Future geothermal survey – Study in Mongolia

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Abstract

The rural population of Mongolia is living sparsely, as in Iceland. Therefore Icelandic experiences could provide a suitable example for direct geothermal utilization to the rural consumers in Mongolia. The Shivert hot spring area is an appropriate site for direct geothermal utilization. Preliminary scientific studies have been carried out there. The Shivert area is located 20 miles northeast of the province centre of Arkhangai. The surface temperature of manifestations is 55°C and the flow rate is 4 l/s. Five geothermal prospecting boreholes were drilled there by Mongolian and Russian scientists in 1980. The preliminary study shows that the hot water temperature is higher than 70°C at a depth of 80 to 100 m. This represents a good potential for building a new and modern tourist centre in the Shivert area.

Keywords: *Shivert hot spring, geothermal heating, hydrogeology, geology.*

1 Introduction

The results of collective exploration work carried out in 1980 only permits general evaluation and do not suffice for a detailed, hydrogeological, balneological and thermal energy evaluation of the area. Figure 1 shows the Shivert hot spring location (number 24) in Mongolia.

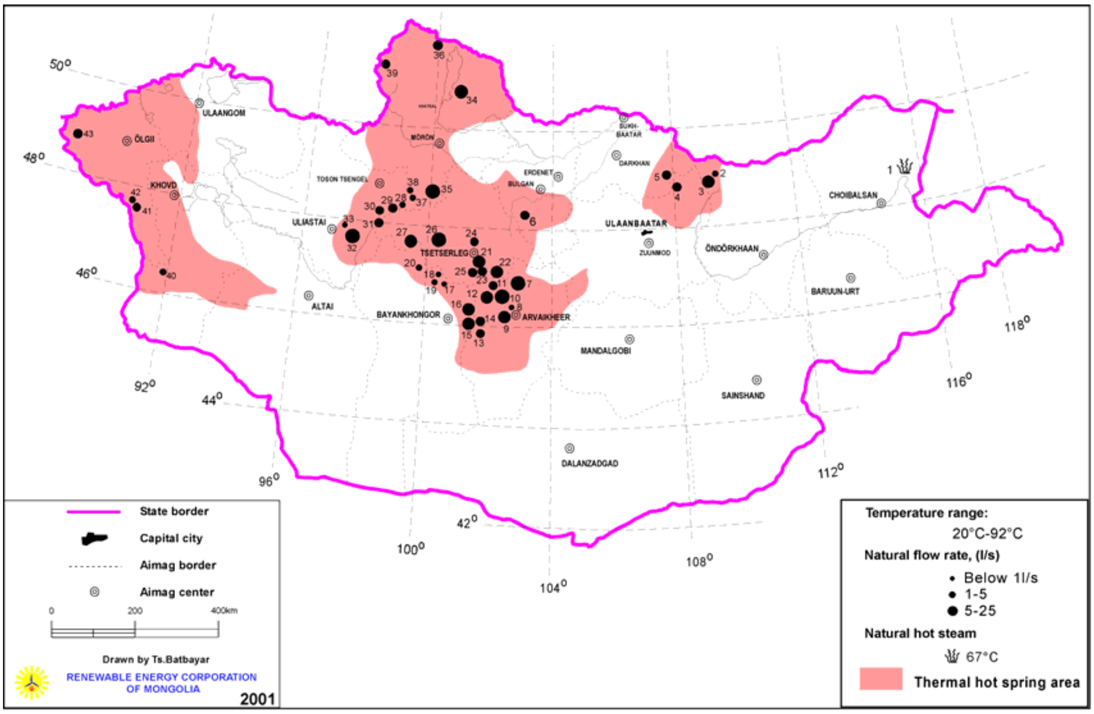

Figure 1: Hot springs of Mongolia.

Collection of data to give us a real and detailed picture of the hydrogeological parameters of the Shivert area, needs to include a detailed study of geological structural and hydrogeological conditions. The following are recommended as a minimum for further complex geological exploration work:

1. Mapping of hydrogeological observations in the deposit area;
2. Ground surface geophysical explorations by vertical electric sounding, which makes it possible to determine the level of underground water and its minerals, fracture and fault zones, and drilling points;
3. Drilling of 80-100 m deep borehole in selected fracture zones, which will bring to the surface water with temperature higher than 70°C;
4. Optimal hydrogeological works;
5. Laboratory work to yield complete geochemical and balneological analyses.

2 Information on geological and hydrogeological conditions of the Shivert hot spring area

A geological profile of the Shivert geothermal aquifer zone is presented as Paleozoic and fourth age sedimentation. Moreover, in this area there was a marked presence of two lithologic-structural tectonic layers. The bottom layer is presented as Paleozoic, once intensively stationed pink granites. The upper layer is presented as fourth age unico-ordinately continentally, terrigenous and calmly lying deposit layer on the Paleozoic base, which has typical sharp facial inconstant character. Thickness of fourth aged lithologic-structural layers varies between 25 and 40 m in depth (REC Fund 1989).

2.1 Stratigraphy and lithography

The Paleozoic group (P_Z): In describing the area's profile, the Paleozoic group formation is the older one. In the deposit area this layer lies everywhere at a depth of 24-50 m, and in the lithographic view they are introduced as pink granites. It is moreover observed as intensively fissured in the zone of core weathering. A minimum of three disjunctive submeridional stretch disturbances were also mentioned in the area, the last one forming a graben structure (see Figure 2). In the whole area the Palaeozoic layer is covered by sedimentary rocks of continental fascia.

The fourth system (Q): The fourth aged sedimentation is spread over the whole study area and mainly presented in three genetic types:

- **Lake type ($Q_{III\text{-}IV}$)** - forming the central part of cross section and lying at a depth of 10-20 m. In the lithography it is presented in green grey clays, thin and fine green grey and middle fine gray sand with clay fraction admixture and small capacity (until 0.5 m) seam clay. Total thickness of sedimentation is no more than 10 m;
- **Alluvial type (a. $Q_{III\text{-}IV}$)** - in a vertical cross section of the fourth aged sedimentation are observed two alluvial beds - bottom bed at a depth of 20-28 m, and an upper bed at a depth of 2-19 m. Both beds consisting of boulder-gallechnicovs and gravely-gallechnicovs sedimentation with sandy dark brown filler. The thickness of the beds is 7-9 m each.
- **Modern sedimentation (Q_{IV}^4)** – is presented by two genetic types:
    - **Alluvial (dQ^4_{IV})** - locally spread in the bed of the Shivert River, consisting of non-sorted sand and gravely-galechicov sandy filler. Thickness of sedimentation is 2-3 m.

- **Preluvialy-diluvial (dQ^4_{IV})** - is wide spread, and it is presented as a yellow grey sandy loam. Thickness of this sedimentation is varying between 2.5 and 5.0 m.

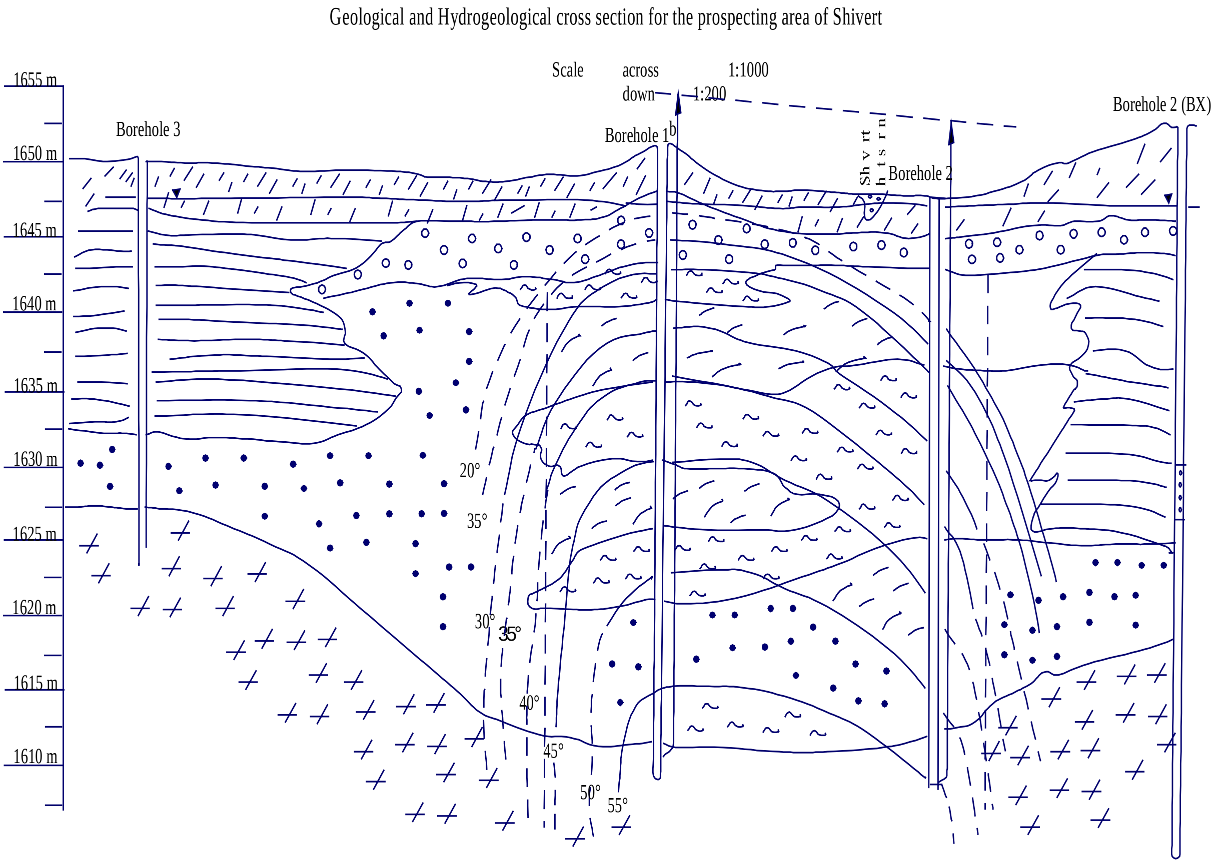

Figure 2: Geological and hydrogeological cross section of the prospecting area of Shivert.

2.2 Hydrogeological condition

In view of the hydrogeological conditions, the observed area represents difficult systems of artesian basins, with inter-mountain hollows. Underground water formed and accumulated in the crusts of a weathering zone, but also in the porous collectors of the sedimentation cover. Water is also collected in fracture zones and especially in the junction centres of differently oriented disjunctive distortions. It should be noted that the deposit area has extremely specific hydro-geological conditions, where the main defining role is played by the fissure-vein for water in fractures (REC Fund 1989) in the formation of hydrogeological, geothermal, and hydro chemical condition.

Palaeozoic group fissure-vein water (Pz): Within the deposit area 3 disjunctive distortions are selected with fissure vein thermal (30-57°C) nitric, mainly hydrocarbon-sulphuric sodium water with mineralization of 0.35-0.36 grams per litre. Water has an ascending character and discharges in fourth age cover, forming in the cover dome of scatter. Fracture zones play the role of “donors” of geothermal water, and upper lying permeable beds play “recipients” role.

A water bearing complex of fourth sedimentation (Q_{IV}): This is a water-bearing sedimentation complex represented in sand and gravel – galechnicovs sedimentation. In the study area under water of fourth age water bearing complex it contains only hydrocarbon-sulphuric sodium with mineralization 0.39-0.45 grams per litre. At a 25-30 m depth the temperature reaches 12-14°C, but at the same time the recorded water temperature is 49°C (see Figure 2) in the geothermal water dome area (borehole number 1[a]) at a depth of 19 m. The well discharge varies from 0.8 to 4.7 liters per second.

Analysis of the above geological structure and hydrogeological conditions makes it possible to come to a conclusion about conditions of the thermal water formation in the Shivert area. Obviously, the main source rock is Palaeozoic granites, with water injected in the cover of fourth aged sedimentation, where there is a specific hydrogeological structure in the form of hydro injection dome of thermal mineral water.

At the centre of the dome in the region of boreholes number 1[b] and 2, the chemical contents of the water correspond to the underground fissure-vein water of Palaeozoic granites. But on the flanks of the region, boreholes number 3, 2, 4 and 5, the water contains the same chemical contents but with a low temperature and high mineralization. The reason for the high mineralization is the inflow underground water from the outside.

In conclusion we could say that there is some prospect and possibility to procure and utilize the thermal mineral water in the Shivert area. Analysis of the conditions of the geological structure makes it possible for us to make a confident forecast for obtaining thermal water with higher temperature.

3 Opportunity of geothermally heated tourist centre in the Shivert

The Shivert hot spring area is the best location and has a bright future as a tourist centre development. The Government decided to build a new road, which will interconnect central and western Mongolia. This road construction is named the “Millennium Road”. Shivert is located only 5 miles southeast from the new road.

The Shivert sanatorium was established in 1967. Most of the buildings were connected to the Central Energy System network, but none of them is in use any longer. There is also a winter building in the sanatorium with a capacity of 150 beds, and a 300-bed summer building. The operation of the sanatorium has ceased due to financial difficulties, but one building is ,however, still in use for veterans (Geodesy and Geographic Authority 1990).

Shivert is also one of the main tourist destinations in Western Mongolia. A tourist centre with geothermal water heating system could operate there all year around. A winter operated tourist centre is really necessary and suitable for Mongolian tourism.

3.1 Floor heating

In the *floor heating system* steel pipes were mostly used before, but now only plastic pipes with high heat endurance are used. Much progress has been made in the production of plastic pipes with high heat tolerance and they will most likely cost less in the future in comparison with other pipe types. These pipes are laid 150-450 mm apart, depending on the size of surface to be heated and the diameter of the pipe used. A least distance from the floor surface to the pipe surface should be 40 mm. Designs have become better and there is much interest in utilizing 40-60°C hot water for heating (VEO, 2000).

The 40 m deep exploration borehole 1[b] could give an output flow rate of 15 l/s by gravity flow at temperatures higher than the 57°C water in the surface manifestation. At this temperature it is possible to use *floor heating system* in the building.

4 Conclusion

Geothermal hot water is suitable for house heating in our extreme climate. Hot water of boreholes number 1[b], 2 and 4 could be used to heat the buildings of the Tourist Centre during winter. Drilling of 80-100 m deep boreholes in selected fracture zones could bring to the surface hot water with temperature higher than 70°C. After drilling of these wells more buildings can be connected to the geothermal hot water heating system.

Acknowledgements

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5 References

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