Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 191 (2017) 426 – 433

Procedia Engineering

www.elsevier.com/locate/procedia

Symposium of the International Society for Rock Mechanics

Changes of Physical Properties of Silesian Granite Due to Heat Loading

Alena Kožušníková[a,b]*, Pavel Konecny[a,c], Eva Plevova[a,b], Lucie Králová[a]

[a]*Institute of Geonics of the Czech Academy of Sciences, Studentská 1768, 708 00 Ostrava-Poruba, Czech Republic*
[b]*Institute of Clean Technologies for Mining and Utilization of Raw Materials for Energy Use, Studentska 1768, 708 00 Ostrava, Czech Republic*
[c]*Planetarium Ostrava, Faculty of Mining and Geology, VSB-Technical University of Ostrava, Czech Republic*

Abstract

Temperature affects both the physical and structural properties of rocks and there may even cause chemical changes of minerals. Rocks are more or less inhomogeneous material, so that during testing the same rock samples taken from one location the measured values of physical properties can vary on large scattering between test specimens. To eliminate the influence of inhomogeneity of rock, we analyzed the effect of heat loading (up to 700˚ C) on the same specimens. For this reason we have used in our research particularly non-destructive testing methods – determination of bulk density, measuring of longitudinal ultrasonic wave propagation velocity, thermal conductivity and volumetric heat capacity. Besides the physical characteristics determined in the same specimen before and after tempering gas permeability and thermal expansion untempered and tempered test specimens was determined. Hg porosity and total porosity of untempered and tempered specimens were found, too. As model material was chosen so-called Silesian granite from Nový lom quarry (Žulová pluton, Czech Republic), which has been previously tested, and over macroscopically homogeneous character the variances in the measured parameters were found. Hg and total porosity and gas permeability increase with increasing temperature. The bulk density, the ultrasonic wave propagation velocity and thermal conductivity decrease with increasing temperature. The most sensitive parameters are ultrasonic wave velocity, thermal conductivity and permeability.

Peer-review under responsibility of the organizing committee of EUROCK 2017

Keywords: granite; temperature; physical properties

* Corresponding author. Tel.: +420-596-979-337.
E-mail address: kozusnik@ugn.cas.cz

Peer-review under responsibility of the organizing committee of EUROCK 2017
doi:10.1016/j.proeng.2017.05.200

1. Introduction

A lot of experts [1–8] studied the effect of thermal loading on the rocks. Temperature affects the porosity, microcracking, ultrasonic wave velocities, thermal conductivity, strength and permeability of rocks and there cause rock expansion and even chemical changes.

Rock is usually more or less inhomogeneous material. To eliminate the influence of inhomogeneity of rocks, we analyzed the effect of heat stress on the same specimens. We have used in our research particularly non-destructive methods – determination of bulk density, measuring the longitudinal ultrasonic waves velocity, thermal conductivity and volumetric heat capacity.

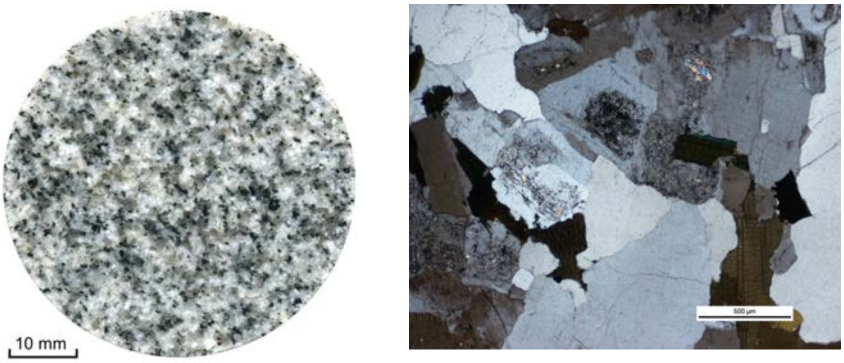
Besides the physical characteristics determined on the same specimen before and after tempering was determined porosity, gas permeability and thermal expansion untempered and tempered test specimens.

2. Tested material

As model material was chosen so-called Silesian granite from Nový lom quarry (Žulová pluton, Czech Republic), which has been previously tested, and over macroscopically homogeneous character the variances in the measured parameters were found.

Petrographic analysis and classification of the tested rock was carried out according to [9–12]: biotite granite, medium-grained texture, massive structure, with equable granularity.

Contain of xenomorphic quartz grains – 49 %; xenomorphic feldspar grains – 26 %; xenomorphic plagioclase grains – 18 % and hypidiomorphic biotite grains – 7%. Typical structure of granite is shown in Fig. 1 (various magnification).



a) b)

Fig. 1. Medium-grained texture and massive structure of granite
a) polished area of tested specimen; b) thin section, transmitted polarization light, crossed nicols.

3. Detailed characterization of rock physical properties

The tested specimens of cylindrical shape with diameter of 48 mm were drilled from rock blocks for determination of most physical properties. The bases of samples were sawed by diamond saw and polished. The slenderness ratio of specimens was 2:1 (high:diameter), finally.

All tested specimens were characterized by bulk density (ρ_{00}) calculated from the mass of the specimen and the bulk volume and by the ultrasonic wave velocity of longitudinal waves (v_{p0}).

Coefficient of thermal conductivity (λ) and specific volumetric heat capacity (c_P) were measured by ISOMET 2104 firm Applied Precision on bases of above mentioned specimens.

The permeability measurements were realized in triaxial cell KTK 100 with maximum confining pressure up to 100 MPa. This equipment enables to input gas (nitrogen) with 3MPa of pressure to tested sample and measure the passed-through gas. During the experiments the constant confining pressure of 5 MPa was applied and axial