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Delineation Of Groundwater Potential Zones Based On The Structures And Landforms Identified From The Landsat Imagery

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Abstract:

Remote sensing is a modern advanced technique to study and identify structural features of Geological formations and landforms. Landsat imageries covering the Pulang river basin and adjacent areas has been used to delineate the structures, lineaments and landforms. Using satellite imagery LISS-II and Landsat-5 (TM), the structural elements such as folds, faults, joint pattern etc., and landforms are also identified for the purpose of assessing their groundwater potential zones in the basin area.

Key words: *Groundwater potential zones, landforms, lineaments, geomorphological features*

1.Introduction

In the present study the landsat imageries have been used in delineating large scale structural feature such as folds, joints, fault zones, domes, regional pattern and landforms. The landsat – 5 (TM) and satellite imagery LISS-II with intensive field checks have been used for the purpose of the present study. The pulang river rises from the Seshachalam hill ranges in Rajampet taluk of Cuddapah District, A.P., flows in general northerly direction and joins Cheyyeru river which is a major tributary to river Pennar. The basin which includes six sub-basins with a drainage area of about 757 km^2 with a course length of 74 km is located in between the North latitudes 13°50', and 14°15' and the East longitudes 79°2' 22'' and 79°18' 50''.

2.Climate

The climate of the river basin is hot and semi-arid for most part of the year especially in the month of May with a mean maximum temperature of 41.2°C, a mean minimum of 26.3°C and a mean of 32.2°C while December being the coldest month. The basin receives an average rainfall of 795 mm. The rainfall is less during the early months of every year and it is generally more during June and December.

3.Geology

The rock formations of the study area represent a suite of sedimentary and metamorphic rocks formed during pre-cambrian times. Lithologically the Cuddapah formations are predominantly argillaceous and arenaceous sequence with subordinate calcareous sediments. Characteristically each group starts with quartzite and ends with dolomite or shale/phyllite. Structurally, the rocks have a general trend of NNW-SSE with dips of formations generally varying from 10° to 40°. The Nagari quartzite is exposed mainly in the southern part of the basin. This is dominantly an arenaceous consisting of conglomerate quartzite, quartzite with shale intercalations.

The Pullampet formation rests over the Nagari quartzite conformably in the southern part of the basin with purple shale, carbonaceous shale and calcareous shale with prominent intercalations of dolomitic limestones. The basal part of the Pullampet is marked by ferruginous chert and Jasper with lensoid dolomite patches. Large outcrops of quartzite are seen in the southern and western portion of the area as hills and ridges.

Dolomitic Limestone occurs at places as discontinuous interbands and lenses. The shale occurs mostly in low-lying lands and strike in a NNW direction with variable dips. The

shale is interspersed by bands with quartzite, which sometimes occurs as low-lying elongated hillocks. Alluvium of recent age is composed mostly of sand and subordinately of silty or clayey sand and is confined all along and on either side of the Pulang river. At places, the alluvium is mixed with boulders of large number.

4.Lineaments

Numbers of lineaments are identified running NNW-SSE direction parallel to the regional trends appears to have deep crustal origin (Fig. 1). The rock types mostly present in the low lying areas are shales and phyllites. The western part of the area is occupied by quartzite hills trending NNW-SSE direction. Lineaments are a kind of fracture planes recognizable by a specific pattern of intrusives and a net work of streams to be readily recognized from imageries. The length of these lineaments may vary from few metres to hundreds of metres which tends usually along the strike direction. The schistose rocks present in the area trend mostly NNW-SSE direction which are isoclinally folded and overturned. The rock types appears to have been highly metamorphosed and deformed repeatedly. The schist belt which is adjacent on the eastern part is a major synformal structure with minor antiforms and synforms.

Number of faults have been identified with clear displacements which run parallel to the regional trends. There are some faults with NNE-SSW direction which are running in transverse directions to the regional trends. These are isoclinally folded and at some places are over turned. The closely spaced small irregular joints and fractures have been observed at number of places along the faults. The profuse development of jointing in quartzites and shales is due to their brittleness and depositional disturbances. The striking feature in the basin is that the river courses at northern side change its course to west due to intersection of two faults which run opposite to each other. With the influence of another major fault trending almost N-S direction the stream flows along the fault and joins cheyyeru river, where a natural spring emerges. The pulang liver basin is located in the eastern margin of the Cuddapah basin adjacent to the Nellore schist belt. Such closures are usually associated with longitudinal faults along which they have transposed. As there are number of transverse faults also seen indicates that the deformational history occurred is identified in both the Nellore schist belt as well as in the Cuddapah basin.

5.Landforms

The landforms and the structural features associated resulted from the neotectonic activity indicate a definite control over the hydrogeological conditions of the Pulang river basin. With the help of the landsat imageries certain favourable areas are identified for the purpose of assessing the groundwater potential zones (Fig. 2).

The pulang river basin presents an ideal geomorphic set up in the Pullampet formations of Cuddapah super group of rocks. The river rises from the Seshachalam hill ranges flows in a general northerly direction and joins Cheyyeru river. The elevation of the river basin varies between 1013 m to 126 m with a relief of 887 m above mean sea level.

A study of landforms is made from the survey of India topographic map and the geomorphological features of the basin are identified from the satellite imagery LISS-II and Landsat-5 (TM) with intensive field checks. It is observed that there is a systematic sequence in the evolution of landforms which makes possible the recognition of the stages of development and the difference in landforms are largely explainable in terms of lithology, structure and geomorphic process.

Generally, the different gemorphic landforms and units are classified on the basis of their geomorphic expansion, relief, slope factor, and surface cover with soil or vegetation. The landforms identified in the study area are broadly classified as denudational and depositional landforms covered by outcrops and depositional landforms (fluvial landforms) covered by colluvium, alluvium and transported soils. The denudational landforms include flat-topped hills, steep to moderately steep escarpments, relict hills, ridges, residual hills, pediments and pediplain, where as fluvial landforms include valley fills, gorges, flood plains, point bar deposits, channel bars and palaeochannels.

The Nagari and Pullampet quartzite occur as flat-topped ridges (RPS) which are massive and fractured with gentle slopes and show moderately steep escarpments towards S-SE to form cuestas in southern and south western parts of the basin area. In certain parts of the region the denudational hills are marked with rugged surface and occur as low but massive hill ranges.

In the area of study, the denudational hills occupy low range areas. They are the resultant landforms due to the natural dynamic process of denudation and weathering. These hills are essentially stony in nature, composed of quartzite with little soil cover and mostly barren. In these denudational hills, the depth of weathering is very shallow and development of soil profile is very negligible. As they do not have weathered mantel and hence these areas are poor groundwater potential zones.

Residual hills are basin relics and stand prominently as narrow dissected pediment of sedimentary terrain. These geomorphic forms are easily recognized in landsat imageries by their dark tone. Most of the residual hills in the area are aligned in N-S direction. The slopes of residual hills are covered by the sub-angular and sub-rounded blocks and are devoid of soil and vegetation cover. These areas are usually low groundwater potential zones except along certain fault and joint planes limited groundwater can be expected.

Pediments comprise of moderately sloping surfaces showing limited degree of weathered mantle and gently sloping surfaces showing a greater degree of weathering. The thin soil cover present over the pediment surface supports scanty vegetation of low shrub and grass. The extent of weathering in the pediment area varies from one metre to six metres. The drainage pattern in the pediment is generally dendritic but at places sub-dendritic. When a pediment is covered with rocky outcrops, it is called rocky pediment but on the other hand if it shows a rugged topography it is called dissected pediment. Numbers of faults are also observed in the pediment zone. Erosion being very active weathering may extend along these joints, fractures and faults. Hence limited groundwater potential is expected along the joints, fractures and faults in these pediments and pediplain areas.

Pediplain results from the "coalescence" of several pediments. It is flat or gently sloping surface extending from foot of the hill slopes. In the area of study pediplains are flat terrains occurring over the weathered shales and dolomites. The thickness of soil profile varies from 2 to 6 metres comprising brown to red soil at top, black soil in the middle and coarse gravel to sandy soil at the bottom. Coarse to fine dendritic drainage pattern is characteristically developed in the pediplain area. Major part of the study area is occupied with pediments and pediplain.

The material eroded from the denudational landforms may get deposited in or outside the basin. The depositional landforms, the valley fills are natural depressions formed by block faulting and fluvial action in linear direction and are filled up with loose detrital material of colluvium and alluvium. In the landsat imagery, this geomorphic unit is identified by its spatial distribution along with shallow valleys as infillings. In the area under study, the colluvial unit is present along the course of shallow streams.

The various geomorphic features related to fluvial landforms present in the area of study are rock cut terraces and flood plain deposits. Flood plains are covered with alluvium transported and deposited by streams. Most of these are developed along Pulang river and its tributaries. Palaeochannels, on the other hand, refer to alluvium deposited by the action of abandoned rivers that may also be referred as buried valleys. When the course

of a river shifts gradually by meandering, deposition exceeds erosion and the thickness of alluvium is expected to be higher than that below an existing river, Palaeochannels of substantial thickness is observed in the northern side of the river course. Usually the flood plains and Palaeochannals are supposed to be good groundwater potential zones, because of the imperfect drainage system, only a limited quantity of groundwater is expected in these areas.

Alluvial fans are formed where a heavily loaded stream emerges from hills or mountains on to a low-land with resulting deposition of alluvium spreading out in fan-like form. The material comprising a fan varies in texture from coarse boulders and pebbles as its head to finer material down its slope. The alluvial fans are formed at foot of the quartzite hillocks in central and near the north eastern part of the basin. A series of adjacent fans coalescence to form an extensive bazadas, that are extended for few kilometers away from the hill slopes at places in the basin area. As these alluvial fans are composed of loose and unconsolidated rocks and pebbles carried by the high gradient streams, high groundwater potential can be expected in these zones.

6.Conclusion

The lineaments observed from the landsat imageries show the structural trends on the eastern part of the Cuddapah basin. The folding, jointing and faulting etc., observed in the eastern margin of the Cuddapah basin may be due to intense deformation. The Nellore schist belt which is adjacent to the eastern margin of the Cuddapah basin is a synformal structure with minor antiforms and synforms. The axial planes of the isoclinical folds and faults noticed in the study area indicate the maximum compression occurred in E-W direction. These evidences clearly show the deformation occurred in both the Nellore schist belt and the Cuddapah basin is identical in nature.

The landforms and the structural features identified from the landsat imageries indicate a definite control over the hydrogeological conditions existing in the Pulang river basin. The denudational hills composed of quartzites do not have weathered mantle and hence these areas are poor groundwater potential zones. The residual hills identified are usually low groundwater potential zones except along certain fault and joint planes. Groundwater zones are also limited along the joints, fractures, and faults of the pediment and piedmont zones. Certain paleochannels, flood plains and alluvial fans consisting of coarse boulders and pebbles of schistose and phyllites are identified from the imageries are supposed to be good groundwater potential zones. But due to imperfect drainage

system by the Pulang river, only a limited quantity of groundwater is expected in these areas.

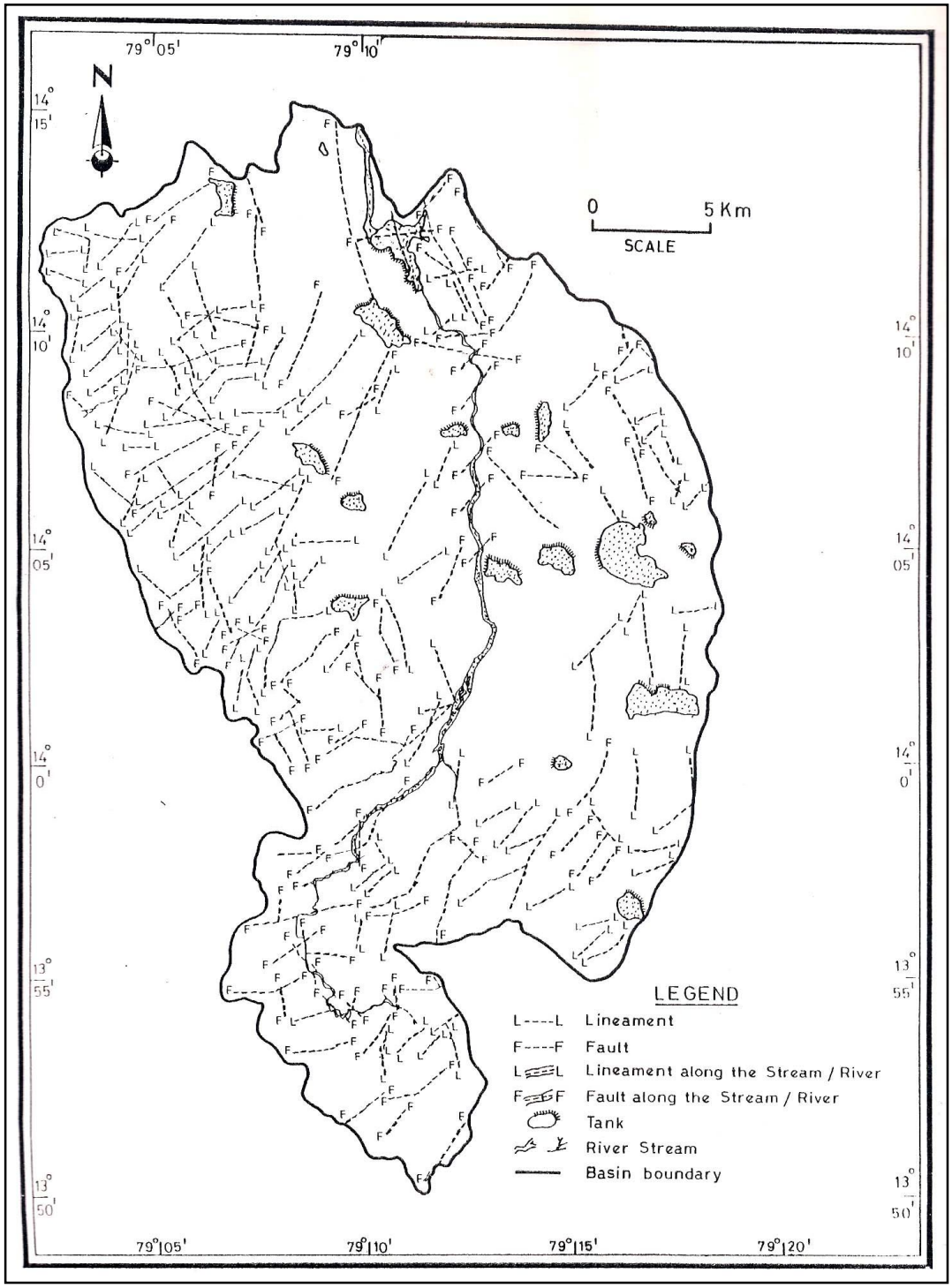

Figure 1: Lineament Patterns Of Pulang River Basin

Figure 2: GEOMORPHOLOGICAL FEATURES OF PULANG RIVER BASIN

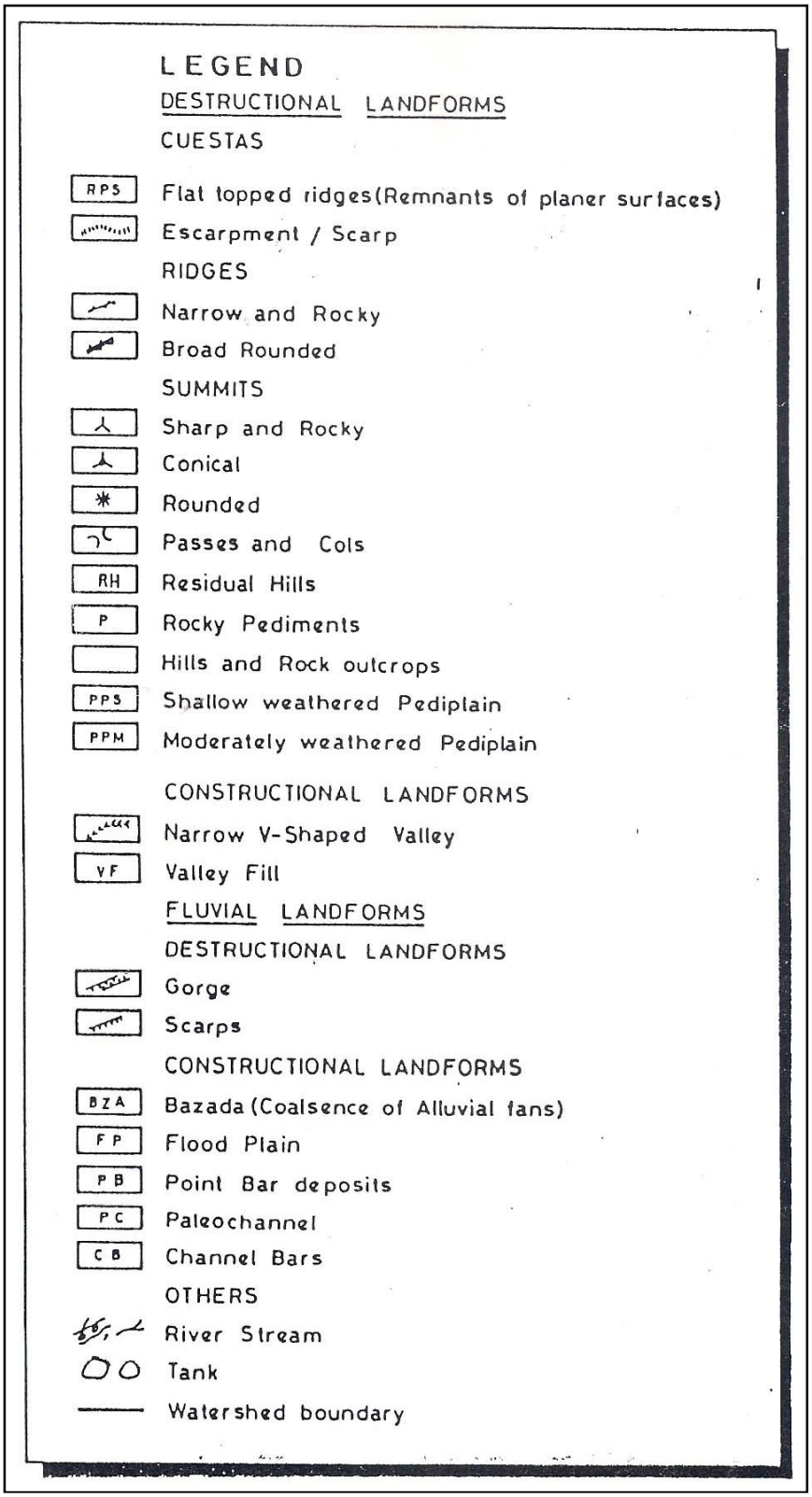
LEGEND
DESTRUCTIONAL LANDFORMS
CUESTAS
RPS
Flat topped ridges(Remnants of planer surfaces)
Escarpment / Scarp
RIDGES
Narrow and Rocky
Broad Rounded
SUMMITS
Sharp and Rocky
Conical
Rounded
Passes and Cols
RH
Residual Hills
P
Rocky Pediments
Hills and Rock outcrops
PPS
Shallow weathered Pediplain
PPM
Moderately weathered Pediplain
CONSTRUCTIONAL LANDFORMS
Narrow V-Shaped Valley
VF
Valley Fill
FLUVIAL LANDFORMS
DESTRUCTIONAL LANDFORMS
Gorge
Scarps
CONSTRUCTIONAL LANDFORMS
BZA
Bazada (Coalsence of Alluvial fans)
FP
Flood Plain
PB
Point Bar deposits
PC
Paleochannel
CB
Channel Bars
OTHERS
River Stream
Tank
Watershed boundary

Figure 11

7.Reference

1. Chakraborti, D.K., Verma, R.P., Gautham, A.M., and Narasiha, S., (1987). Geomorphological map of North/Eastern part of India-A Landsat overview. Geological Survey of India Records Volume. 115, Parts III & IV., pp. 65-74.
2. Chetty, T.R.K. and Murthy, D.S.N., (1983). Eastern margin of Cuddapah basin and the Nellore schist belt – Some observations from landsat imageries, Geophysical Research Bulletin, Vol. 21, No. 2.