地質統計於臺灣地區溫泉觀測井選址之應用-以知本溫泉區爲例

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摘要

溫泉資源的永續利用有賴於有效的管理方案，包含資源調查、開發管制及使用監測；水量、水質及水溫爲管理溫泉資源主要考慮的三項因子，這三項因子會受到不同尺度下的環境變因所影響；雖然地球物理調查，例如：可控源音頻大地電磁法，能提供地下資源完整輪廓，唯其費用昂貴；在考慮私設溫泉井建置皆以最經濟方式，於開挖最淺溫泉井條件下取得最大單位面積流量之假設下，本研究於知本溫泉區 20 口私設溫泉井中，採集包含溫度、導電度、酸鹼值、氧化還原電位、溫泉井單位面積流量及井深度六項變數，進行空間統計分析以推求觀測井最佳設置位置；多因子克力金不同於傳統降低維度分析法，例如：主成分分析法或對應分析法，因其考慮變數間的空間結構且能處理尺度問題；本研究採用多因子克力金將變數間之整體變量分離爲區域及局部兩個尺度下之變量，針對不同尺度下的主成分探討其形成的原因，針對不同的管理需求，利用不同尺度下的主成分值及變異量降低分析法決定觀測井設置位置，以降低目標管理上的不確定性。

關鍵辭：變異量降低分析法, 多因子克力金

An application of geostatistics to locating hot spring monitoring wells in Taiwan - Chihpen Hot Spring Area as an example

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ABSTRACT

Sustainable use of hot spring resources depends on affective management actions, including resource investigation, exploitation control and utilization monitoring. Water quantity, water quality, and water temperature are three major factors concerned in the management of hot spring resources. Moreover, those three factors are determined by environmental variable in different scales. The geophysical

investigation, such as controlled source audio-frequency magnetotelluric (CSAMT), is cost consuming, though it can provide a whole sketch of underground resources. Under the assumption that the private hot spring wells were economically constructed to gain the largest outflows from the shallowest wells, this study adopted six variables, temperature, conductivity, pH value, and oxidation reduction potential, flow rate per unit cross area of a well, and well depth, from 20 private hot spring wells in the Chihpen Hot Spring Area coupled with geostatistics to determine the optimal sites for monitoring wells. Multivariate factorial kriging (MFK) is different from conventional dimension reduction methods, such as principal component analysis (PCA) and correspondence analysis (CA), because it counts on spatial components and deals with scale problems. The MFK were applied to decompose the lumped variation into componential variations at regional and local scales. The principal components at different scales were inspected to clarify the causation of variations. For different management purposes, different principal components at different scales coupled with variation reduction analysis (VRA) were used to decide the optimal sites for hot spring monitoring wells to reduce uncertainty in management by objectives.

Keywords：Variation reduction analysis, Multivariate factorial kriging