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Classification of surrounding rock of large underground water-sealed storage caverns based on evolution back-propagating neural network

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The underground water-sealed storage cavern is a man-made rock cavern to store oil and liquefied petroleum gas, which is located well below the surrounding ground water level and leakage is prevented by water sealing. It has many advantages over aboveground storage in terms of safety, environment and economy. Therefore, storing oil or liquefied petroleum gas in large underground water-sealed storage caverns is an important for strategic energy source reserves in the world (Table 1). With the increase of energy demand in China, constructing large underground water-sealed storage caverns has important economic benefits.

Table 1: Underground storage caverns in the word

NO	storage cavern location	contents	Volume/10^4m^3	lithology
1	Norway	CNG	1.4	siltstone
2	Norway	LPG	10.0	granite
3	Greece	petrol、oil	20.0	limestone
4	Korea	LPG		

			22.4	
			gneiss	
5				
		Korea		
		petrol		
		23.1		
		granite		
6				
		Korea		
		LPG		
		30.0		
		andesite		
7				
		Korea		
		oil		
		423.9		
		diorite		
8				
		China		
		LPG		
		20.6		
		granite		
9				
		China		
		LPG		
		40.0		
		granite		
10				
		China		
		LPG		
		50.0		
		tuff		

Classification of the surrounding rock of underground water-sealed storage caverns is the fundamental requirement in the site selection and design stage. A number of classification systems have been developed in the past 50 years to help characterise rock masses such as Q system [1,2], RMR[3] and several others. But the challenge in developing rock characterisation schemes is often practicality, and the degree of subjectivity inherent in commonly used classification systems. What's more, because the most critical issues of the underground storage cavern are the sealing condition and the stability of the surrounding rock, the current classification of rock mass, based on evaluation for the stability of surrounding rock mass, cannot meet special requirements of underground projects on permeability of the surrounding rock mass. In this paper, a new classification approach of surrounding rock of large

underground water-sealed storage caverns based on evolution back-propagating neural network is introduced and rock uniaxial saturated compressive strength, integrated coefficient, aperture of fracture, groundwater, ground stress and the relative position between the tunnel axis and fracture planes are selected as input samples for the neural network model. Finally, the established classification of surrounding rocks model is used in practice, and the results show that the outcomes of analysis match the actual surrounding rock classification. It proves that the method used in surrounding rock classification of underground storage caverns is rational and effective. The advantage of this approach is that the method is site-data dependent, so it is less subjective than when common engineering terms are used.

References:

[1] Barton, N et al. (1974) Rock mechanics 6(4): 189-236

[2] Barton, N (2013) Journal of Rock Mechanics and Geotechnical Engineering 5(4): 249-261

[3] Bieniawski, Z T (1974) In: *Proceedings of the 3rd Congress of the International Society for Rock Mechanics*, 27-32