Proceedings World Geothermal Congress 2005
Antalya, Turkey, 24-29 April 2005

The 2008 Olympics and Geothermal Project in Beijing

Wei Lianwei

Beijing Bureau of Geological Exploration and Mineral Resources, No.4 Nanwei road, Beijing 100054, China
weilianwei@sina.com

Keywords: geothermal, direct utilization, geothermal development, 2008 Olympics, Beijing

ABSTRACT

Beijing is a fast-growing city, where the direct use of low-temperature geothermal has been developing very fast since late 1990's, bringing great economic social and environmental effect. The 29th Olympics will be held in the City of Beijing in 2008, and "Green Olympics" will be an important feature of the great event. Most of the Olimpic facilities will be build in the Olympic Green, which is in the northern part of the city. It has been identified that there is geothermal potential around the Olympic Green. The geothermal reservoir there is made of limestone or dolomite buried in a depth greater than 2000m. It was proposed that geothermal be used in the Olympic Green, and a preliminary plan was worked out at the end of 2002, and a geothermal exploration project was started in the same time. Geothermal explorations proved that the geothermal wells can produce 53-75□ of hot water. According to the results of the geothermal exploration, the new plan for geothermal development in the Olympic green is being made, and geothermal will be used for the domestic hot water supply of the sports village. The international geothermal community played an important role in the mobilization and planning of the Olympic geothermal project in Beijing.

1. INTRODUCTION

The City of Beijing is the capital of China. Since 1980, the city has been developing tremendously in an all-round way and has now become a modern metropolis with charm of an ancient city in the East. Beijing will host the 29th Summer Olympic Games in 2008, which the main theme is "Green Olympics". Hosting of the Games in Beijing will serve as a "catalyst" for environmental improvement and help to promote sustainable development in Beijing and China.

Beijing is rich with low-temperature geothermal resources, widely used in various direct purpose including space heating, bathing, green house, fish farming, spa and recreation, bringing great economical, environmental and social benefits. It has been identified that there is geothermal potential around the Olympic green where the most important Olympic facilities were planned. At the beginning, it was planned to use geothermal for the domestic hot water and space heating at the sports village. A geothermal exploration project was conducted from December 2002 to April 2004. According to the results, the geothermal development plan for the Olympics is being finalized. It has been decided that geothermal will be used for the domestic hot water supply of the sports village, and the possibility of using geothermal for heating of the sports village has become small.

In the paper, the process of project proposal, preliminary planning, geological exploration and its findings, and the plan revision of the geothermal development for the Olympics will be introduced. The role of the international geothermal community on the mobilization and planning of the project is highlighted.

2. THE 2008 OLYMPICS IN BEIJING

The City of Beijing is the political, scientific, cultural and foreign exchange center of China. It is one of the six ancient cities of China, having over 800 years of history as a capital city. It covers an area of about 16,800km^2, including about 10800km^2 of mountain area in the north and west part, and about 6000km^2 of plain area in the southeastern part, which is the northern end of the North China Plain. It has a population of about 14.56 million at the end of 2003, and over 60% is inside the central area that is about 1000km^2. Since 1980, the city has been developing tremendously in an all-round way and its GDP growth rate was steadily over 10% recently. In 2003, its GDP has increased to 361.19 billion Yuan. Beijing has now become a modern metropolis with charm of an ancient city in the East.

The City of Beijing will host the 29th Summer Olympic Games in 2008. The Olympic Movement's Agenda 21 is Beijing's guideline for hosting the 2008 Olympic Games. One of the themes for 2008 Olympics is "Green Olympics". Hosting of the Games in Beijing will serve as a "catalyst" for environmental improvement and help to promote sustainable development in Beijing and China, to control the environmental impact of the Olympics as much as possible, and to educate the citizens for environment protection.

To prepare for the Olympics, detailed planning was set up, including the planning of Olympic facilities, environmental planning, energy planning etc. According to the plans, the Olympic Green, which will be the main part of the Olympic facilities, will be built in the northern part of the city. A series of measures of environment protection will be carried out including reducing automobile emissions and coal pollution, protecting water resources and improving the city's infrastructure. In the mean time, the consumption of coal will be strictly restricted, and the use of clean energy, such as natural gas, wind and geothermal is greatly encouraged. Totally, 12.2 billion U.S. dollars will be invested in Beijing on protecting the ecological environment in the period of 1998-2007. Since 1998, totally 3.63 billion U.S. dollars has invested in Beijing on promoting the use of clean fuels, controlling gas pollutant emission, treating wastewater, safe disposal of solid waste and protecting wild life species. Strict emission standard has been adopted since 1999, which requires a reduction of emissions by 80 percent. During the period from 2004 to 2007, even stricter standards will be adopted in Beijing so as to further reduce the emission by 60 percent. By December 2007, fuel coal will not be used inside the city except for a few large boilers in power plants. Prior to September 2008, the city's environment will meet the demands to host the Olympic Games in every aspects, and a new Beijing with fresh air, beautiful environment and

sound ecosystem will show itself to the world (Beijing Organizing Committee for the Games of the XXIX Olympiad, 2003[1,2]).

As a kind of green energy, geothermal was included in the energy plan for Olympic Actions, and will be used in the sports village, which is inside the Olympic Green, for domestic hot water supply.

3. GEOTHERMAL RESOURCES IN BEIJING

Beijing is rich with low-temperature geothermal stored in limestone or dolomite reservoirs, and the areas identified with geothermal potential have been over 2300km2, including 10 geothermal fields. The temperature of geothermal water in Beijing is 38-89□. The geothermal water contains SiO_2 and other components that are good for human health.

In the history, water from hot springs was used for bathing and health spa (Liu et al., 2001). The geothermal exploration in Beijing started in 1960's, and large-scale geothermal development commenced in early 1970's. Since late 1990's, geothermal direct use in Beijing has developed tremendously, and 20 to 30 geothermal wells were drilled every year. To the end of 2003, over 230 geothermal wells have been drilled in the city, and the deepest is over 4000m. Geothermal water is used for space heating, bathing, green house, fish farming, spa and recreation, bringing great economical, environmental and social benefits (Zhang and Liu, 2004). Geothermal has been widely accepted by the society, with the increase of geothermal utilization in Beijing. In the planning of a lot of construction projects, geothermal was often considered for space heating and domestic hot water supply at present. To battle the air pollution in the city, geothermal use was encouraged by the government.

4. GEOTHERMAL EXPLORATION AND PLANNING FOR THE OLYMPIC GREEN

4.1 The Origin of the Olympic Geothermal Project

A few geothermal wells about 3000m deep were drilled around the area of the Olympic Green before 2002. This indicates that there is geothermal potential in the Olympic Green (An, et al., 2002; Liu, et al., 2003). Therefore, the geothermal community in Beijing put forward a project proposal through both the Beijing Bureau of Land Resources & Housing (BLRH) and Beijing Bureau of Exploration and Development of Geology and Mineral Resources (BEDGRM), those are the governmental agencies responsible for geothermal in Beijing. It was proposed that geothermal be used for space heating and domestic hot water supply for the Olympic Green. Because of the complexity of the geological condition around the area, it was also proposed that further geothermal exploration be conducted around the area. The Municipal Government of Beijing considered the proposal carefully, and to hear the opinions of geothermal experts form other provinces and the international geothermal community, an international geothermal symposium, taken geothermal and 2008 Olympics in Beijing as its main theme, was held in October 2002 in Beijing. Over 200 geothermal scientists and experts both domestic and abroad attended the symposium, and a lot of suggestions were put forward (Cappetti, 2002; Fridleifsson, 2002; Lund, 2002; Rybach, 2002; Axelsson et al., 2002; Erlingsson et al., 2002; Bin, et al., 2002; Zheng, 2002; Xie and Li, 2002).

4.2 The Preliminary Planning

After the 2002 Beijing International Geothermal Symposium, a working group was set up, for the planning of the Olympic geothermal project. Considering all the suggestions carefully, the geothermal resources were estimated and a preliminary plan was worked out for geothermal development in the Olympic Green. It was planned that geothermal would be used for the space heating (supplemented by heat pumps) and domestic hot water supply in the sports village that will have about 360,000m^2 of floor area.

It was estimated that the temperature of the geothermal water will be 65-75□, and the production capacity of each well will be 60m^3/h. And it was projected that there will be 3,000 households, or 10,800 residents in the sports village, and the domestic hot water need (45□) will be 400,000m^3/a (100L/d·capita); The heat load of space heating was taken as 46W/m^2 and the heating time was taken as 125 days per year according to the related standards in Beijing. It was planned that 10 geothermal wells will be drilled, divided into two groups. There would be 3 production wells and 2 reinjection wells in each group. To meet the needs of space heating, heat pumps were to be incorporated into the heating system. Thus, the geothermal water production would be 1,340,000m^3/a, in which the amount of reinjection of tail water from the heat pumps would be 780,000m^3/a, and the net consumption of geothermal water from the geothermal system would be 560,000m^3/a.

4.3 Geothermal Explorations

Some geological explorations and investigations have been done around the area of the Olympic Green, mostly for cold groundwater purpose (only a few geothermal wells were drilled in the vicinity). It has been found out that there are at least two important regional faults going through the area, which make the geological condition rather complicated. And it was still vague how these faults influence the distribution and characteristics of the geothermal reservoir (there were even disputes on the geological time of the geothermal reservoir), how deep the geothermal wells will be, and what the temperature of geothermal water will exactly be.

Therefore, a government funded geothermal exploration project was started in December 2002, aiming to have a better understanding of the geological structure, distribution and characteristics of the geothermal reservoir, temperature and chemical compositions of geothermal water, production capacity of geothermal wells around the Olympic Green, and lie a sounded basis for the detailed planning of the Olympic geothermal project in Beijing.

The geothermal exploration project was carried out in the period from December 2002 to April 2004, mostly concentrated on a 40km^2 area (Chen, et al, 2003). Geophysical explorations, including CSAMT sounding, magnetic survey and gravitational survey etc. were carried out on profiles totally 76km long, for investigations of geological structure and reservoir distribution. And two geothermal exploration wells of over 3000m were drilled around the area. On the basis of the explorations, geothermal resources assessment was conducted (Liu et al., 2003; Chen, et al., 2003).

The geothermal explorations allow for a better understanding to the occurrence of the geothermal resources in the Olympic Green. It was found out that (1) the two regional faults passing through the area of the

Olympic Green play a very important role in the occurrence of the geothermal in the area, mostly by controlling the distribution and buried depth of the geothermal reservoir; (2) the geothermal reservoirs around the Olympic Green are karsted dolomite beds of lower Proterozoic Erathem, although there are still disputes on the geological time the reservoir rock formed; (3) the temperature of the geothermal water around the Olympic Green is 53-75□, higher in the southeastern part and lower in the northwest part; (4) the production capacity of the geothermal wells is averagely 2000m^3/d; (5) the geothermal water is proper for spa use, with rather low mineral content and rather high SiO_2 content; (6) there is large amount of heat stored in the geothermal reservoir, but water recharge to the reservoir is rather limited; (7) hence cares should be taken to produce from the geothermal reservoir, and reinjection should be considered if it is possible.

4.4 Present Situation of Geothermal Utilization Planning

The most important new findings of the geological exploration is that the production temperature of the geothermal wells in the northwestern part of the Olympic Green is lower than that was predicted as more than 65□. In fact, the production temperature of the two wells close to the sports village was 54□ and 53□ respectively. Therefore, the previous plan can never be applied, and a new plan has to be made.

The developer of the Olympic Green has been determined as the Beijing Municipal Construction Group (BMC), through international bidding. BMC will make final decision on how the geothermal will be used and how the heating, as well as cooling, for the sports village will be realized.

At present, it has been decided that geothermal will be used for domestic hot water supply of the sports village, because the two geothermal wells for exploration purpose can be used as production wells, and their production capacity is enough for the domestic hot water need of the sports village. It is estimated that the annual profit of domestic hot water supply will be over 2 million Yuan.

But for the heating, as well as cooling, a few alternatives are under consideration, including (1) the municipal heating system that has been connected to the area; (2) electricity; (3) heat pump system using local groundwater stored in an aquifer made of conglomerate buried 100 to about 1300m deep; (4) heat pump system using effluent from two wastewater treatment plant nearby. Decision has not been made till the end of September 2004.

Of all the above alternatives, the last one is the most appealing, and will most likely to be adopted at last. The two wastewater treatment plants are at Qinghe that is about 2000m northwest of the sports village, and Beixiaohe that is about 3000m east of the sports village. Their effluent is totally about 40,000m^3/d, enough for the heat pump system of the sports village. Because that it is not necessary to drill wells for groundwater pumping and reinjection, the construction cost of the heat pump system will be much lower than that using local groundwater, and the operation cost will also be lower.

5. CONCLUDING REMARKS

Beijing will host the 2008 Summer Olympic Games, and there is geothermal potential around the area of the Olympic Green that will be the main facilities for the Olympics. It was proposed that geothermal be used for space heating and domestic hot water supply for the sports village that is inside the Olympic Green. An international geothermal symposium was held to discuss the possibility of geothermal development for the 2008 Olympics, and a dedicated geothermal exploration project was carried out. The result shows that the temperature of the geothermal water is 53-75□ (it is lower in the northwestern part of the Olympic Green and higher in the southeastern part), lower than it was predicted. A new plan for the domestic hot water supply and heating (as well as cooling) for the sports village is being made. It has been decided that geothermal will be used for the domestic hot water supply and the plan for heating and cooling of the sports village will soon be settled.

In the process of project proposal, planning and exploration of the Olympic geothermal project in Beijing, the international geothermal community played an important role. Therefore, sincere thanks are due to the International Geothermal Association and the geothermal scientists and experts who attended the 2002 International Geothermal Symposium in Beijing. It is proposed that this kind of cooperation be applied in the mobilization and conduction of other similar projects in China and the world, and the international cooperation for geothermal be strengthened.

REFERENCE

An, J., Hu, S. and Lu, J.: Report for 1st phase geothermal exploration in the area around the Beiyuan Garden, Beijing. Beijing Huaqing Geothermal development Co. Ltd, (2002).

Axelsson, G., Stefansson, V. and Xu, Y.: Sustainable management of geothermal resources, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002).

Beijing Organizing Committee for the Games of the XXIX Olympiad: Beijing Olympic Action Plan, Sub-plan for Environmental Protection, http://olympic.bjinvest.gov.cn (2003[1]).

Beijing Organizing Committee for the Games of the XXIX Olympiad: Action Plan for Beijing Olympic Games 2008, Sub-plan on Energy Development and Energy Mix Readjustment, http://olympic.bjinvest. gov.cn, (2003[2]).

Bin, D., Pan, X., Wang, X. and Ma, J.: Geothermal prospects around Beijing Olympic Park, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002) (in Chinese).

Cappetti, G.: Geothermal Resources and Utilization in Italy, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002).

Chen, J., Liu, Q., Lu, J., Feng, H., Xu, Y., Wu, H. and Zhao L.: Report of Geothermal Resources Explorations for the Area of Olympic Green, Beijing, Beijing Institute of geotechnology, (2003). (in Chinese).

Erlingsson, T., Johannesson, T., Chatenay, C. and Eliasson, E.: Comprehensive Use of Geothermal Energy for Large Sports Complexes, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002).

Fridleifsson, B.I.: Geothermal development in Iceland and China. Proceedings, 2002 Beijing International

Geothermal Symposium, China Geological Publishing House, (2002).

Liu, J.: Geothermal development scheme for the Olympic Park in Beijing. Proceedings of the International Geothermal Conference IGC- 2003, (2003).

Liu, J., Pan X., Yang, Y., Liu, Z. and Wang, X.: Report on the deep geothermal condition investigation in the plain area in Beijing, Beijing Institute of Geological Engineering, (2001), (in Chinese).

Liu, J., Zheng, K., Xu, W., Liu, Z. and Bin, D.: Report of Geothermal Assessment for the Area of the Olympic Green, Beijing Institute of Geological Engineering, (2003), (in Chinese).

Lund, J.: Panel discussion of 2002 Beijing International Geothermal Symposium. October 29-31, 2002, Beijing, China, (2002).

Rybach, L.: Summary of panel recommendations of 2002 Beijing International Geothermal Symposium. October 29-31, 2002, Beijing, China, (2002).

Xie, D. and Li, W.: The feasibility of geothermal heating in Beijing Olympic Park, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002).

Zhang, L. and Liu, J. Report of monitoring of geothermal systems in Beijing in the year 2003, Beijing Institute of Geological Engineering, 2004, (in Chinese).

Zheng, K.: HydrogeochemicaL Study in Beijing Olympic Park Area, Proceedings, 2002 Beijing International Geothermal Symposium, China Geological Publishing House, (2002).