ABSTRACT

EFFECTS OF HEAT TREATMENT AND FREEZE-THAW CYCLING ON MECHANICAL BEHAVIOR OF ROCKS

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This research presents comprehensive results about the impact of the thermal fluctuations on the physico-mechanical properties of various rock that include limestone, sandstone, granitic gneiss, rhyolite, quartzite, dolerite, gabbronorite, amphibolite and granulite collected from different tectonic zones of northern Pakistan. In the first phase, the selected rock samples were subjected to heat treatment at different temperatures, ranging from 150°C to 1000°C for 24 hours. The rocks were also subjected to freeze-thaw cycling from 25°C to -40°C. The duration of single freeze thaw cycle lasted for 8 hours with 4 hours for each freeze and thaw. Destructive (uniaxial compressive strength, point load index) and non-destructive tests (specific gravity, ultrasonic pulse wave velocity, porosity, and water absorption) were conducted to assess the rocks' responses to varying temperatures. The density of induced fractures is calculated for each rock type at the investigated temperatures and also after 50 and 100 freeze-thaw cycles. The results indicate a reduction in uniaxial compressive strength, specific gravity, ultrasonic pulse velocity, and point load strength as the temperature increases or decreases. After thermal treatment of samples at a temperature of

1000°C, the uniaxial compressive strength (UCS) exhibited reductions of 89% for granitic gneiss, 87% for rhyolite, 82% for dolerite, 84% for quartzite, 80% for gabbronorite, 77% for amphibolite, and 74% for granulite compared to the similar sample that is tested at 25°C. Similarly, the aforementioned samples experienced reduction of 17.65%, 13.58%, 10%, 11.95%, 7.43%, 6.98% and 4.47% respectively in the UCS after 100 freeze thaw cycles. Furthermore, limestone and sandstone deteriorated earlier during the thermal treatment i.e. Limestone's UCS decreased to 71% at 600°C, while sandstone experienced a complete reduction of 89% in UCS at 800°C as compared to the similar sample that is tested at 25°C. While, the UCS of aforementioned samples reduced to 22.45% and 28.57% respectively after 100 F-T cycles. Conversely, fracture density, porosity, and water absorption levels increased with elevated temperatures. These findings demonstrate the degradation of rocks and changes in their physico-mechanical properties due to thermal fluctuations, which has significant implications for industries such as mining and construction.