A New View of the Continent Beneath Our Feet – LITHOPROBE's Scientific, Economic and Social Contributions

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Abstract

LITHOPROBE, Canada's internationally acclaimed Earth science research project, was active from 1984 to 2005. It was established to study the development of our continent from its very beginnings and to investigate the varied and complex processes involved in that development. These studies have scientific, economic and social benefits. Collaborative, multidisciplinary research was the key to LITHOPROBE's scientific and related successes. Ten study areas, or transects, across Canada focused on important geological features that represent globally significant processes. Each transect involved a multidisciplinary team of scientists. In addition to individual publications, results from each transect were synthesized in a special issue(s) of the *Canadian Journal of Earth Sciences*.

By combining results from all transects, we compile the LITHOPROBE trans-continental cross-section, which traverses North America at ~50° N for 6000 km and to depths of 100 km. From west to east, it crosses the Juan de Fuca plate, the active Cascadia subduction zone, the ~0.2 Ga southern Cordillera, the ~1.8 Ga Alberta and Trans-Hudson orogens, the ~2.7 Ga Superior Province, the ~1.1 Ga Keweenawan rift, the ~1.0 Ga Grenville orogen, the ~0.4 Ga Newfoundland Appalachians, the Grand Banks continental shelf, and the Atlantic passive margin. The cross-section is based on near-vertical incidence (NVI) seismic reflection and refraction / wide-angle reflection (R/WAR) data, combined with a broad range of other geophysical, geological, geochemical and geochronological data and their interpretation. The constituent profiles are not

vertically exaggerated and include Earth curvature since the Trans-Canada corridor spans 15% of the Earth's circumference. The cross-section provides a view of the North American continent at a scale that emphasizes relationships between orogens rather than detailed patterns within orogens.

A few general results are: 1) the crust is substantially more reflective than the mantle. Although causes of reflectivity are often unknown, dominant reflection patterns define structure and large-scale 'fabric'; 2) with a few notable exceptions, the Moho is generally flat and the crust remains relatively thin across the continent, irrespective of the age of the crustal rocks or the time when the last major deformation occurred; 3) most significant changes in Moho depth occur at rifted margins (active and preserved) and at relict subduction zones, and only two well-preserved crustal roots are imaged; 4) the NVI and R/WAR data reveal significant heterogeneity within the lithospheric mantle, aspects of which are interpreted as relict subduction zones that provide evidence for neo-Archean plate tectonics; and 5) orogens are stacked upon one another such that one forms basement to the next, an example being the volcanic arcs and microcontinents that were assembled at ~2.7 Ga to form the Superior Province are basement to the ~1.0 Ga Grenville orogen, which in turn is basement to the ~0.4 Ga Appalachian orogen, upon which overlies the modern Atlantic passive margin.

Detailed scientific results from individual transects are outstanding. In addition to the pan-LITHOPROBE compilation, the lecture will highlight such results from the region where the lecture is being presented. The focus will be on lithospheric structure and tectonic evolution as revealed by the multidisciplinary studies from the applicable individual transects.

Economic contributions from LITHOPROBE derive from new technology developments, new understanding of regional tectonics and its relevance for stimulation of exploration, and the application of new approaches that benefit the base- and precious-metal, uranium and diamond industries. Social contributions include improved understanding of the hazards of large earthquakes on the west coast, public education and outreach, and the training of hundreds of highly qualified masters, doctoral and postdoctoral students in an environment of multidisciplinary collaboration.

Biography

Dr. Ronald Clowes, a native of Calgary, received his post-secondary education at the University of Alberta, where he obtained a B.Sc. in Honors Physics in 1964 and a M.Sc. and Ph.D. in Geophysics in 1966 and 1969, respectively. From Grade 11 through to his start at graduate school, Ron had informative summer jobs in geology and geophysics with Shell Canada and Mobil Canada. Following his Ph.D., he received a National Research Council Postdoctoral Fellowship, which took him to the Australian National University in Canberra for a year. In 1970, Ron joined the then Department of Geophysics and Astronomy at the University of British Columbia, where he spent the rest of his career. In 1984, he was Principal Investigator for LITHOPROBE Phase 1 and subsequently became Director in 1987, when it was established as a continuing national research project. LITHOPROBE officially concluded in 2005, when NSERC funding ended, but Ron is still working on some outstanding aspects. Having retired as a Professor in the Department of Earth and Ocean Sciences at UBC in 2007, Ron is currently a Professor Emeritus.

Ron's personal research centers on multichannel seismic reflection, seismic refraction/wide-angle reflection and other geophysical studies of the Earth's lithosphere on land and at sea; and relation of the geophysical results to geology and tectonics. Following his appointment at UBC, Ron set up a highly successful marine seismic program, which provided much of the new understanding of crustal structure off the west coast of Canada. For the past 20+ years, much of Ron's research has been associated with LITHOPROBE. He has worked actively on reflection and refraction studies in all areas of western Canada, as well as synthesizing the scientific results. With his colleagues and students, this research has resulted in more than 120 refereed publications in a range of Earth Science journals. As Director of LITHOPROBE, which redefined the way in which Earth Science research is conducted in Canada, he was instrumental in both its success as a project and its international acclaim. During LITHOPROBE's life time, the project involved more than 1000 scientists (including more than 450 students/PDFs), facilitated interaction among the university, government and industry sectors, generated about 1500 publications, transferred newly developed technology to Canadian industry, demonstrated a new approach for exploration in mining camps, developed an important educational and public outreach program, and involved a budget totaling more than 100 million dollars from Science and Engineering Research Canada (NSERC), the Geological Survey of Canada and other sources.

Through his research and LITHOPROBE activities, Ron has received numerous awards, including being named a Member of the Order of Canada in 1998. He was made an Honorary Member of the CSEG in 1995, previously having received CSEG Best Presentation awards in 1966 and 1981 and the SEG Best Paper award for papers

published in Geophysics in 1968. Other awards include the Past President's and Logan Medals of the Geological Association of Canada in 1988 and 2005, respectively, Fellow of the Royal Society of Canada in 1994, the J. Tuzo Wilson Medal of the Canadian Geophysical Union in 1998, and a Canada Council Killam Research Fellowship for 2004-06.