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FULL LENGTH ARTICLE

Study of pertrographical and electrical properties of some Jurassic carbonate rocks, north Sinai, Egypt

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Abstract The Jurassic sedimentary section in north Sinai is of a special interest in particular for its economic potentiality. The understanding of petrographical and electrical properties of these rocks is essential for investigating minerals and oil and water exploration. This paper presents a study of the petrographical and A. C. electrical properties of Jurassic carbonates. Electrical measurements have been conducted for twenty-nine (18) carbonate samples. The slight changes between samples in electrical properties were attributed to the changes in mineral composition, texture pore spaces and pore throat distribution of the samples. Electrical properties generally change with many factors (grain size, mineral composition, grain shape and facies). The dielectric constant decreases with frequency and increases with the presence of conductive solids (silt and clay) and its composition. The conductivity increases with the increase of conductor paths between electrodes. The main goal of this paper is to shed more light on interrelations between electrical properties (conductivity, dielectric constant and impedance as a function of frequency), petrography and mineral composition (carbonates that contain clays and quartz grains).

1. Introduction and geologic setting

The Sinai Peninsula lies at the north east of Egypt (Fig. 1). North Sinai is considered as a shallow shelf area with low relief during the Jurassic period. The complete section of Jurassic rocks is exposed at the Gebel El-Maghara area (Fig. 1), between longitudes 33° 18′–33° 27′ E. and latitudes 30° 38′–30° 44′ N [1,20]. Carbonate rocks were studied by many authors e.g. [7,26], while Jurassic rocks were studied by many authors e.g. [5,6,9,10,23].

El-Far, [11] subdivided the strata below the El-Maghara area into six alternative continental and marine formations having a total thickness of about 1900 m., these formations are arranged from top to bottom as: Masajid Fm., Safa Fm., Bir Maghara Fm., Shusha Fm., Rajabia Fm., and Mashaba Fm. The dominant rocks are limestones and dolomites. The following items are related to carbonates: Marl (about 50% carbonate and about 50% clay), argillaceous limestone, calcite, calcite cement, dolomites, dolostone, sparite cement, foraminifera skeletons, forams, foraminifera, fossils, limestones, micrite, microsparites, microsparry calcite, moldic, sandy limestone, shell fragments, and sparite, (Fig. 2).

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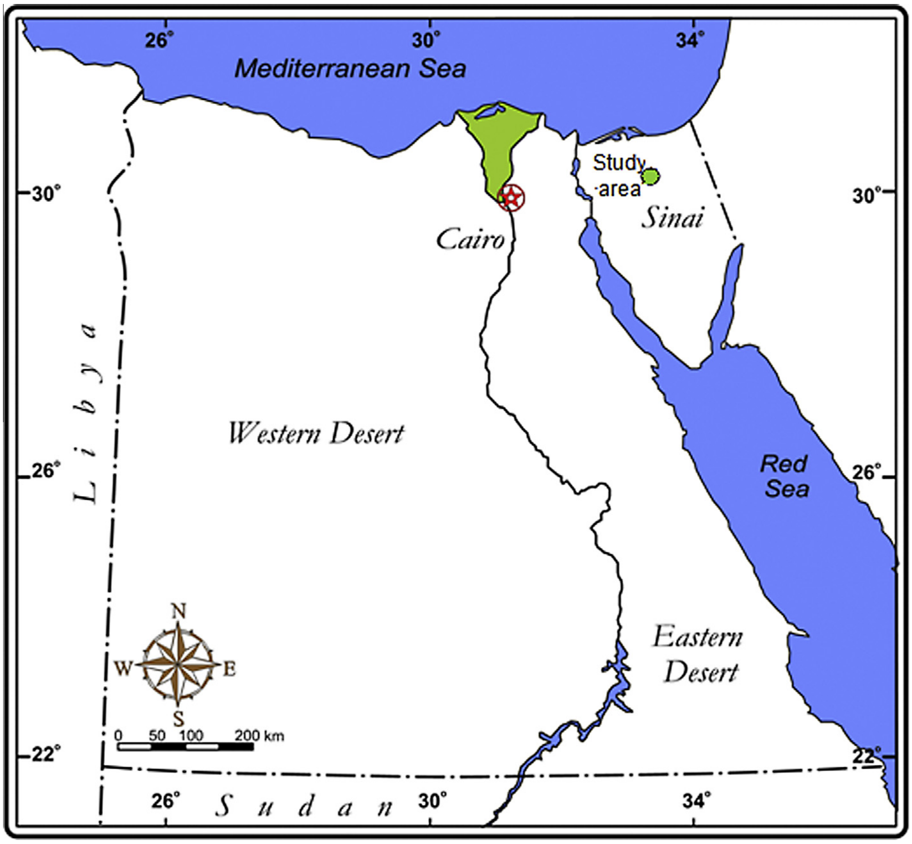

Figure 1 Location map of the studied area.

We will discuss here only the upper three formations:

1- Bir Maghara formation
   It is exposed at Bir Maghara and Bir Moweribe areas (thickness ~444 m) and divided into three members, [11]:
   a. Mahl Member (94 m) consists mainly of limestones, claystones and sandstones.
   b. Bir Member (134 m) consists of clays with some limestone interbeds.
   c. Moweribe Member (134 m) is formed of limestone with varicolored calcareous shales and sandstones.

2- Safa formation
   It is exposed between Wadi Safa and Wadi Samer and is composed of sandstones, clayey sandstones with some limestones and claystones interbedded (thickness ~215 m). Some coal bearing facies is recorded near the base of the Safa formation.
3- Masajid formation
   It is outcropped at Gebel Arousiat, near the Rokba area and the remaining section outcropped at Wadi Safa on the north flank (thickness ~576 m). It is divided into two members:
   a. Keheilia Member: it is composed of limestones, marls with some interbeds of shales (thickness ~133 m).
   b. Arousiah Member: it consists of a massive sequence of limestones with some sandstones and marl intercalations (thickness ~443 m).

In the following parts a discussion takes place on the different relations between electrical properties, petrography and mineral composition. The minor elements of the samples will be divided into conductor or insulator elements from the electrical point of view.

2. Methodology

2.1. Petrographical investigation

Petrography and mineralogy of the studied carbonate samples were examined using a polarizing microscope. The description of carbonate rocks is based on the study of the present thin sections. The samples were impregnated using blue dye, and the blue dye was used to discriminate the different types of pore spaces, [8].

2.2. Petrophysical measurements

The samples were prepared for petrophysical measurements as core plugs of 1 inch in diameter and 1 cm in thickness. The selected samples were cleaned using soxhlet extractor apparatus. The used organic solvents for cleaning samples were toluene and methanol. Toluene was used to remove any residual hydrocarbons (that may be present in pores) and methanol was used to remove water and residual salts. Finally, plugs were placed in an oven at 90 °C. The samples were dried until their weights were constant.