# CLAY MOVEMENT IN A SALINE-SODIC SOIL TOPOSEQUENCE

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# Summary

Sodic soils, cover about 28% (340 million ha) of Australian continent. Many studies have shown that the dispersive propensity of sodic soils causes detrimental changes in soil structure, water logging and soil erosion, leading to severe land degradation. Clay movement from sodic soils has also been recognised as a major cause of turbidity of streams and cause a deterioration of the quality of water.

The Herrmanns sub-catchment in the central Mt. Lofty Ranges (near Mt. Torrens) is one of the regions in South Australia affected by saline-sodic soils. A soil survey of the sub-catchment showed a variation in the levels of salinity and sodicity in relation to topography and that dispersibility of clay also varied along the toposequence. Little is known about the mobility of clays from these soils in relation to the seasonal salinity-sodicity conditions. Consequently, the main objectives of this study were to quantify the interrelationships between clay movement and soil properties (especially salinity and sodicity) down a toposequence.

Three profiles with different levels of salinity and sodicity were excavated and described according to the Australian Soil and Land Survey Handbook (McDonald *et al,* 1990) and classified according to Soil Taxonomy (Soil Survey Staff, 1999). Samples from the profiles were analysed in terms of chemical, physical and mineralogical properties. Two lysimeters were installed in each profile to collect colloids moving vertically. These were embedded in the A/Bt horizon boundary and at the base of the Bt horizon. KBr was applied to assess the possibility of clay being transported laterally by flow of water over the Bt horizon. Overland flow sediment collectors were installed in a typical eroded area of the sub-catchment (a highly sodic area) and in a non-eroded area, which was less sodic. Stream water samples were collected during the periods of rainfall at three locations, chosen randomly. Two toposequences were sampled to characterize the distribution of soil properties (i.e. soil colour, texture, soil EC, gravel contents). The hydrology of the saline ground watertable was inferred from the results of the distribution and value of intensive EC measurements taken from the core samples (up to 1.5 m depth) collected using a systematic grid (50 m x 50 m).

All the soils were classified as Alfisols with Subgroups being dependent on topographic position as follows: Typic Natraqualfs on the eroded areas of the foot slopes, Typic

Natrixeralfs on the waning mid-slopes and stream banks, and Ultic Palexeralfs on the upper waning mid-slopes. Each subgroup had vastly different sodicities. The most sodic was the Typic Natraqualfs (ESP ranged from 9 to 24.3 %), followed by the Typic Natrixeralfs (ESP ranged from 0.4 to 16.5 %) and the Ultic Palexeralfs (ESP ranged from 0.3 to 2.6).

There was a strong positive relationship between clay dispersibility and sodicity in the eroded areas along the foot slopes. For the other profiles (from the mid slope and stream bank), the increase in sodicity was accompanied with a drop in clay dispersibility. In the midslope profiles, the flocculative-dispersive phenomenon was largely controlled by other soil properties (i.e. pH, mineralogical composition, organic carbon, base cation content, etc.) rather than salinity-sodicity effects. In the stream bank profile, the high salinity level caused the clay to flocculate.

Clay dispersibility, hydraulic conductivity and the amount of clay collected in the lysimeters (vertical clay movement) were correlated. Increase in clay dispersibility predisposed clay to move and clog micropores, a process that lead to a decrease in saturated hydraulic conductivity and a decrease in the amount of colloid transported to lower horizons. High hydraulic conductivity correlated with higher amounts of colloids collected in the lysimeters. The Typic Natraqualf in the eroded area along the foot slope was the exception. The profile had the most readily dispersible clay but the hydraulic conductivity remained high. This was thought to be caused the high gravel content (about 35 %), which conferred an appreciable macroporosity in this profile. In this profile, the dispersibility of clay led to an increase in the vertical mobility of clay.

In the Herrmanns sub-catchment, an appreciable amount of clay moved laterally via throughflow of water over Bt horizons (concluded from KBr tracer experiment), and via overland flow. The amount of clay collected via overland flow was 0.425 g/L and 0.034 g/L in eroded (highly sodic) and non-eroded (less sodic) areas respectively. The relatively high concentrations of clay in the overland flow water in the eroded area compared to the non-eroded area was attributed to high potential clay dispersibility, lack of vegetative cover, and the steeper and longer slopes in the eroded area compared to non-eroded area.

The concentration of sediment in the stream water was 0.15 g/L and was less than the concentration of sediment collected from overland flow (0.34 g/L) in eroded area, but higher than the concentration of overland flow sediment (0.03 g/L) collected from non-eroded area. From this, it was concluded that the area with soils having highly dispersive clays with no vegetation cover was a major contributor of sediment into the stream draining the Herrmanns sub-catchment.

The high electrical conductivity values in soils at depths greater than 50 cm across the study site indicated that a saline water table strongly influenced the nature of the soils along the entire foot slope (i.e. from the contour line at 388 m ASL in the stream up to the contour line 392 m ASL). However, the interplay between incoming water from rainfall and the saline groundwater table in the area along the foot slope provided an explanation for the origin of the various soils down the toposequence (i.e. highly sodic, non or slightly sodic soils).

In summary, in the Herrmanns sub-catchment, soil sodicity was the dominant factor causing clay to disperse in the eroded area along the foot slopes, whereas in non eroded areas of the mid-slopes and on the stream banks, the dispersive power of sodicity was attenuated by the flocculative power of other soil properties. The dispersed clay was more easily transported by flow of water laterally over the soil surface than non-dispersed clay. For vertical movement of clay within profiles, however, the dispersed clay appeared to be less mobile than non-dispersed clay, especially where micropores dominated the soil matrix.

# STATEMENT

This thesis contains no material, which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material published previously or written by another person, except where due references is made in the text of the thesis.

I consent to this thesis being made available for photocopying and loan.

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