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Developing a New National Strategy for Mineral Deposits Research in Canada:
A Report of the NUNA 2001 Conference

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Developing a New National Strategy for Mineral Deposits Research in Canada

A Report of
the NUNA 2001 Conference
Kingston, Ontario
15-16 March 2001

By the NUNA 2001 Organizing Committee:

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INTRODUCTION

In the last decade, Canada has developed major "new economy" industries in markets such as information technology, communications, and biotechnology. However, resource-based industries remain vital to the Canadian economy and are an essential part of Canada's future prosperity. The minerals and metals sector accounts for $4.4 billion in export earnings (13.3% of Canada's total for 1999) and $27.7 billion of Canada's GDP (3.7%) (Mining Association of Canada, 2001). This sector of the economy is particularly important to Canada's northern and rural communities and, in many cases, has the greatest potential as a revenue/jobs generator in these parts of the country. The potential for developing new resources in Canada, as well as opportunities for enhancing our role in international exploration and mining, are major incentives for an improved national strategy for minerals-related research. In the past decade new resources of diamonds, copper-nickel, platinum group metals, and lithium-tantalum minerals were discovered as a direct result of new research and new ideas integrated with traditional exploration methods. At the same time, mineral deposits research in Canada has been a cornerstone of the earth sciences, contributing to our basic understanding of a wide range of geological processes from magmatic, sedimentary and hydrothermal systems, to plate tectonics and climate change. However, the role of Canadian mineral deposits research in geoscience and in industry is increasingly at risk. Of critical concern is the threat of diminishing capacity in university research departments brought about by a continuing wave of retirements, a lack of rejuvenation of faculty, low student enrollment, and increasing fragmentation and polarization of research efforts. A consequence of these trends is a growing perception that the research community is unable to meet the needs of the industry or the science in a rapidly changing and expanding global environment.

Such concerns have raised important questions about the delivery of mineral deposits research in Canada:

- Can minerals-related research be better co-ordinated to achieve larger goals and to make better use of research funds?
- Can our research be better integrated with that of other sciences?
- Are our universities able to meet the future training and human resource needs of industry, governments, and research organizations?
- Is Canada's mineral deposits research community equipped to develop the advanced knowledge and high technology required for future discoveries and resource management?
- Is there a need to refocus Canadian minerals research in response to the changing balance of trade and demands on industry for greater environmental and social stewardship?

These and other questions were addressed in a $1^1/_2$ day workshop attended by representatives of industry, academia, and federal and provincial governments at Queen's University's Donald Gordon Centre, 15-16 March 2001. The conference was sponsored by the Geological Association of Canada (GAC), under the banner of GAC's NUNA Conferences, with support from the Geological Survey of Canada (GSC), Natural Sciences and Engineering Research Council of Canada (NSERC), the Society of Economic Geologists (SEG), Barrick Gold Corp., Inco Ltd., Falconbridge Ltd., and Noranda Ltd. The NUNA Conferences (Inuktituk for "the land around us") were developed by GAC to stimulate discussion of topics that are likely to have a major impact on the future of the geosciences in Canada. Previous NUNA Conferences have focussed on themes of scientific importance (*e.g.*, recent developments in stratigraphy, environmental earth sciences, or metallogeny). The 2001 meeting was the first NUNA Conference to address the way in which the science is being delivered rather than a specific aspect of the science. This landmark meeting explored a wide range of viewpoints and opinions from the

community and helped to identify broad areas of agreement about how the path of mineral deposits research in Canada should be charted. A strong message from the meeting was that researchers in the community are ready to move forward and meet the new challenges facing both the science and the industry.

The 71 participants of the conference included representatives from 13 exploration and mining companies, 18 universities, nine provincial geological surveys plus the Northwest Territories and GSC Nunavut, and GSC Ottawa. Representatives from each of the supporting organizations and agencies were also present, including GAC, Canadian Geoscience Council (CGC), Canadian Institute of Mining and Metallurgy (CIM), the Canadian Mining Industry Research Organization (CAMIRO), SEG, and the Prospectors and Developers Association of Canada (PDAC). Guests from the United States Geological Survey and the Centre for Ore Deposits Research (CODES) at the University of Tasmania were also invited to participate.

The workshop began with a morning session of invited talks on different avenues of mineral deposits research in Canada and abroad, including industry-led research, university-led research, government-led research, and geoscience megaprojects (Table 1). In the afternoon, the roles of each of these different elements of Canadian mineral deposits research were debated in breakout groups. The intent was to put everything on the table (key centres, NSERC-funded research networks, CAMIRO-funded projects, *etc.*) and to determine what new initiatives would best serve the needs of the future. A plenary session, on the morning of the second day, began with summaries of each of the breakout sessions and was followed by an open forum on the main task of the workshop: to develop a new national strategy for mineral deposits research in Canada. A Web-based questionnaire was used as a means of gathering input from the larger scientific community (GAC/NUNA website www.esd.mun.ca/~gac/about/nuna.html), and the responses to this survey helped to focus the discussion.

Table 1 List of speakers and their topics

James Franklin (Franklin Consulting Ltd.)
Directions for Mineral Deposits Research: A Retrospective
Jeremy Richards (University of Alberta)
NSERC's Collaborative Research Programs and Research Networks
John Gingerich (Noranda Ltd.)
CAMIRO: A Platform for Industry-based and Directed Funding
Jeremy Hall (Canadian Geoscience Council)
The Role of Mega-Projects in Funding Canadian Geoscience
Tom Lane (Consultant)
MINERALPROBE: An Example for a Minerals-Related Mega-Project
Ross Large (University of Tasmania/CODES)
The Australian Experience in Mineral Deposit Research Funding
John Thompson (Teck Corp.)
Industry's Perception of the Purpose/Need for Research
Bill Mercer and Mary-Claire Ward (Prospectors and Developers Association of Canada)
Mineral Deposits Research: PDAC View
Jeremy Richards (University of Alberta)
A Model for Sustainable Mineral Development: University of Alberta Proposal

SYNOPSIS

A Brief Retrospective on Mineral Deposits Research in Canada

During the 1970s and 1980s, the convergence of rising metal prices, tax incentives for investment in exploration, and major expenditures on research by governments led to the expansion of university departments and considerable growth in government organizations such as the GSC. Much of the present condition of mineral deposits research in Canada is seen in the light of this boom period. The 1990s saw a general downward trend in the profitability of the minerals industry, owing to lower metal prices, and a decline in government funding for mineral deposits research, the latter in response to fiscal restraint and redirection of funds away from regional development. Since then, major mining companies have consolidated operations and downsized.

Most companies have reduced exploration expenditures (especially in Canada), in some cases eliminating exploration groups and relying on junior companies to bring new discoveries to the development stage. As a result, funding for mineral deposits research by industry diminished rapidly. Junior companies, which rarely have the resources to fund research, have also been squeezed financially by the recent shift in venture capital from the mining industry to the technology sector.

NSERC's funding held steady during the early-to-mid 1990s, with a few notable "spikes" related to the appearance of several new research centres such as UBC's Mineral Deposit Research Unit (MDRU) and Laurentian Universitiy's Mineral Exploration Research Centre (MERC). Although NSERC's support of earth sciences has stabilized at about $46.5 million per year, in the last 5 years mineral deposits research has captured less than 1% of NSERC's total earth science funding: a proportion that does not compare favourably with the value of Canada's minerals and metal output. Individual operating grants account for about 40% of the total NSERC funding for mineral deposits research, but these tend to be small (median of $28K). A few large grants have received the majority of the funding. Because many of these major grants are held by senior faculty, a gradual decline in total funding for mineral deposits research can be expected as a result of retirements.

Geoscience Megaprojects

Despite the downturn in minerals-related research in the 1990s, two geoscience megaprojects, the Ocean Drilling Program (ODP) and Lithoprobe, were well funded and highly successful. In 1998-99, Lithoprobe and ODP attracted 10% of the total NSERC funding in the earth sciences ($4.6 million). These projects provided indirect benefits to mineral deposits researchers (*e.g.*, Lithoprobe

transects at the Buchans, Noranda, Matagami, and Selbaie volcanigenic massive sulphide camps, and the Sudbury and Thompson Ni-Cu-PGE districts; ODP Legs 139 and 169 at Middle Valley (Juan de Fuca Ridge), Leg 158 at TAG (Mid-Atlantic Ridge), and Leg 193 (Manus Basin) but were far broader in their overall scientific objectives. Such large projects create a legacy of geological information that, when properly archived, can be used for many years by a large cross section of the geoscience community. These projects also offer significant opportunities for training of highly qualified personnel with a strong multidisciplinary background (*e.g.*, so-called "Lithoprobe graduates"). Despite these benefits, similar large projects have never been proposed by the mineral deposits research community. Industry has participated in some of these mega-projects, but the considerable costs are beyond the financial capabilities of most mining companies.

Several suggestions for flagship projects or initiatives that could provide the new direction for mineral deposits research in Canada were introduced at the conference. These included a Lithoprobe-type project that would seek to develop integrated 3-D models of established or prospective mineral belts, a broader earth systems approach to minerals-related research, and a proposal for broad-based research in sustainable mineral resources development as discussed below. These ideas appealed to the "go big or go home" sense of some of the participants. However, in order to succeed in developing new projects at this large scale, a truly innovative approach is required to attract the support of the principal funding agencies.

NSERC's Collaborative Research Programs and Research Networks

A lack of collaboration between university researchers has been viewed as a major impediment to increased funding for mineral deposits studies in Canada. Thus, any future large-scale funding initiative must rely on increased networking of research groups across Canada. NSERC supports two approaches to networked research. The first is an NSERC-only solution, the Research Networks (RN) Program, which provides support in the low millions of dollars. A more ambitious approach is the Networks of Centres of Excellence (NCE) Program: NCE grants are competed for within all three of Canada's research granting councils (NSERC, Social Science and Health Research Council, Canadian Institutes of Health Research). Such networks are designed to provide major infrastructure and administrative support as well as research funding for complex, linked proposals that involve multi-sectoral collaborations on a set of common research themes. There are currently 18 funded NCEs (seven in health and biotechnology, eight in information technology, two in forestry and wood products, and one in aquaculture). The recently established NCE in Sustainable Forest Management was cited as a potential model for the minerals research community.

To develop an NCE requires identification of leading scientists to champion the proposal, securing consultants to craft the submission, and huge mobilization of academic, government and industry support. Success rate is low, but research support is in the tens of millions of dollars and can last for up to 14 years (7 years renewable). Research Networks (RNs) represent a more readily achievable goal, with a longer-term objective of linked RNs that might lead to the development of an NCE.

Canadian Mining Industry Research Organization (CAMIRO)

An important advance in the delivery of mineral deposits research in Canada has been the growth in multi-client research projects and increased efforts to match researchers with partners in the exploration and mining community. This function has been served in part by the Canadian Mining Industry Research Organization. CAMIRO (formerly MITEC) was created by industry to help develop innovative technologies and methods for the mining industry, with three divisions in exploration, mining, and metallurgy. The organization was modelled after the successful Australian Mineral Industry Research Association (AMIRA) but has been tailored to meet the unique demands of the Canadian mining industry. In 1999, CAMIRO had 27 member companies and administered 23 projects with a total value of $8.4 million (all divisions). This compares with the $44 million handled by AMIRA. CAMIRO is a much smaller organization (3.25 staff compared to 18 at AMIRA), which partly accounts for the sizable difference in the level of activity, but it is also clear that Australian companies are somewhat more accustomed to supporting collaborative research. This positive attitude towards research in Australia has been fostered by tax incentives, government programs, and a long history of successful industry-university collaboration. Despite these differences, support for multi-client research remains strong in Canada and will play a key role in any future programs. Some have suggested that the situation in Canada could be improved by bridging the gap between industry and universities in their views on research directions and job training, and by encouraging a stronger role for junior companies in CAMIRO.

An Industry Perspective on Mineral Deposits Research in Canada

The perspective of the mining industry was articulated with the simple observation that decreasing metal prices and a drive for efficiency have reduced available research funds overall and have increased competition for exploration funds from mining, mineral processing, and environmental sectors. An example was given of one major mining company with an annual budget of $150,000 to fund outside exploration-oriented research. The typical project funded by this company cost $10,000-20,000 per year for 2-3 years. With the available funds, the company can only support 3-4 new projects each year. These expenditures typically come from exploration budgets and therefore have a direct impact on the core activities of the companies involved. Few companies are able to support even this level of research, and ongoing mergers and acquisitions have reduced the number of companies with dedicated research programs. Industry tends to support mineral deposits research that is likely to produce applicable results in a relatively short time frame of 1-3 years. This time frame is not suited to pure science where applications of research may emerge over a much longer time

frame. The solution is to better integrate pure and applied science so that industry derives both short- and long-term benefits. The leverage that mining company research dollars can obtain by taking advantage of developments in other scientific fields (*e.g.*, sedimentary basin analysis and fluid flow modelling in the petroleum industry, high-resolution 3-D crustal imaging, and GIS/data integration) is of potential long-term importance to mining companies. Exploring these opportunities is viewed by industry as a high priority.

Most of the major mining companies and many juniors see mineral deposits research as a global activity — not strictly Canadian — in keeping with their increasingly global exploration interests. Accordingly, researchers, and especially supporting agencies, must broaden their approach from a predominantly Canadian perspective, which is no longer justifiable on economic or scientific grounds, to one that includes globally significant research problems.

The Situation in Australia

Since 1988 mineral deposits research in Australia has been dominated by research centres that were developed as part of a federal government initiative. The centres have involved more than 230 scientists and have focussed on key areas of research such as exploration geophysics, exploration geochemistry, tectonics, and ore deposits. Three types of research centres have been funded by government: Key Centres (A$0.5-0.8 million), Special Research Centres (A$0.8-1.2 million), and Co-operative Research Centres (A$2-4 million). The mineral deposits research centres include the Centre for Strategic Mineral Deposits at the University of Western Australia, the Economic Geology Research Unit (EGRU) at James Cook University, and the Centre for Ore Deposit Studies (CODES) at the University of Tasmania. In 1997, A$12.8 million in government funding was directed toward the research centres, representing 21% of total government spending on minerals geoscience. Industry provided about A$5.1 million, or 0.6% of total mineral exploration expenditures in Australia for 1997. The Australian Mineral Industry Research Association was already an established source of funding for minerals geoscience when the research centres were formed, and AMIRA become an integral part of the government-university-industry partnership that has made these centres a success.

The Australian Research Council (ARC) has promoted collaborative research in the centres, in part by keeping individual grant success rates to below 25%. Many quality researchers can only get funding by collaborating with larger groups located in the centres. ARC's strong role in establishing the research centres stems from the fact that post-secondary education in Australia is the mandate of the federal government rather than the individual state governments, as it is in Canada. For these reasons, it is questionable whether the Australian model could or should be imported to Canada.

The Concept of Sustainable Mineral Resource Development

Another topic that was explored at the NUNA conference was the concept of a national research initiative in sustainable mineral resources development. A Research Network proposal with this title is currently being prepared at the University of Alberta. The intent of the Network is to promote research that is focussed on improved efficiency in exploration, advancing new and emerging technologies for resource development, developing models for zero impact mining, and providing guidelines for effective mine closure and site rehabilitation.

The idea of co-ordinated research on sustainable mineral resources development captured the imagination of many of the participants, including industry representatives who felt that such a broad program might find stronger company support than one focussed only on mineral deposits research. Industry already provides strong support for research related to mineral processing and mine reclamation, which have a direct impact on the sustainability of the industry. Future mineral deposits research must also address sustainability, from the discovery of essential new resources and new commodities, to the reduced impact of mining on the environment, and improved management of mining lands. A strategy of focussed research on the sustainability of mining could lead to marketable "blueprints" for mineral resources development both in Canada and internationally. The Alberta-based network could serve as a pilot for a larger, national network involving researchers from across the country and in fields as diverse as mineral processing, mining engineering, environmental earth sciences, and human health. Sustainable development is also the focus of several new government- and industry-sponsored initiatives that highlight the vital importance of mineral resources to Canada's economy, and promote the need to develop these resources responsibly (*e.g.*, Mining Association of Canada's "Towards Sustainable Mining" and NRCan's "Sustainable Development Strategy": see www.mining.ca and www.nrcan.gc.ca/dmo/susdev). Strong federal backing for such programs is possible if industry and other groups push for their development at a national level, as was done for the Whitehorse Mining Initiative (see www.mining.ca/english/initiatives/whitehor.html).

POINTS OF CONSENSUS

A key question addressed at the conference was: how can mineral deposits researchers organize into an integrated community that will better address the needs of Canada's universities, industry, and governments and, at the same time, position itself to achieve greater support for scientific research? There was considerable debate on this question and a disparity of opinions in some cases, but the result was a constructive exchange of views. Although no votes were taken, general agreement was reached on a number of key points by a majority of the participants at the meeting. These are summarized below along with recommendations for improved integration of research activities among the three principal players in the mineral deposits research community, universities, industry, and government.

The Role of Universities

There was unanimous agreement that improved networking is required among university-based researchers to increase collaboration in project development, promote student exchange, and improve integration among different scientific disciplines. While many informal rela-

tionships already exist between groups, a formal network with the power to attract funding will be an essential first step in developing a new national strategy for mineral deposits research in Canada. Such networks would be most readily established within the framework of the Research Networks Program already supported by NSERC. Implicit in this program is financial assistance from both industry and governments at the corporate level, and an umbrella organization, such as CAMIRO, could play a vital role in co-ordinating and administering such support.

There was considerable discussion on the importance of "key centres." It is clear that research centres such as CODES and MDRU are effective places to carry out industry-supported research. Most of the major mining companies at the meeting were in favour of strong "full service" institutions, as a way of sustaining a critical mass of researchers at one site who are able to tackle diverse and complex problems related to mineral deposits. These centres attract top students and also provide the full range of earth science education that companies seek in new employees. Some researchers who responded to the Web-based questionnaire noted that while key centres are highly productive and are successful at raising the profile of minerals research nationally, there is a concern that expanded centres will attract more of the available funding and leave less support for smaller groups or individuals. However, the development of key centres such as MDRU has been supported mainly by new resources from the granting councils and has not affected the levels of funding for individual researchers. Because university researchers are widely dispersed across Canada, a strong national network, involving both key centres and individuals, offers the best opportunity for engaging the entire community. Such a network would support active roles for smaller universities by inclusion of high-quality researchers from institutions that otherwise might not have an opportunity to be involved in research centre activities. All participants at the meeting recognized the vital importance of curiosity-driven research to the science and to industry, and identifying parallel strategies for supporting non-centralized researchers will be essential for a fully networked program of mineral deposits research in Canada. Formal networking of university-based programs would also provide opportunities for innovative approaches to teaching, some of which are already being tested. Shared teaching between universities with complementary programs would help to offset challenged or declining capacities in some university departments. Perhaps most importantly, a strong research network would dramatically improve public (and political) awareness of the value of our research.

The Role of Industry

Long-term and stable support for mineral deposits research is essential for a healthy and sustainable industry, but the funding for this research cannot come from exploration budgets alone. Innovative funding strategies that make better use of in-kind contributions and that support parallel research in exploration, mineral extraction, and processing are essential. To achieve this goal, industry must take a longer term and broader view of research and must consider research to be a corporate responsibility, not just an exploration-related expenditure. At the same time, junior mining and exploration companies, which are critical to the discovery of many new resources, should become more engaged in research decisions, and a means of incorporating the needs of this sector must be developed (*e.g.*, as "non-paying" participants in CAMIRO-funded projects). Although junior mining companies tend not to support research financially, they are the prime users of new ideas and play a critical role in exploration. Increased communication and networking between industry and university-based researchers was also viewed as essential to maintain the high standing of Canadian mineral deposits research internationally, through better definition of research directions.

Organizations such as CAMIRO, PDAC, and the Mining Association of Canada (MAC) were seen as essential partners for developing new and innovative funding strategies and for encouraging more of the junior and medium-sized exploration and mining companies to participate in a national research program. While the participants appreciated that CAMIRO is a uniquely Canadian solution to marketing and co-ordinating industry-supported research, there was a strong voice for the expansion of its role through adoption of some of AMIRA's best practices. Most participants agreed that CAMIRO should co-operate more fully with AMIRA and other industry-supported centres to avoid duplication of effort. CAMIRO could also make improvements to the process of soliciting and evaluating proposals and assume a more active role in co-ordinating large-scale projects. Several major mining companies would like to see co-ordination of industry-directed research worldwide, under one roof. While there is a need for a Canadian organization to co-ordinate activities in Canada, there is also a strong demand for involvement of Canadian researchers in international projects. This demand could be served by a larger entity, perhaps linking activities between such organizations as CAMIRO and AMIRA.

The Role of Government

Opinions on the role of government in mineral deposits research varied widely. Some suggested that government should not compete with fundamental research at universities. But many agreed that government surveys are well-positioned to play a role in a future research network owing to their long history of integrating strategic mineral deposits research with regional mapping and camp-scale studies [*e.g.*, GSC's Exploration Science and Technology program (EXTECH), National Mapping Program (NATMAP), and Targeted Geoscience Initiatives (TGI)]. An increasing emphasis on regionally based, multidisciplinary research is considered to be an important development that could contribute to improved integration and planning of minerals-related research on a national scale. Combining programs like EXTECH and NATMAP, which involve co-ordinated mapping, technology development, and mineral deposits studies, would be viewed as a positive response by government to this demand. Similar conclusions were reached by the recent CGC review committee on the Minerals Geoscience Program of the GSC (*Geoscience Canada*, 2000, v. 27, n. 4).

The geological surveys maintain strong in-house geoscience expertise as a

basis for policy development on issues such as land-use, northern strategy, and sustainable communities, but they have also played a key role in the development of mineral deposits science in Canada. Major companies look to the surveys mainly for regional data to assist their geoscientists in selecting areas for exploration. These companies have the resources to investigate the data themselves, and they support internal and external research to augment interpretation of these data. However, junior companies, major players in Canada, and individual explorationists who lack financial resources, regularly seek additional input from government surveys including thematic research on ore deposits.

The conference attendees voiced a concern that some government surveys have lapsed in their support for student training in the geosciences. Government research projects commonly involve graduate students, and a majority of government scientists work closely with universities. Many hold adjunct appointments at universities to facilitate this collaboration. However, some government surveys are no longer viewed as a principal source of support for field-related undergraduate and graduate research projects. It was suggested that joint student employment programs with Human Resources Development Canada could do much to alleviate this growing problem.

A WAY FORWARD

Some of the questions addressed at NUNA 2001 were posed in a similar workshop in Toronto, nearly 20 years ago (Future Directions of Mineral Deposits Research in Canada). The Toronto conference recommended a number of solutions to problems that prevailed in mineral deposits research at the time (*e.g.*, need for a shift from commodity-based research to mineral deposit modelling), but the community is facing new difficulties today that were not as serious in the 1980s. The NUNA 2001 Kingston conference has resulted in a clear expression of interest among university, government, and industry groups to change the way mineral deposits research is carried out in Canada. Discussions arising from this forum have helped to identify the key building blocks of a new national strategy for mineral deposits research in Canada. These include:

- A formal network of university, industry, and government-based researchers and key centres that will improve communication and collaboration in the community;
- Innovative approaches to training and education among linked university departments, government surveys, and industry-based organizations;
- A strengthened role for the Canadian Mining Industry Research Organization in co-ordinating industry support for the network;
- A continuing role for government in facilitating networked research through multidisciplinary projects like EXTECH.

The organizing committee of NUNA 2001 has initiated a series of actions that we hope will lead us in this direction:

- Senior officers of NSERC, CGC, MAC, PDAC, and government departments will be briefed on the outcome of the conference.
- Conference presentations and workshop summaries will be released through GAC. It is hoped that this will develop into a Web page hosted by the Mineral Deposits Division of GAC (MDD).
- A Web-based, mineral deposits research directory will be established as a first step in the development of a national research network.
- A national committee of university, industry and government representatives will be established to solicit ideas and concepts for a formal network in mineral deposits research.
- In early 2002, a second conference will be held to begin developing a scientific proposal for the research network. It is anticipated that the timing of this proposal will position the community for possible participation in the next round of NCE competitions in 2004.

The development of a new national network in mineral deposits research will require strong commitment from university departments, supporting government agencies, and granting councils. An effective network cannot rely solely on the efforts of a few volunteers, simply to maintain Web site pages and print newsletters, but must have clear direction and structure as well as tangible support in the form of infrastructure and funding. It is the expectation of the committee that we are embarking on a multi-year process, the success or failure of which will depend on the efforts of the entire mineral deposits research community.

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