Middle-East Journal of Scientific Research 13 (10): 1275-1279, 2013
ISSN 1990-9233
© IDOSI Publications, 2013
DOI: 10.5829/idosi.mejsr.2013.13.10.1060

Effects of Flood Spreading on Soil Clay Minerals Case Study: Tangestan Flood Spreading Station-Booshehr Province

[1]*Ali Jafari,* [2]*Ehsan Zandi Esfahan and* [1]*Fatemeh Avazzadeh Tavakkoli*

[1]Research Center for Agriculture and Natural Resources, Bushehr Province, Iran
[2]Rangeland Research Division, Research Institute of Forests and Rangelands, Tehran, Iran

Abstract: In most projects of natural resources and watershed management, conducting research in order to monitor, evaluate and compare the results with the parameters of the projects is considered as an essential requirement. Also in flood spreading projects the necessity of measuring, processing and evaluating the information obtained from the results is obvious. The occurrence of large floods containing minerals and suspended materials with different origins in one hand and laying sediments on the other hand may alter soil properties. In this study, the effect of flood spreading on soil clay minerals was investigated at Flood Spreading Station after 10 years of its construction. To study these variations, the first three strips with definite flooding were selected as sampling locations and three soil samples were taken from a depth of 0-15 cm. The results of the X-ray diffraction curves indicated the presence of Palygorskite, Chlorite, Vermiculite, Smectite, Illite and a little Kaolinite. Palygorskitewas just observed in soil samples of control treatments and also in samples whose parent materials were more similar to the soil of the study area.

Key words: Clay mineral · Water spreading · X-ray · Tangestan

INTRODUCTION

Uncontrolled growth of the population and the need for food on the one hand and the limitation of water and soil resources on the other hand have necessitated soil and water conservation for human survival. Therefore, preservation and optimum utilization of these resources according to the past experience and new technologies are of utmost importance. Currently, the crisis of water scarcity is one of the most fundamental today's and tomorrow's problems of human societies.

Previous studies on water resources of the earth show that water on this planet is finite and irreplaceable. On the other hand, flood occurrence has been of the oldest human and organism problems which endanger their survival. Consequently, prevention of the erosion caused by flooding and also waste water management is considered as the objectives of watershed management. Flood and waste water management are of the methods applied to achieve various objectives and have long been under consideration. Such methods that are used in Iran (in the past they were mostly used while nowadays they are less used) are as Khoshab, Band, Bandsar, Darband, Hotak, Laviz, Gorab, etc. Applying flood spreading systems established in more than 37 points of the country since now are considered as new method of flood exploiting in recent years. There are several objectives to justify flood spreading operations but the impact on the performance characteristics of soil, vegetation and water quality and quantity are of utmost importance. Soil is also a part of very complex and systematic ecosystem as any change, whether physical, chemical and biological will cause little or dramatic changes in other parts of this series. Knowledge of the physical and chemical characteristics of soils are very important in Watershed studies in very effective in construction projects. Mineralogical composition constitutes the basis of the potential production in all soils of the world [1]. Types of minerals in the soil are more affected by climatic factors and parent materials. Among these, clay minerals are considered as one of the most important parts of the soil solid phase. Effects of clay minerals in soil physicochemical properties such as cation exchange capacity, field capacity, soil fertility, ventilation, etc. are very significant.

Corresponding Author: Ehsan Zandi Esfahan, Rangeland Research Division, Research Institute of Forests and Rangelands, Tehran, Iran.

This effect depends on the type and amount of minerals [2]. Hence, identification of clay minerals in the soil is important, Mahjoory, 1979, studied arid and semi arid soils of Iran and reported the existence of Chlorite, Illite, Smectite, Vermiculite, Kaolinite and Mica-Vermiculite and Mica-Chlorite mixed clays [3]. Investigation on the dominant clay minerals in soils of Iran and the factors influencing their frequency and also the analysis of 50 soil samples from different parts of the country showed that the mineralogy of the clay in soils of Iran especially in arid and semi arid regions mostly depends on the parent materials of the soils including illite and chlorite [2]. The effect of saline and alkali groundwater on soil evolution of semi-arid regions of southern Iran has shown that the role of Palygorskite and smectite is more than other minerals [4]. Study on new sediments of artificial recharging of Garbaygan-Fasa water reservoir and X ray diffraction of clay and non clay minerals showed that chlorite, mica and smectite were observed in all samples while Kaolinite and Palygorskite were just observed in one sample [5]. Mineralogy of Veritisols in Fars province also revealed the presence of Chlorite, Palygorskite, Illite and a little Kaolinite [6]. Smith and Buol, 1968, showed that Illite was the major mineral of arid and semi arid soils while there was a small amount of Kaolinite [7]. Abtahi, 2005 in a study on clay mineralogy of the soils in Fars province concluded that high amount of Kaolinite and absence or small amount of Chlorite, Smectite, Palygorskite and Illite in Lower Cretaceous sediments could be considered as a reason indicating a very hot and humid climate of that period [8]. Karimi *et al*., 2009, stated that formation of Palygorskite in arid soils is closely related to the formation of lime, gypsum and Calcerec horizons. Lesser amounts of and the presence of more Smectite in sediments of Upper Cretaceous indicates a transition from a warm and wet climate to more temperate climate. No Kaolinite and dominance of Palygorskite and Smectite in sediments of the upper Paleocene represents an increase of the dry period that has continued until today. Also in Qazvin, presence of Kaolinite in soil samples is related to the arid and semi-arid climate of the region. With regard to the frequency of flood and aquifer recharge projects in Iran and scientific and technical reports regarding the effects of these operations on soil and vegetation properties, it is not easy to make a definite and final decision on its possible beneficial or negative role. Thus, with study on their effects, if proven effective, its continuation and further implementation could be recommended or necessary changes could be proposed to increase the productivity. With regard to the importance and impact of clay minerals on physical and chemical properties of soil, this study investigated the impact of flood spread on clay mineralogy and its relation with upstream watershed and also the effect of this operation on evolution trend of the clays.

MATERIALS AND METHODS

Study Area: The study area is northeast of Ahram located between longitude 51° 17' and 51° 20' east and latitude 55° 28' and 60° 29' N (Figure 1). Wet streams are the main source of rainfall in the study area with a Mediterranean origin from West to East. Average rainfall is 260.50 mm from 1973- 2010 and the average annual temperature is 25°C. The study area is located in hot dry desert region based on the Domarton classification. According to the field studies and geology maps, formations in the region are as follows: Hormoz, Pabdeh, Asmari, Gachsaran, Mishan, Aghajari and Bakhtiari. With regard to the Hyperthermic thermal regime and Ustic moisture regime and also dug profiles, the soil of the study area is of Regosolic order.

Methodology: Many physical and chemical properties of soil depend on the type and amount of clay and since the flood spreading area is considered as the main site of filtration, planting tree species, sediment deposition and increased soil fertility and other interactions. Consequently, the effect of flood spreading on variations in clay minerals was studied between flowing streams as the first three strips with definite flooding were selected as sampling locations and three soil samples were taken from a depth of 0-15 cm. One soil sample was also taken from the control area and from three flowing streams. Totally 13 soil samples were taken and the part smaller than 2 micron were separated for mineralogical study. To obtain pure clay samples, the cementitious material like carbonate and organic matter were removed from the samples by using Kittrick and Hope method [9]. Iron oxide of the samples was also removed through Mehra and Jackson method [10]. Then the clay was separated by using centrifugation. Two 40 mg clay samples were saturated with magnesium and potassium and each of them were distributed on glass slides with the same thickness. Moreover, for mineralogy experiments using X-ray diffraction, the samples saturated with magnesium and glycerol and samples of 550 c thermal treatments and saturated slides with potassium were prepared. All samples were studied mineralogically at mineralogy laboratory, Faculty of Agriculture, University of Tehran

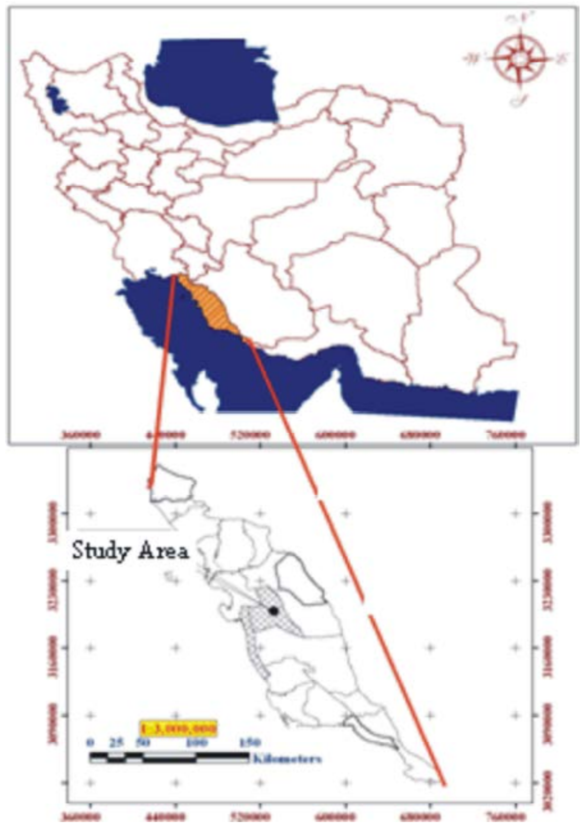

Fig. 1: Study area

[11, 12]. Identification of the clay samples was done using the prepared tables by Peter technique. Quantitative measurement of the clay minerals was performed through the intensity peaks in the saturated treatments with Magnesium and Glycerol using of Jones method.

RESULTS

Although it seems that due to climatic conditions and lack of rainfall in arid and semi arid areas several minerals would not be found, Smectite, Chlorite, Illite and fibrous Palygorskite were identified in this study. The results of the X-ray diffraction curves indicated the presence of Palygorskite, Chlorite, Smectite and Illite (Table 1). According to the results, the treatment saturated with Magnesium caused no changes in its expansion at peak points of 10.4-10.5 angstrom. The peak point was disappeared when the treatment saturated with potassium was at 550°C. Considering the abundance of lime in the soils studied, formation of Palygorskite is almost definite [13]. The peak point of 14.2 angstrom in treatments saturated with magnesium is related to the reflection of the first category of Vermiculite, Chlorite and Smectite as a strong peak point of 18 angstrom in glyserol treatment confirms the presence of Smectite group probably formed by the oxidation of Palygorskite. The pedogenic formation of Smectite is not unexpected due to the relatively high levels of soil acidity, calcium and magnesium [14, 15, 16]. On the other hand, the stable peak point of 14-14.4 angstrom in all treatments indicates the presence of Chlorite in the soils studied in this research. Available Chlorite of the soils is probably inherited from the parent material because of the young soils and their calcareous parent materials. Also, constant peak point of 10 angstrom in all treatments indicates the presence of Illite. This mineral is also hereditary due to the constant peak point of 10 angstrom and young soils [17]. Relatively significant decrease in peak point intensity of 7.1-7.2 angstrom in the treatment saturated with potassium and 550°C is due to the collapse of the Kaolinite crystallization network. Also the peak point of 3.55-3.57 angstrom as the second peak point category of this mineral confirms the presence of Kaolinite [18].

DISCUSSION

The results showed that the treatment saturated with magnesium caused no changes in its expansion at peak points of 10.4-10.5 angstrom while the peak point was disappeared when the treatment saturated with potassium at 550°C [6]. Considering the abundance of lime in the soils studied, formation of Palygorskite is almost definite [13]. According to the studies, the presence of Palygorskite in Calcic horizon of the arid areas is common [19, 20]. Honarjoo and Jalalian, 2009 stated that the current dry climate and lime accompanied with gypsum has provided the conditions for the formation and stability of Palygorskite in soils of Khorasgan region [21]. The peak point of 14.2 angstrom in treatments saturated with magnesium is related to the reflection of the first category of Vermiculite, Chlorite and Smectite as a strong peak point of 18 angstrom in glyserol treatment confirms the presence of Smectite group probably formed by the oxidation of Palygorskite. The pedogenic formation of Smectite is not unexpected due to the relatively high levels of soil acidity, calcium and magnesium [14-16]. Abtahi and Khormali, 2001, found out that Smectite was the main mineral of southern areas of Iran with poor drainage [22]. Smectite in soils with good drainage shows an increasing trend with increasing available soil moisture and consequently an environment with relatively higher leaching for K^+ release of micaceous minerals specifically Illite in a calcareous environment with high MG^{+2} and high

Table 1: Identification of the clay minerals

Treatments (C): 550°C	Treatments (B): Glyserol	Treatments (A): Dry air	Kind of clay minerals
No Peak	Strong 7.15	Strong 7.1-7.3	Kaolinite
	Strong 3.55-3.57	Strong 3.57	
Very strong 10-10.2	Very strong 10-10.2	Very strong 10-10.2	Illite
Strong 5-5.1	Strong 5-5.1	Strong 5-5.1	
Very strong 14-14.2	Very strong 14-14.2	Very strong 14-14.2	Vermiculite
Strong-weak 7-7.1	Strong-weak 7-7.1	Strong-weak 7-7.1	
Average >4.67	Average >4.67	Average >4.67	
Average >3.5	Average >3.5	Average >3.5	
Interval between layers less than 10 angstrom	Very strong 17-18	Strong 15	Smectite
	Weak 8.5	Very strong 7.5	
	Very strong 5.5	Very weak 3.75	
	Strong 4.2-4.4	Weak 3	
	Weak >3.5		
Very strong 14-14.3	Strong-weak 14-14.3	Strong-weak 14-14.3	Chlorite
Very weak or not 7-7.1	Very strong 7-7.1	Very strong 7-7.1	
Very weak or not 4.8-7-4	Strong-average 4.8-7-4	Strong-average 4.8-7-4	
	Very strong 3.5-3.6	Very strong 3.5-3.6	
Average 10.5	Average 10.5	Average 10.5	Palygorskite
	Weak 6.37	Weak 6.37	
	Very weak 5.4	Very weak 5.4	
10	17.5-18	14.5-15	Montmorillonite

SI mobility may provide favorable conditions for the formation of Smectite through deformation [23]. On the other hand, the stable peak point of 14-14.4 angstrom in all treatments indicates the presence of Chlorite in the soils studied in this research [6]. Available Chlorite of the soils is probably inherited from the parent material because of the young soils and their calcareous parent materials. Also, constant peak point of 10 angstrom in all treatments indicates the presence of Illite. This mineral is also hereditary due to the constant peak point of 10 angstrom and young soils [17]. Manafi, 2009, in mineralogical study of arid and semiarid soils reported that Illite and Chlorite were as the two relatively dominant minerals showing a little variation with depth which indicated the inheritance origin of these minerals [24]. Relatively significant decrease in peak point intensity of 7.1-7.2 angstrom in the treatment saturated with potassium and 550°C is due to the collapse of the Kaolinite crystallization network. Also the peak point of 3.55-3.57 angstrom as the second peak point category of this mineral confirms the presence of Kaolinite [18, 6]. Therefore, considering the climate and young soils of the region, if negligible amount of Kaolinite is identified in the soils, it will probably have a hereditary origin. Manafi, 2009 stated that Kaolinite is present in all studied samples and at low levels considered as a part of large clays of the soils [24]. It could be concluded that Kaolinite of Qazvin region is hereditary since the required condition for pedogenic formation of Kaolinite is not available in arid and semi-arid climate.

REFERENCES

1. Owliaei, H.R. and A. Abtahi, 2003. Clay mineralogy of selected soils in Kuhgiluye Boyer Ahmadprovinces. In the Poroceedings of 8th Congress of Soil Science. Gilan Univ.
2. Owliaei, H.R., A. Abtahi and A. Adhami, 2008. Origin and distribution of clay minerals in soils of different climatic regions of Kohgiluyeh Boyerahmad province. Karaj, Iranian Soil Science Congress.
3. Mahjoory, R.A., 1979. The nature and genesis of some salt-affected soils in Iran. Journal of Soil Science, 43: 1019-1024.
4. Abtahi, A., 1980.Soil genesis as affected by topography and time in highly calcareous parent material under semiarid conditions of Iran. Journal of Soil Science. Soc. Am., 44: 329-336.
5. Mirnia, S.K. and S.A. Kowsar, 2000. Reclamation of a Sandy Desert through Floodwater Spreading: II. Characterization of Clay Minerals in the Watershed and the Freshly-Laid Sediment. Journal of Agricultural Science, 2: 197-206.
6. Heidari, A. and S.H. Mahmoodi, 2004. Investigation of Fars Province Vertisols mineralogy and its relation to some physical parameters in the soils. Journal of Engineering Geology, 1(1): 1-24.
7. Smith, B.R. and S.W. Buol, 1968. Genesis and relative weathering intensity studies in three semiarid soils. Journal of Soil Science. Soc. Am. Proc., 32: 261-265.

8. Abtahi, A., 2005. Clay mineralogy of some soils of Fars Province, Research Project, University of Shiraz.
9. Hubbell, D.S. and J.L. Gardner, 1944. Some edaphic and ecological effects of water spreading on range land. Journal of Ecology, 25: 27-44.
10. Kowasar, S.A., 1997. Aquifer management a key to food security in the desert of the Islamic Republic of iran, In the Poroceedings of the 8Th Conference Rain. Catch, Syst, pp: 25-29.
11. Kalantari, R. and H.R. Rahmani, 1999. Evaluation of an artificial recharge system. A case study in Southern Iran, Proceeding of Groundwater and Watershed Development. Dhule Indian, pp: 182-191.
12. Signor, D.C., V.L. Hauser and O.R. Jones, 1969. Groundwater recharge through modified shafts. Am. Soc. Agric. Eng. Trans., 12(4): 486-489.
13. Singer, A., 1989. Palygorskite and sepiolite group minerals. In: J.B. and S.B. Weed, 1989. Minerals in soil environments. ^{2nd} ed., SSSA Book Series, Madison, WI, 1: 829-875.
14. Aba-Husayn, M.M., J.B. Dixon and S.Y. Lee, 1980. Mineralogy of Saudi Arabia: Southwestern. Journal of Soil Science. Soc. Am., 44: 643-649.
15. Lee, S.Y., J.B. Dixon and M.M. Aba-Husan, 1983. Mineralogy of Saudi Arabia, Eastern region. SSSA. J., 47: 321-326.
16. Reid, D.A., R.C. Graham, L.A. Douglas and C. Amrhein, 1996. Smectite mineralogy and charge characteristics along an arid geomorphic transect. SSSA, J., 60: 1602-1611.
17. Barnhisel, R.I. and P.M. Bertsch, 1989. Chlorites and hydroxy interlayered vermiculite and smectite. In: J.B. Dixon and S.B. Weed. Minerals in soil environments. 2nd ed., SSSA Book Series, No. 1, Madison, WI. U.S.A.
18. Grim, E.E., 1968. Clay mineralogy. 2nd ed. McGraw Hill book company, New York, pp: 596.
19. Khademi, H. and A.R. Mermut, 1999. Submicroscopy and stable isotope geochemistry of carbonate and associated palygorskite in Iranian Aridisoils. Journal of Soil Science, 50: 207-216.
20. Bouza, P.J., M. Simon, J. Aguilar, H. Valle and M. Rostage, 2007. Fibrous-clay mineral formation and soil evolution in Aridisols of northeastern Patagonia, Argentina, Geoderma, 139: 38-50.
21. Honarjoo, N. and A. Jalalian, 2009. Evolution of soil in land Khorasgan of Islamic Azad University. Journal of Agricultural Science, 4(2): 254-266.
22. Abtahi, A. and F. Khormali, 2001. Genesis and morphological characteristics of Mollisols formed in a catena under water table influence in southern Iran. Commun. Journal of Soil Plant Anal. 32: 1643-1658.
23. Khormali, F. and A. Abtahi, 2003. Origin and distribution of clay minerals in calcareous arid and semiarid soils of Fars Province, Southern Iran. Journal of Clay Minerals, 38: 511-527.
24. Manafi, S.H., 2009. Mineralogical and micromorphological investigation on arid and semiarid soils and possibility of use these data for reconstruction of paleoclimate in some part in Southern Alborz. PhD thesis, Faculty of Agriculture, Tehran University, Department of Soil, pp: 334.