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Short Communication

Quaternary Soil Formations in Some Godavari Delta Region

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Quaternary changes in river regimes of Godavari, Bhima and Krishna due to global climatic changes in the north-western Deccan upland region of India are evident from the anomalous alluvial deposition and fossiliferous animal remains (Kale & Rajaguru 1987). Krishnan (1968) mentioned about such formations during Middle Miocene to Lower Pleistocene during which Rajahmundry sandstone was overlain by deltaic alluvium along the east coast as evidenced by molluscan shells of the Pleistocene found on raised beaches. The fact that Godavari deltaic depositions are also recent (Wadia 1989) have been observed during field surveys in the Godavari delta region of East Godavari district of Andhra Pradesh and Yanam region of Pondicherry.

The major physiographic units in the Godavari delta region (which comprises a group of islands) are marine landforms with and without swamps and marshes, muddy salt pans (P5), sand bars, interfluves of the delta-lowlands (P2, P3) and interfluves of the delta flatlands. The interfluves of the delta (lowlands and flatlands) are fertile lands in Andhra Pradesh, where rice is the major crop and coconut is the major horticultural crop, which contribute largely towards the highest productivity rating of Andhra Pradesh in coconut yield in India. The swamps and marshes have a scattered mangrove vegetation (*Avicennia martine, Avicennia albra* B1), whereas the muddy salt pans and sand bars mainly bear salt resistant species and herbs (*Trianthema portulacastrum* L., *Acalypha indica* L., *Jatropha gessypifolis* Roxb.). The other areas are dominated by *Acacia arabica* and *Prosopis juliflora*. The temperature regime is isohyperther-

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mic and moisture regime is Typic Tropostic (van Wambeke 1985).

Profile P2 shows properties of a Vertisol (Table 1), but at a depth of 0.97 cm, there is an abrupt discontinuity with layers of different materials having very dark grey to very dark greyish brown colour. Similarly the 1.09-1.45 m horizon in P3 shows discontinuity with a characteristic colour change. The same discontinuity is also seen in profile P5 at a depth of 0.62 m from the surface, but without a characteristic colour change. At other places (not shown in the table), discontinuity varied from 1 to 2 m (or even at greater depths), which was confirmed by augur sampling and from previously excavated wells. It can be thus envisaged that the black soil (or allochthonous material) irregularly fossilized the previous soil (or soil horizons) with varying depths of alluvium depending upon the past climatic and topographic conditions. Further, effervescence is mainly due to calcareous nodules; the matrix having negligible response with dilute acid. As observed in the upper Godavari sediments (Kale & Rajaguru 1987), these nodules are also made up of quartz and calcedony cemented with calcium carbonate (nodules are not soluble completely in acid). This indicates that these nodules are transported, and since then, did not encounter any major climatic changes *vis-a-vis* high rainfall conditions. Yellow mottles may be due to lepidocrocite or pyrite oxidised to jarosite. Presence of sulphate minerals in the form of yellow mottles towards the lower horizons of the profiles may be indicative of previous marine sediments (Fitzpatrick 1984). The horizon designation, "b" (Table 1) implies buried horizon (Soil Survey Staff 1992).

The appearance of two or more trends in the particle size distribution (Table 2) may indicate

Table 1. Morphological properties of some selected pedons

Horizon	Depth (m)	Colour (moist)	Mottle colour	Text. class	Structure	Effer-vescence	Calcareous nodules	Other features
P2 Fine montmorillonitic, isohyperthermic, Typic Haplustert								
Ap	0.0-0.18	10YR 3/2		sic	c 3 sbk	es	f-m m	5-10 cm wide
Al	0.18-0.47	10YR 3/2		sic	c 3 sbk	es	f-m m	cracks up to
Bwss2	0.47-0.80	10YR 3/1		C	c3 abk	e	f-m f	0.20 m and 1-2 cm
Bwss3	0.80-0.97	10YR 3/2		sicl	c 3 abk	e	f-m c	wide cracks
3Ab1	0.97-1.23	10YR 4/3	m2p 7.5YR 4/6	s	f 0 gr	–	–	upto 0.47 m
4Ab2	1.23-1.36	2.5Y 3/2		sic	m 2 sbk	e	f-m f	
2Ab3	1.36-1.54	2.5Y 3/1		ls	m 1 sbk	e	–	
P3 Fine, montmorillonitic, isohyperthermic, Vertic Ustifluvent								
A1	0.0-0.13	10YR 3/2		C	m 2 abk	e		
A2	0.13-0.30	10YR 3/2		sic	m 2 sbk	es		NISS*
A3	0.30-0.54	10YR 3.5/2		sic	m 2 sbk	e		NISS
BC4	0.54-0.82	10YR 3/3	m2f 10YR 4/4	c	m 2 sbk	e		2-3 cm wide cracks
BC5	0.82-1.09	10YR 4/3	m2d 10YR 5/8	sic	m2 sbk	e		upto 0.12 m and
2BCb1	1.09-1.45	2.5Y 2.5/1		sic	m 2 sbk	es		0.5 cm wide cracks up to 0.45 m
P5 Fine, mixed, isohyperthermic, Fluventic Ustropept								
A1	0.0-0.12	10YR 3/2		C	m 1 sbk	ev	f-m m	
Bw1	0.12-0.31	10YR 3/2		C	m 2 sbk	ev	f-m m	
Bw2	0.31-0.47	10YR 3/2	c1f 10YR 5/6	C	m 2 sbk	ev	f m	
2Bw3	0.47-0.62	10YR 4/2	m2f 10YR 5/8	sl	m 1 abk	e	f-m c	
3Bb1	0.62-0.84	10YR 4/2	m2p 7.5YR 4/6	s	f 1 gr	e	f c	
4Bb2	0.84-1.05	10YR 4/3	m2p 7.5YR 4/6	s	f 0 gr	–		
	1.05+	Water table						

* NISS - Non-intersecting slickensides

Table 2. Some soil properties

Profile No.	Depth (m)	Sand (%)	Silt (%)	Clay (%)	Sand/silt ratio	(Sand+silt)/ clay ratio	$CaCO_3$ equiv. (g kg^{-1})	Org. C (g kg^{-1})
P2	0.0-0.18	4.6	46.6	48.8	0.10	1.05	66	9.8
	0.18-0.47	0.9	43.6	55.5	0.02	0.80	–	–
	0.47-0.80	1.5	35.8	62.7	0.04	0.59	71	7.2
	0.80-0.97	8.6	53.6	37.8	0.16	1.65	67	5.6
	0.97-1.23	92.3	3.5	4.2	26.37	22.80	71	0.7
	1.23-1.36	15.4	44.4	40.2	0.35	1.49	51	5.5
	1.36-1.54	82.4	10.9	6.7	7.56	13.93	29	1.4
P3	0.0-0.13	1.6	35.3	63.1	0.05	0.58	55	14.4
	0.13-0.30	0.3	42.6	57.1	0.01	0.75	56	7.6
	0.30-0.54	1.8	44.4	53.8	0.04	0.86	56	6.7
	0.54-0.82	1.0	45.6	53.4	0.02	0.87	60	7.3
	0.82-1.09	1.8	39.5	58.7	0.05	0.70	60	8.2
	1.09-1.45	11.7	40.4	47.9	0.29	1.09	58	13.9
P5	0.0-0.12	22.6	37.0	40.4	0.61	1.48	26	8.9
	0.12-0.31	15.2	26.0	58.8	0.58	0.70	34	9.8
	0.31-0.47	40.8	12.0	47.2	3.40	1.19	3	1.7
	0.47-0.62	79.6	3.0	17.4	26.53	4.75	21	2.4
	0.62-0.84	90.4	2.2	7.4	41.09	12.51	11	1.7
	0.84-1.05	92.9	0.6	6.5	154.80	14.38	20	1.3

some stratification (Barshad 1964). This is further reflected by the sand/silt and (sand + silt)/clay ratios at 0.97-1.23 m, 1.09-1.45 m and 0.47-0.62 m in the profiles P2, P3 and P5, respectively. However, if sand/silt ratio is considered alone, the irregularity begins at 0.31-0.47 m in case of profile P5. The data are similar to the work of Smith and Wilding (1972) who explained homogeneity of parent material by differences in sand/silt ratios of adjacent horizons. Similarly, Sidhu *et al.* (1976) and Ibrahimi *et al.* (1986) envisaged that a change of about 0.2 (arbitrarily) in the sand/silt ratios of adjacent horizons may be indicative of lithological discontinuity. Moreover, many other authors are of the view that changes in texture, structure, consistence, colour, organic carbon and carbonates supported by field observations and distribution of assumed mobile constituents are estimates of homogeneity/heterogeneity of the parent material. Sudden changes in organic carbon in the horizons at 1.23-1.36 m in P2, 1.09-1.45 m in P3 and 0.31-0.47 m in P5 are also indicative of lithological discontinuity. However, $CaCO_3$ equivalent did not show marked changes and the reason is not quite clear.

Thus, occurrence of buried material (paleochannels) and quaternary soil formation is conceivable and that the Godavari has a very old depositional history (Upper Gondwana sediments) along the coast of Andhra Pradesh as far as the Jurassic (Krishnan 1968). However, at this stage of the study, it can not be said that these buried horizons belong to a particular geological period. Lastly, these soils are well drained, owing to the largely loamy to sandy loam texture below the solum of a Vertisol, as related to the productivity status mentioned above.

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