Egypt. J. Agric. Res., 80 (4), 2002.

X-RAY DIFFRACTION STUDY ON THE CLAY FRACTION OF ERODED SOILS IN THE NORTH WESTERN COAST OF EGYPT

SALAH EL–DIN M. ARROUG

Soils, Water & Environment Res. Inst., Agric. Res. Center, Giza, Egypt.

(Manuscript received 18 November 2001)

Abstract

Continuous soil erosion along the hilly landscape of the North Western Coast of Egypt is expected to result in some changes in the mineralogical composition of the clay fraction. Therefore, surface soil samples were collected from top and bottom slopes as well as, inside and outside the main gully.

X-ray diffractograms revealed that kaolinite is the major clay mineral in the eroded soils of EL-Omayed area. Kaolinite crystallization is appeared at the top slope while being dominant in the bottom slope.

The dominant clay minerals in Khashm El–Eish ridge area are semectite (montomorillonites), hydrous mica (illites), attapulgite and kaolinites.

These clay minerals are almost the same at the top and the bottom slopes and also inside or outside the main gully but bearing well crystallization at the lower slope and affect their crystallinity and amount.

INTRODUCTION

Soil erosion either by water or wind is a serious problem in the North Western Coast of Egypt. Khashm EL–Eish ridge located in El –Omayed area (77 km from Alexandria) Map 1 was chosen for these studies. Three main gullies are distinguished in khashm El – Eish ridge area Fig 1. Their shape is like a delta with a depth ranges from 4 m at the gully head to I m at the gully foot, after which, several rills are widely spreaded.

Several investigations have been devoted to the study of origin, sedimentology and geomorphology of the nine main ridges parallel to the Mediterranean Coast (El – Shazly and Shata, 1969 and Hanna, 1987).

El-Gabaly (1962), Gewaifel *et al* (1970) and Mady *et al* (1981) indicated that the Calcareous sandy soils contain attapulgite and illite the dominants in the uncultivated ones.

Continuous soil erosion is expected to result in some changes in the mineralogical composition of the clay fraction. Therefore, surface soil samples were selected out of 4 profiles (No.3, 5, 11 and 12) at top and bottom slopes as well as inside and outside the main gully, (0-15 cm) depth.

MATERIALS AND METHODS

The present work was based on 12 profiles from the left gully were dug along the main slope (3 km length) and inside and outside the gully (1 km width) to reflect the extent of interference between water and wind erosion processes. The locations of soil profiles have been selected to represent the flat depression system and southern sandy slope.

Fine clay (<2 μ) were separated for mineralogical analysis after removing soluble and sparingly soluble materials using several washing with H_2O until peptisation occurred.

X-ray diffractograms of the clay fraction were carried out with a Philips diffractometer (pw1060/00) using, Cu – radiation (Cu K$\propto$ with λ = 1.5418 Å), Ni-filtered generated at 2 θ spead of 2°/min. Oriented clay samples were prepared as Mg–saturated air dried, Mg–saturated glycerol solvated and K–saturated and heated to 550°C for 4 hours. Interpretation of X-ray diffractograms was carried out according to Brown (1961).

RESULTS AND DISCUSSION

Identification of clay minerals:

Examination of the clay minerals using the x–ray technique was carried out on clay samples representing the top and bottom slopes as well as inside and outside the main gully.

The x–ray diffractograms, (representing profiles 3, 5, 11 and 12 respectively) in Figures 2, 3, 4 and 5 revealed the presence of smectite group, hydrous mica and kaolinite. These minerals occurred in both top and bottom slopes as well as, inside and outside the main gully .

The x–ray diffraction patterns of the bottom slope and inside the gully profiles No. 11 and 12 showed an excellent crystallization for smectite minerals. On the other hand, smectite minerals exhibited poor crystallization and gave diffuse and weak peaks for soils at the top slope and outside the main gully profile No. 3.

This behaviour may explain the relatively higher CEC at the lower slope position and inside the gully profiles 11 and 12 (Arroug 1995)

The variation in clay mineral crystallization as influenced by slope position and soil erosion was observed in Burundi by El-Hassanin (1993)

Kaolinite maxima were detected at 7.13 Å (001) and 3.56 Å (002). These reflections disappeared upon heating clay samples at 550°C for 4 hours as shown in Figs 4 and 5 (profiles 11 and 12).

Since the diffraction peak intensity and sharpness reflect the degree of mineral crystallization (Brindly, 1961), consequently kaolinite exhibited poor crystallization at the summit and vice versa down slope.

Hydrous mica minerals (illites) gave frist order at 10 Å (001) and a small diffuse reflection at 5 Å (002). The peak at 10 Å became more intense after heating at 550°C for four hours. Illite is a micaceous clay mineral similar to muscovite in structure but it contains less K^+ ions.

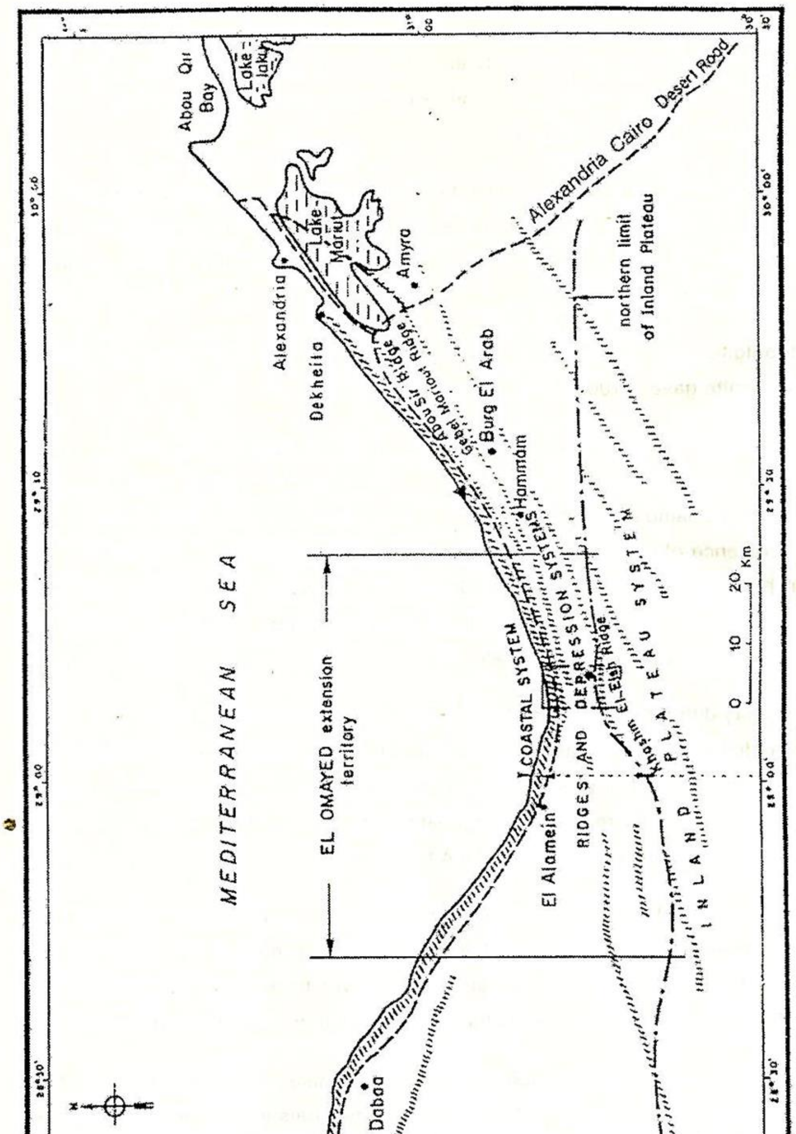
Attapulgite gave in (110) at 10.4 Å and of (330) + (150) reflection at 3.56 Å, while the Calcaite gave in (002) at 3.03 Å.

The position of 14.0 Å and 7.0 Å basal reflection of chlorite mineral is unaffected by glycerol treatment or by heating at 550°C. The basal reflection (001) at 10.4 –10.5 Å which remaind constant after glycerol solvation treatment K-saturation indicates the presence of palygorskite mineral, the existance of 6.45 Å, 4 .34 and 4.20 Å diffraction peaks confirms its presence. Quartiz and feldspars are detected from the presence of 3.55 Å, 3.33 Å ,3.26 Å, 4.44 Å and 4.25 Å stable diffraction peaks, respectively throughout the different treatments.

The x-ray diffraction patterns of smectite showed peaks ranged from 12 to 16 Å which expanded to 18 Å after glycerol solvation. The structure of smectite is similar to mica minerals with interlayer water and other ions instead of K-ions between the layers. The interlayer water was removed after heating the K-saturated samples at 550°C which produced a mineral collapse from 16 Å to 12 Å.

Some interstratification was noticed in most of clay samples which indicated the presence of mixed layer clay minerals. Evedentually, d-spacings are either an integral sequence of the 001 reflection as the sum of the layer thickness (regular stratification), or they are not an integral series the of 001 reflection (random stratifiction).

In this respect, the 27 Å d-spacing may be a regular interstratification of illite (10 Å) and smectite (17 Å). Thus the dominant clay minerals in Khashm El-Eish ridge area are smectites (montomorillonites), hydrous micas (illites) and kaolinites. These clay minerals are almost the same at the top and bottom slopes and also inside or outside the main gully but bearing well crystallization at the lower slope and inside the gully. Therefore, water erosion in Khashm El-Eish environment showed no effect on their crystallinity and amount. This is consequently related to the relevant changes in soil characteristics.



El Omayed site * Khashm El Eish ridge area □

Map 1. London map of El Omayed ridge area and extension territory.

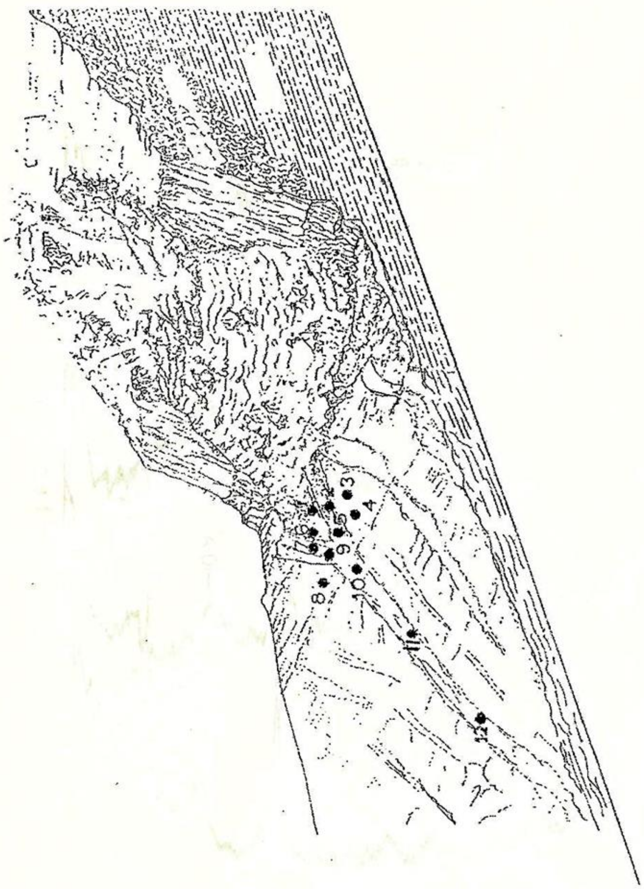


Fig. 1. Blocky diagram of Khashm El Eish ridge and locations of soil profiles.

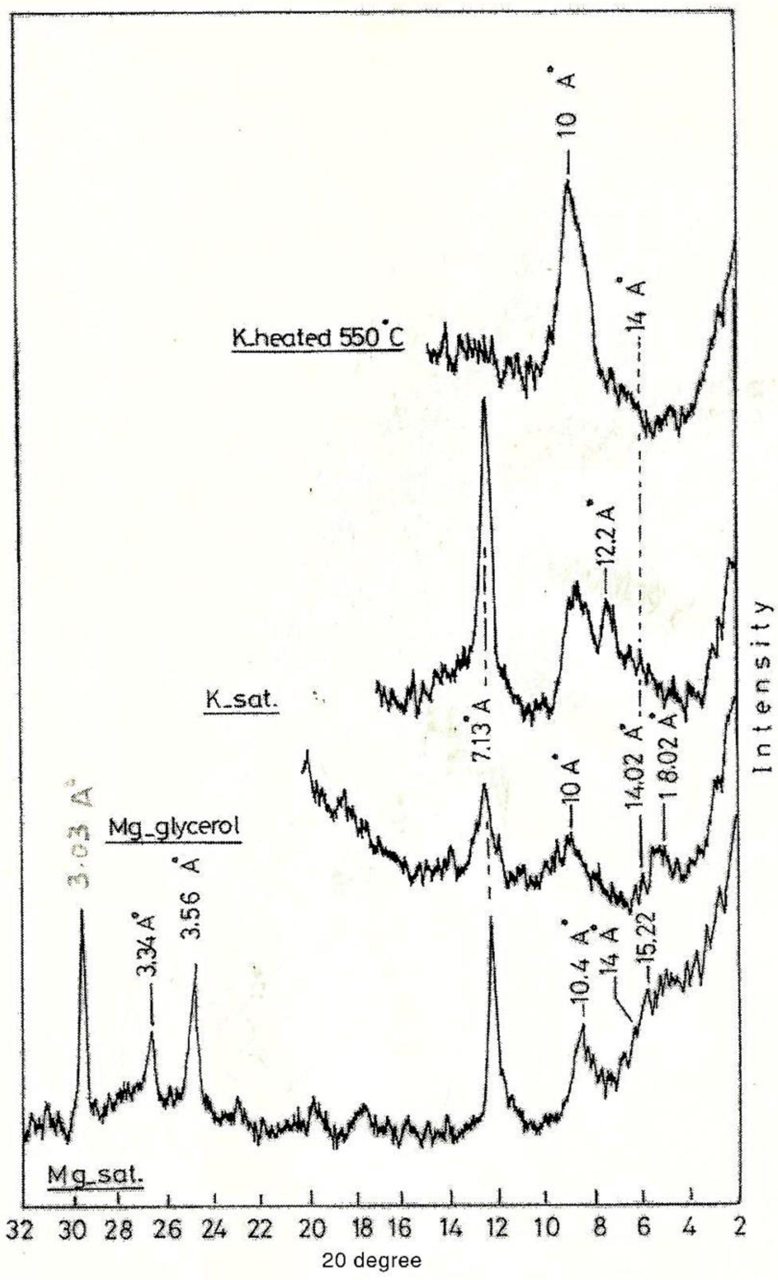


Fig. 2. X-ray diffraction pattern of clay fraction, profile No. 3

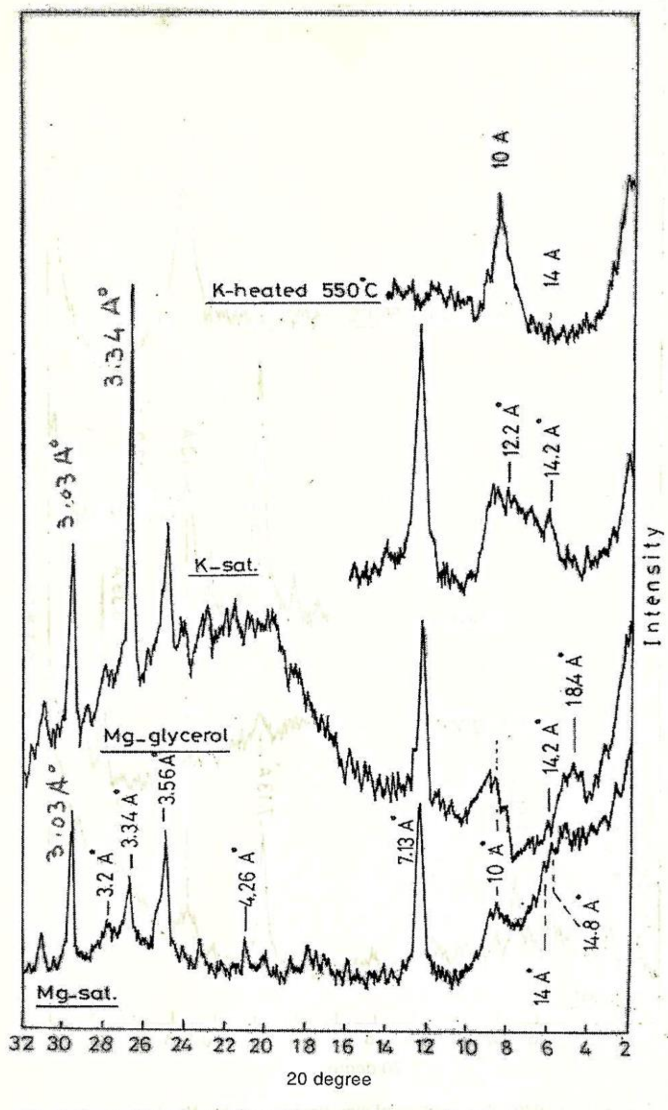


Fig. 3. X-ray diffraction pattern of clay fraction, profile No. 5

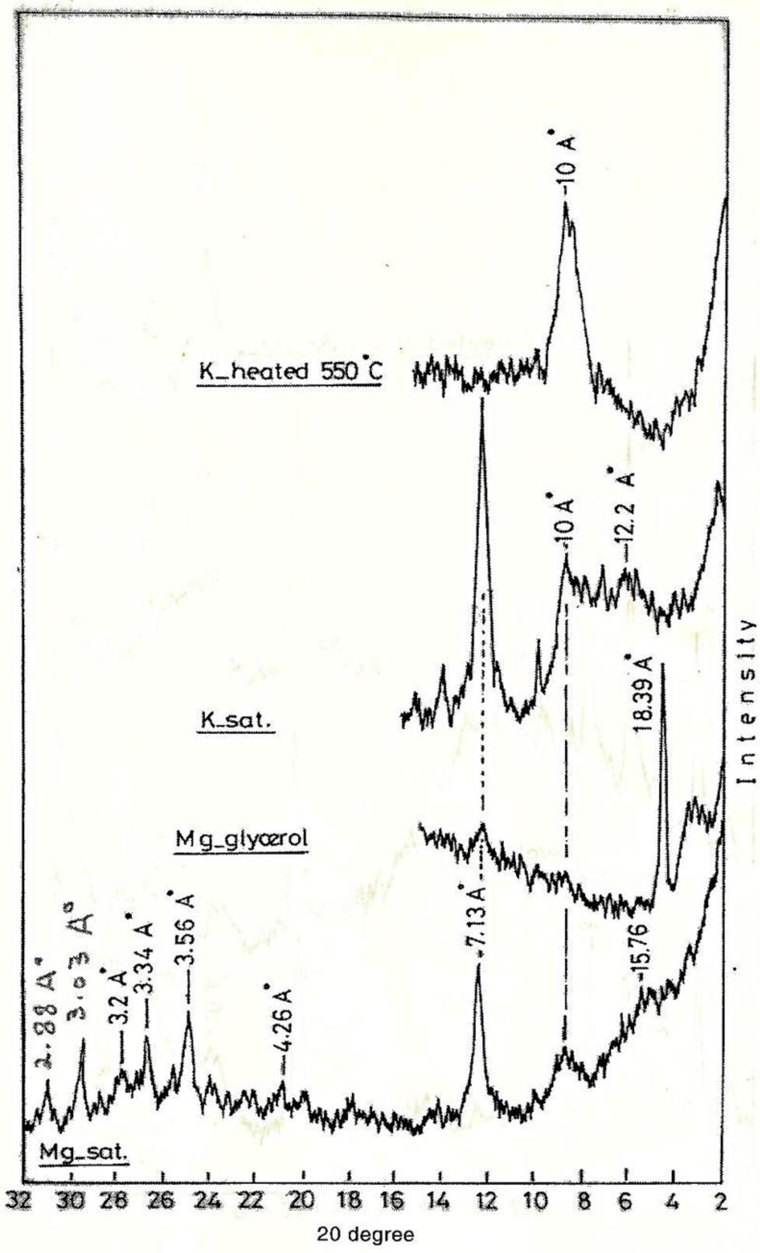


Fig. 4. X-ray diffraction pattern of clay fraction, profile No. 11

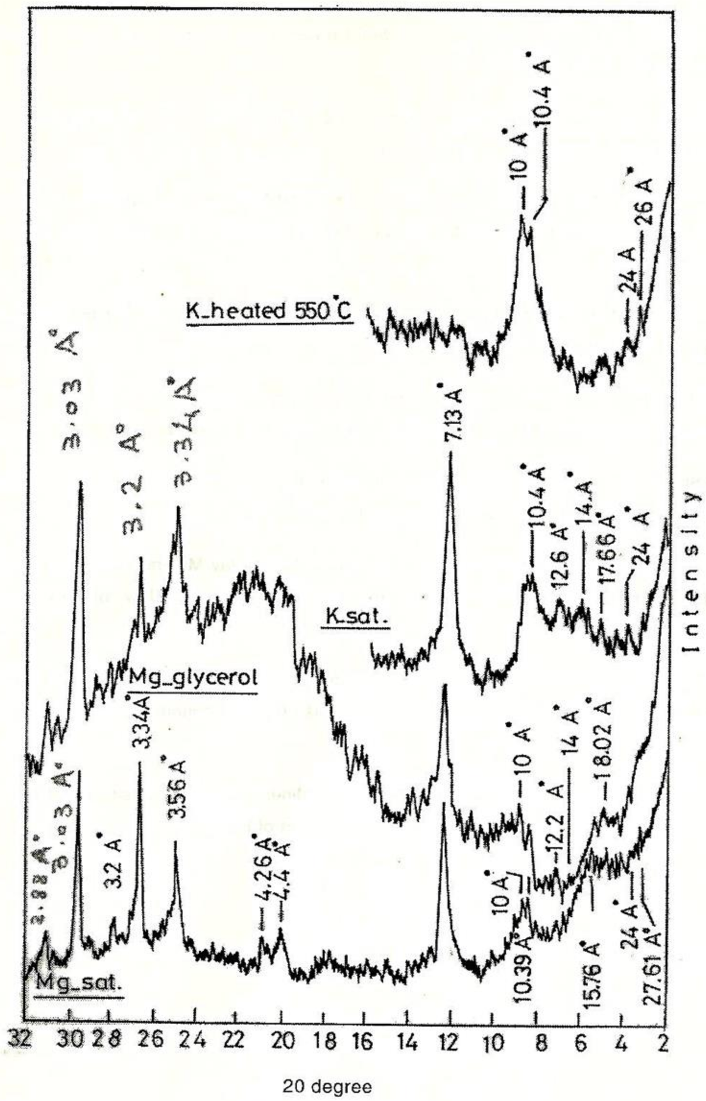


Fig. 5. X-ray diffraction pattern of clay fraction, profile No. 12

REFERENCES

1. Arroug, S. M. 1995. Relation of Some Soil Properties to its Erodibilty. Ph D. Thesis, Fac. Agric., Ain-Shams Univ., Egypt.

2. Brown, C. 1961. The X-ray Identification and Crystal Structure of Clay Minerals. Min. Soc. of Great Britain Monograph, London.

3. Brindly, G. W. 1961. Kaolin, Serpentine and Kindred Minerals. in G. Brown (ed.) "The X-ray Identification and Crystal Structure of Clay Minerals pp. 51-131. Mineral Soc., London".

4. El-Gabaly. M. M. 1962. The Presence of Attapulgite in Some Soils of the Western Desert of Egypt. Soil Sci., 39:387-390.

5. El-Hassanin, A. S. 1993. X-ray and Infrared Studies on Inorganic and Organic Fractions of Eroded Soils of Burundi. Egypt. J. Appl. Sci. (7): 425-443.

6. El-Shazly, M. M. and A. Shata 1969. Gemorphology and Pedology of Mersa Matroh Area, western Mediterranean litoral zone. Desert Inst . Bull. XIX :1-29.

7. Gewaifel, I. M., M. N. Hassan and M. El-Gabaly. 1970. Clay Mineralogy of Some Profiles From Westarn Desert (U.A.R.) Alex. Jour. of Agric. Res., Univ. of Alexandria, Alex., Egypt.

8. Hanna. F. L.1987. Geological and Sedimentological Studies on the Plistocene Limestone West of Alexandria with Special Emphasis on their Economic Use. Ph. D. Thesis, Fac. of Sci., Cairo Univ.

9. Mady F. A., M. A. Aziz and N. E. Fanous. 1981. Mineralogical Composition of the Clay Fraction of the Soils of Siwa Oasis, Western Desert of Egypt.

استخدام الاشعة السينية للتربة المنجرفة فى الساحل الشمالى الغربى لمصر

صلاح الدين محمد مصطفى عروج

معهد بحوث الاراضى والمياة والبيئة - مركز البحوث الزراعية - الجيزة - مصر

يعانى الساحل الشمالى الغربى لمصر من انجراف شديد بفعل المياة والرياح معا مسببا سلسلة مشاكل، وخاصة فى منطقة العميد بخشم العيش ريدج، ولذلك فانة من المتوقع ان ينتج بعض التغيرات فى التركيب المعدنى للطين، ولذلك تم اختبار اربعة عينات تربة سطحية من ١٢ قطاع تمثل قمة وقاعدة الريدج الرئيسى وداخله وخارجه. واظهرت نتائج االاشعة السينية للطين ان معدن الطين السائد فى منطقة خشم العيش يكون السمكتيت يلية الهيدرس ميكا ثم االكاؤلنيت..ومعادن الطين هذة معظمها فى قمة وقاعدة الانحدار واحدة وايضا بداخل وخارج الريدج ،لكن درجة التبلور تختلف باختلاف موقع الانحدار ،أحسنها عند نهاية الانحدار. والمعادن المصاحبة مثل الميكا والكوارتز والاتابولجيت.