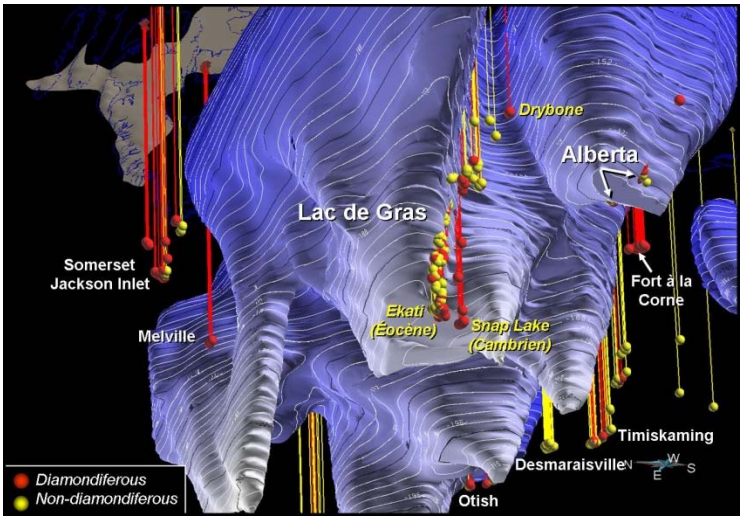
Project 2003-7: Structure of cratons and kimberlite fields

A 3D seismic tomography model of the North American continent was used to locate areas that are the most fertile for diamonds in the cratons. Modelling can be used to represent the morphology of Archean lithospheric keels as well as the overall picture of the real diamond stability field.

The tomographic model used shows that the North American Archean cratons (primarily in Canada) are agglomerated between 100 and 200 km in depth. Lithospheric roots under the cratons differentiate at around 200 km in depth to reach a maximum of 250 km under the Slave Lake Craton. Tomography shows the extent of some of the cratons under the sediment cover and platforms. Kimberlite locations on the surface correlate vertically with the steepest slopes around the cratonic roots, at depths between 160 and 190 km. The morphology of the Archean mantle was spatially correlated with the inferred position of the kimberlitic magmas at depth (base of the continental lithosphere determined from mantle xenolith studies in the public domain). The most favourable regions for diamond preservation since the Archean, that is to say the areas of the craton unaffected by tectono-metamorphic events, are the central areas of the Slave Lake and Lake Superior Cratons, in particular, northwestern Quebec and northeastern Ontario.



Architecture of the cratonic roots of the upper mantle under the North American continent, showing the inferred position of kimberlitic magmas at depth.

The tomographic model was compared to a thermal model. By integrating these two approaches, we propose a morphology for the stability field of diamonds at the base of the Canadian and the northeastern United States lithosphere. Another geophysical model can be used to observe a normal correlation between the depth of the Moho and the thickness of the lithospheric keel. Diamond-bearing kimberlites are vertically correlated with the thickness of the continental crust along the edges of cratons.

Summary: Project 2003-7	
Objectives	• To show a 3D geometry for the Archean cratons of North America. • To image the stability field of diamonds.
Results	• Construction of a seismic tomographic model showing that Archean cratons are agglomerated between 100 and 200 km; • Kimberlites correlated vertically with the steepest slopes at depths between 160 and 190 km around lithospheric roots; • Combining with a thermal model; • 3D delimitation of the diamond stability field.
Tools and Innovations	• Combining seismic and thermal models for a 3D representation of the continental structure to target potential diamond-bearing areas.
Special Collaboration	• Stéphanie Godey, Centre Sismologique Euro Méditerranéen and Francine Fallara, URSTM/UQAT
Note	• Project continuing in 2004-2005 and 2006-2007 (2004-4 and 2006-2).