

# Studies on a Catena in Coimbatore District

## I. Profile Descriptions\*

by

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**Synopsis:** A catena situated near Chettipalayam in Coimbatore district and developed from gneiss has been described with morphological features of eight profiles. Surface features, drainage, colour, soil depth, occurrence of calcium carbonate, structure and consistence are discussed.

**Introduction:** Most of the soils of Madras State are in an immature and virile state of development due to constant surface erosion exposing the lower horizon to the weathering forces. The erosive action is, generally, aided in many regions by a hummocky or undulating topography. The hummocky topography modifies the pattern and the extent of drainage in different sections of the slope. The difference in drainage conditions results in variation of profile characteristics. These soils, though different in the genetic and morphological features are similar in that they occur in situations of similar topography. Such physiographic association of soils is designated as catena (Milne, 1935a).

Milne (1935b, 1936) has coined the term, catena, for a unit of mapping convenience, especially in tropical soils of Africa. The concept of catena has, since then, been extended to the studies of soils of various countries.

Workers in Indian soils have also observed the influence of topography in many instances deciding the nature of soils. (Basu and Sirur, 1938; Sinha, Verma and Lall, 1962 and Biswas and Gawande, 1962). However, papers on field descriptions, physical and chemical characteristics of catenas, which are found to occur commonly in the Red Soils of Madras State, are not forthcoming. In this series of papers, therefore, an attempt has been made to describe and to give a detailed account of physical, physico-chemical and chemical properties of a catena, situated near Chettipalayam in Coimbatore district. The mode of soil development has also been investigated with the available data. The present paper deals with the physical setting of the catena and profile descriptions.

**PHYSICAL SETTING OF CATENA:** *Geology:* The soils of the area have been derived from a parent rock composed of gneiss with feldspar, quartz and mica as chief mineral make up. The rock contains an appreciable

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amount of lime. Veins of quartz or feldspar upto three inches or more running obliquely are occasionally found to occur in the rock. A fair amount of iron is also found.

*Physiography*: The landscape selected for the study lies at an altitude between 1200 and 1300 feet above Mean Sea Level sloping in Western direction. The area is characterized by a hummocky topography possessing numerous water sheds. Each water shed is drained by a small stream at the valley. The landscape studied rises gently from the stream at a gradient of about two per cent. The upper reach of the slope is convex. Outcrops of rocks are exposed in some cases of mound.

*Climate*: The locality is situated in the rainshadow region on the east of the Western Ghats. Therefore, the climate tends to be arid. The mean annual rainfall is 25 inches. In soil studies, the distribution pattern of rainfall is more important than the total rainfall. Major quantity of rainfall is received in two monsoon seasons, namely eight inches in the South West monsoon period and 12 inches in the main rainy season of the North East monsoon. During the hot weather season extending from March to May, the rainfall amounts to five inches and it is more often received as thunder showers. Mean maximum temperature ranges from 83° to 97°F. and mean minimum temperature varies from 62° to 75°F.

*Vegetation*: Since there is only scanty rainfall, the natural vegetation consists of short grasses and scrub jungle predominantly of xerophytic plants. However, tall grasses and other water-loving plants grow well along the drainage water courses along the valleys.

The land selected for the study has been under cultivation over a long period. The upper slopes of the catena are usually cultivated for dry crops such as millets, groundnut, horse gram etc. But on the lower slopes, irrigation culture is practised with the aid of well water. Irrigated cotton, *cholam*, onion, and other vegetables are generally raised.

*Description of the catena*: The location of profile pits in relation to the general landscape is shown in Figure I. Figure II drawn to the scale indicates the section of the water shed and the location of the profiles. Figure III shows diagrammatically essential features of the profile characteristics. The profiles are described below detailing various features of colour, texture, horizon differentiation, etc. The colours are recorded for the moist soil.

FIGURE I  
GENERAL LANDSCAPE OF THE CATENA

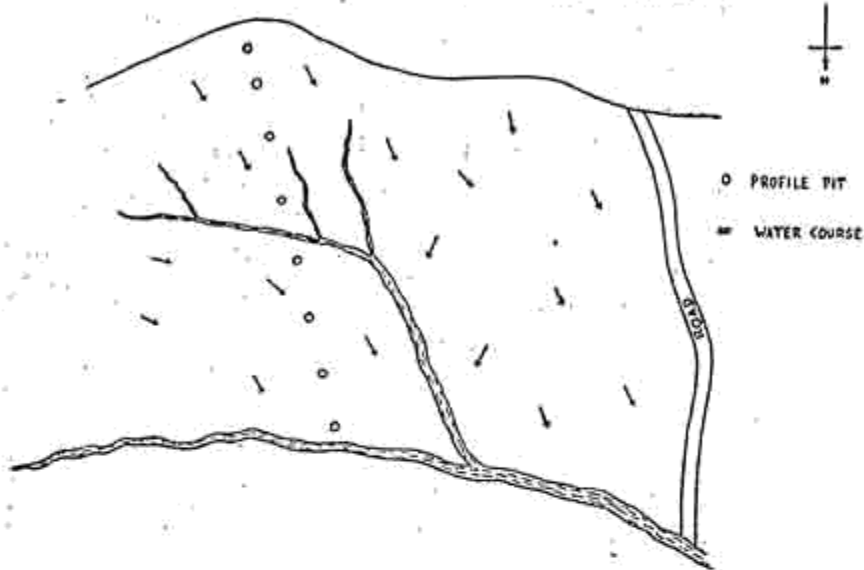


FIGURE II  
CROSS SECTION OF THE CATENA WITH  
THE LOCATION OF THE PROFILE PITS

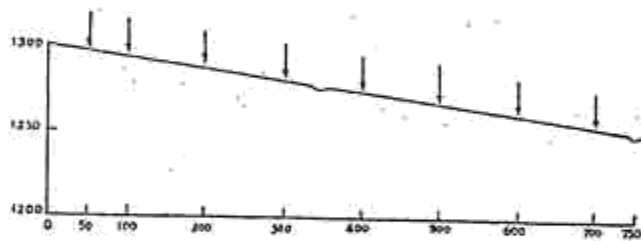
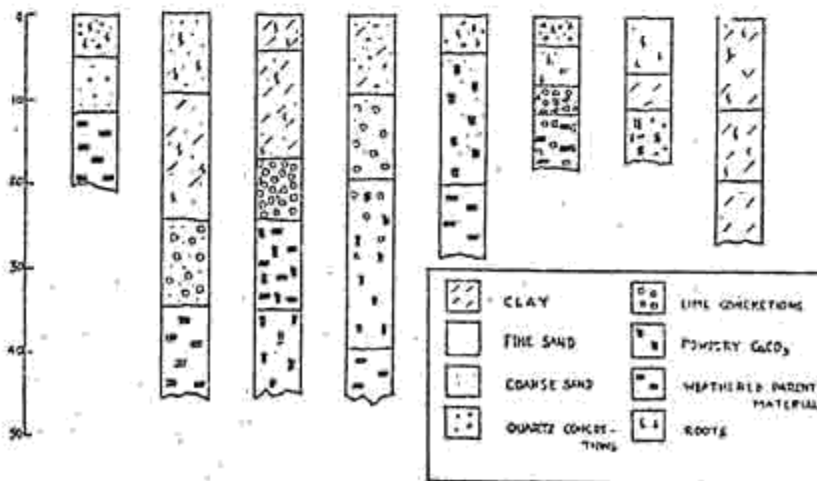


FIGURE - III  
PROFILE CHARACTERISTICS - DIAGRAMMATIC



1. Surface features: Gravels of varying sizes upto three inches in diameter are found on the surface in moderate number. Colourless and milky white to dark brown quartz are found. The land was kept fallow for the past three seasons. The soil is highly permeable and the drainage is good.

0-5" Reddish yellow (5YR 6/6), sandy, single grained, loose, moderate root distribution, slightly moist, highly permeable, angular quartz bits of peanut-size present, gradual change to

5"-11" Yellowish red (5YR 5/6), sandy, single grained, loose, moist, sparse root distribution, highly permeable, rounded quartz pebble present, abrupt change to

below 11" Weathered material of gneissic rock

2. Surface features: Lesser number of quartzite pebbles than the above profile is found. The soil is highly permeable and well drained. It was fallow for the past three seasons.

0-9" Yellowish red (5YR 5/6), sandy loam, single grained, loose, slightly moist, traces of root distribution, highly permeable, gradual change to

9"-28" Yellowish red (5 YR 4/6), sandy loam, single grained, loose, moist, traces of root distribution, highly permeable, small angular pieces of quartz found in very small number, gradual change to

23"-33" Red (2.5YR 4/6), sandy loam, moist, loose, highly permeable, dirty brown concretions which effervesce with HCl, abrupt change to

below 33" Weathered parent material mixed with calcium carbonate which occurs as nodules and in the form of incrustations enclosing quartz nuclei. This horizon changes below into bluish green weathered gneiss.

3. Surface features: Contrasted to the previous profiles, no quartz pebbles are found on the surface. Standing crop is *cumbu*, growth of which is not satisfactory. Drainage is moderate.

0-4" Reddish brown (5YR 4/4), sandy loam, granular structure, loose, slightly moist, moderate root distribution, diffuse change to

4"-17" Dark reddish brown (5YR 3/4), loam, prismatic structure, slightly moist, hard, sparse root distribution, small bits of quartz and calcium carbonate nodule, effervescence on the bits of nodule, slightly impervious, abrupt change to



- 17"-24" Red (2.5 YR 4/6), loam, moist, calcium carbonate nodules of less than half of an inch found mixed with soil, dirty brown mottlings and white precipitate of calcium carbonate, sparse root distribution, effervescence vigorously in calcium carbonate pockets and nodules, permeable, diffuse change to
- 24"-35" Reddish brown (2.5 YR 5/4), sandy, moist, veins of carbonate in precipitate form, no root distribution, permeable, effervescence vigorously on veins of carbonate, diffuse change to
- below 35" Yellowish red (5 YR 5/8), soil material with powdery carbonate pockets, diffused to parent material, vigorous effervescence in carbonate pockets.

4. Surface feature: There is no quartzite pebble or stone. It is at present a fallow field with grass weeds. Drainage is moderate.

- 0"-9" Yellowish red (5YR 4/6), sandy loam, prismatic (nutty) structure, slightly moist, hard when dry and sticky when moist, moderate root distribution, permeable, white specks of carbonate and concretions of quartz and carbonate, effervescence only in calcium carbonate pockets, abrupt change to
- 9"-39" Reddish yellow (5YR 6/8), sandy loam, zone of carbonate accumulation, nodules of carbonate mixed with soil, more powdery below 19 inches, vigorous effervescence with HCl, abrupt change to
- below 39" Reddish yellow (5YR 6/6), highly weathered parent material, rich in iron, carbonate also deposited, effervescence with HCl.

5. Surface feature: Pebbles and quartz of different sizes are found in moderate number. The land was kept fallow. Grass weeds are found.

- 0-4" Yellowish red (5YR 5/8), sandy loam, granular, dry, loose, concretions of quartz and pebbles of feldspars, moderate root distribution, permeable, slight effervescence with HCl, diffused change to
- below 4" Reddish brown (2.5YR 5/4), powdery calcium carbonate mixed with highly weathered material, effervescence with HCl, yellowish green mottlings.

6. Surface feature: Pebbles and quartz of different sizes are present in moderate number. The land was fallow for the past two seasons

- 0-3" Red (2.5YR 5/6), sandy granular, dry, loose, concretions of small pieces of quartz, moderate root distribution, permeable diffuse change to

3"-7" Dark red (2.5YR 3/6), sandy loam, granular, dry, hard small pieces of quartz, sparse root distribution, effervescence with HCl in pockets, slightly permeable, abrupt change to

7"-11" Layer of quartz coated with red iron oxide, size of pebble below 2 inches, mixed with small amount of soil, concretions of iron also present

below 11" Weathered parent material mixed with calcium carbonate nodules.

7. Surface features: Moderate number of different sizes of quartz and pebble is present. The land was kept fallow for the current season and the previous crop was *cumbu*.

0-6" Yellowish red (5YR 5/8), sandy loam, single grained, slightly moist, loose. concretions of carbonate, angular and rounded pebbles of quartz, sparse root distribution, highly permeable, effervescence with HCl in pockets, gradual change to

6"-11" Yellowish red (5YR 4/6), sandy loam, single grained, moist, loose, white specks of carbonate, sparse root distribution, effervescence with HCl in pockets of carbonate, permeable, abrupt change to

below 11" Weathered material breaking into angular pieces of about one inch size of quartz and feldspars interveined by carbonate powder effervescence with HCl.

8. Surface features: Micro flood plain. No pebbles are found. The surface is covered with turf of grasses. The land was not cultivated for some seasons.

0-11" Dark reddish brown (5YR 3/4), sandy loam, massive, moist, slightly sticky, sparse root distribution, moderately permeable, abrupt change to

11"-19" Dark reddish brown (5YR 3/3), sandy loam, wet, massive, sticky, sparse root distribution, moderately permeable, abrupt change to

19"-25" Dark reddish brown (5YR 3/3), sandy loam, massive, wet, sticky sparse root distribution, effervescence with HCl, slightly permeable

below 25" Ground water

COMPARATIVE STATEMENT OF MORPHOLOGICAL FEATURES

	Hill top	II profile	III profile	IV profile	V profile	VI profile	VII profile	Valley profile
Surface feature	Gravels (3/4 size) moderately found	Lesser amount of gravels than first profile	No pebbles	No pebbles	Pebbles in moderate number	Pebbles in moderate number	Pebbles in moderate number	No pebbles
Vegetation	Fallow	Fallow	Poor crop of <i>cumbu</i>	Fallow	Grass weeds	Fallow	Fallow	Turf of grasses
Surface soil	Reddish yellow	Yellowish red	Reddish brown	Yellowish red	Yellowish red	Red	Yellowish red	Dark reddish brown
(a) colour	5YR 6/6	5YR 5/6	5YR 4/4	5YR 4/6	5YR 5/8	2.5YR 5/6	5YR 5/8	5YR 5/8
(b) Texture	Sandy	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy	Sandy loam	Sandy loam
(c) Structure	Single grain	Single grain	Granular	Prismatic	Granular	Granular	Single grain	Massive
(d) Consistence	Loose	Loose	Loose	Hard when dry, Sticky when moist	Loose	Loose	Loose	Slightly sticky
Effervescence with HCl	No Effervescence throughout	Effervescence below 23"	Effervescence below 14"	Effervescence throughout	Effervescence throughout	Effervescence below 3"	Effervescence throughout	Effervescence below 19"
Lime concretions	Nil	23"-33"	17" downward	9"-30"	Nil	Nil	present throughout	Nil
Quartz & iron concretions	Nil	Nil	Nil	Nil	Nil	7-11"	Nil	Nil
Depth of soil	11 inches	33 inches	35 inches	30 inches	4 inches	11 inches	11 inches	Water table at 25"
Drainage	Good	Good	Moderate	Moderate	Good	Good	Good	Poor

*Discussion: Surface features:* The surface features of most of the profiles are characterized by the presence of pebbles and gravels of quartz of varying sizes. These quartz pieces are derived from the veins of quartz found in the gneissic rock foundation of the catena. Being very resistant to weathering, the quartz persists at any depths of the profile, where the vein happens to occur in the rock. When present in the top horizon, it is brought to the surface by the implements worked during cultivation.

*Drainage:* Vertical and lateral drainage in the mound as well as the slope profiles is good, since the texture of the soil ranges from sandy to loam, the structure is mainly single grain and the water table is too deep. There is no impervious layer met with in any of the profile. There is also a considerable surface run off down the valley. A small gully has developed between the fourth and fifth profiles running obliquely for a distance and, then, turning right downward the valley. In the valley, the water table is touching as high a level as 25 inches below the surface of soil even during the last week of January.

*Colour:* The colour of the various horizons ranges, in general, from reddish yellow to yellowish red. But, dark reddish brown is noted in the horizons of the valley profile. Differently hydrated oxides of iron are mainly responsible for the colour of the soil. Iron oxide concretions are absent in all the members of the catena except in one horizon of quartz band of the sixth profile.

*Soil depth:* The normal erosion and redeposition of soil material decide the depth variation in all the members of the catena. The hill-top profile is somewhat shallow and only 11 inches deep, since there is surface washing of soil material to lower levels. Another cause for a shallow depth is, perhaps, a less amount of water available for the soil-forming processes. Much water is lost as surface run-off and/or in the lateral drainage. Succeeding profiles down the slope upto the fourth member show a marked increase in the depth of the solum. The small gully developed between the fourth and fifth profiles interrupts this trend of increase in depth. The gully has truncated the fifth profile leaving barely a four inch solum. The lower members of the catena have again 11 inches of soil. The decreased depth than the upper slope members can be attributed to excessive erosion. As water runs down a slope, it gains speed and erosive power is increased, causing larger extent of surface washing of the soil material. The profile in the valley has the greatest depth because of accumulation of soil wash from above.



*Calcium carbonate concretions:* The calcium carbonate either in the form of powdery deposition in pockets and in veins or kankar nodules is found to occur in all the profiles of the catena with an exception in hill-top and valley profiles. In the latter profiles, the lime has been completely washed away. The carbonate of lime is precipitated as secondary formation during the weathering of parent gneissic rock, which is rich in calcium. Scanty rainfall does not furnish enough water to leach the carbonate formed. Therefore, it accumulates at certain depth of the profiles. In all the slope members of the catena, carbonate is also deposited in the crevices of the parent material.

In the second profile, accumulation of calcium carbonate occurs at the depth of 23-33 inches, while in the case of third profile, the carbonate accumulative layer is found from 17 inches downward. The greatest accumulation is noted in the fourth profile from 9 inches onward. In the case of truncated profile (No. 5), there is no distinct carbonate accumulative horizon. The kankar nodules are found from 3 inches downward in the sixth profile, whereas in the seventh member there are carbonate nodules even in the top horizon.

*Quartz accumulation:* In the sixth member of the catena, there occurs a band of quartz pebbles in the third horizon. This is clearly due to the occurrence of veins of quartz in the parent rock. Such bands reveal the sedentary nature of the profile.

*Structure and consistence:* The horizons of hill-top, second and seventh profiles are loose and have a single grain structure, whereas the surface horizons of the third and fifth profiles and all the horizons of the sixth profile are loose and show a granular or crumb structure. In the sub-soil horizon of the third profile and all the horizons of the fourth profile, a prismatic or nutty structure with a hard consistence is noticed. This suggests an accumulation of salts. The structure observed in the valley profile is massive or compact and the consistence is sticky, showing the presence of soluble salts.

*Summary:* A field investigation of catena, situated in red soils near Chettipalayam in Coimbatore district and developed on gneiss, has been undertaken. Surface features, drainage conditions, colour, soil depth, occurrence of calcium carbonate concretions and quartz pebbles, structure and consistence of the eight profiles dug in the catena are discussed. The paper is the first of a series on the study of catena and will be followed by further papers dealing with the detailed laboratory studies.

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