GEOTHERMAL ASSESSMENT OF TAPOVAN, LOHARINAG PALA AND BADRINATH HOT SPRING ZONES FOR GEO-ENGINEERING PROBLEMS, HIGHER HIMALAYAN REGION, UTTARAKHAND, INDIA.

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ABSTRACT

Many major geoengineering structures are planned in Himalayan region in recent years. Constructions of dams, tunnels are used for generating hydropower and also channelize the rivers for water management. It is important to map the sub-surface before such major constructions. Himalayan region with major faults, thrust zones is known to be a major geothermal province. Geothermal provinces are prominent with high heat flow in a few regions of India. Among these, Himalayan belt region is most important and has drawn the attention of earth scientists. Hot springs have been reported at about 60 locations in the Himalayan region. The most prominent among these are in Puga, Manikaran, Badrinath, Tapovan –Vishnugad, Kullu etc., hot springs located near Puga are most promising from geothermal energy point of view. Apart from Puga, Tapovan–Vishnugad Kullu-Manali, Badrinath areas are also important as these are situated near tectonically active region. Main Central Thrust (MCT) zone in NW Himalayas is considered to be a tectonic margin and is located close to the above regions.

In spite of several geological, and hydro geological and shallow borehole investigations carried out in these regions, investigations for deep subsurface are critical to know the structure that can be related to geothermal field. Magnetotellurics can provide deep subsurface structure that can explain geothermal origin. Magnetotellurics and deep seismic soundings (DSS) are the well-known methods to delineate deep structure upto a few tens of kilometers. Magnetotellurics is more portable compared to DSS. Tapovan Vishnugad, Loharinag-Pala, Badrinath region, the present study areas, covering Dhauliganga, Alakananda, Badrinath river valleys are located at high altitudes of 2000- 4000 m and pose many logistic problems for carrying out geophysical investigations. Magnetotellurics (MT) can be applied in remote locations. It uses natural electromagnetic signals as its source (10^4 to 10^{-4}Hz) and can be applied with ease in logically difficult areas also.

Apart from the advantage of its portability in difficult environments, it is known that electrical conductivity of different rock types in the earth show a large variation from about 10^6 to 10^{-1} mhos-m. This makes the magnetotellurics method more advantageous for studying various geological situations connected with minerals, oil, water resources and geothermal exploration. It is proved to be the effective geophysical technique and has merits In its probing deeper levels of subsurface with the measurements made on the surface. The method utilizes the source field originates from interaction of magnetosphere with ionosphere. It can be considered as a linear system with magnetic field variation as input and induced electric field as the output. The source field signal ranges from a few 1000Hz to a few thousand seconds. The audio-magnetotelluric (AMT) part of the frequency of the signal ranging from a few KHz to 1Hz and are due to the world wide thunder storm activity. These naturally originating signals cover a wide range and can probe the earth's interior from as shallow as a few tens of meters to more than even one hundred kilometers.

The technique plays an important role in detecting the anomalously high conductive zones and can probe the earth to large depths using low frequencies. High frequency signals are used in evaluation of shallow structures, where as the lower frequencies to delineate deeper structures. As most of the geothermal regions are known to be associated with anomalously high conductive regions, MT can be applied to the present study region. Many geothermal regions around the world, for example, Rio grade rift in USA. Ceroprieto in mexico (Gamble et al., 1978, 1982) have been explored using this technique. In most of the investigations, the manifestations are high conducting anomalies reflecting geothermal regions. Even in other geological situations like active tectonic regions, rift zones, thrust zones and buried valleys also reflect high conducting anomalous zones.

The rocks exposed in the study area comprise of quartizite with occasional schistose bands, a thick sequence of gneiss, schists, migmatites and a large thickness of phyllites. Limestone and quartzite with schistose bands have been reported to be traced from

Alakananda and Dhauli Ganga river valleys. All these formation belong to Pandukeshwar formation. The sedimentary sequence overlying the Rorang chatti formation belongs to the Martoli and Ralam. These are intruded by sills of amphibolite. Granite is present in the catchment area but has not been located in the geothermal manifestitation area (Valdiya 1980). High grade metamorphic rocks are exposed in Bagirathi river valley area.

OBJECTIVES:

Accordingly, the objectives of the present study are:

1. To derive the deep subsurface characteristics of the Tapovan-Vishnugad, Loharinagpala and Badrinath hot springs areas.
2. To delineate and estimate of the dimensions of the geothermal source.
3. To Study the magnetotelluric responses for typical geoengineering structures.
4. To Study the topographic effects on the data.
5. To correlate the derived conductivity structure with available results.