Offshore crustal structure of the Meguma Terrane: seismic constraints on its origin

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We conducted a marine wide-angle reflection/refraction experiment along the coast of Nova Scotia. It repeats, with modern techniques, the profile published by Ewart Blanchard and others in the first volume of the Canadian Journal of Earth Sciences. Their general results are confirmed.

Modelling of the arrivals indicates that near-surface rocks have velocities of 5.5–5.7 km/s typical of the Meguma Group with a thickness of only 3 km. The average velocity of the crust

is 6.2–6.4 km/s with a maximum velocity of 6.6 km/s and a total crustal thickness of ~37 km. To the east, the Meguma Terrane overlies the 6–12 km thick lower crust of the Avalon Terrane that has a velocity of 6.8–6.9 km/s over a 200 km long distance. The velocity contrast from these overlapped terranes produces strong reflections that are observed by several ocean bottom seismometers (OBS). This is consistent with a multichannel reflection profile that clearly images Avalon crust underneath the Meguma Terrane. Numerous reflections in the lower crust are clearly observed by many OBS, consistent with a crossing reflection profile that images ~8 km thick reflective lower crust, 17 km thick less reflective mid crust, and ~14 km-thick non-reflective upper crust. A possible origin for the lower crustal reflectivity is lenses of felsic and mafic rock.

Several models have been suggested for the origin of the Meguma Terrane. Using the velocity constraints from both the P and S waves, we examine hot-spot, post-orogenic extension and delamination hypotheses. The extensive granites of the Meguma Terrane indicate temperatures hot enough for the lower crust to flow. Not only is the Moho flat but also the crustal thickness is less than under the adjacent Avalon Terrane as predicted by delamination. Removal of the entire crustal root could result in complete melting of the lower crust consistent with our velocities. The P-T conditions of the granulite-facies xenoliths suggest they come from greater depths than the present Moho and are a feature diagnostic of delaminated terranes. The consequences of delamination for the overlying crust are uplift and erosion. Within a few million years of their emplacement at about 10 km depth, the granitoid plutons were exhumed based on the rapid cooling of the plutons and on miospores from the base of the overlying unconformity. Following uplift a thermal sag basin was created based on the widespread distribution of 2–3 km Carboniferous strata.