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Structure of the southern Senegalo–Mauritanian basin, West Africa, from geoelectrical studies

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Abstract

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The southern part of the Senegalo–Mauritanian basin is geologically featureless, and little is known about the division of the sedimentary sequence and regional geological structure because of the scarcity of deep drillholes. A magnetotelluric survey was, therefore, carried out in an attempt to obtain details concerning the electrical characteristics, thickness and structure of the Mesozoic–Cainozoic Senegalo–Mauritanian basin. From the surface down, the interpretation of magnetotelluric data shows several distinct electrical boundaries. The general trend shows a decrease in near-surface resistivity from east to west. The basin is characterized by water-saturated, unconsolidated, low-resistivity sediments, with a westward-sloping monoclinal style.

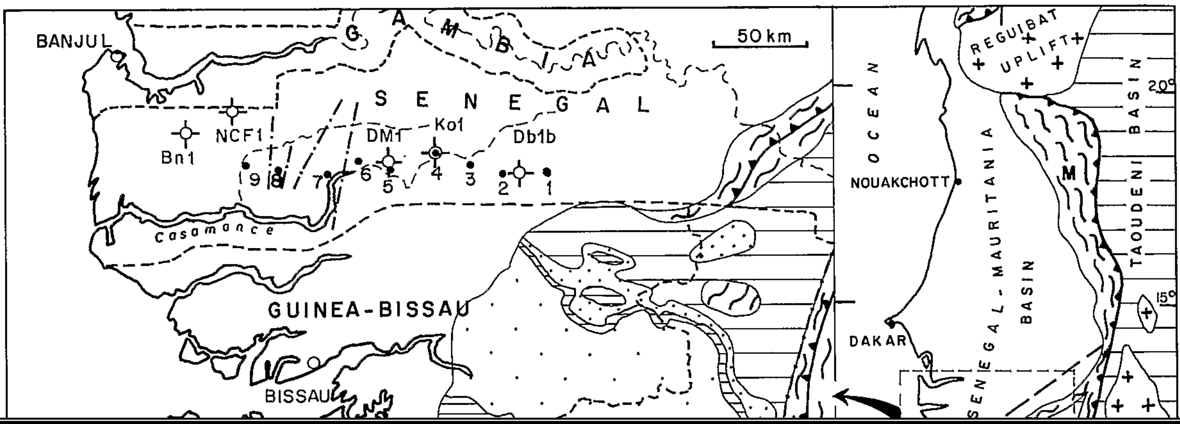
The combination of borehole and geological data with a geoelectrical cross-section provides a simplified model of the geological–electrical units of the basin. This shows the distribution of strata above and below the base of the Senonian. Conductive material (10–30 ohm m) at depth in the central part of the profile may represent a northern extension of the Palaeozoic sediments of the Bove sequence, which lies immediately south of the magnetotelluric line. Significant electrical contrasts between the sediments and basement rocks allow mapping of the top of the high-resistivity basement, which is characterized by progressively deeper burial to the west.

Introduction

The Senegalo–Mauritanian (S–M) coastal basin in western Africa is poorly known from its surface geology and little has been inferred about the structure from oil exploration studies. However, the major structural elements could be defined [redacted]

for the sediments (Ritz and Vassal, 1986). The aims of this paper are firstly to establish the electrical characteristics of the major units, and subsequently to translate the resistivity structure into geological terms with the aid of borehole data.

The MT section cuts across the Casamance [redacted]


BANJUL
GAMBIA
SENEGAL
50 km
NCF1
Bn1
DM1
Ko1
Db1b
9
8
7
6
5
4
3
2
1
Casamance
GUINEA-BISSAU
BISSAU
OCEAN
NOUAKCHOTT
DAKAR
REGUIBAT UPLIFT
SENEGAL - MAURITANIA BASIN
TAOUDENI BASIN
M
20°
15°

mentary units in the survey region is characterized by N–S-trending linear faults due to basement block-faulting or basement flexure (Roussel and Liger, 1983; Bellion and Guiraud, 1984).

Magnetotelluric cross-section

In Fig. 2, a MT cross-section along the traverse across the Casamance region is presented. Three outstanding features are seen in the profile: (1) the sedimentary blanket dips to the west and the depth of the MT basement lies between about 250 m and 5000 m; (2) west of site 6, thick sediments are present, showing a region of extremely good conductivity (east of this site there is an increase in the resistivity with a strong gradient); and (3) the resistivity of the basement is about 100 to 1000 times higher than that of the layer above.

The bulk resistivity of rocks depends on several parameters. For the near-surface rocks, Keller (1971) indicated that the most important factors controlling bulk resistivity are degree of fluid saturation, conductivity of the saturating fluid, and porosity. The interdependence of these different factors, associated with the increase in temperature with depth, indicates that great care is required in any geological interpretation of resistivity structures. However, in completely saturated

hole studies were used to guide the geological interpretation.

Correlation of resistivity structure with geology

The complexity of the structure in the Casamance region is indicated by significant lateral changes in resistivity, and large uniform layers appear to be rare (Fig. 2). There is a significant change in the character of the resistivity profile from east to west. For example, there is no indication west of site 6 for a layer at depth with values exceeding 10 ohm m. Nevertheless, some continuity can be detected west of site 6, with a highly conductive zone in the resistivity range 0.6–3 ohm m occurring at depths of 1500–4500 m. The resistivity cross-section of Fig. 2 depicts four important layers in the electrical stratigraphy, with a general decrease of resistivity from east to west.

On the basis of borehole data, the uppermost zone corresponds to the post-Turonian formations (i.e. from the basal Senonian base to the present). The resistivity of these formations is low, especially in the western part of the basin. From site 1 to site 6 on the east portion of the profile, the uppermost zone has an electrical resistivity of about 50 ohm m and a thickness of 250–500 m. In this area the water table, which is taken to mark water-saturated state of the sediments. This zone is bordered by a zone of very low resistivity (below 1 ohm m) west of site 6. Saline ground water may cause lower resistivity than expected. The Casamance river (close to the MT line) is saline up to 125–150 km inland (Pages and Debenay, 1986). Owing to high permeability, sea water infiltrates [illegible]

ties, where conductive pre-Senonian sandstones and clays with resistivities as low as 2–4 ohm m were encountered at a depth of about 1800 m.

An important discovery is the relatively conductive layer extending from site 2 to site 7 with resistivity varying progressively from about 30 to 10 ohm m from east to west. Below the surface [illegible] basin, but they are only known west of 16°30′W, and Triassic sediments have not been reported in the onshore coastal basin. The high-resistivity layer (> 1000 ohm m) that was detected on all the soundings is believed to represent the metamorphic/granitic basement. From east to west, the top of the assumed basement slopes abruptly below the Palaeozoic Bove basin. The depth to basement increases gradually at first, but then rapidly, to reach a maximum depth of 4500 m into the Mesozoic–Cainozoic S–M basin.

northward extension of Bove basin rocks, and the depth of the basement.

By combining this information and the limited well data with regional geological data, a geological model of the southern part of the S–M basin has been developed (Fig. 3). This shows that the S–M basin is a westward-sloping, open homocline in which the structure is controlled by basement flexures and faults with a more or less staircase profile. The sedimentary section is composed mainly of sandstones and siltstones, which are more argillaceous westwards, with minor intercathought have been a hinge zone separating stable basement to the east from a rapidly subsiding crustal segment to the west.

Sediments of the Palaeozoic Bove basin sequence appear progressively westwards beneath the Mesozoic–Cainozoic S–M basin sequence. The broad geological structure of the Bove basin in this region appears to be controlled by the Bis-

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