stage of cycle the previously formed continental margin is subjected to deep transformation again leaving in the structure of newborn margin only some relics of the previous ocean crust known as ophiolites. However, as the study proves, complete destruction of the previous continental margin is not reached. Always or quite often it is preserved a significant part of newborn continental crust accreting laterally an existing continental plate and modified during further transformations passing though consecutive stages of states that could be called a vertical line of the tectonostages for particular continental margin. Evidence for that conclusion is an age rejuvenation of the continental crystalline crust while moving from the central parts (shield) towards their outskirts (continental margin). It is proposed the geological timescale of tectonostages derived from the Wilson cycle and established their time boundaries for the last 2500 million years. Along with the developed model for continental margins evolution it allows application of the concept of horizontal sequence of tectonostages transition into vertical and vice versa to study structure of continental margins [Karpenko, Prykhodchenko, 2009]. It is supposed that for the Wilson cycle of 1200 million years every continental margin is subjected to the tectonic process as follows. During the first stage of a divergent epoch (0—200 Ma) a new oceanic basin is forming due to a continental rift. Present-day example of such a rift one can consider the Red Sea Rift and latitude-oriented rift system between North and South America stretched into the Pacific and Atlantic Oceans. Predecessor of the future Red Sea ocean was Tethys and Prototethys paleo-oceans originated during the stages of 590,75—385,75 Ma and 992,5—793,0 Ma ago. The Tethys is corresponding to present-day Alpine-Himalayan orogenic zone and related sedimentary basins, and the Prototethys ones to the Donbass Foldbelt and its eastern prolongation into Karpinskiy Ridge. Rejuvenation of continental margins age towards the periphery of the continents set the problem of studying evolution of those margins applying concept of vertical and horizontal sequences of tectonostages. For this purpose the model of evolution (tectonic stratification) of continental margins is developed. It includes six stages of tectonic evolution: origination of a new ocean and its opening (divergent epoch of the Wilson cycle), stage of the oceanic basin shortening and thermal subsidence (convergent stage), the stage of partial inversion, and the next stage of the complete inversion along with the compression thrusting (collision stage) (Table). Corresponding to the stages is the types of crust being formed (ocean, quasi-ocean, quasi-continental, continental). The stages are divided into geosynclinal and orogenic sub-stages (the Bertran cycle). It is demonstrated that tectonostages and orogenies are matching (Alpine, Hercynian, Caledonian, Baikal and others) for the last 1500 million years. Actually, the features and direction of changes in vertical and horizontal sequences of continental margin tectonostages is a basic tectonic regularity to be studied because it determines existing types of sedimentary petroleum-prone basins, sedimentary complexes and separate prospects considered as hydrocarbon traps.

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Model study of influence of internal stresses on deformation and seismic processes in convergent plate boundary zones by the example of Lake Baikal ice cover

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An important class of problems in mechanics of heterogeneous media (including geological ones) is studying regularities of deformation and destruction of specific quasi-two-dimensional (plate) systems, whose structural elements are mainly located in one plane. A classical example of a natural plate medium is the lithosphere. Macroscopic geometry of the lithosphere and mechanic characteristics of substrate stimulate its fragmentation (breaking into ensemble of interacting plates) and appearance of specific deformation mechanisms, connected with removal of mature material from the plane of deformation (subduction) and formation of a new one (spreading). Studying zones of subduction and their influencing the stressed medium condition is one of the most urgent geotectonic and geodynamic problems, connected with understanding regularities of deformation processes in the lithosphere. Due to huge spatial and temporal scale of deformation processes in such zones, one of the perspective ways to analyze their peculiarities is physical modeling with the help of simplified model systems. As the results of previous researches have shown [Hamaguchi, Goto,1978; Psakhie et al., 2009], a perspective model medium for studying tectonic processes (in particular, the conditions of subduction zone formation and development) is a plate ice cover of large water reservoirs. The present paper is devoted to evaluation of typical level of stress in plate medium and the role of underride/subduction as relaxation mechanism by the example of Lake Baikal ice cover.

The conducted full-scale research have shown that regularities of localization of interplate deformations in the Lake Baikal ice cover are determined by distribution, value and sign of internal plate stresses. In particular, convergent interplate movements, leading to forming and developing underride zones (analogous to subduction zones in the lithosphere), are the results of increase in positive (stretching) stresses. Decrease in value and change of stress sign to negative result in partial consolidation of blocks consisting in "healing" some of previously active interfaces and localization of small, mainly divergent interblock movements on the rest of the interfaces. These regularities are consistent with modern conception on the connection between sign and value of regional tectonic stresses near interplate boundaries in the lithosphere and type of relative displacement of tectonic plates (convergent or divergent). It is important to mention that stress distribution inside the consolidated (i.e. not separated by through-thickness cracks) fragments of the ice cover is rather homogeneous and correlates mainly with the direction of movement of the fragments themselves. At the same time, stress state of neighbouring fragments can differ greatly. In accordance with traditional definition [Zoback,1992], stresses determining deformation processes on the ice cover interplate boundaries can be regarded as "tectonic". Thus, measurement results prove the existence of "plate tectonics" in the ice cover of Lake Baikal and support its usage for the physical modeling of tectonic processes in the lithosphere being grounded.

On the basis of measurements of internal plate deformations the threshold stresses of activation of convergent processes in the underride zones as high-rank deformation-induced structures are estimated. The value of these stresses is connected with inner cohesion on the most solid parts of interplate boundaries and, as a rule, varies within the range 2—10 % of the compression strength of plate material. In case of "healed" boundaries (after rather long "calm" periods of deformation activity) the activation threshold value can rise anomalously high (20—30 % of plate material strength). The recent research results show that high internal stresses can provoke changes of the character of deformation processes in a block-structured medium, including the appearance of "precursors" of dynamic convergent events and effects of fragmentation of consolidated blocks. It gives the ground to the supposition that anomalies of deformation regime of the Earth's crust, registered at various times before large earthquakes, seem to be connected with reaching a certain threshold level of stress in the area of registration. Basing on the data obtained on the ice cover we can suppose that a characteristic value of such strains can reach 20—30 % of rock strength.

It is important to mention that activation of interplate boundaries in the ice cover as a multiscale block-structured medium is preceded by the involvement of low-rank deformation mechanisms. As the seismic monitoring data show, the intensity of their involvement rises abruptly when the activation moment approaches. Alongside with it, immediately before the activation the number of relatively high-energetic seismic events increases, which reflects growing characteristic scale of the involved deformation mechanisms with the increase in internal stresses.

All said above indicates that both ice cover and the lithosphere are multiscale media with a hierarchical system of relaxation mechanisms. Each mechanism corresponds to a typical activation threshold (stress). Relaxation (and deformation) mechanisms with maximum involvement threshold are connected with the formation and functioning of interblock boundaries. Thereby, the ice cover of Lake Baikal gives a unique possibility to study the influence of a strained state on the regularities of deformation accommodation processes in block-structured (plate) media of different nature, particularly, in the lithosphere.

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Three-dimensional mantle lithosphere deformation at collisional plate boundaries: A subduction scissor across the South Island of New Zealand

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The continental plate collision across the South Island of New Zealand is highly oblique (dextral) and is bounded by oppositely verging ocean plate subduction zones — with north-west dipping Hikurangi subduction to the north and east-dipping Fiordland-Puysegur subduction to the south [e. g.; Okaya et al., 2007; and references therein]. As such, the region can be considered as a type of "subduction scissor". Within this tectonic context, we use three dimensional computational geodynamic models to consider how convergent mantle lithosphere can be modified by scissor and strike-slip effects. Bounding subduction at both ends of the continental collision causes flow of the descending mantle lithosphere in the direction along-strike of the model plate boundary, with thinning in the centre and thickening towards the subduction zones that bifurcates the continental mantle lithosphere root. With dipping bounding subduction, the mantle lithosphere root takes on a more complex morphology that folds over from one subduction polarity to the other, but remains as a continuous feature as it folds under the collision zone (Figure). In the absence of bounding subduction, the plate convergence causes a linear (along-strike) mantle lithosphere root to develop. A rapid strike-slip motion between the converging plates transfers material in the plate boundary-parallel direction and tends to blur out features that develop in this direction — such as descending viscous instabilities. The along-strike variations in the morphology of the mantle lithosphere root that develop in the models — viz., thickening of the root towards the subduction edges, thinning in the center — are consistent with recent, albeit poorly constrained, geophysical interpretations of the largescale lithospheric structure of the South Island [Kohler, Eberhart-Phillips, 2002; Scherwath et al., 2006]. We speculate that this reflects the nature of the evolution of the South Island collision as a limited continental segment of the plate boundary that it is dominated and guided by adjacent well-developed/developing ocean plate subduction. The modelling provides insights into how varying "three-dimensional effects" could influence the evolution of the continental mantle lithosphere at the South Island and may have implications for understanding other collisional zones where a continental plate ends or transitions into ocean plate subduction.