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Brittle aspects of early Tertiary extension in the Canadian cordillera

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The Lake Okanagan Fault (LOF) coincides with the boundary between Intermontane Terrane and Quesnellia in the southern Canadian Cordillera. The LOF is a complicated detachment associated with the development of the Okanagan core complex (OCC), which juxtaposes Eocene hanging wall successions against the footwall igneous and metamorphic block. In this study we focus on the early Tertiary brittle deformation and changes in stress field trends that accompanied the tectonic and/or erosional exhumation, of the OCC. Three deformational styles, shallow ductile shear, shallow brittle shear and steep brittle faulting ranging from normal to strike-slip, were formed progressively as the structure was exhumed. In the study region macro-structures are rarely exposed, although their existence can be deduced from field relationships. However, mesostructures preserve the deformational record. We measured the fault planes attitude and their striations and use the combination of striae and displaced contacts, and/or recrystallization, mainly calcite, in

pull-aparts to determine the sense of motion on faults. Our study reveals at least two different stress regimes since the early tertiary. The most significant group of faults, in most stations, comprises of closely-spaced faults with very small dispersion of strikes that are either perpendicular to bedding, or which were sub-vertical to inferred paleohorizontal surface. Stereographic projections of this group are very similar to observed open-mode fracture system (joints). They are also parallel to both major extensional faults and early Tertiary dykes. This indicates that the early Tertiary deformation, immediately after the ductile-brittle transition was dominated by WNW to ESE extension resulting in a pervasive and intense fracture set, striking NNE. A later NE-SW compressional deformation resulted in reactivation of these joints as normal, reverse and strike-slip faults, and small or major folds.
Our new data provides a framework for the interpretation of map structures. The oldest early Tertiary structures include a major shallow detachment, with a west-northwest displacement. Paleothermometric data across the detachment indicate the omission of 6-10 km of crust. We document a change in footwall rheology from ductile to brittle as it was exhumed and progressively incorporated into the hanging wall. Once the footwall was largely exhumed, it was, together with both major detachment and the hanging wall Eocene succession, deformed by brittle extensional structures that record, the initial WNW-ESE extension followed by the subsequent northeast-southwest compression. Coal-bearing fault-line sediments at the top of the Eocene hanging wall succession were subsequently exhumed by the erosion of $\sim$3.5 km, probably during regional

epeirogenesis that predates Miocene Plateau basalts.