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Microfissuring, host rock heterogeneities and SNF storage potential at the Krasnokamensk area, NE Transbaikalia

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Crystalline rocks, such as granites, are hosted economic uranium deposits and practically viewed as suitable settings for constructing underground facilities with a view to spent nuclear fuel (SNF) long-term storage or high-level waste (HLW) disposal. The evaluation of mineral resources and safety of the facilities directly depends on the identification of the most probable pathways of fluid flow in connection with spatial-temporal evolution of radionuclide transport conditions. The main aim of the contribution is to combine data on the consecutive stages of deformation, inflow and migration of palaeofluids and accumulation of mineral filling with uranium traces within the faulted-fractured environment at the Krasnokamensk Area, SE Transbaikalia, Russia. The area is conversationally under assessment of the initial data to set-up internationally accepted SNF storage facility. Object of examination is a framework of faulted zones transecting potential sites at the Proterozoic-Paleozoic granitic unit to the extent of northwestern part of uranium-bearing Streltsovskaya caldera of Mesozoic age. Considerations of stress- and permeability-time relationships in faulted-fractured zones were taken with account of stress and strain dependencies within fluid saturated rock massifs at crustal seismogenic level. Stress-time consecution of fault zone permeability was developed using set of fieldwork and lab tests including structural-geological survey, fault slip data analysis, mineral-chemical diagnostics, microstructural observations, and fission track radiography studies. The spatial distribution and geometric characterization of damage at microscale have been analyzed with Fluid Inclusion planes (FIPs) and Open Fissures (OFs) using digital images of thin sections. Oriented hand specimens taken from basic points were preliminarily saturated in vacuum with fluorescent gel at room temperature for 10 days; afterward, polished thin sections were prepared. The saturation of the pore space with low-viscosity gel did not lead to thermomechanical changes and simplified the procedure of identification of OFs or partly mineralized fractures in digital images. The spatial orientation of fault and fracture zones broadly coincides with the orientation of FIPs and OFs, indicating a single mechanism of their formation at diverse tectonic conditions. The dynamics of fluid permeability of the fault zones was reconstructed using spatial distribution and orientation of FIPs (the AnIma video screen method) in connection with data on faulting regimes. Comparative analysis shows that orientation of FIP and fault networks coincides. That denotes the unified mechanism of their formation during different tectonic events: Proterozoic, Caledonian, Variscan, Late Mesozoic, and probably Cenozoic. Three groups of FIPs prevail: NE-SW, NNE-submeridional, and NW-SE. Herewith the NE-SW-trending FIPs form considerable cluster within the NE-SW faulted zone of initial ductile deformation (schistosity). Integrated consecution of the faulting periodicity and hydrothermal events at the NW granitic frame of the caldera is presented at stress-time diagram. The periodicity of structural, deformation and hydrothermal processes coincides on a first approximation with stages of the seismic cycle when long-continued period of the stress accumulation concurs with interseismic stage while relatively compact sequence of stress relieving accedes with preseismic, coseismic, and postseismic stages. The level of structural destruction is governed by magnitude of compression, tension and shearing stress, ultimate yield and shear strength of rocks, fluid pressure and thermal gradient. Detection the hydraulically active heterogeneities allows us to select localities for further examination with a view for SNF long-term storage into the granitic environment.