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Giorgio Ranalli

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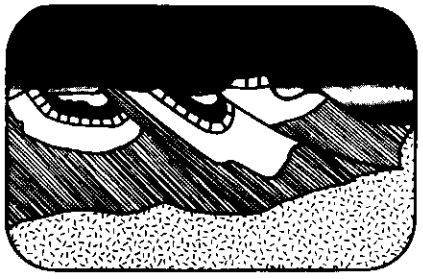

Geodynamics at Grenoble, 1975

Giorgio Ranalli
Secretary, Canadian Geodynamics Subcommittee
Department of Geology
Carleton University
Ottawa, K1S 5B6

The XVI General Assembly of the International Union of Geodesy and Geophysics was held in Grenoble from August 25th to September 6th, 1975. The interests of the IUGG span the entire field of geophysics from seismology and geodesy to oceanography and meteorology. Concurrently with the General Assembly, the Inter-union Commission on Geodynamics held its annual meeting. The purpose of this report is to briefly illustrate recent developments in geodynamics highlighted at the Grenoble meeting, and to make Canadian earth scientists aware of the present status of the International Geodynamics Project.

Grenoble is an ideal setting for an earth science conference. It is situated in the Western Alps, with the Belledonne massif to the east and the Vercors massif to the west. The delegates were accommodated in part in the University residences, and in part in hotels in the central core of the city. The organization of the scientific symposia was at times less than perfect, but luxurious lunch breaks in the University cafeteria with its excellent food and wine seemed to reconcile everyone with the pleasures of life.

The General Assembly was articulated into 34 interdisciplinary symposia, a few specialist symposia, and business meetings. Canadian participation was high. Of the 34 interdisciplinary symposia, covering many aspects of earth science, five had Canadian convenors. Several papers were presented by Canadian scientists.

It would be impossible to cover in detail all the papers relevant to geodynamics within the scope of this report. Aspects of geodynamics and plate tectonics that were covered in the symposia were, among others, experimental petrology, driving mechanisms, heat flow, earthquake precursors, marine magnetism, state of stress within plates, structure of the earth's interior,plate margins, deep-sea drilling, volcanism, and earth tides. The overall impression gleaned from the conference is that plate tectonics has passed the stage of being controversial and is now accepted as a full-fledged paradigm (sometimes with an unnecessary and unfortunate dose of dogmatism) by the great majority of earth scientists. Attention is now concentrating on the evidence that will refine the model by incorporating apparently contradictory data, and on the geodynamic processes driving plate movements. Three themes that were expounded and debated at length and that, in the author's opinion, will prove to be of great importance in the future developments of geodynamic theory were: (i) the collection of new data by old and new methods, and the interpretation of old data in the light of new ideas; (ii) the problem of the definition of "lithosphere" in a way relevant to the time scales involved in geodynamic processes; and (iii) the possible importance of intraplate (as opposed to interplate) stress systems in elucidating the driving mechanism of plate tectonics.

As an example of collection of new data by new methods, preliminary results of project FAMOUS (Franco-American Ocean Under-water Survey) were presented at the conference. A segment of the central rift of the Mid-Atlantic ridge has been surveyed in detail by submarine - and naturally reality, when looked at closely, reveals itself to be more complicated than our mental schemes. This project will greatly improve our knowledge of the processes at accreting plate margins.

The fact that we need to clarify to ourselves what we mean by "lithospheric plate" was emphasized by the presentation of seismological evidence showing that mantle structure under shields is different from mantle structure under oceans to a depth of at least 400 km. It is therefore possible, if not likely, that continental plates move as a unit down to depths corresponding to the mantle transition zone. In this context, the interesting possibility was advanced that decoupling permitting plate motions may occur at phase boundaries in the upper mantle, which could be zones of horizontal shear weakness (transformational superplasticity). If, on the other hand, "lithosphere" is defined as the outer shell of the earth showing elastic behaviour (with imperfections), its thickness is thermally controlled, and its lower boundary cannot be much deeper than the 300°C isotherm. This lithoshpere is in turn different from the seismologists' lithosphere, the lower boundary of which is the seismic low velocity zone.

Intraplate stresses (i.e., occurring within plates) were discussed at length. Evidence was presented that the thermally defined lithosphere is elastic in the sense that stresses are not relaxed over geological time intervals. The possible origins of the intraplate state of stress and its relevance to the problem of determining the driving mechanism of plate tectonics are also receiving much attention.

To sum up (and this conclusion is naturally influenced by the interdisciplinary symposia the author chose to attend in preference over others) one could say, as Sir Edward Bullard once did in a similar situation, that "the earth sciences are in a healthy state of chaos once again". Two or three overriding themes, however, are emerging, and it will be around these that geodynamics research will concentrate during the next few years.

The Inter-union Commission on Geodynamics (ICG) is a body jointly sponsored by the International Union of Geodesy and Geophysics and the International Union of Geological Sciences. Started in 1971 as an offshoot of the Upper Mantle Project, the International Geodynamics Project emphasizes interdisciplinary participation and is focused on the identification and measurement of current and past motions of the earth's lithosphere, and the determination of the causes of these motions. Its operation is articulated through ten international Working Groups, and through National Committees. The ICG annual meeting at Grenoble was particularly important

because it marked the mid-term of the Geodynamics Project (scheduled to be completed in 1979). Participating countries were asked to present mid-term reports on activities and future developments related to geodynamics. *The Canadian report (Third Report by the Canadian Geodynamics Subcommittee,* Ottawa, March 1975) is available from the author upon request. In this report activities covering the following fields are covered: Global dynamics (rotational dynamics and core dynamics); short-term motions and deep-seated causes of motion (earth tides, contemporary movements and seismicity, structure and mechanical behaviour of lithosphere and asthenosphere); crustal evolution (origin of the crust, present crustal structure, modifications to the crust through time); Phanerozoic fold belts and adjacent ocean basins (Cordilleran fold belt and Pacific Ocean basin, Innuitian fold belt and Arctic Ocean basin, Appalachian fold belt and Atlantic Ocean basin); and Canadian Shield (Archean and Proterozoic). The present status and future direction of Canadian participation in the International Geodynamics Project is outlined in the Report within the framework of these five main areas of research.

At its meeting in Grenoble, the ICG elected A. L. Hales of Australian National University as its new President, and R. D. Russell of the University of British Columbia as Secretary-General. Discussion took place on a wide range of topics, and a number of resolutions were adopted. Some of these developments are of interest to the earth science community at large. Working Group chairmen have agreed to coordinate the preparation of "Frontier Reports" reviewing the recent developments in the areas of competence of each Working Group, i.e.: 1) Geodynamics of Western Pacific-Indonesian region; 2) Geodynamics of Eastern Pacific region, Caribbean and Scotia arcs; 3) Geodynamics of the Alpine-Mediterranean region; 4) Geodynamics of the Himalayan region; 5) Geodynamics of continental and oceanic rifts; 6) Properties and processes in the earth's interior; 7) Dynamics of plate interiors; 8) Connections between oceanic and continental structures; 9) History and interactions of tectonic, metamorphic and magmatic processes; and 10) Global syntheses of the distribution of continents and oceans through time. Progress reports on these topics will be presented at the 1976 International Geological Congress in Sydney.

Perhaps the most useful function that the ICG can perform is related to its interdisciplinary character. While scientific unions and associations are usually organized along disciplinary lines, the ICG is problem-oriented and can bring together, at the international and at the national level, scientists from different earth science disciplines to focus their expertise on a set of common topics that can improve our understanding of the processes shaping the earth.

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