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Delineation of Electrical Structure Beneath Saurashtra Peninsula using MT Studies

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ABSTRACT : Magnetotelluric field investigations were carried out at more than 600 stations in a gridded fashion covering the Saurashtra peninsula. The region is covered with Deccan traps with exposed sediments towards north-east of the region. It is conjectured that the sediments might be present below the trap cover and from paleo-channel study, its thickness may be increasing towards south. The MT data successfully delineated the subtrappean Mesozoic sediments. A major sedimentary basin is delineated in the NW part of the Saurashtra peninsula basin whose thickness varies from few hundred meters to as thick as 2-2.5 km. Structural features like faults/fractures are also delineated along Amreli-Chotila line.

INTRODUCTION

Detection and mapping of subtrappean Mesozoic sediments in the Deccan trap covered areas such as Saurashtra, Deccan syneclise, etc., has been a long standing geophysical problem in Oil exploration in India. Magnetotelluric (MT) method, which aims at determining the subsurface electrical structure over a large depth range, is considered to be one of the most effective exploration techniques particularly in investigating subsurface sediments in volcanic covered areas. This is because the target layer that is the buried sedimentary layer, in general, has a marked resistivity contrast with the underlined basement.

METHODOLOGY

MT method aims at determining the subsurface electrical conductivity of the earth utilizing the natural electromagnetic signals of extra terrestrial horizon these signals refer to as "Magnetic pulsations", are generated through the interaction of the solar wind with the earth's magnetosphere and of the magnetosphere with the ionosphere. Frequencies of the pulsations can range from 5 Hertz to several milli Hertz. For the thunder storm activity in the earth's ionosphere generates natural electromagnetic signals in the higher frequency range, i.e., the audio frequency band, extending upto a few tens of kilo Hertz. Thus we have signals of natural electromagnetic field covering a wide band of frequencies ranging from a few thousands of seconds (milli Hertz) to a few killo Hertz and these constitute the source field signals for the MT measurements.

A total of 607 MT soundings were carried out to detect with wide band digital MT data acquisition system to delineate subtrappean Mesozoic sedimentary tracts in Saurashtra peninsula (Fig.1). These field studies cover a major part of western and northern parts of Saurashtra with a station interval of 3-5 km. and eastern and southern parts with 7-10 km. The results have been interpreted both by 1-D and 2-D modelling inversion schemes.

Besides interpreting the data to derive subsurface geoelectric sections along select traverses, contour maps for Deccan trap thickness, sediment thickness, total conductance and basement configuration (Fig.2) for the Saurashtra peninsula have been prepared.

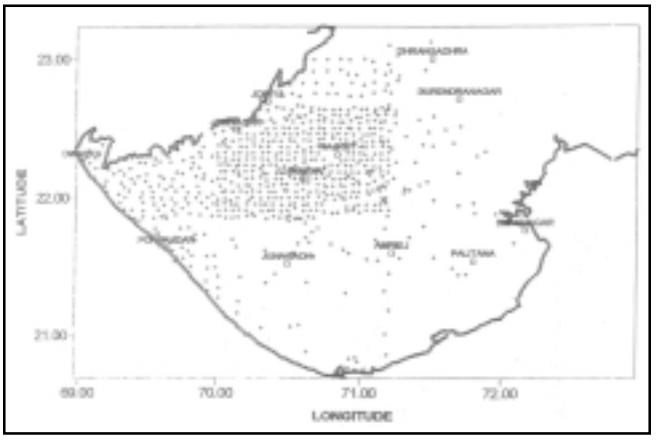

Figure 1 : Locarion of MT sites occupied during 1988-90 and 1994-97

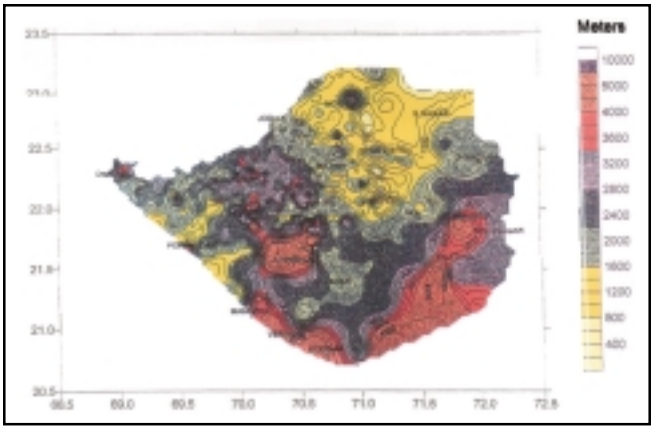

Figure 2 : Basement depth from magnetotellurics Saurashtra region

CONCLUSION

Based on the MT studies significant results have been emerged and some of them are,

i) The thickness of the vast Deccan Trap has been delineated in Saurashtra peninsula. Near and around the exposure of Mesozoics, the traps are either thin or no Deccan Trap cover, indicating a gradual variation. Its thickness increases in all directions from hundred meters to more than a kilometer over a major part of the peninsula. The thickness of traps is (1-2km) large towards the southern half of the peninsula and assumes larger values >3 km in the areas around the volcanic plugs.

ii) The subsurface geometry of the volcanic plugs at Girnar, Porbander, Alech, Palitana, Vallabhipur could be delineated effectively and are shown to have roots going down into deeper levels >10 km of the crust. The subsurface geometry of these volcanic sources derived from MT modeling is highly consistent with the modeling results of the gravity " highs" associated with these features.

iii) The northern half of the peninsula has greater thickness of Mesozoic sediments, while the southern half has less or insignificant amount of sediments. The line dividing these two regions could be demarcated.

iv) In the northern half itself, the sediment thickness increases from northeast to southwest, from a few hundred meters to about 1200-1300 m up to the line joining Jodiya- Rajkot, from where their thickness increases significantly further west up to Lalpur to about 2 to 3 km.

v) Kurunga – Latipur profile extending over a length of about 160 Km starts from Kurunga on the west coast of Saurashtra stretches in an approximately southwest – northeast direction up to Latipur on the northeastern side. A total of 22 MT Sites are located along this profile. A major part of the profile passes through the original MT grid area where the station spacing is nearly 5 Km . The geoelectric section based on the inversion is shown in Fig 3 .

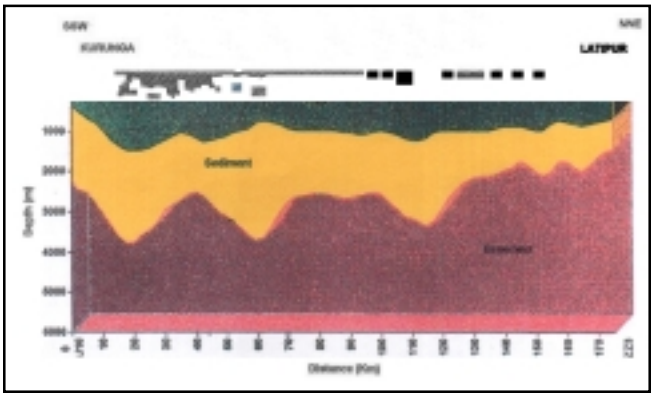

Figure 3: Subsurface section from magnetotellurics kuranga-Latipur traverse, Saurashtra

vi) In addition, the following structural features are also identified:

a) A near N-S trending fault/fracture passing through Amreli to Chotila, which might have also acted as a conduit for basaltic lava.

b) A near NW-SE trending fault passing through west of Lalpur which forms as the western boundary of the Jamnagar basin delinated from the present MT studies.

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