regional geologic setting	T, I	
9	SGR-9	Lithology of the study area	T, I, R	
10	SGR-10	Structure of the study area	T, I, R	
11	SGR-11	Metamorphic history of crystalline map units in the area	T, I, R	
12	SGR-12	Discussion: Geodynamic evolution/geologic history of the area	T, I	
13	SGR-13	Natural resources/significant economic geological aspects in the area	T, I, R	
14	SGR-14	Conclusions and further investigations	T	
15	SGR-15	Acknowledgments	T	
16	SGR-16	References	T	
17	SGR-17	Appendix/appendices	I, T	

B) Codes of report elements

ID	Code	Feature Type
1	T	Text
2	I	Illustration (Graphics and/or table)
3	R	Raster image

C) Report paper format

1) Report paper size; International A4 = 210 X 297 (mm), Portrait.
2) Margins: Left = 25mm, right = 20mm, Top & bottom = 25mm.
3) Header line = 15 mm, Footer line = 15mm

See layout II-4

D) Main report features & word processing format

MAIN REPORT FEATURES	WORD PROCESSING ATTRIBUTES						
	Font	Paragraph					Table of content level (TOC)
		Alignment	Indentation	Spacing Before	Spacing After	Line spacing	
Heading 1	Arial 13, bold & capital	Center of page, top	None	16pts	16pts	Single	1
Heading 2	Arial 12, bold & capital	Left margin of page	None	14pts	12pts	Single	2
Heading 3	Arial 12, bold & small capital	Left margin of page	None	12pts	9pts	Single	3
Heading 4	Arial 11, italics & bold	Left margin of page	None	9pts	6pts	Single	Not applicable
Body text	Arial 12, normal	Fully justified	First line by 13mm	6pts	6pts	1.5 lines	
Figure caption	Arial 11 bold	Left margin and bottom of figure	None	None	None	Single	
Table caption	Arial 11 bold	Left margin and top of table	None	None	None	Single	
Page number	Times New Roman 12, normal	Center of page, bottom	None	None	None	None	

XI-2) Contents of regional geologic report components

1 of 4

Code	Component name /content	Remark
SGR-1	**Cover/title page**	See format of layout II-3 Explanation to the cover photograph should be given on the back of the cover/title page, aligned bottom
1	Logo	
2	Country & ministry	
3	Organization & department	
4	Report title	
5	Photograph (Picture taken from the area)	
6	Memoir number	
7	Compilers name	
8	Month and year	
9	Place	
10	Library reference number	
SGR-2	**ABSTRACT**	The abstract is concise summary of the report. It should attract the reader interms of findings and should spell out the results of the study not what the report is about. It is condensation and concentration of essential information. It do not include undiscussed information and references to text, tables or other works. Avoid the use of terms such as discussed, concluded or investigated
	A very brief account on:-	
1	Location	
2	Objectives	
3	Methods/techniques employed	
4	Lithologies	
5	Structure	
6	Metamorphism (if applicable)	
7	Highlights of present finding and conclusion	
8	Mineral/natural resources in the area	
9	Suggestions for further research	
SGR-3	**TABLE OF CONTENTS**	Use appropriate indentation to separate heading/subheadings. Avoid excessive ranking. Includes page numbers for list of figures, tables, appendix & enclosure. Do not include the page number for the title page and the contents page.
1	Headings and subheadings ordered according to rank	
2	Page column showing page number from on which a chapter starts	
SGR-4	**LIST OF FIGURES**	The list should be descriptive. It should not include captions to subsidiary figures (if any).
1	Figure number	
2	Figure caption	
3	Page number	
SGR-5	**LIST OF TABLES**	
1	Table number	
2	Table caption	
3	Page number	
SGR-6	**LIST OF ENCLOSURES**	
1	Enclosure number	
2	Title of enclosure	
SGR-7	**INTRODUCTION**	
SGR-7.1	**OBJECTIVES AND SCOPE**	
1	Statement on the objective/purpose	
2	Summary of method and approach	
3	Scope of the work /state briefly contents of report	
4	Statement on new findings	
SGR-7.2	**LOCATION AND ACESS**	This section should contain 1. Location map of the area 2. Map of the study area, showing places, roads and main perennial rivers 3. Tabulated list of places in both English and Amharic with geographical coordinate placed in appendix.
1	Location of the area with respect to the capital city (compass direction)	
2	Regions it is found	
3	Location with respect to neighboring country (where applicable)	
4	Boundary limits of the area in geographic coordinate (degrees)	
1	Limits of the area in projected coordinate (UTM)	
2	Size of the area in sq km (mention measuring Unit: spherical/cartesian)	
3	Main access route to the study area from the capital city	
4	Secondary Access routes branching from the main road (including distance)leading to the specific area.	
5	Include nearest town where road branches and type of roads & days it took travel.	

XI-2) Contents of regional geologic report components (contd.) *2 of 4*

Code	Component name /content	Remark
SGR-7.3	**PHYSIOGRAPHY AND DRAINAGE**	This should not be a mere explanation of the topographic division using elevation ranges. It should be a brief summary of geomorphologic features in the study area, from both field observations & analysis of DEM data. One or more illustrative maps or raster images are required.
1	Major physiographic divisions terrains (where applicable)	
2	Basis of division	
3	Characteristics of each division	
4	Statement on drainage basin and drainage patterns	
5	Relation of drainage to physiographic divisions/Geology/structure	
SGR-7.4	**CLIMATE**	General geographical aspects of the study area. Information includes both field observation and other sources
1	General climatic condition with respect to regional perspective	
2	Statement on dry and rainy seasons (local scale)	
3	Statement on temperature variation (local scale)	
4	Notes on precipitation, evapo-transpiration, humidity, wind (local scale)	
SGR-7.5	**VEGETATION AND WILDLIFE**	
1	Description on types of vegetation	
2	Statement on types of wild life and condition	
SGR-7.6	**CULTURE**	
1	Statement about the inhabitants (ethnicity & etc)	
2	Size of population (relative)	
3	Language spoken	
4	Means of subsistence	
SGR-7.7	**PREVIOUS GEOLOGIC STUDIES**	This is short summary to indicate references to earliest & most recent works. The question is who has worked previously, what method was applied & what was the finding (result) Include year of work, purpose & important conclusion.
1	Statement about relevant geologic studies, that has been made within the limits area	
2	Statement on earlier geologic studies close (adjacent) to the study area	
3	Notes on the purpose of prevision works	
4	Notes on the results of the studies	
5	Statement on significant geologic opinions forwarded as compared to earlier or current investigation: – Survey of what has been done – What they have written and said	
SGR-7.8	**METHODS AND TECHNIQUES APPLIED**	This is an explanation to what has been done. It should be clear, concise and detailed statement on current work process and techniques employed in a sequential order. Subsheets layout map is required showing mapping teams area
1	Short list of work process (project phase)	
2	Brief summary about literature surveyed (type, source and availability)	
3	Note on pre-field preparation, material, method and techniques employed.	
4	Summary of field geologic activities: – Nature and density of traverse including duration of field work – Type and number or rock samples collected, specifying kind of analysis to be made – Statement on field data base and map preparation	
5	Notes on petrographic studies: – Type of study and general procedure of sample preparation – Type and number of samples investigated	
6	Notes on geochemical analysis (if any): – Purpose and type of analysis made – Procedures and methods of analysis – Number of samples analyzed	
7	Data acquisition analysis and interpretation: – Type of data analyzed and kind of method (software) used – Techniques of interpretation	
8	Final report and map preparation: – Format and software used for final metadata base, report written, map and illustration	

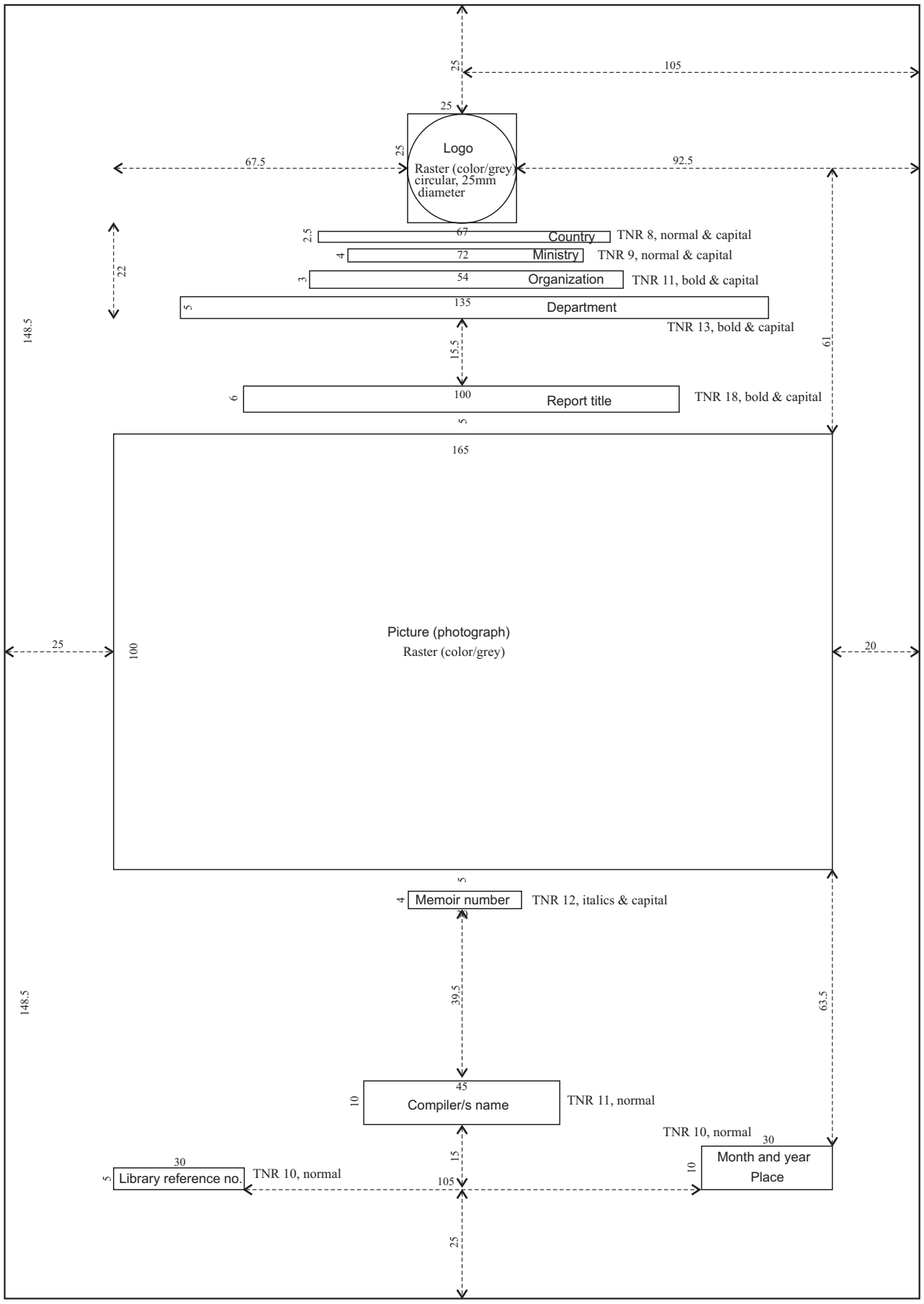
XI-2) Contents of regional geologic report components (contd.) *3 of 4*

Code	Component name /content	Remark
SGR-8	**REGIONAL GEOLOGICAL SETTING**	Introduce different hypothesis that exist to explain the geology of the region. Regional geologic map showing major lithologies may be added.
1	Introductory statement on the general location of the area in relation to regional lithostratigraphic or tecotonic domains in the surrounding region	
2	It includes both geographical and tectonic positions.	
3	Overview of lithological unit in each of regional geologic domains	
4	Brief details of regional structural fabric	
5	Notes on regional metamorphic pattern (if relevant to the study)	
6	Concise overview of regional geodynamics as explained by previous works	
7	Statement on different opinions forwarded by earlier workers including supporting evidences	
SGR-9	**LITHOLOGY OF THE STUDY AREA**	Stratigraphic table/lithstratigraphic domains map (if more than two) is required Classification must be realistic relating to actual data gained from different investigations. Introduce the general relationships of the stratigraphic units in the area to the regional setting.
1	Introductory note on the general type of lithologies exposed, according to class of rocks or geologic age	
2	Statement on previously adopted mapping division (if any)	
3	Notes on major map with division and subdivisions with stratigraphic table,	
4	Summary of all lithologic units that will be described in the subsequence section	
5	Stratigraphic correlation table comparing current detailed units with regional stratigraphic scheme	
SGR-9.1	**Description of map units**	Description should be from oldest to youngest. This should be concise representation of the observations made about the map unit: dominant color, thickness, lithological variation, weathering characteristics Include field photos, sketches, photomicrographs or other illustrations
1	Introductory note on the relative position, aerial extent, physiographic expression, outcrop pattern and nature of contact of the map unit being described	
2	Statement on main lithologies and variations (intercalations) of the formation within limits of the outcrop	
3	Detailed attributes of the map unit as seen in outcrops. It includes color, grain size, texture/fabric, degree of weathering and alterations	
4	Summary of petrography studies. Major, minor and secondary constituents in %.	
5	Discuss micro structures and interrelation of the constituents	
SGR-10	**STRUCTURE OF THE STUDY AREA**	Required field photographs, sketches and stereographic projections of structural elements from field data. This should be clear representation of factual data and interpretation based on supporting references, such as cross-section, stereographic projection & etc
1	Introductory note on the type of structures and general trends indicated by previous works (if any)	
2	Brief overview of structures and major trends observed and scheme of divisions (if any)	
3	Detailed description of structural domains (phases of deformation) indicated earlier (if any): structural elements belonging to each domain, sequence of structural evolution, discuss evidences for age of structures	
4	Notes on structural correlation among deferent domains	
SGR-11	**METAMORPHISIM OF CRYSTALLINE MAP UNITS**	Include sketches of thinsections or photomicrographs (if available) and metamorphic path in a PT space, if one finds diagnostic metamorphc mineral assemblages.
1	Introductory statement about the types of crystalline map units general condition of metamorphism	
2	Brief note on kind of references made to evaluate condition of metamorphism	
3	Overview of classification scheme adopted for subsequent explanation/discussion	
4	List of metamorphic mineral assemblage characterizing condition of metamorphism for each of crystalline map units. It also includes notes on nature of grain boundaries forming the assemblages	
5	Summarized account on sequence of prograde/retrograde metamorphic conditions	
6	Overview of interrelationship between condition of metamorphism and sequence of structural evolution	

XI-2) Contents of regional geologic report components (contd.)

Code	Component name /content	Remark
SGR-12	**GEOLOGIC HISTORY/GEODYNAMIC EVOLUTION OF THE STUDY AREA**	
1	Introductory overview indicating relative position of the study area with respect to regionally known tectonic domains	May include simple sketched illustrations, showing geodynamic events in sequence.
2	Brief statement on the types of map units occurring in the area	
3	General overview of interpreted geodynamic processes responsible for geological evolution of the area under consideration	
4	Summarized discussion on the sequence of geological events/processes and their products from oldest to youngest. It also includes supporting evidences from current observation and also compare with other previous works	
5	Detailed list of events and their outcomes arranged in stratigraphical hierarchy	
SGR-13	**NATURAL RESOURCES IN THE MAP AREA**	Figure showing the location of the resources and other illustrations can be added
1	Introductory overview on the kinds of natural resources (geological) occurring in the area, including existing/abandoned exploitation site	
2	List of resources according to utilization. Agricultural farming, construction materials, metallic minerals and etc	
3	Detailed account on the geographical location, extent, geological attributes of each resources	
4	Notes on the relationship between natural resources with lithology and/or structure	
5	Note on previous/current exploration activities (if any)	
6	Summary on important alteration sites, alteration type and relation with structure and lithology	
SGR-14	**CONCLUSIONS AND FURTHER RESEARCH**	
1	Summarized remarks on stratigraphy, geodynamic processes, significant natural resources.	
2	Notes on the findings of the study and interpretation	
3	Suggestion for further investigation or research.	
SGR-15	**ACKNOWLEDGEMENTS**	
1	Courtesy to anyone or institutions that have contributed/ share ideas in the course of the study	
2	Acknowledgments to sources of figures or tables incorporated (if provided by anyone & not published)	
3	Appreciation to anyone or organization who provided non-technical help towards the accomplishment of the field work or research	
SGR-16	**REFERENCES**	
1	List of articles used and referred in the report	See IV-7 for refernce citation & listing
2	References alphabetically ordered by author and year	
3	Sequence of referencing & typography according to standard conventions	
SGR-17	**APPENDIX/APPENDICES**	
	Additional supporting information, that is not main part of the report & includes:	
1	List of places in the study area referred in the report - Place names written in both English & Amharic with location coordinate - Amended place names not shown in the topographic base map indicated by asterisk or other symbol	
2	List of rock samples thinsectioned & also not thinsectioned (if any) with location coordinate	
3	List & location of structural data measured in the field	
4	Mineralogical & textural attributes of petrographically studied rocks	

XI-3) Layout for cover/title page (reduced format)



NB. 1) This page layout is 80% of actual printing size
2) Numeric figures are distance measurements in millimeter according to actual size of page

XI-3.cdr

XI-3) Layout for cover/title page (Actual size, Example)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF MINES AND ENERGY

GEOLOGICAL SURVEY OF ETHIOPIA

REGIONAL GEOLOGY AND GEOCHEMISTRY DEPARTMENT

GEOLOGY OF XXXXXXX AREA

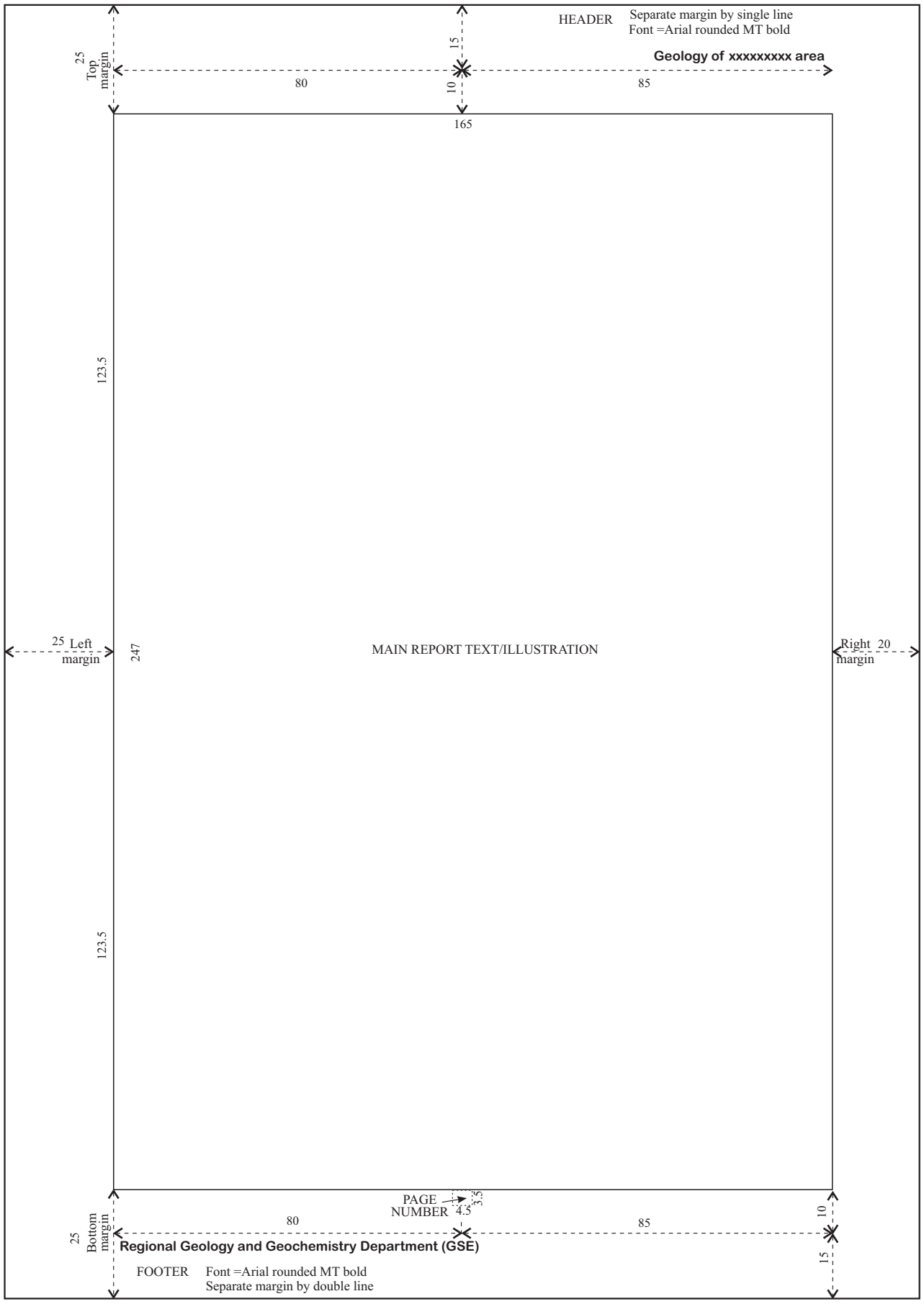
MEMOIR 000

COMPILED BY
XXXXXXX XXXXXX

Library no.

September 2006
Addis Ababa

XI-4) Layout for main body text/illustration pages (reduced format)



NB. 1) This page layout is 80% of actual printing size
2) Numeric figures are distance measurements in millimeter according to actual size of page

XI-4.cdr

MAIN REPORT TEXT/ILLUSTRATION

XI-5) Layout for list of contents, figures, tables & enclosures

A) List of contents (general)

1) List of contents (Table of contents) is commonly placed next to the abstract section. Its title should be formatted differently from the headings and subheadings to avoid its inclusion in the list.. Suggested format is: Font Arial 13, bold, capital underlined, center.

2) Table of contents consist of two columns: title for headings as well as subsequent subheadings, and their respective beginning page numbers.

3) The title section is aligned on the left and the page number on the right margin of the page layout, respectively. The title section should be separated from the page number column by closely spaced doted line.

4) The title section is commonly divided into preliminary and main body sections. The two sections should be separated by an enforced section break command (available in any word processing software, example MsOffice or WordPerfect) so as to allow distinct page numbering. It should be noted here that word processing softwares automatically generate table of contents and associated starting page numbers for properly formatted heading-subheading titles in the report.

5) The preliminary section consists of cover, abstract, list of contents, list of figures, list of tables and list of enclosures page in the order they are placed in the report, respectively. Their page numbers should be in roman numbers. On the other hand the main report titles starting from the introduction section are commonly numbered in arabic numbers beginning from 1.

6) Title for cover page should not be included in the table of contents and should not be numbered. Page numbering begins from the abstract title page and starts from 'iii' as an indirect indicator of two unnumbered pages in the sectiion: title page and explanation to front picture.

B) List of figures and tables (general)

1) Both consists of three columns: Figure/ table number on the left, followed by title and page number on the right of the page layout.

2) Both might be presented in a tabular form in which case columns and rows are separated by light lines.

C) List of enclosures (general)

1) This contains the enclosure number to the left followed by the title.

D) Example

TABLE OF CONTENTS

TITLE	PAGE No.
ABSTRACT	**III**
LIST OF FIGURES	**IV**
LIST OF TABLES	**V**
LIST OF ENCLOSURES	**VI**
1. INTRODUCTION	**1**
1.1 OBJECTIVES AND SCOPE	1

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
1	Location map of the study area	2

LIST OF TABLES

TABLE No.	TITLE	PAGE No
1	Lithostratigraphic units in the study area	3

LIST OF ENCLOSURES

ENCLOSURE NUMBER	TITLE
1	Geological map of the study area (1:250,000 scale)

XI-6) Guidelines for tables and figures (vector/raster)

A) General

1) Tables and figures are very important to clarify any explanations/ discussions indicated in main body text of regional geologic report. Therefore their representation should be clear, concise and simple to be understandable to any one referring them.

2) The size of most figures & tables should conform to the boundary limit of the main body text layout. Figure and tables exceeding 75% of the main page layout need be shown in a new page separated from main body text.

3) Figures/tables should be organized to be read either from bottom or from left, for portrait or landscape page layout formats respectively.

4) In the main body text, figures & tables should be numbered in the order in which they are referred in the text.

B) Main table components and their attributes

S.No.	COMPONENT NAME	ATTRIBUTES	REMARK
T1	Table frame	Unfilled box, line weight = 0.3mm	Contact lines are commonly printed in black
T2	Table title	Aligned left on top of table and font = Arial 10, bold, capital	
T3	Column/row titles	Aligned center , font = Arial 11, bold, regular	
T4	Column/row boundaries	Solid/dashed/doted line and line weight = 0.15mm	
T5	Text elements inside table	Font = variable type with size in the range of 9-10	

C) Main figure components and their attributes

S.No.	COMPONENT NAME	ATTRIBUTES	REMARK
F1	Figure frame	Unfilled region, solid line and line weight = 0.3mm	Figures can be presented in vector graphics and raster images
F2	Figure title	Aligned left on bottom of figure and font = Arial 10, bold, regular	
F3	Line elements inside figure	Solid/dashed/doted line and line weight varying between 0.15mm and 0.25mm	
F4	Text elements inside figure	Font = variable type and size in the range of 7-10	
F5	Coordinate marks for maps	UTM ticks every 10,000 m, 1mm long line weight=0.15mm, label font = TNR 7, italics Degree ticks every 15 minutes, 1.5mm long, line weight = 0.2mm, label font = Arial 7, regular	UTM ticks are for maps of the study area.
F6	Scale for maps	Numeric scale font = TNR 7, visual (bar) scale alternating filled and unfilled rectangle of height = 1mm	
F7	North arrow for maps	Simple symbol, not exceeding 5mm in width and 10 mm in height.	
F8	Station point of observation	Open circle of diameter 2mm, line weight 0.15mm	
F9	Station point of thinsections	Black filled square 2.5mm wide, line weight 0.1mm	
F10	Station point of rock samples	Filled circle of diameter 2mm, line weight 0.15mm	
F11	Traverse route	Line with tick mark and arrow endings, indicating beginning and end of daily field traverse route. line weight 0.15mm	
F12	Triangular diagrams	Size 1 = 80mmx69.3, Size 2 = 1000mmx86.6, Size 3 = 125mmx108.25. Line weight 0.25mm. Axes label font = Arial 9.	
F13	Stereographic diagrams	Unfilled circle of diameter 60mm, line weight 0.25mm Center of circle marked by cross lines 5mm long and line weight 0.25mm	

XI-7) Conventions for reference citation and listing

A) Reference citation

1) Use scientific reference writing often called Harvard System. The system requires insertion of authors name & date of work in the text of the report and full details will be given in the reference list arranged in alphabetical order of authors surnames.

2) In the main text, references are written in the form: authors surname/s, comma, space, year of publication. See examples below.

ID	Citation type	Usage
2.1	(Bonavia and Chorowicz, 1992)	For one or two authors.
2.2	(Ayalew et al. 1990)	For three or more authors
2.3	(Shackleton, 1986; Mosley 1989)	For multiple references made at a certain text and arranged in order of year.
2.4	Abraham (1996)	For authors name mentioned in the main text. Example, according to Abraham (1996) the ultramafics occur along deep faults.
2.5	(Holmes, 1951, pp. 10-13)	For several references to the same publication with page number.
2.6	(Kazmin, 1975a) (Kazmin, 1975b)	For two or more references to same author with identical year of publications.
2.7	(Solomon Tadesse, personal communication, 1998)	For information provided by a colleague/anyone.

B) Full detail reference listing

3) Styles of full detail reference listing varies on kind of publications. It is important to follow the sequence, typography, spacing and punctuation as shown below.

ID	Type of publication	Listing sequence (style)
3.1	Books	AUTHOR, INITIALS. Year of publication. *Title*. Edition (if applicable). Place of publication, Publisher's name.
3.2	Papers in books	AUTHOR, INITIALS. Year of publication. Title. In: Editor/s of the book (ed/s). *Title of the book*. (Series, if any). Place of publication, Publisher's name, pages.
3.3	Papers in journals	AUTHOR, INITIALS. Year of publication. Title of paper. *Title of Journal*. Volume number, Pages.
3.4	Dissertation/PhD thesis (published)	AUTHOR, INITIALS. Year of publication. Title. *Title of publication (work), Series, volume number,* Pages.
3.5	Dissertation/PhD thesis	AUTHOR, INITIALS. Year of award. *Title*. Unpublished M.Sc. dissertation/ Ph.D. thesis, Institution, Pages.
3.6	Maps	AUTHOR, INITIALS. Year of Publication. *Title*. Topographic sheet index name (Sheet number), map scale. NAME OF ISSUING INSTITUTION.
3.7	Geological Survey reports	AUTHOR, INITIALS. Year issued. *Title*. Name of issuing Institution, *Memoir/Note/Bulletin number,* Pages.
3.8	Internet resources	AUTHOR, INITIALS. Year issued. *Title*. URL:, date browsed (accessed)

XII. BIBILOGRAPHY

BARKER L., 17-7-2002. Geological report writing, (2nd edition). Imperial College of Science, Technology & Medicine, Department of Earth Science and Engineering. Http://www3.imperial.ac.uk/earthscienceandengineering. May 10, 2005.

HIBBARD MJ (1995). Petrography to petrogenesis. Prentice-Hall international (UK) Limited, London, PP 587.

INTERNATIONAL COMMISSION ON STRATIGRAPHY, March 2005. Geologic time scale 2004. Http://www.stratigraphy/org/gts.htm. March 10, 2006.

KAZMIN V (1972). Geological map of Ethiopia, 1:2,000,000 scale. Geological Survey of Ethiopia.

KAZMIN V (1975). Explanations to the 1:2,000,000 scale geological map of Ethiopia (Kazmin, 1972), Summarized by Warden J. Geological Survey of Ethiopia, Bulletin 1.

KAZMIN V (1979). Stratigraphy and correlation of volcanic rocks in Ethiopia. Geological Survey of Ethiopia, Note no. 106, pp 26.

]

MENGESHA TEFERA, TADIWOS CHERNET AND WORKINEH HARO (1996). Geological map of Ethiopia (Second edition), 1:200,000,000. Geological Survey of Ethiopia.

MERLA G., ABBATE E., AZZAROLI A., BRUM P., CANUTI P., FAZZUOLI M., SAGRI M. AND TACCONI P. (1979). A geological map of Ethiopia and Somalia (1973), 1:200,000,000. Consiglio Nazionalle delle Ricerche, Florence, Italy.

PLESCH A., 7-24-01. Geologic map patterns for canvas (R), illustrator (R) and freehand (R). Http://structure.harvard.edu/~plesch/map%20patterns/. October 30, 2005.

USGS. Selection of colors and patterns for geologic maps of the USGS. http://pubs.usgs.gov/tm/2005/11B01/05tm11b01.htm. March 5, 2006.

USGS. Public review draft-digital cartographic standards for geologic map symbolization (post script implementation). http://pubs.usgs.gov/of/1999/of99-430. March 5, 2006.

ODP. Proceddings of ocean drilling programs, Vol.301, October 3,1 2005. Http://iodp.tamu.edu/publications/exp301/105/105_.htm. December 20, 2005.

BGS, 10-02-2001. British geological survey map symbols and lithological ornaments. Http://www.bgs.ac.uk/reference/symbols/symbols.html. April 6, 2006.

Department of Geology and Environmental Science, James Madison University. Format for writing scientific reports and papers. Http://csmres.jmu.edu/geollab/studresrch/format.html. May 10, 2005.