Influence of secondary changes on the physical and mechanical properties of volcanic rocks in Yagodninskoe zeolite deposite in Kamchatka Peninsula

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Yagodninskoe deposit is a large deposit of natural zeolite which has been prospected in Kamchatka Peninsula. It is confined to the extrusive-subvolcanic complex of the Miocene-Pleistocene age and belongs to the same named ore-forming hydrothermal-magmatic system.

The studied zeolite-bearing productive stratum was formed under intense heating of perlites and tuffs dacitic and liparytic composition in the upper part of the hydrothermal system.

The main target of presented research is to study alterations of volcanic rocks, to identify types and morphology of zeolites, to determine petrophysical properties of host rocks and to assess the effect of hydrothermal alteration on rock properties.

The host rocks are mostly lapilli, or rarely coarse ash tuffs, consisting of a combination of crystal, rock and glass fragments cemented with vitric matrix. Under the action of thermal water tuffs change their composition, pore-space morphology and volume, and properties, finally transforming into zeolitic or argillic-zeolitic rocks. The original mineral assemblages of volcanic rocks are dissolved and replaced by secondary minerals among which zeolites (clinoptilolite, mordenite, heulandite) are the most abundant; silica oxides, smectites, chlorite, and calcite also occur (figs. 1, 2). Volcanic glass are the most sensitive to alteration totally replaced by zeolites; pyroxene and plagioclase are more stable, while magmatic albite and quartz are the most stable. The intensity of alteration changes from medium to almost 90-95% altered rocks. By the degree of secondary transformation rocks are divided into three groups: almost altered (amount of secondary minerals to 95%, zeolite content up to 90-95%), highly altered (amount of secondary minerals to 85%, zeolite content of about 80%) and average change (amount of secondary minerals to 60%, zeolites - up to 35%). Zeolites substitute volcanic glass, fill pores and fractures, and occur as filmy cement.

Several generations of zeolites, differing in crystal size, morphology and composition were revealed. In general, tuffs are characterized by high porosity but low permeability; they are weak or moderately weak and are resistant to water saturation. The highly argillized tuffs are the weakest and unstable in water-saturated state. It was found that strength and elastic modulus decrease along with increasing porosity and intensity of alteration.

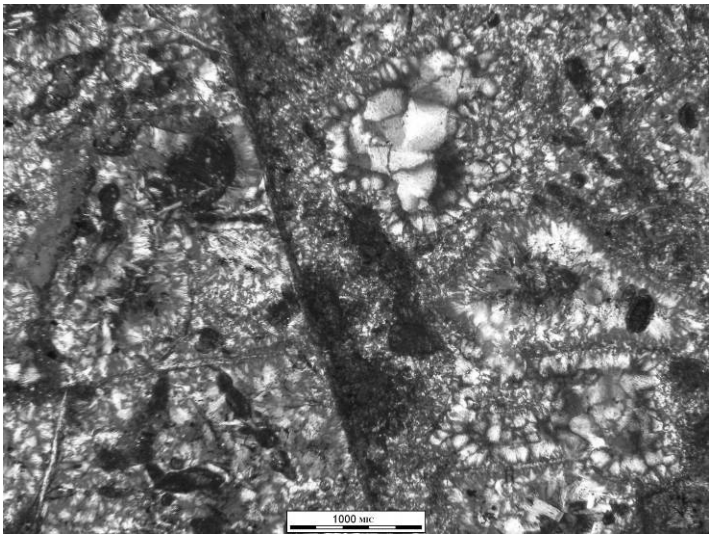

Fig. 1.: Alteration of vitroclasts in almost altered tuff by zeolite and smectite (photo of microsection +N).

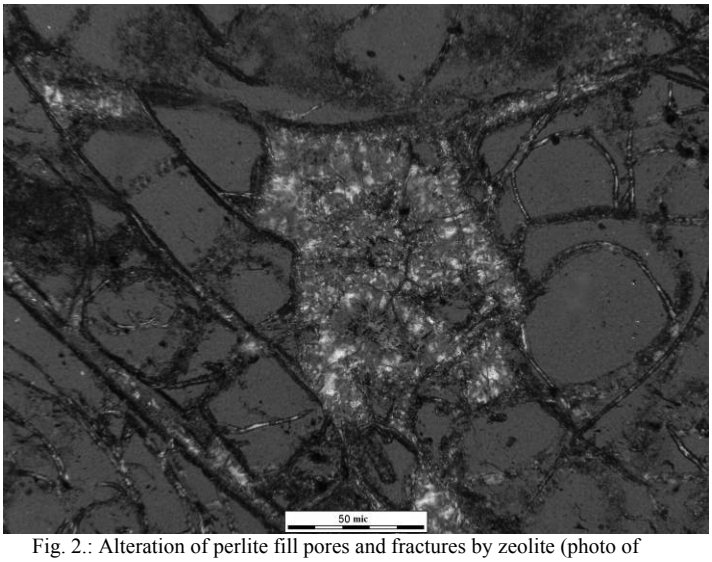

Fig. 2.: Alteration of perlite fill pores and fractures by zeolite (photo of microsection +N).