臺灣地熱場地層儲存及流體流動特性：以大屯火山群和東部板岩帶為例

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摘要

台灣位於太平洋火環帶上，地底下有豐富的地熱資源，近年來，政府再次調查地熱資源。地熱發電必須滿足三個條件：足夠的熱源、水以及流體流動的管道，在岩體中，流動的管道指的主要是岩體的裂隙，重要參數為水力內寬，而力學內寬與孔隙率則為流體儲存特性之參數。

本研究使用 YOKO2 孔隙率/滲透率量測系統，對大屯火山群五指山層的砂岩以及臺東紅葉層的板岩進行完整岩石樣本的孔隙率和滲透率之量測，以及含有節理的砂岩樣本進行水力內寬及力學內寬的量測。其中孔隙率和力學內寬是透過波以耳定律量測，滲透率和水力內寬則是以穩流法與脈衝衰減法來量測。結果顯示，對於所有的板岩樣本，孔隙率差異不大；大致上，板岩平行葉理方向之滲透率大於垂直葉理方向；砂岩的孔隙率為 3.7% ~ 4.7%；滲透率約為 $10^{-16}m^2 \sim 10^{-17} m^2$；含有節理的砂岩樣本的水力內寬約為 9 μm ~ 26 μm，砂岩節理對流體流動之貢獻遠大於完整岩石；力學內寬約為 600 μm ~730 μm。後續將對板岩樣本進行微觀結構的觀察，來解釋平行與垂直葉理板岩樣本之間滲透率的差異。

關鍵字： 地熱、YOKO2、孔隙率、滲透率、力學內寬、水力內寬

Geological Storage and Fluid Flow Characteristics of Geothermal Reservoirs in Taiwan: A Case Study of the Datun Volcanic Group and Eastern Slate Areas

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Abstract

Taiwan, located on the Pacific Ring of Fire, possesses abundant geothermal resources beneath its surface. In recent years, the government has once again investigated geothermal resources. Geothermal power generation relies on three essential conditions: adequate heat source, water, and a pathway for fluid flow through the rock mass. In rock masses, the pathways for fluid flow are primarily fractures, where hydraulic apertures are important parameters. While for fluid storage, the mechanical apertures and porosity are important properties.

In this study, the YOKO2 porosity/permeability measurement system was used to measure the porosity and permeability of intact sandstone samples from the Wuchishan Formation, and slate samples from the Hongye Formation. Additionally, samples of sandstone containing joints were tested for hydraulic apertures and mechanical apertures. Porosity and mechanical apertures were measured using the Boyle's law, while permeability and hydraulic apertures were determined using steady-state tests and pulse decay methods, respectively. The results indicated that for all slate samples, there is little difference in porosity. With generally higher permeability in the parallel foliation orientation. For sandstone, the porosity was 3.7% to 4.7%, and permeability ranged from 10^{-16} m² to 10^{-17} m². For sandstone samples with joints, hydraulic apertures varied from 9 μm to 26μm, and jointed sandstone exhibited significantly greater contributions to fluid flow than intact rock. Mechanical apertures ranged from 600 μm to 730 μm. Subsequent microscopic structure observations will be conducted to explain the differences in permeability between samples of parallel and perpendicular foliation slate.

Keywords: Geothermal, YOKO2, Porosity, Permeability, Machenical aperture, Hydraulic aperture.