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X-Ray Diffraction studies of Calcrete in and around Duraisamipuram, Vilathikulam region, Thoothukudi District, Tamilnadu, India

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Abstract

Calcretes are formed as a widespread deposit within the regolith parts of Duraisamipuram and its surrounding villages near Vilathikulam region, Tuticorin district, Southern Tamilnadu, India. The geological setting of the study area is given. The spatial collection of the calcrete samples from the surface outcrop of various landscape setting were carried out. The calcrete appear as granular or gravel, chalky, massive and hardpan in the surface outcrops. The x-ray diffraction analysis of carbonate and non-carbonate fraction samples of calcrete of the study area reveals the general mineralogy and clay mineralogy respectively. The presence of clay minerals in calcrete reveals the climate of the study area.

Keywords; Regolith, Carbonate and Non-carbonate, Clay minerals and Climate.

Introduction

Calcretes are thick impure carbonate deposits formed within the regolith profile as a penetrative or intrusive form above the basement rock, under the arid and semi-arid climatic conditions. The carbonate development have been introduced within the regolith by the replacive and displacive and passive mechanisms of precipitation (Wright and Tucker 1991).It is further established that the calcrete deposits has been formed by the evapotranspiration of alkaline rich ground water or soil leaching process of surface water or meteoric water conditions (Hill et al 1999). But no research works have been concentrated on calcrete deposits in and around Duraisamipuram, Vilathikulam region, Thoothukudi District, Tamilnadu, India Fig-1. Duraisamipuram is an important panchayat capital in the vilathikulam block. This village capital is connected by various road networks from Vilathikulam and Tuticorin town.

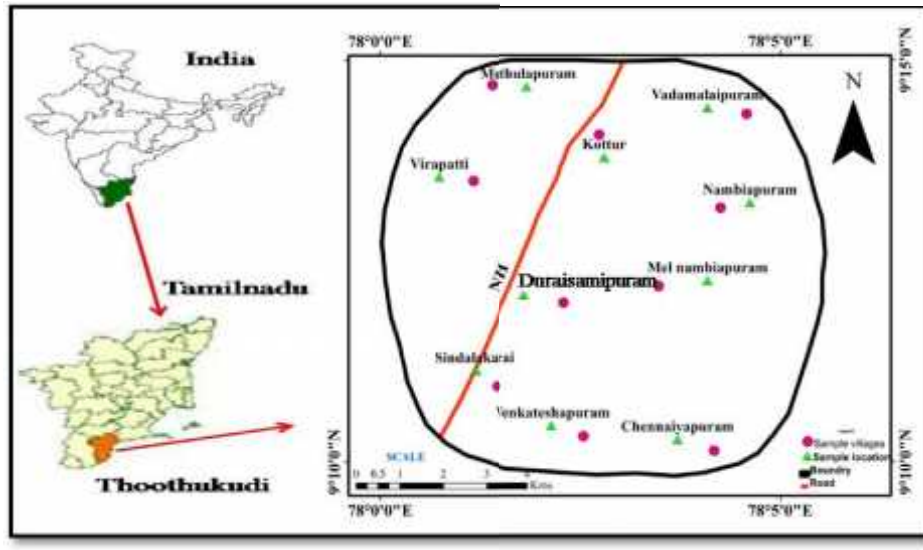


Fig-1. Location map of the study area.

Geology of the study area

The study area is almost flat and plain with the maximum elevation of 60 m above MSL. It receives an average rainfall of 600 mm per year. The Proterozoic hard basement rocks are mainly composed of quartzite, calc-granulite, hornblende biotite-gneiss, charnockite and granite. The black soil rest over the basement rocks which occur as surface outcrops. In between the black soil and basement rocks, calcretes have been well developed as a thick profile, with the thickness of 1 m to 1.25 m Table-I. They also occur as penetrative and intrusive forms within the weathered basement rocks.

Table I - Stratigraphic succession of the study area.

Strata	Thickness	Age	Depth
Black cotton soil	1.25 m	Recent	1.25 m
Calcrete layer	1.20 m	Holocene to Pleistocene	1.25 – 2.45 m
Sap rock or basement rock	Infinitive	Proterozoic	Below 2.45 m

Methodology

Calcrete samples were collected spatially in and around Duraisamipuram village (between the latitudes from 9° 10' to 9° 15' and Longitudes from 78° 0' to 78° 5') from the surface outcrops. The selected representative calcrete sample was

subjected to the x-ray diffraction analysis through the XRD instrument, Manonmanium Sundaranar University, Tirunelveli. The mineralogy was determined by the two ways through the XRD values for carbonate and non – carbonate fractions of the calcrete samples.

Result and discussion

Field observation

The calcrete appear as granular or gravel layer in the surface outcrop. In some places, they occur as chalky, massive, laminated, hardpan in the sub-aerial exposures. Such outcrop is widespread in many area of arid and semi-arid region in Australia (Mc Queen, 2006). The distribution of calcrete is mainly controlled by dissolution of carbonates rich sources from primary limestone's and weathering sources of calcium rich metamorphic rocks (Udayanapillai and Thirugnanasambandam, 2012 and Udayanapillai et al 2016). Such similar controlling factor is existed in the study area Fig 2a-b.

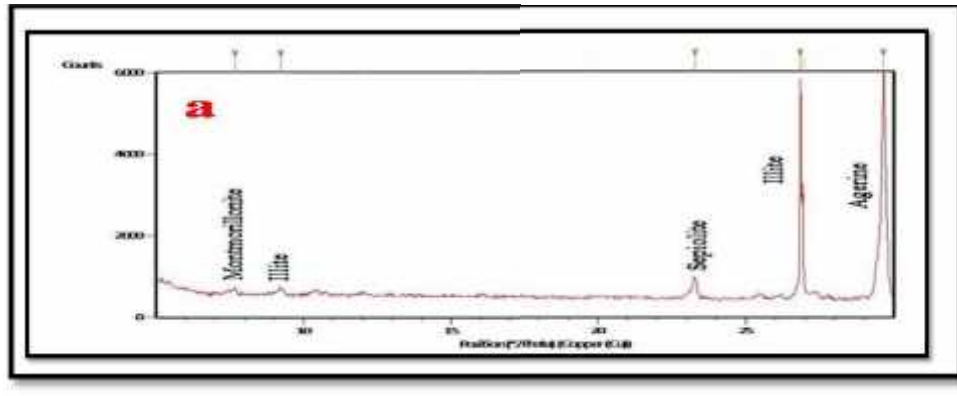
Fig - 2 a-b.The field photographs of the study area. a-A view of the photograph shows the river section top black soil and bottom calcrete layer. b-A view of photograph shows the pond section top black soil and bottom weathered sap-rocks or granitic gneiss.

X-ray diffraction analysis

The calcrete possess regolith clay minerals which indicate the climate history. The clay is regarded as products of hydrolysis of weatherable minerals. They can be linked to the amount of precipitation available for soils (Folkoff and Meetenmeyer, 1987). The Clay composition in soil is controlled by the grain size

and mineral composition of parent materials, temperature, seasonal rainfall and time for formation of a soil. In wet climate, the clay is more likely to possess a 1:1 rather than a 1:2 layer structure. They obtain fewer cations and are lower in general weathering sequence of clay sized minerals. Especially in vertisol, under dry climate, swelleable clays like sodium Smectite produce a distinctive soil structure of domed columnar peds extending throughout the horizon (Veronica Geibler and TU Bergakademine Freiberg, 1998). Some of the clay minerals are considered as indicative for climate. (Mc Cahon and Miller, 1997), has given the indicatives of clay mineral for climate as, Palygorskite and Sepiolite indicative for arid climate: Smectite for mean annual rainfall < 1000mm; Kaolinite for mean annual rainfall between 1000 – 2000mm; Iron oxide and alumina for mean rainfall > 2000mm.

The XRD result of the study area shows the d spacing Å equivalent values of Quartz, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Anorthite, Biotite, Hornblende, Hypersthene, Gypsum, Ilmenite, Rutile, Calcite, Dolomite and clay minerals Kaoline, Illite, Montmorillonite, Bedeilite, Smectite, Sepiolite and Palygorskite Fig-3a-b.The list of carbonate and non-carbonate fraction of the calcrete samples are given in Table-II.The calcrete pseudomorphically replace all underlying silicate rock and form palygorskite and sepiolite in lower calcrete profile under arid climate (Yifeng Wang et al 1993).The palygorskite are formed with calcite minerals under arid climate(Rodas et al 1994).The availability of clay mineral Palygorskite and Sepiolite in the study area shows arid climate, whereas other clay minerals Kaoline, Illite, Smectite and Sesquioxide indicate the semiarid climate. So, in general, the calcrete occurrence of the study area shows the climate of semiarid and arid climatic condition prevailing in the depositional environment.



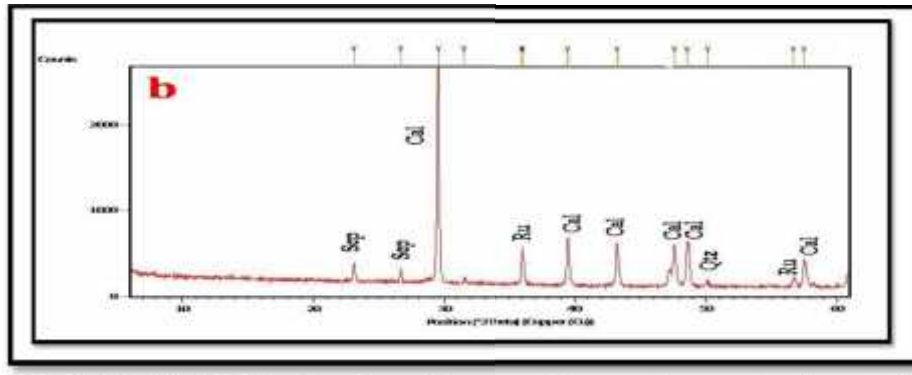


Fig-3a-b - The XRD values for carbonate and non-carbonate fractions of the calcrete samples.

Table-II

Minerals of Carbonate and non-carbonate fraction of the calcrete samples

5.2446	336.54	16.85044	5.98	Montmorillonite
9.2332	205.56	9.57835	3.65	Illite
23.2929	504.14	3.81894	8.96	Sepiolite
26.9198	2356.35	3.31757	41.88	Illite
29.6312	5626.54	3.01241	100.00	Agerine

23.0764	197.26	3.85428	7.89	Sepiolite
26.6058	161.86	3.35046	6.47	Sepiolite
29.4659	2501.27	3.03143	100.00	Calcite
36.0522	440.09	2.49131	17.59	Rutile
39.4639	539.45	2.28155	21.57	Calicte
43.2178	499.54	2.09167	19.97	Calcite
47.5807	488.48	1.90956	19.53	Calcite
48.5534	506.74	1.87355	20.26	Calcite
50.1052	80.13	1.81910	3.20	Quartz
56.6381	106.76	1.62380	4.27	Rutile
57.4727	312.62	1.60219	12.50	Calcite

Conclusion

The calcrete occur as different outcrops in the various landscapes setting of the Duraisamipuram and its surrounding villages, under the influence of arid and semi-arid climatic conditions. The field evidence indicates that calcretes occur as gravel, lumpy, hardpan massive and chalky forms. The XRD analytical results of calcrete indicate the presence of minerals calcite, quartz biotite, orthoclase and other clay minerals of palygorskite, illite and sepiolite. The presence of clay minerals of palygorskite, smectite and kaoline indicates the climate as arid and semi-arid.

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