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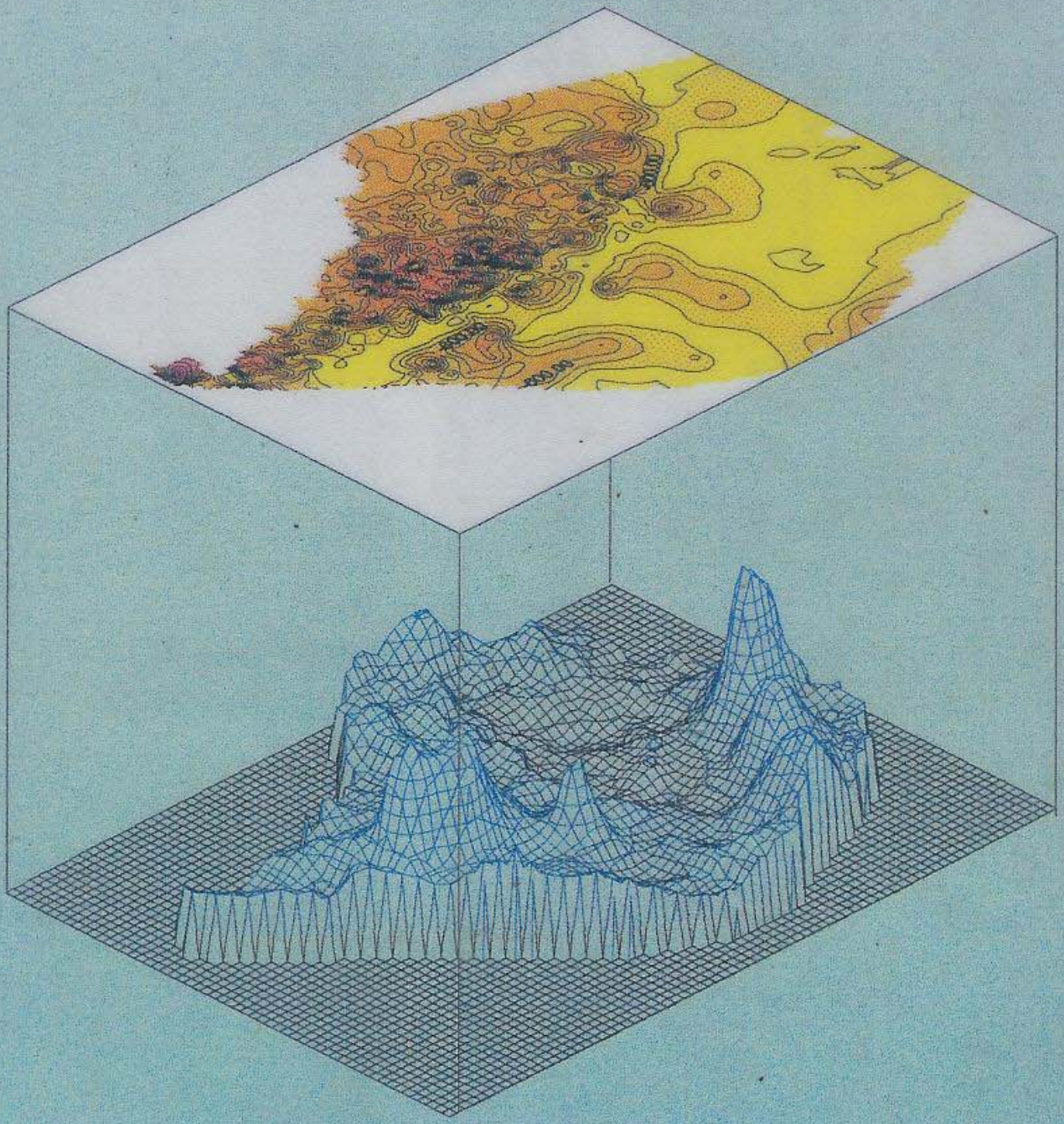

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CHAPTER - 9

SUMMARY AND CONCLUSIONS

In its recent efforts to identify and evaluate new areas for hydrocarbon prospects, the Oil & Natural Gas Commission selected Saurashtra as one of the important areas for detailed Geophysical investigations. The Saurashtra horst covered by a vast sheet of Deccan traps and surrounded by important mega tectonic features like the Kutch and Cambay rifts as also Surat depression, is believed to hold significant hydrocarbon potential because of the possible presence of thick Mesozoic sediments hidden underneath the traps. But detection and delineation of subtrappean sediments has been a long standing complex exploration problem facing the oil industry.

Against the background of past experience with the conventional geophysical exploration efforts carried out in Saurashtra and keeping in view of the challenges posed by the geological situation it has been decided to handle this complex problem using an integrated geophysical strategy involving deployment of a judicious combination of gravity, seismic, magnetotellurics and deep resistivity sounding methods. Accordingly the present project under the sponsorship of the Oil & Natural Gas Corporation Ltd. was formulated and the task of implementation was entrusted to the National Geophysical Research Institute. The successful completion of this project is yet another example for an active and fruitful interaction and cooperation between the R&D organizations and the Oil Industry towards accomplishing im portant national tasks.

Under the project programme, the following field studies were accomplished:
a total of 800 line- kilometers of controlled source seismics, distributed over five select traverses across the Saurashtra peninsula, a gravity coverage of 10,000 sites, MT sounding measurements at 600 sites, covering the western half of the peninsula and deep resistivity soundings measurements at 50 sites distributed over the entire peninsula. The field studies were initiated during November 1994 and with the completion of these

surveys during 1997 the Saurashtra peninsula has become one of the very few regions in the subcontinent to have a coverage by such a wide spectrum of geophysical methodologies. This has helped focussing on to the "target" for hydrocarbon exploration, namely, the subtrappean Mesozoic sediments.

Further the availability of this unique set of geophysical data bases has made it possible to gain significant insights into the subsurface geology and structure of Saurashtra peninsula through an integrated approach in the interpretation. To start with each data set has been processed and examined to identify anomalous zones and their intercomparison amongst independent data sets as a part of integration at the stage of qualitative interpretation itself. For example, the thickness of trap layer obtained from Magnetotelluric modeling results provided very valuable constraints in the modeling of gravity as well as seismic refraction data. Also the comparison of Bouguer gravity anomaly maps with the conductance map for the entire peninsula prepared from magnetotelluric data has been utilized to provide useful constraints in further interpretation. The disposition of anomalies in the residual gravity anomaly map has provided useful clues in the interpretation of electrical conductance map particularly along the coastal belt. The volcanic plugs have been brought out clearly in gravity in the form of well defined gravity 'highs' as also in the MT & DRS results. Subsurface geometry of these volcanic vents modeled from MT coupled with the models obtained from gravity would provide useful understanding of these subsurface features which must have acted as sources of basaltic lava in Saurashtra. While the basement depths from seismic modeling results provided useful constraints for modeling of gravity and electrical data along the CSS profiles, the MT-DRS joint inversion results have helped refining the seismic models for trap and sediment thicknesses. The integration of MT and gravity together with DRS helped infering the presence of several hidden volcanic plug/dyke like features underneath the sediments. The MT responses and the modeling results coupled with the identification of regions of high gravity gradients helped in delineating deep subsurface fault/fracture zones.

Based on the interpretation of modeling results from these investigations and using the integrated approach outlined above several results have emerged and some of the major ones are:

i) The subtrappean Mesozoic sediments in Saurashtra provide an impressive signature as a well defined conductive layer in MT and DRS responses, as a low velocity layer (LVL) producing definitive skips in the first arrival times of seismic refraction data and as well-defined short wave length "lows" in residual gravity.

ii) The northern half and in particular the north-western quadrant of the Saurashtra peninsula is shown to hold significant thickness of sediments excepting the region around Porbandar.

iii) the sediment thickness which amounts to a few hundred meters to a kilometer in the north-eastern Saurashtra increases towards the south-west reaching values more than 2.5 km in the region west of Rajkot and south of Jamnagar extending up to Lalpur.

iv) A major depression has been identified and delineated in the region south of Jamnagar and is named "Jamnagar basin". The Jamnagar basin appears to continue towards northwest into the Gulf of Kutch.

v) Another region of thick sediments is identified around Dwarka at the north-western corner of the peninsula and is referred to as Dwarka basin. This basin might continue towards north towards Kutch.

vi) The sediments in general tend to have significant thickness on on the northern coast of Saurashtra adjacent to Gulf of Kutch.

vii) A moderately deep basement depression between Porbandar and Mangrol on the west coast of Saurashtra is identified. This feature might continue into the offshore region.

viii) The sedimentary thickness decreases in the region south-west of Lalpur, abetting the eastern edge of the E-W trending volcanic vent delineated near Porbandar.

ix) The sediment thickness becomes thinner and negligible at several places in the southern half of the peninsula presumably because of the presence of several lava sources in the form of volcanic vents and fracture zones. However the sediments in the Jamnagar basin tend to continue towards south particularly as seen in the MT data, south of Lodhika towards Visavadar and beyond.

x) The thickness of Deccan trap cover in Saurashtra varies over a wide range. Essentially it may be divided into five broad categories - thin, moderate, thick, very thick and plugs/vents.

xi) The north-eastern part of the peninsula belongs to the first category with thin/no trap cover.

xii) A major part of the north-western quadrant, excepting the region around Porbandar area, belongs to the second category having a trap cover with moderate thickness ranging from several hundred meters to more than a kilometer.

xiii) A major part of the southern Saurashtra belongs to the third category which is overlain by thick trap cover with thicknesses ranging from 1.5 to 2 km.

xiv) There are areas belonging to the fourth category located around the volcanic plugs for example Junagadh, Porbandar, Alech, Palitana, Vallabhipur where the trap thickness is more than 3 km.

xv) The regions over the volcanic plugs themselves belong to the fifth category and are characterised by huge pile of subsurface basaltic material with thickness amounting to several kilometers going down into the crust.

A large portion of the southern peninsula and also a small portion of the western coast near Porbandar host a number of exposed volcanic plugs/vents which might have provided thick columns of lava covering these regions.

The major structural features identified are -

xvi) There exists possibility for presence of several hidden volcanic plugs/dyke like features and several of them have been identified. Some of these are near Jodiya, Jamjuna, Maliya along the northern boundary of Saurashtra and several smaller ones aligned along the zone from west of Amreli towards Morvi etc. These hidden volcanic sources are inferred to be closely related to the second trap layer observed in Saurashtra.

a) The Jamnagar basin appears to be bound by NW-SE trending faults passing west of Dhrol on the eastern side and west of Lalpur on the western side.

b) The NE-SW trending fault like feature on the northern coast of Saurashtra peninsula boardering the Rann of Kutch.

c) The north-south trending fault/fracture zone extending from the region west of Amreli towards Chotila.

d) The near east-west trending fault like feature extending from around Jamjodhpur to Jasdan.

e) The basement shows a downward dip towards west and also to some degree towards south, presumably reminiscent of the Saurashtra arch (?)

f) Along the northern margin of Saurashtra bordering the Gulf of Kutch, the basement depth increases with significant thickness of sediments. This is presumably an expression of down-faulting towards the Gulf of Kutch.

g) There exist several short wave length basement undulations in northern Saurashtra and in particular in the Jamnagar basin.

The availability of thick sediments in the Jamnagar basin as also the Dwarka region may be considered to be very significant from the viewpoint of further exploration for hydrocarbons. The decrease of sediment resistivities in these regions could be attributed to the possible marine influence in these regions.