

# Study on the geothermal model of Gonghe-Guide region, Qinghai, China

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**Abstract**—The Gonghe basin in north-eastern Qinghai-Tibetan plateau of China is a potential geothermal field, where there have been some hot springs discovered in recent years. The seismic and magnetotelluric sounding (MT) inversion results in this area show that there are deep crustal fractures which might be channels of the heat production. However, as for the heat source distribution of the region, it is complex. First, it can exclude the granite through the ratio of heat generation testing. Second, the depths of Moho, Curies surface and the epicentral distribution of earthquake show that there is a stable structure in the study area. The substance of this stable structure might come from the southeast part of the Qinghai-Tibetan plateau. Last, the geothermal model is given. It contains the stable structure and the direction of the mantle substance flowing. The model would be helpful for the next geothermal explorations or geophysical work.

**Keywords**—gonghe-guide geothermal field; geothermal resource; geophysics; geothermal model

## I. INTRODUCTION

The Qinghai-Tibetan plateau is an important geothermal field in China. Gonghe-Guide region is on the northeast part of it, and there are many high temperature springs and geothermal wells discovered in this area (Fig.1). The geothermal prospecting work in Gonghe-Guide basin dated back to the 1990s. To 2013, there were six geothermal wells whose depths were over 1000 meters. And three of them were drilled into the granite layer, the depths of which are 39, 100, 219 meters respectively. The temperature test showed that these granite rocks were hot without any water. Meanwhile there were more than ten shallow geothermal drills whose gradient could be as high as 60-70°C/km. In 2014, the drills at the depth over 3000 meters in Gonghe and those over 2500 meters in Guide were both more than 150°C. These evidence all show that Gonghe-Guide area is a potential geothermal field [1].

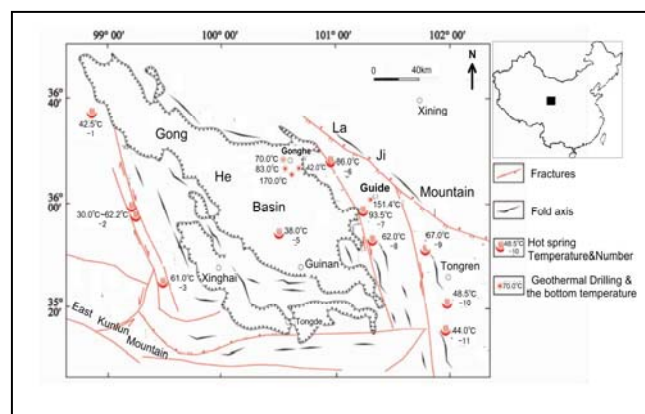


Fig. 1. The locations of drillings and hot springs and the temperature statistic in Gonghe Basin are from [1]. The data near the Gonghe City have been updated according to the recent measuring results (70°C, 83°C, and 170°C).

## II. THE UNDERGROUND STRUCTURE

### A. Natural Seismic, Earthquake and MT Evidence

Using receiver function to inverse the seismic velocity structure can show the underground structure. There is a low velocity zone beneath 15-40 km in the south part of Gonghe Basin, which connects the low velocity zone at the depth of 10km and expands to the underground in the middle of Gonghe basin [2-3].

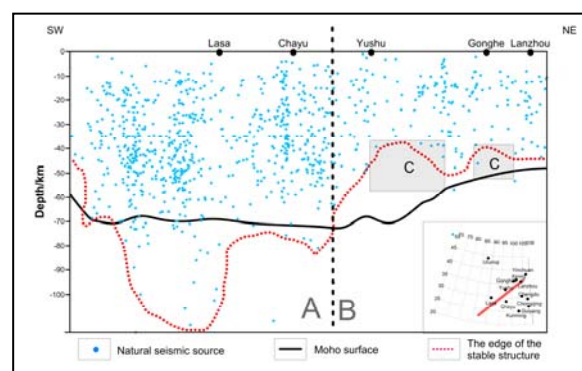


Fig.2 The Epicentral distribution of earthquakes depth are before Oct.2014 from USGS, and Moho depth in the profile from Lasa to Yinchuan is from [4]



The heat source might originate from the crust and upper mantle. But in terms of the geological condition of Xining Basin which is near our study area, the bedrock depth varied. This might make near surface geothermal display differently and deep heat uniformly distributed.

The terrestrial heat flow from Chadamu to Qilian is 50 to 70 mV/m<sup>2</sup>, which is at the medium rate. Besides, it is an important condition for magmatic intrusion that the lithosphere is crispy in the area ranging from Chaidamu to Qinghai. There are still tectonic activities such as shear friction caused by continuous extrusion stress field Qaidam fault. The material in the mantle is to Gonghe in horizontal direction in Qinghai-Tibetan plateau [9]. And the horizontal pushing force towards north formed by the collision of India plate and Eurasian plate during the Himalayan orogenic period is not completely absorbed by the Qinghai-Tibet Plateau, and the rest of which would be transferred to the Qilian structure belt through the north Kunlun-Qaidam terrain. It makes the temperature of the crust-mantle near Qaidam fault zone increase. In spite of this, in terms of temperature distributions, the zone with thick crust and thin mantle has an abnormal heat crust-mantle structure of “Thick crust and thin mantle”, whose formation mechanism is that lithospheric thickens downward as crust thickens, at the same time it destroys the original thermal balance between the boundary of lithosphere and asthenosphere and induces local mantle convection. At last, it leads to the result of melting and thinning of the bottom of lithosphere [10].

#### B. Fractures in Study Area

Deep fracture tectonics could control the formation of a heat-conducting channel where the heat flows and diffuses [11]. And as major parts of the central orogenic system, Qinling and Kunlun orogens constitute a giant orogenic belt that stretches from east to west in central China. But in Gonghe area they are of discontinuous structure. The size and strength of crustal internal structure, interface undulation and low velocity structure between layers gradually are weakened from south to north along the wide-angle reflection/refraction seismic sounding profile from Luqu to Lanzhou. The contact zone of different structural units of the profile has obvious lateral heterogeneity, where there might exist deep crustal fractures [12].

### IV. GEOTHERMAL MODEL

We get the integrating results in Fig.5. It focuses on smaller area than that in Fig. 2. The overshadow area is our study area. The curve of Curies depth is smooth, and it is relatively shallower in the study area. This can show that the heat from deep does play a role for the geothermal anomaly. The Moho curves fluctuated. Similarly, there is an obvious raise in the area between Tongde and Gonghe. The result of velocity of transverse waves made by [2] also shows that there is a zone protruding according to the line 4.2 km/s. Meanwhile, the longitudinal wave velocity and MT results show that there is a band abnormality at the depth between 30 and 40 km beneath Gonghe, where there might be the deep fracture as a passage to transfer the heat. From the discussion of the material flow direction and the geothermal mode, we draw the

bold line to show the mantle materials flowing. At the same time Fig 6 shows the abstract geothermal model based on Fig. 5.

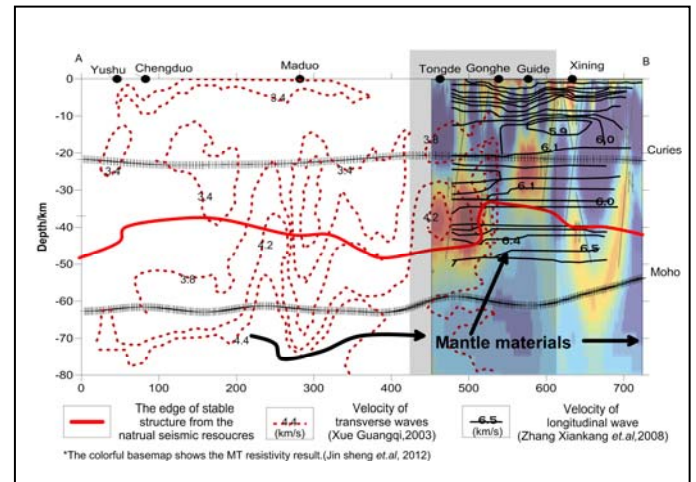


Fig. 5. The profile AB is marked in figure 3 to 4. The result of velocity of transverse waves is from [2].

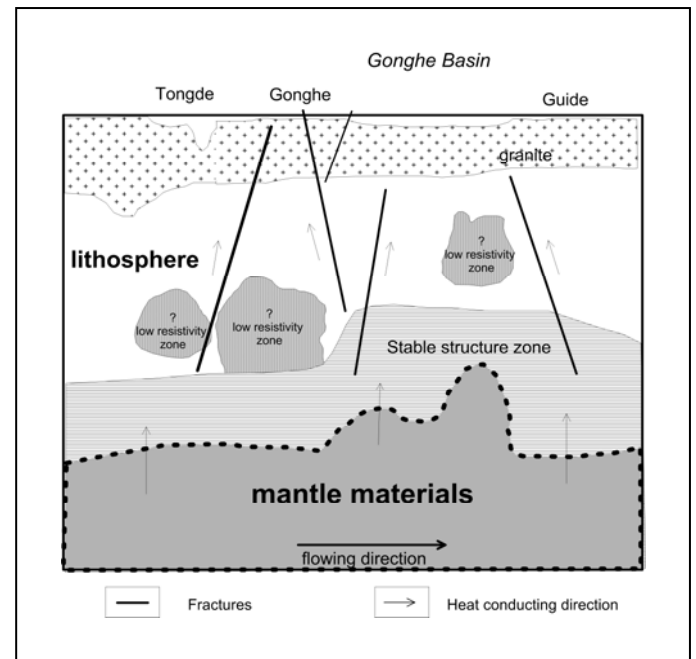


Fig. 6. This abstract geothermal model is based on Fig 5. The upper layer might be the granite. The mantle material and its flowing direction has been shown. However, there are some low resistivity zones which should be discussed more by other geophysical methods.

### V. CONCLUSIONS

From the geothermal statistics, we know that Gonghe area is a potential geothermal field, and the basis is granite. It is significant to study this area for the future geothermal and hot dry rock study. The geophysical results show that there is a stable structure underground. The geothermal conditions are good in this area. The substance in the mantle from southwest and the melting of the mantle may make contribution to the

geothermal anomaly, as granite also provides the heat. The fracture might help to transfer the heat from the deep zone. And the geothermal model in this area has been given.

Through this study, we can know that it is a potential area for the future geothermal exploitation, especially for hot dry rock, because its source is from the deep substance. Besides, the way that we study could be helpful for the geothermal prospecting in other areas. For example, Yushu along its neighbor area has the similar geothermal condition, thus it is worth studying in the future.

However, besides the boreholes statistics in the study area, it lacks precise geophysics work, such as smaller scale's MT work and precise seismic work. They are all required in the future geothermal exploitation.

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