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# SOME PHYSICAL PROPERTIES OF TWO SOILS FROM THE BANGKOK BASIN

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## ABSTRACT

*Two soil profiles from the padi growing area of the Bangkok basin,Thailand, are described and classified as fine clayey non acid mixed isohyperthermic vertic tropaquepts.The lack of change in pH on drying and the sulfur analysis supports the non acid nature of the soils. Clay mineralogy was not done so mineralogy is only deduced.Shrinkage is significant and the COLE values are high hence the vertic great subgroup. Particle size analysis suggests that the soils are bisequent. A shrinkage line was plotted having a slope of one. This implies that stable pores do not exist in the size range 0.2mm- 30mm, possibly due to the low sand content. The soils have a low air filled porosity. The majority of pores are in the micropore range thus a low hydraulic conductivity would be expected. Surface water flooding, a desirable feature for padi growing, could therefore be maintained despite a relatively deep water table.*

The Central Plain of Thailand extends northward for about 430 km from the Gulf of Thailand. At its broadest, it is about 200km wide. It is essentially the flood plain and deltas of four rivers,the Mae Klong, the Tha Chin,the Chao Praya and the Bang Pakong. The southern part of this plain is the Bangkok Basin. This is a flat deltaic plain with an elevation of less than 15m above sea level (Moncharoen *et al.*, 1987). The plain consists of both old and young deltas. The old deltas are of Upper Pleistocene age and the young deltas are of Upper or lower Holocene age.The young deltas are low, on average, only 2m above sea level. These deltas indicate that the sea transgressed into the Bangkok Basin at least twice during the last interglacial and postglacial periods. Thus, during the late Quaternary, the basin was under a marine environment (Takaya and Thiramongkol, 1982).

The soils developed on these Quaternary marine deposits are classified as aquepts reflecting both the water regime and the lack of profile development which are clearly interrelated (Vijarnsorn and Jongpakdee, 1980).

Acid sulfate soils occur in low lying coastal areas derived from marine sediments (Allbrook, 1973). They would therefore be anticipated to occur in the Bangkok basin. A sequence of soils from potential to strongly acid sulfate soils has been recognized (Moncharoen *et al.*, 1987). Potential acid sulfate soils are found on the coast often developed for padi or shrimp farming (Bariboonthana, 1989). Strongly acid sulfate soils, mapped by McWilliam (1984) tend to be found well inland around the periphery of the Bangkok Basin next to fan-terraces of Lower Pleistocene age. These latter soils, have a pH about 3, a low water table and hence pyrite, formed when the soils were under a brackish regime, is being oxidized to sulfuric acid and jarosite.

The climate of the Bangkok basin has been classified as tropical savannah. The annual rainfall is 1220-1400mm, the humidity ranges from 64-74%, mean annual temperature ranges from 27-29 ° C with an average maximum of 44 ° C (Moncharoen *et al.*,1987). Thus there is little excess precipitation to leach the soils so montmorillonite would be expected to be a major clay mineral.

This note examines some physical features of two soils from the Bangkok Basin together with their land use suitability.

## MATERIALS AND METHODS

***Soil descriptions*:-** *Ayutthaya*

Location: 7 km south of Ayutthaya near Ban Pho station,grid reference 795705 sheet 5137(iv), L7017 edition,

Vegetation: padi,

Parent material:Quaternary marine deposit,

Relief: flat

Drainage: very poor,

Precipitation: 1400 mm.

| | | |
|---|---|---|
| Ag | 0 - 20 cm; | dark brown 7.5YR 4/4 strongly mottled yellowish red 5YR 4/8 with a few gray 7.5YR 4/0 mottles; weak prismatic structure; silty clay; clear boundary, |
| $Bg_1$ | 20 - 60 cm; | grayish brown 10YR 5/2 slightly mottled reddish yellow 7.5YR 6/8 and gray 10YR 5/1; weak prismatic structure; silty clay; merging boundary, |
| $Bg_2$ | 60 + cm; | dark grayish brown 10YR 4/2 mottled dark reddish brown, 2.5YR 3/4 strong brown 7.5YR 5/8; weak prismatic structure;silty clay. |

Sampled at 0-10 cm, 30-40 cm, 70-80 cm.

*Mahidol*

Location: on the Salaya campus of Mahidol University,

Vegetation: *Imperata cylindrica*

Parent Material: Quaternary marine deposit, Relief: flat,

Drainage: very poor,

Precipitation: 1400 mm.

| | | |
|---|---|---|
| Ag | 0-10 cm; | strong brown 7.5YR 5/8 mottled gray 10YR 6/1 and dark gray 7.5YR 4/0; weak prismatic structure; silty clay; merging boundary, |
| $Bg_1$ | 10-45cm; | gray 10YR 6/1 mottled black 5YR 2/1, dark yellowish brown 7.5YR 5/8, olive 5Y 4/2; weak prismatic; silty clay; few manganese/iron concretions; merging boundary, |
| $Bg_2$ | 45+cm; | gray 7.5YR 6/0 slightly mottled dark yellowish brown 7.5YR 4/6 and olive 5Y 4/2; weak prismatic structure, silty clay. |

Sampled at 0-10 cm, 20-30 cm, 50-60 cm

Particle size analysis, sulfur determination and moisture retention at 10,100, 300 and 1500 kPa were carried out by the Soil Analysis Division of the Department of Land Development, Ministry of Agriculture and Co-operatives, Bangkok. Water content, pH and bulk density using the core method were carried out on samples in the laboratory of the Faculty of Environment and Resource Studies, Mahidol University,Salaya.

## RESULTS

Results (Table 1) of particle size analysis, showed that the soils are similar although the Mahidol soil is slightly coarser in the surface horizon. The pH, determined in 0.01*M* $CaCl_2$ on field moist and air dried soil, indicated mostly non acid soils. Only the Ayutthya surface soil,dropping by one unit after drying, indicated a moderately acid sulfate soil. Total sulphur shows a greater sulphur content in the Ayutthaya soil but still too low to be classed as sulfidic (Soil Survey Staff 1992).

Bulk density was determined at three moisture levels; field moist, air dry and oven dry. A graph (Fig.1) was drawn of specific volume (1/Bd) against water content. A line of best fit for normal shrinkage (McGarry and Malafant, 1987) gave the equation

$$v = 1.1\theta + 0.40 \ (r^2 = 0.98). \qquad [1]$$

where $v$ is the specific volume ($m^3 \ Mg^{-1}$)and $\theta$ is the water content ($kg \ kg^{-1}$). Assuming no change in density, a second line was drawn from the mean oven dry specific volume (0.54 $m^3 \ Mg^{-1}$) that intersected the normal shrinkage line at the shrinkage limit corresponding to a moisture content of 0.15 $kg \ kg^{-1}$. The line for a saturated soil,assuming a particle density of 2.63 $Mg \ m^{-3}$given by equation.

**TABLE 1.** Selected soil parameters.

| Soil | Depth cm | Sand % | Silt % | Clay % | pH ($CaCl_2$) field moist | air dry | Field moisture content Mg $Mg^{-1}$ | Bulk density Mg $m^{-3}$ | Sulfur % |
|---|---|---|---|---|---|---|---|---|---|
| Ayutthaya | | | | | | | | | |
| | 0-10 | 2 | 42 | 55 | 4.9 | 3.9 | 0.34 | 1.27 | 0.26 |
| | 20-30 | 2 | 41 | 57 | 5.1 | 5.1 | 0.41 | 1.23 | 0.28 |
| | 40-50 | 1 | 45 | 54 | 5.5 | 5.3 | 0.38 | 1.30 | 0.23 |
| Mahidol | | | | | | | | | |
| | 0-10 | 12 | 44 | 43 | 5.8 | 5.9 | 0.33 | 1.30 | 0.24 |
| | 20-30 | 7 | 45 | 48 | 6.3 | 6.1 | 0.30 | 1.32 | 0.08 |
| | 40-50 | 7 | 51 | 42 | 6.5 | 6.0 | 0.43 | 1.13 | 0.06 |

**TABLE 2.** Water retention data.

| Soil | Depth | Water content Mg Mg-1 | | | | AWC | COLE |
|---|---|---|---|---|---|---|---|
| cm | | 10 kPa | 100 kPa | 300 kPa | 1500 kPa | m3 m-3 | |
| Ayutthaya | | | | | | | |
| | 0-10 | 0.44 | 0.32 | 0.28 | 0.23 | 0.16 | 0.12 |
| | 20-30 | 0.49 | 0.34 | 0.29 | 0.23 | 0.19 | 0.15 |
| | 40-50 | 0.49 | 0.35 | 0.29 | 0.23 | 0.19 | 0.13 |
| Mahidol | | | | | | | |
| | 0-10 | 0.44 | 0.32 | 0.2 | 0.2 | 0.17 | 0.13 |
| | 20-30 | 0.45 | 0.31 | 0.26 | 0.21 | 0.17 | 0.12 |
| | 40-50 | 0.45 | 0.31 | 0.2 | 0.2 | 0.18 | 0.17 |

**TABLE 3.** Pore size distribution.

| **Bulk density** $Mg\ m^{-3}$ | **Water content** $Mg\ Mg^{-1}$ | **Total pores** $m^3\ Mg^{-1}$ | **Air filled pores** $m^3$ | **Tension** kPa | **Pore size** mm | **Pore volume** $m^3$ | **Range** µm |
|---|---|---|---|---|---|---|---|
| | | | | | | 0.02 | >30 |
| 1.16 | 0.46 | 0.48 | 0.02 | 10 | 30 | | |
| | | | | | | 0 | 30-3 |
| 1.39 | 0.32 | 0.34 | 0.02 | 100 | 3 | | |
| | | | | | | 0 | 3-1 |
| 1.54 | 0.25 | 0.27 | 0.02 | 300 | 1 | | |
| | | | | | | 0 | 1-0.2 |
| 1.61 | 0.22 | 0.24 | 0.02 | 1500 | 0.2 | | |
| 1.85 | 0.127 | 0.16 | 0.03 | | | - | |
| 1.85 | 0 | 0.16 | 0.16 | 0.14 | <0.2 | | |

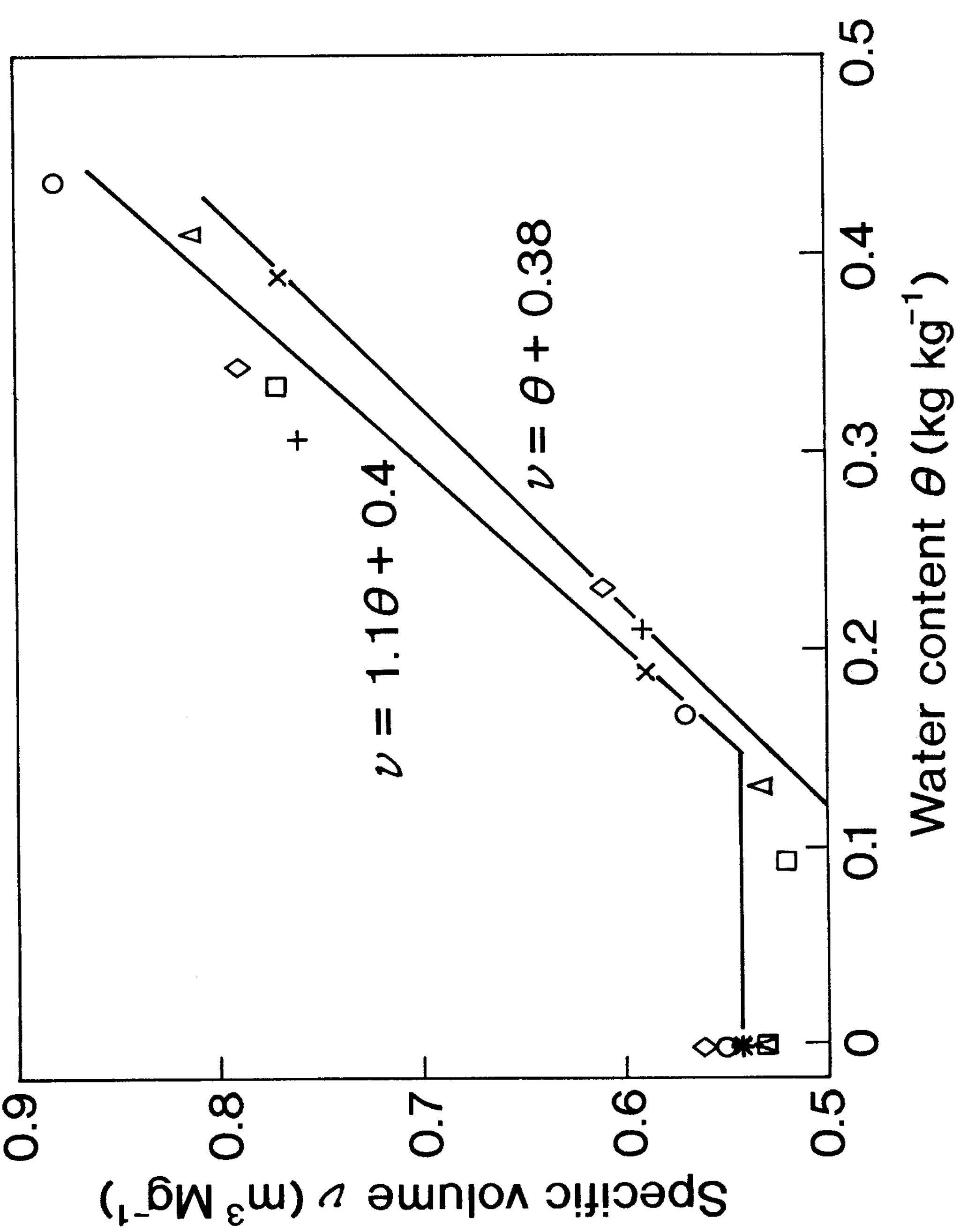


**Fig. 1.** Shrinkage curve from soil cores of Mahidol, 0-10 cm, + 30-40 cm, ○ 70-80 cm and Ayutthya 0-10 cm, 20-30 cm, X 50-60 cm.

$$\nu = \theta + 0.38 \qquad [2]$$

is also shown.

The coefficient of linear extensibility (COLE)(Soil Survey Staff 1992),(Table 2), was calculated from the field moist and oven dry bulk density ($BD_{fm}$, $BD_{od}$) respectively, using the equation

$$COLE = (Bd_{od}/Bd_{fm})^{1/3} -1 \qquad [3]$$

All COLE values exceed 0.09 and hence the soils are classified in the vertic great subgroup.

Water content at suctions of 10,100, 300 and 1500 kPa (Table 2) show no significant difference between the two soils.

## DISCUSSION

Since no argillic horizon or mollic epipedon was found, the soils are classed as inceptisols. The vertisol order, given the climate and texture, is an interesting alternative, However,no gilgai or slickensides were seen and the pH is less than 7. Soil colors and the climate indicate a tropaquept great soil group. Although not dominant some montmorillonite clay is likely since the average value for COLE (Table 2) is 0.138. Both soils are therefore clayey fine mixed non acid isohyperthermic vertic tropaquepts.

Particle size analysis of the Mahidol soil indicates by the changes in the sand content that it is bisequent with different deposits making up the Ag and Bg horizons (Table 1). This may indicate that the Mahidol soil was part of a young delta. The decrease in clay content in the lowest horizon in both soils suggests a change in deposit, quite likely, if the parent material is a marine deposit. The high silt content suggests that the soils are weakly weathered and an alluvial deposit. The pH and the sulfur content (Table 1) confirms the more acid sulfate nature of the Ayutthaya soil and would suggest that this soil would respond to liming (Osborn,1984).

Equation [1], the best fit line, for normal shrinkage in Fig 1 shows a slope of $48^0$. This is hard to reconcile with physical processes and implies that saturation increases as the soil dries out, a slope of $45^0$ is therefore substituted in equation [1]. This is used in Table 3 to calculate the bulk densities listed corresponding to the mean water content of the tensions given in Table 2, total pores are calculated from the bulk density assuming a particle density of 2.63 Mg $m^{-3}$, air filled pores are the difference between total pores and water content. Pore size is calculated assuming the relation

$$d = 300/h \qquad [4]$$

where d is the pore diameter (mm) and h is the tension (kPa) from Table 2. Pore volume is the change in air-filled pore space for the given range of pore sizes.

The table shows that the only stable pores are >30 mm and <0.02 mm. Pores between these sizes dilate or collapse with the changing moisture tension. This situation is a consequence of the 45° slope of the normal shrinkage line.

Air-filled porosity is low in these soils and would make them unsuitable for non-aquatic plants. As a result of the dominance of fine pores and the near absence of transmission pores (>30mm), these soils would have low hydraulic conductivity. Thus the land use for padi is eminently suitable as saturated surface conditions will be maintained regardless of the height of the ground water table.

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