



The effects of hydrothermal alteration on physical and mechanical properties of perlites (Yagodninskoe deposit, Kamchatka Peninsula)

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Yagodninskoe deposit of perlites and zeolites are located on the South Kamchatka. This deposit is confined to a complex volcanic massif of Neogene-Pleistocene age. Perlites form several lava flows and extrusive dome. It is established that perlites are composed mainly of acidic volcanic glass, partially hydrated, with rare phenocrysts of K-Na feldspar (sanidine), plagioclase (oligoclase), and biotite. Some perlites contain spherulites, which are polymineral aggregates composed of K-Na feldspar and cristobalite, sometimes with microcrystals of ilmenohematite. A characteristic feature of perlites is the concentric microcracks, that were probably formed as a result of compression stresses arising during crystallization of water-containing volcanic glass. Later perlites were transformed under the action of hydrothermal-metasomatic processes. Secondary alterations occurred in several stages, beginning with small cracks and ending with the entire volume of volcanic glass. High-silica zeolites (clinoptilolite, heulandite and mordenite) and smectites prevail among the secondary minerals. It should be noted that hydrothermal alteration affects only volcanic glass, while phenocrysts of feldspars, plagioclase and biotite remain unchanged. The composition of the secondary minerals and the character of the alteration indicates that the composition of thermal solutions was alkaline, and the temperature did not exceed 150-200 °C.

Four groups of perlites were distinguished by the degree of alteration - unchanged, weakly, moderately, and highly altered. In the final stage, secondary minerals substitute more than 80% of the rock's volume. The degree of alteration significantly influences on physical and mechanical properties of perlites. Unchanged perlites has relatively high values of bulk density (2200-2280 kg/m³) and elastic properties (E=25,6-39,5 GPa), and low porosity (5-7%). The uniaxial compression strength, despite the similar density of rocks, varies in a wide range and depends on microcracks intensity. Secondary transformations of perlites significantly change their properties. In general, there is a tendency to decrease in density, magnetic susceptibility (by an order of magnitude), elastic modulus (in two times), and increase in porosity, water absorption, and hygroscopic moisture. The change in strength under the influence of the hydrothermal process is ambiguous. In the first stage, due to the filling of multiple cracks with zeolites, the strength increases, but further transformations affecting volcanic glass lead to a reduction in strength. It should also be noted, that the degree of alteration effects on the character of the rock failure.

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