Assessment of geothermal resources of Japan 2008 by with one-km resolution: Overlook of magma chambers from hydrothermal systems

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1. Introduction

Among the assessments of geothermal resources of Japan, the estimate by Miyazaki et al. (1991) had been most commonly referred to in the Japanese geothermal community until recent. The USGS volumetric method is usually applied to such regional-scale assessment (Brook et al., 1979), for in which information of underground temperature distribution and geologic basement depth distribution was necessary. However, the resolution of the previous assessments had not reached a level to visualize local abundance of geothermal resources, because the resolution of these two data had been restricted. Miyazaki et al. (1991) utilized the Curie-point isothermal depth for estimating temperature distribution and gravity data for basement depth evaluation. The lateral resolution of the Curie-point isothermal depth was limited to about 60 km. The gravity basement depth data were not uniformly processed in Japan at that time.

2. Assessment of geothermal resources of Japan 2008

Recently, these two data were dramatically improved. The authors recently published Atlas of Hydrothermal Systems in Japan (Muraoka et al., 2007). On the atlas, the map of the underground temperature distribution by the Activity Index (Hayashi et al., 1981) can utilize the well temperature data as well as discharge temperatures of hot springs at the surface that reach 6,508 point data and enables one-kilometer grid mapping. The Activity Index is normalized but it provides a temperature-depth curve, allowing the temperature extrapolation to an arbitrary depth. Komazawa (2003) published a uniformly processed map of the gravity basement depth in Japan based on about 400,000 gravity measurement data. As a result, this revised assessment indicated 53,720 MWe for 30 years production from hydrothermal resources above 100 ^{o}C, 31,860 MWe from hydrothermal resources above 150 ^{o}C, 21,700 MWe from hydrothermal resources above 180 ^{o}C, and 15,650 MWe from hydrothermal resources above 200 ^{o}C. The estimate of hydrothermal resources above 150 ^{o}C is 1.55 times larger than that of Miyazaki et al. (1991). The reasons are ascribed to the facts that the estimate by Miyazaki et al. (1991) had been made in most potential areas but 50 % of the entire territory of Japan.

3. Considerations

Because of the one kilometer resolution, the obtained geothermal resource map can visualize local abundance of geothermal resources. This could be used for planning of local geothermal developments by local users. Based on the map, the top three potential geothermal fields in Japan are Tokachi-Taisetsu, Northern Japan Alps and Shiretoko Peninsula, all of which are prohibited to develop in the National Parks.

The distribution of the high-temperature hydrothermal resources reflects thermal energy of sub-volcanic magma chambers and could evaluate them. For example, when the gravity basement depth and Activity Index at one-kilometer grids are compared, a clear negative correlation is obtained. The volcanic high-temperature hydrothermal resource fields where the Activity Index is higher than 80 are mostly concentrated in the shallow gravity basement areas where the gravity basement depth is shallower than 2 km. This supports an empirical knowledge that the Quaternary volcanoes are situated at the uplifted areas. Which kinds of volcanoes are associated with high-temperature hydrothermal resources will be further discussed.