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Transform fault zones of the oceanic crust and the role of serpentinite layer in formation of hydrocarbons (Sakhalin Island as an example)

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Hydrothermal fluids migrating in the faults filtrate through the sedimentary cover, and form hydrocarbon and gas hydrate deposits. Transform plate boundaries represent wide zones of deep-seated faults along which the plate motion realizes. Queen Charlotte fault extending along the Western Canada coast and the western part of Aleutian Trench from the Bering Island to Kamchatka, transform fault near Sakhalin Island are the examples of the plate boundaries in the Pacific Ocean. Geological situation in the Gulf of California with enormous sedimentation rates is unique. Therefore, long-living deep-seated faults dissecting sufficiently old oceanic crust with a thick sedimentary cover are more prospective for a possible formation of large hydrocarbon accumulations.

Geological situations favorable for hydrocarbon deposits formation and similar to that along transform plate boundaries may also occur at tectonic boundaries of microplates. In particular, a similar situation is observed at the western boundary of the Sea of Okhotsk plate formed by a long-living dextral fault. For example, a considerable dextral dislocation occurred in the focus of Neftegorsk earthquake. In general, the Sakhalin tectonic boundary zone is characterized by a rather weak shallow-focus seismic activity.

The depression extending along the western coast of Sakhalin Island represents a graben-like structure controlled by meridionally oriented fracture zones with transverse faults of NW and NE strikes and with both lateral and vertical displacements of

crustal blocks. It is filled mainly with Neogene sediments of a great thickness (9—10 km). This basin is formed due to Paleogene—Early Miocene rifting destruction. Deep-seated faults at the microplate boundaries dislocate not only the crust, but also upper mantle rocks resulting in their intense serpentinization. High heat flow values ranging from 23 to 330 mW/m^2 give the evidence of intense hydrothermal activity in the deep-seated faults. Serpentinite bodies exposed on the north-eastern coast of the Sakhalin Island support this suggestion.

Prospective discovery of Sakhalin serpentinites increases considerably in the shelf structures obtained by seismic profiling and in conditions of rocks bedding. Seismic survey profiles on the shelf indicate presence of serpentinites in overthrust blocks. Traps of the serpentinization zone are characterized by the massive reservoir type and by pore-fissure and cavernous-fissure collector types. The decompacted serpentinite complex is prospective throughout the north-eastern Sakhalin shelf (from the Shemyatin sector in the north to the Pogranichnyi sector in the south). However, traps within Trehbratskaya and Eastern Odoptinskaya anticline zones are of the highest potential, because they have a favorable combination of oil and gas generation accumulation conditions.

Density and capacity parameters of the serpentinite collectors are confirmed by seismic survey data. Recovered core samples of serpentinite contain visible bitumoid inclusions. Serpentinites of the overthrusted plate are underlain and overlain by rocks of the Nilsk complex. This considerably increases a possibility of hydrocarbons accumulation in fractured zones of the massif. North Kaigan and East Odoptinsk structures represent first-priority objects for prospecting and exploration works. Estimates of possible hydrocarbons reserves for the East Odoptinsk structure show that a large oil and gas-condensate deposit with geological hydrocarbons resources (sum of oil, gas, and condensate) about 300 million tons may be discovered here.