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The relationship between serpentinization and geotechnical properties of ophiolites (Case study: Paleotethys ophiolites of the Southwest of Mashhad)

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Introduction

In the southern margin of the Mashhad plain in Northeastern Iran, there are strips with tens of kilometers length consisting of metamorphic rocks and ophiolite complexes with the NE-SW trend. Ophiolites are fragments of ancient Oceanic crust (Ghaseminejad and Torabi, 2015; Khanchuk et al., 2016; Shirdashtzadeh et al, 2017) most of which consists of ultramafic rocks. Ophiolites are formed during tectonic displacement in the southern part of the Mashhad plain (Alavi, 1991; Karimpour et al., 2010; Sheikholeslami and Kouhpeyma, 2012; Zanchetta et al., 2013; Shafaii Moghadam and Stern, 2014). These undergoing metamorphosed regions ultimately lead to the formation of serpentines complex due to factors of pressure and temperature. Subsequently, tectonic variations create different levels of serpentinization in the region. Different degrees of serpentines have different geotechnical properties that are discussed in this study.

Materials and methods

To conduct the lithological studies, 313 samples were collected from surface and trenches in the studied area. Following the preparation of the microscopic cross-section of all specimens, the mineralogical characteristics, texture changes, color changes, degradation and microcrack development were studied. Then, the samples were classified based on the general classification of ultramafic rocks (Streckeisen, 1974). According to this classification, the ultramafics extracted from the studied area were classified in the metaperidotite and metapyroxenite groups. After separating various metaperidotites and metapyroxenites the percentage of serpentinization in all specimens were determined and 60 samples with different serpentinite percentages were selected. Also, the stone blocks were provided for preparing the core samples. Physical tests (such as dry and saturated unit weights, porosity, and water absorption percentage), and mechanical tests (such as uniaxial compressive strength, point load strength, and Brazilian tensile strength) were performed based on the Brown (1981) method in the laboratory of the Ferdowsi University of Mashhad.

Results

The results show that there is a good relationship between the percentage of serpentinization of samples and uniaxial compressive strength (the most important geotechnical parameter in rocks). The ultramafic rocks are divided into three groups based on uniaxial strength and 25 to 40% of serpentine are very strong, 40 to 60% of serpentine are strong and 60 to 75% serpentine are of medium strength. Also, the ultramafics with 75% to 95% of serpentine, are named as serpentinite rocks with weak uniaxial compressive strength.

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Discussion

Although most of the ultramafic rocks have good strength as the foundation for building, the construction of a structure on these rocks has numerous problems due to the formation of minerals such as serpentine and talc with one-directional cleavage. With increasing the degree of serpentinization, some phenomena such as slope instability, sliding, excavation collapse will occur. The results of the present research indicated the priority of serpentinization degree of ultramafic rocks compared to their strength. As it is seen, although in a high degree of serpentinization, the metapyroxenites have higher strength and lower water absorption compared to metaperidotites. Therefore, the mentioned issues demonstrated the importance of the degree of serpentinization compared to strength in ultramafic rocks.

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References

Alavi, M., 1991. Sedimentary and structural characteristics of the Paleo-Tethys remnants in northeastern Iran. Geological Society of America Bulletin, 103(8): 983–992.

Brown, E.T. 1981. Rock characterization, Testing and monitoring ISRM suggested methods. Pergamon press, Oxford, 211 pp.

Ghaseminejad, F. and Torabi, Gh., 2015. Petrography and mineral chemistry of Twehrlites in contact zone of gabbro intrusions and mantle peridotites of the Naein ophiolite. Journal of Economic Geology, 6(2): 291–304. (in Persian with English abstract)

Karimpour, M.H., Stern, C.R. and Farmer, G.L., 2010. Zircon U–Pb geochronology, Sr–Nd isotope analyses, and petrogenetic study of the Dehnow diorite and Kuhsangi granodiorite (Paleo-Tethys), NE Iran. Journal of Asian Earth Sciences, 37(4): 384–393.

Khanchuk, A.I. and Vysotsky, S.V., 2016. Different-depth gabbro–ultrabasite associations in the Sikhote-Alin ophiolites (Russian Far East). Russian Geology and Geophysics, 57(1): 141–154.

Shafaii Moghadam, H. and Stern, R.J., 2014. Ophiolites of Iran: Keys to understanding the tectonic evolution of SW Asia: (I) Paleozoic ophiolites. Journal of Asian Earth Sciences, 91(1): 19–38.

Sheikholeslami, M.R. and Kouhpeyma, M., 2012. Structural analysis and tectonic evolution of the eastern Binalud Mountains, NE Iran. Journal of Geodynamics, 61(1): 23–46.

Shirdashtzadeh, N., Torabi, GH. and Samadi, R., 2017. Petrography and mineral chemistry of metamorphosed mantle peridotites of Nain Ophiolite (Central Iran). Journal of Economic Geology, 9(1): 57–72. (in persian with English abstract)

Streckeisen, A., 1974. Classification and nomenclature of plutonic rocks recommendations of the IUGS subcommission on the systematics of igneous rocks. Geologische Rundschau, 63(2): 773–786.