Geoscience Canada

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Volume 14, numéro 2, june 1987

URI : https://id.erudit.org/iderudit/geocan14_2art03

Aller au sommaire du numéro

Éditeur(s)

The Geological Association of Canada

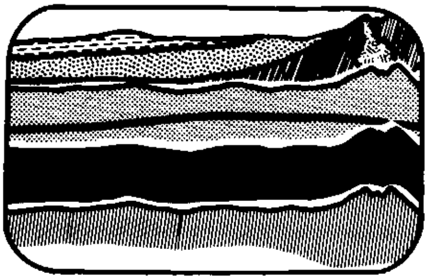
ISSN

0315-0941 (imprimé)
1911-4850 (numérique)

Découvrir la revue

Citer cet article

Monger, J. W. H. (1987). Mapping in the Third Dimension: The Global Geoscience Transects Project. *Geoscience Canada*, *14*(2), 83–84.



Mapping in the Third Dimension: The Global Geoscience Transects Project

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Introduction

The Global Geoscience Transects project (GGT) was initiated in August 1985 as part of the International Lithosphere Program. It uses existing geological and geophysical data to explore the depth dimension of the Earth's crust worldwide, and displays the results in systematic fashion so that crust in one part of the world can be compared directly with that in another.

'Transects' as used by GGT are cross-sections based on geology and geophysics that show composition and structure of the crust of the Earth, which varies in thickness from about 5-80 km. If data are available, features of the underlying lower lithosphere are displayed as well. Transects lie along corridors 100 km wide and up to a few thousand kilometres long that cross major crustal features. They can be regarded as geological strip maps in the vertical rather than horizontal plane, which interpret how the crust along the transect formed.

GGT is not intended to initiate new data collecting, but to utilize geological, geochemical and geophysical information collected in large part by various national surveys for both economic and scientific purposes. The quality and availability of these data can best be evaluated by local experts. For the project to be successful it thus requires a great deal of international co-operation. The enthusiasm of many National Lithosphere Committees for the project suggests that co-operation will be forthcoming.

Need to integrate geological and geophysical perspectives

Geological cross-sections have been made since the first geological maps were drawn and are a necessary part of the description of the geology of any region. Measured attitudes of structures in rocks at the earth's surface are projected downward to define sub-surface structures. Such cross-sections typically extend for no more than a few thousands of metres beneath the earth's surface, although in some regions where the rocks are well-exposed and have distinctive and contrasting lithologies, such as the European Alps, cross-sections were drawn more than 50 years ago to depths of about 10 km.

Geological observations on deeper parts of the crust are limited to places where former deep crust, recognized by minerals formed at high temperatures and pressures, has been brought to the surface in major uplifts, or to places where rocks from great depths are carried to the surface as fragments in upwelling volcanic magmas. The cost of direct sampling by drilling to depths in excess of 10 km is too great for more than a few holes globally, and with present technology such holes are unlikely to penetrate far into the lower crust.

By comparison with drilling, geophysical methods of sampling are cheap, but gravity, seismic refraction, magnetic and heat flow studies provide data that may be difficult to interpret in geological terms. How do we integrate the two types of data?

Such integration has been done for many years, with considerable commercial success, by the petroleum industry. Computer images generated from multi-channel seismic reflection data resemble geological cross-sections in that they show the geometry of reflectors within the crust. The seismic images can be related to geology where the reflector coincides with a rock unit or structure directly observable at the surface or encountered in drill holes. In recent years, the COCORP program in the United States pioneered the use of this technique for purely scientific purposes to obtain results that have modified our concepts of crustal structure.

The North American Transects program

The North American continent:ocean transects program, initiated in 1978 by the US Geodynamics Committee, was designed to integrate the then rapidly accumulating quantity of seismic reflection data from offshore regions of North America, with on-land geological and geophysical data from the margins of the continent. The resulting 26 cross-sections of the crust from the stable continental interior to the ocean basins, are being published by the Geological Society of America.

Each transect display (Figure 1) contains: (1) a geological strip map, with rock units coloured according to age; (2) a 'factual display' of a geological cross-section with, where available, seismic refraction line diagrams, gravity and magnetic profiles, velocity/depth curves and seismic refraction models, and ancillary data such as heat flow, earthquake hypocentres and epicentres and selected isotope geochemistry; (3) a diagram with space:time co-ordinates to show the distribution of stratigraphic, structural, intrusive and metamorphic relationships of rock units along the line of the transect; and (4) a crustal cross-section, scale 1:500,000, that integrates all of the geological and geophysical data into an interpretation of the origin and disposition of components of the crust.

Other regions and nations, such as Western Europe, Australia and the Soviet Union, have proposed and are implementing similar programs. One task of GGT will be to encourage presentation of the results of these programs in a common format so that the crust of all regions can be compared directly.

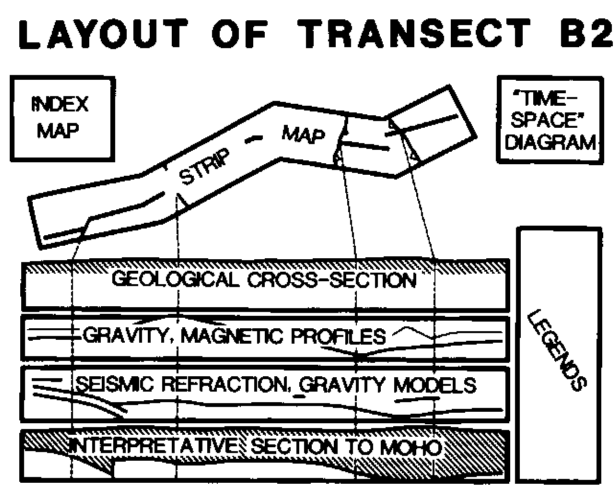

Figure 1 *Lay-out of a North American continental:ocean transect.*

Global Geoscience Transects

The Global Geoscience Transects project is modelled on the North American continent:ocean transects program, but emphasizes continental crust, which contains 95% of the preserved record of earth history, rather than continent:ocean transitions. Guidelines developed for the North American transects will be followed initially, although these will surely become modified as the project progresses and new problems are encountered.

The year 1986 was devoted to getting GGT started. National Lithosphere Committees, and interested individuals, have proposed transect lines shown in Figure 2, and efforts are being directed at filling the gaps in global coverage. A key part of GGT is the personal exchange of information and ideas, and discussion of problems, by scientists compiling transects at regional workshops organized by National Lithosphere Committees. Transects will be displayed at, and symposia organized for, the 28th International Geological Congress in 1989, in Washington.

Conclusions

We appear to be at the beginning of a new approach to understanding our planet: namely, the systematic mapping in three dimensions of major features of the earth's crust. The situation is analogous to that which prevailed in ocean-basin research in the early 1950s, when sophisticated marine exploration tools first became available, and when the discoveries of linear magnetic anomalies and transform faults profoundly influenced the earth sciences. Today, we have newly developed geophysical techniques that make exploration of the deep crust more feasible than ever before, and discoveries at least of comparable magnitude to those made in the ocean basins may await us. However, unlike the freely accessible international waters of the ocean basins, global studies of the continental crust will require the utmost in international co-operation; GGT seems to be the ideal vehicle with which to co-ordinate these research efforts.

Accepted 16 March 1987.

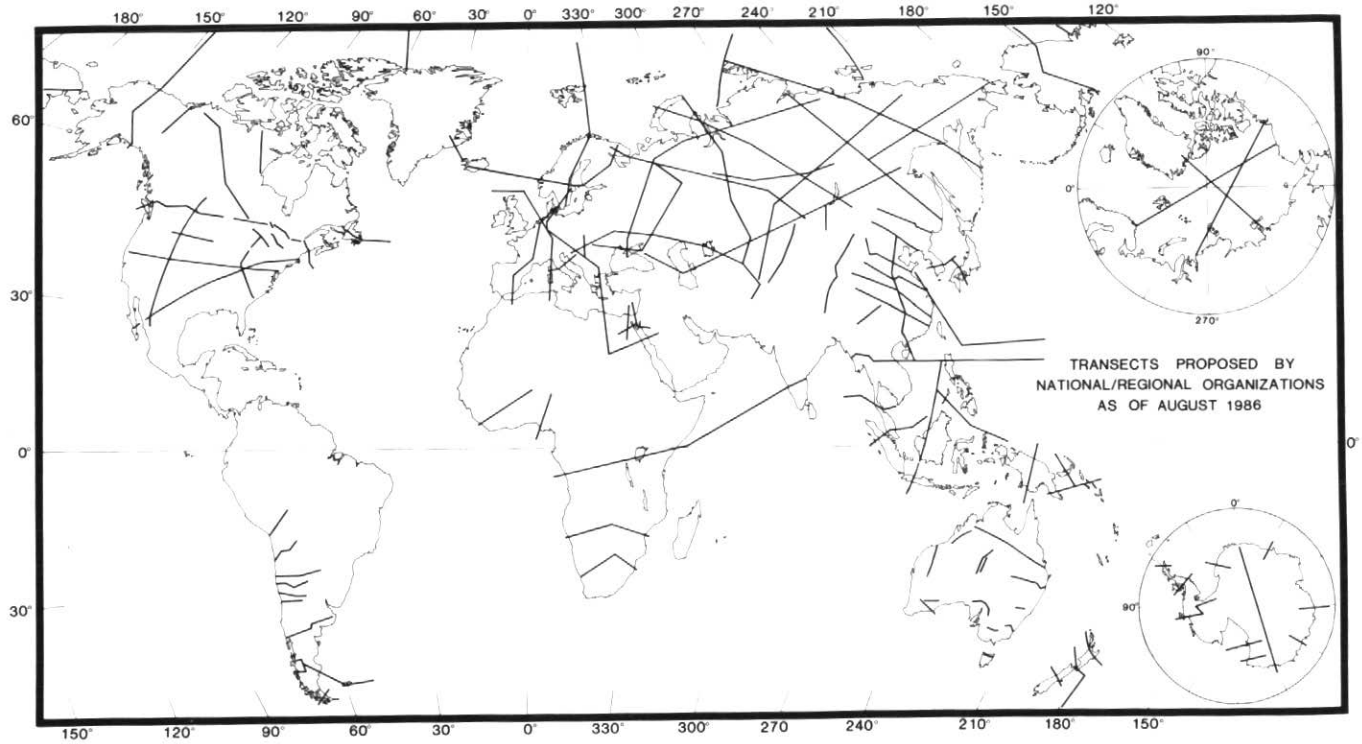

Figure 2 *Approximate locations of Global Geoscience Transects proposed by national/regional organizations as of October 1986.*
Africa/Middle East: *S. Riad, B. Rumvegeri;*
Antarctic: *I.W.D. Dalziel/Scientific Committee for Antarctic Research;*
Arctic: *Arctic Subcommittee of ILP;*
Australia: *R. Rutland/National Committee for ILP;*
People's Republic of China: *National Committee for ILP;*
India: *H.K. Gupta;*
Japan: *K. Tamaki/ National Committee for ILP;*
New Zealand: *F. Davey;*
North America: *LITHOPROBE Steering Committee, Trans-Alaska Lithosphere Investigation, P.F. Hoffman, K.A. Howard, W.R. van Schmus, D.B. Stewart;*
South America: *Argentinian National Committee, Brazilian Geodynamics Commission, U. Cordani;*
Southeast Asia: *J.R. Curry/Studies in East Asian tectonics and resources;*
Soviet Union: *E. Kozlovsky, A. Yanshin/National Committee for ILP;*
Western Europe: *European Geotraverse, P. Giese, M. Von Knorring.*