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Stress modeling for the Cascadia subduction zone

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Joint tectonophysical models including the geological-geophysical-tectonic structure, physical properties of the medium (density and rheology), and its loading mechanism (boundary conditions on forces and movements) are constructed along two profiles across the contrasting northern (Vancouver Island and British Columbia) and central (Oregon margin) segments of the Cascadia subduction zone, north-west Pacific margin of the North America. The models are based on physical parameters such as seismic velocity, density, and temperature and on knowledge of the lithological composition of the rocks. The numerical modeling of stresses caused by separate plate movements and density inhomogeneities is executed. Stresses distribution in the overriding continental plate is investigated depending on direction and velocity of oceanic plate movements and deep mantle flows, availability or absent of the "gap into the slab", etc. A tectonic interpretation for Cenozoic evolution of the crust and upper mantle beneath Oregon margin is offered. The key point is the detachment of the lower portion of the down-going oceanic Farallon slab ("break" of the slab) ˜ 42 Ma and the subsequent rearrangement of mantle convection flows. At that time a paleo mid-oceanic ridge was located close to the continental margin. After the "break" of the slab, the edge of drifting westward North American continent rode over the hot oceanic mantle of the mid-oceanic ridge. Immediately after "break", a short-time back movement of the oceanic plate from beneath the continental margin had to occur. This resulted in a marginal rifting and produced the Early Western Cascades complex of tholeitic volcanic-sedimentary rocks 40-18 Ma at a distance from the oceanic trench twice as small as is common for oceanic arcs. New subduction slab of the Juan de Fuca plate cooled the continental margin, reduced the volcanic activity of the Late Western Cascades (18-10 Ma), and causing the retreat of the volcanic front to the east. Owing to the slow subduction, the North American continent had already drifted westward over a significant distance by the time when the edge of the new slab sank into the

mantle to the depth of the asthenosphere, shutting off the flow of a new hot material under the edge of the continent. As a result, a substantial portion of the hot oceanic asthenosphere of the mid-oceanic ridge happened to underlie the edge of the continent behind the new subduction zone. Approximately 10 Ma, the Oregon margin again experienced the typical conditions of subduction zones and the High Cascades arc was formed with andesitic and dacite magmas. Thus, as a result of the Cenozoic tectonic activity, the upper mantle under the Oregon margin happened to contain magma sources generating basalts similar to the basalts of mid-oceanic ridges and island arcs and to the magmas of intracratonic rifts.