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Importance of ground properties in the relationship of ground vibration–structural hazard and land application

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ABSTRACT

Vibration parameters like frequency, acceleration and particle velocity play an active role in the relationship of ground vibration–structural hazard. These parameters change depending on blasting energy and the properties of rock environment. Therefore, in the first step, rock mass properties and possible directional variation were investigated by using different geophysical methods (electrical resistivity, seismic refraction and multi-channel analysis of surface wave) and current sounding information. Each method offers different sensitivities and resolutions depending on the physical characteristics of different materials. Evaluating these as a whole increased the solubility of the research. According to seismic S- and P-wave velocities, electrical resistivity and sounding information, the study area consists of consecutive sequences of alluvium, clay limestone, tuff and limestone units. And these units show variations from place to place in the study area. In the second stage, evaluations were made according to the structural hazard standards used widely in the literature and components of velocity, acceleration and frequency obtained from blasting vibration seismograph and accelerometers. As a result, it is seen that ground vibrations show different spreading properties in different directions and different hazard risks depending on the geological structure of the region.

1. Introduction

Today, measurement and control of blast-induced ground vibrations are inevitable in the regions close to the residential areas. While some part of the energy released as a result of blasting process was attenuated in the degradation of the rock, unattenuated part spreads outward from the blasting source as seismic waves in circular shape. Vibrations formed during the spread of these seismic waves cause the settlements located around the mine to suffer hazard risks and create financial and psychological disorders for people living there. Sometimes structures suffer damages because of high ground vibration and the people around the field and the field managers often encounter with each other (Khandelwal and Singh, 2009).

In order to determine in which level blast-induced ground vibrations damage the surrounding structures, many different hazard standards were developed. The most common parameters used for evaluating ground vibration and hazard relation are frequency and the peak particle velocity (PPV) (Ak, 2006; Arpaz, 2000; Khandelwal and Singh, 2009; Siskind et al., 1989). The PPV value is defined as the maximum value among the transverse, vertical, and longitudinal velocities of the propagating wave. Particle velocity shows variations depending on the distance from the blasting center and blasting energy, and it is affected by the properties of rock and ground where the wave transmitted while moving away from the blasting source (Dowding, 1985). While rock characteristics greatly change from field to field or one side of the step to the other side, they may show directional variations depending on discontinuities and geological structure. Seismic waves move in one direction in homogeneous and massive rock masses but they scatter to various directions in the rocks with more complex structures. The reason is that discontinuities, fillings and tectonic faults in the rock units change moving directions and intensity of the waves (Blair and Spathis, 1982; Cook, 1992; Fourney et al., 1997; Hao et al., 2001). For this reason, intensity of ground vibrations formed as a result of blasting made in a mine facility may give different directional values (Ak, 2006; Aldaş, 2002; Arpaz, 2000; Blair and Spathis, 1982; ISRM, 1992; Jimeno et al., 1995).

Mostly two devices are used to measure particle velocity and acceleration of ground vibration (Srbulov, 2010). The first one of these is called as blasting vibration seismograph; the other one is named as accelerometer. These devices can only measure one of these parameters directly and the others can be derived mathematically. Accelerometers are used to determine the vibrations with frequencies or amplitudes outside of working limits of blasting vibration seismographs. Resolutions of these devices are lower compared with blasting vibration seismographs in low frequency vibrations and they are more sensitive to

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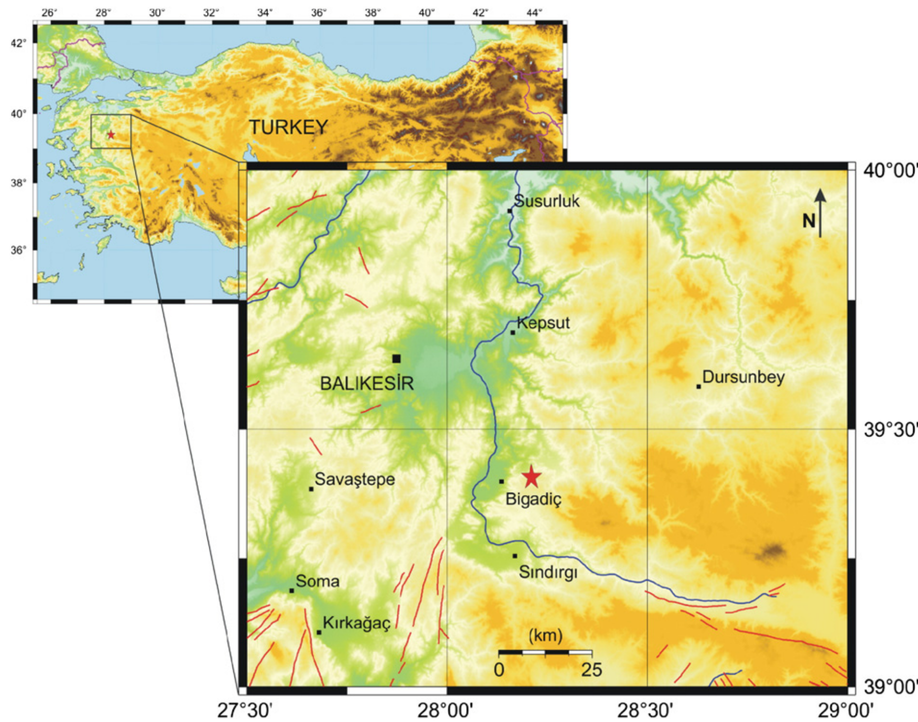

Fig. 1. Location map of study area.

unwanted noise (Srbulov, 2010). In addition, because of relocation values, long-period noises, filtering and signal processing errors, it cannot be determined precisely with accelerometers (Trifunac and Brady, 1975).

Response of the blast to any structure depends on ground vibration frequency. Frequencies below 10 Hz increases hazard possibilities since they cause high level deformations and big replacements in the environment and they increase hazard possibility (Siskind et al., 1980). Studies aiming to eliminate or minimize all the complaints arising from blast-induced ground vibrations were performed and hazard standard has been introduced in order to establish some standards (Bauer and Calder, 1977; BS 7385, 1993; CA 23, 1967; Crandell, 1949; DIN 4150 German Norm, 1999; Edwards and Northwood, 1959; IS 6922, 1973; Langefors et al., 1958; Nicholls et al., 1971; OSM, 1983; Rockwell, 1934; Siskind et al., 1980; SS 25210, 1996; Thoenen and Windes, 1942; Turkey Regulations, 2008).

It is intended to determine the properties of rock mass loosened with blasting made in ETIMINE Bigadiç Boron Processing Management Tülü Open Pit Mine and to estimate which level the vibrations damage the structure around depending on the environmental specifications and directions. Firstly, geophysical methods such as monitoring electrical resistivity, seismic refraction tomography and multi-channel

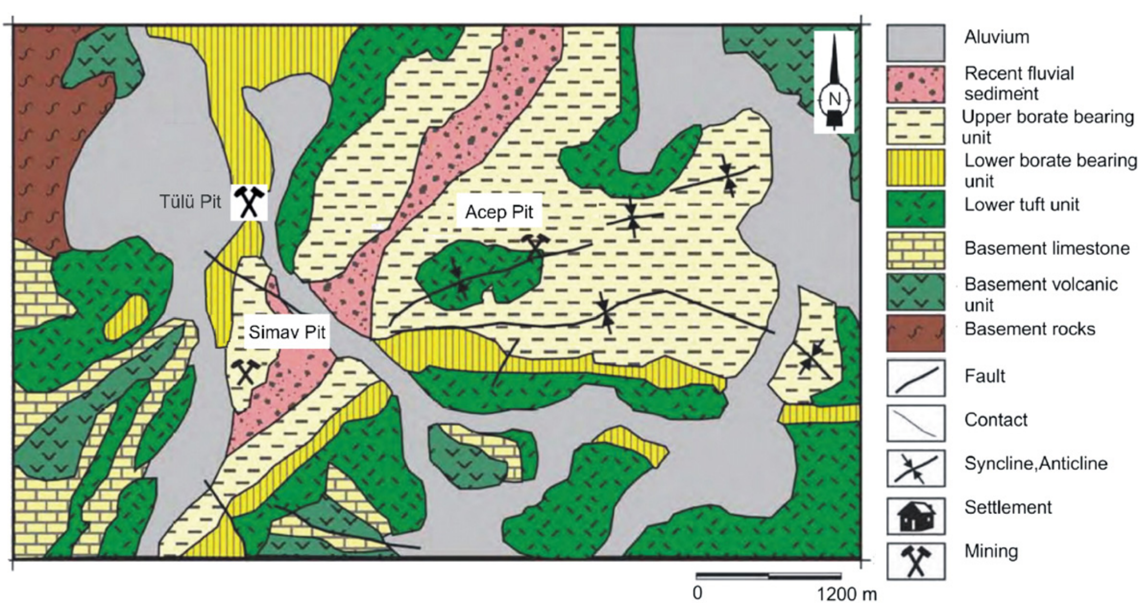

Fig. 2. Geological map of the study area.
(Modified after Helvacı and Alaca, 1991).