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Identification of Underground Formations of Bayburt Kırklartepe Dam Using Vp and RQD Parameters*

Mahmut SARI[1] & Aysel ŞEREN[2]

Keywords
Kırklartepe Dam, P-wave velocity, RQD.

Abstract
It is very important to determine the rock and ground conditions of large engineering structures such as dams with preliminary geotechnical studies. In this study, Kırklartepe Dam in the central district of Bayburt was chosen as the study area, and the underground formations and geometry of the dam axis location were tried to be determined by geological and geophysical methods. For this purpose, the Vp velocity value was determined by applying the Seismic Refraction Tomography (SRT) method, one of the geophysical methods, on vertical lines instead of the dam axis in the study area. In addition, the RQD values were determined by examining the basic drilling samples taken at the dam axis site. The underground zoning with depth has been made by considering the Vp and RQD parameters obtained from SRT and RQD measurements applied at the dam axis site. In this study, the P wave velocity, which characterizes the alluvial zone obtained from the SRT measurement results, ranges between 300-950 m / s, and the alluvial zone thickness varied between approximately 0-15 m depth. In the SRT measurements made on the right and left slopes of the dam axis, it was determined that the transition from bad rock structure to very bad rock characteristics according to the RQD values and the velocity values from approximately 3200 m/s to 2200 m/s indicates the formation of a possible fault in the field of study.

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1. Introduction

Physical and mechanical properties of lithological units are of primary importance in dam studies. The physical properties of the investigated units such as magnetic sensitivity, sound wave velocity and electrical resistivity create geophysical responses, and with the help of these reactions, the structural and sedimentological properties of the units forming the study area provide the opportunity to better define. Before the construction of engineering structures such as dams, geophysical and geological studies are widely used in the planning phase, in determining the lithological characteristics of the area where the

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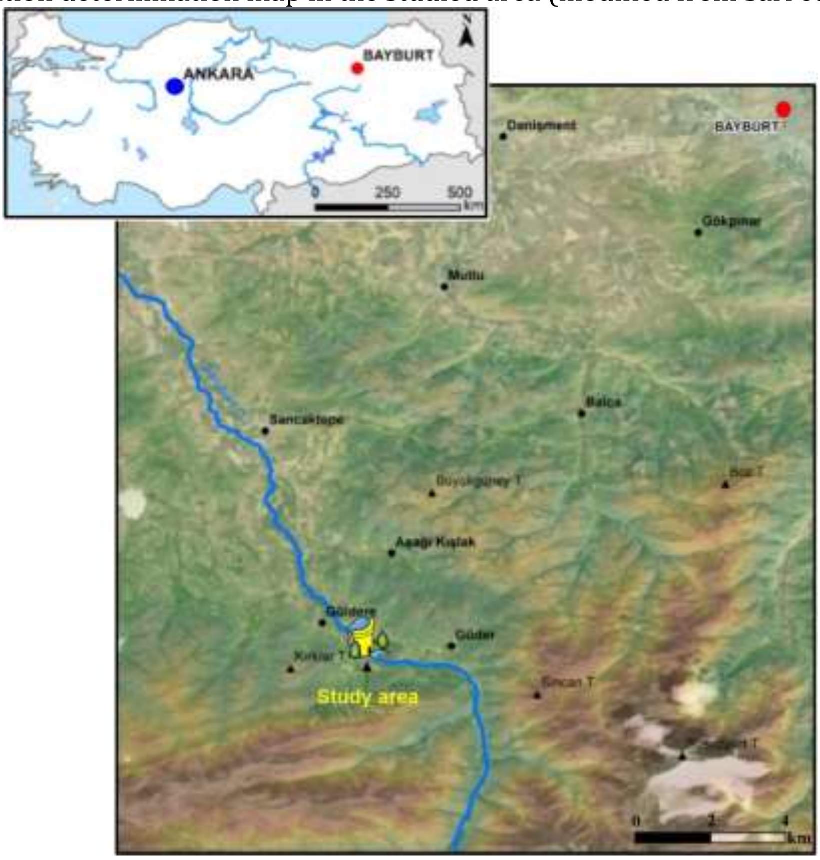
[1] Corresponding Author. ORCID: 0000-0002-6889-5512. Assoc.Prof, Gümüşhane University, msari@gumushane.edu.tr
[2] ORCID: 0000-0003-1134-061X. Prof. Dr., Karadeniz Technical University, aysel.seren@gmail.com

structures will be built. (Sari and Öztürk, 2018). The SRT method from geophysical studies is widely used to calculate interface geometry (Gaba `s et al., 2014; Pandula, 2000), in determining the physical properties of rock sedimentary layers (Marti et al., 2006; Gabr et al., 2012), identifying environmental and groundwater problems (Brixova et al., 2018; Geissler, 1989), in dam site works (Sari et al., 2020, Algül, 2011). The RQD value calculated to determine the rock quality in geological studies has been used in many studies in the literature (Zhang, 2016; Vali and Arpa, 2012).

Kırklartepe Dam site, located approximately 850m southeast of Göldere village in the central district of Bayburt province, has been determined as the study area as the study area. (Fig 1). The lithological features and underground geometry of the Kırklartepe dam axis location were tried to be determined by geophysical and geological studies. For this purpose, a two-dimensional zoning of the dam axis location was created considering the geophysical and geological parameters (P-wave velocity and RQD, respectively), and the variation of the rock mass with depth was tried to be determined.

Fig 1. Location determination map in the studied area (modified from Sari et. al., 2020)

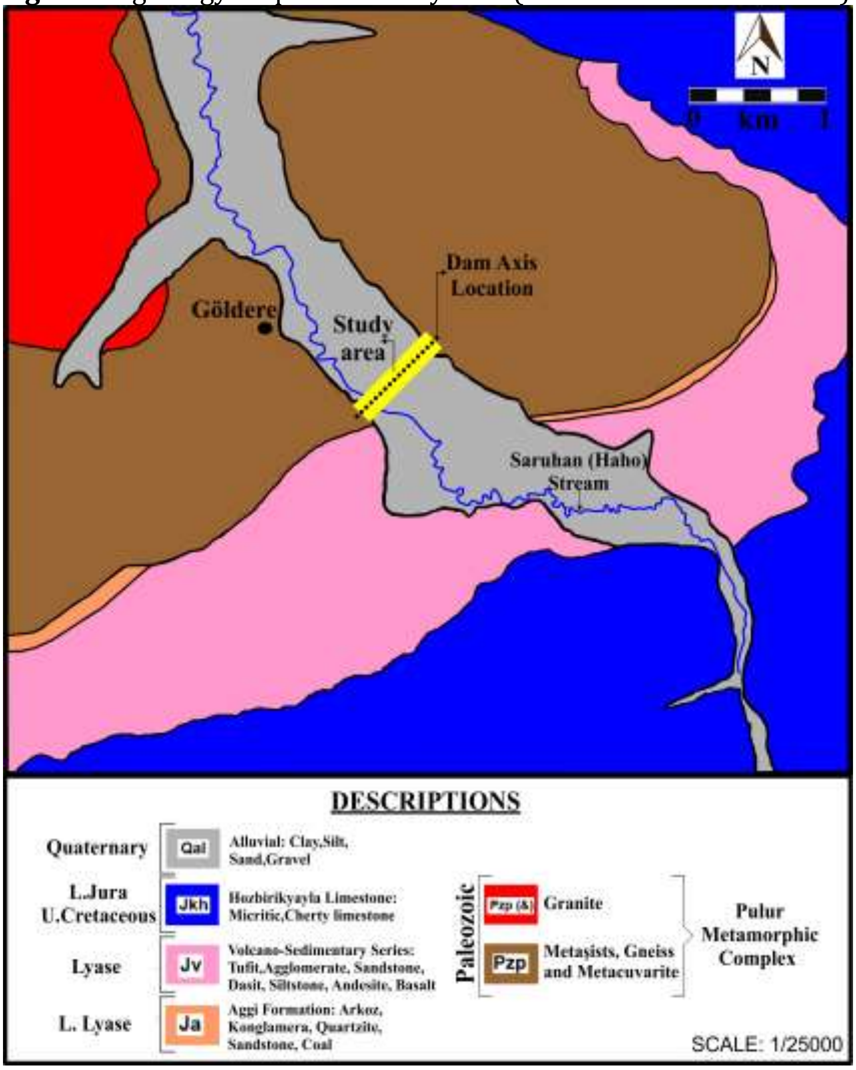


2. Geology and Methodology of the Study Area

At the base of the study area there are Pulur Metamorphics (Pzp) with amphibolite facies of Paleozoic (≥323 My) aged and many tectono-metamorphic units metamorphosed under high Pressure-Temperature (P-T) conditions (Topuz et al., 2004). In the study area, the Pulur metamorphic complex crops out on both slopes of the dam axis, under the alluvium in the thalweg and in the lake area. Alluviums

(Qal) are in the form of a mixture of gravel, sand, silt and clay-sized materials in different proportions, covering large areas where the creek meanders along the Haho stream in the dam axis and in the lake area. Its thickness varies between 12.40-14.70 m in the dam axis location and in the lake area. The slope debris is in the form of a mixture of materials such as blocks, gravel, sand, clay-silt, which are formed by the decomposition and fragmentation of the base rock on both slopes at the axis of the dam, and its thickness varies between 0.4-4.0 m. (Fig 2).

Fig 2. The geology map of the study area (modified from MTA 1985).



Seismic refraction tomography is a tomographic inversion of the initial arrival times to obtain the image of the P-wave velocity distribution on the ground. It requires a lot of travel time data compared to conventional seismic refraction and provides reliable and detailed determination of seismic velocity change in lateral and vertical directions. (Sheehan vd., 2005). SRT method aims to analyze the shallow underground velocity structure from the first arrival times obtained from seismic records. The layout of the source and geophones used in the SRT method and the source measurement points are given in Fig 3a. After the SRT analysis, the first arrival times were peaked accurately and reliably, the two-dimensional seismic velocity-depth section of the shallow underground structure was obtained by subjecting the inverse process in computer environment.

RQD is a numerical index in which the ratio of the total length of the core pieces 10 cm or more in length and maintaining their cylindrical shape to the length of the feed gap, separated by natural discontinuities in a feed range, is expressed in percentage. RQD is determined by the equation given below (Deere, 1964).

$$RQD = \frac{\sum_{i=1}^{n} l_i}{L}$$

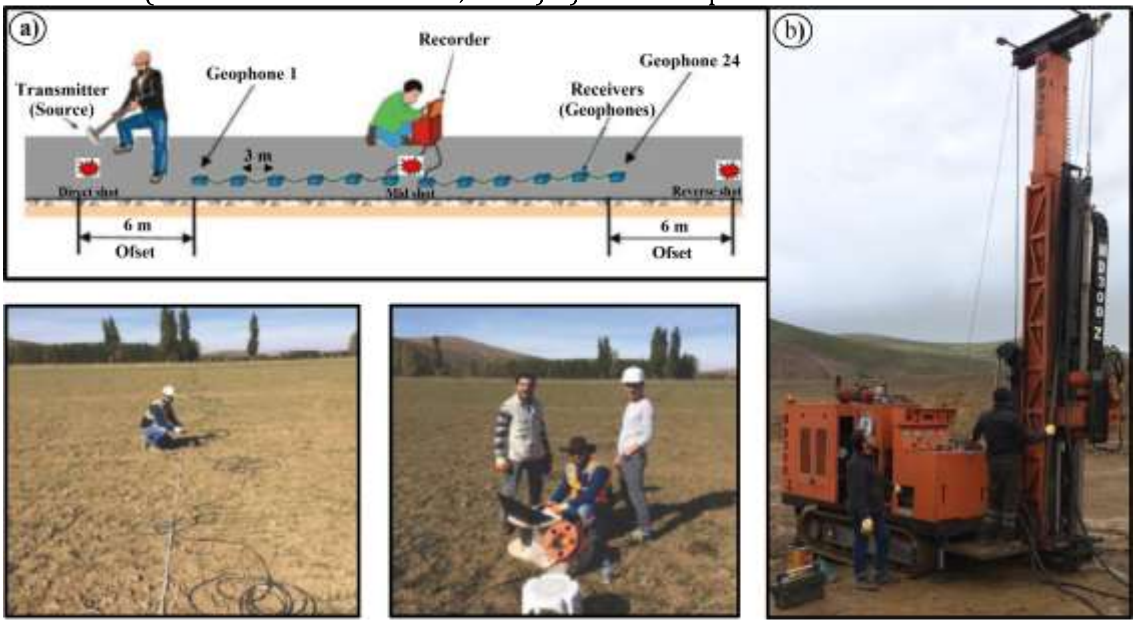
Here, n is the number of core pieces in the advance range, the lengths of the core pieces included in the RQD and whose length is 10 cm or more, and L is the advance length. Deere (1964)'s RQD classification is given in Table 1

Table 1. RQD classification in Deere (1964)

Rock-quality designation (RQD)		
ROD Limit Value	**Rock quality**	**Zoning color scale for our study**
90-100	Very good	
75-90	Good	
50-75	Middle	
25-50	Bad	
0-25	Very bad	

Six basic (BH_1-BH_6) exploration drillings with a total length of 240 m were opened with the dam axis in place. n addition, two (BH_7, BH_8) boreholes with a total length of 40 m were drilled on the right and left slopes of the dam axis within the scope of this study. RQD values varying with depth were determined from the obtained core samples.

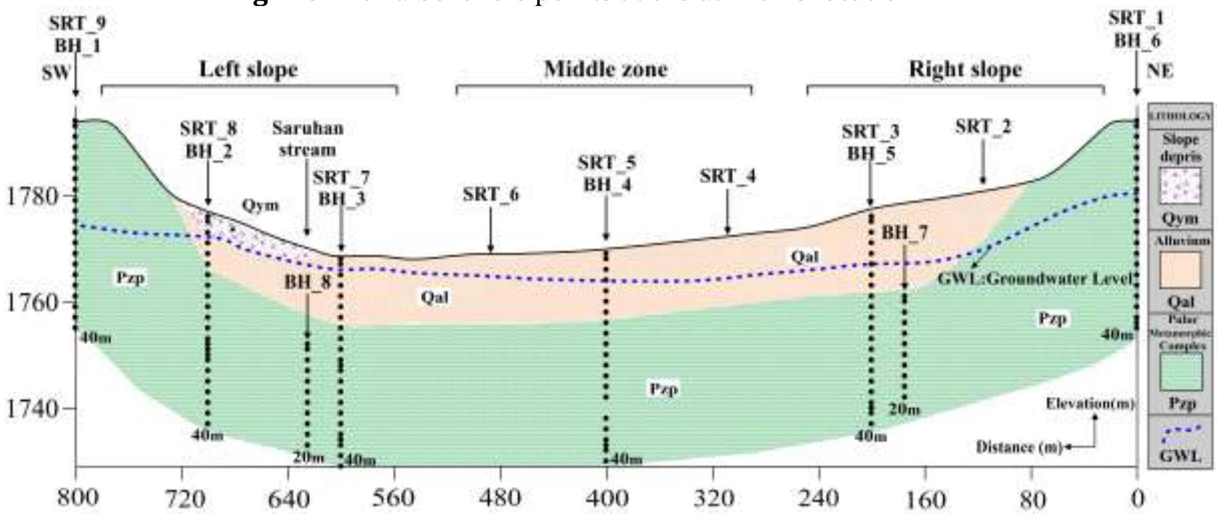
Fig 3. a)Measurement setup of the source and geophones used in the SRTmethod (modified from Said et al., 2015) b) Borehole process at the dam site



3. Results and Discussions

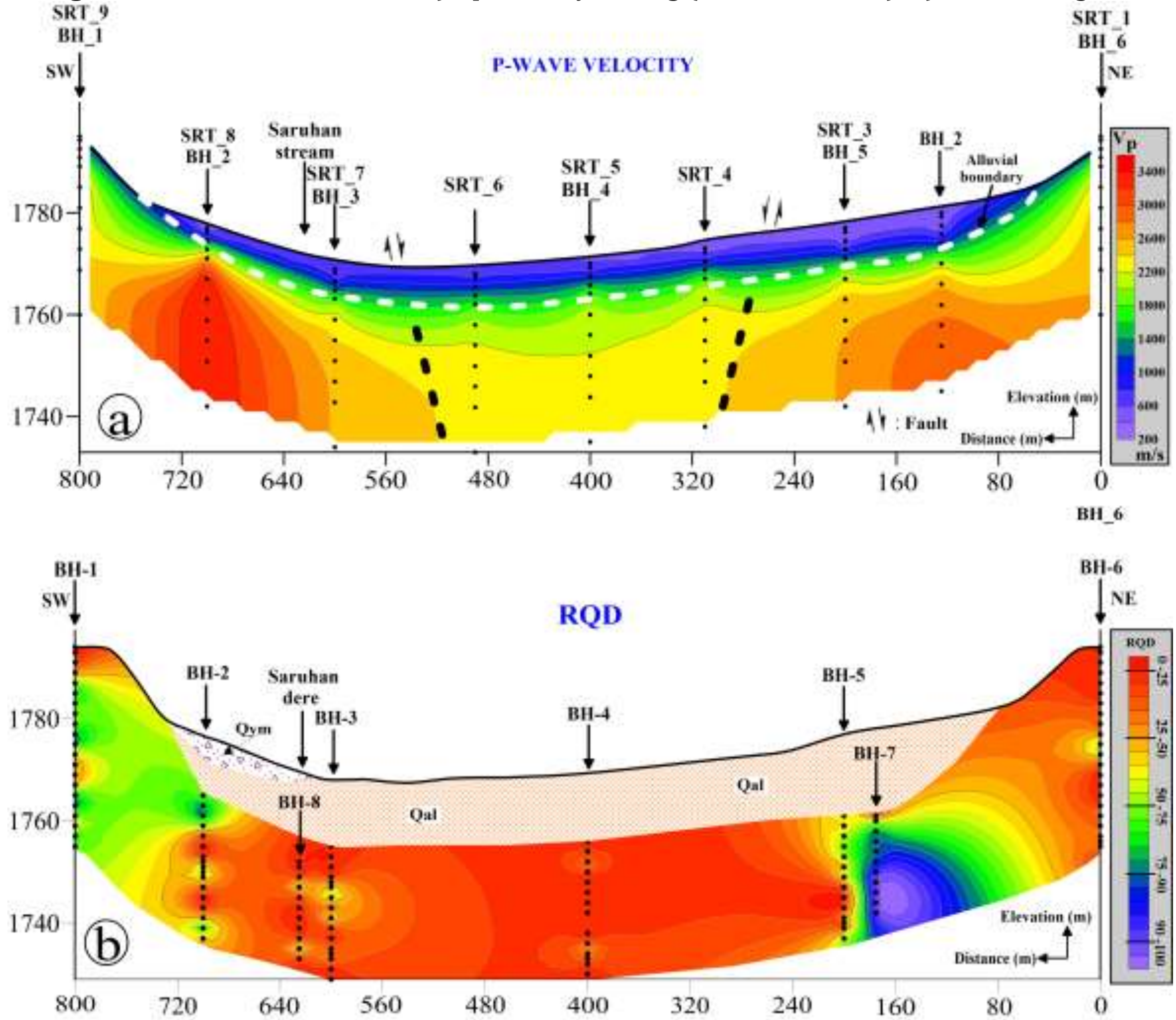
In this study, the measurement lines and endoj locations taken at the axis of the dam axis by using geophysical and geological methods at the axis of Bayburt Kırklartepe Dam are given in Fig 4.

Fig 4. SRT and borehole points at the dam axis location



Two-dimensional P-wave velocity zoning was made by taking SRT measurements on a total of 9 lines at the dam axis site, taking into account the velocity values varying with depth (Fig 5a). As a result of on-site tests in all boreholes drilled, two-dimensional RQD zoning of the base rock varying with depth was made (Şekil 5b).

Fig 5. At the dam axis location a) Vp velocity zoning (Sari et al., 2020), b) RQD zoning



According to the P-wave velocity zoning, the velocity values at the dam axis range between 200-950 m/s and characterize the alluvial zone in the range of about 0-15 m. The velocity changes of the metamorphic rock mass increase from the surface to the deeper, changing between 1000-3200 m/s. This situation indicates that as the rock mass goes deeper, it changes from fractured with multiple cracks to fractured structures with few fractures. When the seismic line data no SRT_4- SRT_6 made in the middle zone are examined, it varies between 1000-2400 m/s speed range as the rock mass is fragmented. In addition, the continuity of the velocity change of the massive rock mass at the same depth with the seismic rupture line SRT_2 could not be observed. Sudden velocity changes in seismic lines indicate that the rock mass in the study area is fragmented and weathered, and therefore fault probability is high in such areas. In the seismic line measurements SRT_8, SRT_7 made on the left slope, according to the RQD values, the transition from bad rock structure to very bad rock characteristics and the transition of velocity values from 3200 m/s to 2200 m/s, both the sudden change in velocity values and The fact that the rock mass shows very bad properties according to the RQD values increases the probability of a fault here.

When the borings BH_7 and BH_5 made on the right slope of the dam axis are examined, the borehole numbered BH_7 shows very good-good rock quality characteristics according to the RQD classification, while the borehole numbered BH_5, which is made about 20 m in the middle zone direction, shows very bad-bad characteristics. This situation indicates that there is a fault between the two examined boreholes.

4. Conclusions

The lithological properties and underground geometry of the dam axis location were revealed by geophysical and geological methods.

In the seismic line measurements SRT_8, SRT_7 made on the left slope of the dam axis, the transition from bad rock structure to very bad rock characteristics according to RQD values and the transition of velocity values from 3200 m/s to 2200 m/s, sudden The change, as well as the very bad characteristics of the rock mass according to the RQD values, increases the probability of a fault here. In the seismic line measurements no SRT_2 and SRT_4 made on the right slope, it was determined that the rock structure showed a transition from very good rock quality to very poor rock quality and the velocity values decreased from 3000 m/s to 2200 m/s, again due to a fault formation.

Drilling works and on-site experiments to determine the basic soil properties in dam axis location and lake area investigations are expensive and time consuming, and geophysical methods should be used with low cost and practical measurement methods and such researches should be generalized and drilling locations should be determined at the necessary points.

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