Energy, Mines and Resources Canada / Énergie, Mines et Ressources Canada

Geofacts

LITHOPROBE

Our planet is much more dynamic than one might think. Its surface is constantly being modified by forces acting in its interior.

In order to learn more about these dynamic changes Energy, Mines and Resources Canada, the Natural Sciences and Engineering Research Council of Canada and the universities have launched the Lithoprobe project. During the next few years the project will enable scientists to use seismic tomography to create three-dimensional, detailed images of the continent at several selected locations from British Columbia to Newfoundland. The 3-D model will permit a better understanding of the important phenomena that led to the formation of the Canadian landmass.

The Lithoprobe project encompasses many geoscientific specialties within the disciplines of geophysics, geology, geochemistry and geodesy. These disciplines explain the geology of the lithosphere on the basis of the relations existing between the surface geology and the structure below. The accumulation of geological knowledge will facilitate the interpretation of data gathered by the scientists and will lead to the production of a satisfactory 3-D model.

The Canadian landmass is part of the earth's crust, which varies between 10 km and 60 km in thickness. The crust is the top part of the lithosphere, the thickness of which varies from 70 km below the oceans to 150 km beneath the continents. The lithosphere is the cold, strong, rigid outer layer of the earth that caps the underlying hot, weak viscous lower mantle. The latter, 2900 km thick, is characterized by convection currents that carry hot material from the depths of the earth toward the lithosphere, then back down upon cooling. This continuous movement shifts the 12 principal interlocking lithospheric plates in relation to one another. In the last few billion years, continents, mountain ranges and oceans have been created or destroyed by these movements.

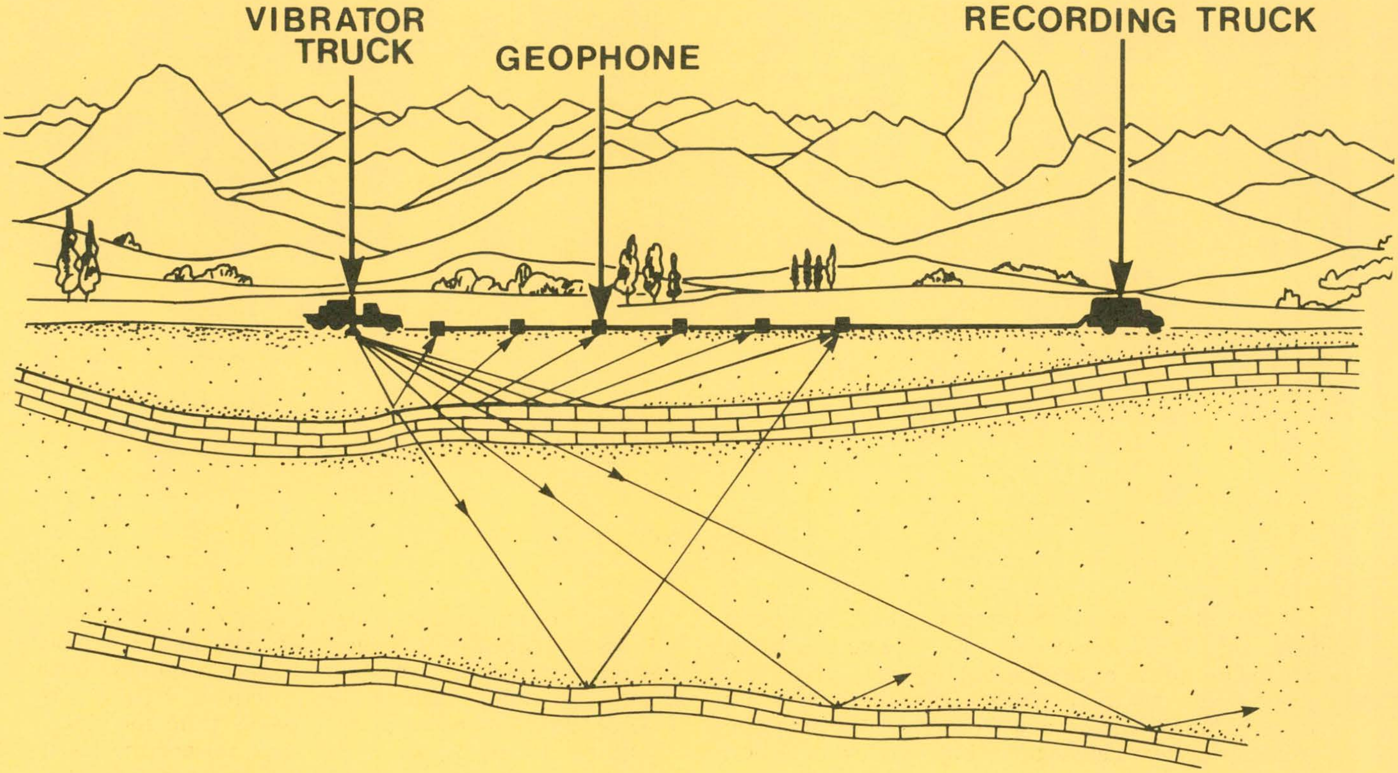
Questions surrounding the origins of Vancouver Island and the convergence of two plates off the coast of British Columbia prompted the scientists to choose that particular section of the west coast for Phase I of Lithoprobe. At the bottom of the Pacific Ocean off the west coast lies the Juan de Fuca Ridge, where an opening between plates allows magma to escape. When cooled this molten rock adds to the Juan de Fuca Plate. Thus the Juan de Fuca oceanic plate expands from the ridge, pushing the older part of the plate toward the coast of Vancouver Island into a subduction zone, located off the island, and down into the mantle.

Geodesists can measure changes in elevation to establish the relationship between surface vertical movement and the structures deeply buried in the crust. Scientists found that the subduction of the Juan de Fuca Plate is responsible for raising Vancouver Island and the area around it. This type of action does not happen without causing numerous earthquakes on the Canadian west coast.

Some specialists consider that subduction ended over a million years ago; others believe that such movement continues today. The data gathered by Phase I of Lithoprobe will produce an answer to this question. Moreover, the results of this first phase will bring a better understanding of the origins of Vancouver Island. Scientific studies of magnetic anomalies on the bottom of the Pacific Ocean indicate that Vancouver Island has a different origin from that of the Canadian landmass.

After the Vancouver Island study, Lithoprobe will move to five or six other regions across Canada. On the basis of these geological studies, other regions will be selected according to certain economic criteria, for example, the presence of mineral deposits, oil-bearing formations or other interesting geological structures such as faults.

During the Lithoprobe project 20-tonne trucks equipped with hydraulic jacks will lower a special plate onto the road at sample sites. When vibrated by a compressed air system the plate will produce shock waves in the earth that will bounce off discontinuities below the surface and return to sensors called geophones placed above ground in a line a few kilometres long. The truck's equipment and the sensing devices are interfaced with a central computer, which ensures that the shock waves are produced simultaneously by the plates. Since the speed at which the waves travel depends on the density and elasticity of the rocks through



which they pulse, the data produced by seismic surveys permit the production of a three-dimensional model of the depths of the earth.

The seismic reflection technique is today the most common method used in geophysics for shallow subsurface studies. Lithoprobe will produce a 3-D model of an area 40 km beneath the surface. That depth is much greater than that accessible by conventional drilling. Although it may provide more detailed information, drilling is also far more expensive than the process Lithoprobe is pioneering.

Projects similar to Lithoprobe and the deep continental drilling that has taken place in the U.S.S.R. are part of a vast international study of the lithosphere. Scientists from the United States, the United Kingdom, France and other countries are all conducting experiments similar to those being carried out by Lithoprobe.

A better understanding of the continental lithosphere will have important economic spin-offs for Canada. As existing geological knowledge now permits geologists to find minerals in certain rock formations, Lithoprobe will lead the way to the hidden minerals and hydrocarbons that Canada needs to ensure its economic future.

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