Mapping of Prerift – Synrift Sedimentary units using Enhanced Thematic Mapper Plus (ETM+): Sidri – Feiran Area, Southwestern Sinai Peninsula, Egypt

A.M. Youssef • A.M. Hassan • A. A. A. El-Haddad

Received: 21 August 2008 / Accepted: 1 August 2009

Keywords Remote sensing • Geology • Mapping • Pre/syn-rift • Sedimentary rocks.

Abstract Different outcropping sedimentary rock units, ranging in age from Paleozoic to Miocene, can provide significant information to understand the development of tectono-sedimentary evolution of the Sidri - Feiran area, southwestern Sinai Peninsula. The aim of this research is to test the ability of Landsat ETM+ imagery for differentiating and mapping these units with the help of Shuttle Radar Topography Mission (SRTM) and field investigations. For this purpose, true and false colour composite images, image enhancement techniques (Principle Component Analysis and Minimum Noise Fraction), and 3D perspective views were applied to the data and the geological-photo interpretations were carried out.

Introduction

Sinai Peninsula constitutes an important district of the Egyptian lands where it forms a triangular portion in northeastern Egypt. The southern portion of the Sinai Peninsula is occupied by the uplifted mountains of the Pan-African basement complex while the Phanerozoic sedimentary rocks cover the middle and the northern parts.

The Gulf of Suez is considered as one of the most active sedimentary basins during rifting processes. It provides an excellent example for different stratigraphical, sedimentological, and structural
investigations. It is also considered as one of the most productive and oil promising provinces in Egypt. It has attracted the attention of a large number of geologists for its hydrocarbon potentialities. The reasons for this importance are due to:

- The presence of the fossiliferous marine shale and marls in Miocene rocks which are the main sources for the oil and gas in the region;
- The presence of Miocene evaporites, which represent the sealing beds in most of the oil fields (Barakat, 1986);
- The presence of huge amounts of siliciclastic sediments as well as dolomites and reefs in the sedimentary column which act as productive zones in most of the oil fields.

The Gulf of Suez is a rift system that initiated in a continental plate interior situated at, or near, sea level (Garfunkel and Bartov, 1977; Sellwood and Netherwood, 1984). As a result, marine waters reached most sub-basins within this rift very early in their development, depositing a stratigraphic sequence ranging from Oligocene to Quaternary ages. The Gulf of Suez region provides an excellent example for the tectonic control on sedimentation in block faulting regions during the Neogene period. Moreover, it also provides good models for siliciclastic-carbonate-evaporite transitions in a depositional rift system. During the initial stages of the Gulf of Suez rifting, many separate ridges, which caused local restriction and open bays resulting in the deposition of different lithofacies, were formed.

The study area is located in the southwestern Sinai extending from Wadi Sidri to Wadi Feiran on the eastern side of the Gulf of Suez (Fig. 1). The area has a semi-arid climate, a mountainous topography, and sparse vegetation. Owing to the oil-exploration potentiality, the study area has been included in some studies by previous workers. Most of these literatures were concerned with general geology, stratigraphy, sedimentology, and structural geology (e.g., Barron, 1907; Hume et al., 1920; Sadek, 1959; Said, 1962; Garfunkel and Bartov, 1977; Issawi et al., 1981; Chenet et al., 1984; Said, 1990; Moustafa, 1992; and Mahran et al., 2001). Hassan (2002) mentioned that the syn-rift Miocene sediments exposed at Wadi Sidri – Wadi Feiran area could be classified into four main units namely: (a) carbonate Unit; (b) fine siliciclastic unit; (c) mixed siliciclastic-carbonate evaporite unit; and (d) mixed siliciclastic-carbonate unit.

However, very few works dealt with mapping of the study area and were mostly carried out through general projects (e.g., the Egyptian General Petroleum Corporation, CONOCO Coral, 1987 and the Geological Survey of Egypt and Mining Authority, 1994). No work has been done using remote sensing application in mapping of the different sedimentary units in the study area.

Remote sensing instruments measure reflected or emitted radiation in the visible, near-infrared, thermal infrared, or microwave portion of the electromagnetic spectrum to obtain information about the earth’s surface from a distance. Satellite images have long been used as an effective exploration tool that can be used in the detection of associated hydrothermal minerals, associated structural elements and lithological mapping (Jensen, 2000; Drury, 2001; Gupta, 2003). The spectral resolutions of the new remote sensing data such as ETM+ can help in the differentiation of varieties of lithological units. Landsat data have been used previously in arid and semi-arid environments to locate areas of iron oxides and/or hydrous minerals (Abrams et al., 1983 and Tangestani and Moore, 2001). The arid and semi-arid types of environment are ideal for application of remote sensing data for lithological mapping due to poor vegetation cover.

In the present research a trail was made to use ETM+ and SRTM data for mapping and discrimination between pre- and syn-rift sedimentary units. It is believed that the understanding of these lithofacies changes on both sides of the tectonically active ridges will help in understanding the nature of sedimentation during active tectonic movements.