TELLURIC AND MAGNETOTELLURIC FIELD STUDIES IN PARTS OF GEOTHERMAL AREAS OF PENINSULAR INDIA

Thesis Submitted to

The Department of Applied Geophysics,
Indian School of Mines, Dhanbad, (India)

For the Award of Ph.D. Degree

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1984

S Y N O P S I S

Telluric and magnetotelluric methods, though known for the last few decades elsewhere, in the world, have not found a place in geophysical activity in India until recently. Telluric method is well known to be a fast and effective technique for reconnaissance as well as detailed studies which aim at detecting lateral variations in the electrical resistivity of the subsurface medium. Magnetotelluric method, though complex, is relatively recent compared to the telluric method, and is now widely used for quantitative estimates of the subsurface electrical conductivity structure to depths of a few hundreds of kilometres. In view of their applicability in a wide spectrum of geological problems such as crustal studies, sedimentary basin studies, geothermics etc., the National Geophysical Research Institute has initiated a programme to introduce these methods for investigation of several problems in India, such as sedimentary basin studies, geothermal areas, mineral exploration studies, geoengineering problems, earthquake studies etc. The author under this programme has carried out various field investigations since 1978, covering the above problems. Based on a suggestion given by Dr. S.V.S. Sarma,

the author took-up the present study entitled "Telluric and Magnetotelluric field studies in parts of geothermal areas of Peninsular India".

The thesis deals with the results of telluric and magnetotelluric studies carried out to investigate the subsurface structure at two important geothermal areas in Peninsular India. These are Konkan geothermal province in Maharashtra on the West Coast of India, and Tatapani hot spring area in Surguja district, Madhya Pradesh. Besides these, the present study also includes development of software for processing of the data and theoretical analysis of telluric field response curves for different geological structures and the evaluation of effects of some topographic features on telluric field measurements.

During the field operations a total of fifty telluric field stations and five magnetotelluric field stations were occupied in the first study area namely the northern part of Konkan geothermal province during 1980 and 1983 in two field season programmes, and another thirty telluric field stations in the second area namely Tatapani hot spring area during 1981. All the data obtained during these field experiments were processed to get the relevant telluric and magnetotelluric field parameters. Necessary software for processing of these data has been developed and all these analysis has been carried out on Vax 11/500

computer at the National Geophysical Research Institute, Hyderabad. The telluric field data have been further subjected to quantitative modelling using the H-polarization programme of Jones and Pascoe (1971). Similarly an attempt has been made to analyse the MT data using 1-D inversion programme. The results of these analyses, have been discussed and interpreted in relation to the geological and geothermal conditions of the areas of investigation.

Under the theoretical studies various geometrical models such as dipping basement, inclined normal fault, anticline, syncline, sphere, horizontal cylinder etc., and the topographic models such as inclined surface and inclined horizontal surface are considered in order to obtain the theoretical telluric field response curves for these models. For the computation of the telluric field response curves, the conformal mapping techniques using Schwartz Christopher transformation coupled with Runga-Kutta method of numerical integration have been employed.

Sets of theoretical telluric field response curves are obtained for all those models which find a general use in interpretation of telluric field data. In order to evaluate the distortions introduced in telluric field measurements due to surface topographic features,

theoretical analysis of these effects for two topographic features viz. inclined surface and inclined horizontal surface have been carried out. Based on the analysis nomograms have been presented which facilitate an easy estimation of topographic effects on the telluric field measurements. The results of telluric and magnetotelluric field studies carried out in the present study have clearly established the utility and scope of application of these techniques for study of geothermal areasin peninsular India. These studies have brought to light several features of significance for understanding the subsurface structure of these geothermal areas. Thus the telluric field studies carried out in the Ganeshpuri-Kokenere area the Konkan geothermal province have brought to light the existence of a well defined telluric field anomaly extending from Sativili to areas beyond Kokenere in this region. It has been shown from these studies that the earlier simplified model based on the circulation of meteoric water through deep fractures in Deccan traps does not explain the observed telluric field anomaly. On the other hand the quantitative analysis of these data has clearly indicated the existence of a subsurface conductor at the base of Deccan traps. The conductor is interpreted as due to the possible presence of a thick column of sediments filled with hot water at the base of Deccan traps; besides this, the results have also indicated the

possibility for lateral spreading of hot waters in the Deccan traps. The evidence provided by the present studies for the presence of these conductive zones in this areas should open up a new phase of geophysical activity for further exploration and exploitation of this vast geothermal province.

Similar to the West Coast studies, telluric field investigations in the Tatapani hot spring area have delineated a well defined east-west trending narrow telluric field anamolous zone occupying the area in the vicinity of hot springs. The results of analysis of this anamoly have shown that there exist a shallow hot water acquifer zone in this area which are connected to a east-west trending fracture zone. These fractures are believed to be related to the tectonics of Narmada-Sone lineament.

The magnetotelluric field studies carried out in the Konkan coast area of Ganeshpuri-Kokenere, though on a limited scale have confirmed the existence of the major conductivity feature delineated from telluric field investigations. Besides this, the magnetotelluric results also show that Deccan traps lie over a high resistive basement and thus indicate the possibility for their effective use in delineating the structures in the region occupied by a vast cover of Deccan basalts in peninsular India.

From the studies of theoretical analysis of telluric field response curves over different geological models it has been found that gradients and second horizontal gradients of the field can be utilized for estimating the parameters of the structure. Based on this an interpretation scheme has been suggested in the case of inclined normal fault model. The distortion of telluric field measurements due to topography has been studied, considering two models and the nomograms have been prepared to correct the field, which also helps in planning the survey ahead to minimise such distortion due to the topographic features.

The details of these studies have been presented in seven chapters, which comprise this thesis. In Chapter-I a brief introduction on telluric and MT methods and relevance, scope of the present studies are given. Chapter-II describes the data acquisition procedures of telluric method and the details of instruments used in the present investigations. Chapter-III gives the theoretical basis of the telluric method and data reduction procedures. In Chapter-IV details regarding the theoretical analysis of telluric field response curves over different geometrical models and the effect of topography on telluric field measurements are presented. In Chapter-V, the details of telluric field investigations in northern part of

Konkan geothermal province, Maharashtra and Tatapani hot spring area, Madhya Pradesh are described. Chapter-VI gives briefly about the basic principles of MT method, processing of MT data and the details of field investigations carried out near west coast along with the results of analyais. In Chapter-VII are presented summary of the discussion of the results and conclusions drawn.

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