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Hydraulic characterisation of some arenaceous rocks of Molise (Southern Italy) through outcropping measurements and Lugeon tests

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Abstract

The hydraulic features of Miocene sandstones within the area between the Matese Mountains and the city of Campobasso have been investigated employing two methods. The first method included the analysis of the characteristics of persistent rock mass discontinuities on 12 significant outcrops. The second method included the processing of 125 Lugeon tests on the same rocks.

Outcrop surveys have provided a model for rock mass characterised by a well-developed persistent discontinuity network, a high frequency of discontinuities and aperture values of generally less than 1 mm. These features correspond to a heterogeneous and anisotropic medium. The discontinuity aperture considerably influences the hydraulic anisotropy and heterogeneity of the sandstones.

Lugeon tests have also clearly shown the heterogeneous nature of the sandstones. Discontinuity aperture and rock permeability have been calculated with reference to the theory of Rissler and assuming a simplified hypothesis for relative roughness. These values (mean value of aperture = 0.35 mm; range of values of hydraulic conductivity = $10^{-5} - 10^{-2}$ m/s) are comparable to values determined from surface survey (mean value of aperture = 0.39 mm; range of values of hydraulic conductivity = $10^{-6} - 10^{-2}$ m/s).The convergent results obtained from the two methods of investigation are indicative of the complementary nature of the two approaches adopted when the hydraulic characterisation regards the portion closest to the surface of the rock mass.

Keywords: Sandstones; Hydraulic conductivity; Rock mass; Discontinuities; Lugeon tests

1. Introduction

The present study concerns the characterisation of Miocene sandstone formations within the area which falls between the Matese Mountains and the city of

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Campobasso (Molise, South Italy). The area is particularly poor in groundwater resources; so much so that dammed reservoirs have been designed and constructed in some cases involving the Miocene rocks themselves. Within the foundation rocks beneath the dams, sandstones are among those rocks which present the greater risk of leakage from the reservoir.

Within this context the study aims to define the procedure and methods for determining the hydrogeological features of hard rocks (see for example, Baecher and Lanney, 1978; Bianchi and Snow, 1968; Caldwell, 1972; Dershowitz et al., 1992; Long et al., 1982; Oda, 1985; Zhang and Liao, 1990; Zhang and Sanderson, 1995). What follows is a comparison between the hydro-structural model obtained from surface surveys and the response of rock mass to Lugeon tests performed during the planning phase of three dams.

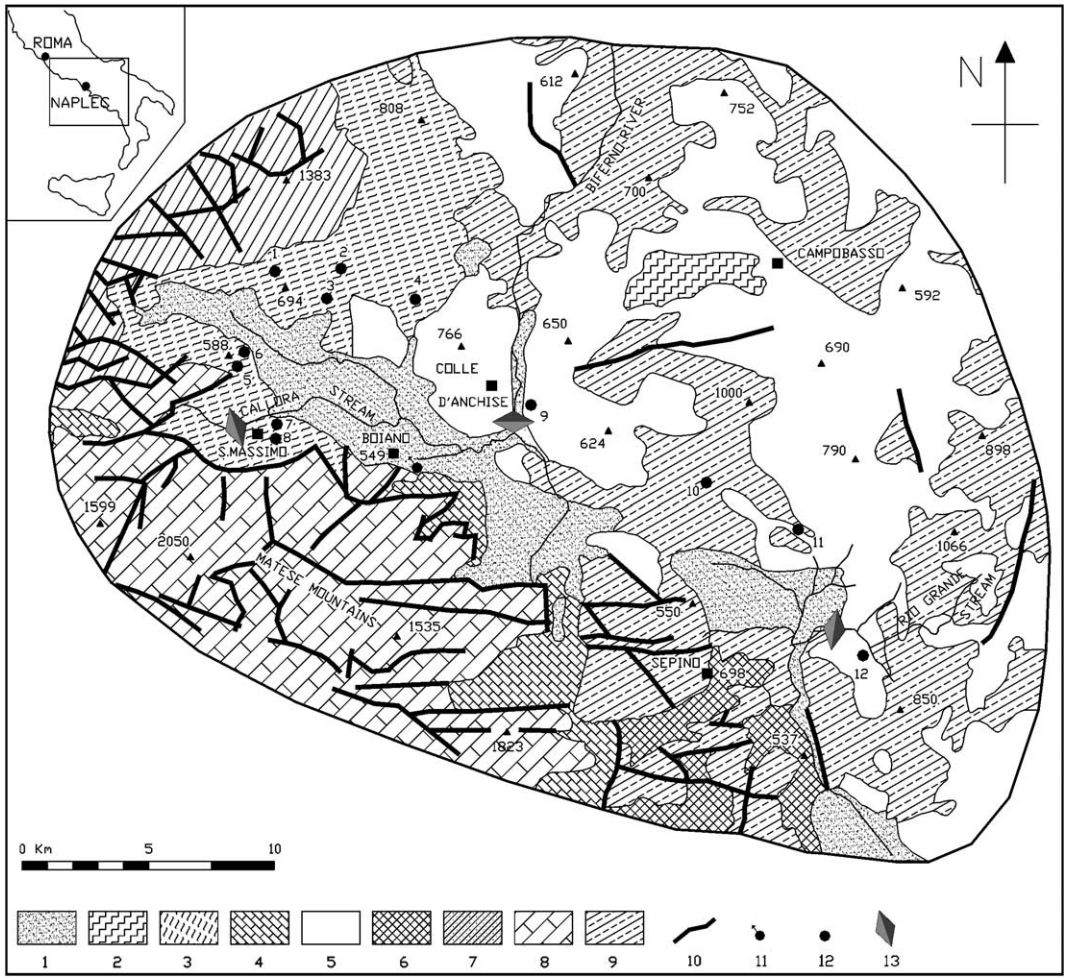

Fig. 1. Geological map of the studied area and location of investigations. 1) Alluvial sediments, talus breccias and lacustrine deposits (Holocene–Pleistocene). 2) Altavilla and Villamaina Units (Lower Pliocene–Upper Tortonian). 3) Frosolone Unit (Upper Miocene). 4) Pietraroia, Longano, Cusano formations (Tortonian–Langhian). 5) Irpinian Units, S. Bartolomeo Flysch (Lower Tortonian–Serravallian). 6) Numidian Flysch (Langhian–Upper Oligocene). 7) Molise Units (Upper Miocene–Cretaceous). 8) Matese–Monte Maggiore Units (Paleocene–Middle Liassic). 9) Lagonegro II Unit, Flysch Rosso (Oligocene–Upper Cretaceous). 10) Faults. 11) Spring. 12) Outcrop examined. 13) Site of planned dams.