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Insight into the Geothermal Structure in Chingshui, Ilan, Taiwan

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ABSTRACT

The Chingshui geothermal field is the largest known productive geothermal area in Taiwan. The purpose of this paper is to delineate this geothermal structure by integrating geophysical data and borehole information. The existence of a magma chamber in the shallow crust and shallow intrusive igneous rock results in a high heat flow and geothermal gradient; furthermore, the NE deep fault system within the meta-sandstones provides meteoric recharge from a higher elevation to artesianally drive the geothermal system. There is evidence that geothermal fluid deeply circulated within the fracture zone and was heated by a deeply located body of hot rock. The geothermal reservoir of the Chingshui geothermal field might be related to the fracture zone of the Chingshuihsi fault. It is bounded by the C-fault in the north and Xiaonanao fault in the south. Based on information obtained from geophysical interpretations and well logs, a 3-D geothermal conceptual model is constructed in this study. Further, the geothermal reservoir is confined to an area that is 260 m in width, N21°W, 1.5 km in length, and has an 80° dip toward the NE. A high-temperature zone is found in the SE region of the reservoir, which is about 500 m in length; this zone is located near the intersection of the Chingshuihsi and Xiaonanao faults. An area on the NE side of the high-temperature zone has been recommended for the drilling of production wells for future geothermal development.

Key words: Chingshui geothermal field, Geothermal reservoir, Gravity, Magnetic, Magnetotellurics, Well log

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1. INTRODUCTION

Promotion of renewable energy sources is growing worldwide. Geothermal energy is one such energy source and it is both relatively cheap and efficient (Fridleifsson 2001; Bertani 2005; Lund et al. 2005). The Chingshui geothermal field is probably the most suitable area for generating geothermal energy in Taiwan as it is Taiwan's largest existing productive geothermal area (Lee 1994). A reconnaissance survey of this field was performed by the Industrial Technology Research Institute (ITRI) from 1973 to 1975 (Lee 1994). Further exploration was subsequently conducted by the Chinese Petroleum Corporation (CPC) from 1976 to 1980. Later, a geothermal power plant was built in this field by the National Science Council in 1981; however, the plant was decommissioned after 11 years.

During the exploitation stage, the ITRI and CPC conducted the following surveys: gravity (Lee 1994), resistivity (Cheng and Lee 1977; Su 1978), transient electromagnetic (Chiang and Liu 1983), and geologic (Tseng 1978; Hsiao and Chiang 1979). Nineteen deep production wells were drilled in a 6-km long band along the Chingshui stream, with commercially successful wells confined to a 2-km^2 area at the SE end of this zone. The highest temperatures measured ranged between 200°C and 220°C (Lee 1994).

Although some exploration of this field has been undertaken in the past (Cheng and Lee 1977; Su 1978; Tseng 1978; Hsiao and Chiang 1979; Chiang and Liu 1983; Lee 1994), the structure of the geothermal reservoir is still not well delineated; this could affect the design of new production wells as regards their appropriate locations and borehole traces. This study aims to delineate the geothermal structure of this field by integrating geophysical data and

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