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Investigation of Rockfall Risks by Using Geophysical Methods in the Rock Slope of Sumela Monastery, Trabzon, Turkey

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Rockfall is the action of large rock blocks on steep slope, affected by morphological and climatological effects. The Sumela Monastery, one of the important cultural property in the north-east of Turkey, is located within the borders of the Altındere neighborhood of the Maçka, Trabzon. The Sumela monastery was built on a rock face in the foothills of Karadağ in the Altındere valley. In 2001, the rockfalls occurred on the southwest slope of the Sumela Monastery and a part of the transportation road and recreational facility of monastery were damaged. Rockfalls occasionally have occurred on the rock slope of the Monastery. Rockfalls happen in steep slope zones of partially disturbed volcanic rock mass with angular blocks formed by 4 joint sets. The dimension of the falling blocks range from 0.3 to 3m3. Since the rolling distance and slope gradient are greater, even very small rock fragments can cause huge damage. Because of these reasons, it has a serious problem for visitors, employees and facility. Due to the rockfalls that have already taken place, a long-term hazard assessment was needed in order to prevent damage to facilities, employees and visitors of Sumela Monastery. In this study, the risky blocks on the rock slope of the Monastery were tried to determine by using geophysical methods. For this purpose, ground penetrating radar (GPR) and electrical resistivity (hard surface measurement) methods were applied on the some risky blocks determined on the rock slope. In addition, ultrasonic measurement technique was used on samples taken from rock blocks. The GPR method was used to find out the depth, orientation and continuity of discontinuity in rock blocks with falling potential and dominated discontinuities for risky blocks were identified. GPR measurements taken with 500 and 800 MHz antennas on vertical and horizontal profiles on the rock slope were evaluated and the internal structure of the slope was displayed in 2 and 3 dimensions to characterize the cracks and fractures. Moreover, electrical resistivity measurements (hard surface measurement) on the risky blocks in the rock slope were conducted and ultrasonic velocity measurements on the samples taken from the blocks were performed to determine the rock quality. The all data were evaluated together and the risky rock blocks were classified in terms of risk of falling according to rock quality and fracture-crack condition. According to the results obtained, it is proposed that some of the blocks on the slope should broke down and some of them are fixed with stainless steel nets.