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Mechanical differences of the permafrost/active layer interface from two neighboring glacigenic and cryogenic rock-glaciers at El Tapado glacier system, IV Region of Chile

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Several refraction seismic surveys were carried out along two adjacent rock glaciers (RG) belonging to the El Tapado Glacier System. The RG Tapado-G is originated from the transformation of a normal glacier into a debris-covered glacier (massive & stratified glacier ice observed at the upper reaches) and further down into a rock glacier according to its geomorphology. The smaller RG, Tapado-C is originated directly at a snow-depleted circus, by the evident accumulation of talus debris presumably together with winter snow & debris avalanches of varied types. Genetic differences of both RG do not print out an external signature on the morphological characteristics of them and both RG frontal talus end at the same altitude, while the lateral talus are partly welded along their lower reaches. In spite of their similar outlook, they show important internal characteristics as imaged by refraction seismics. Three main geophysical differences were detected as follows: 1) The active layer is much thicker at the Tapado-C (11 vs. 4 m) which may be the response of minor constitutive ice proportion of the soil and hence a faster growth of the unfrozen layer. 2) Although P-wave velocity (Vp) across all active layers is quite similar (c. 330 m/s), Vp at the frozen body is almost double at the glacigenic Tapado-G (1662 vs. 3146 m/s) indicating more ice concentration at that permafrost. Besides, in several segments permafrost Vp equals pure ice Vp (˜4200 m/s) suggesting that patches of the original glacier are involved in the Tapado-G, RG structure. 3) The interface of the permafrost/active layer, is sharp at the glacigenic RG but gradational at the cryogenic one, probably as a result of a

thicker humid transitional layer (temperate ice with some water) forming this interface due to the less proportion of ice at the cryogenic RG frozen core. This simple to operate survey establishes a good differentiation of internal measurable properties of two adjacent RG with proved different origin. Refraction seismic studies are also used locally to bring a first quantitative estimation of the ice proportion at the frozen core of rock glaciers being a valuable tool for hydrological purposes as well as for engineering tasks.