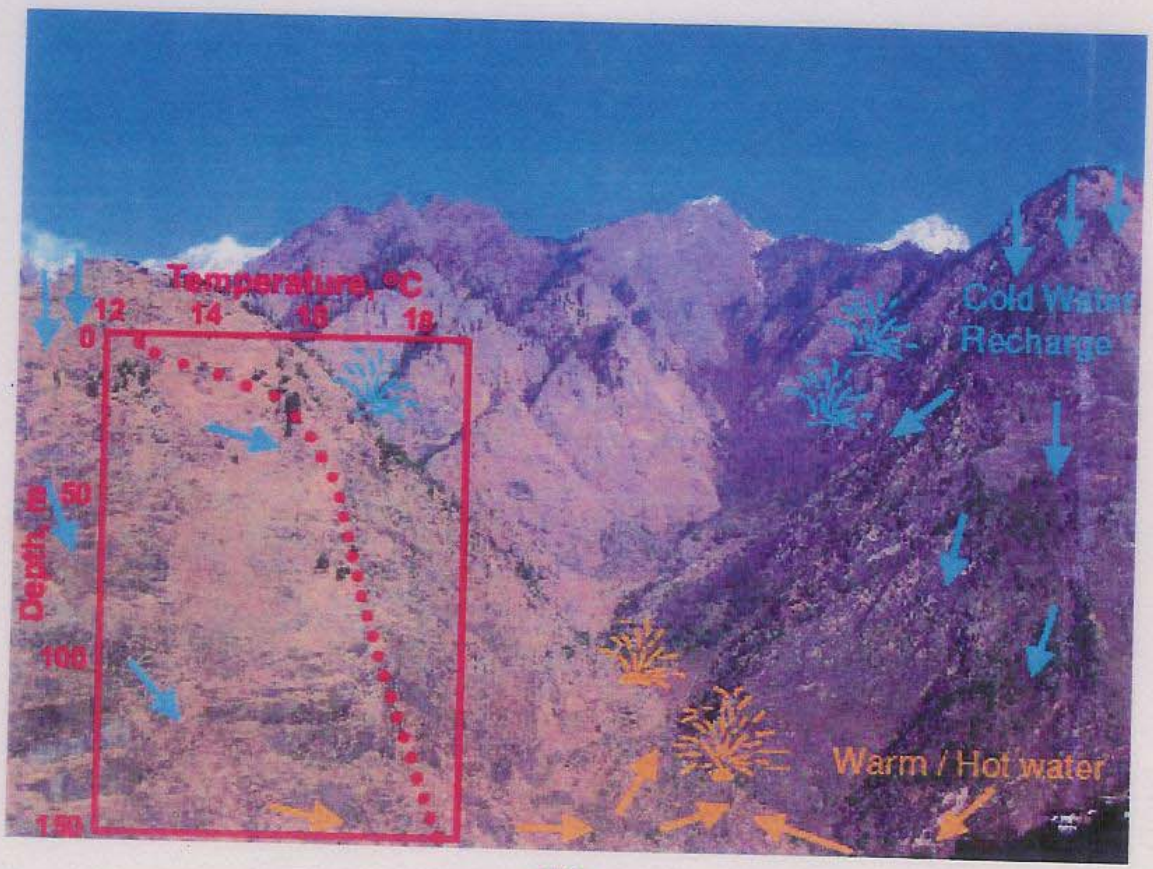
Magnetotelluric and Geothermal Investigations in Tapovan - Vishnugad Hydroelectric Power Project, Uttaranchal

Project Completion Report
submitted to

Water and Power Consultancy Services (India) Limited



Technical Report NGRI-2004-EXP-430

National Geophysical Research Institute
(Council of Scientific and Industrial Research)
Uppal Road, Hyderabad 500007, India

April 2005

Technical Report NGRI-2004-EXP-430

Magnetotelluric and Geothermal Investigations in Tapovan-Vishnugad Hydroelectric Power Project, Uttaranchal

Project Completion Report
submitted to

Water and Power Consultancy Services (India) Limited

National Geophysical Research Institute
(Council of Scientific and Industrial Research)
Uppal Road, Hyderabad 500 007, India

List of Participants

Magnetotelluric Studies

Dr. T. Harinarayana
Sri D.N. Murthy
Sri S. Prabhakar E. Rao
Ms. K. Sudha Rani
Sri T. Srinivasulu
Mr. K.K. Azeez
Sri M. Srinivas
Sri G. Virupakshi

Geothermal Studies

Dr. Sukanta Roy
Dr. Labani

Magnetotelluric and Geothermal Investigations in Tapovan-Vishnugad Hydroelectric Power Project, Uttaranchal

Abstract

In connection with the construction of a tunnel connecting the two rivers Dhauli Ganga and Alaknanda, as part of the Tapovan-Vishnugad hydropower project (Uttaranchal) taken up by the WAPCOS/NTPC, the Magnetotelluric and Geothermal groups of National Geophysical Research Institute (NGRI) have carried out investigations to assess the possibility of geothermal interference during the construction work. In the vicinity of the proposed tunnel alignment, a number of hot springs are reported to occur. The surface water temperature of the hot springs is about 65 °C. Geological Survey of India has drilled three boreholes AGW-2, AGW-3, AGW-5 in this region. The maximum depth drilled in the region is 430 m and bottom hole temperature is nearly 80 °C.

In view of the location of the proposed tunnel area near the hot springs, the possible geothermal interference from these hot springs need to be assessed. Magnetotelluric and geothermal studies have been taken up to map the geoelectrical structure and subsurface temperature regime through direct measurements of temperature in shallow drill holes and thermal conductivity of rock samples. The results obtained from these studies are presented in three parts. Part-I contains the results of magnetotelluric investigations and Part-II consists of the geothermal logging results. Summary and conclusions along with recommendations are provided in Part-III.

MT measurements have been made at 25 locations near the hot springs, close to the tunnel alignment and away from them. Based on 1-D and 2-D modelling results, the subsurface resistivity structure has been estimated up to a

mentioned data and considerations, subsurface temperatures up to the tunnel invert have been estimated at 1 km – intervals along the proposed tunnel alignment, starting from the barrage site. The temperature computations are largely a function of overburden thickness -- highest temperatures (40-45° C) expected in the segment between 3 km and 10 km, in which overburden thicknesses are large (up to and exceeding ~1 km). In the initial stretch of ~3 km and the final stretch of ~2 km, temperatures are much lower, in the range 15° C to 40° C. At the barrage site and surge shaft site, temperatures in the range 13° C to 24° C at the tunnel invert have been directly measured in boreholes. However, these estimates need to be verified on the basis of direct information on temperature gradient from boreholes in the intermediate segment of the proposed tunnel. (vi) Over segments of cold water influx (e.g., fracture / seepage zones, etc.), such as those inferred from the nature of temperature-depth profiles in boreholes as well as from interpretation of magnetotelluric sounding data, departures from a purely conductive heat transfer in the top 1-2 km could result in lower than estimated subsurface temperatures. Such scenarios are quite likely in view of the rugged relief existing over most part of the tunnel segment.

On the basis of these investigations, it is recommended to carry out temperature measurements up to a depth of ~500 m by drilling one borehole each in zone B and zone D (as delineated by MT data), which would help refine the models derived in the present study. Further, it is also recommended to measure temperatures along the tunnel level by drilling shallow horizontal holes as excavation is in progress. Such measurements would provide direct information about any potential high temperature zones / minor zones of hot water influx, and enable improvising suitable engineering strategies during the excavation stage itself.