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Evidence for early plate tectonics in the northern Fennoscandian Shield derived from P- and S- wave velocity models of POLAR and HUKKA wide-angle profiles and FIRE4 reflection profile

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In order to clarify tectonic processes in Archaean and early Proterozoic in the northern part of the Fennoscandian Shield, we interpreted regional wide-angle reflection and refraction POLAR and HUKKA profiles and near-vertical FIRE4 reflection profile. We developed new P- and S-wave velocity models using reprocessing of the old data and compared them to record sections of collocated reflection profiles and to petrophysical data about seismic velocities in the main types of lower crustal and upper mantle rocks. The study revealed pronounced lateral variations of values of Vp, Vs and Vp/Vs ratio in the crust and of the depth to the Moho boundary can be associated with large crustal units along the profile (Archaean and early Proterozoic Central Lapland Complex (CLC) and Karasjok-Kittilä Greenstone Belt (KKGB), Palaeoprorerozoic Lapland Granulite Belt (LGB) and Archaean Inari (IT) and Sörvaranger (ST) terrains). The lower crust beneath the CLC has high P-wave velocities (about 7.28 km/s) and high Vp/Vs ratio (1.8-1.83) that can be explained by high content of anorthosites. In contrast, the lower crust beneath the CLGC has very low P-wave velocity and Vp/Vs ratio (6.85-6.92- and l.71, respectively) indicating its felsic composition. The lower crust beneath the Inari terrain has Vp and Vp/Vs ratio corresponding to mafic granulites (6.91-6.92 km/s and 1.76, respectively). The crust-mantle transition revealed by P- and S wave velocity models is very sharp and despite very complex geometry, rather well constrained by both PmP and SmS phases. It is coincident with transition from

transparent or weakly reflective lower crust to highly reflective upper mantle. This is in contrast with the traditional view that the Moho beneath Archaean provinces is defined by transition from reflective lower crust to the transparent upper mantle. The reflectivity in the upper mantle is subhorizontal (CLGC and IT) or shallowly dipping (LGB). In addition, the values of P- wave velocity and Vp/Vs ratio differ significantly beneath major tectonic units crossed by profiles. The P-wave velocity and Vp/Vs ratio beneath CLGC and IT are 8.08-8.11 km/s and 1.73-1.75, respectively, indicating that the mantle there is peridotitic. However, the P-wave velocity and Vp/Vs ratio in the upper mantle beneath the LGB are significantly higher (8.4 km/s and 1.78, respectively). These values can be explained either by eclogitic composition or by seismic anisotropy due to preferred orientation of olivine. Both explanations suggest, however, that this zone in the upper mantle represents a remnant of subducting slab of oceanic plate, apparently dipping to the SW. The difference in composition of the lower crust and upper mantle and in reflectivity style beneath the Archaean Domain of the Fennoscandian Shield may suggest prevalence of horizontal forces responsible for crust formation and plate-tectonic style of crustal evolution in this region.