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THE ROLE OF SPECTRAL RESPONSES IN THE DISCRIMINATION OF SOILS SURFACE OF SEBKHA SEFIOUNE IN THE NORTH OF OUARGLA (NORTHERN ALGERIAN SAHARA) BY REMOTE SENSING

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Abstract- Quaternary formations occupy all the lower levels of large sedimentary basins, forming thus ephemeral lakes in closed salt depressions, called commonly "sebkhas." They are continental aquatic ecosystems classified as wetlands of inland backwaters (RAMSAR Convention, 1971). They provide several functions; such as aquatic life, geochemical and hydrological cycles.
The aim of this paper is to characterize the surface states of salty soils of sebkha Sefioune in the north of Ouargla (South-eastern Algeria), by linking the remote sensing data acquired by satellite and observation and exploration of land in order to differentiate the surface states of the study area (sebkha Sefioune and nearby).
The realization of spectral signatures from the satellite image (Landsat 7 ETM +), allowed us to individualize the soil surface states of sebkha Sefioune and its surroundings (North of Ouargla-Algeria) according to the spectral responses of each surface states.
This approach allows us to say that the land surface states have different spectral behaviour according to their colour, water content (humidity), structure (roughness,) mineralogical and geochemical nature.

Keywords: *Sebkha, Sefioune, Ouargla, reflectance, spectral profile, spectral signature, remote sensing.*

1. INTRODUCTION

Remote sensing can be a means of characterization and monitoring of saline soils or being salinization (Manchanda. (1984)) **[1]** Richardson et al., (1976) **[2]**. It consists of measuring an electromagnetic signal emitted or reflected by the target. The measurement is performed remotely from space or airborne sensor in the solar reflective domain (0.4-2.5µm). The measured information is related to the amount of energy (solar light) reflected by the surface (Lillesad & Kiefer. (2000) **[3]**. This technique has become a tool for quantifying the risk of salinity in relation to the different components of surface states and their organization, from the choices that provides for the study of saline surfaces and sabkhas the spectral characterization of surface states by their physico-chemical and mineralogical properties.

According to Berenger (1985) **[4]** halite (sodium chloride) and gypsum (hydrated calcium sulfate) are the dominant salts in the soil surface, they correspond to a reflectance in the visible and near infrared usually maximum with reverence to the environment; gypsum, as the other sulphates, has in addition an absorption bands in the medium infrared (Lemasson., (1988)) **[5]**.

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1.-Presentation of the study site:

Our study area is located in the northeast of the city of Ouargla (Fig.1). According to its geomorphology, lithology,

The study site can be subdivided into five main units (AUMASSIP., G. et al (2002)) [6]:

- Limestone and reg (Pliocene plate) plate;
- The aeolian sands (dunes and sandy sails);
- The sandstone hills (outcrops of red sandstone of Mio-Pliocene);
- The sebkha and saline soils (Sebkha Sefioune and surroundings);
- The old alluvial terraces.

2. MATERIALS AND METHODOLOGY

2.1. Realization of the spectral profile on image

The realization of a spectral profile on the image is as following:

- Choice of orientation of the profile (NW-SE);
- Select the type of profile, punctual; space or surface (space);
- Choice of spectral bands and this according to the aim of the study (B1, B4 and B7);

The profile selection is guided by the wish to visit localities marked peaks at high reflectance in the spectral profile (Fig. 3) to specify the origin of the oscillation of reflectance.

2.2. Field mission:

First of all, the realization of the profile is established on image by a spectral profile passing almost by all classes identified on radiometric image component (RGB-742), thereafter on field, using a GPS we operate observation and sampling stations corresponds to the coordinates plotted on spectral profile previously achieved.

Class 3: cyan colour, presented the state of surface crusting gypsum;

Class 4: the olive green colour, presented the state of surface – red sandstone Mio-Pliocene;

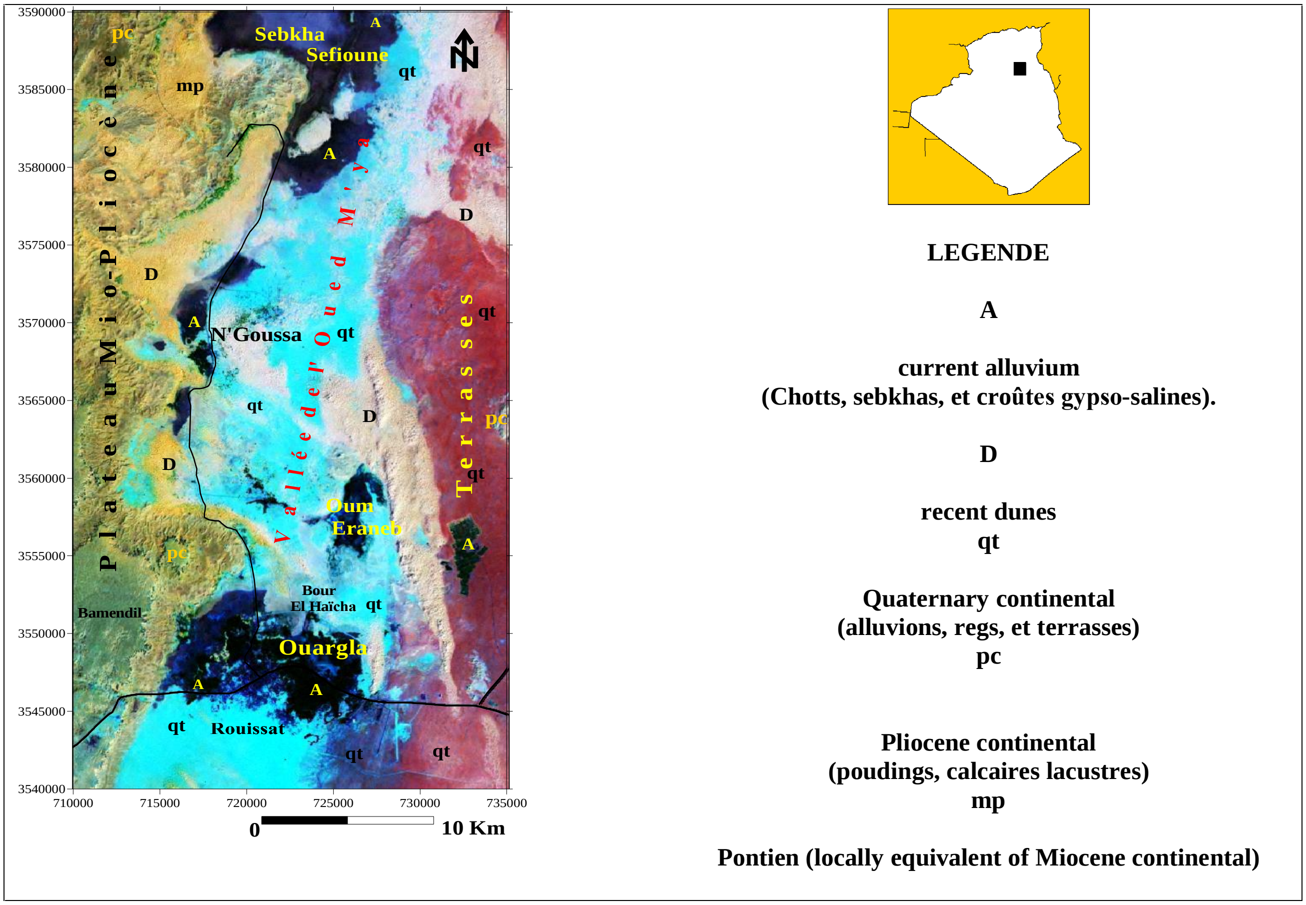

Figure.1: physical setting of the study area

3. Results and Discussion:

The application of remote sensing in monitoring and identification of surface and characterization of saline soils is increasingly used in recent years. This work is to compare data measured on samples of field and digital remote sensing data from Landsat 7 ETM + image and try to establish the relationship between the intrinsic characteristics of the soil surface and their spectral responses.

After a series of operations of image processing, classification, field validation, analysis and interpretation were able to map the surface states of soil (Fig.2) to 1:250,000 with following legend:

Class 1: the yellow colour is the surface of aeolian sand medium to coarse;

Class 2: the pale yellow colour is the state of surface sandy loam fine to medium; slightly carbonated (alluvial sand);

Class 5: the light brown colour, presented surface Pliocene continental shelf (Reg limestone);

Class 6: blood red colour , is the state of surface alluvial terrace (coarse sand and gravel , flint gray to very light gray rounded , sometimes pale to white transparent) ;

Class 7: the sky blue colour is the state of surface wet salt sands;

Class 8: pink colour, is the state of surface white gypsum sand;

Class 9: black colour, is the state of surface non- soil (shade, water and vegetation).

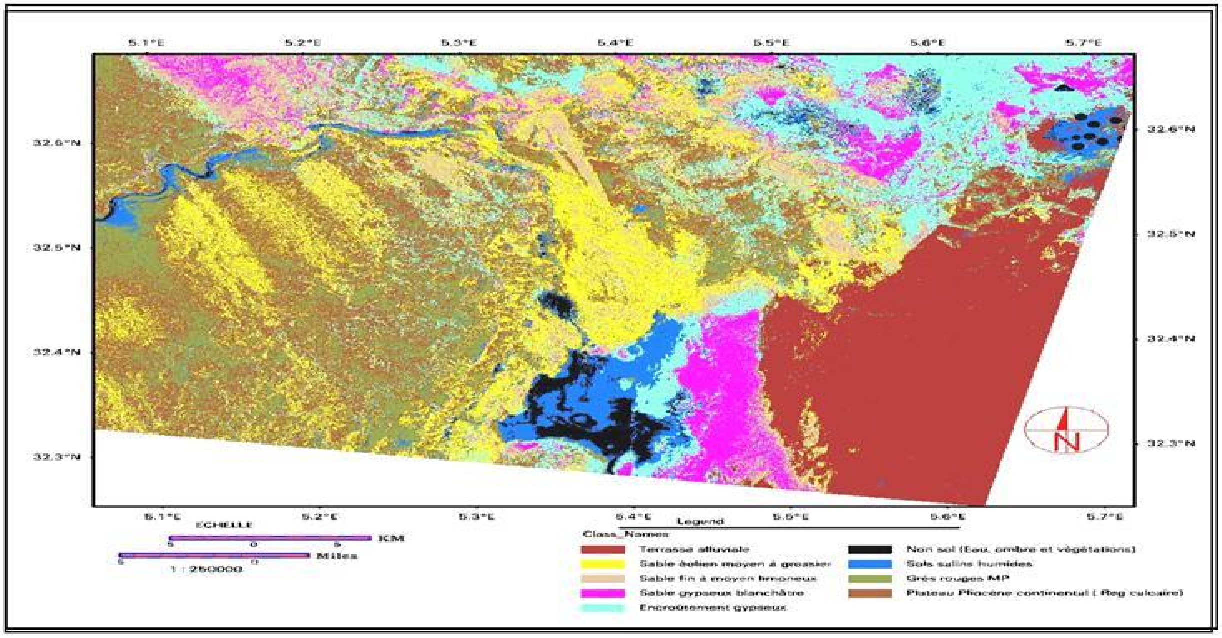

Figure 2: map of the surface states of the study area

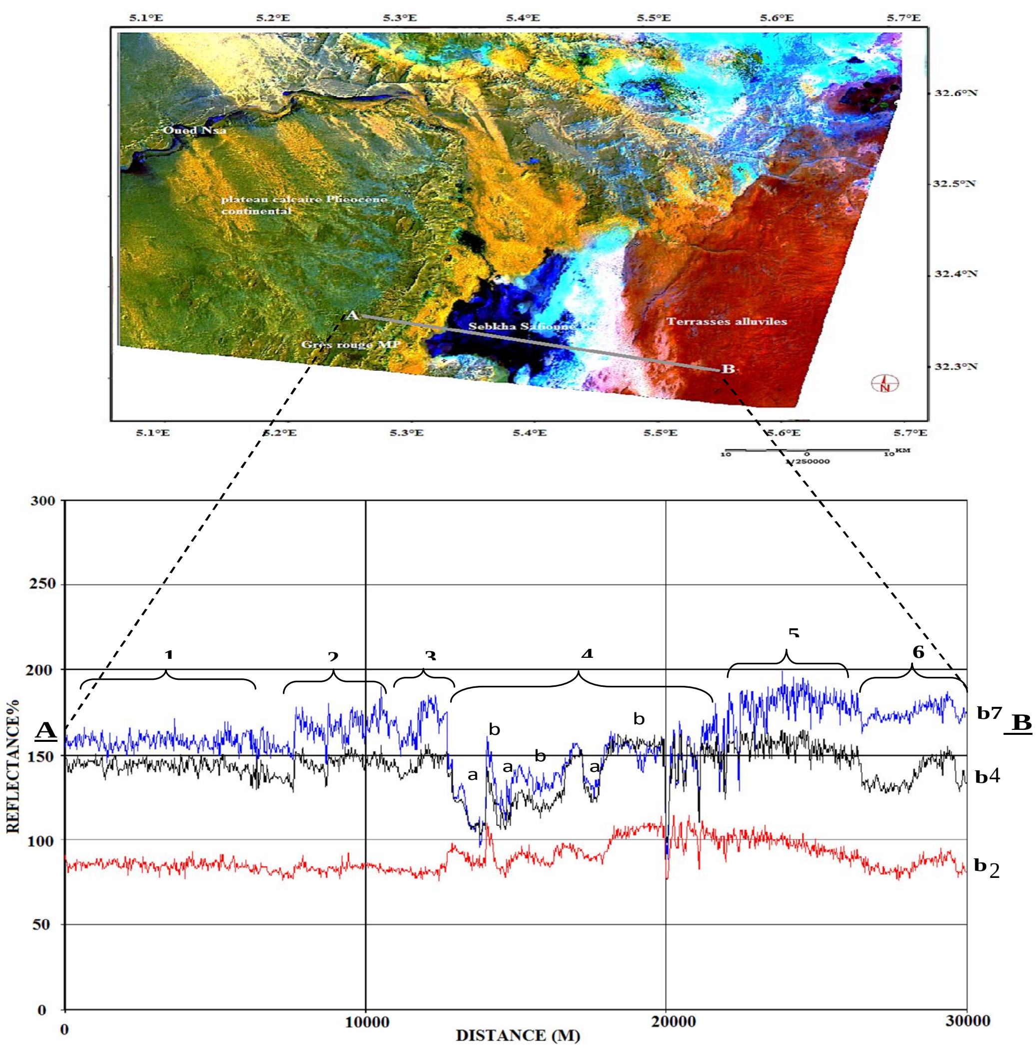

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Figure.3: spectral profile across the study area

1: The Mio-Pliocene red sandstone surfaces (reddish sandstone mounts) medium to low reflectance;

2: yellowish medium to coarse Aeolian Sand and fine silty sand (alluvial sands) high reflectance;

3: gypsum sand and gypsum crusts surfaces: high reflectance;

4: wet saline soils surfaces and saline efflorescence (Sebkha safioune); strong absorption;

a: shallow salt water saturated;

b: wet saline soils;

5: white gypsum sand: medium reflectance;

6: Alluvial Terraces: Medium to low reflectance.

*b7: spectral band 7;

*b4: spectral band 4;

* b2: spectral band 2.

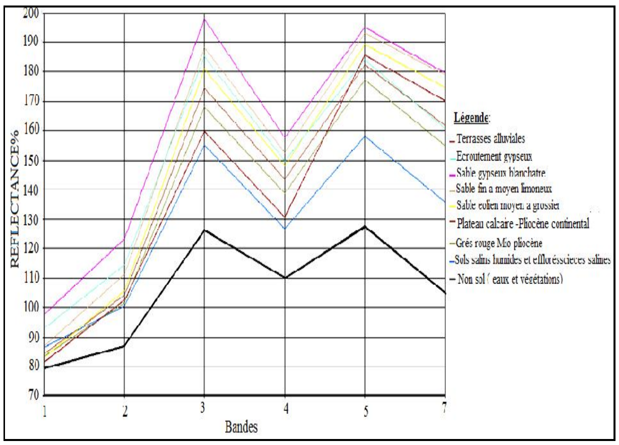

Figure. 4: The curves of the spectral responses of different soil surface states.

4.1. Spectral behavior of surface states on the spectral profile

According Escadafal R., (1989) [7] the spectral response of various surface soil depends on several parameters, namely: the physical state (size, color and moisture), chemical composition, geochemical and mineralogical constituents of the ground surface.

The spectral behaviour of objects of Earth's surface is a favourite way to analyse and interpret satellite imagery, because it relies on general physical laws, MC Girard Girard C (1999) [8].

The spectral responses of the classes that we could highlight is illustrated in the figure (Fig. 4) which shows the reflectance curves of each class, from this figure it can be concluded that the reflectance varied depending on the color and clarity, particle size, moisture content and nature of the mineral soil surface:

1- More clarity is high; the reflectance is stronger;
2 - Clarity the lower the reflectance is lower;
3-The high reflectance in all bands are those of clear soil, fine and dry soil (whitish gypsum sands, gypsum crust, wind and alluvial sands); the lowest reflectance in all bands are those of the dark surfaces, rough, wet and absorbing light (saline wet surfaces and surfaces of free water of Sebkha) surfaces.

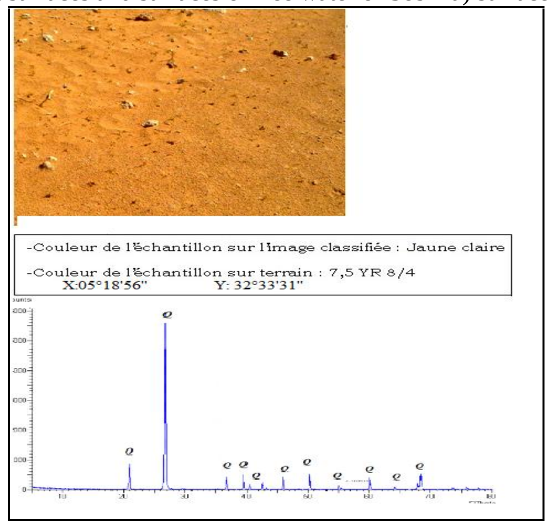

Figure. 5- medium to coarse aeolien sand state.

4/1-1- Aeolian and alluvial sands surfaces: predominantly quartz, appear clearly whatever their position in the region. The rougher the nebkas and wind sails are golden yellow; the finer are pale yellow (alluvial sands for a very fine). On the spectral profile (Fig.3) the relatively high reflectance of the two classes of sand which can specifically be linked to the intrinsic characteristics , composition mineralogy , (Fig.5) texture and structure (arrangement and size of the grains)

4/1-2-the gypsum surfaces and gypsum crusts, presents in the form of two well individualized classes, the first corresponds to gypsum dissected reliefs (Fig.6-a) crusts

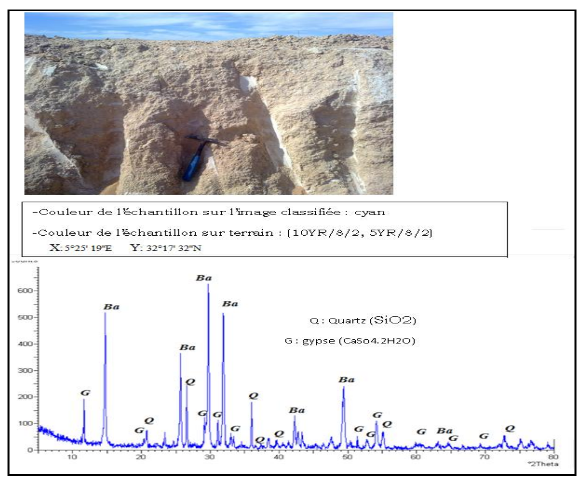

Figure. 6-a-state surface gypsum and gypsum crust.

and the other in white gypsum sands (Fig.6-b) may be the product of wind erosion of mounts and plateau. The high reflectance (Fig.3) of these two classes is overlooking the sandstone probably related to the mineralogy and geochemical of surface gypsum rock composition, texture and structure (grain size and arrangement). According to BRAIN B (1988) **[9]** the main spectral signatures of gypsum are related to the existence of H_2O or hydroxyl radicals (OH^-) involved in the formation of their structure.

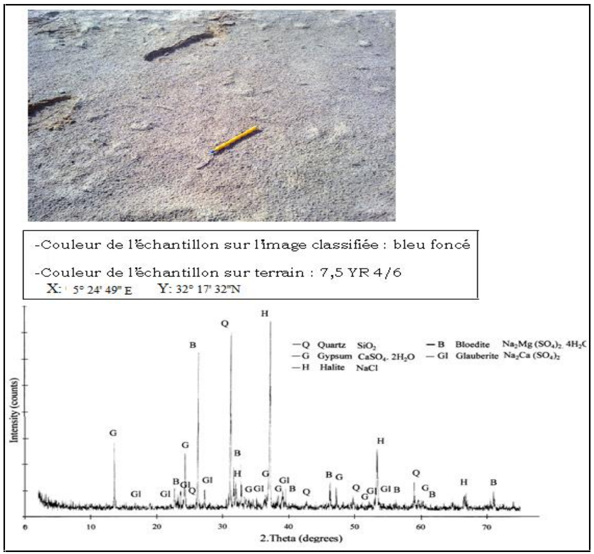

Figure.6-b- state surface whitish fine sand.

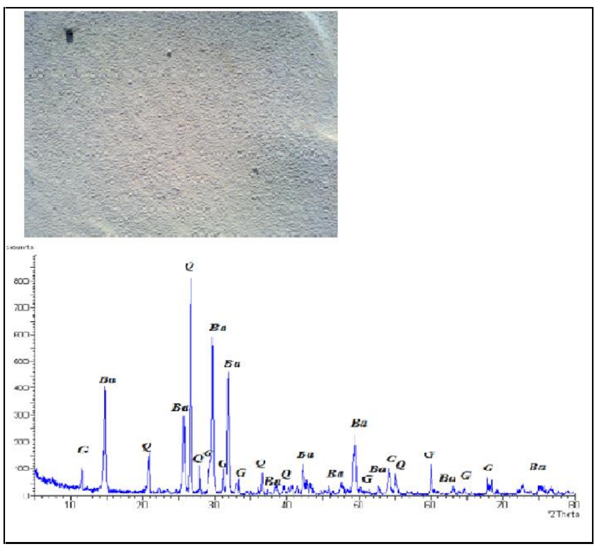

Figure.7 -Etat de surface : sols salins humides et efflorescences salines (Hamdi-Aissa , B.(2004)).

4/1-3-the wet saline soils surfaces and saline efflorescence : these are saline soils with sandy texture (pseudo- sand) with lots of whitish marking and gypsum crystals , dark grayish-brown in dry state (Y4 2.5/2) (Fig.7) ; no effervescence with HCl. On the spectral profile (Fig.3) the fluctuations in the level of reflectance of these classes can be caused by moisture, fine elements and the micro-roughness. According (MOUGENOT (B), (1993)) **[10]** these effects may be compensated if a surface with wet crystallized salts remains maintained for example by a shallow groundwater.

4/1-4- red sandstone Mio-Pliocene surfaces: represented by the reddish sandstone mounts, red stoneware clay-carbonate cement is of Mio-Pliocene age (5YR 6/4) (Fig. 9). The relatively low reflectance (Fig. 3) of this class is probably due to their dark - saturated colour and relatively high content of fines (sandstone with silty and slightly carbonated cement).

4/1-5- Alluvial terraces surfaces: are homogeneous surfaces made of siliceous centimetric detrital material, very rounded mixed with wind coarse quartz sand (Fig. 8). The medium to low reflectance of this surface state is possibly due to the dark colour of components and homogeneous size of particle (Fig.5) of the surface of this class (roughness) (Fig.3). According to BRAIN B (1988). **[9]** the particle size of the material and roughness of surface influencing not only the signal for a given wavelength but also by moving the maxima and minima of a diffuse reflectance spectrum.

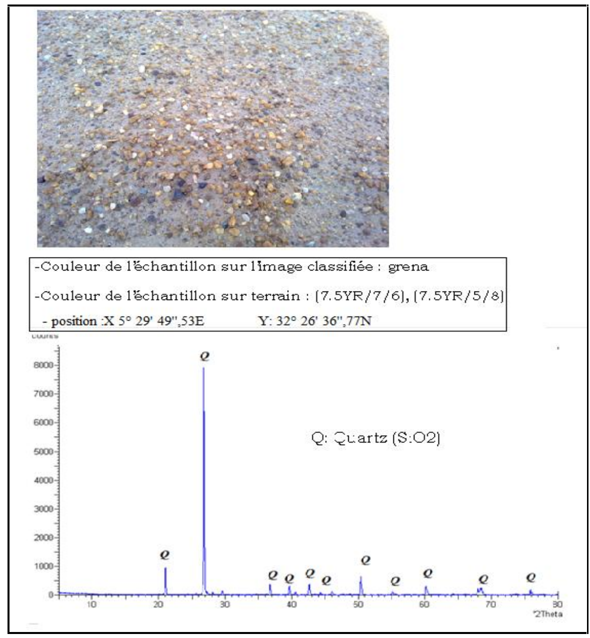

Figure.8- surface state alluvial terrace.

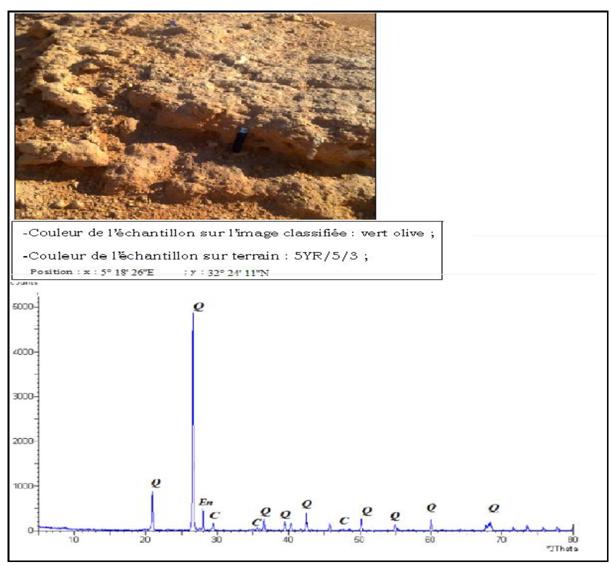

Figure.9- Mio Pliocene red sandstone surface state

Conclusion:

This work is a first approach of the use of spectral signatures produced from satellite imagery (Landsat 7 UTM +) for the detection and discrimination of various surface sebkha Safioune. The examination of the spectral profile shows that in the visible and near infrared (TM1 and TM4) there is a net increase of reflectance; the effect of absorption by water is observed in the centre and borders West sebkha (free water table and high soil moisture); As we moves away from the centre of sebkha (in any direction) humidity decrease and the reflectance increases. During our passage on whitish gypsum sands and aeolian sands, a peak of reflectance can be observed (high reflectance). At dark soil we see a remarkable decrease in reflectance, which may be due to the combined effect of mineralogy and physical condition of the soil (texture, structure and size). Topography and geomorphology may also cause disruption of spectral responses by the shadow effect due to the acquisition of the image with an oblique angle.

At the end we can conclude that the surface states of soils have very different spectral response according to their colour, humidity, mineralogical and geochemical nature and structure (roughness).

Indeed, it would be interesting for future research work to go further into the details of the surface states will be studied with greater precision ; using more efficient image (high resolution) and the reflectance spectra of the soil is determined in the field by means of a portable spectroradiometer (in the field) adjusted in the measurement conditions similar to those of satellite sensors in order to try to determine the most appropriate spectral bands and their combinations (indices) to identify salty surfaces.

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